Horizon 2020

Call: H2020-MSCA-IF-2016

(Marie Skłodowska-Curie Individual Fellowships)

Topic: MSCA-IF-2016

Type of action: MSCA-IF-EF-ST

(Standard EF)

Proposal number: 740073

Proposal acronym: CLIM4CROP

Deadline Id: H2020-MSCA-IF-2016

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How to fill in the forms?

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

Proposal ID **740073** *Acronym* **CLIM4CROP**

1 - General information

Topic	MSCA-IF-2016
Call Identifier	H2020-MSCA-IF-2016
Type of Action	MSCA-IF-EF-ST
Deadline Id	H2020-MSCA-IF-2016

Acronym: CLIM4CROP

Proposal title: Climate monitoring and seasonal forecast for global crop production

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: *Meteorology, atmospheric physics and dynamics*

Descriptor 2: *Climatology and climate change*

Descriptor 3: *Agriculture related to crop production, soil biology and cultivation, applied plant biolo* Remove

Add

Free keywords: *climate monitoring, crop yields, seasonal forecasts*

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Abstract

When provided in a climate-services context, seasonal climate forecasts can enable a more effective adaptation to climate variability and change, offering an under-exploited opportunity to minimise the agricultural impacts of adverse climate conditions. However, the development of seasonal prediction systems of climate-driven impacts on agriculture is still largely in the early stages, especially on a global scale. CLIM4CROP is designed as a multidisciplinary project aimed at exploring how to best exploit seasonal forecasts for crop management decision making on a global scale. This goal will be achieved through three specific supporting objectives: a) characterising the uncertainties in global datasets of climate observations covering the last three decades and providing data in near-real time; b) understanding the role of climate as underlying mechanisms driving crop yields, and thereby developing statistical models linking climate and yields; c) exploring the seasonal predictability of crop yields with the above-mentioned developed models and implementing a model suite operationally using the data available in near-real time. These objectives will be addressed by making use of the latest advances in climate information, including the most complete and up-to-date sets of seasonal forecast systems. The expected outcomes of this project are an improved understanding of the interaction between climate and crop yields, and new insights allowing more efficient crop management. This could prove useful to policy-makers and commercial entities in their decision-making processes. To this end, the transfer of knowledge to impact users is envisaged.

Remaining characters 332

Has this proposal (or a very similar one) been submitted to a Horizon 2020 Marie Skłodowska-Curie Individual Fellowship call? ○ 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) confirms:

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

5) The 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

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

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

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List of participants

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

Proposal ID **740073** *Acronym* **CLIM4CROP** *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

NACE Code: 72 - Scientific research and development

Does this participant deliver doctoral degrees that are recognised as such by the relevant national authorities? ○ Yes ◉ No

Proposal ID **740073** *Acronym* **CLIM4CROP** *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.

Proposal ID **740073** *Acronym* **CLIM4CROP** *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.

Researcher ID	0000-0001-8589-7459		
Last Name*	TURCO	Last Name at Birth	
First Name(s)*	Marco	Gender*	◉ Male ○ Female
Title	Dr.	Country of residence*	Spain
Nationality*	Italy	Nationality 2	
Date of Birth (DD/MM/YYYY)	22/01/1978	Country of Birth*	Italy
		Place of Birth	Cuneo

Contact address

Current organisation name	BARCELONA SUPERCOMPUTING CENTER - CENTRO NACIONAL DE SUPE		
Current Department/Faculty/Institute/ Laboratory name	Earth Sciences Department		

☒ Same as organisation address

Street	Calle Jordi Girona 31		
Postcode/Cedex	08034	Town	BARCELONA
Phone	0034675050362	Country	Spain
Phone2 / Mobile	*+xxx xxxxxxxxx*		
E-Mail*	marco_turco@yahoo.it		

Proposal ID **740073** *Acronym* **CLIM4CROP** *Short name* **BSC**

Qualifications

University Degree	Date of award (DD/MM/YYYY)	20/04/2002
Doctorate (in progress)	Date of award (DD/MM/YYYY)	
Doctorate	Date of award (DD/MM/YYYY)	25/07/2012
Full time postgraduate research experience	Number of months	49
Other Academic qualifications	Date of award (DD/MM/YYYY)	

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 (14/09/2016).

Period from	Period to	Duration (days)	Country
18/01/2016	14/09/2016	241	Spain
01/01/2012	17/01/2016	1478	Italy
01/09/2009	31/12/2011	852	Spain
	Total	2571	

Proposal ID **740073** *Acronym* **CLIM4CROP** *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: Prof. Sex: (•) Male ( ) Female

First name*: **Francisco Javier** 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: Jordi Girona, 29

Town: Barcelona Post code: 08034

Country: Spain

Website: https://www.bsc.es/about-bsc/staff-directory/doblas-reyes-francis

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

Other contact persons

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

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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

Proposal ID **740073** *Acronym* **CLIM4CROP**

5 - Call specific questions

Eligibility Researcher (future fellow)

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

Other Questions

For communication purposes only, the REA asks for permission to publish the name of the researcher (future fellow) should the proposal be retained for funding.

1. Does the researcher (future fellow) give this permission? ◉ Yes ○ No

2. 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 Leeds

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: Joint Research Centre of the European Commission

Country: Italy

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Data management activities

A new focus within Horizon 2020 is data management, for example through the use of Data Management Plan (DMP).

DMPs detail what data the project will generate, whether and how it will be exploited or made accessible for verification and re-use, and how it will be curated and preserved.

The use of a DMP is required for projects participating in the Open Research Data Pilot in the form of a deliverable in the first 6 months of the project (possible updates during the project).

Other projects are invited to submit a DMP if relevant for their planned research.

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

Open Research Data Pilot in Horizon 2020

All applicants can participate in the Pilot on Open Research Data in Horizon 2020[1] on a voluntary basis. This Pilot aims to improve and maximise access to and re-use of research data generated by actions.

Participants in the Pilot will be invited to formulate a Data Management Plan (DMP). DMPs detail what data the project will generate, whether and how it will be exploited or made accessible for verification and re-use, and how it will be curated and preserved.
Participating in the Pilot is flexible in the sense that it does not mean that all research data needs to be open. Rather, projects can define certain datasets to remain closed via a Data Management Plan (DMP).

Please note that participation in this Pilot does not constitute part of the evaluation process. Proposals will not be evaluated favourably because they participate in the Pilot on a voluntary basis.

We wish to participate in the Pilot on Open Research Data in Horizon 2020 on a voluntary basis	○ Yes	◉ No

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

DOCUMENT 1

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MARIE SKŁODOWSKA-CURIE ACTIONS

Individual Fellowships (IF)
Call: H2020-MSCA-IF-2016

PART B

"CLIM4CROP"

"Climate monitoring and seasonal forecasts for global crop production"

This proposal is to be evaluated as:

Standard EF

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List of Participating Organisations

Participating organisations	Legal Entity Short Name	Academic (tick)	Non-academic (tick)	Country	Department / Division / Laboratory	Supervisor	Role of Partner Organisation
Beneficiary							
Barcelona Supercomputing Center	BSC	✔		Spain	Earth Sciences Department	Prof. Francisco Javier Doblas Reyes	
Partner Organisation							
Joint Research Centre of the European Commission	JRC		✔	Italy	Monitoring Agricultural Resource Unit	Dr. Andrea Toreti	Host of Secondment
University of Leeds	UL	✔		United Kingdom	Institute for Climate and Atmospheric Science, School of Earth and Environment	Prof. Andy Challinor	Host of Secondment

1. Excellence

1.1 Quality and credibility of the research/innovation action

Crop yields are increasing globally but at an insufficient rate to meet the projected growing demands in 2050[1]. On the other hand, both the occurrence of and changes in climatic extremes constitute a great concern to food security, aggravated in the absence of adaptation responses[2]. **Seasonal climate forecasts enable a more effective and dynamic adaptation to climate variability and change,** offering an under-exploited opportunity to minimise the impact of adverse climate conditions and thus agricultural losses and crop yield variability.

Over the past 30 years, the development of climate predictions at seasonal timescales has grown from a research activity undertaken in a few academic and research institutes to a routine operational activity in a number of meteorological forecasting services[3]. As a result, seasonal climate forecasts are being increasingly used across a range of application areas (e.g. energy, water, insurance)[4]. Whilst global early warning systems have recently been developed (e.g., the Global Information and Early Warning System of the Food and Agriculture Organization of the United Nations[5]), and new data and research efforts have significantly boosted our knowledge of climate-crop modelling[1,2,6,7], **studies addressing seasonal prediction of climate-driven impacts on agriculture are still relatively scarce** and mostly limited to small spatial domains (see e.g. Hansen et al. 2011 and references therein)[8]. A recent study (Iizumi et al., 2013)[9] provides for the first time a global assessment of seasonal forecasts for agriculture purposes. Using a relatively simple model framework that combines a statistical yield model with a nine-member ensemble of seasonal forecasts of monthly mean values of temperature and soil moisture forecasts, Iizumi et al. (2013) indicate promising results on the reliability of yield hindcasts three months before the harvest. Although this study has provided significant new insights, and in spite of the growing awareness of the importance of integrating global seasonal climate forecasts for agriculture, certain aspects of this topic remain largely unexplored. This is mainly due to limitations in observations, difficulties in disentangling the many determinants of crop yields and in translating climate predictions into useful information. In this sense, **three key research gaps have been identified**:

1. **A global evaluation of long-term and continuous climate data for timely monitoring and modelling purposes is required**. Indeed, long-term archives combined with near-real time data are crucial for monitoring and yield forecasting. However, a global assessment of meteorological datasets covering the last three decades and providing data in near-real time (e.g. with updates during the first days of the following month) is still missing;
2. **Improved understanding of the climate-crop relationship is needed**. In developing global crop simulations based on climate variables, several aspects still lack a systematic assessment on a global scale. For instance, uncertainties still exist with regard to the influence of climate extremes on both yield and yield variability on a large scale;
3. **A comprehensive evaluation of available retrospective forecasts is required in order to better estimate the prediction uncertainties and forecast quality**. A large number of public multi-model databases of operational global seasonal predictions are now available. A set of climate-crop models applied to the largest possible ensemble of up-to-date seasonal climate forecasts is required in order to better highlight the overall uncertainties in the seasonal forecasts estimation of crop yields. Besides, forecasting extreme indices based on daily data such as the number of frost days or the number of hot days within a season can be more useful for industries such as agriculture than the more traditional forecasts of monthly mean values. However, in spite of the increasing interest in estimating the ability of forecast systems to predict extreme events, little work has been performed on a global scale[10].

