

# REQUEST FOR A SPECIAL PROJECT 2022–2024

**MEMBER STATE:** Denmark

**Principal Investigator<sup>1</sup>:** Martin Olesen, Climate scientist, PhD

**Affiliation:** Danish Meteorological Institute

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**Other researchers:** Ole B Christensen, Senior Scientist, PhD, Danish Meteorological Institute

Ruth Mottram, Climate Scientist, PhD, Danish Meteorological Institute

**Project Title:** Polar Regions in the Earth System: Role of local-regional scale polar processes in the changing polar and global climate system (PolarRES)

If this is a continuation of an existing project, please state the computer project account assigned previously.	<b>SP</b> _____	
<b>Starting year:</b> (A project can have a duration of up to 3 years, agreed at the beginning of the project.)	2022	
<b>Would you accept support for 1 year only, if necessary?</b>	YES (X)	NO

<b>Computer resources required for 2022-2024:</b> (To make changes to an existing project please submit an amended version of the original form.)	2022	2023	2024
High Performance Computing Facility (SBU)	8.5 million	8.5 million	8.5 million
Accumulated data storage (total archive volume) <sup>2</sup> (GB)	12000	24000	36000

*Continue overleaf*

<sup>1</sup> 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.

<sup>2</sup> 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.

**Principal Investigator:**

Martin Olesen

**Project Title:**

Polar Regions in the Earth System: Role of local-regional scale polar processes in the changing polar and global climate system (PolarRES)

## Extended abstract

*The completed form should be submitted/uploaded at <https://www.ecmwf.int/en/research/special-projects/special-project-application/special-project-request-submission>.*

*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.*

*Following submission by the relevant Member State the Special Project requests will be published on the ECMWF website and evaluated by ECMWF as well as the Scientific Advisory Committee. The evaluation of the requests is based on the following criteria: Relevance to ECMWF's objectives, scientific and technical quality, and 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 asking for 3,000,000 SBUs or more should be more detailed (3-5 pages). Large requests asking for 10,000,000 SBUs or more might receive a detailed review by members of the Scientific Advisory Committee.*

The proposed special project is to provide new insights into key local to regional scale physical and chemical processes for atmosphere-ocean-ice interactions in the Arctic and Antarctic, their responses to, and influence on, projected changes in the global circulation and their implications for society and the environment. This is also the overall objective of the upcoming Horizon-2020 funded PolarRES project, where we will zoom into the climate of both Polar regions with state-of-the-art regional climate models (RCMs), run at unprecedented resolutions, to investigate the influence of projected changes in the global circulation on the climate of the Arctic and Antarctic. Polar in a global context. These teleconnections remain poorly understood, and thus climate change projections in Polar regions have large uncertainties and this hampers mitigation and adaptation efforts.

PolarRES proposes an innovative 'storyline' approach and novel analysis methods to address these challenges. We will accomplish this by exploiting the recent CMIP6 global climate model (GCM) projections and novel developments in GCMs such as variable resolution grids. High-resolution regional projections will be co-designed with and exploited by impact modellers to produce impact-relevant projections of future climate change for both Polar regions. PolarRES will combine these high-resolution simulations from state-of-the-art RCMs and next generation fully coupled RCMs with a comprehensive range of existing and novel observations including satellite products from relevant projects funded by the ESA Earth Observation Programme. The consortium consists of leading European groups in the areas of polar-lower latitude teleconnections, polar oceanography, meteorology, climatology, biogeochemistry, global climate modelling, and regional climate modelling in the Arctic and Antarctic. PolarRES will contribute to the EU Strategy on Climate Action and EU strategy for international cooperation in R&I.

**DMI has the following objectives in the project:**

We will contribute to build a detailed ensemble of polar climate projections at unprecedented spatial resolutions using RCMs to dynamically downscale GCMs selected. In PolarRES this will be done on the basis of their representation of circulation-based story lines identified in the project for both the Arctic and Antarctic (e.g. Storm tracks and SAM, respectively). Furthermore we aim to

determine the response of the Polar Regions to future circulation changes using high-resolution RCM climate projections.

We will use HARMONIE-Climate (HCLIM, Belusic et al., 2019), the regional climate model based on the HARMONIE numerical weather prediction model system (Bengtsson et al., 2017), using the AROME physics setup which allows for very high resolution, non-hydrostatic simulations.

The computational resources applied for in this Special Project will be used to perform these HCLIM simulations at the ECMWF HPC system.

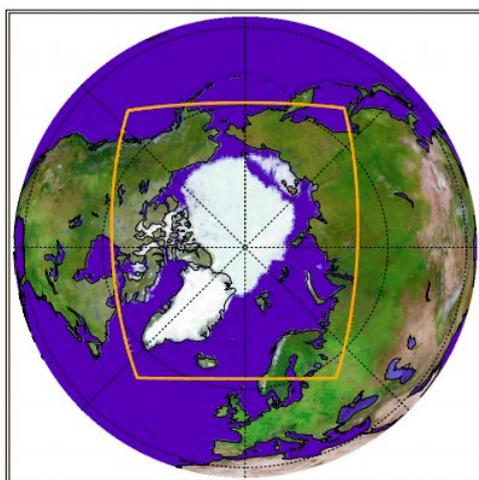


### **The Harmonie Climate setup and costs**

HCLIM will be set up with ALADIN physics for an Arctic domain defined within CORDEX (figure 1) in a 0.1 deg resolution forced with the GCM, EC-Earth version 3 for two transient 90 year periods for two different scenarios. The resources required for this simulation are as follows:

SBUs: 2 transient simulations ( $2 \times 90 \text{ yr} * 0.408 \text{ MSBUs/yr} = 73.44 \text{ MSBUs}$ ). This will be shared between 3 HCLIM members within PolarRES. Therefore the cost for DMI will be:  $73.44 \text{ MSBUs} / 3 = 24.5 \text{ MSBUs}$  corresponding to  $\sim 8.5 \text{ MSBUs}$  per year for a 3 year special project.

Storage:  $0.6 \text{ TB per simulated year} * 180 \text{ years} = 108 \text{ TB}$ . For DMI this accumulates to  $108 \text{ TB} / 3 = 36 \text{ TB}$  during the 3 year special project period.



*Figure 1: The circum-Arctic domain covered by high resolution, multi-model ensemble climate projection. Images taken from [https://cordex.org/wp-content/uploads/2012/11/CORDEX-domain-description\\_231015.pdf](https://cordex.org/wp-content/uploads/2012/11/CORDEX-domain-description_231015.pdf)*