Horizon 2020

Call: H2020-MSCA-IF-2017

(Marie Skłodowska-Curie Individual Fellowships)

Topic: MSCA-IF-2017

Type of action: MSCA-IF-EF-ST

(Standard EF)

Proposal number: 800154

Proposal acronym: INADEC

Deadline Id: H2020-MSCA-IF-2017

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How to fill in the forms?

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

This proposal version was submitted by **Virginie GUEMAS** on **14/09/2017 16:09:46** Brussels Local Time. Issued by the Participant Portal Submission Service.

Proposal ID **800154** *Acronym* **INADEC**

1 - General information

Topic	MSCA-IF-2017
Call Identifier	H2020-MSCA-IF-2017
Type of Action	MSCA-IF-EF-ST
Deadline Id	H2020-MSCA-IF-2017

Acronym	INADEC
Proposal title	Impacts of the North Atlantic Decadal variability on European Climate: mechanisms and predictability

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

Duration in months	24
Scientific Area	ENV

Please select up to 5 descriptors (and at least 3) that best characterise the subject of your proposal, in descending order of relevance.

Descriptor 1	*Climatology and climate change*
Descriptor 2	*Oceanography, marine science, coastal engineering*
Descriptor 3	*Meteorology, atmospheric physics and dynamics*
Descriptor 4	*Numerical analysis, simulation, optimisation, modelling tools*
Descriptor 5	*Data Analysis*
Free keywords	*Climate decadal variability, North Atlantic ocean dynamics, atmospheric teleconnection dynamics, climate predictions*

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Abstract

During the last century, the North Atlantic sea surface temperature exhibited superimposed long-term warming trend and multidecadal fluctuations. This multidecadal variability is referred to as the Atlantic Multidecadal Variability (AMV). The AMV has been pointed as the source of marked climate anomalies and associated human impacts over many areas of the globe. This includes droughts in Africa and North America, decline in sea-ice, changes of tropical cyclone activity in the Atlantic, as well as temperature and precipitation impacts over Europe.
Decadal climate forecast systems are able to capture the historical evolution of the AMV. This is encouraging for the prospect of getting skillful decadal predictions over continents through the impacts of the AMV. However, to date decadal prediction systems show only limited prediction skill over Europe in terms of temperature and precipitation. A possible explanation for this paradoxical missing skill is that current decadal forecast systems are missing key mechanisms to correctly simulate the AMV-Europe teleconnections and their associated predictability.
The main goal of INADEC is to better estimate and understand the teleconnections between the AMV and European climate in order to precisely determine their predictability.

Remaining characters 711

Has this proposal (or a very similar one) been submitted to a Horizon 2020 Marie Skłodowska-Curie Individual Fellowship call, with the same supervisor and future host institution (and partner organization for Global Fellowships)? ○ Yes ◉ No

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Declarations

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

4) The applicant (future beneficiary) hereby declares:

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

The applicant (future beneficiary) is only responsible for the correctness of the information relating to his/her own organisation. Where the proposal to be retained for EU funding, the applicant (future beneficiary) 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).

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List of participants

#	Participant Legal Name	Country
1	BARCELONA SUPERCOMPUTING CENTER - CENTRO NACIONAL DE SUPERCOMPUTACION	Spain

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Proposal ID **800154** *Acronym* **INADEC** *Short name* **BSC**

2 - Administrative data of participating organisations

Future Host Institution

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

Short name: BSC

Address of the organisation

Street Calle Jordi Girona 31

Town BARCELONA

Postcode 08034

Country Spain

Webpage www.bsc.es

Legal Status of your organisation

Research and Innovation legal statuses

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

Legal person ..... yes

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Proposal ID **800154** *Acronym* **INADEC** *Short name* **BSC**

Department(s) carrying out the proposed work

Department 1

Department name: Earth Sciences ☐ not applicable

☐ Same as organisation address

Street: Jordi Girona, 29

Town: Barcelona

Postcode: 08034

Country: Spain

If the location of the Department carrying out the proposed work is not the same as the location of the Host Institute, please note that although the proposal submission system calculates the budget of the project based on the location of the Host Institute, the budget of the project for the grant agreement will be calculated by using the country coefficient of the location of the Department carrying out the proposed work.

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Proposal ID **800154** *Acronym* **INADEC** *Short name* **BSC**

Researcher

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

Last Name*	RUPRICH-ROBERT	Last Name at Birth	RUPRICH-ROBERT
First Name(s)*	Yohan	Gender*	◉ Male ○ Female
Title	Dr.	Country of residence*	Spain
Nationality*	France	Nationality 2	
Date of Birth (DD/MM/YYYY)	01/12/1985	Country of Birth*	France
		Place of Birth	Paris

Contact address

Current organisation name	Barcelona Supercomputing Center		
Current Department/Faculty/Institute/ Laboratory name	Earth Sciences		
☒ Same as organisation address			
Street	Calle Jordi Girona 31		
Postcode/Cedex*	08034	Town*	BARCELONA
Phone	+33679920806	Country*	Spain
Phone2 / Mobile	*+xxx xxxxxxxxx*		
E-Mail*	yruprich@gmail.com		

ORCID ID	0000-0002-4008-2026		
Researcher ID			*The maximum length of the identifier is 11 characters (ZZZ-9999-2010) and the minimum length is 9 characters (A-1001-2010).*
Other ID	*Please enter the type of ID here*	*Please enter the identifier number here*	

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Qualifications

University Degree giving access to PhD	Date of award (DD/MM/YYYY)	02/07/2010
Doctorate	Start date (DD/MM/YYYY)	12/10/2010
Doctorate	Date of (expected) award (DD/MM/YYYY)	08/04/2014
Full time research experience	Number of months	82

(Measured from the date when a researcher obtained the degree entitling him/her to embark on a doctorate, either in the country in which the degree was obtained or in the country in which the researcher is recruited, even if a doctorate was never started or envisaged.)

Place of activity/place of residence (previous 5 years - most recent one first)

Indicate the period(s) and the country/countries in which you have legally resided and/or had your main activity (work, studies, etc) during the last 5 years up until the deadline for the submission of the proposal. Please fill in this section without gaps, until the call deadline (14/09/2017).

Period from	Period to	Duration (days)	Country
01/09/2017	14/09/2017	14	Spain
01/05/2017	31/08/2017	123	France
01/05/2014	30/04/2017	1096	United States
01/12/1985	30/04/2014	10378	France
	Total	11611	

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Proposal ID **800154** *Acronym* **INADEC** *Short name* **BSC**

Supervisor

The name and e-mail of the Researcher and Supervisor are read-only in the administrative form, only additional details can be edited here. To give access rights and 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*: **Virginie** | Last name*: **Guemas**

E-Mail*: **virginie.guemas@bsc.es**

Position in org.: Head of the Climate Prediction Group

Department: Earth Sciences

☐ Same as organisation address

Street: Jordi Girona, 29

Town: Barcelona | Post code: 08034

Country: Spain

Website:

Phone: +34934137679 | Phone 2: *+xxx xxxxxxxxx* | Fax: *+xxx xxxxxxxxx*

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Dorota	Chmielewska	dorota.chmielewska@bsc.es	+34934134082

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3 - Budget

Is the Researcher eligible for family allowance? (•) Yes ( ) No

Participant Number	Organisation Short Name	Country	Country Coefficient	Number of Months	Researcher Unit Cost			Institutional Unit Cost		Total
					Living Allowance	Mobility Allowance	Family Allowance	Research, training and networking costs	Management and Overheads	
1	BSC	ES	0,976	24	108921,60	14400,00	12000,00	19200,00	15600,00	170121,60
Total				24	108921,60	14400,00	12000,00	19200,00	15600,00	170121,60

Partner Organisation from Third Country does not sign the Grant Agreement, does not recruit the researcher and does not directly claim costs from the action. The entire EC contribution is transmitted to the Host organisation located in Members States or Associated Countries.

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4 - Ethics issues table

1. HUMAN EMBRYOS/FOETUSES		Page
Does your research involve Human Embryonic Stem Cells (hESCs)?	○ Yes ◉ No	
Does your research involve the use of human embryos?	○ Yes ◉ No	
Does your research involve the use of human foetal tissues / cells?	○ Yes ◉ No	
2. HUMANS		**Page**
Does your research involve human participants?	○ Yes ◉ No	
Does your research involve physical interventions on the study participants?	○ Yes ◉ No	
3. HUMAN CELLS / TISSUES		**Page**
Does your research involve human cells or tissues (other than from Human Embryos/ Foetuses, i.e. section 1)?	○ Yes ◉ No	
4. PERSONAL DATA		**Page**
Does your research involve personal data collection and/or processing?	○ Yes ◉ No	
Does your research involve further processing of previously collected personal data (secondary use)?	○ Yes ◉ No	
5. ANIMALS		**Page**
Does your research involve animals?	○ Yes ◉ No	
6. THIRD COUNTRIES		**Page**
In case non-EU countries are involved, do the research related activities undertaken in these countries raise potential ethics issues?	○ Yes ◉ No	
Do you plan to use local resources (e.g. animal and/or human tissue samples, genetic material, live animals, human remains, materials of historical value, endangered fauna or flora samples, etc.)?	○ Yes ◉ No	
Do you plan to import any material - including personal data - from non-EU countries into the EU?	○ Yes ◉ No	
Do you plan to export any material - including personal data - from the EU to non-EU countries?	○ Yes ◉ No	
In case your research involves low and/or lower middle income countries, are any benefits-sharing actions planned?	○ Yes ◉ No	
Could the situation in the country put the individuals taking part in the research at risk?	○ Yes ◉ No	

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7. ENVIRONMENT & HEALTH and SAFETY		Page
Does your research involve the use of elements that may cause harm to the environment, to animals or plants?	○ Yes ◉ No	
Does your research deal with endangered fauna and/or flora and/or protected areas?	○ Yes ◉ No	
Does your research involve the use of elements that may cause harm to humans, including research staff?	○ Yes ◉ No	
8. DUAL USE		**Page**
Does your research involve dual-use items in the sense of Regulation 428/2009, or other items for which an authorisation is required?	○ Yes ◉ No	
9. EXCLUSIVE FOCUS ON CIVIL APPLICATIONS		**Page**
Could your research raise concerns regarding the exclusive focus on civil applications?	○ Yes ◉ No	
10. MISUSE		**Page**
Does your research have the potential for misuse of research results?	○ Yes ◉ No	
11. OTHER ETHICS ISSUES		**Page**
Are there any other ethics issues that should be taken into consideration? Please specify	○ Yes ◉ No	

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

How to Complete your Ethics Self-Assessment

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5 - Call specific questions

Eligibility Researcher (future fellow)

1. Were you in the last 5 years in military service? ○ Yes ◉ No

Other Questions

1. For communication purposes only, the European Commission REA asks for permission to publish the name of the researcher (future fellow) should the proposal be retained for funding. Does the researcher (future fellow) give this permission? ◉ Yes ○ No

2. Some national and regional public research funding authorities run schemes to fund MSCA applicants that score highly in the MSCA evaluation but which cannot be funded by the MSCA due to their limited budget. In case this proposal could not be selected for funding by the MSCA, do the researcher and supervisor consent to the European Commission disclosing to such authorities the results of its evaluation (score and ranking range) together with their names and contact details, non-confidential proposal title and abstract, proposal acronym, and host organisation? ◉ Yes ○ No

3. Is there a secondment in Member States or Associated Countries envisaged in Part B of this proposal? ◉ Yes ○ No

In which sector is the secondment in Member States / Associated Countries foreseen?