[1]Ray, D. K. et al. Yield trends are insufficient to double global crop production by 2050. PloS ONE (2013); [2]Challinor, A. J. et al. A meta-analysis of crop yield under climate change and adaptation. Nature Climate Change (2014); [3]Doblas-Reyes, F. J. et al. Seasonal climate predictability and forecasting: status and prospects. Wiley Interdisciplinary Reviews: Climate Change (2013); [4]Buontempo, C. et al. Climate service development, delivery and use in Europe at monthly to inter-annual timescales. Climate Risk Management (2014); [5]Global Information and Early Warning System, Food and Agriculture Organization (FAO); available at: www.fao.org/giews/english/index.htm [Accessed 7/9/2016]; [6]Iizumi, T. et al. Historical changes in global yields: major cereal and legume crops from 1982 to 2006. Global ecology and biogeography (2014); [7]Asseng, S. et al. Rising temperatures reduce global wheat production. Nature Climate Change (2015); [8]Hansen, J. W. et al. Review of seasonal climate forecasting for agriculture in sub-Saharan Africa. Experimental Agriculture (2011); [9]Iizumi, T. et al. Prediction of seasonal climate-induced variations in global food production. Nature climate change (2013); [10]Pepler A. S. et al. The ability of a multi-model seasonal forecasting ensemble to forecast the seasonal distribution of daily extremes. Weather Climate Extremes (2015)

For the above reasons, global seasonal forecasting for agriculture purposes is still in a rather early stage of state of development and substantial improvements are possible, but they require a more interdisciplinary environment. To address the aforementioned issues, ***CLIM4CROP*** **aims to explore how best to exploit seasonal forecasts for crop management decision making on a global scale making use of the latest advances in climate and crop sciences**. The three following tasks have been designed to achieve this goal.

Task 1. Characterising the uncertainties relevant to agriculture in global datasets of climate observations.

As a first step in developing pragmatically useful seasonal forecasts for agriculture, it is necessary to carefully analyse long observational datasets that are continuously updated. Indeed, to monitor current conditions, generate drought indicator forecasts (as recommended by the World Climate Research Programme[11]), and force climate-crop models, near-real time observed data are a paramount need. These data are also essential to produce seasonal forecasts based on empirical methods such as systems based on persistence. However, a number of constraints, such as periods of unavailability and poor data coverage, may limit such analysis. This is especially challenging when observations are needed to be available strictly in near-real time (because less time is available to retrieve and control the observations) and over data-poor regions (e.g. Africa). To meet these requirements, we will evaluate several global datasets available in near-real time: gridded observations[12,13,14], state-of-the-art reanalyses[15,16,17], satellite data[18] or mixed products obtained merging gauge observations with satellite estimates[19]. These data will be also compared with the most recent versions of well-established gridded databases that are not available in near-real time (thus in theory more reliable since more time is available for their quality control) such as those analysed by the applicant in a recent study[20]. Special attention will be paid to soil moisture, a variable that is very difficult to measure. In particular, we will compare reanalysis datasets with the soil moisture data generated by the European Space Agency[19] on a global scale, and also with more regionally focused, publicly available soil moisture datasets for Europe[21]. To sum up, this task will first quantify the limits of the datasets available in near-real time. Then an ensemble of observation/reanalysis will be used to produce a probabilistic monitoring product to better quantify the observational uncertainty and, ultimately, to better inform the end users. **With this innovative aspect, we plan to produce a seamless climate monitoring tool in which an ensemble of observations will be used to obtain the best observational estimate with its associated uncertainty**.

Task 2. Developing innovative statistical models to analyse the climate-driven impact on crops.

The links between crops and heat/water stress drivers will be analysed to better understand their interactions and develop statistical models. These models will be used to explore the seasonal predictability in the third task. We will use historical yield data of the four principal crops worldwide (maize, rice, soybean and wheat) from the Food and Agricultural Organization[22] as well as from gridded data available on a global scale[7]. The historical data on crop and potential climate predictors will be used to calibrate parsimonious regression models, providing a computationally inexpensive alternative to process-based models that usually require as input several variables at very fine scale where seasonal forecasts are not yet skilful. To assess uncertainties in the methods developed, we will apply various regression analysis strategies (e.g. multi-linear regression models, partial least squares regressions[23], and logistic regressions) following and extending the model strategies already used by the applicant in a different context[24,25,26]. In addition to climate predictors based on temperature, precipitation and soil

[11] WCRP, 2012: WCRP Global Drought Information System (GDIS) Workshop. Final Rep., 17 pp. Available at http://eprints.soton.ac.uk/342410/1/GDIS_Report_final.pdf [Accessed 7/9/2016]; [12]www.esrl.noaa.gov/psd/data/gridded/data.gpcc.html [Accessed 7/9/2016]; [13]www.esrl.noaa.gov/psd/data/gridded/data.ghcncams.html [Accessed 7/9/2016]; [14]www.climdex.org/datasets.html [Accessed 7/9/2016; [15]Reichle R. H. et al. Assessment and enhancement of MERRA land surface hydrology estimates. Journal of Climate (2011); [16]Dee, D. P. et al. The ERA-Interim reanalysis: Configuration and performance of the data assimilation system. Quarterly Journal of the Royal Meteorological Society (2011); [17]Harada, Y. et al. The JRA-55 Reanalysis: Representation of atmospheric circulation and climate variability. Journal of the Meteorological Society of Japan (2016); [18]Liu, Y. Y. Developing an improved soil moisture dataset by blending passive and active microwave satellite-based retrievals. Hydrology and Earth System Sciences (2011); [19]www.esrl.noaa.gov/psd/data/gridded/data.cmap.html [Accessed 7/9/2016]; [20]Turco, M. et al. Observed climate change hotspots. Geophysical Research Letters (2015); [21]Orth, R. & Seneviratne S. I. Introduction of a simple-model-based land surface dataset for Europe. Environmental Research Letters (2015); [22]http://faostat3.fao.org/browse/Q/QC/E [Accessed 7/9/2016]; [23]Ceglar, A. et al. Impact of meteorological drivers on regional inter-annual crop yield variability in France. Agricultural and Forest Meteorology (2016); [24]Turco, M. et al. Impact of climate variability on summer fires in a Mediterranean environment (northeastern Iberian Peninsula). Climatic Change (2013); [25]Turco, M. et al. Climate change impacts on wildfires in a Mediterranean environment. Climatic Change (2014); [26]Marcos, R. et al. Seasonal predictability of summer fires in a Mediterranean environment. International Journal of Wildland Fire (2015)

moisture data (including indicators of daily extremes), we will also employ large-scale climate indices (like NAO-North Atlantic oscillation, or ENSO-El Niño Southern Oscillation). These climatic patterns can produce synchronous variations of local variables (e.g. temperature) over large areas and are generally forecast more accurately than any single variable. Finally, merging observational information within the growing season (e.g. antecedent precipitation, temperature and accumulated soil moisture) with seasonal forecasts for the rest of the crop growth calendar (e.g. anthesis and harvesting stages) can significantly contribute to an increase in the crop predictability. **A global analysis of the potential link between yields and climate anomalies during the most sensitive initial phases of crop growth remains to be made. A comprehensive assessment of the climate-crop lagged relationships, as planned here, can help narrow this gap**.

Task 3. **Assessing the ability of current seasonal forecasts for agriculture.**

The forecast system will be based on the combination of the observed antecedent climate (wherever it plays a role in determining crop yields) with forecasts of the remaining-growing season climate conditions. Both empirical (such as persistence-based systems or methods based on resampled climatology[27]) and dynamical predictions will be considered. **The main goal of this task and of *CLIM4CROP* is to develop an integrated climate crop model that combines empirical crop models with climate seasonal forecasts.** As a result, the model suite will be implemented operationally at the end of the project to provide information for a range of stakeholders as part of a prototype (see Section 2.2). The availability in near-real time of the observed climate variables (see task 1) and models to link climate and crop data (see task 2) should guarantee the feasibility of the development of the prototype of an operational forecast system. Specifically, the project will examine sets of retrospective forecasts (re-forecasts or hindcasts) from a large number of operational dynamical forecast systems. These systems have been or are being developed in the framework of an on-going European project (SPECS - Seasonal-to-decadal climate Prediction for the improvement of European Climate Services) in which the Host Institution (HI hereinafter) is involved, and comprise state-of-the-art in terms of seasonal forecasting models. We will also use the systems developed in the EUROpean Seasonal-to-Interannual Prediction (EUROSIP[28]), which will shortly be made public by the Copernicus Climate Change Service, and the North American Multi-Model Ensemble (NMME[29]). All these systems represent the most comprehensive set to date of seasonal forecasts and reforecasts. The study will also analyse experimental forecast systems developed at the BSC. In particular, we will analyse a set of seasonal hindcasts with realistic land initialization at high resolution, which has been shown to increase the forecasting skill of dynamical models also in low skill regions such as Europe[30]. Specifically, a seasonal forecast quality assessment of key climatic indicators (those defined in task 2), including extremes indicators, will be performed by comparing the predicted fields with the reference datasets analysed in task 1. Secondly, the skill of the entire climate-crop model chain will be evaluated to provide an assessment of the current seasonal predictability and to identify the most useful sources of information for the agriculture community. **It is worth noting that no study so far has attempted the inter-comparison exercise of assessing the relative qualities of seasonal prediction systems to forecast climatic indicators and crop yields, an aspect in which this fellowship will be pioneering**.

CLIM4CROP is expected* to provide a substantial contribution to the development of a seasonal forecast system allowing more efficient crop management.** This will surely be useful in the decision-making process of policy-makers such as national governments and commercial entities. To this end, the transfer of knowledge to impact users in various sectors and organizations dealing with the agriculture sector has been planned in the proposal. In addition, from examination of the developed crop-climate model, a better understanding of the involved underlying mechanisms is expected to be gained. Also, as a useful by-product for a larger community, we expect to provide additional information on climate (extremes) monitoring and seasonal forecast predictability comparing different indicators and datasets. **These actions highlight the multidisciplinary nature of *CLIM4CROP. **This** is a **project** that combines research and production and **will have relevant socio-economic impacts**. Given the significant socio-economic impacts of climate and agriculture, implementation of *CLIM4CROP* could contribute positively, and in a very targeted way, to both societies and economies. For instance, it could support the European Commission through the direct link with the JRC (as acknowledged by the director

[27]Hao Z. et al. Global integrated drought monitoring and prediction system. Scientific Data (2014); [28]www.ecmwf.int/en/forecasts/documentation-and-support/long-range [Accessed 7/9/2016]; [29]www.cpc.ncep.noaa.gov/products/NMME [Accessed 7/9/2016]; [30]Prodhomme, C. et al. Impact of land-surface initialization on sub-seasonal to seasonal forecasts over Europe. Climate Dynamics (2015)

of the Directorate for Sustainable Resources of the JRC; see Section 7), whose decisions can influence farmers' welfare and food security in Europe. The global spatial coverage of *CLIM4CROP* will make it possible to provide estimates of crop production in Europe and other areas of the world for import/export decisions, including those where the seasonal forecasts show higher skill scores, thus enhancing overall European excellence and competitiveness. Finally, *CLIM4CROP* will offer the applicant the opportunity to **develop innovative research topics with large societal impact** as well as to **design a long-term plan for his scientific career**, taking advantage of the expertise gathered in several fields of environmental science and the training activities acquired during the fellowship. The idea is first to integrate *CLIM4CROP*'s structure and establish a network of collaborations to set-up the project and, with a longer time scale, provide the means (through national and European funding calls) to **build an independent research group to lead** from a permanent research position.

