

Relationship status: It's complicated - AMOC and the Nordic Seas Overturning

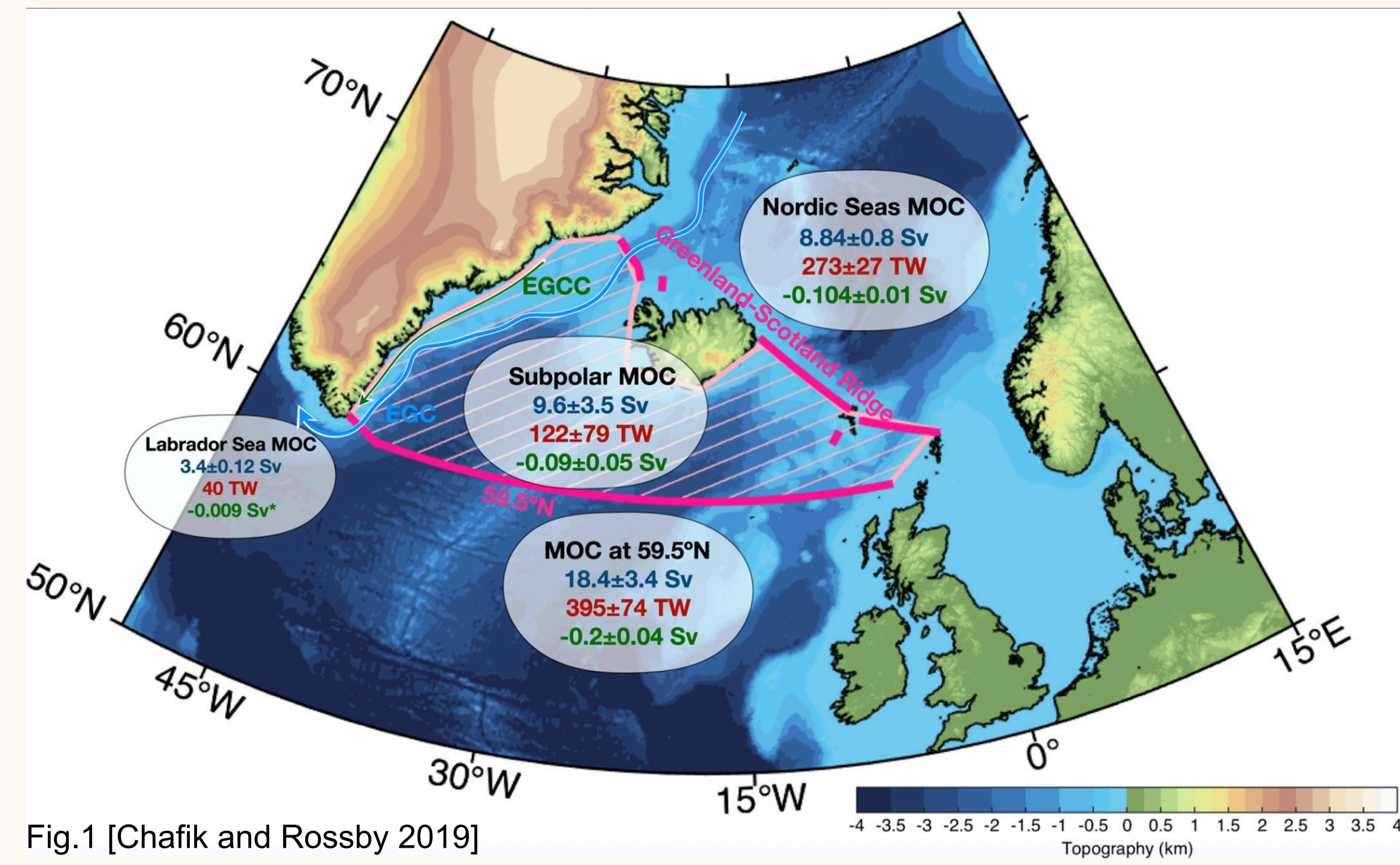


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← Overview of the currents in the North Atlantic; The Nordic Seas Overturning Circulation lies to the North-East of the Greenland-Scotland-Ridge. The numbers indicate volume transport (blue), heat loss (red) and freshwater flow (green). The AMOC spans across the whole North Atlantic.

