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: 748750

Proposal acronym: SPFireSD

Deadline Id: H2020-MSCA-IF-2016

Table of contents

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 **748750** *Acronym* **SPFireSD**

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	SPFireSD
Proposal title	Seasonal Prediction of Fire danger using Statistical and Dynamical models

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	*Natural hazards*	
Descriptor 2	*Climatology and climate change*	
Descriptor 3	*Meteorology, atmospheric physics and dynamics*	Remove
Descriptor 4	*Earth observations from space/remote sensing*	Remove
Descriptor 5	*Atmospheric chemistry, atmospheric composition, air pollution*	Remove

Free keywords	*wildfire; fire danger; seasonal climate prediction; drought; Europe; tropics; ENSO*

Proposal ID **748750** *Acronym* **SPFireSD**

Abstract

Wildfires have a great impact on the environment and can pose a threat to property and human lives and health. The occurrence of fire in natural vegetation is dependent on human activities and climate variability. In tropical areas such as the Amazon basin and Indonesia, wildfires are greatly affected by inter-annual fluctuations in tropical Sea Surface Temperatures (SSTs). During the El Niño events of 1997-1998 and 2015-2016, uncontrolled wildfires caused record impacts on health, transportation and the economy. The European countries of the Mediterranean basin are frequently plagued by drought episodes (e.g. during the summer of 2016), causing dangerous wildfires which result in deaths, health problems and economic losses.

Seasonal climate prediction is a field which typically forecasts seasonal average precipitation and temperature anomalies with a few months lead time. The main sources of predictability are SSTs, soil moisture, snow cover and teleconnections with the tropics. Seasonal climate predictions are performed operationally in Europe and globally, and are used in fields such as agriculture, health, water management and energy. While some effort has been put into short-term forecasts of fire danger in Europe, there is currently no operational seasonal wildfire forecasting system for Europe and only a few for other continents. The goal of this project is to develop and assess seasonal fire prediction capability through a variety of complementary and innovative methods, with a focus on Europe, the Amazonian basin and Indonesia.

Remaining characters 437

Has this proposal (or a very similar one) been submitted to a Horizon 2020 Marie Skłodowska-Curie Individual Fellowship call? ○ Yes ◉ No

Proposal ID **748750** *Acronym* **SPFireSD**

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) .

Proposal ID **748750** *Acronym* **SPFireSD**

List of participants

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

Proposal ID **748750** *Acronym* **SPFireSD** *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 **748750** *Acronym* **SPFireSD** *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 **748750** *Acronym* **SPFireSD** *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	ORCID: 0000-0003-4628-1461 / ResearcherID: L-3431-2016		
Last Name*	TOURIGNY	Last Name at Birth	
First Name(s)*	Etienne	Gender*	(•) Male ( ) Female
Title	Dr.	Country of residence*	Spain
Nationality*	Canada	Nationality 2	
Date of Birth (DD/MM/YYYY)	07/02/1977	Country of Birth*	Canada
		Place of Birth	Montreal

Contact address

Current organisation name	Barcelona Supercomputing Center		
Current Department/Faculty/Institute/ Laboratory name	Earth Sciences		
	☐ Same as organisation address		
Street	Jordi Girona, 29		
Postcode/Cedex	08034	Town	Barcelona
Phone	+34934137678	Country	Spain
Phone2 / Mobile	+34657597234		
E-Mail*	etienne.tourigny@bsc.es		

Proposal ID **748750** *Acronym* **SPFireSD** *Short name* **BSC**

Qualifications

University Degree	Date of award (DD/MM/YYYY)	19/05/2009
Doctorate (in progress)	Date of award (DD/MM/YYYY)	
Doctorate	Date of award (DD/MM/YYYY)	26/05/2014
Full time postgraduate research experience	Number of months	87
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
19/05/2016	14/09/2016	119	Spain
04/09/2014	18/05/2016	623	Canada
17/02/2009	03/09/2014	2025	Brazil
	Total	2767	

Proposal ID **748750** *Acronym* **SPFireSD** *Short name* **BSC**

Supervisor

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

Title: Dr. Sex: ○ Male ◉ Female

First name*: **Virginie** Last name*: **Guemas**

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

Position in org.: Head of the Climate Prediction Group

Department: Earth Sciences

☐ Same as organisation address

Street: Jordi Girona, 29

Town: Barcelona Post code: 08034

Country: Spain

Website:

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

Other contact persons

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

Proposal ID **748750** *Acronym* **SPFireSD**

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.

Proposal ID **748750** *Acronym* **SPFireSD**

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	

Proposal ID **748750** *Acronym* **SPFireSD**

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 **748750** *Acronym* **SPFireSD**

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: CNRM (Météo-France, CNRS)

Country: France

Proposal ID **748750** *Acronym* **SPFireSD**

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

START PAGE

MARIE SKŁODOWSKA-CURIE ACTIONS

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

PART B

"SPFireSD"

Seasonal Prediction of Fire danger using
Statistical and Dynamical models

This proposal is to be evaluated as:

Standard EF

TABLE OF CONTENTS

List of Participating Organisations

Participating organisations	Legal Entity Short Name	Academic (tick)	Non-academic (tick)	Country	Dept./ Division / Laboratory	Supervisor	Role of Partner Organisation
Beneficiary							
Barcelona Supercomputing Center	BSC	X		Spain	Department of Earth Sciences	Dr. Virginie Guemas	
Partner Organisation							
Centre National de Recherches Météorologiques	CNRM (Météo-France, CNRS)	X		France	GMGEC	Dr. Roland Séférian	Host of secondment

1. Excellence

1.1 Quality and credibility of the research/innovation action (level of novelty, appropriate consideration of inter/multidisciplinary and gender aspects)

1.1.1. Introduction: Need and opportunity for fire prediction

Wildfires are the largest source of biomass burning (approximately 70% of global annual sources) and a great source of pollutants and atmospheric CO2, with all biomass burning accounting for approximately 2GtC, equivalent to 25% of emissions from fossil fuels[1] [2]. In addition to having a great impact on the environment, wildfires can also pose a threat to property and human lives and health, especially when they occur at the Wildland-Urban Interface (WUI)[3]. The occurrence of fire in natural vegetation is dependent on several factors: human activities, accumulation of fine dead fuels (grass, leaves and twigs) and climatic variability. During the last 30 years, large wildfires affected 5 million people globally and the associated economic losses were estimated to more than USD 50 billion[1].

In tropical areas such as the Amazon basin and Indonesia, wildfires are greatly affected by inter-annual fluctuations in tropical Sea Surface Temperatures (SSTs)[4]. During the El Niño event of 1997-1998, uncontrolled peat and deforestation fires in Indonesia led to a severe haze disaster which had impacts on health and transportation, generating economic costs of approximately USD 9 billion and damages[5] [6]. Likewise, the Amazon region and other tropical areas of Latin America were greatly affected by wildfires in 1998, with damages estimated between USD 10 and 15 billion[6]. The 2015-2016 El Niño event was also associated with above-average wildfires in Indonesia and Amazonia.

The European countries most affected by wildfires are in the Mediterranean basin, with summer fires occurring during periods of drought[7]. In Portugal, the severe fires of 2003 caused the death of 21 people and material losses of over EUR 1 billion and the fires of 2005 caused the death of 18 people, injured over a thousand people and also caused substantial damages to properties[8]. In the summer of 2009, Greece was stricken by two "megafire" events which resulted in 80 deaths and damages evaluated at EUR 1.5 billion[8]. During the summer of 2016, a combination of high temperatures and winds and low rainfall were associated with intense and dangerous wildfires in southern Europe, namely in southern France, northwestern Spain and on the mainland and Madeira Island of Portugal.

The Earth's climate undergoes natural variability at seasonal-to-decadal timescales. Informing public sectors that are vulnerable to its variations is a key societal and economical challenge. Seasonal climate prediction typically forecasts anomalies in precipitation and temperature a few months in advance. The sources of seasonal climate predictability are mainly linked to SST: while the El Ñino/Southern Oscillation (ENSO) in the tropical Pacific, has the greatest impact on climate in the Tropics and beyond, other oceans such as the Atlantic and Indian Oceans also influence surrounding continents[9]. Over the extra-tropics, local soil moisture and land snow anomalies [10] as well as teleconnections with the Tropics [11] or the Arctic [12] also contribute to climate predictability, which is lower than in the Tropics. The quasi-biennial oscillation (QBO), sudden stratospheric warmings (SSW), changes in greenhouse gas (GHG) and aerosol concentrations, land-use changes and volcanic eruptions have been suggested as potential sources of predictability as well[13]. Statistical and dynamical methods (and a combination of the two) can be used to provide skillful seasonal forecasts[13]. Operational seasonal climate predictions are now routinely performed around the world (e.g. CanSIPS, NCEP) and multi-model ensemble forecasts systems, such as those performed within the framework of the EUROSIP European project and now the Copernicus seasonal forecast initiative, provide more realistic forecasts than those provided by a single model. This climate information is used for many applications in fields such as agriculture, health, water management and energy[13].

