Horizon 2020

Call: H2020-EINFRA-2015-1

Topic: EINFRA-5-2015

Type of action: RIA

Proposal number: 675191

Proposal acronym: ESiWACE

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How to fill in the forms

The administrative forms must be filled in for each proposal using the templates available in the submission system. Some data fields in the administrative forms are pre-filled based on the previous steps in the submission wizard.

Proposal ID **675191** *Acronym* **ESiWACE**

1 - General information

Topic EINFRA-5-2015 Type of action RIA

Call identifier H2020-EINFRA-2015-1 Acronym ESiWACE

Proposal title* Excellence in SImulation of Weather and Climate in Europe

Note that for technical reasons, the following characters are not accepted in the Proposal Title and will be removed: < > " &

Duration in months *48*

Fixed keyword 1 *Computer sciences, information science and bioinformatics* Add

Free keywords *weather, climate, model optimizations, exa-scale, HPC, scalability, usability, exploitability, workflow, software governance*

Abstract

ESiWACE will substantially improve efficiency and productivity of numerical weather and climate simulation on high-performance computing platforms by supporting the end-to-end workflow of global Earth system modelling in HPC environment. This will be obtained by improving and supporting (1) scalability of models, tools and data management on state-of-the-art supercomputer systems (2) Usability of models and tools throughout the European HPC eco-system, and (3) the Exploitability of the huge amount of resulting data.
We will develop solutions for cross-cutting HPC challenges particular to the weather and climate domain. This will range from the development of specific software products to the deployment of user facing services for both, computing and storage.
ESiWACE leverages two established European networks, namely (1) the European Network for Earth System modelling, representing the European climate modelling community and (2) the world leading European Centre for Medium-Range Weather Forecasts. The governance structure that defines the services to be provided will be driven by the European weather and climate science community.
Weather and climate computing have always been one of the key drivers for HPC development, with domain specific scientific and technical requirements that stretch the capability and capacity of existing software and hardware to the limits. By developing solutions for Europe and at European scale, ESiWACE will directly impact on the competitiveness of the European HPC industry by engendering new products, providing opportunities for exploitation beyond the project itself, and by enhancing the skills base of staff in both industry and academia.
ESiWACE will be at once thematic, as it focuses on the HPC application domain of climate and weather modeling, transversal, as it covers several aspects of computational science, and challenge-driven, as climate and weather predictability represents a major societal issue.

Remaining characters 28

Has this proposal (or a very similar one) been submitted in the past 2 years in response to a call for proposals under the 7th Framework Programme, Horizon 2020 or any other EU programme(s)? ○ Yes ◉ No

Proposal ID **675191** *Acronym* **ESiWACE**

Declarations

1) The coordinator declares to have the explicit consent of all applicants on their participation and on the content of this proposal.	☒
2) The information contained in this proposal is correct and complete.	☒
3) This proposal complies with ethical principles (including the highest standards of research integrity — as set out, for instance, in the European Code of Conduct for Research Integrity — and including, in particular, avoiding fabrication, falsification, plagiarism or other research misconduct).	☒

4) The coordinator confirms:

- to have carried out the self-check of the financial capacity of the organisation on https://ec.europa.eu/research/participants/portal/desktop/en/organisations/lfv.html. Where the result was "weak" or "insufficient", the coordinator confirms being aware of the measures that may be imposed in accordance with the H2020 Grants Manual (Chapter on Financial capacity check); or	◉
- is exempt from the financial capacity check being a public body including international organisations, higher or secondary education establishment or a legal entity, whose viability is guaranteed by a Member State or associated country, as defined in the H2020 Grants Manual (Chapter on Financial capacity check); or	○
- as sole participant in the proposal is exempt from the financial capacity check.	○

5) The coordinator hereby declares that each applicant has confirmed:

- they are fully eligible in accordance with the criteria set out in the specific call for proposals; and	☒
- they have the financial and operational capacity to carry out the proposed action.	☒

The coordinator is only responsible for the correctness of the information relating to his/her own organisation. Each applicant remains responsible for the correctness of the information related to him and declared above. Where the proposal to be retained for EU funding, the coordinator and each beneficiary applicant will be required to present a formal declaration in this respect.

According to Article 131 of the Financial Regulation of 25 October 2012 on the financial rules applicable to the general budget of the Union (Official Journal L 298 of 26.10.2012, p. 1) and Article 145 of its Rules of Application (Official Journal L 362, 31.12.2012, p.1) applicants found guilty of misrepresentation may be subject to administrative and financial penalties under certain conditions.

Personal data protection

Your reply to the grant application will involve the recording and processing of personal data (such as your name, address and CV), which will be processed pursuant to Regulation (EC) No 45/2001 on the protection of individuals with regard to the processing of personal data by the Community institutions and bodies and on the free movement of such data. Unless indicated otherwise, your replies to the questions in this form and any personal data requested are required to assess your grant application in accordance with the specifications of the call for proposals and will be processed solely for that purpose. Details concerning the processing of your personal data are available on the privacy statement. Applicants may lodge a complaint about the processing of their personal data with the European Data Protection Supervisor at any time.

Your personal data may be registered in the Early Warning System (EWS) only or both in the EWS and Central Exclusion Database (CED) by the Accounting Officer of the Commission, should you be in one of the situations mentioned in:
-the Commission Decision 2008/969 of 16.12.2008 on the Early Warning System (for more information see the Privacy Statement), or
-the Commission Regulation 2008/1302 of 17.12.2008 on the Central Exclusion Database (for more information see the Privacy Statement) .

Proposal ID **675191** *Acronym* **ESiWACE**

2 - Administrative data of participating organisations

PIC	***Legal name***
998692310	*DEUTSCHES KLIMARECHENZENTRUM GMBH*

Short name: DKRZ

Address of the organisation

Street BUNDESSTRASSE 45A

Town HAMBURG

Postcode 20146

Country Germany

Webpage http:/www.dkrz.de

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes
Non-profit ..... yes
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... no
Research organisation ..... yes
Small and Medium-sized Enterprises (SMEs) ..... no

Legal person ..... yes

Nace code 721 -

Proposal ID **675191** *Acronym* **ESiWACE**

Department(s) carrying out the proposed work

Department 1

Department name: Applications

☒ Same as organisation address

Street: BUNDESSTRASSE 45A

Town: HAMBURG

Postcode: 20146

Country: Germany

Dependencies with other proposal participants

Character of dependence	***Participant***	
Controls	MAX PLANCK GESELLSCHAFT ZUR FOERDERUNG DER WISSENSCHAFTEN	

Proposal ID **675191** *Acronym* **ESiWACE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr. Sex: ○ Male ◉ Female

First name: **Kerstin** Last name: **Fieg**

E-Mail: **fieg@dkrz.de**

Position in org.: Scientist - Applications

Department: *Please indicate the department of the Contact Point above in the organisation*

☒ Same as organisation address

Street: BUNDESSTRASSE 45A

Town: HAMBURG Post code: 20146

Country: Germany

Website:

Phone: +4940460094137 Phone 2: *+xxx xxxxxxxxx* Fax: +4940460094270

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Joachim	Biercamp	biercamp@dkrz.de	+4940460094314
Sonja	Kempe	kempe@dkrz.de	+4940460094105
Katja	Brendt	brendt@dkrz.de	+4940460094415
Chiara	Bearzotti	chiara.bearzotti@gmail.com	

Proposal ID **675191** *Acronym* **ESiWACE**

PIC	***Legal name***
999916741	*EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS*

Short name: ECMWF

Address of the organisation

Street SHINFIELD PARK

Town READING

Postcode RG2 9AX

Country United Kingdom

Webpage www.ecmwf.int

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes
Non-profit ..... yes
International organisation ..... yes
International organisation of European interest ..... yes
Secondary or Higher education establishment ..... no
Research organisation ..... yes
Small and Medium-sized Enterprises (SMEs) ..... no

Legal person ..... yes

Nace code - Not applicable

Proposal ID **675191** *Acronym* **ESiWACE**

Department(s) carrying out the proposed work

Department 1

Department name	Research Department
	☒ Same as organisation address
Street	SHINFIELD PARK
Town	READING
Postcode	RG2 9AX
Country	United Kingdom

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **675191** *Acronym* **ESiWACE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr. Sex: (•) Male ( ) Female

First name: **Peter** Last name: **Bauer**

E-Mail: **peter.bauer@ecmwf.int**

Position in org.: Head of Model Division

Department: Research Department

☒ Same as organisation address

Street: SHINFIELD PARK

Town: READING Post code: RG2 9AX

Country: United Kingdom

Website: www.ecmwf.int

Phone: +44 118 9499080 Phone 2: *+xxx xxxxxxxxx* Fax: +44 118 9869450

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Adam	Zonic	adam.zonic@ecmwf.int	+44 118 9499211
Rebecca	Calnan	rebecca.calnan@ecmwf.int	+44 118 9499418

Proposal ID **675191** *Acronym* **ESiWACE**

PIC	***Legal name***
999997930	*CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE*

Short name: CNRS-IPSL

Address of the organisation

Street Rue Michel -Ange 3

Town PARIS

Postcode 75794

Country France

Webpage www.cnrs.fr

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes
Non-profit ..... yes
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... no
Research organisation ..... yes
Small and Medium-sized Enterprises (SMEs) ..... no

Legal person ..... yes

Nace code 721 -

Proposal ID **675191** *Acronym* **ESiWACE**

Department(s) carrying out the proposed work

Department 1

Department name	IPSL/ Laboratoire des Sciences du Climat et de l'Environnement
	☐ Same as organisation address
Street	Orme des Merisiers, Bat 712, CE Saclay
Town	Gif sur Yvette
Postcode	91191
Country	France

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **675191** *Acronym* **ESiWACE**

Person in charge of the proposal

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Title: Dr. Sex: ○ Male ◉ Female

First name: **Sylvie** Last name: **Joussaume**

E-Mail: **sylvie.joussaume@lsce.ipsl.fr**

Position in org.: Directeur de Recherche au CNRS

Department: IPSL/ Laboratoire des Sciences du Climat et de l'Environnement

☐ Same as organisation address

Street: Orme des Merisiers, Bat 712, CE Saclay

Town: Gif sur Yvette Post code: 91191

Country: France

Website:

Phone: +33169085674 Phone 2: +xxx xxxxxxxxx Fax: +xxx xxxxxxxxx

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Francesca	Guglielmo	francesca.guglielmo@lsce.ipsl.fr	
Marie	Parinet	marie.parinet@lsce.ipsl.fr	
Philippe	Cavelier	spv@dr5.cnrs.fr	
Nizar	Larabi	nizar.larabi@cnrs.fr	+33145075301

Proposal ID **675191** *Acronym* **ESiWACE**

PIC	***Legal name***
999990267	*MAX PLANCK GESELLSCHAFT ZUR FOERDERUNG DER WISSENSCHAFTEN E.V.*

Short name: MPG

Address of the organisation

Street Hofgartenstrasse 8

Town MUENCHEN

Postcode 80539

Country Germany

Webpage www.mpg.de

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... no
Non-profit ..... yes
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... no
Research organisation ..... yes
Small and Medium-sized Enterprises (SMEs) ..... no

Legal person ..... yes

Nace code 721 -

Proposal ID **675191** *Acronym* **ESiWACE**

Department(s) carrying out the proposed work

Department 1

Department name	Max-Planck-Institute für Meteorologie
	☐ Same as organisation address
Street	Bundesstraße 53
Town	Hamburg
Postcode	20146
Country	Germany

Dependencies with other proposal participants

Character of dependence	***Participant***	
Controls	DEUTSCHES KLIMARECHENZENTRUM GMBH	

Proposal ID **675191** *Acronym* **ESiWACE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Mr. Sex: (•) Male ( ) Female

First name: **Reinhard** Last name: **Budich**

E-Mail: **reinhard.budich@mpimet.mpg.de**

Position in org.: Strategic IT Partnerships, SIP

Department: Max-Planck-Institut für Meteorologie

[ ] Same as organisation address

Street: Bundesstraße 53

Town: Hamburg Post code: 20146

Country: Germany

Website: http://mpimet.mpg.de/

Phone: +494041173369 Phone 2: +xxx xxxxxxxxx Fax: +xxx xxxxxxxxx

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Chiara	Bearzotti	chiara.bearzotti@vw.mpimet.mpg.de	
Martina	Boether	martina.boether@mpimet.mpg.de	

Proposal ID **675191** *Acronym* **ESiWACE**

PIC	***Legal name***
999940118	*CENTRE EUROPEEN DE RECHERCHE ET DE FORMATION AVANCEE EN CALCUL SCIENTIFIQU*

Short name: CERFACS

Address of the organisation

Street Avenue Gaspard Coriolis 42

Town TOULOUSE

Postcode 31057

Country France

Webpage www.cerfacs.fr

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... no
Non-profit ..... no
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... no
Research organisation ..... no
Small and Medium-sized Enterprises (SMEs) ..... no

Legal person ..... yes

Nace code - Not applicable

Proposal ID **675191** *Acronym* **ESiWACE**

Department(s) carrying out the proposed work

Department 1

Department name: Climate Modelling and Global Change team

☒ Same as organisation address

Street: Avenue Gaspard Coriolis 42

Town: TOULOUSE

Postcode: 31057

Country: France

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **675191** *Acronym* **ESiWACE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr. Sex: ○ Male ◉ Female

First name: **Sophie** Last name: **Valcke**

E-Mail: **sophie.valcke@cerfacs.fr**

Position in org.: Research Engineer

Department: Climate Modelling and Global Change team

☒ Same as organisation address

Street: Avenue Gaspard Coriolis 42

Town: TOULOUSE Post code: 31057

Country: France

Website:

Phone: +33561193076 Phone 2: +xxx xxxxxxxxx Fax: +xxx xxxxxxxxx

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Dominique	Roffi	roffi@cerfacs.fr	
Michele	Campassens	campasse@cerfacs.fr	

Proposal ID **675191** *Acronym* **ESiWACE**

PIC	***Legal name***
999655520	*BARCELONA SUPERCOMPUTING CENTER - CENTRO NACIONAL DE SUPERCOMPUTACION*

Short name: BSC

Address of the organisation

Street Calle Jordi Girona 31

Town BARCELONA

Postcode 08034

Country Spain

Webpage www.bsc.es

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes
Non-profit ..... yes
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... no
Research organisation ..... yes
Small and Medium-sized Enterprises (SMEs) ..... no

Legal person ..... yes

Nace code 72 - Computer & related activities

Proposal ID **675191** *Acronym* **ESiWACE**

Department(s) carrying out the proposed work

Department 1

Department name: Earth Sciences Department

☐ Same as organisation address

Street: C. Jordi Girona 29

Town: Barcelona

Postcode: 08034

Country: Spain

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **675191** *Acronym* **ESiWACE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Prof. Sex: (•) Male ( ) Female

First name: **Francisco** Last name: **Doblas-Reyes**

E-Mail: **francisco.doblas-reyes@ic3.cat**

Position in org.: Department Director

Department: Earth Sciences Department

[ ] Same as organisation address

Street: C. Jordi Girona 29

Town: Barcelona Post code: 08034

Country: Spain

Website: http://www.bsc.es/earth-sciences

Phone: +34934137719 Phone 2: +34934137525 Fax: +34934137722

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Oriol	Mula-Valls	oriol.mula-valls@ic3.cat	+34935679977
Oriol	Pineda	oriol.pineda@bsc.es	+34934137525
Kim	Serradell	kim.serradell@bsc.es	
Domingo	Manubens	domingo.manubens@ic3.cat	

Proposal ID **675191** *Acronym* **ESiWACE**

PIC	***Legal name***
999980179	*SCIENCE AND TECHNOLOGY FACILITIES COUNCIL*

Short name: STFC

Address of the organisation

Street Polaris House North Star Avenue

Town SWINDON

Postcode SN2 1SZ

Country United Kingdom

Webpage www.scitech.ac.uk

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes

Non-profit ..... yes

International organisation ..... no

International organisation of European interest ..... no

Secondary or Higher education establishment ..... no

Research organisation ..... yes

Small and Medium-sized Enterprises (SMEs) ..... no

Legal person ..... yes

Nace code

Proposal ID **675191** *Acronym* **ESiWACE**

Department(s) carrying out the proposed work

Department 1

Department name	Centre for Environmental Data Archival
	☒ Same as organisation address
Street	Polaris House North Star Avenue
Town	SWINDON
Postcode	SN2 1SZ
Country	United Kingdom

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **675191** *Acronym* **ESiWACE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr. Sex: (•) Male ( ) Female

First name: **Jens** Last name: **Jensen**

E-Mail: **jens.jensen@stfc.ac.uk**

Position in org.: Director of the Centre for Environmental Data Archival

Department: Centre for Environmental Data Archival

☒ Same as organisation address

Street: Polaris House North Star Avenue

Town: SWINDON Post code: SN2 1SZ

Country: United Kingdom

Website:

Phone: Phone 2: *+xxx xxxxxxxxx* Fax: *+xxx xxxxxxxxx*

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Bryan	Lawrence	bryan.lawrence@ncas.ac.uk	

Proposal ID **675191** *Acronym* **ESiWACE**

PIC	***Legal name***
999892685	*MET OFFICE*

Short name: METO

Address of the organisation

Street FitzRoy Road

Town EXETER

Postcode EX1 3PB

Country United Kingdom

Webpage www.metoffice.gov.uk

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes
Non-profit ..... no
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... no
Research organisation ..... no
Small and Medium-sized Enterprises (SMEs) ..... no

Legal person ..... yes

Nace code - Not applicable

Proposal ID **675191** *Acronym* **ESiWACE**

Department(s) carrying out the proposed work

Department 1

Department name	IT
	☒ Same as organisation address
Street	FitzRoy Road
Town	EXETER
Postcode	EX1 3PB
Country	United Kingdom

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **675191** *Acronym* **ESiWACE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr. Sex: (•) Male ( ) Female

First name: **David** Last name: **Matthews**

E-Mail: **david.matthews@metoffice.gov.uk**

Position in org.: IT Manager

Department: *Please indicate the department of the Contact Point above in the organisation*

☒ Same as organisation address

Street: FitzRoy Road

Town: EXETER Post code: EX1 3PB

Country: United Kingdom

Website:

Phone: Phone 2: *+xxx xxxxxxxxx* Fax: *+xxx xxxxxxxxx*

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Katie	Herring	katie.herring@metoffice.gov.uk	
Mick	Carter	mick.carter@metoffice.gov.uk	

Proposal ID **675191** *Acronym* **ESiWACE**

PIC	***Legal name***
999984156	*THE UNIVERSITY OF READING*

Short name: UREAD

Address of the organisation

Street WHITEKNIGHTS CAMPUS WHITEKNIGHTS H

Town READING

Postcode RG6 6AH

Country United Kingdom

Webpage http://www.rdg.ac.uk

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes

Non-profit ..... yes

International organisation ..... no

International organisation of European interest ..... no

Secondary or Higher education establishment ..... yes

Research organisation ..... yes

Small and Medium-sized Enterprises (SMEs) ..... no

Legal person ..... yes

Nace code - Not applicable

Proposal ID **675191** *Acronym* **ESiWACE**

Department(s) carrying out the proposed work

Department 1

Department name	National Centre for Atmospheric Science, Department of Meteorolog
	☐ Same as organisation address
Street	Early Gate
Town	Reading
Postcode	RG66BB
Country	United Kingdom

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **675191** *Acronym* **ESiWACE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr. Sex: (•) Male ( ) Female

First name: **Grenville** Last name: **Lister**

E-Mail: **g.m.s.lister@reading.ac.uk**

Position in org.: Computational Scientist

Department: National Centre for Atmospheric Science Department of Meteorology

[ ] Same as organisation address

Street: Early Gate

Town: Reading Post code: RG66BB

Country: United Kingdom

Website:

Phone: +441183787995 Phone 2: +xxx xxxxxxxxx Fax: +xxx xxxxxxxxx

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Pier Luigi	Vidale	p.l.vidale@reading.ac.uk	
Nicola	Bray	n.d.bray@reading.ac.uk	
Anna	Macey	a.i.macey@reading.ac.uk	
Mischa	Phillips	m.phillips@reading.ac.uk	

Proposal ID **675191** *Acronym* **ESiWACE**

PIC	***Legal name***
999507983	*SVERIGES METEOROLOGISKA OCH HYDROLOGISKA INSTITUT*

Short name: SMHI

Address of the organisation

Street Folkborgsvaegen 1

Town NORRKOEPING

Postcode 601 76

Country Sweden

Webpage www.smhi.se

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes

Non-profit ..... yes

International organisation ..... no

International organisation of European interest ..... no

Secondary or Higher education establishment ..... no

Research organisation ..... no

Small and Medium-sized Enterprises (SMEs) ..... no

Legal person ..... yes

Nace code L - Public administration & defence

Proposal ID **675191** *Acronym* **ESiWACE**

Department(s) carrying out the proposed work

Department 1

Department name	Research Department, Rossby Center
	☒ Same as organisation address
Street	Folkborgsvaegen 1
Town	NORRKOEPING
Postcode	601 76
Country	Sweden

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **675191** *Acronym* **ESiWACE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr. Sex: (•) Male ( ) Female

First name: **Uwe** Last name: **Fladrich**

E-Mail: **uwe.fladrich@smhi.se**

Position in org.: Scientific Software Developer

Department: Research Department, Rossby Center

☒ Same as organisation address

Street: Folkborgsvaegen 1

Town: NORRKOEPING Post code: 601 76

Country: Sweden

Website: www.smhi.se

Phone: +46114958351 Phone 2: +46114958000 Fax: +xxx xxxxxxxxx

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Monica	Wallgren	monica.wallgren@smhi.se	+46114958104

Proposal ID **675191** *Acronym* **ESiWACE**

PIC	***Legal name***
999978045	*NATIONAL UNIVERSITY OF IRELAND, GALWAY*

Short name: ICHEC

Address of the organisation

Street UNIVERSITY ROAD

Town GALWAY

Postcode

Country Ireland

Webpage www.nuigalway.ie

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes
Non-profit ..... yes
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... yes
Research organisation ..... no
Small and Medium-sized Enterprises (SMEs) ..... no

Legal person ..... yes

Nace code - Not applicable

Proposal ID **675191** *Acronym* **ESiWACE**

Department(s) carrying out the proposed work

Department 1

Department name	Irish Centre for High End Computing
	☐ Same as organisation address
Street	IT302, IT Building, NUI Galway
Town	Galway
Postcode	000000
Country	Ireland

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **675191** *Acronym* **ESiWACE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr. Sex: (•) Male ( ) Female

First name: **Alastair** Last name: **McKinstry**

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Position in org.: Environmental Sciences Activity Leader

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Country: Ireland

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Other contact persons

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Proposal ID **675191** *Acronym* **ESiWACE**

PIC	***Legal name***
999419422	*CENTRO EURO-MEDITERRANEO SUI CAMBIAMENTI CLIMATICI SCARL*

Short name: CMCC

Address of the organisation

Street VIA A IMPERATORE 16

Town LECCE

Postcode 73100

Country Italy

Webpage www.cmcc.it

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... no
Non-profit ..... yes
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... no
Research organisation ..... yes
Small and Medium-sized Enterprises (SMEs) ..... no

Legal person ..... yes

Nace code 721 -

Proposal ID **675191** *Acronym* **ESiWACE**

Department(s) carrying out the proposed work

Department 1

Department name	ASC - Advanced Scientific Computing division
	☐ Same as organisation address
Street	Via per Monteroni
Town	Lecce
Postcode	73100
Country	Italy

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **675191** *Acronym* **ESiWACE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Prof. Sex: (•) Male ( ) Female

First name: **Giovanni** Last name: **Aloisio**

E-Mail: **giovanni.aloisio@unisalento.it**

Position in org.: ASC Division Director

Department: ASC - Advanced Scientific Computing Division

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Other contact persons

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Proposal ID **675191** *Acronym* **ESiWACE**

PIC	***Legal name***
998059094	*DEUTSCHER WETTERDIENST*

Short name: DWD

Address of the organisation

Street FRANKFURTER STRASSE 135

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Postcode 63067

Country Germany

Webpage http://www.dwd.de

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes
Non-profit ..... yes
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... no
Research organisation ..... yes
Small and Medium-sized Enterprises (SMEs) ..... no

Legal person ..... yes

Nace code - Not applicable

Proposal ID **675191** *Acronym* **ESiWACE**

Department(s) carrying out the proposed work

Department 1

Department name	Research and Development, Department FE 1 (Meteorological Analysi
	☒ Same as organisation address
Street	FRANKFURTER STRASSE 135
Town	OFFENBACH AM MAIN
Postcode	63067
Country	Germany

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **675191** *Acronym* **ESiWACE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr. Sex: (•) Male ( ) Female

First name: **Florian** Last name: **Prill**

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Proposal ID **675191** *Acronym* **ESiWACE**

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999728076	*SEAGATE SYSTEMS UK LIMITED*

Short name: SEAGATE

Address of the organisation

Street LANGSTONE ROAD

Town HAVANT

Postcode PO9 1SA

Country United Kingdom

Webpage

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... no

Non-profit ..... no

International organisation ..... no

International organisation of European interest ..... no

Secondary or Higher education establishment ..... no

Research organisation ..... no

Small and Medium-sized Enterprises (SMEs) ..... no

Legal person ..... yes

Nace code 2620 -

Proposal ID **675191** *Acronym* **ESiWACE**

Department(s) carrying out the proposed work

Department 1

Department name	CSS Emerging Technology
	☒ Same as organisation address
Street	LANGSTONE ROAD
Town	HAVANT
Postcode	PO9 1SA
Country	United Kingdom

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **675191** *Acronym* **ESiWACE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Mr. Sex: (•) Male ( ) Female

First name: **Malcolm** Last name: **Muggeridge**

E-Mail: **malcolm.muggeridge@seagate.com**

Position in org.: Sr Director Engineering

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☒ Same as organisation address

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Website:

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Other contact persons

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Proposal ID **675191** *Acronym* **ESiWACE**

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996058081	*Bull SAS*

Short name: Bull

Address of the organisation

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Town LES CLAYES SOUS BOIS

Postcode 78340

Country France

Webpage www.bull.com

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... no
Non-profit ..... no
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... no
Research organisation ..... no
Small and Medium-sized Enterprises (SMEs) ..... no

Legal person ..... yes

Nace code 72 - Computer & related activities

Proposal ID **675191** *Acronym* **ESiWACE**

Department(s) carrying out the proposed work

Department 1

Department name	Bull BDS - Center for Excellence in Parallel Programming
	☐ Same as organisation address
Street	1, rue de Provence
Town	Echirolles
Postcode	38432
Country	France

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **675191** *Acronym* **ESiWACE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr. Sex: (•) Male ( ) Female

First name: **Xavier** Last name: **Vigouroux**

E-Mail: **xavier.vigouroux@bull.net**

Position in org.: Director of Center for Excellence in Parallel Programming

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Proposal ID **675191** *Acronym* **ESiWACE**

PIC	***Legal name***
969276478	*ALLINEA SOFTWARE LIMITED*

Short name: ALLINEA

Address of the organisation

Street WARWICK TECHNOLOGY PARK

Town WARWICK

Postcode CV34 6UW

Country United Kingdom

Webpage www.allinea.com

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... no
Non-profit ..... no
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... no
Research organisation ..... no
Small and Medium-sized Enterprises (SMEs) ..... yes

Legal person ..... yes

Nace code 72 - Computer & related activities

Proposal ID **675191** *Acronym* **ESiWACE**

Department(s) carrying out the proposed work

Department 1

Department name: Allinea

☒ Same as organisation address

Street: WARWICK TECHNOLOGY PARK

Town: WARWICK

Postcode: CV34 6UW

Country: United Kingdom

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **675191** *Acronym* **ESiWACE**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr. Sex: (•) Male ( ) Female

First name: **Jacques** Last name: **PHILOUZE**

E-Mail: **jacques@allinea.com**

Position in org.: Manager

Department: *Please indicate the department of the Contact Point above in the organisation*

☒ Same as organisation address

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Town: WARWICK Post code: CV34 6UW

Country: United Kingdom

Website:

Phone: Phone 2: *+xxx xxxxxxxxx* Fax: *+xxx xxxxxxxxx*

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
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Proposal ID **675191** *Acronym* **ESiWACE**

3 - Budget for the proposal

Participant	Country	(A) Direct personnel costs/€	(B) Other direct costs/€	(C) Direct costs of sub-contracting/€	(D) Direct costs of providing financial support to third parties/€	(E) Costs of inkind contributions not used on the beneficiary's premises/€	(F) Indirect Costs / € (=0.25(A+B-E))	(G) Special unit costs covering direct & indirect costs / €	(H) Total estimated eligible costs / € (=A+B+C+D+F+G)	(I) Reimburse-ment rate (%)	(J) Max. grant / € (=H*I)	(K) Requested grant / €
DKRZ	DE	654 600	225 600	0	0	0	220 050	0	1 100 250	100	1 100 250	1 100 250
ECMWF	UK	552 544	35 600	0	0	0	147 036	0	735 180	100	735 180	735 180
CNRS-IPSL	FR	353 331	27 300	0	0	0	95 158	0	475 789	100	475 789	475 789
MPG	DE	163 300	58 100	0	0	0	55 350	0	276 750	100	276 750	276 750
CERFACS	FR	180 000	27 000	0	0	0	51 750	0	258 750	100	258 750	258 750
BSC	ES	198 000	17 800	0	0	0	53 950	0	269 750	100	269 750	269 750
STFC	UK	260 172	16 400	0	0	0	69 143	0	345 715	100	345 715	345 715
METO	UK	277 590	35 300	0	0	0	78 223	0	391 113	100	391 113	391 113
UREAD	UK	39 000	6 000	0	0	0	11 250	0	56 250	100	56 250	56 250
SMHI	SE	142 800	12 900	0	0	0	38 925	0	194 625	100	194 625	194 625

Proposal ID **675191** *Acronym* **ESiWACE**

Participant	Country	(A) Direct personnel costs/€	(B) Other direct costs/€	(C) Direct costs of sub-contracting/€	(D) Direct costs of providing financial support to third parties/€	(E) Costs of inkind contributions not used on the beneficiary's premises/€	(F) Indirect Costs / € (=0.25(A+B-E))	(G) Special unit costs covering direct & indirect costs / €	(H) Total estimated eligible costs / € (=A+B+C+D+F+G)	(I) Reimburse-ment rate (%)	(J) Max. grant / € (=H*I)	(K) Requested grant / €
ICHEC	IE	40 038	6 000	0	0	0	11 510	0	57 548	100	57 548	57 548
CMCC	IT	203 000	29 100	0	0	0	58 025	0	290 125	100	290 125	290 125
DWD	DE	0	16 500	0	0	0	4 125	0	20 625	100	20 625	20 625
SEAGATE	UK	136 044	13 400	0	0	0	37 361	0	186 805	100	186 805	186 805
Bull	FR	179 520	7 400	0	0	0	46 730	0	233 650	100	233 650	233 650
ALLINEA	UK	40 500	6 000	0	0	0	11 625	0	58 125	100	58 125	58 125
Total		3 420 439	540 400	0	0	0	990 211	0	4 951 050		4 951 050	4 951 050

Proposal ID **675191** *Acronym* **ESiWACE**

4 - Ethics issues table

1. HUMAN EMBRYOS/FOETUSES		Page
Does your research involve Human Embryonic Stem Cells (hESCs)?	○ Yes ◉ No	
Does your research involve the use of human embryos?	○ Yes ◉ No	
Does your research involve the use of human foetal tissues / cells?	○ Yes ◉ No	
2. HUMANS		**Page**
Does your research involve human participants?	○ Yes ◉ No	
Does your research involve physical interventions on the study participants?	○ Yes ◉ No	
Does it involve invasive techniques?	○ Yes ◉ No	
3. HUMAN CELLS / TISSUES		**Page**
Does your research involve human cells or tissues (other than from Human Embryos/ Foetuses, i.e. section 1)?	○ Yes ◉ No	
4. PERSONAL DATA (ii)		**Page**
Does your research involve personal data collection and/or processing?	○ Yes ◉ No	
Does your research involve further processing of previously collected personal data (secondary use)?	○ Yes ◉ No	
5. ANIMALS (iii)		**Page**
Does your research involve animals?	○ Yes ◉ No	

Proposal ID **675191** *Acronym* **ESiWACE**

6. THIRD COUNTRIES		Page
Does your research involve non-EU countries?	○ Yes ◉ No	
Do you plan to use local resources (e.g. animal and/or human tissue samples, genetic material, live animals, human remains, materials of historical value, endangered fauna or flora samples, etc.)? (v)	○ Yes ◉ No	
Do you plan to import any material from non-EU countries into the EU? *For data imports, please fill in also section 4.* *For imports concerning human cells or tissues, fill in also section 3.*	○ Yes ◉ No	
Do you plan to export any material from the EU to non-EU countries? *For data exports, please fill in also section 4.* *For exports concerning human cells or tissues, fill in also section 3.*	○ Yes ◉ No	
If your research involves low and/or lower middle income countries, are benefits-sharing measures foreseen? (vii)	○ Yes ◉ No	
Could the situation in the country put the individuals taking part in the research at risk?	○ Yes ◉ No	
7. ENVIRONMENT & HEALTH and SAFETY See legal references at the end of the section. (vi)		Page
Does your research involve the use of elements that may cause harm to the environment, to animals or plants? *For research involving animal experiments, please fill in also section 5.*	○ Yes ◉ No	
Does your research deal with endangered fauna and/or flora and/or protected areas?	○ Yes ◉ No	
Does your research involve the use of elements that may cause harm to humans, including research staff? *For research involving human participants, please fill in also section 2.*	○ Yes ◉ No	
8. DUAL USE (vii)		Page
Does your research have the potential for military applications?	○ Yes ◉ No	
9. MISUSE		Page
Does your research have the potential for malevolent/criminal/terrorist abuse?	○ Yes ◉ No	
10. OTHER ETHICS ISSUES		Page
Are there any other ethics issues that should be taken into consideration? Please specify	○ Yes ◉ No	

I confirm that I have taken into account all ethics issues described above and that, if any ethics issues apply, I will complete the ethics self-assessment and attach the required documents. ☒

Proposal ID **675191** *Acronym* **ESiWACE**

5 - Call specific questions

Open Research Data Pilot in Horizon 2020

If selected, all applicants will participate in the Pilot on Open Research Data in Horizon 2020[1] , which aims to improve and maximise access to and re-use of research data generated by actions. Participating in the Pilot does not necessarily mean opening up all research data. Actions participating in the Pilot will be invited to formulate a Data Management Plan in which they will determine and explain which of the research data they generate will be made open.

Applicants have the possibility to opt out of this Pilot and must indicate a reason for this choice.

Participation in this Pilot does not constitute part of the evaluation process. Proposals will not be evaluated favourably because they are part of the Pilot and will not be penalised for opting out of the Pilot.

We wish to opt out of the Pilot on Open Research Data in Horizon 2020.	○ Yes	◉ No

[1] *According to article 43.2 of Regulation (EU) No 1290/2013 of the European Parliament and of the Council, of 11 December 2013, laying down the rules for participation and dissemination in "Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020)" and repealing Regulation (EC) No 1906/2006.*

Data management activities

The use of a Data Management Plan (DMP) is required for projects participating in the Open Research Data Pilot in Horizon 2020, in the form of a deliverable in the first 6 months of the project.

All other projects may deliver a DMP on a voluntary basis, if relevant for their research.

Are data management activities relevant for your proposed project?	◉ Yes	○ No

A Data Management Plan will be delivered (Please note: Projects participating in the Open Research Data Pilot **must** include a Data Management Plan as a deliverable in the first 6 months of the project).	☒
Data Management is part of a Work Package.	☒
Data Management will be integrated in another way.	☐

Centre of
Excellence in **S**imulation of **W**eather **a**nd **C**limate in **E**urope

Technical Annex Sections 1-3 of Proposal for:

Horizon2020 Work Programme 2014-2015, European research infrastructures

Call:	e-Infrastructures
Topic:	EINFRA-5-2015: Centres of excellence for computing applications
Acronym:	ESiWACE
Proposal title:	Excellence in Simulation of Weather and Climate in Europe
Type of action:	Research and Innovation Action

List of participants

Nr	Participant organisation name	Acronym	Country
1	Deutsches Klimarechenzentrum GmbH **COORDINATOR**	DKRZ	Germany
2	European Centre for Medium-Range Weather Forecasts	ECMWF	United Kingdom
3	Centre National de la Recherche Scientifique	CNRS-IPSL	France
4	Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V. / Max-Planck-Institut für Meteorologie	MPG	Germany
5	Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique	CERFACS	France
6	Barcelona Supercomputing Center	BSC	Spain
7	Science and Technology Facilities Council	STFC	United Kingdom
8	Met Office	MetO	United Kingdom
9	The University of Reading	UREAD	United Kingdom
10	Sveriges meteorologiska och hydrologiska institut	SMHI	Sweden
11	National University of Ireland Galway (Irish Centre for High End Computing)	ICHEC	Ireland
12	Centro europeo-mediterraneo sui cambiamenti climatici scarl	CMCC	Italy
13	Deutscher Wetterdienst	DWD	Germany
14	Seagate Systems UK Limited	SEAGATE	United Kingdom
15	BULL SAS	BULL	France
16	Allinea Software Limited	ALLINEA	United Kingdom

TABLE OF CONTENTS

1 EXCELLENCE

Numerical weather prediction and climate modelling are highly dependent on the available computing power in terms of the achievable spatial resolution, the number of members run in ensemble simulations as well as the completeness of physical processes that can be represented. Both domains are also highly dependent on the ability to produce, store and analyse large amounts of simulated data, often with time constraints from operational schedules or international coordinated experiments. The ever increasing complexity of both numerical models and high performance computing (HPC) systems has led to the situation that today, one major limiting factor is no longer the theoretical peak performance of available HPC systems, but the relatively low sustained efficiency that can be obtained with complex numerical models of the Earth system.

The differences in model complexity as well as the temporal and spatial scales that were historically characteristic for climate and weather modelling are vanishing since both applications ultimately require complex Earth system modelling capabilities which resolve the same physical process detail across atmosphere, ocean, cryosphere and biosphere. With increasing compute power and data handling needs, both communities must exploit synergies to tackle common scientific and technical challenges. A joint climate and weather community engagement in research and service provision is urgently required and timely given the substantial societal investment in European wide infrastructures through the Copernicus services that are coordinated and managed by the European Commission.

ESiWACE will deliver the required research and services through leveraging two established European networks, namely (1) the European Network for Earth System modelling (ENES), representing the European climate modelling community contributing to the internationally coordinated experiments of the World Climate Research Program (WCRP) and the Intergovernmental Panel on Climate Change (IPCC) assessments, and (2) the world leading European Centre for Medium-Range Weather Forecasts (ECMWF), which is an independent European organisation supported by 34 member and cooperating states, and also the operator of the Copernicus services for atmospheric monitoring (CAMS) and climate change (CCCS).

1.1 Objectives

ESiWACE pursues the following objectives

ESiWACE will substantially improve the efficiency and productivity of numerical weather and climate simulation on high-performance computing platforms.

Improvements in efficiency, and hence in productivity, will be delivered by developing solutions for cross-cutting HPC challenges particular to the weather and climate domain. Solutions will range from the development of specific software products to the deployment of user facing services – and will encompass both computing and storage.

ESiWACE will support the end-to-end workflow of global Earth system modelling for weather and climate simulation in high performance computing environments.

We will improve and support Scalability of models, tools and data management on state-of-the-art supercomputer systems, Usability of models and tools throughout the European HPC eco-system, and the Exploitability of the results.

The European weather and climate science community will drive the governance structure that defines the services to be provided by ESiWACE.

We have already identified major themes which will immediately be addressed in the project. Representatives from the European weather and climate science community will contribute to setting priorities and define operational governance. A network of supporters will be formed and external organisations will be invited to participate in workshops, general assemblies, and training activities to support this process.

ESiWACE will foster the interaction between industry and the weather and climate community on the exploitation of high-end computing systems, application codes and services.

Our challenges mandate a trans-disciplinary approach. ESiWACE will foster co-design and vendor engagement through specific and generic industrial and academic interactions across the software and hardware spectrum.

ESiWACE will increase competitiveness and growth of the European HPC industry.

Weather and climate computing have always been one of the key drivers for HPC development, with domain specific scientific and technical requirements that stretch the capability and capacity of existing software and hardware to the limits. By developing solutions for Europe and at European scale, ESiWACE will directly impact on the competitiveness of the European HPC industry by engendering new products, providing opportunities for exploitation beyond the project itself, and by enhancing the skills base of staff in both industry and academia.

How ESiWACE's objectives translate to specific goals in the work plan (section 3.1).

ESiWACE will:

- Provide **services** to the user community that will impact beyond the lifetime of the project. This will be obtained by **engaging** with the user community to set up governance structures with long-term objectives and work strategies. (WP1 and WP5)
- Improve **scalability** and shorten the time-to-solution for climate and operational weather forecasts at increased resolution and complexity to be run on future extreme-scale HPC systems.
  This will be obtained by investigating and implementing scientific and technical options for compute efficiency upgrades and model output reduction (WP2).
- Foster **usability** of the available tools, software, computing and data handling infrastructures. This will be obtained by identifying, designing and supporting the end-to-end workflow for climate modelling and weather forecasting applications in both research and production mode (WP3).
- Pursue **exploitability** of climate and weather model results.
  This will be obtained by addressing the major barriers that hinder the efficient use of the huge amounts of data produced by weather prediction and climate simulation, in particular the performance and volume limits of key storage technologies on a range of timescales (WP4).
- Establish governance of common software management to avoid unnecessary and redundant development and to deliver the best available solutions to the user community. This includes also the provision of **support and training** for software tools and **documentation of best practices** for efficient climate and weather simulations using state-of-the-art HPC resources (WP1 and WP2).
- Provide **open access** to research results and **open source** software at international level. This will be obtained by sharing results, codes and documentation with a broad audience from diverse communities beyond our own, thus developing a science culture of excellence (all WPs).
- Exploit **synergies** with other relevant activities and projects and also with the global weather and climate community (all WPs, but driven by WP1).Liaise with the **European HPC ecosystem**, in particular with the European Technology Platform for High Performance Computing (ETP4HPC[1]) and the Partnership for Advanced Computing in Europe (PRACE[2]) (WP1).

[1] http://www.etp4hpc.eu/
[2] http://www.prace-ri.eu/

1.2 Relation to the Work Programme

ESiWACE responds to the call EINFRA-5-2015 – Centres of Excellence for computing applications.

ESiWACE addresses the specific challenge of the call EINFRA-5-2015:

HPC applications are essential to perform the complex multi-dimensional and multi-scale calculations and to handle the large-scale datasets necessary for modern numerical weather and climate simulation. ESiWACE will develop a European culture of excellence field by focusing on the needs of the user community. ESiWACE activities will join weather and climate modellers, software developers, vendors, and HPC centres: scientific discovery will evolve in parallel and in synergy with cutting-edge HPC development. The achievements of ESiWACE will go beyond the scientific and technological challenges they directly aim at, by impacting European society as well.

Given the challenges addressed and the activities planned, ESiWACE will be at once:

- **Thematic**, as it focuses on the HPC domain of climate and weather modelling,
- **Transversal**, as it covers several aspects of computational science (algorithms, analytics, numerical methods), and
- **Challenge-driven**, as progress in climate and weather predictability represents a major societal issue with multi-disciplinary implications

ESiWACE addresses the expected scope of the call EINFRA-5-2015:

- ESiWACE is a **user-driven** Centre of Excellence: the partners of the ESiWACE consortium are direct application users and owners. The ESiWACE governance model is explicitly based on implementing a user committee to provide feedback on on-going development of model codes and software tools, together with an advisory board of external scientific experts. The users have a well-defined role in the governance and are involved directly in the implementation of the activities.
- ESiWACE is **integrated**, encompassing not only HPC software but also relevant aspects of hardware, data management, data storage, connectivity, and security. Public and private partners will concentrate on development and scaling of climate and weather models toward the exascale, on evaluation and optimisation of specific model components and on data management on different architectures with, among others, development of methods for exploiting storage supports. The usability of all resources will be enhanced with tasks on benchmarking, co-design and development of best practices.
- ESiWACE is **multidisciplinary**, as it covers both HPC and weather and climate modelling areas, and fosters the interaction between industry and academia on the exploitation of high-end computing systems, application codes and services communities.
- ESiWACE is **distributed**, by federating capabilities around Europe (France, Germany, UK, Italy, Spain, Ireland, Sweden), and will **ensure synergies** with existing national programmes and with several joint European efforts already in place such as the development of the coupled climate model EC-Earth[3], the ocean modelling platform NEMO[4] or the coupler module OASIS[5].
- ESiWACE **exploits available competences**, as it brings together general-purpose HPC centres involved in PRACE (Partners BSC and ICHEC), dedicated centres (Partners ECMWF, DKRZ, MetO, CMCC, STFC), and research institutions and private partners developing hardware and software. Each partner of ESiWACE contributes its own network of users of climate and weather simulations. All these groups and institutions are connected in a larger network of supporters to ESiWACE. ESiWACE will strengthen the scientific and technological exchange and therefore the EU competitiveness in these fields.

[3] EC-Earth: http://ecearth.knmi.nl/
[4] NEMO: http://www.nemo-ocean.eu/
[5] OASIS: https://verc.enes.org/models/software-tools/oasis

ESiWACE will directly address:

- **Provision of services** such as: (1) Optimisation of model codes and associated software tools as well as development of new methods for data storage to improve efficiency for petascale computing and prepare for exascale computing. (2) Benchmarking activities and governance to test and validate shared community software and to contribute to their maintenance. (3) Investigation into the potential for co-design through involvement (as partners) of hardware-vendors and an SME providing tools for software development. Addressing the skills gap in computational science through support and training of weather and climate scientists.
- **Synergy with the pan-European HPC infrastructure:** We will organize relations with PRACE ensuring adequate dedicated resource allocation and will work with PRACE and other HPC centres towards provision of an efficient and adequate software environment for weather and climate simulations using complex Earth system models. We will network with ETP4HPC, relevant hardware and software industry and the weather and climate scientists to foster efficient use of HPC in this context. In particular strengthen the European HPC strategy by developing a specific roadmap for weather and climate simulations.
- Long-term **sustainability** of support and services by developing options for sustained funding in form of a business plan. [D1.3]
- **Creation of communities around specific codes** by establishing or strengthening (when already in progress) the user-driven evolution of the community software via improved user support, enhanced training, and fast integration of existing models and tools (NEMO and EC-Earth models, OASIS coupler, XIOS[6] I/O server, Cylc[7] meta-scheduler), in response to a well-defined software governance strategy.
- A **governance structure driven by the needs of the users**: The governance of ESiWACE will be driven by the user community, made up of experts from the fields of Earth system modelling across the public and private sector. The continuous interaction with the user community sought through various instruments (workshops, user groups, direct feedback, and general assemblies) will allow a progressive definition and adjustment of the scope of all ESiWACE activities

1.3 Concept and approach

1.3.1 Overall concept underpinning the project: main ideas, models, assumptions, trans-disciplinary considerations.

ESiWACE targets the convergent use of Earth System Modelling for weather and climate science (ESM)[8]. Global Earth System Models, the post-processing methods to handle the vast amounts of data they produce, and their complex end-to-end workflow, are the central tools for weather and climate science - in both research and operations. The productivity that can be achieved with these tools is significantly limited by technical and structural properties of the available software, hardware, computing and data infrastructure. Many of these bottlenecks are domain-specific since they originate from special requirements inherent to climate and weather simulation. However, there are also examples of shortcomings that appear domain-specific but are merely historically artefacts. Therefore, overcoming these bottlenecks does not only require meteorological or climatological expertise, but multi-disciplinary efforts.

To address this scientific and technical challenges ESiWACE will leverage multi-disciplinary, world leading expertise hosted in Europe in the fields of weather forecasting, climate modelling,

[6] XIOS:http://forge.ipsl.jussieu.fr/ioserver/wiki
[7] Cylc: http://cylc.github.io/cylc/
[8] **Throughout this application the term „Earth System Modelling“ (ESM) is used as short for „Earth System Modelling for weather and climate science”. Earth System Modelling in a broader sense would also incorporate the solid Earth.**

computer science and the provision of HPC services. ESiWACE will expand well beyond individual existing efforts and activities (see section 1.3.2) by a concerted multi-disciplinary action. The leading partners of ESiWACE are centres dedicated to climate research and weather prediction that combine a wide spectrum of expertise in research as well as operational production. This will ensure synergies with available services and domain specific technical competence, and it will also ensure that the achievments of ESiWACE directly translates into user benefit – both within the consortium and for the wider community. Moreover, each project task will be supported by domain and technical experts from specialized institutions and partners from industry, to foster co-design of basic computer code components, community models and tools in close touch with available and future hardware.

