

Please check our [wiki](#) for help on navigating the form.

Horizon 2020

Call: H2020-LC-CLA-2018-2019-2020

(Building a low-carbon, climate resilient future: climate action in support of the Paris Agreement)

Topic: LC-CLA-08-2018

Type of action: RIA

Proposal number: SEP-210489744

Proposal acronym: FORCeS

Deadline Id: H2020-LC-CLA-2018-2

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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 steps in the submission wizard.

1 - General information

Topic	LC-CLA-08-2018	Type of Action	RIA
Call Identifier	H2020-LC-CLA-2018-2019-2020	Deadline Id	H2020-LC-CLA-2018-2

Acronym **FORCeS**

Proposal title **Constrained aerosol forcing for improved climate projections**

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 **Climatology and climate change**

Fixed keyword 2 **Atmospheric chemistry, atmospheric composition, air pollution**

Fixed keyword 3 **Meteorology, atmospheric physics and dynamics**

Free keywords **Radiative forcing, Earth system models, climate policy, air pollution policy, climate sensitivity, climate projections**

Abstract

The overall objective of FORCeS is to understand and reduce the long-standing uncertainty in anthropogenic aerosol radiative forcing, which is crucial in order to increase confidence in climate projections. These projections are highly relevant for decision makers, as they provide key information on emission pathways that will facilitate the targets of the Paris Agreement to be achieved. FORCeS will identify key processes governing aerosol radiative forcing, as well as climate feedbacks related to aerosols and clouds, and improve the knowledge about these processes by bringing together leading European scientists with trans-disciplinary expertise to i) exploit the wealth of in-situ and remote sensing data that have emerged during the recent decades; ii) perform dedicated laboratory and field experiments; iii) utilize a range of state-of-the-art computational models; and iv) apply novel theoretical methods including machine learning techniques. The process analysis within FORCeS will be conducted with the overall aim of improving a set of leading European climate models, which all provide essential information to climate assessments such as the IPCC report. The gap between knowledge on the process scale and model application on the climate scale is currently a main reason preventing the climate science community to move forward in terms of understanding the role of aerosols and aerosol-cloud interactions in the climate system. FORCeS will bridge this knowledge gap using systematically designed scale chains that involve methodologies for constraining processes on scales ranging from hours to decades, ultimately leading to the desired refinement of model-estimated aerosol forcing and climate sensitivity. FORCeS will reach out to decision makers and stakeholders and provide added-value information through e.g. workshops where climate science and climate policy experts meet to achieve maximum impact.

Remaining characters

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Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym **FORCeS**

Has this proposal (or a very similar one) been submitted in the past 2 years in response to a call for proposals under Horizon 2020 or any other EU programme(s)?

Yes No

Please give the proposal reference or contract number.

XXXXXX-X

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym **FORCeS**

Declarations

1) The coordinator declares to have the explicit consent of all applicants on their participation and on the content of this proposal.	<input checked="" type="checkbox"/>
2) The information contained in this proposal is correct and complete.	<input checked="" type="checkbox"/>
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).	<input checked="" type="checkbox"/>
4) The coordinator confirms:	
- to have carried out the self-check of the financial capacity of the organisation on http://ec.europa.eu/research/participants/portal/desktop/en/organisations/lfv.html or to be covered by a financial viability check in an EU project for the last closed financial year. 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	<input checked="" type="radio"/>
- 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	<input type="radio"/>
- as sole participant in the proposal is exempt from the financial capacity check.	<input type="radio"/>
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	<input checked="" type="checkbox"/>
- they have the financial and operational capacity to carry out the proposed action.	<input checked="" type="checkbox"/>
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

The assessment of your grant application will involve the collection and processing of personal data (such as your name, address and CV), which will be performed 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 purposes and means of the processing of your personal data as well as information on how to exercise your rights are available in 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 Detection and Exclusion system of the European Commission (EDES), the new system established by the Commission to reinforce the protection of the Union's financial interests and to ensure sound financial management, in accordance with the provisions of articles 105a and 108 of the revised EU Financial Regulation (FR) (Regulation (EU, EURATOM) 2015/1929 of the European Parliament and of the Council of 28 October 2015 amending Regulation (EU, EURATOM) No 966/2012) and articles 143 - 144 of the corresponding Rules of Application (RAP) (COMMISSION DELEGATED REGULATION (EU) 2015/2462 of 30 October 2015 amending Delegated Regulation (EU) No 1268/2012) for more information see the [Privacy statement for the EDES Database](#).

2 - Participants & contacts

#	Participant Legal Name	Country	Action
1	STOCKHOLMS UNIVERSITET	Sweden	
2	EIDGENOESSISCHE TECHNISCHE HOCHSCHULE ZUERICH	CH	
3	KARLSRUHER INSTITUT FUER TECHNOLOGIE	DE	
4	FOUNDATION FOR RESEARCH AND TECHNOLOGY HELLAS	EL	
5	KONINKLIJK NEDERLANDS METEOROLOGISCH INSTITUUT-KNMI	NL	
6	UNIVERSITAET LEIPZIG	DE	
7	HELSINGIN YLIOPISTO	FI	
8	CONSIGLIO NAZIONALE DELLE RICERCHE	IT	
9	BARCELONA SUPERCOMPUTING CENTER - CENTRO NACIONAL DE SUPERCOMPUTACION	ES	
10	METEOROLOGISK INSTITUTT	NO	
11	ITA-SUOMEN YLIOPISTO	FI	
12	UNIVERSITY OF LEEDS	UK	
13	UNIVERSITETET I OSLO	NO	
14	FORSCHUNGSZENTRUM JULICH GMBH	DE	
15	THE CHANCELLOR, MASTERS AND SCHOLARS OF THE UNIVERSITY OF OXFORD	UK	
16	ILMATIETEEN LAITOS	FI	
17	SVERIGES METEOROLOGISKA OCH HYDROLOGISKA INSTITUT	SE	
18	NATURVARDSVERKET	SE	
19	INSTITUT NATIONAL DE L ENVIRONNEMENT ET DES RISQUES INERIS	FR	
20	INTERNATIONALES INSTITUT FUER ANGEWANDTE SYSTEMANALYSE	AT	

2 - Administrative data of participating organisations

PIC	Legal name
999885022	STOCKHOLMS UNIVERSITET

Short name: STOCKHOLMS UNIVERSITET

Address of the organisation

Street Universitetsvaegen 10

Town STOCKHOLM

Postcode 10691

Country Sweden

Webpage www.su.se

Legal Status of your organisation

Research and Innovation legal statuses

Public bodyyes

Legal personyes

Non-profityes

International organisationunknown

International organisation of European interestunknown

Industry (private for profit).....no

Secondary or Higher education establishmentyes

Research organisationyes

Enterprise Data

SME self-declared status..... unknown

SME self-assessment unknown

SME validation sme..... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **STOCKHOLMS UNIVERSITET**

Department(s) carrying out the proposed work

Department 1

Department name

Department of Meteorology (MISU)

not applicable

Same as proposing organisation's address

Street

Universitetsvägen 10A

Town

Sockholm

Postcode

106 91

Country

Sweden

Department 2

Department name

Department of Environmental Science and Analytical Chemistry

not applicable

Same as proposing organisation's address

Street

Svante Arrhenius väg 8,

Town

Stockholm

Postcode

11418

Country

Sweden

Dependencies with other proposal participants

Character of dependence	Participant	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **STOCKHOLMS UNIVERSITET**

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

Sex

Male

Female

First name **Ilona**

Last name **Riipinen**

E-Mail **ilona.riipinen@aces.su.se**

Position in org.

Department

Same as organisation name

Same as proposing organisation's address

Street

Town

Post code

Country

Website

Phone

Phone 2

Fax

Other contact persons

First Name	Last Name	E-mail	Phone
Anna-Karin	Tidén	anna-karin.tiden@su.se	+648161706
Tanja	Dallafior	tanja.dallafior@aces.su.se	+6486747642
Annica	Ekman	annica@misu.su.se	+648162397
Claudia	Mohr	claudia.mohr@aces.su.se	+6486747549

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **ETH Zürich**

PIC 999979015 **Legal name** EIDGENOESSISCHE TECHNISCHE HOCHSCHULE ZUERICH

Short name: ETH Zürich

Address of the organisation

Street Raemistrasse 101

Town ZUERICH

Postcode 8092

Country Switzerland

Webpage www.ethz.ch

Legal Status of your organisation

Research and Innovation legal statuses

Public bodyyes

Legal personyes

Non-profityes

International organisationno

International organisation of European interestno

Industry (private for profit).....no

Secondary or Higher education establishmentyes

Research organisationyes

Enterprise Data

SME self-declared status.....06/01/2009 - no

SME self-assessment unknown

SME validation sme.....06/01/2009 - no

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **ETH Zürich**

Department(s) carrying out the proposed work

Department 1

Department name

Institute for Atmospheric and Climate Science

not applicable

Same as proposing organisation's address

Street

Raemistrasse 101

Town

ZUERICH

Postcode

8092

Country

Switzerland

Dependencies with other proposal participants

Character of dependence	Participant	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **ETH Zürich**

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

Sex

Male

Female

First name **Ulrike**

Last name **Lohmann**

E-Mail **ulrike.lohmann@env.ethz.ch**

Position in org.

Department

Same as organisation name

Same as proposing organisation's address

Street

Town

Post code

Country

Website

Phone

Phone 2

Fax

Other contact persons

First Name	Last Name	E-mail	Phone
Regina E.	Notz	regina.notz@sl.ethz.ch	+XXX XXXXXXXXX
Agatha	Keller	grants@sl.ethz.ch	+XXX XXXXXXXXX

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **KIT**

PIC

990797674

Legal name

KARLSRUHER INSTITUT FUER TECHNOLOGIE

Short name: KIT

Address of the organisation

Street KAISERSTRASSE 12

Town KARLSRUHE

Postcode 76131

Country Germany

Webpage www.kit.edu

Legal Status of your organisation

Research and Innovation legal statuses

Public bodyyes

Legal personyes

Non-profityes

International organisationno

International organisation of European interestno

Industry (private for profit).....no

Secondary or Higher education establishmentyes

Research organisationyes

Enterprise Data

SME self-declared status.....01/10/2009 - no

SME self-assessment unknown

SME validation sme..... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **KIT**

Department(s) carrying out the proposed work

Department 1

Department name

Institute of Meteorology and Climate Research

not applicable

Same as proposing organisation's address

Street

KAISERSTRASSE 12

Town

KARLSRUHE

Postcode

76131

Country

Germany

Dependencies with other proposal participants

Character of dependence	Participant	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **KIT**

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

Sex

Male

Female

First name **Corinna**

Last name **Hoose**

E-Mail **corinna.hoose@kit.edu**

Position in org.

