MINISTERIO
DE CIENCIA, INNOVACIÓN
Y UNIVERSIDADES

AGENCIA
ESTATAL DE
INVESTIGACIÓN

AYUDAS JUAN DE LA CIERVA-INCORPORACIÓN
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 75 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 75 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, Eduardo Moreno Chamarro, aims to conduct his research on variability and decadal forecast of Arctic ice in the Earth Sciences Department of the Barcelona Supercomputing Centre - Centro Nacional de Supercomputación (BSC-CNS) as part of the Climate Prediction Group. His tutor investigator is Pablo Ortega, currently co-leader of the group.

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

Overview of the Host Research Team

The Barcelona Supercomputing Centre - Centro Nacional de Supercomputación (**BSC-CNS**) is the national supercomputing facility of Spain. BSC-CNS's mission is to develop and manage information and technology to facilitate scientific and technological progress. BSC-CNS hosts a range of high-performance computing (HPC) systems, including the MareNostrum IV, the most powerful computer in Spain with 165,888 cores and 11.15 Pflops of peak performance. The BSC-CNS is also an important research centre, with more than 500 scientists and students who conduct research in the fields of Computer Sciences, Life Sciences, Earth Sciences, and Computational Applications in Science and Engineering. Such a multi-disciplinary approach and the combination of world-class researchers and HPC experts with state-of-the-art HPC resources make BSC-CNS a unique research institution. In fact, BSC-CNS has been accredited as one of the eight *Severo Ochoa* Centres of Excellence since its first call in 2011. The award, given by the Spanish Government, recognizes leading research centres in Spain which are internationally well known institutions in their respective areas.

Within the BSC-CNS, the Earth Sciences department (**ES-BSC**) conducts multifaceted research on Earth system modelling. Since the designation of Prof. Francisco J. Doblas-Reyes as ES-BSC's Director in 2014, the department has in a short time become a European leading actor in the development of climate prediction and climate services. ES-BSC is structured around four Groups with more than 80 employees, including technical and support staff, and 10 PhD students. The major areas of research covered in the ES-BSC range from air quality, atmospheric emission, and mineral dust transport to climate variability and prediction. Scientifically, the department is highly productive and has published more than 200 research articles in peer-reviewed journals over the last five years, including seven in prestigious high-impact journals (e.g., Nature and Science Publishing Groups; a complete list of the department's publications is at https://earth.bsc.es/wiki/doku.php?id=publications:publications). During the last five years, the ES-BSC has been granted 20 H2020/FP7 European projects, 8 European Copernicus contracts, 5 national MINECO-funded projects, and a substantial number of private contracts, which have helped consolidate a dense international collaborative network that counts with at least 50 institutes worldwide.

The candidate will be hosted by the Climate Prediction Group (**CPG**), one of the four Research Groups in the ES-BSC. The CPG 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 is achieved, first, identifying the strengths and the weaknesses in state-of-the-art climate forecast systems through a comparison with the most up-to-date observational datasets, and, second, by exploiting such detailed analyses to refine the representation of climate processes in our climate forecast systems and their initialization. Special emphasis is placed on forecasting changes in high-impact climate events such as persistent strong winds, floods, droughts, and temperature extremes. Other important scientific topics covered by the group are the impact of the Arctic sea ice decline on climate variability and predictability at mid-latitudes, the predictability of the ocean productivity and the oceanic carbon uptake, the role of volcanic aerosols in the global climate, the prediction of tropical cyclones, and inter-basin climate teleconnections, among others.

Many of the modelling and prediction activities are developed with the EC-Earth climate forecast system. EC-Earth is a state-of-the art coupled climate model which is developed and used for climate predictions and projections by a European consortium of more than 20 operational and research institutions, including the ES-BSC. These activities include the production and analyses of experiments which will contribute to the sixth phase of the Coupled Model Intercomparison Project (CMIP6) and which will be used to produce the UN Intergovernmental Panel on Climate

Change (IPCC) Sixth Assessment Report (AR6), and a ground-breaking ultra-high resolution global climate simulations which feature a horizontal spacing resolution of 1/12° in the ocean and of 15 km in the atmosphere and which have been envisaged within the HiResMIP. Positioned at the cutting-edge of the climate prediction research, the CPG has been recently designated by the WMO as a global producing centre for annual-to-decadal climate predictions. The CPG thus combines a large variety of expertise in climate processes within the group from the stratosphere down to the deep ocean and from tropical to polar latitudes, together with expertise in climate modelling and data assimilation. This creates the optimal environment to be leveraged by the candidate to develop a post-doctoral project on the study of the role of the sea ice in the Arctic climate variability and decadal forecast with state-of-the-art climate models.