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

CLIM4CROP is designed in such a way as to offer a unique chance to **reinforce and expand the multi-sectorial experience** of the applicant, linking his background in meteorology and climate change studies and the theoretical and practical requirements for climate prediction applications in agriculture. Four lines will mainly characterize the advanced and high-quality research training:

- **Seasonal prediction**. The applicant will gain knowledge of the theoretical dynamical/statistical aspects regarding climate predictability in one of the leading centres in the world conducting research on this topic under the supervision of Prof. Doblas-Reyes, who holds vast experience in seasonal forecasting;
- **Crop yield impacts**. The researcher will learn about agriculture production and food security, and widen his competences in the statistical aspects regarding climate-impact models and, specifically, in climate-driven crop yield impacts. The training of the applicant will benefit from the large experience in the field of the supervisors in the secondments, Prof. Andy Challinor and Dr. Andrea Toreti.
- **Programming skills**. The fellow will benefit from the vast experience of the BSC in analysing and processing large quantities of data, which will improve his programming skills. For instance, the BSC has developed open-source R packages for statistical analysis and data mining in climatology (s2dverification = seasonal to decadal verification) and manages supercomputing facilities, notably Marenostrum, the most powerful supercomputer in Spain. The applicant also plans to follow machine learning training courses and, specifically, the PRACE training courses (www.training.prace-ri.eu/nc/training_courses/index.html);
- **User engagement.** The applicant will benefit from the unique training opportunity offered by the *CLIM4CROP* development at the BSC and secondments since it will allow him to learn about the entire operational chain, including user engagement. With its competences in operational crop monitoring and yield forecasting activities, the JRC will provide specific training on the use of the scientific/technological achievements derived from *CLIM4CROP* for specific operational applications.

In addition, the applicant will develop complementary skills in:

- **Leadership and management**. The applicant will take active part in the research and financial management of the project, under the close supervision of Prof. Doblas-Reyes and the personnel of the Project Management Office of the BSC.
- **Training and organization**. The researcher will collaborate in training Master's/Doctorate students and organize and participate in the various dissemination events described in Sections 2.2 and 2.3. The applicant's training will benefit both from the workshops and tutorials given by the HI on a regular basis and from the opportunity to interact with the large number of multidisciplinary groups of researchers at the host, thus enhancing his collaborative skills.
- **Communication.** Fundamental skills such as presenting results and grant writing will be trained in close collaboration with the human resources and education departments, enhancing communicative (oral and written) skills.

Also, scientific challenges in the context of *CLIM4CROP*, such as undertaking a highly collaborative research, will guarantee the **two-way transfer of derived new knowledge strengthening the skills of all participants**. Specifically, the applicant will bring to the HI his competences on operational weather forecasting, on post processing methods of weather and climate model, on the analysis of the climate-driven variability of ecosystems. As the BSC is currently exploring which characteristics an operational climate service should have, the applicant's skills will help in this task. In addition, the newly acquired

skills, knowledge and collaborations during the secondments will be transferred back to the BSC. The global assessment of monitoring and seasonal forecast applications for agriculture is still at an early stage. *CLIM4CROP* will open new strategic lines of research and collaboration opportunities for the HI and will open up the best career possibilities for the applicant to become a leader in this field.

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

Qualifications and experience of the supervisors

Prof. Doblas-Reyes is Research Professor at ICREA (Institució Catalana de Recerca i Estudis Avançats) and Head of the BSC Earth Sciences department (ES-BSC). He is very highly regarded in the field of climate prediction and services development, having received the 2006 Norbert Gerbier-MUMM International Award of the World Meteorological Organization (WMO), and being lead author of the chapter 'Near-term Climate Change: Projections and Predictability' of the Fifth Assessment report (AR5) of the IPCC (Intergovernmental Panel on Climate Change). He is a member of numerous international scientific committees: e.g. co-chair of the Working Group on Seasonal-to-Interannual Prediction (WGSIP) and Decadal Climate Prediction Panel (DCPP) of the World Climate Research Programme (WCRP), Polar Prediction Project (PPP) of the World Weather Research Programme, European Climate, Observations and Modelling for Services panel of the European Commission. Prof. Doblas-Reyes is a prominent researcher in the fields of climate dynamics and climate prediction with outstanding proven project management skills. In addition to a long list of more than 100 scientific peer-review papers with high citation impact, his standing is also confirmed by the fact that he is currently leading numerous projects (see Section 5). Finally, it is worth noting that one of the MSC Individual Fellowships has been awarded under his supervision (DPETNA, H2020-MSCA-IF-2014-655339).

Prof. Challinor is Professor of Climate Impacts at the UL. His research focuses principally on using climate modelling and process studies to understand food production and food security, treatments of uncertainty and managing risk, and climate-resilient pathways and adaptation. Prof. Challinor is also theme leader for the CGIAR program on 'climate change, agriculture and food security', Principal Investigator on NERC EQUIP on 'end-to-end quantification of uncertainty for impacts prediction', and Research Director for the Africa College Partnership. He has written more than 100 research papers and was lead author of the chapter 'Food Production Systems and Food Security' of the AR5 of the IPCC.

Dr. Toreti is a senior scientist at the European Commission's Joint Research Centre (JRC) in Ispra. His main research interests focus on: climate extremes and impacts on agriculture, climate variability and change, statistical climatology, and agro-meteorology. In 2011, he received the MedCLIVAR award for his important contribution to research, which addressed issues on climate extremes in the Mediterranean region. He is author/co-author of more than 30 publications in peer-reviewed journals, and is currently leading a project on climate extremes and shocks on agricultural markets at the global scale (C2ESAM).

Hosting arrangements

The applicant will be engaged in the ES-BSC as part of the Earth Sciences Services group. He will also be an integral part of the groups hosting the secondments and of the daily life of those teams, participating in seminars, informal conversations and teaching activities. At both the HI and the secondments, **the applicant will have access to the required computational facilities and datasets for the successful execution of the project** (see Sections 3.2, 3.3 and 3.4 for more details). *CLIM4CROP* advancements will be monitored by the supervisor during weekly meetings throughout the duration of the fellowship. Monthly written reports detailing the progress and issues raised during the evolution of the research plan will be prepared. At least four coordination meetings with Prof. Doblas-Reyes, Prof. Challinor and dr. Toreti will be planned in order to foster collaboration between the groups, discuss the progress of *CLIM4CROP*, and tailor the research plan to the difficulties encountered and/or focus on the most promising aspects of the research developed (see Section 2.2). **To ensure the research and training objectives are achieved within the indicated timeframe, a Career Development Plan (CDP) will be drafted with the supervisor** before the start of the fellowship. The secondment institutions will also contribute to the CDP. The progress of the fellowship will be revised in the mid-term report. Thanks to this, any necessary actions could be taken if any unexpected delay occurs in the delivery of the project outputs.

It is also worth mentioning that the applicant has already established a collaboration with both the BSC and JRC (January 2016) thanks to participation in the BSC-JRC project devoted to testing seasonal forecasts to be used within MARS Crop Yield Forecasting System (MCYFS) at JRC. This collaboration,

the basis for the development of *CLIM4CROP,* has led to promising results toward future operational use of the seasonal forecasts within MCYFS.

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

Besides a thorough training in climate prediction, agriculture impacts and climate services, the mentoring will also include a solid part oriented towards acquiring and developing leadership, management, communication, training and organizational skills. **This fellowship will provide him with the expertise needed to become a completely independent scientist able to lead a research group.**

During his first professional period as a meteorologist, he learned about atmospheric dynamics and developed skills in operational weather forecasting. During his career as a researcher since his PhD, the applicant has focused mostly on the development of regionalized climate change scenarios using statistical downscaling methods and regional climate models, on the climate impacts on hydrogeological risks and on forest fires (see Section 4). The realization that prior climate effects of forest fires can provide predictability for summer burned area[26] motivated his interest in seasonal predictions, leading him to start a collaboration with Prof. Doblas-Reyes and the BSC. At present, the applicant is investigating how best to exploit seasonal forecasts for agriculture application over Europe. **The applicant's past and present activities have served as inspiration for the global assessment proposed in *CLIM4CROP***.

At this stage of his career (seven years as a meteorologist and seven more as a climate researcher), he gained skills in addressing climate statistical analysis, and the ability to work in teams and manage international collaborations as confirmed by the number of international and cross-institutional co-authorships in his publications. ***CLIM4CROP* could help to build a bridge between his background on operational and research activities, enriching his understanding of analysis of the scales of the weather forecasts and climate change projections to dimensions of seasonal climate predictions.** The multidisciplinary and multi-sectorial experiences in operational and research activities, together with the very high-quality training, will **guarantee the accurate execution of *CLIM4CROP.*** As briefly mentioned in section 1.3, all research and training opportunities will be identified and accurately planned before the start of the project in order to ensure that the project maximises the impact on the fellow's future career prospects. This document, drafted by the fellow and supervisor, will include a detailed description of the planned training and research activities including meetings, expected publications, tutoring, networking opportunities, planned public engagements etc.

2. Impact

2.1 Enhancing the potential and future career prospects of the researcher

As outlined in Section 1, **the proposed fellowship aligns well with the profile of the researcher** and is an unquestionable opportunity to enhance the applicant's professional experience with the essential skills and knowledge required to successfully undertake **the path towards research seniority**. Specifically, the applicant will collaborate with groups involved in the development of the climate services concept, such as those participating in the Climateurope CSA (www.climateurope.eu). The applicant will be able to take part in in the project meetings of the Climateurope, PRIMAVERA, IMPREX and APPLICATE H2020 projects, which are usually held every year and offer excellent opportunities to network with the community and engage in new collaborations. These **new collaborations will broaden his vision and increase his experience in engaging in international initiatives**.

At the BSC, the applicant will occasionally be involved in supervising Master's students and engaged with PhD fellows in the fields of climate dynamics, climate forecasting and climate services. At the first secondment (UL), the fellow will also be in an environment used to dealing with tutoring students. At the second secondment (JRC), the fellow will be in an environment used to meeting the needs of stakeholders, a fundamental step in combining climate forecasts with agricultural practice. These experiences will reinforce his ability to adapt his experience to realistic requirements, a fundamental characteristic of an experienced researcher. **The proposal will also be a great opportunity for the applicant to improve the project management skills needed to become an efficient multidisciplinary researcher.**

Finally, BSC has the recognized capacity to absorb new researchers, and the supervisor will support the candidature of the applicant to the **prestigious Spanish program Ramón y Cajal**. It is worth noting that the fellow would be the first researcher with expertise in this field at the BSC. Also, after completing the fellowship, the researcher will be applying for the **ERC Starting Grant programme**, which will give him a

concrete opportunity to establish his own research team. Importantly, the current knowledge on decadal climate prediction is still limited and no studies on its usability in crop yield forecasting exist, which opens **new opportunities for the near future**. Further training on this field is also an objective.

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

CLIM4CROP aims to transfer useful and usable results to decision makers, as well as to the scientific community and the general public, communicating the results and achievements through different channels. Importantly, to guarantee the accomplishment of the dissemination measures, this proposal has a dedicated work package (see Section 3.1).