Department

Same as organisation name

Same as proposing organisation's address

Street

Town

Post code

Country

Website

Phone

Phone 2

Fax

Other contact persons

First Name	Last Name	E-mail	Phone
Kristine	Bentz	eu@for.kit.edu	+49 721 608-45192
Almut	Arneth	almut.arneth@kit.edu	+49 8821 183131
Jan	Cermak	jan.cermak@kit.edu	+49 721 608-24510

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **FORTH**

PIC

999995893

Legal name

FOUNDATION FOR RESEARCH AND TECHNOLOGY HELLAS

Short name: FORTH

Address of the organisation

Street N PLASTIRA STR 100

Town HERAKLION

Postcode 70013

Country Greece

Webpage www.forth.gr

Legal Status of your organisation

Research and Innovation legal statuses

Public bodyno

Legal personyes

Non-profityes

International organisationno

International organisation of European interestno

Industry (private for profit).....no

Secondary or Higher education establishmentno

Research organisationyes

Enterprise Data

SME self-declared status.....11/05/2016 - no

SME self-assessment unknown

SME validation sme.....25/09/2008 - no

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **FORTH**

Department(s) carrying out the proposed work

Department 1

Department name

Institute of Chemical Engineering Sciences

not applicable

Same as proposing organisation's address

Street

Stadiou Str., PO Box 1414

Town

Platani, Patras

Postcode

26504

Country

Greece

Dependencies with other proposal participants

Character of dependence	Participant	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **FORTH**

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

Sex

Male Female

First name **Spyros**

Last name **Pandis**

E-Mail **spyros@chemeng.upatras.gr**

Position in org.

Department

Same as organisation name

Same as proposing organisation's address

Street

Town

Post code

Country

Website

Phone

Phone 2

Fax

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **KNMI**

PIC

999518944

Legal name

KONINKLIJK NEDERLANDS METEOROLOGISCH INSTITUUT-KNMI

Short name: KNMI

Address of the organisation

Street UTRECHTSEWEG 297

Town DE BILT

Postcode 3731 GA

Country Netherlands

Webpage www.knmi.nl

Legal Status of your organisation

Research and Innovation legal statuses

Public bodyyes

Legal personyes

Non-profityes

International organisationno

International organisation of European interestno

Industry (private for profit).....no

Secondary or Higher education establishmentno

Research organisationyes

Enterprise Data

SME self-declared status.....15/05/2008 - no

SME self-assessment unknown

SME validation sme.....15/05/2008 - no

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **KNMI**

Department(s) carrying out the proposed work

Department 1

Department name not applicable

Same as proposing organisation's address

Street

Town

Postcode

Country

Dependencies with other proposal participants

<i>Character of dependence</i>	<i>Participant</i>	
<input type="text"/>	<input type="text"/>	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **KNMI**

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 **Twan**

Last name **van Noije**

E-Mail **noije@knmi.nl**

Position in org. Senior scientist

Department R&D Weather and Climate Models

Same as organisation name

Same as proposing organisation's address

Street UTRECHTSEWEG 297

Town DE BILT

Post code 3731 GA

Country Netherlands

Website <http://www.knmi.nl/over-het-knmi/onze-mensen/twan-van-noije>

Phone +31-30-2206562

Phone 2 +xxx xxxxxxxxx

Fax

+31-30-2210407

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **ULEI**

PIC

999854564

Legal name

UNIVERSITAET LEIPZIG

Short name: ULEI

Address of the organisation

Street RITTERSTRASSE 26

Town LEIPZIG

Postcode 04109

Country Germany

Webpage <http://www.uni-leipzig.de>

Legal Status of your organisation

Research and Innovation legal statuses

Public bodyyes

Legal personyes

Non-profityes

International organisationno

International organisation of European interestno

Industry (private for profit).....no

Secondary or Higher education establishmentyes

Research organisationyes

Enterprise Data

SME self-declared status.....31/12/2014 - no

SME self-assessment31/12/2014 - no

SME validation sme..... 11/06/1999 - no

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **ULEI**

Department(s) carrying out the proposed work

Department 1

Department name

Institute for Meteorology

not applicable

Same as proposing organisation's address

Street

Stephanstr. 3

Town

Leipzig

Postcode

04103

Country

Germany

Dependencies with other proposal participants

Character of dependence	Participant	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **ULEI**

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

Sex

Male Female

First name **Johannes**

Last name **Quaas**

E-Mail **johannes.quaas@uni-leipzig.de**

Position in org.

Department

Same as organisation name

Same as proposing organisation's address

Street

Town

Post code

Country

Website

Phone

Phone 2

Fax

Other contact persons

First Name	Last Name	E-mail	Phone
Gerhard	Fuchs	eu@uni-leipzig.de	+49 341 97 35012

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **UHEL**

PIC

999994535

Legal name

HELSINGIN YLIOPISTO

Short name: UHEL

Address of the organisation

Street **FABIANINKATU 33**

Town **HELSINGIN YLIOPISTO**

Postcode **00014**

Country **Finland**

Webpage **www.helsinki.fi**

Legal Status of your organisation

Research and Innovation legal statuses

Public bodyyes

Legal personyes

Non-profityes

International organisationno

International organisation of European interestno

Industry (private for profit).....no

Secondary or Higher education establishmentyes

Research organisationyes

Enterprise Data

SME self-declared status.....09/02/2009 - yes

SME self-assessment unknown

SME validation sme.....09/02/2009 - no

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **UHEL**

Department(s) carrying out the proposed work

Department 1

Department name

Faculty of Science, Institute for Atmospheric and Earth System Re

not applicable

Same as proposing organisation's address

Street

Gustaf Hällströmin katu 2a

Town

University of Helsinki

Postcode

00014

Country

Finland

Dependencies with other proposal participants

Character of dependence	Participant	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **UHEL**

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

Sex

Male Female

First name **Markku**

Last name **Kulmala**

E-Mail **markku.kulmala@helsinki.fi**

Position in org.

Department

Same as organisation name

Same as proposing organisation's address

Street

Town

Post code

Country

Website

Phone

Phone 2

Fax

Other contact persons

First Name	Last Name	E-mail	Phone
Risto	Makkonen	risto.makkonen@helsinki.fi	+358504156796
Tuukka	Petäjä	tuukka.petaja@helsinki.fi	+358504155278
Mikael	Ehn	mikael.ehn@helsinki.fi	+358503199420
Ulrika	Backman	ulrika.backman@helsinki.fi	+358504487524

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **CNR**

PIC

999979500

Legal name

CONSIGLIO NAZIONALE DELLE RICERCHE

Short name: CNR

Address of the organisation

Street PIAZZALE ALDO MORO 7

Town ROMA

Postcode 00185

Country Italy

Webpage www.cnr.it

Legal Status of your organisation

Research and Innovation legal statuses

Public bodyyes

Legal personyes

Non-profityes

International organisationno

International organisation of European interestno

Industry (private for profit).....no

Secondary or Higher education establishmentno

Research organisationyes

Enterprise Data

SME self-declared status.....18/05/2016 - no

SME self-assessment unknown

SME validation sme.....05/12/2008 - no

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **CNR**

Department(s) carrying out the proposed work

Department 1

Department name not applicable

Same as proposing organisation's address

Street

Town

Postcode

Country

Dependencies with other proposal participants

Character of dependence	Participant	
<input type="text"/>	<input type="text"/>	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **CNR**

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 **Cristina**

Last name **Facchini**

E-Mail **mc.facchini@isac.cnr.it**

Position in org.

Director of Research

Department

Institute of Atmospheric Sciences and Climate (ISAC)

Same as organisation name

Same as proposing organisation's address

Street

Via Gobetti 101

Town

Bologna

Post code

40129

Country

Italy

Website

<http://www.isac.cnr.it/en/users/maria-cristina-facchini>

Phone

+390516399563

Phone 2

+xxx xxxxxxxxx

Fax

+xxx xxxxxxxxx

Other contact persons

First Name	Last Name	E-mail	Phone
Stefano	Decesari	s.decesari@isac.cnr.it	+390516399560

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **BSC**

PIC

999655520

Legal name

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 bodyyes

Legal personyes

Non-profityes

International organisationno

International organisation of European interestno

Industry (private for profit).....no

Secondary or Higher education establishmentno

Research organisationyes

Enterprise Data

SME self-declared status.....01/03/2005 - no

SME self-assessment unknown

SME validation sme..... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **BSC**

Department(s) carrying out the proposed work

Department 1

Department name

Earth Science Department

not applicable

Same as proposing organisation's address

Street

NEXUS II building, Jordi Girona 29

Town

Barcelona

Postcode

08034

Country

Spain

Dependencies with other proposal participants

Character of dependence	Participant	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **BSC**

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 **Carlos**

Last name **Perez Garcia-Pando**

E-Mail **carlos.perez@bsc.es**

Position in org.

