Preconditioning the Arctic outflow west and east of Greenland: Ocean circulation in the Lincoln Sea and Western Fram Strait in eddy-resolving and permitting global ocean models

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1. Motivation

- Arctic fresh and cold waters flow in the North Atlantic via Canadian Straits and Fram Strait (Fig. 1)
- Arctic outflow affects deep convection in the Nordic and Labrador Seas
- Potentially impacts on the meridional overturning circulation.
- Outflow has been observed in Fram and Nares straits and to the south
- Pathways upstream of Fram Strait and north of Greenland are unknown
- No data to attribute west-east pathways partitionning of the outflow and its variability (Fig. 1); use high-resolution models to examine mechanisms.

2. Methods

- Use the eddy-permitting/resolving global ocean models NEMO, 3-km resolution [1] and OCCAM, 8-km resolution [2] to investigate watermass dynamics in the Lincoln Sea and north of Greenland
- Compare model circulation and T&S with observations from the available transects and moorings [3-7]; examine fresh water transports
- Use Montgomery function on pseudo-neutral surfaces to examine the geostrophic component of the flow [2]
- Examine buoyancy vs. wind forcing of the flow [8]

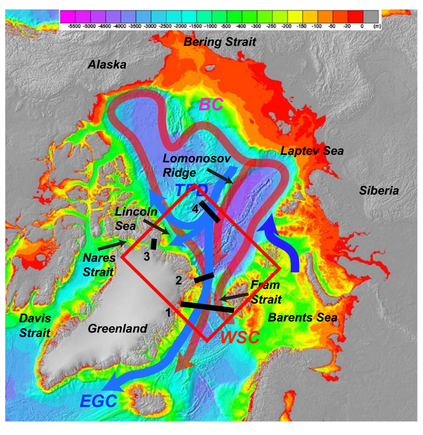

Fig. 1 Schematic of the Atlantic (red) and Arctic (blue) flow over the IBCAO topography (m). Red rectangle is the study area. Moorings: Fram Str. (1), NE Greenland (2), Robeson Channel (3), Lomonosov Ridge (4).

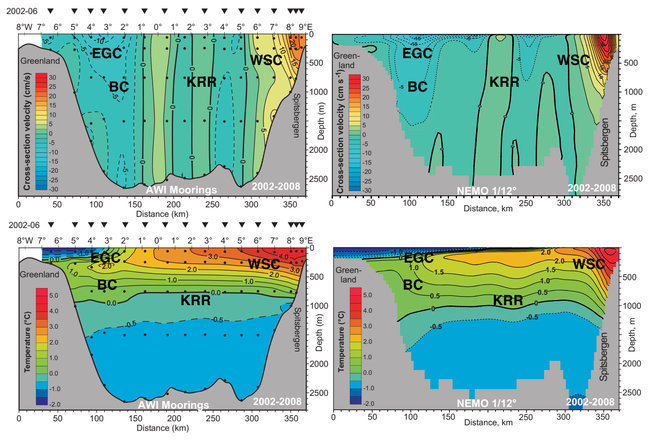

Fig. 2 Northward velocity and potential temperature in Fram Strait from moorings and NEMO. Key: West Greenland Current (WGC), East Greenland Current (EGC), Arctic Boundary Current (BC) and Knippovich Ridge Recirculation (KRR).