What happens to Nordic Overturning in case AMOC collapses?

- In climate model simulations, Nordic Overturning collapses together with AMOC
- The strengthening of the NOC is only a transient phenomena of a declining AMOC
- However, the mechanism strengthening the NOC may make AMOC less prone to full collapse
- Uncertainties remain regarding the potential for full AMOC collapse under anthropogenic forcing

Why does AMOC slow down due to global warming?

Global warming reduces deep water formation because:

- A rapidly warming Arctic is slower in cooling down surface waters
- Massive melt from the Greenland Ice Sheet makes the northern surface waters fresher, and fresh water is lighter and hence more buoyant

What does this all mean for Norway?

- Ocean temperatures in the Nordic Seas, as well as in the North Atlantic, strongly affect Norway's climate
- Transient NOC strengthening may be able to reduce the impact of a weakened AMOC on Norway's climate
- In case of AMOC collapse, Nordic Overturning is no rescue
- Reducing the use of fossil fuels is the only way to reduce the risk

Introduction

- The Atlantic Meridional Overturning Circulation (AMOC) is a system of ocean currents in the Atlantic Ocean that transports water from the Southern Hemisphere to the Northern Hemisphere near the surface, and the other way around at large depths
- The Nordic Seas Overturning Circulation (NOC) is a part of the AMOC - namely, the part that goes across the Greenland-Scotland-Ridge towards the North, especially affecting Scandinavia
- AMOC slows down due to global warming, but climate models predict the Nordic Overturning to remain strong - how does this fit together?

Why is it important?

- AMOC has a strong influence on global climate - due to AMOC, the Northern Hemisphere is about 1-2 K warmer than the Southern Hemisphere
- AMOC has an especially strong influence on the climate of Norway - without AMOC, Norway would be about 10 K cooler, with winter temperatures in Oslo averaging -16.5 °C
- Even moderate changes in AMOC have the potential for serious consequences around the world, and especially for Norway

Why does Nordic Overturning not follow the AMOC trend?

- Freshwater inflow in the North Atlantic weakens the AMOC
- For NOC, the fresher North Atlantic leads to a larger density difference to the waters in the Nordic Seas, hence strengthening of NOC

What drives AMOC?

«Drag and Pull»

- Drag: Warm, salty surface water gets cooled in the North Atlantic and sinks deep down into the ocean, where it move southward
- Pull: Divergence in the Southern Ocean produces Upwelling, helping pull up the waters

Density changes between 2004 and 2024 in a) the upper 200m of the ocean and c) the layer between 200 - 940m depth. Marked in black is the line along which the RAPID array measures AMOC strength.

