MINISTERIO
DE ECONOMÍA, INDUSTRIA
Y COMPETITIVIDAD

AGENCIA
ESTATAL DE
INVESTIGACIÓN

AYUDAS JUAN DE LA CIERVA-FORMACIÓN
HISTORIAL CIENTÍFICO-TÉCNICO DE LOS ÚLTIMOS CINCO AÑOS DEL EQUIPO DE INVESTIGACIÓN

(SCIENTIFIC/TECHNICAL RECORD DURING THE LAST FIVE YEARS OF THE RESEARCH TEAM*)*

Según el artículo 45 de la Resolución de convocatoria el equipo de investigación es el compuesto por el personal investigador que desarrolla la línea de investigación en la que se integrará el investigador candidato.
(According to what is established in article 45 of Call Resolution, the research team is defined as the one formed by the researchers developing the research line in which the candidate is to participate)

Especificar los trabajos de investigación desarrollados, publicaciones, proyectos, patentes, la capacidad formativa pre y posdoctoral y cualquier otro aspecto de interés.
(Please specify the research work that the team has developed, publications, funded projects, patents, capacity for providing guidance and training and any other aspect that may be of interest).

CUMPLIMENTAR PREFERIBLEMENTE EN INGLÉS – FILL IN BETTER IN ENGLISH

The candidate, Dr. Juan Camilo Acosta Navarro, plans to conduct research in prediction of Arctic sea ice and its effects on mid-latitude weather and climate at the Earth Sciences department of the Barcelona Supercomputing Center - Centro Nacional de Supercomputación, and his tutor investigator is the head of the Earth Sciences department, Dr. Francisco Doblas-Reyes.

Note: *A glossary of acronyms is given at the end of this document.*

Research Center: Barcelona Supercomputing Center-Centro Nacional de Supercomputación

The Barcelona Supercomputing Center - Centro Nacional de Supercomputación (BSC-CNS) is the national supercomputing facility of Spain. BSC-CNS's mission is to research, develop and manage information technology in order to facilitate scientific and technological progress. BSC-CNS hosts a range of high-performance computing (HPC) systems, including MareNostrum IV, with 165,888 cores and 11.15 Pflops capacity. More than 350 researchers and students, from more than 40 different countries, perform research in Computer Sciences, Life Sciences, Earth Sciences and Computational Applications in Science and Engineering at BSC-CNS. This multi-disciplinary approach and the combination of world-leading researchers and HPC experts with state-of-the-art HPC resources make BSC-CNS a unique research institution.

BSC-CNS is located on a campus of the Technical University of Catalonia (Universitat Politècnica de Catalunya - UPC) and has an agreement with the UPC to use university facilities and services. Furthermore, many of the group leaders at BSC-CNS are also university professors with broad knowledge and experience in advance research and teaching, i.e., the BSC-CNS substantially contributes to and benefits from UPC's higher educational environment. The BSC-CNS is a key element of and coordinates the Spanish Supercomputing Network (RES), 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. BSC-CNS has been accredited as one of the first eight Severo Ochoa Centres of Excellence. This award is given by the Spanish Government as recognition for leading research centres in Spain that are internationally well known institutions in their respective areas. The candidate will carry out his project within the Earth Sciences department of the BSC-CNS.

Earth Sciences Department

The Earth Sciences department of the BSC-CNS (BSC-ES) conducts multi-faceted research in Earth system modelling. Established in 2006, the initial core activity was focused on atmospheric composition modelling. The designation of Prof Francisco J. Doblas-Reyes as Director of the BSC-ES in 2014 initiated the merging of the BSC-ES with the Climate Forecasting Unit of the Institut Català de Ciències del Clima (IC3-CFU), which he was leading at the time and that had become in a short time a main European actor in the development of climate predictions and climate services. The newly merged department is structured around four groups with more than 65 employees, including technical and support staff. It is a highly productive scientific entity that has published more than 150 research articles in peer-reviewed journals over the last 5 years, including 5 in prestigious high-impact journals. (For a complete list of the publications of the department see https://earth.bsc.es/wiki/doku.php?id=publications:publications) and with a very dense international collaborative network counting at least 50 institutes worldwide. BSC-ES focuses research on atmospheric emissions, air quality, mineral dust transport, computational efficiency of air quality and climate codes, data storage, analysis and dissemination, and global and regional climate modelling and prediction. The BSC-ES works on the development of and conducts research with a multi-scale set of comprehensive single-component and coupled regional and global models.

