SPECIAL PROJECT PROGRESS REPORT

Progress Reports should be 2 to 10 pages in length, depending on importance of the project. All the following mandatory information needs to be provided.

Reporting year 2018

Project Title: Present-day and future climate of Antarctica and Greenland modelled with RACMO2.

Computer Project Account: SPNLBERG

Principal Investigator(s): Dr. W. J. van de Berg

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

Name of ECMWF scientist(s) collaborating to the project
(if applicable)

Start date of the project: 1-1-2018

Expected end date: 1-1-2019

Computer resources allocated/used for the current year and the previous one

(if applicable)
Please answer for all project resources

		Previous year (preceding project)		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	40.000.000	28.585.423	30.000.000	8.533.220
Data storage capacity	(Gbytes)	210.000	655.285	125.000	754.254

Summary of project objectives

(10 lines max)

For all low-lying coastal zones across the globe, sea level rise due to significant mass loss from the Antarctic Ice Sheet (AIS) and the Greenland Ice Sheet (GrIS) is the largest threat associated with projected climate change. In this project, the polar version of the regional climate model RACMO2 is used to simulate historic and future AIS and GrIS surface mass balance – the mass fluxes due to precipitation accumulation, sublimation and meltwater runoff. Firstly, updated estimates of the recent contribution of surface mass loss from GrIS have been provided. Furthermore, a future climate runs (1980-2100) for the AIS and GrIS will be carried out. Finally, a novel snow albedo scheme is being implemented, tested and evaluated. The runs will provide new insights in the driving aspects of the current and future contribution of the AIS and GrIS to global sea level rise.

Summary of problems encountered *(if any)*

(20 lines max)

The execution of the planned climate projection runs have been severely delayed because the release of CESM2, the Earth System Model we will use to drive the simulations, has been delayed from early 2017 to June 2018. We decided to wait for the final version of CESM2 for two reasons. Firstly, CESM2 is expected to provide a more accurate description of current and past polar climate in comparison to many other Earth System Models. Secondly, our research group contributed to the development of CESM2 with a focus on the improved representation of the climate of the large ice sheets.

As a result, the RACMO2 simulations driven by CESM2 that were planned for 2017 will be carried out in the remainder of 2018. These consist of a reference (1980-2010) CESM2 driven simulation and two climate projections up to 2100 using the SSP1-26 and SSP5-85 scenarios. As the CESM2 code is now finally released, no further delays are expected.

Finally, the slower than expected release of ERA5 dataset affects also our planning of simulations.

Summary of results of the current year

(from July of previous year to June of current year)
This section should comprise 1 to 8 pages and can be replaced by a short summary plus an existing scientific report on the project

Discussed here are the results achieved in 2018. Results from the SPNLBERG allocation for 2017 are discussed in the final report of the SPNLBERG 2017 project

Greenland Ice Sheet

In 2018, we completed a 5.5 km resolution 1958-2017 run resolving the Greenland Ice Sheet (GrIS) and its peripheral glaciers and ice caps. This simulation was driven by ERA-40 (1958-1978) and ERA-Interim (1979-2016) as the ERA5 data set was not timely available. After completion of the simulation, the daily surface mass balance (SMB) is statistically downscaled to 1 km following the procedure described by Noël et al (2016). A rerun of the simulation using ERA5 data has been cancelled due to the limited differences observed between ERA5 and ERA-Interim driven simulations for the GrIS (X. Fettweis, ULG, Belgium, personal communication).

The higher resolution used for this run, compared to the default resolution of 11 km for the GrIS, allows to resolve the ablation zone - where the surface mass balance (SMB) is negative - of the GrIS in much more detail (Fig. 1). Furthermore, many more “small” glaciers and ice caps are resolved. An evaluation of the modelled and statistically downscaled shows that both the modelled and statistically downscaled SMB agrees better with observations than the equivalent data from the 11 km simulation (Fig 2). For many observations, both the 11 km and 5.5 km run give good SMB estimates. However, for a substantial fraction of the observations, the ablation is underestimated by RACMO2. This underestimation has been reduced in the 5.5 km run. As a result, the statistical downscaled SMB from 5.5 km data correlates better with observations than the equivalent product from 11 km data. Seeming exceptions are the modelled SMBs for QAS_L, located in South Greenland; stars denote the different SMBs of subsequent years. The ablation zone at this location is rather narrow and the SMB gradient of elevation is steep due to the local low albedo of glacier ice, only 0.2, and large precipitation gradients. In both runs melt and subsequent runoff are underestimated. Nevertheless, this local bias is well corrected in the statistical downscaling step largely removing the local deviations.