The central integrating part of our approach is "**Governance and Engagement".** We will create a governance structure, which ensures that the users from the weather and climate community (inside and outside the consortium) define the scope and priorities of the services to be provided by ESiWACE. Long-term sustainability of reliable support and service will be sought and achieved through the development of a business plan. In the preparation of the proposal the major themes to be addressed in ESiWACE have been identified in interaction with members of the wider scientific community. The emerging themes, having been mapped onto three technical work packages in ESiWACE, are:

The "Scalability" theme will coordinate performance assessment and upgrade development of state-of-the-art community models and tools, for example, ESMs, coupling and I/O technologies. To ensure that the community will be able to optimally exploit these models and tools, support and training will be provided. Community wide coordinated performance inter-comparisons, along with review, analysis and implementation of scientific and technical solutions for efficiency increase will be carried out. Further towards the exascale horizon, selected strategies will be investigated to prepare for the next-generation models and tools, and the workflows associated with challenging volumes of high-resolution model output.

The "Usability" theme will focus on the ease-of-use of available tools, software, computing and data handling infrastructures for ESM. Aspects of application software and data handling environment as well as system software and hardware stack will be covered for both research and operations. Further, the end-to-end workflow in ESM will be addressed and improved by providing recommendations, example use cases and best practice definition. Prototypical support and development will be put in place for a common workflow solution for weather and climate modelling building on an existing, successful product.

The "Exploitability" theme addresses major data handling barriers that hinder exploiting HPC for ESM. In a first stage, ESiWACE will address how to best exploit existing and future storage hardware and software at peta- and exascale. ESiWACE will aim at improving the performance and capabilities of both disk and tape storage systems in ESM workflows. Disk performance will be improved by developing "Earth system data aware" software libraries that optimize information layout in heterogeneous disk storage environments. Tape performance and capacity will be improved by developing new "Earth system data aware" strategies and software.

1.3.2 National or international research and innovation activities linked with the project

ESiWACE will establish strong links with a broad range of projects:

(a) ESiWACE will be a significant **beneficiary of the FP7 project IS-ENES2** (Infrastructure for the European Network for Earth System modelling)[9]. IS-ENES2 is the second phase project of the distributed e-infrastructure of models, model data and metadata of ENES (European Network for Earth System modelling[10]). It integrates the European climate modelling community, stimulates

[9] http://is.enes.org
[10] https://portal.enes.org/

common developments of software for models and their environments, fosters the execution and exploitation of high-end simulations and supports the dissemination of model results to the climate research and impact communities.

ESiWACE will **extend and widen the scope of IS-ENES2**, exploiting developments from IS-ENES2, issues identified by IS-ENES2, and growing the community. In particular:

- ESiWACE will **take on governance** of selected software tools relevant to the three ESiWACE themes, extending the scope of the support to include the weather community, as well as delivering developments beyond the end of ISENES2, resulting in a long-term support and service activity for the weather and climate community.
- Several **concepts developed** in ESiWACE originate from networking activities in IS-ENES2, such as the need to invest in a common meta-scheduler Cylc, the need to develop common workflows, to address code convergence issues the benefit of annual international HPC workshops and to define common protocols to compare performance of Earth system models.

Since IS-ENES2 is funded until March 2017, both projects will run in parallel for a period of ca. 18 months. We will profit from this time overlap to ensure the full transfer of results relevant to long-term support of Earth system models in HPC environments from the I3 project IS-ENES2 into ESiWACE.

(b) ESiWACE will exploiting **existing partner activities and collaborations aiming at improvement of efficiency of Earth system models**. ESiWACE will leverage these from primarily bilateral (or at best trilateral) activities by fostering common developments, information exchange and co-design, always pursuing the core objective of improving the effectiveness of the weather and climate community in Europe as a whole. Examples include the cooperation of CNRS-IPSL, CMCC and Bull to improve the NEMO model, the cooperation of DKRZ, MPG and Bull to improve the ICON[11] model and its I/O performance, and the ECMWF Scalability programme relying on partnerships with Cray and NVIDIA. The latter aims at developing the next-generation forecasting system addressing the challenges of the future exascale high-performance computing and data management architectures. Similar activities are pursued by the MetO (GungHo and LFRic with UK NERC) and by MPG, DWD and DKRZ (HD(CP)^2 project with German BMBF support)[12].

(c) Another foundation activity in ESiWACE will be exploiting **existing and new relationships with groups working on storage challenges.** CMCC, DKRZ and STFC all have existing storage vendor engagement programmes, and a range of existing and planned European collaborations. ESiWACE will allow the leveraging of these activities towards common goals, and the dissemination of best practice into the wider community. Key relationships will include the EUDAT community (whether or not an expected EUDAT2 project is funded) and with the exascale I/O community (especially the European Open File System – EOFS – working group within the E10-consortium[13]). ESiWACE partners established relationships with netCDF and GRIB technical teams and launched an early relationship with the HDF technical team[14]. At the working level we also share problems and solutions with the high-energy physics community through close links with the LHC storage community). On data dissemination, close collaboration with the Earth System Grid Federation (ESGF), as supported within IS-ENES2 comes naturally. Partner DKRZ and STFC are the leading European organisations in technical support of ESGF.

(d) ESiWACE envisage interacting with future H2020 **Future and Emerging Technologies** research projects that deal with new long-term developments of Earth system models and their components and system models for future HPC-architectures. Existing project proposals of this category include the ESCAPE proposal led by ECMWF and the CHANCE proposal led by CMCC.

[11] ICON: http://www.mpimet.mpg.de/en/science/models/icon.html
[12] HD(CP)2: http://hdcp2.zmaw.de/
[13] E10: http://www.exascale10.com
[14] The netCDF http://www.unidata.ucar.edu/software/netcdf/ and GRIB http://en.wikipedia.org/wiki/GRIB are two major file formats in use in the community, modern versions of netCDF are based on version 5 of the Hierarchical Data Format, HDF, http://www.hdfgroup.org/HDF5/.

(e) Alongside these technical collaborations ESiWACE will **also liaise with established user communities and scientific projects** using ESM as a tool. This includes the EC-Earth consortium (currently chaired by SMHI), consortia managing regional weather applications such as ALADIN[15], HIRLAM[16], LACE[17], and COSMO[18] as well as existing and planned weather and climate European environmental (SC5-2014-1 "Earth systems" call under final evaluation) projects such as CRESCENDO, IMPULSE, PRIMAVERA, and the European Training Network Marie Skłodowska-Curie submitted project HPC4CM. Members of these groups will be invited to workshops and to participate in user groups for specific foster code to ensure ESiWACE activities match their requirements.

(f) ESiWACE will also **closely work with WMO programs** in the field of climate (World Climate Research Program, WCRP), and weather (World Weather Research Program, WWRP) in order to ensure ESiWACE developments serve international requirements. ESiWACE will cooperate with the CMIP panel coordinating international experiments (e.g. CMIP6), related intercomparison projects (such as OBS4MIPS[19]) and other WCRP and WWRP international projects in which the ESiWACE community are engaged. An agreed activity will be the planning of a few **joint workshops in coordination with WCRP and WWRP** working groups and programs (such as S2S[20], WGNE[21], WGCM[22]) to demonstrate usability, exploitability, seamless access, data processing integration for services development.

Letters of support and commitment to ESiWACE from several of these networks have been provided in Appendix 1.

1.3.3 Overall approach and methodology

The approach of ESiWACE follows the general overall approach: (i) networking to establish common requirement and governance methodology; (ii) joint research activities to develop towards the requirements, and (iii) service activities to provide both training and support.

The type of **networking activities** depends on the community's maturity in a given area. In some areas we can build on previous activities around established shared software especially from IS-ENES2. This includes the evaluation of coupling technologies and the support of the OASIS coupler, the development of I/O strategies, the development and support of the XIOS I/O server and the Cylc workflow engine, common analyses of model codes such as NEMO and EC-Earth. In this case **networking for existing community software** will foster community co-operation based on an agreed set of benchmarks and will drive continued research towards improvement of these tool through engagement with the existing user community. Dissemination of community software will be enhanced by improved user support and training as well as fastest possible integration of new software versions.

In other areas, the community's maturity is lower and will focus on **networking for new community software** with activities supporting to share specialist knowledge that exists but is not yet available across the community. An example is the development of suitable software stacks for HPC systems.

Networking activities will feature introductory workshops on specific tasks to foster cooperation between the partners, and include external stakeholders and the wider community. The outcomes of the workshops will be white papers in the form of web documents, followed by updates as demanded by changing environments and evolving requirements. A central overarching objective of the **networking activities** will be the provision of a governance framework for the sustainable provision of community codes and the ability to identify and to prioritize user-driven requirements.

[15] ALADIN: http://www.cnrm.meteo.fr/aladin/
[16] HIRLAM: http://www.hirlam.org/
[17] LACE: http://www.rclace.eu/
[18] COSMO: http://www.cosmo-model.org/
[19] OBS4MIPS: https://www.earthsystemcog.org/projects/obs4mips/
[20] S2S: Subseasonal to Seasonal Prediction Project -http://www.wmo.int/pages/prog/arep/wwrp/new/S2S_project_main_page.html
[21] WGNE: Working Group on Numerical Experimentation - http://www.wmo.int/pages/about/sec/rescrosscut/resdept_wgne.html
[22] WGCM: Working Group on Coupled Modeling - http://www.wcrp-climate.org/wgcm/

This is underpinned by having a dedicated work package (WP1 on governance, engagement and long-term sustainability), which will take charge of **networking across communities**: science (climate and weather science), HPC ecosystem and HPC industry.

Joint research towards enhancement of existing and new development of systems and services is different across tasks, depending upon ground laying work achieved in other contexts like IS-ENES2 or others. The mechanism of governance of shared software and of innovative ESiWACE developments, which is secured through WP1, will make sure that the development work follows the requirements of the users. In particular the specifications for the development will be reviewed and discussed during the project. Additionally we will set up dedicated interest groups on cross-cutting issues which are of interest for all of our three themes (for example the IO problem or the impacts of evolutions in the HPC ecosystem). Through these mechanisms we hope to maintain the flexibility to adjust the path of the research activities and to set appropriate goals for the continuation of our ESiWACE after the initial funding period.

Joint research activities will effectively contribute to quantitative and qualitative improvements of the services provided to the weather and climate community. Joint research on model and tool optimization will ensure that existing codes, which represent an integral part of the ESiWACE infrastructure, will evolve to better exploit massively parallel supercomputers, thereby enhancing the effectiveness of climate and weather research based on these codes. In addition, undertaking first steps towards the preparation of the next-generation model components will also help securing these efficiency gains in the longer term on exascale platforms. The research into development and provision of a common software stack and common runtime environment for ESM will considerably ease the path for new users and also for the deployment of complex model systems on different HPC platforms. The research on knowledge compression of ensemble data, efficient storage of ESM data (on disk and tape) and on the mapping between netCDF and GRIB file formats will lay the basis for providing support and service for a novel and much more efficient way to handle and share data within the weather and climate community.

Prototypical and limited **services** for European community climate models and tools were for the first time offered in the framework of IS-ENES and IS-ENES2 and are exploitable on-line through the ENES portal. ESiWACE will ensure that these services are maintained, enlarged and improved. This includes user-driven improvements of central models and tools and the delivery of support and training for existing community tools. **New services** will mainly be developed within the usability theme around the provision of a common HPC software stack and run time environment for weather and climate models. Both will proto-typically be installed and tested in a quasi-operational environment. As a first real use case the usage of the environment within an ENES summer school is foreseen. The **definition of a broader portfolio of services** is an integral goal of the ESiWACE project itself and will be an integral part of two central deliverables of the project: The HPC-roadmap for the climate and user community and the business plan for the future of this Centre of Excellence in Simulation of Climate and Weather in Europe.

1.3.4 How sex and/or gender analysis is taken into account in the project's content

Issues regarding gender equality, equal opportunity and diversity are considered extremely important. After careful thought, we consider the gender dimension of ESiWACE as neutral. The Consortium agrees to undertake actions during the course of the project to promote and guarantee gender equality in the project, ensuring it will act upon the EC recommendations listed in the "Gendered Innovation". Additionally, the Consortium is ready to contribute to surveys and investigations fostered by the European Commission.

At a project level, the Consortium is aware of the importance of attracting more high quality female researchers into the sphere of research and innovation and management, stimulating and promoting the progress of women in scientific careers. Currently, two of eight work package leaders / co-leaders are women. Gender balance among the personnel primarily responsible for carrying out the research and innovation activities will be ensured. The Consortium will support equal participation between men and women in the implementation of the actions and will aim to the extent possible for a gender balance at all levels of personnel assigned to any action, including at supervisory and managerial levels (ref. Art. 33 of the Grant Agreement). The promotion and monitoring of gender equality throughout the project will be the responsibility of the coordinator.

1.4 Ambitions

As indicated in section 1.3.1 ESiWACE focuses on three major themes, namely **Scalability**, **Usability**, and **Exploitability** addressing technical challenges and on a **Governance** activity to engage the community and to align the services along the requirement of the users..

Governance (WP1)

Currently, the productivity of climate and weather simulation is significantly limited by the technical and structural properties of the available software, hardware, computing and data-handling infrastructure. While selected individual solutions exist, the community does not benefit from a common strategy on how to develop portable methodologies that benefit a wider user group and that can be maintained and extended with complementary resources. The **ESiWACE ambition** is to introduce such a strategy through a governance of science software, models and tools with more developed community engagement. It will transpose existing and newly generated knowledge from current to future technologies and train young scientists. Further, ESiWACE will foster the interaction between industry and academia on the exploitation of high-end computing systems, application codes and services.

In our research field central, crucial software is generally developed in single institutions. It is not directly generating revenue. ESiWACE will nevertheless strive to engage and involve industry and solutions providers in long-term commitment to development, support and maintenance of such software, and to generate benefits and revenues of it from downstream usage, as e.g. for improved PDE solvers in the oil and gas industry. Enhanced shared software developments will be a method offering a huge **potential** in terms of focusing institutional resources onto science rather than onto technology and method development:

Further, ESiWACE will leverage significant **innovation potential** by bridging the perceived gap between **"traditional"** numerical weather prediction and climate modelling, which were understood to be physical only for the former, and climate time scale only for the latter: Both WMO and WCRP sport the concept that "weather" and "climate" work on space and time scales and with processes, which will become less and less differentiable, and are conceptually both described by the term "Earth system". ESiWACE will support this approach in the recognition that the weather and climate science communities have much more in common than usually perceived, and that the respective modelling or simulation approaches face problems which are very similar, especially when exascale comes into play.

These goals are both **technically and organisationally ambitious**, particularly in dealing with the necessity to integrate activities and responsibilities between institutions and across domains such as academia and industry. By centralizing these activities and providing an interface to other similar endeavours, we expect a big step forward for our community but also will be able to significantly contribute to reinforcement and growth of the European HPC ecosystem as forseen in the Strategic Research Agenda of ETP_4HPC[23].

Scalability (WP2):

Historically, code is developed with a science focus, and code architectures or numerical techniques are developed by single institutes with a well-defined application in mind. Code optimizations are only applied incrementally to these code bases and within the limitations of the computing expertise at hand. This approach has produced very large legacy codes, which are difficult to manage within a wider community, difficult to migrate between different HPC architectures and nearly impossible to adapt to future exascale compute and data handling environments requiring, in parts, fundamentally new code design, work flow management and scientific algorithms.

[23] "European Technology Platform for High Performance Computing ETP4HPC Strategic Research Agenda Achieving HPC leadership in Europe". (http://www.etp4hpc.eu/strategy/strategic-research-agenda/)

The solution to this dilemma is a combination of radical and incremental change of direction, for which ESiWACE will **pave the way** in tight collaboration with the weather and climate modelling community.

More radical re-engineering is rather difficult to perform for code used across institutes or communities due to user and application specific requirements and hardware. However, there is often **potential** for unifying the framework in which user-specific code is embedded as well as for identifying common and generic code components that can be managed and optimized as common libraries. ESiWACE will foster this through the **development of strategies** for (i) new unifying coupling and I/O functionalities, (ii) concurrency in crucial science code workflows, and for examining the trade-off between (i) precision and memory/speed and (ii) information content and data volume.

At the same time, less intrusive code adaptation is preferable where substantial efficiency gains can already be obtained without intrusive code re-design and on shorter time scales. ESiWACE will **provide this** by supporting more stringent (i) overlap of communication and computation, (ii) two-sided and asynchronous communication, or (iii) the use of OpenMP in community models and tools. **Fundamentally new** in this context is a dedicated effort to define efficiency metrics (i) allowing an objective benchmarking of community tools and (ii) guiding code optimization efforts.

This **level of ambition** has never been realized in this community as it breaks away from the existing legacy code development approach and because it introduces a view ranging from support and evolutionary changes for existing tools towards designing next-generation systems suitable for the exascale.

ESiWACE adds **substantial innovation potential** in the following areas:

- Through unified and community wide science and computing strategies, the pull-through of new scientific and computing methodologies into community models and tools will be greatly facilitated and provide benefit for a much wider user group than before.
- Those European Copernicus services relying on weather and climate modelling will immediately benefit from developments and services.
- The present European excellence in scientific research and operational applications in weather and climate will be extended to the area of computing and data handling.
- The interaction with hardware and software providers will be greatly facilitated since co-design of code components and libraries will be facilitated, and hardware dependent performance will be easier to gauge. Thus procurements for future hardware will be optimized.
- The European weather and climate community will be prepared for the challenges presented by exascale HPC systems.

Usability (WP3):

Today, it is realized that sophisticated and flexible workflow solutions are increasingly important in production environments. However the emerging solutions are still far from universal and currently rare in the research environment. IS-ENES2 has established a growing appetite for a step change in capability of workflow solutions in the research environment and this proposal is able to capitalize on recent investments at NIWA[24], the MetO, MPG and others aimed specifically at this user base.

ESiWACE has the ambition to significantly improve the interaction between those with deep computing knowledge and those with the best scientific ideas. This way we will drive research in workflows solutions which offer a much greater potential for performance optimization in the non-computer-architecture-minded sense, as does the standard way of experiment design and execution. This will allow for considerable advances in a number of areas:

[24] The NZ National Institute of Water and Atmosphere

- Large difficulties exist to organize and carry out multi-model ensembles (see projects like PRIMAVERA, IMPULSE, CRESCENDO) ESIWACE will develop an environment to remedy this situation, including education of young researchers.
- The complete stack from the science application down across the complete system and data handling software to the hardware is much more heterogeneous than it is healthy for the communities involved. ESiWACE will provide some counterbalance against the commoditization trend currently observable in the computing industry by testing solutions, proposing and proliferating standards, and educating young scientists in their use.
- Information about best practice and working examples is often missing. ESiWACE will improve this with its dissemination methods.
- Involvement with solution providers is low. Providing a funded platform to engage and exchange with industry, also directly with ETP4HPC by involving an SME is a new approach. ESiWACE will gain the attention of the computing industry via greater and better co-ordinated engagement for the ESM community. With this activity ESiWACE will be very involved with the milestones of ETP4HPC, “Programming Environment”, from 2016/17 **on**.
- Increased complexity of earth system model suites and the need to automate more data pre- and post-processing means that there is the urgent need to find tools to free the scientists from the increasing burden as HPC resources grow. ESiWACE’ activity on meta-scheduling, like the provisioning of the Cylc workflow engine, suitable for research and production environments and specifically developed for the climate and weather communities, provides the opportunity to give step-change improvements in the management of complex workflows.
- Dissimilar and disparate working environments and software stacks are a hindrance not only for multi-site, multi-model high-resolution full complexity Earth system model experiments, but also for the individual researcher needing to be flexible in terms of the usage of his computational and storage resources across different (topical or PRACE) sites, and for the software engineer in need of benchmarking his model or tool across different platforms. A huge potential lies in the provisioning of recommendations for shared common environments and software stacks across sites and architectures in terms of usability and maintainability.
- Rational scheduling of simulations based upon concrete parameters of the according experiments has the **potential to exploit** machines and resources much more elegantly than possible currently, and will be supported by ESiWACE through training and services for provisioning of technical support.

Exploitability (WP4):

Data volumes produced by the weather and climate community have been growing with a doubling time just short of two years for decades. Ongoing growth at these rates will stress **existing infrastructure** – both in terms of storage and bandwidth to and from storage – and will stress time-to-solution for most weather and climate workflows (where solution is defined as the production of knowledge or information, not data). It is **already recognized** that analysis time is a growing proportion of time-to-solution, and that trend will only be exacerbated without intervention, since increased use of tape will introduce even more latency and bandwidth constraints in the system (and increased use of tape will be mandated by the storage costs – both in terms of energy and finances).

The bandwidth issue is further compromised by difficulties with the POSIX file system in massively parallel environments with large numbers of files or high volume files with internal complexity that is hidden from the file systems (such as occurs with GRIB and netCDF). The complexity of multiple file formats also leads to difficulties for humans too: while software can mediate between formats, it can only do so when the semantic relationships are well understood – in the case of GRIB and netCDF, **they are not**.

ESiWACE will **drive innovation** in the following areas::

- **Currently**, planning for storage growth is mostly carried out separately from planning for operational and scientific activities, and all institutions carry out such planning independently. Storage vendors are not always aware of the requirements. Developing a parametric model for storage within ESiWACE which is inclusive of the scientific workflow is

an **ambitious** activity, that has the **potential to significantly improve** the ability to both plan realistic scientific experiments and deliver optimal storage configurations – not least since vendors will be able to consider the workflow of multiple institutions when designing solutions. PRACE, EUDAT and other e-infrastructure providers will be better able to understand the storage requirements and costs of the weather and climate communities.

- **Moving beyond** POSIX file systems within the ESiWACE project **is too ambitious** for the resources and timescale available, but the proposed innovative approach to providing middleware that can accelerate I/O to scientific formats, even in POSIX file systems, will provide an important interim milestone, with significant **potential benefit** to the community – not least because it may end up saving significant amounts of money in comparison to traditional approaches (thus allowing greater volumes of data to be stored and handled efficiently). This **potential** is in part because the use of object stores and other non-traditional storage backend middleware will be **innovative** in our community, although it's success will depend on ambitious expectations for the performance of the middleware.
- **Current** tape systems in use in weather and climate cannot effectively employ parallelism to extract data from the same file, and rely on multiple copies of the same data to effect reliability against corruption. Developing a software library which can be used to provide more parallelism and more efficient storage of extra copies of data utilizing the Redundant Array of Independent Tape (RAIT) concept **will be ambitious**, particularly where several generations of tape drives and tape media share the same library, but it is necessary. While RAIT itself cannot be thought of as an innovation, making such a library available to the open source community will be new, and allow generic e-infrastructure providers deploy services similar to those such as dedicated providers such as ECMWF and the Met Office.
- Finally, in terms of exploitability, the conversion of data to information involves extracting meaning from data. Despite a quarter of a century of co-existence**, it has not been possible, yet** for the community to create a semantic mapping between GRIB and netCDF allowing users to reliably convert data (and information) between the two. Accordingly, developing such a mapping is both **ambitious and innovative**, and should lead to much greater interworking between the two communities – meaning that tools which improve performance for one type of data will be deployable in support of the other type of data. This will significantly support the objectives and infrastructure necessary to further the aims of the World Climate Research Programme.

2 IMPACT

2.1 Expected impacts

2.1.1 Expected impacts set out in the work programme, under the relevant topic

ESiWACE will achieve all four impacts indicated in the text of the call EINFRA-5-2015:

Impact 1) Improved access to computing applications and expertise that enables researchers and industry to be more productive, leading to scientific excellence

Simulations in weather and climate research always have been limited by the computational power available. Scientific progress would have been faster, if computers would have been more efficient, that is: more efficient per computational core, better scalable, easier to use, and better to exploit. Although growth in peak computing power came for free for a very long time, code optimization still was mandatory due to this limitation in efficiency. The exascale era will now bring the coercion not only to parallelize to much higher number of processes than so far, but also for heterogeneous processor architectures, as they are provided by commoditized products available today. Researchers both in ESM will suffer even more from the fact that their tool development needs to address performance and efficiency in a very technical sense, and not focus on ease of use or comprehensibleness. Further commoditisation of computing architectures will decrease usability for ESM. In many cases, suboptimal usability of the modelling environment leads to decreased productivity: Scientists need to concentrate on the tool instead of the scientific experiment they are forced to foster technical instead of the scientific skills. So, despite all technical efforts to improve scalability and exploitability, bad usability degrades time to solution, and, such, scientific excellence.

Scalability traditionally was at the heart of model and tool developers and is considered of major importance. But considering exploitability of data and models as well as their usability offers lower hanging fruits in terms of efficiency. Sharing software development will enable the ESiWACE user community to devote more concentration upon scientific topics, and methods. ESiWACE will also foster services for the use of modern software engineering methods and tools like version control systems, rapid coding environments, performance and debugging tools, and others.

With increased scalability, improved usability, enhanced exploitability, and a better balance between them, researchers will be empowered in keeping and extending their internationally leading role in the field of weather and climate research. The governance employed will improve community bind-in, enable more exchange within the weather and climate community, and ensure logical and traceable selection of development and service topics of interest for the community.

It is safe to assume that with the joint efforts of ECMWF and ENES, a large fraction of the EU community in ESM will be impacted by the innovations from ESIWACE, since all major European institutions are involved with or part of these two organisations. In particular, the developments within ESiWACE will benefit a large weather forecasting community in Europe since ECMWF represents the global medium-range weather forecasting interest of the majority of the European countries. Regional services organised through consortia such as ALADIN (16 countries), HIRLAM (11 countries), LACE (7 countries), and COSMO (7 countries) will immediately benefit from the outcomes of this project, with the first three consortia already directly sharing many computer code components with ECMWF, including the dynamical core. All consortia share a common research expertise with ECMWF in several areas handled by this project. Also, all European modelling groups participating to CMIP programs with their Earth system models are members of ENES.

Impact 2) Improved competitiveness for companies and SMEs through access to ESiWACE expertise and services

In terms of HPC capacity deployed, the EU lost 10 % of its high-end computing capacity from 2008 to 2010 , whereas other nations increased their efforts in this area during the same period. Fewer high-end computing resources available in the EU mean that scientific know-how which critically relies on HPC and influences the development of new HPC systems25, is weakening in Europe. The European Union has many successful scientific and engineering software firms and is strong in many important areas of parallel software development. In fact, the large majority of the principal

parallel software applications in use at EU HPC sites has been created and is further developed in Europe. However, the mastering of advanced HPC hardware is closely linked to the associated software and losing out on one side inevitably leads to a loss on the other

By increasing efficiency in using super computers for one of the most challenging fields of applications for computer based simulations, namely the modeling of weather and climate. ESiWACE will contribute to increased competitiveness and growth of European HPC industry. ESiWACE will lay the foundation for new knowledge and skills. Scientific discovery will be boosted by HPC developments and by weather and climate modellers, software developers, computing scientists, vendors and target users working closely together striving towards a culture of excellence. The net gain in terms of scientific and technical innovation and efficiency will then enhance competitiveness for European science and industry and, by granting open access to research results, enable Europe- and world-wide transfer of the newly acquired state-of-the-art knowledge. In particular, ESiWACE will unite the weather and climate communities to provide a single, stronger interface to HPC suppliers and encourage them to engage (WP3). Those suppliers able to engage will not only strengthen their position with this user groups, but with a much wider weather and climate community globally.

Impact 3) European leadership in applications that address societal challenges or are important for industrial applications through better code performance and better code maintenance and availability

ESiWACE unites the European climate and weather communities in their struggle to keep abreast of technological progress on the way to exascale. Only with this merging of forces a level of competitiveness can be reached, which will enable both communities to maintain and even improve their high scientific performance standards in the area of climate and weather research, which are both of considerable scientific and societal relevance. Improved scalability of codes will lead to faster time-to-solution and decreased uncertainty in forecasts and projections. Enhanced maintainability and better usability of frameworks and re-usage of workflow elements will lower learning curves and improve applicability of complex workflows to new scientific problems. Standard environments on pan-European Infrastructures like PRACE will ameliorate their usability to new levels. Faster, less complex storage access will lead to speed-ups both in production and analysis modes, leading to faster production of scientific results, and enable exploitation of results with unprecedented speed.

Impact 4) Larger number of scientists and engineers will be trained in the use of computational methods and optimization of applications

There is only a small workforce available that has the adequate educational background and is well trained in HPC, especially in parallel programming. In addition, scientists that develop and maintain the computational tools and application codes often do not have an attractive career path. This hinders the exploitation of HPC in research and industry. By 2020 the computing power available in today's most performing HPC systems will be available on desktop systems. A well trained workforce capable of efficiently using this computing power is essential. Additionally, at Member States, there is still fragmentation of HPC in climate and weather domain and this leads to inefficient use of resources and only partial exchange of expertise.

In ESiWACE, the ESM scientist and scientific programmers will experience a new level of expertise available to them from the services provided by the ESiWACE workshop series, white papers, portals, improved support and training on community models (e.g. NEMO) and tools (e.g. OASIS, XIOS, Cylc), and sharing of best practices in trainings and mutual visits count to the measures employed.

2.1.2 *Improving innovation capacity and the integration of new knowledge*

The **user-driven, integrated, multidisciplinary, distributed approach** of ESiWACE will lay the foundation for new knowledge and skills.

ESiWACE will contribute to increased competitiveness and growth of European HPC industry by:

- Increasing efficiency in using super computers for one of the most challenging fields of applications for computer based simulations, namely modeling of weather and climate
- Bringing together weather and climate modellers, software developers, computing scientists, vendors and target users working closely together striving towards a culture of excellence, consequently boosting HPC developments and achieving a net gain in terms of scientific and technical innovation and efficiency;
- Uniting the weather and climate communities to provide a single, stronger interface to HPC suppliers and encourage them to engage, thus strengthening the position, growth and competitiveness of these user groups;
- Granting open access to research results, enabling transfer of the newly acquired state-of-the-art knowledge to other actors on the European and global market.

2.1.3 *Contribution to environmental and socially important impacts*

The targeted improvements in efficiency and productivity will directly address important societal challenges around climate change and extreme weather prediction. Improved use of HPC will allow:

- More reliable weather and climate forecasting across scales.
- More accurate projections of future climate under various scenarios providing better guidance for climate change mitigation policies.
- Better understanding and prediction of weather and climate extremes impacting on economic and political decision making for emergency response and change adaptation.

As indicated in the EC Communication “High-Performance Computing: Europe's place in a Global Race”, the race for leadership in high performance computing systems is driven by the need to address societal grand challenges more effectively.

Without HPC there would be no

- Projection of climate evolution;
- Forecasting of weather, which is necessary for planning our daily activities and dealing with severe weather conditions that can devastate lives and properties;
- Prevention and management of large-scale climate changes;
- Rational decision making in this area for policy makers, influencing public and private levels.

But HPC is also vital for the EU industrial capabilities:

- Returns on investment in HPC are extremely high: Companies and countries investing most in HPC lead in science and economics
- Advances in the area of HPC such as new computing technologies, software, or storage applications feed into the broader ICT industry and the consumer mass market, becoming available in households within five years of their introduction in high-end HPC**.**

2.1.4 *Barriers/obstacles, and any framework conditions that may determine whether and to what extent the expected impacts will be achieved*

Usability and complexity are problems in the software development field in general. Simulation workflows both in ESM are very complex, and are used by a comparatively low number of experts. Rather, they are perceived as single-site problems, resulting in a natural tendency to single-site solutions. These are often not very well usable, for other colleagues, but also across sites or

communities. The communities might not be ready to take more concrete steps to turn shared software development into an every-day commodity way of working. The support by the individual centres might be too low since the usual way of working is the do-it-yourself method. They often trust their in-house developments more than quality-controlled software developed externally. Also, sharing of IPR and engaging in open-source projects are often perceived as contrary to earning appropriate merit and credentials.

The ESiWACE community needs to ensure and take all measures available so that it benefits from sharing all aspects of the software development and application processes not only between centres, but also between the communities. Language barriers, skill gaps and missing information links play crucial, obstructing roles. These have to be identified and remedied by the governance processes initiated by ESiWACE.

2.2 Measures to maximise impact

2.2.1 Dissemination and exploitation of results

Dissemination and exploitation activities are of high relevance in ESiWACE.

For maximising the impact of the project results, we have chosen a combination of measures for:

- **Dissemination and Exploitation**
- **Media and Communication.**

These activities will involve **all consortium partners** and their respective staff, including researchers from **climate, weather and HPC community**. These activities will be managed partly in WP1 “Governance, Engagement & long-term Sustainability” and partly in WP5 “Management and Dissemination”. More specifically under WP5 we have planned tasks (Task 5.3 and Task 5.4) dedicated to the implementation of a well-structured plan to support an effective sharing of the results within all relevant target stakeholders.

The work done in WP2-4 will provide the feed to WP1 and WP5. Dissemination of the concrete results of work completed in WP 2-4 will be done at different levels: Through the active engagement with potential users, the implementation of communication activities, the structuring of an exchange between the consortium and other countries. The partners in the project have professional communication and public engagement officers in their organizations, and we will take advantage of their network.

- In the early stage of ESiWACE, the **Dissemination and Exploitation Plan** [D5.5] and a **Media and Communication Plan** [D5.3] will be set up to steer the activities of all partners. The plans will be based on the elements reported in the Table 2.2a here below.
- During the project implementation, the contents of the plans will be updated on the basis on the development of the project, for maximizing the impact of ESiWACE in a consistent manner.
- ESiWACE focuses on the role and synergies between partners’ experiences, competences, capabilities and on spreading knowledge all over Europe.

The activities will include organising workshops, meetings and training activities with external stakeholders, such as industry and end-users; potentially interested groups.
Specific annual dissemination events will be organised by ESiWACE to be held at partner sites (General Assembly, Work packages workshops) and will help us publicize our work in such a way that the consortium will profit from publicity and generate interest in the project and its outcomes; encourage scientists to join our partner institutes, companies and activities, draw the attention of national and regional governments and other public and private funding sources to the needs of long-sustainability of our researches and innovation plans.

	Dissemination and Exploitation Strategy	Media and Communication Strategy
Objective	Enable and facilitate implementation of ESiWACE outputs for the climate abs weather community	Promote ESiWACE outputs and interact with the wider climate and weather community as well as HPC centres and industry
Target Audience	ESiWACE partners ESiWACE supporters User Group Committee (UGC) European Commission	General public Climate research institutions and National weather services. Wider scientific community HPC industry ETP4HPC European Commission (as a multiplicator)
Instruments	ESiWACE Portal / wiki[D5.1]] ESiWACE workshops ESiWACE public website [D5.2]	ESiWACE website [D5.1] Progress reports to the EC Scientific publications
Access	Project partners General public	General public
Who is in charge?	WP1 / WP5	WP1 / WP5

Table 2.2a: Overview: the Pillars of the ESiWACE strategy for dissemination, exploitation and communication activities.

This comprehensive programme of offline activities, training, and dissemination activities will be complemented by a web presence to ensure the maximum engagement with **public and private sector** representatives of a full range of users and uses both within the scientific community and beyond this, in a wider European and international context. WP5 will establish a central web-platform based on the existing ENES portal and collaboration tools such as a wiki. The web presence will be based on:

- **Public Website** and its interactive facilities for the exchange of information and data. The website will include data (sample input and output), scientific outcome (papers, reports, documentation, and conference proceedings), and an online exchange function to track the communication between partners on global project topics. Exchange forums for discussion between partners will be linked to the respective repositories (D5.2).
- **Project Portal** (online platform): will provide limited access for project partners as well as the European Commission, and direct access to all material generated in the course of the project as well as quick looks at the project status. It will contain a repositories for project documentation (plans, progress tracking, reports, financial information) including **Wiki and project management tool as** the central collaboration platform for the partners and the supporters (D5.1).

Progress reports on the activities and the results will be submitted on regular basis to the European Commission. Summary reports in a language accessible for a lay audience will be made available on the project website.

Scientific and technical results of ESiWACE will be disseminated at European and international level through **scientific articles**, submitted for **peer-reviewed publication**, strategy papers, participation in conferences and workshops. ESiWACE results will be exploited at European and international level by weather and climate modelling groups (research institutions, weather forecast services) relying on HPC resources.

2.2.2 Data/software policy and management of intellectual property rights (IPR)

A key objective of publicly-funded research is that it should lead to the exploitation of results, which goes one step further than the mere production and dissemination of new scientific knowledge. Innovation is understood as any activity aiming to promote not only the dissemination, but crucially

the subsequent exploitation of the results of the research and development projects. The strategic use and management of Intellectual Property (IP) in international research initiatives and in business is essential for strengthening the European scientific and technological base, boosting innovation and ensuring growth in the EU. In this context our consortium is aware that Horizon 2020 places much emphasis on systematic Intellectual Property exploitation strategies as a means to better protect innovation initiatives, and to reap commercial and economic benefits from EU-funded research.

The strategy for the knowledge management, protection, dissemination and for the exploitation of result, the will be defined in **Dissemination and Exploitation Plan** [D5.5]. The strategic document will be regularly updated during the entire project. Updates will be submitted to the European Commission as an integral part of the Project Periodic Reports. A final document, a Strategy for intellectual property exploitation [D5.6] will also be made available at the very end of the project. ESiWACE results will be exploited at European and international level by weather and climate modelling groups (research institutions, weather forecast services) relying on HPC resources.

- **Open access to peer-reviewed scientific publications**: Open access will be granted to all scientific publications resulting from ESiWACE with a combination of golden and green open access. We will make use of institutional and topic repositories for making our publications available. ESiWACE scientists, as EC grant recipients, will ensure that electronic copies of peer-reviewed scientific publications become freely available to anyone as soon as possible and in all cases no later than six months after publication. Additionally, wherever results are suitable (content and size) to be distributed or stored by using open access repositories, ESiWACE will use **ZENODO**[25] for disseminating the results of the project to larger audiences and larger networks, in full open access.
- **Open access to software and tools**: Software and tools developed in ESiWACE will be managed through an open-access license and the project will produce test suites under which the software can be operated for selected hardware options. External users will have free and full access to these tools and documentation through the project website. The software policy pursued in ESiWACE is fundamentally open. Data, documentation and training tools will be made freely available, and software produced by ESiWACE will be managed through an Apache-2 open source.

The procedures above will be monitored by the Project Office (see section 3.2.1 for more details).

2.2.3 Media and Communication activities for promoting the project and its findings

We understand communication as much more than a reporting duty: There is a major difference between a communication, which has been strategically planned with the expected societal impacts we would like to make happen, and ad hoc efforts made just for meeting contractual requirements. We are aware of the contractual obligations related to communication efforts requested by Horizon 2020, but our goal is to go beyond these and strive for **high quality outcomes**.

The communication element of the project will involve **all consortium partners** and their respective staff, including researchers. Already in the preparation stage of the proposal, we have set high priority in raising the awareness that communication is a continuous process, not a one-time effort when the project ends. The partners in the project have professional communication and public engagement officers in their organizations, and we will take advantage of their network.

Right from the beginning, the project will be guided by key partners for planning to achieve the desired outcomes, and on the basis of clearly identified objectives. Appropriate resources have been allocated to this task. As indicated in the section 2.2b table, we have already foreseen **a number of tools** for the implementation of our communication strategy.

[25] www.zenodo.org

Target Audience	Communication objective	Communication materials	Communication tools	Who is in charge
Project Partners and Supporters	Ensure an integrated project	Results of WP tasks, risks, benefits, queries, new scientific questions arising	Project wiki / collaboration Platform [D5.1], General Assembly meetings (GA), Work package Meetings, email, web and telephone conferencing (WebCo, Telco)	All Partners
Scientific Advisory Board (SAB)	Ensure the external SAB is fully informed	Progress reports, issues, deliverables, questions, problems arising	project wiki / collaboration platform, General Assembly meetings, WebCo, TelCos with MSB / EMB	Management Steering Board (MSB), Coordinator, Executive Management Board (EMB)
User Group Committee	Share relevant project progress and knowledge	Progress reports, deliverables, results, strategic documents	project webpage / portal, conferences, workshops, General Assembly meetings	Scientific Officer (SO), MSB, Coordinator, WP leaders (WPL)
Wider NWP and Climate Community	Share relevant project progress and knowledge	Progress reports, deliverables, Communication Plan, strategic documents	portal, conferences, workshops, peer reviewed articles	SO, WPL, Project Partners, Supporters, Project Office
Business Sector *(Hardware vendors, SMEs)*	Ensuring maximum benefit	Progress reports, deliverables, products documentation	user guides and training material, workshops	SO,WP1 and WP5
Other EU – Projects	Sharing the understanding of project and results	Progress reports, deliverables, and results	public project website / portal, project meetings with other EU projects, scientific conferences and presentations [D5.2]	SO, MSB, WP1 & WP5, All Partners
Public and Society	Share relevant project progress and knowledge, Ensure visibility of the project	Relevant results and implications, FAQ	public project webpage, press releases, media contacts, animations, flyers, public lectures, links to other relevant web contents, project progress and significant results, progress reports	SO, PO, WP1 & WP5, All Partners

*Table 2.2b: Overview of ESiWACE main communication and tools (**this list is not exhaustive**)*

2.2.4 The ESiWACE Legacy – Beyond the Project

A particularity of Earth System Modelling is the fact that many activities have much longer time-scales than can be supported in a 4-year project. For example the typical lifetime of a weather, ocean or climate model is several decades during which the models evolve around some aging legacy code, corresponding to the order of 1000 man-years of development. Analysis of data from large endeavours such as the simulation for IPCC reports may also take many years. The computing hardware and most of the middleware layer of software change drastically in much shorter time scales. A central goal of ESiWACE is to identify and support components of the ESM workflow which have the potential to be sustainably supported on the longer time scale but be kept synchronized with evolving super computing environment in order to maintain the efficiency of the tools and consequently of the scientists.

The ESiWACE partners recognizes that there is a need to create a sustained funding for an infra - structure to continue this work (e.g. Mitchell et al., 2012[26]). There is no direct market today for the products and services we will provide even if downstream users such as climate service centres or private weather services will benefit from it. Indeed, our commitment to open access would make it difficult to monetize products, which is consistent with most of our scientific institutional partners being non-profit organisations. To be successful in the long run, the centre will therefore to a large extent be dependent on its ability to raise national or international funds.

A central task and delivery of ESiWACE will therefore be the development of a business plan to address this need [D1.3]. The matter of long-term sustainability and commitment of support for Earth system models is of central importance for the climate and weather community as a whole and we will foster a strategic planning involving existing governance structures such as the ENES and ECMWF boards. This will be supplemented by community building achieved through ESiWACE workshops, task-forces and special interest groups and exploiting the ENES portal to provide for discussion and cooperation by leading partners.

Specific options to consider within the business plan will be developed and discussed, both in terms of on-going funding for ESiWACE itself, and in terms of the activities and products that might be engendered. Additional possibilities of partnering with the private sector will be addressed. For this we will build on input from our private partners and also from interactions with the ETP4HPC.

Specific actions we envision so far include:

- ESiWACE private partners will investigate the possibility of providing selected components of the ESM workflow as building blocks. The increased maintainability of the ESM applications and increased efficiency of the associated workflow through commercial products (e.g. adding to established tools such as debuggers) could be beneficial not only for ESM users, but at the same time applicable to other markets and thus be rendered profitable.
- A very concrete goal we have set in this respect is the long-term continuation of the series of annual high quality workshops on HPC. The partners will commit to organize these and funding through private partners will be secured.
- Commitment from the partners of ESiWACE and potentially some of the supporters to long-term support of individual software components from institutional funding, This is in their own interest, fulfilling their own needs, but also benefitting from other partners, through distributed and shared efforts (thus avoiding redundant re-development). ESiWACE, by strengthening the sharing of software development, is an important step in that direction.
- Investigation as to whether collaborative funding could be sought from existing and future downstream services and projects.
- Address “classical” funding schemes through the Joint Programming Initiative on Climate, national funding agencies or through subsequent calls of the European Commission.

[26] Mitchell J., Budich R., Joussaume S., Lawrence B. and Marotzke J. (2012), “Infrastructure strategy for the European Earth System Modelling community 2012-2022”, ENES Report Series 1, 33 pp.
URL https://verc.enes.org/community/about-enes/the-future-of-enes/ENES foresight.pdf

The current ESiWACE proposal has some built-in features to guarantee that the work will be of benefit for the community whichever funding futures transpire in. Although we ask for funding for a three years period, we plan for project duration of 48 months. An initial phase of 4 months will be used to set up the governance structure of the project and establish a mood of cooperation. A closing phase of 9 months (i.e. project month 41 to 48) will see no more directly funded work in the technical work packages (WP2, WP3, WP4), but governance and management will be continued by the coordinating entities (ENES through CNRS-IPSL, DKRZ and ECMWF). This phase will be used to transfer the support and service into a next phase, be it directly funded as a continuation of ESiWACE or through continued commitments of the partners.

ESiWACE will close with a number of outputs. All project results will be made available in open access. We will present all its results and products in a coherent form at the large-scale by big events such as EGU and similar.

Dissemination measures *in the closing phase* of the project:

The final report of the project will include a plan for the use and dissemination of results, to demonstrate the added value and positive impact of the project on the European Union. A final publishable summary of the results will be made available to the Commission for dissemination in the public domain. This will include information on expected results, and their wider societal implications. The text will be drafted in a way to be understandable for a lay audience.

Dissemination measures *after the closure* of the project:

After the official end of the project, the results of the project will stay available on the project website hosted by DKRZ. The website archives all documentation related to the project, including publications, and will be accessible for 5 years after the end of the project

2.2.5 Achievement of Expected Impacts through Dissemination, Exploitation and Communication

The innovation of products, services and business is deeply linked to Europe's future economic growth. Target, audience and messages of the communication strategy will be clarified before deciding on the most appropriate media. With the appropriate choice of the tools mentioned above, ESiWACE aims at demonstrating how its research contributes to a **European Innovation Union** and how the public spending is accounted for, by providing a tangible proof that collaborative research and innovation actions add value by 1) showing how the European collaboration achieves more than would have been otherwise possible, contributing to competitiveness and solving societal issues; 2) showing how the outcome are relevant for our lives by introducing novel technologies and creating new jobs; 3) making better use of the results by making sure that they are taken up by the business sector and the scientific community to ensure follow up.

3 IMPLEMENTATION

3.1 Work plan — Work packages, deliverables and milestones

3.1.1 Brief presentation of the overall structure of the work plan

The work plan of ESiWACE is organized in five work packages (WP), three of which encompassing the bulk of the foreseen technical and scientific work (WP2, WP3, WP4) and two dealing with governance of ESiWACE products and services (WP1) and coordination of the project itself (WP5) respectively (Fig 3.1a)..

Table 3.1a List of work packages, Leaders and Co-Leaders

Nr.	Work Package Title	Lead Institution short name	Co-Lead Institution, short name	Person-Months
WP1	Governance, Engagement & long-term sustainability	CNRS-IPSL, Sylvie Joussaume	DKRZ, Joachim Biercamp	47
WP2	Scalability	ECMWF, Peter Bauer	CERFACS, Sophie Valcke	193
WP3	Usability	MPG Reinhard Budich	BSC, Oriol Mula-Valls	120
WP4	Exploitability	STFC Bryan Lawrence	DKRZ, Thomas Ludwig	118
WP5	Management & Dissemination	DKRZ, Joachim Biercamp	ECMWF Peter Bauer	36
Total Amount of Person Months				514

WP1 "Governance, Engagement and long-term sustainability" addresses governance and strategic questions for ESiWACE, establishing the integration of the project into the existing scientific and HPC infrastructure and ensuring ESiWACE serves the community Europe-wide in a long-sighted, sustainable way.

WP 5 "Management and Dissemination" comprises coordination and management tasks, to monitor the work progress of the consortium, to identify factors of risk for ESiWACE, to establish efficient internal communication (mutual exchange with users and scientific advisors) as well as interaction with the European Commission, and to ensure punctual dissemination of the results and communication.

The activities of WP1 and WP5 are classified as **Networking Activities**.

The technical and scientific tasks have been mapped to the three overarching themes of ESiWACE based on the peculiar requirements of ESM simulations and on the various challenges this community faces, especially in view of the changing HPC landscape with new high-end multicore parallelized architectures and increasing data volumes. These scientific-technical WPs address short and long-term aspects within the following type of activities:

- Networking Activities (NA)
- Service Activities (SA)
- Joint Research Activities (JRA)

WP2 on **"Scalability"** deals with the improvements in performance of model codes and tools (model coupler, I/O libraries) in order to augment their efficiency User training and support acting upon user requirements as well as provision of improved codes are an important follow-up ensuring that the modellers take full benefit of the planned software optimization and development.

