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On the modified warm deep water flow toward the Filchner Ronne Ice Shelf

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1. Background

The **Filchner Ronne Ice Shelf**, located in the southeastern Weddell Sea, plays a key role in the bottom water formation, by producing Ice Shelf Water (ISW, purple & blue arrows in map).
Modified Warm Deep Water (MWDW) intrusions are observed along the eastern flank of the **Filchner Trough** (red arrows), imposing a potential threat on the Antarctic ice sheet in a warming climate.

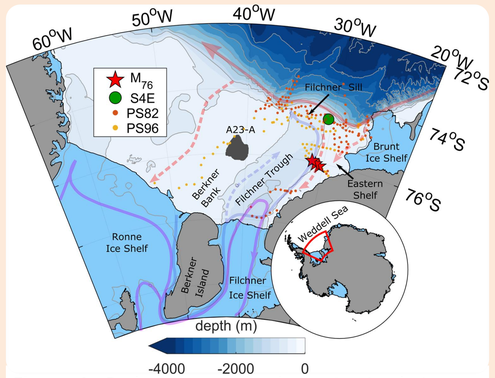
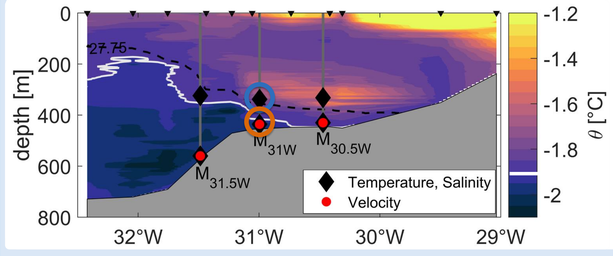


Figure 1: Bathymetry and schematic circulation on the continental shelf in the southern Weddell Sea. Positions of CTD stations and moorings are marked.

2. Observed warm inflow



A distinct seasonal southward flow of MWDW is found along the eastern flank of the trough in summer and autumn. In winter, temperatures drop to the surface freezing point and the ISW layer extends further east. The seasonal cycle is driven by a seasonal hieving of the Antarctic Slope Front and winter convection on the shelf.

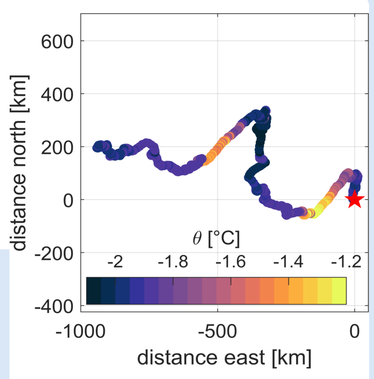


Figure 2: a) Pot. temperature θ along 76°S from PS96 and mooring positions. b) Progressive vector diagram from M_{31W} (2 years) with θ as shading.

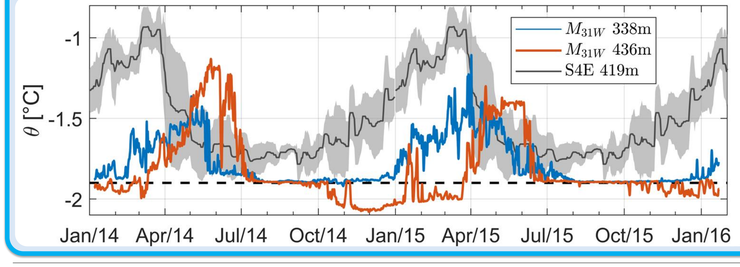


Figure 3: Pot. temperature θ time series from M_{31W} and mean seasonal temperature at S4E (2007-2009) with standard deviation in grey.

3. Model experiment

The Finite Element Sea-ice Ocean Model (FESOM) is used with hybrid vertical coordinates. The model is forced with the NCEP-CFSR reanalysis (1979-2010) and initialised with the World Ocean Data Atlas 2013 (WOA13).
Increased resolution in the Weddell Sea with focus on the southern continental shelf (~3km) .

