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	2023
Project Title:	AMOC decline and recovery under strong warming and overshoot scenarios
Computer Project Account:	spitmehl
Principal Investigator(s):	Oliver Mehling
Affiliation:	Politecnico di Torino, Italy
Name of ECMWF scientist(s) collaborating to the project (if applicable)	–
Start date of the project:	01/01/2023
Expected end date:	31/12/2024

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)	–	–	22,500,000	0
Data storage capacity	(Gbytes)	–	–	45,000	0

Summary of project objectives (10 lines max)

This Special Project aims at improving our understanding of the long-term evolution of the Atlantic Meridional Overturning Circulation (AMOC) under strong future anthropogenic forcing. To this end, we will extend CMIP6 simulations with the EC-Earth3 model beyond the 21st century for two scenarios: a high-end emission scenario (SSP5-8.5) and an "overshoot" scenario (SSP5-3.4-OS). Because meltwater input from the Greenland Ice Sheet (GrIS), which has previously been shown to increase the probability for an AMOC collapse in the 22nd and 23rd centuries, is not well-represented in the current generation of climate models, we also compare the AMOC evolution with and without a newly implemented simplified parametrization for GrIS meltwater.

Summary of problems encountered (10 lines max)

No major problems have been encountered so far.

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

We plan to start the simulations in September 2023, beginning with the extension of SSP5-8.5 simulations beyond 2100. Taking into account that the separation of AMOC strength becomes already quite clear in 2150 (Fig. 2), we plan to first extend a larger number of ensemble members for 50 years, before re-selecting a smaller number of members to be extended to 2300. Given that the meltwater parametrization will need to be newly implemented, during the remainder of first project year we will use the HPC resources mainly for our proposed simulations with the standard GCM configuration of EC-Earth3.

List of publications/reports from the project with complete references

No publications so far.

Summary of results

The Special Project was granted in late February and the planned simulations have not started yet. So far, we have compiled the model on Atos, and discussed the model setup and availability of restart files with SMHI, who performed a large ensemble (SMHI-LENS) with EC-Earth3. To select suitable members for our extended SSP simulations from the 50-member SMHI-LENS, we analyzed the trend and low-frequency variability of AMOC strength in the existing SSP5-8.5 simulations up to 2100. Based on these criteria, we identified several members that should be representative for the range of possible outcomes for the AMOC also beyond the 21st century (e.g., Fig. 1).

In addition, we computed the AMOC strength in a set of ScenarioMIP simulations with EC-Earth3-Veg, for which one ensemble member per scenario (2 members for SSP5-8.5) has recently been extended to 2300 (Fig. 2). We find that the separation between scenarios becomes much clearer in 2150 compared to 2100, which motivates extending a larger number of ensemble members until 2150 at first.

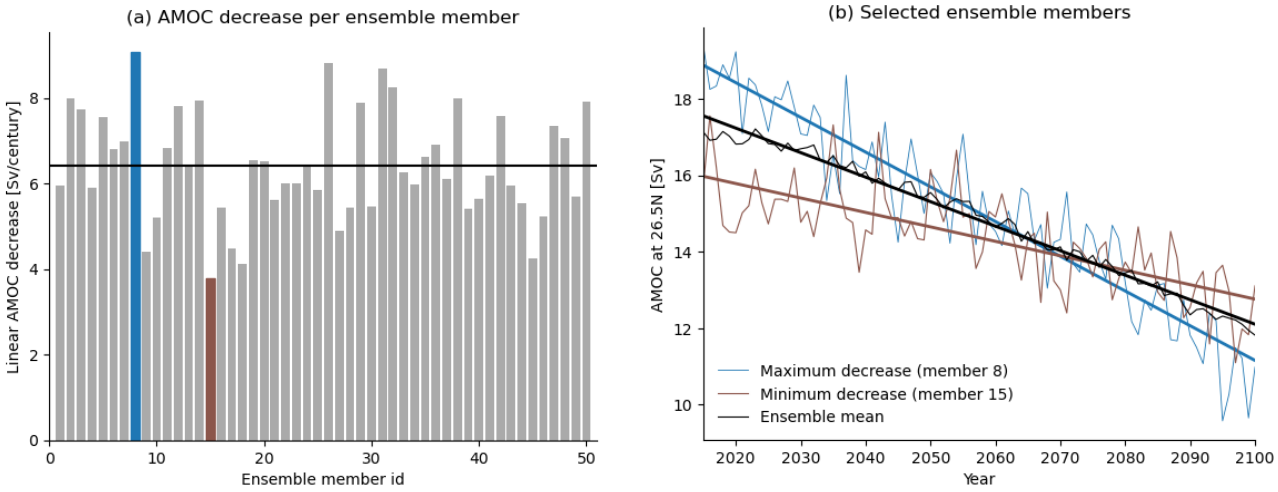

Fig. 1: (a) AMOC decrease in the EC-Earth3 SSP5-8.5 ensemble (2015-2100). The AMOC decrease was obtained by linear regression on the AMOC strength at 26.5°N for each ensemble member. The two members from panel b are highlighted. **(b)** AMOC time series and linear fits for the ensemble member with the strongest decrease (#8), the member with the weakest decrease (#15), and the ensemble mean. (AMOC time series kindly provided by Klaus Wyser, SMHI)

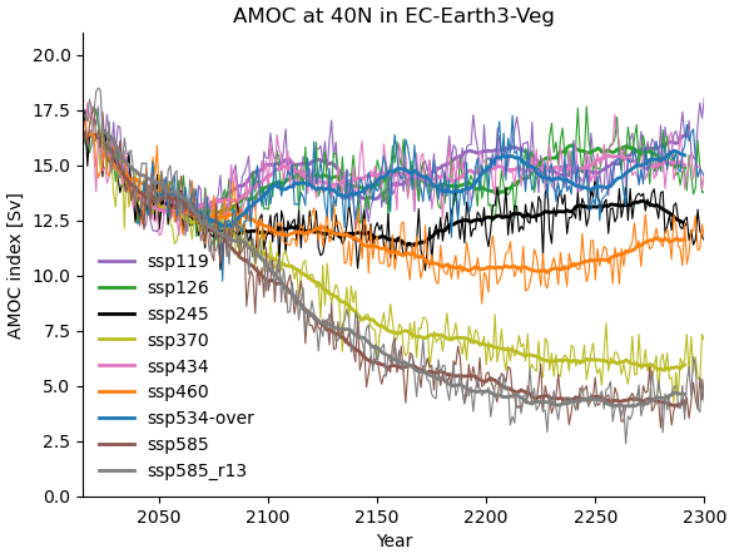

Fig. 2: AMOC strength at 40°N in the extended SSP simulations with EC-Earth3-Veg.