The fellowship will benefit from the experience of the **BSC, one of a few institutions in Europe where a services group is located next to groups working in climate modelling, which is a unique way of channelling cutting-edge scientific knowledge and the associated technology towards both markets and society**. Special attention will be paid to transferring useful results to organizations dealing directly with the agriculture sector, such as decision-makers in the European Commission (through the direct link to the JRC, see Section 7), but also directly at the producer level, taking advantage of the links the BSC has with stakeholders like Bodegas Torres or Codorniu (see Section 7). As a first step towards climate services, the project will provide stakeholders with an electronic climate outlook and agriculture potential implications quarterly (Exploitation actions E1, E3, E5 and E7 described in Section 3.1). In addition, it is worth noting the unique opportunity that the BSC offers to perform user engagement strategies (e.g. surveys) to understand users' needs and define user driven tailored products, which follows the latest recommendations of the Global Framework for Climate Services (GFCS) promoted by the WMO to develop climate services. Specifically, *CLIM4CROP* will perform three questionnaires, at months 7, 13 and 22 to different users (e.g. JRC personnel and employees of private companies), to monitor the evolution of the users' responses and feedbacks with respect to the project achievements and ultimately to co-develop useful information for decision making processes (E2, E4 and E6). *CLIM4CROP* will also take advantage of the fact that the BSC is involved in the Copernicus project SECTEUR, which connects with businesses and other organizations to understand their requirements, in terms of weather and climate data to support decision-making.

Four scientific meetings will be planned (at BSC at months 3 and 22, UL at month 8 and JRC at month 14). These project meetings are conceived to be open sessions, to which researchers not directly involved in the fellowship will be invited (e.g. from initiatives like Copernicus Climate Change Service) in order to facilitate the applicant in establishing new collaborations. The latter will also benefit the HI with a wider involvement in research. The applicant, in collaboration with the BSC and the UL/JRC, will prepare a final report by collecting all the results of the project, as well as a reference manual for the end users on how best to use the products, providing recommendations for the international crop monitoring community and also with regard to the future research lines to prioritize.

Another fundamental part of the fellowship is the dissemination of the achievements of *CLIM4CROP* to the scientific community, using all possible scientific channels, such as the participation in international conferences and publications in high-impact, peer-reviewed journals (following European Commission policy on open access for research articles).

The BSC will support the applicant in managing the intellectual property rights and licensing matters potentially arising from the project. This centre has great experience in the development and exploitation of business strategies, as well as in identifying results with the potential to be translated into products for the benefit of society.

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

The priorities of the project include obtaining public engagement through the active and effective communication of outcomes to students and to a non-specialized audience, and raising awareness of the risks of extreme events (like drought and heatwaves), their impacts and the possible actions to advance climate change adaptation, which is closely related to the effort carried out within *CLIM4CROP*.

The project will be supported by the BSC communication team and the Earth System Services Group of BSC in the following planned activities (see Section 3.1):

- **Development and maintenance of a web site** in which two parallel levels of communication are provided, one for the specialized audience and another for the non-specialized. The web site will contain the project progress and results (with updates posted via twitter), animations from climate monitoring/ forecasts and simple explanations of the features observed in the animations.

- **Inclusion of the project information, progress and results in several BSC dissemination events**, e.g. leaflets, factsheets, project deliverables, e-based dissemination tools, multi-media, daily press. Specifically, at the beginning of the project, a first leaflet containing basic information about the project (e.g. objectives and premises; Communication action C1, described in Section 3.1) will be disseminated. Periodic newsletter-like brochures will be produced and web-based interactive information will be uploaded to the host institution's (BSC) webpage (C2-C5). A final leaflet will be distributed at the end of *CLIM4CROP* reporting the main results (C6). These activities will be possible thanks to the strong BSC communication team and the members of the technology transfer of the Department.
- **Academic cooperation** with Universitat Politécnica de Catalunya (UPC) and the University of Barcelona (UB; where the researcher did his PhD) in the joint PhD and MSc programmes, offering the opportunity of becoming involved in teaching. In addition, the applicant plans to participate in the 'Marie Curie Ambassador programme' during the project. He will visit universities (making use of the academic environment of the UL and of the university linked to the BSC - UB, UPC) in order to describe his scientific activities. The applicant will also contact other MSCA (Marie Skłodowska-Curie actions) alumni for networking, discussions and knowledge exchange.

3. Quality and Efficiency of the Implementation

3.1 Coherence and effectiveness of the work plan

The work plan of the project is detailed in the following Gantt chart and has been conceived to ensure its overall coherence with respect to *CLIM4CROP*'s specific objectives, the skills of the participants and the available resources, and consequently its successful achievement. *CLIM4CROP's* implementation has been designed in such a way that most of the time only two different research work-packages (WPs) occur simultaneously, in order to better define the course of the project and make the development of the WPs more efficient. These activities have been organized into four work-packages: one for project management and dissemination (WP1) and three for research (WPS 2-4). Further details follow below, including milestones, deliverables and meetings defined to tracking the progress of *CLIM4CROP*.

pm	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
WP1		C1				C2						C3						C4					C5	C6
						E1	E2					E3	E4					E5				E6	E7	
WP2																								
WP3																								
WP4																								
Milestones	M1						M2					M3	M4						M5					
Deliverables													D1						D2			D3		D4
Meetings			Me1					Me2						Me3								Me4		
Secondments							At UL						At JRC											

Table 1*.Gantt chart indicating the CLIM4CROP work plan with the deliverables, milestones, meetings and secondments (note that the scheduling date of each element is indicated in terms of the corresponding project month, pm).*

Milestones*. **M1**: Career Development Plan [pm 1]; **M2**: First dataset assessment [pm 7]; **M3**: Internal mid-term report [pm 12]; **M4**: First climate-crop model implementation [pm 13]; **M5**: Seasonal forecasts prototype implemented [pm 19]; **Deliverables**. **D1**: Assessment of the observed datasets [pm 13]; **D2**: Assessment of the climate-crop models [pm 19]; **D3**: Assessment of the seasonal forecasts for agriculture [pm 22]. **D4**: Final scientific report and recommendations [pm 24]. **Meetings**. **Me1**: Kick-off meeting at BSC [pm 3]; **Me2**: Project meeting at UL [pm 8]; **Me3**: Project meeting at JRC [pm 14]; **Me4**: Final project meeting at BSC [pm22]. **Secondments**: (i) at UL [pm 7-9]; (ii) at JRC [pm 13-15]. **Communication actions**. **C1**: First leaflet describing CLIM4CROP; **C2-C5**: Periodic newsletter-like brochures; **C6**: Final leaflet with main results. **Exploitation actions**. **E1**, **E3**, **E5** and **E7:** Climate outlooks and agriculture potential implications; **E2**, **E4** and **E6**. User's questionnaires.*

WP1. Project management and dissemination of results*.* This WP will monitor the progress of the project, ensure timely development of scientific reports and dissemination actions (see Sections 2.2 and 2.3), facilitate communication between the partner organisations (BSC, UL, JRC), and organize the fellowship meetings. WP1 will be monitored through M1 and M3. A final report will be prepared (D4).

WP2. Observational analysis. The beginning of *CLIM4CROP* will be devoted to collecting and providing a preliminary analysis of global datasets of climate observations available in near-real time. All these data can serve as a reference to develop and validate the models of the third and fourth WPs. The first analysis of the datasets will be delivered at the end of the first year, although this activity will take

place throughout the entire duration of the project, including updating or incorporating new data. It comprises Task 1 and will be monitored through M2 and D1.
WP3. Climate-crop model. The development of the climate-crop model will start in the second part of the first year of the project. The applicant will be further trained on the analysis of climate-driven impacts on agriculture at UL and at JRC. Additional improvements to the model (e.g. through an update of the datasets) will be made subsequently, during the remaining part of WP2. It comprises Task 2 and will be monitored by M4 and D2.
WP4. Seasonal forecast prototype and its quality*.* This WP is devoted to exploring the seasonal predictability of (i) key climate variables and (ii) crop yield, driving the climate-crop model with observed antecedent climate variables (should they play any role) and seasonal forecast systems to build the operational prototype. It comprises Task 3 and will be monitored by M5 and D3.

3.2. Appropriateness of the allocation of tasks and resources

As designed from its construction, the research project has been devised with the goal of tailoring the applicant's experience, the supervisors' know-how and the resources at the hosting institutions, in order to guarantee its successful achievement. The work plan follows this conception and considers concrete actions to reach the main objective in time. The feasibility and credibility of the proposal are demonstrated by this work plan and by the fact that the fellow either has experience in the technical aspects of the proposal or is supported by the expertise of the supervisors and facilities at the host institutions.
Specifically, the host institutions will provide an office space, a computer workstation, access to computing facilities, and any other resources necessary to perform the research. Moreover they will provide access to the datasets for the development of the work scheduled. BSC manages outstanding high-performance computing resources that will be available to the applicant to carry out the research plan. Additionally, high quality specialists will provide advice and support to manage the scientific infrastructures. For instance, highly skilled technicians are in charge of downloading all the model outputs and observed datasets, allowing the applicant to start analysing them directly without any delay for data pre-processing. Note that no other special scientific instrumentation or lab equipment is required.
Two secondments have been devised in order to bring together expertise in agriculture and climate:

- **UL** [pm7-9]. The stay at UL is placed firstly in the chronogram to take full benefit of UL's expertise in the climate-driven impacts on agriculture. The secondment starts when WP2 is already on-going (which will support the discussion about the climate data assessment) and WP3 is starting (which will help to guide the climate-crop model development). The crop data will be provided by UL. The first results will be discussed at the project meeting at the UL [pm8], when the strategy to tackle WP3 is also established.
- **JRC** [pm13-15]. This secondment is placed in the middle of the chronogram, reflecting its central role for the success of the project. This allows advantage to be taken of the expertise of Dr. Toreti and the JRC group for discussing the on-going assessment of WP3 and to guide the analysis of WP4. In addition, this secondment will start by defining tailored products for decision makers by taking advantage of the expertise of the JRC group as an end-user that operationally delivers crop yield forecasts. The results of WP2 and WP3 will be discussed at the project meeting at the JRC [pm14], when the approach to address WP4 is also drafted.

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

Considering the strong background of the supervisors on climate predictability and climate-crop interactions, the availability of statistical competences, of the most recent data and computational resources, the host and secondment institutions offer a solid basis for developing this fellowship. In addition, the BSC is used to handling international projects and through its administration will offer comprehensive support for smooth and fruitful execution of the project. Moreover, the applicant will be assisted during the Grant Agreement Preparation Phase, and ensuring that all required documents (Fellowship Agreement and Career Development Plan) are prepared by the Project Management Office. Specifically, the Human Resources team will provide the researcher with the Employment Contract ensuring that all key requirements are included; the Communication Team will support the applicant in dissemination activities and public engagement (as per section 2.3); and the Finance Team at BSC will ensure that the project budget is set up correctly in the BSC internal system.

