

SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

Reporting year

2026

Project Title:

Sensitivity of regional Models to Improved Land-air interactions and External forcings setup: Approaching a "seamless" sTrategy to reduce sYstematic biases in very high-resQlution climate simUlations (*SmileAtYou*)

Computer Project Account:

spesgonz

Principal Investigator(s):

J. Fidel González Rouco

Affiliation:

IGEO-CSIC

Name of ECMWF scientist(s) collaborating to the project
(if applicable)

Félix García-Pereira (IGEO), Cristina Vegas-Cañas (IGEO), Jorge Navarro Montesinos (CIEMAT), Elena García Bustamante (CIEMAT), Nagore Meabe (IGEO), Sara Madera Sánchez (CIEMAT), Luana Cardoso (University of Lisbon).

Start date of the project:

01/01/2024

Expected end date:

31/12/2026

Computer resources allocated/used for the current year and the previous one
(if applicable)

Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	15.500.000	21.944.037	15.500.000	505.610.783
Data storage capacity	(Gbytes)	250.000	166.047	250.000	948.157

Summary of project objectives (10 lines max)

The project main objective is to perform regional simulations at very high spatial resolution with a regional climate model (RCM, WRF). The objective is to achieve a refined version of the regional simulations over the EURO CORDEX domain by incorporating the external climatic forcings to the regional model and by increasing the realism of the soil component in high resolution simulations. A smaller region of complex terrain (Central System) within the Iberian Peninsula is selected due to its availability of observational data, to generate convection permitting RCM (CP-RCM) simulations with the aim of testing the ability of the model to resolve the atmospheric physics at convective scales making use of convection permitting schemes. Therefore, the main objectives within the present project imply a pool of sensitivity experiments of those parametrizations that remain active when the cumulus scheme is muted (convection permitting scheme) in shorter and smaller domain within the Iberian Peninsula.

Summary of problems encountered (10 lines max)

During this annual cycle, core-hour utilization and System Billing Units (SBUs) significantly exceeded the initially requested allocation. The execution of the 1-km horizontal resolution Convection-Permitting Simulations (CPS) over the Iberian Peninsula, coupled with the dynamic generation of initial and boundary conditions, demanded higher HPC resources than preliminarily estimated. Furthermore, post-processing routines and the subsequent massive data transfer of the simulated fields to our institutional servers introduced additional computational and networking overheads that were underestimated in the initial planning phase. Specifically, operating the critical 1-km domain across a massively parallel architecture of 25 nodes (3,200 processors) established a real burn rate exceeding 2,000,000 SBUs per simulated year. We went too far over the limit and apologize for this. We should have rediscussed resources with the managing office.

Summary of plans for the continuation of the project (10 lines max)

At this stage, access to HPC resources is shut due to the over consumption. Nevertheless, if there would be future chances of computing, the following lines would represent our standpoint. One of the primary objectives during this period is to advance the high-resolution (1 km) Convection-Permitting Regional Climate Model (CP-RCM) integrations. Multidecadal continuous simulations (spanning 1994–2025) are currently being conducted across two spatial scales: a restricted subdomain covering the Central System of the Iberian Peninsula, and a full-domain setup covering the entire peninsula. However, due to the high computational overhead accumulated to date, a strategic reallocation of computing resources has been implemented for the remainder of this cycle.

List of publications/reports from the project with complete references

PUBLISHED

- Arribas L., Domínguez J., Borsato M., Martín A. M., Navarro J., García-Bustamante E., Zarzalejo L. F. y Cruz I. (2025). *The potential of utility-scale Hybrid Wind–Solar PV power plants deployment: from data to results. A simplified application for the Spanish potential.* Wind, 5(3), 16.
- Plaza-Martín N. et al. (2026). *Evaluation of ERA5, ERA5-Land, CERRA and NEWA datasets in reproducing observed near-surface wind speeds across Spain.* Advances in Climate Change Research.

IN REVISION

- Salazar L. L., et al. *High-resolution numerical simulation over the Iberian Peninsula with the coupled WRF-SFIRE atmosphere and wildfire model.* International Journal of Wildland Fire.
- Greciano-Zamorano E. et al. *Evaluation of precipitation variability over complex terrain based on observations and high-resolution WRF v4.2.2 modelling.* Geoscientific Model Development.
- Gallego-Castillo C. et al. *Wind power potential in low environmental sensitivity areas of Spain: a regional assessment.* Wind Energy Science.

