

Impacts of ocean model resolution on conditions near the Antarctic Ice Sheet

Mira Berdahl, Eric Steig (UW)

Gunter Leguy , Bill Lipscomb,
Bette Otto-Bliesner (NCAR)

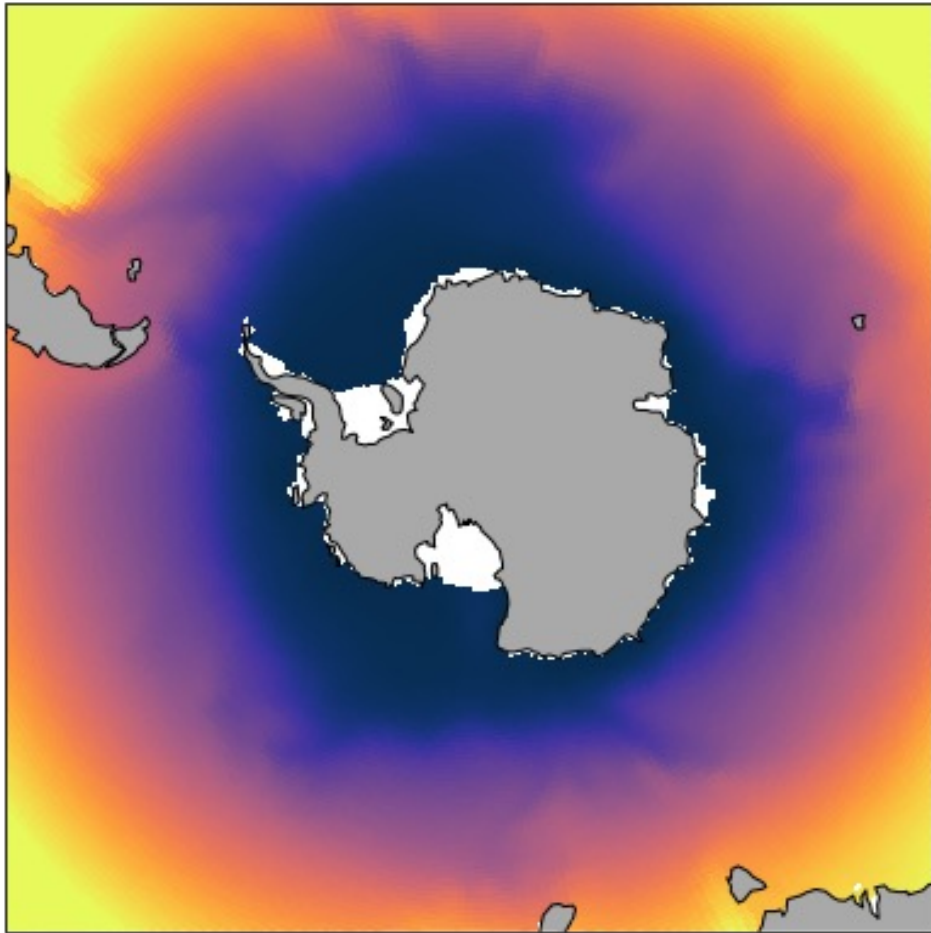
Ian Miller (WA SeaGrant)

Harriet Morgan (WDFW)

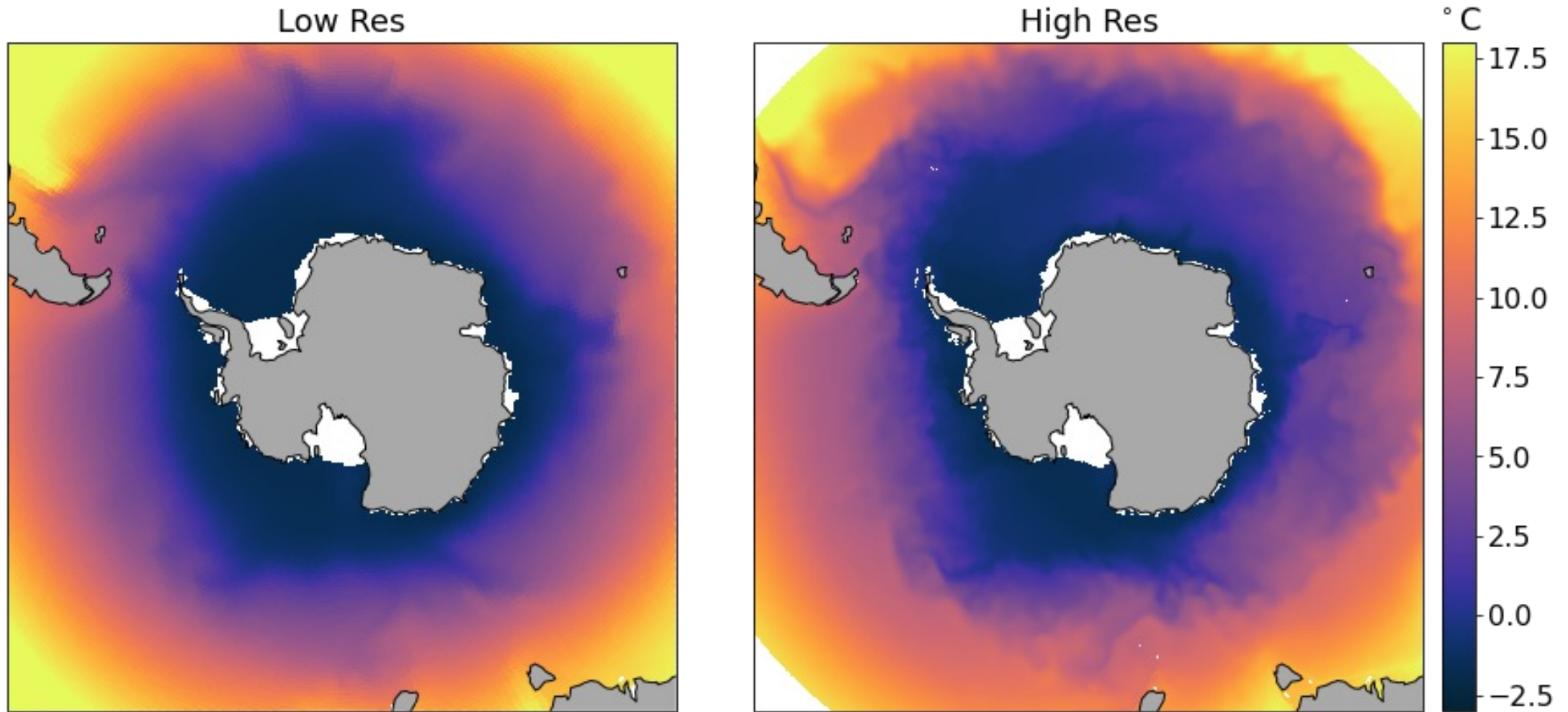
Nathan Urban (Brookhaven Labs)

Higher resolution has been shown to increase model skill and reduce biases

Low Res



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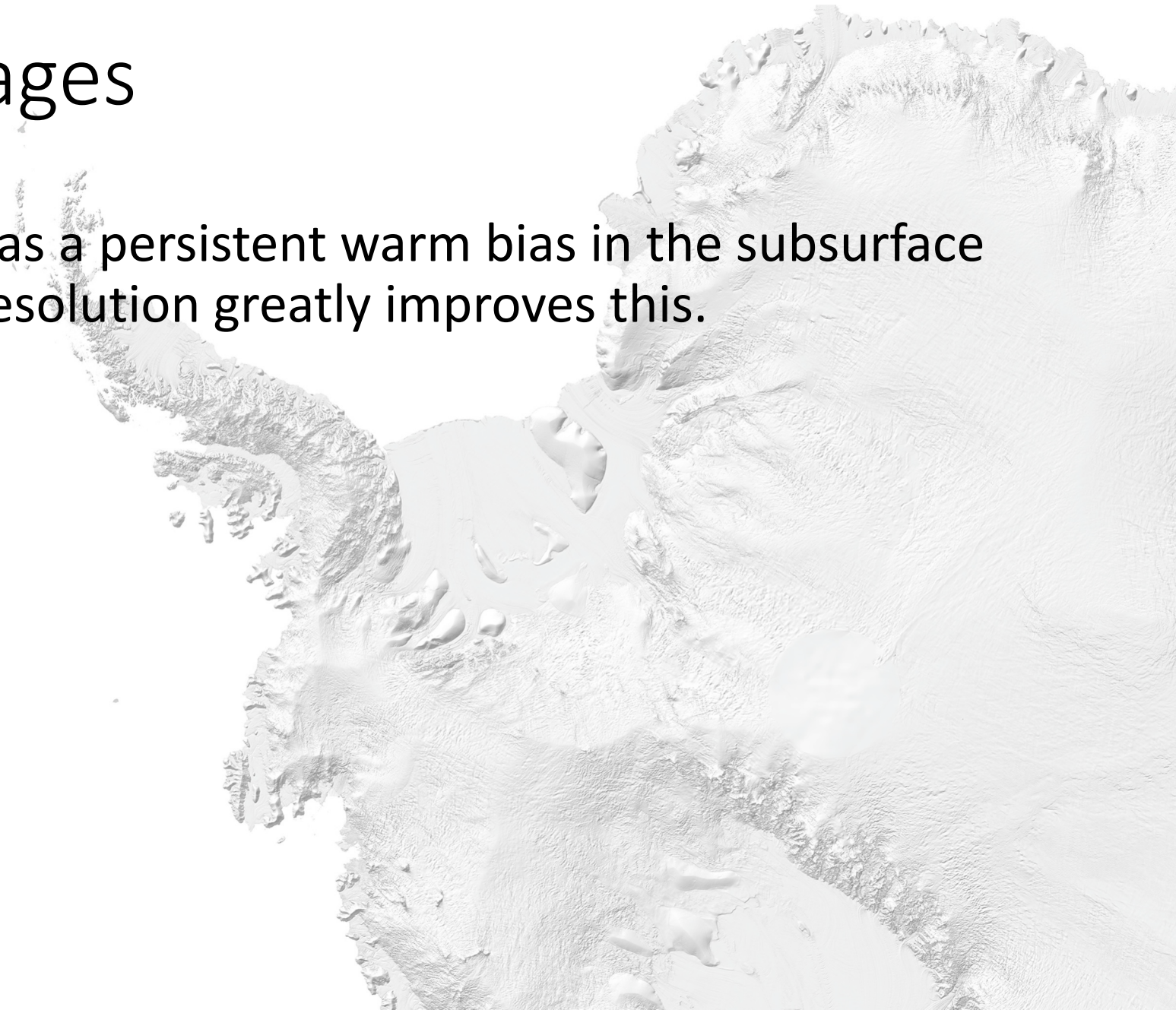


What simulations were used?

Low Resolution	High Resolution
CESM2	CESM1
Ocean 1deg POP	Ocean 0.1deg POP
Atmos 2deg CAM	Atmos 0.25 deg CAM
Historical (1850-2014)	Historical (1850-2005)
3 ensemble members	1 ensemble member

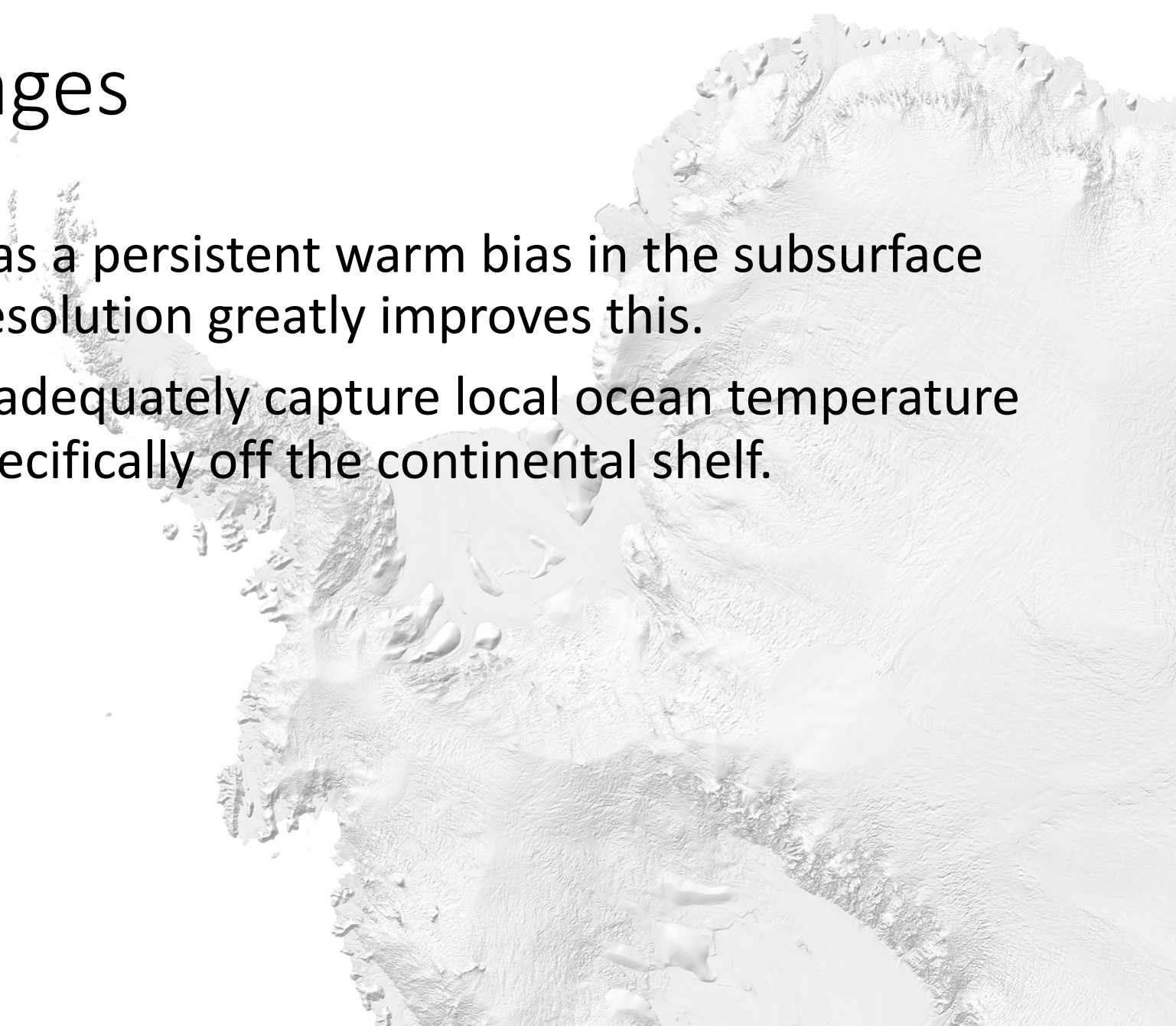
Take-home messages

- 1) Low resolution ocean has a persistent warm bias in the subsurface southern ocean. High resolution greatly improves this.