The BSC-ES is composed of four distinct but highly integrated groups: 1) Earth System Services group, 2) Climate Prediction group, 3) Atmospheric Composition group, and 4) Computational Earth Sciences group. The candidate will carry out his project in close collaboration with two of the four groups of the BSC-ES: the computational earth science group and the climate prediction group. Dr. Acosta Navarro is currently part of the latter group.

The **Computational Earth Sciences** group is a multidisciplinary team with different profiles that interacts closely with all the other groups of the Department. The group provides expertise and guidance to the other scientists in the technical issues and develops a framework for the most efficient use of HPC applied to ESMs. In order to improve the use of the variety of computing resources available at the BSC and in other HPC institutions, a solid software development, profiling and optimisation team has been created for ESM codes towards exascale computing. This team aims to provide feedback on model efficiency to modellers around Europe. Last but not least, the development of a framework to disseminate the outputs generated by the BSC-ES among the research and service community is pursued. This team takes advantage of the unique environment the BSC offers, where research in HPC applied to interdisciplinary areas such as Earth Science is already a priority that will be extended in the next years.

One of the Computational Earth Sciences research lines is dedicated exclusively to HPC applied to ESMs. The group also provides HPC expertise such as performance analysis to identify bottlenecks and apply optimizations. For this process, state-of-the-art programming models and profiling tools are used to prepare ESMs to run on next generation exascale HPC systems. Also improving the efficiency of existing computational models and post processing tools interacting with developers and earth system scientists. The activities also include the theoretical and mathematical study of the computational fluid dynamic (CFD) models used by the department scientists and others European partners, in order to improve the performance of the models taking into account both the computational (architecture of the machine, paradigm of parallelism, type of interconnection, etc.) and the scientific (type of equations, discretization method, type of numerical solver, etc.) point of view. These interdisciplinary studies are increasingly in demand in order to improve the development of models created by scientists and understand the mathematical needs of the operations done with these codes.

The **Climate Prediction group** undertakes advanced research to forecast climate variations from one month to several years into the future (also known as seasonal-to-decadal predictions) and from regional to global scales. This relies on expanding our understanding of the climate processes through a deep analysis of the strengths and weaknesses of state-of-the-art climate forecast systems in comparison with the most up-to-date observational datasets, and on exploiting these detailed analyses to refine the representation of climate processes in our climate forecast systems and their initialization. Emphasis is made on forecasting changes in high-impact climate events such as the persistent winds, floods, droughts and temperature extremes.

Many of the activities in modelling and prediction are based on research, development and predictions with the EC-Earth climate forecast system. EC-Earth is a state-of-the art coupled climate model that is being developed and used for climate predictions and projections by a European consortium of more than 20 operational and research institutions, including the BSC-ES. The main components of EC-Earth are two computational models, IFS as atmospheric model and NEMO as ocean model. Besides contributing to the fifth phase of the Coupled Model Intercomparison Project (CMIP5), which is one of the key datasets used to produce the UN Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5), global climate research activities of this group enabled production of historical global climate reconstructions and initial conditions for the EC-Earth community. Such data is critical for analysis of climate dynamics and initialization of seasonal-to-decadal climate predictions. This group is already active in the planning of the

next phase of Coupled Climate Model Intercomparison project, CMIP6, and is preparing to make core contributions including the ground-breaking high-resolution global climate simulations with EC-Earth (with horizontal spacing of 0.25° in the ocean and 25 km in the atmosphere).

