

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

Country/Organisation: Spain

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Project Title: High-resolution WRF modelling and multi-case attribution of heavy precipitation events (DANA / cut-off lows) in the Western Mediterranean

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.		
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?	X YES	

Computer resources required for project year:	2026	2027	2028
High Performance Computing Facility [SBU]	0	0	0
Graphics Processing Unit Cluster-A [GBU]	0	0	0
Graphics Processing Unit Cluster-B [GBU]	0	0	0
Accumulated data storage (total archive volume) ² [GB]	150	300	450

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	[#]	0	0	0
Total memory	[GB]	0	0	0
Storage	[GB]	0	0	0
Number of vGPUs ³	[#]	0	0	0

Continue overleaf.

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Extended abstract

All EMI R&D Project requests should provide an abstract/project description including a scientific plan, a justification of the computer resources requested and the technical characteristics of the code to be used. The completed form should be submitted/uploaded at <https://www.ecmwf.int/en/research/special-projects/special-project-application/special-project-request-submission>.

Following submission by the relevant Member State the EMI R&D Project requests will be published on the ECMWF website and evaluated by ECMWF and its Scientific Advisory Committee. The requests are evaluated based on their scientific and technical quality, and the justification of the resources requested. Previous EMI R&D Project reports and the use of ECMWF software and data infrastructure will also be considered in the evaluation process.

Requests exceeding 5,000,000 SBU should be more detailed (3-5 pages).

Scientific objective

This project investigates the sensitivity and evolution of high-impact heavy precipitation events (DANA / cut-off low episodes) in the Western Mediterranean under present-day and perturbed climate conditions, using high-resolution WRF numerical simulations. Beyond single-case attribution, the project's core objective is a multi-case comparative analysis: by simulating several independent extreme precipitation episodes with a consistent methodology, we aim to characterise how their intensity, spatial structure, and dynamical drivers would change under different global warming levels (GWL +1.5C to +4C) and emission scenarios (SSP1-2.6 to SSP5-8.5), following a Pseudo-Global Warming (PGW) approach based on Calvo-Sancho et al. (2026, Nature Communications).

Case studies

The project currently targets the following episodes, selected for their high societal and hydrological impact in Catalonia and the Ebre basin:

- 1-4 November 2024: DANA affecting the Valencia region and Catalonia (primary case, currently under study using ERA5 forcing).
- 28-29 September 2025: extreme rainfall in the Terres de l'Ebre (up to 305.9 mm/24h at Amposta), associated with the remnants of ex-hurricane Gabrielle.
- 5-8 March 2026: extensive precipitation event ('llevantada') affecting the prelitoral ranges of Catalonia (>200 mm accumulated, plus significant Pyrenean snowfall).

Additional comparable episodes identified in the same period (e.g. December 2025 and January 2026 events, also exceeding 200-250 mm) may be incorporated as the study progresses, to build a broader and more statistically robust sample for the comparative analysis. A data allocation margin beyond the currently identified episodes is therefore requested to accommodate this expected extension.

Methodology and technical characteristics

Simulations are performed with the WRF model (with WPS pre-processing: geogrid, ungrib, metgrid) on a Linux/Ubuntu environment. For each case, the workflow includes:

- Factual simulations, forced with reanalysis/operational-analysis initial and boundary conditions.
- Counterfactual (pre-industrial) simulations: PGW methodology, removing the estimated anthropogenic climate change signal (delta) calculated from 10 CMIP6 GCMs (difference between present climate 2009-2038 and pre-industrial baseline 1850-1879) for variables tas, ta, ts, hus.
- Future-scenario simulations: analogous PGW approach projecting each historical episode onto future warming levels (+1.5C to +4C) under SSP1-2.6 to SSP5-8.5 scenarios.

Model output is validated against dense surface observation networks (Meteocat XEMA/XOM, AEMET) via Inverse Distance Weighting interpolation, and cross-checked against independent precipitation products (CERRA, MSWEP, E-OBS). Post-processing uses Python (wrf-python, xarray, cfrib, cdsapi) and CDO, computing error metrics (MAE, RMSE, BIAS) to rank physical parameterization configurations (microphysics, PBL, surface layer, radiation) against observations.

Requested data and technical retrieval details

Initial and boundary conditions for the factual simulations are currently obtained from ERA5/ERA5-Land (0.25 deg). For the comparative multi-case analysis, access to the higher-resolution ECMWF Operational Analysis (IFS 0.1 deg, 6-hourly) via MARS is requested, to better resolve the fine-scale convective structure and moisture gradients that characterise these short, intense Mediterranean episodes, improving the consistency of cross-case comparisons.

Data will be retrieved for two adjacent sub-areas to avoid known technical issues at the 0 degree meridian in the WPS pre-processing chain:

- AREA_WEST: [50N, 15W, 25N, 0E]

- AREA_EAST: [50N, 0E, 25N, 15E]

The two sub-areas are subsequently merged into a single continuous domain covering the Western Mediterranean and Iberian Peninsula. For each case study, the retrieval period covers the full days of the event plus a 12-hour buffer before and after (to allow adequate model spin-up and avoid boundary discontinuities at simulation start/end):

- 1-4 Nov 2024 (DANA): 31 Oct 2024 12 UTC - 5 Nov 2024 00 UTC

- 28-29 Sep 2025 (Ebre floods): 27 Sep 2025 12 UTC - 30 Sep 2025 00 UTC

- 5-8 Mar 2026 (llevantada): 4 Mar 2026 12 UTC - 9 Mar 2026 00 UTC

Justification of requested resources

This request concerns data archive access only (MARS retrieval of IFS 0.1° HRES operational analysis for the listed episodes plus a reserve margin for additional cases); no ECMWF HPC or GPU computing resources are requested, as all WRF simulations are run on the applicant's own institutional infrastructure.