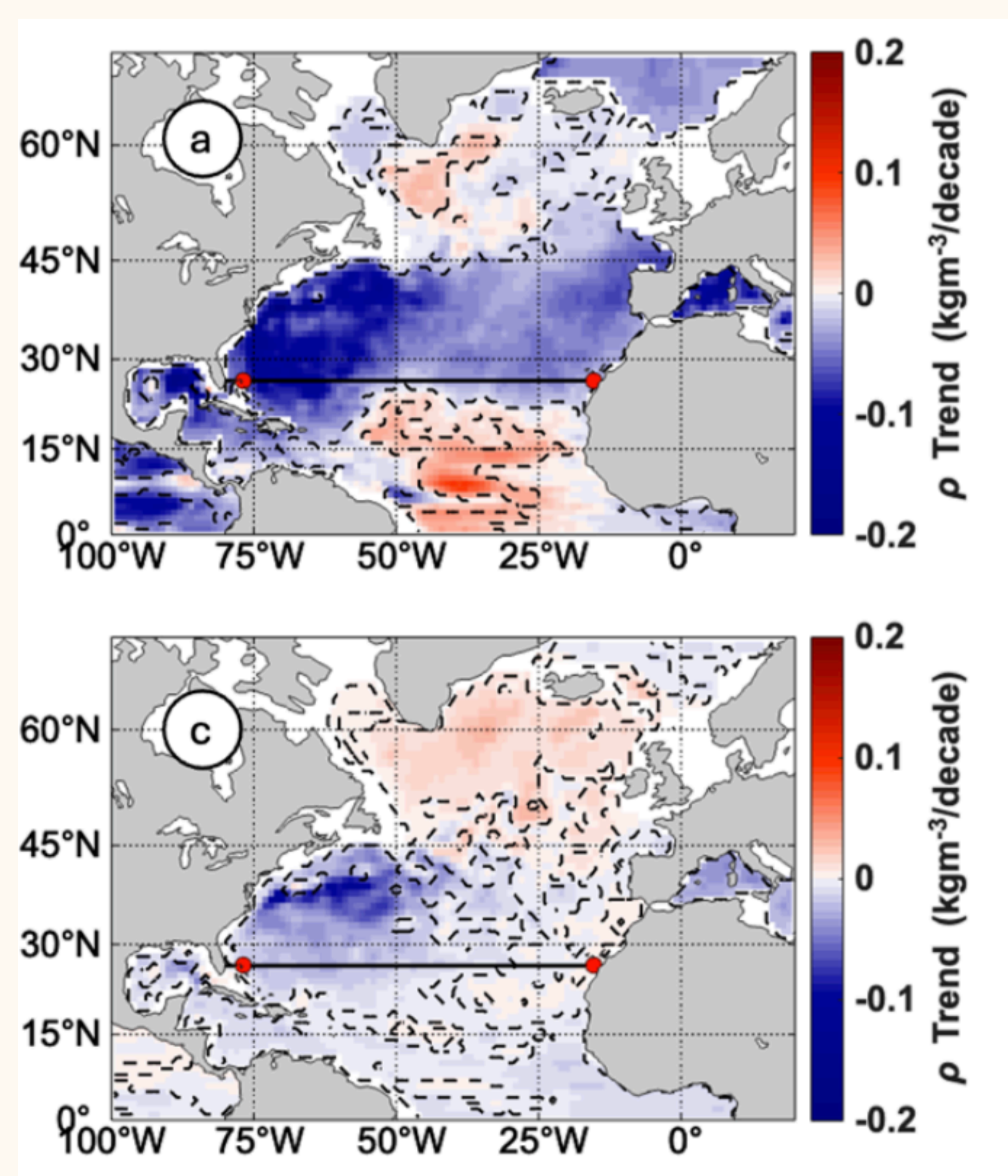
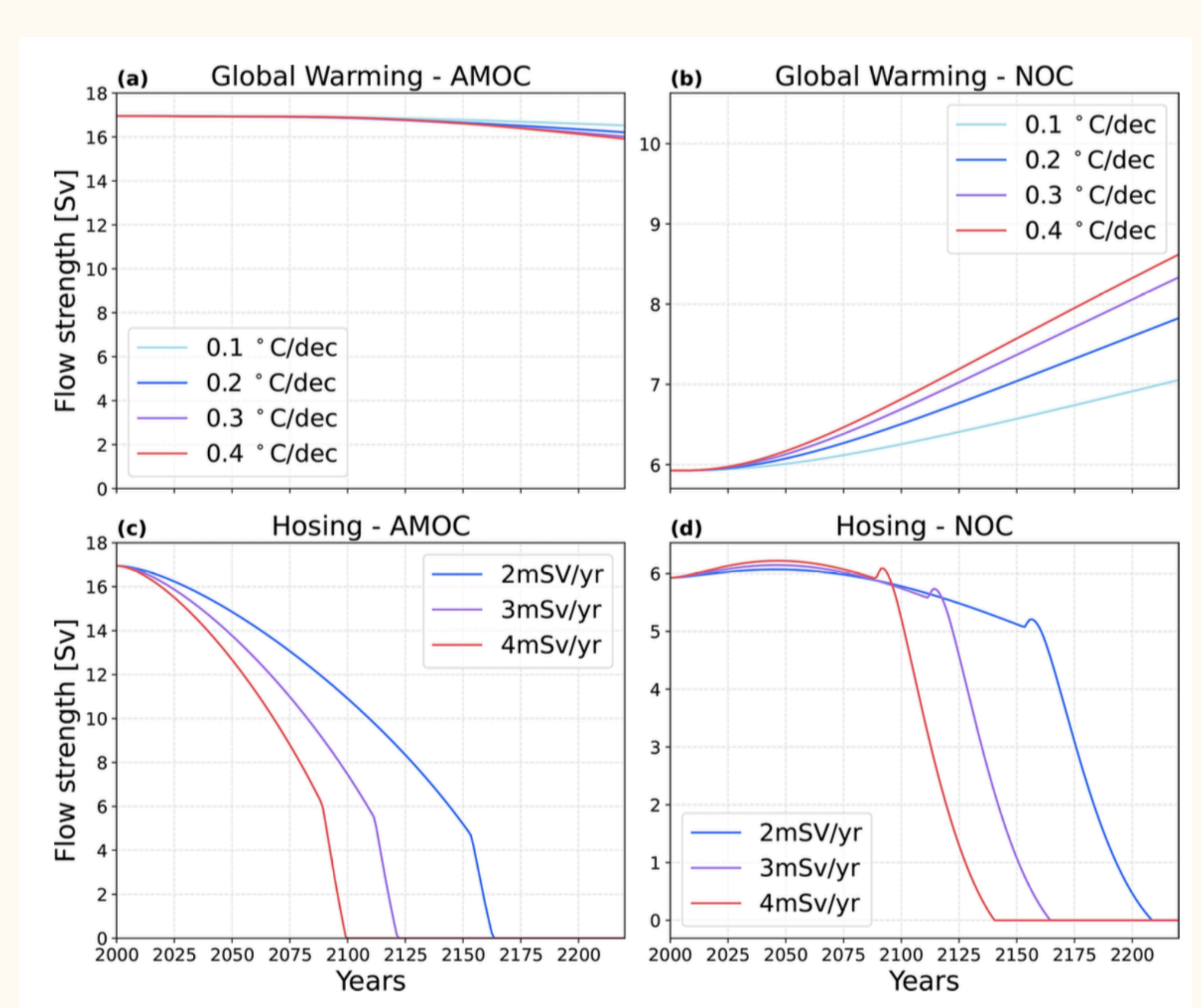
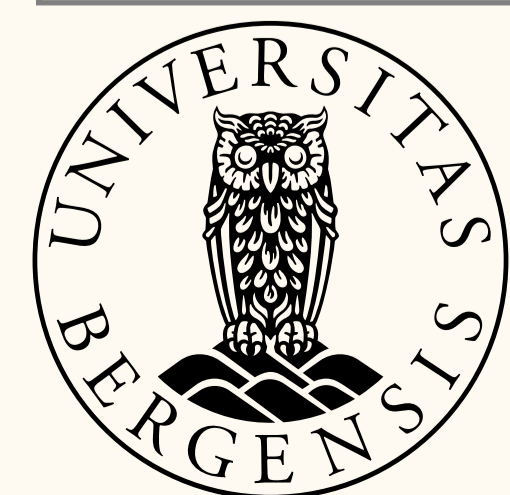