☒ Academic ☐ Non Academic

Do you already know the organisation to which this secondment will be? ◉ Yes ○ No

Name: University of Reading

Country: United Kingdom

In which sector is the secondment in Member States / Associated Countries foreseen?

☒ Academic ☐ Non Academic

Do you already know the organisation to which this secondment will be? ◉ Yes ○ No

Name: ISPL - LOCEAN

Country: France

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Extended Open Research Data Pilot in Horizon 2020

If selected, applicants will by default participate in the Pilot on Open Research Data in Horizon 2020[1] , which aims to improve and maximise access to and re-use of research data generated by actions.

However, participation in the Pilot is flexible in the sense that it does not mean that all research data needs to be open. After the action has started, participants will formulate a Data Management Plan (DMP), which should address the relevant aspects of making data FAIR – findable, accessible, interoperable and re-usable, including what data the project will generate, whether and how it will be made accessible for verification and re-use, and how it will be curated and preserved. Through this DMP projects can define certain datasets to remain closed according to the principle "as open as possible, as closed as necessary". A Data Management Plan does not have to be submitted at the proposal stage.

Furthermore, applicants also have the possibility to opt out of this Pilot completely at any stage (before or after the grant signature). In this case, applicants must indicate a reason for this choice (see options below).

Please note that participation in this Pilot does not constitute part of the evaluation process. Proposals will not be penalised for opting out.

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

Further guidance on open access and research data management is available on the participant portal: http://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/open-access-dissemination_en.htm and in general annex L of the Work Programme.

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

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START PAGE

MARIE SKŁODOWSKA-CURIE ACTIONS

Individual Fellowships (IF)
Call: H2020-MSCA-IF-2017

PART B

"**INADEC**
Impacts of the **N**orth **A**tlantic **D**ecadal variability on **E**uropean **C**limate:
mechanisms and predictability"

This proposal is to be evaluated as:

[EF-ST]

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List of participating organisations

Participating organisations	Legal Entity Short Name	Academic (tick)	Non-academic (tick)	Country	Dept./ Division / Laboratory	Supervisor	Role of Partner Organisation
Beneficiary							
Barcelona Supercomputing Center	BSC	x		Spain	Earth Sciences Department	Dr. Virginie Guemas	
Entity with a capital or legal link							
- NAME							
Partner Organisation							
Institut Pierre Simon Laplace	ISPL	x		France	LOCEAN (UMR 7159)	Dr. Juliette Mignot	Secondment
University of Reading	University of Reading	x		UK	Department of Meteorology	Dr. Jonathan Robson	Secondment

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1. Excellence

1.1 Quality and credibility of the research/innovation action

1.1.1 Introduction

a) State-of-the-art

The Atlantic Multidecadal Variability (AMV). During the last century, the North Atlantic sea surface temperature (SST) exhibited superimposed long-term warming trend and multidecadal fluctuations. This multidecadal variability is referred to as the Atlantic Multidecadal Variability (AMV). The AMV has been pointed as the source of marked climate anomalies and associated human impacts over many areas of the globe (cf. Figure). This includes droughts over Africa (in particular the extremely severe and long lasting 70s-80s sahelian drought, responsible for 100,000 human losses[1]) and North America[2-3], decline in Arctic sea ice[4], changes in Atlantic tropical cyclone activity[5], and the recent global temperature hiatus[6,7] . The North Atlantic SST is also a main actor of the European climate variability. Previous studies argued for the existence of a causal link between the warm phase of the AMV and warm conditions over Central Europe, dry conditions over the Mediterranean basin, and wet conditions over Northern Europe[8,9], modulating the river streamflow and the electricity production[10]. The AMV can also impact the location and activity of the North Atlantic storm track by modulating the number of blocking events and/or by driving North Atlantic Oscillation anomalies[11-13]. **Given the numerous climate impacts of the AMV and their related consequences on human society, predicting its evolution and its teleconnections is of high interest.**

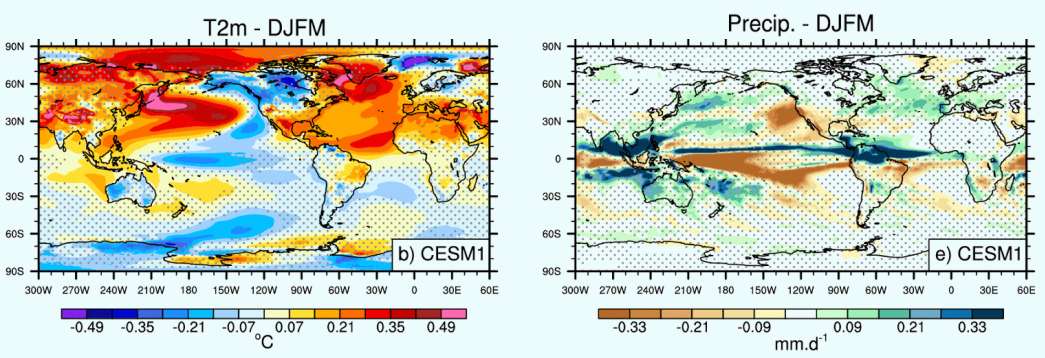

Figure: Differences of December to March (DJFM) of (left) 2-meter air temperature and (right) precipitation between the positive and the negative AMV phases, as simulated by the NCAR-CESM1 numerical AMV experiments introduced in Ruprich-Robert et al. (2017)[14]. Stippling indicates regions that are below the 95% confidence level of statistical significance according to a two-sided t-test.

Decadal prediction of the North Atlantic region. Coupled Global Climate Models (CGCMs) have been first developed and used as numerical tools to investigate and understand the climate system through sensitivity experiments (e.g., effects of external forcings, ocean-atmosphere coupling, or soil moisture on climate behaviour), and to assess the climate variability in a statistical way through long control integrations. There was no effort to phase the model variability with the observed one. Recently, CGCMs were thought to have reached a sufficient level of reliability to track observed variability and to be used for predict the climate of the next 10 years or so. In this context, the European ENSEMBLES project and the 5th Coupled Model Intercomparison Project (CMIP5) have conducted internationally coordinated retrospectives decadal forecasts (hindcasts). This exercise consists in integrating CGCMs initialized from the available observations and comparing their outputs to observations. Results from these hindcasts highlighted that **the North Atlantic basin is the most predictable region of the world at multi-year to decadal timescales**[15].

The origin of the North Atlantic decadal prediction skill has been linked to the predictability of the oceanic heat transport anomalies[16,17]. In particular, the evolution of **the hindcast oceanic heat transport is consistent with the idea of an oceanic response to the late 20th century long lasting NAO forcing** that the prediction initialization process imprints into the coupled predictions. But, it still remains to be tested whether the current generation of

1. Africa environment outlook: Past, present, and future perspectives. United Nations Environmental Program (2002); **2**. Mohino et al. (2011, *Clim Dyn*, doi:10.1007/s00382-010-0867-2); **3**. Enfield et al. (2001, *Geophys. Res. Lett*. 28, 2077-2080); **4**. Mahajan et al. (2011, *J. Clim*, doi:10.1175/2011JCLI4002.1); **5**. Vimont, and Kossin (2007, *Geophys. Res. Lett.* 34, L07709); **6**. McGregor et al. (2014, *Nat. Clim. Chang.* 4, 888–892); **7.** Li et al. (2015, *Nat. Clim. Chang.*, doi:10.1038/nclimate2840); **8.** Sutton and Hodson (2005, *Science*, doi:10.1126/science.1109496); **9.** Sutton and Dong (2012, *Nat. Geosci.*, doi:10.1038/ngeo1595); **10.** Boer et al. (2016, *Geosci. Model Dev. Discuss*., doi:10.5194/gmd-2016-78); **11.** Hakkinen et al. (2011, *Science*, doi:10.1126/science.1205683); **12.** Peings and Magnusdottir (2014, *Environ. Res. Lett.*, doi:10.1088/1748-9326/9/3/034018); **13.** Gastineau and Frankignoul (2012, *Clim. Dyn.*, doi:10.1007/s00382-011-1109-y); **12.** Peings and Magnusdottir (2014, *Environ. Res. Lett.*, doi:10.1088/1748-9326/9/3/034018); **15.** Doblas-Reyes et al. (2013, *Nat. Comm.*, doi: 10.1038/ncomms2704); **16.** Robson et al. (2012, *J. Clim.*, doi:10.1175/JCLI-D-11-00443.1); **17.** Yeager et al. (2012, *J. Clim.*, doi:10.1175/JCLI-D-11-00595.1).

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CGCM has the capacity to reproduce this succession of events (i.e., NAO forcing / heat transport response / SST anomalies). The long lasting historical NAO event also raise the question of **what kind of NAO/atmospheric forcing is required to imprint a predictable oceanic response** in decadal prediction. Is a strong and long lasting NAO forcing a prerequisite to force large enough heat content anomalies to obtain skillful SSTs? This will be tested in INADEC.

The high predictive skill of the North Atlantic region is encouraging for the prospect of getting skillful decadal predictions over Europe through the impacts of the AMV[18]. However, in the CMIP5 hindcasts the prediction skill over the continents was mostly coming from the global warming trend due to anthropogenic emission. To date, **the ocean initialization from observations barely provides any additional prediction skill over continents**. This missing skill could be explained by any or a combination of these following reasons: (1) the teleconnection mechanisms between the AMV and continents are poorly simulated by climate models, (2) no AMV impacts over Europe truly exist or, (3) the forecast drift[19], due to the different mean states between model and observations/reality, leads to a rapid loss of the initial condition information and then to a loss of the potential prediction skill. **These different hypotheses have to be tested in order to assess the predictability of European climate at decadal timescales**. Within the Decadal Climate Prediction Panel (DCPP)[10] of the incoming CMIP6 exercise, new decadal predictions (DCPP-component A) and AMV sensitivity experiments (DCPP-component C) will be performed. In the latter, following Ruprich-Robert et al. (2017)[14] protocol, the CGCMs' North Atlantic SSTs are restored to SST anomalies corresponding either to the warm or the cold phase of the observed AMV. The two components of the DCPP offer the opportunity to test the different hypotheses mentioned above.

Model uncertainties. There are several hints that the current generation of CGCM (of typical 1° resolution) is missing key mechanisms to correctly simulate the observed AMV – Europe teleconnections. For example, if CGCMs tend to simulate a positive phase of the AMV some years after a strengthening of the northward oceanic heat transport[20], the tropical SST anomalies associated with this transport are weaker than the ones associated with the observed AMV[21]. If the tropical SST associated with the AMV are driving (at least part of) the AMV – Europe teleconnections[22], t**he discrepancy between observed and simulated AMV tropical SST signature may explain the lack of the AMV – Europe teleconnection** in decadal predictions. A possible explanation for the weak decadal tropical SST anomalies may come from the poor simulation of clouds and of their associated feedbacks, as well as to underestimated dust-SST-rainfall feedbacks in current CGCMs[23,24]. Without CGCMs correctly representing such processes, the level of decadal predictability of the tropical North Atlantic and of its associated teleconnections cannot be ascertained.

