LATE REQUEST FOR AN EMI R&D PROJECT 2026–2028

Country/Organisation: Spain

Principal Investigator[1]: Josipa Milovac

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Project Title: Next-generation CORDEX simulations across multiple regional domains within the context of the FUTURA project

To make changes to an existing project please submit an amended version of the original form

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP** ……..	
Starting year: (A project can have a duration of up to 3 years, agreed at the beginning of the project.)	2026	
Would you accept support for 1 year only, if necessary?	**YES** ☑	NO ☐

Computer resources required for project year:		**2026**	**2027**	**2028**
High Performance Computing Facility	[SBU]	20 million	30 million	30 million
Graphics Processing Unit Cluster-A	[GBU]			
Graphics Processing Unit Cluster-B	[GBU]			
Accumulated data storage (total archive volume)[2]	[GB]	60 000	160 000	300 000

[1] The Principal Investigator will act as contact person for this EMI R&D Project and, in particular, will be asked to register the project, provide annual progress reports of the project's activities, etc.
[2] These figures refer to data archived in ECFS and MARS. If e.g. you archive x GB in year one and y GB in year two and don't delete anything you need to request x + y GB for the second project year etc.
[3]The number of vGPU is referred to the equivalent number of virtualized vGPUs with 8GB memory.

EWC resources required for project year:		**2026**	**2027**	**2028**
Number of vCPUs	[#]			
Total memory	[GB]			
Storage	[GB]			
Number of vGPUs[3]	[#]			

Continue overleaf.

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Extended abstract

The FUTURA project (***FUTUR**e of climate change scenarios of the Earth system, impacts and socio-economic outcomes for **A**ssessment and society*) is a four-year Horizon Europe initiative designed to coordinate major European modelling and infrastructure efforts to develop and deploy a sustainable and unified system for delivering future emissions and land-use scenarios, and climate and impact projections. This project represents a significant step toward the sustained and responsive delivery of climate projections to support climate assessment and policymaking, including the upcoming IPCC Seventh Assessment Report (AR7). It promotes a multidisciplinary approach that reduces fragmentation and fosters inclusiveness, to build a coherent and collaborative climate science community.

Our group from the Institute of Physics of Cantabria (IFCA) is centrally involved in this effort through regional climate modelling (RCM), including the production and analysis of model outputs, as well as the provision of technical support for the Earth System Grid Federation (ESGF).

A core component of our HPC requirements involves the production of regional climate simulations within the CORDEX framework (Giorgi et al., 2009) to support the FUTURA project. Specifically, our work plan addresses two critical CORDEX modelling cycles: CORDEX-CORE CMIP6 (Coppola et al. 2026) and CMIP7 (Fernandez et al., 2025). Furthermore, these simulations are planned to support Machine Learning (ML)-based emulators. The ECMWF HPC resources requested will facilitate the simulation of centennial regional climate projections required to assess the risks, plausibility, and potential reversibility of future climate pathways, directly supporting international climate policy and adaptation planning.

1. Motivation

The escalating climate crisis has created an unprecedented demand for actionable climate information to support essential policy frameworks (IPCC,2023). However, the scientific infrastructure generating this knowledge faces a systemic challenge, which is the historical fragmentation of international modelling communities (Jones et al., 2024). Previous major assessments, such as the IPCC AR6 (IPCC,2023), suffered from delays and inconsistencies because global emissions, regional downscaling, and impact models were not cross-coordinated. The FUTURA project is designed as a direct strategic response to this challenge, implementing a paradigm shift from linear "causal-chain" workflows in modelling to a fully integrated "climate pathways system", encouraging interdisciplinary collaboration within the consortium and with the wider community of users (Figure 1).

High-performance computing (HPC) resources are vital to achieve this mission due to the high state-of-the-art resolution in regional climate modelling and the number of simulations required to provide a global view of regional climate. The new generation simulations proposed will contribute to the CORDEX-CORE initiative (Giorgi et al. 2022, Coppola et al. 2026). The same initiative driven by the old generation CMIP5 global climate models (GCMs) has been a major contribution from CORDEX to the last IPCC AR6, providing key regional-scale information. With this special project we

will update CORDEX-CORE to the new CMIP6 and the soon-available CMIP7 GCM projections, following the standards of this WCRP initiative (Coppola et al. 2026).