During last 5 years (2013-2017), BSC-ES was granted 9 EU H2020 projects, 5 EU FP7 projects, 5 EU Copernicus projects, 10 projects funded by the Ministerio de Economía y Competitividad (MINECO), 2 projects funded by the European Space Agency, 1 project funded by the French Ministry of Sciences and 1 project from ERA-NET. During that same period, BSC-ES also participated in 21 RES and 4 PRACE projects. BSC-CNS has been awarded with the *Severo Ochoa*'s Centre of Excellence project of the Spanish government since its first call (2011). Short descriptions of the most recent and most relevant projects are given towards the end of this document. The BSC-ES international activity includes the coordination of the two World Meteorological Organisation (WMO) regional centres specialised in sand and dust warning and forecasting, as well as the participation in climate services initiatives like the Climate Services Partnership (CSP). Members of the BSC-ES participate in committees of the World Climate Research Programme (WCRP), such as the CLIVAR Scientific Steering Group or the Working Group on Seasonal to Interannual Prediction (WGSIP).

The other two groups that the applicant will interact with, but not directly work with, are the earth system services group and the atmospheric composition group. The former aims to bridge the gap between climate information and end users via tailored services to stakeholders in key sectors of society: wind energy, solar energy, urban development, insurance and infrastructure, transport, health, agriculture and water management, big data and HPC. The atmospheric composition group aims at further our understanding of the chemical composition of the atmosphere and its effects upon air quality, weather and climate, while improving predictions from local to global scales. This is addressed through the development and use of the NMMB/BSC Chemical Transport Model (NMMB/BSC-CTM), an online multi-scale non-hydrostatic chemical weather prediction system that can be run either globally or regionally. This group also develops and operates the CALIOPE system ("CALIdad del aire Operacional Para España"), which provides high-resolution short-term air quality forecasts for Europe, with a special focus over Spain and its main urban areas, using the in-house HERMES emission model.

Finally, the BSC-ES hosts a new AXA Chair on Sand and Dust Storms. This chair is an ambitious, comprehensive and long-term programme that combines fundamental research, operational forecasting and impact research, with the much-needed development of user-oriented products, services and capabilities, all under one roof. This unprecedented programme will improve our understanding of sand storms and their variability; quantify dust effects upon weather, climate, atmospheric chemistry and ocean biogeochemistry; develop and distribute skilful sand storm short and medium-range forecasts and long-range dust predictions and projections; assess sand storm impacts upon key sectors of society and economy; and promote capacity building, technology transfer, dissemination and public engagement.

Scientific expertise and capacity for training of the supervisor – Dr Francisco Doblas-Reyes

The tutor investigator of the candidate is the ICREA Research Prof Francisco J. Doblas-Reyes who is also the director of the BSC-ES. Prof Doblas-Reyes is an 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 in the development of climate services. Over those years, he has worked at the Instituto Nacional de Técnicas Aerospacioles (INTA, Madrid), Centre National de Recherches Météorologiques (CNRM, France), the European Centre for Medium-Range Weather Forecasts (ECMWF, UK) and the Institut Català de Ciències del Clima, (IC3, Barcelona). At ECMWF, he worked on seasonal climate forecasting in two ground-breaking European projects, the Development of a European Multimodel Ensemble system for seasonal to inTERannual prediction (DEMETER) and the Ensembles-Based Predictions of Climate Changes and Their Impacts (ENSEMBLES). Both led to the development of operational systems in climate prediction. For his work in seasonal forecasting at ECMWF, Prof Doblas-Reyes was awarded the Norbert Gerbier-MUMM International Award from the UN World Meteorological Organization (WMO) in 2006.

Prof Doblas-Reyes has led the Climate Forecasting Unit at the Institut Català de Ciencies del Clima (IC3) from 2010 to 2015. This research group of around 20 members became, in a short time, a main European actor in the development of climate predictions and climate services and had an outstanding track record in terms of publications and competitive funding and computing time. Prof Doblas-Reyes became the head of BSC-ES in 2015 and is currently working to implement the department plan for the development of weather, air quality and climate modelling and data analysis capabilities, using the latest developments of HPC and Big Data research to make them available to both the Earth sciences research community and a range of public and private stakeholders. Prof Doblas-Reyes serves on scientific panels of the World Climate Research Programme (WCRP) and the World Weather Research Programme (WWRP) under the UN World Meteorological Organization (WMO), is a member of the European Network for Earth System modelling HPC Task Force and has either led or participated in a number of national and European FP4, FP5, FP6, FP7 and H2020 projects. Currently,

Prof Doblas-Reyes is the coordinator of a key FP7 European project (SPECS) and of a service contract with the Copernicus Climate Change Service (C3S, QA4Seas), as well as the principal investigator of a H2020 project (PRIMAVERA) and co-investigator in several others (C3S, FP7 and H2020 combined). He has also earned an outstanding amount of computing time for through PRACE, RES and ECMWF competitive calls.

