Please check our wiki for help on navigating the form.

Horizon 2020

Call: H2020-MSCA-IF-2019

(Marie Skłodowska-Curie Individual Fellowships)

Topic: MSCA-IF-2019

Type of action: MSCA-IF-EF-RI

(Reintegration panel)

Proposal number: 899077

Proposal acronym: ArcIce4MedCalRain

Deadline Id: H2020-MSCA-IF-2019

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How to fill in the forms

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

1 - General information

Topic	MSCA-IF-2019	Type of Action	MSCA-IF-EF-RI
Call Identifier	H2020-MSCA-IF-2019	Deadline Id	H2020-MSCA-IF-2019

Acronym: ArcIce4MedCalRain

Proposal title: Decreasing the uncertainties in future Mediterranean and Californian rainfall changes by constraining the impacts of Arctic sea ice loss

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 - Environmental and Geosciences (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: Meteorology, atmospheric physics and dynamics

Descriptor 3: Hydrology, water management

Free keywords: *climate modeling, climate dynamics, atmospheric teleconnections, Mediterranean climate types, precipitation, Arctic warming, climate model projections, decadal predictions*

Please choose the scientific area and descriptors carefully, and in order of importance, since this will guide the REA in the selection of experts for proposal evaluation and the allocation of proposals to experts. To help you select the most relevant area for your proposal, please consult the Guide for Applicants which provides a breakdown of each scientific area into a number of descriptors.

*Abstract**

Despite substantial recent advances, climate model simulations continue to disagree about both the magnitude and sign of future precipitation changes over the Mediterranean and California, hindering planning and adaptation efforts over these highly populated regions. Recent work has indicated that the erroneous representation of future sea-ice changes could affect the accuracy with which precipitation changes over the Mediterranean and California are simulated. Addressing this knowledge gap has the potential to provide an important tool for decreasing the intermodel spread of future rainfall changes. This project will investigate and summarize the physical linkages between Arctic sea-ice loss and subtropical rainfall. It will utilize experiments from a hierarchy of climate model simulations, including the state-of-the-art perturbed sea-ice physics parameter simulations and the ones carried out within the context of the European H2020 projects that the host institution participates in. The physical mechanisms and teleconnections identified will subsequently be used to define a physically based framework for selection of the less reliable model projections within the Climate Model Intercomparison Project Phase 6. By defining such physical criteria, this project will seek to reduce the range of projected precipitation changes over the two study regions. In the final objective, the improved understanding of sea-ice induced atmospheric teleconnections will be utilized to improve decadal climate predictions. This project combines the applicant's expertize in global atmospheric teleconnections with the host institution's proficiency in climate prediction. The successful completion of the proposed work will support societally important goal of reduction in spread of projected rainfall changes over the Mediterranean and California and help position the candidate and the host institution as one of the leaders in investigating the remote drivers of Mediterranean rainfall.

Remaining characters 3

Has a similar proposal in terms of research objectives been submitted to a Horizon 2020 Marie Sklodowska-Curie Individual Fellowship call? ○ Yes ◉ No

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.

Note:

For **multi-beneficiary applications**, the coordinator vouches for its own organization and that all other participants confirmed their participation and compliance with conditions set out in the call. If the proposal is retained for funding, each participant will be required to submit a formal declaration of honour confirming this.

False statements or incorrect information may lead to administrative sanctions under the Financial Regulation 2018/1046.

Personal data will be collected, used and processed in accordance with Regulation 2018/1725 and the **Funding & Tenders Portal privacy statement**.

Please be however aware that, to protect EU financial interests, your data may be transferred to other EU institutions and bodies and be registered in the EDES database. Data in the EDES database is also subject to Regulation 2018/1725 and the EDES privacy statement.

2 - Participants & contacts

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

2 - Administrative data of participating organisations

Future Host Institution

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

Short name: BSC

Address

Street Calle Jordi Girona 31

Town BARCELONA

Postcode 08034

Country Spain

Webpage www.bsc.es

Specific Legal Statuses

Legal person ..... 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

Public body .....yes

Academic Sector ..... yes

Department(s) carrying out the proposed work

Department 1

Department name: Earth Sciences ☐ not applicable

☐ Same as proposing organisation's address

Street: Calle 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.

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*	Cvijanovic	Last Name at Birth	Cvijanovic
First Name(s)*	Ivana	Gender*	○ Male ◉ Female
Title	Dr.	Country of residence*	Spain
Nationality*	Serbia	Nationality 2	
Date of Birth (DD/MM/YYYY)	04/11/1982	Country of Birth*	Serbia
		Place of Birth	Belgrade

Contact address

Current organisation name	Barcelona Supercomputing Center		
Current Department/Faculty/Institute/ Laboratory name	Earth Science		
☒ Same as organisation address			
Street	Calle Jordi Girona 31		
Postcode/Cedex	08034	Town	BARCELONA
Phone	+34674478200	Country	Spain
Phone2 / Mobile	+xxx xxxxxxxxx		
E-Mail*	ivanacbegg@gmail.com		

ORCID	*If you have a ORCID number please enter it here (e.g. 9999-9999-9999-999X. where 9 represents numbers and X represents numbe*		
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	Scopus Author ID	35344689700	

Qualifications

Doctorate Date of (expected) award	Select the exact date (DD/MM/YYYY)	02/05/2012
Doctorate start date	Select the exact date (DD/MM/YYYY)	15/09/2008
University Degree giving access to PHD*	Date of award (DD/MM/YYYY)	29/08/2008

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. Short stays (as defined in the Guide for Applicants) shall not be listed in this box.

Period from	Period to	Duration (days)	Country
03/12/2018	11/09/2019	283	Spain
16/08/2018	02/12/2018	109	Serbia
22/11/2014	15/08/2018	1363	United States
31/08/2014	21/11/2014	83	Serbia
	Total	1838	

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: Prof. Sex: (•) Male ( ) Female

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

E-Mail*: **francisco.doblas-reyes@bsc.es**

Position in org.: Earth Sciences Department Director

Department: Earth Sciences

☒ Same as organisation address

Street: Calle Jordi Girona 31

Town: BARCELONA Post code: 08034

Country: Spain

Website: https://www.bsc.es/doblas-reyes-francisco-j

Phone: +34934137719 Phone 2: *+xxx xxxxxxxxx* Fax: *+xxx xxxxxxxxx*

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Dorota	Jouet	dorota.jouet@bsc.es	*+34 934134082*

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	0,954	24	111732,48	14400,00	12000,00	19200,00	15600,00	172932,48
Total					111732,48	14400,00	12000,00	19200,00	15600,00	172932,48

4 - Ethics

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	

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

5 - Call specific questions

Eligibility Researcher (future fellow)

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

2. Did you spend time on procedures for obtaining refugee status (according to the 1951 Geneva Refugee Convention and the 1967 Protocol) in a Member State or Associated Country? ○ Yes ◉ No

3. Are you a national of a Member State or Associated Country? ◉ Yes ○ No

Country: Serbia

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

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 Funding & Tenders 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.*

1. Excellence

1.1. Quality and credibility of the research/innovation project

Introduction and problem background According to the Köppen-Geiger climate classification scheme[1] the Mediterranean Basin and California represent the two largest 'Mediterranean climate' zones in the Northern hemisphere. Regions featuring the Mediterranean climate are defined by cool, wet winters and hot, dry summers, and are typically located underneath the poleward edges of the Hadley circulation in the subtropics, in zones of predominantly descending flow. The rainfall over these areas is influenced by both tropical and mid-latitude atmospheric circulation changes and, as such, is subject of large inter-model spread in projections of future precipitation changes[2-4]. Future planning and adaptation efforts over these highly populated regions in response to global climate change are hindered by the fact that the state-of-art model simulations disagree regarding the magnitude (and in the case of California even the sign) of future precipitation changes[4].

One possible cause of these inter-model discrepancies is that some climate models underestimate the magnitude of the Arctic sea-ice loss observed over the satellite era. The applicant's recent work has shown that the erroneous representation of future sea-ice changes in climate models could affect the accuracy with which subtropical precipitation changes are simulated[5]. The proposed project will investigate how the physical links between Arctic sea-ice loss and the subtropical rainfall can be used to improve seasonal to decadal predictions of rainfall over the two study regions (Mediterranean Basin and California). It will employ the state-of-the-art energy conserving simulations designed to isolate the climate impacts of sea-ice loss (developed by the applicant), reinforced by a suite of multi-model simulations from a range of international projects the host institution participates in.

The physical mechanisms and teleconnections identified in the first part of this project and in the study by Cvijanovic et al. (2017)[5], will be used to define a physically based framework for selection of the less reliable model projections within the ongoing Climate Model Intercomparison Project Phase 6 (CMIP6)[6]. By defining these criteria, this project will reduce the range of projected precipitation changes over the two study regions. Finally, the improved understanding of sea-ice induced atmospheric teleconnections will be combined with the expertise in climate prediction within the host institution to improve seasonal to decadal climate predictions of rainfall.