Department

Same as organisation name

Same as proposing organisation's address

Street

Town

Post code

Country

Website

Phone

Phone 2

Fax

Other contact persons

First Name	Last Name	E-mail	Phone
Mar	Rodríguez	mar.rodriguez@bsc.es	+34 93 413 75 66

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **METEOROLOGISK INSTITUTT**

PIC

999510893

Legal name

METEOROLOGISK INSTITUTT

Short name: METEOROLOGISK INSTITUTT

Address of the organisation

Street HENRIK MOHNS PLASS 1

Town OSLO

Postcode 0313

Country Norway

Webpage www.met.no

Legal Status of your organisation

Research and Innovation legal statuses

Public bodyyes

Legal personyes

Non-profityes

International organisationno

International organisation of European interestno

Industry (private for profit).....no

Secondary or Higher education establishmentno

Research organisationyes

Enterprise Data

SME self-declared status.....12/03/1995 - no

SME self-assessment unknown

SME validation sme.....12/03/1995 - no

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **METEOROLOGISK INSTITUTT**

Department(s) carrying out the proposed work

Department 1

Department name

Research and Development Division

not applicable

Same as proposing organisation's address

Street

HENRIK MOHNS PLASS 1

Town

OSLO

Postcode

0313

Country

Norway

Dependencies with other proposal participants

<i>Character of dependence</i>	<i>Participant</i>	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **METEOROLOGISK INSTITUTT**

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 **Michael**

Last name **Schulz**

E-Mail **michaels@met.no**

Position in org. Co-leader Research Group

Department Research and Development Division

Same as organisation name

Same as proposing organisation's address

Street HENRIK MOHNS PLASS 1

Town OSLO

Post code 0313

Country Norway

Website <https://www.met.no/>

Phone +4722963330

Phone 2 +xxx xxxxxxxxx

Fax +xxx xxxxxxxxx

Other contact persons

First Name	Last Name	E-mail	Phone
Per Helmer	Skaali	perhs@met.no	+4722963318

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **University of Eastern Finland (UEF)**

PIC

991207984

Legal name

ITA-SUOMEN YLIOPISTO

Short name: University of Eastern Finland (UEF)

Address of the organisation

Street YLIOPISTONRANTA 1 E

Town KUOPIO

Postcode 70211

Country Finland

Webpage www.uef.fi

Legal Status of your organisation

Research and Innovation legal statuses

Public bodyyes

Legal personyes

Non-profityes

International organisationno

International organisation of European interestno

Industry (private for profit).....no

Secondary or Higher education establishmentyes

Research organisationyes

Enterprise Data

SME self-declared status.....09/09/2009 - no

SME self-assessment09/09/2009 - no

SME validation sme..... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **University of Eastern Finland (UEF)**

Department(s) carrying out the proposed work

Department 1

Department name

Department of Applied Physics

not applicable

Same as proposing organisation's address

Street

YLIOPISTONRANTA 1 E

Town

KUOPIO

Postcode

70211

Country

Finland

Dependencies with other proposal participants

Character of dependence	Participant	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **University of Eastern Finland (UEF)**

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

Sex

Male

Female

First name **Annele**

Last name **Virtanen**

E-Mail **annele.virtanen@uef.fi**

Position in org.

Department

Same as organisation name

Same as proposing organisation's address

Street

Town

Post code

Country

Website

Phone

Phone 2

Fax

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **UNIVLEEDS**

PIC

999975426

Legal name

UNIVERSITY OF LEEDS

Short name: UNIVLEEDS

Address of the organisation

Street WOODHOUSE LANE

Town LEEDS

Postcode LS2 9JT

Country United Kingdom

Webpage www.leeds.ac.uk

Legal Status of your organisation

Research and Innovation legal statuses

Public bodyyes

Legal personyes

Non-profityes

International organisationno

International organisation of European interestno

Industry (private for profit).....no

Secondary or Higher education establishmentyes

Research organisationno

Enterprise Data

SME self-declared status.....31/07/2015 - no

SME self-assessment31/07/2015 - no

SME validation sme..... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **UNIVLEEDS**

Department(s) carrying out the proposed work

Department 1

Department name

School of Earth and Environment

not applicable

Same as proposing organisation's address

Street

WOODHOUSE LANE

Town

LEEDS

Postcode

LS2 9JT

Country

United Kingdom

Dependencies with other proposal participants

Character of dependence	Participant	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **UNIVLEEDS**

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

Sex

Male Female

First name **Ken**

Last name **Carslaw**

E-Mail **k.s.carslaw@leeds.ac.uk**

Position in org.

Department

Same as organisation name

Same as proposing organisation's address

Street

Town

Post code

Country

Website

Phone

Phone 2

Fax

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **UNIVERSITY OF OSLO**

PIC

999975814

Legal name

UNIVERSITETET I OSLO

Short name: UNIVERSITY OF OSLO

Address of the organisation

Street **PROBLEMVEIEN 5-7**

Town **OSLO**

Postcode **0313**

Country **Norway**

Webpage **www.uio.no**

Legal Status of your organisation

Research and Innovation legal statuses

Public bodyyes

Legal personyes

Non-profityes

International organisationno

International organisation of European interestno

Industry (private for profit).....no

Secondary or Higher education establishmentyes

Research organisationno

Enterprise Data

SME self-declared status.....20/05/2008 - no

SME self-assessment unknown

SME validation sme.....20/05/2008 - no

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **UNIVERSITY OF OSLO**

Department(s) carrying out the proposed work

Department 1

Department name

Department of Geoscience

not applicable

Same as proposing organisation's address

Street

Sem Saelands vei 1 (P.O. Box 1047 Blinde)

Town

Oslo

Postcode

0371

Country

Norway

Dependencies with other proposal participants

<i>Character of dependence</i>	<i>Participant</i>	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **UNIVERSITY OF OSLO**

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 **Trude**

Last name **Storelvmo**

E-Mail **trude.storelvmo@geo.uio.no**

Position in org.

Associate Professor

Department

Department of Geoscience

Same as
organisation name

Same as proposing organisation's address

Street

Sem Saelands vei 1 (P.O. Box 1047 Blindern)

Town

Oslo

Post code

0371

Country

Norway

Website

<http://www.mn.uio.no/geo/english/about/>

Phone

+47 22 85 66 56

Phone 2

+xxx xxxxxxxxx

Fax

+xxx xxxxxxxxx

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **FZJ**

PIC

999980470

Legal name

FORSCHUNGSZENTRUM JULICH GMBH

Short name: FZJ

Address of the organisation

Street WILHELM JOHNEN STRASSE

Town JULICH

Postcode 52428

Country Germany

Webpage www.fz-juelich.de

Legal Status of your organisation

Research and Innovation legal statuses

Public bodyno

Legal personyes

Non-profityes

International organisationno

International organisation of European interestno

Industry (private for profit).....no

Secondary or Higher education establishmentno

Research organisationyes

Enterprise Data

SME self-declared status.....05/12/1967 - no

SME self-assessment unknown

SME validation sme.....05/12/1967 - no

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **FZJ**

Department(s) carrying out the proposed work

Department 1

Department name

Institute of Energy and Climate Research, Troposphere (IEK-8)

not applicable

Same as proposing organisation's address

Street

WILHELM JOHNNEN STRASSE

Town

JULICH

Postcode

52428

Country

Germany

Dependencies with other proposal participants

Character of dependence	Participant	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **FZJ**

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

Sex

Male

Female

First name **Astrid**

Last name **Kiendler-Scharr**

E-Mail **a.kiendler-scharr@fz-juelich.de**

Position in org.

Department

Same as organisation name

Same as proposing organisation's address

Street

Town

Post code

Country

Website

Phone

Phone 2

Fax

Other contact persons

First Name	Last Name	E-mail	Phone
Petra	Insberg	p.insberg@fz-juelich.de	+xxx xxxxxxxxx

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **UOXF**

PIC

999984350

Legal name

THE CHANCELLOR, MASTERS AND SCHOLARS OF THE UNIVERSITY OF OXFORD

Short name: UOXF

Address of the organisation

Street WELLINGTON SQUARE UNIVERSITY OFFICE

Town OXFORD

Postcode OX1 2JD

Country United Kingdom

Webpage www.ox.ac.uk

Legal Status of your organisation

Research and Innovation legal statuses

Public bodyyes

Legal personyes

Non-profityes

International organisationno

International organisation of European interestno

Industry (private for profit).....no

Secondary or Higher education establishmentyes

Research organisationyes

Enterprise Data

SME self-declared status.....22/12/1570 - no

SME self-assessment unknown

SME validation sme..... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **UOXF**

Department(s) carrying out the proposed work

Department 1

Department name

Department of Physics

not applicable

Same as proposing organisation's address

Street

Clarendon Laboratory, Parks Road

Town

Oxford

Postcode

OX1 3PU

Country

United Kingdom

Dependencies with other proposal participants

Character of dependence	Participant	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **UOXF**

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

Sex

Male Female

First name **Philip**

Last name **Stier**

E-Mail **philip.stier@physics.ox.ac.uk**

Position in org.

Department

Same as organisation name

Same as proposing organisation's address

Street

Town

Post code

Country

Website

Phone

Phone 2

Fax

Other contact persons

First Name	Last Name	E-mail	Phone
Michele	Warren	grants@physics.ox.ac.uk	+441865272406
Gill	Wells	ecresearch@admin.ox.ac.uk	+441865289842
Joanna	Frost	joanna.frost@physics.ox.ac.uk	+xxx xxxxxxxxx

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **FMI**

PIC

999591306

Legal name

ILMATIETEEN LAITOS

Short name: FMI

Address of the organisation

Street Erik Palmenin aukio 1

Town HELSINKI

Postcode 00560

Country Finland

Webpage www.fmi.fi

Legal Status of your organisation

Research and Innovation legal statuses

Public bodyyes

Legal personyes

Non-profityes

International organisationno

International organisation of European interestno

Industry (private for profit).....no

Secondary or Higher education establishmentno

Research organisationyes

Enterprise Data

SME self-declared status..... unknown

SME self-assessment unknown

SME validation sme..... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **FMI**

Department(s) carrying out the proposed work

Department 1

Department name not applicable

Same as proposing organisation's address

Street

Town

Postcode

Country

Dependencies with other proposal participants

Character of dependence	Participant	
<input type="text"/>	<input type="text"/>	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **FMI**

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 **Sami**

Last name **Romakkaniemi**

E-Mail **sami.romakkaniemi@fmi.fi**

Position in org.

Head of Unit

Department

Atmospheric Research Centre of Eastern Finland

Same as organisation name

Same as proposing organisation's address

Street

Yliopistonranta 1 F

Town

Kuopio

Post code

70211

Country

Finland

Website

www.ilmatieteenlaitos.fi

Phone

+358 50 4461061

Phone 2

+xxx xxxxxxxxx

Fax

+358 17 162301

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **SMHI**

PIC

999507983

Legal name

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 bodyyes

Legal personyes

Non-profityes

International organisationno

International organisation of European interestno

Industry (private for profit).....no

Secondary or Higher education establishmentno

Research organisationno

Enterprise Data

SME self-declared status..... unknown

SME self-assessment unknown

SME validation sme..... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **SMHI**

Department(s) carrying out the proposed work

Department 1

Department name

Rosby Centre, Research Department

not applicable

Same as proposing organisation's address

Street

Folkborgsvaegen 1

Town

NORRKOEPING

Postcode

601 76

Country

Sweden

Dependencies with other proposal participants

Character of dependence	Participant	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **SMHI**

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 **Ralf**

Last name **Doescher**

E-Mail **ralf.doescher@smhi.se**

Position in org.

