SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

Reporting year	2024……………………………………………………
Project Title:	Freshwater influence on the Atlantic Meridional Overturning Circulation
Computer Project Account:	spiesemm…………………………………………….……
Principal Investigator(s):	Tido Semmler
Affiliation:	Met Eireann
Name of ECMWF scientist(s) collaborating to the project (if applicable)	N/A……………………………………………..…… ……………………………………………………..……
Start date of the project:	01.01.2024…………………………………………..……
Expected end date:	31.12.2025……………………………………………..……

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

(if applicable)

Please answer for all project resources

		Previous year		**Current year**	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	N/A	N/A	100,000,000	2,000,000
Data storage capacity	(Gbytes)	N/A	N/A	0	0

Summary of project objectives (10 lines max)

Since the fate of the Atlantic Meridional Overturning Circulation (AMOC) is very crucial for the climate of Northwestern Europe, it is imperative to include the influence of the increasingly melting Greenland ice sheet and its freshwater contribution on the ocean circulation. Since it is known that the ocean model resolution plays a major role in how the additional freshwater is distributed in the main convection areas Labrador Sea and Nordic Seas, this project aims to address the sole influence of the additional Greenland ice sheet freshwater contribution on these convection areas and the wider ocean circulation in a very high resolution of 4-5 km in these key areas. In addition, since the AMOC is part of the global ocean circulation and known to be influenced by Antarctic ice sheet melting in addition, its influence will be investigated first without any extra Greenland ice sheet melting and then with both increased Greenland and Antarctic ice sheet melting.

Summary of problems encountered (10 lines max)

A major problem is the computational performance of the Alfred Wegener Institute Climate Model version 3 (AWI-CM3). Compared to the high-performance computer Levante at the German Climate Computing Centre (DKRZ), the model runs about 3 times slower and would use 3 times more computing resources than anticipated in the original project proposal. The ECMWF support did not have the human resources to help with this up to now. For this reason, hardly any computing time has been used. Instead, the most recent Greenland runoff dataset by Igneczi and Bamber (2024) based on sophisticated downscaling methods that gives regional details about the runoff distribution on catchment area basis rather than an aggregated estimate around large stretches of the Greenland coast has been investigated. Regional details as well as the seasonal cycle of the meltwater input have been shown to have important consequences for the ocean circulation.

Summary of plans for the continuation of the project (10 lines max)

Now, that the ECMWF support has offered dedicated support, test simulations with the AWI-CM3 are ongoing. In addition, the new dataset by Igneczi and Bamber (2024) will be prepared as input for the Greenland freshwater input experiment. Once the computational performance is satisfactory, first short test simulations with the additional Greenland freshwater input will be performed as sanity checks before going to the production runs set out in the original proposal. Subsequently, first the Antarctic freshwater input experiments and then the combined Greenland and Antarctic freshwater input experiments will be prepared and carried out.

List of publications/reports from the project with complete references

N/A

Summary of results

Main points of the investigation of the most recent Greenland freshwater input data set are:

In the beginning of the period from 1950-2021, there is multi-decadal variability in the runoff dataset by Igneczi and Bamber (2024). Only over the last two decades, the Greenland runoff has substantially increased (Fig. 1a), in terms of percentage mainly at the north coast (Fig. 2) because in the beginning of the period runoff was negligible.

(a) (b)