Accurate prediction of future precipitation changes and drought risks is a key factor in planning and adapting water supply to ensure food and water security and protect natural resources. Ideally, model predictions of the conditions expected in the coming decades would be employed to plan infrastructure and policy methods of adaptation. However, large disagreements in the future projections of Mediterranean and Californian rainfall changes are delaying accurate assessments of climate change impacts over these areas. This project will provide a 'tighter' range of possible outcomes for densely populated regions such as the Mediterranean Basin and California - a result that is beneficial both scientifically and societally.

State-of-the-art Previous work has identified the Mediterranean Basin as a climate change "hot-spot": a highly populated region that may experience greater aridification than any other area in the world[7,8]. Between 1950 and 2004, total winter precipitation in the Mediterranean decreased by more than 15% while the recent drought of 2008 has demonstrated the extreme fragility of the eastern parts of the Iberian peninsula with regards to continued replenishment of its natural water resources by winter storms[9]. Prolonged dryness, in combination with high summer temperatures, increases the danger of wildfires[10], and is suspected to have contributed to the extreme wildfire seasons of 2016 and 2017 in Spain and Portugal. Model simulations of historical climate are unable to accurately capture the recent decline in winter precipitation over the Mediterranean (Fig. 1).

1. Kottek, M et al (2006) Met. Zeitschr. 15 259-263. **2.** Knutti, R and Sedláček, J (2012) Nat. Clim. Change 3(4): 369–373. **3.** Neelin, JD, et al. (2013) J. Clim. 26, 6238–6256. **4.** Polade, SD, et al. (2017) Scientific Reports 7, 10783. **5.** Cvijanovic, I., et al., (2017) Nat. Comm. 1947, 10.1038/s41467-017-01907-4. **6.** Eyring, V, et al. (2016) Geosci. Model Dev., 9, 1937–1958. **7.** Giorgi, F (2006) Geophys. Res. Lett. 33 (L08): 707. **8.** Diffenbaugh, NS and Giorgi F (2012) Clim. Change 114: 813–822. **9.** Seager, R., et al. (2014) J. Clim. 27, 4655–4676. **10.** Turco, M, et al. (2017) Scientific Reports 7 (81).

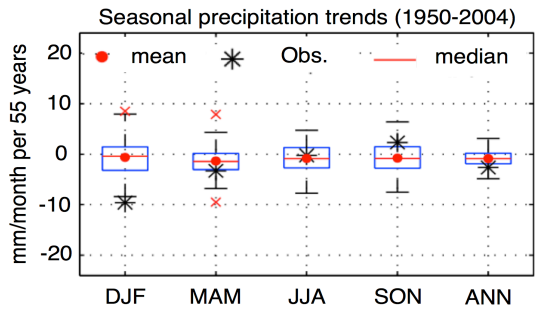


Fig. 1: Seasonal precipitation trends over the Mediterranean region (1950-2004): comparison of observed (Global Precipitation Climatology Centre) and simulated (23 model ensemble mean of historical simulations from Coupled Model Intercomparison Project Phase 5) values. The 25th and 75th percentiles of the model distributions are shown by the edges of the boxes, 0.35% and 99.65% range by whiskers (from Kelley et al. 2012)[11].

California's winter precipitation has also shown a decreasing trend over the last two decades[12] and between 2012 and 2016, California entered into one of the most severe droughts on record[13]. The recent California drought caused statewide emergency water restrictions, depletion of drinking water supplies, reduction in groundwater levels, and fallowing of thousands of acres of farmland resulting in significant loss of agricultural jobs and revenue[14]. Climatological assessment of the recent drought indices indicates that record high temperatures have magnified the effects of the lack of precipitation[15], suggesting that as the Earth warms through anthropogenic climate change, severe droughts are expected to become more common. Moreover, as was the case with the Mediterranean Basin, the present day winter precipitation decrease over California is not reproduced in coupled model simulations of historical climate[16]. The Mediterranean Basin and California both suffer from large inter-model disagreements in terms of the magnitude (and even the sign) of future precipitation changes (see Fig. 2). In general, model projections agree that the Mediterranean Basin will undergo further drying in the future, although the amount of projected drying largely varies between the models. Over California, the inter-model spread encompasses both positive and negative projections of future rainfall changes over the wet season. This results in a multi-model mean that is close to zero, and a large envelope of uncertainty.

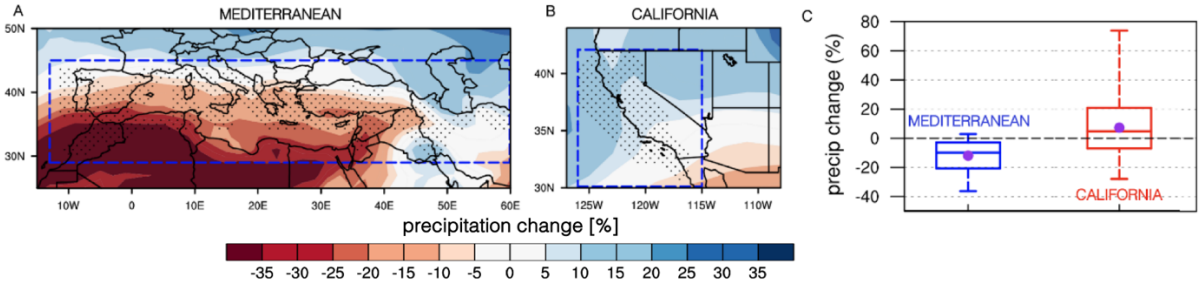


Fig. 2: Model projections of winter precipitation changes over Mediterranean and California under *business as usual* scenario (2060–2089 minus 1960–1989) using the 30-model ensemble. (**A**), (**B**) multi-model ensemble mean, (**C**) area average over the Mediterranean and Californian climate grids (stippled regions shown in A and B); circles - multi-model mean; horizontal line - median; box - the interquartile range; whiskers - 99% range (from Polade et al. 2017)[4].

The delicate balance between tropical and mid-latitude influences makes future rainfall changes over the Mediterranean Basin and California very challenging to model. For example, with global warming, tropical circulation is expected to undergo several 'modes' of changes, all of which are capable of affecting rainfall in the subtropical regions. Hadley circulation has widened in recent decades[17]and is projected to continue to widen in the future due to the combined influence of global warming and decreased temperature gradients between the tropics and mid-latitudes[18,19]. Hadley cell widening manifests itself over the Mediterranean Basin through increased subsidence and stronger anticyclonic conditions leading to a decrease in precipitation[20]. Hadley circulation is also expected to

11. Kelley, C, et al, (2012) Geophys. Res. Lett., 39, L21703. **12.** Lukovic et al. 2018 Geophys. Res. Abstracts 20, EGU2018-883: https://meetingorganizer.copernicus.org/EGU2018/EGU2018-883.pdf. **13.** Diffenbaugh, NS, et al. (2015) Proc. Natl Acad. Sci. USA 112, 3931–3936. **14.** Howitt, RE et al (2015) Economic Analysis of the 2015 Drought, University of California Davis, Davis, CA, 16 pp. **15.** Williams, AP, et al. (2015) Geophys. Res. Lett. 42(16): 6819–6828. **16.** Seager, R., et al. (2012) Nat. Clim. Change 3, 482–486. **17.** Hu, Y, and Fu, Q (2007) Atmos. Chem. Phys. 7, 5229-5236. **18.** Lucas, C, et al. (2014) Wiley Interdiscip. Rev.: Clim. Change 5, 89-112. **19.** Adam, O., et al. (2014) J. Clim. 27, 7450–7461. **20.** Giorgi, F and Lionello, P (2008) Glob. Clim. Change, 63, 90–104.

weaken in warmer climates, as a result of weakened meridional temperature gradients and changes in static stability and moisture convergence[21-23]. Changes in the atmospheric moisture content and moisture convergence are expected to intensify the amount of precipitation generated by the cyclones[9]. With warming temperatures, factors such as increased subsidence and stronger cyclones are expected to have opposing impacts that could, for example, manifest in a decreased number of cyclones but an increased amount of precipitation carried by each cyclone[24]. Finally, changes in the interhemispheric temperature gradient have also been implicated in affecting the dynamics of Hadley circulation. By affecting the position of the "energy equator" and the Intertropical Convergence Zone, differential warming in one hemisphere relative to another can lead to latitudinal shifts of the Hadley circulation[25,26] that could substantially impact the subtropical rainfall. During the boreal winter, as the Hadley circulation weakens and shifts southward, the subsidence across the northern hemispheric subtropical regions decreases, clearing the path for mid-latitude influences and the arrival of the precipitation rich storms. Decreased temperature gradients between the northern mid-latitudes and the pole due to sea-ice loss, have been linked to increased westerly wind strengths[29-31] and have been suggested to result in a 'wavier' jet and/or more blocking events[5,29]. The 'wavier' jet scenario could also have a substantial impact on subtropical precipitation.