Department

Same as organisation name

Same as proposing organisation's address

Street

Town

Post code

Country

Website

Phone

Phone 2

Fax

Other contact persons

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

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **SEPA**

PIC

998884079

Legal name

NATURVARDSVERKET

Short name: SEPA

Address of the organisation

Street Valhallavagen 195

Town STOCKHOLM

Postcode 106 48

Country Sweden

Webpage www.naturvardsverket.se

Legal Status of your organisation

Research and Innovation legal statuses

Public bodyyes

Legal personyes

Non-profityes

International organisationunknown

International organisation of European interestunknown

Industry (private for profit).....no

Secondary or Higher education establishmentno

Research organisationno

Enterprise Data

SME self-declared status..... unknown

SME self-assessment unknown

SME validation sme..... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **SEPA**

Department(s) carrying out the proposed work

No department involved

Department name

Name of the department/institute carrying out the work.

not applicable

Same as proposing organisation's address

Street

Please enter street name and number.

Town

Please enter the name of the town.

Postcode

Area code.

Country

Please select a country

Dependencies with other proposal participants

Character of dependence	Participant	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **SEPA**

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 **Erik**

Last name **Adriansson**

E-Mail **erik.adriansson@naturvardsverket.se**

Position in org.

Analyst

Department

NATURVARDSVERKET

Same as organisation name

Same as proposing organisation's address

Street

Valhallavagen 195

Town

STOCKHOLM

Post code

106 48

Country

Sweden

Website

www.naturvardsverket.se

Phone

+ 46 10 698 14 13

Phone 2

+xxx xxxxxxxxx

Fax

+xxx xxxxxxxxx

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **INSTITUT NATIONAL DE L ENVIRONNEME**

PIC

999958063

Legal name

INSTITUT NATIONAL DE L ENVIRONNEMENT ET DES RISQUES INERIS

Short name: INSTITUT NATIONAL DE L ENVIRONNEMENT ET DES RISQUES INERIS

Address of the organisation

Street Parc Technologique Alata

Town VERNEUIL EN HALATTE

Postcode 60550

Country France

Webpage www.ineris.fr

Legal Status of your organisation

Research and Innovation legal statuses

Public bodyyes

Legal personyes

Non-profityes

International organisationunknown

International organisation of European interestunknown

Industry (private for profit).....no

Secondary or Higher education establishmentno

Research organisationyes

Enterprise Data

SME self-declared status.....19/08/2008 - no

SME self-assessment unknown

SME validation sme.....19/08/2008 - no

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **INSTITUT NATIONAL DE L ENVIRONNEME**

Department(s) carrying out the proposed work

Department 1

Department name not applicable

Same as proposing organisation's address

Street

Town

Postcode

Country

Dependencies with other proposal participants

Character of dependence	Participant	
<input type="text"/>	<input type="text"/>	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **INSTITUT NATIONAL DE L ENVIRONNEME**

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 **Laurence**

Last name **Rouil**

E-Mail **laurence.rouil@ineris.fr**

Position in org.

Department

Same as organisation name

Same as proposing organisation's address

Street

Town

Post code

Country

Website

Phone

Phone 2

Fax

Other contact persons

First Name	Last Name	E-mail	Phone
Augustin	Colette	augustin.colette@ineris.fr	+33 344 55 64 82

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **IIASA**

PIC

999452596

Legal name

INTERNATIONALES INSTITUT FUER ANGEWANDTE SYSTEMANALYSE

Short name: IIASA

Address of the organisation

Street Schlossplatz 1

Town LAXENBURG

Postcode 2361

Country Austria

Webpage www.iiasa.ac.at

Legal Status of your organisation

Research and Innovation legal statuses

Public bodyno

Legal personyes

Non-profityes

International organisationno

International organisation of European interestno

Industry (private for profit).....no

Secondary or Higher education establishmentno

Research organisationyes

Enterprise Data

SME self-declared status..... unknown

SME self-assessment unknown

SME validation sme..... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **IIASA**

Department(s) carrying out the proposed work

Department 1

Department name

Air Quality and Greenhouse Gases (AIR)

not applicable

Same as proposing organisation's address

Street

Schlossplatz 1

Town

LAXENBURG

Postcode

2361

Country

Austria

Dependencies with other proposal participants

Character of dependence	Participant	

Proposal Submission Forms

Proposal ID **SEP-210489744**

Acronym

FORCeS

Short name **IIASA**

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 **Markus**

Last name **Amann**

E-Mail **amann@iiasa.ac.at**

Position in org.

Program Director

Department

Air Quality and Greenhouse Gases (AIR)

Same as organisation name

Same as proposing organisation's address

Street

Schlossplatz 1

Town

LAXENBURG

Post code

2361

Country

Austria

Website

Phone

+43(0)2236 807432

Phone 2

+xxx xxxxxxxxxx

Fax

+xxx xxxxxxxxxx

Other contact persons

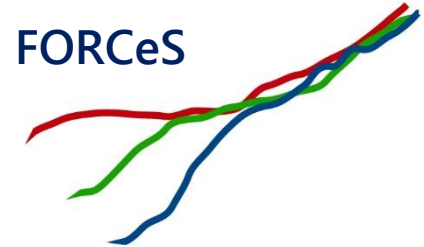
First Name	Last Name	E-mail	Phone
Zbigniew	Klimont	klimont@iiasa.ac.at	+43(0)2236 807547

Proposal ID **SEP-210489744**

Acronym **FORCeS**

3 - Budget

Total requested EU contribution for the proposal/ €	7 985 000
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H2020 Research and Innovation action

Constrained aerosol forcing for improved climate projections (FORCeS)

Coordinator: Stockholm University, Sweden

	Participant organization name	Country
1	Stockholm University (SU)	Sweden
2	Barcelona Supercomputing Centre (BSC)	Spain
3	ETH Zürich (ETHZ)	Switzerland
4	Finnish Meteorological Institute (FMI)	Finland
5	Forschungszentrum Jülich (FZJ)	Germany
6	Foundation for Research and Technology Hellas (FORTH)	Greece
7	Karlsruhe Institute for Technology (KIT)	Germany
8	National Research Council – Institute of Atmospheric Science and Climate (CNR-ISAC)	Italy
9	Norwegian Meteorological Institute (MetNo)	Norway
10	Royal Netherlands Meteorological Institute (KNMI)	Netherlands
11	Swedish Meteorological and Hydrological Institute (SMHI)	Sweden
12	University of Eastern Finland (UEF)	Finland
13	University of Helsinki (UHEL)	Finland
14	University of Leeds (ULEEDS)	United Kingdom
15	University of Leipzig (ULEI)	Germany
16	University of Oslo (UO)	Norway
17	University of Oxford (UOX)	United Kingdom
18	Swedish Environmental Protection Agency (NV)	Sweden
19	French National Institute For Industrial Environment and Risks (INERIS)	France
20	The International Institute for Applied Systems Analysis (IIASA)	Austria

1. Excellence

1.1 Objectives

The challenge: In the *Paris Agreement (PA)*, adopted within the United Nations Framework Convention on Climate Change (UNFCCC) in December 2015, a majority of the world's countries agreed to keep global warming within 2°C above pre-industrial levels. The actions needed to reach this goal, and the urgency to implement them, crucially relies on accurately predicting the time-evolution of *radiative forcing*¹ as well as the corresponding *climate response*. According to the Intergovernmental Panel on Climate Change (IPCC), *the largest and most persistent uncertainty in estimates of the total anthropogenic climate forcing is associated with aerosols and clouds*. This uncertainty severely hampers our ability to understand the past and predict future climate change^{2,3}. Strong reductions of well-mixed greenhouse gases are urgent for reaching the targets of the PA, but the amount of time remaining for achieving the necessary net-zero global greenhouse gas emissions is critically determined by the current level of human-induced warming and its rate of increase⁴. In this context, it is crucial to establish the extent to which anthropogenic aerosols and aerosol-related climate feedbacks (e.g. a change in the natural aerosol burden due to a warming) offset present-day greenhouse gas warming⁵.

In climate science, equilibrium climate sensitivity (ECS) and *transient climate sensitivity* (TCS, also referred to as transient climate response) are commonly used for describing Earth's climate response to a prescribed change in carbon dioxide concentrations⁶. ECS and TCS are fundamental for objectively comparing and evaluating inherent model uncertainty in a projected climate response to greenhouse-gas forcing. However, the high-demand interest from the general public and policy makers is the *near-term climate evolution* (i.e. climate change over the 21st century), and this will be governed by the transient response to the combined changes in *anthropogenic aerosol* and greenhouse gas emissions⁷. Emissions of aerosol particles and their precursors are likely to decrease in the future as a necessity to improve air quality and health in different parts of the world⁸. A strong reduction in aerosol emissions is expected to significantly increase the rate of warming⁵ (Fig. 1.1), bringing forward the date of reaching 1.5°C by several decades, and potentially allowing for an overshoot of the 2°C target by 2070.

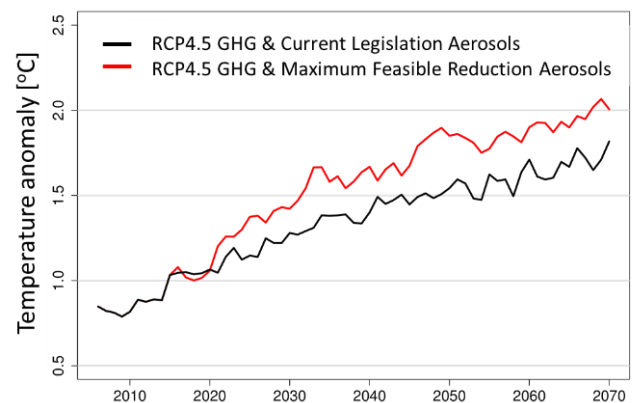


Figure 1.1. Modeled anomalies of the mean global surface temperature with respect to the 1880-1900 mean. Greenhouse gases follow the RCP4.5 scenario and aerosols follow either strong (red line, top) or weak (black line, bottom) global average aerosol emission reductions.

An evident *outstanding* problem is that much of the uncertainty in determining aerosol radiative forcing is caused by poorly constrained, and potentially inaccurate, representations of processes governing aerosol-radiation and aerosol-cloud interaction in climate models⁹. In addition, the radiative forcing concept builds on knowledge of a “pre-industrial state” from which observations are rare by default. Ground-breaking progress has been made during recent decades in the scientific understanding and decadal-scale observation of relevant aerosol and cloud processes, for instance through several European collaborative projects (cf. Fig. 1.3.1). However, many of these discoveries have not yet been used to improve climate models¹⁰, or the efforts have been scattered and ad-hoc, without systematic investigation⁹.

