

Comment on section 9: “Reanalysis data” by Susanna Winkelbauer, Michael Mayer and Leopold Haimberger

The discussion of AMOC trends in ocean reanalyses is currently based on only a small subset of the available products and therefore does not provide a representative assessment of the current evidence from ocean reanalyses. While uncertainties are indeed substantial, particularly prior to the Argo era, the statement that ocean reanalyses lead to strongly diverging conclusions likely overstates the level of disagreement.

In particular, the positive AMOC trend reported for SODA3.15.2 should be re-examined, as independent recalculation (see Fig. 1) does not reproduce an increasing trend but rather indicates a decline. In addition, ORAS5 exhibits one of the strongest long-term declines among currently available ocean reanalyses, with a substantial portion of the trend arising from a well-understood spurious shift during the 1990s (Tietsche et al., 2020). This issue has been reduced in the successor reanalysis ORAS6 (H. Zuo, personal communication; Zuo et al., 2024; ECMWF, 2026). Given this known issue, the ORAS5 trend should be interpreted with caution.

A broader assessment across a larger ensemble of ocean reanalyses suggests that most products indicate a weakening of Atlantic overturning and/or northward heat transport over recent decades. Although the magnitude of the trend remains uncertain and inter-product spread increases substantially before the Argo era, the majority of products do indeed support a negative trend (Winkelbauer et al., in prep.). We therefore suggest revising this section to better distinguish between uncertainty in trend magnitude and uncertainty in trend sign, which are not equivalent.

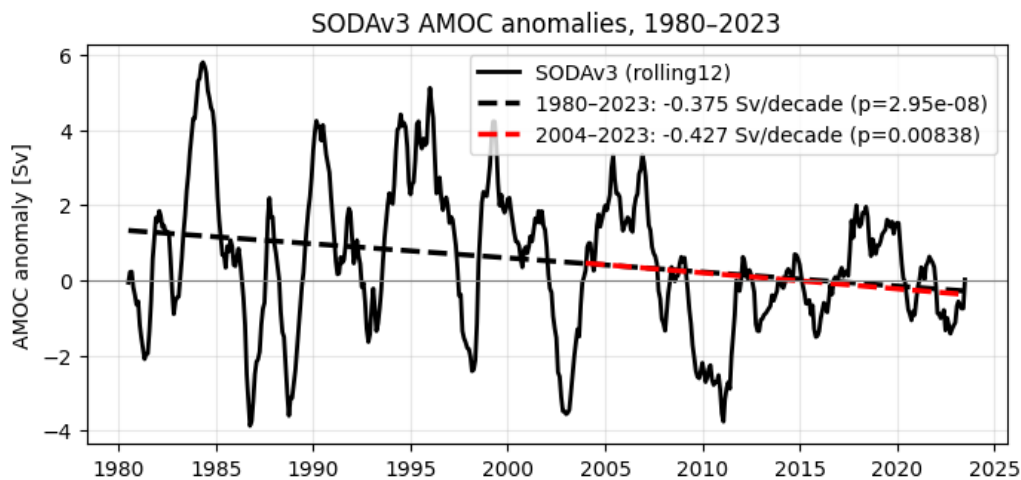


Fig 1. AMOC anomalies at the RAPID section from the ocean reanalysis SODA3.15.2 for 1980–2023 using Straitflux (Winkelbauer et al. 2024). The black curve shows the 12-month rolling mean used for visualization. Dashed lines indicate linear trends calculated from the underlying monthly time series over 1980–2023 (black), and 2004–2023 (red). Trend estimates and associated p-values are given in the legend.

Tietsche, S., Balmaseda, M., Zuo, H. *et al.* The importance of North Atlantic Ocean transports for seasonal forecasts. *Clim Dyn* **55**, 1995–2011 (2020). <https://doi.org/10.1007/s00382-020-05364-6>

Winkelbauer, S., Mayer, M., and Haimberger, L.: StraitFlux – precise computations of water strait fluxes on various modeling grids, *Geosci. Model Dev.*, 17, 4603–4620, <https://doi.org/10.5194/gmd-17-4603-2024>, 2024.

Winkelbauer, S., Mayer, M., Haimberger, L., *et al.* Evaluating Meridional Heat Transport in Ocean Reanalyses Using Observations and Heat Budget Constraints. In preparation for *Ocean Science*

Zuo, H., Balmaseda, M., de Boissésou, E., *et al.*: ECMWF’s next ensemble reanalysis system for ocean and sea ice: ORAS6, *ECMWF Newsletter No. 180*, Summer 2024. Available at: <https://www.ecmwf.int/en/newsletter/180/earth-system-science/ecmwfs-next-ensemble-reanalysis-system-ocean-and-sea-ice>

ECMWF: New ORAS6 ocean reanalysis supporting forecasting and climate monitoring, *ECMWF News*, 8 June 2026. Available at: <https://www.ecmwf.int/en/about/media-centre/news/2026/new-oras6-ocean-reanalysis>

Zuo, H.: Personal communication regarding the reduction of the spurious North Atlantic transport discontinuity identified in ORAS5 and improvements in ORAS6, June 2026.