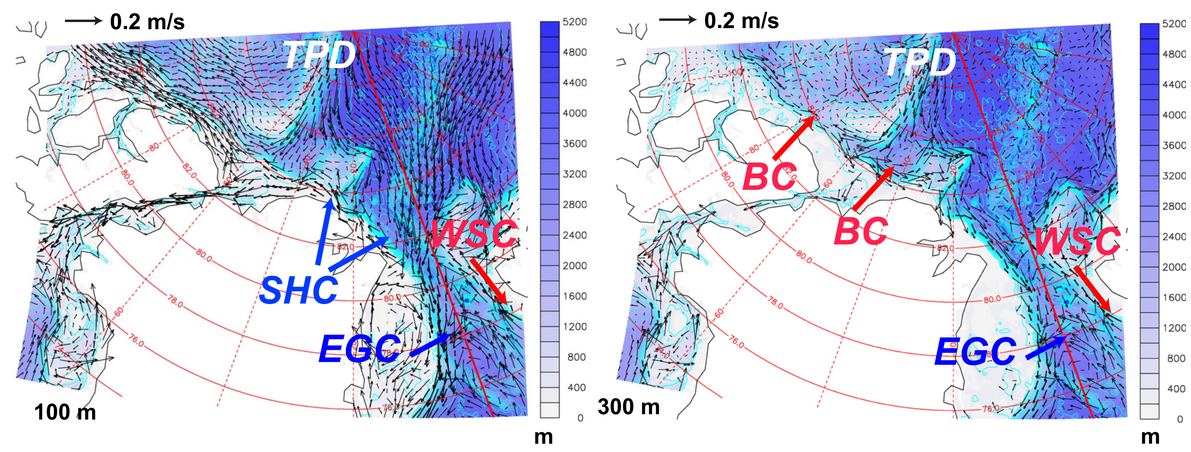

Fig. 3 Mean 2000-2007 ocean circulation simulated in NEMO (vectors) at 100 m and 300 m depth overlaying model bathymetry in colour (m). West Greenland Current (WGC), East Greenland Current (EGC), Arctic Boundary Current (BC) and Trans-Polar Drift (TPD) are shown.

3. Results & Discussion

- Model is consistent with current-meter and T&S data (example in Fig. 2)
- Lincoln Sea: westward flow in <300 m, eastward flow in >300 m (Fig. 3)
- Montgomery potential in NEMO shows split of the Arctic outflow (Fig. 4)
- Westwrad fresh Shelf current (SHC) originates from the Belgica Bank and carries 30 mSv of fresh water along the Greenland shelf (Figs. 3-5)
- SHC is buoyancy driven (winter Ub=0.18 m/s, summer Ub= 0.06 m/s)
- Seasonal variability of the surface circulation is due to winds (Fig. 6).
- Little seasonal variations in T&S and currents at ~200-900 m depth.

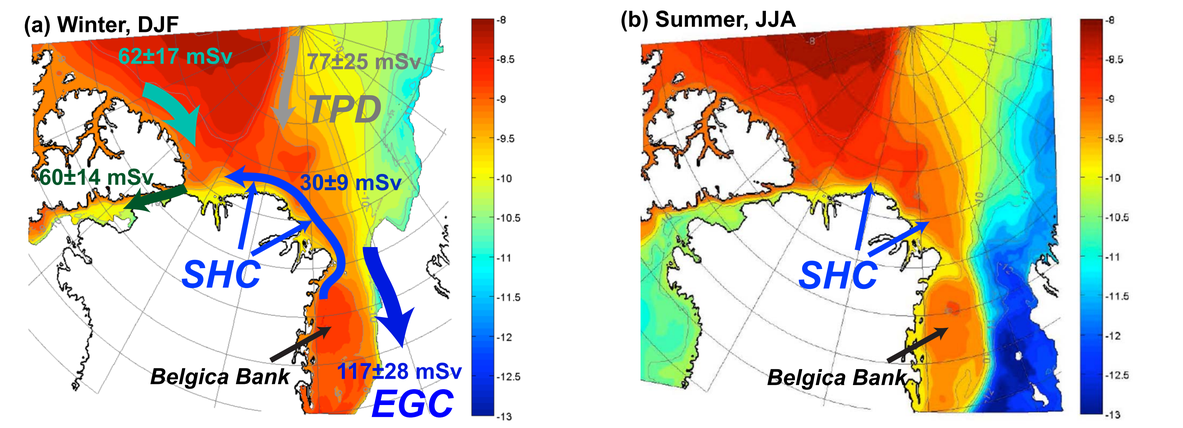

Fig. 4. Simulated mean 2000-2007 Montgomery potential on pesudo-neutral surface with constant density anomaly of 26.0 for the winter month Dec-Feb (a) and for the summer months June-Aug (b). The Montogomery potential is equivalent to the streamfunctions of the geostrophic flow on the corresponsing density surface. The geostrophic flow follows the Montgomery countours wiht the higher values of the potentail to the right in the Northern Hemisphere. Arrows and numbers show mean fresh water transports along outlfow pathways for 2000-2007 with the standard deviation based on the monthly mean series.

