REQUEST FOR A SPECIAL PROJECT 2026–2028

MEMBER STATE: Greece

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Project Title: Regional coupled model simulations over the Med-CORDEX domain (RECOMED)

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]	20M	20M	15M
Accumulated data storage (total archive volume)[2]	[GB]	30K	55K	55K

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

Continue overleaf.

[1] The Principal Investigator will act as contact person for this Special 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.

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Extended abstract

The Mediterranean region is a recognized climate change hotspot, exhibiting high sensitivity to global warming (Cos et al., 2022). It is also known for its strong air-sea feedbacks, complex terrain, intense mesoscale variability, and socio-economic vulnerability, particularly due to rising occurrences of extreme events such as Medicanes (Mediterranean hurricanes) (e.g., Flaounas et al., 2022) and marine heatwaves (e.g., Darmaraki et al., 2019). Under the CORDEX umbrella, the Med-CORDEX initiative (https://www.medcordex.eu/) provides a coordinated scientific framework for the implementation and evaluation of high-resolution Regional Climate Models (RCMs) tailored for the Mediterranean regional climate processes. The third phase of Med-CORDEX (Med-CORDEX3; Somot et al., 2023) builds on this foundation by focusing on downscaling the latest CMIP6 global model outputs using high-resolution coupled RCMs. This approach enables the assessment of climate change impacts at spatial and temporal scales relevant to regional policy-making, adaptation strategies, and risk-informed planning. Furthermore, the resulting datasets will contribute to addressing key knowledge gaps identified in the IPCC Sixth Assessment Report (AR6), particularly about regional extremes, compound events, and interactions across land-sea-atmosphere systems under different global warming scenarios.

In this context, the RECOMED project aims to produce a suite of high-resolution coupled model simulations, contributing to the Med-CORDEX3 multi-model ensemble. These simulations will provide critical insights into the physical drivers and dynamics of regional-scale phenomena, while also supporting downstream applications such as coastal hazard assessments and water resource planning. The main objectives of the RECOMED project can be summarized as follows:

- Contribute to an ensemble of high-resolution coupled model simulations driven by the ERA5 reanalysis and the CMIP6 models.
- Analyze key climate features (e.g., heatwaves, precipitation extremes, ocean circulation) and their regional feedbacks.
- Support stakeholder-relevant applications (e.g., coastal risks, water resources) through high-resolution output.

Methodology and computational resource requirements

We will employ a fully coupled regional climate system model, called **NKUA MedX-CM**, which builds upon the framework of Karagiorgos et al. (2024, 2025) and incorporates additional components and updates aligned with the Med-CORDEX Phase 3 protocol. The coupled system integrates:

- **WRF-v4.3.3** (Skamarock et al., 2021) for the atmosphere (12 km horizontal, 45 vertical levels),
- **NEMO-v4.2.0** (Madec et al., 2022) for ocean dynamics (1/12° horizontal, 50 vertical levels),
- **WW3-v6.07** (WW3DG, 2019) for wave modelling (shared mesh with NEMO),
- **Noah-MP** (Liu et al., 2011) for land surface processes (within WRF),
- **PISCES-v4.0** (Aumont et al., 2015) for ocean biogeochemistry (within NEMO; *optionally*),
- **HD-v5.01** (Hagemann et al., 2020) for river routing (1/12° horizontal),
- **OASIS-MCT-v4.0** (Craig et al., 2017) as the coupler (1-hour coupling frequency; daily for river-ocean coupling). The exchanged variables between the different model executables are shown in Figure 1.

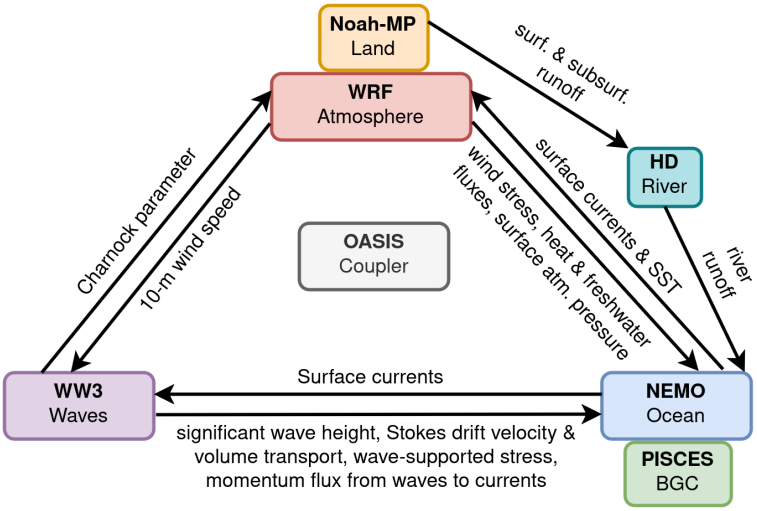

Figure 1. *Schematic diagram of the coupling strategy. The WRF, NEMO, and WW3 components exchange variables every 1 hour, while the HD river routing model interacts with both WRF and NEMO every 1 day.*

The scheduled simulations of the RECOMED project will be conducted over the Med-CORDEX domain (Figure 2), including:

- An evaluation run (1980–2020) forced by ERA5 reanalysis,
- Historical (1960-2014) and scenario runs (2015-2100) forced by CMIP6 GCM *(to be selected)* under SSP3-7.0 and SSP1-2.6.