Frontal oceanic regions such as the Gulf Stream and its extension are also regions where important mechanisms may be missing in the current CGCM generation due to their relatively coarse resolution. These fronts have been shown to shape both the local and the large scale atmospheric circulation characteristics[25,26]. Additionally, CGCMs studies demonstrated fundamental changes on the atmosphere-ocean coupling from meso-scale (~0.1°) to large scale (>1°), with SSTs being forced by winds at large scale whereas SSTs force the winds at frontal- and meso-scales[27]. Because the oceanic mechanisms driving the North Atlantic decadal fluctuations have a strong surface temperature signature over the Gulf Stream and its extension[13], this suggests that the current generation of CGCMs is misrepresenting part of the atmospheric response to the AMV. This may partly explain the lack of AMV – Europe teleconnections in the current decadal prediction systems. To investigate this uncertainty, **tests need to be done with higher model resolutions**.

b) Specific objectives and overview of the action

To summarize, the observed AMV is linked to strong modulations of the European climate at decadal timescale. Decadal climate predictions broadly capture the historical AMV evolution. However, decadal climate predictions show only limited prediction skill over Europe, with no real contribution coming from ocean initialization. **The main goal of INADEC is to better estimate and understand the teleconnections between the AMV and the European climate in order to precisely determine their predictability**. To reach this goal, INADEC is articulated around three work packages (WP), each tailored to address a specific objectives:

- Explore and document the heterogeneity of the AMV-Europe teleconnections as represented by the latest generation of CGCMs (**WP1**),
- Review and test the role of different key mechanisms proposed in literature to explain AMV variability and predictability over the North Atlantic region (**WP2**),

18. Guemas et al. (2015, *Q. J. Roy. Meteor. Soc.*, doi:10.1002/qj.2379); **19.** Sanchez-Gomez et al. (2016, *Clim. Dyn*., doi:10.1007/s00382-015-2678-y); **20.** Ba et al. (2014, *Clim. Dyn*. 43, 2333-2348); **21.** Medhaug and Furevik (2011, *Ocean Sci. Discuss.*, doi:10.5194/os-7-389-2011); **22.** Peings and Magnusdottir (2015, *Clim. Dyn.*, doi:10.1007/s00382-015-2887-4); **23.** Martin et al. (2014, *J. Clim.*, doi:10.1175/JCLI-D-13-00242.1); **24.** Yuan et al. (2016, *Geophys. Res. Lett.* 43, 1349-1356); **25.** Chelton et al. (2001, *J. Clim.* 14, 1479-1498); **26.** Minobe et al. (2008, *Nature* 452, 206-209); **27.** O'Reilly et al. (2016, *Clim. Dyn*., doi:10.1007/s00382).

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- Quantify and understand the decadal prediction skill over Europe in the new CMIP6 decadal predictions (**WP3**).

1.1.2 Research methodology and approach

WP1: Making sense of the diversity of AMV-Europe teleconnections simulated by CMIP5/6 models

Task 1.1 – Simulated AMV: origins, teleconnections, and uncertainties [pm1–8]. Our first effort will consist in a clustering analysis of the simulated AMV from the preindustrial and historical simulations of the CMIP5 and CMIP6 databases. Previous CMIP exercises have shown that the models' AMV exhibit a large inter-model spread of spatio-temporal characteristics[21,22,28]. As different AMV spatial patterns are expected to lead to different climate impacts, we will perform the AMV classification based on spatial pattern similarity. It has also been shown that different AMV timescales may lead to different climate impacts[29]. The classification will hence also be based on the simulated AMV period. This will be done by computing the cluster analysis from outputs of an Extended Empirical Orthogonal Function (E-EOF)[30] analysis of the North Atlantic SST field. The E-EOF extracts mode of variability using the covariance matrix of a field at different time lags, hence combining spatial and temporal characteristics. This classification will give us an interpretative framework to test whether similar simulated AMVs: (1) are driven by similar mechanisms, and (2) lead to similar European climate impacts. It will also tell us which regions of the North Atlantic drive European decadal climate variability in climate models. Results will be compared with observational estimates (i.e. reanalyses and reconstructions) to evaluate the accuracy of the simulated teleconnections. The comparison of the AMV classification between the preindustrial and the historical simulations will give us information on the relative importance played by external forcing and internal variability on the characteristics of the AMV and on its associated climate impacts.

Task 1.2 – Teleconnections between the observed AMV and the European climate [pm4–8]. The current CGCM generation may miss key mechanisms to correctly simulate the spatial pattern of the observed AMV. Investigate the AMV impacts using CGCMs can only offer limited insight into the observed teleconnections insofar as simulated AMV patterns are usually different from the observed one. Task 2.1 will palliate this limitation through the analyzes of DCPP-component C AMV experiments, in which the observed AMV anomalies are imposed over the CGCMs' North Atlantic region. In this case, as compared to Task1.1, cross-model differences are expected to emerge only from different simulated atmospheric response, as the imposed AMV pattern will be identical. We will concentrate on the mean surface temperature and precipitation response over Europe as well as on the modulation of the occurrence of heat waves / cold spells and droughts / floods. As the AMV SST forcing will be the same for all models, the multi-model comparison will allow us to test the robustness of the AMV impacts. We will compare these results with those from Task 1.1. In particular, we will identify models exhibiting consistent AMV – Europe teleconnections among the different experiments.

WP2: Climate response to an NAO forcing

Task 2.1 – Physical processes driving the North Atlantic decadal variability [pm12–19]. Ensemble experiments (10 members initialized from different states of a preindustrial control simulation) with the EC-Earth, IPSL-CM6, and HadGEM3 models will be performed to evaluate the climate predictability following an idealized NAO forcing. In the following, these experiments are referred as to "NAO experiments". The procedure is as follows: additional surface heat fluxes, characteristic of an NAO forcing, are given to the ocean component of the fully coupled models for several consecutive winters over the North Atlantic entire region. The model is then let freely adjusting to the atmospheric impulse forcing (i.e. integrated for 10-20 years after the end of the forcing). We will test the strength and the length of the atmospheric forcing required to obtain a significant oceanic response. This analysis will take advantage from the tools developed at LOCEAN and University of Reading to investigate the North Atlantic 3D structure in both depth and density coordinates, as well as to compute oceanic heat budget analysis. The predictability of the climate response will be assessed by estimating signal-to-noise ratios. Results from the classification performed in Task 1.1 will also be used to trace back the atmospheric forcing driving the North Atlantic decadal variability in the different CMIP5/6 models, and to evaluate whether they are consistent with an NAO / heat transport / SST mechanism.

Task 2.2 – Impacts of model resolution on the North Atlantic decadal variability characteristics [pm19–24]. Within the European project PRIMAVERA, the BSC developed a ground-breaking resolution version (~15km atmosphere and ocean) of the EC-Earth coupled model. This extremely high resolution configuration will be used to carry out a 100 years control simulations under perpetual 1950 conditions and a Shared Socioeconomic Pathway (SSP) simulation covering the 1950-2050 period following the CMIP6 HighResMIP protocol. To test the impact of the model resolution, this protocol will be followed using also a standard version of EC-Earth (100km in the ocean, 80km in the atmosphere) and a high resolution version (40km in the atmosphere and 25km in the ocean). BSC will

28. Zhang and Wang (2013, *J. Geophys. Res. Ocean.*, doi:10.1002/jgrc.20390); **29.** Delworth and Zeng (2015, *J. Clim.*, doi: 10.1175/JCLI-D-15-0396.1); **30.** Bryan and Nasstrom (1982, *J. Atmos*. 110, 481-485).

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be the only institute worldwide contributing to HighResMIP with such a high resolution as 15km globally and with three different configurations. This unprecedented set of simulations will be exploited to assess the role of resolution on the spatio-temporal characteristics of the North Atlantic variability and its impact on the European climate. Additionally, we will perform NAO idealized experiments with the low and the high resolution versions of EC-Earth.

WP3: Understanding the European climate predictive skill of the CMIP6 decadal predictions

Task 3.1 – Prediction skill of the North Atlantic and Europe climate in the CMIP6 decadal predictions [pm8–11]. The prediction skill of the North Atlantic – Europe climate will be assessed from the new sets of decadal predictions performed within CMIP6[10]. In particular, we will investigate how the representation of the AMV in decadal predictions evolves as a function of the forecast lead-time/drift and how it impacts the AMV – Europe teleconnections. This Task will benefit of the s2dverification tool developed by BSC (https://cran.r-project.org/web/packages/s2dverification/index.html). The classification performed in Task 1.1 will be used as an interpretative framework to understand the prediction skill. For example, the AMVs simulated at the different hindcasts lead-time will be classified within the clusters computed from the historical simulations. We will investigate in particular whether models simulating AMV characteristics close to the observed ones at each lead-time exhibit higher prediction skill than the others.

Task 3.2 - Physical processes driving the North Atlantic decadal predictability [pm14-24]. We will investigate whether models simulating a mechanism of internal North Atlantic decadal variability close to the one suspected to be at the origin of the decadal prediction skill (i.e. NAO forcing / oceanic heat transport / SST anomalies) exhibit higher predictive skill than the others. Furthermore feeding from the results of the sensitivity experiments performed within Tasks 2.2, additional decadal prediction experiments will be performed with the high resolution version of EC-Earth to investigate the impacts of model resolution on the decadal predictive skill.

1.1.3 Originality and innovative aspects of the research program

Historical AMV evolution is broadly captured by decadal climate predictions. Given the climate impacts of AMV, this predictive skill is encouraging for the prospect of climate predictions over Europe. The present project aims to elucidate the paradoxical lack of prediction skill in the current decadal forecast systems in European temperature and precipitation. The proposal is built following a logic of hand-in-hand development of scientific knowledge and prediction systems: hypotheses developed from the first are tested through the second. In this sense, our proposed research will lead to both a better understanding of the climate decadal variability and future development of decadal forecast systems. INADEC tackles therefore challenging issues ranked as “priority” by several World Climate Research Program (WCRP) panels. This proposal also presents innovative approaches:

- the cluster analysis performed within Task 1.1 introduce for the first time an AMV classification based on both spatial and temporal characteristics. This novel and synthetic classification could enable a major breakthrough in our understanding of the AMV and of its European climate impacts,
- Tasks 1.2 and 2.1 offer an inventive process based approach to understand the mechanisms that drive the AMV – Europe teleconnections. Understand these mechanisms, and using the exact same experimental setup with different CGCMs, will allow us to identify model deficiencies, which is the first step to improve climate models and decadal forecast systems,
- our project will go beyond the limit of the actual CGCM generation by testing high (40 km atmosphere and 25 km ocean) and ground breaking (15 km ocean-atmosphere) model resolution within Task 2.2,
- the results from Tasks 1.1 to 2.2 will be used as a guideline to understand the different prediction skills assessed in Tasks 3.1 and 3.2. Using this original guided framework, we will identify the rationale behind the prediction skills and determine the strengths and weaknesses of the current decadal prediction systems.

1.1.4. Interdisciplinary aspects of the action

This project brings together climate dynamics and climate prediction, and relies on highly advanced statistical tools to analyze and interpret them conjointly. This work is computationally costly, and will be possible to the high-performance computing structure offered by BSC, supported by a strong IT team that has developed, among other things, an efficient 15 km global climate model and a user friendly platform to use it. Additionally, the outcomes of this project will provide relevant information for different socio-economics sectors (e.g., energy production, water management, agriculture). In this context, the researcher will benefit of its interactions with the climate service group at BSC to target and disseminate his research results in non-scientific communities, and, when possible, to address the needs. This project is therefore highly interdisciplinary, gathering expertises on atmospheric and oceanic sciences, HPC, mathematics, and socio-economy.