Prof Doblas-Reyes was a lead author of the chapter 11. "Near-term Climate Change: Projections and Predictability", in the UN IPCC AR5 Working Group I – The Physical Sciences Basis report. The IPCC is a United Nations scientific intergovernmental body that was established in 1988 by the World Meteorological Organization and the United Nations Environment Programme. The IPCC is composed of the most prominent world experts in climate studies; its reports are authoritative and provide policy guidelines for governments to address climate change. He is also involved in the design of the sixth phase of the Coupled Model Intercomparison Project (CMIP6), which will lay the modelling ground for the next IPCC assessment report.

Overall, Prof Doblas-Reyes has authored and co-authored more than 130 peer-reviewed papers on climate modelling, prediction and services, and currently has a total of 9065 citations, with an h-index of 46 and an i10-index of 94 (accordingly to Google Scholar). Combined, Prof Doblas-Reyes and the other members of BSC-ES have published more than 150 peer-reviewed articles over the last 5 years, many of which in high-impact journals such as Science, Nature Climate Change, Nature Communications and the Bulletin of the American Meteorological Society. A non-exhaustive selection of the recent publications by Prof Doblas-Reyes is offered towards the end of this document.

Prof Doblas-Reyes in particular, and BSC-ES in general, have been able to provide researchers with exceptional training support and conditions for their scientific growth, steering improvements in their scientific and management skills alike. The training capability of researchers is very extensive, and has been demonstrated through the successful experience in training numerous pre- and postdoctoral scientists. The BSC-ES has participated in 4 Initial Training Networks (ITN) from FP7 program and one from Horizon2020 program, and is continuously involved in the organization of numerous summer schools (e.g. European Network for Earth System modelling schools), workshops and other training events (e.g. PRACE Advanced Training Centre, PATC, courses) related to the use of HPC resources in air quality and climate modelling. Former postdocs and Ph.D. students hosted at the BSC-ES hold positions in several well-known scientific institutions and energy companies around the globe, such as the School of Geography and Environment at the University of Oxford in UK (Dr Karsten Haustein) and EnBW Energie Baden-Württemberg AG in Germany (Dr Matthias Piot). A complete list of Ph.D. thesis with research conducted at BSC-ES and under Prof Doblas-Reyes supervision is given at the end of this document.

Specific objectives of the candidate – Dr. Juan Camilo Acosta Navarro

Dr. Acosta Navarro's expertise is on atmospheric dynamics, cloud and aerosol microphysics and remote climatic changes induced by regional radiative forcing with a particular emphasis on Arctic climate and its atmospheric and oceanic linkages with mid-latitude climate. Dr Acosta Navarro's research is well embodied in the ES-BSC as can be seen by comparing his expertise and the main activities carried out at ES-BSC. His main goal is to help improve the understanding of the physical mechanisms connecting the Arctic region and mid-latitudes, which could have a positive socio-economic impact on billions of people. A research area of high priority according to the WMO.

Despite his short career as a scientist (he received his PhD in 2017), Dr. Acosta Navarro has published nine scientific peer reviewed articles in first quartile journals, being first author in three of them. His h-index is 5, and has been cited 124 times (according to google scholar). He has also been involved in large projects as scientific collaborator: CRAICC (Norden, NordForsk), PEGASOS (EU FP7 Large Scale Integrating Project) and APPLICATE (H2020). Additionally, he has been co-supervisor of two MSc theses at department of meteorology in Stockholm University.