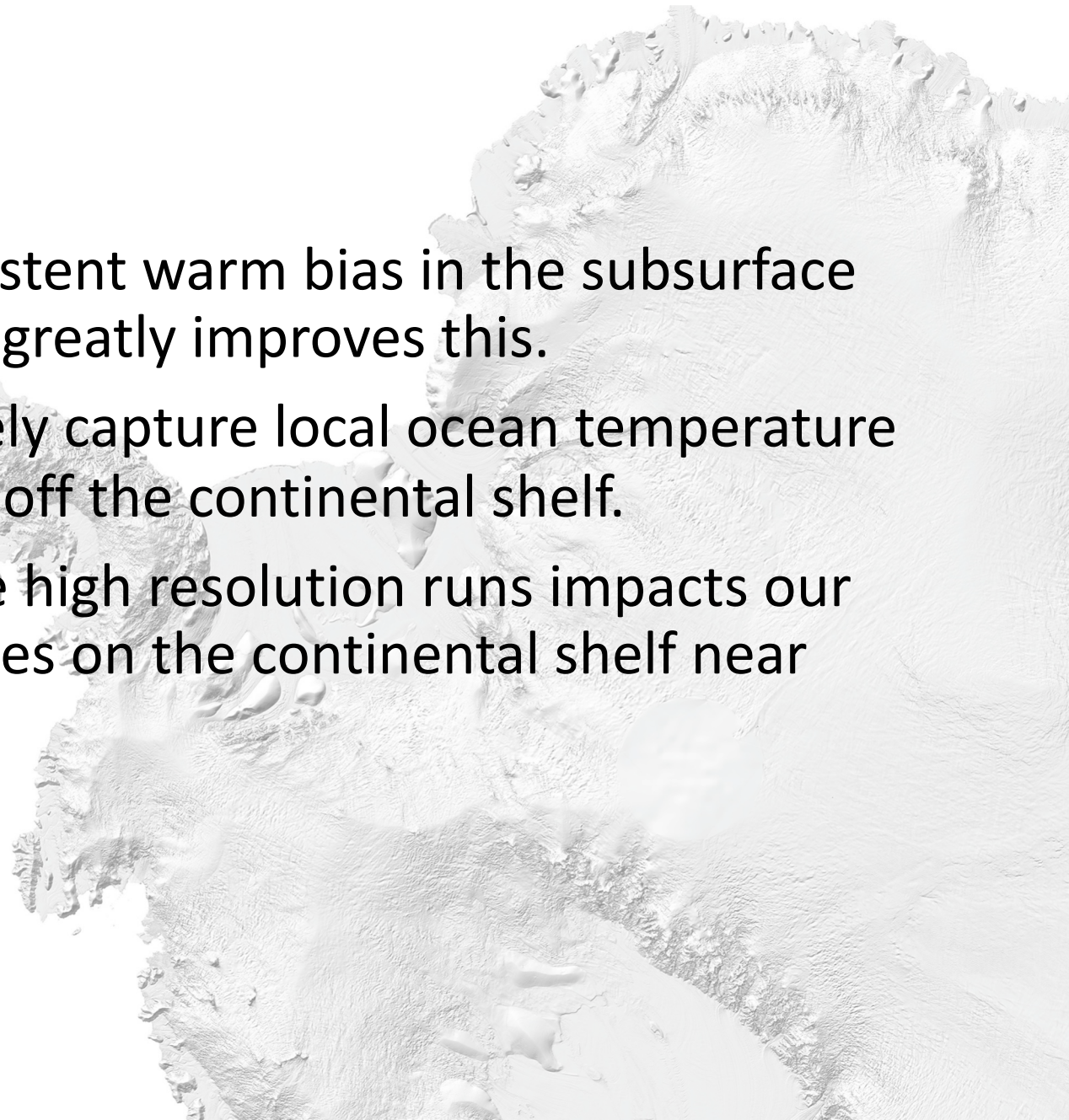
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- 3) The smoothed bathymetry in the high resolution runs impacts our ability to trust ocean temperatures on the continental shelf near the ice sheet.



Antarctic mass balance is controlled largely by ocean interactions

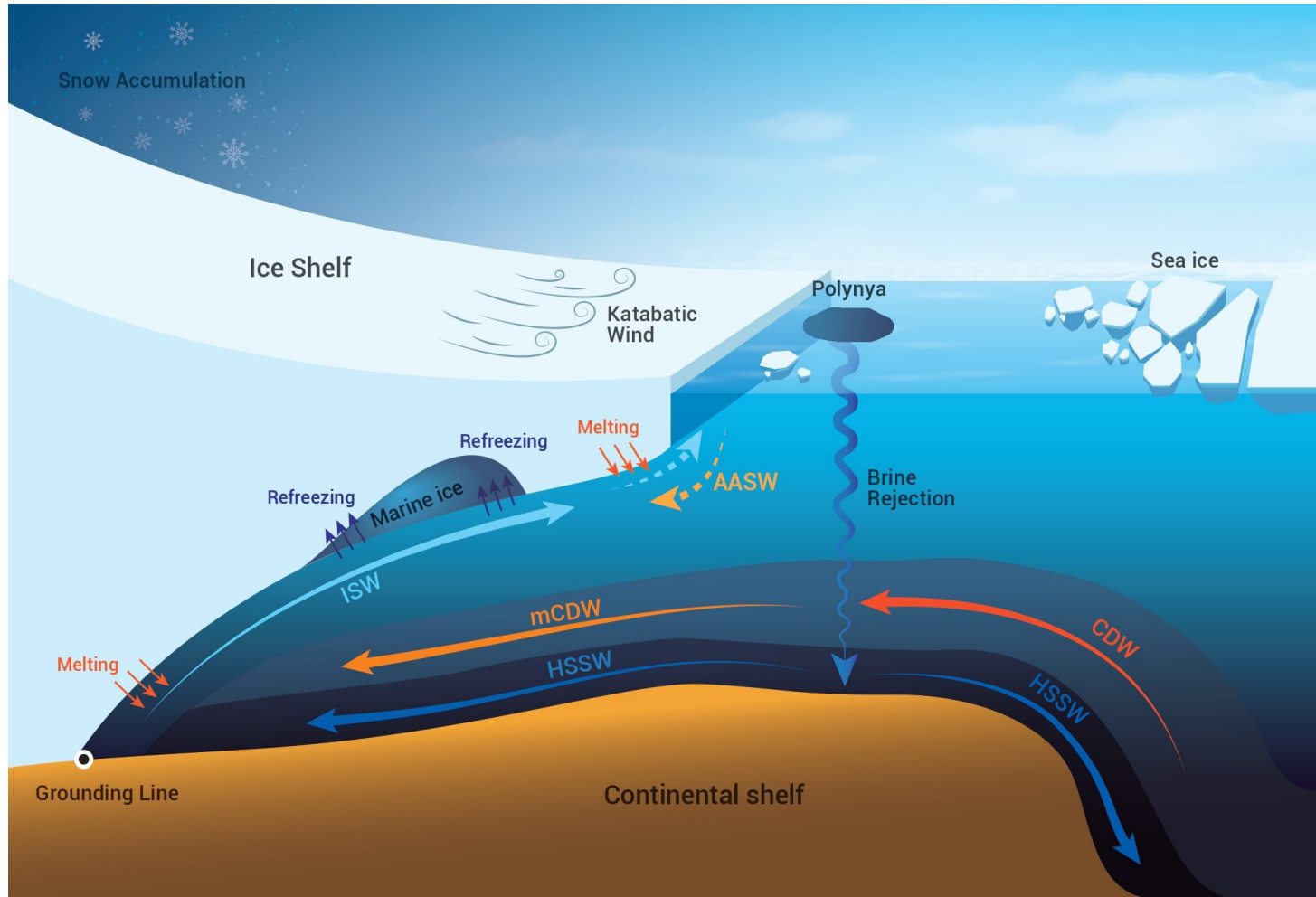


Image: Phys.org

Thickness change rate (m/yr)

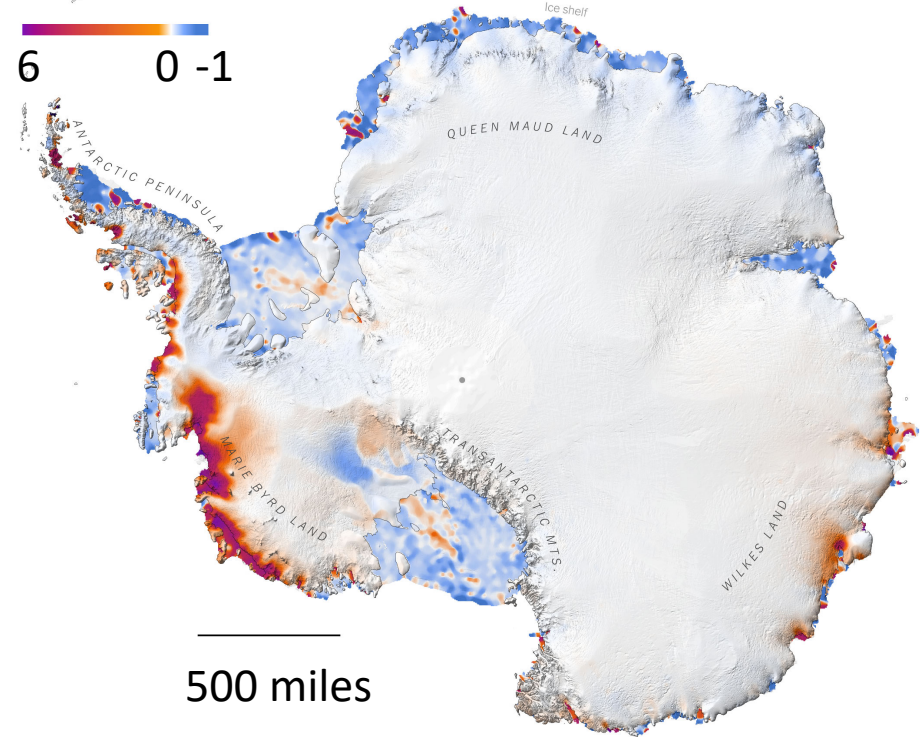
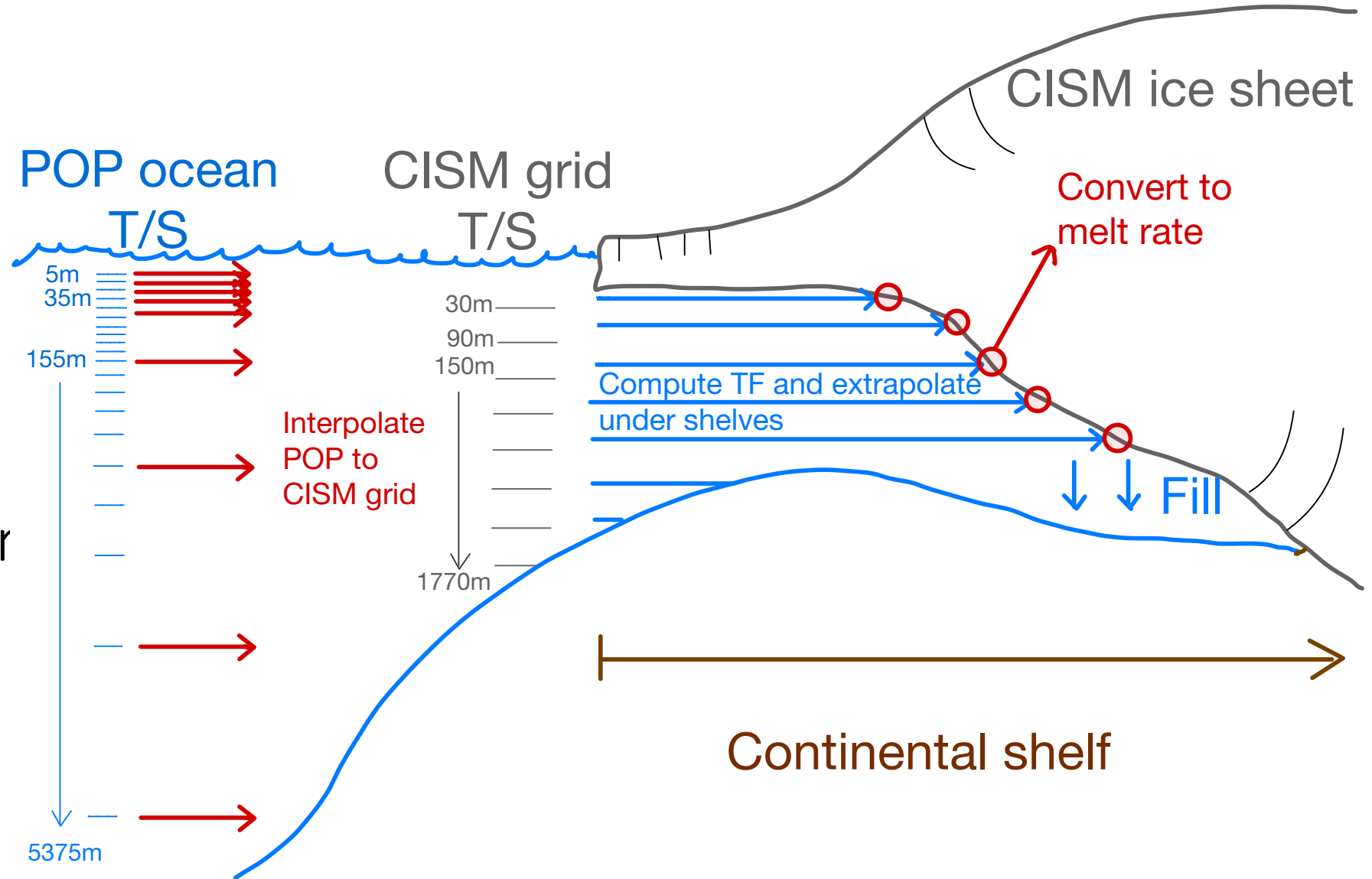


Image: nytimes.com

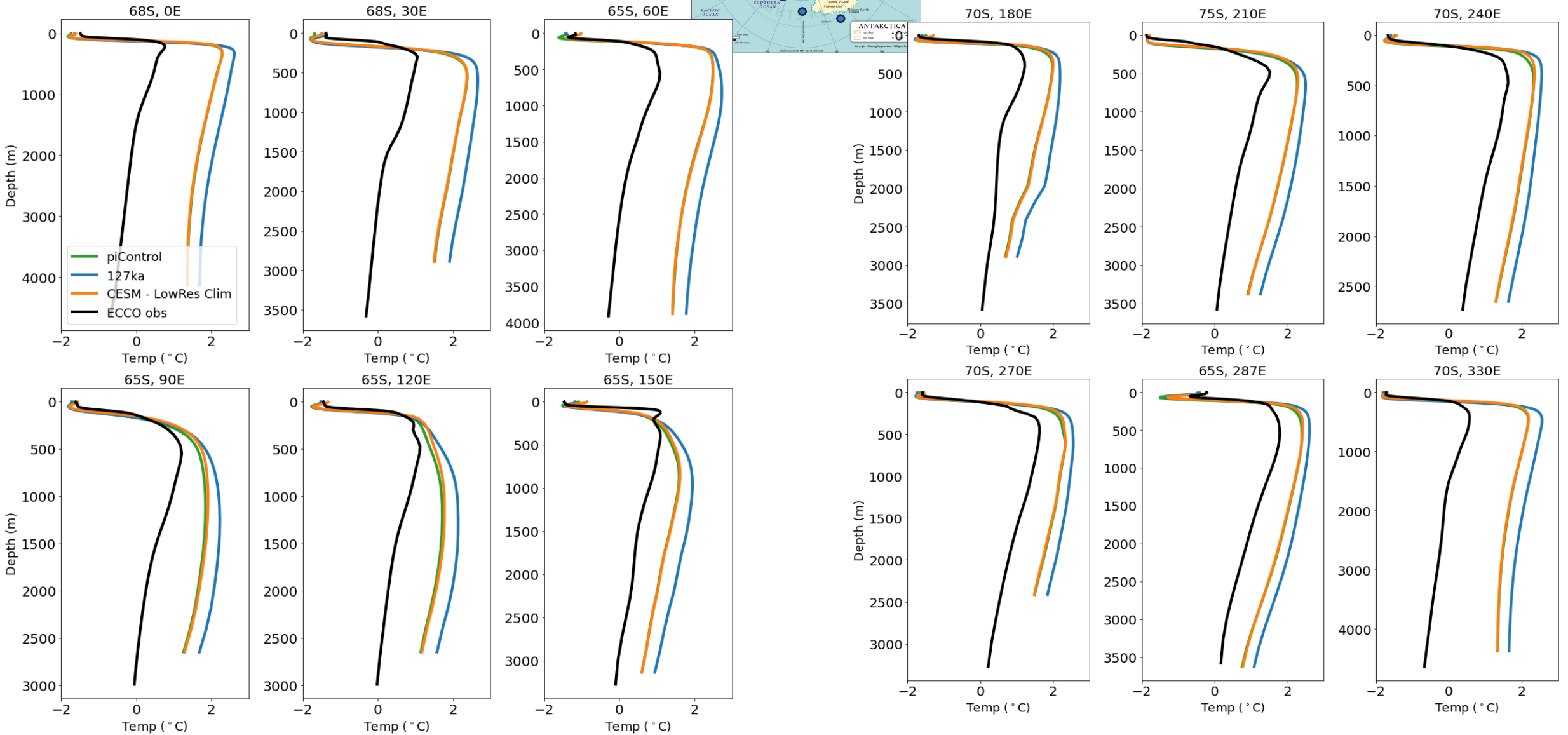
To get ocean forcing, CMIP6 ocean temp and salinity are extrapolated under the ice shelves