The differences between simulated and observed precipitation changes over the Mediterranean Basin and California are likely to be, at least in part, a consequence of the different expression of internal or forced variability in the 'real' and 'model' worlds. However, recent work has revealed at least one factor contributing to the erroneous prediction of future precipitation changes in the subtropics: the incorrect representation of sea ice changes in climate models[5]. In their recent study, Cvijanovic et al. (2017)[5] demonstrated that Arctic sea-ice loss, of the magnitude expected in the coming decades, could lead to reorganization of tropical convection, triggering an anticyclonic response over the North Pacific that results in a significant drying over California. The same study indicated that the sea-ice loss drives precipitation changes across other subtropical regions, including the Mediterranean Basin. The high latitude sea-ice loss affects both the high-to-low latitude temperature gradients and the interhemispheric temperature gradients. As discussed above, all of these factors can contribute to changes in tropical and mid-latitude circulations thus affecting the precarious balance of their influences over subtropical regions. Inspired by this intricate web of atmospheric influences linking geographical regions that otherwise stand very far apart, this project will seek to disentangle some of the impacts arising from the dramatic loss in Arctic sea-ice cover and provide new insights into the interconnectedness of our planet's changing climate. It will apply this knowledge to one of the most burning issues for climate adaptation in two highly-populated Mediterranean regions. As such, this project has the potential for important theoretical advances in the field of climate science and for providing the long-overdue recommendations needed by policy makers.

Project Overview This project aims to improve understanding of sea-ice induced atmospheric teleconnections into the subtropics and subsequently apply this knowledge towards decreasing the uncertainties in projections and predictions of rainfall changes.

There is an apparent disagreement in how the Arctic sea-ice loss affects the weather and climate away from the Arctic. The atmospheric response to Arctic sea-ice loss described by, for example, Sewall and Sloan (2005)[32], Cvijanovic et al. (2017)[5], Simon et al. (2019)[33] and Seidenglanz et al. (2019)[34] showing the North Pacific geopotential ridge and drying over California disagrees with the one summarized in Screen at al. (2018)[35] showing the strengthening of Aleutian pressure low. There are a number of methodological differences between these different studies making it difficult to asses the causes of different responses, with some of the most likely candidates being: (1) different model spin-

] **21.** Held, IM and Soden, BJ (2006) J. Clim., 19(21), 5686–5699. **22.** Seo, K-H, et al. (2014) Geophys. Res. Lett., 40, 5251–5258. **23.** Lau, WKM, et al. (2015) Proc. Natl. Acad. Sci. USA 112, 3630–3653. **24.** Zappa, G, et al. (2015) Clim. Dyn. 45: 1727-1738. **25.** Chiang, JCH and Friedman, AR (2012) Annual Reviews of Earth and Planetary Sciences, 40, 383-412. **26.** Schneider, T et al. (2014) Nature 513, 45–53. **27.** Collins, M, et al. (2013) Climate Change 2013: The Physical Science Basis, T. F. Stocker et al., Eds., Cambridge University Press, 273–309. 28. Fereday, D, et al. (2018) J. Clim., 31,963–977. 29. Francis, J., and Vavrus, S., (2012) Geophys. Res. Lett., 10.1029/2012GL051000. **30.** Cvijanovic, I, Caldeira, K, (2015) Clim. Dyn., 44, 1173–1186. **31**. Pedersen, R, et al. (2016) J. Clim. 29, 889-902. **32.** Sewall and Sloan (2005) J. Clim. 17.1550–1568. **33.** Simon, A, et al. (2019) Geophys. Res. Abstract vol. 21, EGU2019-3184. **34**. Seidenglanz, A, et al. (2019) Geophys. Res. Abstract vol. 21, EGU2019-9271-1. **35.** Screen, J., et al. (2018) Nat. Geoscience 11, 155-163.

up times leading to different time scales of reported responses (seasonal to decadal vs. centennial); (2) energy vs. non-energy conserving methods for isolating the impacts of sea-ice loss; (3) consideration of Arctic only forcing, as opposed to assuming that Antarctic forcing has no impact and studying the response to changing both Arctic and Antarctic sea-ice cover. Understanding the impacts of these different approaches and methodologies on observed climate response to sea-ice changes is of key importance for advancing our current knowledge. Likewise, any recommendation for policy makers is not possible without a systematic review and understanding of how different methods may be shaping the results. Better understanding of the atmospheric linkages between the Arctic and the subtropics will further allow us to define physical constrains to select the 'best' model projections in order to narrow the range of projected changes. Current model limitations in simulating future precipitation changes over highly populated regions like the Mediterranean and California make the standard approach of treating every model equally disadvantageous, and additional physical criteria for selecting and weighting the models is needed to minimize the model spread. As a final scientific goal, the inferred mechanisms will be employed towards the development of multi-annual and decadal predictions of Californian and Mediterranean rainfall.

Key Objectives The project is organized into three complementary objectives:

1. Understanding the short-term response to Arctic sea-ice changes: investigate and systematize the physical mechanisms by which high latitude changes affect Californian and Mediterranean rainfall. Distinguish between: i) the process important at the seasonal and decadal timescales (in contrast to the existing studies that have been describing the centennial response to sea-ice changes[35]; ii) the impacts of different methodologies; and iii) combined Arctic and Antarctic sea-ice forcing (as opposed to Arctic only).

2. Decreasing the uncertainties in climate projections of future rainfall changes over the Mediterranean and California: investigate whether the large intermodel spread in simulations of Mediterranean and Californian precipitation changes can, at least in part, be explained by different representations of: i) high latitude sea-ice cover; and ii) sea-ice induced teleconnections explored in Objective 1 and in the applicant's previous work[5].

3. Determining the impact of 'sea-ice' on decadal and multi-annual predictions of Mediterranean and Californian rainfall: analyze decadal and multi-annual climate predictions to explore whether the forecasts featuring more realistic sea-ice conditions show increased predictive skill of precipitation changes over the two study regions.

Methodology and approach The project is organized into four Work Packages (WPs), the first three are aimed at achieving the completion of the main scientific objectives and the fourth aimed at extracting and communicating the relevant information for policy makers.

WP1. The baseline simulations used to accomplish Objective 1 in WP1 are specially tailored to isolate the impacts of sea-ice loss without imposing artificial energy fluxes in the high latitudes. In contrast to the studies that achieve sea-ice loss by imposing artificial energy flux anomalies in the high latitudes, the perturbed sea-ice physics parameter simulations (psipps), utilize small perturbations to sea-ice physics parameter values to achieve the sea-ice loss. This methodology ensures that the observed climatic response originates from the sea-ice changes only and that it is not altered by imposed energy flux perturbations. The sea-ice physics parameters values are varied *only within their respective expert-defined ranges,* in order to achieve the sea-ice loss in a manner that is in accordance with physical laws. At least three sets of psipps simulations will be considered: CESM/CAM4 slab ocean simulations described in Cvijanovic et al. (2017)[5], CAM5/nemo fully coupled simulations by Seidenglanz et al. (2019), and the EC-Earth model simulations currently performed at the Barcelona Supercomputing Center (BSC). The psipps simulations will be complemented by another set of specialized simulations that apply non-energy conserving methodology for isolating the impacts of sea-ice changes: nudged sea-ice simulations from the H2020 APPLICATE project that the host institute, BSC, currently participates in.

Task 1.1 will summarize the impacts of sea-ice loss in perturbed sea-ice parameter simulations on seasonal and decadal timescales with an accent on possible intermodel differences and impacts of ocean dynamics at different time-scales (slab ocean vs. fully coupled). **Task 1.2** will explore the impacts of different methodologies (conserving vs. non-energy conserving) at different timescales on the observed response to sea-ice changes. The EC-Earth sea-ice nudging simulations are currently performed at the BSC and will be available for the Task 1.2. The analysis may be further extended to

other available nudging simulations from the APPLICATE project. **Task 1.3** will explore the contrasting findings of Cvijanovic et al. 2017 and Screen et al. 2019 on the importance of Antarctic changes, using the Arctic only, Antarctic only and combined pssips experiments.

WP2. Investigations of sea-ice induced teleconnections (**Tasks 1.1 and 1.2**) will provide the foundation for WP2, aimed at narrowing the uncertainties in climate projections of future rainfall changes over the Mediterranean Basin and California. In order to determine how the representation of Arctic sea-ice cover and sea-ice-induced teleconnections affect the intermodel spread, WP2 will focus on the analysis of the simulations of historical climate and future projections from the CMIP6 initiative[6]. **Task 2.1** will employ sea-ice indices describing the total and sectorial (e.g., Pacific vs. Atlantic) sea-ice cover loss to test how their intermodel spread is linked to the intermodel spread in Mediterranean and California rainfall. Following this, the same analysis will be repeated using the atmospheric indices describing sea-ice induced teleconnections. These indices will include the atmospheric variables important for the propagation of sea-ice influence: tropical Pacific and tropical Atlantic outgoing longwave radiation changes, North Pacific geopotential and stream function anomalies, and tropical Atlantic wind strength changes. In **Task 2.2**, the model projections that perform the best at simulating both the sea-ice changes and the sea-ice induced teleconnections over the historical period will be selected. This will done by using the observational and reanalysis data from: ERA-Interim[36] and JRA-55[37], the Global Precipitation Climatology Project (GPCP)[38], and sea ice concentrations from the National Snow and Ice Data Centre (NSIDC)[39]. This will serve as a basis for further selection of the future projections, that will be additionally constrained by the other existing estimates of future sea-ice changes[40].

