Towards new eddy-resolving simulations with FESOM in the southwestern Weddell Sea

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Key Points

- New global grid with increased resolution over the whole Weddell Sea
- Significant improvement of the ASF structure and the Weddell Gyre transport
- Vertical mixing below the ice shelf is important for the sub-ice shelf circulation.

1. Introduction

The **Filchner Ronne Ice Shelf** (FRIS), being one of the largest ice shelves in Antarctica, has long been known to play an important role in the production of dense overflow waters. The ice pump mechanism produces Ice Shelf Water (ISW), which leaves the area via the **Filchner Trough**. Warm Deep Water (WDW), which has circumpolar origin, circulates clockwise in the Weddell basin and is separated from the shelf waters by the Antarctic Slope Front (ASF). WDW enters the continental shelf along the eastern flank of the Filchner Trough in a modified version as **modified WDW** (MWDW) and imposes a potential threat on the Antarctic ice sheet in a warming climate[1;2].

2. FESOM

The Finite Element Sea-ice Ocean Model (FESOM)[3] is a primitive-equation, hydrostatic global ocean model with a dynamic-thermodynamic sea-ice and ice-shelf component[4]. Hybrid coordinates are used in the vertical, consisting of 22 terrain-following sigma-layers for ocean depths less than 2500m and of 36 z-layers in the deeper ocean. The model was forced with the NCEP-CFSR (1979-2010) reanalysis.

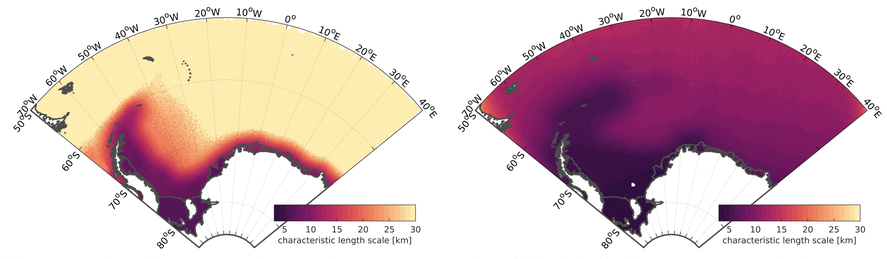

Figure 1: *Horizontal resolution over the Weddell Sea sector of the coarse (left) and high-resolution grid (right).*

3. Weddell Gyre

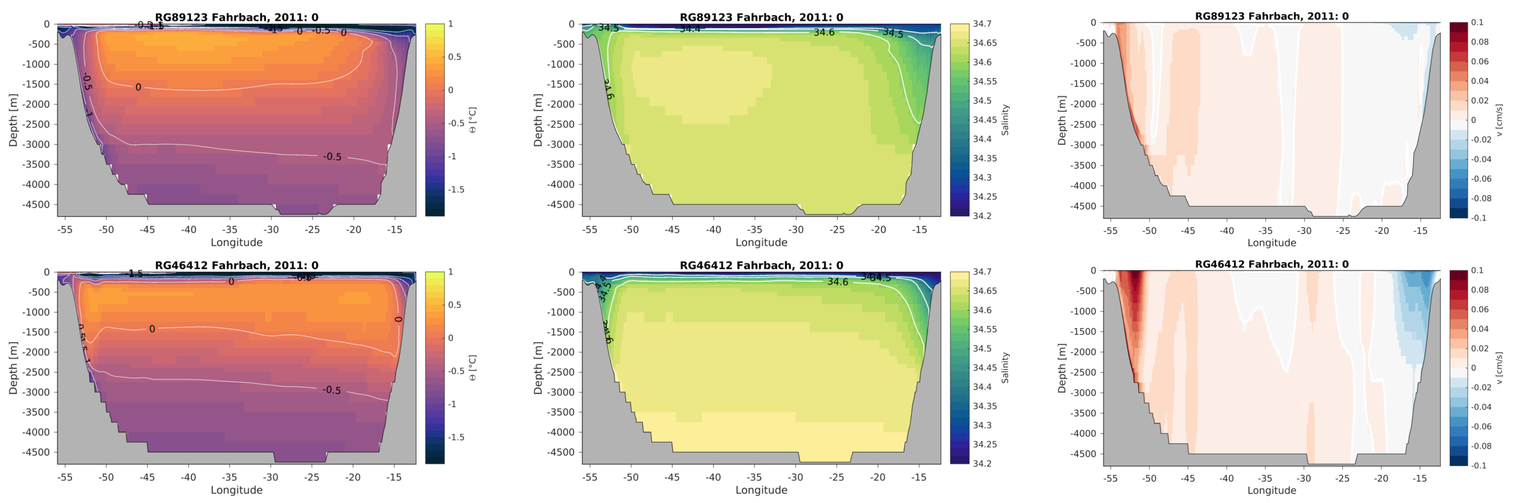

Figure 2: *Annual mean temperature (left), salinity (middle) and meridional velocity (right) section across the Weddell Sea from Kapp Norwegia to the tip of the Antarctic Peninsula for the coarse (top) and fine (bottom) grid.*