The Finance Team will submit the financial report (Form C) at the end of the fellowship.
In general, no substantial limitations or risks have been identified since the participants have wide experience of similar projects and possess the necessary expertise to carry out this study, and all datasets to be analysed are available for research purposes. Indeed, thanks to the regular meetings with the supervisor and carefully drafted career development plan, risks of delays will decrease and the objectives of the project will be reached. Even so, all the main risks are listed here along with the related mitigation measures.
WP2. Risk: the agreement between the available observational datasets is insufficient for daily scale indices and at local (e.g. grid-point) scale over certain regions to provide robust recommendations. Likelihood: low/medium. Mitigation method: uncertainties will be assessed considering different spatial/temporal aggregation of the data determining the best range of applicability. **WP3**. Risk: the development of the climate-crop models takes longer than expected. Likelihood: low. Mitigation method: the WP will be extended as much as necessary but never beyond the duration of the project. **WP4**. Risk: both the analysis of the vast number of seasonal forecast systems available and the integration of seasonal forecasts within the climate-crop models are more difficult than expected. Likelihood: low/medium. Mitigation method: the focus will be shifted to a limited number of forecast systems (e.g. considering the ECMWF System-4, already used by the applicant). Although this new path reduces the number of models involved, it aims to provide an outcome before the end of the project.

3.4 Appropriateness of the institutional environment (infrastructure)

Within *CLIM4CROP*, the complementary qualities and competences of the applicant, host (BSC) and secondment institutions (UL, JRC) will merge, guaranteeing **effective development of the research**. These three groups are international leaders in climate sciences, seasonal predictability and climate effects on agriculture, and will provide the researcher with **high-quality training programs**. In addition, the applicant will be given all the necessary administrative support by the hosting institutions, as well as a **very strong base in terms of scientific infrastructure and user support**, and thus a **suitable atmosphere for the project to be a success**.
The **ES-BSC** in particular, where most of the fellowship will take place, performs research in environmental forecasting. It is structured in four groups working on climate prediction and modelling, atmospheric composition forecasting, computational services for Earth sciences and Earth system services. The Department is heavily involved in the progress and application of seasonal forecasting, paying special attention to both the identification of the main sources of predictability and the development of climate services. In addition, BSC manages high-performance computing facilities (like MareNostrum), and all the BSC's computational resources (see Section 5) will be available to the candidate to carry out the research plan. BSC has also a highly skilled group of specialists who can provide advice and support to the scientists to manage the large amount of data and use the available high performance computing infrastructures. The combination of all these capabilities makes the Department a unique place in Europe where research on computing and Big Data, Earth system modelling, and services work together to address some of the most challenging technological and scientific problems. BSC has extensive experience in hosting Marie Skłodowska-Curie research fellows (7 awarded individual fellowships, 2 MSC RISE, 1 MSC ITN; see Section 5).
UL/JRC have vast experience in helping international employees/visitors, many of whom are supported by Marie-Curie grants. They assist new employees from abroad in finding accommodation as well as dealing with administrative tasks. In addition, UL/JRC will provide an office space, a computer workstation, access to computing clusters, and any other resources necessary for research. Specifically, the **UL** group hosting the secondment uses climate and crop modelling, and treatments of uncertainty, to develop strategies for managing risk and adapting food systems to climate change. Prof. Challinor has over 100 publications (in prestigious journals such as Nature; see Section 5 for more details). Importantly, Prof. Challinor is co-author of the first global assessment of seasonal forecasts for agriculture purposes, cited in the introduction of this proposal (Iizumi et al., 2013).
The team of the **JRC**, where the secondment will take place, has recognized expertise in monitoring agriculture resources and forecasting crop yields, and develops services to support EU aid and assistance policies. While this team utilises a range of data sources, such as meteorological observations and weather forecasts, it does not yet operationally fully exploit existing seasonal forecasts. The recent collaboration between JRC and BSC has been devoted precisely to evaluating meteorological seasonal forecast products to be used within the MCYFS at JRC. The promising results of this activity provide a **solid setting to start successful implementation of the proposed research**.

DOCUMENT 2

4. CV of the Experienced Researcher

Name: MARCO TURCO
Place and date of birth: Cuneo, Italy, 22/01/1978
Family: Married with one child
Languages: Italian (native), English (fluent), Spanish (fluent) and French (beginner)
Website: www.am.ub.es/∼mturco/Index.html

Employment

Jan 2016 to present	**Research Assistant** Barcelona Supercomputing Center (BSC), Earth Sciences Department, Barcelona (Spain) Analysis of seasonal forecasts based on the ECMWF System 4 to be used within the MARS Crop Yield Forecasting System of the JRC in collaboration with Prof. Francisco J. Doblas-Reyes
Jul 2015 to Jan 2016	**Research Assistant** Institute of Biometeorology of the Italian National Research Council (IBIMET-CNR), section of Florence (Italy). Development of regionalized climate change scenarios: stochastic generation of multi-site synthetic climatic data; in collaboration with Dr. Massimiliano Pasqui
Jan 2014 to May 2015	**Postdoctoral Fellow** Institute of Atmospheric Sciences and Climate (ISAC) of the Italian National Research Council (CNR), section of Turin (Italy) Climate downscaling and impacts on the water cycle and ecosystems in mountain environment; in collaboration with Dr. Antonello Provenzale
Jan 2012 to Dec 2013	**Research Assistant** Euro-Mediterranean Centre on Climate Change (CMCC), Impacts on Soil and Coasts Division of Capua (Italy) Impact of climate change on hydrogeological risk on Mediterranean area in collaboration with Paola Mercogliano and Pasquale Schiano
Sep 2009 to Dec 2011	**Research Assistant** Department of Astronomy and Meteorology, University of Barcelona (Spain) Development of regionalized climate change scenarios: Statistical downscaling methods; in collaboration with Prof. Maria Carmen Llasat
Sep 2002 to Aug 2009	**Meteorologist** Weather Service of the Environmental Agency of Piedmont (ARPA), Turin, Italy Development of a meteo-hydrological system for civil protection purposes in collaboration with Renata Pelosini

Education

Ph.D., Physics	University of Barcelona (Spain), PhD, Physics, 25 July 2012 • Thesis title: Climate change in a Mediterranean environment (Catalonia): precipitation extremes, regional scenarios, impacts on forest fires • Final mark: summa cum laude • Supervisor: Prof. Maria Carmen Llasat
M.Sc., Physics	University of Turin (Italy), MSc, Physics, 20 April 2002 • Topic: Climate variability and glacier snout fluctuations in the western Alps • Final mark: 110/110 • Supervisors: Prof. A. Biancotti, Prof. A. Longhetto and Dr. A. Provenzale

Awards

- MedCLIVAR young scientific award 2014

- Travel Award: European Union, COST Action Value ES1102. Grant for a Short-Term Scientific Mission (STSM) to the University of Cantabria, Spain. November 2013
- Travel Award: European Union, COST Action Value FP1204. Grant for a Short-Term Scientific Mission (STSM) to the University of Tel Aviv, Israel. May 2015

IT skills

- OS: Mac OS X, Windows, Linux, Unix
- Office programme suites: Microsoft Office (Word, PowerPoint, Excel), OpenOffice
- Programming and script: Matlab, R, Fortran, Unix bash (Ksh, sh, csh)
- Data analysis and plotting facilities: CDO, NCO, Grads, Gnuplot

Peer-reviewed publications (21, h-index 8, 124 citation, without self-citations)

Turco, M., Ceglar, A., Prodhomme C., Soret A., Toreti A., Doblas-Reyes F. J. Seasonal predictability of meteorological summer drought over Europe. In preparation

Turco, M., von Hardenberg, J., AghaKouchak, A., Llasat, M. C., Provenzale A., Trigo R. The key role of drought in summer fires in Mediterranean Europe. In preparation

Turco, M., Herrera, S., Llasat, M. C. and Gutiérrez, J. M. MOS downscaling of mean and extreme precipitation regimes in present climate and future projections over Spain. Under review in J. Geophys. Res.

Quintana-Seguí P., **Turco M.**, Herrera S., and Miguez-Macho G. Validation of a new SAFRAN based gridded precipitation product for Spain and comparison to Spain02 and ERA-Interim. Under review in Hydrol. Earth Syst. Sci.

1. Turco, M., Levin, N., Tessler, N., Hadas, S. Recent changes and relations among drought, vegetation and wildfires in the Eastern Mediterranean: the case of Israel. Accepted in Global Planet. Change

2. Marcos, R., Llasat, M. C., Quintana-Seguí P., Turco M. Seasonal predictability of water resources in a Mediterranean environment and assessment of its utility for water managers. Accepted in Sci. Total Environ (2016).

3. Quintana-Sequí, P., Peral, C., Turco, M., Llasat, M. C. and Martin, E. Meteorological analysis systems in the North-East of Spain. Validation of SAFRAN and comparison to SPAN. J. Environ. Inform. 27(2) 116-130 (2016)

4. Llasat, M. C., Marcos, R., **Turco, M.**, Gilabert, J., & Llasat-Botija, M. Trends in flash flood events versus convective precipitation in the Mediterranean region: The case of Catalonia. J. Hydrol., doi:10.1016/j.jhydrol.2016.05.040, (2016). **Times Cited: 2**

5. **Turco M.**, Bedia J., Di Liberto F., Fiorucci P., von Hardenberg J., et al. (2016) Decreasing Fires in Mediterranean Europe. PLoS ONE 11(3), (2016). **Times Cited: 3**

6. Marcos, R., **Turco, M.**, Bedia, J., Llasat, M. C., Provenzale, A. Seasonal predictability of summer fires in a Mediterranean environment. Int. J. Wildland Fire 24(8) 1076-1084 (2015). **Times Cited: 2**

7. Turco, M., Palazzi, E., Hardenberg, J. and Provenzale, A. Observed climate change hotspots. Geophys. Res. Lett. 42 (9), 3521-3528 (2015). **Times Cited: 2**

8. **Turco, M.**, Llasat, M. C., Hardenberg, J. and Provenzale, A. Climate change impacts on wildfires in a Mediterranean environment. Clim. Change 125 (3-4), 369-380 (2014). **Times Cited: 8**

9. Llasat, M. C., Marcos, R., Llasat-Botija, M. Gilabert, J. **Turco, M.** and Quintana-Seguí P. Flash floods evolution in Catalonia: from precipitation to societal aspects. Atmos. Res. 149, 230-243 (2014). **Times Cited: 10**

10. **Turco, M.**, Marcos, R., Quintana-Seguí, P. and Llasat, M. C. Testing instrumental and downscaled reanalysis time series for temperature trends in NE of Spain in the last century. Reg. Environ. Chang. 14 (5), 1811-1823 (2014). **Times Cited: 4**

11. Llasat, M. C., **Turco, M.**, Quintana-Seguí, P. and Llasat-Botija M. The snow storm of the 8th of March 2010 in Barcelona: a paradigmatic case. Nat. Hazards Earth Syst. Sci. 14, 427-441 (2014). **Times Cited: 3**

12. Fernández-Chacón, A., Stefanescu, C., Genovart, M., Nichols, J. D., Hines, J. E., Páramo, F., **Turco, M.** and Oro, D. Determinants of extinction-colonization dynamics in Mediterranean butterflies: the role of landscape, climate and local habitat features. J. Anim. Ecol. 83 (1), 276-285 (2014). **Times Cited: 4**

13. **Turco, M.**, Sanna, A., Herrera, S., Llasat, M. C. and Gutiérrez, J. M. Large biases and inconsistent climate change signals in ENSEMBLES regional projections. Clim. Change 120, 859-869 (2013).