WP3. This final work package will assess the importance of accurate representation of sea-ice cover and sea-ice induced teleconnections on Mediterranean rainfall in the context of decadal and multi-annual climate predictions. The candidate will analyze the experiments performed within the context of the European H2020 project EUCP that BSC's Climate Prediction group participates in, and a new set of forecasts (currently ongoing at BBSC) using initial conditions in which sea-ice concentrations are not assimilated (**Task 3.1)**. To test the importance of accurate Arctic sea-ice representation for increased model skill in predicting the rainfall over Mediterranean and California (**Task 3.2**), a collection of statistical tools for climate prediction "s2dverification"[41] will be employed. This diagnostic tool is developed and maintained by the BSC's Earth System Services team.

WP4. Policy briefs and summaries and/or perspective/opinion pieces will be prepared for each completed scientific objective and distributed to relevant policy and stakeholder groups. **Task 4.1**: create a clear coherent summary describing how the climate response to Arctic sea-ice changes looks on seasonal and decadal time-scales (clear up current ambiguities introduced by consideration of different methodologies and time-scales in the existing scientific literature). **Task 4.2**: based on findings from WP2 and WP3 that decrease the range for the 'worst' case scenarios, create new recommendations for the climate adaptation policies over California and the Mediterranean.

Novelty and Interdisciplinary aspects. While the influences of Arctic sea-ice loss on mid-latitude weather and climate have been widely investigated, current scientific findings are contradictory and do not allow for a coherent and actionable story to emerge. By closing the knowledge gaps caused by the lack of information on how different methodologies affect the described responses to sea-ice loss, this project will allow us to systematize the existing knowledge, maximize its application for future scientific advancement and usability by policy makers. This is of great importance for climate policy and stakeholder groups focusing on climate adaptation in the face of rapid Arctic changes.

The analysis performed in this project has the potential to be a 'game-changer' for climate predictions. Improving the real-time decadal forecasts through the proposed novel approach could mark the first step towards a multi-annual forecast of Mediterranean and Californian rainfall – a longstanding and highly desired outcome, both scientifically and societally.

Successful completion of the project in terms of narrowing the range of future precipitation changes will directly benefit efforts aimed at strengthening the climate resiliency of the two study regions, leading to multiple interdisciplinary exit strategies within the socio-economic sector. In collaboration

36. Dee, DP, et al. (2011) Quart. J. Roy. Met. Soc.137: 553-597. **37.** Ebita, A, et al (2011) SOLA, 7, 149-152. **38.** Adler, RF, et al. (2003) J. Hydromet. 4,1147-1167. **39**. Cavalieri, DJ et al. (1996) Sea Ice Concentrations from Nimbus-7 SMMR and DMSP SSM/I-SSMIS Passive Microwave Data, NASA DAAC at the National Snow and Ice Data Center, Boulder, Colorado, USA. **40.** Overland, JE and Wang, M (2013) Geophys. Res. Lett. 40, 2097–2101. **41.** Manubens N, et al. (2018) Environ. Model. Softw., doi:10.1016/j.envsoft.2018.01.018.

with BSC's Climate Services team, project results will be disseminated and communicated throughout their already established user network that includes multiple entities from the European energy and industry sector. This will ensure additional exit strategies for the candidate after the completion of the project. Finally, the perturbed sea-ice physics parameter setup will provide invaluable information for climate model tuning and development, opening a pathway for the advancement of the EC-Earth model.

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

The candidate's research curriculum will be enriched by BSC's proficiency in seasonal and decadal climate predictions. This will help increase her scientific versatility and provide exciting new avenues in which to apply her existing expertise. In order to help her transition into an expert in climate prediction, the candidate will be provided training in employing the in-house set of statistical tools for climate prediction (s2dverification)[40], developed and maintained by BSC's Earth Sciences department. The Computational Earth Science group (CES) will provide tutorials on internal diagnostic and modeling tools, including the use of their "earthdiagnostics" tool and ESMValTool. CES will also provide support in using and adapting the existing diagnostic and prediction tools for the needs of the project and will assist the candidate in case of any issues with supercomputing resources.

The candidate will benefit from BSC's strong network of European partners and research projects. For the needs of proposed project, the applicant will be provided with the simulations from BSC's H2020 partner projects: APPLICATE, PRIMAVERA and EUCP. The multi-model analysis envisioned by the project will require substantial storage capacities while several proposed tasks (e.g., WP2 and WP3 diagnostics) are expected to be computationally expensive. BSC's supercomputing resources and expertize will be made available to fully support these needs. Finally, the candidate's modeling skills will also be strengthened through the opportunity to employ the EC-Earth3 climate model (as opposed to the National Center for Atmospheric Research's models she has used thus far).

The candidate's expertize in atmospheric dynamics and remote impacts of Arctic sea-ice changes is complementary to the current scientific goals and targets of the host institution: BSC's Climate Prediction Group is expanding to investigate the impacts of sea-ice loss. The proposed project will not only strengthen this initiative but also position BSC as one of the leaders in the field. This project is expected to lead to a number of high-impact scientific publications and policy briefs, leading to an increased scientific versatility and visibility for both the candidate and the host institution. The candidate brings to BSC a new capability to perform perturbed sea-ice physics simulations[5] that will allow exploration of sea-ice induced teleconnections in a state-of-the-art manner that is both physical and energy conserving. The candidate will also foster other collaborations of benefit to BSC. In particular, collaboration with prof. John Chiang at the University of California, Berkeley will provide expertize in atmospheric dynamics and collaboration with Dr. Benjamin Santer and Dr. Donald Lucas at Lawrence Livermore National Laboratory will provide world-class expertize in model analysis and intercomparison.

Since the candidate already has an established network of US based collaborators who will support this project through their expertize in climate model intercomparison and climate dynamics, shorter research visits to other institutions (instead of secondments) are suggested. This will allow the candidate to maximize her exposure to BSC's climate prediction expertize. However, it also affords the opportunity to expand her scientific network by interacting closely with BSC's European collaborators while maintaining her existing relationships.

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

The candidate will work under the direct supervision of Prof. Francisco Doblas-Reyes, head of the Earth Science (ES) department at BSC. Prof. Doblas-Reyes is an expert in seasonal-to-decadal climate predictions – a field that is highly relevant for this project proposal. He has more than 20 years of experience in weather and climate modelling, climate prediction and development of climate services, and over 100 peer-reviewed publications. He is currently a member of several international scientific committees, including the Working Group on Seasonal-to-Interannual Prediction, the Decadal Climate Prediction Panel of the World Climate Research Program, and the European Network for Earth System Modelling. He was the lead author of Chapter 11 of the Fifth Assessment

Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), and is designated Coordinating lead author of Chapter 10 in the 6th Assessment Report. For his work in seasonal forecasting at the European Center for Medium-Range Weather Forecasts (ECMWF), Prof. Doblas-Reyes was awarded the Norbert Gerbier-Mumm Award by the World Meteorological Organization. Prof. Doblas-Reyes has supervised numerous post-doctoral fellows since becoming head of the department and is currently supervising 4 Marie Skoldowska-Curie Individual Fellowship holders (DPETNA (655339), INCLIDA (275505), CLIM4CROP (740073) and SPFireSD (748750). He also currently participates in a number of FP7 and H2020 projects (SPECS, EUCP, PRIMAVERA), C3S contracts as well as several national projects.

The candidate will carry out her work within the Earth Sciences department's **Climate Prediction** group and in collaboration with the **Climate Services** group. The Climate Prediction group carries out advanced research in regional and global scale seasonal-to-decadal climate forecasting. It is a highly productive scientific environment that has published more than 150 peer-reviewed research articles over the last 5 years. The Climate Services (CS) group aims to provide relevant climate information to end users in key societal sectors, including energy, urban development, infrastructure, and transportation. Due to the high level of alignment between the goals of the CS group and the proposed project deliverables (e.g. improved climate projections and predictions of Mediterranean and California rainfall), multiple exit strategies involving the CS group are expected. At the BSC, the candidate will be provided access to a personal workstation, personal computer and high performance computing facilities and any other infrastructure available to Earth Sciences department employees. The project supervisor will help her in development of an individual career plan, tailoring it to ensure she transitions into an independent researcher by the end of the fellowship. Scientific progress will be discussed weekly, with review and planning meetings occurring on a quarterly basis. He will help guide the candidate through the key questions in climate prediction and ensure she has received all the necessary training in s2dverification tools. Additional supervision and expertize in climate prediction from Dr. Pablo Ortega and Dr. Markus Donat, the leaders of the Climate Prediction group, will also be made available to the candidate. The applicant will benefit from the highly collaborative environment in the department through their regular group, and monthly departmental, meetings as well as through various internal scientific seminars that will help foster her integration into the research team and improve her visibility within the department.

