North Atlantic response to Greenland ice sheet melt in eddy-resolving simulations with EC-Earth3P-VHR

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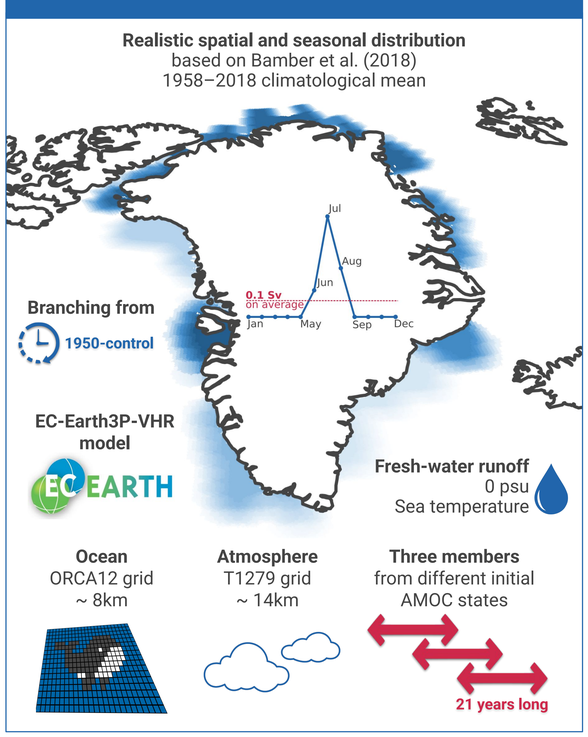
Highlights

- Most of the freshwater remains in the boundary currents, increasing their across density gradient, and thus their speed
- The new waters also induce sea-ice growth and upper-ocean cooling
- In the Labrador Sea interior, density changes are dominated by the freshening from the 6th year onwards
- Mixing is strongly reduced in the Labrador Sea, due to freshwater penetration
- The freshwater also reaches the eastern subpolar North Atlantic (SPNA)
- The Atlantic Meridional Overturning Circulation (AMOC) strength weakens across all North latitudes

1. Implementation



2. Subpolar North Atlantic

The mean response to freshwater forcing in the last 10 years of the simulations shows the following surface changes:

- Most of the injected freshwater remains near Greenland
- Sea ice concentration grows along the sea ice edge (indicated by the 15 % concentration contour line)
- Sea surface temperatures decrease over the whole region, especially along the sea ice edge, the western boundary currents and the central SPNA
- The mixed layer becomes much thinner in the Labrador Sea interior

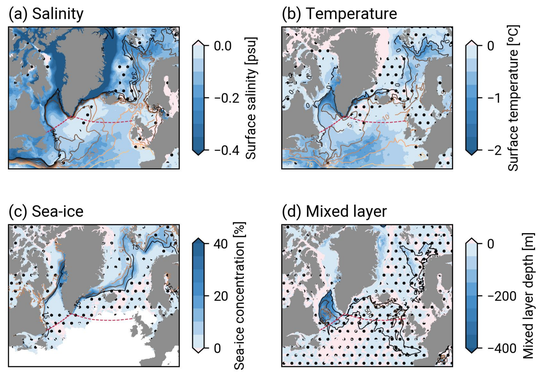


Figure 1: *Surface differences between water-hosing and control experiments for the last 10 years of simulation. Annual data for salinity (a) and temperature (b), DJF data for sea-ice (c), and March data for mixed layer (d). Contour lines show the average value in the control experiment. Dots denote non-significant differences. The dashed red line indicates the OSNAP section.*

3. OSNAP transect

The last 10 year mean response along the OSNAP section is characterized by:

- Fresher conditions in the Greenland and Newfoundland coasts, where the boundary currents are located, with some penetration in the interior Labrador Sea and the eastern SPNA
- Cold anomalies in the upper levels of the Labrador Sea
- Density loss in the upper 2000 m, much stronger in the boundary currents
- An acceleration of the boundary currents