Times Cited: 10
14. **Turco, M.**, Zollo, A. L., Ronchi, C., De Luigi, C. and Mercogliano, P. Assessing gridded observations for daily precipitation extremes in the Alps with a focus on northwest Italy. Nat. Hazards Earth Syst. Sci. 13, 1457-1468 (2013). **Times Cited: 7**
15. **Turco, M.**, Llasat, M. C., Tudela, A., Castro, X. and Provenzale, A. Decreasing fires in a Mediterranean region (1970-2010, NE Spain). Nat. Hazards Earth Syst. Sci. 13, 649-652 (2013). **Times Cited: 9**
16. **Turco, M.**, Llasat, M. C., Hardenberg, J. and Provenzale, A. Impact of climate variability on summer fires in a Mediterranean environment (northeastern Iberian Peninsula). Clim. Change 116, 665-678 (2013). **Times Cited: 9**
17. **Turco, M.**, and Llasat, M. C. Trends in indices of daily precipitation extremes in Catalonia (NE Spain), 1951-2003. Nat. Hazards Earth Syst. Sci. 11, 3213-3226 (2011). **Times Cited: 17**
18. **Turco, M.**, Quintana-Seguí, P., Llasat, M. C., Herrera, S. and Gutiérrez, J. M. Testing MOS precipitation downscaling for ENSEMBLES regional climate models over Spain. J. Geophys. Res. 116, 1-14 (2011). **Times Cited: 12**
19. Milelli, M., **Turco, M.** and Oberto, E. Screen-level non-GTS data assimilation in a limited-area mesoscale model. Nat. Hazards Earth Syst. Sci. 10, 1129-1149 (2010). **Times Cited: 1**
20. **Turco, M.** and Milelli, M. The forecasters added value in QPF. Adv. Geosci. 25, 29-36 (2010). **Times Cited: 1**
21. Calmanti, S., Motta, L., **Turco, M.** and Provenzale, A. Impact of climate variability on Alpine glaciers in northwestern Italy. Int. J. Climatol. 27, 2041-2053 (2007). **Times Cited: 19**

Other publications

1. Fiorucci P., D'Andrea M., Biondi G., **Turco M.**, Severino M., Negro D., Gollini A., Gualtieri S., Bastia S. Gli incendi boschivi in Italia e le attività di previsione del Dipartimento della Protezione Civile nazionale. V. Bacciu, M. Salis, D. Spano Strumenti e modelli a supporta della pianificazione, prevenzione e difesa dagli incendi boschivi, Nuova Stampa Color, pp.50-80, 2015, ISBN: 978-88-99 323-05-9, 20, (2015)
2. **Turco, M.**, Llasat, M. C., von Hardenberg, J., & Provenzale, A. Climate change leads to more frequent but smaller fires in a Mediterranean environment. Black Sea/Mediterranean Environment 21. ISSN: 1304-9550. Proceedings of MedCLIVAR 2014 Conference, (2015)
3. Zollo A. L., **Turco, M.**, Mercogliano P. Assessment of hybrid downscaling techniques for precipitation over the Po river basin. In: Engineering Geology for Society and Territory - Volume 1. Lollino, G., Manconi, A., Clague, J., Shan, W. and Chiarle, M. (Eds), Springer International Publishing. ISBN: 978-3-319-09299-7, 193-197, (2014). **Times Cited: 2**
4. **Turco, M.**, Sanna, A., Herrera, S., Llasat, M. C. and Gutiérrez, J. M. Evaluation of the ENSEMBLES transient RCM simulations over Spain: present climate performance and future projections. In: Engineering Geology for Society and Territory - Volume 1. Lollino, G., Manconi, A., Clague, J., Shan, W. and Chiarle, M. (Eds), Springer International Publishing. ISBN: 978-3-319-09299-7, 199-203, (2014). **Times Cited: 1**
5. **Turco, M.**, Zollo A. L., Vezzoli R., Ronchi C., and Mercogliano P. Daily precipitation statistics over the Po Basin: observation and post-processed RCM results. Climate change and its implications on ecosystem and society: Proceedings of I SISC (Società Italiana di Scienze del Clima) Conference; Lecce, 23-24 September 2013. ISBN: 978-88-97666-08-0, 222-234 (2013)
6. Cane D., Milelli M., Sanna A., and **Turco, M.** Meteorological Forecasting. In: Evaluation and prevention of natural risks. Campus S., Barbero S., Bovo S., and Forlati F. (Eds), Taylor & Francis Group, Balkema, London. ISBN: 978-0-415-41386-2, 265-300 (2007)

Selected conferences, workshops, etc.

1. Seminar: Toward seasonal forecasts for MARS Crop Yield Forecasting System JRC, 5 May 2016, Ispra (Italy)
2. Oral presentation. Droughts and forest fires in Mediterranean Europe. Turco, M., Llasat, M. C., von Hardenberg, J. and Provenzale, A. Geophysical Research Abstracts 17: EGU2015-10836, 2015, EGU 2015, 12 17 April 2015, Vienna (Austria)
3. Oral presentation. Climate change and forest fires in a Mediterranean environment. Turco, M., Llasat, M. C., von Hardenberg, J. and Provenzale, A. Geophysical Research Abstracts 16: EGU2014-12180,

2014, EGU 2014, 27 April - 2 May 2014, Vienna (Austria)

4. Poster presentation. A Comparison of Statistical, Dynamical and Combined MOS Downscaling Approaches in the Framework of the PNACC-2012 Spanish Program. Gutiérrez, J. M., Turco, M., Herrera, S. International Conference on Regional Climate - CORDEX 2013, 4-7 Nov 2013, Brussels (Belgium)
5. Seminar. Forest fires under climate change in a Mediterranean environment (Catalonia, NE of Spain). CIMA Research Foundation, 5 May 2013, Savona (Italy)
6. Oral presentation. Climate variability and summer forest fires in a Mediterranean context: the case of Catalonia. Marcos, R., Turco, M., Llasat, M. C., von Hardenberg, J. and Provenzale, A. MedCLIVAR 2012, 26-28 September 2012, Madrid (Spain)
7. Poster presentation. Analyses of possible changes in the mean and extreme precipitation regimes over Spain under climate change scenarios. Turco, M., Llasat M. C. and Quintana-Seguí P. 13th Plinius Conference on Mediterranean Storms, EGU Topical Conference Series, 7-9 September 2011, Savona (Italy)
8. Oral presentation. Analysis of extreme rainfall variability in NE of Spain in the framework of esTcena project. Turco, M., Llasat M. C. International Precipitation Conference, 23-25 June 2010, Coimbra (Portugal)
9. Oral presentation. The forecaster's added value. Turco, M., Milelli M. 9th EMS Annual Meeting, 28 September - 2 October 2009, Toulouse (France)
10. Poster presentation. QPF verification: quality and value of operational numerical model for civil protection. Turco, M. Joint D-PHASE and COST731 meeting: "Challenges in Hidrometeorological forecasting in complex terrain", 19-22 May 2008, Bologna (Italy)
11. Poster presentation. Results of precipitation verification over Italy. Oberto E., Turco, M. Third International Workshop on Verification Methods, 29 January - 2 February 2007, ECMWF, Reading (UK)

(A complete list is available at www.am.ub.es/~mturco/Index.html)

Teaching activities (1 PhD thesis, 2 MsC)

- 2016-present. Co-supervision of PhD thesis at the Department of Astronomy and Meteorology, University of Barcelona (Spain)
  Maria Cortès Simó, "Analysis of extreme precipitation and flooding and their future projections"
  together with Prof. M. C. Llasat
- 2014-2015. Co-supervision of master thesis at the University of Turin (Italy)
  Jacopo Balocco, "Modeling climate influence on Alpine glacier mass balance"
  together with Dr. A. Provenzale
- 2009-2010. Co-supervision of master thesis at the Department of Astronomy and Meteorology, University of Barcelona (Spain)
  Estíbaliz Gascón, "La galerna del Cantábrico. Aplicación al método de los análogos" (Galerna wind in Cantabria region. Application of the analogs method.)
  together with Prof. M. C. Llasat
- Lectures on meteorology at the HYDROAID course at the ITCILO International Training Center ILO, Turin, Italy, 2007
- Lectures on meteorology at the national DPC-AINEVA avalanches course held in Rieti, Italy, 2007
- Lectures on meteorology at the regional AINEVA avalanches courses (Piemonte, Italy) from 2005 to 2008
- Lectures on meteorology at the regional FORMONT courses (Piemonte, Italy) in 2007 and in 2008

Scientific projects

- JRC-Agriculture (Jan 2016 - Jul 2016). Testing and evaluating meteorological long-term forecast products based on the ECMWF long-term weather forecasts to be used within the MARS Crop Yield Forecasting System at JRC - Joint Research Centre of the European Commission
- NEXTDATA (2014-2015; http://www.nextdataproject.it/) A national system for the retrieval, storage, access and diffusion of environmental and climate data from mountain and marine areas
- GEMINA (2011-2013) The main aim was to study the impact of climate change on hydrogeological risk on Mediterranean area

- esTcena (2009-2011; http://www.meteo.unican.es/en/projects/esTcena). Its main objective was to develop regional (20 km) and local (stations) scenarios for temperature (maximum and minimum) and precipitation for the XXI (twenty first) century, at a daily scale in Spain
- Italian project with the Civil Protection Department (2002-2009). Development of a meteo-hydrological system for civil protection purposes
- EURORISK/PREVIEW (2005-2006; http://www.preview-risk.com/). Preview was an EU FP6 project to develop pre-operational information services to support the management of atmospheric, geophysical and man-made risks at a European level

Collaborations

Most of my research is carried out through collaborations with several research institutions:

- Arpa Piemonte, Regional Environmental Protection Agency, Turin, Italy
- CIMA Research Foundation, Savona, Italy
- CMCC, Euro-Mediterranean Center on Climate Change, Lecce, Italy
- Ebro Observatory, Roquetes, Spain
- Italian Civil Protection Department, Roma, Italy
- Italian Forestry Corps (Corpo Forestale dello Stato), Roma, Italy
- Santander Meteorology Group, CSIC-UC, Santander, Spain
- SPIF (Servicio de Prevención de Incendios Forestales de la Generalitat de Catalunya), Barcelona, Spain
- University of Barcelona, Department of Astronomy and Meteorology, Barcelona, Spain
- University of Tel Aviv, Tel Aviv, Israel
- Instituto Dom Luiz, IDL, Universidade de Lisboa, Lisboa, Portugal
- University of California, Irvine, United States
- Joint Research Centre of the European Commission (JRC), Ispra, Italy

I am also involved in several research networks:

- COST Action VALUE network - Validating and Integrating Downscaling Methods for Climate Change Research
- IS-ENES network - InfraStructure for the European Network for the Earth System Modelling
- MedCLIVAR network - Mediterranean CLImate VARiability and Predictability

Courses/summer schools/etc.