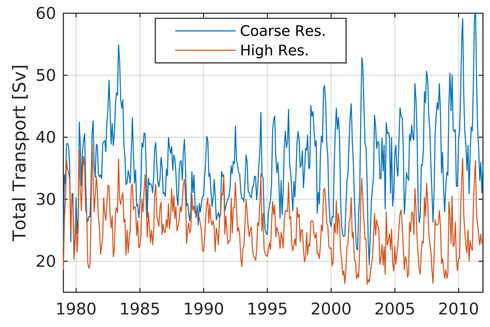

Figure 3: *Annual mean total transport across a section between Kapp Norwegia and the tip of the Antarctic Peninsula for the coarse and high resolution grid*

- The ASF and its associated slope current are significantly improved in the high-resolution run and become stable after 20 years spin-off time.
- The total transport between Kapp Norwegia and the tip of the Antarctic peninsula is over 10 Sv higher, which is desirable.
- Slope front is too wide and smeared compared to the observations. Likely due to too much entrainment of fresh water from the shelves.

4.Filchner Ronne Ice Shelf

Bottom Properties

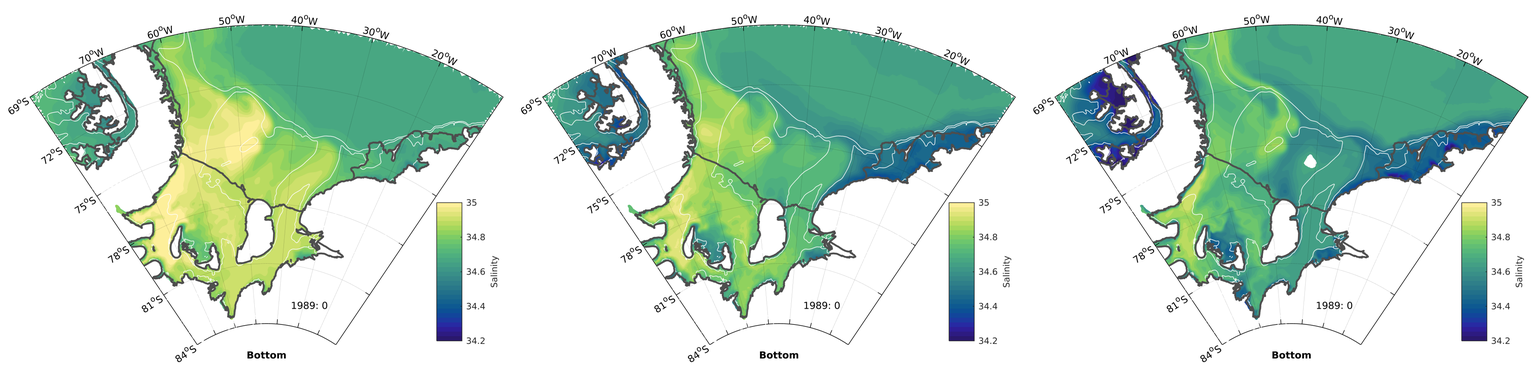

Figure 4: *Annual mean bottom salinity in 1989 for the coarse grid forced with ERA-Interim and pp-mixing (left), coarse grid (middle) and high-resolution grid (right) forced with CFSR and KPP-mixing.*

Sub-Ice Shelf

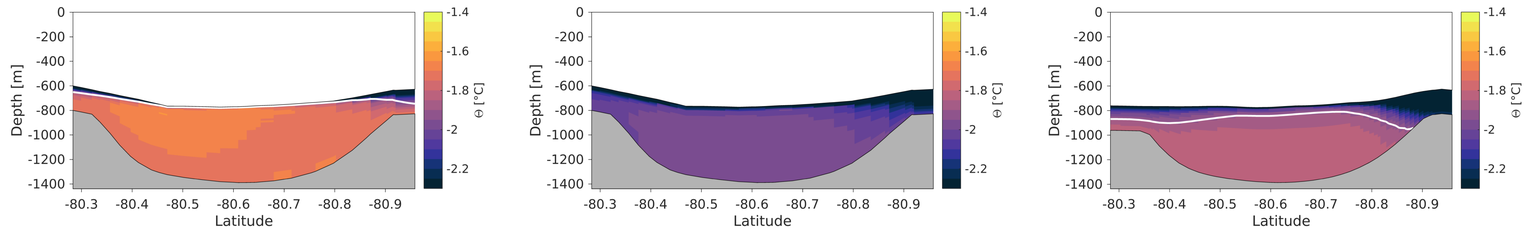

Figure 5: *Annual mean temperature section (1989) south of Berkner Island for the coarse grid forced with ERA-Interim and pp-mixing (left), coarse grid (middle) and high-resolution grid (right) forced with CFSR and KPP-mixing.*

5. Outlook

- Perform a run with seasonal restoring to ASF observations that are implemented into the World Ocean Data Atlas (2013) to bring the correct water mass to the Filchner sill
- Change from hybrid vertical coordinates to z-levels
- Analyse seasonal and interannual variability of the ASF and the MWDW flow onto the continental shelf in coarse and finer mesh

References

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[3] Q. Wang, S. Danilov, D. Sidorenko, R. Timmermann, C. Wekerle, X. Wang, T. Jung, and J. Schröter. The Finite Element Sea Ice-Ocean Model (FESOM) v.1.4: Formulation of an ocean general circulation model. *Geoscientific Model Development*, 7(2):663–693, 2014.

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