1.1.5. Career possibilities for the *experienced researcher* and new collaboration opportunities for the host organization

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Combining his expertise on the AMV dynamics and impacts with the strong background of the climate prediction group at BSC on developing forecasting capabilities, the experienced researcher will be in position to build a new research line on the prediction of the AMV. Being hosted by the BSC, the experienced researcher will enrich the BSC collaborative network by bringing his previous collaborations with the GFDL, the NCAR, WHOI, and Cerfacs (cf. Section 4). It will also represent an opportunity to reinforce the BSC's collaborations with the LOCEAN and the University of Reading, thanks to the secondments. Having participated to the creation of the DCPP-component C simulation protocol of CMIP6, the researcher will be a key asset for the involvement of the BSC in this project, and to facilitate the collaborations with the other climate institutes participating to it.

1.2 Quality and appropriateness of the training and of the two way transfer of knowledge between the researcher and the host

The implementation of this proposal in the Earth Sciences department at BSC (ES-BSC) offers an excellent opportunity to strengthen and expand both the applicant's and BSC's competences. In particular, the applicant could bridge the gap between his theoretical background in climate dynamics and climate variability diagnosis, and some demanding practical requirements of climate predictability and forecasting. During his doctoral and postdoctoral studies, the candidate acquired a strong understanding of the climate system, including oceanic and atmospheric dynamics and ocean-atmosphere coupling, and he developed excellent skill in data-processing. In particular, the researcher became an expert on the AMV dynamics and its climate impacts. As such an expert, he co-designed the experimental protocol of the AMV experiments of the DCPP-component C[10,14].

To understand the diversity of AMV mechanisms and impacts simulated by the different CMIP simulations, the applicant will rely on his knowledges acquired from his previous studies on the AMV of CNRM-CM5[31,] GFDL-CM2.1, GFDL-FLOR, and NCAR-CESM1 climate models (cf. Section 4), but also on the knowledges of Dr. Virginie Guemas, Dr. Juliette Mignot, and Dr. Jonathan Robson on the EC-Earth, IPSL-CM, and HadGEM3 climate models. During his PhD., the applicant acquired an in-depth knowledge of the potential climate predictability, performing decadal prediction within a perfect model framework. However, he lacks the convenient skills and experience on actual decadal forecasting. This fellowship will provide him this competence. Hosted by the Climate Prediction group of BSC under the supervision of Dr. Virginie Guemas, the applicant will be introduced to climate prediction and he will learn tools like forecast quality assessment. He will also benefit from participating in discussions and meetings within the H2020-funded PRIMAVERA and APPLICATE projects, and the ERA4CS MEDSCOPE project in which the ES-BSC participates. The applicant also strongly benefit from the high decadal prediction expertise of Dr. Juliette Mignot and Dr. Jonathan Robson through the secondments.

The researcher will also improve his coding and data analysis skills via the PATC courses (organized by PRACE, Partnership for Advanced Computing in Europe: www.bsc.es/education/training/patc-courses) and the regular training of the Computational Earth Sciences group of the ES-BSC. The latter also focuses on improving scientific and project writing abilities, and will introduced the researcher to project management. All this will be implemented via the formal courses organized by the Education and Training team and Human Resources, and the participation in the regular seminars organized by the department.

1.3 Quality of the supervision and of the integration in the team/institution

The Earth Sciences Department of the Barcelona Supercomputing Center (ES-BSC), led by Pr. Francisco J. Doblas-Reyes, conducts multi-facet research in Earth system modelling. It is a main European actor in the development of climate predictions and climate services. The ES-BSC has a very dense international collaborative network counting at least 50 institutes worldwide. The ES-BSC works on the development of and conducts research with a multi-scale set of comprehensive single-component and coupled GCMs. It is composed of four groups: 1) climate prediction group, 2) atmospheric composition group, 3) earth system services group, and 4) computational earth sciences group. The candidate will carry out his project in close collaboration with both the Climate Prediction and the Earth System Services groups.

The Climate Prediction group undertakes advanced research to forecast climate variations from one month to several years into the future (also known as seasonal-to-decadal predictions) and from regional to global scales. This objective relies on expanding our understanding of the climate processes through deep analyses of the strengths and weaknesses of state-of-the-art climate forecast systems in comparison with the most up-to-date observational datasets, and on exploiting these detailed analyses to refine the representation of climate processes in our climate forecast systems and their initialization. It is a highly productive scientific entity that has published more than 150 research articles in peer-reviewed journals over the last 5 years, including 13 in prestigious high-impact journals.

31. Ruprich-Robert and Cassou (2015, *Clim. Dyn*., doi:10:1007/s00382-014-2176-7).

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The Earth System Services group aims to bridge the gap between climate information and end users in key sectors of society (energy, urban development, infrastructure, transport, health and agriculture) via tailored services to societal actors. Members of this group actively work in identifying user needs, which partly guide research in the ES-BSC and aim to quantify the impact of weather, climate, aerosols and gaseous pollutants upon socio-economic sectors through the development of user-oriented services that ensure the transfer of the technology developed and the adaptation to a rapidly changing environment, especially of those highly vulnerable. They develop these non-profit services in-house in collaboration with public administrations, private contracts with companies or funding agencies, and spin-off companies that could exploit operational opportunities.

The other two groups that the applicant will interact with are the computational earth sciences group and the atmospheric composition group. The former provides help and guidance to the scientists with the technical issues relating to their work and develops a framework for the most efficient use of HPC resources. Support includes optimization of the tools developed by scientists, development of automatic tools to compile, launch, monitor and post-process climate simulations and handle the large amount of data produced, as well as installation and upgrade of a variety of software to facilitate the scientists work. The latter group aims at further our understanding of the chemical composition of the atmosphere and its effects upon air quality, weather and climate, while improving predictions from local to global scales.

Dr. Virginie Guemas is the head of the climate prediction group in which the candidate will carry out his project. She is a Ramon y Cajal fellow since November 2015 and an expert on sub-seasonal to decadal climate prediction. Her PhD, carried out at Météo-France (Toulouse, France) and funded by a highly competitive PhD grant from the Commissariat à l'Energie Atomique, was defended in 2009 and awarded the Adrien Gaussail PhD prize, granted every 2 years to a scientific PhD. She is member of the WCRP (World Climate Research Program) CLIVAR (Climate and Ocean Variability, Predictability, and Change) SSG (Scientific Steering Group). She has participated in 17 national and international research projects up-to-date. Currently, she is co-coordinator of the MEDSCOPE project funded by ERA4CS and Principal Investigator (PI) of seven European projects funded under the FP7 (PREFACE), H2020 frameworks (IMPREX, APPLICATE, INTAROS), Copernicus (C3S-MAGIC), one MINECO-funded project (HIATUS), one PRACE-funded project (HiResSIR), one special project from ECMWF (HighResMIP_BSC) and she is WP leader in the H2020 PRIMAVERA project.

She was contributing author for the IPCC (Fifth Assessment Report) Chapter 11 Near-term Climate Change: "Projections and Predictability", in the UN IPCC AR5 Working Group I – The Physical Sciences Basis report. She is also author of 48 articles on climate modelling and predictions in international peer-reviewed journals, among which 9 in high-impact journals, such as Sciences, Nature Climate Change, Nature Communications and the Bulletin of the American Meteorological Society. She has a total of 1105 citations, with a h-/i-index of 16/24.

Dr. Virginie Guemas has supervised 3 PhD students and 17 post-doctoral scientists, including 2 Marie Sklodowska-Curie fellows. Virginie Guemas in particular, and ES-BSC in general, have been able to provide researchers with exceptional training support and conditions for their scientific growth, steering improvements in their scientific and management skills alike. The training capability of researchers is very extensive, and has been demonstrated through the successful experience of numerous pre- and postdoctoral scientists. Former postdocs and Ph.D. students hosted at the ES-BSC hold or held positions in several well-known scientific institutions and energy companies around the globe, such as the NASA Goddard Institute for Space Studies in USA (Dr. Carlos Përez García-Pando, currently at BSC), the School of Geography and Environment at the University of Oxford in UK (Dr. Karsten Haustein), and EnBW Energie Baden-Württemberg AG in Germany (Dr. Matthias Piot).

The proposed project will be managed through **weekly meetings with the supervisor to ensure full coherence between the research planned and the general objectives of ES-BSC**. **Regular meetings will take place involving the rest of the ES-BSC members**, especially those in the Climate Prediction and Earth System Services groups, **to ensure an adequate integration of this project into the rest of the research carried out in the host department**. In this context, the applicant will be encouraged to participate in discussions and meetings involving the H2020-funded projects PRIMAVERA and APPLICATE, as well as the MEDSCOPE project and HIATUS, ensuring his integration into and the build-up of an international network.

The Laboratoire d'Oceanographie et du Climat (**LOCEAN;** UMR 7159) is a leading laboratory in France employing about 100 permanent scientists in the field of climate research. The laboratory research activities address a wide range of topics contributing to better understanding the role of the ocean in the coupled climate system and its variability. Topics range from the ocean general circulation to ocean-atmosphere interactions, sea-ice physics, ocean dynamics and biogeochemistry at various scales and their coupling, ocean biology and ecology, and the ocean carbon cycle. LOCEAN is a leading institute in ocean modelling, responsible for the development of the NEMO model system, which is widely distributed among climate institutes around the world, including the BSC and the UK-MetOffice. Researchers from LOCEAN are also responsible for the development and the validation of the oceanic component of the IPSL climate model. The LOCEAN is indeed part of the IPSL federation, which widely contribute

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to the IPCC assessments reports, in particular in the framework of the development of the IPSL climate model and the participation to almost all the Model Intercomparison Projects. LOCEAN is much involved in the analysis of the climate variability and predictability in the North Atlantic. It has been involved in numerous international projects (cf. Section 5), in which LOCEAN senior scientists act as PIs and/or coordinators. The LOCEAN is also leading many research programs that evaluate the impacts of changing climate for human activities, and the improvement of climate services.

Dr. Juliette Mignot is a researcher at IRD working at LOCEAN. She is specialized in physical oceanography and climate variability. Her objectives are to better understand the climate low frequency variability and in particular the role of the ocean and of external forcing (e.g. role of volcanoes). Her expertise lies mainly in the North Atlantic region, and she has worked on the decadal climate variability in the Atlantic, on decadal prediction and predictability assessment, on understanding and characterizing the role of salinity in the oceanic stratification. She uses several statistical tools and climate models. She has been one of the initiators of the decadal predictability activities at IPSL/LOCEAN. She is also a member of the steering committee of the IPSL modelling group and actively participates to the development and validation of the IPSL-CM6 climate model. She has been involved in 6 European projects and several ANR projects, and she is regularly leading the LOCEAN activities for these projects. She is currently the PI of 2 national projects (LEFE-INSU and Labex-L-IPSL). J. Mignot has mentored 5 post docs, 4 PhD students and 6 master students. She has published 57 papers in rank-A journals (h-/i-index 24/47).

The Department of Meteorology of University of Reading is internationally renowned for its pioneering research in atmospheric, oceanic and climate science. The department is one of the biggest in the world with over 200 academic and research staff, including staff from the UK Met Office, and the UK's Natural Environment Research Council's (NERC) national research centres, the National Centre for Atmospheric Science (**NCAS**) and the National Centre for Earth Observation (NCEO). The most recent national evaluation, the Research Excellence Framework (2014), rated 86% of the Department of Meteorology's research as world leading or internationally excellent, making it the highest graded UK institution focusing on the fundamentals of weather and climate. Within the Department, the climate directorate of NCAS (NCAS-Climate) is an international leader in climate modelling, climate processes and climate predictions. NCAS also retains strong links with collaborators at the Met Office, including the assessment of UK Met Office climate models, and NCAS leads the development of the UK Earth System Model. The Meteorology department is also the home of NCAS Computational modelling support, who offer support and training for the UK's academic researchers who use Weather and Climate modelling tools.