WP3 on **"Usability"** aims to considerably improve the ease-of-use of available tools, computing and data handling infrastructures. The workload focuses on structuring and supporting the end-to-end workflow both in research and in production modes and on contributing in software

development and in definition and spreading of best practices. WP3 will organize workshops and foster user exchange on the planned activities

WP4 on **"Exploitability"** tackles the major roadblocks that hinder efficient use of the considerable amounts of data produced by weather and climate simulations. WP4 plans to co-design with industrial partners' data access interfaces and storage layouts and to develop new methods of tape exploitation. WP4 aims furthermore at increasing the compatibility of the two most used data formats in climate and weather modelling.

The Leaders and Co-Leaders of the work packages are listed in table 3.1.

Project duration

The overall project duration is of 48 months. During this period, we have foreseen three stages of the project (see Table 3.1.b):

- **Phase-in** from project month 1 to 4. This is the launching phase of all activities in the work packages, and for the setting up of the governance bodies of the project;
- **Core** starting in project month 5 and ending at the end of project month 40, in this phase all work packages are up and running and the groups are fully operational;
- **Phase-out** from project month 41 to end of project month 48: in this phase only the WP1 and WP 5 will be actively running, for finalising the management, dissemination, and exploitation activities and pursuing the sustainability of ESiWACE.

A more exhaustive, thorough description of the WPs and of the associated tasks and their required classification are to be found in the descriptions in the following pages

*Fig. 3.1a List of work packages and tasks (left) and graph showing the relation between work packages (right): The graph illustrates the spirit of creating a **centre** serving the community. The interaction of the three scientific/technical work packages which focus on the three ESiWACE themes is supported on the administrative level by WP5 and steered by WP1 to guarantee that the work is informed by and responds to community requirements.*

WP1 Governance and engagement

- T1.1 Engagement and governance
- T1.2 Enhancing community capacity in HPC
- T1.3 Strategic interaction with HPC ecosystem and HPC industry
- T1.4 Sustainability and business planning

WP2 Scalability

- T2.1 Support, training and integration of state of-the-art community models and tools
- T2.2 Performance analysis and inter-comparisons
- T2.3 Efficiency enhancement of models and tools
- T2.4 Preparing for exascale

WP3 Usability

- T3.1 ESM end-to-end workflows Recommendations
- T3.2 ESM system software stack recommendations
- T3.3 ESM scheduling
- T3.4 Co-Design for Usability

WP4 Exploitability

- T4.1 The business of storing and exploiting high volume climate data
- T4.2 New storage layout for Earth system data
- T4.3 New methods of exploiting tape
- T4.4 Semantic mapping between netCDF and GRIB

WP5 Management and Dissemination

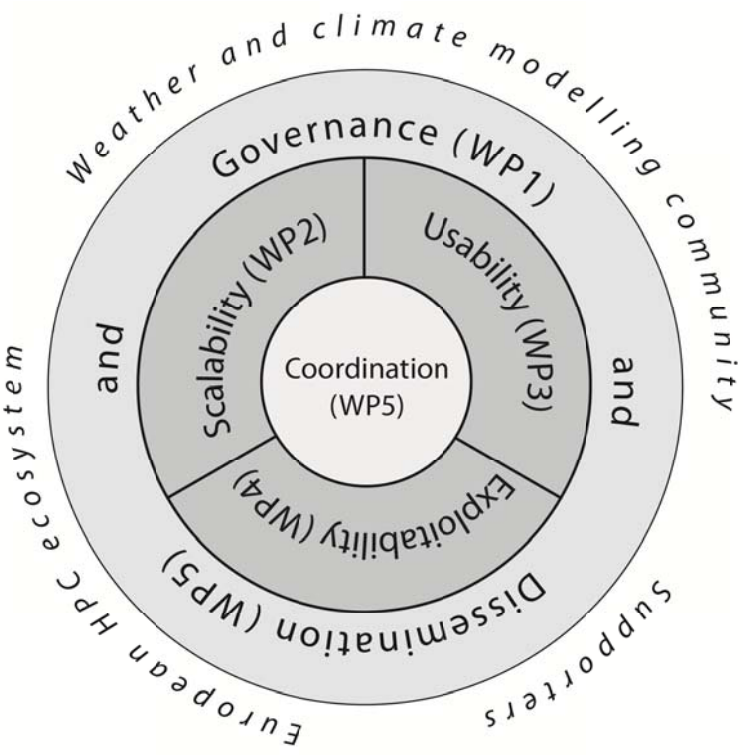
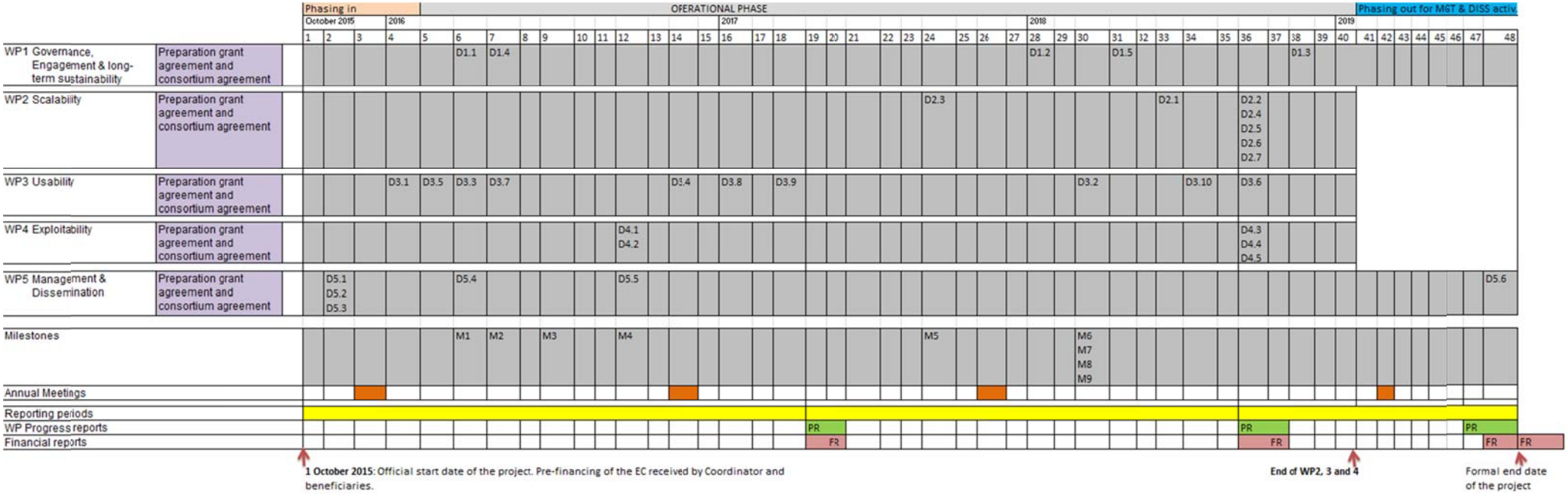


Table 3.1b Gantt chart: Timing of the different Work Packages. Deliverables, Milestones and Reports



M = Milestone
D = Deliverable
WP = Work Package
PR = Progress Report
FR = Financial Report

Description of each work package
In the upper part of the following tables, beneficiary institutions leading and co-leading the work package are in bold.

Work package number	1	**Start Date or Starting Event**		Project Month 1	
Work package title	Governance, Engagement & long-term Sustainability				
Participant number	3	1	2	4	5
Short name of participant	**CNRS-IPSL**	**DKRZ**	ECMWF	MPG	CERFACS
Person/months per participant:	**17**	**13**	4	2	3
Participant number	6	10	12	15	
Short name of participant	BSC	SMHI	CMCC	BULL	
Person/months per participant:	4	1	1	2	

Objectives
WP1 focuses on the governance of the ESiWACE. It is a **networking activity** in support to ESiWACE. More specifically WP1 aims at:

- **Community engagement and governance**: WP1 aims at better engaging the climate and weather modelling communities using Earth system models in the ESiWACE and ensure the ESiWACE serves the communities.
- WP1 will ensure:
  - User representation in the governance of common software and in ESiWACE new developments
  - Consistency and exploitation of possible synergies with other relevant activities in which the community is engaged (infrastructure projects, FETs, environment projects…).
- **Enhancing community capacity in HPC:** WP1 will foster efficient use of HPC through regular exchanges with the communities. It will also organize relations with PRACE and will deal with the PRACE resource allocation dedicated to the ESiWACE.
- **Networking with industry and ETP4HPC:** WP1 will network with ETP4HPC and relevant hardware and software industry.
- **Strengthening strategy and business planning:** WP1 will develop:
  - An HPC roadmap for HPC and ESM for the climate and weather communities
  - Upgrade the business plan, for which a first version is included in this proposal, and prepare for future activities, taking benefit from all the ESiWACE activities

This work package is led by: Sylvie Joussaume CNRS-IPSL (lead) and Joachim Biercamp DKRZ (co-lead)

Task 1.1 Engagement and governance
[Lead: CNRS-IPSL; Participants: DKRZ, CERFACS, MPG, ECMWF] Networking activity, service activity

Task 1.1.1 Liaising with the community [Lead: CNRS-IPSL; Participant: ECMWF, DKRZ]
Task 1.1.1 will:

- Address HPC issues relevant for the ESM communitiy, in particular cross-cutting issues, through discussions at the General Assembly and HPC workshops [**D1.4** and **D1.5**] as well as through feedback from the HPC Task Force (see Task 1.2.1), Scientific Advisory Board and supporting partners.
- Whenever needed, organize dedicated task forces for specific areas (HPC, Data, Networks) and special interest groups for specific software (Scalable IO, new dynamical cores, No-Posix, Software defined networks, Agile methods…), gathering ESiWACE members, supporting partners and other experts; this will offer an opportunity to link and coordinate engineering resources between different centres.
- Liaise with other European projects involving ESM and HPC and deploy this interaction as a

source of user feedbacks.

Task 1.1.2 Governance on community software [Lead: CNRS-IPSL; Participants: CERFACS, MPG]
Task 1.1.2 mainly concerns heritage software further developed and supported by the ESiWACE. It will:

- Establish general governance rules for community software, identifying different levels according to the maturity of software; the governance associated with each software shared in ESiWACE (e.g. OASIS, XIOS, CDOs, Cylc, NEMO) will be defined by identifying its stakeholder, steering and user groups **[D1.1];** a stronger organisation will be tested with the coupler OASIS and lessons will be used for other shared software.
- Establish criterion and procedure for prioritizing user requirements and defining the ESiWACE activities on shared community software accordingly.

Task 1.1.3 Governance on innovative ESiWACE developments [Lead: DKRZ; Participants: CNRS-IPSL]
Task 1.1.3 mainly concerns new software that is developed by ESiWACE. It will ensure that this software will be usable by a large range of users. It will:

- Establish governance rules for new ESiWACE developments); it will define stages of development and review process by users.
- Apply a user-driven approach and collect users scientific and technical requests and problems regarding their applications / tools; this will involve partners, supporting partners and, when relevant, computing centres where applications are deployed.

Task 1.2. Enhancing community capacity in HPC
[Lead: CNRS-IPSL; Participants: CERFACS, ECMWF, CMCC, BSC] Networking Activity

Task 1.2.1 Community building [Lead: CNRS-IPSL Participants: CERFACS, ECMWF, CMCC]
Task 1.2.1 will:

- Enlarge the ENES task force to better include the weather community; this task force will advise the ESiWACE on HPC issues for the community, such as relations with PRACE.
- Organise annual workshops, gathering the ESM community, to share experience on the state of the art in HPC and to discuss relevant cross-cutting issues
-

Task 1.2.2 Strengthening the interface with PRACE [Lead: CNRS-IPSL; Participants: BSC]
Task 1.2.2 will:

- Manage relations with PRACE, in particular regarding the ESiWACE dedicated computing allocation, ensuring that this resource is used by project partners for developments in the framework of the ESiWACE (e.g. the performance benchmarking of WP2 T2) but also, through open calls, for external partners testing software developed with the support of the ESiWACE.
- Strengthen interactions with PRACE, through reporting on community needs, participating to PRACE foresights, interaction with PRACE projects.

Task 1.3. Strategic Interaction with HPC eco-system and HPC industry
[Lead: DKRZ; Participants: ECMWF, BSC] Networking Activity
Task 1.3 will liaise with ETP4HPC and the European HPC eco-system. In this task, we will:

- Map the activities of ESiWACE to the Strategic Research Agenda[27] and research topic timelines of ETP4HPC and contribute to their updating and extrapolation.

[27] www.etp4hpc.eu/wp-content/uploads/2013/06/ETP4HPC_book_singlePage.pdf

- Ensure close links with HPC related hard- and software industry and will foster their involvement in ESiWACE activities, in particular their participation to the annual HPC workshops.
- Establish links on the technical level with PRACE and other HPC centres. This will ensure that on one hand ESiWACE developments are informed by technical constraints and on the other hand that requirements of ESM applications are considered by the centres.

Task 1.4. Sustainability and business planning
[Lead: DKRZ; Participants: CNRS-IPSL, Bull, ECMWF, SMHI] Networking Activity

Task 1.4.1 Roadmap for HPC for ESM
Task 1.4.1 will produce a roadmap for HPC for ESM **[D1.2].** This will integrate input from other tasks and other work packages and will form a basis for the ESiWACE long-term sustainability. It will benefit from discussions at general Assemblies and the annual HPC workshops. It will be elaborated with input from the HPC task force and will benefit from exchanges with the supporting partners. The roadmap will address:

- The "place" of ESM applications in the HPC eco-system (Input from Task 1.1.3 and Task 1.2.2)
- A strategy for community tools (input from Task 1.1.2 / 1.1.3 and WP2 T2.1.2)
- How to cope with the changing HPC landscape and technology in the form of a programmers' guide for ESM (Input from WP2)
- A users' guide of best practices for ESM applications (basically prepared by WP3)

Tasks 1.4.2 Business plan
Task 4.2 will take care of the update of the business plan **[D1.3]**. Two alternative concepts will be developed: one for a second funded phase of ESiWACE and one for continued engagement without further EU funding. The concepts will include the findings and experiences from those tasks that deal with shared and newly developed software and will lay out how continued community support can be secured. This will include alternate support concepts and the potential for integrating the developed support schemes, tools and software into national and international funding schemes.

Interactions with other Work Packages
This Work Package, in strong interaction with the WP5 management tasks, provides:

- Scientific guidance and leadership for all Work Packages and to the project as a whole, in particular to WP2 on common shared software and to WP2, WP3 and WP4 on new developments.
- Support, guidance and management assistance to all Work Packages as required and to the project as a whole.

This Work Package receives:

- Input from WP2 on user feedbacks regarding application of governance defined in T1.1.2
- Input from WP2, WP3 and WP4 on HPC issues and cross-cutting activities
- Input from WP2, WP3 and WP4 on needs for PRACE ESiWACE allocation and report from the use of allocation

Deliverables
D1.1 Agreed portfolio of community tools: D1.1 will report on shared software. It will define general governance rules for shared software and how they are applied for each software, in particular their user group and how it interacts with ESiWACE (CNRS-IPSL, R, PU, PM6).
D1.2 White paper on HPC roadmap for ESM modelling community: the deliverable will report on strategy of the weather and climate community on HPC,(DKRZ, R, PU, PM36).
D1.3 Business Plan (DKRZ, R, PU, M38).
D1.4 First International HPC workshop (CERFACS, OTHER, PU, PM7)
D1.5 Second International HPC workshop (CMCC, OTHER, PU, PM31)

Work package number	2	Start Date or Starting Event			Project Month 1	
Work package title	Scalability					
Participant number	2	5	1	3	4	6
Short name of participant	**ECMWF**	**CERFACS**	DKRZ	CNRS-IPSL	MPG	BSC
Person/months per participant:	**37**	**27**	10	36	3	22
Participant number	8	10	11	12	13	15
Short name of participant	MetO	SMHI	ICHEC	CMCC	DWD (*)	Bull
Person/months per participant:	3	20	6	9	0	20
(*) No person months, but contribute to the activities in this work package with the organisation of workshops						

Objectives

- Centralize support of community models and tools and provide improved access to scientific and performance upgrades
- Coordinate efforts on performance inter-comparisons between community models and tools
- Provide support and training for community I/O tools and strategies for the future
- Investigate scientific and technical options for efficiency upgrades and methodologies to reduce volume of future high-resolution modelling output

This work package is led by: Peter Bauer ECMWF (lead) and Sophie Valcke CERFACS (co-lead)

Task 2.1. Support, training and integration of state-of-the-art community models and tools [Lead: SMHI; Participants: CERFACS, BSC, ECMWF, CNRS-IPSL], Networking Activity

This task fosters improved user support, enhanced training, and fastest integration of existing community models and tools, in response to the software governance defined in WP1, leading to enforced user-driven evolution of the community software. The metrics that will be used to monitor the two sub-task are the frequency of official releases, the number of downloads, development tickets opened and closed, bug fixes, wiki page edits, and mails exchanged with users.

Task 2.1.1 NEMO and EC-Earth [Lead: SMHI; Participants: BSC, ECMWF, CNRS-IPSL]

NEMO and EC-Earth are leading edge community applications both driven by consortium of European countries. NEMO is a modelling framework for oceanographic research, operational seasonal forecast and climate studies and EC-Earth represents a mature Earth System Model at the interface between weather and climate modelling. This task will facilitate community wide access and use of NEMO and EC-Earth latest versions, including version control and ticketing system, diffusion of best practice in using these models and will accelerate their update cycle. In particular, it will ensure a faster integration of OpenIFS, the open source version of the atmosphere component in EC-Earth (https://software.ecmwf.int/wiki/display/OIFS/OpenIFS+Home) resulting in more rapid benefit from on-going scientific developments for the community.

Task 2.1.2 OASIS coupler and, XIOS I/O server [Lead: CERFACS; Participants: CNRS-IPSL]

Use of the well-established OASIS coupler and the newer XIOS I/O server is constantly increasing in the climate modelling community. Beyond traditional user support in the form of a mail help-desk, on-line forum, User Guide, tutorials, FAQs, trainings and hints for best practice that will be established for XIOS and maintained for OASIS, this task will be devoted to governed integration of specific user needs in the software. Using the governance structure defined in WP1 T1.1.2, user-specific problems and requirements will be analysed, bug fixes will be developed when needed, but new strategic functionalities will possibly also be added.

Task 2.2. Performance analysis and inter-comparisons
[Lead: CERFACS. Participants: ECMWF, BSC, Bull, CMCC, DKRZ, DWD, CNRS-IPSL,

MetO, MPG, SMHI], Networking Activity
On the road to exascale, the performance of the I/O systems and coupling technologies is becoming a major challenge in weather and climate coupled models. This task will propose a set of metrics, with a focus on energy efficiency, for measuring the performances of parallel applications and will use them to benchmark I/O and coupling tools. A common kick-off workshop will offer training on HPC performance tools and will launch the preparation of the benchmarks. PRACE tier-0 and tier-1 systems are targeted to run the benchmark associated test cases, in the framework of the resource allocation dedicated to ESiWACE negotiated in WP1 T1.2.2. Results will be analysed in a final common workshop [**D2.1 DWD**] and a strategy to overcome main efficiency bottlenecks and to make appropriate choices for the future exascale platforms will be proposed.

Task 2.2.1 Standard efficiency metrics for parallel performance analysis
[Lead: CMCC; Participants: BSC, SMHI]
In this task, the set of standard metrics defined in IS-ENES2 for ESM performance analysis will be extended to integrate energy efficiency for compute intensive tasks. The definition of a standard methodology will allow to perform the energy profiling of the applications and to identify the main sources of the energy cost (e.g. data moving on and off chip). Through the PAPI library, these measures will be enabled/disabled for specific routines and Extrae and Paraver, product developed by BSC, will then be used to visualise the corresponding data per routine.

Task 2.2.2 Benchmarking I/O servers and coupling technologies
[Lead: DWD; Participants: CERFACS, Bull, CMCC, DKRZ, CNRS-IPSL, MetO, MPG, SMHI]
A first benchmark suite for coupling technologies has been defined in IS-ENES2 and is currently under implementation. In this task, the existing benchmark suite will be revised and the tests will be extended targeting new platforms with O(10K-100K) cores accessible during the ESiWACE longer timeframe. OASIS, OpenPALM, ESMF, XIOS and YAC will be considered.
Benchmark suites for I/O libraries and servers will have to be built from scratch. The inter-comparison will include XIOS, ESMF and CDI-pio. EC-Earth will be used as a benchmark application.

Task 2.3 Efficiency enhancement of models and tools
[Lead: BSC. Participants: Bull, CMCC, DKRZ, ECMWF, CNRS-IPSL, SMHI, CERFACS, ICHEC]
Joint research activity
Radical refactoring of ESM codes and tools will most probably be required to take full advantage of future exascale computing platforms. Until then however, existing codes still need to be incrementally revised to fully exploit massively parallel supercomputers accessible today.

Task 2.3.1 Model optimisation
[Lead: BSC; Participants: Bull, CMCC, DKRZ, ECMWF, CNRS-IPSL, SMHI]
This task will assess compute/communication performance of different codes, i.e. OpenIFS and NEMO (being part of EC-Earth) as well as ICON, with analysis tools that employ adequate tracing protocols, for example Extrae/Paraver, developed by BSC. Strategies for performance enhancement will be developed and optimizations such as overlap of communication and computation (e.g. YAXT for ICON), fewer but bigger communications, two-sided communication, asynchronous communications through partitioned global address space concepts (PGAS), improved code vectorization and use of OpenMP will be implemented. This task relates to Task 3.2 of WP 3 about software stack since Fortran-PGAS is currently not supported by all compilers. [**D2.2, BSC**].

Task 2.3.2 Tool optimization and enhancement
[Lead: CNRS-IPSL; Participants: Bull, CERFACS, ICHEC]
Even before reaching the exascale, it is clear today that key developments are needed in our community tools to fit user needs in terms of performance and parallel functionalities. In this task, the following priority issues will be addressed:

- Currently, both the OASIS coupler and the XIOS I/O server support only MPI-task

parallelism and it is known that multithreading is becoming essential in climate codes. For example, 240 threads are needed to fully exploit the 60-core Intel Xeon Phi processor. The client part of OASIS and XIOS will evolve to become multithreaded and/or thread safe in order to fully fit the calling program multithreaded structure. [**D2.3, CERFACS**]

- XIOS, originally developed for the climate modelling community, naturally supports the netCDF file format. To extend its use to the weather community, support of the GRIB2 format is imperatively needed. It is planned here to enhance XIOS so to support GRIB2 format in parallel mode with a multi-process server and for all types of grids, i.e. regular but also curvilinear, reduced Gaussian, and unstructured grids. This work will be based on the semantic mapping between netCDF and GRIB developed in WP4 T4.2. [**D2.4, CNRS-IPSL**]
- It is now clearly recognized that the main functions of an I/O server and of a coupler, i.e. communication and interpolation of data (also envisaged in I/O systems for data output reduction) are extremely alike. In this task, we will work toward a convergence of these tools by proposing a unified API (Application Programming Interface) for both I/O and coupling in component models. In particular, XIOS will be upgraded so to include full coupling functionalities: fully parallel 2nd order conservative on-the-sphere regridding functions developed in the framework of the G8 ICOMEX project, communication of data between two parallel component processes, etc. The coupling performance of XIOS will be benchmarked and compared to other couplers (see T2.2.2) and if judged appropriate, a strategy for full convergence of I/O and coupling tools will be defined (**D2.5, CNRS-IPSL**).

Task 2.4 Preparing for exascale
[Lead: ECMWF. Participants: CERFACS, DKRZ, CNRS-IPSL, SMHI, BSC], Joint research activity
This task targets few precise developments to prepare for the next-generation model components that will be assembled for exascale systems by projects like CHANCE (for NEMO) and ESCAPE (for IFS), which have been recently submitted to the call FETHPC-1-2014 of H2020: Research & Innovation Actions (RIA).

Task 2.4.1 Concurrency and accuracy [Lead: ECMWF; Participants: CERFACS, DKRZ, CNRS-IPSL]
Weather and climate models integrate equations describing the equations of motion, mass and heat and add non-resolved process contributions through physical parameterizations. These scientific modules are usually executed sequentially on the same set of computing resources and the scientific performance of the overall model strongly depends on this sequence. This task will investigate the possibility in NEMO, ICON and OpenIFS of de-sequencing and thus enhancing concurrency between e.g. expensive parts of atmospheric physical parameterizations (such as radiation) and other calculations, or the sea-ice and biogeochemistry and the ocean dynamics.
Further, while the representation of models variables in double precision is common practice to ensure accuracy, recent studies suggest that significant efficiency gains can be achieved from single-precision representation. This option will be investigated for EC-Earth, in particular running long ensemble integrations.
Linking with the performance analysis in T2.1, this task will produce a report (**D2.6, ECMWF**) outlining a strategic approach based on concurrency and accuracy for efficiency gains in ESMs without jeopardizing the scientific performance of the models.

Task 2.4.2 Knowledge compression [Lead: ECMWF. Participants: BSC, CNRS-IPSL, SMHI]
Significant growth of ensemble weather and climate model output requires new approaches to output management without deteriorating the information contained in the model integrations. The dimensions that drive output volume are saved time steps, horizontal and vertical resolution as well as ensemble size. This task will investigate avenues for mostly reducing the ensemble dimension using operational NWP model and EC-Earth ensemble output. The task will deliver a report [**D2.7, ECMWF**] making recommendations for knowledge compression for ensemble weather and climate model output management.

Interactions with other Work Packages

This Work Package provides

- Through the support and training on state-of-the-art community tools (see T2.1) WP2 will establish privileged contacts with users and is therefore in a strong position to provide feedbacks to WP1 T.1.1.2 for defining the rules of a governance for community tools.
- Input to WP1 in cross cutting issues
- Input to WP1 on the need for resource
-

This Work Package receives

- The governance established in WP1 T1.1.2 will in turn help identify key strategic functionalities to implement in these tools as requested by the users. The allocations on tier-0 platforms dedicated to ESiWACE negotiated in WP1 T1.2.2 will provide an essential resource to realize the coupling and I/O benchmarks described in T2.2.2.
- Work done in T3.2 of WP3 about software stack will be greatly facilitate realization of T2.3.1 “Model optimisation”
- Supporting GRIB2 format in XIOS (see T2.3.2) will be based on the semantic mapping between netCDF and GRIB developed in WP4 T4.2
-

Deliverables

D2.1: Final workshop report including benchmark results and software development strategy for future exascale platforms (DWD,R, PU, PM33).
D2.2: Optimised community model code options tested on selected cases (BSC, OTHER, PU, M36).
D2.3: OASIS version adapted to many-core architectures (CERFACS, OTHER, PU, PM24).
D2.4: XIOS version supporting GRIB2 format, including on-line diagnostics and adapted to many-core architectures (CNRS-IPSL, OTHER, PU, M36).
D2.5: White paper on a strategy for full convergence of I/O and coupling tools (CNRS-IPSL, R, PU, PM36).
D2.6: Report outlining a strategic approach for efficiency savings based on concurrency and accuracy (ECMWF, R, PU, PM36).
D2.7: Report from study of data compression assessment of dimensions required for Earth system model output archiving retaining information but reducing volume (ECMWF, OTHER, PU, PM36).

Work package number	3		Start Date or Starting Event		Project Month 1			
Work package title	Usability							
Participant number	4	6	1	2	8	9	12	16
Short name of participant	**MPG**	**BSC**	DKRZ	ECMWF	MetO	UREAD	CMCC	Allinea
Person/months/ participant:	**15**	**18**	6	3	54	6	9	6

Objectives of WP3 / of the proposal are to:

- Support scientific excellence through provision of effective HPC and big data infrastructures by allowing scientists to more easily design and carry out simulation campaigns that seamlessly exploit the existing multi-model framework, including the inherent value of model diversity.
- Considerably improve the ease-of-use of the software, computing and data-handling infrastructure for ESM scientists from the applications through the software stack to the hardware.
- Support the uptake of scheduling engines within the community through user-driven development, training and support services. This activity will absorb 40% of the effort in this work package, since it will provide a step change in the community's ability to cope with increasing suite complexity for both climate and weather applications in production and research modes. MetO, who have existing skills in Cylc and are supporting its adoption, will lead this task
- Reduce the skills gaps at individual centres by sharing best practice through worked examples using use-cases derived from user-driven engagement, and governance.
- Propose avenues for co-design of system software and architectures between industry and applications

This work package is led by: Reinhard Budich, MPG (lead) and Oriol Mula-Valls, BSC (co-lead)

Task 3.1 ESM End-to-end Workflows Recommendations
[Lead: MPG. Participants: DRKZ, BSC, UREAD, Allinea]
In this task, an Application Software Environment necessary for multi-model simulations will be specified and assembled in a prototype ESM workflow framework, which will be necessary to exploit the exascale opportunities of the future.

Task 3.1.1. Requirements and Specification
[Lead: MPG; Participants: BSC, UREAD] Networking Activity
MPG, with the aid of BSC and UREAD, will host an introductory workshop where end-user requirements for environments and workflows will be discussed as well as best practices and lessons learned in specifying and implementing them. The aim of the workshop is to initiate the specification of a standard recommendation for an ESM End-to-end Workflows and Application Software Environments framework. Informed by experienced users, key players from the user and technical provider communities will be invited both from Europe and the US (National Centre for Atmospheric Research NCAR, Boulder, USA; Geophysical Fluid Dynamics Laboratory GFDL, Princeton, USA). Allinea will provide assistance for ensuring the ability of the design to support development and performance tools. The product will be versions [D3.2] of a white paper, published and kept up-to-date on the ENES portal by ESiWACE. For the first version [D3.1] of the white paper, several writing sprints of the smaller writers team will be scheduled.

Task 3.1.2. Development of Use Case
[Lead: BSC; Participants: MPG, UREAD, Allinea] Joint research activity
Once first drafts of the white paper are circulated, a small team of scientific programmers from BSC (team lead), MPG and UREAD will start to convert the recommendations into a real life

environment, our use case [D3.3]. This use case will be the workflow necessary for the ENES summer schools, planned to be held by UREAD at CSC[28], Finland, – a PRACE Tier1 centre - in 2016 (3rdE2SCMS, European Earth System and Climate Modelling School). At the previous two E2SCMS, three GCMs were used to teach the students, each operated in its own framework. The use case will make it possible for students to better co-design and exploit the simulation exercises, by providing a unified framework. This way the use case shows on a somewhat smaller scale, what the system specification will be able to deliver to projects. The group will start with first framework sketches very early in the project, and iterate through further drafts. Allinea will ensure the readiness of the prototype for their methods and tools, and that the prototype is able to integrate into a modern scheduling environment. The prototype will then be handed over to T3.1.3 in time for the 3rdE2SCMS to be tested in a provisional environment at CSC.

Task 3.1.3. First Installations
[Lead: UREAD; Participants: BSC, MPG, Allinea] Joint research activity, Development of service
For these tests UREAD (team lead, organizer of the 3rdE2SCMS), BSC and MPG will install the software collection provided by T3.1.2 at CSC, and test it, aided by Allinea. Success metrics shall be established in advance. The ultimate test will be if the environment is usable for the 3rdE2SCMS and gets good ratings by the participants [D3.4]. The next step will then be to transport the environment to other PRACE and tier1 machines with more models than in 3rdE2SCMS.

Task 3.2 ESM System Software Stack Recommendations
[Lead: BSC. Participants: DKRZ, Allinea, MPG, UREAD]
In this task, a methodology for maintaining a portable HPC system software stack will be developed for ESM applications, with their specific needs in terms of e.g. Pre- and Post-Processing, Analysis, Compilation and data handling software. This will support the exploitation of the pan-European HPC infrastructure.

Task 3.2.1 Requirements and Specification
[Lead: BSC; Participants: MPG, DKRZ, UREAD, Allinea] Networking Activity
An introductory, user-driven workshop will discuss best practices and lessons learned in specifying and implementing software stacks, and requirements for them. BSC will, with the aid of DKRZ, invite experienced system administrators, users and software architects from Europe, the US (GFDL, NCAR) and New Zealand (National Institute of Water and Atmospheric Research NIWA)). The aim of the workshop is to initiate the specification of a standard recommendation for an ESM System Software Stack. Allinea will provide assistance for ensuring the ability of the design to support development and performance tools. The recommendation will have the form of versions [D3.6] of a white paper, published on the ENES portal. The white paper should be a handbook for system administrators [D3.5] on how to select, configure and install ESM software stacks in order to be prepared for applications from our community and could serve as a base for a quality label for compute centres ("This centre is enabled for ESM applications"). The handbook needs scheduled updates.

Task 3.2.2 Prototyping [Lead: BSC; Participants: DKRZ] Joint research activity
Once first drafts of the white paper are circulated, a small team of scientific programmers will convert the recommendations to be expected into a real software stack. This will be installed at DKRZ, and used and tested also by non-DKRZ-administrators and users (BSC, other partner volunteers). It will enable the workflow necessary for the 3rdE2SCMS [D3.8]. The group will start with first prototypes of the stack as soon as possible, and iterate through the development cycles as further drafts become available [D3.7]. The stack will then be handed over to T3.1.3 in time for the 3rdE2SCMS to be tested in different environments.

[28] CSC = Centre for Scientific Computing, Helsinki, Finland

Task 3.2.3 First Installations
[Lead: DKRZ; Participants: BSC, UREAD, Allinea] Joint research activity, Development of service
For those tests it will be necessary to install the software collection and stack provided by T3.1.2 and T3.2.2 on different machines at BSC, CSC, and UREAD and test it against agreed upon success metrics and evaluation plans. The ultimate test will be, if the stack is easy to install and maintain by the system administrators, and easily usable for the 3rdE2SCMS. In parallel to this activity, different computing centres will be approached by the tasks participants in order to negotiate the conditions under which they would consider hosting the ESM system SW stack on their machines. The next step will then be to transport the stack to other PRACE- and topical tier 1-machines, using the different (configurations of the) operating system installed in the different centres: This activity is probably beyond the end of this project.

Task 3.3 ESM Scheduling [Lead: MetO. Participants: MPG, BSC, CMCC]
This task will maximise the chances of building a supported, user-driven community around the Cylc meta-scheduler for complex climate and weather suites on HPC systems.

Task 3.3.1: Scoping of the Work
[Lead: MetO; Participants: MPG] Networking Activity, Development of service
A user-centric, initial workshop will establish the development priorities and the most effective form of user support services. It will, with the aid of WP1, establish a governance process for continued support and development activities within and after the project (consistent with the ESiWACE business plan[D3.1]). MetO will organize and evaluate the workshop; the other partners will help prepare, participate, and will assist in the evaluation.
We plan to involve in this task two supporting institutions, NIWA and GFDL (see the letters of support provided in Appendix 1)

Task 3.3.2 Cylc Development [Lead: MetO; Participants: MPG] Development of service
Informed by the workshop and the governance activity, under the Lead of MetO and assisted by BSC and MPG, in cooperation with NIWA and inviting involvement from GFDL, Cylc will be developed to support a wider community and set of platforms. The development will consist of two activities: Firstly to refactor code to ensure continued supportability and to allow a wider community engagement in the code of Cylc; second, to develop any new features required by the community according to the results of the governance activity in particular considering the challenges of exploiting exascale computing in climate and weather applications in a pan-European context [D3.9].

Task 3.3.3 Cylc Support Services [Lead: MetO; Participants: BSC] Provisioning of service
Informed by the workshop and the governance activity, training and support services will be provided to the community as prioritised by the governance activity. MetO will be responsible for level 2 support with level 1 support coming from local help-desk services. They will also be responsible for training, including the training of the local level 1 support.

Task 3.3.4 Scheduling Systems Development
[Lead: CMCC; Participant: BSC] Networking Activity, Joint research activity
The areas of data analytics and multi-site, multi-model experiments need special attention in terms of their scheduling. An initial workshop on these topics will develop ideas for system architectures and design sketches for the appropriate software solutions, and will show paths to first implementations. Where systems already exist like Autosubmit[29] (supported by IS-ENES2 and adhering to PRACE guidelines), Ophidia[30], Cylc, and others, implementation strategies, possibly on the interaction between them, will be suggested informed by the governance

[29] http://ic3.cat/wikicfu/index.php/Tools/Autosubmit
[30] http://ophidia.cmcc.it/

process to be established like in T3.3.1, and interacting with T3.1 and T3.2. BSC and CMCC will share the task to organize and run the workshop and it's evaluation, in close cooperation with WP1 and informed by the other WP partners [D3.10].

Task 3.4 Co-Design for Usability [Lead: ECMWF. Participants: MPG, Allinea]
If the community is to design efficient, powerful and usable simulation systems, a multi-disciplinary approach linking scientific software engineers with industry experts is essential. This task is to help develop such relationships employing a two-stranded strategy.

Task 3.4.1 Requirements Capture, Recommendations for Activities, and Implementation Methods for an ESM Co-Design Approach [ECMWF] Networking Activity
The aim of the task is to develop an exchange platform for the ESiWACE community and industry supporting the co-design of compiler standards. Output is a white paper that will take into account that boundary conditions and requirements will change during and after the project.
In an introductory workshop, experienced developers from NWP centres, the seven ENES modelling communities, international centres, contact points from open source compiler and software builders, and key representatives of the industry on the working level will be invited by ECMWF. They will reduce skill and knowledge gaps by sharing best practices and lessons learned in co-design approaches and activities. These experts should not only be interested in co-design, but also in representing ESiWACE in bodies governing software standards for, e.g., compilers. A key aim will be to engender a unified voice to influence the HPC suppliers on behalf of a coordinated and increasingly convergent weather and climate community. The workshop will result in a white paper specifying recommendations for this interaction. The white paper will provide the basis for a comprehensive requirements capture, recommend activities to liaise with industry, solution providers, and standards bodies, and describe implementation methods to achieve an efficient lobbying in the future. The initial workshop should be organised back-to-back with one of the HPC workshops of ECMWF, ENES (planned) or NCAR. The sustained business plan of ESIWACE will contain a series of follow-on workshops for continuing the discussion within this group, revise requirements and recommendations, and report on implementation status.

Task 3.4.2 Usability Concepts: Joint developments by Communities, Solution Providers, and Industry [Participants: Allinea, MPG] Networking Activity
Simulation workflows in Earth system modelling for climate and weather are very complex, and do not serve high numbers of users. Rather, they are perceived as single-site problems, resulting in a natural tendency to single-site solutions. These are often not very well usable.
Usability and complexity are problems in the software development field in general. The ESiWACE community would benefit substantially from sharing all aspects of e.g. complexity hiding or solutions optimized for usability from the software industry.
Allinea will, with the aid of WP1 and ETP4HPC, initiate a series of workshops – only an initial one taking place during the lifetime of the ESiWACE co-located with another larger event of interest – bringing together Communities, Solution Providers, and Industry. In such workshops concerns about site dependencies, support structures, and many other aspects like future developments can be discussed, but also (their) solutions be presented. These workshops can serve as a platform to foster community involvement e.g. in standardization committees, where future common developments are decided, by establishing direct contacts to solution providers and industry: They are involved in such bodies and will provide appropriate links for more co-design activities between communities and industry.

Interaction with other Work Packages

This Work Package provides

- Input to WP1 in cross cutting issues
- Input to WP1 on the need for resource
- Information to WP2 in particular T2.2 about system software stack available in most centres
- Information to WP1 about the system software stack available in most centres
- Input to W2 and WP4 regarding the requirement of tools and methods arising from the end-to-end workflow of ESM
- D3.4 (T3.1) and D3.8 (T3.2) will provide input to the governance processes established by WP1

This Work Package receives

- Input from WP1 regarding requirements on new developments
- Input from WP2, in particular task 1 on maturity and popularity of common software
- For D3.2, D3.6 and D3.10 input from both WP2 and WP4 on recent shared software development

Deliverables

D3.1: ESiWACE Application Software Framework: A White Paper. Version 1, Specification of a Standard Recommendation for an ESM End-to-end Workflows and Application Software Environments Framework (MPG, R, PU, PM4).
D3.2: Update of ESiWACE Application Software Framework (D3.1), Version 2 (MPG, R, PU, PM30).
D3.3: Software specification for the 3rdE2SCMS, narrowing down D3.1 for the 3rdE2SCMS (MPG, R, PU, PM6)
D3.4: Experiences with ESM Multi-model Ensembles for Educational Purposes: A report from the use of D3.1 for the 3rdE2SCMS(MPG, R, PU, PM14)
D3.5: How to select, configure and install ESM software stacks: Handbook for system administrators Specification of a standard recommendation for an ESM System Software Stack in the form of a white paper (BSC, R, PU, PM5)
D3.6:Update Handbook for system administrators (D3.5) (BSC, R, PU, M32)
D3.7: Software Stack for ESM– A Specification narrowing down D3.5 for the 3rdE2SCMS (BSC, R, PU, PM7)
D3.8: Experiences with the ENES System Software Stack: A Report from the use of D3.5 for the 3rdE2SCMS (DKRZ, R, PU, PM16)
D3.9: ESiWACE Scheduler development and support activities: a first report of Scheduler development and support activities for T3.3.2 and T3.3.3. (MetO, R, PU, PM18)
D3.10: ESiWACE Scheduler development and support activities, v2: a second report of Scheduler development and support activities, updating D3.9 and reporting on T3.3.4 (MetO & CMCC, R, PU, PM 34)

Work package number	4	Start Date or Starting Event			Project Month 1
Work package title	Exploitability				
Participant number	**1**	**7**	2	12	14
Short name of participant	**DKRZ**	**STFC**	ECMWF	CMCC	SEAGATE
Person/months per participant:	**45**	**33**	12	10	18

Objectives

Making the best use of HPC in Earth simulation requires storing and manipulating vast quantities of data. Often such manipulation involves **handling** very high volumes of data (by contrast to many commercial applications which **sift**, or query into, high volumes of data). Existing storage hardware and software is not well adapted to these use modes, particularly, for binary data. Hence the overall goal of this work package is to address the exploitability of storage systems in weather and climate HPC, first by modelling existing and possible future systems, then by developing improved software and exploitation strategies for both disk and tape systems.

The work is broken into four specific tasks:

1. **Understanding the business of storing and exploiting high volume Earth system data** by developing a model which can be used to both understand the cost and performance of a range of storage strategies in weather and climate HPC workflows (and compare those with typical commercial strategies).
2. Developing a **New disk storage layout for Earth system data** to overcome the performance limitations of existing fixed on-disk formats and APIs by providing a novel data-specific layout interface. The new interface will be capable of supporting both interoperability between higher-level file formats and of customisation to local heterogeneous disk storage environments.
3. Developing **New tape access strategies and software customised for Earth system data** by first modelling and simulating possible strategies, and then developing a new software library which provides both higher bandwidth to tape storage and increased storage redundancy.
4. **Supporting semantic mapping between key weather and climate formats.** While format interoperability exists between GRIB (primarily weather) and netCDF (primarily climate) data, conversion currently involves information loss. ESiWACE will provide support for the community to define and populate a semantic mapping that will facilitate community interoperability.

This work package is led by: Bryan Lawrence, STFC (lead) and Thomas Ludwig, DKRZ (co-lead)

Task 4.1 The business of storing and exploiting high volume climate data [Lead: DKRZ. Participants: STFC] Joint research activity and partly networking activity

System and data centre design and procurement are complex tasks. We will parameterise the required activities into a business model that could, for example, given building and power capacity, predict storage capacity and power drawdown. In and of itself, such a model is very straightforward, but building in the ability to understand how choices as to ensemble-size, model resolution, and run length, will impact both on compute and storage requirements, is a much more demanding. This new model will expose the very direct trade-offs between scientific aspirations and physical limits (power, machine room and tape library size). Specifically, the very significant increases needed in the proportion of budget devoted both to storage capital costs, and storage recurrent costs will be contrasted with future compute availability. The model will also be designed to help direct future research in I/O towards the most promising activities. Addressing this will require a short period of sustained working in the two main academic partners to develop, test and publish suitable business models. In a first step, the developed model will be disseminated to participating data centres and checked. In a second step, it will be published. DKRZ will develop model components to cover hardware, software and data centre aspects where STFC will incorporate domain-specific aspects for Earth system models and operation. A report describing the model and a lightweight

implementation that allows experimenting with model parameters will be released as [**D4.1**].

Task 4.2 New Storage Layout for Earth system data [Lead: DKRZ; Participants: Seagate, CMCC, STFC, ECMWF] Joint research activity

I/O is being addressed at a number of levels within ESiWACE, since both current experience and projections have highlighted the performance/volume challenges ahead. The main goal of this task is to address performance and physical capacity issues associated with writing, accessing, and Earth system data in the disk subsystems themselves. One key problem that can be addressed is separation of file metadata operations from data access – this is the strategy some hybrid disk systems use to improve performance by putting file system metadata on SSD and data itself on spinning platters. However, with netCDF or GRIB data, the scientific relevant metadata and much of the information about actual data layout is invisible to the file system (whether parallel or serial), which cannot then exploit acceleration techniques. To address this, we propose to develop and test a Earth system data (ESD) middleware library which understands these key formats, and which is customisable for different hardware environments (as will occur in differing data centre architectures). It will support, for example, writing the scientific metadata and possibly coordinate axes to SSD systems, and the binary data fields to traditional systems potentially split into multiple files. Where in-memory storage back ends are available, fast online data analytics will also become possible. The architecture is illustrated in the Figure below. The layout components will decide the data placement and orchestrate data access on the storage characteristics. Both blocking and non-blocking APIs will be supported to address typical use-cases. Tools will accompany the library so that data can be reconstructed as compatible with netCDF/GRiB and can be archived and exchanged. The design of the architecture will be documented in [**D4.2**], an operational demonstrator will be released and a performance optimized version for all data centres released in [**D4.3**].

DKRZ will implement the base architecture and modules, while Seagate who will provide an optimised object storage backend, and co-develop ESD to integrate best-practices in storage access for the needs of the scientific domain. The layout components will be adapted and evaluated by CMCC and STFC by exploiting the petabyte-scale storage environments of their data centres. Additionally, CMCC will support the investigation of suitable memory and storage back-ends able to support horizontally scalable management of multidimensional scientific data. CMCC will specifically develop a back-end for the object store technology WOS[31] from DDN to prevent vendor lock-in.

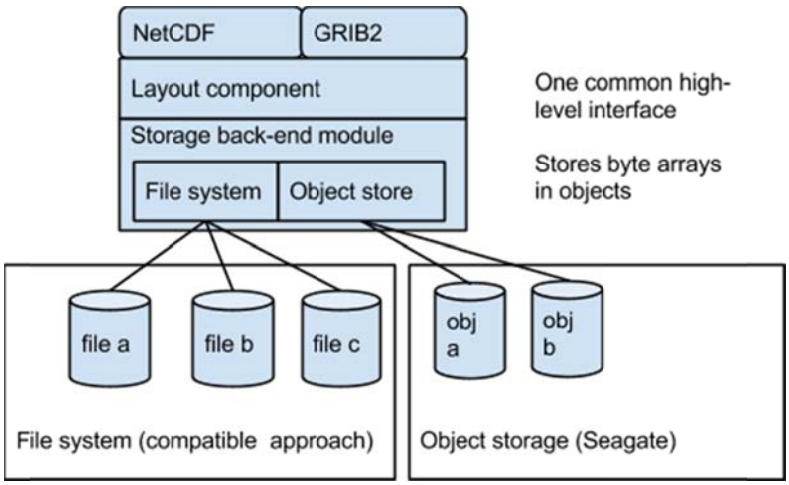


Figure WP4a: ESD middleware as backend for arbitrary Earth system data.

[31] http://www.ddn.com/products/object-storage-web-object-scaler-wos/

Task 4.3 - New methods of exploiting tape [Lead: STFC; Participant: DKRZ] Joint research activity

High-end climate computations are likely to generate such large volumes of data that not only will disk performance and cost be limiting, but the physical capacity in machine rooms, too. Leaving aside completely new storage media such as holographic storage, one possible way forward is to make better use of tapes. Traditionally, the climate community has used tape primarily for archive, that is, for backup, and recovery of small amounts of data from very big volumes. Sites such as ECMWF and the Met Office have developed bespoke environments (MARS and MASS respectively) which by controlling data and scientific metadata structures, and introducing carefully configured servers and storage cache, have extended
the "write once, read infrequently" mode to allow higher performance environments, but these require large teams, and are still limited by serial processes. Similarly, at STFC, the JASMIN[32] interface to tape currently utilises the CASTOR[33] tape system designed by CERN. By contrast, some applications of HPSS have used RAIT concept (Redundant Array of Independent Tapes) and noting the complexity of tape management at scale, proposed some sophisticated strategies of using tapes in parallel. We propose to first model and simulate, then build, a prototype open source tool that offers configurable flexibility between high performance and increase in capacity vs. resilience. In contrast to existing approaches such as in HPSS, our approach can be deployed in the typical scenario where a library is equipped with different tape generations and technology. We would expect to evaluate the tape performance simulations in comparison to existing strategies in the climate community, and deploy the prototype tape library at STFC (M4.5). The system would be designed for insertion into existing workflows at other centres, but we expect an operational setting demonstration is mandatory to demonstrate its benefit. STFC focuses on the implementation and deployment whereas DKRZ leads the core modelling and simulation. The outcome of this will be documented in [**D4.4]**.