Selection of the 10 most relevant projects from the climate prediction group

Here, we highlight the projects where the climate prediction group plays a key role and whose outcome will benefit the applicant:

1. **APPLICATE** (Advanced Prediction in Polar regions and beyond: Modelling, observing system design and LInkages associated with a Changing Arctic climaTE) is an EU H2020 project (start date: 11/2016; lasting 34 months; funding: 8.715.066€). Its main objective is to improve the understanding of processes involved in polar climate variability and teleconnections with the mid-latitudes. This goal will be achieved through novel model developments, a

wide variety of ambitious sensitivity experiments, the exploitation of new polar observations and improved understanding of polar climate and linkages predictability. This project gathers experts from 16 research centers across Europe.

2. **SPECS** (Seasonal-to-decadal climate Prediction for the improvement of European Climate Services) is an EU FP7 project (start date: 11/2012; lasting 39 months; funding: 11.766.236€) supported by 19 European institutions and a Brazilian institution and is coordinated by BSC-ES. The main scientific objective of SPECS is to deliver a new generation of European climate forecast systems and efficient regionalisation tools. These will produce local climate information over land at seasonal-to-decadal time scales with improved forecast quality including a critical prediction of extreme climate events. It aims, among other things, to coalesce many different research efforts with climate services (both public and private).

3. **PRIMAVERA** (Process-based climate siMulation: AdVances in high resolution modelling and European climate Risk Assessment) is an EU H2020 project (start date: 11/2015; lasting 36 months; funding: 14.967.969€). The goal of PRIMAVERA is to deliver novel, advanced and well-evaluated high-resolution global climate models capable of simulating and predicting regional climate with unprecedented fidelity, out to 2050. Sector-specific end-users in policy and business are engaged individually, with iterative feedback, to ensure that new climate information is tailored, actionable and strengthen societal risk management decisions. This project gathers experts from 19 research centers across Europe.

4. **PREFACE** (enhancing PREdiction oF tropical Atlantic ClimatE and its impacts) is an EU FP7 project (start date: 11/2013; lasting 11 months; funding: 12.170.344€). It involves 28 institutional partners across 18 countries in Europe and Africa. This project aims to reduce uncertainties in our knowledge of the dynamics of Tropical Atlantic climate, particularly of climate-related ocean processes and circulation, coupled ocean-atmosphere-land interactions, and internal and externally forced climate variability. Also, it plans to improve the simulation and prediction of Tropical Atlantic climate on seasonal and longer time scales, and contribute to better quantification of climate change impacts in the region.

5. **EUCLEIA** (EUropean CLimate and weather Events: Interpretation and Attribution) is an EU FP7 project (start date: 09/2015; lasting 4 months; funding: 2.990.915€). It aims to provide well verified assessments of the extent to which weather- related risks have changed due to human influences on climate, as well as to identify those types of weather events where the science is still too uncertain to make a robust assessment of attributable risk. It gathers experts from 11 academic, research and operational institutions across Europe to develop a system that will deliver reliable and user-relevant attribution assessment on a range of time scales from immediate aftermath of extreme events to seasonal and annual basis.

6. **EUCP** (European Climate Prediction system) is an EU H2020 project (start date: 12/2017; lasting 48 months; funding 12.999.515€) whose main goal is to develop an innovative European regional ensemble climate prediction system based on a new generation of improved and typically higher-resolution climate models, covering timescales from seasons to decades initialised with observations, and designed to support practical and strategic climate adaptation and mitigation decision-taking on local, national and global scales. This project gathers experts from 16 research centers across Europe.

7. **INTAROS** (Integrated Arctic observation system) is an EU H2020 project (start date: 11/2016, lasting 48 months, funding 15.490.141€). Its main objective is to gather new observational data from the Arctic, gather them in widely distributed database with an efficient data portal and assess the added-value of these novel observations in a wide range of applications, including polar climate forecasting. This project gather experts from 48 research centers across Europe.