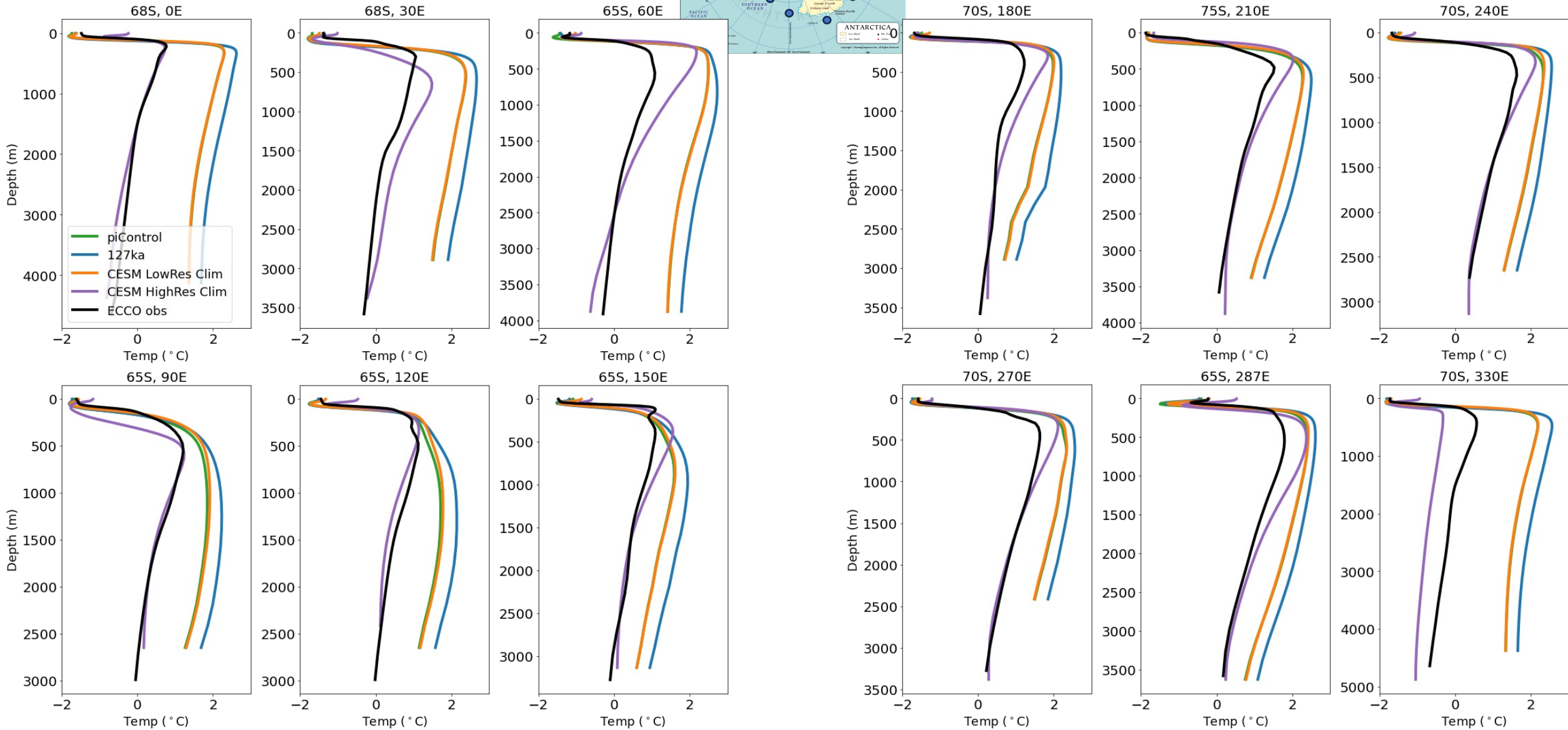


Sampling goes clockwise, starting at 0° longitude

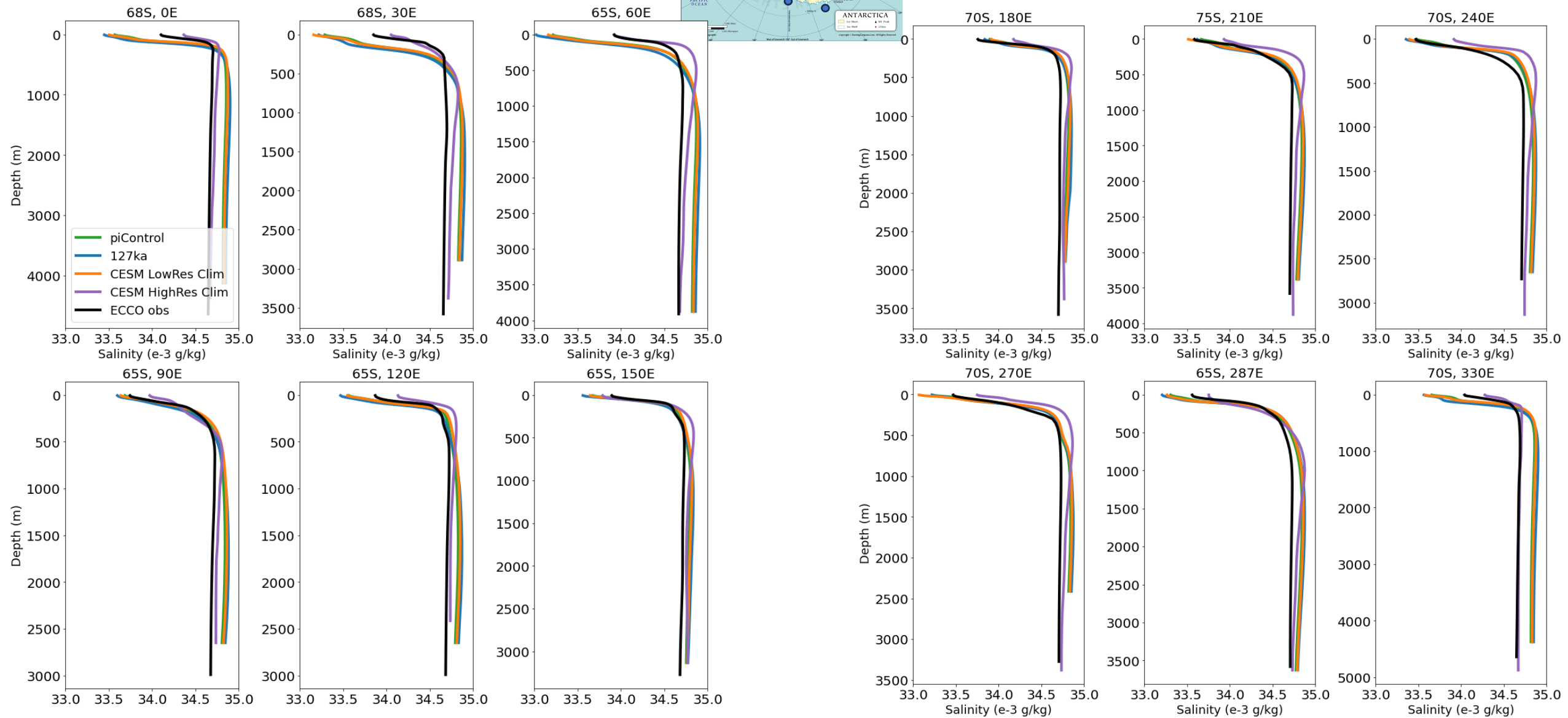


Temp profiles



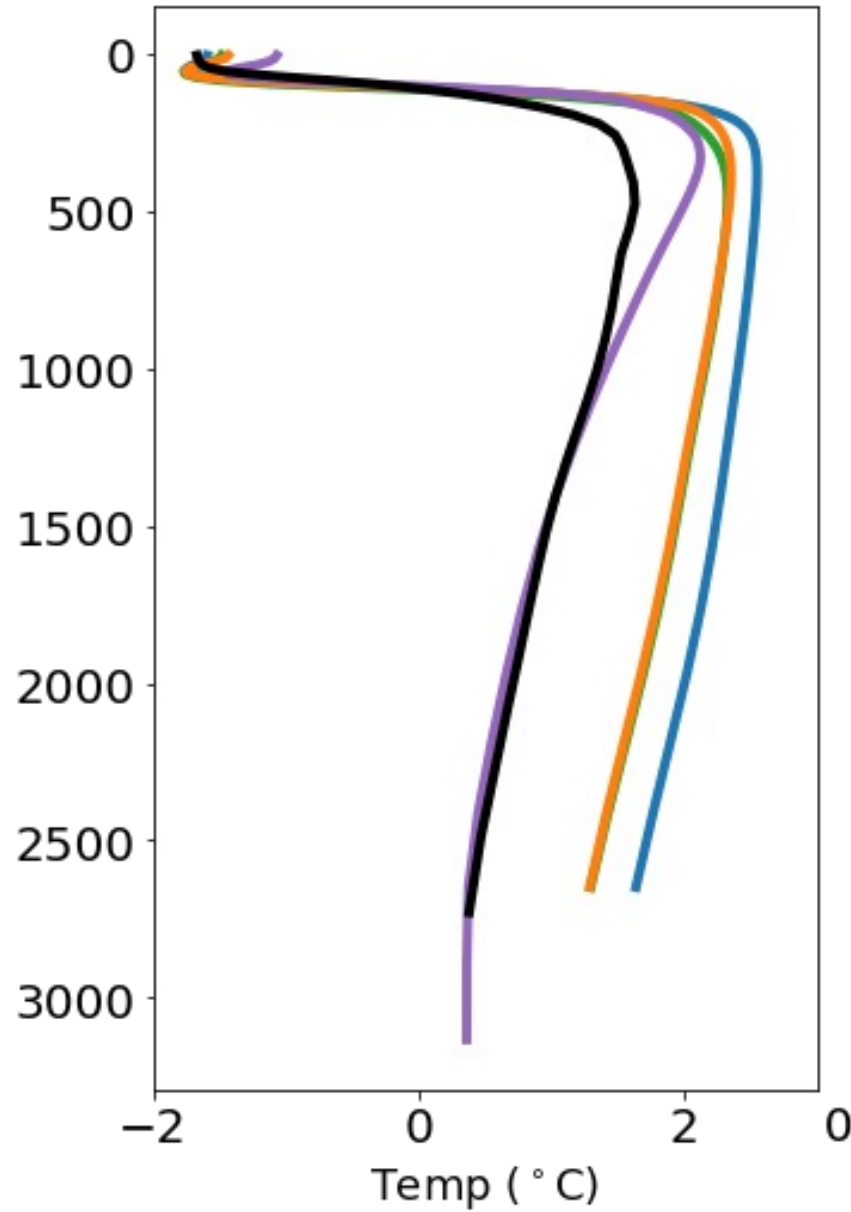


Salinity profiles

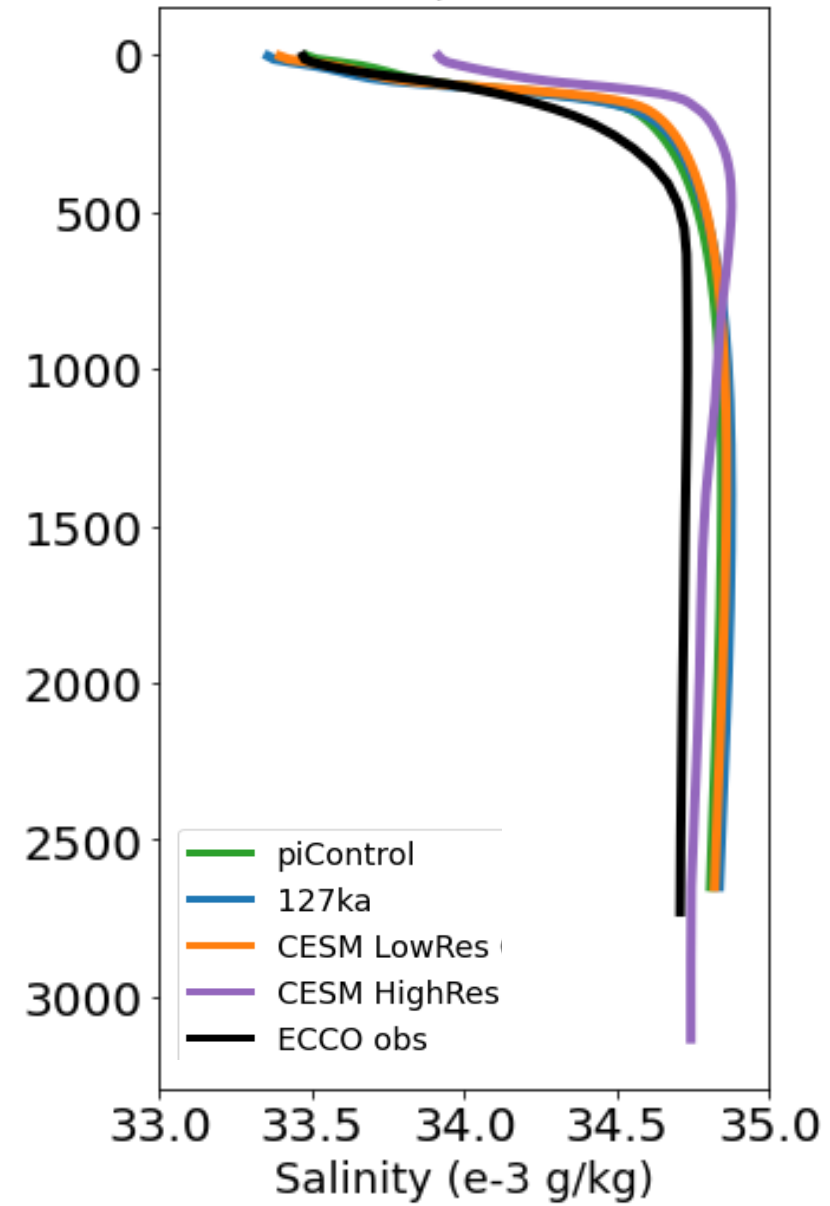