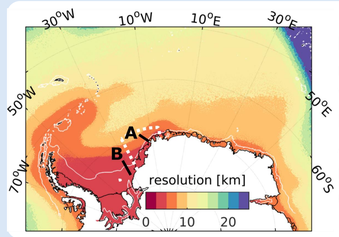


Figure 4: Model resolution in the Weddell Sea sector. Marked are section A and B (black) and restoring area (white).

A restoring experiment is performed, in order to improve the slope front properties upstream of the study region. Data from a mean hydrographic section compiled from available observations is implemented into WOA13 over a defined patch.

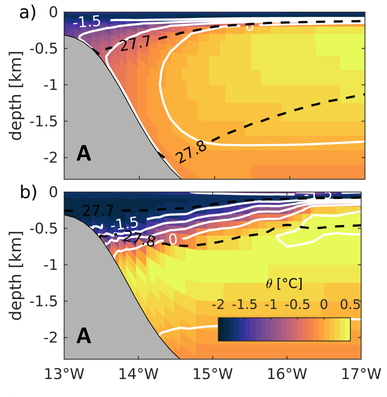
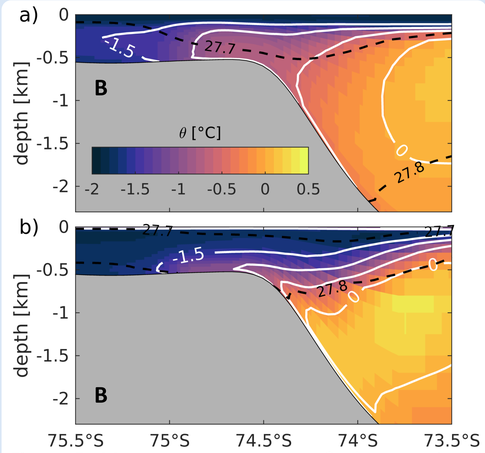


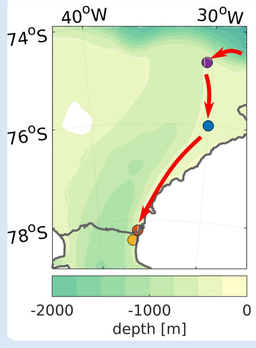
Figure 5: Mean pot. temperature θ along section A (2000-2010) without (a) and with (b) restoring. Black, dashed lines are pot. density referenced to the surface.

4. Modeled warm inflow



Upstream restoring over the continental slope leads to a significant improvement of the Antarctic Slope Front properties and the Filchner Trough hydrography.
The model reproduces the observed seasonal cycle of temperature along the eastern flank of the trough. Furthermore, the MWDW is strongly modified by the time it arrives at the ice shelf front.

Figure 5: Mean pot. temperature θ along section A (2000-2010) without (a) and with (b) restoring. Black, dashed lines are pot. density referenced to the surface.



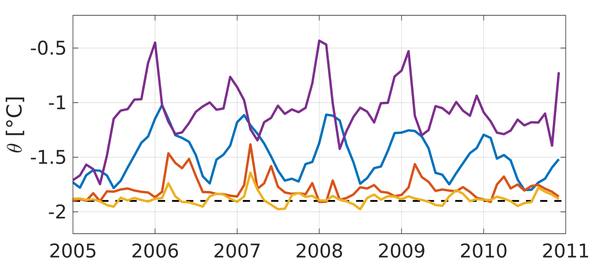


Figure 7: Time series of modeled bottom temperature at four stations along the eastern flank of the Filchner Trough.

5. Conclusions

- Observations show **seasonal warm inflow** along the eastern flank of the Filchner Trough in summer and deep mixed layers in winter.
- A **correct representation of the Antarctic Slope Front** properties upstream of the Filchner Trough is essential to model a realistic on-shelf flow of MWDW
- **Stong modification of MWDW** during southward progression on continental shelf

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