Scientific expertise and integration of the candidate in the Research Team

Dr. Moreno Chamarro is an expert on atmosphere–ocean–sea ice interactions who has developed his career at word-leading research centres: he completed his PhD with *magna cum laude* at the Max Planck Institute of Meteorology (Hamburg; Germany) in 2016, after which he joined the Massachusetts Institute of Technology (Cambridge; USA) as postdoctoral associate; eventually, in early 2018, he joined the CPG in the ES-BSC. Throughout his career, the candidate has investigated and has thus gained a deep understanding of climate dynamics on a wide range of spatial and temporal scales, as well as experience in using climate models of different complexity, analysing extensive data sets, publishing scientific literature as past of a broad international network, and contributing to international projects, including the two European H2020 projects APPLICATE and PRIMAVERA.

In the ES-BSC, Dr. Moreno-Chamarro will investigate climate interactions between the Northern Hemisphere mid and high latitudes on decadal times scales. He will generate sea ice initial conditions for the EC-Earth climate model, will perform sensitivity experiments with such conditions, and will investigate sources of sea ice predictability. Additionally, he will assess the sensitivity of the mean state and variability of the sea ice to new physic schemes introduced in the EC-Earth models. The candidate will also investigate the role of a realistic Greenland ice melting in the near-term climate of the Arctic and North Atlantic in climate models. The here-proposed investigation will leverage the candidate's previous experience on the study of fundamental climate interactions in state-of-the-art climate models to advance our understating of the importance of the Arctic cryosphere for the predictability of the mid-latitude climate. The implementation of this research as part of the CPG is an unquestionable opportunity to strengthen and expand both the candidate's and the ES-BSC's competences.

Role and responsibilities of the supervisor in the Research Team

The tutor investigator of the candidate will be Dr. Pablo Ortega, one of the two co-leaders of the CPG. Dr. Ortega is a Ramon y Cajal fellow expert in decadal climate variability and predictability who has more than ten years of experience as a climate modeller and oceanographer. He is directly supervising the work of nine postdocs (including a Marie Curie fellow), two PhD students, and two undergraduate students. He also coordinates the CPG contributions to the EC-Earth Consortium and acts as PI at the BSC in four international research projects: two H2020 projects (APPLICATE and INTAROS), one ESA-funded project (CMUG-CCI+), and one Belgian-funded project (PARAMOUR). He has also been PI of a MINECO-funded RETOS project (DANAE), which finished in December 2018, and will act as the BSC PI in a new H2020 project that will kick-off in spring of 2019 (TRIATLAS).

The scientific quality and relevance of his research is supported by 23 publications in journals of the first quartile (nine as a first author, five as second), including five in high-impact journals (two in Nature, one as first author, two in Nature Geoscience, and one in Nature Communications). His articles have received a total of 422 citations (316 since the beginning of 2017) and his h-index is 12 (all metrics from Scopus, January 2019).

Participation in Scientific Projects at the CPG

The CPG has an active involvement in national and international scientific projects, both in the leading and contributing role. During the last 5 years (2014–2018), the CPG has participated in **5 EU H2020** projects**, 2 EU FP7** projects**, 3 EU Copernicus** projects**, 7** projects funded by the Ministerio de Economía y Competitividad **(MINECO), 2** projects funded by the **European Space Agency (ESA), 1** project funded by **the Belgian institution FNRS, 2 from ERA4CS,** and 1 **AXA-funded private contract.**

In the following it is highlighted 10 of these projects, in which the CPG has played a key role in the past years:

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 48 months; total funding: 8.715.066€, ES-BSC funding: 698.144€, PI at ES-BSC: Pablo Ortega, ES-BSC leads WP5 and WP7 and contributes to WP1, WP3 and WP4). The 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 centres across Europe.

2. **EUCP** (European Climate Prediction system) is an EU H2020 project (start date: 12/2017; lasting 48 months; total funding 12.999.515€, BSC funding: 1.026.593€, PI at ES-BSC: Francisco Doblas-Reyes, ES-BSC leads WP1 and contributes to WP4, WP5 and WP6) 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

centres across Europe.