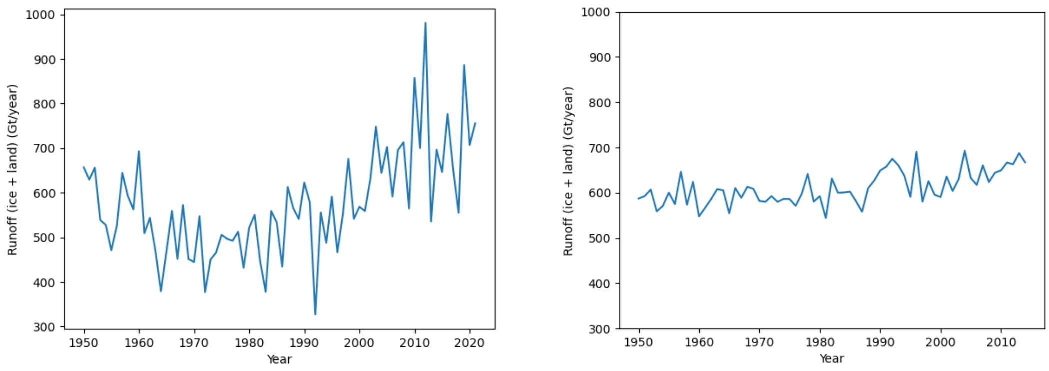

Fig. 1: Yearly mean runoff summed over the coast of Greenland from (a) Igneczi and Bamber (2024), (b) AWI-CM3 baseline simulation.

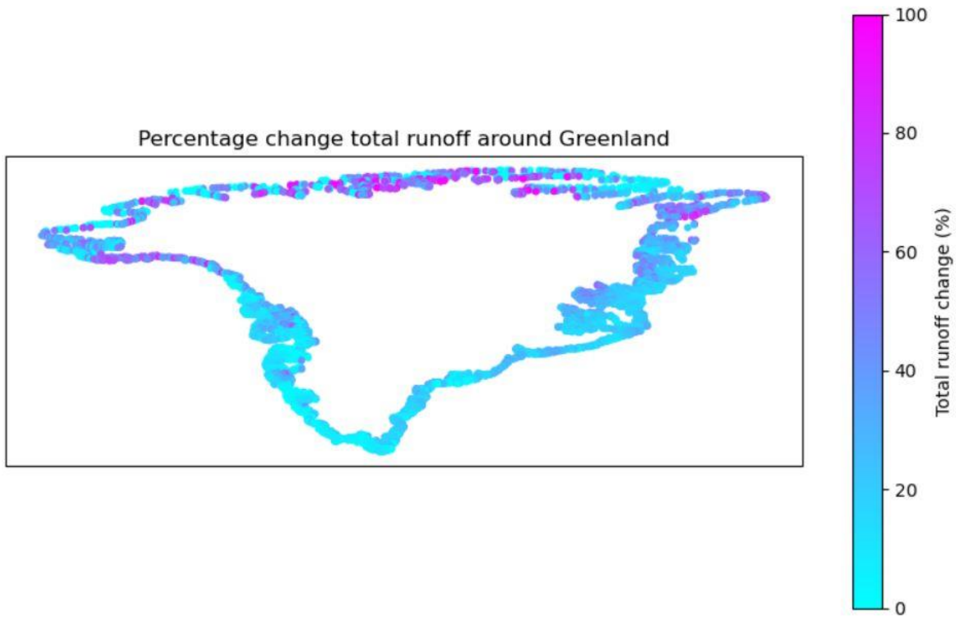

Fig. 2: Increase in runoff from Greenland 1991-2020 compared to 1961-1990 from Igneczi and Bamber (2024)

The annual cycle of runoff is less pronounced in the AWI-CM3 baseline simulation compared to Igneczi and Bamber (2024) (not shown). This baseline simulation has been performed at Levante (DKRZ) by Martina Zapponini from Alfred Wegener Institute in Bremerhaven (Germany) without any adjustment of the Greenland runoff. Furthermore, there is far less interannual to multi-decadal variability in the AWI-CM3 baseline simulation (Fig. 1b) compared to Igneczi and Bamber (2024) (Fig. 1a) and no spatial variation by design in the baseline simulation. There only is a slight increase in the Greenland runoff in the recent decades. Therefore, changing the variability in time and space as well as changing the trend towards the end of the historical time period and beyond this into the future, has the potential to influence the ocean circulation.

Reference:

Igneczi, A., J. Bamber (2024): Pan-Arctic land-ice and tundra meltwater discharge database from 1950 to 2021 [dataset]. PANGAEA, https://doi.pangaea.de/10.1594/PANGAEA.967544