BSC regularly organizes employee workshops covering topics such as intellectual property, scientific communication, and proposal writing, that candidate will be invited to participate in throughout the course of fellowship. Other specialized training activities available at BSC include: methods for data assimilation, initialization, bias correction and calibration; efficient data post-processing and visualization; statistical programming and high performance computing; and project management. In discussion with the mentor during the development of the individual career plan, the candidate will select any of the above listed specialized and non-specialized training activities. Finally, the candidate will also be offered a free Spanish language lessons organized through BSC. Since the BSC attempts to foster a healthy and friendly work culture, it sponsors multiple sports activities for the employees that the candidate will also be invited to participate in.

1.4 Potential of the researcher to reach or re-enforce professional maturity/independence during the fellowship

After accumulating almost 4 years of postdoctoral experience in the US between 2012 and 2016, and being awarded a 3-year research grant (~1.5 million USD) at Lawrence Livermore National Laboratory, the candidate was primed to make the transition into an independent researcher. However, the applicant experienced a sudden and unexpected 2-year career break that involved a combination of medical, maternity and medical-caregiver's leave. The chance to join BSC as a Marie Skłodowska-Curie fellow will provide the candidate an important opportunity to resume her original career path. Over the course of the fellowship, she will strengthen her professional, personal and leadership skills both through specialized courses and hands-on experience. The candidate will build on her previously established expertize in climate dynamics and impacts of Arctic sea-ice loss while also developing new competencies in climate prediction, resulting in a new research avenue at BSC. She will be encouraged and supported in maintaining her existing research collaborations at the University of California Berkeley and LLNL and introduced into a network of European research centers through a number of European projects (APPLICATE, PRIMAVERA, EUCP, MEDSCOPE). She will also be

offered the opportunity to supervise PhD and MSc students in order to further strengthen her teaching skills. The candidate has so far authored and co-authored 16 publications that have resulted in over 1100 citations and extensive media coverage; the proposed research project is expected to result in several high impact publications that will help her both re-establish and further enhance her international research presence.

2. Impact

2.1 Enhancing the future career prospects of the researcher after the fellowship

Through the expected publications and international collaborations, the proposed project will help Dr. Cvijanovic re-establish herself as an internationally recognized researcher. In conjunction with the high prestige of the fellowship, this will put her in an excellent position to apply for national and international research grants, allowing her to start to build her own research group towards the end of the project. Mentoring and supervision of MSc and PhD level students will enhance her academic prospects, allowing her to consider professorships at universities as well as positions in research institutions.

The successful completion of the proposed project will result in multiple societal applications. Improved prediction of precipitation changes on annual and decadal scales is a highly desirable outcome for developing climate services and forecasts for relevant government and private entities, as well as improving understanding of the societal impacts of climate change. As such, this project will not only help increase the candidate's scientific versatility, but also place her at the forefront of the application of these new methods towards climate adaption and climate risk assessment. Likewise, since the project deliverables represent actionable climate information that is significant for public stakeholders and decision makers, this will allow the candidate to expand her professional network within the public sector too.

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

The proposed project is expected to result in a number of scientific publications and policy briefs. The successful completion of WP1 will result in a paper describing and summarizing the short-term response to Arctic sea-ice changes with specific focus on rainfall changes over the Mediterranean and California. This scientific publication will be accompanied by a policy brief summarizing the main points of importance for policy makers and stakeholders, with particular accent on how the use of different scientific methods may be affecting the general understanding of its consequences. The analysis performed in WP2 and WP3, will provide a physically-based framework for reducing the uncertainties in global climate model projections of future precipitation changes over the Mediterranean and California (WP2), and improving the skill in climate predictions of rainfall over the same regions (WP3). These findings will be organized in two scientific publications and one policy maker summary. The scientific results will be presented at international scientific conferences and meetings, including: European Geosciences Union General Assembly, American Geophysical Union Fall Meeting, European Meteorological Society Meetings and CLIVAR conferences.

Since the scientific outcomes of the proposed project are of substantial relevance to H2020 projects APPLICATE, PRIMAVERA and MEDSCOPE, and given BSC's participation in those, their dissemination resources will be utilized in order to maximize publication impacts. These projects feature work packages dedicated to user engagement activities (including regular meetings with representatives from the main stakeholder groups) and provide support for production of material and its communication and dissemination. For each scientific publication, a short news article will be produced and distributed through the partner projects' websites, social media platforms and mailing lists, while additional material will be adapted for the specific stakeholder groups.

Given the substantial significance of the proposed research for the policy-making and industrial sector, the candidate will be supported by the BSC's Climate Services team in further promoting the outcomes of the project. The Climate Services team will assist the candidate in preparing the policy briefs and summaries and help communicate them through their user networks and upcoming side events (for example, the Arctic Circle Assembly features regular attendance by the Climate Services group organizing side events as well as Arctic Science Summit Week and Arctic Council events). Additional Climate Services group networks that this project will exploit, include: EU Arctic Cluster, the International Maritime Organization as well as number of companies from energy and industry sector (through S2SRE project).

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

Arctic sea-ice cover is currently undergoing unprecedented changes, and is a highly discussed topic within the climate community. At the same time, both the Mediterranean and California represent 'uncertainty hotspots' in terms of future climate projections of rainfall. By linking these two research topics, the project outcomes are expected to be of wide scientific and societal interest. The candidate has substantial experience in communicating research results to journalists, scientific writers, and educational programs and will continue to share published research within this established network. Project results will be disseminated through the Sea Ice Action Network (aimed at communicating and advancing public awareness on the consequences of Arctic sea-ice loss), The Study of Environmental Arctic Change (SEARCH) as well as APPLICATE, PRIMAVERA and MEDSCOPE project networks (H2020 projects that BSC is an active member of) and communicated to the entities that have in the past followed candidates research (Climate Central, Arctic911). With each scientific publication, the candidate will prepare press release, fact sheet for journalists and simple figures that are accessible to the general public. BSC's Project Dissemination Unit will assist the candidate in communicating the project results and producing visualization material. The material will be made available on the BSC website and shared using its official social media platforms. All publications will be deposited in UPCommons in order to guarantee their long-term preservation and free accessibility. Policy and energy/industry sector related material will be produced and communicated in collaboration with BSC's Climate Services group (as described in Section 2.2).

Locally, the candidate will also participate in 'MareNostrum Open Days' aimed at communicating science to a general audience. Based on previous successful public outreach activities at the California Academy of Sciences, in San Francisco, the candidate will seek to collaborate with similar public entities focused on biological conservation (e.g., Barcelona Natural History Museum) to organize public lectures that would introduce the concepts of climate change in the Arctic and its global consequences. These lectures are expected to commence in the second year of the project.

A short stay at the University of Belgrade, Serbia will be carried out in the first half of the second year. The purpose of this visit is scientific engagement and knowledge transfer with students at the University of Belgrade, Serbia as well as public lecture that will be organized by the Nature and Science Faculty at the University of Belgrade.

3. Quality and Efficiency of the Implementation

Appropriateness of the management structure and procedures, including risk management

Management structure and procedures The Project Management Office at BSC will support the fellowship with regard to financial and administrative matters and will ensure that the grant agreement follows both Marie Skłodowska- Curie contractual rules and Spanish fiscal and social security laws. The candidate will have access to BSC's Technology Transfer manager (orientation/help with science exploitation, proposal writing, seeking new opportunities), Communications Team (support with outreach activities, organization of events, and press releases), Legal Assessment unit and Education and Training unit (high-quality training in scientific, technical, and general skills). The candidate will be employed as a full-time researcher with a standard 2-year contract in full accordance with the European Charter for Researchers and Code of Conduct for the Recruitment of Researchers. This will provide the salary and all other benefits made available by the MSC Fellowship, in conformity with the H2020 framework program. It will provide full access to the Spanish Social Security system, including comprehensive health care and pension provisions. Secretarial staff at the host institute will provide local support for financial administration and logistical organization.

Anticipated challenges and risk management

1. The identification of the sea-ice induced teleconnection in model simulations may be hindered by large internal climate variability. If encountered, this issue will be resolved by increasing the number of ensemble members or by sub-sampling only the periods with a large forcing.

2. In case the production of EUCP experiments for WP3 is substantially delayed (expected to start in the second half of 2018), the analysis would be complemented by the CMIP5 decadal hindcasts, and other sets of analogous experiments from the FP7 SPECS project, all of which are already available.

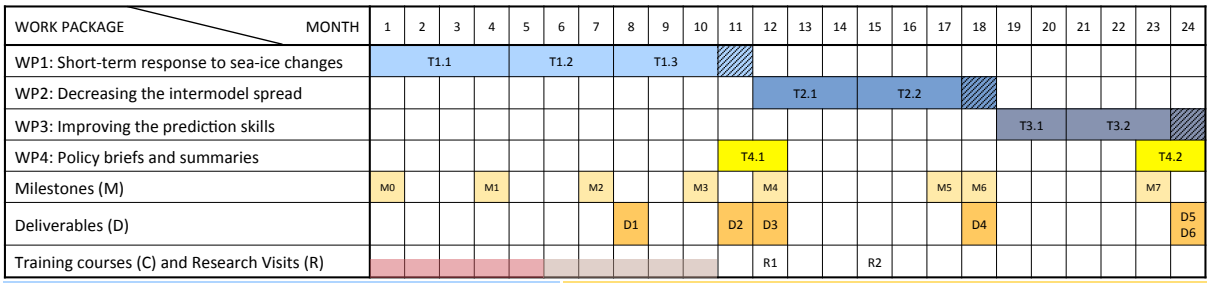
3. While WP2 and WP3 are dependent on successful completion of WP1, it is highly reassuring that the candidates' previous work and several other studies[5,44,45] have indicated Arctic sea-ice loss as a factor affecting rainfall over the Mediterranean Basin and California.