In light of this, **seasonal prediction of wildfire danger** appears as a priority for **health, safety and economic welfare**. Building on climate prediction experience and developing such an innovative activity is necessary for

1 Hantson, S.,et al., 2016. Biogeosciences 13, 3359–3375.
2 Knorr, W., et al., 2016. Biogeosciences 13, 267–282.
3 Modugno, et al., 2016. J. Environ. Manage. 172, 112–126.
4 Chen, Y., et al., 2016. Environ. Res. Lett. 11, 45001.
5 Spessa, A. C., et al., 2015. Nat. Hazards Earth Syst. Sci., 15(3), 429–442.
6 Bowman, D. M. J. S., et al., 2009. Science, 324(5926), 481–484.
7 Marcos, R., et al., 2015. Int. J. Wildland Fire 24, 1076–1084.
8 San-Miguel-Ayanz, J., et al., 2013.Forest Ecol. Manag. 294, 11–22.
9 Troccoli, A., 2010. Meteorol. Appl. 17, 251–268.
10 Prodhomme, C., et al., 2015. Clim Dyn 47(3), 919–935.
11 Shaman, J., 2014. J. Climate 27, 6423–6438.
12 Jung, T., et al., 2015. Bull. Amer. Meteor. Soc. 96, ES197-ES200.
13 Doblas-Reyes, F.J., et al., 2013. WIREs Clim Change 4, 245–268.

raising awareness and preparing for wildfire prevention and suppression strategies. While several short-term (up to 10 days in advance) fire danger systems are in place (e.g. The European Forest Fire Information System for Europe), there is currently no operational seasonal wildfire forecasting system for Europe and only a few for other continents. Climate is partially predictable on seasonal timescales and operational seasonal climate forecasts show significant skill. Opportunities therefore exist of relying on this climate skill to develop potentially skillful seasonal wildfire forecasting systems. ***SPFireSD proposes to develop and assess seasonal fire prediction capability through a variety of complementary and innovative methods using statistical and dynamical models, with a focus on Europe, the Amazonian basin and Indonesia.***

1.1.2. State-of-the-art

Oceanic Climate Indices (OCIs), obtained from regional averages of SST anomalies, can be used for statistical forecasting of fire danger in tropical areas with few months lead times[4]. Following the strong El Niño event of 2015, extremely high fire danger was forecasted for the 2016 dry season in the Amazonian basin using this approach[14] (see http://www.ess.uci.edu/~amazonfirerisk/ForecastWeb/SAMFSS2016.html). Wildfire occurrence in Indonesia can be predicted a few months in advance, using a simple statistical fire model combined with operational seasonal forecast of precipitation[5].

Although the source of most fires in Southern Europe is related to human activities, fire danger is also largely influenced by currently dry and previously wet climatic conditions in the same area, favoring accumulation of fuel due to enhanced vegetation growth followed by drought related senescence[7 15 16]. Live fuel moisture content, obtained through remote sensing data, is a potential predictor of fire danger in the Iberian peninsula[17]. Statistical models obtained through MLR of Burned Area (BA) on precipitation and temperature at various lag times are well correlated (~0.8) with observed BA in the Iberian Peninsula[15 16]. The prediction of summertime fire danger with lead times of a few months requires a forecast of precipitation and temperature anomalies. However, anomalies obtained through operational seasonal forecasts have been found to provide less BA skill than persistence anomalies, suggesting that more predictors, better models and model bias correction techniques should be investigated as a way to produce more accurate fire predictions[7].

The Canadian Fire Weather Index (FWI)[18] has been used for decades to evaluate fire danger in forested areas. Daily timeseries of FWI are computed from daily values (taken at 12h local) of temperature, relative humidity, wind and rain. Other fire danger indices used by national fire management agencies worldwide are relevant to this study. KBDI: the Keetch-Byram Drought Index[19], developed in the United States, a simple function of daily maximum temperature and precipitation. FFDI: the McArthur Forest Fire Danger Index[20], used in Australia for many decades, is based on empirical studies and is a function of temperature, relative humidity, wind speed and the KBDI. MNI: the Modified Nesterov Index[21], based on the Nesterov Index which was developed in Russia, is a cumulative function of temperature and dew point deficit which decreases following rainfall events.

Meteorological forecasts are used instead of observed meteorological data to compute forecasted FWI and predict future fire danger. The Canadian FWI has been adopted by the European Forest Fire Information System (EFFIS) [22] for short-term (1-10 days) fire danger forecasts based on ensemble weather forecasts from ECMWF. Real-time fire information and fire danger forecasts are available at http://forest.jrc.ec.europa.eu/effis/applications/current-situation/. The Global Fire EWS (A Global Early Warning System for Wildland Fire) produces 1-10 day forecasts of FWI, based on the Canadian Meteorological Centre's (CMC) Global Deterministic Prediction System (GDPS). The Daily Severity Rating (DSR), obtained from a power function of daily FWI values, can be averaged over a month/season to compute Monthly/Seasonal Severity Ratings (MSR/SSR)[23]. Climate forecasts provided by the CanSIPS seasonal forecast system from Environment Canada are used to compute MSR in order to inform on seasonal fire danger over Canada. However, there are no known operational global seasonal fire danger forecasts based on European seasonal prediction systems and FWI or similar indices.

Seasonal climate prediction of key variables influencing fire danger, such as precipitation and temperature, are most commonly performed, even operationally, using process-based dynamical models[13]. One such model is EC

14 Chen, Y., et al., 2011. Science 334, 787–791.
15 Turco, M., et al., 2013. Climatic Change 116, 665–678.
16 Turco, M., et al., 2014. Climatic Change 125, 369–380.
17 Jurdao, S., et al., 2012. Fire Ecology 8, 77–97.
18 Van Wagner C.E., 1987. Canadian Forestry Service. Forestry Technical Report 35. 37 pp.
19 Keetch, J.J., Byram, G.M., 1968. U.S.D.A. Forest Service Research Paper SE-38. 35 pp.
20 Dowdy, A.J., et al., 2009. CAWCR Technical Report No 10,
21 Groisman, P.Y., et al., 2007. Global and Planetary Change 56, 371–386.
22 San-Miguel-Ayanz, J., et al., 2013. Forest Policy and Economics 29, 19–25.
23 Anderson, K.R., et al., 2007. 7th Symposium on Fire and Forest Meteorology, Am. Meteorol. Soc.

Earth [24] which couples state-of-the-art atmospheric, oceanic, sea ice and land surface models. Dynamic Global Vegetation Models (DGVMs) are based on Land Surface Models (LSMs), which simulate the interactions between the land surface and the atmosphere, and incorporate, as an improvement compared to LSMs, vegetation dynamics and the carbon cycle[25]. The LPJ-Guess model[26] a variant of the LPJ model[27] with the addition of population dynamics is coupled to the current version of EC-Earth (3.2). LPJ and LPJ-GUESS have been used for studies on wildfire using various fire models in order to study past and future fire sensitivity to climate change and its role in the carbon cycle. The first such fire model, Glob-FIRM[28], using a moisture extinction threshold for fire occurrence, is included in EC-Earth. Several other fire models have been incorporated into the LPJ and LPJ-Guess models: Reg-FIRM[29] using the Nesterov Index; SPITFIRE[30] using the Rothermel fire behaviour equations; SIMFIRE[31] considering climate and human impacts based on population density. Many other wildfire models incorporated into ESMs have been used for long-term studies (e.g. paleoclimatology, sensitivity to climate change)[1], but their use for seasonal prediction of wildfire danger and burned area has not been attempted yet.

1.1.3. Research Objectives and Overview of the action

This project will develop and assess seasonal prediction capability of wildfire danger using three complementary approaches:

1) *Fire danger indices approach:* simple fire danger indices computed from seasonal dynamical climate prediction systems
2) *Statistical approach:* statistical fire danger models using a combination of past observational data and seasonal dynamical climate forecasts
3) *Dynamical approach:* ensemble dynamical predictions using state-of-the-art fire models within Earth System Models

While the first approach is a mere extension of current methods widely used in other continents, the second approach proposes a substantial leap forward compared to existing simple methods and the third approach aims at cutting-edge developments and applications of Earth System Models unattempted up-to-date. This project therefore proposes particularly novel and ground-breaking activities with potentially large socio-economic benefits.