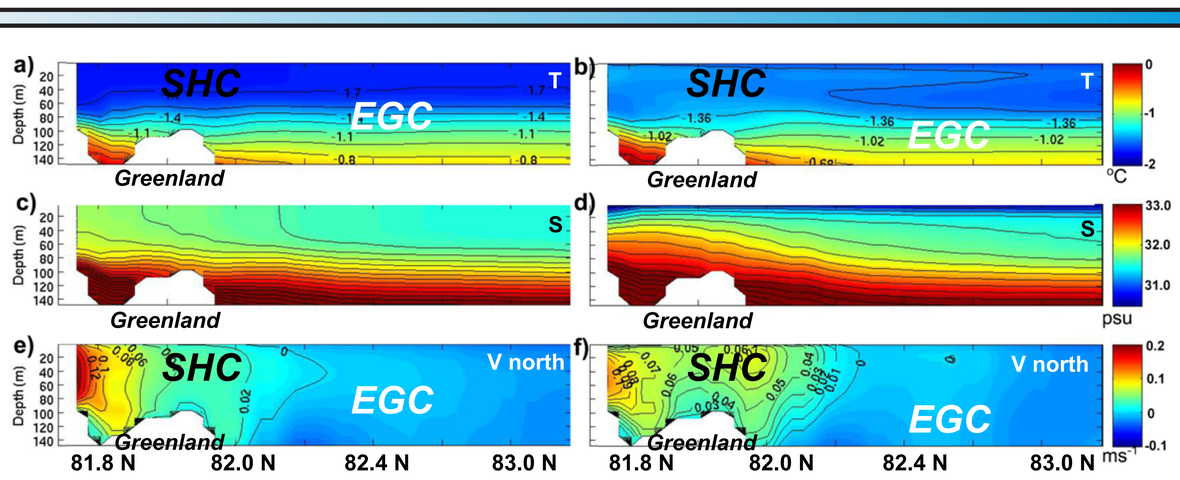

Fig. 5 Simuated in NEMO potential temperature (a,b), salinity (c,d) and northward velocity (e,f) at the section NE off Greenland shown in Fig.1 [5], averaged for the winter month Dec-Feb (a,c,e) and for the summer months June-Aug (b,d,f) for the period 2000-2007. The East Greenland Current (EGC) and the Shelf Current (SHC) are marked. Northward velocity is positive.

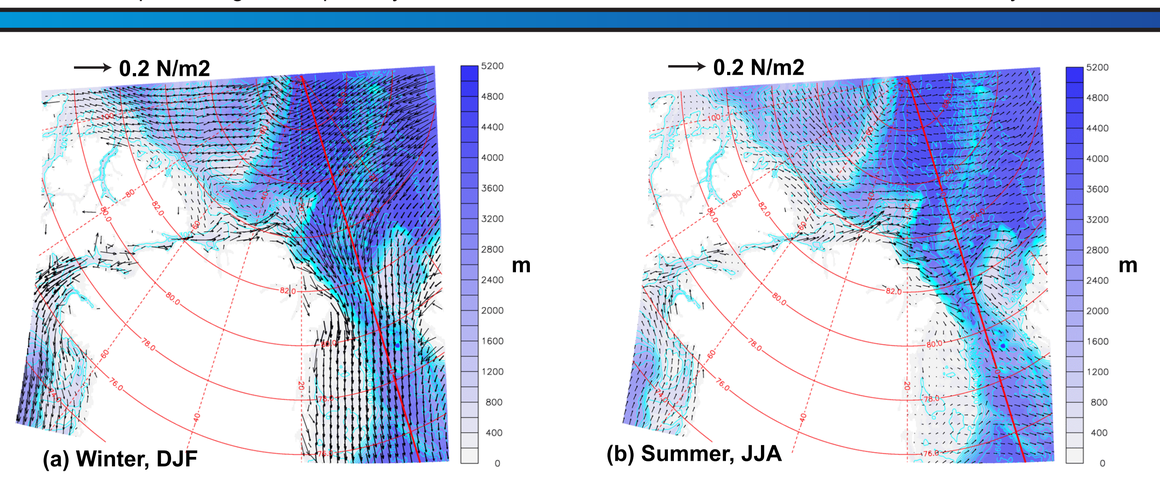

Fig. 6 Wind stress acting on the ocean surface in the model. Plots show averages for the winter month Dec-Feb (a) and for the summer months June-Aug (b) for the period 2000-2007. Strong northerly- and north-westerly winds dominate in the winter (a) and weak south-westerly and westerly winds prevail in the summer (b).

4. Summary

- Two-layer circulation in the Lincoln Sea and on the north Greenland shelf
- Seasonalilty in surface circulation due to wind, no seasonality >300m
- Buoyancy driven Shelf current carries ~30 mSv of fresh water along the norther Greenland shelf.

References

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