3. **INTAROS** (Integrated Arctic observation system) is an EU H2020 project (start date: 11/2016, lasting 48 months, total funding 15.490.141€, BSC funding: 62.500€, PI at ES-BSC: Pablo Ortega, ES-BSC contributes to WP6). 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 gathers experts from 48 research centres across Europe.

4. **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 55 months; total funding: 14.967.969€, BSC funding: 1.277.425€, PI at ES-BSC: Francisco Doblas-Reyes, ES-BSC leads WP1 and WP11 and contributes to WP2, WP3, WP4, WP5, WP6, WP9 and WP10). 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. This project gathers experts from 19 research centres across Europe.

5. **IMPREX** (Improving Predictions and management of hydrological EXtremes) is an EU H2020 project (start date: 10/2015; lasting 36 months; total funding: 7.996.848€, BSC funding: 240.000€, PI at ES-BSC: Louis-Philippe Caron, ES-BSC contributes to WP2, WP3, and WP14). The goal of IMPREX is to improve forecast skill of meteorological and hydrological extremes in Europe and their impacts by applying dynamic model ensembles, process studies, new data assimilation techniques and high resolution modelling. This project gathers experts from 23 research centres across Europe.

6. **CMUG-CCI+** (Climate Model User Group-Climate Change Initiative+) is an ESA project (start date: 10/2018; lasting 36 months; total funding: 1.500.000 €, BSC funding: 184.179€, PI at ES-BSC: Pablo Ortega, ES-BSC contributes to WP1, WP3, and WP4) specifically conceived to ensure that the ESA-CCI data products are developed and provided in a form most useful for climate analysis and modelling work and that they are widely promoted within the climate research community, with a special emphasis on the activities related to the Climate Model Intercomparison Project. This project gathers experts from 8 research centres across Europe.

7. **PARAMOUR** (Decadal Predictability and vAriability of polar climate: the Role of AtMosphere–Ocean–cryosphere mUltiscale inteRactions) is a project funded by the Belgian institution FNRS (Fonds de la Recherche Scientifique; lasting 48 months, start date: 01/2018 – 12/2021, total funding 3.578.500€, BSC funding: 170.274€, PI at ES-BSC: Pablo Ortega, ES-BSC contributes to WP2, WP3, and WP4) whose main goal is to improve the understanding of key processes that control the variability of the ice-ocean- atmosphere system at decadal time scales and to determine how those interactions will lead to some predictability using a hierarchy of climate models of different complexity (global coupled models, regional atmospheric models and ice-sheet models). This project gathers experts from 5 research centres from Belgium and the BSC in Spain.

8. **C3S_512** is a Copernicus CS3 contract (**lead by ES-BSC**, start date: 07/2016; lasting 15 months; total funding: 6.000.000€€, BSC funding: 1.504.275€, PI at ES-BSC: Francisco Doblas-Reyes, ES-BSC contributes to WP1, WP2 and WP3) for the Evaluation and Quality Control (EQC) of the Copernicus Climate Change Service (C3S). The outcomes will be employed to perform a gap analysis of the current capabilities of the Climate Data Store (CDS) and formulate recommendations that support the evolution of the service. This contract involves 9 research institutes across Europe.

9. **HIATUS** (**fully implemented at the ES-BSC,** XXIst century surface temperature Hiatus: Investigation, Attribution, Thorough Understanding and Sensitivity experiments) is a project funded by the MINECO (start date: 01/2016, lasting 42 months, total funding 101.640€, PI at ES-BSC: Louis-Philippe Caron). 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.

10. **DeCUSO** is a MINECO-funded project (**fully implemented at the ES-BSC,** start date: 01/2018, lasting 36 months, total funding 114.000€, PI at ES-BSC: Raffaele Bernardello) aiming at objective to provide an extensive assessment of our ability to predict the ocean carbon uptake on timescales ranging from one month to one decade ahead. It will involve the production and study of decadal predictions of Carbon Uptake in the Southern Ocean and an analysis of the impact of the biological carbon pump uncertainty.

Another aspect to highlight is that two new H2020 projects in which the CPG is involved (**TRIATLAS** and **CCiCC**) have reached the stage of Grant Agreement preparation and are currently in the negotiation phase with the European Commission. They will start in the spring of 2019.