This data is not yet formally published but it is already being shared with (international) collaborators. Furthermore, as the output of this simulation is clearly superior to the output of the 11 km simulation, this data will be used in our following publications on the climate and SMB of the GrIS.

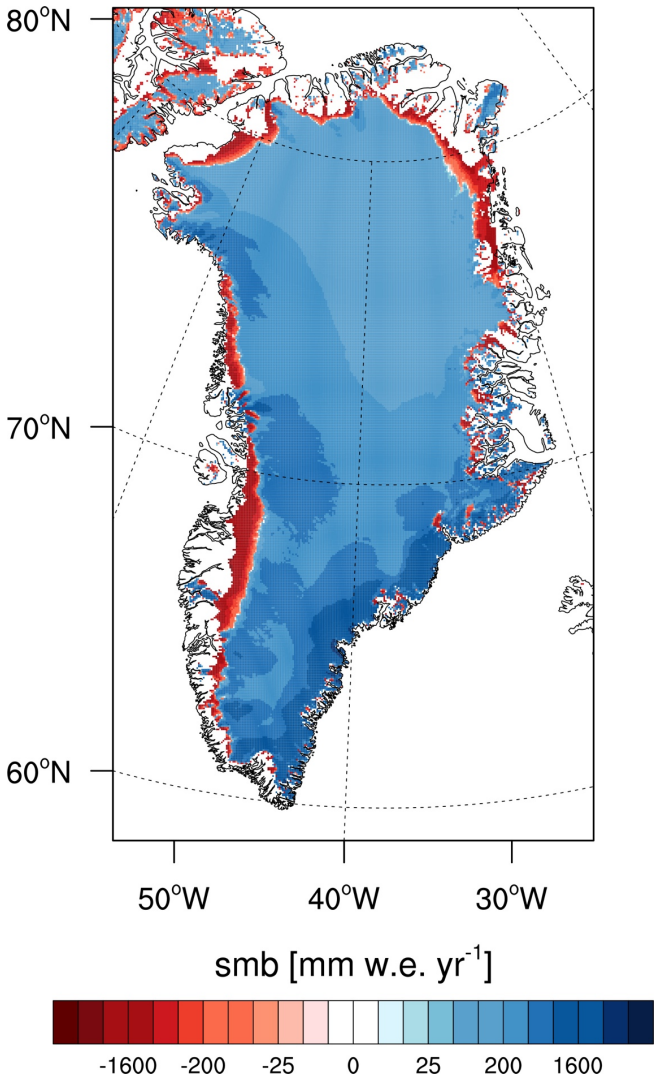

Figure 1: Mean modelled surface mass balance (SMB) for 1958-2017.