4. In an unlikely case that MareNostrum supercomputing facilities have a failure and are not available for a period of time, computing resources from the two collaboration institutions (UCB and LLNL) will be made available for the use in this project.

Appropriateness of the institutional environment (infrastructure) The applicant will be provided access to a personal workstation, personal computer and high performance computing facilities and other infrastructure available to BSC's employees. The BSC serves as the National Supercomputing Facility in Spain, hosting one of the fastest supercomputers in the world, the MareNostrum4 (https://www.bsc.es/marenostrum/marenostrum). In addition, starting in 2021, BSC will transition into a new generation pre-exascale supercomputer facility (MareNostrum5) and these resources will be made available to the candidate during the second year of the project. The BSC computational infrastructure will fully cover the project needs. The BSC also fosters a highly skilled team of technicians able to provide advice and support in high performance computing. By developing tools for automatizing the running of climate prediction experiments, their post-processing, and code optimization strategies, the Computational Earth Sciences group provides powerful support to researchers throughout BSC that the candidate will strongly benefit from. Outstanding supercomputing facilities, high quality user support and experience in hosting fellows will provide the candidate with a very strong basis for a successful completion of the proposed project.

Coherence and effectiveness of the work plan, including appropriateness of the allocation of tasks and resources

The Gantt chart below summarizes the envisioned project timeline



Tasks (T):
T1.1 Seasonal and decadal response analysis (psipps)
T1.2 Energy vs. non-energy conserving methods (psipps vs. nudging)
T1.3 Arctic vs. Arctic and Antarctic forcing (psipps)

T2.1 Linking the intermodel spread in Arctic sea-ice loss with CA-MED rainfall changes
T2.2 'best' models selected, new uncertainty ranges for CA-MED rainfall derived

T3.1 DCPP and degraded experiments analysis
T3.2 impacts of sea-ice conditions on CA-MED rainfall prediction skill

T4.1 Policy summary on atmospheric response to Arctic sea-ice changes
T4.2 Policy summary and recommendations for climate adaptation based on the updated 'worst' case scenario for Mediterranean and California

Work Package wrap-up

Training courses (C) completion : specialized, non-specialized
Research Stays: Belgrade University (R1), University of California Berkeley (R2)

Milestones (M):
M0: Career Development Plan drafted
M1: psipps analysis completed
M2: energy vs. non-energy conserving (psipps vs. nudging) models analysis completed
M3: Arctic only vs. Arctic and Antarctic forcing
M4: sea-ice areas and Mediterranean and Californian rainfall data ready
M5-6: analysis of the intermodel spread completed; new rainfall ranges provided
M7: analysis of the impacts of accurate sea-ice representation for multi-annual and decadal climate predictions.

Deliverables (D):
D1: Manuscript draft on the short term response to Arctic sea-ice loss (psipps);
D2: First year project report
D3: Manuscript draft on the impacts of different methodologies
D4: Manuscripts draft on the links between the intermodel spread in Arctic sea-ice cover and rainfall over California and Mediterranean
D5: Assessment of the role of accurate representation of sea-ice cover on the rainfall prediction skill (Mediterranean and California);
D6: Second year project report.

Section 4: CV of the experienced researcher

Name: Ivana Cvijanovic

Email: ivanacvijanovic@bsc.es

Professional Experience:

01/12/2018 – present	Beatriu de Pinos Research Fellow Earth Science Department Barcelona Supercomputing Center Barcelona, Spain
12/01/2015 – 21/09/2016	Postdoctoral Researcher Atmospheric, Earth and Energy Division Lawrence Livermore National Laboratory, LLNL, Livermore, CA *(On medical, maternity and medical caregivers leave from LLNL from 21/09/2016 to 01/05/2018)*
03/01/2013 – 01/09/2014	Postdoctoral Researcher Carnegie Institution for Science, Stanford, CA and Niels Bohr Institute, University of Copenhagen, Denmark
05/11/2012 – 31/12/2013	Visiting Research Scholar Department of Global Ecology Carnegie Institution for Science, Stanford, California
01/06/2007 – 01/08/2008	Summer Research Assistant in Groundwater Modeling Centre for Applied Geoscience Eberhard-Karls University Tuebingen, Germany

Education:

15/09/2008 – 02/05/2012	Ph.D. in Atmospheric Sciences Niels Bohr Institute, University of Copenhagen Copenhagen, Denmark Ph.D. Dissertation Title: Abrupt climate change and high to low latitude teleconnections as simulated in climate models.
01/08/2006 – 29/08/2008	M.Sc. in Applied Environmental Geosciences Faculty of Geoscience, Eberhard-Karls University Tuebingen, Germany M.Sc. Thesis Title: The influence of shallow subsurface moisture and heat transport on the mass and energy balances at the land surface. GPA: 1.2 (Excellent)
01/09/2001 – 17/03/2006	Diploma in Physics, Meteorology and Env. Modeling Nature and Science Faculty, University of Novi Sad Novi Sad, Serbia. GPA: 9.94 out of 10 (Excellent)

Career Break:

21/09/2016 – 01/12/2018	Medical, maternity and medical-caregivers leave

Ph.D. Mobility Stays:

10/2010 - 04/2011 and 07/2011-10/2011: University of California, Berkeley, USA.
Research topic: the mechanisms of high to low latitude atmospheric propagation.

Publications:

(1) Santer, B.D., Po-Chedley, S., Zelinka,M. D., **Cvijanovic, I.**, Bonfils, C., Durack, P., Fu, Q., Kiehl, J., Mears, J., Painter, J., Pallotta, G., Solomon, S., Wentz, F.J., and Z. Cheng-Zhi Zou (2018): Human Influence on the Seasonal Cycle of Tropospheric Temperature. *Science* 361, 6399. Citations: 7.

(2) Cvijanovic, I., Bonfils, C., Santer, B. D., Lucas, D. D., Chiang, J.C.H and S. Zimmerman (2017): Future loss of Arctic sea-ice cover could drive a substantial decrease in California's rainfall. *Nature Communications* 8, doi:10.1038/s41467-017-01907-4. Citations: 31.

(3) Bonfils, C., Anderson, G., Santer, B.D., Phillips, T.J., Taylor, K.E., Cuntz, M., Zelinka, M.D., Marvel, K., Cook, B.I., **Cvijanovic, I.** and P.J. Durack (2017): Competing Influences of Anthropogenic Warming, ENSO, and Plant Physiology on Future Terrestrial Aridity. *Journal of Climate,* 30, 6883–6904. Citations: 7.

(4) Santer, B. D., Fyfe, J. C., Pallotta, G., Flato, G. M., Meehl, G. A., England, M. H., Hawkins, E., Mann, M. E., Painter, J. F., Bonfils, D., **Cvijanovic, I.**, Mears, C., Wentz, F. J., Po-Chedley, S., Fu, Q. and C-Z Zou (2017): Causes of differences in model and satellite tropospheric warming rates, *Nature Geoscience* 10, 478-485. Citations: 17.

(5) Santer, B. D., Solomon, S., Pallotta, G., Mears, C., Po-Chedley, S., Fu, Q., Wentz, F., Zou, C-Z., Painter, J., **Cvijanovic, I.** and C. Bonfils (2016): Comparing Tropospheric Warming In Climate Models and Satellite Data. *Journal of Climate* 30, 373-392. Citations: 21.

(6) Pedersen, R.A, **Cvijanovic, I.**, Langen, P.L. and B. M. Vinther (2016): The Impact of Regional Arctic Sea Ice Loss on Atmospheric Circulation and the NAO. *Journal of Climate* 29, 889–902. Citations: 43.

(7) Cvijanovic, I., Caldeira, K. and D. MacMartin (2015): Impacts of ocean albedo alteration on Arctic sea ice restoration and Northern Hemisphere climate. *Environmental Research Letters* 10, 044020. Citations: 12.

(8) Cvijanovic, I. and K. Caldeira (2015): Atmospheric impacts of sea ice decline in CO_2 induced global warming. *Climate Dynamics* 44,1173-1186. Citations: 22.

(9) Caldeira, K. and **I. Cvijanovic** (2014): Sea ice radiative forcing, sea ice area, and climate sensitivity. *Journal of Climate* 27, 8597–8607. Citations: 10.

(10) Rasmussen et al. (2014): A framework for robust naming and correlation of past abrupt climatic changes during the recent glacial period based on three synchronized Greenland ice cores. *Quaternary Science Reviews* 106, 14–28. Citations: 642.

