

**Project:** 1313

**Project title:** Horizon EU-project EPOC [Explaining and Predicting the Ocean Conveyor]

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**Report period:** 2025-07-01 to 2026-06-30

### 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 period 1990-2030**. 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 had been successfully completed during the period of 2024-05-01 to 2025-04-30, and **the historical run has been integrated for 31 years from last period**. With the telescopic grid in the North Atlantic with grid spacing down to ~1.8 km, we study the roles of mesoscale and submesoscale eddies in AMOC variability and AMOC coherence. A paper based on 35-year coupled ICON control run is under preparation. We investigate how water is transferred from the upper to the lower AMOC limb, and reconcile transports diagnosed in density and in depth spaces (Fig. 1). We further demonstrate that eddies have significant contribution to volume transport into the AMOC lower limb in the Irminger Basin, and eddies are important for restratifying current fronts and producing realistic mixed layer depth (Fig. 2).

The MPI-ESM historical simulations with fixed GHG forcing had been completed, and both historical and 4xCO<sub>2</sub> MPI-ESM simulations are available from the PRIMAVERA project. The MPI-ESM simulations are utilized for the WP3 and WP4, and the research on the response of AMOC to greenhouse gas forcing is being conducted.

### Progress of EPOC simulations

Model	Simulations	Years (finished)	Utilized compute time [Node-hours]	Years (remaining)
ICON-Sapphire (telescopic R2B9 ocean/ R2B8 atm)	control (fixed 1990 forcing)	35	760,000 (including test run and spinup)	✓
ICON-Sapphire (telescopic R2B9 ocean/ R2B8 atm)	Historical (1990-2030; 41 years)	31	244,956 (with additional 182,000 from MPG shareholder)	10 years remaining
MPI-ESM1.2-ER (1° atm/ 0.1° ocean)	Control; Historical; Historical with fixed GHG forcing; Abrupt 4 xCO <sub>2</sub> experiments	100	---	✓
MPI-ESM1.2-HR (1° atm/ 0.4° ocean)	Control; Historical; Historical with fixed GHG forcing; Abrupt 4 xCO <sub>2</sub> experiments	100	---	✓