In light of the above, and in support of the next IPCC assessment report, *FORCeS will increase the confidence in estimates of aerosol radiative forcing by bridging a crucial gap that currently exists between knowledge on the process scale and model application on the climate scale*. The overall project objective is to identify, constrain and efficiently parameterize the most critical processes determining aerosol radiative forcing and aerosol- and cloud-related climate feedbacks. Observations, computational models, and theoretical considerations on a *continuum of temporal and spatial scales* will be used to develop and optimize accurate model descriptions of processes and parameters that are key for predicting the anthropogenic aerosol impact on climate. FORCeS will also inform decision

¹ Radiative forcing is the change in energy flux caused by a climate driver, e.g. aerosols or carbon dioxide, cf. IPCC (2013).

² Armour, K. C and Roe, G. H. Geophys. Res. Lett., doi:10.1029/2010GL045850, 2011.

³ Knutti, R. et al., Nat. Geosci., doi:10.1038/ngeo3017, 2017.

⁴ Ricke, K.L. et al., Sci. Rep., doi:10.1038/s41598-017-14503-9, 2017.

⁵ Acosta Navarro, J.C. et al, J. Clim, https://doi.org/10.1175/JCLI-D-16-0466.1, 2017.

⁶ IPCC, Summary for Policymakers in Climate Change 2013, doi:10.1017/CBO9781107415324, 2013.

⁷ Rotstayn, L.D. et al., J Clim., https://doi.org/10.1175/JCLI-D-14-00712.1, 2015.

⁸ Cofala, J., et al., 2012. Final Report to Sponsor: International Energy Agency, Paris, France (June 2012). IIASA Contract no. 12–129.

⁹ Reddington, C.L. et al., Bull. Am. Meteorol. Soc., https://doi.org/10.1175/BAMS-D-15-00317.1, 2017.

¹⁰ Malavelle, F.F. et al., Nature, doi:10.1038/nature22974, 2017.

and policy makers about the effect of aerosol emission changes on climate evolution. The link between stakeholders and FORCeS is ensured by the involvement of e.g. the Swedish Environmental Protection Agency, IIASA and INERIS in the consortium as well as through the Scientific Advisory Group (Sections 1.3 (b) and 2.1).

The specific project objectives of FORCeS are the following:

No.	Objective	Expected impact
O1	Identify the most important cloud and aerosol processes or components controlling climate forcing and transient climate sensitivity and make targeted improvement of the corresponding parameterizations in a set of leading European climate models, integrating knowledge from the microscale to the global scale.	Strengthening and affirmation of Europe's leadership in climate science, and increased confidence in climate change projections.
O2	Exploit models, statistical methods and the recent wealth of observations to reduce the uncertainty in anthropogenic climate forcing associated with aerosols and aerosol-cloud interactions from more than 100% ⁶ to closer to 50%.	Invaluable new knowledge needed for upcoming scientific assessments (e.g. the next IPCC report), clarity with respect to the role of aerosols and greenhouse gases in the climate evolution of the industrial era.
O3	Quantify the near-term climate impact and associated uncertainty ranges for a set of plausible combinations of near-term greenhouse gas and aerosol emissions, in support of the PA.	Provide added-value to decision and policy makers, facilitating cost effective multi-beneficial mitigation strategies.

1.2 Relation to the work programme

The proposed work relates to the Horizon 2020 Work Programme 2018-2020: “**Climate action, environment, resource efficiency and raw materials**” and the topic LC-CLA-08-2018: “**Addressing key knowledge gaps in climate science, in support of IPCC reports**” with specific emphasis on the sub-topic: “**a) Improving the understanding of key climate processes for reducing uncertainty in climate projections and predictions**”.

“**Actions should achieve better understanding of key processes, and associated feedbacks, affecting the climate-Earth system over time in order to improve climate projections and predictions and constrain climate sensitivity estimates.**”

Cloud and aerosol dynamics and cloud-aerosol interactions will be the main focus of the science within FORCeS. In line with the specific call text, FORCeS will identify knowledge gaps regarding critical aerosol and cloud processes affecting Earth's climate over time and address these using i) the wealth of in-situ and remote sensing data that have emerged during the latest decades together with ii) dedicated process level laboratory and field experiments, iii) a range of state-of-the-art computational models and iv) novel theoretical methods including statistical emulation of perturbed physics ensembles and machine learning techniques. We will furthermore investigate climate feedbacks related to aerosols and clouds, and evaluate their importance for accurately predicting Earth's climate evolution. Constraining the aerosol forcing will increase the confidence when determining the past and future climate response to changes in anthropogenic greenhouse gas and aerosol emissions. FORCeS will also identify and constrain key aerosol and cloud processes affecting transient climate sensitivity. Furthermore, FORCeS will investigate the influence of time-dependent changes in biochemical cycles on aerosol emissions and forcing, the interactions between aerosol and atmospheric circulation, the influence of sea ice change on aerosol emissions, as well as the role of aerosol particles and clouds in linking the atmosphere, land surface, and ocean. Finally, FORCeS will also contribute to major international scientific assessments, by generating the crucial knowledge needed, through participation in coordinated model experiments (e.g. those endorsed by the Coupled Model Intercomparison Project, CMIP), and active participation in e.g. IPCC report writing (cf. Section 2.1).

1.3 Concept and methodology

(a) Concept

Overall concept underpinning the project: FORCeS will *constrain not only the present-day but also the time-dependent aerosol forcing to reduce uncertainty in near-term climate projections*, which is particularly important for deciding which measures are needed to reach the targets of the PA. To succeed with this task, all process-level investigations within FORCeS will be guided by and conducted with the ultimate aim of improving the climate models used within FORCeS. The overall concept is based on four pillars, which are explained in detail below:

- 1) *Constraining aerosol loadings and aerosol climate forcing;*
- 2) *Systematic investigation of critical processes and aerosol-related feedbacks;*
- 3) *Drawing from and building on previous and ongoing major research initiatives;*
- 4) *Active communication with climate assessment groups and stakeholders*

1) *Constraining aerosol loadings and aerosol climate forcing*: We will focus on the effective radiative forcing of aerosol-radiation (ERFari) and aerosol-cloud interactions (ERFaci) as defined in the latest IPCC report¹¹. The current best estimate of the anthropogenic ERF due to aerosols, comparing the years 2011 and 1750, is -0.9 Wm^{-2} with a range of -1.9 Wm^{-2} to $+0.1 \text{ Wm}^{-2}$. Constraining the aerosol ERF is important as i) accurately determining the past time-dependent aerosol forcing means better constraints on the near-term future warming induced by greenhouse gases¹²; ii) any change in aerosol emissions, e.g. due to air pollution mitigation, will result in an almost immediate response, i.e. the near-term climate evolution will largely depend on the atmospheric aerosol loading and forcing⁷; iii) if strong reductions in greenhouse gas emissions occur, reductions in co-emitted aerosols are inevitable and may result in short-term warming⁵. ***Reducing the uncertainty in aerosol forcing is necessary to increase confidence in near-term climate projections.***

2) *Systematic investigation and simplification of critical processes and aerosol-related feedbacks*: Simulation of aerosol particles is challenging due to their physical and chemical complexity, and their convolute interactions with clouds. Vice versa, cloud microphysical processes are shaped by the aerosol particles on which cloud droplets and ice crystals form. Much progress has been made on the one hand in the molecular understanding of atmospheric chemistry involving aerosol particles (cf. Fig. 1.3.1) and on the other hand in the development of global climate and Earth system models⁶. Systematic work connecting these scales is fundamental to take the step from understanding atmospheric aerosol properties and loadings to quantifying their true impact on clouds and their climate forcing. However, increased complexity of the models does not necessarily guarantee better predictive power^{13,14,9}. ***Efficient ways to identify and simplify key processes, which are often complex and small-scale, are urgently needed.***

3) *Drawing from and building on previous and ongoing major research initiatives*: There has been a persistent uncertainty in the aerosol loading and forcing caused by anthropogenic aerosols in all five major IPCC assessment reports published since 1990. An important cause is the lack of experimental data on clouds and aerosols during the pre-industrial time, which typically serves as the reference period for ERF estimates^{6,15}. Robust data series are now available, collected over annual and decadal scales from both in-situ and remote sensing techniques (cf. Section 1.3 (b)). Novel, robust theoretical descriptions of the processes influencing aerosol emissions and loadings will help in reliably extrapolating to past and future conditions beyond the range of observations. Modeling and data analysis across different temporal and spatial scales is crucial as aerosol-radiation and aerosol-cloud interactions involve many feedbacks¹⁶. ***FORCeS will exploit the untapped potential that lies in systematic analysis of the wealth of existing data to quantify the aerosol climate impacts over various climate-relevant temporal and spatial scales***

4) *Active communication with climate assessment groups and stakeholders, i.e. users of climate model output and knowledge*: As mentioned in Section 1.1, the near-term temperature evolution is crucially dependent on changes in aerosol emissions: documenting and interpreting the response to rapidly-changing emissions as mitigation efforts begin will be critical to the PA stock taking process. Other climate variables that are important for peoples' livelihoods, such as precipitation patterns, monsoon circulations, and the hydrological cycle in general are also known to be strongly influenced by the inhomogeneous spatial and temporal forcing pattern induced by aerosols^{17,5}. ***Providing policy and decision makers with relevant information on the climate effect of near-future aerosol emission changes is key for developing efficient climate and air pollution mitigation strategies.***

Positioning of the project: Our project will start on a level corresponding to Technology Readiness Level 2 (TRL2) where our science concept for reducing aerosol ERF uncertainty is formulated. The aim is to have the methodology tested and evaluated (TRL6) at the end of the project. The current uncertainty in aerosol ERF is more than 100%, and our goal is to understand the reasons for the uncertainty, and to reduce it to closer to 50%. This will make it more similar to the uncertainty of other climate drivers⁶. We will make our results available for users in the scientific community, contribute to scientific assessments, and inform policy makers about relevant outcomes (cf. Section 2.1).

National and international research activities linked to FORCeS: An important aspect of FORCeS will be drawing upon past and ongoing research activities. These include the following projects where FORCeS consortium members have been or are currently actively involved:

¹¹ Boucher, O. et al., Clouds and Aerosols in Climate Change 2013, doi:10.1017/CBO9781107415324, 2013.

¹² Mauritsen, T. and Pincus, R., Nat. Clim. Change, doi:10.1038/nclimate3357, 2017.

