# 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**

2025

**Project Title:**

LIMALOC: Long-term Impact of Meltwater from Antarctica on Large-scale Oceanic Circulations

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**Computer Project Account:**

spittro2

**Principal Investigator(s):**

Irene Trombini

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**Affiliation:**

University of Bologna

National Research Council, Institute of Atmospheric Sciences and Climate (CNR-ISAC)

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

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**Start date of the project:**

……01.01.2025……

**Expected end date:**

……31.12.2027……

## 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) | - | - | 7’750’000 | 168’000 |
| **Data storage capacity** | (Gbytes) | - | - | 17’500 | 0 |

## Summary of project objectives (10 lines max)

The LIMALOC project aims to investigate the long-term impact of Antarctic meltwater on large-scale oceanic circulations, particularly the Antarctic Circumpolar Current (ACC) and the Atlantic Meridional Overturning Circulation (AMOC). Using the EC-Earth3 model, the project aims at comparing prescribed meltwater forcing (hosing experiments) with simulations where meltwater is computed interactively via coupling with the PISM ice sheet model. It explores how two-way coupling affects meltwater fluxes and their climatic consequences under different SSP scenarios. By extending simulations beyond 2100, LIMALOC assesses multicentennial responses and the role of internal Southern Ocean variability. The project also aims to complete the SOFIAMIP Tier 2 experiment suite and eventually use simplified models to perform computationally efficient, long-term simulations. Ultimately, LIMALOC contributes to understanding how meltwater from ice sheets could influence future ocean circulation stability under climate change.

## Summary of problems encountered (10 lines max)

- Availability of working version of EC-Earth3-PISM

- Use of netcdf parallel module during runtime in EC-Earth3-OPTIMESM (especially for writing NEMO data), both for AOGCM and for AOGCM+Meltwater emulator versions.

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

If a version of EC-Earth3 with interactive ice sheets is not available during the project period, simulations with prescribed freshwater will be compared to simulations using the Meltwater Emulator for the Antarctic Ice Sheet, developed by Van der Linden et al. (in preparation), with whom we are actively collaborating.
The development described below, that will be performed in the next months, will enable a cleaner comparison between experiments with prescribed freshwater forcing and those using the Antarctic meltwater emulator in the latest version of EC-Earth3.
It is also essential for conducting TIMIP-AMOC experiments, which assess AMOC stability under overshoot scenarios. This development is required for experiment A of the TIMIP-AMOC protocol, which the EC-Earth community has committed to run.

## List of publications/reports from the project with complete references

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## Summary of results

If submitted **during the first project year**, please summarise the results achieved during the period from the project start to June of the current year. A few paragraphs might be sufficient. If submitted **during the second project year**, this summary should be more detailed and cover the period from the project start. The length, at most 8 pages, should reflect the complexity of the project. Alternatively, it could be replaced by a

short summary plus an existing scientific report on the project attached to this document. If submitted **during the third project year**, please summarise the results achieved during the period from July of the previous year to June of the current year. A few paragraphs might be sufficient.

In the first months of the project I installed, compiled and configured EC-Earth3 in the OPTIMESM version (post CMIP6 version) and got familiar with the model. I carried out test runs and resolved technical issues for the following configurations: AOGCM alone, AOGCM with the Antarctic meltwater emulator, and AOGCM coupled with PISM for the Greenland Ice Sheet. These efforts ensure that piControl experiments can now be successfully run with each configuration.

The next near-term objective (by September 2025) is to port the hosing code from the EC-Earth3 CMIP6 version to the OPTIMESM version. This will require a small development step to harmonize the sbcfwf.F90 routine in the NEMO ocean component. The implementation will be tested in piControl runs.This development is instrumental for enabling comparisons between SOFIAMIP hosing experiments and simulations under similar conditions using the Meltwater Emulator for Antarctica.

In parallel, the full Earth System Model configuration—including vegetation, ocean biogeochemistry, and the $CO_2$box module—will be tested. With the full model in place, ramp-up and ramp-down emissions experiments will be conducted to validate the final configuration for the TIMIP AMOC runs.