(11) NEEM community members (2013): Eemian interglacial reconstructed from Greenland folded NEEM ice core strata, *Nature* 493, 489-94. Citations: 178.

(12) Cvijanovic, I., Langen, P.L., Kaas, E. and P.D. Ditlevsen (2013): Southward Intertropical Convergence Zone shifts and implications for an atmospheric bipolar seesaw, *Journal of Climate* 12, 4121-4137. Citations: 22.

(13) Cvijanovic, I. and J.C.H. Chiang (2013): Global energy budget changes to high latitude North Atlantic cooling and the tropical ITCZ response, *Climate Dynamics* 40, 1435-1452. Citations: 51.

(14) Cvijanovic, I., Langen, P.L. and E. Kaas (2011): Weakened atmospheric energy transport feedback in cold glacial climates, *Climate of the Past* 7. Citations: 5

(15) Borreguero, L.H., Mottram, R. and **I. Cvijanovic** (2010): Discussing Progress in Understanding Ice Sheet-Ocean Interactions: Advanced Climate Dynamics Course 2010, *Eos, Transactions American Geophysical Union*. Citations: 1.

(16) Kollet, S.J., **Cvijanovic, I.**, Schüttemeyer, D., Maxwell, R.M., Moene, A.F., and P. Bayer (2009): The influence of rain sensible heat and subsurface energy transport on the energy balance at the land surface, *Vadose Zone Journal* 8, 846-857. Citations: 43.

Governmental Reports:

California's Fourth Climate Change Assessment Report 2018 – contributing author.

Selected Talks:

European Geosciences Union General Assembly 2019, Vienna, Austria: *Opposing influences of Arctic sea-ice loss on Californian and Mediterranean rainfall*

Bridging the Mediterranean Climates MedCLIVAR 2018, Belgrade, Serbia: *Through distant worlds and times: The story of Milutin Milankovich* (*invited conference opening talk*)

American Meteorological Society 96th Annual Meeting 2016, New Orleans, Louisiana: *Seasonally ice-free Arctic favors dry California*

American Geophysical Union Meeting 2015, San Francisco, California: *Impacts of ocean albedo alteration on Arctic sea ice restoration and Northern Hemisphere climate* (*invited*)

American Geophysical Union Meeting 2015, San Francisco, California: *Can large scale sea ice cover changes affect precipitation patterns over California?*

Lawrence Livermore National Laboratory, Atmospheric, Earth and Energy division, Livermore, California, 2014: *Climate impacts of changing sea ice cover in CO_2 induced global warming* (*invited*)

Columbia Climate Center, Earth Institute, Columbia University, 2013: *The effects of changing sea ice cover on global warming and climate consequences of sea ice geoengineering*

American Geophysical Union Meeting 2013, San Francisco, California: *Atmospheric impacts of changing sea ice cover in CO_2 induced global warming.*

Department of Global Ecology Seminar Series, Carnegie Institution for Science, Stanford, 2012: *Abrupt climate change and high to low latitude teleconnections* (*invited*)

INTIMATE WG3 workshop 2012 - The last deglaciation: towards model-data integration, Copenhagen, Denmark: *Global energy budget changes to high latitude North Atlantic cooling and the role of tropical SSTs* (*invited*)

American Geophysical Union Meeting 2011, San Francisco, California: *Global energy flux changes to high latitude North Atlantic cooling and the tropical ITCZ response*.

European Meteorological Society Meeting 2008, Amsterdam, Netherlands: *The influence of shallow subsurface moisture and heat transport on the mass and energy balances at the land surface* (*EMS student award talk*)

Fellowships and Grants:

09/2018 Beatriu de Pinos Research Fellowship Grant by the Government of Catalonia (92.000 euros research grant to investigate the impacts of Arctic sea-ice loss on the climate of the Mediterranean Basin).

09/2016 Lawrence Livermore National Laboratory Exploratory Research Grant – LDRD 17-ERD-052, Principal Investigator: Ivana Cvijanovic (3-year funding grant, ~$550.000 USD/year).

Prizes and Awards:

Lawrence Livermore National Laboratory 2018 Physical and Life Science directorate Outstanding Paper Award for Cvijanovic et al. (2017)

Lawrence Livermore National Laboratory SPOT Award for outreach efforts (2016)

Nature Climate Change research highlight for Pedersen et al. (2016)

IoPselect paper and Environmental Research Web highlight for Cvijanovic et al. (2015) http://iopscience.iop.org/article/10.1088/1748-9326/10/4/044020/meta

European Meteorological Society Young Scientist Award (2008)

German Academic Exchange Service (DAAD) scholarship award 2006-2008

University of Novi Sad Excellence Awards: 2002-2005

Kingdom of Norway Award for one of the 500 best students in Serbia (2005)

Nature and Science Universities of Serbia Annual Competitions: 3rd place in physics (2005), 2nd place in physics (2004)

Teaching and supervision:

Teaching:

Guest Lecturer for course Climate Change, University of Belgrade, 05/2018.

Teaching assistant for Geophysics 3, University of Copenhagen, 09-12/2008.

Teaching assistant for Numerical methods, University of Copenhagen, 01-04/2009.

Guest Lectures: PhD courses "Weather in a tank" (2011) and "California Hydrology" (2016), University of California, Berkeley.

Supervision:

PhD project supervision: University of Copenhagen and Carnegie Institution for Science, Stanford, 2014-2015.
BSc student supervision: University of Copenhagen, 2013.

Curriculum development:

Development of a lesson plan on climate change and sustainable living for elementary school level English-as-a-foreign-language classes (in collaboration with J. Rakovic, Aarhus University, Denmark)

Fieldwork training and participation:

The North Greenland Eemian Ice Drilling (NEEM) Campaign: ice core processing (July 2009)

Development of specialized climate model configurations

(1) aquaplanet setup (Cvijanovic et al. (2013), J. Clim.)
(2) 'hybrid' data ocean/slab ocean configuration (e.g., tropical data ocean with extratropical slab ocean, Cvijanovic et al. (2013), Clim. Dyn.)
(3) prescribed and zero sea-ice setups (Caldeira and Cvijanovic (2014), J. Clim., Cvijanovic and Caldeira (2015) Clim. Dyn., Pedersen et al. (2016) J. Clim.)
(4) altered ocean albedo setup (Cvijanovic et al. (2015), Env. Res. Lett.)
(5) perturbed sea-ice physics parameter setup for CESM/CICE4 model (Cvijanovic et al. (2017), Nat. Comm.)
(6) perturbed sea-ice perturbed physics parameter setup for EC-Earth3 model (NEMO3.6, LIM3) (Cvijanovic et al. (2019), CMIP6 Model Analysis workshop)
(7) EC-Earth3 (ORCA1L75) historical and scenario runs for CMIP6

Public Outreach:

Climate and Weather Seminar Series organizing committee: Lawrence Livermore National Laboratory 01/2015-10/2016

California Academy of Sciences, Dark and Stormy Nightlife Event: presentations on the topic of California's drought, San Francisco, 2016

Lawrence Livermore National Laboratory, Kids2work Day 2016: science presentations and experiments

Global Ecology Seminar Series organizer: Carnegie Institution for Science, Stanford 09/2013-09/2014

University of Copenhagen, Culture Night Event 2009: public lectures on climate and ice core research

Reviewer:

Journal of Climate (since 2011), Climate Dynamics (since 2011), Environmental Research Letters (since 2013), Geophysical Research Letters (since 2014), Nature Publishing Group (since 2014), AGU Journals of Geophysical Research (since 2015).

Media and Editorial Highlights:

Climate Central, CBC News, Voice of America: interviews and commentaries on the topic of climate change. Work reported by 100+ newspapers, radio and television stations, a brief selection provided below.

The Washington Post
https://www.washingtonpost.com/news/capital-weather-gang/wp/2017/12/06/thanks-to-climate-change-the-weather-pattern-burning-up-california-and-freezing-the-east-may-thrive/?utm_term=.091949cc2a8e

The New York Times
https://www.nytimes.com/2017/12/07/climate/california-fires-warming.html?_r=0

Los Angeles Times
http://beta.latimes.com/politics/la-na-pol-climate-california-20171205-htmlstory.html

San Francisco Chronicle
http://www.sfchronicle.com/bayarea/article/Arctic-ice-loss-could-spell-more-drought-for-12405285.php#photo-12686982

National Public Radio (NPR)
https://www.npr.org/sections/thetwo-way/2017/12/12/570119468/arctics-temperature-continues-to-run-hot-latest-report-card-shows?ft=nprml&f=

The Guardian
https://www.theguardian.com/environment/climate-consensus-97-per-cent/2017/dec/11/californias-hellish-fires-a-visit-from-the-ghost-of-christmas-future

Zeit Online
http://www.zeit.de/wissen/umwelt/2017-12/kalifornien-waldbraende-los-angeles-klimawandel

MIT Review
https://www.technologyreview.com/s/609974/how-nuclear-weapons-research-revealed-new-climate-threats/

NBC News
https://www.nbcnews.com/news/us-news/disappearing-arctic-ice-could-make-california-droughts-worse-n826461