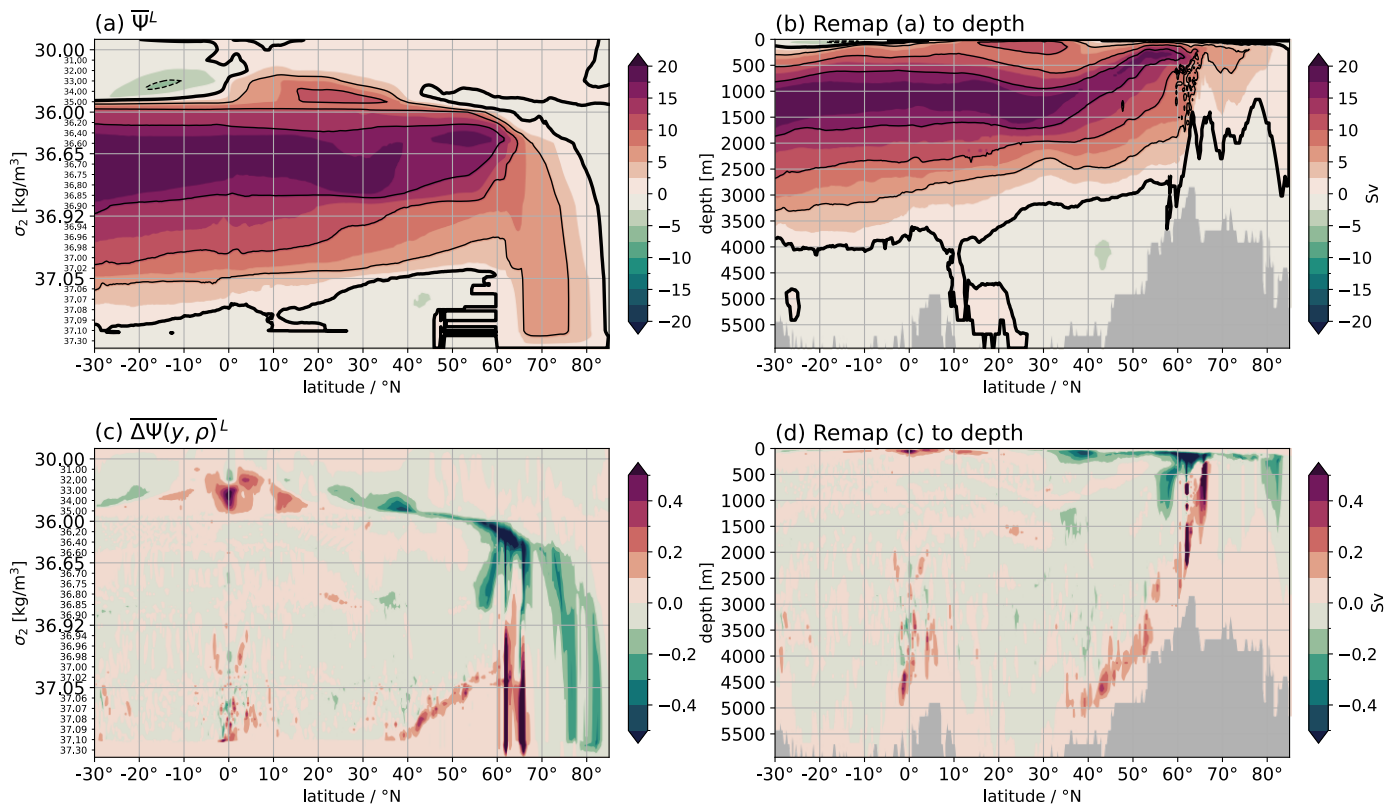


Fig. 1. Residual AMOC stream function in (a) density coordinates and remapped to (b) depth coordinates. Overturning transport in (c) density coordinates and remapped to (d) depth coordinates in ICON.

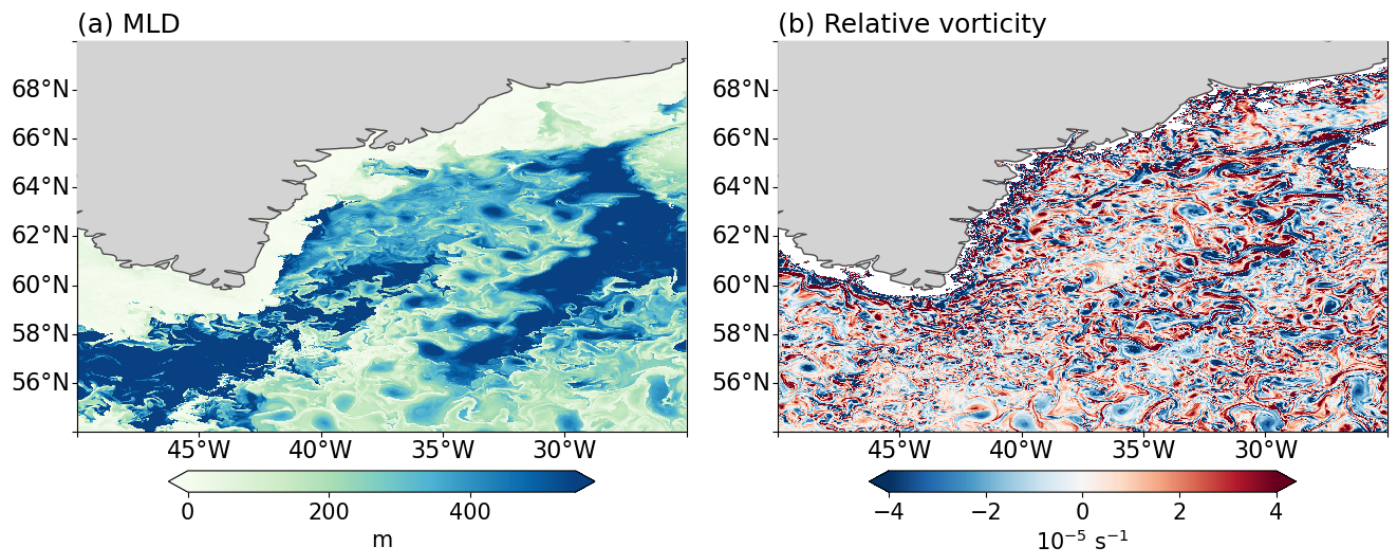


Fig. 2. Snapshots of (a) MLD and (b) relative vorticity at 200 m in March in ICON.