Task 4.4 Semantic mapping between netCDF and GRIB [Lead: STFC, Participants: ECMWF] Joint research activity

One of the points of intersection between the operational weather and climate communities is data sharing, and differing data formats are a key barrier to exploitability - with both tools and semantic differences in content being significant issues. There are a number of tool building activities, but
all are hampered by a lack of an agreed semantic cross walk between netCDF and GRIB, the two main formats involved. Such a semantic walk involves more than matching names, since key semantic concepts are built into coordinate definitions as well as parameter names. For example, the common concept 'maximum air temperature at 2m' requires knowledge of the time bounds to evaluate what maximum means, the definition of air temperature, and interaction with the vertical coordinate. While there is a one-to-one mapping between this concept in the two formats, there is not a two-way mapping in the way the information is implemented. The lack of a comprehensive map is both a barrier to data sharing between communities, and a barrier to evolution. Technology exists to maintain such a mapping, but the community needs to resource someone to populate, maintain and extend the mapping. This task will effectively contribute to a WMO action aiming to increase the support for such semantic mapping, and has been specifically identified by WMO colleagues as an important deliverable from ESiWACE. The web presence to support this activity will be made available, with a report on activity and advances of the current status delivered as [**D4.5]**.

[32] http://www.jasmin.ac.uk/
[33] CASTOR: CERN Advanced STORage manager

Interactions with other Work Packages

This Work Package provides:

- Input to WP1 on status of development
- The governance and community liaison tasks from WP1 will receive and incorporate the knowledge from the best-practices established in T4.4.1 according to the prediction of the developed model and research activities that also target future supercomputers
- Input to WP2, T2.3.2 on the semantic mapping between netCDF and GRIB developed in WP4
-

This Work Package receives:

- Input from WP1 regarding governance of new developed software

Deliverables (all deliverables are public)

- D4.1 Business model with alternative scenarios (DKRZ, R, PU, PM12).
- D4.2 ESD middleware design (DKRZ, R,PU, PM12).
- D4.3 Final implementation of the ESD middleware. (DKRZ, OTHER, PU, PM36).
- D4.4 Final report on alternative tape usage. (STFC, R, PU, PM36).
- D4.5 Final report on community support for semantic mapping (STFC,R, PU, PM36).

Work package number	5	Start Date or Starting Event			Project Month 1
Work package title	Management and Dissemination				
Participant number	1	2	3	4	5	6
Short name of participant	DKRZ	ECMWF	CNRS-IPSL	MPG	CERFACS	BSC
Person/months per participant:	27	9	2	2	1	1

Objectives:

The general objective of this Work package 5 (WP5) is to ensure effective and smooth high-quality implementation of the project and delivery of innovation actions, and impacts. This includes general administrative and management practices that can be expected for programs founded via EU programs, including financial and scientific reporting. In particular this means

- to set-up and maintain a structure, procedures and tools that will allow a coherent and efficient technical and administrative management of the project;
- to keep the project on time and within the assigned budget;
- to identify and manage risks and to solve problems;
- to identify opportunities for improved results and collaboration;
- to coordinate the communication and interactions between work packages and partners;
- to coordinate the communication process between ESiWACE and the Scientific Advisory board (SAB);
- to coordinate the communication process between ESiWACE and the EC;
- to manage quality assurance;
- to establish and coordinate the dissemination and exploitation processes for ESiWACE.

The management structure and procedures of the project are extensively described in Section 3.2. More on innovation management (Section 1.4.2, 2.1.2, 2.2.2, 3.2.3), dissemination and exploitation measures as well as communication activities is already described in Sections 2.2.1., 2.2.3. In this text: that information is not repeated.

Lead: Joachim Biercamp (DKRZ) lead, Peter Bauer ECMWF co-lead. Participants: all WPL and co-WPL.

Task 5.1 Coordination and Management [Lead: DKRZ. Participants: ECMWF] Networking activity

Coordination:

- The Coordinator will carry out the coordination and monitoring of scientific excellence within the project. This includes regular discussion with the Executive Management Board (EMB), Management Steering Board (MSB), Scientific Advisory Board (SAB). The management processes are described in more detail in Section 3.2.1.
- The Coordinator will ensure that planed work is carried out in time and budget. For this he will be supported by the Project Office (PO).
- The Coordinator will monitor the scientific review of reports and deliverables to the EC and ensure that any necessary scientific aspects are incorporated into the project.
- The WP leaders will ensure that the progress of milestones and deliverables is actively monitored and that they are delivered on time.

Management:

- The setting up of a **consortium agreement** in the very early stage of the project and prior to the signature of the grant agreement. The consortium agreement will regulate the consortium, rules for participation, and ownership and access to key knowledge (IPR, results, etc.);
- The PO at DKRZ will be in charge of managing the project using effective management procedures based on the **project cycle management** formal methodology. For more information on the tasks and composition of the PO, please refer to Section. 3.2.1. The PO will provide administrative / financial / legal support to all partners involved during the implementation of the project, this can include administrative tasks involved in the preparation, executing of and post-processing of major project meetings of the

committees and panels.

- Management of the **gender dimension**: with support from the PO, the Coordinator will ensure that gender aspects of the project are fully considered within the research that is being undertaken, and that ESiWACE acts to promote gender equality wherever possible. For more details refer to Section 1.3.4.
- Liaison with the European Commission (EC): this includes
  a) The preparation of Project Periodic Reports, the Final Report and the Final Report on the EU Financial Contribution Distribution
  b) To maintain regular and comprehensive contact with the EC.

c) To ensure the appropriate follow-up of project obligations from the Grant Agreement (formal reporting: of science results and finances, project reviews, communication, and management).
d) To ensure that the appropriate EC representative is invited to the General Assembly meetings and any other relevant project meetings.
e) If there are any major difficulties within the project that cannot be resolved using the appropriate management structure, the Coordinator will liaise with the EC to seek advice and a solution.

Task 5.2 Risk management [Lead: DKRZ. Participants: ECMWF] Networking Activity

- The General Assembly will be responsible for dealing with risks, issues and benefits realization of the project.
- The Coordinator will be responsible for management of the risks within the project, and day-to-day maintenance of the risk registers will be undertaken by the PO (for more details refer to Section 3.2.4)
- Critical risks to project implementation, which have the potential to impact the project objectives being achieved, have been identified and described in Table 3.2.a.

Task 5.3 Innovation and IPR management, exploitation of results [Lead: DKRZ. Participants: ECMWF] Networking activity

- Management of knowledge and innovation is an integral part of our project. We will focus on the role and synergies between partners' experiences, competences, capabilities, and on how partners will protect, share, manage IPR capital actual exploitation. Detailing of the exploitation plans and preparation for innovation activities will be continuously followed up throughout the project. The innovation management is well integrated in the management structure of the project and in the work plan (see Section 3.2.3).
- The **consortium agreement** (CA) will be set up for regulating the ownership and access to key knowledge (IPR, data etc.) and scientific results, among other things, after the communication of the approval of the project by the European Commission and before the signature of the Grant Agreement with the European Commission.
- A strategy for the knowledge management, protection and for the exploitation of results, the **Plan for Dissemination and Exploitation [D5.5],** will be defined for the consortium in the early stage of the project, based on the principles explained extensively in Section 2.2. The strategy will be regularly updated during the entire project. Updates will be submitted to the EC as an integral part of the Project Periodic Reports.
- A **Strategy for the Intellectual Property exploitation [D5.6]** will be drafted at the end of the project for providing best practices in capturing and assessing the Intellectual Property and providing measures for exploitation after the end of the project.
- ESiWACE will provide **open access to peer-reviewed scientific publications** through a combination of golden open access and green open access, and it is voluntarily taking part in the European Commission **Open Access Data Pilot for Research Data** (see Section 2.2.2): we have included a **Data Management Plan** as a deliverable for project-month 6 **[D5.4]** to be drafted in compliance with the guidelines given on data management in the Horizon 2020 Online Manual. This deliverable will evolve during the lifetime of the project and represent faithfully the status of the project reflections on data management. Updates of the data management plan are thus planned and will be

submitted to the EC as an integral part of the Project Periodic Reports.

Task 5.4 Dissemination [Lead: DKRZ. Participants: ECMWF] Networking activity
We have identified three stages for the dissemination of project results:

- Dissemination measures *during the lifetime* of the project
- Dissemination measures *in the closing phase* of the project
- Dissemination measures *after the closure* of the project

As indicated above, we will comply with EC open access guidelines. Additionally, wherever results are suitable (content and size) to be distributed or stored by using online repositories, we will use **ZENODO** for disseminating the results of the project. For more details refer to Section 2.2.2

Task 5.5 Communication [Lead: DKRZ. Participants: ECMWF] Networking activity
The communication activities of the project will involve **all consortium partners** and their respective staff, including researchers. The project office (PO) with the Scientific Officer (SO) is central part of the activities. As indicated in the table in Section 2.2.3, we have already foreseen tools for the implementation of our communication strategy; a Media and Communication Plan **[D5.3]** focusing on the most suitable tools for the most suitable audiences will be set up in PM2 of the project and regularly updated by the Project Office. We have identified different levels of communication activities:

- Communication activities to promote the project and its findings (ref. to Section 2.2.3 for more details). The website will be set up in PM2 **[D5.2]**
- Coordination of internal communication within the consortium, with the supporters, the user group committee and the scientific advisory board
- Communication with other EU funded projects and the European Commission

For more details refer to Section 2.2.3.

Interactions with other Work Packages
This Work Package provides:

- Scientific guidance and leadership for all WPs and to the project as a whole
- Support, guidance and management assistance to all WPs as required and to the project as a whole
- Support to organisations invited to participate to ESiWACE workshops, General Assemblies, training activities.
- Support to the Advisory Board: the Advisory Board will be consulted on ESiWACE activities and communities' needs.

This Work Package receives:

- Regular summaries of the scientific progress from each work package leader, so that the Coordinator can review progress and provide scientific guidance.
- Financial and administrative updates from all other WPs and partners.

Deliverables
D5.1: Design and implementation of the intranet, portal, wiki: The intranet is a tool for the legal, financial and administrative management of the project. It contains contractual documents, consortium documents, templates for the legal, financial administrative management, and copies of reports to the EC. The intranet will be web based (DKRZ, DEC, CO, PM2)
D5.2 Project Public website (DKRZ, DEC, PU, PM2)
D5.3 Media and Communication Plan (DKRZ, R, PU, PM2)
D5.4 Data Management Plan (DMP): The DMP will be drafted in compliance with the guidelines given on data management in the Horizon 2020 Online Manual (DKRZ, R, PU, PM6)
D5.5 Dissemination and Exploitation Plan (EP): Plan identifying types of potential pathways of market- oriented exploitation, converting or transforming knowledge will be identified, together with key factors for a successful innovation management. DKRZ, R, PU, PM12)
D5.6 Strategy for the Intellectual Property exploitation: Strategy for defining measures for exploitation "after the project" phase, providing evidence of best practices in capturing and assessing (DKRZ, R, PU, PM48)

Table 3.1c List of deliverables

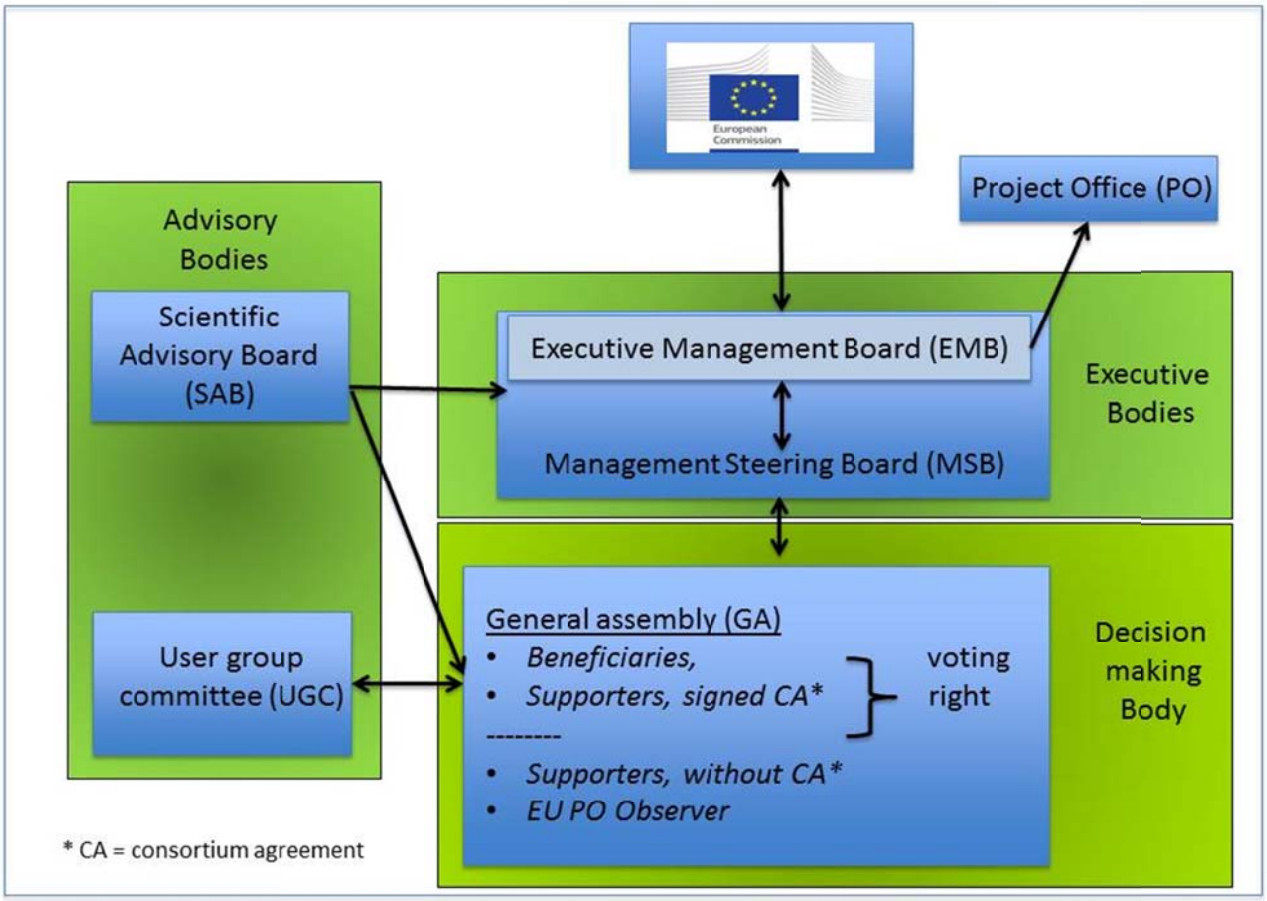
Deliv. No	Deliverable Name	WP No	Short Name of Lead Participant	Type	Dissemination level	Delivery Date (PM = Project Month)
D1.1	Agreed portfolio of community tools	1	CNRS-IPSL	R	PU	PM6
D1.2	White paper on HPC roadmap for the ESM community: The deliverable will report on strategy for the climate and weather community in using ESM on HPC	1	DKRZ	R	PU	PM36
D1.3	Updated business plan	1	DKRZ	R	PU	PM38
D1.4	First International HPC workshop	1	CERFACS	OTHER	PU	PM7
D1.5	Second International HPC Workshop	1	CMCC	OTHER	PU	PM31
D2.1	Final workshop report including benchmark results and software development strategy for future exascale platforms	2	DWD	R	PU	PM33
D2.2	Optimised community model code options tested on selected cases	2	BSC	OTHER	PU	PM36
D2.3	OASIS version adapted to many-core architectures	2	CERFACS	OTHER	PU	PM24
D2.4	XIOS version supporting GRIB2 format, including on-line diagnostics and adapted to many-core architectures	2	CNRS-IPSL	OTHER	PU	PM36
D2.5	White paper on a strategy for full convergence of I/O and coupling tools	2	CNRS-IPSL	R	PU	PM36
D2.6	Report outlining a strategic approach for efficiency savings based on concurrency and accuracy	2	ECMWF	R	PU	PM36
D2.7	Report from study of data compression assessment of dimensions required for Earth system model output archiving retaining information but reducing volume	2	ECMWF	R	PU	PM36
D3.1	ESiWACE Application Software Framework: A White Paper. Version 1: Specification of a Standard Recommendation for an End-to-end Workflows and Application Software Environments Framework	3	MPG	R	PU	PM4
D3.2	Update of ESiWACE Application Software Framework (D3.1) including recent experiences.	3	MPG	R	PU	PM30
D3.3	Software specification for the third E2sCMS, Narrowing down D3.1 for the 3rdE2SCMS	3	MPG	R	PU	PM6
D3.4	Experiences with ESM Multi-model Ensembles for Educational Purposes: A Report from the use of D3.1 for the 3rdE2SCMS	3	MPG	R	PU	PM14
D3.5	How to select, configure and install ESM software stacks: A Handbook for system administrators Specification of a standard	3	BSC	R	PU	PM5

	recommendation for an ESM System Software Stack in the form of a white paper					
D3.6	Update Handbook for system administrators (D3.5)	3	BSC	R	PU	PM32
D3.7	Software Stack for ESM– A Specification: Narrowing down D3.5 for the 3rdE2SCMS	3	BSC	R	PU	PM7
D3.8	Experiences with the ENES System Software Stack: A Report from the use of D3.5 for the 3rdE2SCMS	3	DKRZ	R	PU	PM16
D3.9	ESiWACE Scheduler development and support activities. A First report of Scheduler development and support activities for T3.3.2 and T3.3.3.	3	MetO	R	PU	PM18
D3.10	ESiWACE Scheduler development and support activities, v2: Second report of Scheduler development and support activities, updating D3.9 (T3.3.2 and T3.3.3) and reporting on T3.3.4	3	MetO & CMCC	R	PU	PM34
D4.1	Business model with alternative scenarios	4	DKRZ	R	PU	PM12
D4.2	ESD middleware design	4	DKRZ	R	PU	PM12
D4.3	Final implementation of the ESD middleware	4	DKRZ	OTHER	PU	PM36
D4.4	Final report on alternative tape usage	4	STFC	R	PU	PM36
D4.5	Final report on community support for semantic mapping	4	STFC	R	PU	PM36
D5.1	Design and implementation of the intranet (web based)	5	DKRZ	DEC	CO	PM2
D5.2	Project Public website	5	DKRZ	DEC	PU	PM2
D5.3	Media and Communication Plan (MCP)	5	DKRZ	R	PU	PM2
D5.4	Data Management Plan (DMP)	5	DKRZ	R	PU	PM6
D5.5	Dissemination and Exploitation Plan (EP)	5	DKRZ	R	PU	PM12
D5.6	Strategy for the Intellectual Property exploitation	5	DKRZ	R	PU	PM48

Table 3.1d List of milestones

MS Nr.	Milestone Name	Related WPs	Estimated Date	Means of Verification
M1	Scheduler support and development plan (T3.3.1)	WP3	PM6	Allow the first deliverable D3.9 to meet the needs of the user community
M2	System Software Stack D3.7 handed over to T3.1.3 team	WP3	PM7	Report published in the website
M3	Application Stack running at FMI/CSC, preparation of System Stack T3.2 Team	WP3	PM9	Summer School operational
M4	Establish governance rules for new ESiWACE developments	WP1, WP2, WP3, WP4, WP5	PM12	Report published on the intranet
M5	Operational demonstrator of ESD middleware	WP4	M24	Demonstrator operative
M6	Reports on user support, training, and integration of NEMO and EC-Earth community models, user-oriented development of XIOS and OASIS and Kick off Workshop on Metrics and Benchmark Strategies for dynamical ores, I/O Systems and coupling technologies	WP2	PM30	Reports published on the intranet
M7	Implementation of ESD middleware at STFC and CMCC	WP4	M30	ESD middleware finalised and rolled out
M8	Prototypes of alternative storage backends	WP4	M30	Prototypes available
M9	Prototype tape library for advanced tape subsystems	WP4	M30	Prototypes available

Figure 3.2: Governance structure of ESiWACE



3.2 Management structure and procedures

3.2.1 Description of the organisational structure and the decision-making

The main target of the governance structure described here is to enable fast flow of information between all parties involved in the ESiWACE. To minimize overhead and friction loss we keep the structure as simple as possible.

The consortium consists of 16 beneficiaries from science and industry from 7 countries.

Additionally, the consortium is supported by a number of institutions, called *supporters* (see Section 3.3.2), who have committed to support the project without being beneficiaries.

The picture below describes the organizational structure in the project.

In the governance structure we have foreseen roles for

- **Decision-making** bodies i.e. the General Assembly
- **Executive bodies** i.e. the Coordinator, the Management Steering Board and the Executive Management Board
- **Advisory** bodies i.e. the Scientific Advisory Board and the User Group Committee

In support to the above and to the beneficiaries, we will establish a **Project Office (PO).**

Decision-making body

The ultimate decision-making body of the consortium is the **General Assembly (GA)**. The GA is responsible for taking key decisions for the project as a whole, on the basis of issues raised by the Executive Bodies and the user group committee. It consists of one representative of each consortium partner (beneficiaries and supporters who signed the Consortium Agreement) and it is

chaired by the coordinator. All consortium members have the right to vote. Decisions of the GA have to be made at least by simply majority. Supporting institutions (without having signed the Consortium Agreement) have the right to attend the GA and raise topics.

Formal meetings of the GA will be held during the annual project meetings.

Executive bodies (EB)

The Executive Bodies consist of the **Coordinator**, the **Management Steering Board (MBS)** and the **Executive Management Board (EMB)**.

- The **Coordinator** of the project is Joachim Biercamp (DKRZ) and Co–Coordinator is Peter Bauer, (ECMWF). They are responsible for the overall scientific coordination of the project and function as liaise with the European Commission on behalf of the consortium.
- The Management **Steering Board** (MSB) is responsible for the execution of the project. It proposes decisions to the General Assembly (GA) and is monitors their execution.

  The MSB consists of

  - Coordinator and Co-Coordinator
  - Work package leader (WPL) and work package Co–Leaders
  - Scientific Officer of the Project Office

  MSB assists the coordinator in monitoring the project progress, proposing corrective and preventive actions, promoting the project and its findings, engaging with the public and media about the project, facilitating the communication within the consortium, as well as coordinating the reporting for the European Commission. Furthermore, MSB will implement, promote and monitor gender and diversity equality throughout the lifetime of the project. Awareness of best practice in gender and diversity equality can be shared and may instigate longer-term changes, taking into account regional and cultural differences.
  The MSB will meet regularly every two months in a telephone/web conference or on person to secure the smooth information flow. Decisions in the MSB will have to be made at least by simply majority.

- The **Executive** Management **Board (EMB)** role is to execute the decisions taken by the GA, monitor the project progress and to propose corrective and proactive actions for the scientific coordination of the project. The EMB can react promptly when immediate questions have to be answered or intervention is required.

  The EMG consists of:

  - Coordinator and the co-coordinator
  - Up to 2 members of the **Management Steering Board** elected
  - Scientific Officer of the Project Office

  The EMB meets weekly in a telephone / web conference or in person.

Advisory bodies

We have foreseen two advisory bodies**: Scientific Advisory Board (SAB)** and **the User Group Committee (UGC).**

- The **Scientific Advisory Board (SAB)** is established for ensuring scientific evaluation of the project and links to other programs. Furthermore, it gives advice on the project's scientific approach and orientation by liaison with the EB. It is comprised of selected key international experts with a scientific high profile. For the SAB we have already contacted international experts (see Section 3.3.2), who have their interest in becoming SAB members.
- The **User Group Committee (UGC)** has the commitment to reflect the users' opinion, to propose upcoming topics and forward requests to the GA and / or the Executive Bodies. The UGC will be the key tool for the ESiWACE to get input from the wider scientific community and disseminate the results achieved by the ESiWACE. The **UGC** represents:

- the members of the scientific weather and climate community interested in the outcomes of the ESiWACE,
- The users of the shared (task 1.2) and newly developed software (task 1.3) identified in WP, which are not represented by beneficiaries in the consortium.
- The representatives of the users from supporters.

Supporting organisations within UGC will be invited to participate in COE workshops, general assemblies, and training activities.

Project office

The **Project Office (PO)** is in charge for the day-to-day management of the project, in a supporting role to the Coordinator, Co-Coordinator and the other governance bodies.
It consists of:

- Coordinator and Co-Coordinator
- **Scientific officer (**SO**)** , she/he will play an important role in WP1 on the governance issues and. She/he will help CNRS-IPSL in liaising with the communities, in enhancing community capacity in HPC and liaising with PRACE. She/he will help DKRZ on the governance for new developments, on liaising with industrial partners and in the elaboration of the roadmap on HPC.
- **Administrative assistant (AA)** based at DKRZ, who is in charge of monitoring the financial and administrative implementation of the project. Moreover, the AA is supporting the partners in the implementation of the financial rules of Horizon 2020 and the requirements deriving from the Grant and the Consortium Agreement. The AA will be the contact person for the partners in preparing their interim financial payment requests, in dealing with the formalities of the financial reports and of the certificate of financial statements.
- **Web administrator** in charge of the project intranet, the website and web-based dissemination activities.

3.2.2 How the organisational structure and decision-making mechanisms are appropriate to the project

One main target of ESiWACE is to foster the inclusion and cooperation of within the weather and climate research community. A consequence is that networking activities play a major role in the project.

Special features of the project structure are the following:

- The rather limited size of core partners compared to the larger number of supporting partners contributing to selected tasks in single work packages;
- The large influence of the user community on thematic focus points of ESiWACE.

This requires special procedures of decision making and flexibility in the management / implementation of the activities at different levels (work package and tasks):

- The role of the **User Group Committee** for ESiWACE is central: we consider it crucial for bringing in new ideas, requests for new research and tasks forces to be installed. During the complete project runtime the UGC can address issues to MSB. Depending on the scientific relevance, the issues will be passed to WPs with the request to comment. This kind of interaction / feedback processes will ensure that the project responds to upcoming new themes and requirements in the most efficient way. In this way the project will be responsive to any internal and external opportunities that may arise.
- **Task Forces** can be installed by the Executive Bodies either when cross cutting issues will be identified (e.g. HPC task force) or when new and unforeseen themes arise during project run time, that require collaboration of project members and / or supporting partners.
- The **General Assembly** ensures that all partners, supporting partners and members of the user group committee involved in the project can have a voice in the decision-making of ESiWACE.

- The **Executive Bodies** collect inputs on specific topics from the advisory boards and user group committee, preparing the ground for the decisions of the General Assembly and being responsible for the execution of these decisions within the consortium.
-

3.2.3 Innovation management

The Consortium Agreement (CA) will be produced and signed before the signature of the Grant Agreement with the European Commission is an internal agreement establishing their rights and obligations of the consortium members with respect to the implementation and organisation of the action, in accordance with the Grant Agreement. Items regulated in the EC Grant Agreement will not be repeated in the CA. The CA will formalize project management procedures and regulate joint ownership, use of background and Intellectual Property Rights (IPR). Based on the agreement outlined in the project's CA, a structured strategy for the protection of intellectual property arising from the project will be updated and implemented with consensus of all parties (i.e. Dissemination and Exploitation Plan [D5.5]).

Effective innovation management within this project will require an overview of the project in its entirety and for this reason the Coordinator and the Scientific Officer will be in charge of innovation management. In practice, the Coordinator and the Scientific Officer 1) will ensure the development of a strategy and concrete actions of the consortium for the protection, exploitation and dissemination of the results of the project -including software licensing issues if applicable-; 2) will address and combine the technical, scientific and application aspects of innovation and benefit from the expertise regarding all these aspects represented in the consortium; 3) produce an overview of the WPs and the outcomes of ESiWACE to provide effective management and therefore exploitation of these both during and after the project; 4) track and propose commercialisation and exploitation strategies for the whole consortium; 5) give advice to the parties concerned about the ownership, access rights, legal and commercial implications, patents, publications, copyrights, etc.

In an early stage of the project the innovation management will be integrated into the Dissemination and Exploitation Plan [D5.5] and so becomes formal constituent of the project plan. **At a more mature stage** of the project, this plan will be adapted to take into account best practice methods of maximizing the value of intellectual property, for dealing with technology transfer/exploitation/protection, and with the assessment of IP and research results. Finally, **towards the end of the project**, the focus will be on defining a Strategy [D5.6] for the intellectual property exploitation after the project.

3.2.4 Risks and risk management strategy

Critical risks, which have the potential to impact the project objectives, are identified and collected in Table 3.2a below. At the present stage, all these risks have been identified and analysed by the beneficiaries. The Scientific Officer (SO) will actively monitor the work progress in order to raise awareness on the occurrence of such risks throughout the duration of the project. As explained in Section 3.2.1, the Executive Management Board (EMB) is in charge of managing the risks on a day-to-day basis, and the GA will be responsible for deciding on proposed preventive and corrective actions. At each meeting of the EMB, the list of risks will be analysed and updated.

Table 3.2a: Critical risks for implementation

Nr.	Description of risk	Likelihood	Impact	WP(s) involved	Proposed risk–mitigation measures
1.1	Limited engagement with the broader scientific community not directly represented by the ESiWACE partners.	Low	High	WP1	ESiWACE relies already on two well-established European networks, ENES and ECMWF. In order to extend even more the developing culture of excellence to the broader climate and weather modelling community ESiWACE will organise HPC workshops fostering ESiWACE visibility, which, even more than GAs, will play a key role in keeping the community engaged. Interactions with the supporters (see also 3.2.5 Quality management) will help to assess as soon as possible if the community is aware of and content with ESiWACE services.
1.2	Uneven engagement of climate and weather modelling groups.	Medium	Medium	WP1	ESiWACE organises and promotes workshops on aspects common to climate and weather modelling. For assessment of engagement the same methods hold as above, with ENES and ECMWF taking special responsibly to assess engagement of climate and weather scientists, respectively.
1.3	Difficulty in achieving long-term sustainability.	Low	Medium	WP1/WP 5	The Business plan (see also Section 2.2.4) will be developed and continuously updated.
2.1	Limited strength of the governance structure established in WP1 to help defining priorities of developments for community tools.	Medium	Medium	WP2	Through continuous feedback with the user community WP2 will contribute to the coordination of model/tool development. ESiWACE representatives will moreover participate in developer community meetings
2.2	Scarcity of computing resources allocated by PRACE to ESiWACE: impossibility to test benchmarks for I/O and couplers on tier-0 platforms on very high number of cores.	Low	Medium	WP2	ESiWACE will actively engage with PRACE to obtain allocations. ESiWACE partner resources will be exploited for tests on O(10000) computational processor cores.
2.3	Lack of significant improvements from the implementation of strategies for performance enhancement of tools and models.	Low	High	WP2	ESiWACE will: Perform an early cost-benefit assessment using existing experiments, Provide an early definition of efficiency gain metrics for objective evaluation. Carry on further work and interaction with computer scientists to increase the gains.

2.4	Change in the scientific response of the models as a result of increasing the concurrency of the different scientific modules of the models.	Medium	High	WP2	Accuracy and reproducibility requirements will be defined early in the project. ESiWACE will define a minimum experiment set-up required for evaluation.
2.5	Applicability of the knowledge compression only limited to selected user groups.	Medium	Medium	WP2	ESiWACE will devise a Strategy [D2.7] for addressing requirements for a wide range of applications.
3.1	Difficulties in catching the requirements for the application (T3.1) and system (T3.2) software stack, scheduling issues, co-design approaches, and related benefits, especially for inexperienced users and leaders.	Medium	High	WP3	WP partners will need to make convincing statements and arguments at the workshops, emphasizing the benefits to be expected from shared software development. The participation in the workshops needs to be spread as wide as possible in terms of skills and experience sets to be convincing.
3.2	Insufficient fulfilment of the needs of the communities involved by the published recommendations.	Low	High	WP3	The evolving versions of the specifications will be appropriately fine-tuned.
3.3	Too high complexity of the meta-scheduler Cylc for research applications.	Low	Low	WP3	Cylc will be applied initially in operational and production mode where the benefits are better recognised.
3.4	Limited combinability of different scheduling approaches.	High	Low	WP3	The number of approaches will be minimized, without imposing rules
4.1	Higher than expected complexity of the Earth system specific middleware (T4.1). Possible occurrence of design flaws in architecture and implementation.	Medium	Medium	WP4	ESiWACE involves experts from computer science and industry from the early design phase on.
4.2	Lack of funding for related projects in H2020 (ExaIO from Exascale10). Limited effectiveness of the co-design approach. Impossibility to merge ESiWACE results into a worldwide domain independent middleware. Slowing-down in the potential standardization for an API independent layer.	Medium	Low	WP4	ESiWACE will support the Exascale10 working group by supplying the developed ESD middleware as proof-of-concept to build upon, which secures the impact of the working group and the effort.
4.3	Undeployability of RAIT as a consequence of lack of redundancy (for incompatibility of tape archives).	Medium	Low	WP4	ESiWACE will interact with vendors and communicate and discuss on the required interface.

3.2.5 Quality Management

The quality control management involves the product description and quality expectations of key deliverables, and an internal review and acceptance procedure. The procedures for the quality control process of deliverables will take into account Technology Readiness Levels (TRL). When a deliverable is ready for review, it will be forwarded to the Project Office (PO), which verifies its general compliance. Moreover internal quality control will be conducted by Management Steering Board (MSB) and PO to secure the highest possible scientific standard of the deliverable. If necessary, they can request a revision of the deliverable before approval.

On a more general level, the MSB will interact with the named representatives of the supporters to assure that the project results and services are well disseminated and to evaluate the perceived benefit that ESiWACE generates for the community.

3.2.6 Financial and Administrative Management

The Project Office is in charge of the financial and administrative management of the project. Regular reporting to the EC in the form of activity and financial progress reports is planned in the Gantt Chart (Table 3.1b). To ensure the transparency of the project management, all reports will be made available on the ESiWACE website. Only documents or part of documents concerning individuals will be kept confidential. The payments will be distributed to the beneficiaries according to the provisions of the Grant Agreement and the consortium agreement, and decisions taken by the General Assembly, if the case. Budget forecasts will be established as an input for MSB meetings.

3.3 Consortium as a whole

3.3.1 Consortium: the Beneficiaries

The ESiWACE consortium is built from two established European networks: the European Network for Earth System modelling (ENES), gathering the European climate modelling community contributing to the World Climate Research Program international coordinated experiments and Intergovernmental Panel on Climate Change assessments, and The European Centre for Medium-Range Weather Forecasts (ECMWF) which is an independent intergovernmental organisation supported by 34 states. The ESiWACE partners are leading public and private institutions having long standing expertise in delivering products and services for HPC based climate research and numerical weather prediction. In particular we want to emphasize the scientific and technical expertise related to weather and climate research software as well as high performance computing. During the proposal preparation, partners showed high communication, collaboration, adaptation and team-working skills, which pave the way for a successful project. By this, we are prepared to translate the outcomes of ESiWACE into substantial societal benefit.

The consortium will be led by two topical super-computing centres each operating one of the largest computing facilities in Europe. The coordinator, the German climate computing centre (DKRZ) since nearly three decades is a provider for high performance compute and data management facilities and services tailored to the need of climate modelling. The coordinator will in its management and dissemination efforts be supported by ECMWF running an operational service, producing and disseminating numerical weather predictions.

The expertise of the scientific partners optimally matches our objective to develop solutions for cross-cutting HPC issues particular to the weather and climate domain. The consortium comprises world leading climate research institutions, operational weather services, super-computer centres including two PRACE members and also experts in computer science including university members. Table 3.3a provides an overview of the expertise and roles relevant for the objectives of ESiWACE.

The expertise of the three partners from industry matches the three main tools that our communities share with others but which need co-design and information exchange between weather and climate science and industry to efficiently address our needs on the long run: the

super computer themselves, the storage hardware, the software environment. Bull SA, a leading European Computer vendor, has several climate and weather centres among its customers and accordingly is well acquainted with their applications. Seagate Technology is a world leader in storage solutions and through the acquisition of Xyratex Ltd, a leading provider of data storage technology has large customers from the climate and weather domain. ALLINEA, a UK-based SME, provides integrated software development tools, designed to handle the scale of today's systems. All industry partners (as well as ECMFW and BSC) are members of ETP4HPC.

Table 3.3a: Partners and principal expertise

	Climate Research	Operational numerical weather forecast	Computer Science	Development of models and tools	Operation of HPC-facilities
DKRZ	X		X	X	X
ECMWF		X	X	X	X
CNRS-IPSL	X			X	
MPG	X			X	
CERFACS			X	X	X
BSC			X	X	X
STFC			X	X	X
MetO	X	X		X	X
UREAD	X			X	
SMHI		X		X	
ICHEC			X	X	X
CMCC	X		X	X	X
DWD		X		X	X

3.3.2 The Supporters of ESiWACE

Major themes for ESiWACE have already been identified, but we expect representatives of the European weather and climate science community to carry out detailed priority setting, as well as operational governance which will continually adapt and improve our services. To foster and organize this process we started to form a group of supporters and were overwhelmed by the large number of reactions: up to now, we have received nearly 40 Letters of Commitment and Support (Table 3.3b) from consortia, institutions and individuals which qualify ESiWACE goals and the anticipated outcomes as very important for their own work and objectives.

The supporters of ESiWACE are legal national and international entities which are not beneficiaries but wish to support ESiWACE through complementary activities. Most of them commit explicitly to specific supporting activities such as

- implementation and evaluation of the ESiWACE software stack,
- active participation in ESiWACE workshops or meetings,
- contribution to software intercomparison or evaluation,
- to name contact persons to interact with ESiWACE on scientific and technical level,
- support of the dissemination of ESiWACE results and outcomes
- fostering cooperation between ESiWACE and projects or activities of supporter

All individual committed contributions can be found in the Letters of Commitment (Appendix 1).

The presence of the supporters will significantly strengthen ESiWACE and underline the importance attached to ESiWACE by the climate and weather community as well as HPC centers.

Moreover, the following leading scientists declared their availability to become members of the scientific advisory board (SAB):

- Isabelle Bey, Center for Climate System Modelling (C2SM), Switzerland
- Alison Kennedy, Edinburgh Parallel Computing Centre (EPCC), UK
- Rudolf Fischer, NEC Deutschland GmbH, Germany
- Peter Fox, Rensselaer Polytechnic Institute (RPI), USA
- Wilco Hazeleger, Netherlands eScience Center (NLeSC), The Netherlands
- Heikki Järvinen, University of Helsinki, Finland
- Thomas Schulthess, Swiss National Supercomputer Centre (CSC), Switzerland

The supporters will be listed on the project website with indication of their complementary activities. The application of new supporters is constantly evaluated by the Management Steering Board.

Table 3.3b: List of Letters of Commitment and Support (in alphabetical order of affiliation or consortium). For the various individual and institutional commitments, see Appendix 1

Signatories	Affiliated Institution / Federation / Network	Named contact person
W. Hiller Director of Computer Center	AWI, Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Germany	Bernadette Fritzsch
P. May; Assistant Director	Bureau of Meteorology, Australia	Kamal Puri
P. Pišoft, Senior Scientist	Charles University, Czech Republic	Thomas Halenka Michal Belda
I. Bey, C2SM Executive Director	C2SM, Center for Climate System Modelling, Switzerland	Isabell Bey (for SAB)
A.Will, Senior Scientist Member of Scientific Management Board	CLM-Community, Climate Limited-area Modelling-Community, Germany	Klaus Keuler Andreas Will
V Eyring Chair of CMIP Panel	Coupled Model Intercomparison Project (CMIP) Panel	-
D. Ulmer, Director, EMEA Operations	CRAY U.K. Limited, UK	Philip Brown
T. C. Schulthess Director	CSC, Swiss National Supercomputing Centre, Switzerland	Will Sawyer
T. Christoudias, Research Scientist	The Cyprus Institute, Cyprus	NN
T. Beckers, Director HPC Sales EMEA	DataDirect Networks, Germany	-
R. Sausen, Head of ESM Department	DLR, Institut für Physik der Atmosphäre, Germany	NN
K. Krogh Andersen, Director of Research and Delvelopment	DMI, Danish Meteorological Institute, Denmark	Bent Hansen Sass
R. Döscher, Chair of Steering Committee	EC-Earth Consortium, Europe	Ralf Döscher
A.Bode, Director of LRZ	EnCompAS (proposal to H2020) Consortium	
A. Kennedy, Executive Director	EPCC, Edinburgh Parallel Computing Centre, UK	Alison Kennedy (for SAB)
E. Robinson, Executive Director P. Fox, President	ESIP, Foundation for Earth Science, USA	Erin Robinson

I. Pisso, Scientific Secretary	eSTICC, eScience tools for investigating Climate Change in Northern High Latitudes, Norway	-
P. Taalas, Director General	FMI, Finnish Meterological Institute, Finland	Hanelle Korhonen
U. Cubasch, Senior Scientist, Professor of Meteorology	Freie Universität Berlin, Germany	Ingo Kirchner
V. Balaji, Head, Modelling Systems Group	GFDL, Geophysical Fluid Dynamics Laboratory Princeton University, USA	V. Balaji
D. Turek, Vice President Technical Computing	IBM, USA	-
S. Negre, President	Intel Corporation SAS, France	-
M. Tsukakoshi, Director, Information Systems Department	JAMSTEC, Japan Agency for Marine-Earth Science and Technology, Japan	-
G. van der Steenhoven, Director General	KNMI, Royal Netherlands Meteorological Institute, The Netherlands	Jan Barkmeijer
Patrick Jöckel Speaker of the consortium	MESSy, Modular Earth Submodel System Consortium, Germany	NN
P. Bougeault, Director General	Météo-France, France	NN
R. Fischer, Senior Manager HPC	NEC Deutschland GmbH	Rudolf Fischer (for SAB)
W. Hazeleger, Director	NLeSC, Netherlands eScience Center	Wilco Hazeleger (for SAB)
M. Uddstrom, Principal Scientist	NIWA, The NZ National Institute of Water and Atmosphere, New Zealand	-
H. L. Tolman Dirctor Environmental Modeling Center	NOAA, US Dept of Commerce, National Oceanic and Atmosph. Administration, National Weather Service, National Center for Environmental Prediction ,USA	John Michalakes Hendrik Tolman
Ø. Hov, Director of Research	Norwegian Meteorological Institute, Norway	-
S. Kraemer, Director Business Development HPC-EMEA	NVIDIA, Germany	-
P. Fox. Director	RPI, Rensselaer Polytechnic Institute, USA	Peter Fox (also for SAB)
C. Heinze, Leader of project EVA	University of Bergen, Norway	-
H. Järvinen Senior Scientist, Professor of Meteorology	University of Helsinki, Finland	Heikki Järvinen (for SAB)
T. Fichefet, Senior Scientist, Professor of Physics	UCL-TECLIM, Universite Catholique de Louvain, Belgium	Pierre-Yves Barriat
T. Palmer, Director	University of Oxford, UK	Tim Palmer
D. Carlson, Director WCRP P.M. Ruti, Chief WWRC	World Meteorological Organisation (WMO): WCRP & WWRP	-

3.4 Resources to be committed

The total amount of EC contribution requested by ESiWACE amounts to 4,951,050 Euro distributed over 4 years. The total **direct costs** of the project amount to 3,960,839 Euro, the amount of the **indirect costs** amounts to 990,211 Euro.

The table below provides an overview of the planned budget and requested EC contribution per budget line *(figures below are indicative)*:

Budget lines	Planned budget (€)	EC contribution requested (€)	In % on the total direct+indirect costs
Personnel	3,420,439	3,420,439	69%
Other direct costs	540,400	540,400	11%
Subcontracting	-	-	0%
Total direct costs	3,960,839	3,960,839	80%
Total indirect costs	990,211	990,211	20%
Total direct + indirect costs	4,951,050	4,951,050	100%

Looking at the distribution of the direct costs only, and excluding the indirect costs, which are just a lump-sum attributed by the EC, the total direct costs budget is mostly devoted to staff (86%), corresponding to 514 person-months over 4 years, and the rest is assigned to "other direct costs" such as travels, organisation of workshops, summer schools, network meetings, and dissemination and communication activities (13.5 %) and audit costs (0.5%). We so not plan to subcontract tasks.

The direct cost distribution across the work packages can be seen in the chart here below.

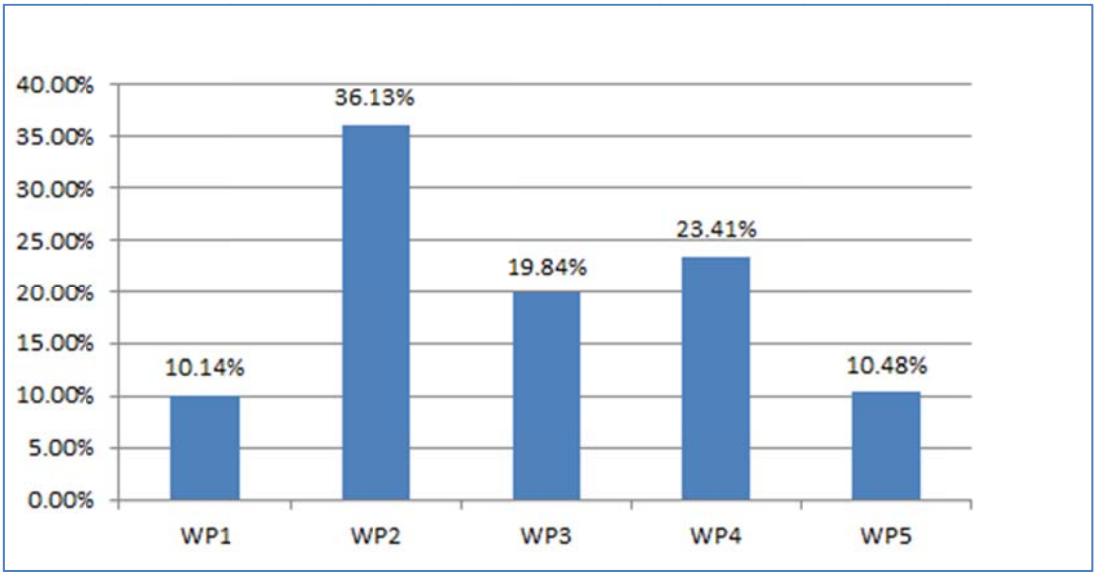


Chart 3.4 a: Distribution across the work packages of the direct costs. Figures are indicative.

The sum of the planned budget for the implementation of activities linked to the governance, engagement, planning of the long-term sustainability (WP1) and dissemination, communication and management tasks (WP5) correspond to 20% of the entire budget of the project.

Across the work packages, the distribution of the direct costs according to "personnel" and "other direct costs" highlights again how the WP5 in particular will take care of funding all the activities related to the funding of the work of the committees and panels mentioned in the governance, the dissemination activities, and will actually sustain financially the engagement and governance activities under WP1.