¹³ Ekman, A.M., J. Geophys. Res., doi: 10.1002/2013JD020511, 2014.

¹⁴ Knutti, R. and Sedláček, J., Nat. Clim. Change, 2013.

¹⁵ Ghan, S. et al., Proc. Natl. Acad. Sci. U.S.A., <https://doi.org/10.1073/pnas.1514036113>, 2016.

¹⁶ Stevens, B. and Feingold, G., Nature, doi:10.1038/nature08281, 2009.

¹⁷ Chung, E.S. and Soden, B.J., Clim. Dyn., doi: 10.1007/s00382-017-3682-1, 2017.

Project acronym	Full name and scope	Type of activity and time frame
AeroCom	Aerosol Comparisons between observations and models	Open international collaboration research initiative, ongoing
ACTRIS I and II	European Research Infrastructure for the observation of Aerosol, Clouds, and Trace gases	EU FP7 and H2020 Research and Innovation, 2011-2015 and 2015-2019.
BACCHUS	Impact of Biogenic versus Anthropogenic emissions on Clouds and Climate: towards a Holistic UnderStanding	EU FP7 collaborative project 2013-2018
CLOUD	Cosmics Leaving Outdoor Droplets	Experiment run by CERN, ongoing
CORDEX	Coordinated Regional Climate Downscaling Experiment	World Climate Research Program International Initiative, ongoing
CRESCENDO	Coordinated research in Earth Systems and climate: experiments, knowledge, dissemination and outreach	EU H2020 Research and Innovation project, 2015-2020
EUCAARI	European Integrated Project on Aerosol Cloud Climate and Air Quality Interactions	EU FP6 Integrated project 2007-2010
EUROCHAMP 2020	Integration of European Simulation Chambers for Investigating Atmospheric Processes – Towards 2020 and beyond	EU H2020, Research and Innovation project, 2016-2020
GAP	GEWEX Aerosol Precipitation initiative	Open international collaboration research initiative, ongoing
GASSP	Global Aerosol Synthesis and Science Project	UK-funded (NERC, NCAS, N8, CEDA) project, 2013-2016.
PEEX	Pan-Eurasian Experiment	Open international collaboration research initiative, ongoing
PEGASOS	Pan-European Gas-aeroSOls-climate interaction Study	EU FP7 Large-scale integrating project 2011-2014
PRIMAVERA	PRocess-based climate sIMulation: AdVances in high resolution modelling and European climate Risk Assessment	EU H2020 Research and Innovation, 2015-2019

Figure 1.3.1 Previous and ongoing international projects and initiatives related to FORCeS.

(b) Methodology

The work within FORCeS will be organized around seven scientifically interconnected Work Packages (WPs, cf. Fig. 1.3.2) and one management WP, in effect co-led by leading European scientists specialized in different fields of climate science. The co-leadership facilitates interactions between climate scientists and stakeholders, the different scientific traditions within atmospheric science, different scales, and experimental as well as theoretical approaches. FORCeS will make sure that key knowledge gaps identified both within FORCeS as well as by previous projects (cf. Fig. 1.3.1) are filled and that the relevant processes are improved in climate models. These gaps can be related to natural aerosol emissions (e.g. brown carbon, nitrate, secondary organic aerosol, dust, sea spray), aerosol-cloud processes (e.g. droplet and heterogeneous ice nucleation, secondary ice formation, collection, aerosol cloud processing, sedimentation), and methodological questions (e.g. impact of model complexity for predictive power). FORCeS will more specifically rely on computational models, observations, theoretical methods, and communication method, described further below:

Computational models: The use and development of state-of-the-art Earth System Models (ESMs) will be at the heart of all FORCeS activities, focusing on those actively developed within the consortium, namely the European community model (EC-Earth), the Norwegian Earth System Model (NorESM), the UK Earth System Model (UKESM) and the suite of MPI-ESMs (based on e.g. the atmospheric models ECHAM and ICON) developed by the Max-Planck Institute in collaboration with other European partners. Existing climate model output archives e.g. from CMIP-endorsed experiments (in particular CMIP6¹⁸) and international projects (cf. Fig. 1.3.1) will also be used. The development of models with European scientific origin will **“strengthen and affirm Europe’s leadership in climate science”** (cf. Section 2.1).

To fill the gap between the ESM scale (tens to hundreds of kilometers) and the temporal and spatial scales where observations and parameterization development typically are done (nanometers to kilometers), ***FORCeS will also develop and use other computational models than ESMs, in particular Large Eddy Simulation (LES) and cloud-resolving models (CRMs).*** These high-resolution 3-dimensional models will be used to study aerosol-radiation and aerosol-cloud interactions on spatial domains and time periods relevant for both the climate scale and the observational scale¹⁹. LES and CRM will be used as testbeds for parameterization development and will include both detailed descriptions of e.g. the evolution of aerosol populations and cloud microphysics, as well as more simplified, computationally more efficient, parameterizations that are suitable for ESMs.

¹⁸ Eyring, V. et al., Geosci. Model Dev., doi: 10.5194/gmd-9-1937-2016, 2016.

¹⁹ Heinze, R. et al., Q. J. Royal Meteorol. Soc., doi: 10.1002/qj.2947, 2017.

For examining the impact of aerosol constituents and processes on radiative forcing, feedbacks, and climate sensitivity, FORCeS will rely on three different types of ESM simulations, respectively:

<i>Effective radiative forcing (ERF) simulation</i>	<i>Transient climate evolution (TCE) simulation</i>	<i>Transient climate sensitivity (TCS) simulation</i>
Following the CMIP protocol for calculating ERF with prescribed sea surface temperatures, to evaluate the importance of different aerosol-cloud processes and aerosol components for aerosol ERF.	Interactive ocean-atmosphere simulations over the industrial time period and near-term future following historical emissions of aerosols and greenhouse gases or projections, to examine the climate response to anthropogenic aerosols and feedbacks in the climate system.	Interactive ocean-atmosphere simulations following the CMIP protocol for calculating TCS, i.e. the global mean temperature change for a 1% yr ⁻¹ carbon dioxide increase with subsequent stabilization at 2×CO ₂ and 4×CO ₂ .

Observations: For understanding processes and to constrain the computational models, we will *make use of observational and experimental data series as well as databases of aerosol, cloud and radiation measurements, collected within FORCeS and established by previous research initiatives*, i.e. from laboratory studies and in-situ observations (Fig. 1.3.1) and other open-source data from in-situ observations, satellites and re-analysis, e.g. the European Earth Observation Programme (Copernicus), the Global Energy Balance Archive²⁰, the European Space Agency (ESA) and the Global Earth Observation System of Systems (GEOSS). We will develop robust constraints of aerosol forcing and climate response on decadal scales. The existing data will, where knowledge gaps exist, be complemented by new field and laboratory investigations of the key processes governing aerosol loadings, properties and their interactions with clouds. Existing observational platforms available within FORCeS, such as the Zeppelin Station (NO), Puijo (FI) and the Po Valley (IT) as well as simulation chambers such as SAPHIR (DE), will be utilized.

Theoretical methods: We will use and develop molecular theories and dynamic models targeted for interpretation of experimental data or prediction of processes or aerosol emissions^{21,22}. Mathematical methods and *machine learning techniques* including statistical emulation of perturbed physics ensembles²³, network analyses techniques²⁴, neural networks²⁵, Lagrangian-based process evaluation²⁶, and radiative kernels²⁷ will also be used to understand the drivers of uncertainty in ESMs and observations.

Communication method: FORCeS will organize workshops during different stages of the project where climate science experts, climate data users, and policy makers will meet to discuss and contrast potential climate implications of different greenhouse gas emission reductions and air pollution mitigation strategies. FORCeS will *leverage on the networks* provided by e.g. IPCC, Future Earth, the Arctic Council, the Convention on Long-range Transboundary Air Pollution (CLRTAP), the Climate and Clean Air Coalition (CCAC), the World Climate Research Programme (WCRP) and their initiatives such as the Global Energy and Water Exchanges (GEWEX) project, the European Commission and the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) *for workshop participation and for exploitation, dissemination and communication* of the results (cf. Section 2.1).

Work plan:

The work within WP1-WP6 will follow a common general approach involving three work phases to 1) find and understand the key processes; 2) ensure progress of knowledge from the process to the climate scale; 3) constrain aerosol forcing, feedbacks, and climate sensitivity:

Phase 1: Evaluating and investigating “scale chains”, i.e. a chain of events, occurring on a range of spatial and temporal scales, following an aerosol (or aerosol precursor) perturbation in the climate system. A combination of experimental and theoretical techniques will be used to identify key processes governing the aerosol ERF, aerosol and cloud feedbacks, transient climate evolution and climate sensitivity. The identified key processes will define the scale chains to be studied, which can be associated with perturbations of i) natural aerosol, ii) anthropogenic aerosol, iii) warm cloud microphysical processes, and iv) cold cloud microphysical processes. The scale chains will be traced through at least two temporal or spatial scales and involve at least one climate model, i.e. they will be designed to go

²⁰ Wild, M., Bull. Am. Meteorol. Soc., <https://doi.org/10.1175/BAMS-D-11-00074.1>, 2012.

²¹ Olenius, T. and Riipinen, I., Aerosol Sci. Technol., <https://doi.org/10.1080/02786826.2016.1262530>, 2017.

²² Rastak, N., Geophys. Res. Lett., doi: 10.1002/2017GL073056, 2017.

²³ Lee, L.A., et al., Proc. Natl. Acad. Sci. U.S.A., <https://doi.org/10.1175/2007JCLI2110.1>, 2016.

²⁴ Bracco, A., et al., npj Climate and Atmospheric Science, doi:10.1038/s41612-017-0006-4, 2018.

²⁵ Andersen, H. et al., Atmospheric Chem. Phys., <https://doi.org/10.5194/acp-17-9535-2017>, 2017.

²⁶ Tunved, P. et al., Atmospheric Chem. Phys., <https://doi.org/10.5194/acp-13-3643-2013>, 2013.

²⁷ Soden, B.J. et al., J. Clim., <https://doi.org/10.1175/2007JCLI2110.1>, 2008.

across scales from e.g. the microphysical to the cloud scale, from the cloud scale to the cloud field scale, from the cloud field scale to the regional scale, and from the regional scale to the global scale.

Phase 2: Implementation of the most important processes, emissions or feedbacks identified in phase 1 in the ESMs employed by FORCeS with the best available knowledge from the smaller scales.