1.1.4. Research methodology and approach

The work plan is based on the main research objectives, each corresponding to a distinct Work Package (WP). The main regions of interest are Southern Europe (as it is the European area most affected by wildfire), the Amazon region and Indonesia (where wildfire is impactful and predictable according to previous literature). The study period will be from 1997 to 2016, the period when global fire observation datasets are available. Calibration and validation of fire danger will be done against the following global Burned Area (BA) and Active Fire (AF) datasets: monthly GFEDv4 BA covering the 1997-present period[32], Fire_cci global BA covering 2005-2011[33] and MCD14CMG AF covering from 2001 to present[34].

WP1 [M1-M5] Fire danger indices computed from seasonal dynamical climate prediction systems

This work package will rely on the fire danger indices described previously, as they are typically used for early warning in other countries and their computation requires climate variables which are available globally.

Task 1.1 [M1-M3] Validation of fire danger indices: Relationship between observationally-derived fire danger indices and fire danger

As a preliminary step to the use of fire danger indices for seasonal prediction of fire danger, we will assess the trustworthiness of these indices as indicators of fire danger by validating them globally using observations. ERA-Interim reanalysis data will be used as input climate data, since there are currently no global observational datasets of the required climate variables available at sub-daily timescales. Monthly averages of the indices will be

24 Hazeleger, W., et al., 2012. Clim Dyn 39, 2611–2629.
25 Pitman, A.J., 2003. Int. J. Climatol. 23, 479–510.
26 Smith, B., et al., 2014. Biogeosciences 11, 2027–2054.
27 Sitch, S.,et al., 2003. Global Change Biology 9, 161–185.
28 Thonicke, K.,et al., 2001. Global Ecol. Biogeogr. 10, 661–677.
29 Venevsky, S., et al., 2002. Global Change Biology 8, 984–998.
30 Thonicke, K., et al., 2010. Biogeosciences Discuss. 7, 697–743.
31 Knorr, W., et al., 2016. Climate, Biogeosciences 13, 267–282.
32 Giglio, L., et al., 2013. J. Geophys. Res.-Biogeo. 118, 317–328.
33 Chuvieco, E., et al., 2016. Global Ecol. Biogeogr. 25, 619–629.
34 Giglio, L., et al., 2003. Int. J. Remote Sens. 24, 4505.

compared to global fire observations. This assessment will rely on global maps and spatial averages over the main regions of interest, through metric-based evaluation (e.g. timeseries anomaly correlations).

Task 1.2 [M3-M5] Fire danger indices obtained from dynamical seasonal climate prediction systems

To develop a simple seasonal fire prediction system for Europe, Indonesia and the Amazonian basin, in line with those available for other regions, sub-daily outputs of seasonal dynamical climate forecasts (instead of reanalysis data as in Task 1.1) will be used to compute fire danger indices. Ensemble climate predictions in re-forecast mode from ECMWF System 4, EC-Earth (produced internally at BSC) and Météo-France seasonal forecast system 5 will be used to generate ensemble fire danger indices at monthly timescales from 1997 to present. These will be verified first against the fire danger indices computed from reanalysis data in Task 1.1. Secondly, global maps and regional averages of monthly fire danger indices will be compared to observed BA and AF data as in Task 1.1. Both deterministic and probabilistic forecast verification scores [35] will be computed to assess the performance of this simple seasonal fire prediction system.

WP2 [M6-M12] Statistical fire danger models for Southern Europe

This WP will develop statistical fire danger models for Southern Europe exclusively.

Task 2.1 [M6-M8] MLR model using observed precipitation and temperature (SPFire-PT)

This task aims to expand on previous attempts at predicting fire danger on seasonal timescales using MLR of Burned Area onto monthly precipitation and temperature. While previous works only focused on predictions for Catalunya [7 15 16], this task will produce predictions for the entire southern Europe. A procedure and associated tools for finding optimal lead times and coefficients of the MLR equations will be designed. The MLR model (that we will name SPFire-PT) will be constructed from gridded monthly observations of precipitation and temperature from the CRU and E-OBS datasets, against the global fire observation datasets. This will be done for the entire Mediterranean region at 0.5° resolution and areas of significant prediction skill will be identified, using a wide variety of prediction scores typically used for climate at BSC.

Task 2.2 [M8-M10] MLR model combining observed and predicted precipitation and temperature

Fire danger depends on past as well as current drought conditions**Z**. This task aims at refining the method developed under Task 2.1 through the use of precipitation and temperature observations for the past conditions (i.e. prior to the start date of the prediction) combined with bias-corrected forecasts from several seasonal prediction systems for the current conditions (i.e. target forecast time). The systems used will be the ECMWF Seasonal Forecast System 4, Météo France Seasonal Forecast System 5, Met Office Global seasonal forecasting system (GloSea5), NCEP Climate Forecast System v2 (CFSv2), the Canadian Seasonal to Interannual Prediction System (CanSIP) and seasonal predictions from the EC-Earth 3.2 model done at BSC. Bias correction techniques that will be tested will account for the sensitivity of the bias to climate change and climate variability and calibration techniques correcting for higher moments will also be considered. The skill at predicting wildfire danger will be assessed for each forecast system at various lead times based on both deterministic and probabilistic verification scores.

Task 2.3 [M10-M12] Enhanced MLR model (SPFire-MULTI) with meteorological and geographic factors

This task will expand Tasks 2.1 and 2.2 in a number of ways and lead to the development of a multivariate MLR model (that we will name SPFire-MULTI). The SPFire-PT model created in Task 2.1 will be enhanced to support more input variables and select the optimal combination of variables and lead times which leads to the highest skill, using a multiple linear regression analysis method[36]. SST and Oceanic Indices represent a significant source of predictability. Other atmospheric variables which could bring some predictive skill are the North Atlantic Oscillation (NAO), precipitation, near-surface wind and air humidity and soil moisture. The inclusion of geographic factors such as population density, economic welfare, land use/land cover and live and dead fuel moisture data will be investigated, during a series of short visits to the Grupo de teledetección ambiental of the Universidad de Alcalá. The list of potential predictors will be refined prior to designing an advanced and comprehensive statistical fire danger model.

WP3 [M7-M24] Earth System Models with dynamical fire models

This WP aims to implement the EC-Earth-Fire seasonal prediction system (that we will name SPFire-ECA).

Task 3.1 [M7-M15] Incorporation of dynamical fire models within EC-Earth

35 Wilks, D. S., 2011. Statistical methods in the atmospheric sciences. Vol. 100. Academic Press.

36 Suckling, E.B., et al., 2016. Clim Dyn 1–24.

The Glob-FIRM fire model is included in the LPJ-GUESS model within the EC-Earth ESM model version 3.2. The SIMFIRE and SPITFIRE models are included in different implementations of the LPJ-GUESS model maintained by research groups at Lund University and the Senckenberg Biodiversity and Climate Research Centre (BiK-F), respectively. They are expected to be included in a timely manner in the main (trunk) version of the LPJ-GUESS model maintained by the LPJ-GUESS group at Lund University. The incorporation of the SIMFIRE model into EC-Earth will be done by the Lund group and is planned by mid-2017. The incorporation of SPITFIRE into EC-Earth, as part of this project, is conditional on successful merging into the official LPJ-GUESS version by the Senckenberg group, assistance from this group when including it into the EC-Earth model, as well as the lack of significant, unforeseen obstacles. Should this incorporation fail, the next tasks will be done with the other two fire models (Glob-FIRM and SIMFIRE) only.

Task 3.2 [M10-M18] Initialization of the EC-Earth-Fire seasonal prediction system

Implementing a seasonal prediction system requires the generation of initial conditions at each start date of prediction. While expertise is available at BSC for the generation of atmosphere, ocean and sea ice initial conditions, a methodology will be defined and tested for the generation of land and vegetation (for LPJ-GUESS) surface initial conditions. Two options will be tested:

1. Running a LPJ-GUESS only simulation forced with the ERA-Interim reanalysis - ERA-Interim being used as a source of atmospheric initial conditions for the predictions afterwards, this will allow for generating land surface and vegetation initial conditions that are consistent with the atmospheric initial conditions.
2. Running a fully coupled EC-Earth simulation where data assimilation is implemented in the atmosphere, ocean, and sea ice components toward the ORAS4 and ERA-Interim reanalyses and gridded observational datasets of sea ice concentration and thickness respectively; the ORAS4 reanalysis being used as a source of oceanic initial conditions for the predictions afterwards.