The next-generation CMIP7 GCMs and scenario set will allow assessing Overshoot and Reversibility: As global temperatures have already begun to exceed 1.5°C above pre-industrial levels, understanding the consequences of "overshoot pathways" is a paramount policy concern (Reisinger et al., 2025). Our simulations will explore the feasibility of returning to cooler temperatures, the risks of crossing Earth system tipping points, and the potential reversibility of impacts on critical systems like ice sheets, oceans, and ecosystems.

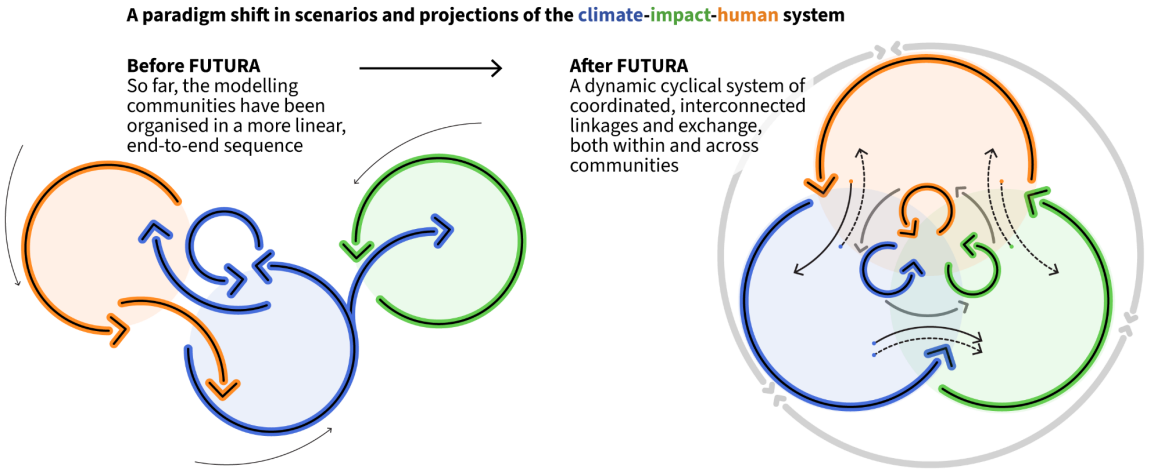

Figure 1: Schematic of the FUTURA paradigm shift in scenarios and projections of the climate-impact-human system

These requested HPC resources will enable us to generate the 1st CORDEX-CORE simulations with the Weather Research and Forecasting (WRF) model (Skamarock et al., 2019), and the first regional downscaling of CMIP7 Assessment Fast Track (AFT) projections, ensuring a timely and robust European contribution to the IPCC AR7. These simulations will also pave the way for km-scale convection-permitting simulations that can be nested into them for limited time slices.

2. Code and the Technical specification

CORDEX-CORE CMIP6 and CMIP7 simulations will be performed with a well coordinated interinstitutional configuration of the WRF model, in strict accordance with the CORDEX protocols. The WRF version will be 4.6.1, or a later release if required. WRF is open-source software written in Fortran and C and requires Intel compilers for optimal performance. It supports multiple parallel execution paradigms, including OpenMP, MPI, or hybrid OpenMP/MPI configurations. The model will be compiled using Intel compilers together with an MPI implementation (Intel MPI or OpenMPI). The model source code is being adapted to meet the specific requirements of the planned simulations. For the ongoing WRF CORDEX-CORE simulations, the model version and configuration are available in the GitHub repository https://github.com/CORDEX-WRF-community/cordex-core-cmip6.

3. Methodology and working plan

The simulation protocol is aligned with the FUTURA project timeline. In this special project we cover the regional dimension of FUTURA Phase 1, which aims to contribute to the IPCC AR7 with:

Task 1: CORDEX-CORE CMIP6

As part of the CORDEX-CORE-CMIP6 initiative, IFCA is contributing to a coordinated ensemble of continental-scale simulations, for the first time with the WRF model**.** These simulations will provide high-resolution climate projections (targeting 0.11° resolution) to support the IPCC AR7. The protocol requires downscaling at least three driving Global Climate Models (GCMs) for the priority SSP3-7.0 scenario (Figure 2). This involves 150 simulated years per downscaled GCM (i.e., 450 years per domain in total), ensuring a robust assessment of regional climate sensitivity and climate extremes. All simulations must be completed by the end of 2026. We require resources to complete projection simulations for several CORDEX continental-scale domains (to be decided).

