Project: 1313
Project title: Horizon EU-project EPOC [**E**xplaining and **P**redicting the **O**cean **C**onveyor]
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Report period: 2024-05-01 to 2025-04-30

Project and computational overview

This project aims to develop a conceptual framework of the Atlantic Meridional Overturning Circulation (AMOC), understanding the key processes responsible for maintaining or breaking meridional connectivity of ocean transport [WP2], identifying processes and drivers of recent change in AMOC and inferring the role of external forcing [WP3]. Additionally, it evaluates the key processes and feedback for future changes in AMOC [WP4].

For WP2, we conduct two **EPOC simulations: a control run for the period 1990-2024 with fixed 1990-forcing and a historical run with transient forcing for the same period.** The EPOC configuration is based on ICON-Sapphire, with a uniform R2B8 (10 km) grid in the atmosphere with 90 vertical levels that is coupled to a telescoping R2B9 grid with 72 levels in the ocean, achieving approximately 1.8 km resolution around Flemish Cap and less than 5 km for a significant portion of the North Atlantic. For the WP3 and WP4, MPI-ESM-HR and MPI-ESM-ER simulations are employed. However, **only the MPI-ESM historical simulations with fixed GHG forcing experiments needed to be conducted,** since the rest of the simulations are available from the PRIMAVERA project.

Completed work from last period

The **35-year coupled ICON control run has been configured and successfully completed**. The ICON control run simulates realistic winter mixed layer depth in the subpolar North Atlantic (Fig. 1) and exhibits reasonable AMOC strength. The added layer diagnostics complement the Eulerian perspective with an isopycnal view (Fig. 2, 3), an approach that will improve our understanding of the dynamical processes in the downward limb of the AMOC. Additionally, age tracer output has been incorporated, allowing us to explore the relationship between ventilation and AMOC strength. With the telescopic grid around Flemish Cap with grid spacing down to ~1.8 km, we can study the roles of mesoscale and submesoscale eddies in AMOC variability and AMOC coherence. The analysis is being conducted and will be complemented by the ICON historical run.

The MPI-ESM simulations will be utilized for the WP3 and WP4. **The MPI-ESM historical simulations with fixed GHG forcing have been completed,** and both historical and 4xCO_2 MPI-ESM simulations are available from the PRIMAVERA project.

Progress of EPOC simulations

Model	Simulations	Years	Compute time [Node-hours]	Progress
ICON-Sapphire (telescopic R2B9 ocean/ R2B8 atm)	control (fixed 1990)	35	760,000	✓
ICON-Sapphire (telescopic R2B9 ocean/ R2B8 atm)	Historical (1990-2024)	35	516,040	Pending
MPI-ESM1.2-ER (1^{o} atm/ 0.1^{o} ocean)	Control; Historical; Historical with fixed GHG forcing; Abrupt 4 xCO_2 experiments	100	---	✓
MPI-ESM1.2-HR (1^{o} atm/ 0.4^{o} ocean)	Control; Historical; Historical with fixed GHG forcing; Abrupt 4 xCO_2 experiments	100	---	✓