For both methods, if possible, nudging toward ERA-Interim/Land, soil moisture data and/or other land surface observational data will be implemented, depending on the best options available. The performance of these two methods for generating initial conditions will be assessed in Task 3.3.

Task 3.3 [M14-M24] EC-Earth-Fire seasonal prediction system

A set of 10-member forecasts will be initialized every 1st February and 1st May between 1997 and 2016 (coincident with the years when BA and AF reference data are available for verification). These forecasts will be extended until the end of September to cover the target summer period with each of the fire models included in EC-Earth ESM and for each initialization technique tested under Task 3.2. The ensemble members will be generated by applying initial perturbations obtained by singular vectors for the atmosphere and through the various members of ocean and sea ice reanalyses used for initialization. Both probabilistic and deterministic verification scores against global fire observations will be computed to provide a comprehensive skill assessment. The performance of such advanced dynamical fire prediction systems will be compared with the performance of the simpler predictions systems developed under WP1 and WP2.

Task 3.4 [M22-M23] Météo France seasonal prediction system and multi-model ensemble fire predictions

Météo-France will be developing their own coupled climate and fire dynamical prediction system within the coming 2 years. The CNRM-ESM model contains a fire module derived from the GlobFirm fire model and accounts for several relevant processes including vegetation type sensitivity, peat fires and updated emissions factors, and benefits from an accurate coupling with the Météo-France land surface model hydrological scheme. So far, the fire module has been solely used for centennial-long climate change projections, but it will be adapted for climate prediction. This task will aim at comparing the performance of the EC-Earth and Meteo-France prediction systems as well as assessing the performance of a multi-model ensemble forecast system comprising the Meteo-France prediction system as well as the different variants of EC-Earth-Fire based on different fire models. This task will be undertaken during a two-months visit to Météo-France-CNRM.

1.1.5 Career turning point and collaboration opportunities

This novel project combines optimally the candidate's strong past expertise on fire and vegetation modeling with BSC's widely recognized expertise and leadership on climate prediction, enabling the development of a new field of expertise in Europe: seasonal prediction of fire danger. As a consequence of the candidate's secondments (Météo-France), visits (University of Alcala) and collaboration with other institutions and research groups, new collaboration opportunities will emerge for the BSC. The large BSC network of collaborators (e.g. ECMWF, SMHI, KNMI) will benefit both the candidate and the project outlined in this proposal.

During the preparation of this proposal, the candidate has started building a network of contacts which will foster collaboration during the implementation of the fellowship. This network of contacts, which is expected to grow

during and after the implementation of this proposal, includes the seasonal prediction and Earth System groups of Météo-France-CNRM (France), the Grupo de teledetección ambiental of the Universidad de Alcalá (Spain), Lund University (Sweden), the Senckenberg Biodiversity and Climate Research Centre (Germany) and the Forecast Department at ECMWF. The implementation of the research plan included in this proposal will represent a significant turn in the candidate's career, as it will represent a significant opportunity to become a European leader in the seasonal fire prediction field with groundbreaking developments via the use of statistical and dynamical prediction systems.

1.1.6 Originality and innovative aspects of the research programme

Such a wide exploration of various techniques to forecast fire danger on seasonal timescales has never been attempted up to now. This wide set of techniques ranges from very simple fire indices to largely advanced dynamical fire models coupled to dynamical climate prediction systems. The first approach of this project aims to apply known techniques to new areas of the globe. The second approach aims to develop advanced statistical methods relying on a much larger set of predictors than ever considered up to now. The third and final approach uses ESMs and integrated fire models, which has never been applied previously to the seasonal fire prediction field. This project combines the most novel knowledge in terms of fire representation with the most updated climate prediction techniques to develop cutting-edge fire prediction systems.

1.1.7 The interdisciplinary aspects of the action

Seasonal prediction involves the sciences of meteorology, oceanography and climatology as it relies on initialization techniques developed within the numerical weather prediction field and must account for climate change following developments from the climatology field. Wildfire science is interdisciplinary as it involves meteorology and ecology. Vegetation dynamics include aspects of climatology and ecology. The consideration of geographic factors in Task 1.2 adds remote sensing and socio-economic aspects to the topics tackled by this project. Finally, statistics are tantamount to forecast verification. This project is therefore a highly interdisciplinary one gathering expertise on meteorology, oceanography, mathematics, ecology and socio-economy.

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

An extensive training of the candidate will be conducted at BSC during the first months of this project. BSC expertise on climate prediction, including data assimilation, initialization, initial shock and drift, bias correction and calibration methods, tools for efficient post-processing and visualization of the large amount of data, will be readily available to the candidate. The candidate will acquire general knowledge and experience on initializing, executing and analyzing coupled climate model simulations. Other training activities will include grant negotiation, grant/proposal writing skills, project management, statistical programming and high performance computing. o disseminate efficiently the project results to a large public, training in communication to non-specialist will also be considered. All trainings will be revised and gaps will be identified before the start date of the project by drafting a Career Development Plan with the assistance of the supervisor.

On the other hand, the candidate is the first member of the climate prediction group at BSC with prior experience in fire and vegetation modelling, which will enable the creation of a new line of research and open new collaboration opportunities in seasonal prediction of fire danger. Moreover, his solid computational background will be of great benefit to BSC in assisting other members of the team and improving existing tools and creating new ones (e.g. statistical methods and tools created in WP2). New contacts, knowledge and experience obtained during the secondment will be transferred to the BSC. The candidate's existing and future contact network will be integrated into the Host Institution as a result of this project.

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

Qualifications and experience of the supervisor:

The candidate will be carrying out his proposal within the **climate prediction group**, led by **Dr. Virginie Guemas**, who is an expert on seasonal to decadal climate prediction, head of the climate prediction group and a Ramon y Cajal fellow (national grant with 2% success). She was awarded the 2010 Adrien Gaussail PhD prize, granted every two years to a scientific PhD. She is member of the WCRP (World Climate Research Program) CLIVAR (Climate and Ocean Variability, Predictability, and Change) SSG (Scientific Steering Group). She has participated in 13 national and international research projects. Currently, she is Principal Investigator (PI) of six European projects, one national project and one Copernicus project. She contributed to the IPCC (Fifth Assessment Report). She is author of 39 articles on climate modelling and predictions in international peer-reviewed journals, among which six in high-impact journals. She has supervised three PhD students and several post-doctoral scientists.

Hosting Arrangements:

BSC will facilitate the integration of the fellow by providing access to a personal workstation, laptop, BSC's High Performance Computing facilities, BSC and UPC facilities such as library, conference rooms and several services (e.g. internal trainings and seminars, language classes, health insurance, entry permits). BSC is an ideal institution for hosting the fellow, as it has made a Declaration of Endorsement to the principles of the "European Charter for Researchers" and "The Code of Conduct for the recruitment of researchers" and was awarded with the "HR Excellence in research" logo. The fellow will fully benefit from participating in the various projects that BSC is involved in and will be exposed to various networking opportunities. This proposal is fully in line with BSC's centers of interests and those of the climate prediction group in particular, by focusing on developing a new application of the climate prediction capability being developed at the host institution. This will further facilitate the candidate's integration within the host organization.

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

The candidate has a strong multi-disciplinary background, having studied physics, computer science, atmospheric science and biosphere-atmosphere interactions. He has professional experience in the Information Technology sector as both employee and entrepreneur, before transitioning to the climate research field. He has published 6 papers which have been cited in 27 publications, an H-index of 2, presented 3 talks and 9 posters (1 prized) in international conferences and events and participated in two field experiments.

The candidate has past experience in the field of seasonal prediction, having studied the impacts of ENSO on precipitation anomalies in the tropical Americas. The past involvement of the candidate in the development of the Brazilian Earth System Model (BESM) at INPE – CCST has provided him with a very strong expertise on vegetation and fire modelling, high-performance computing and multi-disciplinary collaboration. His PhD studies and related work have allowed him to grow a contact network within the Brazilian (INPE-CCST and its partners) and global research community in the fields of Earth System and fire modelling, remote sensing, fire danger monitoring, variability and sensitivity to climate change.

Building on the BSC's expertise on climate prediction, the candidate will develop a new research line within the climate prediction group. With the help of the supervisor and BSC's Project Management staff, the candidate will produce a Career Development Plan before the start of the project, including short and long-term objectives. As the subject of seasonal prediction of fire danger in Europe is novel and has many socio-economic applications, this research topic can become self-funded and grow into a research team led by the candidate, establishing him as a leader in a topic which has not yet been tackled in Europe. As a result of this fellowship, the candidate will gain more experience in multidisciplinary collaboration, project management and leadership, applied science and research, seasonal prediction and model development and evaluation.