IN PREPARATION

- García-Bustamante E. et al. *Evaluation of the NEWA wind atlas.* En preparación para *International Journal of Climatology*.
- Madera-Sánchez S. et al. *Assessment of temperature variability over the Central System of the Iberian Peninsula: Multi-resolution model evaluation.* Climate Dynamics
- L.C. Santos et. al. *How does re-afforestation shape the occurrence of summer extreme temperatures across Europe?*
- García-Bustamante E. et al. *Increasing the realism of the forcing conditions in regional climate simulations: a case-study in the Euro-Mediterranean CORDEX domain.*
- Cardoso R. M. et al. *What is the compound effect of re/afforestation and extreme heat on summer land-atmosphere coupling across Europe?*

CONFERENCES AND WORKSHOPS

- Sara Madera Sánchez, Fidel González Rouco, Elena García Bustamante, Jorge Navarro Montesinos, Cristina Vegas Cañas, Esteban Rodríguez Guisado, Ernesto Rodríguez Camino, Juan Carlos Sánchez Perrino, Ignacio Prieto Rico, Emilio Greciano Zamorano, Rita M. Cardoso Tavares, and Luana Cardoso dos Santos: *Assessment of temperature variability over the Central System of the Iberian Peninsula: Multi-resolution model evaluation*, session AS1.23, abstract EGU26-10030, oral presentation, EGU General Assembly 2026, Vienna, Austria, 03–08 May 2026.
- Cristina Vegas Cañas, J. Fidel González Rouco, Esteban Rodríguez Guisado, Ernesto Rodríguez Camino, Rita M. Cardoso, Luana C. Santos, Jorge Navarro Montesino, Elena García Bustamante, Carlos Pereira, Yolanda Luna, Ana B. Morata, Guillermo Robles Martínez, and Jose A. Hinojal: *CIMAs: A multi-source climate dataset for high-mountain environments in the Iberian Central System*, session AS1.23, abstract EGU26-15032, poster presentation, EGU General Assembly 2026, Vienna, Austria, 03–08 May 2026.
- Luana C. Santos, Rita M. Cardoso, Jorge Navarro Montesinos, Elena García Bustamante, J. Fidel González Rouco, Carlos DaCamara, and Pedro M. M. Soares: *How do land-use changes shape future extreme temperatures across Europe?* session CL4.4, abstract EGU26-15125, poster presentation, EGU General Assembly 2026, Vienna, Austria, 03–08 May 2026.
- Fidel González-Rouco, Félix García-Pereira, Nagore Meabe-Yanguas, Álex Martínez-Vila, Johann Jungclaus, Stefan Hagemann, Stephan Lorenz, Philipp De Vrese, Francisco José

Cuesta-Valero, Almudena García-García, Hugo Beltrami, Elena García-Bustamante, Jorge Navarro, Ru Huang, Jason Smerdon, and Ernesto Tejedor: Simulating the Common Era and climate change scenarios with the MPI-ESM: opportunities for model-data comparison, session CL1.2.2, abstract EGU26-19068, oral presentation, EGU General Assembly 2026, Vienna, Austria, 03–08 May 2026.

- Rita M. Cardoso, Luana C. Santos, Jorge Navarro, Elena García Bustamante, J. Fidel González Rouco, Carlos C. Camara, and Pedro M M Soares: How do future land-use changes jointly influence summer land&atmosphere coupling and fire danger across Europe? session CL4.4, abstract EGU26-20768, oral presentation, EGU General Assembly 2026, Vienna, Austria, 03–08 May 2026.

Summary of results

If submitted **during the first project year**, please summarise the results achieved during the period from the project start to June of the current year. A few paragraphs might be sufficient. If submitted **during the second project year**, this summary should be more detailed and cover the period from the project start. The length, at most 8 pages, should reflect the complexity of the project. Alternatively, it could be replaced by a short summary plus an existing scientific report on the project attached to this document. If submitted **during the third project year**, please summarise the results achieved during the period from July of the previous year to June of the current year. A few paragraphs might be sufficient.

Multi-decadal continuous climate simulations spanning the 1989–2025 period have been partially completed for the Central System region. A preliminary validation was conducted for key control variables—specifically temperature, precipitation, and wind speed—by comparing simulated annual daily means against the observational dataset from the Guadarrama Monitoring Network (GUMNET). Furthermore, the Max Planck Institute Earth System Model (MPI-ESM) was successfully coupled with the Weather Research and Forecasting (WRF) model to perform Convection-Permitting Regional Climate Model (CP-RCM) simulations under both historical conditions and the future SSP3-7.0 emission scenario. This coupling framework enabled an initial comparative evaluation of spatial precipitation patterns over the Iberian Peninsula, contrasting WRF simulations driven by ERA5 reanalysis against those forced by the MPI-ESM global climate model across selected years within the simulated timeframe.

The simulations performed are produced in coordination with AEMET, that is developing similar simulations with the HCLIM model for comparison purposes. These simulations will provide resources to develop two ongoing PhDs.