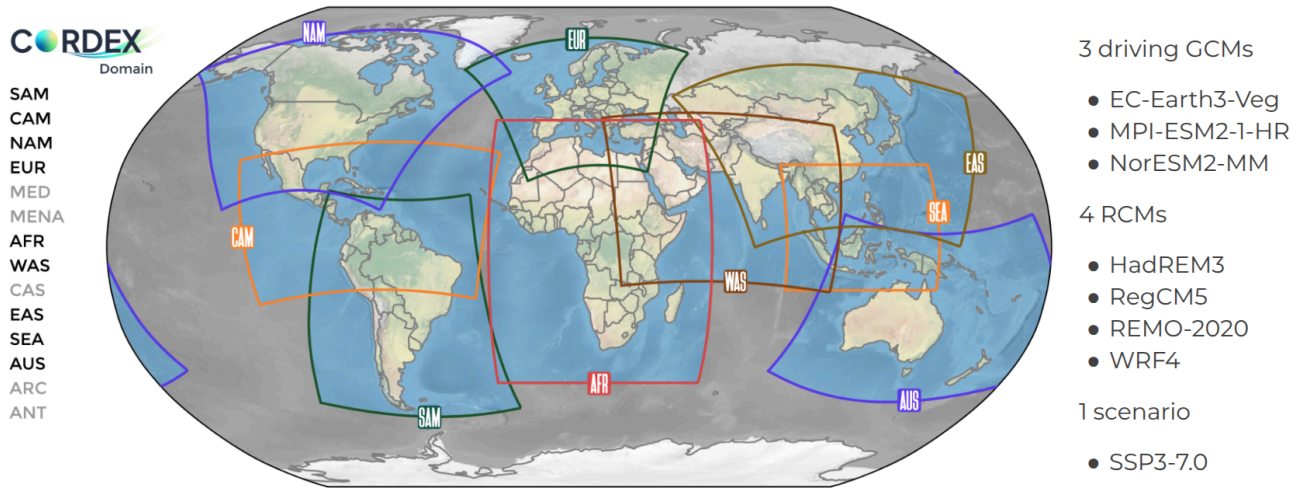

Figure 2: CORDEX-CORE simulation protocol: Domains, downscaled GCMs and scenarios, and RCMs. Adapted from Coppola et al (2026).

Task 2: CORDEX-CMIP7

FUTURA will lead the first regional downscaling of the CMIP7 Assessment Fast Track (AFT) projections. This involves implementing a revised CORDEX protocol that bridges the gap between global Earth System Models (ESMs) and regional impacts. We plan to downscale these new CMIP7-AFT GCM runs, focusing on overshoot scenarios. The simulations are planned to be initiated during the last quarter of 2026.

4. Resources

Similar CORDEX-CORE simulations were conducted using approximately 20 compute nodes, each with 64 CPU cores, using Intel MPI. With this configuration, one simulated year requires approximately 25-40 wall-clock hours, depending on the domain size. Therefore, producing a 300-year simulation proposed for 2026 would require approximately equivalent to 10-16 million core-hours. With included preprocessing and postprocessing, 20 million SBUs would be sufficient to complete the planned CORDEX-CORE simulations.

Resources required for the tasks proposed above, considering that each simulation requires approximately 10 million core-hours (Mhr) per GCM, domain, and scenario (i.e., 150 simulated years), based on our experience with running the similar simulations on other HPC systems:

Task 1: 300 simulated years in two domains/GCMs (most likely, EC-Earth3 GCM over SAM and AFR)
~ 20 million SBU

~ 0.6 TB per year of storage
6 TB of scratch storage
Completed by the end of 2026

Task 2: 3 GCMs downscaled for 2 scenarios per 1 domain will produce approximately ~ 900 years simulations
~ 60 million SBU
~ 0.6 TB per year of storage
6 TB of scratch storage
This WP will be conducted during 2027 and extended to 2028

We would require at least 6 TB (ideally 10 TB) of scratch storage to run the simulations efficiently. The simulation workflow consists of running the model one simulated year at a time, post-processing the output, and then deleting the corresponding raw model output once post-processing has been completed. The raw output generated for a single simulated year occupies approximately 15 - 20 TB, while the post-processed data amount to approximately 0.5 - 0.8 TB per simulated year. To allow simulations and post-processing to proceed concurrently without interruptions, we would require a minimum of 60 TB of temporary storage space. These files will be transferred to our local storage systems and/or published through ESGF. Once the transfer and publication have been completed, the post-processed data will be deleted from the ECMWF system.

References

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