

REQUEST FOR A SPECIAL PROJECT 2024–2026

MEMBER STATE: Denmark

Principal Investigator¹: Ole Bøssing Christensen, special consultant, PhD

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Project Title: EURO-CORDEX2 simulations with Harmonie-Climate downscaling the IPSL GCM

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.) | 2024 | |
| Would you accept support for 1 year only, if necessary? | YES <input checked="" type="checkbox"/> | NO <input type="checkbox"/> |

| Computer resources required for project year: | 2024 | 2025 | 2026 |
|---|----------------|----------------|----------------|
| High Performance Computing Facility [SBU] | 10 million SBU | 10 million SBU | 10 million SBU |
| Accumulated data storage (total archive volume) ² [GB] | 40TB | 80TB | 120TB |

| EWC resources required for project year: | 2024 | 2025 | 2026 |
|---|------|------|------|
| 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.

Principal Investigator:

Ole Bøssing Christensen, special consultant, PhD

Project Title:

EURO-CORDEX2 simulations with Harmonie-Climate downscaling the IPSL GCM

Extended abstract

All Special 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 Special 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 Special 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).

This proposed special project will enable and facilitate a contribution from the DMI to the next generation of downscaling simulations over Europe, this time based on CMIP6 global climate models following the most recent set of greenhouse gas emission scenarios.

The Harmonie-Climate (HCLIM) Consortium is a collaboration between meteorological institutes of several European countries: Sweden, Finland, Norway, the Netherlands, Eire, Spain, Denmark, and Hungary. Building on the operational Harmonie model, a regional climate model has been constructed and is continually developed and enhanced (Belušić et al., 2020). The ECMWF Atos system is one of the main computing platforms for production simulations with this model.

The CORDEX project of the WCRP is a large international collaboration aiming for the construction of large climate model ensembles, where several GCMs simulating several emission scenarios are downscaled with regional climate models by participating institutions, with common definitions of integration domains, output variables, frequencies etc. See <http://cordex.org/>.

The European branch of CORDEX, EURO-CORDEX (<http://euro-cordex.net>) has organised a collection of more than 100 separate regional climate simulations for around 11 GCMs from CMIP5 and 10 RCMs. An enormous collaborative effort has been spent on the creation of this ensemble, and it has been analysed and used extensively as a means to estimate future climate change in Europe and not least uncertainties of these estimates (e.g., Jacob et al., 2020; Vautard et al., 2020; Coppola et al., 2021; Demory et al., 2020). The EURO-CORDEX CMIP5-based ensemble has been used extensively in impacts analyses, in climate services (e.g., www.klimaatlask.dk), and in assessments of climate change at regional level, for example in the IPCC AR6 Climate Atlas.

With the more recent SSP emission scenarios (Riahi et al., 2017) and the CMIP6 SSP-based global simulations (Eyring et al., 2016), it becomes necessary to work on replacing the first-generation EURO-CORDEX simulation with new ones. Just like the first generation ensemble, it will take considerable time and effort to generate a new ensemble with a sufficient amount of simulations to reliably quantify the model uncertainties associated with calculated metrics of climate change.

A list of 10 specific CMIP6 GCM simulations (Tab. 1) has been constructed as the main set of drivers of the second-generation EURO-CORDEX simulations. In the Harmonie-Climate community, several of these simulations are already under way, particularly at SMHI and at MET Norway.

| GCM name | Run |
|---------------|----------|
| MPI-ESM1-2-LR | r1i1p1f1 |
| NorESM2-MM | r1i1p1f1 |
| MIROC6 | r1i1p1f1 |
| MPI-ESM1-2-HR | r1i1p1f1 |

| | |
|---------------|-----------|
| CNRM-ESM2-1 | r1i1p1f2 |
| CESM2 | r11i1p1f1 |
| CMCC-CM2-SR5 | r1i1p1f1 |
| IPSL-CM6A-LR | r1i1p1f1 |
| EC-Earth3-Veg | r1i1p1f1 |
| UKESM1-0-LL | r1i1p1f2 |

Table 1. CMIP6 simulations to be downscaled in EURO-CORDEX2.

The contribution from the DMI should preferably be run at the ECMWF Atos system, as this is the place available at the moment for our institution, where the HCLIM model runs most efficiently. According to an agreement with the other HCLIM partners, we will downscale the IPSL-CM6A-LR simulations. In order to facilitate the production of this important regional-model ensemble member, we ask for a resource allocation as specified above. This corresponds, at our current estimate, to 250 model years of the EURO-CORDEX domain, i.e., a historical period followed by two different emission developments (SSP1-2.6 and SSP3-7.0).

The total domain (Fig. 1) consists of 480x480 points at 12.5 km grid distance, run at 450 sec. time steps. Each month requires 9000 SBU at the Atos system as currently set up, and delivers 35GB of output.



Figure 1. The HCLIM EURO-CORDEX domain.

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