2. Impact

2.1 Enhancing the potential and future career prospects of the researcher

As consequence of the implementation of the project at the host and secondment organizations, the candidate will develop a range of new competences, in particular on prediction: data assimilation, initialization, ensemble generation, bias correction and calibration, post-processing and visualization of a large quantities of data. Being hosted at BSC, the candidate will benefit from a very favorable working environment, with access to a large amount of computing resources and strong IT support, which are further described in section 3.4.

The secondments and collaborations planned will be beneficial to the candidate by helping to expand his contact network and giving him access to other facilities. The visits to the University of Alcala will give access to new observational data and enhance the candidate's knowledge in Geographic Information Systems. The secondment at Météo-France-CNRM will benefit the candidate in helping him assess the robustness of the dynamical techniques developed by comparing them with Météo France's ESM. The candidate will also profit from expertise in modeling the land surface, vegetation and the carbon cycle and model evaluation at seasonal timescales.

The project will allow to develop a new research line within the Earth Sciences Department which is fully complementary to the current strategic plan. This research line could grow in the coming years into a new research team under the responsibility of the candidate. Indeed, the candidate will become a European leader in a novel topic, which responds timely to pressing societal needs for seasonal fire danger prediction, due to climate change, and exploits new opportunities building on recent developments on climate prediction and fire modelling. As beneficiary of the MSC fellowship and leader in the seasonal fire prediction field, the candidate will be in a favorable position to apply for subsequent grants such as ERC Starting Grant and national and international research projects (Horizon 2020) to develop and maintain a new research group to develop his fire prediction activities.

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

In order to disseminate the results to a wide scientific community, the following peer-reviewed publications are planned in international journals, of high-impact if the results allow it:

- A European seasonal fire prediction system combining fire danger indices and dynamical climate prediction systems
- An advanced statistical seasonal fire prediction system: description and performance
- Development of the EC-Earth Earth System Model for fire danger seasonal prediction
- Multi-model ensemble dynamical seasonal prediction of fire danger

Additionally, the project activities and results will be disseminated in high-level international conferences. The European Geoscience Union (EGU) holds General Assemblies every year and is attended by climate prediction and wildfire specialists alike. The International Association of Wildland Fire also organizes several conferences yearly, which focus on wildfire management and modeling. The candidate will also search for other conferences to be held during the project covering the topics of climate prediction and its applications and wildfire modeling. Attending several of these conferences will allow to disseminate results to key researchers and end-users as well as expand the candidate's contact network and increase his knowledge on cutting-edge wildfire research.

The socio-economic impacts of wildfires (e.g. damages to property, health, transportation) and their potential predictability imply the need to communicate predictions of wildfire danger and risk to the relevant authorities in order to benefit society. Within the BSC, the Earth Sciences Services group of the Earth Sciences Department develops close contacts with end users in key socio-economic sectors of applications of climate prediction such as wind energy, agriculture and insurance. Their members include a communication expert and sociologist to ensure efficient networking with potential end users and dissemination. Their products are derived from the work performed by the Climate Prediction group, in which the candidate will carry out his project. A close collaboration between both groups therefore allows for an efficient transfer of knowledge and for ensuring that it reaches society. This in-home expertise of a complete workflow from the production of climate prediction to its application and dissemination to various socio-economic sectors can be exploited to develop services in the seasonal fire prediction field following the outcome of the candidate's project. The visualization department at BSC has already been involved in the past in developing website to disseminate climate prediction products such as tropical cyclone prediction and damages (www.seasonalhurricanepredictions.org). This expertise could also be applied to building a website to disseminate fire predictions in the future.

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

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

- Inclusion of the project information, progress and results in several dissemination activities of BSC, e.g. website, presentations, leaflets, brochures, videos.
- Development and maintenance of a webpage for disseminating the fire predictions using the various techniques developed in this project.
- Participation in MareNostrum open day events, aimed at high school, graduate students, and general public.
- Academic cooperation with the Grupo de Análisis de Situaciones Meteorológicas Adversas of the Facultat de Física at Universitat de Barcelona and related MSc and PhD programmes.

3. Quality and Efficiency of the Implementation

3.1 Coherence and effectiveness of the work plan

Work Packages

WP1 [M1-M5] Fire danger indices computed from seasonal dynamical climate prediction systems
WP2 [M6-M12] Statistical fire danger models for Southern Europe
WP3 [M7-M24] Earth System Models with dynamical fire models

Deliverables

D0.1 [M1] Career Development Plan – Year 1 drafted
D1.1 [M5] Article on the use of fire danger indices obtained from dynamical climate prediction systems submitted
D2.1 [M10] Statistical fire prediction system coded in an open-source language

D0.2 [M12] Career Development Plan – Year 2 drafted
D2.2 [M12] Article on the performance of the statistical fire prediction system using dynamical climate prediction systems submitted
D3.1 [M22] Article on the development and performance of EC-Earth fire submitted
D3.2 [M24] Article on multi-model ensemble prediction system submitted

Milestones

M1.1 [M3] Fire danger indices validated from reanalysis data
M2.1 [M8] Simple statistical fire prediction system based on observed precipitation and temperature tested
M3.1 [M9] EC-Earth in climate prediction mode with LPJ-GUESS and Globfirm fire model tested
M3.2 [M13] Initial data for EC-Earth fire generated and SIMFIRE model is integrated
M3.3 [M19] Climate prediction experiments performed with EC-Earth-Fire

Secondments/Visits

Visits to Météo-France-CNRM are planned to obtain daily and monthly output of the Météo France climate prediction system for use as input to the SPFire-FWI model (Task 1.2) and SPFire-PT model (Task 2.2), as well as to analyze the performance of the Météo France seasonal prediction system for seasonal forecasting of fire danger (Task 3.4).
Short visits to the Grupo de teledetección ambiental of the Universidad de Alcalá will be done to study which geographic factors should be included in the SPFire-MULTI model (Task 2.3).

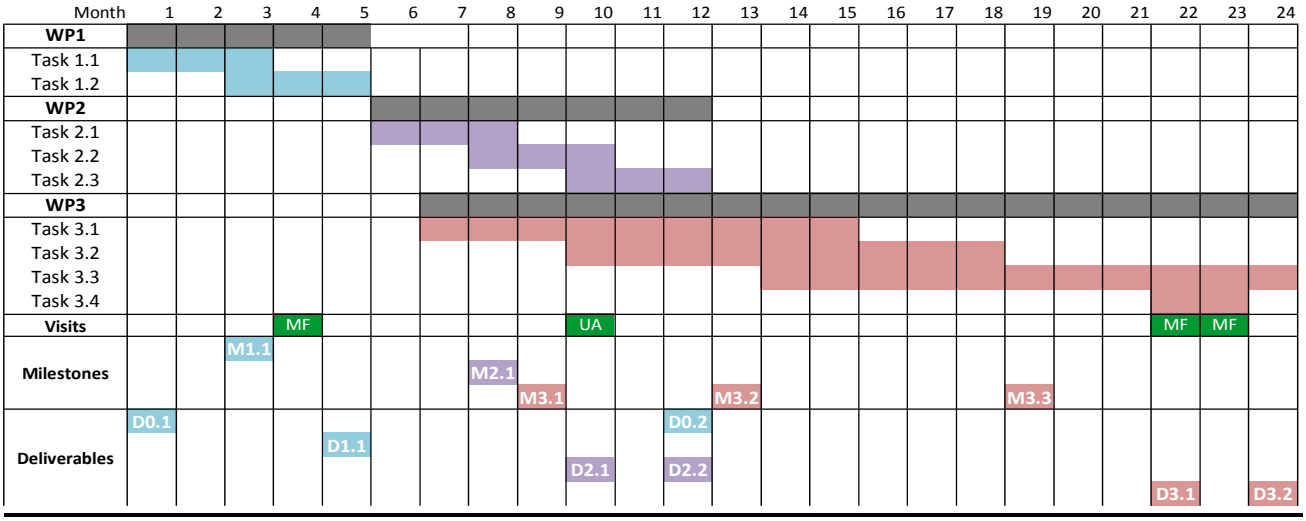

Table 1 – Gantt Chart

3.2. Appropriateness of the allocation of tasks and resources

The infrastructure and computational resources (desktops, laptops, super-computing facilities) and computing time available at BSC and partner organizations is more than sufficient for attaining the project objectives, as described in section 3.4 in more detail. The candidate has extensive computing knowledge and the BSC has a large support staff ready to assist in computational and technical issues. Scientific knowledge and training of the candidate in the area of fire modeling and remote sensing turns him the ideal person for implementing this project. All the resources of BSC and secondment institutions will be available to complement his training in the areas of climate prediction and model assessment. The BSC's experience and expertise in project planning and resource management will be fully available to assist the candidate during the implementation of the action. The planning of the project in terms of person-months has been carefully thought out and allows to account for delays and re-planning if necessary. As the three Work Packages are independent, significant delays could be remedied by advancing the execution of other Work Package(s).