8. **HIATUS** (XXIst century surface temperature Hiatus: Investigation, Attribution, Thorough Understanding and Sensitivity experiments) is a project funded by the MINECO (start date: 01/2016, lasting 36 months, funded 101.640€). Its objective is to exploit successful climate predictions of the global warming slowdown which occurred in the last decade to investigate the reasons for this global warming slowdown, based on innovative sensitivity experiments and exploiting advanced observations. The main application will be to forecast whether the climate is expected to experience a rebound effect and when.

9. **VOLCADEC** (Volcanic activity in seasonal to decadal climate forecasts) is a project funded by the MINECO (start date: 01/2016, lasting 36 months, funding 168.190€). Its main objective is to assess the impact of volcanic eruptions on the global climate, especially on the large-scale ocean circulation, the occurrence of El Nino events, the phase of the North Atlantic Oscillation and the Arctic sea ice cover and its dependence on the background climate state. The main application of these analyses is to improve the representation of the climate response to volcanoes in climate predictions, but also to improve the representation of the scenario of emissions of volcanic aerosols in a climate forecasting framework.

10. **DANAE** is a project funded by the MINECO (start date: 01/2016, lasting 36 months, funded 146.410€). The goal of DANAE is twofold: on the one hand, to gain understanding in the mechanisms responsible for the predictability; and, on the other hand, to gain insight into the sources of prediction skill and point at the key elements/processes that need to be better represented in seasonal forecast systems. The systematic assessment of the atmospheric pathways proposed here may address the elusive unifying view of the canonical ENSO-NAE relationship in mid/late-winter.

Selection of the 10 most relevant publications from Dr Francisco Doblas-Reyes since 2013

Listed below are some of the main papers published since 2013 by the suggested mentor of the applicant. The list of publications for the Earth Sciences department as a whole can be found here: https://www.bsc.es/research-and-development/publications

Hewitt C., Buontempo C., Newton P., **Doblas-Reyes F.**, Jochumsen K., Quadfasel D. (2017) Climate observations, climate modelling, and climate services. Bulletin of American Meteorological Society, 10.1175/BAMS-D-17-0012.1 (Impact Factor: 7.929). This paper summarizes the main points of a large meeting of experts discussing the challenges and opportunities behind a changing climate.

F Massonnet, O Bellprat, V Guemas, **FJ Doblas-Reyes** (2016). Using climate models to estimate the quality of global observational data sets.- Science (Impact Factor: 37.025): This paper investigates whether climate models could be used to assess the quality of observational references.

Massonnet, F., V. Guemas, N. Fuckar and **F. J. Doblas-Reyes** (2015) The 2014 high record of Antarctic sea ice extent. In Explaining Extreme Events of 2014 from a Climate Perspective. Bulletin of American Meteorological Society, 96, S163-S167, doi:10.1175/BAMS-D-15-00093.1. (Impact Factor: 7.929). This paper investigates the causes of the record high 2014 Antarctic sea ice extent.

Jung, T., **F.J. Doblas-Reyes**, H. Goessling, V. Guemas, C. Bitz, C. Buontempo, R. Caballero, E. Jakobson, J. Jungclaus, M. Karcher, T. Koenigk, D. Matei, J. Overland, T. Spengler and S. Yang (2015). Polar-lower latitude linkages and their role in weather and climate prediction. Bulletin of the American Meteorological Society, 96, ES197-ES200, doi:10.1175/BAMS-D-15-00121.1. (Impact Factor: 7.929): This article investigates the role of the Arctic in mid-latitude weather and seasonal forecasts.

Guemas V., Blanchard-Wrigglesworth E., Chevallier M., Day J. J., Déqué M., **Doblas-Reyes F. J.**, Fučkar N., Germe A., Hawkins E., Keeley S., Koenigk T., Salas y Mélia D., Tietsche S., 2015, A review on Arctic sea ice predictability and prediction on seasonal-to-decadal timescales, Quarterly Journal of the Royal Meteorology Society (Impact Factor: 3.327), doi:10.1002/qj.2401.

Guemas V., L. Auger, **F. J. Doblas-Reyes**, H. Rust, A. Ribes (2014) Dependencies in Statistical Hypothesis Tests for Climate Time Series, 95 (11), 1666-1667. Bulletin of the American Meteorological Society (Impact Factor: 7.929): This article proposed a more advanced and more robust approach to account for the data dependency in the statistical test performed classically on the estimated prediction skill in climate and weather sciences.