Fig.2 [Pita et al 2026]



↑ Evolution of AMOC and NOC strength in global warming and water hosing experiments [Roewer et al 2026].



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REFERENCES

- Roewer, S., Fiedler, L., Arthun, M., Huiskamp, W., and Rahmstorf, S.: Nordic overturning increases as AMOC weakens in response to global warming, *Ocean Sci.*, 22, 1195–1211, <https://doi.org/10.5194/os-22-1195-2026>, 2026.
 - Pita, I., Johns, W., Elipot, S., Smeed, D., Moat, B., and Volkov, D.: Upper ocean warming in the western subtropical Atlantic drives AMOC weakening at 26.5°N, *Research Square* [preprint], <https://doi.org/10.21203/rs.3.rs-8897292/v1>, 2026.
 - Chafik, L., & Rossby, T. (2019). Volume, heat, and freshwater divergences in the subpolar North Atlantic suggest the Nordic Seas as key to the state of the meridional overturning circulation. *Geophysical Research Letters*, 46, 4799–4808. <https://doi.org/10.1029/2019GL082110>
 - van Westen, R. M. and Baatsen, M. L. J.: European temperature extremes under different AMOC scenarios in the Community Earth System Model, *Geophys. Res. Lett.*, 52, e2025GL114611, <https://doi.org/10.1029/2025GL114611>, 2025.