The tools required for computing fire danger indices in WP1 (equations and observational datasets) already exist and are publicly accessible to the general public and the climate predictions used in WP1 are already available in the climate prediction group database. Existing expertise and tools at BSC will be leveraged for computation of the statistical models and bias correction needed in WP2. As EC-Earth, used in WP3, is the main dynamical prediction system used in the climate prediction group at BSC, the candidate will benefit from strong expertise with this model, as well as the BSC's partners in the EC-Earth consortium which will be available for assistance with any issues for which the BSC lacks expertise. The climate prediction group's existing experience and tools for model

initialisation, experiments and analysis will be beneficial to the candidate and allow him to extend the tools in order to implement additional aspects on wildfires within an existing workflow.

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

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

Finances of the project will be managed according to MSC funding rules signed at the grant agreement and will follow the already established processes in the centre. Moreover, the financial management strategy will try to maximize the impact of travels by associating each conference participation to short visits or research talks at other institutions. The applicant will work in close contact with the supervisor of this project and presents progress and results to the supervisor and scientific staff on a regular basis, through reports and presentations. This will allow the evaluation of his progress against the work plan and Career Development Plan, identify any potential risk and seek assistance in a timely and periodic manner if the necessity arises.

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

Task	Risk	Mitigation measure
Task 1.1	Some fire danger indices do not capture properly the fire danger as compared to observed BA data.	Task 1.2 restricted to those fire indices which capture properly the fire danger.
Task 2.3	No significant new geographic factors are found or cannot be used.	The SPFire-Multi model will be based on meteorological data only.
Task 3.1	The SPITFIRE model is not implemented in EC-Earth.	Use only other fire models for tasks 3.2 and 3.3.
Task 3.4	Dynamical seasonal fire danger prediction framework at Météo France is not implemented.	Task 3.4 will not be done, but results of Task 3.3 will be sufficient.

Table 2 – Risks and mitigation measures

3.4 Appropriateness of the institutional environment (infrastructure)

BSC-CNS is the National Supercomputing Facility of Spain and 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 BSC-CNS is a key element of and coordinates the Spanish Supercomputing Network, which is the main framework for granting competitive HPC time to Spanish research institutions. Furthermore, BSC-CNS is one of six hosting nodes in France, Germany, Italy and Spain that form the core of the Partnership for Advanced Computing in Europe (PRACE) network. PRACE provides competitive computing time on world-class supercomputers to researchers in the 25 European member countries. The Earth Sciences Department in which the candidate will be carrying out his project has privileged access to these super-computing resources with a few million CPUhours every year. The climate prediction group has furthermore been very successful in the past in obtaining competitive computing resources on a wide range of platform through various projects such as SPIESM (Sweden), SPAITAC (UK), HighResClim (Spain) and LSHIP (Spain) granted by PRACE and SPESICCF, which is a special project at ECMWF. These projects have provided the group with an additional few million CPUhours every year. These resources will largely cover the needs of the candidate.

Additionally, BSC has also a highly skilled and well trained team of technicians able to provide advice and support to the scientists that use the available high performance computing infrastructures. Within the Earth Sciences Department, the Computation Earth Sciences group provides strong support to the Climate prediction, by developing tools to automatize the running of climate prediction experiments, their post-processing and basic analysis following widely used methodologies and to manage efficiently the computing resources. They also provide strong support in optimizing model code as well as any tool developed by the climate prediction group members.

The BSC has extensive experience in hosting fellows and researchers, which is described in more detail in section 5. The combination of outstanding available supercomputing facilities, high quality user support and experience in hosting fellows will provide the candidate with a very strong basis in terms of scientific infrastructures to be successful in the research project he aims to develop at BSC.

DOCUMENT 2

4. CV of the Experienced Researcher

Personal information:

Etienne Tourigny, Ph.D.
Postdoctoral Researcher, BSC

E-mail: etienne.tourigny@bsc.es
ORCID: 0000-0003-4628-1461
ResearcherID: L-3431-2016

Written and spoken languages: French (Native), English (Native), Portuguese (fluent), Spanish (fluent)

Metrics (Google Scholar):

Publications:	11
Citations:	28
h-index:	2
i10-index:	1

Studies

2009-2014 **Ph.D. in Meteorology**
Instituto Nacional de Pesquisas Espaciais (INPE) – CPTEC

2004-2008 **M.Sc. in Atmospheric Science**
Université du Québec à Montréal (UQAM)

1998-2000 **B.Sc. in Computer Science**
Université de Montréal

1996-1997 **Sc. Minor in Physics**
Université de Montréal

Professional Experience

2016/05- **Postdoctoral researcher**
Barcelona Supercomputing Center (BSC) – Earth Sciences Department

2014- **Scientific literature translation and revision (Portuguese-English)**

2012-2014 **CNPq DTI-A scholarship**
INPE – CCST, BESM project

2009-2011 **Doctoral (B2) research scholarship**
FQRNT (for PhD at INPE/CPTEC)

2004-2007 **Programmer and website maintainer**
UQAM – ESCER Center, MRC and CRCMD networks

2002-2004 **Computer programmer and president**
OM/EO Computing Inc.

2001-2002 **Programmer Analyst**
Fédération des caisses Desjardins du Québec – Support et Correctifs

1999-2000 Computer Programmer
Université de Montréal – Laboratoire de Biologie Informatique et Théorique

Publications

Casagrande, F., P. Nobre, R. B. de Souza, A. L. Marquez, E. **Tourigny**, V. Capistrano and R. Mello, 2016: Arctic sea ice: Decadal simulations and future scenarios using BESM-OA. Atmospheric and Climate Sciences, 6(2), 351-366. doi: 10.4236/acs.2016.62029.

Carvalho Jr., J.A., S.S. Amaral, M.A.M. Costa, T.G. Soares Neto, C.A.G. Veras, F.S. Costa, T.T. van Leeuwen, G.C. Krieger Filhog, E. **Tourigny**, M.C. Forti, A.H. Fostier, M.B. Siqueira, J.C. Santos, B.A. Lima, P. Cascão, G. Ortega, E.F. Frade Jr., 2016:. CO2 and CO Emission Rates from Three Forest Fire Controlled Experiments in Western Amazonia. Atmospheric Environment, 135, 73–83. doi:10.1016/j.atmosenv.2016.03.043.

Rezende, L. F. C., B. C. Arenque, S. T. Aidar, M. S. B. Moura, C. Von Randow, E. **Tourigny**, R. S. C. Menezes, and J. P. H. B. Ometto, 2016: Is the Maximum Velocity of Carboxylation (Vcmax) Well Adjusted for Deciduous Shrubs in DGVMs? A Case Study for the Caatinga Biome in Brazil. Modeling Earth Systems and Environment, 2:42. doi: 10.1007/s40808-016-0099-5

Rezende, L. F. C., B. C. Arenque, S. T. Aidar, M. S. B. Moura, C. Von Randow, E. **Tourigny**, R. S. C. Menezes, and J. P. H. B. Ometto, 2015: Evolution and challenges of dynamic global vegetation models for some aspects of plant physiology and elevated atmospheric CO2. International Journal of Biometeorology, 1-11. doi: 10.1007/s00484-015-1087-6

Tourigny, E, 2014: Multi-scale fire modeling in the neotropics: coupling a land surface model to a high resolution fire spread model, considering land cover heterogeneity. PhD thesis in Meteorology, Instituto Nacional de Pesquisas Espaciais (INPE), São José dos Campos, Brazil.

Tourigny, E., S. Rabin, A. Lima, S. Pacala and C. Nobre, 2014: Evaluation of global burned area products in the Brazilian Arc of Deforestation. Remote Sensing of Environment (accepted with major revisions).

Tourigny, E. and C. G. Jones, 2009: An analysis of regional climate model performance over the tropical Americas. Part I: simulating seasonal variability of precipitation associated with ENSO forcing. Tellus A, 61(3), 323-342. doi: 10.1111/j.1600-0870.2008.00386.x

Tourigny, E. and C. G. Jones, 2009: An analysis of regional climate model performance over the tropical Americas. Part II: simulating subseasonal variability of precipitation associated with ENSO forcing. Tellus A, 61(3), 343-356. doi: 10.1111/j.1600-0870.2008.00387.x

Tourigny, E., 2008: Analyse de performance d'un modèle régional du climat à simuler la variabilité de la précipitation associée au forçage ENSO dans les tropiques américaines. Master's thesis in Atmospheric Science, Université du Québec à Montréal, Montréal, Canada.