Dr. Jonathan Robson is a Senior Research Scientist (equivalent to a Lecturer) in the **NCAS**. He is an expert on AMV and decadal climate prediction, especially in the Atlantic sector, and is particularly interested in improving the understanding of the mechanism associated with climate decadal variability and understanding whether these mechanisms can provide useful predictability for society. He has previously worked on understanding how the atmosphere can drive decadal variability in the Atlantic circulation, on initialized predictions of the North Atlantic, and on documenting the mechanisms involved in recent changes in the North Atlantic Climate. He was also part of a team who developed high-resolution initialized predictions. He is currently PI to 2 national projects (DYNAMOC and DYVA), and is the science program manager of the ~£ 9 million ACSIS project (www.acsis.ac.uk), which is a 5-year multidisciplinary research program focusing on improving the understanding of decadal variability in the North Atlantic. He was involved in EU projects (SPECS) and developed international collaborations with scientists in the U.S.A. (NCAR and GFDL) and across Europe (CERFACS). He currently supervises 5 post-doctoral researchers, and has previously supervised 1 PhD student, 3 Master students and 2 Undergraduate students. He has published 22 peer-reviewed papers in international Journals, including papers in high-impact journals (Nature Geoscience, Science, BAMS), and his h-/i-index is 15/16.

1.4 Capacity of the researcher to reach or re-enforce a position of professional maturity/independence

The researcher has already reached a status of expert on the AMV topic during his doctoral and postdoctoral research at Cerfacs and GFDL, contributing to the development of internationally coordinated experiments through the DCPP-component C[10,14]. He also developed collaborations with several recognized climate institutions (Cerfacs, IPSL, GFDL, NCAR, WHOI) and he co-supervised a PhD student from the University of Bologna during her 3 months stay at GFDL. Centered at the BSC, the proposed project will allow the researcher to be involved in several European (PRIMAVERA, PREFACE, MEDSCOPE) and national (HIATUS) projects and to be at the center of a large collaborative network. Working at BSC and collaborating with the University of Reading and the LOCEAN, the researcher will also re-enforce his knowledge on climate variability / predictability and on climate models. Being a leader on a novel research line at BSC, the candidate will be in position to build consortia to develop follow-up ambitious international projects and develop further his activities. This will highly benefit him to develop his own and independent research. Furthermore, a fundamental training objective of this project are new responsibilities through the managing of his fellowship research funds as well as through the tutoring of young scientists (master and PhD students). In contact of the BSC climate services team, the researcher will also gain skills in the dissemination

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of information about his research activities in both the scientific and industrial communities, as well as society in general.

2. Impact

2.1 Enhancing the potential and future career prospects of the researcher

Working at BSC and taking part to the ES-BSC European projects, as well as collaborating with the University of Reading and LOCEAN, the researcher will build-up an extensive international network. The project will also allow the researcher to become an European expert on climate prediction, and in particular a leader on the North Atlantic decadal variability and predictability. Finally, this project hosted at BSC will allow the researcher to pursue his own research line, managing a project (scientifically and financially), observing the management, logistics, and leadership of both small, local projects, and international, multi-institution projects, leading international collaborations, tutoring young scientists (master and PhD students), which are all required competences to successfully develop a productive and long-lasting scientific career. After the fellowship, the researcher's skills and network will hence allow him to build and run an independent research group. The competences on climate predictions acquired during this project will also allow the researcher to eventually work in climate services sector after the fellowship.

2.2 Quality of the proposed measures to exploit and disseminate the action results

Peer-reviewed publications and conferences. The research activities/results of the project will be disseminated to the scientific community through publications in international peer-reviewed journals, in particular in high-impacts journals such as Science, Nature, or PNAS whenever it is possible. At least 3 research papers are foreseen. One article will be dedicated to the representation of the AMV-Europe teleconnections as simulated by the CMIP5/6 models (Tasks 1.1 and 1.2). A second article will focus on the models outputs of the NAO experiments and to their sensitivity to grid refinement (Tasks 2.1 and 2.2). And a third article will be dedicated to the rationale behind the prediction skill of the North Atlantic - Europe region in the decadal hindcasts of CMIP6. In order to guarantee open access to all peer-reviewed scientific publications related to project results, BSC will provide open access, and will deposit all the papers in a repository to ensure they are preserved in long term. For this aim, BSC uses the institutional repository UPCommons.

In addition to peer-reviewed articles, the researcher will attend international conferences to present his original work. In particular, he will attend to the American and European Geophysical Union General Assemblies, the Ocean Sciences conference, and workshops focusing more specifically on climate decadal variability and predictability (cf. Gantt chart). He will also use his visits to LOCEAN and the University of Reading as opportunities to present is research results. It is also planned to visit NCAR and Cerfacs to present and discuss the applicant's results to an aimed research community.

Scientific projects. The engagement of the BSC in scientific projects such as PRIMAVERA, APPLICATE, MEDSCOPE and HIATUS will be a way to disseminate the outputs of this proposed research. In particular, the researcher will use these projects as an opportunity to encourage other European climate centers and research institutions to perform the NAO experiments described in Task 2.1. This would potentially lead to a model intercomparison study.

Dissemination through the Earth System Services group. The project will be conducted in tight collaboration with the Earth System Services group of the ES-BSC to ensure that their products, dedicated to end users, will benefit from the most recent advances in understanding and improving climate prediction capability over Europe.

2.3. Quality of the proposed measures to communicate the action activities to different target audiences

One of the priorities of the fellowship will be to seek public engagement through the active and effective communication of results to the non-specialized audience and to students. The applicant will have the support of the BSC communications department and the Earth System Services group of ES-BSC for the following planned activities:

- Inclusions of the project information, progress and results in several dissemination activities of BS (e.g., website, presentations, leaflets, brochures, videos),
- Development and maintenance of a webpage for disseminating the AMV classification tool and the NAO experimental protocol developed in this project,
- Participation in MareNostrum open day events, aimed at high school, graduate students, and general public,
- Academic cooperation with Universitat Politectica de Catalunya in the joint PhD programs and MSc courses and programs (in particular Master's degree in Oceanography and Marine Management).

In additions, for the overall of his project and for each published article, the researcher will write on his BSC's webpage a one page summary targeted to a broad scientific audience. As much as possible, the researcher will also publish highlights of his research to less specialized scientific journals like CLIVAR Exchanges or La Recherche.

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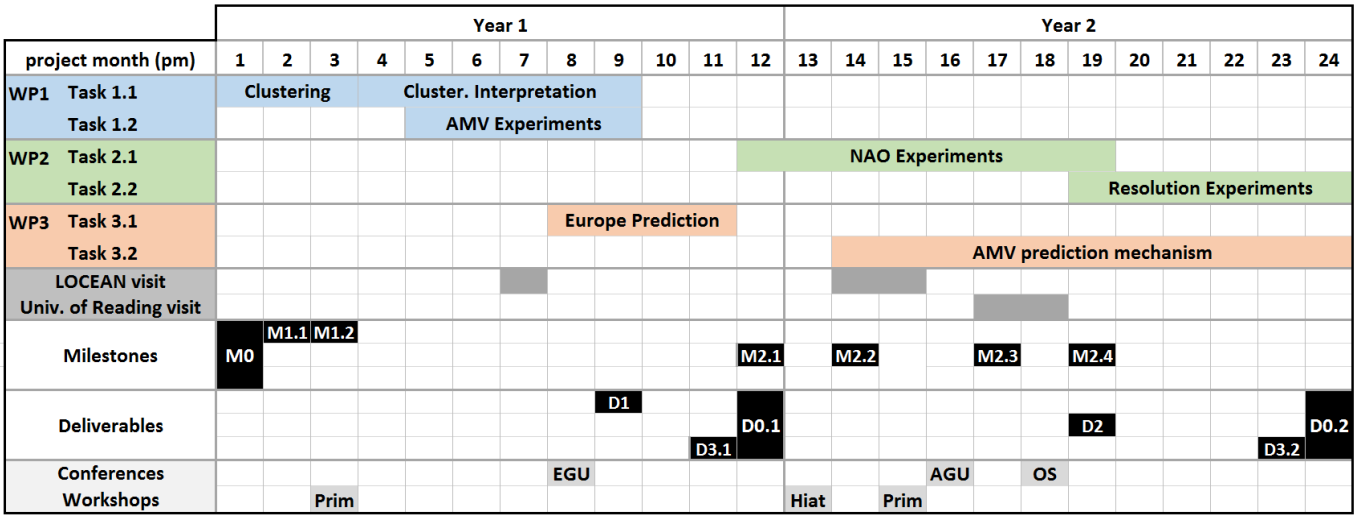
3. Quality and Efficiency of the Implementation

3.1 Coherence and effectiveness of the work plan

Has envisaged from its conception, the research project has been designed with the aim to improve decadal prediction systems following a logic of hand-in-hand development of scientific knowledges and prediction systems. In this regard, the Tasks focusing on the predictive skill (WP3) are always addressed conjointly with their process based homologs from WP1 and WP2. The following Gantt chart reflects this idea:



Gantt chart of the INADEC project. The chart assume that the project will start in September 2018. (Prim: PRIMAVERA; Hiat: HIATUS)

Work Packages (WP):

- **WP1:** Making sense of the diversity of AMV-Europe teleconnections simulated by the CMIP5/6 models,
- **WP2**: Climate response to an NAO forcing,
- **WP3**: Understanding the predictive skill of the European decadal climate prediction.

List of milestones (M):

- **M0** [pm1]: Career Development Plan drafted,
- **M1.1** [pm2]: database needed for the project fully downloaded,
- **M1.2** [pm3]: cluster analysis based on E-EOF data is functional and can be applied to all CMIP simulations,
- **M2.1** [pm12]: Model setup for NAO experiments is ready **and** simulations with EC-Earth have started,
- **M2.2** [pm14]: NAO experiments performed with IPSL-CM6,
- **M2.3** [pm17]: NAO experiments performed with HadGEM3,
- **M2.4** [pm19]: NAO experiments performed with the high resolution version of EC-Earth

List of deliverables (D):

- **D1** [pm9]: Assessment of the relevant processes in the AMV-Europe teleconnections,
- **D3.1** [pm11]: Assessment of dynamical forecasting capabilities of the AMV-Europe teleconnections,
- **D0.1** [pm12]: 1st year project report,
- **D2** [pm19]: Assessment of the dynamical climate response to NAO forcing,
- **D3.2** [pm23]: Assessment of the forecasting capabilities of the North Atlantic ocean dynamic,
- **D0.2** [pm24]: 2nd year and final project report.

Secondments:

- **LOCEAN**. A first stay at LOCEAN will occur during the Tasks 1.1 and 1.2 [pm7]. The results of the cluster analysis and of the AMV experiments will hence largely benefit of profoundness discussions at LOCEAN. This stay will also be the opportunity for the applicant to exchange with the team NEMO of the LOCEAN in order to prepare the setup of the NAO experiments of Task 2.1 (**M2.1**). The second stay at LOCEAN will occur during Task 2.1 [pm14-15]. It will be long enough to perform NAO experiments with the IPSL-CM6 model (**M2.2**) and to perform extensive analyses on the experiment outputs.
- **University of Reading**. The stay at the University of Reading will also take place during Task 2.1 [pm17-18]. NAO experiments will be performed with the HadGEM3 model (**M2.3**) and outputs will be analyzed in collaboration with Dr. Jonathan Robson. From this visit, the applicant will also greatly benefit of the University of Reading expertise in forecasting methodology/verification and facilities to complete Task 3.2.