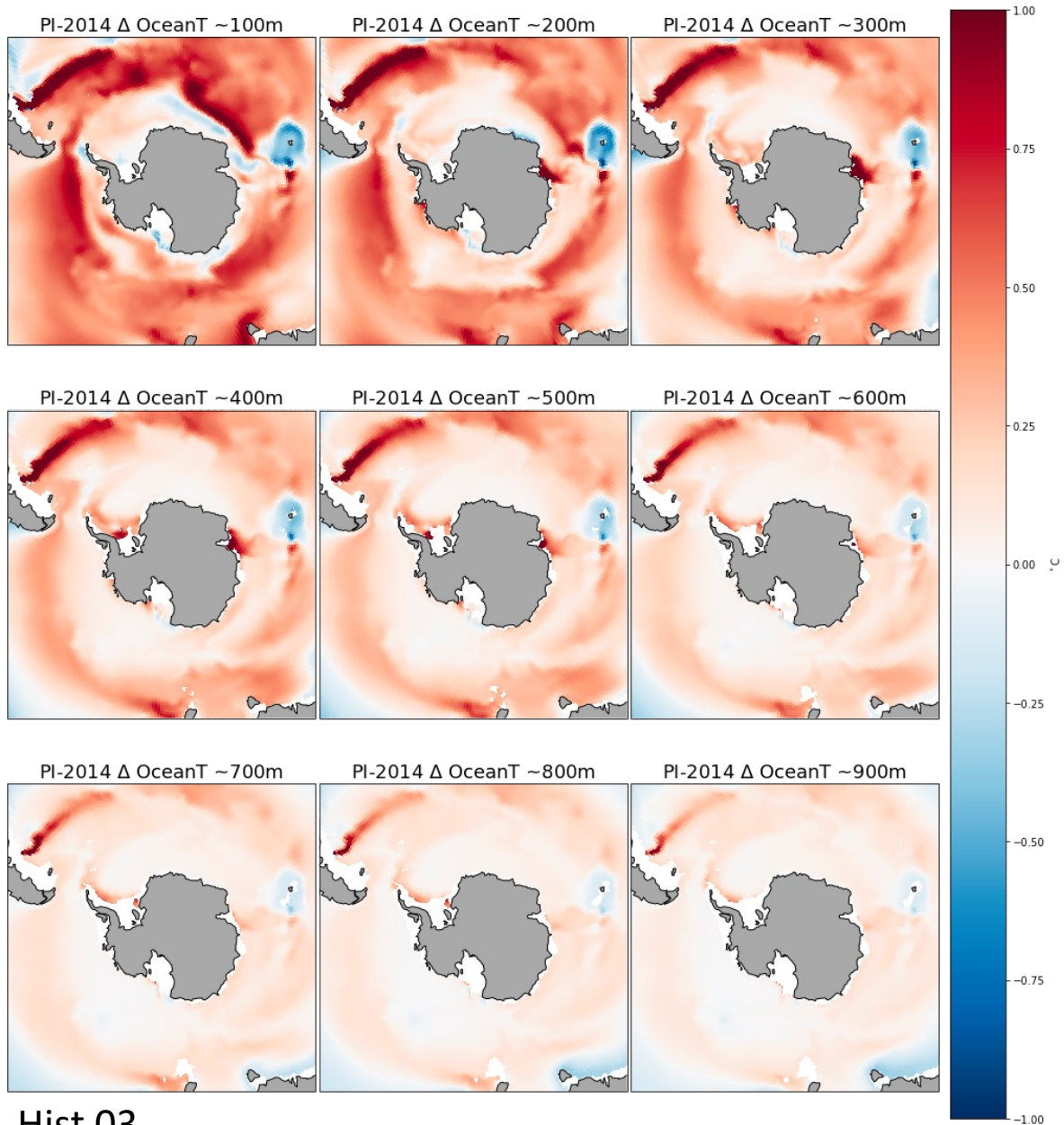
70S, 240E



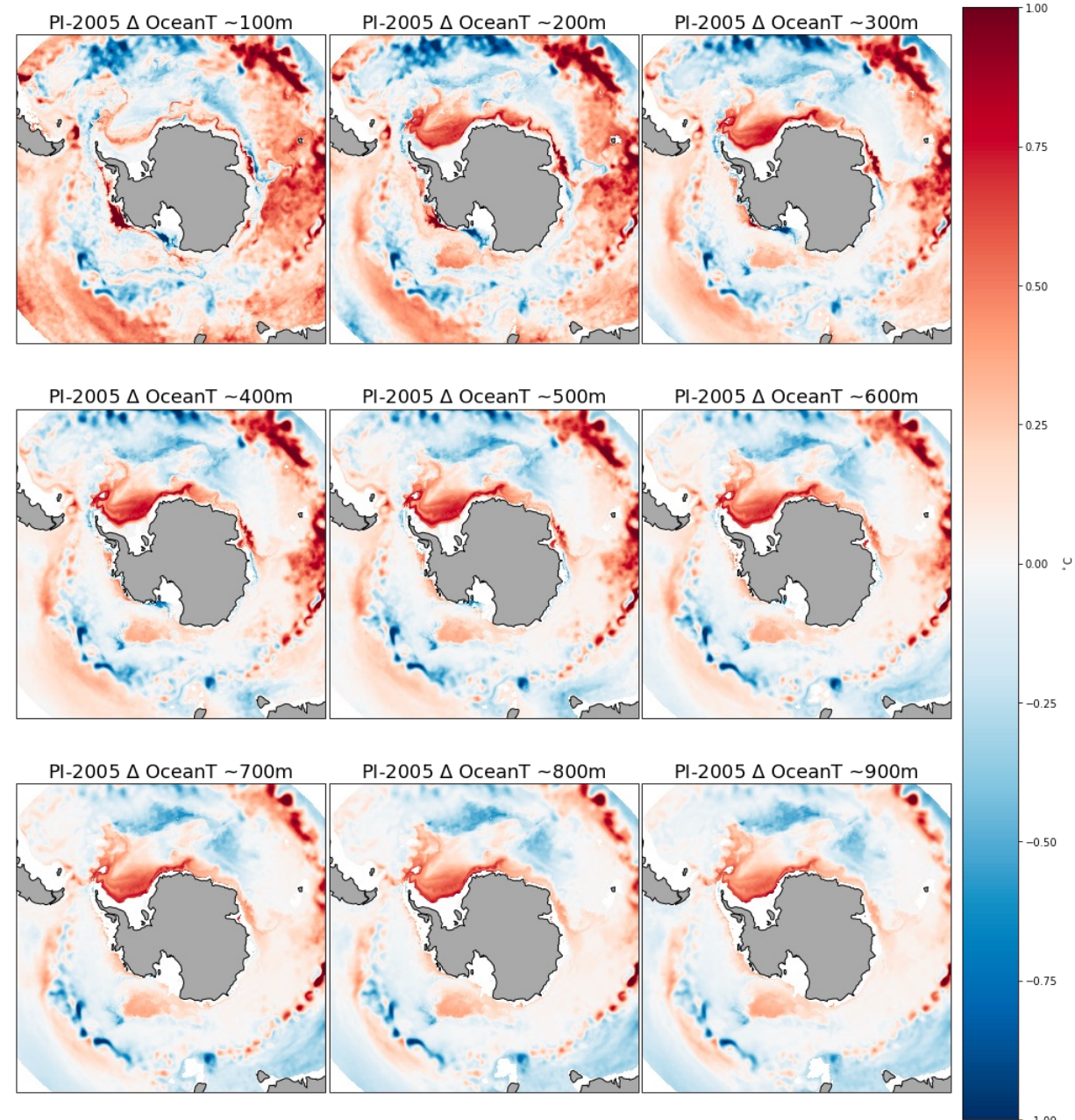
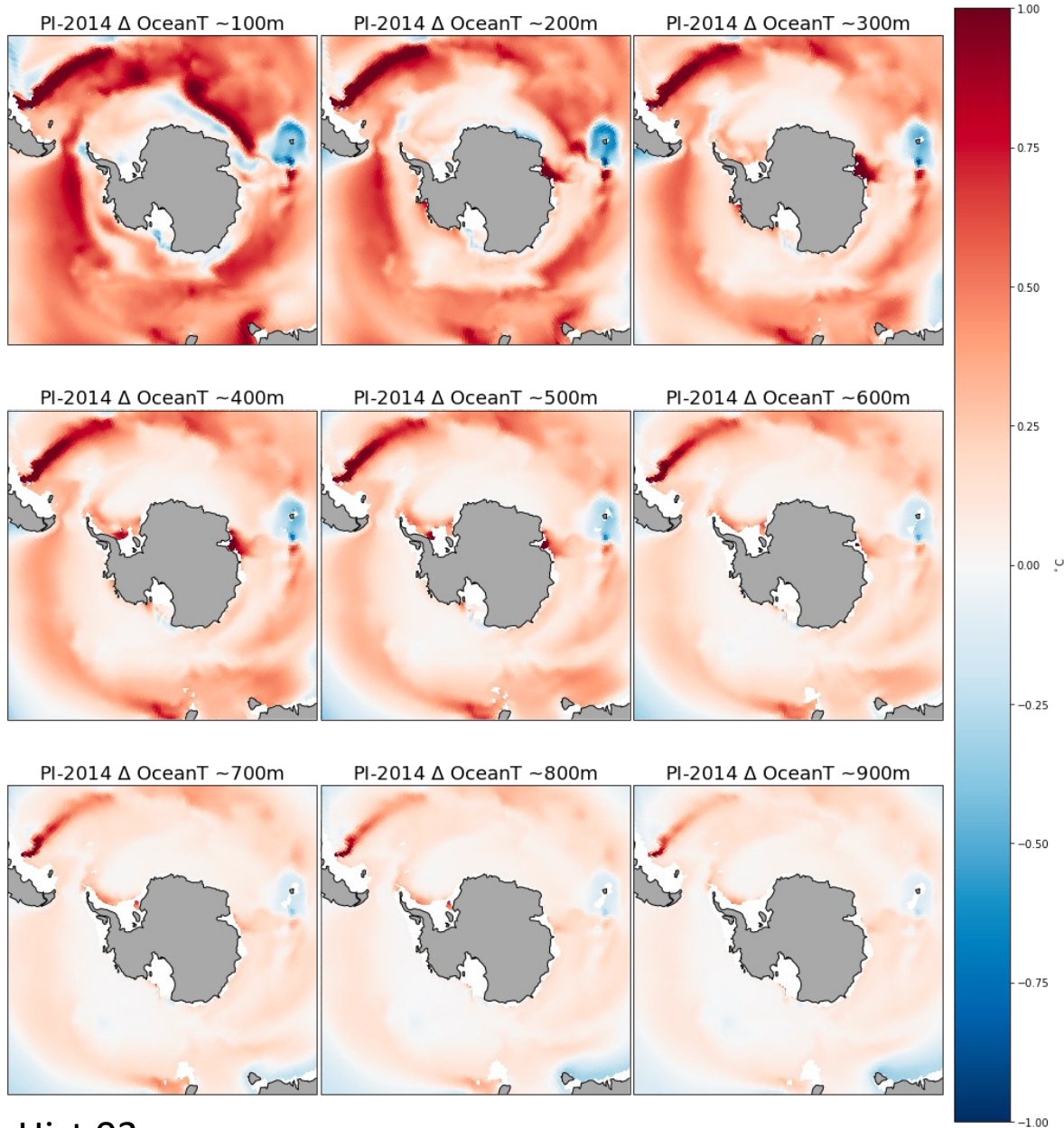
70S, 240E



Low res POP simulates broad warming since PI



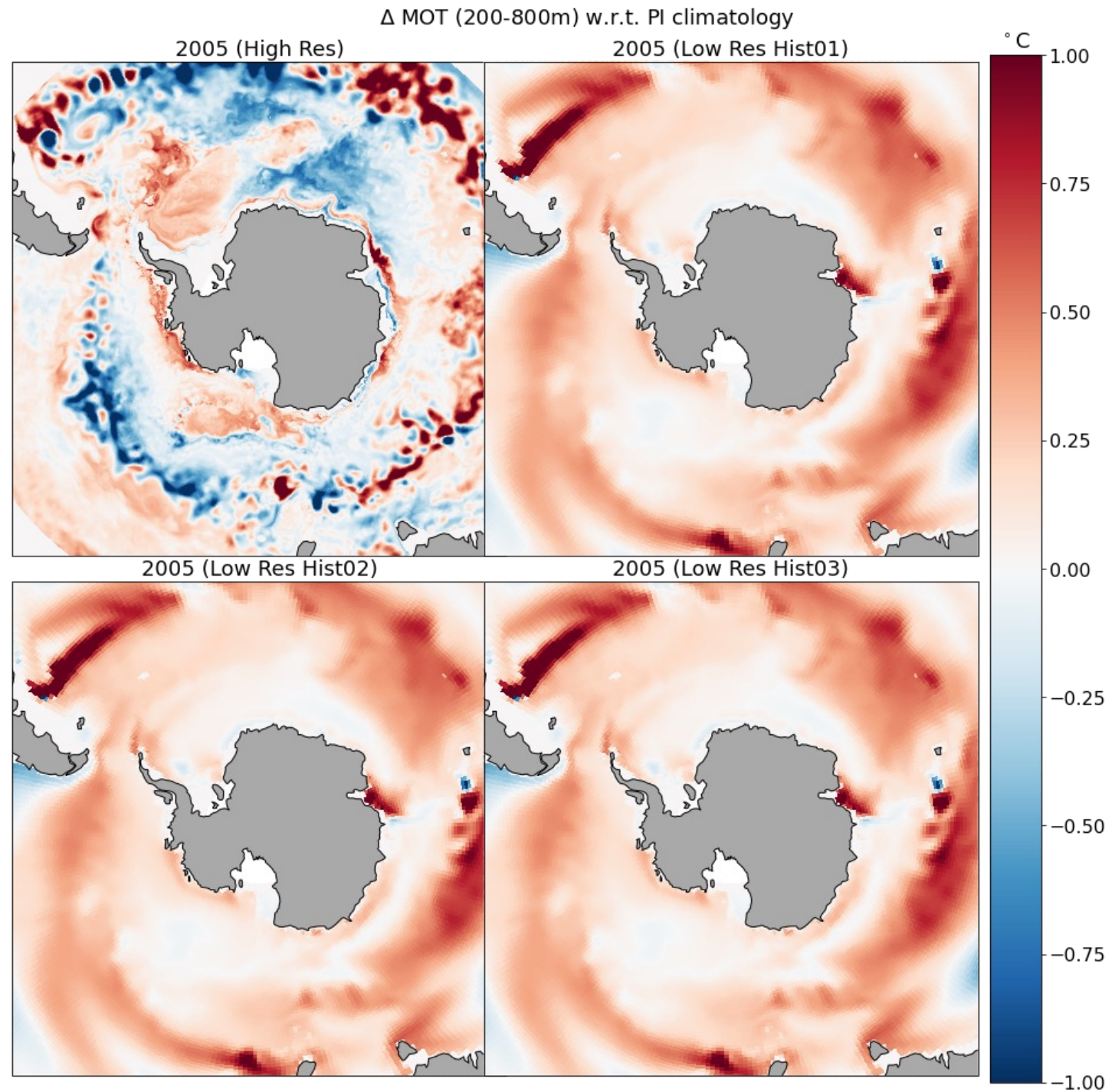
High res POP simulates more complex Δ temp since PI