Guemas V., Auger L, **Doblas-Reyes F**., 2014, Hypothesis testing for auto-correlated short climate time series. Journal of Applied Meteorology and Climatology (Impact Factor: 2.463), 53(3), 637-651, doi:10.1175/JAMC-D-13-064.1.

Guemas, V., **F. J. Doblas-Reyes**, A. Germe, M. Chevallier and D. Salas y M.lia (2013) September 2012 Arctic sea ice minimum: Discriminating between sea ice memory, the August 2012 extreme storm and prevailing warm conditions, Bulletin of the American Meteorological Society, 94, S20-S22, in "Explaining Extreme Events of 2012 from a Climate Perspective" (Impact Factor: 7.929): This article performed an attribution of the September 2012 record minimum in Arctic sea ice extent to climate change.

Guemas V., **F. J. Doblas-Reyes**, I. Andreu-Burillo, M. Asif (2013) Retrospective prediction of the global warming slowdown in the past decade. Nature Climate Change, 3, 649-653, doi : 10.1038/nclimate1863. (Impact factor: 15.295): This article highlighted the ocean heat uptake as the dominant cause for the recent global warming slowdown.

Doblas-Reyes F. J., Andreu-Burillo I., Chikamoto Y., García-Serrano J., Guemas V., Kimoto M., Mochizuki T., Rodrigues L. R. L. and van Oldenborgh G. J., 2013, Initialized near-term regional climate change prediction. Nature Communications (Impact Factor: 11.574), 4, 1715, doi:10.1038/ncomms2704.

Recent Ph.D. thesis at the UPC with research conducted at the ES-BCS (last 5 years):

1. Veronica Torralba
Title: Seasonal climate prediction for the wind energy sector: methods and tools for the development of a climate service.
Expected Reading date: 06/2018

2. LLuís Vendrell
Title: Modeling the dust life cycle and its associated meteorological processes from global to regional scales. Reading date 11/2017

3. Luis Rodrigues
Title: Calibration and combination of seasonal climate predictions in tropical and extratropical regions. Reading date: 01/2016

4. Michele Spada
Title: Development and evaluation of an atmospheric aerosol module implemented within the NMMB/BSC Chemical Transport Model (NMMB/BSC-CTM). Reading date: 11/2015

5. Danila Volpi
Title: Benefits and drawbacks of different initialization techniques in global dynamical climate predictions. Reading date: 03/2015

6. Albert Soret Miravet
Title: Air quality management: assessing the impacts of on-road transport strategies and industrial emissions in urban areas. Reading date: 12/2014

7. Marc Guevara Vilardell
Title: Development of a high-resolution emission model for air quality modelling in Spain. Reading date: 12/2014

8. Alba Badia i Moragas
Title: Implementation, development and evaluation of the gas-phase chemistry within the Global/Regional NMMB/BSC Chemical Transport Model (NMMB/BSC-CTM). Reading date: 12/2014

9. Ángel A. Rinc.n Rodr.guez
Title: Sistema de pronóstico de radiación solar a corto plazo a partir de un modelo meteorológico y técnicas de post-proceso para España. Reading date: 06/2013

Glossary

AR5 - Fifth Assessment Report

BSC-CNS - Barcelona Supercomputing Center – Centro Nacional de Supercomputación

CLIVAR – Climate and Ocean: Variability, Predictability and Change (one of four core projects of the WCRP

CMIP - Coupled Model Intercomparison Project

ES-BSC - Earth Sciences department of the Barcelona Supercomputing Center

HPC - High-Performance Computing

IC3 - Institut Catalá de Ciencies del Clima

ICREA - Catalan Institution for Research and Advanced Studies

IPCC - Intergovernmental Panel on Climate Change

PI - Principal Investigator

PRACE - Partnership for Advanced Computing in Europe

RES - Red Española de Supercomputación

UN - United Nation

UPC - Universitat Politecnica de Catalunya

WCRP – World Climate Research Programme

WMO - World Meteorological Organization