Tourigny, E. and C. Jones, 2007: Seasonal Prediction at the Regional Scale: An Analysis of Regional Climate Model Performance Over the Tropical Americas. *CAS/JSC WGNE Research Activities in Atmospheric and Oceanic Modelling*, 2007, pp. 5.39-5.40.

Conferences

Tourigny, E., C. Nobre and M. Cardoso, 2013: Fire modeling in the Brazilian arc of deforestation using the INLAND/IBIS dynamic vegetation model coupled to a simple fire spread model. V Simpósio Internacional de Climatologia da SBMET, Florianópolis - SC, Brazil, September 15-19, 2013 (poster).

Tourigny, E., C. A. Nobre, and M. F. Cardoso, 2012: Fire modeling in the Brazilian arc of deforestation through nested coupling of atmosphere, dynamic vegetation, LUCC and fire spread models. AGU 2012 Fall Meeting, San Francisco, California, USA, December 3-7, 2012 (contributed).

Tourigny, E., 2011: Multi-scale fire modelling in the tropics: coupling atmospheric and land surface models to high resolution fire spread models, considering land cover heterogeneity. ESCER Annual Science Meeting, UQAM, Montreal, Canada, May 24-25, 2011 (invited talk).

Tourigny, E., H. França and C. A. Nobre, 2010: Comparação de dados de área queimada obtidos por sensores remotos TM e MODIS no Parque Nacional Serra da Canastra, MG. 5º Simpósio Controle de Incêndios Florestais, Campinas – SP, Brazil, April 11-12, 2011 (poster).

Tourigny, E. and C. A. Nobre, 2010: Fire spread modeling in the tropics: coupling fire spread, atmospheric, dynamic vegetation and land-use change models. 3rd Fire Behavior and Fuels Conference, International Association of Wildland Fire, Spokane – WA, United States of America, October 25-29, 2010 (poster).

Tourigny, E. and C. A. Nobre, 2010: Estimation of CO2 emissions from deforestation and land use change in the Amazon: nested coupling of atmosphere, dynamic vegetation, LUCC and fire spread models. AGU Meeting of the Americas 2010, Foz do Iguaçu - PR, Brazil, August 8-12, 2010 (poster).

Tourigny, E. and C. Jones, 2009: An analysis of Regional Climate Model performance over the tropical Americas : simulating seasonal and sub-seasonal variability of precipitation associated with ENSO forcing. IX EPGMET – Encontro dos Alunos da Pós-Graduação em Meteorologia do INPE (Meeting of the INPE graduate students in Meteorology), Cachoeira Paulista - SP, Brazil, October 28-30, 2009 (poster).

Tourigny, E. and C. Jones, 2009: An analysis of Regional Climate Model performance over the tropical Americas : simulating seasonal and sub-seasonal variability of precipitation associated with ENSO forcing. III Simpósio Internacional de Climatologia da SBMET, Canela - RS, Brazil, October 18-21, 2009 (poster-outstanding award).

Tourigny, E. and C. Jones, 2007: Seasonal Prediction at the Regional Scale: An analysis of Regional Climate Model performance over the tropical Americas. Session on High Resolution Climate Modelling at the annual Canadian Meteorological and Oceanographic Society (CMOS) conference. St John's, Newfoundland, Canada, May 28 - June 1 2007 (contributed).

Tourigny, E., C. Jones and R. McTaggart-Cowan, 2006: Prévision saisonnière à l'échelle régionale: une analyse de performance d'un modèle régional du climat sur l'Amérique Centrale. Symposium Ouranos 2006. Montréal, Québec, Canada, November 2-3 2006 (poster).

Tourigny, E., C. Jones and R. McTaggart-Cowan, 2006: Seasonal Prediction at the Regional Scale: An Analysis of Regional Climate Model Performance Over Central America. Session on Regional Climate Modelling at the spring American Geophysical Union (AGU) Joint Assembly. Baltimore, Maryland, USA, May 23-26 2006 (poster).

Tourigny, E. C. Jones, and R. McTaggart-Cowan., 2006: Analysing the performance of regional Climate Models over Central and South America. European Geosciences Union (EGU) Third General Assembly 2006. Vienna, Austria, April 02-07 2006 (poster).

Training and Experience

- Field experiment on biomass burning near Rio Branco, AC, Brazil, September 2012.
- Field experiment on biomass burning near Cruzeiro do Sul, AC, Brazil, September 2010.
- THE 2010 SOUTHWESTERN HEMISPHERE WORKSHOP SERIES ON CLIMATE CHANGE: CO2, THE BIOSPHERE AND CLIMATE, University of Buenos Aires,Argentina, March 15-26 2010.
- Internship, IMN (Instituto Meteorológico Nacional), San José, Costa Rica, May 2005
- Private pilot's licence - airplane, Aéroclub de Montréal
- Paragliding pilot training, experience and rating (HPAC Advanced, IPPI)

Computer Skills

- Operating systems: Unix, Linux, Windows, Mac OSX, Dos and OS/2
- Programming : C, C++, Fortran, python, Java, bash, sh, csh
- Scientific tools : GRADS, netCDF, nco, cdo, R project, Matlab, latex
- Web tools: HTML, Javascript, PHP, Perl
- Databases: MySQL, PostgreSQL, DB2, REXX
- Git, cvs, svn, ssh, STL, Qt, OpenGL, GNU applications,
- MS Office and Open Office/Libre Office, Lotus Notes
- experience with GIS environments (QGis, ArcGIS)
- collaborator and maintainer of various Open Source projects (e.g. GDAL, QGis)
- Local Area Networks and Internet, system administration
- Data structures, software engineering, operational research, hardware