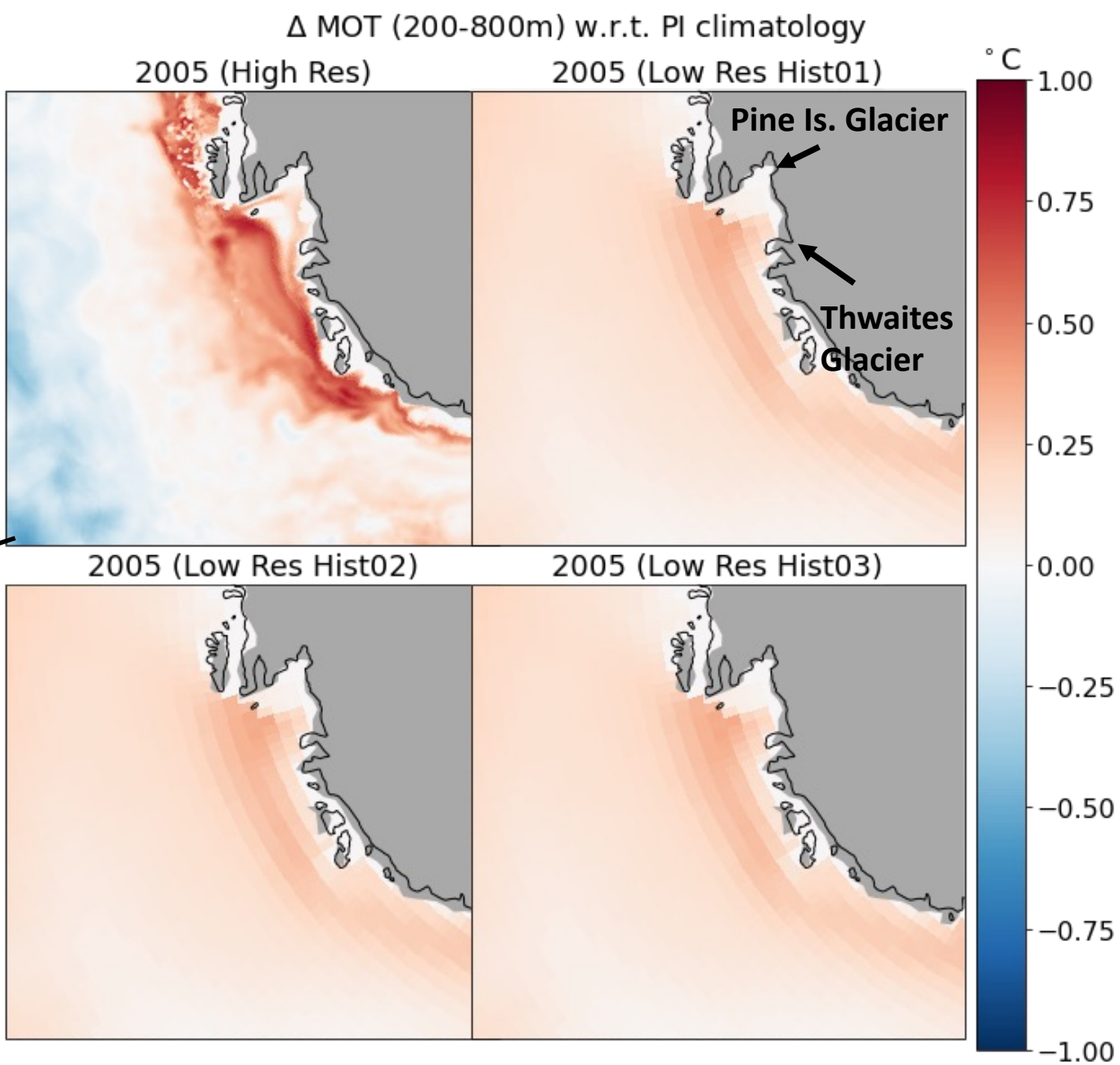
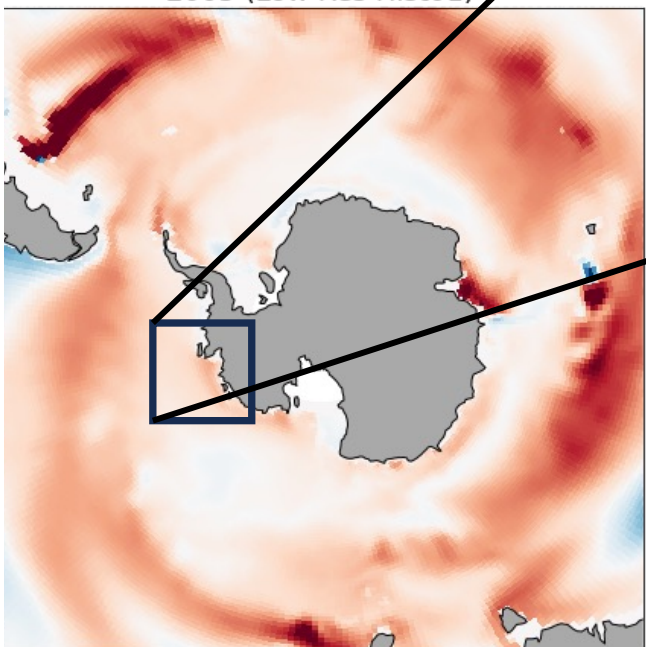
Changes in MOT (200-800m)

→ All of Southern Ocean warms in low res runs

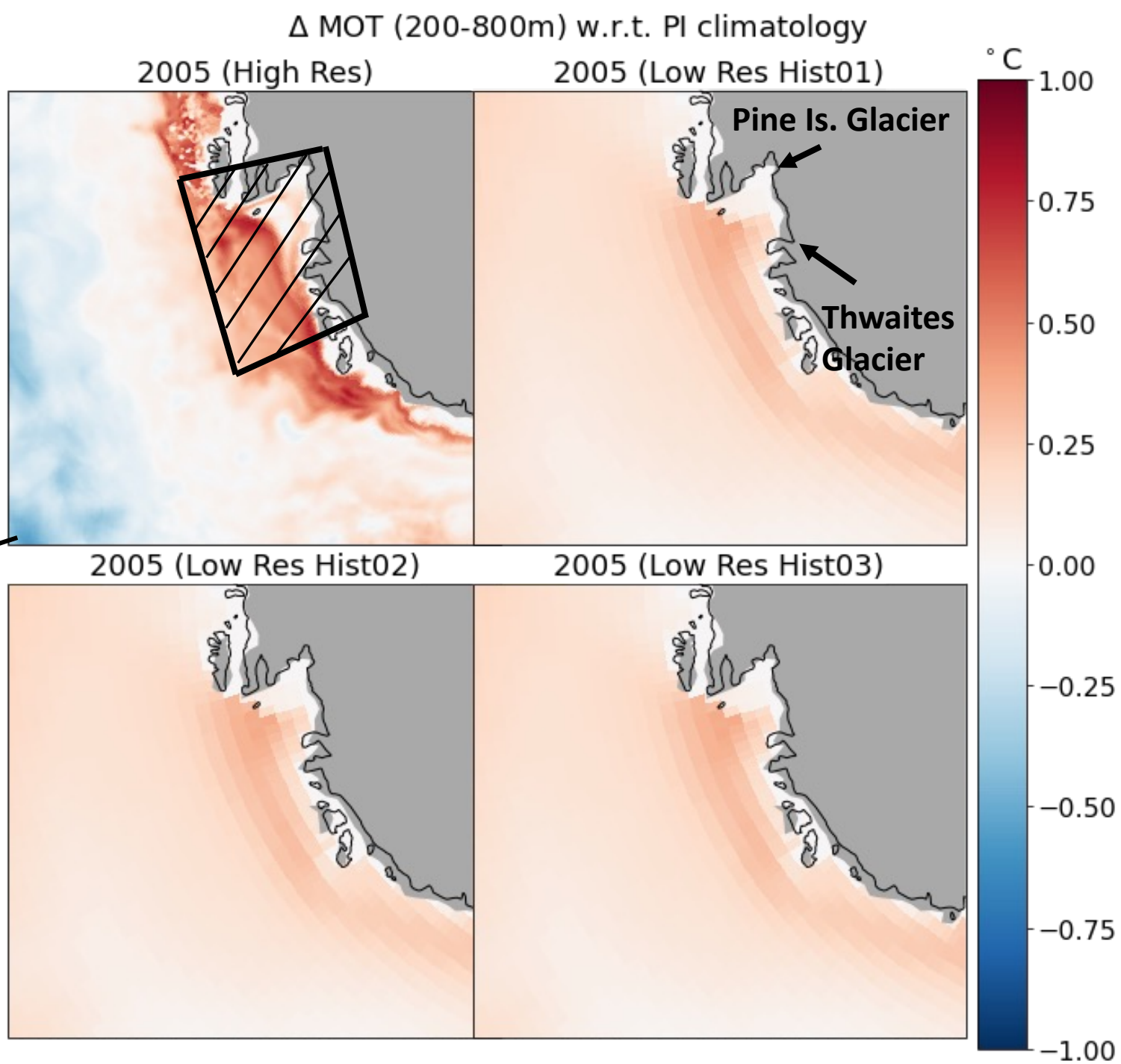
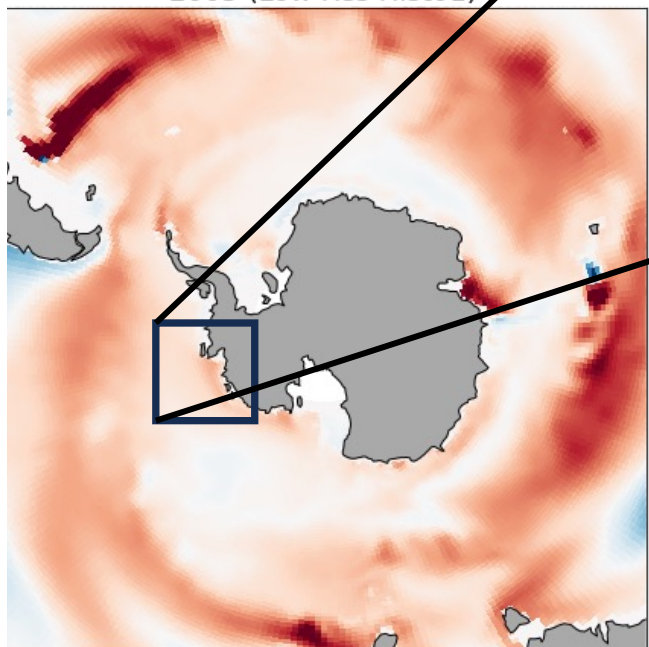
→ More complex ocean temperature change in high res run



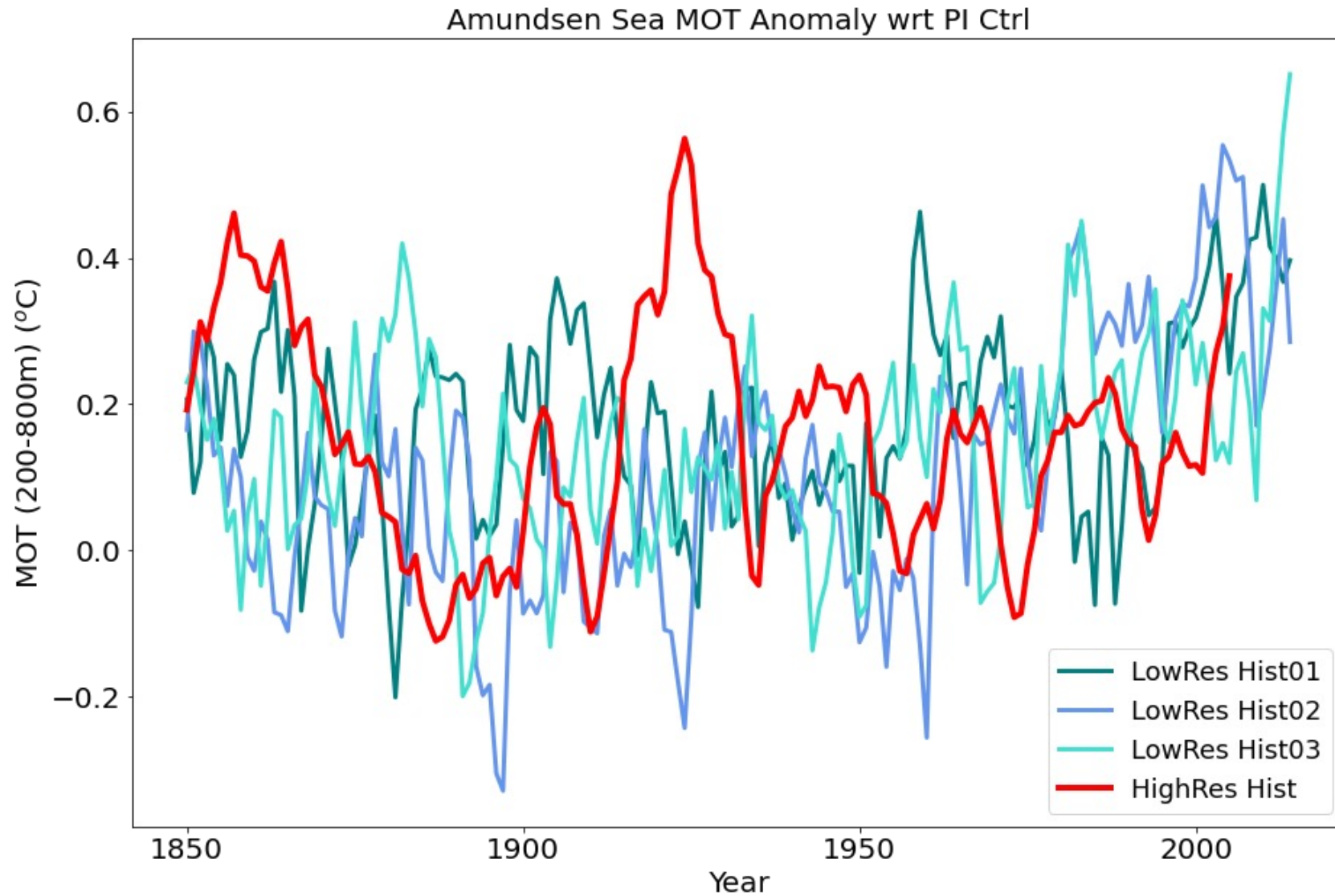
Let's look closer at the Amundsen Sea Region



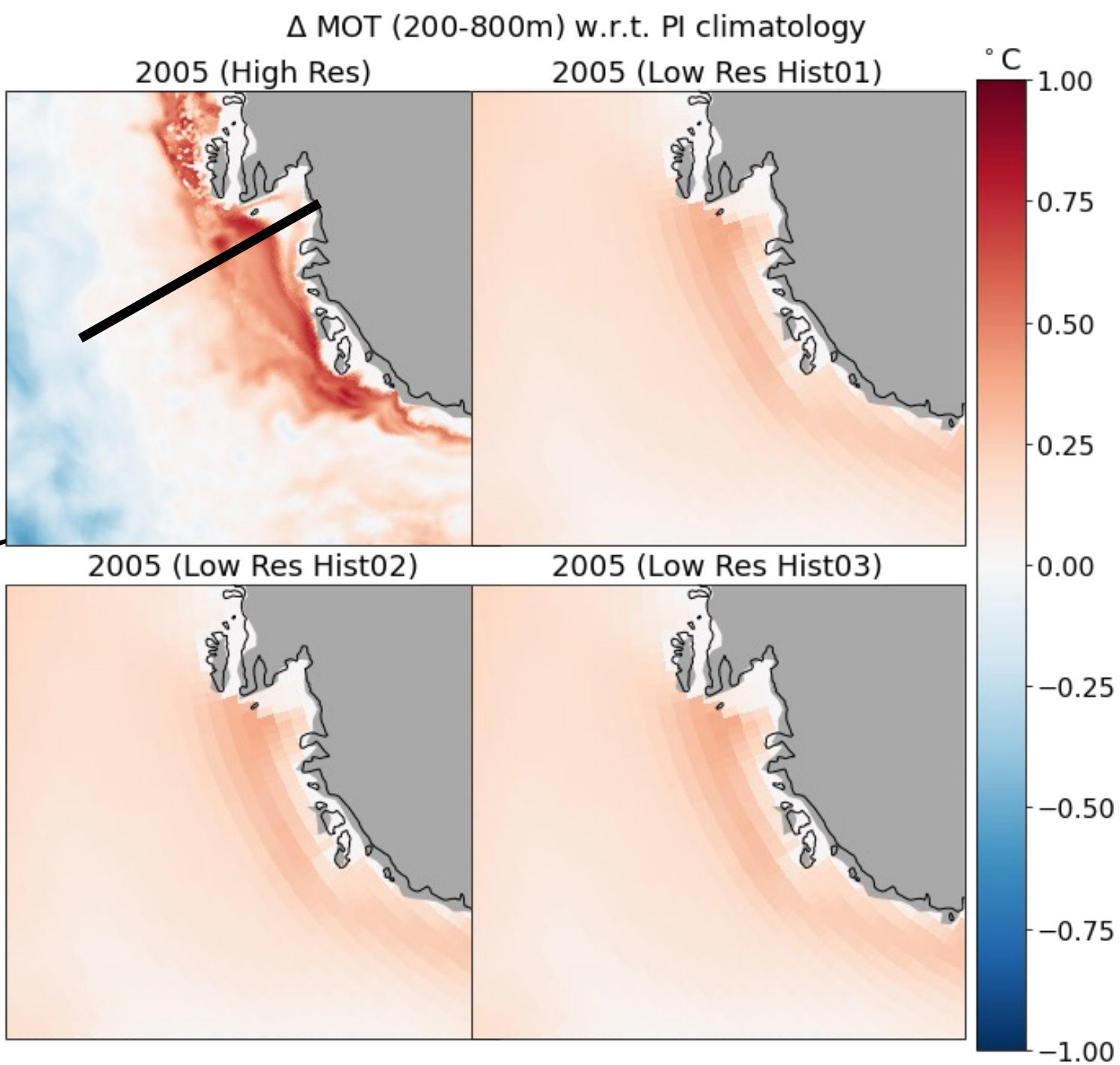
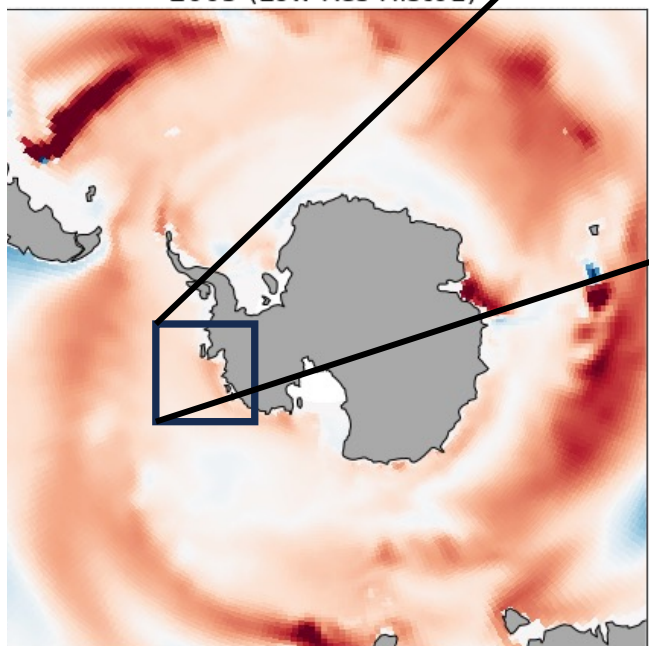
Let's look
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Low res and high res Amundsen MOT anomalies are comparable