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3.2. Appropriateness of the allocation of tasks and resources

The planning of the project in terms of person-months has been carefully thought and allows to account for delays and re-planning if necessary (cf. Section 2.3). **M1.1** will be guarantee by the climate prediction group's existing tools for downloading CMIP dataset, and also by the overlap with the datasets needed for previous BSC projects, implying that some data are already present at BSC. **M1.2** will benefit of the clustering tool developed by the ES-BSC under the Copernicus C3S-MAGIC project. The NEMO development group of LOCEAN will be leveraged for **M2.1**, and the close collaboration with the hosting institutions, and in particular their IT team, during the applicant's stay will allow to smoothly reach **M2.2**, **M2.3**, and **M2.4**. Finally, as envisaged from its conception, the research project has been designed to tailor the applicant background on North Atlantic dynamics (**WP1**), the supervisors' expertise on decadal prediction (**WP3**), and the HPC and computational resources of the hosting institutions (**WP2**) in order to ensure its successful completion.

3.3 Appropriateness of the management structure and procedures, including risk management

A **Career Development Plan will be drafted with the supervisor** during the first month of the fellowship (**M0**), which will include specific training and research objectives and will help the applicant monitor the outcomes of the fellowship. The ongoing project will be monitored through annual project reports (**D0.1** and **D0.2**) and it will be managed through **weekly meetings with the supervisor to ensure full coherence between the ongoing research and the project objectives**. At all meetings with Dr. Virginie Guemas, the advancements of the research will be discussed and the supervisor will provide adequate mentoring in the general background of climate prediction, helping with the adaptation of the research program to the difficulties encountered and encouraging progress in the most promising aspects of the research undertaken.

A project manager will support the researcher in all the legal, financial and administrative arrangements needed and work in close contact with Education, Human Resources and Communications departments for all training arrangements and dissemination and outreach activities. Recently new measures have been implemented at BSC with the aim to foster research careers and strengthen internal training, based on the principles of the European Charter for Researchers and on the Code of Conduct for Recruitment. As a result of this effort, BSC has been awarded with the badge of Human Resources Excellence in Research (HRS4R) in April 2015.

The potential risks identified at this stage do not pose a threat to endanger the successful implementation of the project goals. Nonetheless, we list below the minor risks and mitigation measures associated to these risks:

Risk	**Mitigation measure**
No more HPC resources at BSC	The analysis of CMIP database can still be done (Tasks 1.1, 1.2, 3.1, 3.2) and NAO experiments can still be performed at LOCEAN and University of Reading (Task 2.1). Task 2.2 will not be done.
CMIP6 exercise delayed	We propose to delay the kick off the project. However, CMIP5 database can still be analyzed (Tasks 1.1, 3.1, 3.2) and NAO and AMV experiments can still be performed (Tasks 1.2, 2.1, 2.2).
Results of Task 1.1 clustering are not discriminant	This will be a scientific result in itself. The comparison of AMV characteristics between preindustrial and historical simulations can still be done (Task 1.1) and other Tasks are not impacted.

3.4 Appropriateness of the institutional environment (infrastructure)

The BSC and partner organizations provide outstanding HPC infrastructures, computational resources, and IT support to perform and analyze the climate model simulations of this project (cf. Section 5). The BSC has a high-quality IT support team - optimizing computational codes, developing tools to launch, monitor and process experiments - who is ready to assist the applicant in computational and technical issues. The NEMO development group at LOCEAN will also provide technical support regarding experiments implementation.

The BSC has extensive experience in hosting fellows always providing them project manager support. The combination of outstanding HPC facilities, high quality user support, and experience in hosting fellows will provide the candidate perfect environment to guarantee a successful completion of the proposed research.

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4. CV of the Experienced Researcher

Dr. Yohan Ruprich-Robert graduated in Climate sciences from the **University Toulouse III** (France) in 2014 (Laboratory: Centre Européen de recherche et de formations avancée en calcul scientifique - **Cerfacs**; supervisors: Dr. Christophe Cassou and Dr. Laurent Terray). He worked between 2014 and 2017 at **Princeton University / GFDL** (Geophysical Fluid Dynamics Laboratory; NJ, USA) as a postdoctoral researcher (supervisors: Dr. Tom Delworth and Dr. Rym Msadek) in close collaboration with **NCAR** (National Center for Atmospheric Research, Boulder, CO; collaborators: Dr. Gokhan Danabasoglu and Dr. Stephen Yeager) and **WHOI** (Woods Hole Oceanographic Institution, Woods Hole, MA; collaborator: Dr. Young-Oh Kwon). He is conducting since September 2017 postdoctoral researches at the **BSC** (Barcelona Supercomputing Center, Barcelona, Spain; supervisor: Dr. Virginie Guemas). He has **4 published, 1 in press, 2 in revision, and 2 submitted articles in international peer-reviewed journals**. He has a total of **47 citations**, with a **h-index of 4** and a **i-index of 3**. He gave about 20 presentations (including 2 invited talks) in international conferences and workshops. He has contributed to 4 scientific projects and he is currently involved in 3 European projects (PRIMAVERA, PREFACE, MEDSCOPE) and 1 national project (HIATUS).

During his doctoral and postdoctoral researches he developed expertise on decadal climate variability and potential predictability. Using several state-of-the-art climate models, he investigated the mechanisms driving the Atlantic Meridional Overturning Circulation (AMOC) decadal variability and its impacts on the North Atlantic – Europe climate. He performed ensemble member simulations to estimate the potential decadal predictability associated with AMOC variations and their climatic impacts. These simulations are currently used within the French ANR project MORDICUS (http://www.agence-nationalerecherche.fr/?Project=ANR-13-SENV-0002), which main goal is to evaluate the respective impacts of external forcing and internal variability on climate variability. He set up an innovative experimental protocol, which allows to highlight the climate teleconnections associated with the observed North Atlantic decadal variability using coupled models. His protocol has been adopted by the Decadal Climate Predictability Panel (DCPP) of the 6th Coupled Model Intercomparison Project (CMIP6) and it will be used for internationally coordinated experiments (cf. DCPP-component C).

4.1 Publications

Peer-reviewed publications:

Ruprich-Robert Y, Msadek R, Castruccio F, Yeager S, Delworth T, Danabasoglu G (2017) *Assessing the climate impacts of the observed Atlantic Multidecadal Variability using the GFDL CM2.1 and NCAR CESM1 global coupled models*. Journal of Climate, 30(8), 2785–2810, doi: 10.1175/JCLI-D-16-0127.1.

Boer J, Smith D, Cassou C, Doblas-Reyes F, Danabasoglu G, Eade E, Kirtman B, Kushnir Y, Kimoto M, Meehl G, Msadek R, Mueller W, Rixen M, **Ruprich-Robert Y**, Taylor K, Zwiers F (2016) *The Decadal Climate Prediction Project (DCPP) contribution to CMIP6*. Geoscientific Model Development, doi:10.5194/gmd-9-3751-2016.

Sanchez-Gomez E, Cassou C, **Ruprich-Robert Y**, Fernandez E, Terray L (2016) *Drift dynamics in a coupled model initialized for decadal forecasts*. Clim Dyn, doi:10.1007/s00382-015-2678-y.

Ruprich-Robert Y, Cassou C (2015) *Combined influences of seasonal East Atlantic Pattern and North Atlantic Oscillation to excite Atlantic multidecadal variability in a climate model*. Clim Dyn, 44, 229-253, doi:10:1007/s00382-014-2176-7.

Ruprich-Robert Y (2014) *Variabilité climatique de l'Atlantique Nord aux échelles de temps décennale à multidécennale : mécanismes et prévisibilité*. PhD thesis.

In press:

Menegoz M, Cassou C, Swingedouw D, **Ruprich-Robert Y**, Bretonniere P-A, Doblas-Reyes F (2017) *Role of the Atlantic Multidecadal Variability in modulating the climate response to a Pinatubo-like volcanic eruption*, Clim. Dyn.

In Revision:

Ruprich-Robert Y, Delworth T, Msadek R, Castruccio F, Yeager S, Danabasoglu G (in revision) *Impacts of the Atlantic Multidecadal Variability on North American Summer Climate and Heat Waves*. Journal of Climate.

Castruccio F, **Ruprich-Robert Y**, Yeager S, Danabasoglu G, Msadek R, Delworth T (in revision) *Modulation of Arctic Sea Ice Loss by Atmospheric Teleconnections from Atlantic Multi-decadal Variability*. Geophysical Research Letters.

Submitted:

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Mavilia I, Bellucci A, Athanasiadis P, Gualdi S, Msadek R, **Ruprich-Robert Y** (submitted) *On the spectral characteristics of the Atlantic Multidecadal Variability in an ensemble of multi-century simulations.* Submitted to Climate Dynamics.

Vial J, Cassou C, Codron F, Bony S, **Ruprich-Robert Y** (submitted) *Thermodynamic influence of the Atlantic Meridional Overturning Circulation on tropical precipitation changes*. Submitted to Geophysical Research Letters.

In preparation:

Ruprich-Robert Y, Murakami H, Delworth T (in prep.) *The Atlantic Multidecadal Variability as a driver of decadal changes in tropical cyclone activity*. To be submitted to Nature Climate Change.

Ruprich-Robert Y, Kwon Y-O, Frankignoul C, Gastineau G, Msadek R, Delworth T (in prep.) M*echanism of the decadal variability of the Atlantic Meridional Overturning Circulation in a suite of GFDL models: what sets the timescale?*

Kim W, **Ruprich-Robert Y**, Kwon Y-O, Yeager S, Danabasoglu G, Delworth T (in prep.) *Assessing the North Atlantic Oscillation impacts on the Atlantic Meridional Overturning Circulation using the NCAR CESM1 and GFDL FLOR coupled models.*

Technical documents:

Cassou C, **Ruprich-Robert Y**, Msadek R (2016) Technical note for DCPP-Component C – I: definition of the Anomalous Sea Surface Temperature patterns. WCRP, https://www.wcrp-climate.org/experimental-protocol

Cassou C, **Ruprich-Robert Y**, Msadek R (2016) Technical note for DCPP-Component C – II: Recommendation for surface restoring and ensemble generation. WCRP, https://www.wcrp-climate.org/experimental-protocol

Non-peer-reviewed articles:

Ruprich-Robert Y, Msadek R (2017) *Global impacts of the Atlantic Multidecadal Variability during the boreal winter*. Clivar Exchanges 72, doi: 10.22498/pages.25.1.7.

Ruprich-Robert Y, Danabasoglu G (2017) *Global impacts of the Atlantic Multidecadal Variability*. US Clivar webpage: https://usclivar.org/research-highlights/global-impacts-atlantic-multidecadal-variability

Contribution to the 2016 US AMOC Progress report. US Clivar AMOC Program: https://indd.adobe.com/view/a0b66acf-8959-4082-8867-a07b582a3d73

4.2 Presentations

Invited talks

Ruprich-Robert Y. *The Atlantic Multidecadal Variability: from its driving mechanisms to its climate impacts*, 16th CTWF International Symposium on Advances in Seasonal to Decadal Prediction, September 2017, Beijing (China).