- June 2013. ISAC-CNR Course XXI. Climate Change and the Mountain Environment. Valsavarenche, Valle d'Aosta (Italy).
- June 2011. ISAC-CNR Course XIX. Regional Climate Dynamics in the Mediterranean and beyond: An Earth System perspective. Valsavarenche, Valle d'Aosta (Italy).
- April 2008. ECMWF Meteorological Training Course on "Predictability, Diagnostics and Extended Range Forecasting". ECMWF, Reading (UK)
- April 2005. Specialized Business Language Training (natural risks, nivology and meteorology).
- April 2003. ECMWF Meteorological Training Course on "Use and Interpretation of ECMWF Products". ECMWF, Reading (UK)
- August 2002. Summer school on Mountain Meteorology on "Modification of Airflow by Mountains". Trento (Italy)

Service

- Reviewer for Environmental Research Letter, Climatic Change, International Journal of Climatology, Global and Planetary Change, Hydrology and Earth System Sciences, Natural Hazards and Earth System Sciences, Advances in Meteorology, Advances in Geosciences, PLOS One, Theoretical and Applied Climatology, iForest - Biogeosciences and Forestry
- Referee of PhD thesis. Applicant: Joaquín Bedía, Affiliation entity: University of Cantabria
- Convener of Session1.7-Downscaling Climate Information for Impact studies; International Association of Engineering Geology and the environment (I.A.E.G.), Turin, Italy, 2014
- Co-convener of Session1.4-Climatechange: impacts on natural resources and hazards; International Association of Engineering Geology and the environment (I.A.E.G.), Turin, Italy, 2014

5. Capacity of the Participating Organisations

Beneficiary - Barcelona Supercomputing Center (BSC)	
General Description	The Barcelona Supercomputing Center (BSC) was established in 2005 and serves as the national supercomputing facility. Currently, it is hosting one of the most powerful European Tier-0 supercomputers. BSC strives to be a first-class research centre in supercomputing and in scientific fields that demand high performance computing resources such as Life and Earth Sciences and Engineering. It has brought together a critical mass of first-rate researchers, high performance computing experts and cutting-edge supercomputing technologies in order to foster multidisciplinary scientific collaborations and innovations. In terms of attraction of talent, during the period 2011-2015, the BSC has recruited 75 pre-doctoral students, 51 Postdocs and Senior Scientist, 83 technical support staff members and 31 management staff, 146 from Spain, 39 coming from EU countries and 55 from outside Europe, being currently more than 380 staff members, from around 40 countries. Recruitment procedures are based on principles of merit, transparency, competition and gender balance and the centre has been awarded with the badge of Human Resources Excellence in Research (HRS4R) in April 2015. Following a gap analysis, areas for improvement have been identified and new actions are going to be implemented. A Career Plan is made on a yearly basis by all staff members of centre and is revised at the end of the year, through a new online tool accessible by staff members and by their supervisors. The applicant will be enrolled at the Department of Earth Sciences (ES-BSC).
Role and Commitment of key persons (supervisor)	ICREA Research Prof. Francisco J. Doblas-Reyes is the director of the ES-BSC. He is a worldwide expert in the development of seasonal-to-decadal climate prediction systems and has more than 20 years of experience in weather and climate modelling, climate prediction, as well as the development of climate services. Prof. Doblas-Reyes serves on scientific panels of the World Climate Research Programme (WCRP) and the World Weather Research Programme (WWRP) and has authored and co-authored more than 100 peer-reviewed papers on climate modelling and prediction, as well as on climate services. He is a member of the European Network for Earth System modelling HPC Task Force and has participated in numerous national and European FP4 and FP7 projects. Prof. Doblas-Reyes is also involved in Horizon 2020 Collaborative projects as a Principal Investigator (PRIMAVERA, H2020-SC5-2014-641727; ERA4CS, H2020-SC5-2015-690462; ECOMS2, H2020-SC5-2015-689029, SPECS: FP7-ENV-2012-308378) and is supervising one of Marie Skłodowska-Curie Individual Fellowship awarded at BSC (DPETNA, H2020-MSCA-IF-2014-655339).
Key Research Facilities, Infrastructure and Equipment	BSC hosts a range of high performance computing (HPC) systems, including MareNostrum III, one of the most powerful supercomputers in Europe with 48,128 cores and 1.1 Pflops capacity. The infrastructure, equipment and key research facilities will be available for the fellow.
Independent research premises?	All BSC's departments maintain independent research premises.
Previous Involvement in Research and Training Programmes	BSC has hosted around 44 national and European fellowships among early-stage and senior postdoctoral fellowships which also include Marie Curie ITN projects (e.g. SCALUS, FP7-PEOPLE-ITN-2008-238808; NEMOH, PF7-PEOPLE-2011-ITN-289976, COPA-GT) and several Marie Curie IEF (e.g. EEPPIBM, FP7-PEOPLE-2012-IEF-327899; MDRAF, FP7-PEOPLE-2013-IEF-622662).
Current involvement in Research and Training Programmes	Collaboration with universities: within BSC, there is a large record of collaboration with Universidad Politècnica de Catalunya (UPC) and Universidad de Barcelona (UB), including the Master degree in Environmental Engineering (UPC), associated with ES-BSC. Excellence Programmes and Networks: A number of training activities are organized under the framework of: Severo Ochoa Excellence Programme (Research seminars series); RES (RES training sessions); NVIDIA CUDA/GPU excellence center (PUMPS summer school); PRACE (PRACE Advanced Training Center); HiPEAC (ACACES summer school, Computing system weeks and HiPEAC conferences). Research Fellowships: BSC is currently awarded with 9 early-stage postdoc (7 Juan de la Cierva and 2 Beatriu de Pinós), 12 senior (5 Ramón y Cajal, 3 I3 and 6 ICREA) and is supporting 3 ITN 2 MSC RISE and 4 Marie-Curie Individual Fellowships. Noteworthy, two of these Marie-Curie actions are currently developed in ES-BSC, which will host the present Marie-Curie proposal. On-going projects: SPECS (Seasonal-to-decadal climate Prediction for the improvement of European Climate Services). This project is coordinated by the BSC (Principal Investigator: Prof. Francisco J. Doblas Reyes) and includes 19 Partners (18 European and 1 Brazilian Institutions). EUPORIAS (European Provision Of Regional Impacts Assessments on Seasonal and Decadal Timescales). The BSC is a partner for this project. Current Research and training programme: RESILIENCE – Project co-funded by the European Regional Development Fund and Spanish Ministry of Economy and Competitiveness. The Principal Investigator: Prof. Francisco Doblas J. Reyes. The main goal of the project is to provide to the researchers an exceptional training and support for their scientific growth by improving their scientific and management skills.
Relevant Publications and/or research/innovation products	**(1)** Bellprat, O. and F.J. Doblas-Reyes (2016). Geophysical Research Letters, 43. **(2)** Batté, L. and F.J. Doblas-Reyes (2015). Climate Dynamics, 45. **(3)** Pepler, A.S., L.B. Díaz, C. Prodhomme, F.J. Doblas-Reyes and A. Kumar (2015). Weather and Climate Extremes, 9. **(4)** Buontempo, C., C.D. Hewitt, F.J. Doblas-Reyes and S. Dessai (2014). Climate Risk Management, 6. **(5)** Doblas-Reyes, F.J., I. Andreu-Burillo, Y. Chikamoto, J. García-Serrano, V. Guemas, M. Kimoto, T. Mochizuki, L.R.L. Rodrigues and G.J. van Oldenborgh (2013). Nature Communications, 4.

Partner Organisation - University of Leeds (UL)	
General description	The University of Leeds has more than 200 academic staff working on climate related research with £100m in research income and 40 papers published in Nature and Science between 2010 and 2015. Five lead authors for the IPCC AR5 came from Leeds, which is one of very few worldwide institutions with leaders on all four AR5 reports. Research on the relationships between climate, agriculture, land use and food security at Leeds is significant: £3.66M between 2010 and 2015, involving 24 academics. A range of funders support this work, e.g. NERC, BBSRC, ESRC, EU, UNDP, DEFRA, Met Office and the CGIAR. Leeds has received considerable research council and other investment (over £20 million) to host cross-cutting centres such as the NERC NCAS and the ESRC Centre for Climate Change and Economic Policy (CCCEP) (with LSE)
Key Persons and Expertise (supervisor)	Prof. Andy Challinor (AC), Chair of Climate Impacts, Institute for Climate & Atmospheric Science, University of Leeds is a climate impacts specialist with a particular interest in crops. He is a Lead Author on the Intergovernmental Panel on Climate Change (IPCC) AR5 and the UK Climate Change Risk Assessment 2017. Both of these are highly relevant to Post-Plus. The CCRA report is novel examination of international dimensions of climate change, and contains the foundation for understanding food systems policy and business as influenced by climate change. AC has received >£14M funding (over £3M as PI) in the last ten years, from e.g. NERC, ESRC, BBSRC, CGIAR, DFID and DEFRA. He led the NERC-funded EQUIP consortium of leading universities, government agencies and an NGO. EQUIP improved quantification of uncertainty in climate and impacts and resulted in more than 45 peer-reviewed publications, including a special issue of Climatic Change. Its findings fed directly into IPCC and Met Office assessments. 10% of AC's time is funded by the CGIAR Climate Change, Agriculture and Food Security (CCAFS) programme.
Key Research facilities, infrastructure and equipment	The Priestley International Centre for Climate, established in 2016, is a major investment (£6.82 m over 5 years) by the University of Leeds to grow interdisciplinary research to underpin robust and timely climate solutions. The Priestley Centre aims to promote interdisciplinary research of the highest standard on climate change and its impact on nature and society.
Previous and Current Involvement in Research and Training Programmes	Research programmes: (1) CGIAR programme 'Climate change, agriculture and food security' (CCAFS) Project Leader (2014-ongoing), total value to Leeds $420 per annum; (2) UK Technology and Strategy Board Developing project 2014-2015: "Breeding strategies for a variable climate" with Limagrain and Environmental Systems; (3) FP7 SPECS (Seasonal-to-decadal climate Prediction for the improvement of European Climate Services), 2012-2016, £215k, Co-I; (4) FP7 EUPORIAS (European Provision of Regional Impact Assessment on a Seasonal-to-decadal timescale), 2012-2016, £1.1M, Co-I; (5) BBSRC-funded contribution to FACCE MACSUR Knowledge Hub on Crop Modelling 2012-2015, £80k, Co-I; (6) BBSRC project "Effects of environmental change: increased nematode pest status on UK crops," 2012-2016, £880k, Co-I; (7) ESPA Partnership and Project Development grant 2010 "Enhancing water for food: poverty reduction through improved management of ecosystem services for sustainable food production in sub-Saharan Africa," Co-I; (8) Private donor grant of £250k for a Fellowship in Sustainable Agriculture for Global Food Security 2010-2013, awarded following a proposal by a team of three academics; (9) BBSRC project "Sustainable pollination services for UK crops" (2011-2013) Co-I, £674k for Leeds component; (10) China-UK Sustainable Agriculture Innovation Network (SAIN) project "Addressing vulnerabilities and building capacity for adaptation of agriculture to climate change in China" 2010-2013, PI for Leeds component, £49k; (11) NERC consortium grant PI 2009-2014: End-to-end quantification of uncertainty for impacts prediction (EQUIP). Total value £1.4M; (12) University of Leeds Africa College Co-I (2010-2014), £1.4M over six years; (13) ESRC Centre for Climate Change Economics and Policy 2008-13 Co-Investigator. Total value £5.5M. Training: (1) Designer and programme manager of MSc in Climate Systems Science, Leeds 2010 – 2011; (2) MSc Module 'Climate Change: Impacts and Adaptation' as part of MSc in Sustainability (Climate Change); (3) Development of an international crop modelling community through maintenance of a website for access to the crop simulation model GLAM, which AC jointly developed and continue to develop. The site has nearly 100 registered users and we regularly receive requests for new accounts; (4) Regular supervision of Masters and Undergraduate project dissertations; (5) Supervised five PhD students to completion.
Relevant Publications and/or research/innovation product	**(1)** Iizumi, T., Luo, J. J., Challinor, A. J., Sakurai, G., Yokozawa, M., Sakuma, H., Brown, M. E., Yamagata, T. (2014) Nature communications, 5. **(2)** Challinor, A. J., Watson, J. Lobell, D. B., Howden, S. M., Smith, D. R., Chhetri, N. (2014) Nature Climate Change, 4, 287-291. **(3)** Iizumi, T., Sakuma, H., Yokozawa, M., Luo, J. J., Challinor, A. J., Brown, M. E., Sakurai, G., Yamagata, T. (2013) Nature Climate Change, 3, 904-908.