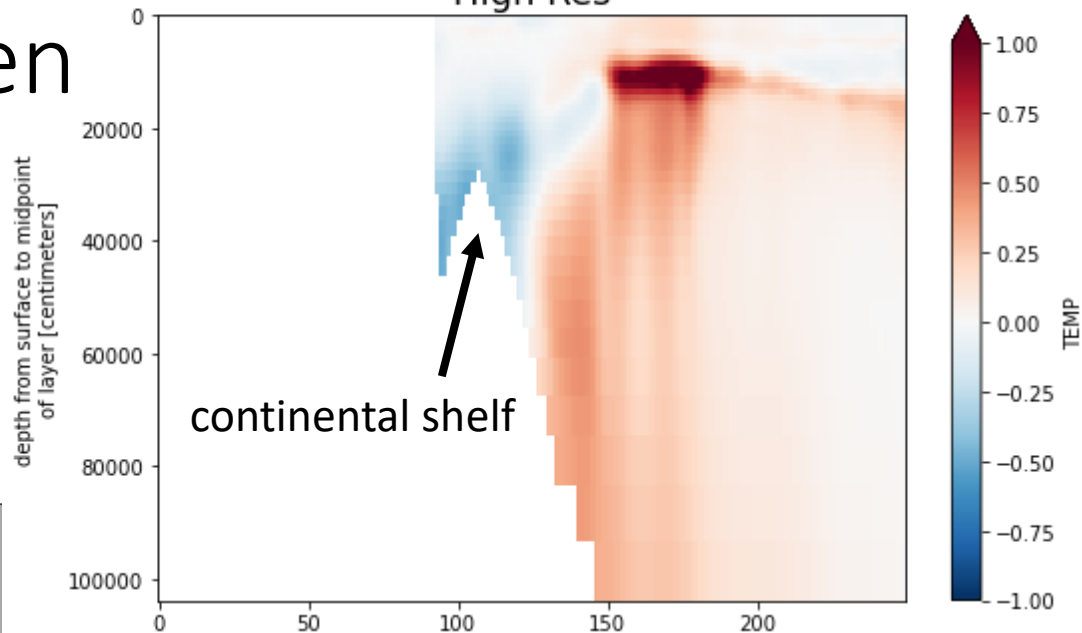
Let's look closer at a cross section



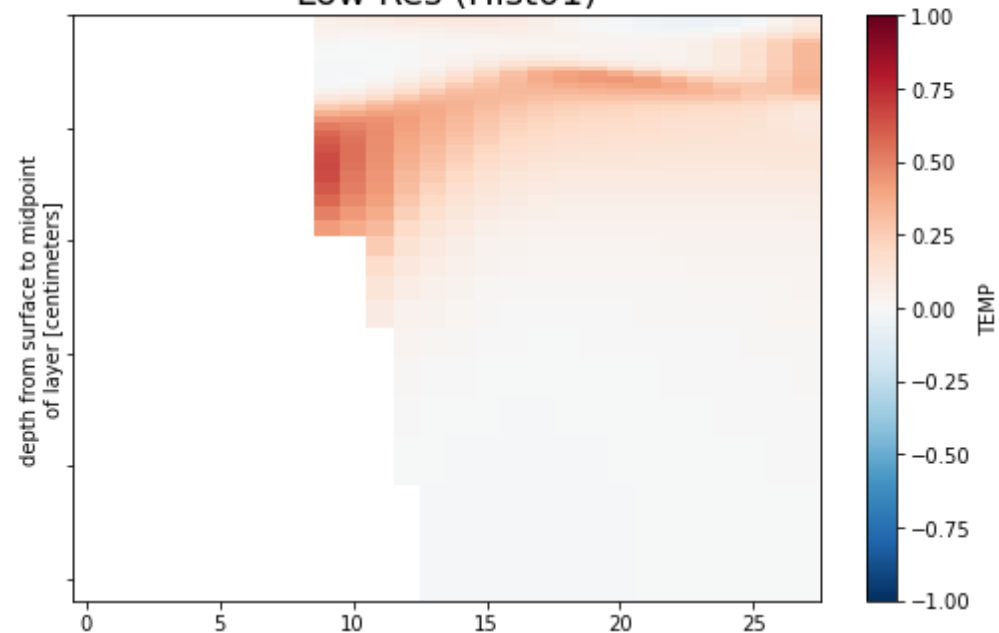
Amundsen Cross section

Amundsen ΔT (Modern (1990-2005) wrt PI)

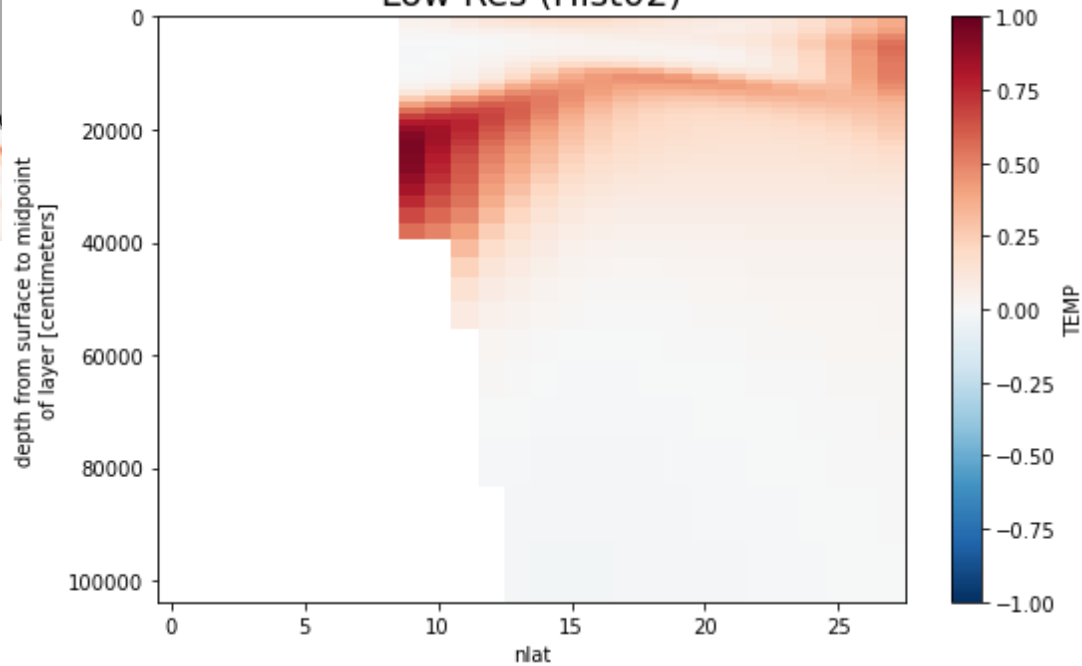
High Res



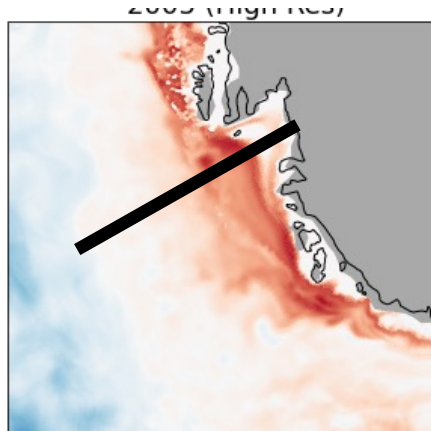
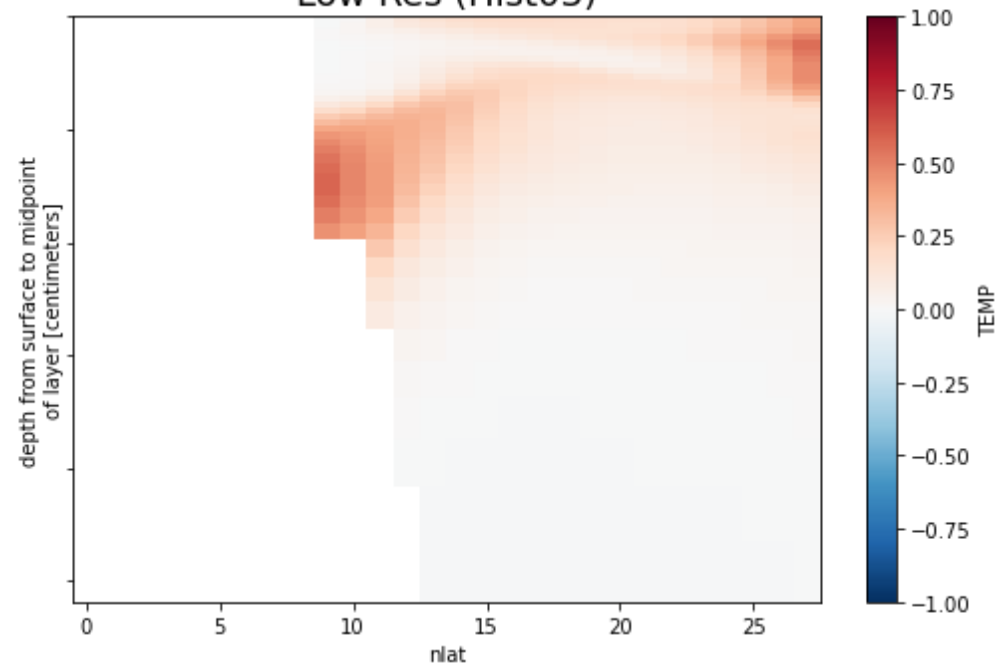
Low Res (Hist01)



Low Res^{nlat} (Hist02)



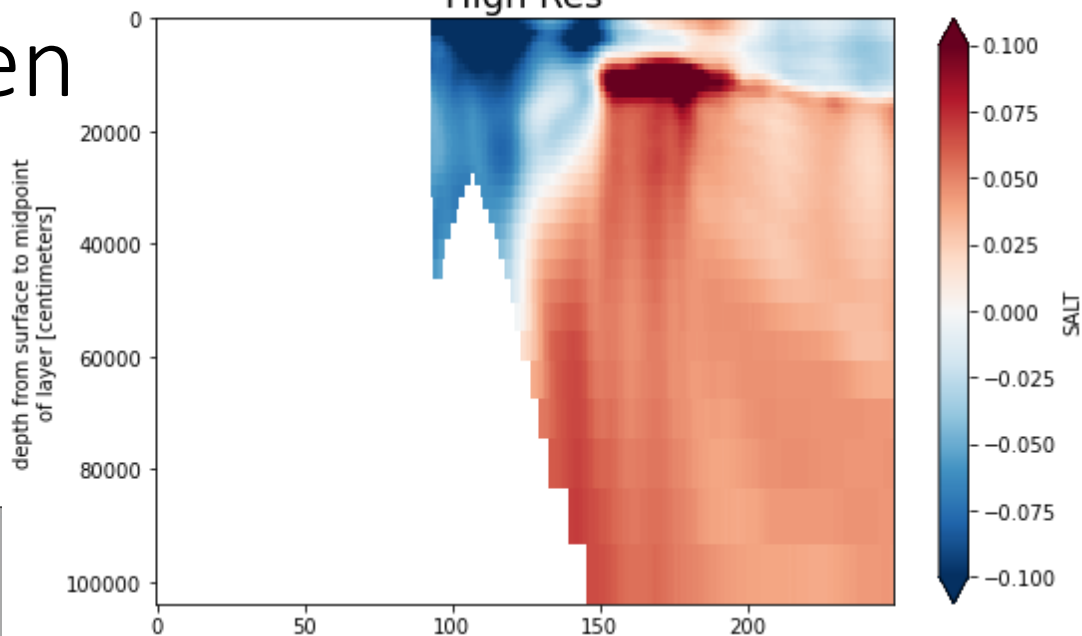
Low Res^{nlat} (Hist03)



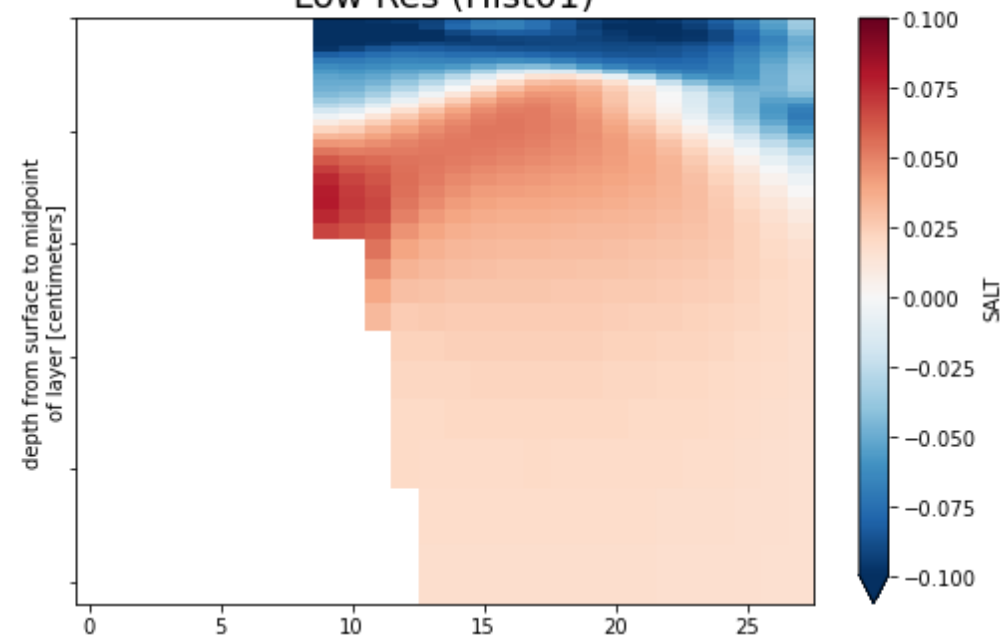
Amundsen Cross section

Amundsen ΔS (Modern (1990-2005) wrt PI)