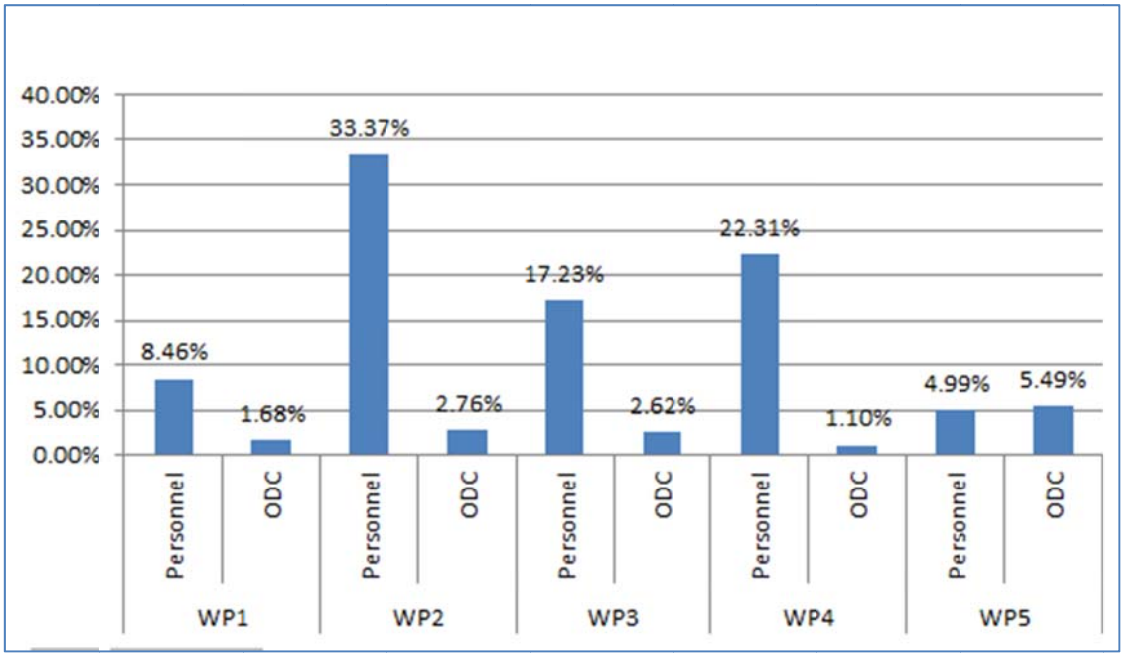


Chart 3.4 b: Distribution of the direct costs according to "personnel" and "other direct costs" (ODR) in the work packages. Figures are indicative.

Table 3.4a Summary of staff effort in terms of person/months: Figures are indicative.

	WP1	WP2	WP3	WP4	WP5	Total P/M per Participant
1/DKRZ	13	10	6	45	24	98
2/ECMWF	4	37	3	12	6	62
3/CNRS-IPSL	17	36	0	0	2	53
4/MPG	2	3	18	0	2	23
5/CERFACS	3	27	0	0	1	30
6/BSC	4	22	18	0	1	44
7/STFC	0	0	0	33	0	33
8/MetO	0	3	54	0	0	57
9/UREAD	0	0	6	0	0	6
10/SMHI	1	20	0	0	0	21
11/ICHEC	0	6	0	0	0	6
12/CMCC	1	9	9	10	0	29
13/DWD	0	0	0	0	0	0
14/SEAGATE	0	0	0	18	0	18
15/BULL	2	20	0	0	0	22
16/ALLINEA	0	0	6	0	0	6
Total P/M	47	193	120	118	36	514

Details on the other direct costs

For participants where these planned budget exceed 15% of the personnel costs (according to the budget table reported in the administrative forms), we provide here a breakdown of the other direct costs and a justification for them.

Table 3.4b 'Other direct cost' item Figures below are indicative

	Cost (€)	Justification
1/ DKRZ		
Travel	37600	Travel budget for the project office, including the coordinator and the scientific officer, and for the DRKZ scientists for joining the annual meetings and project workshops, and for the coordination of the activities planned across all the other work packages.
Equipment	0	
Other goods and services	188000	• Organisation of the general assembly and project meetings, incl. invitation of the members of committees / panels / reviewers / external experts. • Organisation of meetings for tasks forces / special interest groups • Overall project publications / maintenance of web portal • Audit costs for the certificate of the financial statements (CFS) for approx.8000 euro
Total	225600	

	Cost (€)	Justification
4/ MPG		
Travel	10100	Travel to the workshops organised in the framework of WP3, travel for joining additional project meetings
Equipment	0	
Other goods and services	48000	Organization of workshops and networking meetings and the summer schools in the framework of WP3, including the invitation of external speakers and experts to project meetings
Total	58100	

	Cost (€)	Justification
5/ CERFACS		
Travel	12000	Travel to the workshops organised in the framework of WP1, travel for joining additional project meetings
Equipment	0	
Other goods and services	15000	Organization of workshops in the framework of WP1
Total		

	Cost (€)	Justification
9/ UREAD		
Travel	6000	Travel budget for joining workshops and general assembly meetings
Equipment	0	
Other goods and services	0	
Total	6000	

	Cost (€)	Justification
11/ ICHEC		
Travel	6000	Travel budget for joining workshops and general assembly meetings
Equipment	0	
Other goods and services	0	
Total	6000	

	Cost (€)	Justification
13/ DWD		
Travel	12000	Travel to the workshops organised in the framework of WP2, travel for joining additional project meetings
Equipment	0	
Other goods and services	4500	Organization of three workshops in the framework of WP2
Total	16500	

	Cost (€)	Justification
16/ ALLINEA		
Travel	6000	Travel budget for joining workshops and general assembly meetings
Equipment	0	
Other goods and services	0	
Total	6000	

Glossary

AA	Administrative Assistant
ALADIN	Aire Limitée, Adaptation Dynamique, Development International
API	Application Programming Interface
BMBF	Bundesministerium für Bildung und Forschung
CAMS	Copernicus Atmosphere Monitoring Service
CASTOR	CERN Advanced STORage manager
CCCS	Copernicus services and climate change
CDI-pio	Climate Data Interface – parallel i/o
CERN	http://home.web.cern.ch/
CHANCE	Co-design of High performance Algorithms and Numerics for oCean models at Exascale
CoE	Centre of Excellence
COSMO	Consortium for Small-Scale Modelling
CMIP	Coupled Model Intercomparison Project
CMIP6	Coupled Model Intercomparison Project Phase 6
CRESCENDO	Coordinated Research in Earth Systems and Climate: Experiments, Knowledge, Dissemination and Outreach, project application submitted for the call SC5-01-2014
DMP	Data Management Plan
EC	European Commission
EMB	Executive Management Board
EOFS	European Open File System
EP	dissemination and Exploitation Plan
ESD	Earth System Data
ENES	European Network for Earth System modelling
EOFS	European Open File System
ESCAPE	Energy-efficient Scalable Algorithms for Weather Prediction at Exascale, project application submitted for the call FETHPC-1
ESGF	Earth System Grid federation
ESM	Global Earth System Models [34]
ESMF	Earth System Modeling Framework
ETP4HPC	European Technology Platform for High Performance Computing
EUDAT	European Data Infrastructure
EUDAT2020	Project application submitted for the call H2020-EINFRA-2014-2
FET	Future and Emerging Technologies
GA	General Assembly
GCM	General Circulation Model
GFDL	Geophysical Fluid Dynamics Laboratory, Princeton
GRIB	GRIdded Binary
GungHo	Globally Uniform Next Generation Highly Optimized
G8 ICOMEX	ICOsahedral-grid Models for Exascale Earth System Simulations
HD(CP)2	High Definition Clouds and Precipitation for advancing Climate Prediction
HIRLAM	High Resolution Limited Area Model
HPC4CM	High performance computing for climate modelling, project application submitted for the call H2020-MSCA-ITN-2015
HPSS	High Performance Storage System
I3	Integrated Infrastructures Initiative
ICON	Icosahedral non-hydrostatic (general circulation model)
IFS	Integrated Forecast System

[34] **PLEASE NOTE: Throughout this application the term „Earth System Modelling“ (ESM) is used as short for „Earth System Modelling for weather and climate science“. Earth System Modelling in a broader sense would also incorporate the solid Earth.**

IMPULSE	Improved Modelling and Physical Understanding of Decadal to Centennial Scale Climate Changes, project application submitted for the call SC5-2014
I/O	Input/Output
IPCC	Intergovernmental Panel on Climate Change
IPR	Intellectual Property Rights
IS-ENES2	Infrastructure for the European Network or Earth System modeling – phase 2
JRA	Joint Research Activities
LHC	Large Hadron Collider
LACE	Regional Cooperation for Limited Area Modeling in Central Europe
LFRic	Lewis Fry Richardson
MARS	Meteorological Archival and Retrieval System
MASS	Mass Archive Storage System
MESSy	Modular Earth Submodel System
MSB	Management Steering Board
NA	Networking Activities
NCAR	National Centre for Atmospheric Research, Boulder
NEMO	Nucleus for European Modelling of the Ocean
netCDF	network Common Data Form
NIWA	The NZ National Institute of Water and Atmosphere
NWP	Numerical Weather Prediction
OA	Open Access
OASIS	Couper software see https://verc.enes.org/oasis
OBS4MIPS	Observations for Model Intercomparisons
OpenIFS	Open Integrated Forecast System
OpenMP	Open Multi-Processing
OpenPALM	Open Projet d'Assimilation par Logiciel Multiméthode
PAPI	Performance Application Programming Interface
PGAS	Partitioned Global Address Space
PO	Project Office
POSIX	Portable Operating System Interface
PRACE	Partnership for Advanced Computing in Europe
PRIMAVERA	PRocess-based climate sIMulation: AdVances in high resolution modelling and European climate Risk Assessment, project application submitted for the call SC5-01-2014
RAIT	Redundant Array of Independent Tapes
RIA	Research & Innovation Actions
SA	Service Activities
SAB	Scientific Advisory Board
SO	Scientific Officer
SSD	Solid-State Drive
S2S	Subseasonal to Seasonal Prediction Project
TRL	Technology Readiness Levels
UGC	User Group Committee
WCRP	World Climate Research Programme
WGCM	Working Group on Coupled Modeling
WGNE	Working Group on Numerical Experimentation
WMO	World Meteorological Organization
WP	Work Package
WPL	Work Package Leader
WWRP	World Weather Research Programme
XIOS	eXtended Input/Output System
YAC	Yet Another Coupler
YAXT	Yet Another eXchange Tool

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https://verc.enes.org/community/about-enes/the-future-of-enes/ENES_foresight.pdf

ETP4HPC, The European Technology Platform for High performance Computing, Vision Paper, http://www.etp4hpc.eu/publications/key-documents/

ETP4HPC, The Strategic Research Agenda:
http://www.etp4hpc.eu/publications/key-documents/

European Commission Brussels, 15.2.2012, COM(2012) 45 final, Communication from the Commission to the European Parliament, the council, the European economic and social committee and the committee of the regions, High-Performance Computing: Europe's place in a Global Race

European Commission, 10th July 2013, Communication (COM(2013) 494 - "Public-private partnerships in Horizon 2020: a powerful tool to deliver on innovation and growth in Europe"

European Commission, Action 132: Invest in High Performance Computing, http://ec.europa.eu/digital-agenda/en/pillar-v-research-and-innovation/action-132-invest-high-performance-computing

European Commission, Press Release Brussels, 17 December 2013, EU industrial leadership gets boost through eight new research partnerships

European Commission, 17 December 2013, Factsheet High Performance Computing PPP: Mastering the next generation of computing technologies for innovative products and scientific discovery

European Commission, Guidelines on Open Access to Scientific Publications and Research Data in Horizon 2020

European Commission, Guidelines on Data Management in Horizon 2020

European Commission, Communication EU Research and innovation guidance for project participants

European Commission, Communicating EU Research and Innovation, A guide for project participants

European Commission, Guidance on the evaluation of innovation, social sciences and humanities and other aspects of H2020 proposals

European Commission, Guidance on Gender Equality in H2020

Mark Sawyer, Mark Parsons, 2011, A strategy for research and innovation through high performance computing, The University of Edinburgh

Section 4: Members of the consortium

4.1. Participants (applicants)

Deutsches Klimarechenzentrum GmbH (DKRZ)

About the institute

DKRZ, the German Climate Computing Centre, is a national service provider which constitutes an outstanding research infrastructure for model-based simulations of global and regional climate and the investigation of the processes in the climate system. DKRZ's principal objectives are provision of adequate computer performance, data management, and service and support to use these tools efficiently. DKRZ operates one of the largest supercomputers in Germany and provides its more than 1000 scientific users with the technical infrastructure needed for the processing and analysis of huge amounts of data from climate simulations. This also includes training and support for related application software and data processing issues. DKRZ participates in many national and international projects aiming to improve the infrastructure for climate modeling. Through its research group on scientific computing DKRZ is linked to the Department of Informatics of the University of Hamburg.

DKRZ is a non-profit and non-commercial limited company with four shareholders. MPG (Partner 5) holds 55% of the shares of DKRZ (see http://www.dkrz.de/about-en/Organisation/gesellschafter for more references). The dependency relationship has been declared in the Part 2 – Administrative data of participating organisation of this application form

Contribution to the specific project

In ESiWACE, DKRZ will coordinate the entire project in WP5, co-lead WP1 and WP4. Moreover, DKRZ will contribute to WP2 and WP3.

Dr. Joachim Biercamp (male) holds a PhD in Physical Oceanography and has a long standing experience in supporting data intensive climate simulations. He is leading the Application department of DKRZ. His responsibilities include the organization of user support and the interaction with DKRZ's user group and scientific steering committee. He coordinated the procurement and benchmarking of the previous two generations of DKRZ super computers (a NEC SX6, and an IBM Power6 system). Both ranked within the TOP 30 of the TOP500 list. Joachim also was in charge of procuring the latest super computer, a BULLX system which is currently being installed and will be reach a peak performance of more than 3 PetaFLOPS and a file system of world leading 50 PetaBytes. He is involved in several national and international projects dealing with infrastructure for climate modeling. In particular he is member of the steering committee of the project HD(CP)2 aiming at development and operation of a cloud resolving version of the ICON model which is used for both, climate research and numerical weather prediction.

Dr. Kerstin Fieg (female) works in the Application department of DKRZ as work package leader in third-party funding projects. She holds a PhD in Meteorology has 20-year experience in supporting data intensive climate simulations and project management. She worked in the field of development, coupling and performance optimization of Earth System Models and has contributed to procurement and management of several HPC systems. Furthermore she worked as Project Manager for ORACLE Deutschland GmbH for 4 years. Currently Kerstin is involved in several national and international projects dealing with infrastructure to support climate modeling. Kerstin will support the WP5 and WP1

Prof. Thomas Ludwig (male) is the director of DRKZ and leader of the research group Scientific Computing of the DKRZ. His research activity is in the fields of high volume data storage, energy efficiency, and performance analysis concepts and tools for parallel systems. At DKRZ Thomas

takes the responsibility for accomplishing its mission: to provide high performance computing platforms, sophisticated and high capacity data management, and superior service for premium climate science. Thomas will lead WP4.

Dr. Julian Kunkel (male), he is Principal Investigator in the group Scientific Computing at the DKRZ. Since 2006, Julian has been working on tracing environments and tools for client and server-side I/O. In 2013, he defended his thesis about the monitoring and simulation of parallel programs on application and system level. Julian is member in several program committees and chairing the Research Poster sessions of the International Supercomputing Conference (ISC) in 2014. Also, he is co-chair for ISC's Research Paper sessions since 2010. He was responsible for the University of Hamburg's contributions to the SIOX and ICOMEX project. Currently, with his role as member of the steering committee of the Exascale10 EOFS working group, he is focusing on system-wide monitoring, optimization of parallel I/O and on novel I/O interfaces for Exascale. Julian will support WP4.

Sonja Kempe (female) has more than 10-year experience in the management and administration of third-party funding projects. She is also in charge management of multi-partner consortia where DKRZ is involved. Sonja will support the WP5 in particular and the entire consortium in administrative and financial matters.

Irina Fast (female) graduated in Meteorology at the Free University Berlin, Germany. She has expertise in different areas of Earth System Modelling such as development of workflow infrastructure for performance of long-term climate simulations and data management, running of high-resolution simulations, processing and analysis of model output, as well as porting and benchmarking of climate models on various HPC systems, analysis and improvement of the computational performance, and implementation of asynchronous model output via CDI-PIO library. She will contribute to WP2 and WP3.

Dr. Kerstin Ronneberger (female) works in the Application Department of DKRZ. She holds a PhD in Earth System Research. Since 2005 she worked in several projects dealing with grid-software, data-access and workflow in Earth-System Modeling.

Dr. Panagiotis Adamidis (male) holds a PhD in Mechanical Engineering. He has 17 years of experience in the area of High Performance Computing with emphasis on parallel numerical algorithms and parallel programming models. Since 2006 he has been working for DKRZ, dealing with the development of parallel algorithms for earth system models and optimization issues at application level. He participates in the project HDCP2 (High Definition Clouds and Precipitation for Climate Prediction) where his focus is on enhancing scalability of the ICON model for future generation supercomputers. He will contribute to WP2.

Publications, and/or products or other achievements

1. Julian Kunkel, Michael Kuhn, and Thomas Ludwig: Exascale Storage Systems – An Analytical Study of Expenses. Supercomputing Frontiers and Innovations, pages 116–134, 06 2014.
2. Christopher Bartz: An in-depth analysis of parallel high level I/O interfaces using HDF5 and NetCDF-4. Master's thesis, University of Hamburg, 04 2014.
3. Dirk Meister, Jürgen Kaiser, Andre Brinkmann, Michael Kuhn, Julian Kunkel, and Toni Cortes: A Study on Data Deduplication in HPC Storage Systems. In Proceedings of the ACM/IEEE Conference on High Performance Computing (SC). IEEE Computer Society, 11 2012.
4. Konstantinos Chasapis, Manuel Dolz, Michael Kuhn, and Thomas Ludwig: Evaluating Power-Performace Benefits of Data Compression in HPC Storage Servers. In Steffen Fries and Petre Dini, editors, IARIA Conference, pages 29–34. IARIA XPS Press, 04 2014.
5. Stockhause, M., Höck, H., Toussaint, F., and Lautenschlager, M.: Quality assessment concept of the World Data Center for Climate and its application to CMIP5 data. Geosci. Model Dev., 5, 1023-1032, 2012, doi:10.5194/gmd-5-1023-2012.

6. Quadt, F., Düsterhus, A., Höck, H., Lautenschlager, M, Hense, A.V., Hense, A.N., Dames, M.: ATARRABI – A Workflow System for the Publication of Environmental Data. Data Science Journal, 11, 89-109, 2012, doi:10.2481/dsj.012-027.
7. Julian Kunkel, Alvaro Aguilera, Holger Mickler, Xuan Wang, Andrij Chut, Thomas Bönisch, Jakob Lüttgau, Roman Michel, Johann Weging. The SIOX Architecture – Coupling Automatic Monitoring and Optimization of Parallel I/O. In Supercomputing, Supercomputing, pp. 245–260, Springer International Publishing, ISBN: 978-3-319-07517-4, 2014
8. Andre Brinkmann, Toni Cortes, Hugo Falter, Julian Kunkel, Sai Narasimhamurthy Whitepaper: http://www.exascale10.com/ (not peer reviewed)
9. Panagiotis Adamidis, Irina Fast, Thomas Ludwig (DKRZ).Performance Characteristics of Global High-Resolution Ocean (MPIOM) and Atmosphere (ECHAM6) Models on Large-Scale Multicore Cluster. Parallel Computing Technologies - 11th International Conference, PaCT 2011, Kazan, Russia, September 19-23, 2011. Proceedings; 01/2011

Projects, and/or activities, services

- EU FP7 IS-ENES Infrastructure for the European Network for Earth-System-Modelling, EU FP7 Project fostering simulations with global earth system models
- EU FP7 EUDAT: European Data Infrastructure; building and supporting a collaborative data infrastructure (http://www.eudat.eu)
- ScalES: Scalable Earth System Models, funded by BMBF (https://www.dkrz.de/Klimaforschung/dkrz-und-klimaforschung/infraproj/scales/scales).
- C3-Grid & C3-INAD: Collaborative Climate Community Data and Processing Grid, funded by BMBF
- HD(CP)2: "High definition clouds and precipitation for advancing climate prediction" focusing on cloud resolving models, funded by BMBF
- ICOMEX: ICOsahedral-grid Models for EXascale earth system simulations (http://wr.informatik.uni-hamburg.de/research/projects/icomex/)
- Scalus: SCALing by means of Ubiquitous Storage (http://www.scalus.eu/)
- SIOX: Scalable I/O For Extreme Performance (http://www.hpc-io.org/)
- A full list of projects led or participated by DKRZ is available here: http://www.dkrz.de/Klimaforschung-en/projects

DKRZ supports complex and compute intensive national and international collaborative projects: simulations are carried out and resulting data are managed and made available through the World Data Center Climate WDCC operated by DKRZ (http://www.dkrz.de/daten-en/wdcc) .

- IPCC AR4: Simulations for the Fourth Assessment Report of the Intergovernmental Panel on Climate Change
- IPCC AR5: Simulations within the frame of the international climate model comparison project CMIP5 and for the 5th climate assessment report of the United Nation
- Climate simulations for Europe with CLM: the regional climate model CLM, which is based on the weather forecast model "LM" by the German Weather Service, was used for ensemble simulations of regional climate changes in Europe.
- STORM - development of a high resolution climate model: STORM is a consortium project by several German climate research institutes with the common goal of developing a climate model with very high spatial resolution. The impact of small scale processes on the quality of climate simulations is planned to be evaluated on the basis of a 21st century simulation with the model
- Climate Simulations for Europe with CLM: the regional climate model CLM, which is based on the weather forecast model “LM” by the German Weather Service DWD, was used for ensemble simulations of regional climate changes in Europe.

Significant infrastructure, and/or major items of technical equipment

DKRZ is running one of Germany's most powerful high performance computers and world class data storage and archiving hardware. The current system, an IBM Power6 computer with 8500 processor cores and a peak performance of 160 TFLOPS will be replaced by a new BULL system in March 2015. The new system will be installed in two stages, starting with 36000 processor cores and a peak performance of 1.5 PetaFLOPS to be upgraded to ca 8000 cores and 3.2 PetaFLOPS in spring 2016.
The file system will be based on lustre and will initially have a net storage capacity of 20 PetaBytes in 2015 which will be upgraded to 50 PetaBytes in 2016.
For long term archiving of data DKRZ runs a tape library with the capacity to 75 PetaByte of data annually.
A data nodes and data portal of the Earth System Grid Federation (ESGF) are run by DKRZ (http://esgf-data.dkrz.de

European Centre for Medium-Range Weather Forecasts (ECMWF)

About the institute

The European Centre for Medium-Range Weather Forecasts (ECMWF) is an international organisation supported by 34 European and Mediterranean States. ECMWF's longstanding principal objectives are the development of numerical methods for medium-range weather forecasting, the operational delivery of medium-to-seasonal range weather forecasts for distribution to the meteorological services of the Member States, to lead scientific and technical research directed to the improvement of these forecasts, and the collection and storage of appropriate meteorological data. ECMWF has extensive competence in operating complex global forecasting suites on high-performance computers and in transitioning top-level science from research to operations exploiting innovative approaches in computing science to fulfil the tight runtime and delivery constraints required by Member States. ECMWF has signed the delegation agreement with the European Commission to operate the Copernicus Atmospheric Monitoring Service and the Copernicus Climate Change Service.

Contribution to the specific project

ECMWF's contribution to ESiWACE is dedicated to WP1, WP2, WP3, WP4 with coordinator in WP2 .Further, ECMWF will co-coordinate Work Package 2, through the support of the integration of the OpenIFS model in the climate community EC-Earth system, the contribution to detailed performance assessment and code optimization work enhancing the level of concurrency and the overlap of communication and computation. ECMWF will also investigate the information content of ensemble model output to propose ways for significantly reducing data volume produced by long model integrations.

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Dr Peter Bauer (male) is co-coordinating Work Package 2 of this proposal. He joined ECWMF in January 2000 and heads the Model Division iin the research Dept. that comprises the physical and numerical aspects of numerical weather prediction. Before joining ECMWF, he was leading a DLR research team on satellite meteorology in Cologne, Germany. His background covers physical modelling, data assimilation and satellite remote sensing. He obtained his masters and PhD degrees in meteorology from the universities in Cologne and Hamburg, respectively. During his career, he was awarded research fellowships by NOAA and NASA, and a science award by DLR. He is the author and co-author of 100 peer-reviewed scientific journal papers, and his publications have an h-index of 34. He is a member of several scientific advisory committees at the international level (WMO, ESA, EUMETSAT) and has extensive experience with managing international research projects. At ECMWF, his current duties also include the management of the transition of new model cycles from research to operations and he is the manager of the recently

launched Scalability Programme. He has contributed to the EU project EURAINSAT (FP5) and numerous other ESA/EUMETSAT/NASA/BMBF projects.
Dr Tiago Quintino (male) is the Team Leader for Data Handling within the Forecast Dept. at ECMWF. He and his team develop software for data encoding and decoding, pre and post-processing of meteorological products, storage and perpetual archival of weather observations and forecast data. Tiago develops the meteorological archival software (MARS) and the high performance I/O middleware (FDB). Previously, he worked for the Von Karman Institute for Fluid Dynamics on high performance CFD software for aerospace applications and contributed to multiple EU funded projects. He is also the author of 25 journal publications and book chapters in the area of high performance scientific computing.
Dr Glenn Carver (male) will contribute to Work Package 2 of this proposal. He joined ECMWF in 2011 and leads the OpenIFS project to deliver academic versions of the IFS forecast model. Before joining ECMWF he was a senior research fellow at the University of Cambridge, UK where he led development of a community atmospheric chemistry model and was PI on two national awards and co-PI on two others totaling 680kEuro. He has over 40 peer-reviewed publications with 1300 citations and an h-index of 17.
Dr Filip Vana (male) will contribute to Work Package 2 of this proposal. He joined ECMWF in early 2012 to work on the OpenIFS project. Before joining ECMWF, he was working as the Area Leader for Dynamics for the LACE (Limited Area model for Central Europe) Consortium representing the Czech weather service (CHMI) there. His background covers model dynamics & numerics including variational methods, physics and parallelization aspects. He was a member of Scientific Advisory Committee of LACE and the Committee for Scientific and System/maintenance Issues (CSSI) of Aladin consortium (Cooperation of over 15 National Meteorological Services of Europe and Northern Africa in the field of Numerical Weather Prediction (NWP). He has 8 per-reviewed publications.

Publications, and/or products, services or other achievements

1. Geer A.J., P. Bauer and C.W. O'Dell, 2009: A revised cloud overlap scheme for fast microwave radiative transfer in rain and cloud. J. Appl. Meteorol. Climat., **48**, 2257-2270.
2. Carver, G.D., Váňa, et al., The ECMWF OpenIFS model, EGU General Assembly Abs., 15, 2013.

Projects, and/or activities

1. EU FP7 project **CRESTA** (2011-2014): Collaborative Research into Exascale Systemware, Tools & Applications (CRESTA) on investigating the efficiency gains from a Partitioned Global Address Space (PGAS) implementation for numerical weather prediction.
2. EU FP7 ERC Advanced Grant project **PantaRhei** (2013-2018): Inter-disciplinary integrated forecasting system for fluid flow.
3. EU H2020 project **MACC-III** (2014-2015): Monitoring atmospheric composition and climate based on IFS as main global model component leading to **Copernicus Atmospheric Monitoring Service**.
4. EU H2020 project **ERA-Clim2** (2013-2016): Global coupled reanalysis covering the 20th century based on the IFS as main global model component to be integrated in **Copernicus Climate Change Service**.

Significant infrastructure, and/or major items of technical equipment

- ECMWF's computer facility includes supercomputers (current Cray XC-30 clusters are ranked 19th and 20th in top500 list), archiving systems and networks.
- ECMWF produces operational forecasts, archives and disseminates global model output to member states under tight schedules employing its computing and data handling infrastructure.
- Both Copernicus services ECMWF will be operating will be supported by the ECMWF computing and data handling infrastructure.

Centre National de la Recherche Scientifique (CNRS-IPSL)

About the institute

The Centre National de la Recherche Scientifique (CNRS) is the main French public research institution under the responsibility of the French Ministry of Education and Research. CNRS acts here in the name of the Institut Pierre Simon Laplace (IPSL), which is a federal institute located in Paris and composed of 9 research laboratories working on global environmental and climate studies. IPSL gathers about thousand scientists and represents more than a third of the French research potential in atmospheric and oceanic sciences. Main laboratories from IPSL involved in ESiWACE are Laboratoire des Sciences du Climat et de l'Environnement, and Laboratoire d'Océanographie et du Climat. One of the main objectives of IPSL is to understand climate variability, both natural and anthropogenic, and future evolution, at global and regional scales. IPSL's work relies on the development of Earth system models of different complexity (e.g. IPSL-ESM). IPSL is strongly involved in IPCC Working Group 1. CNRS-IPSL coordinates IS-ENES and IS-ENES2, and has also been involved in several European projects such as ENSEMBLES, METAFOR, EMBRACE. CNRS-IPSL was a pioneer in developing since the 1980s a numerical model of the global physical ocean taking into account the HPC issues from the very beginning. This led to the NEMO Consortium involving different research/operational oceanography centres in Europe (CNRS through LOCEAN and LGGE, CMCC, INGV, Mercator Ocean, UK Met Office, NOC), which join efforts for the sustainable development of NEMO (www.nemo-ocean.eu). Today, CNRS is, among the consortium partners, the largest contributor in terms of number of experts to the NEMO System Team, including the Scientific Leader and the Project Manager, and leading the NEMO HPC working group. CNRS-IPSL with the Commissariat à l'Energie Atomique et aux Energies Alternatives (CEA) have developed XIOS, a software library dedicated to efficient IO management for climate models.

Contribution to the specific project

CNRS-IPSL will lead ESiWACE's WP1 and substantially contribute to WP2 on NEMO and XIOS

Dr. Sylvie Joussaume (female) is a researcher at CNRS since 1983. She is an expert in climate modelling. She has been coordinating IS-ENES (EU FP7) phases 1 and 2 since 2009 and is Chair of the ENES Scientific Board. She is Review Editor in IPCC-AR5. She is involved in the Management Committee of JPI Climate (Joint Programming Initiative on Climate, collaboration between 14 European countries to coordinate jointly their climate research and fund new transnational research initiatives). She has been vice chair of the PRACE scientific committee since 2011 and will chair PRACE SSC in 2015.

Marie-Alice Foujols (female) is a research engineer at CNRS. She is in charge of coordinating technical aspects of the Earth system modelling activities at IPSL, and the head of the IPSL engineers group working across the IPSL laboratories. She has 20 years expertise in high performance computing.

Sébastien Denvil (male) is a research engineer at CNRS. An applied mathematician, he holds a Master's degree in "Information treatment and data processing". He joined the global climate modelling group at CNRS-IPSL where he is responsible for the long IPCC-type simulations and for the distribution of model outputs. He is strongly involved in international metadata standards and in ESGF.

Claire Lévy (female), software engineer at CNRS, is NEMO Project Manager since 2008. She has been working on NEMO (previously OPA) development since the 1990s. Claire will contribute to WP2.

Françoise Pinsard (female)**,** software engineer at CNRS, is a member of the NEMO R&D team at LOCEAN and will contribute to WP2.Françoise Pinsard started to worked on NEMO 10 years ago when the model was running on the Earth Simulator in Japan. She was working on the

benchmarking and optimisation of the code in order to obtain the maximum of parallelism from the code. Since then, she is still working on the HPC aspect in NEMO, for example by developing specific tools to identify and quantify bottleneck in NEMO scalability.

Dr Sébastien Masson (male) is a researcher in oceanography and climatology at Université Pierre et Marie Curie (UPMC), linked third party to CNRS. Member of the NEMO Developing Team for 10 years, he has been running the model on high performance computers for more than 15 years, such as the Japan Earth Simulator, national facilities within "GENCI grand challenges", and on PRACE projects. He is the PI of the 4-year PULSATION project (French National Research Agency). He is responsible for the upscaling part of the WP2 of project EMBRACE (EU FP7) and participates to the projects IS-ENES and IS-ENES2 (EU FP7)

Dr Yann Meurdesoif (male) is an engineer at CEA, linked third party to CNRS, and has a background in theoretical physics. He has been working for several years as a consultant for high performance computing at the CEA supercomputing centre and has then acquired a strong background on parallelism, code porting and optimization on a large variety of supercomputer. He has developed the parallel versions of several components of the IPSL Earth system model and is responsible at IPSL for the development of XIOS, a software library dedicated to efficient IO management for climate models.

Arnaud Caubel (male) engineer at CEA, linked third party to CNRS, in charge of coordinating technical aspects of the IPSL Earth System climate model and its environment. He has expertise on coupling aspects and high performance computing and is involved in the use of XIOS (WP2).

Publications, and/or products, services or other achievements

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Projects, and/or activities

- EU FP7 Project **IS-ENES** phase 1 (2009-2013), phase 2 (2013-2017) is the distributed e-infrastructure of models, model data and metadata of the European Network for Earth System Modelling (ENES). IS-ENES projects, coordinated by CNRS-IPSL, combine expertise in climate modelling, computational science, data management and climate impacts. They aim at fostering the integration of the European Climate and Earth system modelling community, enhancing the development of Earth system models for the understanding of climate variability and change, supporting high-end simulations, and at facilitating model applications to better predict and understand climate change impacts on society.
- EU FP7 Project **EMBRACE** (Earth system Model Bias Reduction and assessing Abrupt Climate change, 2011-2015): bringing together the leading Earth system models (ESMs) in Europe around a common set of objectives to improve our ability to simulate the Earth system and to make reliable projections of future global change. The project has a number of key goals: to reduce the main, known biases in existing European ESMs, to fully evaluate ESM simulation capabilities and improvements made in the project, to increase the realism of, and

interactions between, the physical and biogeochemical components of ESMs, to assess the risks of abrupt or irreversible changes.

- ANR (French National Research Agency) Project **PULSATION** (Peta-scale mULti-gridS ocean-ATmosphere coupled simulatIONs) aims to explore new pathways toward a better representation of the multi-scale physics that drive climate variability.
- ANR (French National Research Agency) Project **CONVERGENCE (**Convergence facing Big Data era and Exascale challenges for Climate Sciences).aims to develop a platform capable of running large ensembles of simulations with a suite of models, to handle the complex and voluminous datasets generated, to facilitate the evaluation and validation of the models and the use of higher resolution models.

Significant infrastructure, and/or major items of technical equipment

- CNRS-IPSL is strongly involved in IPCC Working Group 1 through authors and review editors. CNRS-IPSL is one of the seven European modelling groups developing and performing international global model inter-comparison projects, such as CMIP5.
- CNRS-IPSL also contributes to the NEMO HPC Group, active in analysing the future possible developments of NEMO and of its components in view of the evolving computational landscape in the coming 5-10 years. These activities include the conception of new solvers and mathematical algorithms.

Max-Planck-Institut für Meteorologie (MPG)

About the institute

The Max Planck Institute for Meteorology (MPG) performs basic research in the interest of the general public. Its mission is to understand the Earth's changing climate.
It comprises three departments (The Atmosphere in the Earth System, The Land in the Earth System, The Ocean in the Earth System) and hosts independent research groups focused on: Fire in the Earth System, Forest Management in the Earth System, Sea Ice in the Earth System, Stratosphere and Climate, Turbulent Mixing Processes in the Earth System.

Scientists at MPG investigate what determined the sensitivity of the Earth system to perturbations such as the changing composition of its atmosphere, and work towards establishing the sources and limits of predictability within the Earth system. The MPG develops and analyses sophisticated models of the Earth System which simulate the processes within atmosphere, land, and ocean. Such models have developed into important tools for understanding the behavior of our climate. Models form the basis for international assessments of the climate change. Targeted in-situ measurements and satellite observations complement the model simulations.

MPG is committed to informing public and private decision-makers and the general public on questions related to climate and global change.
Together with the University of Hamburg, MPG runs an international doctoral programme, the International Max Planck Research School on Earth System Modelling (IMPRS-ESM) to promote high-quality doctoral research into the Earth's climate system, hosting approximately 50 PhD students per year.
MPG is actively involved in the cluster of excellence "Integrated Climate System Analysis and Prediction" (CliSAP), a research and training network whose goal is to bridge the gap between natural sciences, economics and humanities, creating synergies for analysing natural and human-caused climate change and developing scenarios for the future.
The MPG is the major shareholder of German Climate Computing Centre (DKRZ GmbH), the coordinator of the ESiWACE project. DKRZ is an outstanding research infrastructure for model-based simulations of global climate change and its regional effects. DRKZ provides tools and the associated services needed to investigate the processes in the climate system, computer power, data management, and guidance to use these tools efficiently.

Contribution to the specific project

MPG's contribution to ESiWaCE is dedicated to WP1, WP2, WP3, WP5
Reinhard Budich (male) is responsible for the strategic IT partnerships of MPG. As an Oceanographer he has been working in Earth system modelling for over 20 years. He has held responsibility for the IT at MPG in many roles, was the Technical Coordinator of the FP7 project IS-ENES, is member of the board of ENES, was running the COSMOS network as a project manager and was Director of the FP5 PRISM project. Since 2001 he has been running the ENES office in Hamburg. Reinhard was involved as technical coordinator in ISENES1, has initiated the International summer school series E2SCMS of ENES, is work package leader in ISENES2 and member of the Council of EUDAT. Reinhard also is a member of the IUAC of GEANT. Reinhard will lead the WP 3 "Usability" and supports WP1 and 2.

Dr. Luis Kornblueh (male) graduated at the Technical University of Darmstadt, Germany and received his PhD in Meteorology from University of Hamburg. His first task at MPG has been refactoring and parallelizing a comprehensive GCM (ECHAM). At the same time he has been participating in Science- and Mission-Advisory groups of ESA and EUMETSAT projects for radio-occultation instruments and working on the influence of those on numerical weather prediction. During the last couple of years he focused more on the performance of models in detail: Optimization on the loop level, correct and fast OpenMP implementations, MPI handling, and I/O strategies. Recently, the problem of optimizing workflows is a new subject he is looking into, because there is more potential to gain improvements compared to hard-core optimization. Luis will be involved in WP 2 and 3.

Karl-Hermann Wieners (male) is scientific software developer with the Computational Infrastructure and Model Development group at MPG. His primary interest is scientific workflow, data processing, and database applications. Before joining MPG, he has worked for 8 years as software engineer and technical consultant in an SME, with customers in retail and media industry. At MPG, he has contributed to the EU Project IS-ENES, and is currently contributing to IS-ENES2. Karl-Hermann will be involved in WP 2 and 3.

Chiara Bearzotti (female) is in charge of Unit for project development and project monitoring at the MPG. Her role is to support scientists granted third-party funding in managing their projects and implementing them according to the requirements of the funding agencies, not only on contractual and financial issues, but also on issues related to Open Science /Open Access, intellectual property rights management, communication, dissemination and public engagement. Chiara has degrees in economics, project design and project management, rounded up by sound legal knowledge of EU law; Chiara is an Open Access Ambassador at the MPG. In the last 16 years, Chiara has been working in the project development and management both on the side of those applying for funding and for those, like European Commission agencies, funding projects. She has been the project manager for the FP7 research projects THOR and NACLIM, ESFRI European XFEL project and she has been involved in several Horizon 2020 applications and grant agreement preparations. Given the institutional link between Max Planck Meteorology and DKRZ, Chiara will support DKRZ in the implementation of the activities foreseen under WP5.

Publications, and/or products, services or other achievements

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Projects, and/or activities

- EU FP7 Project **EUDAT** (http://eudat.eu/) is building a data e-infrastructure which supports collaborations for, among others, climate modellers (ENES). STFC is leading the work package on scalability in the (now extended till March 2015) project as well as the task force on authentication and accounting
- EU FP7 project **IS-ENES2**: Infrastructure for the European Network for Earth System modelling - Phase 2

Significant infrastructure, and/or major items of technical equipment

- MPG is the major shareholder (55%) of the supercomputer at the German Climate Computing Center (DKRZ)
- MPG is one of the key laboratories developing and performing large model intercomparison exercises, such as CMIP5.

Centre Européen de Recherche et de formation Avancée en Calcul Scientifique (CERFACS)

About the institute

CERFACS (http://www.cerfacs.fr), established in 1987 in Toulouse (France), is currently one of the world's leading research institutes working on efficient algorithms for solving large-scale scientific problems. The CERFACS Climate Modelling and Global Change team conducts basic

scientific research and high-level technical developments in the field of climate studies. In particular, the team develops the OASIS coupler currently used by more than 40 climate-modelling groups in Europe and around the world. CERFACS activities in high performance computing encompass assembling high-resolution coupled climate based on state-of-art component models, porting and optimising them on a variety of platforms. CERFACS has participated in CMIP5 and one of its main scientific objectives is to make significant contributions to the understanding of the world climate variability on regional to global scales and to climate impact studies at seasonal-to-decadal time scales. CERFACS is getting also involved in building new approaches to deal with large data volumes produced in climate science together with large data centres in Europe.
Thanks to its strong expertise in code coupling and the central role played by the OASIS coupler in the European climate community, CERFACS was heavily involved in the set-up of the IS-ENES1 (2009-2012) and IS-ENES2 (2012-2016) projects and now actively participates in IS-ENES2 as leader and co-leader of 2 work packages and leader of the HPC task force. CERFACS is also involved in several other e-infrastructure and scientific FP7 European projects: PREFACE, 2014-2018 (WP leader); CLIPC, 2014-2018 (participant); SPECS, 2012-2016 (WP leader); EUDAT 2011-2015 (Task leader).

Contribution to the specific project

CERFACS is co-leading WP2 and is leading T2.2 on performance benchmarking for I/O and coupling technologies. Within this work package, CERFACS is of course also involved in the tasks addressing user support and training for the OASIS coupler (T2.1.2) and optimization of the coupler (T2.3.2). Thanks to its experience on governance for the OASIS software, CERFACS is participating to WP1 in T1.1.2 about the governance for community software. Finally, CERFACS also commits to continue leading the HPC task force and to organize an HPC workshop (WP1, T1.2.1).

Dr. Sophie Valcke (female) holds a "highly qualified" research engineer position at CERFACS where she is working on high-resolution atmosphere-ocean-ice coupled modelling and is leading a team of 4 engineers developing the OASIS coupler. Thanks to her expertise in HPC for climate, Dr Valcke currently sits on the PRACE Access Committee, participated to the PRACE Scientific Case Panel and in the related working group for the European Exascale Software Initiative. Dr Valcke is CERFACS Principal Investigator for the current IS-ENES2 project and was CERFACS PI in IS-ENES1 and METAFOR project. These projects favour Dr Valcke's interaction with many climate-modelling groups in Europe and with other groups internationally developing coupling frameworks, such as the USA-led ESMF or the NCAR Community Earth System Model (CESM). Dr Valcke also played a key role in the set-up of the International Working Committee on Coupling Technologies that organizes global efforts related to the characterization, comparison, and benchmarking of Earth system model coupling technologies (http://earthsystemcog.org/projects/iwcct/).

Dr. Laure Coquart (female) has a PhD in fluid dynamics from Univ. of Paris VI. She is now a research engineer in the Climate Modelling and Global Change team at CERFACS where she tests and validates the development of the OASIS coupler on different computing platforms. Dr Coquart also provides user support by email and via the OASIS forum or by visiting research teams in France. Through this support, Dr Coquart developed a strong expertise in coupled climate modelling and established working contacts with many climate-modelling groups in Europe.

Publications, and/or products, services or other achievements

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Projects and/or activities

CERFACS provides advanced HPC training in code coupling for PhD & post-doctoral students and engineers (see http://www.cerfacs.fr/19-25708-Home.php).
CERFACS is involved in the current EU and national projects:

- EU FP7 project **PREFACE**, 2014-2018: Variability, previsibility and impacts of climate change on the Tropical Atlantic.
- EU FP7 project **CLIPC**, 2014-2018: Climate change indicators.
- EU FP7 project **SPECS**, 2012-2016: High-resolution decadal prediction.
- EU FP7 project **IS-ENES2**, 2012-2016: Development and implementation of OASIS3-MCT coupler, coupling technology performance benchmarking, multi-model multi-member high-resolution ESM experiments, standardisation and metadata, development of a climate date portal for impact community.
- EU FP7 project **EUDAT,** 2011-2015: Infrastructure for scientific data in the context of Big Data
- ANR (French Agence Nationale de la Recherche) project **CONVERGENCE** 2013-2017: Infrastructure for the French climate modelling community.

Significant infrastructure, and/or major items of technical equipment

CERFACS has indoor HPC capacity of 75 peak Tflops, thanks to a BULL Intel SandyBridge cluster and HP AMD MagnyCours cluster.

Barcelona Supercomputing Center(BSC)

About the institute

The Barcelona Supercomputing Center-Centro Nacional de Supercomputación (BSC-CNS, BSC henceforth), created in 2005, has the mission to research, develop and manage information technology in order to facilitate scientific progress not only in computer science but also in a large range of applications. More than 350 people from 40 different countries perform and facilitate research into Computer Sciences, Life Sciences, Earth Sciences and Computational Applications in Science and Engineering at the BSC. The BSC is one of the eight Spanish “Severo Ochoa Centre of Excellence” institutions selected in the first round of this prestigious programme in Spain, as well as one of the four hosting members of the European PRACE Research Infrastructure. The BSC hosts MareNostrum III, a Tier-0 PRACE system currently ranked as the 24th most powerful supercomputer in Europe (57th in the world) with 1 Pflop/s capacity. In addition, the BSC hosts other High-Performance Computing (HPC) resources, among which it is worth mentioning MinoTauro, a hybrid system with GPUs incorporated.

The Earth Sciences Department of the BSC (ES-BSC) was established with the objective of carrying out research in Earth system modelling. The ES-BSC conducts research on air quality, mineral dust and climate modelling and strongly contributes to the scientific and technological advancement in atmospheric and mineral dust modelling. In this sense, the ES-BSC develops and maintains a state-of-the-art mineral dust model: NMMB/BSC-Dust. The excellent results of the group on this field have contributed to the recently creation of the first World Meteorological

Organization (WMO) Regional Meteorological Center specialized on Atmospheric Sand and Dust Forecast, the “Barcelona Dust Forecast Center”. In which the NMMB/BSC-Dust model has been selected as the reference mineral dust model. Currently the model provides mineral dust forecasts to the World Meteorological Organization (WMO) Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) Northern Africa- Middle East-Europe (NAMEE) Regional Centre that is managed by a consortium between the Spanish Weather Service (AEMET) and BSC. Furthermore, BSC and UNEP are collaborating in the development and implementation of the WMO SDS-WAS West Asia Regional Centre in which the NMMB/BSC-Dust is designed to perform mineral dust forecast simulations. ES-BSC also undertakes research on the development and assessment of dynamical and statistical methods for the prediction of global and regional climate on time scales ranging from a few weeks to several years. The EC-Earth model is used for this purpose. The formulation of the predictions includes the development and implementation of techniques to statistically downscale, calibrate and combine dynamical ensemble and empirical forecasts to satisfy specific user needs in the framework of the development of a climate service.

The high performance capabilities of MareNostrum III and the close collaboration with the Computer Sciences department allow efficiently increasing the spatial and temporal resolution of atmospheric modelling systems, in order to improve our knowledge on dynamic patterns of air pollutants in complex terrains and interactions and feedbacks of physico-chemical processes occurring in the atmosphere, as well as to push the boundaries of global climate prediction. To this, it should be added the increasing collaboration between the different BSC departments on the rapidly growing field of Big Data. Therefore, BSC offers a unique infrastructure to carry out the range of Earth system simulations on which the ES-BSC is a reference worldwide.

Contribution to the specific project

BSC’s contribution to ESiWACE is concentrated in WPs 1, 2 and 3.
In WP3 the BSC leads task 3.1. ES-BSC has a vast experience in deploying climate models not only on the Marenostrum3 supercomputer, but also on several other HPC platforms like Archer (Edinburgh), CCA (ECWMF; Reading), etc. BSC has already organized a summer school on climate modelling and therefore has the knowledge required to successfully perform the task. Also, the department can take advantage of the strong links between climate modellers, technical staff of the department and system administrators.

In WP2 leads task 2.3. ES-BSC can offer a wide range of services (based on software and hardware) to ESiWACE to analyse and improve performance of Earth system models. Increasing climate model efficiency requires the application of a wide set of tools to analyse and understand the behaviour of these models running in a parallel environment. BSC, through the Tools Group, develops tools like Paraver or Dimemas that can easily help the user of these codes to understand the behaviour of the code and identify possible bottlenecks and hardware related problems of the application. Furthermore, BSC provides the OmpSs programming model and COMPSs Superscalar (both developed in the institution). OmpSs can exploit parallelism through data dependencies or use different devices (GPU’s, accelerators) in a transparent way for the user and COMPSs Superscalar is a programming model that aims to ease the development of applications for distributed infrastructures, such as clusters, grids and clouds.

Prof. Francisco Doblas-Reyes (male) is an expert in the development of seasonal-to-decadal climate prediction systems and the head of the ES-BSC. He is involved in the development of the EC-Earth climate forecast system since its inception. He was an IPCC lead author in the Fifth Assessment Report, serves in WCRP and WWRP scientific panels, is a member of the ENES HPC Task Force, has participated in a number of FP4 to FP7 projects and is author of more than 100 peer-reviewed papers. He is shaping BSC’s plans for the development of a weather and climate modelling service that brings the latest developments of HPC and Big Data research to the Earth science community, increasing at the same time the resilience of the European society to weather, air quality and near-term climate extremes.