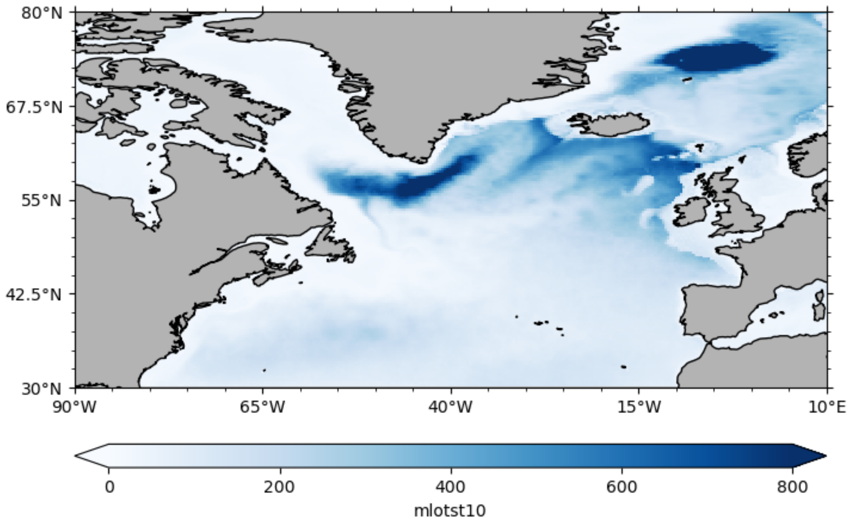

Fig. 1. The climatology of mixed layer depth in March (meters). It shows reasonable mixed layer depth in the subpolar North Atlantic, whereas it is overestimated by coarse-resolution models.

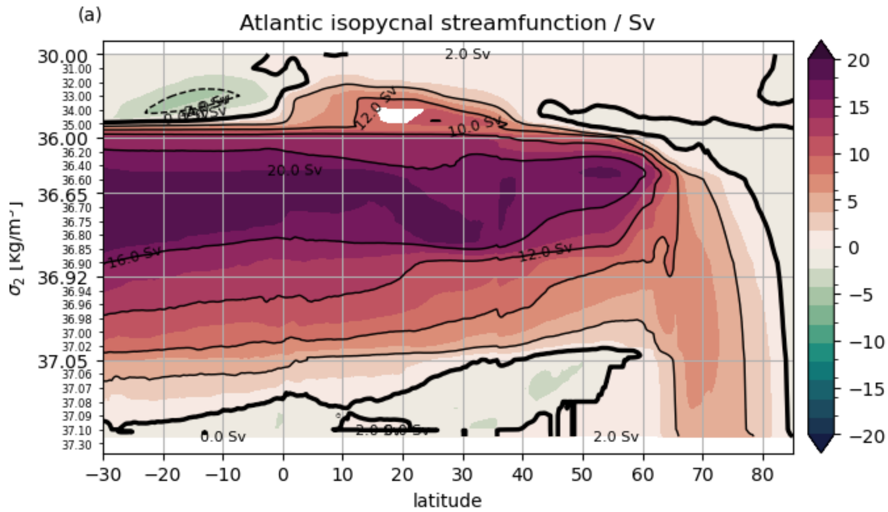

Fig. 2. The AMOC stream function in density coordinates (Sv), depicting the overturning cells in the subtropical North Atlantic, the subpolar North Atlantic and the Nordic Seas.

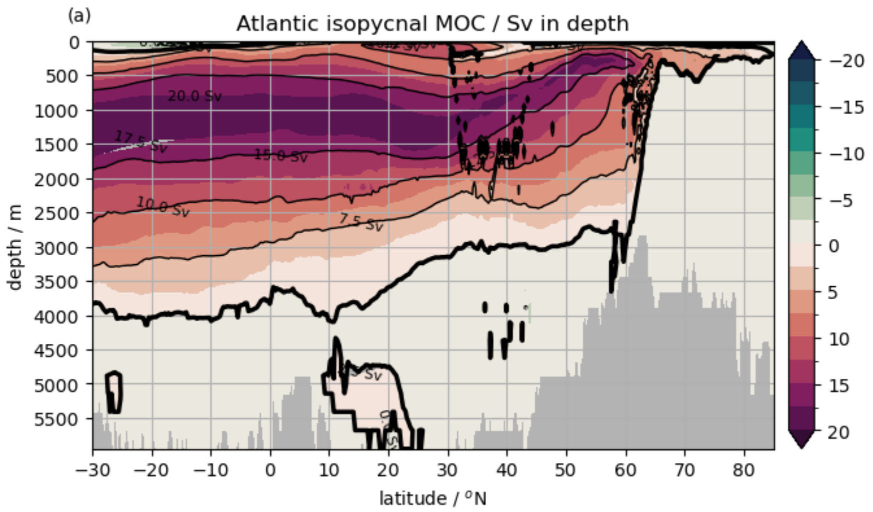

Fig. 3. AMOC stream function remapped from density coordinates to depth coordinates.