LATE REQUEST FOR A SPECIAL PROJECT 2023–2025

MEMBER STATE: Netherlands

Principal Investigator[1]: Dr. Willem Jan van de Berg

Affiliation: Utrecht University
Institute for Marine and Atmospheric Research Utrecht (IMAU)

Address: Princetonplein 5
3584 CC, Utrecht
The Netherlands
+31 30 253 3273

Other researchers: Dr. Peter Kuipers Munneke, Dr. Christiaan van Dalum, Dr. Carleen Reijmer, Dr. Linda Gavras-van Gareren, Dr. Kristiina Verra, Dr. Valeria Di Biase, Max Brils MSc, Dr. Maurice van Tiggelen, Sanne Veldhuijsen MSc (IMAU/UU), Dr. Erik van Meijgaard (KNMI)

Project Title:

Bipolar regional climate projections

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SPNLBERG**	
Starting year: (A project can have a duration of up to 3 years, agreed at the beginning of the project.)	2023	
Would you accept support for 1 year only, if necessary?	YES ☒	NO ☐

Computer resources required for the years: (To make changes to an existing project please submit an amended version of the original form.)		**2023**	**2024**	**2025**
High Performance Computing Facility	(SBU)	27.700.000		
Accumulated data storage (total archive volume)[2]	(GB)			

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.

Principal Investigator: Dr. Willem Jan van de Berg

Project Title: Bipolar regional climate projections

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).

The core of the SPNLBERG projects are simulations with the polar regional atmospheric climate model RACMO. In the fall of 2023, after two years of model development, the new version 2.4.1 became ready for production. As proposed and motivated in the SPNLBERG project proposals for 2023 and 2024, this model version is used to dynamically downscale ERA5 and CMIP6 weather over Antarctica, Greenland, and the Arctic to estimate in more detail the climate of these regions. Furthermore, we estimate with RACMO the surface mass balance - the local accumulation or loss of snow and ice - of the Antarctic and Greenland Ice Sheet as well as all other glaciated areas in the Arctic and of the islands in the South Atlantic Ocean nearest to Antarctica.

Ongoing and planned simulation for December 2023

1) An ERA5 forced RACMO2.4.1 simulation for Antarctica, at ~11 km horizontal resolution.

This simulation has been started in 1960 and will run until 1 October 2023. The simulation is using the new Antarctic CORDEX domain. This simulation, once analysed, will become our core product of the estimated climate and surface mass balance over Antarctica and its glaciated regions, and is expected to be used in many studies like the ongoing IMBIE project (e.g., Otosaka et al., 2023; Shepherd et al., 2018). All data of this simulation, and the other simulations listed below, will be made publicly available after quality control.

Currently (4/12/2023), this simulation has reached AD 1989, so 34 years are yet to be completed. One model year requires about 500.000 SBU, so 17.0 million SBU are needed to complete this simulation.

2) An ERA5 forced RACMO2.4.1 simulation for the Arctic, at ~11 km horizontal resolution.

This simulation has been started in 1980 and will be continued until 1 October 2023. The simulation is using the new Arctic CORDEX domain. This simulation is part of our commitment for the ongoing EU H2020 project PolarRES. Results will be used, for example, to drive permafrost models.

Currently (4/12/2023), this simulation has reached AD 1998, so 25 years are yet to be completed. One model year requires about 350.000 SBU, so about 8,8 million SBU are needed to complete this simulation.

3) An ERA5 forced RACMO2.4.1 simulation for the Greenland Ice Sheet, at ~5.5 km horizontal resolution

This simulation will be started in 1940 after a 5-year spin-up. The simulation will be extended to the end of 2023. This domain covers, besides the Greenland Ice Sheet, also Iceland, Svalbard, and the Canadian Arctic Archipelago. It will become our primary surface mass balance product for the Greenland Ice Sheet and the glaciers in this region and is expected be used in numerous studies.

This simulation is not yet started. Therefore, running this simulation is expected to extend well into 2024. Currently, we run RACMO2.4.1 on 8 nodes, thus 1024 cores, so running RACMO one physical day on the

ATOS HPCF costs about 500.000 SBU, with about 25 run-days left, about 12.5 million SBU is needed to start running this simulation in 2023.

4) An CESM2 driven historical RACMO2.4.1 simulation for Antarctica, at ~5.5 km horizontal resolution.

This simulation will be started in 1985, branching off from the ERA5 simulation, and will be extended to the end of 2014. In 2024, we will extend this simulation until 2100 following the SSP3-7.0 scenario. This simulation is also part of our committed contribution to the ongoing EU H2020 PolarRES project.

This simulation is not yet started, and we plan to run 10 years of this simulation in 2023. Therefore, with a cost of 500.000 SBU per model year, we require 5 million SBU to run this first decade of the simulation.

Required budget for 2023

To perform all these simulations in the remainder of 2023, we require a total of 46,5 million SBU. Currently (4/12/2023), 15,6 million SBU is still available in the SPNLBERG budget for 2023. So, 27,7 million SBU would be required to complete these plans of 2023.

References

Otosaka, I. N., Shepherd, A., Ivins, E. R., Schlegel, N.-J., Amory, C., van den Broeke, M. R., Horwath, M., Joughin, I., King, M. D., Krinner, G., Nowicki, S., Payne, A. J., Rignot, E., Scambos, T., Simon, K. M., Smith, B. E., Sørensen, L. S., Velicogna, I., Whitehouse, P. L., . . . Wouters, B. (2023). Mass balance of the Greenland and Antarctic ice sheets from 1992 to 2020. *Earth System Science Data*, *15*(4), 1597-1616. https://doi.org/10.5194/essd-15-1597-2023

Shepherd, A., Ivins, E., Rignot, E., Smith, B., van den Broeke, M., Velicogna, I., Whitehouse, P., Briggs, K., Joughin, I., Krinner, G., Nowicki, S., Payne, T., Scambos, T., Schlegel, N., A, G., Agosta, C., Ahlstrøm, A., Babonis, G., Barletta, V., . . . The, I. t. (2018). Mass balance of the Antarctic Ice Sheet from 1992 to 2017. *Nature*, *558*(7709), 219-222. https://doi.org/10.1038/s41586-018-0179-y