Mr. Oriol Mula-Valls (male) is an engineer that acts as system administrator of the local network, maintains the environment where the software development takes place and coordinates the design of new solutions for the problems that continuously affect the modellers.

Mr. Kim Serradell (male) is an engineer that as research support engineer. He has a vast experience in the implementation of operational and research meteorological and air quality models on different supercomputing platforms. He is interested in analysing the behaviour of these models with different tools and techniques in order to improve the performance of such codes.

Mr. Domingo Manubens (male) is an engineer that acts as software engineer. He is involved in the design of new solutions in the framework for managing complex global climate coupled models workflows in supercomputing environments. He is the lead developer of Autosubmit. He is interested in facilitating the collaboration during develop and test processes and in the continuous integration of codes developed by the modellers.

Publications, and/or products, services or other achievements

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Projects, and/or activities

- EU FP7 project **IS-ENES**: Infrastructure for the European Network of Earth System Modelling.
- EU FP7 project **SPECS**: Seasonal-to-decadal climate Prediction for the improvement of European Climate Services.
- PRACE Tier-0 project **HiResClim**: High Resolution Climate Modelling.

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Significant infrastructure, and/or major items of technical equipment

- BSC-CNS hosts MareNostrum, the most powerful supercomputer in Spain. MareNostrum has a peak performance of 1,1 Petaflops, with 48,896 Intel Sandy Bridge processors in

3,056 nodes, and 84 Xeon Phi 5110P in 42 nodes, with more than 104.6 TB of main memory and 2 PB of GPFS disk storage.
- BSC-CNS hosts MinoTauro, an NVIDIA GPU cluster with 128 nodes, each one carrying two Intel E5649 (6-Core) processor and two M2090 NVIDIA GPU cards.
- BSC-CNS has a dedicated storage for the Earth Sciences Department of more than 600 TB net space that will be grown to 2 PB in the following two years. This system also acts as ESG node for the Spanish climate modelling community.

Science and Technology Facilities Council (STFC)

About the institute

The Science and Technology Facilities Council (STFC) is one of seven research councils in the UK. Its facilities, instruments, and expertise support an extremely wide range of research at universities, in research councils, and industry. The research council is one of Europe's largest multi-disciplinary research organisations, and has considerable world-class research expertise in areas ranging from nanostructures to lasers, from particle physics to cosmology, from high performance computing and supercomputing to peta-scale data management.

STFC, in particular, provides services to NERC, the National Environment Research Council, so support climate modelling and climate data management. These services include data services for CEDA, the Centre for Environmental Data Archival, and the JASMIN high performance computing cluster, which is backed by the largest Panasas storage system in the world (or at least the largest which is not secret.). The services also include the tapestore, which for NERC, holds both backups of the data archives, and provides an elastic storage facility for research data. (The tapestore infrastructure also supports other communities, including the LHC Tier-1 data centre.)

As a partner in this project, STFC's work is split across the Scientific Computing Department (SCD) which provides the expertise in data storage and processing, and the RAL Space department which will provide the expertise in climate modellingmodelling, climate data formats, and environmental data management and the data formats used. Together they are currently responsible for in excess of 10 PB of environmental data, in millions of files, held primarily on spinning disk, supporting many national and international projects.

Contribution to the specific project

The STFC primary interest and contribution to ESiWACE is twofold: Firstly, projections for future data growth in the STFC environmental data archive have have already led to major concerns as to how the community ambitions can be met. STFC will both generate project requirements, and trial new solutions and technologies developed by ESiWACE. The challenge lies not just in the volume, but also in the ability to ingest data at the required rates, in providing both archives and working repositories, in making data available for analysis in high performance computing clusters, and in providing support for the data throughout its lifecycle, from initial capture to publications of the results.

The second objective lies in supporting data interoperability. While format interoperability is to some extent a solved problem, semantic interoperability of data held in differing formats is not. CEDA has considerable expertise in supporting metadata management, but has not been able to resource NetCDF/GRIB semantic interoperability, despite the enormous importance of such interoperability to the Weather and Climate community. The work proposed here will meet significant international programmatic objectives.

Professor Bryan Lawrence is the Director of CEDA. He also holds a joint position as professor of weather and climate computing at the University of Reading, where his role also includes leadership of the Models and Data Division of the National Centre for Atmospheric Science. With a PhD in atmospheric physics, he has collaborated widely in the field of climate research and the

development of computational models, alongside his interest and leadership in data science. Professor Lawrence has in excess of one hundred relevant publications, and was recently awarded the AGU Leptoukh Lecture for “significant contributions to informatics, computational or data science”.

Dr Jens Jensen is a group leader of the data services group in the scientific computing department. His primary responsibility is the group delivering data storage and database services to CEDA (and others), and he also leads the storage and data management group in GridPP, the UK part of the large hadron collider computing grid. With a background in maths, his research interests include large scale scientific data management for global collaborations, particularly the data security aspects and the need for globally trusted infrastructures and interoperable identity management. He is Area Director for security in the Open Grid Forum, and is currently leading the authentication and authorisation task force in EUDAT.

Esther Conway joined CEDA in 2011 as an Earth Observation Data Scientist providing level management support to ESA in the ESA LTDP initiative in addition to data curation and management activities at CEDA. Before transferring to CEDA she worked as an Analyst within STFC (2006 -2011) working on UK and European research projects aimed at strengthening the long-term reuse and exploitation of scientific data: SCIDIP- ES, ENSURE; SCAPE, PARSE INSIGHT; CASPAR; DCC – SCARP, BACI and FIDCUCIO. Her role on these projects involved the provision of research analysis, training and project management. The particular focus of her research was the development of process/information models and methods which support the creation and exploitation of scientific research assets. Responsibilities included writing of project proposal, papers and deliverables. She has also spent 4 years (2010-2014) providing consultancy and project managemnet expertise to the ESA LTDP programme.

Philip Kershaw is the Technical Manager in STFC-CEDA, responsible for the development of information and computing systems in support of CEDA. Phil joined CEDA in 2004 following work in a number of software-based projects within RAL. Prior to joining RALSpace Phil worked in the EO industry developing applications for image processing and image registration for EO data, leading to his present 15 years development experience as an experienced software engineer in EO and remote sensing, climate and space science. Through this work Phil has gained specialist knowledge in access control and security for federated systems, for example being a major contributor to the access control architecture for the Earth System Grid Federation, a globally distributed infrastructure deployed to support CMIP5. He is the Technical lead on academic CEMS, and leads the data modelling work in CHARME, an EU FP7 funded project aiming to link commentary metadata (e.g. annotations, supporting information about the data) and climate datasets.

Publications, and/or products, services or other achievements

1. J-C Andre, G Aloisio, J Biercamp, R Budich, S Joussaume, **B Lawrence**, S Valcke: *High Performance Computing for Climate Modeling*, J. Am. Met. Soc., Vol. 95, Issue 5 (May 2014), http://journals.ametsoc.org/doi/abs/10.1175/BAMS-D-13-00098.1
2. Mizielinski, M. S., Roberts, M. J., Vidale, P. L., Schiemann, R., Demory, M.-E., Strachan, J., Edwards, T., Stephens, A., **Lawrence, B. N**., Pritchard, M., Chiu, P., Iwi, A., Churchill, J., del Cano Novales, C., Kettleborough, J., Roseblade, W., Selwood, P., Foster, M., Glover, M., and Malcolm, A.: High-resolution global climate modelling: the UPSCALE project, a large-simulation campaign, Geosci. Model Dev., 7, 1629-1640, doi:10.5194/gmd-7-1629-2014, 2014
3. **Lawrence, B.N**., V.L. Bennett, J. Churchill, M. Juckes, P. Kershaw, S. Pascoe, S. Pepler, M. Pritchard, and A. Stephens. Storing and manipulating environmental big data with JASMIN. Proceedings of IEEE Big Data 2013, p68-75. doi:10.1109/BigData.2013.6691556
4. S Waddington, J Zhang, G Knight, **J Jensen**, R Downing, C Ketley: Cloud repositories for research data -- addressing the needs of researchers, Journal of Cloud Computing: Advances, Systems and Applications 2013, 2:13 (15 June 2013)

5. **J Jensen**: Clouds and Trust and All That. Norwegian Information Security Conference, Stavanger, Nov. 2013
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7. **E Conway,** D Giaretta, S Lambert, B Matthews. Curating scientific research data for the long term : a preservation analysis method in context International Journal of Digital Curation 6 (2) (2011);
8. **E Conway**, B Matthews, S Lambert, D Giaretta, M Wilson, N Draper. Managing Risks in the Preservation of Research Data with Preservation Networks. International Journal of Digital Curation 7 (1) (2012).
9. **Esther Conway**, Sam Pepler, Wendy Garland, David Hooper, Fulvio Marelli, Luca Liberti, Emanuela Piervitali, Katrin Molch, Helen Glaves, and Lucio Badiali: Ensuring the Long Term Impact of Earth Science Data through Data Curaton and Preservation. ISQ / v.25 no.3 Fall 2013 (http://www.niso.org/apps/group_public/document.php?document_id=11598&wg_abbrev=isq)
10. D. Ross (ed): SCARF annual report (2014): https://epubs.stfc.ac.uk/work/12275693

Projects, and/or activities

- EU FP7 Project IS-ENES2 (https://verc.enes.org/ISENES2). IS-ENES2 is the second phase project of the distributed e-infrastructure of models, model data and metadata of the European Network for Earth System Modelling (**ENES**).IS-ENES2 combines expertise in climate modelling, computational science, data management and climate impacts.
- EU FP7 Project EUDAT (http://eudat.eu/) is building a data e-infrastructure which supports collaborations for, among others, climate modellers (ENES). STFC is leading the work package on scalability in the (now extended till March 2015) project as well as the task force on authentication and accounting
- SCIDIP-ES FP7 project (http://www.scidip-es.eu/scidip-es/), led by ESA, developed scalable digital preservations for Earth sciences data. It also investigated the use of (computing) clouds for trustworthy processing of data.
- The SCAPE project (www.scape-project.eu) finished at the end of September 2014. It developed a framework for workflows for the preservation of large scale science data, and the workflows, automated processes, and quality assurance tools could be relevant to the present proposal.
- The CHARMe project, also FP7 (http://www.charme.org.uk/), aims to share climate knowledge through commentary annotations and linked data linked to the original datasets.

Significant infrastructure, and/or major items of technical equipment

CEDA hosts four major data centres: the British Atmospheric Data Centre, the NERC Earth Observation Data Centre, the IPPC Data Distribution Centre, and the Solar System Data Centre, as well as providing a hosting infrastructure to support analysis and exploitation of the data holdings.

The analysis infrastructure includes the JASMIN computing cluster, operated by SCD and owned by RAL Space. Based on VMWare vCloud, it is a significant HPC infrastructure for climate sciences, with 4K cores dedicated to analysis (not simulation) backed by a 12 PB Panasas system – the largest (known) in the world – it is capable of moving about 2 terabits per second. (See the SCARF report, its sister cluster, in references).

The analysis and data centre infrastructure is backed by the SCD datastore, based on Oracle/Sun/StorageTek tape robots. With a nominal nearline capacity of 170 PB, it serves as a dark archive, backup store, and working repository. With data volumes growing roughly exponentially over the years (by, very roughly, a factor 10 every five years), the growth in climate data is one of the key challenges.

Met Office (MetO)

About the institute

The Met Office (MetO) has been operating as a Trading Fund since 1996, originally as an Executive Agency of the UK Ministry of Defence (MoD). As part of a Machinery of Government change in July 2011 MetO became a Trading Fund within the Department for Business, Innovation and Skills (BIS). As the UK's national meteorological service, it provides a range of products and services to a large number of public and private sector organisations. It also represents the UK within the World Meteorological Organisation (WMO) and plays a prominent role in international meteorology.

MetO is one of the world's leading providers of environmental and weather-related services. It delivers proven weather related services for many different types of industry on a twenty-four hour basis. Many of these services are time critical. MetO is involved in many areas of research and development in the fields of atmospheric and oceanic sciences and observations. Its research and development activities aim to improve the accuracy of our weather forecast services and the efficiency with which they can be produced. This enables its customers to benefit from the progressive international advancement of weather forecasting techniques.

MetO provides the Met Office Hadley Centre Climate Programme which is supported by the Department of Energy and Climate Change (DECC), and the Department for Environment, Food and Rural Affairs (Defra). Their investment provides the core science on which Government can make decisions to help the UK become resilient to climate variability and change, benefit from opportunities for growth, and engage in international climate negotiations. For example, research findings from the programme help ensure cost-effective deployment of renewable energy, and a resilient future for the nation's infrastructure. To achieve this, the Hadley Centre needs a large production facility to run complex multi-model integrations and ensembles of integrations as well as a resource for research and development. These models can run over periods of months and are time critical to meet deadlines for the customer and for the International Panel for Climate Change (IPCC) producing significant output that needs analysis over long periods of time.

MetO has a long experience in developing successful software infrastructures to support both Weather and Climate scientists and models including archive systems, user interfaces, build and configuration management systems.

Contribution to the specific project

MetO will contribute to the following tasks: Work Package 2, Tasks 2.2 and 2.3. Work Package 3, Task 3.3

Mr Mick Carter (male) has 31 years of experience working in Scientific Software Engineering for the Weather and Climate Communities at the Met Office (MetO). Mick is currently the Strategic Head of Scientific Software for the Met Office Hadley Centre for Climate Prediction. He is also the chair of the Technical Advisory Group for the Unified Model Partnership and a member of the HPC Taskforce for ENES.

David Matthews (male) has 17 years of experience working in Scientific Software Engineering at the Met Office (MetO). He leads the Modelling Infrastructure team containing 4 developers who contribute to development and support the CYLC meta-scheduler and are the primary developers of the Rose and FCM systems.

Professor Nigel Wood (male) has 28 years experience of numerical modelling of geophysical flows, including the design, analysis and implementation of various novel numerical methods. He is currently the Scientific Strategic Head of the Dynamics Research group, responsible for all aspects of the dynamical core of the Unified Model. He is the author of 76 peer reviewed journal papers and holds an honorary visiting professorship at the University of Exeter.

Dr. Michael Rezny (male) has over 20 years experience in High Performance Computing, mostly in the area of Earth Systems Modelling. His main areas of expertise are in performance analysis,

benchmarking, and optimising applications running at large scale and he has worked in this role at three international HPC vendors: NEC, Cray, and SGI. He has also developed and presented numerous courses on these topics. More recently, he has been applying these skills at the Met Office on the GungHo / LFRic projects which are developing replacements for the current suite of Unified Models.

Mr Mike Hobson (male) is a computer scientist and software engineer with over 20 years of experience working on a wide variety of different projects including meteorological graphical display systems, defence projects and the Unified Model. He is currently sharing his time between working on the replacement for the Unified Model and working towards producing benchmarks for use with coupled systems.

Publications, and/or products, services or other achievements

1. Earth System Modelling – Volume 5. Tools for Configuring, Building and Running Models. Chapter 4, Configuration Management and Version Control in Earth System Modelling. Chapter Authors **Mick Carter and Dave Matthews**. Springer Briefs in Earth System Science Rupert Ford, Graham Riley, Reinhard Budich, Rene Redler.
2. Cascades, backscatter and conservation in numerical models of two-dimensional turbulence. John Thuburn, James Kent and **Nigel Wood**. 2014 QJ 140 pp 626-638
3. Runge-Kutta IMEX schemes for the Horizontally Explicit/Vertically Implicit (HEVI) solution of wave equations. Hilary Weller, Sarah-Jane Lock and **Nigel Wood**. 2013 JCP 252 pp 365-381
4. An inherently mass-conserving semi-implicit semi-Lagrangian discretisation of the deep-atmosphere global nonhydrostatic equations. **Nigel Wood,** Andrew Staniforth, Andy White, Tom Allen, Michail Diamantakis, Markus Gross, Thomas Melvin, Chris Smith, Simon Vosper, Mohamed Zerroukat and John Thuburn. 2014 QJ 140 pp 1505-1520
5. Numerical analyses of Runge-Kutta implicit-explicit schemes for horizontally-explicit vertically-implicit solutions of atmospheric models. Sarah-Jane Lock, **Nigel Wood**, and Hilary Weller. 2014 QJ 140 pp 1654-1669
6. Mixing properties of SLICE and other mass-conservative semi-Lagrangian schemes Kohei Aranami, Mohamed Zerroukat and **Nigel Wood**. 2014 QJ 140 pp 2084-2089
2. Using the UM dynamical cores to reproduce idealised 3D flows. N. J. Mayne, I. Baraffe, David M. Acreman, Chris Smith, **Nigel Wood**, David Skålid Amundsen, John Thuburn and David R. Jackson. 2013 GMDD 6 pp 3681-3741
3. The unified model, a fully-compressible, non-hydrostatic, deep atmosphere global circulation model, applied to hot Jupiters. ENDGame for a HD 209458b test case. N. J. Mayne, I. Baraffe, David M. Acreman, Chris Smith, Matthew K. Browning, David Skålid Amundsen, **Nigel Wood**, John Thuburn and David Jackson. 2014 Astronomy and Astrophysics 561
4. GungHo: A code design for weather and climate prediction on exascale machines
5. R. Ford, M.J. Glover, D.A. Ham, C.M. Maynard, S.M. Pickles, G.D. Riley and **N. Wood**. 2013 Submitted to Advances in Engineering Software
6. A mass restoration scheme for limited area models with semi-Lagrangian advection . Kohei Aranami, Terry Davies and **Nigel Wood**. 2014 To appear in the QJ

Projects, and/or activities

- EU FP7 METAFOR
- EU FP7 IS-ENES
- EU FP7 IS-ENES2
- EU FP6 PRISM

Significant infrastructure, and/or major items of technical equipment

The Met Office has recently secured a capital grant for HPC and related funding of £97M for HPC, tape based mass storage, a new computer building, networking and post processing infrastructure

that will be installed in phases between 2015 and 2017.The HPC part is expected to grow beyond 350,000 cores and the archive in excess of 300 PBytes.

University of Reading (UREAD)

About the institute

The Department of Meteorology at the University of Reading (UREAD) is the largest in Europe with over 20 teaching staff, 80 research staff and around 50 PhD students. It has received the highest research rating of 5* in all UK Research Assessment Exercises, indicating an international reputation in all aspects of research. It is a member of Reading's Walker Institute for Climate System Research, established to promote integrative research across the University. This is reflected in the long-standing presence of staff from the UK Met Office, and the presence of the Natural Environment Research Council (NERC) funded National Centre for Atmospheric Science (NCAS) and the National Centre for Earth Observation (NCEO). The department also works closely with the European Centre for Medium-Range Weather Forecasts (ECMWF), which is located close to the University.
The Department hosts the Computational Modeling Services group of the UK's National Centre for Atmospheric Science (NCAS-CMS). The NCAS-CMS group at Reading provides modeling support the U.K. academic community for a wide range of climate and earth-system areas on several supercomputer platforms. The scope of support provided is wide ranging, covering areas as diverse as code management; model performance optimization; access to and management of high-performance compute and data services. It currently consists of 12 scientists, several of whom are on grants from NERC and other organizations, with a core of staff funded by NCAS. NCAS-CMS has strong links with the UK Met Office and works closely with them on many aspects of model infrastructure development and deployment. In addition to providing support NCAS-CMS is actively developing software for data processing, analysis, and visualization.

Contribution to the specific project

UREAD's contribution to ESiWACE is primarily in relation to WP3.

Complex modeling systems such as, for example, the UK Met Office Unified Model (UM), require a significant degree of supporting infrastructure to be in place in order to run successfully. Software for data pre-processing to satisfy model input requirements and software for output data post-processing are just two essential components which must be installed, configured, and supported to run a numerical simulation. A given model itself requires a particular compute environment to function. Different models have evolved to require distinct compute environments, peripheral software, and workflow systems; NCAS-CMS will contribute to the design of a specification which will define a framework in which many modeling systems can be run seamlessly and we shall assist in implementing the specification.

The product will be installed by NCAS-CMS to provide the computational basis for the 3rd ENES summer school. NCAS-CMS has been responsible for installing and maintaining the UM on UK national supercomputers for many years along with additional software installation support and maintenance and consequently has the wealth of experience needed to efficiently complete this task.

Dr. Grenville Lister (male) is Head of NCAS-CMS. He leads a team of highly experienced computational scientists who among them have diverse and long standing expertise in complex numerical model installation, porting, trouble-shooting, and optimization. He was the computational support for the NERC-funded CASCADE project, and currently oversees the computational component of the NERC-funded SWAMMA project. Dr Lister leads the NCAS UM training course delivered biannually to the UK atmospheric research community. He was co-PI on a dCSE (www.hector.ac.uk) project to port and implement asynchronous IO in OpenIFS on the national HPC.

Professor Pier Luigi Vidale (male) is the Willis Chair of Climate System Science and Climate Hazards, Director of the Weather and Climate Hazards Laboratory at UREAD Department of Meteorology, and Senior Scientist at NCAS in Reading. He has over 18 years' international experience in the development of weather and climate models, focused on high-resolution and land surface modeling. Prof. Vidale has led, in partnership with Dr. M. Roberts (Met Office), four global high-resolution climate modeling programs in the UK, Europe and Japan: UK-HiGEM, UK-Japan Climate Collaboration (UJCC), Partnership for Advanced Computing in Europe (PRACE)-UPSCALE, and Joint Weather and Climate Research Programme (JWCRP) in Global High-Resolution (HadGEM3-H). He currently leads a large consortium project, PAGODA, within NERC's Changing Water Cycle program, and is a co-I in the EU's IS-ENES2 project. Before joining UREAD, he was co-I in two European regional climate programs (MERCURE and PRUDENCE) from which he has published highly-cited papers on changes in the variability of European summers. Prof. Vidale is currently a member of the Gung-Ho Exec, monitoring the development of the next-generation dynamical core for UK Earth System Models.

Publications, and/or products, services or other achievements, projects, and/or activities

- The NCAS-CMS web site (cms.ncas.ac.uk) summarizes activities undertaken by the group, at the level of both core national capability (NCAS funded) and externally funded projects, including model porting (to ARCHER, MONSooN (joint NERC/MO HPC), Polaris(Leeds), Mobilius(Southampton), HPC Wales), trouble-shooting (see NCAS-CMS helpdesk), and training.
- NCAS-CMS has developed UM-specific software tools widely used in the modeling community (xconv and xancil) and is actively developing CF-aware utilities (eg CF-python (http://cfpython.bitbucket.org/)) for use by more diverse research groups.
- NCAS-CMS delivers the PUMA (Providing UM Access) service to the academic community and MO partner. PUMA hosts several code repositories including the UM and OpenIFS, and is the system which manages remote job submission.
- NCAS-CMS has representation on several HPC management groups and committees, including the ARCHER Scientific Advisory Committee, the MONSooN Management Group, and the NERC HPC Steering Committee.

Swedish Meteorological and Hydrological Institute (SMHI)

About the institute

SMHI (http://www.smhi.se) is a government agency under the Swedish Ministry of Environment. SMHI offers products and services that provide organisations with important environmental information to support decision-making. The main fields include weather and climate forecasts/projections, industry-specific services, simulations and analyses. SMHI has a strong R&D focus. With climate research involving all of six research sections, including the Rossby Centre that is responsible for the development and application of regional and global climate models. In particular the Rossby Centre is active in the development of EC-Earth, being responsible for the development and release of the most recent generation, EC-Earth 3. The Rossby Centre also has extensive experience in the development and application of advanced regional climate models.

Contribution to the specific project

SMHI's contribution to this project is dedicated to WP1 and WP2 2.

SMHI will coordinate the efforts to provide community-wide access to the NEMO and EC-Earth models. This will include user support facilities as well as improvements for the scientific software

development process. SMHI will contribute to the development of climate model performance metrics and provide performance benchmark results for the EC-Earth model. SMHI's will also assess the performance optimisations for the EC-Earth model. Finally SMHI will be analysing performance enhancements and maintain new developments in forthcoming EC-Earth releases.

Dr. Uwe Fladrich (male) is scientific software developer (education in applied mathematics and computer science) and one of the core developers of the EC-Earth model. His focus lies on efficient software development processes and numerical aspects of climate models. He is contributing to the EU project IS-ENES2, co-leading the work package JRA1 on multi-model, multi-member high-resolution experiments.

Publications, and/or products, services or other achievements

1. Koenigk, T., L. Brodeau, R. Grand Graversen, J. Karlsson, G. Svensson, M. Tjernström, U. Willen, and K. Wyser, 2013. *Arctic Climate Change in the 21st Century in an Ensemble of AR5 Scenario Projections with EC-Earth.* Clim. Dyn. 40:2719-2743, doi:10.1007/s00382-012-1505-y.
2. Smith D. M., Scaife A. A., Boer G. J., Caian M., Doblas-Reyes F. J., Guemas V., Hawkins E., Hazeleger W., Hermanson L., Ho C. K., Ishii M., Kharin V., Kimoto M., Kirtman B., Lean J., Matei D., Merryfield W. J., Müller W. A., Pohlmann H., Rosati A., Wouters B., Wyser K., 2013. *Real-time multi-model decadal climate predictions.* Climate Dynamics, 41(11-12), 2875-2888, doi:10.1007/s00382-012-1600-0
3. Hazeleger, W., V. Guemas, B. Wouters, S. Corti, I. Andreu-Burillo, F. J. Doblas-Reyes, K. Wyser and M. Caian, 2013. *Multiyear climate predictions using two initialisation Strategies.* Geoph. Res. Lett., DOI: 10.1002/grl.50355.

Projects, and/or activities

- EU FP7 project **IS-ENES2**: Infrastructure for the European Network for Earth System modelling - Phase 2
- EU FP7 project **CLIPC**: Climate Information Platform for Copernicus
- EU FP7 project **SPECS**: Seasonal-to-decadal climate Prediction for the improvement of European Climate Services
- EU FP7 project **EMBRACE**: Earth system Model Bias Reduction and assessing Abrupt Climate change

Significant infrastructure, and/or major items of technical equipment

- SMHI is providing the technical infrastructure for developer-developer and developer-user interaction for the EC-Earth model (the EC-Earth Development Portal)
- SMHI is one of the key laboratories developing and performing large model intercomparison exercises, such as CMIP5.

National University of Ireland Galway/Irish Centre for High-End Computing (ICHEC)

About the institute

The Irish Centre for High-End Computing (ICHEC) is legally a centre within the National University of Ireland, Galway; PIC code 999978045.
ICHEC, founded in 2005, is Ireland's national high performance computer centre. Its mission is to provide High-Performance Computing (HPC) resources, support, education and training for

researchers in third-level institutions and through technology transfer and enablement to support Irish industries large and small to contribute to the development of the Irish economy.

ICHEC works on code optimisation and development of climate and weather codes wirth academia and public organisations, in particular the EC-Earth climate model, where it is a consortium member, and the 'Harmonie' weather model with Met Éireann in the Hirlam consortium.

ICHEC has experience providing operational services for Met Éireann, the national weather service, since 2007. This involves redundant compute and computational scientist support as part of a scientific collaboration, where ICHEC scientists optimise and develop weather and climate codes on next-generation systems. This has recently expanded to include emergency dispersion modelling for the EPA (Environmental Protection Agency) and RPII (radiation), and Dept. of Agriculture (foot and mouth, disease dispersion); Met Éireann and ICHEC have also demonstrated flood forecasting for the Irish Office of Public Works.

ICHEC manages an Earth System Grid Federation (ESGF) portal for climate model data on behalf of the EC-Earth consortium, publishing data on behalf of 14 organisations; we have developed processing workflows and data management systems for this.

Contribution to the specific project

ICHEC's contribution to WP2 is dedicated to WP2 task 3 and 4.

ICHEC will work on the integration of GRIB2 format file output to the XIOS (XML I/O Server) library from IPSL. I/O is a major bottleneck for climate and weather codes, and ICHEC have worked with IPSL, integrating the XIOS library into the EC-Earth climate model, adding memory caching for scaling, and GRIB format writing.
ICHEC plans to add two components: use current and planned changes to XIOS by IPSL in memory layout to enable GRIB writing of large files. Currently GRIB output is limited by the need to do an in-memory transpose, requiring all of a dataset to be in memory simultaneously. Planned changes by IPSL in the server layer will make it possible to complete the transpose over multiple nodes, enabling high-resolution GRIB writing. IHEC as original author of the GRIB code will adapt the GRIB model for this.
Secondly, the current GRIB code is limited to lat-long and simple Gaussian outputs. There is no GRIB equivalent to the NetCDF unstructured grid outputs. We will work with partners (in particular ECMWF) to standardize the GRIB output for unstructured grids, and provide GRIB output in unstructured and icosahedral grids.

Dr Alastair McKinstry is a computational scientist with 15 years experience in HPC and Unix code optimization, originally in industry (Digital, Compaq, Oracle) and weather and climate code development.
He has worked on XIOS development within PRACE 2IP, leading development of the GRIB output, and memory caching to enable XIOS scaling on large low-memory-per-node HPC systems, and adding XIOS to the IFS atmosphere model within EC-Earth.
At ICHEC Alastair leads environmental activities, optimizing user and community codes.

Publications, and/or products, services or other achievements

1. Colin O'Dowd, Saji Varghese, Damien Martin, Robert Flanagan, Darius Ceburnis, Jurgita Ovadnevaite, Giovanni Martucci, Jakub Bialek, Ciaran Monahan, Harald Berresheim, Aditya Vaishya, Zachary McGraw Grigas, **Alastair McKInstry** S Gerard Jennings, Baerbel Langmann, Tido Semmler, Ray McGrath (2011): The Eyjafjallajökull Ash Plume–Part 2: Simulating ash cloud dispersion with REMOTE Atmospheric environment
2. J Donners, C Basu**, A McKinstry**, M Asif, A Porter, Eric Maissonave, Sophie Valcke, Uwe Fladrich Performance Analysis of EC-EARTH 3.1, PRACE technical report, 2012
3. P.Nolan, A**. McKinstry**, Scaling Coupled Climate Models to Exascale: OpenACC-enabled EC-Earth3 Earth System Model, 2013, PRACE technical report

4. Shiyu Wang, Ray McGrath, **Alastair McKinstry**, Recent Irish Weather Extreme and Change of Extreme Precipitation Due to Climate Change, EPA Climate Change report, 2010

Projects, and/or activities

- EU FP7 **PRACE:** ICHEC was WP co-leader for climate code development in PRACE2IP,
- **CMIP5 EC-EARTH**: ICHEC managed the data publication for CMIP5 for the EC-Earth climate model in CMIP5, doing code development and optimization, running ensemble runs with Met Éireann, and post-processing ocean data from EC-Earth partners.

Significant infrastructure, and/or major items of technical equipment

- ICHEC's primary HPC facility is "Fionn", a 7680-core SGI ICE X / SGI UV 2000 system (147 Tflop peak) with additional accelerator and high-memory regions. This has 560 TB formatted Lustre storage, and multiple login nodes, including dedicated nodes for NWP and emergency service use
- ICHEC is also part of the eINIS collaboration, managing an Earth System Grid Federation (ESGF) node managing climate model data on 1 PB of storage based at DIAS in Dublin.

Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC)

About the institute

The Euro-Mediterranean Center on Climate Change (CMCC; http://www.cmcc.it/) is a research center funded by the Italian Ministries of the Environment and Land Protection, of Education, of University and Research, and of Economy and Finance, that aims at furthering knowledge in the field of climatic variability, including causes and consequences, through the development of high-resolution simulations and impact models. CMCC gathers the know-how from its funding Institutions (Istituto Nazionale di Geofisica e Vulcanologia, Università del Salento, Centro Italiano di Ricerche Aerospaziali, Università Ca' Foscari Venezia, Fondazione Eni Enrico Mattei, Università di Sassari, Università della Tuscia, Università degli Studi del Sannio), focusing on climate change issues and applications for environmental management. The mission of CMCC is also to encourage and foster collaboration among universities, national and international research institutions, local institutions and industrial sectors. CMCC represents, at the national and international scale, an institutional point of reference for decision makers, public institutions, as well as private and public companies seeking technical-scientific support. CMCC brings together highly qualified experts from different climate research areas in a single unique institution. The following eight research Divisions[1] work together in an interdisciplinary manner: ASC (Advanced Scientific Computing), CSP (Climate Simulations and Predictions), ECIP (Economic Analysis of Impact and Policy), IAFES (Impacts on Agriculture, Forests and Ecosystems Services), ODA (Ocean Modelling and Data Assimilation), OPA (Ocean Predictions and Applications), RAS (Risk Assesment and Adaptation Strategies), REMHI (Regional Models and Hydrogeological Impacts). Moreover, CMCC hosts in Lecce the Supercomputing Center (180 Tflops of computing power, 1.2 Petabyte on-line storage and 3 PetaBytes Archiving capacity).

The Advanced Scientific Computing (ASC) Division of CMCC carries out Research & Development activities on Computational Sciences applied to Climate Change. In particular, the Division works both on the scalability, the optimization and the parallelization of numerical models for climate

[1] *Here is reported the new CMCC organization starting from January 1st, 2015. The CMCC web site (http://www.cmcc.it) reports the old organization.*

change simulations and on the design and implementation of open source solutions addressing efficient access, analysis, and mining of large volumes of scientific data in the climate change domain. In this regard, CMCC provides a big data analytics framework (Ophidia), targeting parallel data analysis on large volumes of scientific/multidimensional data (e.g. multi-terabytes order datasets). The Ocean Modelling and Data Assimilation (ODA) Division focuses on the development of numerical models, methods of data assimilation, production of reanalysis and data sets for global marine forecasts and the study of the interactions between the physical and biogeochemical processes of oceans and the cryosphere in climate variability. The Climate Simulations and Predictions (CSP) Division deals with the development of models of the Earth system, the production of climate predictions and the realization of projections of climate change on scales which range from seasonal to centuries.
CMCC is member of the NEMO Consortium contributing to its System Team, whose main goal is, among the others, the optimizations of NEMO on the computers available in the Consortium. Moreover CMCC participates to the NEMO HPC working group. CMCC is also member of the European Network for Earth System Modelling (ENES) and partner of the Earth System Grid Federation (ESGF), providing access to 100TB CMIP5 data through its data node deployed at the CMCC Supercomputing Center. Finally, CMCC is partner of several EU FP7 and other national and international projects, working on the development of high resolution global and regional climate models, their parallel optimization on manycore clusters as well as on the development of efficient solutions for data management.

Contribution to the specific project

CMCC's contribution to ESiWACE is dedicated to Wp1, Wp2, WP3, WP4.

Prof. Giovanni Aloisio (male) is Full professor of Information Processing Systems at the Dept. of Innovation Engineering of the University of Salento, Lecce, Italy, where is leading the HPC laboratory. Former director of the Advanced Scientific Computing (ASC) Division at the Euro-Mediterranean Center on Climate Change (CMCC), he is now the Director of the CMCC Supercomputing Center and member of the CMCC Strategic Council. He is also member of the ENES (European Network for Earth System modelling) HPC Task Force. His expertise concerns high performance computing, grid & cloud computing and distributed data management. He has been involved into several EU grid projects such as GridLab, EGEE, IS-ENES1. He has been the responsible for ENES of the EU-FP7 EESI (European Exascale Software Initiative) project chairing the Working Group on Weather, Climate and solid Earth Sciences. He has also contributed to the IESP (International Exascale Software Project) exascale roadmap. He has been the chair of the European panel of experts on WCES that has contributed to the PRACE strategic document "The Scientific Case for HPC in Europe 2015-2020. Presently, he is coordinating CMCC activities into several EU FP7 projects such as EUBrazilCC, IS-ENES2, CLIP-C and the G8 ExArch. As CMCC, he also the coordinator of the OFIDIA (Operational FIre Danger preventIon plAtform) project in the context of the European Territorial Cooperation Program Greece-Italy 2007-2013. As University of Salento (PRACE Third Party), he is the responsible of the EU-FP7 EESI2 project, chairing the Working Group on Weather, Climate and solid Earth Sciences. He is the author of more than 100 papers in referred journals on high performance computing, grid computing and distributed data management.

Dr. Antonio Navarra (male) graduated in Physics in Bologna in 1980 and returned to Italy in 1986, after getting a Ph.D. at the Geophysical Fluid Dynamics Laboratory at Princeton University. He is Dirigente di Ricerca at the National Institute of Geophysics and Volcanology (INGV), where he carries out his activity in the field of the climate simulation with general circulation numerical models. He is now President of the CMCC Centro Euro-Mediterraneo sui Cambiamenti Climatici. The scientific interests of Dr. Navarra focus on the investigation of the dynamical mechanisms which control climate on the global scale, particularly regarding the natural climate variability of the atmosphere-ocean system on interannual, decadal and centennial scales. The general aim is to understand and document the main modes of climate variability on interannual and decadal scales (teleconnections) by means of statistical methods, numerical simulations and simplified models. These studies are the natural complement of the second activity field, which concerns the simulation and the evaluation of the climate changes using scenarios of the future climate. Dr.

Navarra is also teaches in the PhD Program on “Science and Management of Climate Science” at Universita’ Ca’ Foscari, Venice. He is the author of several books and articles of general interest and contributes to national newspapers. He has written: El Nino, Truth and Myths of the Climate phenomenon of the Century (Avverbi, 1997); Weather Predictions (Il Saggiatore, 1996); and, with Andrea Pinchera, The Climate (Laterza, 2000).

Dr. Sandro Fiore (male) *Ph.D.*, is the Director of the Advanced Scientific Computing (ASC) Division of the Euro-Mediterranean Centre on Climate Change (CMCC). His research activities focus on distributed data management, data analytics/mining and high performance database management. He is Visiting Scientist at Lawrence Livermore National Laboratory (LLNL) working at PCMDI in the context of the Earth System Grid Federation. He is the P.I. of the Ophidia research project and he is involved in several EU FP7 (IS-ENES2, CLIP-C, EUBrazilCC) and international (ORIENTGATE, OFIDIA) projects. He is author of more than 60 papers in refereed books/journals/proceedings on parallel and distributed computing. He is editor of the book Grid and Cloud Database Management (Springer, 2011). He is ACM Member.

Dr. Silvia Mocavero (female) *Ph.D.*, is Scientist at the “Advanced Scientific Computing” (ASC) Division of the "Euro-Mediterranean Centre on Climate Change" (CMCC). She received a Ph.D. in 2006 in “Innovative Materials and Technologies” from the ISUFI at the University of Lecce, Italy. Her skills include high performance computing, distributed and grid computing. She is working on the analysis of scalability, optimisation and parallelisation of Earth System Models with a particular focus on NEMO as member of the System Team.

Dr. Simona Masina (female) *Ph.D.* (Princeton University) in Atmospheric and Oceanic Sciences, is Senior Researcher at Istituto Nazionale di Geofisica e Vulcanologia (INGV) and the Head of the “Ocean Modelling and Data Assimilation” (ODA) Division at CMCC. She has more than fifteen years of experience in the field of global ocean modelling, data assimilation and interactions between physical and biogeochemical processes in the climate system. During these years she has been involved in several national and international projects and has been principal investigator for many European projects. Since 2007 she teaches in the Ph.D. Programme in Science and Management of Climate Change at Ca’ Foscari University in Venice. She is member of the Governing Board of the “Italian Society for Climate Sciences” (SISC), and INGV representative at the “Commissione Oceanografica Italiana” (Italian IOC). She is also member of the CLIVAR Working Group on Ocean Model Development (WGOMD) and coordinator of the PRACE Project Ens4Ocean.

Dr. Silvio Gualdi (male) is Senior Scientist at CMCC, where he leads the “Climate Simulations and Predictions” Division (CSP). He holds a PhD in Geophysics and has more than 15 years of experience in climate modelling and simulations. During this period, he has contributed to the development of climate models (e.g., SINTEX, CMCC-Med, CMCC-CM) and seasonal-to-decadal prediction systems (e.g DEMETER, MERSEA, ENSEMBLES, COMBINE). He has been principal investigator and WP in several international projects.

Publications, and/or products, services or other achievements

1. **S. Fiore**, A. D’Anca, D. Elia, C. Palazzo, I. Foster, D. N. Williams, **G. Aloisio**, “Ophidia: a full software stack for scientific data analytics”, IEEE Workshop on Big Data Principles, Architectures & Applications, HPCS2014, Bologna, Italy, July 21-25, 2014.
2. **S. Fiore**, C. Palazzo, A. D'Anca, I. T. Foster, D. N. Williams, **G. Aloisio**, “A big data analytics framework for scientific data management”, IEEE BigData Conference 2013, Santa Clara, USA, 6-9 Oct. 2013, pp. 1-8, doi: 10.1109/BigData.2013.6691720.
3. **S. Fiore**, A. D'Anca, C. Palazzo, Ian T. Foster, Dean N. Williams, **Giovanni Aloisio**: Ophidia: Toward Big Data Analytics for eScience. ICCS 2013, June 5-7, 2013 Barcelona, Spain, ICCS, volume 18 of Procedia Computer Science, pp. 2376-2385. Elsevier, (2013).

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Projects, and/or activities

- **EU FP7 Project EUBRAZILCC (2013-2016).** CMCC is working on the development of a PaaS level for big data analytics for climate change, exploiting scalable and dynamic VM-based solutions. CMCC is also leading the WP3 on the Federated Infrastructure of the project, as well as the Use Case 3 (WP5) on Biodiversity and Climate Change, working (i) on the use of observed and simulated data to better understand how climate change impacts on terrestrial

biodiversity and (ii) on the implementation of a Science Gateway for scientific, multidimensional data analysis (climate and satellite data).

- **EU FP7 Project CLIP-C (2013-2016).** CMCC is working in this project to provide an interoperable interface (e.g. OGC Web Processing Service compliant) to analysis services for climate data and a caching systems for climate indicators.
- **INTERREG Project OFIDIA (2013-2015).** CMCC is providing a specialized data analysis platform for fire danger prevention, by working (i) on the implementation of specific fire danger indices and their integration into big data frameworks as well as (ii) on the development of a Science Gateway for fire danger data analysis. The main use cases concern the Apulia-Epirus cross-border regions.
- **EU FP7 Project IS-ENES (2009-2013) and its follow on IS-ENES2 (2013-2017).** The goal of IS-ENES is the development of a common climate and Earth system modelling distributed research infrastructure in Europe. IS-ENES2 further integrates the European climate modelling community, stimulates common developments of software for models and their environments, fosters the execution and exploitation of high-end simulations and supports the dissemination of model results to the climate research and impact communities. CMCC is working on the use of exascale to develop next generation climate models and on the data node monitoring infrastructure.
- **EU FP7 Project EESI1 (2010-2011) and its follow on EESI2 (2012-2015)**. The goal of these projects is the production of the European Roadmap on Exascale. CMCC is chairing the WP3/Task3.2 on Weather, Climatology and solid Earth Sciences.
- **G8 Project ExArch (2011-2014).** As partner of this project, CMCC has been involved in evaluating/extending/testing climate data analysis services/frameworks in use cases at large scale.
- **PRACE Preparatory Access "Optimisation of the NEMO oceanic model in the GLOB16 configuration" and its follow on 8th PRACE Project "ENS4OCEAN" (2014-2015).** CMCC aims to produce a simulation of an eddy-resolving global ocean (NEMO at 1/16° horizontal resolution and 98 vertical levels), which will be the base for a real-time forecasting system able to provide on daily basis forecasts of global oceanographic parameters for the following 10 days. Starting from the hindcast for a few selected dates, an ensemble of perturbed forecasts will be also produced. This ensemble will form the basis for short-range predictability studies and for estimating ensemble-derived background-error covariances for further use in variational data assimilation experiments. The goal of the preparatory access has been the design and implementation of suitable strategies to overcome the scalability bottlenecks to improve the parallel efficiency.
- **EU FP7 Project MyOcean2 and MyOcean FollowOn (2012-2015)**. CMCC is working on the production of a set of validated global ocean re-analysis for the physical and biogeochemical state of the ocean over multidecal period. CMCC is leading the WP18 concerning the production and assessment of reprocessed satellite and in-situ data sets and re-analysis of the 3D ocean state for Global and European Regional Seas. CMCC participates also to WP4, WP10 and WP19 where contributes to the improvement of data assimilation schemes with the development of ensemble protocols to specify more realistic background error covariance models and analysis uncertainties.
- **EU FP7 Project ERA-Clim2 (2014-2016).** It is a collaborative research project funded by the European Union, with the goal of preparing input data and assimilation systems for a new global coupled reanalysis of the 20th century. CMCC will contribute to ERA-CLIM2 by developing and testing hybrid variational and ensemble ocean data assimilation systems and exploring the impact of coupled ocean-atmosphere model error covariances to correct near-surface meteorological fields through ocean data assimilation.

Significant infrastructure, and/or major items of technical equipment

Infrastructure: The HPC infrastructure managed at the CMCC Supercomputing Centre is composed of a 960 cores IBM Power6 cluster (peak performance 18TFlops) and a 8000 cores Intel Xeon Sandy Bridge (peak performance 160TFlops). Part of this infrastructure will be used for running data management/analysis services and training activities.

Datasets: CMCC publishes about 100TB of climate simulations datasets in the CMIP5 federated data archive related to the following three models: CMCC-CM, CMCC-CESM, and CMCC-CMS.

Software: CMCC provides the Ophidia software, a cross-domain big data analytics framework for the analysis of scientific, multi-dimensional datasets. This framework exploits a declarative, server-side approach with parallel data analytics operators.

Deutscher Wetterdienst (DWD)

About the institute

The Deutscher Wetterdienst (DWD), which was founded in 1952, is as National Meteorological Service of the Federal Republic of Germany responsible for providing services for the protection of life and property in the form of weather and climate information. This is the core task of the DWD and includes the meteorological safeguarding of aviation and marine shipping and the warning of meteorological events that could endanger public safety and order. The DWD, however, also has other important tasks such as the provision of services to Federal and Regional governmental authorities, and the institutions administering justice, as well as the fulfilment of international commitments entered into by the Federal Republic of Germany. The DWD thus co-ordinates the meteorological interests of Germany on a national level in close agreement with the Federal Government and represents the Government in intergovernmental and international organisations as, for example the World Meteorological Organization (WMO). Currently DWD has a total staff of about 2300 employees at more than 130 locations all over Germany. DWD's spectrum of activity is very wide and comprises of:

- Weather observation and forecasting around the clock,
- Climate Monitoring and modelling at local, regional and global scale,
- Development of precautionary measures to avoid weather-related disasters and to provide support for disaster control
- Advice and information on meteorology and climatology to customers,
- National and international co-operation in meteorological and climatological activities,
- Outlooks on possible future climatic conditions at local, regional and global scale,
- Research and development.

Contribution to the specific project

DWD's contribution to CoE Weather and Climate is dedicated to Task 1 in Work Package 2:
DWD will organize workshops on model I/O for Exascale simulations. It combines mid-term objectives, e.g. exploiting the available hardware bandwidth through I/O servers, with longer-term I/O developments beyond MPI. Among the design goals is the provision of a unified interface for model I/O which transparently maps between available file formats. As a side-effect of the project, the participating modelling groups will obtain the abilities to accurately analyze the model codes I/O performance, to predict their scalability and to design proper benchmarks mimicking larger models in reduced environments.

Dr. Florian Prill (male) is a senior scientist in the Numerical Modelling Department at DWD. He is responsible for the design, coding and optimization of the asynchronous, parallel I/O packages (for GRIB2 and NetCDF) which are part of the new non-hydrostatic global model ICON.

Publications, and/or products, services or other achievements

1. **Günther Zängl,** Daniel Reinert, Pilar Rípodas, Michael Baldauf. (2014) The ICON (ICOsahedral Non-hydrostatic) modelling framework of DWD and MPI-M: Description of the non-hydrostatic dynamical core. Quarterly Journal of the Royal Meteorological Society, n/a-n/a. Online publication date: 1-May-2014.

2. **Michael Baldauf,** Daniel Reinert, Günther Zängl. (2014) An analytical solution for linear gravity and sound waves on the sphere as a test for compressible, non-hydrostatic numerical models. Quarterly Journal of the Royal Meteorological Society, n/a-n/a. Online publication date: 1-Feb-2014.

Projects, and/or activities

- **G8 project ICOMEX** (Icosahedral-grid models for exascale Earth system simulations) from 2011 to 2014: Development of key components for global atmospheric models (parallel I/O, parallel internal postprocessing, compute optimization / GPU usage) in order to prepare them for applications on future massively parallel computer architectures. G. Zängl (DWD) was Project Leader of ICOMEX.