Ruprich-Robert Y., Msadek R., Delworth T. *Climate impacts of the Atlantic Multidecadal Variability: an experimental protocol*, AGCI workshop on Decadal Climate prediction, June 2015, Aspen (CO).

Others

Ruprich-Robert Y., Msadek R., Castruccio F., Delworth T., Yeager S., Danabasoglu G. (poster) *Impacts of the Atlantic Multidecadal Variability on the North Pacific*, EGU 2017, April 2017, Vienna (Austria).

Ruprich-Robert Y., Msadek R., Delworth T., Castruccio F., Yeager S., Danabasoglu G. (poster) *Impacts of the Atlantic Multidecadal Variability on North American Climate and Heat Waves*, EGU 2017, April 2017, Vienna (Austria).

Ruprich-Robert Y., Msadek R., Castruccio F., Yeager S., Delworth T., Danabasoglu G. (oral) *Impacts of the Atlantic Multidecadal Variability on the North Pacific*, NOAA Climate Variability and Predictability, November 2016, AMOC webinar.

Ruprich-Robert Y., Msadek R., Castruccio F., Yeager S., Delworth T., Danabasoglu G. (poster) *Impacts of the Atlantic Multidecadal Variability on the North Pacific*, WCRP Model Hierarchies Workshop, November 2016, Princeton (USA).

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Ruprich-Robert Y., Msadek R., Delworth T., Castruccio F., Yeager S., Danabasoglu G. (oral) *Role of the Atlantic Multidecadal Variability on extreme climate conditions over North America*, CLIVAR, September 2016, Qingdao (China).

Ruprich-Robert Y., Msadek R., Delworth T., Castruccio F., Yeager S., Danabasoglu G. (poster) *Role of the Atlantic Multidecadal Variability on extreme climate conditions over North America*, European Geosciences Union, April 2016, Vienna (Austria).

Ruprich-Robert Y., Msadek R., Delworth T., Castruccio F., Yeager S., Danabasoglu G. (oral) *Extremes conditions over North America: the role of the Atlantic Multidecadal Variability*, Ocean Sciences, February 2016, New-Orleans (LA).

Ruprich-Robert Y., Msadek R., Delworth T., Castruccio F., Yeager S., Danabasoglu G. (oral) *Pacific impacts of the Atlantic Multidecadal Variability*, Rapid - US AMOC International meeting, July 2015, Bristol (UK).

Ruprich-Robert Y., Msadek R., Delworth T., Castruccio F., Yeager S., Danabasoglu G. (oral) *Pacific impacts of the Atlantic Multidecadal Variability*, IUGG General Assembly, June 2015, Prague (Czech Republic).

Ruprich-Robert Y., Msadek R., Delworth T. (oral) *Climate impacts of the Atlantic Multidecadal Variability: an experimental protocol*, AGCI workshop on Decadal Climate prediction, June 2015, Aspen (CO).

Ruprich-Robert Y., Msadek R. and Delworth T. (poster) *Consistency of AMOC decadal variability in a suite of GFDL models: what sets the timescale?*, US AMOC meeting, September 2014, Seattle (WA).

Ruprich-Robert Y., Cassou C. (oral) *Importance of the seasonality of the ocean-atmosphere relationship to produce AMV/AMOC multidecadal variability*, US AMOC meeting, July 2013, Baltimore (MD).

Ruprich-Robert Y., Cassou C. (poster) *Mechanisms of the North Atlantic decadal predictability in the CNRM-CM5 model*, International workshop on seasonal to decadal prediction, May 2013, Toulouse (France).

Ruprich-Robert Y., Cassou C (poster) *Mechanisms of the North-Atlantic multidecadal internal variability in the CNRM-CM5 model*, EGU, April 2012, Vienna (Austria).

Ruprich-Robert Y., Cassou C. (oral) *Mechanisms of the North Atlantic multidecadal internal variability in the CNRM-CM5*, AMA conference, January 2012, Toulouse (France).

Ruprich-Robert Y., Cassou C. (poster) *Impact of the ocean-atmosphere local coupling on the Madden-Julian Oscillation and on associated extratropical teleconnections*, Tropiques 2010 conference, May 2010, Toulouse (France).

4.3 Participation to Scientific projects

Ongoing projects

PRIMAVERA (high resolution global modeling)

PREFACE (understanding the tropical Atlantic climate and improving its representation in climate models)

MEDSCOPE (sources of predictability of the Mediterranean climate including the Atlantic Ocean variability)

HIATUS (causes and future effects of the global temperature hiatus)

Past projects

A collaborative Multi-Model Study: Understanding AMOC Variability Mechanisms and their Impacts on Decadal Prediction. NOAA, USA

MORDICUS, ANR, France

EPIDOM. French Department of Ecology, France

IRCAAM. ANR, France

4.4 Funding

2010-2014 **Ph.D** half funded by a grant from **EDF** (Electricie de France)

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2012 Grant to attend the **European Earth System and Climate Modeling School** (E2SCMS)

4.5 Supervising and Mentoring activities

Feb-Apr 2015 Co-supervising of Irene Mavilla (PhD student from University of Bologna, Italy) during here visit at GFDL (NJ, USA).

4.6 Research visits

July 2016 **15 days stay in Woods Hole Oceanographic Institute** (USA, MA) to work with Young-Oh Kwon and Claude Frankignoul on the mechanisms driven the AMOC decadal variability in the GFDL-FLOR model.

Jan-Feb 2017 **1.5 month stay at Cerfacs** (Toulouse, France) to work with Christophe Cassou and Rym Msadek on the impacts of atmospheric resolution on the simulation of weather regimes over the North Atlantic – Europe region.

4.7 At sea experiment

March 2011 Opportunity campaign on board M/V Reykjafoss (EIMSKIP, Island) Reykjavik-St Johns (8 days). Water sampling collection and XBT launching (Dr. Gilles Reverdin).

4.8 Reviewer for specialized journals

Journal of Climate, Climate Dynamics

4.9 Education

2014 Ph.D. degree in Physical Oceanography and Climate Sciences on the topic: variability and predictability of the North Atlantic climate at decadal timescale. Cerfacs / Ecole doctorale SDU2E - Toulouse, France. Ph.D. Advisors: Dr. Christophe Cassou and Dr. Laurent Terray.

2010 Master degree in Earth and Environmental Sciences, option: Ocean Atmosphere and Continental Land Surfaces - Université Paul Sabatier - Toulouse, France. Including: meteorology, oceanography and continental land surfaces dynamics, cloud physics, biogeochemistry, remote sensing radiative transfer, numerical methods, atmospheric mixed-layer and climate system interaction.

2008 Bachelor degree in Physics, option Applications to Universe and Environmental Science - Université Paul Sabatier - Tarbes, France.

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5. Capacity of the Participating Organizations

Beneficiary: BARCELONA SUPERCOMPUTING CENTER - CENTRO NACIONAL DE SUPERCOMUTACIÓN	
General Description	**The Barcelona Supercomputing Center (BSC)** combines unique high performance computing facilities and in-house research departments on computer, life, and Earth sciences, and computational applications, counting more than 400 researchers and students from more than 42 different countries. Between 2013 and 2017, BSC has recruited 86 pre-doctoral students, 111 Postdocs and Senior Scientists, 132 technical support staff and 47 management staff members, 255 from Spain, 71 from EU countries and 50 from outside Europe. BSC-CNS has been accredited as one of the first eight Severo Ochoa Centers of Excellence. This award is given by the Spanish Government as recognition for leading research centers in Spain that are internationally well known institutions in their respective areas. Established in 2006, **the Earth Sciences Department (ESD) of the BSC**, worked on atmospheric composition modelling. The designation of Professor Francisco J. Doblas-Reyes as Director of the ESD in 2014 initiated the merging of the Climate Forecast Unit of the Institut Català de Ciències del Clima (IC3-CFU), which he was leading and that in a short time became a main European actor in the development of climate predictions and climate services into the ESD. The newly merged department is structured around 4 groups, with more than 65 employees, including technical and support staff. It is a highly productive scientific entity that has published more than 135 research articles in peer-reviewed journals over the last four years (2014-2017), including 103 in prestigious high-impact journals (https://earth.bsc.es/wiki/doku.php?id=publications:publications). The **Climate Prediction Group** aims at developing a climate forecast system based on the EC-Earth model and performs regular assessments of the characteristics of this forecast system compared to all other operational and quasi-operational systems available in the world. This group participates currently in t10 European projects, 4 national projects and 3 Copernicus projects. BSC is one of the world leaders in the development of climate prediction applicability and climate services. These objectives rely on expanding the understanding of the climate predictability mechanisms through tailored and comprehensive forecast quality assessment, on the development of the EC-Earth climate forecast system through the testing of new model parameterisations/components as well as the development of innovative initialization strategies.
Role and Profile of key persons (supervisor)	**Dr Virginie Guemas** is an expert on seasonal to decadal climate prediction, head of the climate prediction group and a Ramon y Cajal fellow. She was awarded the 2010 Adrien Gaussail PhD prize, granted every two years to a scientific PhD. She is member of the WCRP (World Climate Research Program) CLIVAR (Climate and Ocean Variability, Predictability, and Change) SSG (Scientific Steering Group). She has participated in 17 national and international research projects. Currently, she is Principal Investigator (PI) of 8 European projects, 1 national project and 1 Copernicus project. She contributed to the IPCC (Fifth Assessment Report). She is author of 46 articles in rank-A journals, among which 9 in high-impact journals. She has supervised 3 PhD students and 17 post-doctoral scientists, including 2 Marie Skłodowska-Curie Individual Fellows.
Key Research Facilities, Infrastructure and Equipment	BSC hosts and manages a range of HPC systems, including MareNostrum 4, with 148,176 cores and 13.7 Pflops capacity. Additionally, BSC manages Minotauro, a Sandy Bridge's cluster with NVIDIA GPUs, providing more than 100 TFlops.
Independent research premises?	Yes. All key research facilities, infrastructure, and equipment will be available for the fellow.
Previous Involvement in Research and Training Programmes	BSC has coordinated and participated in more than 150 projects including 43 individual grants and fellowships; 9 EU-FP6 projects 51 EU-FP7 and 73 national projects (e.g. IS-ENES, APPRAISAL, FIELD_AC, PRACE 1lP, PRACE 2iP, Mont-Blanc, ScalaLife, OPTIMIS, PELE, RISC) and many private contracts. BSC also participated in the MC ITN project (SCALUS: FP7-PEOPLE-ITN-2008-238808) and 3 Marie Curie IEFs (EEPPIBM: FP7-PEOPLE-2012-IEF-327899, MatComPhys: FP7-PEOPLE-2011-IEF-302320 and MDRAF: FP7-PEOPLE-2013-IEF-622662).
Current involvement in Research and Training Programmes	**Collaborations with universities:** BSC closely collaborates with Universidad Politècnica de Catalunya (UPC) including a joint Master degree in Environmental Engineering. **Excellence Programs and Networks**: Severo Ochoa Excellence Programme (Research seminars series); RES training sessions; NVIDIA CUDA/GPU excellence center (PUMPS summer school); PRACE Advanced Training Center; HiPEAC (ACACES summer school, Computing system weeks and HiPEAC conferences) and H2020-EINFRA-Centers of Excellence for computing applications. **Research Fellowships:** BSC is currently awarded with 6 early-stage postdocs (4 Juan de la Cierva and 2 Beatriu de Pinós), 12 seniors (5 Ramón y Cajal, 3 I3 and 6 ICREA) and is supporting 4 MSCA ITN and 5 MSCA-IF. Noteworthy, 3 of these MSCA-IF are currently conducted at BSC-ES (NeTNPPAO, ACRoNNim, SPFireSD), which will host the proposal on hand. In addition, BSC is the main beneficiary of a MSCA COFUND program for postdoc fellows, which foresees the implementation of a training programme (STARS; H2020-MSCA-COFUND-754433). **Projects:** Total of 111 ongoing projects are funded by the European Commission (FP7, Horizon 2020, Copernicus, COST Action): e.g. Euroserver, DEEP, PRIMAVERA, EUDAT, PRACE 3IP; 37 at BSC-ES (4 EU-FP7, 21 EU-H2020) and 8 National Projects.
Relevant Publications and/or research/innovation products	***Massonnet F, et al, 2017. Sciences, doi : 10.1126/science.aaf6369*** *Doblas-Reyes F.J., et al., 2013. Nature Communications, 4, 1715.* *Guemas V., et al., 2013. Nature Climate Change, 3, 649-653.* *Guemas V., et al., 2014. Bull. Amer. Meteor. Soc., 95 (11), 1666-1667.* *Guemas V. et al., 2013. Bull. Amer. Meteor. Soc., 94 (9), S20-S22.*