Publications

The CPG is really active scientifically and has published 84 papers since 2015 in well-recognised peer-review journals. A selection of the 20 most relevant ones is listed below (with CPG members highlighted in **bold**):

- **Prodhomme**, **C.**, A. Voldoire, **E. Exarchou**, A.-L. Deppenmeier, **J. García-Serrano** and **V. Guemas** (2019). How does the seasonal cycle control equatorial Atlantic interannual variability? Geophysical Research Letters, Published online, doi:10.1029/2018GL080837.

- de la Vara, A., P. Galan del Sastre, **T. Arsouze**, C. Gallardo, M. A. Gaertner (2019). Role of atmospheric resolution in the long-term seasonal variability of the Tyrrhenian Sea circulation from a set of ocean hindcast simulations (1997–2008). Ocean Modelling, Published online.

- Dunic, N., I. Vilibić, J. Šepić, H. Mihanović, F. Sevault, S. Somot, R. Waldman, P. Nabat, **T. Arsouze**, R. Pennel, G. Jordà, R. Precali (2019).

Performance of multi-decadal ocean simulations in the Adriatic Sea. Ocean Modelling, Published online. https://doi.org/10.1016/j.ocemod.2019.01.006

- **Cruz-García, R**., **V. Guemas**, M. Chevallier and **F. Massonnet** (2019). An assessment of regional sea ice predictability in the Arctic ocean. Climate Dynamics, Published online. doi:10.1007/s00382-018-4592-6.

- **Acosta Navarro**, **J.C**., **P. Ortega**, **J. García-Serrano**, **V. Guemas**, **E. Tourigny**, **R. Cruz-García**, **F. Massonnet** and F.J. Doblas-Reyes (2018). December 2016: Linking the Lowest Arctic Sea-Ice Extent on Record with the Lowest European Precipitation Event on Record. Bulletin of the American Meteorological Society, Explaining Extreme Events of 2017, doi:10.1175/BAMS-D-18-0097.1

- **Caron, L.-P**., L. Hermanson, A. Dobbin, J. Imbers, L. Lledó and G.A. Vecchi (2018). How skilful are the multi-annual forecasts of Atlantic hurricane activity? Bulletin of the American Meteorological Society, 99, 403-413, doi:10.1175/BAMS-D-17-0025.1

- **Donat, M.G.,** A.J. Pitman and O. Angelil (2018). Understanding and reducing future uncertainty in midlatitude daily heat extremes via land surface feedback constraints. Geophysical Research Letters, 45, 10,627-10,636, doi:10.1029/2018GL079128

- **Exarchou, E., C. Prodhomme, L. Brodeau, V. Guemas** and F.J. Doblas-Reyes (2018). Origin of the warm eastern tropical Atlantic SST bias in a climate model. Climate Dynamics, 51, 1819-1840, doi:10.1007/s00382-017-3984-3

- **Fučkar, N.S., V. Guemas**, N.C. Johnson and F.J. Doblas-Reyes (2018). Dynamical prediction of Arctic sea ice modes of variability. Climate Dynamics, doi:10.1007/s00382-018-4318-9.

- **Massonnet, F.**, M. Vancoppenolle, H. Goosse, D. Docquier, T. Fichefet and E. Blanchard-Wrigglesworth (2018). Arctic sea-ice change tied to its mean state through thermodynamic processes. Nature Climate Change, 8, 599-603, doi:10.1038/s41558-018-0204-z

- **Ménégoz, M., R. Bilbao, O. Bellprat, V. Guemas** and F.J. Doblas-Reyes (2018). Forecasting the climate response to volcanic eruptions: prediction skill related to stratospheric aerosol forcing. Environmental Research Letters, 13, 064022, doi:10.1088/1748-9326/aac4db

- Alexander-Turner, R., **P. Ortega** and J. Robson (2018). How robust are the surface temperature fingerprints of the Atlantic Overturning Meridional Circulation on monthly time-scales? Geophysical Research Letters, 45, 1-9, doi:10.1029/2017GL076759.

- Amores, A., G. Jordà, **T. Arsouze** and J. Le Sommer (2018). Up to what extent can we characterize ocean eddies using present-day gridded altimetric products? Journal of Geophysical Research, doi:10.1029/2018JC014140.

- Baudouin, J.-P., **L.-P. Caron** and M. Boudreault (2018). Impact of reanalysis boundary conditions on downscaled hurricane activity. Climate Dynamics, doi:10.1007/s00382-018-4352-7.

