SPECIAL PROJECT PROGRESS REPORT

Reporting year	2024
Project Title:	Tipping points of the Antarctic Ice Sheet in EC-Earth-PISM
Computer Project Account:	ita4210
Principal Investigator(s):	Irene Trombini
Affiliation:	University of Bologna, CNR ISAC
Name of ECMWF scientist(s) collaborating to the project (if applicable)	…… ……
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

		Current year	
	units	Allocated	Used
High Performance Computing Facility	(SBU)	21 500 000	23 492
Data storage capacity	(Gbytes)	32 250	19

Summary of project objectives

The project aims to investigate key aspects and consequences of the tipping behavior of the West Antarctic Ice Sheet (WAIS) and East Antarctic Subglacial Basins (EASB). It is ment to determine the temperature thresholds for these regions and assess the potential for temporary overshoots without causing irreversible ice loss. Additionally, the project will examine whether meltwater input from Antarctic ice loss can induce abrupt changes in the Antarctic Overturning Current (AOC) and Atlantic Meridional Overturning Circulation (AMOC), potentially leading to tipping cascades. The project will perform two sets of simulations: one for abrupt stabilization and one for overshoot scenarios. The simulations are performed with the PISM ice sheet model coupled with a low resolution version of the EC-Earth climate model (EcEarth-FAST), along with the intermediate complexity GCM SPEEDY-NEMO.

Summary of problems encountered

As EcEarth-FAST is not available yet to be used, we performed first test-runs with EcEarth4 (to get familiar with the model) and SPEEDY-NEMO.

Summary of plans for the continuation of the project

As EcEarth-FAST is not available yet to be used, for the remaining part of 2024 we plan to

- proceed with exploring of the potential of using SPEEDY-NEMO by:
  - performing test runs of a modified version of SPEEDY-NEMO that allows meltwater injection in the ocean module
- get familiar and perform a modified version of the proposed simulations with EcEarth3-PISM by:
  - porting of the necessary boundary conditions and restart fields for a spun up version of the Antarctic Ice Sheet on ATOS

- test runs of PISM stand-alone for the Antarctic Ice Sheet
- runs and analysis of PISM stand-alone forced by the SSP5-8.5 abrupt stabilization scenario
- porting and first test runs with EcEarth3
- test runs of EcEarth3-PISM in coupled configuration for the Greenland Ice Sheet (already available and runned by other members of the team)
- test runs of EcEarth3-PISM in coupled configuration for the Antarctic Ice Sheet

List of publications/reports from the project with complete references

N/A

Summary of results

Due to delays in the project approval process, resources were made available only from end of February 2024. Despite this delay, we were able to make the following progress to date. The SPEEDY-NEMO model, provided by P. Ruggieri from the University of Bologna, was successfully ported to the ECMWF HPC system with guidance from A. Bellucci (CNR ISAC, Special Project BONSAI). This process involved loading the necessary libraries for compiling the different model components, including the coupling software, adjusting the runscript, and compiling the model. We familiarized ourselves with SPEEDY-NEMO and conducted initial test runs for pre-industrial climate to ensure the model operates correctly. Additionally, we developed and customized the post-processing of the model output to meet the needs of our project.

Similarly, for the EcEarth4 model, we successfully ported it to the system following guidance from P. Davini (CNR ISAC) and completed initial test runs to confirm its proper functionality. We further familiarized ourselves with the bash script used for running EcEarth in a coupled configuration with PSIM. This script was provided by Christian Rodehacke of the Danish Meteorological Institute (DMI).

These accomplishments have established a good foundation for the subsequent phases of our project.