Significant infrastructure, and/or major items of technical equipment

The German weather service DWD has long-standing experience in the field of high performance computing, dating back as far as the 1960's. Recently, two independent Cray XC40 supercomputers have been installed at the German Meteorological Computing Centre in Offenbach, each system with more than 500 TFlop/s reaching rank 128 on the current Top500 list (Nov 2014).
Daily runs of a comprehensive numerical weather prediction suite produce more than 4 TByte of data/day. Meteorological data is moved between a 3 PByte file system and an archive with 50 PByte capacity and products are distributed to numerous institutions world-wide..

Seagate Systems UK Ltd (SEAGATE)

About the institute

Seagate is the worlds leading provider of Data Storage devices, equipment and services.
The organisation is a worldwide multi-national registered in Ireland (Seagate Technology plc) with more than 56,000 employees; the division of the organisation responsible for this project is Seagate Systems UK Ltd.
Seagate operates two primary divisions within its corporate operations, Seagate Technology develops and produces data storage devices including disk drives, solid state drives and solid state storage for use in applications from consumer to extreme performance HPC, a large facility is located in Northern Ireland. The newer division, Seagate Systems has been created following the acquisition of Xyratex Technology by Seagate in April 2014, combining this organisation with EVault and other internal Seagate systems activities to create a high capability storage systems supply organisation.
A key product line acquired from Xyratex and continuing with Seagate is the ClusterStor range of products, these are fully engineered data storage systems with all hardware, file systems software and system management provided. Systems are provided through our OEM or business partnerships including with BULL. These systems support some of the worlds most powerful supercomputers. The systems are installed or planned in a number of installations in Europe including ones in Met Office UK, EPCC, DKRZ and ECMWF with capacities of up to 45 Petabytes and >1.4 TB/s performance in future deployments.
The Seagate systems (ex Xyratex) group has around 500 engineers employed in creating Hardware and supporting Software for the Enterprise and High Performance Computing applications. Seagate owns the Lustre trademark and several of their engineers were involved in the original Lustre architecture and design.
Within Seagate Systems (UK) the Emerging Technology Group manages collaborative research activities within Europe and will work in concert with development engineering groups based in UK.

Contribution to the specific project

Seagate is happy to take part in ESiWACE as we see significant opportunity for business growth based around its success.

Seagate's skills have been harnessed to create a next generation object storage technology with capabilities well beyond any similar solutions on the market. Seagate will provide instances of this storage technology and develop native support software that enables the NETCDF and GRiB data formats to be efficiently stored and accessed, providing multiple 'views' of the stored data.
Seagate will also contribute its deep skills and knowledge of current and future data storage technologies to assist the study of optimized data management by the community.
Seagate Systems is a key supplier of data storage systems (in partnership with Other Equipment Manufacturers) with installations of their equipment in a number of sites of partners within this proposal. We are keen to work much more closely, understanding the user needs and specific opportunities to create or tune systems to maximize the effectiveness of our systems in these user environments.

Andy Nimmo (male): Andy is a Principal Engineer in Systems Design and Systems Integration for Seagate. Andy holds a BEng (Hons) in Software Engineering and joined Seagate from Adaptive Computing in January 2014. He has 10 years experience working in both private and public sectors of the the HPC sector and has extensive experience from systems administrator level all the way up to system architecture, consultancy and security. After initially working as a QA Engineer focussing around networking and kernel comms on the ASCI Q project in 2003 he spent some time as a senior software engineer before moving to system management and workload scheduling back in HPC space. Since joining Seagate Andy has been chiefly involved with the next-generation High Availability project but more recently has been tasked with being in charge of systems integration for Seagate's next-gen systems product and is heavily involved with both scoping and the architecture of many aspects of this project.

Dr. Sai Narasimhamurthy (male): Sai is currently Staff Engineer, Seagate Research (formerly Lead Researcher, Emerging Tech, Xyratex) working on Research and Development for next generation storage systems (2010-). He has also actively led and contributed to many European led HPC and Cloud research initiatives on behalf of Xyratex (2010-). Previously(2005 - 2009) , Sai was CTO and Co-founder at 4Blox, inc, a venture capital backed storage infrastructure software company in California addressing IP SAN(Storage Area Network) performance issues as a software only solution. During the course of his doctoral dissertation at Arizona State University (2001-2005), Sai has worked on IP SAN protocol issues from the early days of iSCSI(2001). Sai also worked with Intel R&D and was a contributing participant in the first stages of the RDMA consortium (put together by IBM, Cisco and Intel) for IP Storage and 10GbE (2002). Earlier in his career, Sai worked as Systems Engineer with Nortel Networks through Wipro, India focussing on Broadband Networking solutions(2000-2001).

Malcolm Muggeridge (male): Malcolm is Sr Dir Engineering responsible for collaborative research at Seagate Systems UK. He joined Seagate through its acquisition of Xyratex in 2014 and was with Xyratex at its creation as a management buyout from IBM in 1994.
Malcolm has more than 38 years experience through his employment with IBM and Xyratex in the Technology, manufacturing, quality and reliability of Disk drives and Networked data storage systems and in recent years in HPC data storage, architecting and managing designs and new technologies across many products. More recently he has been focused on Strategic Innovation and Business development, Research & Technology. He is a steering board member of the ETP4HPC defining research objectives for future within Euorpe and is active in the Partnership board of the cPPP on HPC. He is a member of the UK eInfrastructure board with Special interest in HPC. Malcolm has a B.Eng degree in Electronics from Liverpool University.

Dr Nikita Danilov (male): Nikita Danilov is a Consultant Software Architect at Seagate. His work on storage started in 2001, when he joined Namesys to develop the reiserfs file system for Linux. Since 2004 he worked on Lustre in ClusterFS, later acquired by Sun. In 2009 he followed the original Lustre architect—Peter Braam—to the latter's new company Clusterstor to design and implement an exascale storage system, this technology was acquired by Xyratex and forms the

basis of the NEXT system. He received a PhD in mathematical cybernetics from Moscow Institute of Physics and Technology.

Publications, and/or products, services or other achievements

As a commercial organisation Seagate does not generally submit material for publication in academic journals or to conferences however they do present publicly on selected technical aspects of the systems and solutions with presentations at major events such as Supercomputing, ISC and events such as Lustre developer conferences LAD and LUG.
As stated earlier Seagate is an active supplier within this and other HPC use domains.

Projects, and/or activities

Seagate Systems is deeply involved with the strategy toward HPC in Europe with active membership of ETP4HPC and contribution to the Strategic Research Agenda.
Seagate Systems has been involved in a number of FP7 projects including leading IRMOS; creating Quality of Service capability for storage in 'real time' cloud systems and currently is a member of the DEEP-ER project particular focused on improved IO guidance mechanisms. The organisation also has involvement in a number of Research projects in the area of Optical Interconnects including PHOXTROT.
Seagate is also a supporter of educational activities with Early Stage Researcher development through the SCALUS project and recently awarded BIGSTORAGE Marie Curie, Initial training Network project.

Significant infrastructure, and/or major items of technical equipment

Seagate Systems has within its development operations some medium scale storage systems linked to small scale computational capabilities for the evaluation and test of new storage hardware and software. For this project this facility will be utilised to explore the characteristics of IO with new storage techniques.

Bull SAS (BULL)

About the institute

Bull is the trusted partner for enterprise data. The Group, which is firmly established in the Cloud and in Big Data, integrates and manages high-performance systems and end-to-end security solutions. Bull's offerings enable its customers to process all the data at their disposal, creating new types of demand. Bull converts data into value for organisations in a completely secure manner. Bull currently employs around 9,200 people across more than 50 countries, with over 700 staff totally focused on R&D. In 2013, Bull recorded revenues of €1.3 billion with a particularly strong presence in the public, healthcare, finance, telecommunications, manufacturing and defence sectors.
Bull has organized its activities into two major segments, Data Management and Data Infrastructure, highlighting how technological issues are now so closely intertwined. Whether in a supercomputer, a mobile application or an embedded M2M solution, performance and security issues depend at least as much on hardware components as they do on software. Because the most significant innovations often arise from an ingenious combination of these two aspects, Bull has chosen to bring together all its R&D activities to support its entire business.
Closely attuned to changes in technology and business, Bull R&D is involved in all key areas of the Group's activities: high-performance computing, cyber-security, Cloud computing, information systems modernization, Big Data. In recent years, the Bull R&D labs have developed many major products that are recognized for their originality and quality. These include the bullx supercomputer, bullion servers for the private Clouds and Big Data, the Shadow intelligent jamming system designed to counter RCIEDs, the libertp tool for modernization of legacy

applications and, most recently, hoox, the first European smartphone featuring native security. To explore new areas and develop tomorrow's solutions, today, Bull R&D is investing heavily in customers – with whom it has forged many successful technological partnerships – as well as in institutional collaborative programs (such as competitiveness clusters and European projects) and in partnerships with industry (Open Source, consortiums).
On the long-term, the objective of Bull is to create, with the CHANCE project, market differentiators. The main areas are the efficient support of applications and optimization, new job scheduler strategies, and better performance at node, interconnect and I/O level. With these differentiators, Bull aims at developing its market share in the supercomputer segment worldwide and especially in Europe. In its HPC development strategy, software is a key element, hence the CHANCE project is essential for Bull.

Contribution to the specific project

BULL will take part in WP1 and WP2.

The people involved in this project are located in the CEPP (Center for Excellence in parallel Programming). This center is based in Grenoble and its activity consists in porting, profiling and optimizing applications for their efficient use of a parallel computers. Their everyday duty requires a high expertise in the computer architectures, the trends in their evolutions, and the impact on the software. Today, the constraints on the hardware are no longer transparent for the software. To get benefits from the coming architecture, the software has to be deeply studied and modified. The notion of co-design, without being strictly mandatory becomes highly necessary.
Beside their high skills in parallel programming, most of the CEPP experts have a Ph.D. in a scientific domain: molecular dynamic, chemistry, oceanography, fluid dynamics, astrophysics, … Thanks to these two scientific pillars (HPC and science), the experts in the CEPP are able to understand the behavior of the application and also the goals and needs of the science.
The experts who will be involved in this project will be selected thanks to these two background. It is clear that people having oceanography background would bring more benefits to the project, but, some others experts may have a specific knowledge that would be necessary (co-processors, IO, network, …). Thus, this will not be one expert who will implement the work, but probably several different according to the needs.
However, an overall envelope can be agreed and the dedicated expert will be the best possible one.

Dr Xavier Vigouroux (male) after a Ph.D. from Ecole normale Superieure de Lyon in Distributed computing, worked for several major companies in different positions. He has now been working for bull for 9 years. He led the HPC benchmarking team for the first five years, then in charge of the "Education and Research" market for HPC at Bull, he is now managing de "Center for Excellence in Parallel Programming" of Bull.

Dr Cyril Mazauric (male) obtained his Ph.D. in Applied Mathematics from the University of Grenoble concerning “Data assimilation applied to flood modelling”. Since 2008, he is part of the Application and Performance Team that is dealing with applications performance commitments during bidding process. However, Cyril activities lead him to be part of research projects, and, more specifically around NEMO performance profile, its coupling with WRF … Finally, he has been contributor to the scalability improvement of Meteo France and DKRZ applications.

Franck Vigilant (male) received his Applied Mathematics M.S degree in Numerical simulation and Modelling Engineering in 2008 from the Joseph Fourier University of Grenoble and his M.S. degree in Process Engineering in 1999 from the National Polytechnique Institute of Grenoble. After a 7-year position as expert engineer at Philips semiconductors and NXP R&D, a IC manufacturer, he worked as expert developer at the National Institute for Computer Science and Control (INRIA). His work was related to data assimilation applied to ocean modelling. He is now HPC consultant at BULL in the Applications and Performances team for HPC business. His interests includes high performance computing for environmental sciences.

Enguerrand Petit (male) received a HPC Computer Master in 2014 from INRIA Bordeaux in Runtime team supervised by Denis Barthou and Olivier Aumage. His skills are centered on codes

optimization on ARM and Intel processor in the European Mont Blanc project and the impact of the vectorization on energy consumption.Enguerrand also worked on optimizing NEMO as part of a project between Bull and Intel.

Publications, and/or products, services or other achievements

The CEPP has been involved in different **code optimizations**:

1. **Cardiff "fast start"**: when bull delivered the machine to Cardiff, some codes have to be ported to this new machines. This list had been selected by Cardiff staff and Bull had to make it available and efficient on the new machine.
2. **P3M - Université Reims Champagne Ardennes**: The problem here was to optimize a workload aiming at find the interaction between one ligand to thousands of protein. This method is called "inverse docking" and requires a huge computation resources. CEPP experts studied the implemented and optimized the throughput (by 9 times) and create a very scalable implementation.
3. CEPP experts are involved in a **DKRZ optimization service**. They have to optimize the DKRZ code of the newly acquired machine. This project is in his starting phase.
4. **NEMO optimization analysis** on Xeon Phi for intel.

Projects, and/or activities

Bull Application experts are involved in all the deals answered by Bull and requiring application level commitments: DKRZ, AEMET, Meteo France, …
Besides, they have worked on projects linked with NEMO (funded or as provided services): porting on Intel Xeon Phi, application tuning, IO analysis, scalability analysis, … The team was involved in the PULSATION project (funded by ANR in France).
If we focus on the most three relevant projects

- Project 1: PULSATION Project: This project is funded by ANR French Agency. Its goal is to create a coupled (ocean atmosphere) multigrid simulation. This multigrid simulation makes it possible to focus on very precise zone with relevant effect (for instance el nino and el nina). Then, this precise zone is embedded in a coarse one for the holistic simulation.
- Project 2: DKRZ. DKRZ has selected bull has their supercomputer provider. Beside the material, they asked bull to work on the application to prepare the future evolution. The work load is around 2PY
- Project 3: NEMO Ported on Phi: Intel has asked bull to work on NEMO and port it on Phi. NEMO is very complex and the approach in this project is to focus on a very small part of the code (few functions, 10 loopnest) but makes it very efficicient on Phi

Significant infrastructure, and/or major items of technical equipment

Different supercomputers are part of the CEPP; they are selected according to the different needs: reproducibility, ability to be modified. In the CHANCE context, the experiments will be done on targeted hardware provided by the project. CEPP is used to integrate, modify and give access to the hardware, they can host it a reliable infrastructure (login nodes, storage, …).
For instance, we have pure CPU nodes, nodes with latest GPU and accelerators. Besides, in terms of interconnect, storage, software stack; we are able to build configurations with a lot of flexibility. This will bring to the project the ability to rely on an flexible infrastructure administrated by professional sysadmin.
The size of the machines evolves continuously, but, there are generally, around one hundred of CEPP nodes up and running.

Allinea Software Limited (ALLINEA)

About the institute

Allinea Software is a UK SME providing world-leading development tools and application performance analytics software and training for high performance computing (HPC).

Its headquarters and Research and Development groups are in the UK, and it has sales or technical operations in France, Germany, Canada and the USA. It has a customer base throughout the world, including over 75% of Europe's leading HPC centres. Allinea's integrated profiling and debugging developer tools are relied on in fields ranging from climate modeling to astrophysics, and from computational finance to engine design - and together provide proven capability beyond Petascale computing.

Allinea provides training in the best practices of software development - including using debugging and profiling tools - enabling scientists to develop more maintainable and efficient software faster. This training is provided regularly including at PRACE, university and lab workshops.

Contribution to the specific project

Allinea will contribute to WP3.

Within the ESIWACE Allinea will bring its expertise in training of best practices for software engineering and development tools to HPC community and work with the climate community to help it develop excellent software to the benefit of the community and society.

Publications, and/or products, services or other achievements

Florent Lebeau (male) is an HPC Applications and Support Analyst at Allinea and develops and provides training in software tools. Being involved in HPC for many years, he has expertise in parallel programming, optimization, tools and training. Before joining Allinea, Florent graduated from the University of Dundee with an MSc in Applied Computing and has worked for CAPS entreprise, were he developed profiling tools for HMPP Workbench and provided training on parallel technology. Florent will contribute to WP 3.

4.2. Third parties involved in the project (including use of third party resources)
4.2.1 Subcontracting

	Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	Description of subcontracting	Value (€) *(Figures below are indicative)*
Deutsches Klimarechenzentrum GmbH **COORDINATOR**	NO		
European Centre for Medium-Range Weather Forecasts	NO		
Centre National de la Recherche Scientifique	NO		
Max Planck Institute for Meteorology	NO		
Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique	NO		
Barcelona Supercomputing Center	NO		
Science and Technology Facilities Council	NO		
Met Office	NO		
The University of Reading	NO		
Swedish Meteorological and Hydrological Institute	NO		
National University of Ireland Galway (Irish Centre for High End Computing)	NO		
Centro europeo-mediterraneo sui cambiamenti climatici scarl	NO		
Deutscher Wetterdienst	NO		
Seagate Systems UK Limited	NO		
BULL SAS	NO		
Allinea Software Limited	NO		

4.2.2 Work is performed by linked third parties

	Does the participant envisage that part of its work is performed by linked third parties	Description of third party and link to the participant	Description of tasks
Deutsches Klimarechenzentrum GmbH **COORDINATOR**	NO		
European Centre for Medium-Range Weather Forecasts	NO		
Centre National de la Recherche Scientifique	Yes	CNRS foresees to have part of the work done by its linked third parties (Art: 14 of the GA): Commissariat à l'Energie Atomique et aux Energies Alternatives (CEA): **Commissariat à l'Energie Atomique et aux Energies Alternatives (CEA)** is associated with CNRS within the Joint Research Unit LSCE which is part of IPSL. Université Pierre et Marie Curie (UPMC). **Université Pierre et Marie Curie (UPMC)** is associated with CNRS within the Joint Research Unit LOCEAN which is part of IPSL.	**Commissariat à l'Energie Atomique et aux Energies Alternatives (CEA)** is associated with CNRS within the Joint Research Unit LSCE which is part of IPSL. CEA will be involved in WP2 for tasks concerning the I/O server XIOS, a software library dedicated to efficient IO management for climate models (Tasks 1.2, 2.2, 2.3, 3.2, 4.1). CEA will be involved through two engineers Yann Meurdesoif and Arnaud Caubel. They will lead the support and development associated with XIOS. CEA has budgeted the following costs in the proposal: personnel costs, estimated 4 person-months, for a direct cost of 32.000€. This budget is currently included in the budget of CNRS. Upon approval of the proposal, CEA will claim these costs to the EC through CNRS. **Université Pierre et Marie Curie (UPMC)** is associated with CNRS within the Joint Research Unit LOCEAN

			which is part of IPSL. UPMC is involved with CNRS in the NEMO system team and will contribute to the support and developments activities on the European ocean platform NEMO in WP2 (Tasks 1.1 and 3.1). **Dr Sébastien Masson** (male) is a member of the NEMO Developing Team for 10 years and will participate to these activities. UPMC has budgeted the following costs in the proposal: personnel costs, estimated 1 person-months, for a direct cost of 8.000€. This budget is currently included in the budget of CNRS. Upon approval of the proposal, UPMC will claim these costs to the EC through CNRS.
Max Planck Institute for Meteorology	NO		
Centre Européeen de Recherche et de Fformation Avancéee en Calcul Scientifique	NO		
Barcelona Supercomputi ng Center			
Science and Technology Facilities Council	NO		
Met Office	NO		
The University of Reading	NO		
Swedish Meteorological and Hydrological Institute	NO		
National University of Ireland Galway (Irish Centre for High End Computing)	NO		

Centro europeo-mediterraneo sui cambiamenti climatici scarl	NO		
Deutscher Wetterdienst	NO		
Seagate Systems UK Limited	NO		
BULL SAS	NO		
Allinea Software Limited	NO		
Centre Européeen de Recherche et de Formation Avancée en Calcul Scientifique	NO		

4.2.3 Contribution in kind

	Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)
Deutsches Klimarechenzentrum GmbH **COORDINATOR**	NO
European Centre for Medium-Range Weather Forecasts	NO
Centre National de la Recherche Scientifique	NO
Max Planck Institute for Meteorology	NO
Centre Européen de Recherche et de Formation Avancéee en Calcul Scientifique	NO
Barcelona Supercomputing Center	**Yes** ICREA (Institució Catalana de Recerca i Estudis Avançats) will provide resources free of charge to the BSC as a third party (**Article 12 Grant Agreement**). ICREA is a foundation supported by the Catalan Government and guided by a Board of Trustees which aims to recruit top scientists for the Catalan R&D system: scientists capable of leading new research groups, strengthening existing groups, and setting up new lines of research. Following the rules of ICREA, although the salary costs of Dr. Doblas-Reyes are paid by ICREA, he is assigned to physically work at the Earth Sciences Department of the BSC and considered a full member of the BSC. The terms and conditions of this cooperation between ICREA and BSC are reflected in a bilateral agreement between the two parties. The beneficiary, BSC, is free to use these resources at will. They are therefore assimilated as "own resources" of the beneficiary, and will be charged to the project without being considered as a receipt. The cost will be declared by the beneficiary and it will be recorded in the accounts of the third party. These accounts will be available for auditing if required.
Science and Technology Facilities Council	NO
Met Office	NO
The University of Reading	NO
Swedish Meteorological and Hydrological Institute	NO
National University of Ireland Galway (Irish Centre for High End Computing)	NO
Centro europeo-mediterraneo sui cambiamenti climatici scarl	NO
Deutscher Wetterdienst	NO
Seagate Systems UK Limited	NO
BULL SAS	NO
Allinea Software Limited	NO

Section 5: Ethics and Security

5.1 Ethics

There are no ethical issues foreseen during the ESiWACE project.

5.2 Security

ESiWACE project will not involve activities or results raising security issues.
ESiWACE project will not involve 'EU-classified information' as background or results.

APPENDIX 1: Letters of Commitment and Support to ESiWACE

Australian Government
Bureau of Meteorology

In reply please quote

January 5, 2015
Centre for Australian Weather and Climate Research,
Bureau of Meteorology,
700 Collins Street,
Docklands, Victoria 3008, Australia

Dr Joachim Biercamp
Coordinator of ESiWACE

Letter of Commitment

Dear Dr. Biercamp,

With this letter we express our commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding. The Centre for Australian Weather and Climate Research (CAWCR), which a partnership between the Bureau of Meteorology and CSIRO, with help from the Australian Universities and the Australian Government Department of Environment has developed the Australian Community Climate and Earth System Simulator. ACCESS is a fully coupled Earth system model which is being used for predictions and projections across all time and space scales ranging from numerical weather prediction, multi-week to seasonal prediction and climate/climate change projections. An important aspect of ACCESS development is the strong international collaboration particularly with the Met Office (Exeter, UK) on atmospheric modelling and data assimilation, the Geophysical Fluid Dynamics Laboratory (Princeton, USA) on ocean modelling, and CERFACS (France) on the OASIS coupler. Earth system modelling is highly dependent on high performance computing, including software engineering and optimization, and it is in this context our interest in ESiWACE lies.

Our commitment includes the following elements:

- Engage in fostering cooperation between ESiWACE and ACCESS, including future development of the simulator;
- Participate and contribute to workshops on HPC for weather/climate modeling;
- Dr Kamal Puri will act as the contact point and to respond to interviews or questionnaires on user requirements;
- Interest in the support of ESIWACE on models such as EC-Earth, HadGEM, NeMO, tools such as OASIS coupler, Cylc, XIOS, and developments for data management;

- Interest in participating in evaluations or intercomparisons of some of the software supported or developed by ESIWACE such as software stack, I/O server, coupler software by attending workshops and proposing relevant test cases;
- Support ESiWACE in dissemination of results to our institution or support ESIWACE in outreach, dissemination and public engagement activities through our communication networks and through Australian universities.

We are happy to provide any additional information on our commitment to the project upon your request or request of the European Commission.

We are looking forward to work together with you in this exciting project.

Sincerely yours,

Dr Peter May
Assistant Director (Research and Development)
Bureau of Meteorology
Ph: +61-3-9669-4490
Email: p.may@bom.gov.au

Princeton University

Program in Atmospheric and Oceanic Sciences
Princeton Forrestal Campus
300 Forrestal Road
Princeton, New Jersey 08540-6654

7 January 2015

To Dr Joachim Biercamp
Coordinator of ESiWaCE

Letter of Commitment

Dear Dr. Biercamp,

I am Dr. V. Balaji, Head of the Modeling Systems Group at Princeton University's Cooperative Institute for Climate Science and NOAA's Geophysical Fluid Dynamics Laboratory. With this letter I would like to express my group's fullest commitment to engage in the project ESiWaCE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding.

Our commitment includes the following elements:

- Our centre is committed to the same goals as the ESiWaCE project: namely scalability, usability and exploitability of the software for running Earth System Models (ESMs) for climate research and weather prediction.
- We will be fully engaged as external partners in defining the software goals for HPC, couplers, and data management. This will include helping to define the user requirements, identifying the relevant use cases and test cases, participating in evaluations and intercomparisons of software stacks, and collaborating in disseminating the results to the global research community through papers and collaboratively organized international workshops.
- We will collaborate with ENES in defining meaningful metrics for measuring and comparing performance of ESMs.

I will serve as the principal technical point of contact for this collaboration. Please accept this as our letter of support for this project. Please do not hesitate to contact me should you have further questions.

Sincerely yours,

V. Balaji
Head, Modeling Systems Group
GFDL Princeton University
Tel: +1-609-452-6516
Email: balaji@princeton.edu

Letter of commitment (SUPPORTING ORGANISATION)

Center for Climate Systems Modeling (C2SM)
ETH Zurich
Zurich, Switzerland
Isabelle Bey
Phone: +41 44 632 79 15
E-mail: isabelle.bey@env.ethz.ch

To
Dr Joachim Biercamp
Coordinator of ESiWACE

Letter of Commitment

Dear Dr. Biercamp,

With this letter we like to express our fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding.

The Center for Climate Systems Modeling (C2SM) is a joint initiative between 5 Swiss institutions (ETH Zurich, MeteoSwiss, Empa, WSL, and Agroscope) which main goal is to improve the understanding of the Earth's climate system and our capability to predict weather and climate. The center actively contributes to the development and maintains several families of models, including the MPI-ESM-HAMMOZ model (a comprehensive Earth System Model that couples the atmosphere, ocean and land surface and includes a full description of chemistry and aerosols) and the regional climate and numerical weather prediction (NWP) model COSMO. The centers also provide support for the management and dissemination of relevant climate model output data base (e.g., CMIP5 and CORDEX archive).

Our commitment includes the following elements:

- Engage in fostering cooperation between ESiWACE and some of our projects (e.g., projects within the Platform for Advanced Scientific Computing (PASC) initiative that aim at exploiting the next generation of high-performance computers for high-resolution climate and NWP applications)
- Participate and contribute to workshops on HPC for weather/climate modeling
- Name one or more persons to act as contact point and to respond to interviews or questionnaires on user requirements
- Interested by the support of ESIWACE on models (ICON), tools (OASIS coupler) and developments for data management
- Supporting ESiWACE in dissemination results to our institution.

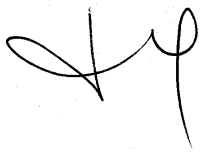
Letter of commitment (SUPPORTING ORGANISATION)

In addition, Dr. Isabelle Bey declares her availability to act as member of the scientific advisory board of ESiWACE. In this capacity she would bring her expertise in the field of Earth System Models and HPC.

We are happy to provide any additional information on your commitment to the project upon your request or request of the European Commission.

We are looking forward to work together with you in this exciting project!

Sincerely yours,



Isabelle Bey
C2SM Executive Director

Letter of commitment (SUPPORTING ORGANISATION)

Cray U.K. Limited
2 Brewery Court, High Street, Theale
Reading, Berkshire RG7 5AH
United Kingdom
Philip Brown
Earth Sciences Segment Leader
Phone: +44 117 927 3549
Fax: +44 118 903 3208
E-mail: philipb@cray.com

To
Dr Joachim Biercamp
Coordinator of ESiWACE

Letter of Commitment

Dear Dr. Biercamp,

With this letter we would like to express our fullest support of the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding.
Cray builds innovative systems and solutions enabling researchers to meet existing and future simulation and analytics challenges. Leveraging years of experience developing the world's most advanced supercomputers, Cray brings a comprehensive portfolio of high performance computing, storage, and data analytics solutions delivering unrivaled performance, efficiency, and scalability. Cray continues to invest in and leverage key technologies in order to provide the best possible solutions to the numerical weather prediction and earth system modelling communities. In addition, Cray has more than 25 software application personnel dedicated to weather, climate, and ocean modelling - many in Europe. Cray also has a long and strong collaborative relationship with the weather community around the world.

Our support activities will include the following commitments:

- Participate and contribute to workshops on HPC for weather/climate modeling
- Name one or more persons (Philip Brown) to act as contact point and to respond to interviews or questionnaires on user requirements
- Interest in the support of ESiWACE on models (EC-EARTH/NEMO/ICON), tools (OASIS coupler, XIOS, CYLC) and developments for data management
- Interest in participating in evaluations or intercomparisons of some of the software supported or developed by ESiWACE (software stack, I/O server/ coupler / dynamical core) by attending workshops and proposing relevant test cases
- Supporting ESiWACE in outreach, dissemination and public engagement activities through our Marketing and Business Development units (for example assisting in the creation of whitepapers highlighting ESiWACE activities)

We are happy to provide any additional information on our commitment to the project upon your request or request of the European Commission.

Letter of commitment (SUPPORTING ORGANISATION)

We are looking forward to work together with you in this exciting project!

Sincerely yours,

Dominik Ulmer
Director EMEA Operations

The Cyprus Institute
20 Konstantinou Kavafi Street
2121 Aglantzia
Nicosia, Cyprus
Theodoros Christoudias
CaSToRC
Phone: +35722208677
Fax: +35722208625
E-mail: christoudias@cyi.ac.cy

To
Dr Joachim Biercamp
Coordinator of ESiWACE

Letter of Commitment

Dear Dr. Biercamp,

With this letter we like to express our fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding.
The CaSToRC Climate Modeling group conducts research in Numerical Weather Prediction (NWP) and air quality modeling, and Earth System Modeling (ESM) and is interested in participating in geophysical model development, code optimization and porting to new architectures and the management, analysis and visualization of climate and atmospheric model generated data in ESiWACE.

Our commitment includes the following elements:

- Participate and contribute to workshops on HPC for weather/climate modeling.
- Name one or more persons to act as contact point and to respond to interviews or questionnaires on user requirements.
- Interested by the support of ESIWACE on models (EC-EARTH/ICON), tools (OASIS coupler, XIOS, CYLC) and developments for data management.
- Interested to participate to evaluations or intercomparisons of some of the software supported or developed by ESIWACE (software stack, I/O server, coupler, dynamical core) by attending workshops and proposing relevant test cases.
- Supporting ESiWACE in dissemination results to our institution OR Supporting ESIWACE in outreach, dissemination and public engagement activities through our Visualisation Laboratory.

We are happy to provide any additional information on our commitment to the project upon your request or request of the European Commission.

We are looking forward to work together with you in this exciting project!

Sincerely yours,

Theodoros Christoudias

DataDirect™
NETWORKS
INFORMATION IN MOTION

DataDirect Networks GmbH

Toine Beckers
Phone: +49 162 237 1444
Fax: +49 162 237 1444
E-mail: tbeckers @ddn.com

To:

Dr Joachim Biercamp
Coordinator of ESiWACE

Letter of Commitment

Dear Dr. Biercamp,

With this letter we like to express our fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding.

DDN is the world's largest, privately-held, data storage infrastructure provider. With a focus on the requirements of today's most demanding Top500 supercomputer sites, DDN specialises in High Performance Computing and Big Data applications which are optimised for the world's most data-intensive environments, including, but not limited to: National Governmental Research and Development organisations, Oil & Gas Exploration, Life Science Research, Web & Cloud Content, Professional Media, Homeland Security, Intelligence and more. DDN currently supports over 2/3 of the top100 supercomputers in the world.
DDN is currently developing novel software, referred to as Infinite Memory Engine™ (IME), which is a code name for a burst buffer implementation intended to provide a much more space/cost/energy efficient way to provision I/O performance. IME does this by creating a fast tier of NVM that is a result of virtualizing a number of disparate SSDs into a single pool that applications recognize as conventional storage. This approach enables the decoupling of the file system and storage from the application, delivering orders of magnitude greater acceleration in I/O performance. DDN is actively introducing this technology (as testbeds) to strategic customers and partners throughout 2014 /2015 with plans for full commercial offerings towards the end of 2015.
DDN believes that this IME technology would be a perfect fit to address the I/O problems in NWP and ESM especially when it comes to 'Scalability' and 'Usability'.

DataDirect NETWORKS
INFORMATION IN MOTION

DDN will support ESiWACE in particular by participating and contributing to workshops on HPC for weather and climate modeling and is very interested in becoming a partner of the Center of Excellence at a later stage.

We are happy to provide any additional information on your commitment to the project upon your request or request of the European Commission.

We are looking forward to work together with you in this exciting project!

Sincerely yours,

DataDirect NETWORKS
Im Haindell 1
D-65843 Sulzbach

p.p.a. Antoon Beckers
Director HPC Sales EMEA

Institut für Physik der Atmosphäre

Deutsches Zentrum
DLR für Luft- und Raumfahrt

DLR e. V. Institut für Physik der Atmosphäre
Oberpfaffenhofen, Postfach 11 16, 82230 Weßling

Dr. Joachim Biercamp
Co-ordinatir of ESiEaCE
Deutsches Klimarechenzentrum
Bundesstraße 45a
20146 Hamburg

Ihr Zeichen
Ihr Schreiben
Unser Zeichen RS

Ihr Gesprächspartner Prof. Dr. Sausen

Telefon 08153 28- 2500
Telefax 08153 28- 1841
E-Mail robert.sausen@dlr.de

7 Januar 2015

Letter of Commitment

Dear Dr. Biercamp,

With this letter we would like to express our fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 in case the project will be selected for funding.

The DLR-Institut für Physik der Atmosphäre develops and runs ESMs (EMAC) and atmosphere GCMs (ECHAMn, ICON), mainly for studying climate-chemistry interaction and the impact of transport (aviation, road transport, shipping) on the composition of the atmosphere (air quality) and on climate, at different spatial resolutions. Both, the impact of emissions from Europe and the impact global emissions on Europe, are of particular interest. In order to perform these studies efficient, scalable and reliable numerical models are necessary. ESiWaCE appears to provide a suitable platform for these needs. In addition, DLR develops the Earth System Model validation tool (ESMValTool) with the ultimate goal is of testing performance of CMIP6 models routinely alongside the ESGF.

Our commitment includes the following elements:

- Engagement in fostering cooperation between ESiWaCE and our projects, in particular DLR-VEU-2, DLR-WeCare, DLR-KliSAW, EC-StratoClim, German BMBF-MiKlip and potentially EC ADVITAM;
- Participation and contribution to workshops on HPC for weather/climate modeling;
- Name one or more persons / organisational units to act as contact point and to respond to interviews or questionnaires on user requirements;
- Interest in support of ESiWaCE on models (ICON, EMAC), tools (MESSy, ESMValTool) and in developments for data management;
- Interest in participation in evaluations or inter comparisons of some of the software supported or developed by ESiWaCE (software stack, (I/O server/ coupler / dynamical core) by attending workshops and proposing relevant test cases;
- Support of ESiWaCE in dissemination results to DLR institutions.

Oberpfaffenhofen
Münchener Str. 20
82234 Weßling
Telefon 08153 28-0
Internet DLR.de

We are happy to provide any additional information on your commitment to the project upon your request or request of the European Commission.

We are looking forward to work together with you in this exciting project!

Best regards

Robert Sausen

Deutsches Zentrum
für Luft- und Raumfahrt e.V.
Institut für Physik
der Atmosphäre
Erdsystem-Modellierung
Prof. Dr. R. Sausen
Oberpfaffenhofen
D-82234 Weßling

Letter of Commitment

Ralf Döscher
Rossby Centre/SMHI
601 76 Norrköping
ralf.doescher@smhi.se

To:
Dr Joachim Biercamp
Coordinator of ESiWACE

January 7, 2015

Dear Dr. Biercamp,

With this letter we like to express our fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding.

EC-Earth is a European consortium developing and using the Earth System Model EC-Earth 3. Climate modelling relies on technical development and an infrastructure of model tools and services. EC-Earth utilizes the ocean model NEMO, the coupler OASIS, and plans to use the I/O manager XIOS and possibly the meta-scheduler CYCL. Provision, optimization and further development of those tool will greatly faciliate the application of the EC-Earth model, the possibilities to configure it and its productivity. Improvements in scalability will further allow for more efficient uage of high-performance computing facilities.

Our commitment includes the following elements:

- Engage in fostering cooperation between ESiWACE and the EC-Earth community
- Participate and contribute to workshops on HPC for climate modeling
- The chair of EC-Earth, Ralf Döscher, Science Coordinator at Rossby Centre/SMHI will act as contact point and to respond to interviews or questionnaires on user requirements
- The EC-Earth community is interested in the support of ESIWACE on models (EC-EARTH/NEMO/ICON), tools (OASIS coupler, XIOS, CYLC ?) and developments for data management
- The EC-Earth community is also interested to participate in evaluations of intercomparisons of some of the software supported or developed by ESIWACE (I/O server/ coupler / dynamical core) by attending workshops and proposing relevant test cases.

We are happy to provide any additional information on your commitment to the project upon your request or request of the European Commission.

We are looking forward to work together with you in this exciting project!

Sincerely yours,

Dr. Ralf Döscher
Chair of the Steering Committee of EC-Earth, Science Coordinator of Rossby Centre/SMHI

Name and signature

Letter of commitment (eSTICC)

eSTICC
NILU- ATMOS
Instituttveien 18
Kjeller, Norway
Ignacio Pisso, scientific secretary
Phone: +47 63 89 80 00
Fax: +47 63 89 80 50
E-mail: ip@nilu.no

To
Dr Joachim Biercamp
Coordinator of ESiWACE

Letter of Commitment

Dear Dr. Biercamp,

With this letter we like to express our fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding. eSTICC (eScience tools for investigating Climate Change in Northern High Latitudes) is a Nordic Center of Excellence committed to the development of eScience tools for research on the arctic climate change.

eSTICC's goal is a more accurate description of the high-latitude feedback processes in the climate system by improving the eScience tools of the climate research community. Particular objectives are to:

- integrate the data and computational tools from the existing NCoEs CRAICC, SVALI and DEFROST to further strengthen the leading Nordic position in climate data hosting.
- facilitate the information flows between experimentalists and modelers.
- improve the handling and processing of the large measurement and model data sets available from several relevant data bases.
- enhance inverse modeling tools that are used to determine emission fluxes.
- integrate Nordic Earth System Modeling by exploiting the multi-model approach.
- develop more efficient process parameterizations for Earth System Models.
- challenge the competing demands of model complexity versus spatial resolution by experimenting with model resolution vs. complexity in the present Nordic ESMs, with a focus on Arctic phenomena.
- improve the efficiency in the utilization of computing resources, by porting and optimizing code to new and emerging platforms, as well as by utilizing novel algorithms to increase scalability of modeling software, thereby enabling larger and more accurate models.
- develop workflow schemes to integrate different data, to make them more accessible to scientists.

Our commitment includes the following elements:

Letter of commitment (eSTICC)

- Engage in fostering cooperation between ESiWACE and our project eSTICC. eSTICC members focus on data management, inverse modeling, Earth System modeling, model parametrisation, high performance computing, outreach and education. A number of these are common objectives and we firmly believe that cooperation between both centres will foster excellence and create opportunities for exciting new results.
- Participate and contribute to workshops on HPC for weather/climate modeling
- eSTICC is interested by the support of ESiWACE on models (EC-EARTH/NEMO/ICON), tools (OASIS coupler, XIOS, CYLC ...) and developments for data management. Many of the eSTICC members are active users of come of the mentioned models and tools.
- Interested to participate to evaluations or inter comparisons of some of the software supported or developed by ESiWACE (software stack, (I/O server/ coupler / dynamical core) by attending workshops and proposing relevant test cases.
- Supporting ESiWACE in dissemination results to our institution OR Supporting ESiWACE in outreach, dissemination and public engagement activities through our education work package.

We are happy to provide any additional information on your commitment to the project upon your request or request of the European Commission.

We are looking forward to work together with you in this exciting project!

Sincerely yours,

Ignacio Pisso
Senior Scientist, ATMOS - NILU
eSTICC scientific secretary

FINNISH METEOROLOGICAL INSTITUTE

Letter of commitment

Finnish Meteorological Institute
Address: P. O. Box 503
00101 Helsinki, Finland
Prof. Petteri Taalas
Director General's office
Phone: +358 29 539 2200
Fax: +358 29 539 2203
E-mail: petteri.taalas@fmi.fi

To
Dr Joachim Biercamp
Coordinator of ESiWACE

Dear Dr. Biercamp,

With this letter we would like to express our commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1, should the project be selected for funding.

The Finnish Meteorological Institute (FMI) is the National Weather Service provider in Finland, a research and service agency operating under the Ministry of Transport and Communications of Finland. The FMI is committed to engage in the ESiWACE as we are interested in the objectives to enable researchers and industry partners to be more productive through improved access to computing applications and expertise and this way together with others achieve upgrades in performance and increase in efficiency.

Our commitment includes the following elements:

- Exchange of information and guidance where ESIWACE overlaps with ongoing efforts at your institute; for externally funded activities please add project name and funding source.
- Participation in ESIWACE workshops (funded by ESIWACE).
- Evaluation of selected activities given the needs of your organization.
- Contribution to strategic discussions on software, high-performance computing and data management developments.

I am pleased to name Dr Hannele Korhonen, (email: hannele.korhonen@fmi.fi) as the point of contact here at the FMI.

We are happy to provide any additional information on your commitment to the project upon your request or the request of the European Commission.

Sincerely yours,

Petteri Taalas
Director General

Freie Universität Berlin

Fachbereich Geowissenschaften
Institut für Meteorologie
Carl-Heinrich-Becker-Weg 6-10
D-12165 Berlin

Univ.-Prof. Dr. Ulrich Cubasch
Geschäftsführender Direktor

Telefon: (++49 30) 838 71217
Fax : (++49 30) 838 71160
E-Mail: cubasch@zedat.fu-berlin.de
www.geo.fu-berlin.de/met/ag/klimod
Bearb.-Zeichen: Prof.Cu/Ge
Bearbeiterin: C. Geisler

Berlin, den 05.01.2015

Freie Universität Berlin, FB Geowissenschaften, Institut für Meteorologie,
Carl-Heinrich-Becker-Weg 6-10, D-12165 Berlin

To
Dr Joachim Biercamp
DKRZ
Coordinator of ESiWACE

Letter of Commitment

Dear Dr. Biercamp,

With this letter we like to express our fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding.
Our institute carries out research in the field of climate variability modeling, numerical weather forecasting and climate diagnosis. As part of its duties as university institute, it also trains graduate and postgraduate students in the development and usage of Earth system models on super-computers. ESiWACE is there fore located at the center of our research and training interests.

Our commitment includes the following elements:

- Engage in fostering cooperation between ESiWACE and our projects MIKLIP (Medium Term Climate Prediction), SPP Climate engineering, VEXICOM (Extreme weather forecasting), and CADY (Central Asian Climate Dynamics).
- Participate and contribute to workshops on HPC for weather/climate modeling
- Dr. Ingo Kirchner will act as contact point and to respond to interviews or questionnaires on user requirements
- We are Interested by the support of ESIWACE on models (CLM, EC-EARTH, NEMO, ICON), tools (OASIS coupler, XIOS, CYLC ...), developments for data management and graphics.
- We will participate in evaluations and intercomparisons of some of the software supported or developed by ESIWACE (software stack, I/O server, coupler, dynamical core) by attending workshops and proposing relevant test cases.
- We intend to support ESiWACE in dissemination results and to train students at various levels with the software and hardware provided by ESiWACE.

We are happy to provide any additional information on your commitment to the project upon your request or request of the European Commission.
We are looking forward to work together with you in this exciting project!

regards (Prof. U. Cubasch)

150 Kettletown Road
Southbury, CT 06488-2600
1-720-395-4377
dturek@us.ibm.com

January 6, 2015
Dr Joachim Biercamp
Coordinator of ESiWACE
Letter of Commitment

Dear Dr. Biercamp,

With this letter we express our enthusiastic commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding. I am the business leader of IBM's Technical Computing Business and believe that many keen insights are likely to be derived from this project which will help IBM understand more clearly the system requirements required to better support this community with our future products.

In particular, we would expect to engage in some of the following ways:

- Engage in fostering cooperation between ESiWACE and our some of our future system design projects.
- Participate and contribute to workshops on HPC for weather/climate modeling
- Name one or more persons / organisational units to act as contact point and to respond to interviews or questionnaires on user requirements. It is likely that this relationship will be managed either through our laboratory in Zurich or our R&D center in Boebligen.
- Involve additional members of the OpenPower Foundation to participate in software related issues. In particular, to bring in nVIDIA and Mellanox (existing IBM development partners) to comment and potentially work on application level codes. We would also be keenly interested to assess whether certain data management products in IBM could be helpful to analytics related issues.
- Participate in evaluations or intercomparisons of some of the software supported or developed by ESIWACE (software stack, (I/O server/ coupler / dynamical core) by attending workshops and proposing relevant test cases.
- Support ESiWACE in disseminating results throughout the relevant communities.

Dave Turek
Vice President, Technical Computing, OpenPOWER

DKRZ
Attention : Dr Joachim Biercamp
Bundesstraße 45a
D-20146 Hamburg
Germany

Meudon, Wednesday, 07 January 2015

TO WHOM IT MAY CONCERN

Dear Dr Biercamp,

The purpose of this letter is to express Intel's strong support to your consortium efforts to develop a Centre of Excellence called ESIWACE on numerical earth system modelling and on numerical Weather prediction as a response to the H2020-EINFRA-2015-1 call "EINFRA-5-2015: Centres of Excellence for computing applications".

We feel that indeed the new computing tools are offering opportunities and challenges both to the software programs used in earth system modelling and to the numerical weather prediction. "Scalability" is a must have in view of the future exascale systems which will bring together over hundreds thousands of core. "Usability" is a critical element of the puzzle so that scientists can easily extract the information their required for their innovative research. And "exploitability", for the movement of the huge data generated by the simulations, is an important part of the dissemination of the data and of their analysis.

Intel as a leader in HPC technology is committed to develop and build Exascale HPC systems. We are interested to support your efforts as a "supporter" to provide feedback on software support and development, to participate in workshops and to provide inputs on issues such I/O, coupler, common software as well as developments on workflows and data management. Dr Marie Christine Sawley will be your main contact for these discussions.

The terms of this Letter of Support are not binding and do not create any legal rights or obligations. Intel will ask the project partners to sign Non-Disclosure Agreements before exchanging any confidential information.

Sincerely Yours,

Stéphane Negre,
Président,
Intel Corporation SAS (France)

Intel Corporation SAS
Les Montalets
2, rue de Paris
92196 Meudon Cedex
Tel. +33 (0)1 58 87 71 71
Fax +33 (0)1 58 87 70 00
Internet www.intel.fr

Royal Netherlands
Meteorological Institute
Ministry of Infrastructure and the Environment

> Return address PO Box 201 3730 AE De Bilt

KNMI

Visiting address
Utrechtseweg 297
3731 GA De Bilt
The Netherlands
PO Box 201
3730 AE De Bilt
The Netherlands
T +31 302206911
telefax +31 302210407
www.knmi.nl

Royal Bank of Scotland
Account No 56.99.98.387
IBAN NL23RBOS0569998387
BIC RBOSNL2A

Contact
Prof. Gerard van der Steenhoven,
E: Gerard.van.der.Steenhoven@knmi.nl
T +3130 2206336

Our reference
KNMI/2015-37

Your reference

Enclosure(s)

To: Dr Joachim Biercamp
Coordinator of ESiWACE

Date: January 6, 2015
Subject: Letter of Commitment

Dear Dr. Biercamp,

With this letter we would like to express our commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1, should the project be selected for funding.

KNMI is the national Netherlands institute for weather, climate research and seismology (approx. 400 fte's). It disseminates weather information to the public at large, the government, aviation and the shipping industry in the interest of safety, the economy and a sustainable environment. To gain insight into long-term developments, KNMI conducts research on climate change.

KNMI actively participates in both ESM (EC-Earth) and NWP (Hirlam-Alladin cooperation) and is aware of the importance to address the three topic (Scalability, Usability and Exploitability) that are central in the project ESiWACE.

KNMI therefore fully supports ESiWACE in setting up a Centre of Excellence serving both, ESM and NWP, and recognizes as possible interactions with ESiWACE:

- Exchange of information and guidance where ESIWACE overlaps with ongoing efforts at KNMI
- Participation in ESIWACE workshops (funded by ESIWACE).
- Evaluation of selected activities given the needs of KNMI.
- Contribution to strategic discussions on software, high-performance computing and data management developments.