- Befort, D.J., **S. Wild**, J.R. Knight, J.F. Lockwood, H.E. Thornton, L. Hermanson, P.E. Bett, A. Weisheimer and G.C. Leckebusch (2018). Seasonal forecast skill for extratropical cyclones and windstorms. Quarterly Journal of the Royal Meteorological Society, doi:10.1002/qj.3406.

- Butchart, N., J.A. Anstey, K. Hamilton, S. Osprey, C. McLandress, A.C. Bushell, Y. Kawatani, Y.-H. Kim, F. Lott, J. Scinocca, T.N. Stockdale, M. Andrews, **O. Bellprat**, P. Braesicke, C. Cagnazzo, C.-C. Chen, H.-Y. Chun, M. Dobrynin, R.R. Garcia, **J. García-Serrano,** L.J. Gray, L. Holt, T. Kerzenmacher, H. Naoe, H. Pohlmann, J.H. Richter, A.A. Scaife, V. Schenzinger, F. Serva, S. Versick, S. Watanabe, K. Yoshida and S. Yukimoto (2018). Overview of experimental design and comparison of models participating in phase 1 of the SPARC Quasi-Biennial Oscillation initiative (QBOi). Geoscientific Model Development, 11, 1009-1032, doi:10.5194/gmd-2017-187.

- Ceglar, A., A. Toreti, **C. Prodhomme**, M. Zampieri, M. Turco and F.J. Doblas-Reyes (2018). Land-surface initialisation improves seasonal climate prediction skill for maize yield forecast. Scientific Reports, 8, doi:10.1038/s41598-018-19586-6.

- Kimmritz, M., F. Counillon, C.M. Bitz, **F. Massonnet**, I. Bethke and Y. Gao (2018). Optimising assimilation of sea ice concentration in an Earth system model with a multicategory sea ice model. Tellus A, doi:10.1080/16000870.2018.1435945.

- King, M.P., I. Herceg-Bulic, I. Bladé**, J. García-Serrano**, N. Keenlyside, F. Kucharski, C. Li and S. Sobolow (2018). Importance of late-fall ENSO teleconnection in the Euro-Atlantic sector. Bulletin of the American Meteorological Society, 99, 1337-1343, doi:10.1175/BAMS-D-17-0020.1.

- Lavender, S.L., K.J.E. Walsh, **L.-P. Caron**, M. King, S. Monkiewicz, M. Guishard, Q. Zhang and B. Hunt (2018). Estimation of the maximum annual number of North Atlantic tropical cyclones using climate models. Science Advances, 4, doi: 10.1126/sciadv.aat6509.

- Lledó, Ll**., O. Bellprat**, F.J. Doblas-Reyes and A. Soret (2018). Investigating the effects of Pacific sea surface temperatures on the wind drought of 2015 over the United States. Journal of Geophysical Research Atmospheres, 123, 4837-4849, doi: 10.1029/2017JD028019.

- Mamadjanova, G., **S. Wild**, M. Walz and G.C. Leckebusch (2018). The role of synoptic processes in mudflow formation in the piedmont areas of Uzbekistan. Natural Hazards and Earth System Sciences, 18, 2893-2919, doi: 10.5194/nhess-18-2893-2018.

- Manubens, N., **L.-P. Caron**, A. Hunter, **O. Bellprat, E. Exarchou, N.S. Fučkar, J. Garcia-Serrano, F. Massonnet, M. Ménégoz**, **V. Sicardi**, L. Batté, **C. Prodhomme**, V. Torralba, N. Cortesi, O. Mula-Valls, K. Serradell, **V. Guemas** and F.J. Doblas-Reyes (2018). An R package for climate forecast verification. Environmental Modelling & Software, 103, 29-42, doi:10.1016/j.envsoft.2018.01.018.

- Mavilia, I., B. Alessio, P. J. Athanasiadis, S. Gualdi, R. Msadek and **Y. Ruprich-Robert** (2018). On the spectral characteristics of the Atlantic multidecadal variability in an ensemble of multi-century simulations. Climate Dynamics, doi:10.1007/s00382-018-4093-7.

- McGee, D., **E. Moreno-Chamarro**, J. Marshall and E.D. Galbraith (2018). Western US lake expansions during Heinrich stadials linked to Pacific Hadley circulation. Science advances, 4, eaav011, doi:10.1126/sciadv.aav0118.