Partner Organisation - Joint Research Centre of the European Commission (JRC)	
General description	The Joint Research Centre (JRC) of the European Commission is the in-house science service of the Commission; its mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle. Its work has a direct impact on the lives of citizens by contributing with its research outcomes to a healthy and safe environment, secure energy supplies, sustainable mobility and consumer health and safety. The Food Security Unit of the Directorate on Sustainable Resources develops methods, tools and systems for use within agricultural monitoring activities applied to Europe and other areas of the world. The crop forecasting activities support the EU's Common Agriculture Policy (CAP) by providing scientifically relevant, independent and timely crop yield forecast products and data. The Unit supports the EU Food Security Thematic Programme and food assistance policies by providing assessments and early warnings of agricultural production in food-insecure regions of the world. It works on the assessment of climate change impacts on agriculture in support to the EU climate change policy agenda and the Europe 2020 flagship initiative for a resource-efficient Europe.
Key Persons and Expertise (supervisor)	Andrea Toreti is a senior scientist/scientific officer at the European Commission's Joint Research Centre (JRC) in Ispra. He graduated in Mathematics at the University of Rome La Sapienza (Rome, Italy) and obtained a Ph.D. in Climate Sciences at the University of Bern (Bern, Switzerland). Before joining the JRC in 2013, he was at the Italian Institute for Environmental Protection and Research (Italy), at the University of Bern (Switzerland) and at the University of Giessen (Germany) as Assistant Professor. In 2011, he got the MedCLIVAR award for his important contribution to research which addressed issues on climate extremes in the Mediterranean region. His main research interests focus on: climate extremes and impacts on agriculture; climate variability, climate change and impacts on agriculture; extreme value theory; statistical climatology; change point detection and attribution; agro-meteorology. He is author/co-author of more than 30 publications, referee for the most relevant international peer-reviewed journals on climate sciences, co-organiser of the European Geosciences Union (EGU) sessions on 'The climate of the Mediterranean Region' and 'Times series analyses in geoscience', and the nonlinear session at the International Meeting on Statistical Climatology.
Key Research facilities, infrastructure and equipment	Interdisciplinary research environment. Access to the most important scientific journals, books and data. HPC infrastructure with 28 nodes (that will become 35 next year), each of them having 4 x Intel Xeon Processor with 8x2.2GHz Cores**.**
Previous and Current Involvement in Research and Training Programmes	• C2ESAM: on-going JRC project on climate extremes and shocks on global agricultural markets. • AGRI4CLIMATE: on-going JRC project on climate change impacts, adaptation and greenhouse gases emissions in the agricultural sector. • AGRI4CAST: on-going JRC project on crop yield monitoring and forecasting. • ETESIANS: 2012-13 DAAD project on the Etesian wind system in the Aegean. • VINCEX: 2012-13 DAAD project on wind resources. • ACQWA: 2010-13 FP7 project on assessing climate impacts on the quantity and quality of water. • ACT: 2010-11 LIFE08 project on adapting on climate change in time. • CIRCE: 2008-11 FP6 project on Climate change and impact research on the Mediterranean environment. • HOME: 2007-11 COST action on homogenisation methods for climate time series.
Relevant Publications and/or research/innovation product	**(1)** Ceglar A., Toreti, A. Lecerf, R. Van der Velde, M., Dentener, F. (2016) Agricultural and Forest Meteorology, 216. **(2)** Toreti, A., Giannakaki P., martius, O. (2016) Climate Dynamics, Doi 10.1007/s00382-015-2942-1. **(3)** Fontana, G., Toreti, A., Ceglar, A., De Sanctis, G. (2015). Natural Hazards and Earth System Sciences, 15.

6. Ethical Issues

As detailed in the Part A of the present proposals, there are no potential ethical issues identified for *CLIM4CROP*.

7. Letters of commitment

The next letters of commitment for this proposal have been signed by:

- Prof. Andy Challinor, Chair of Climate Impacts, Institute for Climate & Atmospheric Science, University of Leeds, Leeds, United Kingdom; http://www.see.leeds.ac.uk/people/a.challinor.

- Dr. David Wilkinson, Director of the Directorate for Sustainable Resources, European Commission Joint Research Centre (JRC), Ispra, Italy; https://ec.europa.eu/jrc/en/person/david-wilkinson.

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UNIVERSITY OF LEEDS

Letter of commitment for CLIM4CROP

12th July 2016

To whom it may concern,

This letter is to express my personal commitment and institutional support to the H2020-MSCA-IF-2016 proposal entitled "Climate monitoring and seasonal forecast for global crop production (CLIM4CROP)" and submitted by the Barcelona Supercomputing Center (BSC), Barcelona, Spain. This is also to confirm my agreement to host Dr. Turco at the University of Leeds for a 3-month stay as part of the project.

I fully support the current proposal (CLIM4CROP) based on very innovative approaches, in particular the use of an ensemble of observations available in near-real-time to obtain the best observational estimate with its associated uncertainty, the development of statistical models to exploring the interaction between crop yields and climate, including the relevance of extreme events, and finally the use of a comprehensive set of seasonal forecast systems to assess the ability of current seasonal predictions for agriculture. The proposed analyses could advance knowledge about climate (extremes) monitoring and seasonal forecast predictability and could help the development of an early warning system allowing more efficient crop management. CLIM4CROP tackles challenging issues ranked as "priority" by several World Climate Research Program (WCRP) panels. The host institution (BSC) closely fits with the activities to be done and my team at the University of Leeds strongly encourages the project to be granted.

Andy Challinor

EUROPEAN COMMISSION
DIRECTORATE-GENERAL
JOINT RESEARCH CENTRE
Directorate D – Sustainable Resources
Director

Ispra, 14 July 2016
D00/DW/jrc.d.dir(2016)

Subject: **Subject: Letter of support for a Marie Skłodowska- Curie Action: Dr Marco Turco**

I hereby express my support to the scientific objectives and the work organisation of the Marie Skłodowska- Curie Action entitled "Climate monitoring and seasonal forecast for global crop production (CLIM4CROP)" submitted by BSC/Dr. Marco Turco.

I also express the commitment of the JRC to provide scientific advice and guidance to Dr. Marco Turco related to his project and to host him for a period up to 3 months at the European Commission - Joint Research Centre (JRC) in Ispra (Italy) during the term of his grant. The responsible scientist within the JRC will be Dr Andrea Toreti.

This project will build upon on-going research activities with Dr.Turco concerning the use of seasonal forecasts in the Crop Yield Forecasting System of the JRC and the significant contributions he has already given to the field of climate prediction for agriculture. To conclude, the JRC is happy to contribute to the challenging objectives of this project and to work closely with Dr Turco

With kind regards,
David Wilkinson

European Commission, Via Enrico Fermi 2749, I-21027 Ispra (Varese) - Italy. Telephone: (39)0332-78-9307.
Office: 100 2303. Telephone: direct line (39)0332-78-6541. Fax: (39)0332-78-9222.

E-mail: David.WILKINSON@ec.europa.eu

8. Letter of support

The next letter of support for this proposal have been signed by:

- Joan Esteve, Viticulture Technical Manager of the Codorniu group; Lleida, Spain; www.codorniu.com/.

CODORNIU 1551 RAVENTOS 1872

CODORNÍU

BODEGAS

BODEGAS RAIMAT, S/N • 25111 RAIMAT (LLEIDA)

TEL. 973 724 000 • FAX. 973 724 061

Date: July 27th, 2016

Subject: Letter of support for an application to the European Marie Skłodowska-Curie program: Marco Turco

My company, Codorniu group is one of the main premium wine producers in Spain. Our wines are produced in the most recognised Spanish Apellations of Origin. It has been demonstrated the impact of climate on viticulture. However, due to their inherent uncertain nature, probabilistic climate predictions are difficult to access and poorly understood, and therefore under-utilised by end user groups. It is obvious that our company is paying a lot of attention to the development of climate services in Europe, following with attention the investigations of climate centres involved in this research activity. From an operational point of view, BSC clearly appears as the unique group in Spain that is likely to provide seasonal forecasts in an operational way.

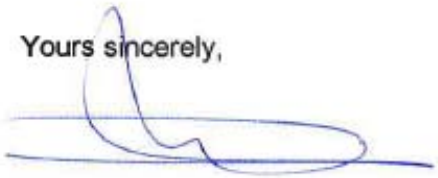
For these reasons, I would like to offer my enthusiastic support for the Marco Turco proposal "Climate monitoring and seasonal forecast for global crop production" (CLIM4CROP) to the Marie Skłodowska-Curie program. Benefiting from this program, Marco Turco will provide a substantial effort to increase the performances of climate forecast systems for agriculture. We are expecting that CLIM4CROP will help to develop climate service for the agriculture/wine sector ensuring that research reaches the industry and society in a timely and usable manner.

Three main reasons encourage me to support his project: (1) BSC is highly active in the development of climate services, by being involved in several European projects devoted to the valorisation of climate research for applications in several sectors. Based at BSC, Marco Turco will efficiently share its results with the other climate centres; (2) I hope its research activities to contribute to the improvement of the forecasts quality globally and in particular in Spain; (3) the BSC climate services team will support Marco Turco to reach practical applications of its research trough an improvement of the climate forecast

systems and its dissemination to the users of seasonal forecasts.

I would be happy to collaborate more with Marco Turco in the future, hoping to reinforce the links between public and private groups facing together the challenging issue of agriculture management. For these reasons I whish Marco Turco to success with his Marie-Curie proposal.

Yours sincerely,



Joan Esteve

Viticulture Technical Manager

ENDPAGE

MARIE SKŁODOWSKA-CURIE ACTIONS

Individual Fellowships (IF)
Call: H2020-MSCA-IF-2016

PART B

"CLIM4CROP"

"Climate monitoring and seasonal forecast for global crop production"

This proposal is to be evaluated as:

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