Phase 3: Testing and evaluating the effects of improved key model descriptions in the ESMs in terms of reproducing physical process constraints as well as reducing uncertainty in predicted aerosol forcing, climate sensitivity, and near-term climate evolution.

WP1: Identification of critical aerosol forcing processes and factors (co-lead: *ETH, FORTH*).

WP1 will address O1 and O2 and reduce uncertainty in aerosol ERF by systematically investigating which aerosol and cloud processes provide the largest uncertainty in modeled (ERF simulations) and observed aerosol forcing estimates. WP1 will also investigate if the model performance improves (in terms of representing aerosol and cloud radiative properties) when aerosol components that are currently missing or crudely implemented in models are considered.

Aerosol and cloud processes that are not important for aerosol forcing will be simplified to optimize the use of computational resources.

WP2: Understanding of cloud processes and aerosol-cloud interactions (co-lead: *UEF, ULEI*). WP2 will address O1 and O2 by exploiting existing field observations and laboratory studies and, where knowledge gaps exist, conducting new complementary measurements. Computationally efficient and accurate parameterizations of key aerosol-cloud processes will be developed. Simulations using LES or CRMs on spatial domains relevant for climate models will be used as detailed, reference modeling. Global improvements of ESMs (ERF simulations) will be assessed by e.g. process-oriented evaluation using satellite data.

WP3: Production of time series of aerosol physical and chemical properties (co-lead: *FZJ, MetNo*). WP3 will address O1 and O2 and produce time series for key aerosol components and characteristics (e.g. number size distribution) to calculate aerosol forcing during the industrial period and the near-term future (ERF simulations). The time-series will be improved compared with the ones currently produced or used by ESMs as they will be constrained by observations and updated with new parameterizations to consider aerosol components currently missing or crudely implemented in models. Several key periods will be of particular interest, e.g. the period with high aerosol loading during the 1970s and the near-term future when aerosols will play a major role in mitigation.

WP4: Development of constraints on aerosol forcing (co-lead: *UHEL, UOX*). WP4 will derive novel constraints on aerosol forcing during the industrial time, improving climate models in support of IPCC. WP4 will address O2 by taking full benefit of all observations and FORCeS' computational models. The development of constraints based on relationships between parameters (e.g. aerosol optical depth and cloud droplet number concentration) will facilitate tracing chains. Perturbed physics ensembles will be employed for global parametric uncertainty analysis (ERF simulations) and to quantify the strength of observational constraints. A new generation of LES and CRM with explicit representation of aerosols and their interactions with clouds will be used for process studies as well as to simulate observables and to develop new observational strategies.

WP5: Examination of climate response and feedbacks in response to aerosol forcing (co-lead: *MetNo, SMHI*). WP5 will examine the climate response to aerosol forcing in ESMs as well as feedbacks in the climate system. WP5 will target O1 and O3 by analyzing and evaluating existing (CMIP) and new ESM simulations (TCS and TCE simulations) with focus on feedback quantification using radiative kernel methods to identify key feedbacks. The new ESM experiments will target the importance of specific processes and feedbacks and address the impact of new

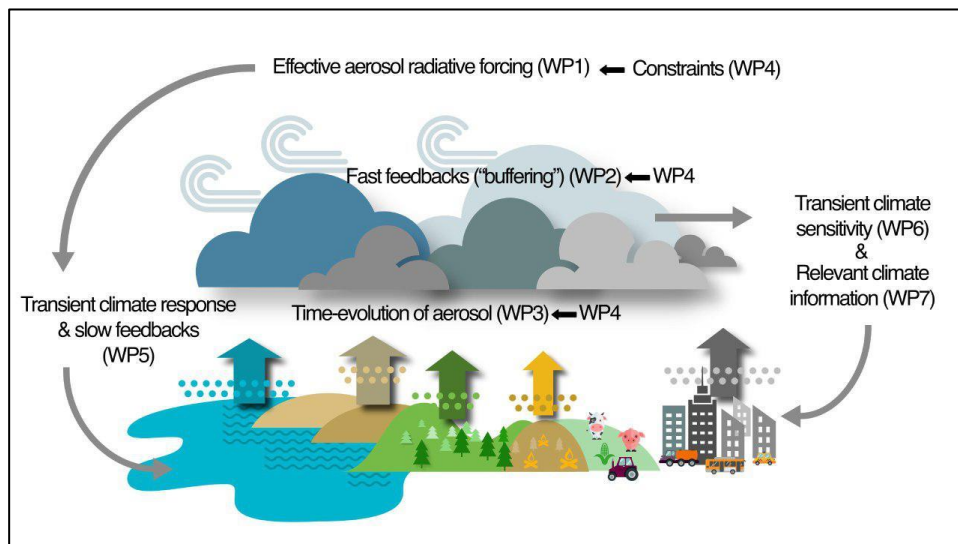


Figure 1.3.2. Overview of work package connections

parameterizations of aerosol and cloud processes (reduced forcing uncertainty) on climate evolution (TCE simulations).

WP6: Constraining climate sensitivity (co-lead: FORTH, UiO). WP6 will examine TCS in ESMs and evaluate and develop constraints on parameters critical for the TCS. WP6 addresses O1 and will initially focus on evaluating the FORCeS ESMs in terms of their TCS. WP6 will specifically focus on the ESMs performance with respect to so-called “emergent constraints”³. To disentangle the individual contribution of each new process representation to the overall ESM climate response, WP6 will make use of an innovative new network analysis technique. The aim is to develop a new set of metrics for ESM performance particularly relevant for TCS.

WP7: Delivering relevant climate information: dissemination and exploitation (co-lead: SMHI, SU). WP7 will synthesize, disseminate, and exploit results obtained within FORCeS. WP7 activities will address O3: to provide policy and decision makers with relevant climate information, in particular related to the development of strategies for reaching the goals of the PA and CLRTAP concerning air quality. Stakeholder and data user workshops will be organized (cf. Section 2.1). WP7 will also be responsible for communicating the science findings to the general public and for making sure that FORCeS’ technical output such as new parameterizations, data, tools etc. are openly available. In collaboration with all other WPs, WP7 will also make sure that FORCeS members contribute with scientific papers and results to major international scientific assessments, such as the ones produced by the IPCC.

WP8: Project management (SU). The FORCeS project office at SU will be responsible for coordination tasks including being the main contact between FORCeS and the EC as well as project report writing, deliverables database, gender equality aspects and overall day-to-day management. The Project Coordinator (PC), Prof. Ilona Riipinen and the Science Coordinator (SC) Prof. Annica Ekman will be supported by a project officer and administrative staff. The project office will also have support from experts at the Research Support Office at SU regarding legal matters, innovation, finance, communication, etc. A steering group will be set up consisting of the PC, SC and the WP co-leaders. The project and the steering group will be guided by a Scientific Advisory Group (SAG) with external experts on climate modeling, climate sensitivity, observations, machine learning as well as stakeholder interaction (cf. Section 2.1).

The FORCeS consortium will promote gender equality and foster balance in the research teams and research leadership. We will strive towards having 50% female participation in the SAG and in the workshops organized by WP7.

1.4 Ambition

The FORCeS concept and project represents the cutting edge of development of predictive climate models, using e.g. novel machine learning methods to identify the key processes governing aerosol effective radiative forcing (ERF) as well as climate sensitivity, and using a trans-disciplinary, multi-scale approach to bridge the critical gap that currently exists between knowledge on the process scale and model application on the climate scale.

Advancement beyond state-of-the-art: FORCeS aims to constrain the anthropogenic aerosol ERF with much better accuracy than available to date. The estimates of the magnitude, uncertainty and variability of aerosol forcing based on present climate models (Section 1.3 (a)) are astonishingly inconclusive with an uncertainty range of more than 100%¹¹. One of the main reasons for this inconclusiveness has been a separation of scientific communities working either on large-scale cloud and climate dynamics or on atmospheric chemistry and cloud microphysics¹⁶. FORCeS will integrate these top-down and bottom-up views on aerosol-cloud-climate interactions across spatial and temporal scales, using systematically designed scale chains (cf. Section 1.3 (b)) together with novel computational and experimental approaches. The aim is to reduce the uncertainty range in aerosol forcing by 50%, making it more similar to the uncertainty of other climate forcing drivers⁶.

Systematic prioritization of the process investigations is an important prerequisite for reaching the ambitious goal of FORCeS, based on the best available scientific knowledge on the processes themselves and their contribution to climate sensitivity and aerosol ERF. Such **prioritization will in FORCeS be done on a level never achieved before**, based on a number of successful pioneering studies conducted by FORCeS members^{28,29,23,24,9}. Our knowledge about aerosols and clouds has increased substantially during the recent decades (cf. Fig. 1.3.1). However, as mentioned in Section 1.1, this has not yet resulted in increased model robustness regarding aerosol ERF and climate sensitivity. In FORCeS, all process-level investigations will be guided by and conducted with the ultimate aim of improving climate models in a way that substantially reduces uncertainty.

Another important cause of the uncertainty in aerosol ERF is that the estimates are based on comparisons between a present-day and a pre-industrial state^{6,15}. To model a natural background population of aerosols is highly challenging

²⁸ Carslaw, K.S. et al., Curr. Clim. Change Rep., <https://doi.org/10.1007/s40641-017-0061-2>, 2017.

²⁹ Sullivan et al., Atmospheric Chem. Phys., <https://doi.org/10.5194/acp-16-2611-2016>, 2016.

and differences in the modeled pre-industrial state can result in a large range of aerosol ERF values²⁸. Vast amounts of data and knowledge on aerosols, clouds and aerosol-cloud interactions have become available during the recent decades (cf. Fig. 1.3.1). **FORCeS will utilize these long-term observations, and conduct new dedicated experiments, to produce novel, robust theoretical descriptions of the processes influencing aerosol emissions and loadings,** which will help in reliably extrapolating to past and future conditions beyond the range of observations.