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Partner Organisation: LOCEAN Research Laboratory	
General description	The LOCEAN is hosted at the university Pierre et Marie Curie (UPMC). With more than 35,000 students, 100 laboratories and 3,500 doctoral students in science and medicine, UPMC is one of the leading French universities. According to the 2016 Shanghaï ranking (ARWU), UPMC is the 1st French, 7th European and 39th university worldwide. UPMC is involved in numerous European and International partnership agreements and has France's largest scientific library and infrastructures. With over 400 million Euros allocated to research and 6,600 publications per year (approximately 10% of the French production), UPMC is a major player in international knowledge and innovation economy, as evidenced by its many international awards and medals. UPMC has also adopted the European Charter for Researchers and the code of conduct for the recruitment of Researchers. UPMC European Affairs office, which is in charge of the EU projects at UPMC, has managed so far 150 FP7 and 70 H2020 projects, as coordinator or partner and will manage all the financial, administrative and legal aspects for the UPMC participation in this project.
Key Persons and Expertise (supervisor)	Dr J. Mignot is a researcher at IRD working at LOCEAN. She is specialized in physical oceanography and climate variability. Her objectives are to better understand the climate low frequency variability and in particular the role of the ocean and of external forcing (e.g. role of volcanoes). Her expertise lies mainly in the North Atlantic region, and she has worked on the decadal climate variability in the Atlantic, on decadal prediction and predictability assessment, on understanding and characterizing the role of salinity in the oceanic stratification. She uses several statistical tools and climate models. She has been one of the initiators of the decadal predictability activities at IPSL/LOCEAN. She is also a member of the steering committee of the IPSL modelling group and actively participates to the development and validation of the IPSL-CM6 climate model. She has been involved in 6 European projects and several ANR projects, and she is regularly leading the LOCEAN activities for these projects. She is currently the PI of 2 national projects (LEFE-INSU and Labex-L-IPSL). J. Mignot has mentored 5 post docs, 4 PhD students and 6 master students. She has published 57 papers in rank-A journals (h-/i-index 24/47).
Key Research facilities, infrastructure and equipment	The IPSL climate model is running in particular on the Curie supercomputer, owned by GENCI and operated into the TGCC by CEA. This is the first French Tier0 system, open to scientists through the French participation into the PRACE research infrastructure. GENCI opens a yearly call for CPU time and storage which the IPSL answers regularly with almost 100% of the requested computing time being attributed. In case of success, experiments to be run with the IPSL model within the present proposal will be submitted to this call with very little risk of failure. IPSL also has an internal computing and storage network for all post processing computations, and including a local replication of the CMIP database. In case of success, the applicant will have an access to this network.
Previous and Current Involvement in Research and Training Programmes	PI of 2 national french projects and co-investigator in 2 European H2020 projects and 2 national ones. Has been involved in 4 previous European projects and 10 national ones. Has supervised 5 post-doctorate researchers, 4 phD students and 8 master students
Relevant Publications and/or research/innovation product	**Mignot J.**, Garcia-Serrano J, Swingedouw D, Germe A, Nguyen S, Ortega P, Guilyardi E, Ray S Decadal prediction skill in the ocean with surface nudging in the IPSL-CM5A-LR climate model, 2016, Clim. Dyn. DOI 10.1007/s00382-015-2898-1 Volume 47, Issue 3, pp 1225–1246 Born A. **Mignot J.** Stocker T. Multiple Equilibria as a Possible Mechanism for Decadal Variability in the North Atlantic Ocean (2015) Journal of Climate 28, 8907-8922. doi: 10.1175/JCLI-D-14-00813.1 Pablo O., **Mignot J.**, Swingedouw S., Sévellec F., Guilyardi E. (2015) Reconciling two alternative mechanisms behind bi-decadal AMOC variability Prog. Ocean. 137(A), pp237-249 doi:10.1016/j.pocean.2015.06.009

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Partner Organisation: University of Reading	
General description	The Department of Meteorology is internationally renowned for its pioneering research in atmospheric, oceanic and climate science. The department is one of the biggest in the world with over 200 academic and research staff, including staff from the UK Met Office, and the UK's Natural Environment Research Council's (NERC) national research centres, the National Centre for Atmospheric Science (NCAS) and the National Centre for Earth Observation (NCEO). The most recent national evaluation, the Research Excellence Framework (2014), rated 86% of the Department of Meteorology's research as world leading or internationally excellent, making it the highest graded UK institution focusing on the fundamentals of weather and climate. Within the Department, the climate directorate of NCAS (NCAS-Climate) is an international leader in climate modelling, climate processes and climate predictions. NCAS also retains strong links with collaborators at the Met Office, including the assessment of UK Met Office climate models, and NCAS leads the development of the UK Earth System Model. The Meteorology department is also the home of NCAS Computational modelling support, who offer support and training for the UK's academic researchers who use Weather and Climate modelling tools.
Key Persons and Expertise (supervisor)	Dr. Jonathan Robson is a Senior Research Scientist in NCAS (equivalent to a Lecturer), and is an expert on Atlantic Multidecadal Variability and the on decadal climate prediction, particularly in the Atlantic sector. He has participated in 8 national and international projects, and currently is Principal Investigator of two projects. He is also science program manager for the UK North Atlantic Climate System Integrated Study (ACSIS) project; a ~£ 9 million multi-centre and multidisciplinary project working to improve our understanding of Atlantic Multi-decadal variability. He has published 22 peer-reviewed papers in international Journals, including papers in high-impact journals. He has supervised one PhD student, and currently supervises 5 post-doctoral scientists.
Key Research facilities, infrastructure and equipment	Weather and climate researchers in the UK have access multiple multiple high performance computing platforms, including the national super computer, ARCHER, and can apply for access to the joint UK Met Office - NERC supercomputers, MONSooN2 and NEXCS. Data processing, analysis and visualisation for NCAS scientists is largely done at the NERC's JASMIN "super-data-cluster" facility, which offers direct access to key datasets, such as CMIP archives.
Previous and Current Involvement in Research and Training Programmes	Scientists at the Department of Meteorology and in NCAS have been involved with research projects funded from UK national (NERC, ESPRC) and international (EU-FP7, Horizon2020, Belmont) funding bodies. There are more than 100 early career post-doctoral researchers working at the Department, including a number of early career fellowship holders, including NERC, the Royal Society, AXA fellowships and, previously, Marie Curie fellowships. The Department is also an active training and teaching department, with undergraduate and post-graduate taught causes in Meteorology and Climate, Ocean and Atmosphere Dynamics, and Environmental Physics degrees. There is also an active doctoral training program, with ~90 doctoral students. The department has a rich scientific research culture, with a number of research seminars each week focusing on the fundamentals of atmosphere, ocean and climate science. A number of specific training activities are also available, including, for example, training of how to use the UK climate model (via NCAS CMS) and media training (via the University).
Relevant Publications and/or research/innovation product	Robson, et al (2016) A reversal of climatic trends in the North Atlantic since 2005. Nature Geoscience, doi: 10.1038/ngeo2727 Robson, et al (2014) Atlantic overturning in decline? Nature Geoscience, 7 (1). doi: 10.1038/ngeo2050 Robson, et al (2012) Causes of the rapid warming of the North Atlantic ocean in the mid-1990s. Journal of Climate, doi: 10.1175/JCLI-D-11-00443.1

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6. Ethics

As detailed in the Part A of the present proposals, there are no potential ethical issues identified for INADEC

7. Letter of supports

The next letters of supports have been written by the following researchers:

- Dr. Juliette Mignot, senior scientist in the Laboratoire d'Oceanographie et du Climat (LOCEAN), Paris, France.
- Dr. Jonathan Robson, senior scientist in the National Center for Atmospheric Sciences, University of Redading, Reading, UK.

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LABORATOIRE D'OCEANOGRAPHIE ET DU CLIMAT : EXPERIMENTATION ET APPROCHES NUMERIQUES

UNITE MIXTE DE RECHERCHE 7159
CNRS / IRD / UNIVERSITE PIERRE & MARIE CURIE / MNHN

INSTITUT PIERRE-SIMON LAPLACE

Paris, september 13th 2017

This is a letter of support for the Marie Curie proposal: "INADEC - Impacts of the North Atlantic Decadal variability on European Climate: mechanisms and predictability" presented by Yohan Ruprich-Robert.

I express thereby my strong support for the Marie Curie proposal cited above. The science proposed in this proposal fits the main objective of the LOCEAN and IPSL modelling group in terms of understading and attributing the climate decadal variability. The efforts recently put by our group in the development of the latest version of the climate model shed specific light on the necessity for us to assess and understand more systematically the model uncertainties and their effect on their representation of the climate variability. Our climate model will be at your disposal for the specific sensitivity experiments you propose and I am confident that they will benefit not only the BSC and the LOCEAN groups but also the whole community. Finally, my colleagues and myself will also be deeply involved in performing decadal prediction experiments with our climate model We look forward to the possibility to interact with you on these experiments and their reliability.

The LOCEAN will host any of stays in the framework of this collaboration. You will have a free access to our local computing and storage network. Access to the french supercomputer Curie will also be ensured by a separate proposal that will be, in case of success, submitted to the yearly french call for computing resources.

I look forward to this collaboration and very exciting science.

Dr Juliette Mignot

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Reading, 12th September 2017

Letter of support

Dear Yohan,

This letter is to confirm my support for your Marie Curie proposal entitled 'INADEC - Impacts of the North Atlantic Decadal variability on European Climate: mechanisms and predictability'

Your proposed research project fits perfectly with the areas of research that we are interested in within the NCAS-climate group here in Reading. Understanding and predicting Atlantic Multi-decadal Variability and its impacts is a key goal for NCAS, and we would be delighted to collaborate on this topic as part of your fellowship. In particular, we welcome the collaboration to analyse CMIP6 decadal predictions over the North Atlantic, and your proposed NAO experiments, which would complement and extend our ongoing activities here.

During your Marie Curie fellowship we would be delighted for you to visit Reading for a number of months to perform collaborative experiments and analysis. While you are here we would ensure that you had a desk and access to computing facilities. I also confirm that you will be able to run the UK Met Office climate models for your experiments using NCAS's computing resources.

Yours Sincerely

Jon Robson
Senior Research Scientist – NCAS-Climate,
University of Reading

University of Reading

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