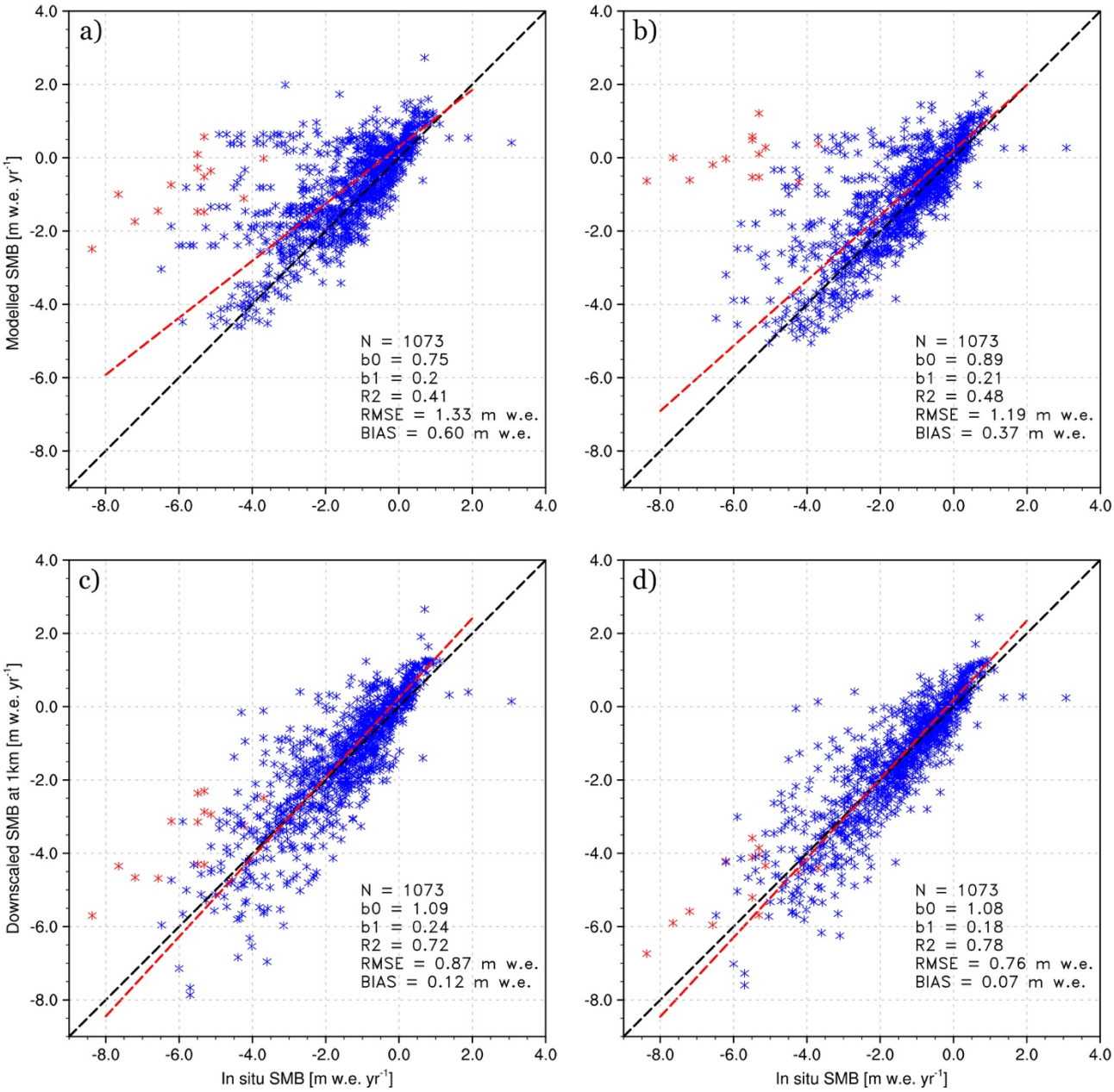

Figure 2: *Evaluation of* ***(a,b)*** *modelled and* ***(c,d)*** *statistically downscaled SMB from the* ***(a,b)*** *11 km and* ***(c,d)*** *5.5 km RACMO2.3p2 simulations against all available in situ SMB observations. Red squares mark SMB observations from the PROMICE station QAS_L located in south Greenland (61.03° N, 46.84° W).*

Overview of used computer resources

Model	Simulation	Resources (million SBU) Requested	Used so far
RACMO2	Greenland, 5.5 km, 1958-2017, driven by ERA-40 and ERA-Interim		6.6
	Completion of other runs started in 2017		1.9
	Greenland, 5.5 km, 1958-2017, driven by ERA5	8.7	*Cancelled*
	Antarctica, 18 km, 1979-2016, driven by ERA5	4.2	*Delayed by ERA5*
	Antarctic Peninsula, 5.5 km, 1980-2100, CESM2 driven	15.0	*Postponed to 2019*
	Greenland, 11 km, climate projections, CESM2 driven		*Planned for 2018*
	Antarctica, 27 km, climate projections, CESM2 driven		*Planned for 2018*
	Model development	1.0 to 2.0	*Negligible*
Total		30.0	8.5

Usage of storage on ECFS by spnlberg users is significantly higher than requested because also model output derived and stored on ECFS in the preceding years count. All spnlberg users will actively remove older and outdated model output from ECFS.

List of publications/reports from the project with complete references

Data from the 5.5 km simulation of the Greenland Ice Sheet has not yet been used in a publication. An recent brief overview of papers in which polar RACMO2 data is used is given in the final special project report of the preceding project in 2017.

Summary of plans for the continuation of the project

(10 lines max)

- For the remained of 2018, we plan to carry out the CESM2 driven historic and future climate simulations of Greenland and Antarctica. The CESM2 runs required to drive RACMO will be launched early August this year on Dutch supercomputer facilities. After quality control, it is expected that early September the historic (1980-2010) RACMO2 simulations for the GrIS and AIS can be launced on the ECMWF HPCF.
- Online implementation of the spectral albedo scheme TARTES nears it completion. Several test runs will be carried out for code verification and tuning.
- An ERA5 driven RACMO2.3p2 simulation for 1979-2017 covering the Antarctic Ice Sheet will be executed once all the required ERA5 data are released and tests have shown that ERA5 provides a noticeable better-represented climate and SMB.