Finally, communication is vital for bridging the gap between policy-makers and the latest findings by the climate science community. **FORCeS will focus on relating all the acquired results to scales and measures that are directly relevant for meeting the targets of the PA.**

Innovation potential:

Novel descriptions of critical aerosol processes and feedbacks in ESMs: FORCeS will identify the processes and parameters that contribute to the largest uncertainty in aerosol loadings, forcing and feedbacks in climate projections (WP1, WP5 & WP6) and make targeted improvements of these in climate models (WP2-WP4). **The outcome will be a set of observationally constrained descriptions of critical aerosol and cloud processes, systematically exploiting knowledge from the smallest molecular-scale processes to global-scale trends and climate evolution.**

Innovative metrics and constraints on time-dependent aerosol loadings, forcing, feedbacks and climate sensitivity in preparation for IPCC assessments: FORCeS will use the most comprehensive set of observations ever compiled for evaluating and constraining the representation of aerosols, clouds and their interactions and time-evolution in global climate models (cf. Section 1.3 (b)). A new set of constraints for time-dependent aerosol loading, forcing and feedbacks will be derived (WP1 & WP4). FORCeS will also develop a novel set of constraints on cloud and aerosol parameters critical for climate sensitivity (WP6), as well as novel metrics targeting processes and scales directly relevant for policy-making (WP7). The metrics and observational constraints will be implemented in new evaluation packages for community evaluation tools (e.g. ESMValTool, CIS tools, AeroCom interface) aimed at reducing the uncertainties in aerosol loading and forcing. **This will lead to the first observationally constrained aerosol forcing ensemble in CMIP climate models, in preparation for the IPCC 6th assessment report (AR6).**

Interaction with international climate assessment groups and stakeholders, i.e. users of climate model output and knowledge: FORCeS will actively involve climate data users in framing solutions-driven questions to be answered by the project (WP7). Workshops aimed at defining **new climate diagnostics suitable** (in terms of simplicity, transparency, and predictive power) **for 1) understanding the cause of past and future climate change; 2) quantifying feedbacks between the climate system and environmental policies, and 3) to pave the way for European and global efforts to achieve the targets of the PA, and generally supporting the objectives of the SDGs.** The focus will be on climate and air pollution mitigation in Europe, but specific attention will also be paid to climate change hotspots in other parts of the world. An important influence in this respect will be the inclusion of key international collaborators in workshops and in the SAG (cf. Section 2.1).

2.1 Expected impacts

FORCeS will work towards a reduction of the uncertainty in ERF estimates of aerosol-radiation and aerosol-cloud interactions. **The main aim is to provide more reliable future climate projections, in particular for the near-term future (21st century; O1 and O2).** Aerosol particles also have considerable environmental and health effects. A reduction of short-lived climate forcers, i.e. aerosol components such as sulfate, nitrate, black carbon and gases such as methane and ozone, may partly counteract future carbon dioxide emission decreases⁵ (see also Section 1.1). **This intricate mixture of connections and feedbacks has to be considered to develop cost-effective multi-beneficial climate and air quality abatement strategies that both limit climate change and improve air quality (i.e., two important sustainable development goals, O3).** FORCeS will contribute to each of the four expected key impacts mentioned in the work programme (Section 1.2). In the following we describe how FORCeS will achieve these goals:

“Supporting major international scientific assessments”: At a fundamental level FORCeS will contribute with publication of scientific findings in the peer-reviewed literature (WP1-WP6) that is assessed by e.g. the IPCC and the Arctic Monitoring and Assessment Programme (AMAP). In addition, FORCeS models (see Section 1.3 (b)) will contribute with simulations to CMIP6 and CMIP6-endorsed experiments, which serve as a basis for the next IPCC report. Analysis of CMIP6 models and simulations is also part of FORCeS (WP5 and WP6). This implies that the FORCeS team according to objective O2 will contribute to the peer-reviewed literature being assessed by the IPCC both via the team’s own studies but also via contributions from other scientists analyzing results from the FORCeS models. The improvement of FORCeS ESMs will generally lead to more accurate climate projections, benefiting future model intercomparison projects and scientific assessments. The FORCeS team will also participate in the writing and review process of the next IPCC assessment. **Within the consortium, two participants will be coordinating lead authors (CLAs) of the next IPCC report, three will be lead authors (LAs), and more than six have been CLAs and LAs in past IPCC reports.**

“Increase confidence in climate change projections”: *FORCeS will contribute to an improved understanding of past and present climate change and more reliable climate projections* through reducing the uncertainty in anthropogenic aerosol ERF (O2) and improving the representation of aerosol climate effects in climate models (O1). With reduced uncertainty in aerosol ERF, the temperature span for a certain emission scenario will decrease significantly¹². As the climate response to the atmospheric aerosol content is almost immediate, reducing uncertainty in aerosol forcing is fundamental when addressing the near-term climate evolution. FORCeS will through WP1-WP6 also *improve the understanding of the role of natural aerosols and anthropogenic forcing in the climate change context*. This work will lead to constrained transient climate sensitivity estimates in ESMs, which is also crucial for increasing confidence in climate change projections. Important geographical aspects of aerosol forcing exist and work within FORCeS will lead to increased confidence in regional climate change projections, for example in the Arctic⁵. FORCeS consortium members are also active within the AeroCom and GAP community (cf. Fig. 1.3.1) and will work jointly with them towards a better understanding and improvement of the predictive power of climate models in reproducing measured aerosol concentrations and loadings.

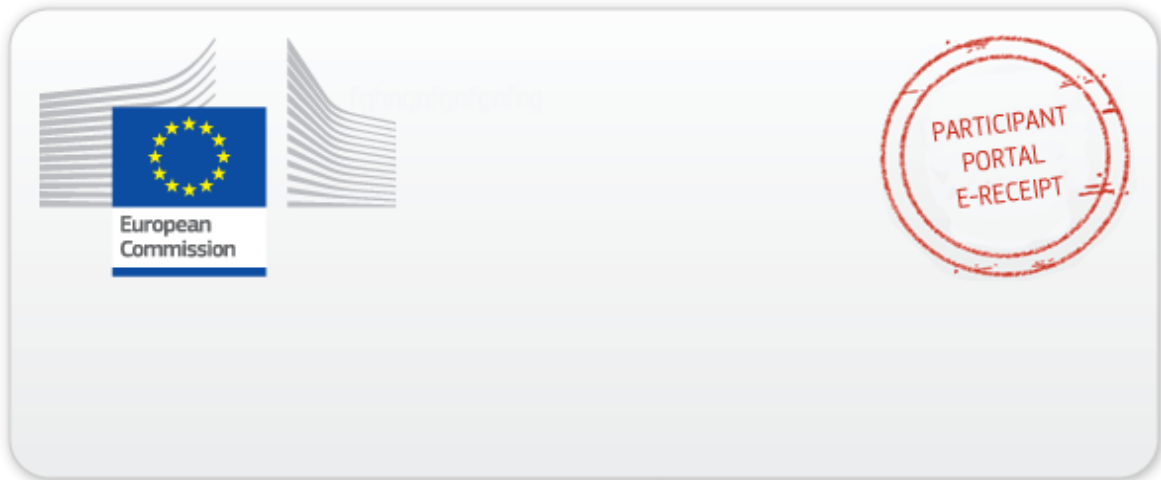
“Providing added-value to decision and policy makers”: By improving our understanding of aerosol forcing and constraining transient climate sensitivity, FORCeS will provide added-value to decision and policy makers (O3). *The climate projections with a reduced uncertainty span will be of direct use in addressing climate change and to develop co-beneficial air quality and climate mitigation strategies*. As a necessity for improving air quality and health in different parts of the world, emissions of aerosol particles and their precursors are likely to decrease in the near future. These emission changes may have profound impacts on important climate variables such as precipitation and disproportionately large effects on e.g. Arctic climate^{30,31,5}. FORCeS will provide essential basic information for developing cost effective multi-beneficial abatement strategies not only for climate but also for air quality, providing better health, higher food production and increased carbon-sequestration supporting several Sustainable Development Goals (SDGs), in particular SDG 3, 7, 11, 13 and 15. The SAG of FORCeS will be set up to maximize the expected impact on the scientific community, policy-making and the society in general. The following experts have already expressed their support for our project: Prof. Hong Liao (Nanjing University of Information Science & Technology, CLA of the upcoming IPCC AR6), Prof. Nicolas Bellouin (University of Reading, PI of several EU projects including Copernicus Atmospheric Monitoring Service: Climate Forcings), Dr. Elisabetta Vignati (Head of the European Commission’s Joint Research Center’s Air and Climate Unit), Ms. Cat Downy (European Space Agency - Future Earth Liaison Officer) and Dr. Jean-Noël Thépaut (head of Copernicus Climate Change Service).

FORCeS will also exploit and benefit from the expertise of the Swedish EPA, IIASA and INERIS in the dissemination of results to a wider next user community (cf. Section 1.3 and 1.4). In addition, the FORCeS project will coincide with the UNFCCC “Talanoa Dialogue” informing the first full stocktake of progress towards the long-term temperature goal of the Paris Agreement (2019-2023). *FORCeS will contribute extensively to this dialogue through Conference of Parties (COP) side-events stakeholder workshops* (WP7). FORCeS will also organize workshops to disseminate knowledge to climate data users (WP7 with contribution from WP1-W6). Furthermore, FORCeS consortium members are active within the CCAC, the Arctic council, CLRTAP and CORDEX (cf. Section 1.3 (b)) and will work with them towards a better understanding of the regional impact of aerosols on climate as well as on the link between climate and air pollution mitigation. With organizations such as Future Earth and GESAMP (Section 1.3 (b)), FORCeS will work towards better knowledge of the general impact of aerosols on climate.

“Sustaining Europe’s leadership in climate science”: This goal will be achieved through the i) continued long-term improvement by targeted development of key aerosol and cloud parameterizations of leading European Earth System Models (O1, WP1-WP5); ii) profiting and building on a wealth of unique data and model development obtained in previous European projects (O2, WP1-WP6); iii) fostering collaboration between European climate scientists working on different scales, from different perspectives and with different methods (WP1-WP7) and in networks external to the project); iv) promoting and training researchers and research leaders within the project (WP7). FORCeS brings together leading scientists working on aerosol forcing and climate feedbacks of the climate system from 20 research institutes and universities distributed over 13 European countries. The consortium will support and inspire the development of a new generation of leading scientists by recruiting and training outstanding early career scientists. A summer school will be organized to further support this demand (WP7 with support from WP1-WP6 & 8). The consortium is led by two mid-career scientists who through the project will be established as internationally recognized research leaders thus contributing to forming the next generation of European leadership in aerosol-climate science. The FORCeS consortium also includes five lead authors for IPCC AR6 chapters.

³⁰ Sand, M. et al., J.Clim., <https://doi.org/10.1175/JCLI-D-14-00050.1>, 2015.

³¹ Acosta-Navarro, J.A. et al., Nat. Geosci., doi:10.1038/ngeo2673, 2016.



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