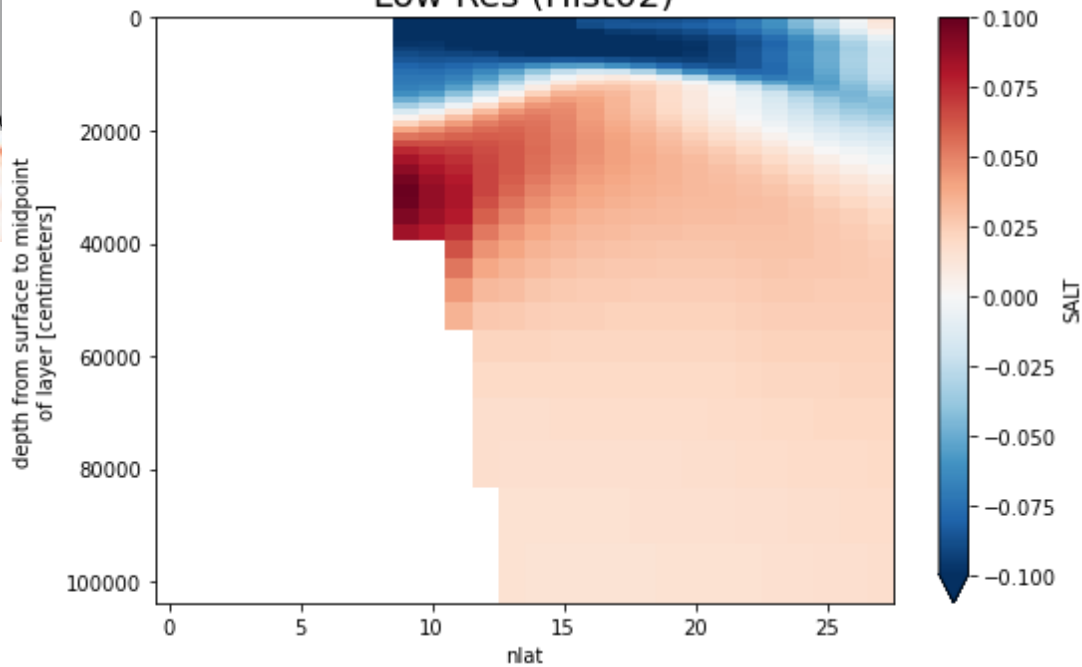
High Res



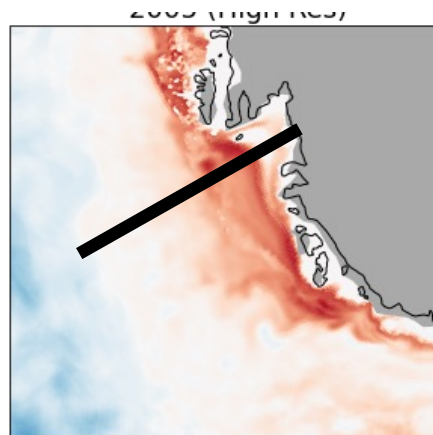
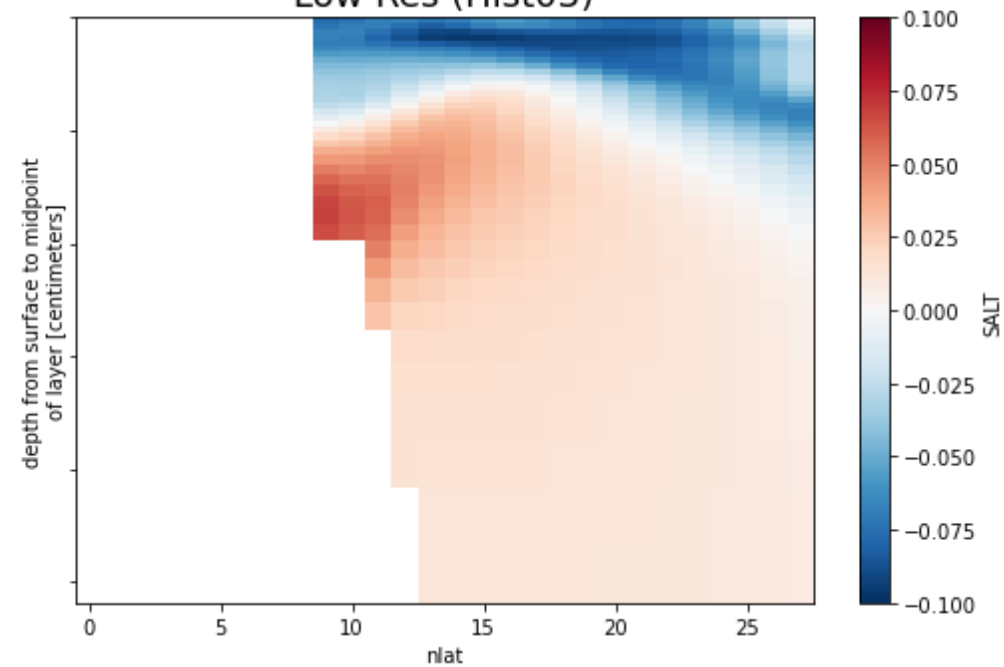
Low Res (Hist01)



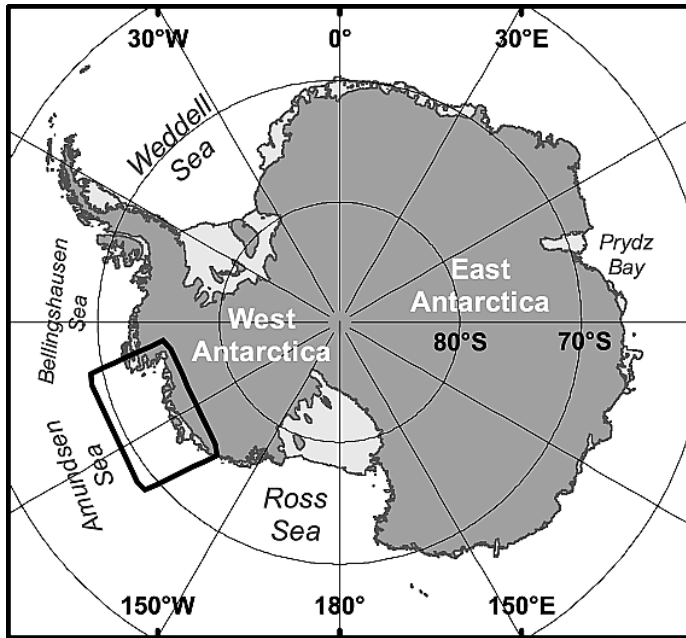
Low Res^{nlat} (Hist02)



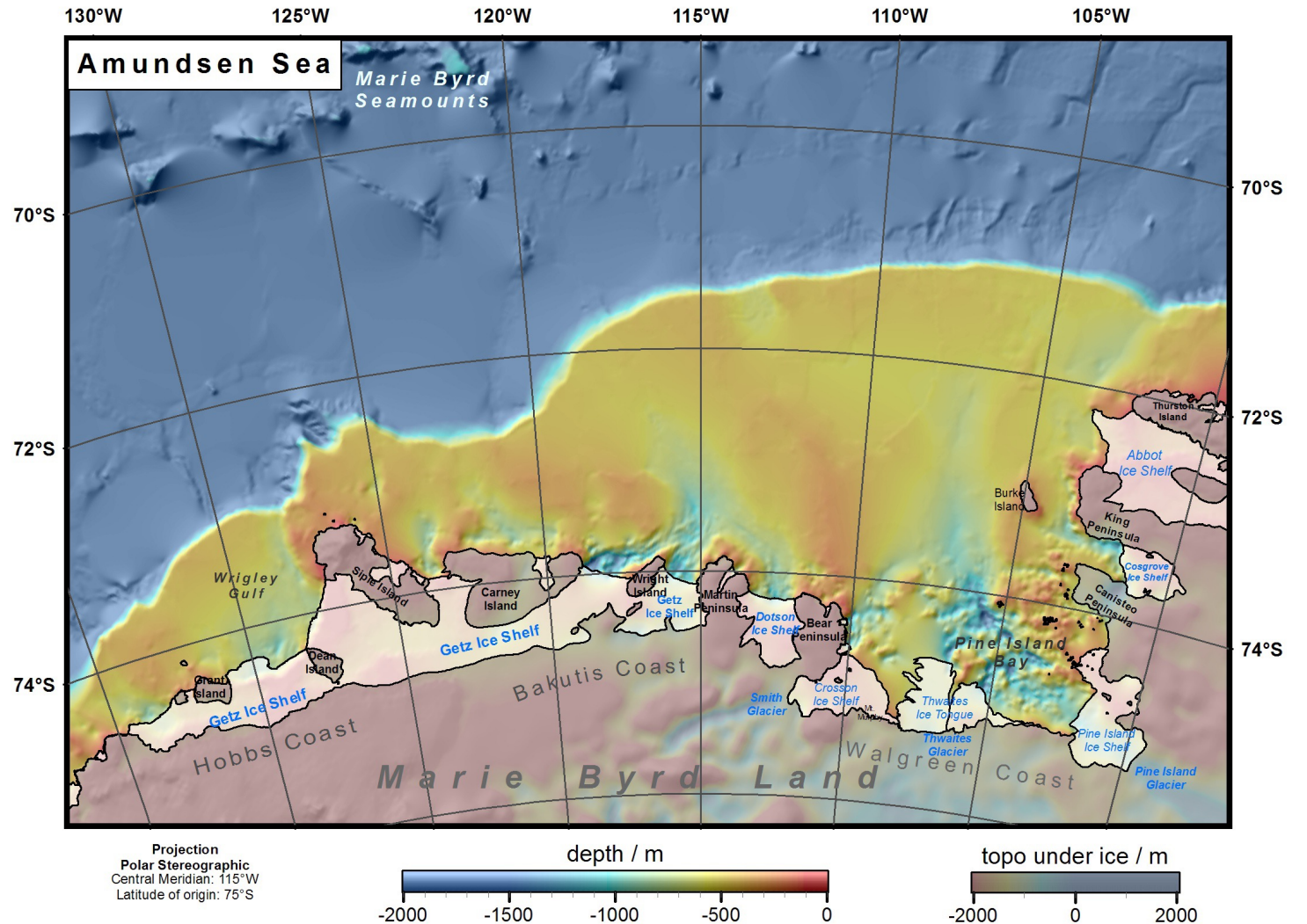
Low Res^{nlat} (Hist03)



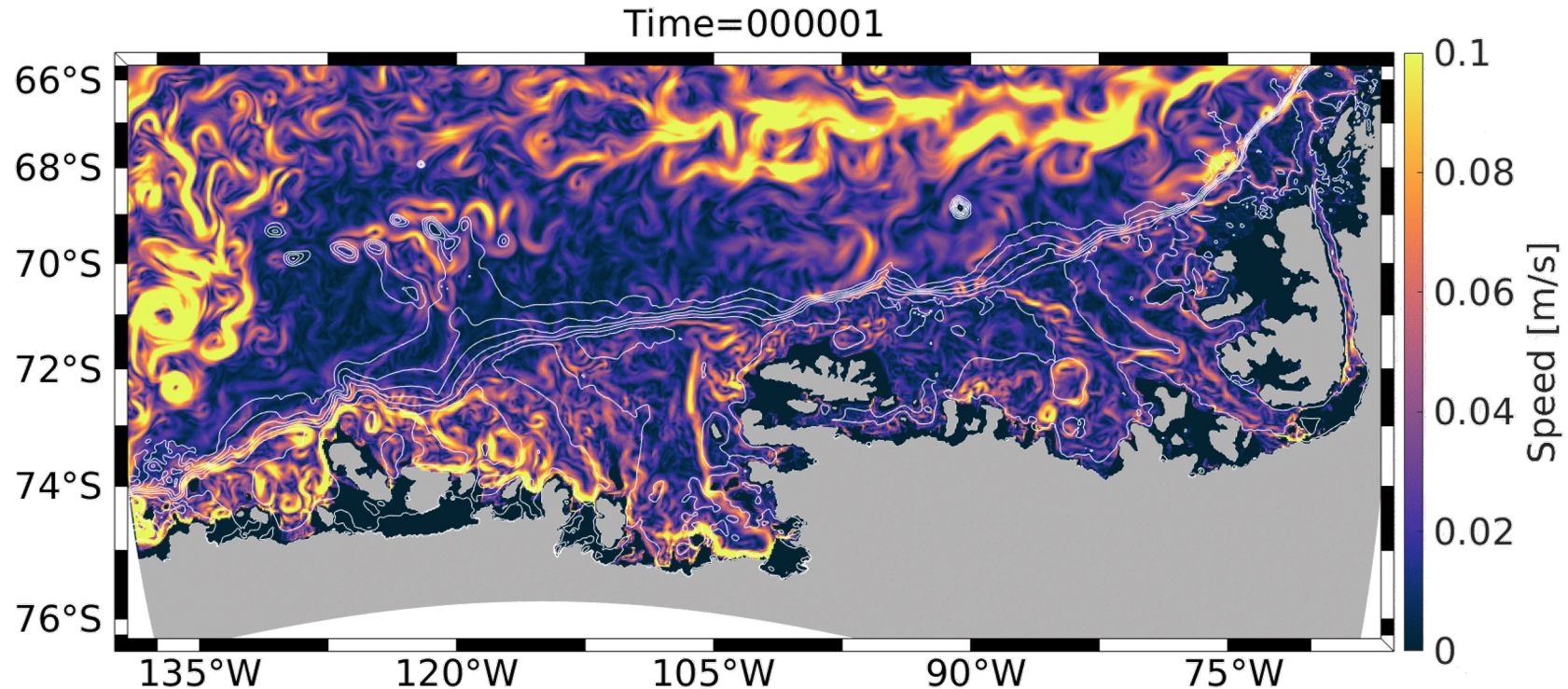
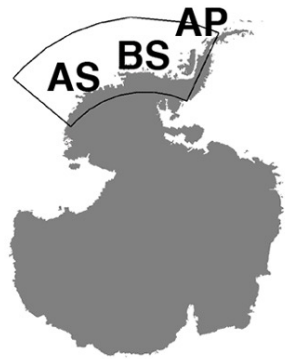
The bathymetry in the Amundsen Sea is essential to how warm water flows into the ice shelf cavities



Images: Nitsche et al., 2007

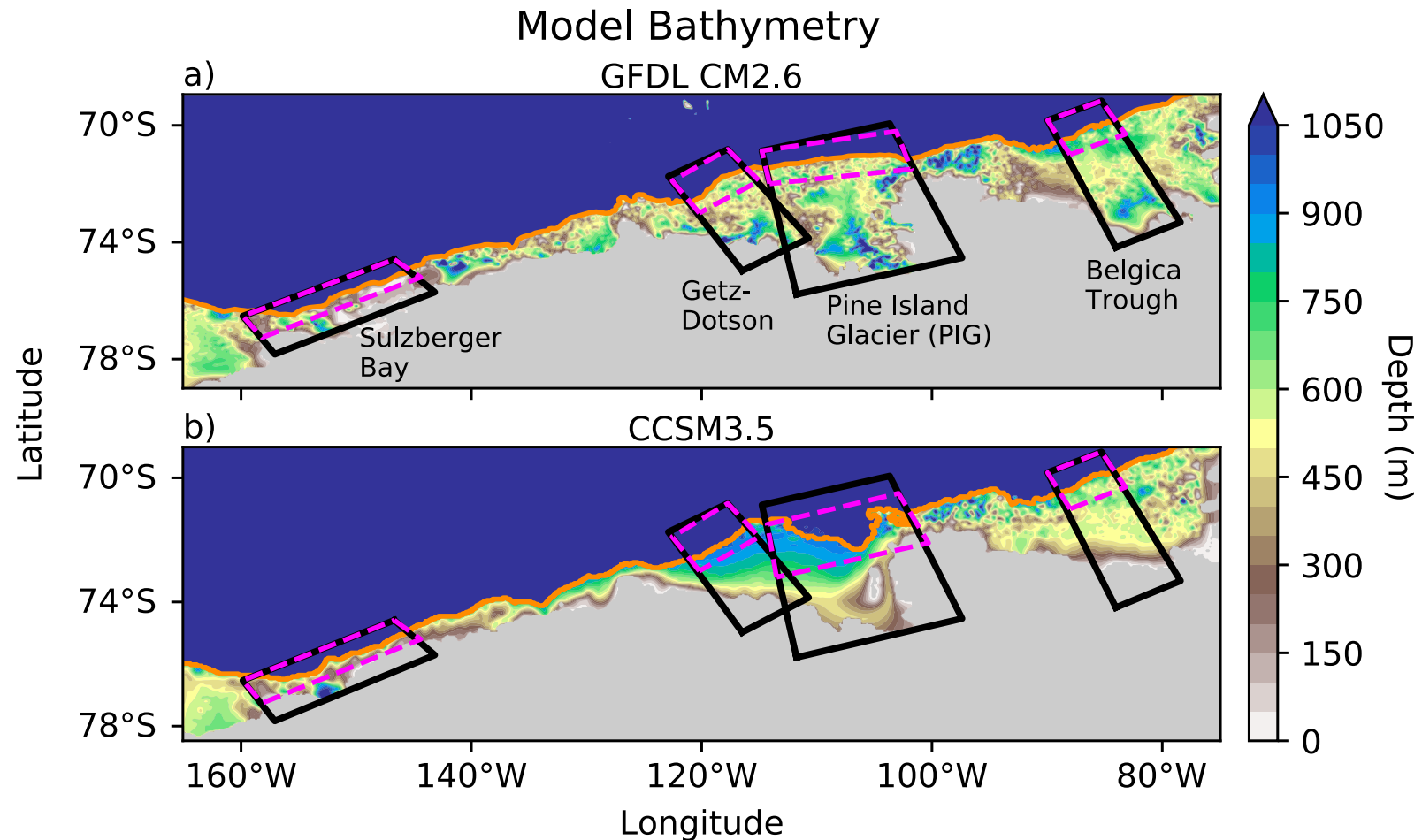


High resolution ocean modeling reveals complex transport of warm water toward the ice front