Royal Netherlands
Meteorological Institute
Ministry of Infrastructure and the Environment

As point of contact for ESiWACE at KNMI we propose Jan Barkmeijer (Jan.Barkmeijer@knmi.nl)

We are happy to provide any additional information on our commitment to the project upon your request or the request of the European Commission.

Sincerely yours,

Professor Gerard van der Steenhoven
Director-General KNMI

METEO FRANCE

Centre National
de Recherches
Research
Météorologiques
42 avenue Gaspard Coriolis
31057 Toulouse cedex 01. France
Tél : +33(0)5 61 07 93 70
Fax : +33(0)5 61 07 96 00

To
Dr Joachim Biercamp
Coordinator of ESiWACE

Letter of Commitment

Dear Dr. Biercamp,

With this letter we like to express our fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding.
Météo-France is the French weather prediction service. It leads research activities aiming in particular at improving the numerical tools to analyse and forecast the state of the environment, and aiming at improving climate simulations in order to contribute to public policies for adaptation to climate change. These activities are conducted in close collaboration with some of the participants of the ESiWACE project (in particular CERFACS, ECMWF and CNRS). The project has the main interest for us to gather strong expertise in the fields of numerical weather prediction and climate modeling at the European level in order to prepare the next generation of numerical tools implemented on exascale computers.

Our commitment includes the following elements:

- Participate and contribute to workshops on HPC for weather/climate modeling
- Name one or more persons / organisational units to act as contact point and to respond to interviews or questionnaires on user requirements
- Interested by the support of ESiWACE on models (NEMO), tools (OASIS coupler, XIOS) and developments for data management
- Interested to participate to evaluations or intercomparisons of some of the software supported or developed by ESiWACE (software stack, (I/O server/ coupler / dynamical core) by attending workshops and proposing relevant test cases.
- Supporting ESiWACE in dissemination results to our institution.

We are happy to provide any additional information on your commitment to the project upon your request or request of the European Commission.

We are looking forward to work together with you in this exciting project!

Sincerely yours,

METEO-FRANCE
Le Directeur du Centre National
de Recherches Météorologiques
P. BOUGEAULT

Dr Joachim Biercamp
Coordinator of ESiWACE

Norwegian Meteorological Institute

Our ref.	Matter handled by	Our date
<Our ref>		7 January 2015
Your ref.		**Your date**
<Your ref>		<date>

Letter in support of proposal ESiWACE

Dear Madame, Dear Sir,

With this letter I would like to confirm that the work as described in proposal ESiWACE submitted to the EC under call H2020-EINFRA-2015-1 is of significant interest to the Norwegian Earth system modelling community, in which the Norwegian Meteorological Institute is a core partner. The topics as addressed by the proposal are of key relevance also to the NorESM (Norwegian Earth system model) which we maintain and further develop together with several other institutions in Norway such as the Universities in Bergen and Oslo.

Should the proposal be funded, we would be interested in participating in the project activities depending on resources available. Examples for such activities would be workshops on HPC for climate modelling, user surveys, software testing etc. We would also be happy to benefit from products that will come out of ESiWACE once they become available. ESiWACE would be an excellent activity which certainly would enhance the outcome of EU FP7 infrastructure project IS-ENES2 in which we are a partner.

Sincerely yours

Øystein Hov
Professor, Director of Research

Norwegian Meteorological Institute
Org.no 971274042
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NEC Deutschland GmbH
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Internet http://www.hpce.nec.com

NEC Deutschland GmbH
Prinzenallee 11, · D-40549 Düsseldorf

To:
Dr. Joachim Biercamp
Coordinator of ESiWACE

Düsseldorf, 5th January 2015

Letter of Commitment

Dear Dr. Biercamp,

With this letter we like to express our fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1, should the project be selected for funding.

NEC provides HPC-hardware and solutions for many years, and has a particular interest in the market of meteorology and climatology. NEC's product plans should meet the requirements of these markets and the related applications, and we are interested to learn in detail about the necessities of such application fields and how we could address these in an optimal way.

Our commitment includes the following elements:

- Participate and contribute to workshops on HPC for weather and climate modeling.
- We will assign a person to act as contact point and to respond to interviews or questionnaires on user requirements.
- We are interested in the support of ESIWACE on models (EC-EARTH/NEMO/ICON), tools (OASIS coupler, XIOS, CYLC) and developments for data management.
- We are interested to participate in evaluations or comparisons of some of the software supported or developed by ESIWACE (software stack, I/O server/ coupler / dynamical core) by attending workshops and proposing relevant test cases.
- Supporting ESiWACE in dissemination results to our institution OR Supporting ESIWACE in outreach, dissemination and public engagement activities through our Communication- and PR-unit.

NEC
Deutschland GmbH
Prinzenallee 11
D-40549 Düsseldorf, Germany
Telefon 0211 / 53 69-0

For SAB only:

- Dr. Rudolf Fischer, Senior Manager HPC at NEC, declares his availability to act as member of the scientific advisory board of ESiWACE. In this capacity he would bring his expertise in the field of HPC to the project.

We are happy to provide any additional information on your commitment to the project upon your request or request of the European Commission.

We are looking forward to work together with you in this exciting project.

Sincerely yours,

NEC Deutschland GmbH

Dr. Rudolf Fischer
Senior Manager HPC

+49 152 2285 1527
rudolf.fischer@emea.nec.com

Andreas Göttlicher
Senior Sales Manager

+49 152 2285 1530
andreas.goettlicher@emea.nec.com

NEC
Deutschland GmbH
Prinzenallee 11
D-40549 Düsseldorf, Germany
Telefon 0211 / 53 69-0

Letter of commitment (SUPPORTING ORGANISATION)

National Institute of Water & Atmospheric Research Ltd.
301 Evans Bay Parade
Greta Point
Wellington, 6021
New Zealand

Dr Michael J. Uddstrom
Principal Scientist, Environmental Forecasting
Phone: +64 4 386 0365
E-mail: michael.uddstrom@niwa.co.nz

To:

Dr Joachim Biercamp
Coordinator of ESiWACE

Letter of Commitment

Dear Dr. Biercamp,

With this letter we wish to express our fullest commitment to engage in the project submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding.

NIWA, the National Institute of Water and Atmospheric Research, established in 1992, is a Crown Research Institute. It is owned by the Government of New Zealand, and operates as a stand-alone company with its own Board of Directors and Executive. Its mission is to "conduct leading environmental science to enable the sustainable management of natural resources for New Zealand and the planet". As such, we are involved in both weather prediction and earth system modelling research.

Our particular interest in ESiWACE is in the proposed development and wider use of the Cylc Suite Engine (originally developed at NIWA), a workflow engine and meta-scheduler particularly developed for the weather and climate communities.

Our commitment is as follows:

- To recognise the advantage of the increased development effort for Cylc that will be provided as part of ESiWACE and the benefits this will bring to this Open Source software for all users;
- To participate and actively contribute to workshops on Cylc under work-package 3;
- To advise on proposals for a governance process for Cylc for ESiWACE and to encourage a single source code governance for the whole Cylc community, internationally;
- To advise the Technical Advisory Group of the UM partnership on the implications of proposed Cylc developments for the ESiWACE community;
- To advise ESiWACE developers of the requirements of the wider Cylc user community;
- To encourage the alignment of the work for the two user communities;

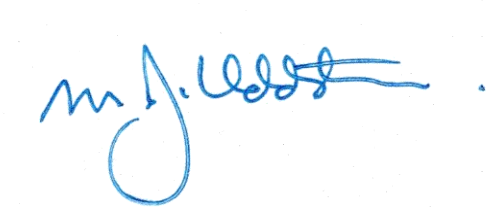
Letter of commitment (SUPPORTING ORGANISATION)

- To maintain the Cylc open source software portal on GitHub as a community resource;
- To encourage and be supportive of community investment in the Cylc software;
- To maintain a Cylc development roadmap.

We are happy to provide any additional information on your commitment to the project upon your request or request of the European Commission.

We are looking forward to working together with you on this exciting project!

Sincerely yours,



Dr Michael J. Uddstrom

netherlands eScience center

Date
5 januari 2015

Name of contact
Prof. dr. ir. W. Hazeleger

Telephone
020 - 4604770

Our reference
NLeSC C 15.0002

E-mail
w.hazeleger@esciencecenter.nl

Subject
Letter of Commitment

Dr Joachim Biercamp
Coordinator of ESiWACE

Dear Dr. Biercamp,

With this letter we like to express our fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding. The Netherlands eScience Center (NLeSC) bridges information technology with applications in a wide range of domains. We have efficient high performance computing, optimal (big) data management and big data analytics as our key competences. In the field of "Environment and Sustainability" we work with global climate models and regional weather model applications. ESiWACE will deliver advances in technology that are extremely relevant to NLeSC and its partners.

ESIWACE will focus on large scale global weather and climate models. In fact the project very nicely complements a competing proposal, ENCOMPASS, in which NLeSC participates, which focusses on high resolution regional weather and climate models and focuses on hazards. It will therefore also include disciplines close to meteorology and climate science, such as hydrology and seismology and it will deal with optimizing models of weather and climate impacts. If both projects will be funded, a strong community on Earth system and Environmental modelling will develop in Europe on all scales. Efficient exchange of technologies and standards could take place through which Europe can lead on environmental modelling.

Our commitment includes the following elements:

- Prof. Dr. Wilco Hazeleger declares his availability to act as member of the scientific advisory board of ESiWACE. In this capacity he would bring his expertise in the fields of Earth System and climate modelling and escience technologies.

We are happy to provide any additional information on your commitment to the project upon your request or request of the European Commission.

We are looking forward to work together with you in this exciting project!

Sincerely yours,

Prof. dr. ir. Wilco Hazeleger
Director Netherlands eScience Center

Netherlands eScience Center

Science Park 140
1098 XG Amsterdam

+31 (0)20 888 41 97

info@eScienceCenter.com
www.eScienceCenter.com

by SURF & NWO

To
Dr Joachim Biercamp
Coordinator of ESiWACE

Letter of Commitment

Dear Dr. Biercamp, Monday, January 5th, 2015

With this letter we like to express our fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding.

NVIDIA would like to participate in GPU developments for various atmosphere and ocean model components of the 7 global models in ENES.

As for the ESiWACE proposal, NVIDIA has activities and developments in each of the 3 central topics of scalability, usability, and exploitability.

Our commitment includes the following elements:

- Participate and contribute to workshops on HPC for weather/climate modeling
- Provide nominal seed hardware of latest generation Tesla GPUs for local development
- Provide remote access to a GPU cluster at NVIDIA HQ for performance testing
- Technical guidance on applications engineering from the NVIDIA Devtech group
- Access to latest PGI compilers including OpenACC collaborations with ESiWACE
- Quarterly roadmap updates on hardware and system software relevant to ESiWACE
- Technical support on local installations; cluster access and use; bug fix support
- Marketing support and worldwide distribution of content on project success

We are happy to provide any additional information on your commitment to the project upon your request or request of the European Commission.

We are looking forward to work together with you in this exciting project!

Stefan Kraemer
Director Business Development HPC-EMEA
Professional Solutions Group

NVIDIA
Adenauer Str. 20 A4
52146 Würselen
Germany

Department of Physics
Atmospheric, Oceanic and Planetary Physics
Clarendon Laboratory, Parks Road, Oxford OX1 3PU

UNIVERSITY OF OXFORD

Tel: +44-(0)1865-272901 Fax: +44-(0)1865-272924 www.physics.ox.ac.uk

Dr Joachim Biercamp
Coordinator of ESiWACE

05 January 2015

Letter of Commitment

Dear Dr. Biercamp,

With this letter I would like to express my fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1, should the project be selected for funding. As Royal Society Research Professor in the Physics Department at the University of Oxford and head of a research group working on the predictability and dynamics of weather and climate, the ESiWACE project will impact strongly on the efficiency and productivity of my group's work in representing and handling uncertainty in (computationally intensive) ensemble-based weather and climate prediction. Moreover, as you know I have pioneered the concept of seamless prediction of weather and climate and have written in high-profile journals about the need to coordinate the development of such models at the international level, for the benefit of society. I see ESiWACE as a necessary and important step towards the full realisation of these goals.

A specific area of research where my group and I will interact strongly with ESiWACE is in the development of weather and climate models at reduced numerical precision, as part of work on the topic of code optimization in weather and climate ensemble prediction systems. This links closely with the issue of approximate or inexact computing for weather and climate prediction, a major theme for my research group at Oxford.

I am committed to engaging with ESiWACE through workshops and through public engagement activities, and am happy to provide any additional information on our commitment to the project upon your request or the request of the European Commission.

I am looking forward to work together with you in this exciting project!

Yours sincerely,

T.N.Palmer

Royal Society Research Professor, Oxford University
Director, Oxford Martin Programme on Modelling and Predicting Climate

January 6, 2015

Dr. Joachim Biercamp
Abteilungsleiter Anwendungen
Deutsches Klimarechenzentrum GmbH (DKRZ)
Bundesstraße 45 a
D-20146 Hamburg, Germany

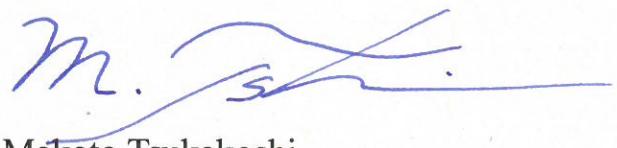
Dear Dr. Biercamp,

It is my pleasure to write a letter in support of the proposal (ESiWaCE) being submitted to the Horizon 2020 e-Infrastructures call H2020-EINFRA-2014-2015.

Reading the summary, I, as a HPC expert, fully agree that *Scalability*, *Usability* and *Exploitability* are the major issues for us to break the limit of the productivity of latest hardware and software platforms.

I believe that the project will contribute significantly to advance the usage of the latest technology in the field of Earth System Modeling (ESM) and Numerical Weather Prediction (NWP).

Sincerely,



Makoto Tsukakoshi
Director, Information Systems Department
Center for Earth Information and Technology
Japan Agency for Marine-Earth Science and Technology

Letter of commitment (UCL-TECLIM)

Université catholique de Louvain (UCL)
Georges Lemaître Centre for Earth and Climate Research (TECLIM)
Prof. Thierry Fichefet
Place Louis Pasteur 3, L4.03.08
B-1348 Louvain-la-Neuve, Belgium
Phone: +32-10-473295
Fax: +32-474722
E-mail: thierry.fichefet@uclouvain.be

To
Dr. Joachim Biercamp
Coordinator of ESiWACE

Letter of Commitment

Dear Dr. Biercamp,

With this letter we like to express our fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding.

The main research area of our centre is the development and use of Earth system models of various levels of complexity to understand past climate changes and predict/project the evolution of climate in response to anthropogenic emissions of greenhouse gases, with focus on polar regions. Our interest in ESiWACE is therefore very high.

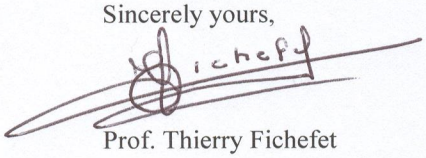
Our commitment includes the following elements:

- Engage in fostering cooperation between ESiWACE and (1) the development/use of the future versions of the Louvain-la-Neuve sea ice model (LIM) coupled to the ocean modelling platform NEMO and (2) our ongoing projects to investigate polar climate variability and predictability with EC-Earth.
- Participate and contribute to workshops on HPC for weather/climate modelling.
- Name one person to act as contact point and to respond to interviews or questionnaires on user requirements: Pierre-Yves Barriat (pierre-yves.barriat@uclouvain.be).
- Interested by the support of ESiWACE on models (EC-Earth, NEMO-LIM), tools (OASIS coupler, XIOS, CYLC, …) and developments for data management.
- Interested to participate to evaluations or intercomparisons of some of the softwares supported or developed by ESiWACE (software stack, I/O server, coupler, dynamical core, …) by attending workshops and proposing relevant test cases.
- Supporting ESiWACE in dissemination results to our institution.

We are happy to provide any additional information on your commitment to the project upon your request or request of the European Commission.

We are looking forward to work together with you in this exciting project!

Sincerely yours,



Prof. Thierry Fichefet

UNIVERSITY OF HELSINKI

Prof. Heikki Järvinen
University of Helsinki
Department of Physics
P.O. Box 64
FI-00014 University of Helsinki
FINLAND
+35850 5012202
heikki.j.jarvinen@helsinki.fi

To
Dr Joachim Biercamp
Coordinator of ESiWACE

Letter of Commitment

Dear Dr. Biercamp,

With this letter I would like to express our commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding. We are actively developing and applying OpenIFS atmospheric model based on the ECMWF IFS system, and partners in the EC-Earth Earth system modelling consortium. For both these activities the objectives of ESiWACE are highly beneficial and we sincerely hope the project to be selected for funding.

Our commitment includes the following elements:

- Participation and contribution to workshops on HPC for weather and climate modeling
- Being active in responding to interviews or questionnaires on user requirements
- Interested by the support of ESIWACE on models (EC-Earth), tools (esp. OASIS coupler) and developments for data management
- Supporting ESiWACE in dissemination results to our institution
- Prof. Heikki Järvinen declares his availability to act as member of the scientific advisory board of ESiWACE. In this capacity he would bring his/her expertise in the fields of HPC/NWP/ESM to the project.

We are happy to provide any additional information on your commitment to the project upon your request or request of the European Commission.

We are looking forward to work together with you in this exciting project!

Sincerely yours,

Heikki Järvinen

UNIVERSITY OF BERGEN
GEOPHYSICAL INSTITUTE

To whom it may concern

From:
Prof. Dr. Christoph Heinze
University of Bergen, Geophysical Institute &
Bjerknes Centre for Climate Research
Allégaten 70, N-5007 Bergen
Email: christoph.heinze@gfi.uib.no
Phone: +47 55 58 98 44
Mobile phone: +47 97557119
Fax: +47 55 58 98 83

Bergen, 19 December 2014

Letter in support of proposal ESiWACE

Dear Madame, Dear Sir,

With this letter I would like to confirm that the work as described in proposal ESiWACE submitted to the EC under call H2020-EINFRA-2015-1 is of significant interest to the Norwegian Earth system modelling community. The Geophysical Institute, University of Bergen, is one of the key partners in the Bjerknes Cente for Climate Research, the largest climate research unit in northern Europe.

The topics as addressed by the proposal are of key relevance also to the NorESM (Norwegian Earth system model) which we maintain and further develop together with several other institutions in Norway such as the Meteorological Service of Norway. Should the proposal be funded, we would be interested in participating in the project activities depending on resources available. Examples for such activities would be workshops on HPC for climate modelling, user surveys, software testing etc. We also would be happy to benefit from resulting products of ESiWACE once they become available. ESiWACE would be an excellent activity which certainly would enhance the outcome of EU FP7 infrastructure project IS-ENES2 in which we are a partner in.

Sincerely,

Christoph Heinze
(professor in chemical oceanography,
leader of national RCN Earth system modelling project EVA, www.uib.no/eva)

P.O. Box 7800
N-5020 Bergen
Norway

Visiting address
Allégaten 70, N-5007 Bergen,
Norway

Tel.: +47 55 58 26 02
Fax: +47 55 58 98 83
www.uib.no/gfi
Post@gfi.uib.no

EPCC

The University of Edinburgh
James Clerk Maxwell Building
Mayfield Road
Edinburgh EH9 3JZ
UK

Telephone +44 131 650 5030
Fax +44 131 650 6555

22 December 2014

Dr Joachim Biercamp
Coordinator of ESiWACE

Dear Dr. Biercamp,

Letter of Commitment in Support of the ESiWACE Centre of Excellence

With this letter, EPCC expresses our fullest commitment to engage with the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding.

EPCC is the supercomputing centre of the University of Edinburgh, one of Europe's leading research universities. EPCC (http://www.epcc.ed.ac.uk) was established in 1990, and the organisation is at the forefront of HPC service provision and research in Europe. EPCC has a full-time staff of 80 and a large array of HPC systems including the 118,080 core, 2 Petaflop Cray XC30-based UK National HPC service - ARCHER. We work with a wide variety of scientific and industrial partners; collaborative projects with industry represent 50% of the Centre's annual turnover (£5 million in FY13/14 excluding capital costs). EPCC has led the UK's technical work in all the PRACE projects to date and is the coordinator of the CRESTA project, which focuses on the software challenges of Exascale computing.

In addition to its role as a national HPC service provider, EPCC provides a wide variety of services to both industry and academia including: HPC application design, development and re-engineering; HPC application performance optimisation; distributed computing consultancy and solutions (with a particular focus on Grid and Cloud computing); HPC facilities access; project management for software development; and data integration and data mining consultancy. The organisation has considerable experience of running training programmes including Masters programmes in HPC and Data Science, the UK ARCHER training programme, a PRACE Advanced Training Centre, training for doctoral students and bespoke training for industry.

We welcome the opportunity to engage with ESiWACE as a supporter of the project.

Our commitment includes the following elements:

- Participating in and contributing to workshops on HPC for weather/climate modeling, based on experience derived from our position as a national HPC services provider, as the leader of the applications enabling activities in the PRACE projects and as a leading player in an number of Exascale software initiatives
- Acting as the UK contact point to respond to interviews or questionnaires on user requirements and facilitating similar contact with PRACE

- Following closely the progress of ESiWACE on models (EC-EARTH/NEMO/ICON), tools (OASIS coupler, XIOS, CYLC) and other developments for data management and contributing our knowledge of relevant transversal activities which could be of interest to ESiWACE, from our position of a HPC centre supporting a wide cross-section of communities
- Showing an interest in participating in evaluations or inter-comparisons of some of the software supported or developed by ESiWACE (software stack, (I/O server/ coupler / dynamical core) by attending workshops and proposing relevant test cases.

In addition, Alison Kennedy, Executive Director of EPCC and Member of the Board of Directors of PRACE declares her availability to act as member of the scientific advisory board of ESiWACE. In this capacity she would bring her expertise in the field(s) of HPC, in data infrastructures, in training and in sustainability issues to the project.

We are happy to provide any additional information on your commitment to the project upon your request or request of the European Commission.

We are looking forward to work together with you in this exciting project!

Yours sincerely,

Alison Kennedy

EPCC Executive Director

World Meteorological Organization
Organisation météorologique mondiale

Secrétariat
7 bis, avenue de la Paix – Case postale 2300 – CH 1211 Genève 2 – Suisse
Tél.: +41 (0) 22 730 81 11 – Fax: +41 (0) 22 730 81 81
wmo@wmo.int – www.wmo.int

Weather • Climate • Water
Temps • Climat • Eau

Our ref.: 4406-15/RES

Dr Joachim Biercamp
Abteilungsleiter Anwendungen
Department Head Applications
Deutsches Klimarechenzentrum GmbH (DKRZ)
Bundesstraße 45
D-20146 Hamburg
Germany

GENEVA, 9 January 2015

Dear Dr Biercamp,

We are writing on behalf of the World Climate Research Programme (WCRP) and the World Weather Research Programme (WWRP) in support of the proposal "Excellence in SImulation of Weather and Climate in Europe" (ESiWaCE) submitted by the Deutsches Klimarechenzentrum GmbH to the EC H2020 under call H2020-EINFRA-2015-1.

WCRP and WWRP are very pleased to endorse this ESiWaCE project because its objectives and expected outcomes align very nicely with activities conducted jointly by both programmes at the intersection between weather and climate science priorities, infrastructures and communities.

ESiWaCE is expected to make unique and defining contributions to the Global Framework for Climate Services in further developing the infrastructure to support Earth System modelling for the benefit of both weather and climate communities in Europe, leveraging two well established entities, namely the European Network for Earth System modelling (ENES) and the European Centre for Medium-Range Weather Forecasts (ECMWF), together with a well-selected set of partner organizations, thereby ensuring the development of an end-to-end workflow from HPC infrastructures to Copernicus services for atmospheric monitoring (CAMS) and climate change (CCCS).

Joint training activities and workshops proposed by ESiWaCE will ensure the widest visibility of Europe's investment in this critical field, the congruence of global and European governance regarding Earth System Modelling initiatives, and the global exposure of ESiWaCE outcomes to both weather and climate communities.

We expect substantial progress and benefit from ESiWaCE on WCRP's and WWRP joint work programmes in substantially improving the efficiency, productivity, scalability, access, usability and exploitation of numerical weather predictions and climate simulations on high-performance computing platforms, in driving necessary governance structures, in promoting the interaction between industry, the weather and climate community, practitioners and services,

and in increasing the competitiveness and growth of the European HPC sector. Hence we strongly support ESiWaCE as a Horizon 2020 programme.

We would be pleased to provide any additional information you may require for your evaluation.

Yours sincerely,

Dr David Carlson
Director, WCRP

Dr Paolo M Ruti
Chief, World Weather Research Division

Letter of commitment (SUPPORTING ORGANISATION)

Dr.Andreas Will
BTU Cottbus
LS Umweltmeteorologie
Burger Chaussee 2 , Haus 4/3
D-03044 Cottbus
Tel.: +49-355-69-1171,
Fax: +49-355-69-1128
e-Mail: will@tu-cottbus.de

Brandenburgische
Technische Universität
Cottbus - Senftenberg

To
Dr Joachim Biercamp
Coordinator of ESiWACE

Letter of Commitment

Dear Dr. Biercamp,

With this letter we like to express our fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding.
I represent the Climate Limited area Modelling (CLM-) Community (www.clm-community.eu) which is an international network of scientistst for further development and application of the state of the art regional climate model COSMO-CLM. The COSMO-CLM is the climate mode of the NWP model of the COSMO consortium. The capability of atmosphere-atmosphere, atmosphere-ocean and atmosphere-soil 2-way coupling via OASIS3-MCT makes it a regional climate system model.

Our commitment includes the following elements:

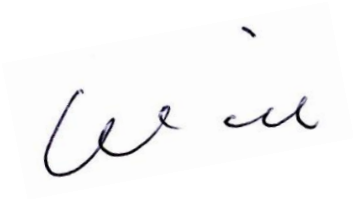
- Engage in fostering cooperation between ESiWACE and the CLM-Communit in the field of scalability and usability of COSMO-CLM.
- Dr. Klaus Keuler, BTU Cottbus, will be the contact person for aspects related to conduction, analysis and data storage of community scenario simulations.
- Dr. Andreas Will, BTU Cottbus, will be the contact person for aspects related to the application of the fully coupled climate system model via OASIS3-MCT.
- Participate and contribute to workshops on HPC for weather/climate modeling
- Dr. Andreas Will will act as contact point and respond to interviews or questionnaires on user requirements.
- Interested by the support of ESIWACE on models NEMO/ICON, the OASIS coupler and developments for data management.
- Interested to participate to evaluations or intercomparisons of some of the software supported or developed by ESIWACE (I/O server/ coupler / dynamical core) by attending workshops and proposing relevant test cases.
- Supporting ESiWACE in dissemination results to our community through our community coordination office.

Letter of commitment (SUPPORTING ORGANISATION)

We are happy to provide any additional information on your commitment to the project upon your request or request of the European Commission.

We are looking forward to work together with you in this exciting project!

Sincerely yours,



(Dr. Andreas Will)

7 January 2015

To
Dr Joachim Biercamp
Coordinator of ESiWACE

Danish Meteorological Institute

Lyngbyvej 100
DK-2100 Copenhagen Ø

T +45 3915 7500
F +45 3927 1080

www.dmi.dk
epost@dmi.dk

CVR 1815 9104
EAN 5798000893252

DANISH MINISTRY OF CLIMATE, ENERGY AND BUILDING

Letter of Commitment

Dear Dr. Biercamp,

With this letter we would like to express our commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1, should the project be selected for funding.

DMI is an institution under the Danish Ministry of Climate, Energy and Building. DMI is the national meteorological institute of Denmark and Greenland. DMI has a solid and long-lasting experience in developing and operating atmospheric models for weather and climate applications, with special emphasis on predicting regional weather and climate. DMI has strong collaborative links with the international meteorological communities in Europe and is a member of the HIRLAM NWP consortium. Our commitment includes

- Exchange of information and guidance where ESiWACE overlaps with the ongoing activities at DMI. This includes central topics of ESiWACE, i.e., *Scalability, Usability* and *Exploitability.* Relevant issues coming up through collaboration in the HIRLAM consortium will be communicated to ESiWACE when appropriate.
- Participation in ESiWACE workshops
- Evaluation of selected activities given the needs of DMI
- Contribution to strategic discussions on software, high performance computing and data management developments.

We are happy to provide any additional information on our DMI commitment to the project upon your request or the request from the European Commission. The contact point is senior scientist Bent Hansen Sass.(e-mail: bhs@dmi.dk).

Yours sincerely

Dr. Katrine Krogh Andersen
Dir. of Research and Development , DMI

Rensselaer
TWC
EARTH AND ENVIRONMENTAL SCIENCE
COMPUTER SCIENCE
COGNITIVE SCIENCE
INFORMATION TECHNOLOGY AND WEB SCIENCE

December 30, 2014

Dr Joachim Biercamp
Coordinator of ESiWACE

Letter of Commitment

Dear Dr. Biercamp,

With this letter we express our fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding.

The Tetherless World Constellation (TWC) at Rensselaer Polytechnic Institute (RPI) is a constellation of multidisciplinary researchers who study the scientific and engineering principles that underlie the Web, to enhance the Web's reach beyond the desktop and laptop computer, and develops new technologies and languages that expand the capabilities of the Web under three themes: Future Web, Xinformatics and Semantic Foundations. Our specific interest in ESIWACE surrounds our long-standing efforts in climate and environmental informatics applications and involvement in the Earth System Grid Federation, and current attention to the U.S. Global Change Information System and the NOAA Marine Fisheries Integrated Ecosystem Assessment Interoperability Initiative.

Our commitment includes the following elements:

- Engage in fostering cooperation between ESiWACE and our projects indicated above.
- Participate and contribute to workshops on HPC for weather/climate modeling
- Prof. Peter Fox will act as contact point and respond to interviews or questionnaires on user requirements
- Interest in the support of ESIWACE on models (EC-EARTH/NEMO/ICON), tools (OASIS coupler, XIOS, CYLC …) and developments for data management
- Interest to participate to evaluations or intercomparisons of software supported or developed by ESIWACE (software stack, (I/O server/ coupler / dynamical core) by attending workshops and proposing relevant test cases.
- Supporting ESiWACE in dissemination of results to our institution.

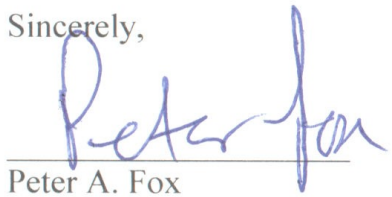
Science Advisory Board:

- Professor Peter Fox declares his availability to act as member of the scientific advisory board of ESiWACE. In this capacity he would bring expertise in the field(s) of ocean and environmental informatics, computational and computer science, and semantic data frameworks to the project. More details on Dr. Fox are available at: http://tw.rpi.edu/web/person/PeterFox.

Tetherless World Constellation, Rensselaer Polytechnic Institute
110 8th Street, Troy, NY 12180-3590 | Winslow
Email: pfox@cs.rpi.edu, foxp@rpi.edu, Phone (518) 276-4862 | Fax (518) 276-4464 tw.rpi.edu/web/Person/PeterFox

Rensselaer | TWC
EARTH AND ENVIRONMENTAL SCIENCE
COMPUTER SCIENCE
COGNITIVE SCIENCE
INFORMATION TECHNOLOGY AND WEB SCIENCE

Sincerely,



Peter A. Fox
Professor of Earth and Environmental Science,
Computer Science and Cognitive Science
Tetherless World Constellation Chair
Director, IT and Web Science Program

Tetherless World Constellation, Rensselaer Polytechnic Institute
110 8th Street, Troy, NY 12180-3590 | Winslow
Email: pfox@cs.rpi.edu, foxp@rpi.edu, Phone (518) 276-4862 | Fax (518) 276-4464 tw.rpi.edu/web/Person/PeterFox

CHARLES UNIVERSITY PRAGUE
faculty of mathematics and physics

To
Dr Joachim Biercamp
Coordinator of ESiWACE

Letter of Commitment

Dear Dr. Biercamp,

With this letter we like to express our fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding.
We are interested and actively contributing to the numerical modelling of the atmospheric processes, especially with the emphasisi to the regional dynamical downscalilng of climate simulations and the development of ESM in regional scale. From this point of view we are interested in some aspects of the ESiWACE project.

Our commitment includes the following elements:

- Participate and contribute to workshops on HPC for weather/climate modeling
- Doc. RNDr. Tomas Halenka, CSc. and Mgr. Michal Belda, Ph.D. will act as contact point and they will respond to interviews or questionnaires on user requirements
- Interested by the support of ESIWACE on models (EC-EARTH/NEMO/ICON), tools (OASIS coupler, XIOS, CYLC ...) and developments for data management
- Interested to participate to evaluations or intercomparisons of some of the software supported or developed by ESIWACE (software stack, (I/O server/ coupler / dynamical core) by attending workshops and proposing relevant test cases.
- Supporting ESiWACE in dissemination results to our institution.

We are happy to provide any additional information on our commitment to the project upon your request or request of the European Commission.

We are looking forward to work together with you in this exciting project!

Sincerely yours,

Doc. RNDr. Petr Pišoft, Ph. D.

Department of Atmospheric Physics
V Holešovičkách 2, 182 00 Praha 8
phone: +420 22191 2547
fax: +420 22191 2533
e-mail: kmop@mff.cuni.cz

Leibniz Supercomputing Centre
of the Bavarian Academy of Sciences and Humanities

Leibniz Supercomputing Centre, Boltzmannstr. 1, 85748 Garching b. München, Germany

Dr. Joachim Biercamp
Deutsches Klimarechenzentrum
Bundesstraße 45a
20146 Hamburg
Germany

Prof. Dr. Arndt Bode
Phone: +49 89 35831-8700
Telefax: +49 89 35831-7000
E-Mail: arndt.bode@lrz.de

Subject: Letter of Support

Garching, January 9, 2015

Project: ESiWaCE – Excellency in the Simulation of Weather and Climate in Europe

Dear Dr. Biercamp,

On behalf of the partner consortium pursuing a “Centre of Excellence for Environmental Computing Application Software” (EnCompAS) I would like to express my strong support for the collaborative initiative towards establishing the European project

ESiWaCE – Excellency in the Simulation of Weather and Climate in Europe

under the European funding instrument H2020-EINFRA-2015-1 call “EINFRA-5-2015: Centres of Excellence for computing applications”.

ESiWaCE will focus on the support of the end-to-end workflow of global climate and weather models, whereas EnCompAS will target HPC software addressing environmental issues on a local or regional scope, related to e.g., the investigation of natural disasters, sustainability management, or renewable energy sources.

Therefore, the existence of both Centres of Excellence will cover the largest part of the very extensive area of environmental science. We are convinced that funding both centres simultaneously will have an extraordinary impact on high-demand software in environmental science with international scope.

The EnCompAS centre is prepared to intensively collaborate with the ESiWaCE centre. To foster this collaboration, both centres will be mutually represented in each other’s advisory board.

The EnCompAS partners are LRZ, KIT, FhG-SCAI (Germany), CSC, Univ. Helsinki (Finland), SURFsara, NLeSC, KNMI, EGI.eu (The Netherlands).

Yours sincerely

Prof. Dr. Arndt Bode
Director of the LRZ

6300 CREEDMOOR ROAD, SUITE 170-315 • RALEIGH, NC 27612 • WWW.EARTHSCIENCEFOUNDATION.ORG | ESIPFED.ORG

January 9, 2015

Erin Robinson
Foundation for Earth Science

Peter Fox
Federation of Earth Science Information Partners

Dear Dr. Biercamp,

With this letter we express our fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding on behalf of the Federation of Earth Science Information Partners (ESIP) and the management arm, the Foundation for Earth Science (FES).

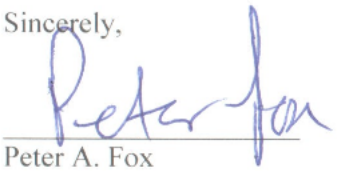
The ESIP Federation is an open networked community that brings together science, data and information technology practitioners. In this forum, practitioners work together on interoperability efforts across Earth and environmental science allowing self-governed and directed groups to emerge around common issues, ebbing and flowing as the need for them arises. These efforts catalyze connections across organizations, people, systems and data allowing for improved interoperability in distributed systems. By virtue of working in the larger community, ESIP members experience the network effect, which enables more coordinated cyberinfrastructure across domain-specific communities.

Our support includes the following elements:
· Engage in fostering cooperation between ESiWACE and our projects indicated above.
· Participate and contribute to workshops on HPC for weather/climate modeling
· Ms. Erin Robinson will act as contact point and respond to interviews or questionnaires on user requirements
· Interest in the support of ESIWACE on models (EC-EARTH/NEMO/ICON), tools (OASIS coupler, XIOS, CYLC …) and developments for data management
· Interest to participate to evaluations or intercomparisons of software supported or developed by ESIWACE (software stack, (I/O server/ coupler / dynamical core) by attending workshops and proposing relevant test cases.
· Supporting ESiWACE in dissemination of results to our organization.

ESIP has a 15-year track record, using an open, community-based approach to work on application efforts like this. We look forward to working with you to leverage ESIP on this project.

Sincerely,
Erin Robinson
Erin Robinson
Executive Director, FES

Peter Fox
President, ESIP



Letter of commitment (MESSy Consortium)

MESSy Consortium
Münchner Strasse 20
82234 Weßling
Patrick Jöckel (speaker of the consortium)

Phone: +49-(0)-8153 282565
Fax: +49-(0)-8153 281841
E-mail: Patrick.Joeckel@dlr.de

To
Dr Joachim Biercamp
Coordinator of ESiWACE

Letter of Commitment

Dear Dr. Biercamp,

With this letter we like to express our fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding.

The MESSy Consortium (http://www.messy-interface.org) comprises currently 14 research institutions and universities and aims at integrating the by now distributed knowledge and methodologies of the earth system science and climate research communities into a joint Earth System Model of flexible complexity, which combines a global and a limited area model two-way nested into the global model coupled to an ocean model, different algorithmic approaches and various alternative process formulations. By this, the MESSy Consortium builds up and applies a continuously growing, comprehensive but consistent chemistry-climate model system enabling numerical modelling of different atmospheric processes over different scales and considering all atmospheric layers from the troposphere up to the thermosphere. To achieve this goal, the MESSy Consortium makes use of the MESSy infrastructure.
ESiWACE appears to be a suitable platform to continuously further develop and improve our model infrastructure.

Our commitment includes the following elements:

- Engage in fostering cooperation between ESiWACE and our various development projects
- Participate and contribute to workshops on HPC for weather/climate modeling
- Name one or more persons / organisational units to act as contact point and to respond to interviews or questionnaires on user requirements
- Interested by the support of ESiWACE on models (EMAC, MECO(n), ICON), model infrastructure (MESSy) and developments for data management
- Interested to participate to evaluations or intercomparisons of some of the software supported or developed by ESiWACE (software stack, (I/O server/ coupler / dynamical core) by attending workshops and proposing relevant test cases.

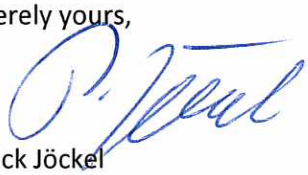
Letter of commitment (MESSy Consortium)

- Supporting ESiWACE in dissemination results to our consortium.

We are happy to provide any additional information on your commitment to the project upon your request or request of the European Commission.

We are looking forward to work together with you in this exciting project!

Sincerely yours,



Patrick Jöckel

CSCS
Centro Svizzero di Calcolo Scientifico
Swiss National Supercomputing Centre

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Prof. Dr. Thomas C. Schulthess
CSCS
Via Trevano 131
6900 Lugano
Switzerland

To
Dr. Joachim Biercamp
Coordinator of ESiWaCE

January 13, 2014

Letter of Commitment

Dear Dr. Biercamp:

With this letter we would like to express our fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1, should the project be selected for funding.

The Swiss National Supercomputing Centre (CSCS) develops and provides key supercomputing capabilities to solve challenging problems in science and/or society. The centre enables world-class research with a scientific User Laboratory that is available to domestic and international researchers through a transparent, peer-reviewed allocation process. The resources of CSCS are available to users from the academia, as well as from the industry and the business sector.

CSCS, in collaboration with MeteoSwiss, is presently at the cutting edge with the development of special-purpose computing systems (appliances) for numerical weather predictions (NWP). The centre is in the process of deploying the first GPU-based NWP appliance that will be an order of magnitude more energy efficient than current state of the art supercomputers, and that will be used for operational weather predictions by MeteoSwiss in January 2016. The NWP appliance is the result of a multi-year co-design effort between CSCS, MeteoSwiss and the Centre for Climate Systems Modelling (C2SM) with the industrial partners NVIDIA and Cray.

Considering this background in co-design, CSCS is naturally interested in the successful development of the Weather and Climate simulations communities worldwide, and in particular the proposed Center of Excellence ESiWaCE for the European community. CSCS commitment includes the following elements:

- Engagement in fostering cooperation between ESiWaCE and CSCS projects funded by the Swiss initiative for High-Performance Computing and Networking (HPCN), and especially the Platform for Advanced Scientific Computing (PASC) that has been funding the specific

application developments necessary for the NWP appliance described above. PASC continues to support the development of follow-on software systems, such as GridTools, a domain specific library/language (DSL) that is embedded in the C++ template meta-programming framework, as well as structured or block-structures grids used in NWP and climate simulations. These efforts are complementary to ESiWaCE and the resulting software is available to the Center of Excellence.

- Participation in and contribution to workshops on HPC for weather/climate modeling
- Member of CSCS Community Engagement Group Dr. Will Sawyer, in charge of supporting the climate and NWP community, is actively involved in the development of COSMO and ICON. He will act as contact point and respond to interviews or questionnaires on user requirements.
- Interest in the support of ESIWaCE models (ICON), tools (OASIS coupler) and developments for data management.
- Interest to participate in evaluations or inter comparisons of some of the software supported or developed by ESiWaCE by attending workshops and proposing relevant test cases.
- Support ESiWaCE in the dissemination of results within our institution.

Furthermore, I assert my availability to act as member of the scientific advisory board of ESiWaCE. In this capacity I would bring my expertise in the field of supercomputing and the development/co-design of highly efficient solution to exascale challenges based on emerging technologies.

I remain available to provide any additional information regarding our commitment to the project upon your request or the request of the European Commission.

We look forward to working together on this exciting project!

Sincerely yours,

Prof. Dr. Thomas C. Schulthess
Professor of Computational Physics and Director of the Swiss National Supercomputing Centre
schulthess@cscs.ch
+41 79 758 24 15

CSCS
Centro Svizzero di Calcolo Scientifico
Swiss National Supercomputing Centre

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service
National Centers for Environmental Prediction
5830 University Research Court, Suite 2050, W/NP
College Park, MD 20740

Dr Joachim Biercamp
Coordinator of ESiWACE

Letter of Commitment

Dear Dr. Biercamp,

We are writing to express our willingness to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding. Although outside the EC, the Environmental Modeling Center of the NOAA National Centers for Environmental Prediction in the U.S. National Weather Service is vitally concerned with continued progress towards leveraging new generations of HPC hardware for operational numerical weather prediction software and data management and analysis systems on new generations of high-performance computing hardware. Specifically, the U.S. National Weather Service is undertaking a $US 15M, 5-year effort to develop our Next Generation Global Prediction System to meet evolving national requirements over the next 15-20 years in global high-resolution weather prediction, high-impact weather such as hurricanes and severe storms, extending forecast skill to 30 days and seasonal climate prediction, ensemble based forecasting and data assimilation, and ecosystem modeling. Aspects of your proposal that address computational scalability and usability of HPC hardware and software are of direct interest and the subject of complementary activities within NOAA.

Our commitment includes the following elements:

- Participate and contribute to workshops on HPC for weather/climate modeling,
- Particpate in planning activities to plan for collaboration with your proposal in greater detail,
- John Michalakes, a NOAA-Affiliated HPC Scientific Programmer/Analyst working at EMC, and EMC director Dr. Hendrik Tolman will serve as technical and administrative points of contact, respectively, to respond to interviews or questionnaires on user requirements.

We are happy to provide any additional information on your commitment to the project upon your request or request of the European Commission.

We are looking forward to working together with you in this exciting project!

Sincerely yours,

Dr. Hendrik L. Tolman
Director
Environmental Modeling Center

Institute of Atmospheric Physics

Deutsches Zentrum
für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

German Aerospace Center

DLR Institute of Atmospheric Physics
Oberpfaffenhofen, Postfach 11 16, 82230 Weßling, Germany

Dr. Joachim Biercamp
Coordinator of ESiWACE
Deutsches Klimarechenzentrum GmbH (DKRZ)
Bundesstraße 45a
20146 Hamburg
Germany

Your reference Germany
Your letter
Our reference

Your correspondent PD Dr. habil. Veronika Eyring

Telephone +49 8153 28- 2533
Telefax +49 8153 28- 1841
E-mail veronika.eyring@dlr.de

14 January 2015

Dear Dr Biercamp,

I am writing to you as chair of the Coupled Model Intercomparison Project (CMIP) Panel to confirm my strong support for the proposal ESiWACE submitted to the EC under the Horizon 2020 e-Infrastructures call H2020-EINFRA-2015-1. Earth System modelling activities are internationally coordinated through CMIP which has characterized the evolution and progress of climate science since the World Climate Research Programme (WCRP) Working Group on Coupled Models (WGCM) organized the first CMIP phase in the mid-1990s. The objective of CMIP is to document and provide understanding of past, present and future climate variability and change through a coordinated international multi-model experiment design.

CMIP activities are international and require the broad support of the international community if they are to succeed. Overall, the CMIP5 simulations were performed by more than 40 different models or versions of models. This multi-model community ensemble has created an enormous resource and enabled a large amount of science. It is because of this international scope that CMIP initiatives have provided such critical input into the IPCC Assessment Report processes.

At this moment the climate community is actively engaged in preparing for the 6th Phase of CMIP (CMIP6) which will feed into the next round of assessments. There is now a growing number of Earth System Models (ESMs) participating in CMIP that can simulate a large range of physical and biogeochemical climate feedbacks. The growing complexity and data production of ESMs and the needs of the CMIP user community call for further infrastructure improvements supporting data services, model evaluation and analysis. Ongoing support is required to maintain the existing infrastructure framework and to enhance it to meet CMIP6's new demands. One naturally looks at the European Network for Earth system modelling (ENES) to play a leading role in providing a European infrastructure for CMIP climate simulations. The proposed three central topics of ESiWACE that will improve scalability, usability, and exploitability of the data are expected to make a unique contribution in this regard.

I will therefore work together towards a strongly cooperative exchange between your group and CMIP so that the goal of a sustained and improved infrastructure for CMIP6 and future phases can be reached.

Yours sincerely,

Veronika Eyring

Veronika Eyring (*Senior Scientist at DLR and CMIP Panel Chair)*

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Dr Joachim Biercamp
Coordinator of ESiWACE
Deutsches Klimarechenzentrum GmbH

Bundesstr. 45a
D-20146 Hamburg

14.01.2015
Letter of Commitment

Dear Dr Biercamp,

With this letter we like to express our fullest commitment to engage in the project ESiWACE submitted to the EC under the call H2020-EINFRA-2015-1 should the project be selected for funding.
The Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI) carries out Polar and Marine research as central themes of Global system and Environmental Science. AWI has high expertise in numerical simulations of coupled ocean-ice-atmosphere system and model development. Therefore we expect essential support of our research activities from the planned Center of Excellence ESiWACE with respect to scalability of our model codes and efficient data handling.

Our commitment includes the following elements:

- Engage in fostering cooperation between ESiWaCE and AWI, Scientific Computing Group with respect to scalability and usability especially for our FESOM model
- Participate and contribute to workshops on HPC for weather/climate modeling
- Dr. Bernadette Fritzsch will act as contact point and to respond to interviews or questionnaires on user requirements
- Interested by the support of ESiWaCE on OASIS coupler and developments for data management
- Interested to participate to evaluations or inter comparisons of some of the software supported or developed by ESiWaCE (software stack, (I/O server/ coupler / dynamical core) by attending workshops and proposing relevant test cases.

Prof. Dr. Wolfgang Hiller

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HELMHOLTZ-ZENTRUM FÜR POLAR-
UND MEERESFORSCHUNG

We are happy to provide any additional information on your commitment to the project upon your request or request of the European Commission.

We are looking forward to work together with you in this exciting project!

Sincerely yours,

W. Hiller

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