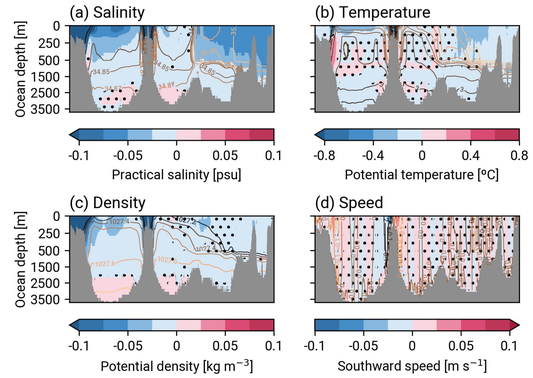


Figure 2: *Differences between water-hosing and control experiments for the last 10 years of simulation in the OSNAP transect. Annual data for salinity (a), temperature (b), density (c), and speed (d). Contour lines show the average value in the control experiment. Dots denote non-significant differences.*

4. Labrador sea interior

The time evolution of salinity, temperature and density changes in the Labrador Sea interior show an almost instantaneous penetration of the injected freshwater:

- Both salinity and temperature compete during the first years, having periods of higher and lower density
- From the 6th year onwards, salinity dominates the density response, which is increasingly reduced at the surface, eroding vertical stratification
- Mix layer depth evolution responds to the changes in density

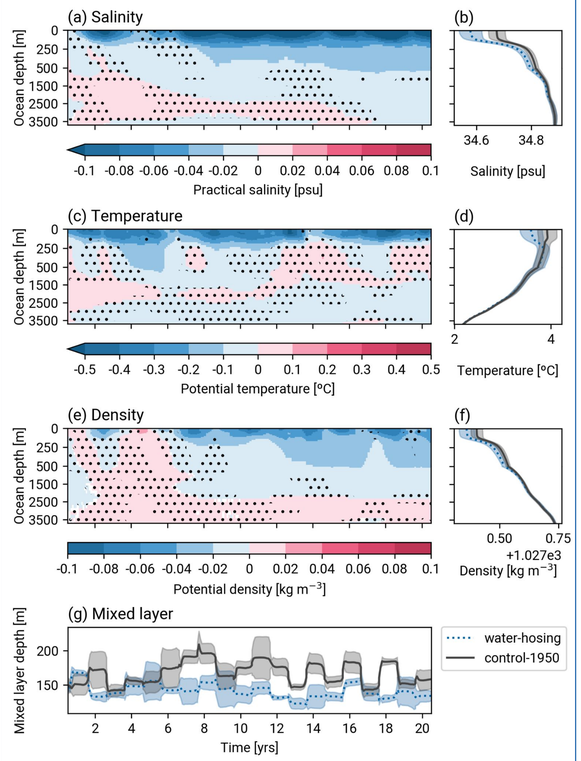


Figure 3: *Labrador sea interior differences between water-hosing and control experiments. Time evolution of averages with 12-month moving average (first column) and average profile of the last 10 DJFs with its standard deviation (second column). Dots denote non-significant differences.*

5. Atlantic Meridional Overturning Circulation

The response of the AMOC in the last 10 years of the simulation is characterized by a generalized slowdown:

- The slow-down slightly exceeds 1 Sv in some latitudes, it is in general higher than 0.5 Sv
- Highest reduction happens around 35º N, where it almost reaches 1.5 Sv
- There is also strong reduction between 40º N and 55º N, which is also the region with the highest relative difference
- Although the detectable slow-down signal in the AMOC, the current experimental set up is far away of provoking an AMOC collapse in 21-years simulations

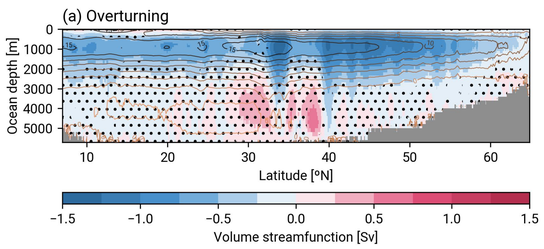


Figure 4: *Differences of the annual overturning volume stream function in the North Atlantic basin between water-hosing and control experiments for the last 10 years of simulation. Contour lines show the average value in the control experiment. Dots denote non-significant differences.*

Effect of horizontal resolution in North Atlantic mixing and ocean circulation in the EC-Earth3P HighResMIP simulations
Martin-Martinez et al. (EGUsphere, preprint)

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