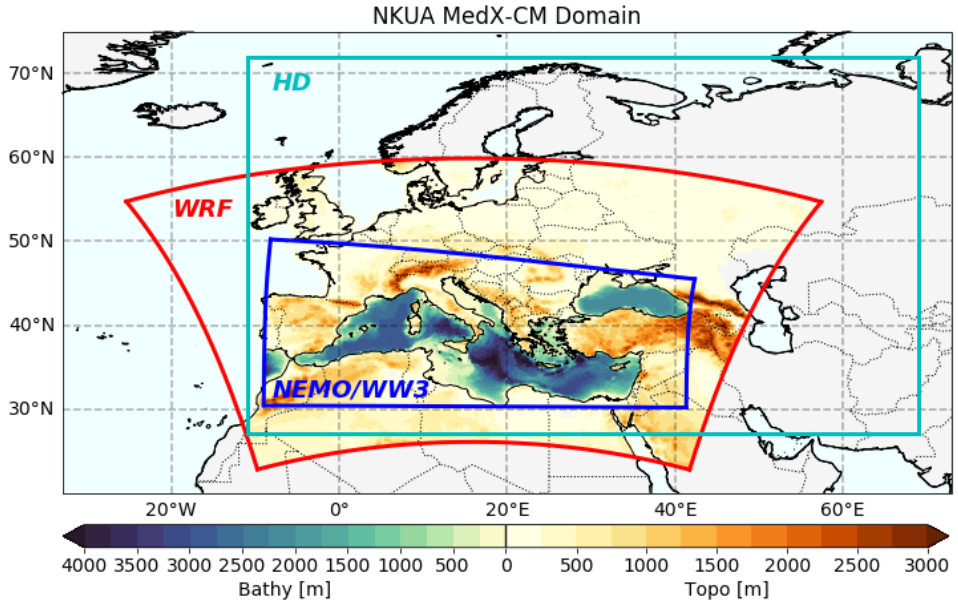

Figure 2. *Computational domain of the NKUA MedX-CM regional climate model, illustrating the spatial extent of its various components. Filled contours depict bathymetry within the NEMO ocean domain and topography within the WRF atmospheric domain.*

The MedX-CM coupled model has previously been executed on the GRNET ARIS HPC infrastructure (https://www.hpc.grnet.gr/en/) using 240 CPU cores across 12 nodes, with each simulation month requiring approximately 5 wall-clock hours. This CPU configuration was selected based on prior performance benchmarking, representing an optimal balance between computational load across coupled components, I/O throughput, and overall simulation efficiency. On the ECMWF Atos system, we intend to use 256 CPU cores (2 nodes) per job. This configuration maintains a similar core count while offering architectural advantages expected to improve performance, including (a) reduced MPI communication overhead due to fewer nodes, and (b) enhanced memory bandwidth and cache performance. Although MedX-CM has not

yet been benchmarked on the Atos architecture, we anticipate a moderate performance improvement of approximately 20%, reducing the wall-clock time per simulated month to around 4 hours. Table 1 summarizes the estimated computational and data storage requirements for each type of simulation run. Based on the scope and resolution of the planned experiments, we estimate a total request of 55 million SBUs and 55 TB of data storage, which we expect to be sufficient for the successful completion of the project.

Table 1. *Scheduled simulations of the NKUA MedX-CM system with estimated computational and data storage resources per run type.*

Run type	Period (years)	SBUs (approx.)	Storage (TB)
Evaluation (ERA5)	1980-2020 (40)	8M	10
Historical (CMIP6)	1960-2014 (54)	11M	15
SSP scenarios (x2)	2015-2100 (85) x2	35M	25
Model spinup, pre/post-processing, model evaluation, slurm job failures	-	1M	5

Technical characteristics of the code to be used

The main codes of the coupled system, i.e., for NEMO, WW3, WRF, and HD model, are parallelized using the MPI library. NEMO also employs a domain decomposition method, where the domain is divided into smaller subdomains to solve equations by addressing independent local problems. Each processor, with its local memory, computes the model equations over a subdomain (or tile) of the entire model domain. Similarly, WRF can run in parallel using both shared and distributed memory techniques by partitioning the simulation domain. For example, the grid can be divided into patches, with each assigned to different processors via MPI, and further subdivided into tiles processed by different threads using OpenMP.

The following packages/libraries are required to compile the above codes:
(i) compiler: intel, (ii) parallel: intel MPI, (iii) libraries: netcdf4, hdf5, szip, zlib, jasper.

Work plan and data sharing

The RECOMED project will be implemented over three years. The first year will focus on setting up the coupled NKUA MedX-CM model, performing test and tuning runs, and completing the historical/hindcast simulations using both ERA5 and CMIP6 forcings. The second and third years will be dedicated to the future scenario runs under SSP3-7.0 and SSP1-2.6. Throughout the project, we will carry out post-processing, perform model evaluation and diagnostics, disseminate results, and contribute to Med-CORDEX3 outputs.

The simulation outputs will be delivered in CF-compliant NetCDF format, following CORDEX metadata conventions and variable naming standards. The data will be accessible through ESGF nodes and the Med-CORDEX portal. Additionally, the project will provide climate indicators to support the broader scientific community, national climate services, regional risk assessments, and stakeholder-driven applications.

Our research team has extensive experience in numerical modelling on HPC systems and has previously participated in ECMWF Special Projects[2] [3] [4] [5].

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[2] https://www.ecmwf.int/en/research/special-projects/spgrverv-2016
[3] https://www.ecmwf.int/en/research/special-projects/spgrver2-2018
[4] https://www.ecmwf.int/en/research/special-projects/spgrver2-2021
[5] https://www.ecmwf.int/en/research/special-projects/spgrver2-2022