The Independent
http://www.independent.co.uk/news/science/artificially-manipulating-arctic-climate-by-whitening-surface-of-ocean-to-reflect-sunlight-back-into-10210896.html

The Guardian
https://www.theguardian.com/environment/climate-consensus-97-per-cent/2015/dec/21/the-best-of-climate-science-and-humanity-come-together-at-agu

New York Post
https://nypost.com/2017/12/06/california-droughts-could-get-worse-from-melting-arctic-ice/

Der Standard
http://derstandard.at/2000015059031/Forscher-gegen-die-Idee-die-Arktis-weiss-zu-faerben

Cienciaplus
http://www.europapress.es/ciencia/habitat-y-clima/noticia-tenir-blanco-artico-puede-ayudar-hielo-no-clima-20150429104251.html

La Repubblica
http://www.repubblica.it/ambiente/2015/05/03/news/artico_imbiancare-113438645/?ref=search

Al Jazeera
http://www.aljazeera.com/news/2017/12/california-wildfires-stay-171208080521885.html

Section 5: Capacity of the Participating Organizations

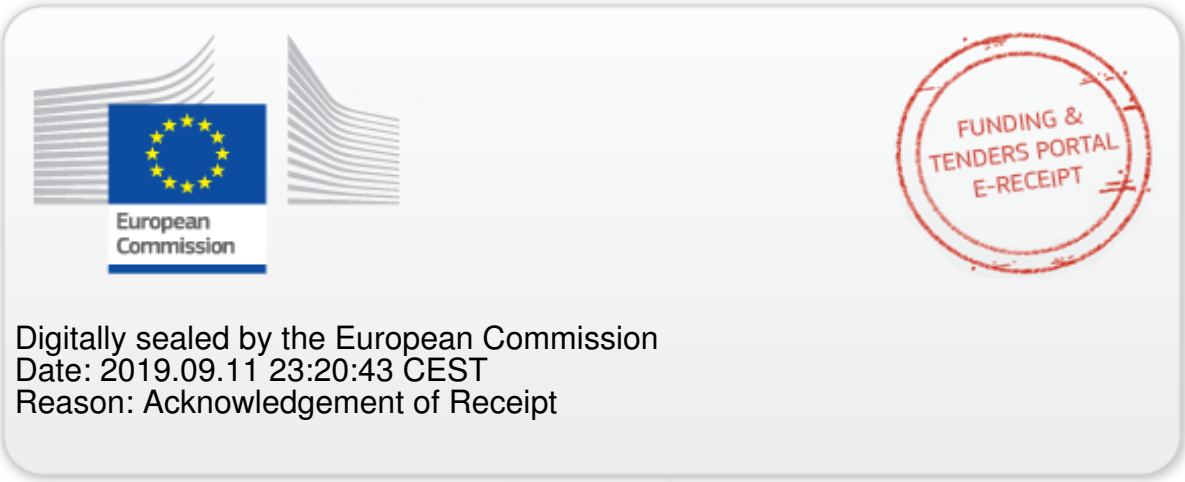
Participating Organizations	Legal Entity Short Name	Country	Supervisor/ Responsible Person(s)	Role of Partner Organization
Beneficiary				
Barcelona Supercomputing Center	BSC	Spain	Prof. Francisco Doblas-Reyes	N/A (Host organization)
Collaboration Organizations[2]				
University of California Berkeley	UCB	USA	Prof. John Chiang	Scientific collaboration: providing expertize in atmospheric dynamics and hosting a short research stay
Lawrence Livermore National Laboratory	LLNL	USA	Dr. Benjamin Santer and Dr. Donald Lucas	Scientific collaboration: providing expertize in climate model projections and perturbed physics ensemble simulations
University of Belgrade	UB	Serbia	Dr. Jelena Lukovic	Hosting a short research stay and organizing public lectures

[2] Since according to the MSCA guidelines, collaboration organization is not considered a 'partner organization' these are only listed here but will not be described in the reminder of the section.

Barcelona Supercomputing Center - Centro Nacional de Supercomputación (BSC), Spain	
General Description	The Barcelona Supercomputing Center (BSC) is the national supercomputing facility of Spain, hosting one of the most powerful supercomputers in the world MareNostrum 4. It employs over 600 researchers focusing on a multidisciplinary research across the fields of Earth and Life Sciences and Scientific Computing. The BSC is recognized as a Severo Ochoa Centre of Excellence by the Spanish Ministry of Science and Innovation for being one of the top internationally renowned research institutions in Spain (only 11 research centres across the country). Starting in 2020, it will host a new pre-exascale supercomputer The European Supercomputer MareNostrum 5, ensuring BSC's leading position on the future map of supercomputing in Europe. The fellow will be hosted at the **Earth Sciences (ES) Department,** within the **Climate Prediction Group**. This group carries out advanced research in seasonal-to-decadal climate forecasting. It is one of the world leaders in the field of climate prediction with more than 150 peer-reviewed research articles published over the last 5 years. The candidate will be supervised by Prof. Francisco Doblas-Reyes, head of the Earth Sciences Department and co-supervised by Dr. Pablo Ortega and Dr. Markus Donat, leaders of the Climate Prediction Group.
Academic Organization	Yes. The BSC closely collaborates with the Universidad Politècnica de Catalunya (UPC) running a joint MSc degree programme in Environmental Engineering.
Role and Profile of Key Persons (Supervisor)	ICREA research professor **Francisco Doblas-Reyes** is the director of the Earth Science Department at the BSC. He is a world expert in the development of "s2d" climate prediction systems and has more than 20 years of experience in weather and climate modelling, climate prediction and development of climate services. He has authored and co-authored 100+ peer-reviewed publications. He was the PI on 1 FP7 project, is currently involved in 4 Horizon 2020 collaborative projects, leading 2 C3S contracts and has supervised 4 MSCA-IF researchers (DPETNA (655339), INCLIDA (275505), CLIM4CROP (740073) and SPFireSD (748750). His expertize in seasonal-to-decadal climate predictions is essential to this Marie Skłodowska-Curie project proposal.
Dept./Division / Laboratory	The project will be hosted by the Climate Prediction Group within the Earth Sciences Department.
Key Research Facilities, Infrastructure and Equipment	The BSC hosts outstanding high performance computing facilities the MareNostrum 4, one of the fastest supercomputers in the world (composed of 165,888 processors and 14 Petabytes of disk storage, with a peak performance of 11.15 petaflops. In 2020, a new pre-exascale supercomputer MareNostrum 5 with a peak performance of 200 petaflops will start its operation at BSC.
Independent research premises?	All BSC's departments have their own research premises. The infrastructure, equipment and key research facilities will be available for the fellow during the entire duration of the project.
Previous and current involvement in Research and Training Programmes	The **BSC-ES Department** is a highly productive scientific institution that has been granted 25 EU Horizon 2020 projects, 6 EU FP7 projects, 10 Copernicus contracts, 13 national projects and 4 European Space Agency projects in the last five years. The most relevant projects for this MSC proposal that the Climate Prediction Group currently participates in, are H2020 projects **APPLICATE** (H2020-BG-2016-2017-727862; providing multi-model simulations for WP1), **PRIMAVERA** (H2020-SC5-01-2014-641727; high resolution simulations for WP1&WP2), **EUCP** (H2020-SC5-2016-2017-776613; high resolution simulations for WP3). The BSC is also the beneficiary of Marie Skłodowska-Curie Action COFUND program for postdoctoral fellows (**STARS**; H2020-MSCA-COFUND-754433). The BSC-ES is currently awarded 6 early stage postdoctoral fellowships (5 Juan de la Cierva and 1 Beatriu de Pinos), 6 senior research grants (4 Ramon y Cajal and 2 ICREA) and hosts 7 MSCA-IF research projects: NeTNPPAO, ACRoNNim, SPFireSD, DUST.ES, PROTECT, INADEC, CLIM4CROP.
Relevant Publications and/or research/innovation products	Selected list of 5 publications by Prof. Doblas-Reyes most relevant for this proposal: **1.** Acosta Navarro, J.C., et al., (2019): December 2016: Linking the lowest Arctic sea-ice extent on record with the lowest European precipitation event on record. **Bulletin of the American Meteorological Society**, 100, S43-S48, doi:10.1175/BAMS-D-18-0097.1. **2.** Massonnet, F., et al., (2016):Using climate models to estimate the quality of global observational data sets. **Science**, 6311, 452-455. **3**. Guemas V.,et al (2016). Impact of sea ice initialization on sea ice and atmosphere prediction skill on seasonal timescales. **Geophysical Research Letters**, 43, 3889-3896. **4.** Fučkar, N.S., et al., (2019): Dynamical prediction of Arctic sea ice modes of variability. **Climate Dynamics**, 52, 3157-3173, doi:10.1007/s00382-018-4318-9. **5.** Doblas-Reyes, F.J., et al., (2013): Initialized near-term regional climate change prediction. **Nature Communications**, 4, 1715.

Section 6 - Ethical Issues

There are no ethical issues flagged in the Ethics Issues Table, this proposal meets the EU and national legal and ethics requirements.



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