- **Ménégoz, M**., C. Cassou, D. Swingedouw, **Y. Ruprich-Robert**, P.-A. Bretonnière and F.J. Doblas-Reyes (2018). Role of the Atlantic Multidecadal Variability in modulating the climate response to a Pinatubo-like volcanic eruption. Climate Dynamics, 51, 1863-1883, doi:10.1007/s00382-017-3986-1

- Messori, G., D. van Wees, F.S.R. Pausata, **J.C. Acosta Navarro**, A. Hannachi and F.J. Dentener (2018) The impact of future atmospheric circulation changes over the Euro-Atlantic sector on urban PM2.5 concentrations. Tellus B: Chemical and Physical Meteorology, doi:10.1080/16000889.2018.1468704.

- Mishra, N., **C. Prodhomme** and **V. Guemas** (2018). Multi-model skill assessment of seasonal temperature and precipitation forecasts over Europe Climate Dynamics, doi:10.1007/s00382-018-4404-z.

- Neukermans, G., T. Harmel, **M. Galí**, N. Rudorff, J. Chowdhary, O. Dubovik, C. Hostetler, Y. Hu, C. Jamet, K. Knobelspiesse, Y. Lehahn, P. Litvinov, A.M. Sayer, B. Ward, E. Boss, I. Koren and L.A. Miller (2018). Harnessing remote sensing to address critical science questions on ocean-atmosphere interactions. Elementa: Science of the Anthropocene, doi:10.1525/elementa.331.

- **Ruprich-Robert, Y.,** T. Delworth, R. Msadek, F. Castruccio, S. Yeager and D. Danabasoglu (2018). Impacts of the Atlantic Multidecadal Variability on North American summer climate and heat waves. Journal of Climate, 31, 3679-3700, doi:10.1175/JCLI-D-17-0270.1.

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Capacity for training and supervision

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 the 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.

In addition, ES-BSC provides to all its 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 ES-BSC has participated in four 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 atmospheric and climate modelling.

Since 2014 eight PhD theses have been completed at ES-BSC, one of them within the CPG:

1. Vincenzo Obiso
Title: *Assessment of dynamic aerosol-radiation interaction in atmospheric models*
Reading date: 03/2018

2. Lluís Vendrell
Title: *High-resolution dust modelling based on the non-hydrostatic mesoscale model NMMB/BSC-Dust*
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. Danila Volpi (CPG)

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

5. Michele Spada
Title: *Development and evaluation of an atmospheric aerosol module implemented within the NMMB/BSC Chemical Transport Model*
Reading date: 11/2015

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.*
Reading date: 12/2014

Besides, ten more students are currently performing their PhD on the department, out of which three are in the Climate Prediction group.

Both the PhDs students and the postdoctoral researchers benefit from the highly collaborative working environment in the ES-BSC department, and participate to regular meetings with their supervisors and with other group members to ensure an adequate integration of their research within the department activities, and to maximize the potential collaborations. Likewise, they are encouraged to attend and participate actively in international project meetings and scientific conferences to increase the visibility of their research, and to help them strengthen their international network of collaborators.

Additional resources provided by the BSC-CNS

The outstanding high performance computing infrastructures, computational resources, and IT support available at BSC-CNS are more than sufficient to guarantee an optimal work environment for PhD students and postdocs. The BSC-CNS has a highly skilled and well-trained team of technicians who will advice and support the candidate on the use of the available high-performance computing infrastructure. Also, within the ES-BSC, the Computation Earth Science group provides strong support to researchers, develops tools to automate running, post-processing, and detailed analyses of climate model experiments and helps them manage the computing resources efficiently.

BSC will facilitate the fellow immediate access to a personal workstation, laptops, BSC's high-performance computing facilities, library, conference rooms, and other services such as internal training and seminars, language classes, health insurance, and 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 has been 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 many networking opportunities. The combination of outstanding available supercomputing facilities, high quality user support, and experience in hosting fellows at BSC will provide the candidate a very strong basis of scientific infrastructure to be successful in his research.

GLOSSARY

AR6: Sixth IPCC Assessment Report

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

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

CCI: Climate Change Initiative

CMIP6: Coupled Model Intercomparison Project Phase 6

CMUG: Climate Model User Group

CPG: Climate Prediction Group

ESA: European Space Agency

HPC: High Performance Computing

IPCC: Intergovernmental Panel on Climate Change

IT: Information Technology

MINECO: Ministerio de Economía y Competitividad

PI: Principal Investigator

UN: United Nations

UPC: Universitat Politècnica de Catalunya

WMO: World Meteorological Organization