5. Capacity of the Participating Organisations

Beneficiary: Barcelona Supercomputing Center	
General Description	The ***Barcelona Supercomputing Center – Centro Nacional de Supercomputación (BSC-CNS)*** combines unique high performance computing facilities and in-house research departments on computer, life, and Earth sciences, and computational applications, counting more than 350 researchers and students from more than 40 different countries. BSC-CNS has been accredited as one of the first eight Severo Ochoa Centers of Excellence. This award is given by the Spanish Government as recognition for leading research centers in Spain that are internationally well known institutions in their respective areas. Established in 2006, the Earth Sciences Department (ESD) of the BSC, worked on atmospheric composition modelling. The designation of Professor Francisco J. Doblas-Reyes as Director of the ESD in 2014 initiated the merging of the Climate Forecast Unit of the Institut Català de Ciències del Clima (IC3-CFU), which he was leading and that in a short time became a main European actor in the development of climate predictions and climate services into the ESD. The newly merged department is structured around four groups, with more than 50 employees, including technical and support staff. It is a highly productive scientific entity that has published more than 300 research articles in peer-reviewed journals over the last 5 years, including 5 in prestigious high-impact journals. (For a complete list of the publications of the department: https://earth.bsc.es/wiki/doku.php?id=publications:publications). The candidate will be carrying out his proposal within the **climate prediction group**, led by **Virginie Guemas**. The climate prediction group amis at developing a climate forecast system based on the EC-Earth model and performs regular assessments of the characteristics of this forecast system compared to all other operational and quasi-operational systems available in the world. This group participates currently in eight European projects, three national projects and three Copernicus projects. Of special interest for this Marie Curie fellowship, are the European H2020 IMPREX (2015-2019) project, which focuses on seasonal prediction of heavy precipitation events and droughts with tight relations with end users at the local scale in Europe, and the Copernicus QA4Seas (2016-2018) project which focuses on developing computationally efficient tools for automatic and objective forecast verification and visualization. BSC is one of the world leaders in the development of climate prediction applicabilité and climate services. These objectives rely on expanding the understanding of the climate predictability mechanisms through tailored and comprehensive forecast quality assessment, on the development of the EC-Earth climate forecast system through the testing of new model parameterisations/components as well as the development of innovative initialization strategies.
Role and Commitment of key persons (supervisor)	Dr Virginie Guemas is an expert on seasonal to decadal climate prediction, head of the climate prediction group and a Ramon y Cajal fellow (national grant with 2% success). She was awarded the 2010 Adrien Gaussail PhD prize, granted every two years to a scientific PhD. She is member of the WCRP (World Climate Research Program) CLIVAR (Climate and Ocean Variability, Predictability, and Change) SSG (Scientific Steering Group). She has participated in 13 national and international research projects. Currently, she is Principal Investigator (PI) of six European projects, one national project and one Copernicus project. She contributed to the IPCC (Fifth Assessment Report). She is author of 39 articles on climate modelling and predictions in international peer-reviewed journals, among which six in high-impact journals. She has supervised three PhD students and several post-doctoral scientists.
Key Research Facilities, Infrastructure and Equipment	BSC-CNS 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. Additionally, BSC manages Minotauro, a Sandy Bridge's cluster with NVIDIA GPUs, providing more than 100 TFlops.
Independent research premises?	Yes. All key research facilities, infrastructure and equipment will be available for the fellow.
Previous Involvement in Research and Training Programmes	BSC has coordinated and participated in more than 150 projects including 43 individual grants and fellowships; 9 EU-FP6 projects 38 EU-FP7 and 73 national projects (e.g. IS-ENES, APPRAISAL, FIELD_AC, PRACE 1lP, PRACE 2iP, Mont-Blanc, ScalaLife, OPTIMIS, PELE, RISC) and many private contracts. BSC also participated in the MC ITN project (SCALUS: FP7-PEOPLE-ITN-2008-238808) and three Marie Curie IEFs (EEPPIBM: FP7-PEOPLE-2012-IEF-327899, MatComPhys: FP7-PEOPLE-2011-IEF-302320 and MDRAF: FP7-PEOPLE-2013-IEF-622662).
Current involvement in Research and Training Programmes	**Collaboration with universities:** within BSC, there is a large record of collaboration with Universidad Politècnica de Catalunya (UPC) including the Master degree in Environmental Engineering (UPC), associated with BSC Earth Science department. **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) and H2020-EINFRA-Centers of Excellence for computing applications (PoP: EINFRA-5-2015-676553, ESiWACE: EINFRA-5-2015-675191, BioExcel: EINFRA-5-2015-675728, NoMaD: H2020-EINFRA-2015-676580, MaX: H2020-EINFRA-2015-676598, EoCoE: H2020-EINFRA-2015-676629-). **Research Fellowships:** BSC is currently awarded with 4 early-stage postdoc (2 Juan de la Cierva and 2 Beatriu de Pinós), 11 senior (4 Ramón y Cajal, 3 I3 and 6 ICREA) and is supporting 4 ITN and 4 Marie-Curie Individual Fellowships. Noteworthy in BSC's Earth Sciences Department, which will host the present Marie-Curie proposal, one Marie Curie Fellowship has started in 2014: Marie-Curie IEF MDRAF (FP7-PEOPLE-2013-IEF-622662); and one in 2015: DPETNA (H2020-MSCA-IF-2014-655339). All the education and training activities are available to this link: https://www.bsc.es/marenostrum-support-services/hpc-trainings
Relevant Publications and/or research/innovation products	**(1)** *Doblas-Reyes F.J., et al., 2013. Nature Communications, 4, 1715.* **(2)** *Guemas V., et al., 2013. Nature Climate Change, 3, 649-653.***(3)** *Guemas V., et al., 2014. Bull. Amer. Meteor. Soc., 95 (11), 1666-1667.* **(4)** *Guemas V. et al., 2013. Bull. Amer. Meteor. Soc., 94 (9), S20-S22.* **(5)***Fučkar N., et al., 2014. Geophys. Res. Lett., 41 (14), 5200–5207.*

Partner Organisation : CNRM (Météo-France, CNRS), UMR 3589	
General description	The Centre National de Recherches Météorologiques (CNRM) is the research department of Météo-France. It is responsible for conducting the largest part of the research activities in weather forecasting, climate modelling and predictability, atmospheric chemistry, land-surface processes including snow related processes, oceanography, and for coordinating research/development within other departments of Météo-France, from the historical data rescue to numerical weather forecast, avalanche prediction, or wave and storm surge forecasting. Within CNRM, the climate research group «GMGEC» is in charge of the development of global state-of-the-art CNRM Earth system model (CNRM-ESM), which includes components dealing with the atmosphere dynamics and chemistry (ARPEGE), ocean and sea ice (NEMO), land surface & biosphere (SURFEX), and oceanic biogeochemistry processes (PISCES), as well as the CNRM coupled land-atmosphere-ocean model CNRM-CM. The Météo-France seasonal forecasting system, based on CNRM-CM, is developed and run operationally by the GMGEC group as part of international efforts EUROSIP and Copernicus Climate Change Services. Alongside the development of CNRM-ESM and CNRM-CM, CNRM contributes to the study of climate variability and predictability, of the projection of climate at global and regional scales, of atmospheric chemistry, ocean-air interactions and global carbon cycle. CNRM has a long history within the climate research community and contributes to the successive IPCC reports.
Key Persons and Expertise (supervisor)	Dr. Roland Séférian is early carrier scientist involved in the development of the carbon cycle components of CNRM-ESM. His main expertise is on the global carbon cycle and its relation to climate focussing on understanding of both land and ocean carbon flux variability and their evolution in response to climate change. He is the author or co-author of about 40 peer-reviewed articles and is involved in several international initiatives such as Global Carbon Project (GCP) or MARine Ecosystem Model Intercomparison Project (MAREMIP). In addition, He has presented his work as at numerous international conferences, European project's workshop and invited seminars.
Key Research facilities, infrastructure and equipment	CNRM (located in Toulouse and Grenoble) is a research center affiliated to CNRS and Météo-France (the French national weather service). Météo-France and CNRS provide CNRM most of its support, especially through permanent staff wages and super-computing facilities. The second phase of upgrade in term of supercomputing will rely on a Bullx B700 DLC (5Pflops) in 2016. Webpage:http://www.cnrm.meteo.fr/spip.php?rubrique1&lang=en
Previous and Current Involvement in Research and Training Programmes	CNRM has been involved in a number of relevant FP7 projects including: **COMBINE**, which aimed at improving Earth system models and their ability to predict climate by including new components such as atmospheric chemistry, carbon cycle and land ice. **PREFACE**, which aims at reducing systematic climate model biases in the Tropical Atlantic in order to improve seasonal-to-decadal forecasts. **SPECS**, which focuses on climate prediction at seasonal to decadal timescales **H2020-CRESCENDO** (Coordinated Research in Earth Systems and Climate: Experiments, kNowledge, Dissemination and Outreach) [2015-2020], which focuses on the development of improved Earth system models.
Relevant Publications and/or research/innovation product	Séférian, R. et al., 2016. Geosci. Model Dev., 9, 1423-1453. Le Quéré, C., Séférian, R. et al., 2015. Earth Syst. Sci. Data, 7(2), 349–396. Séférian, R., et al.:, P. Natl. Acad. Sci., 111(32), 11646–11651. Boucher, O., Séférian, R., et al., 2016. P. Natl. Acad. Sci., 113(27), 7287–7290. Mao, J., Séférian, R., et al., 2016. Nature Climate Change (in press), http://doi.org/10.1038/nclimate3056.

6. Ethical Issues

This project concerns research in applied mathematics and computer science. The application to flow problems of industrial interest by simulation with high-order unstructured solvers on curved meshes does not involve any ethical issues of any sort, nor it is expected to have any undesired social implications. Therefore, in this proposal there is not any issue entered in the Ethical Issues Table in Part A, and any text for the Ethics Self-Assessment in Part B.

7. Letter of Commitment

The following letter of commitment for this proposal has been signed by Dr. Roland Séférian from the Centre National de Recherches Météorologiques/Groupe de Météorologie de Grande Echelle et Climat (CNRM/GMGEC), Toulouse, France; http://www.cnrm-game-meteo.fr/spip.php?article989&lang=en .

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rseferian.cnrm@gmail.com

6th September 2016

Subject : Letter of commitment for Dr. Etienne Tourigny's MSCA application

Dear Sir or Madam:

This letter is to support the scientific objectives and the work organisation of the Marie Skłodowska-Curie Action IF-EF entitled "Seasonal Prediction of Fire danger using Statistical and Dynamical models (SPFireSD)" submitted by BSC/Dr. Etienne Tourigny. It is also to express my personal commitment to advise Dr. Etienne Tourigny in his work and to host him at CNRM (the research center of Météo-France, the French national weather service) as part of his research project. Dr. Etienne Tourigny's research project is in line with our own objectives and I am confident in his ability to achieve the goals of this project.

Yours sincerely,

Roland Séférian

ENDPAGE

MARIE SKŁODOWSKA-CURIE ACTIONS

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

PART B

"SPFireSD"

Seasonal Prediction of Fire danger using
Statistical and Dynamical models

This proposal is to be evaluated as:

Standard EF

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