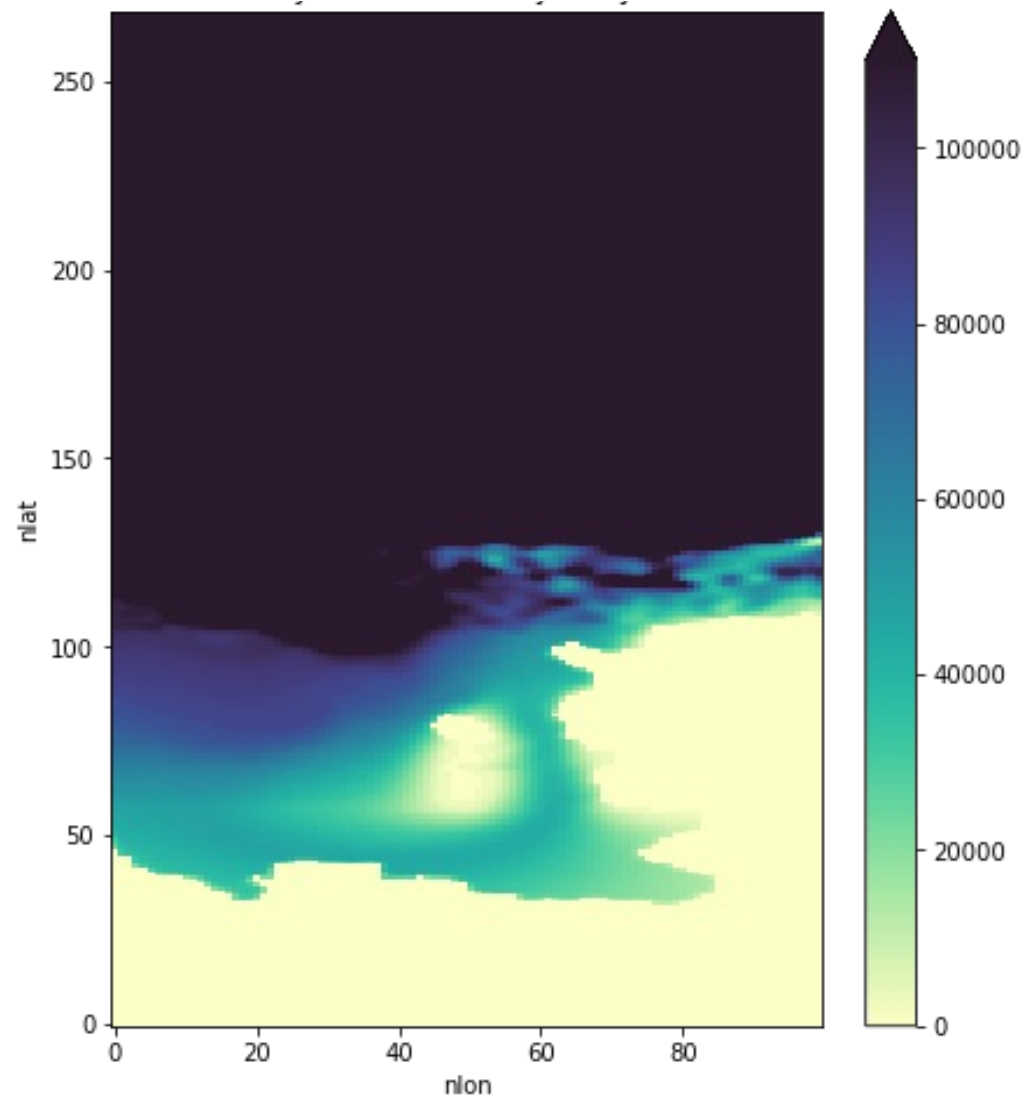


Daily ocean speed at 300m depth in 1998

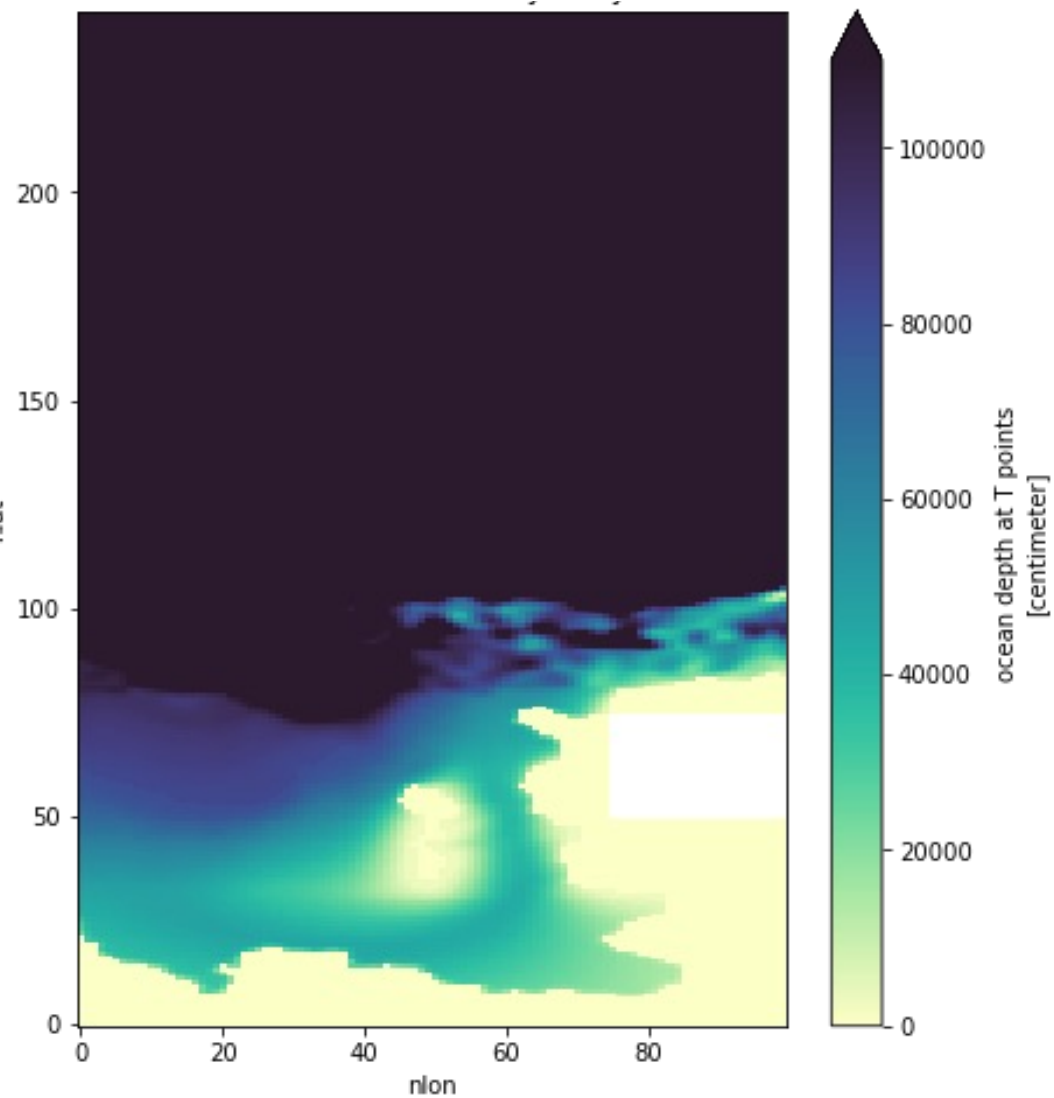
The smoothed bathymetry in the high resolution runs impacts our ability to trust ocean temperatures on the continental shelf near the ice sheet



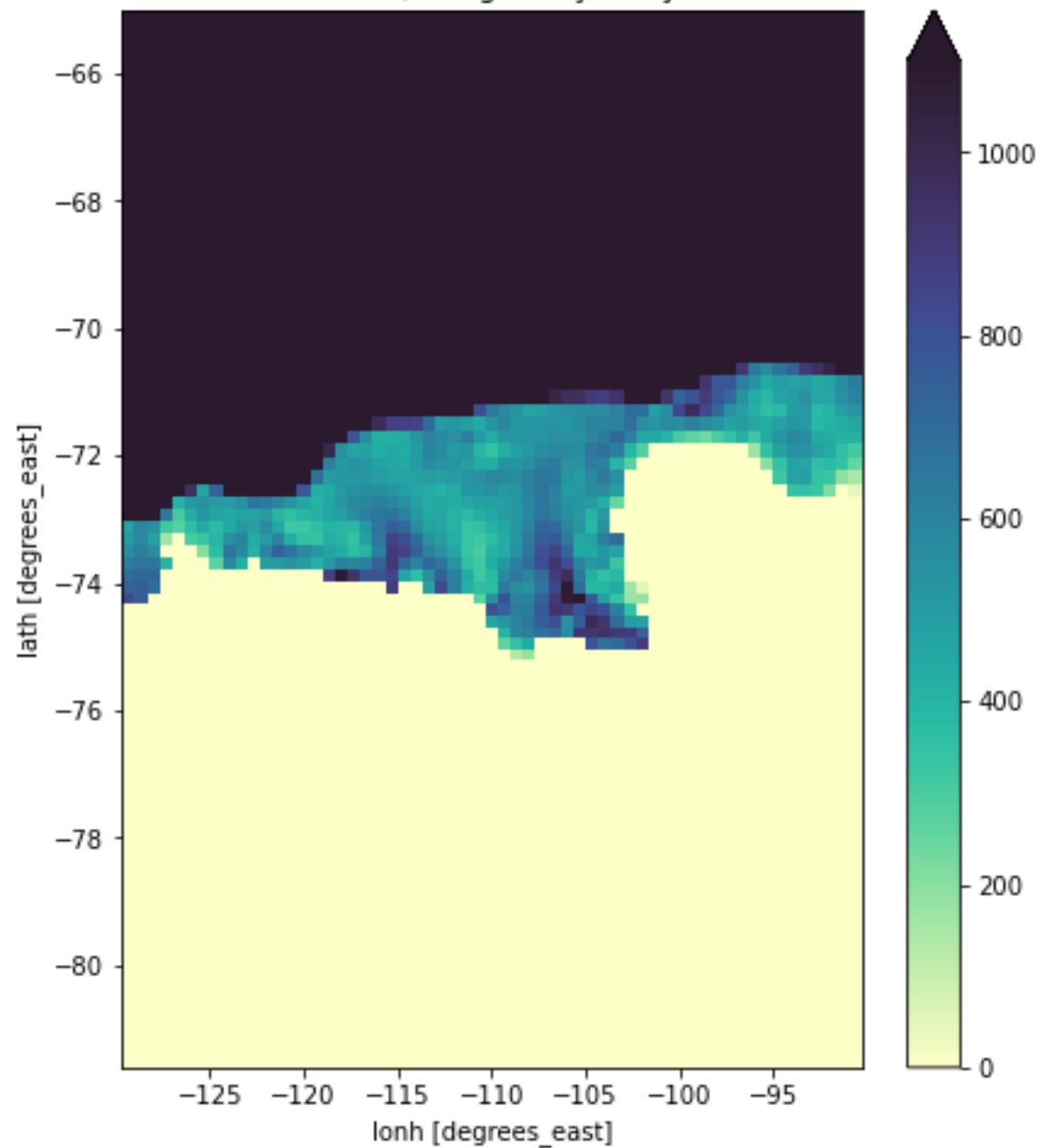
2014 Bathymetry



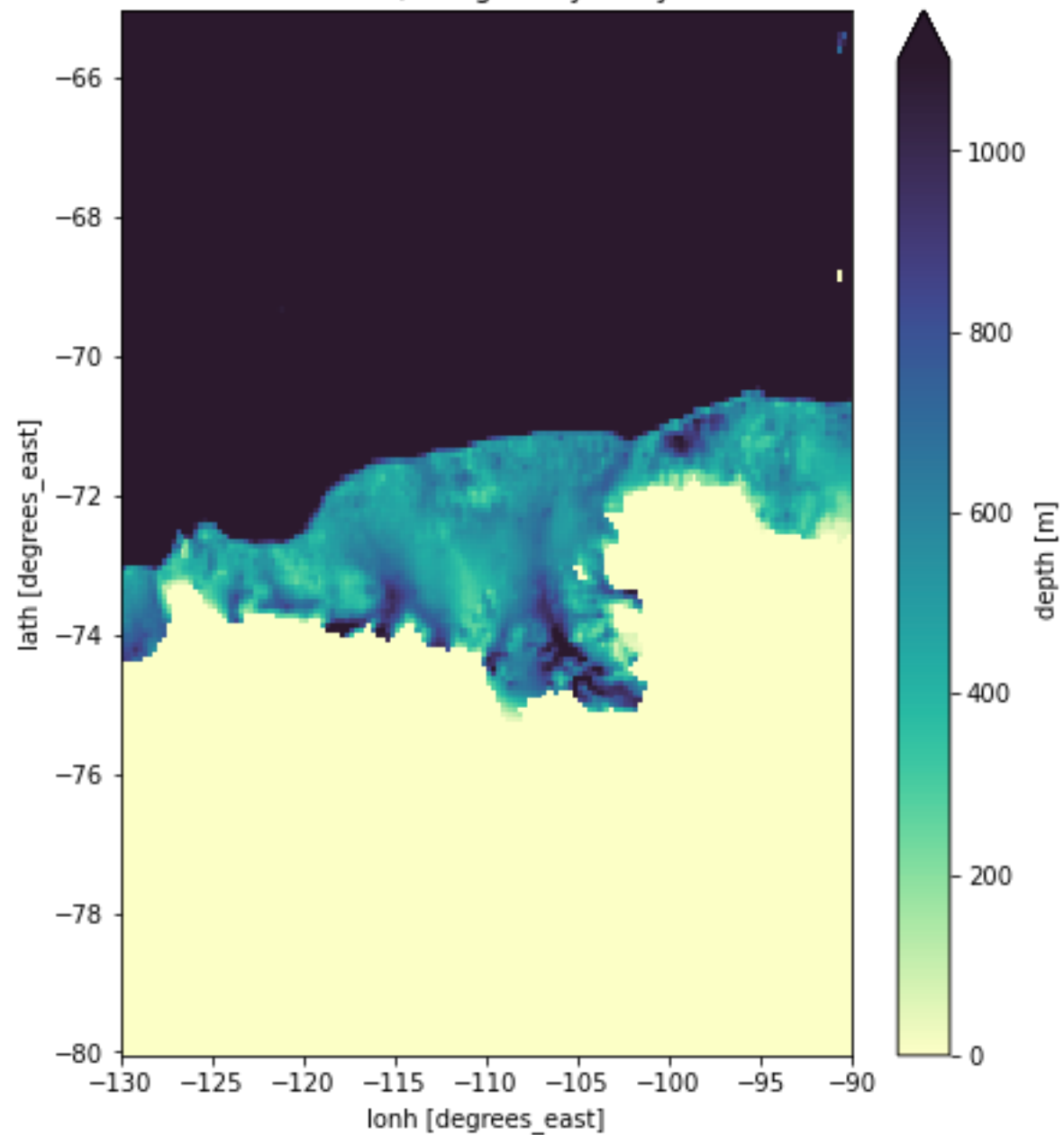
2020 Bathymetry



MOM 2/3 deg Bathymetry



MOM 1/4 deg Bathymetry



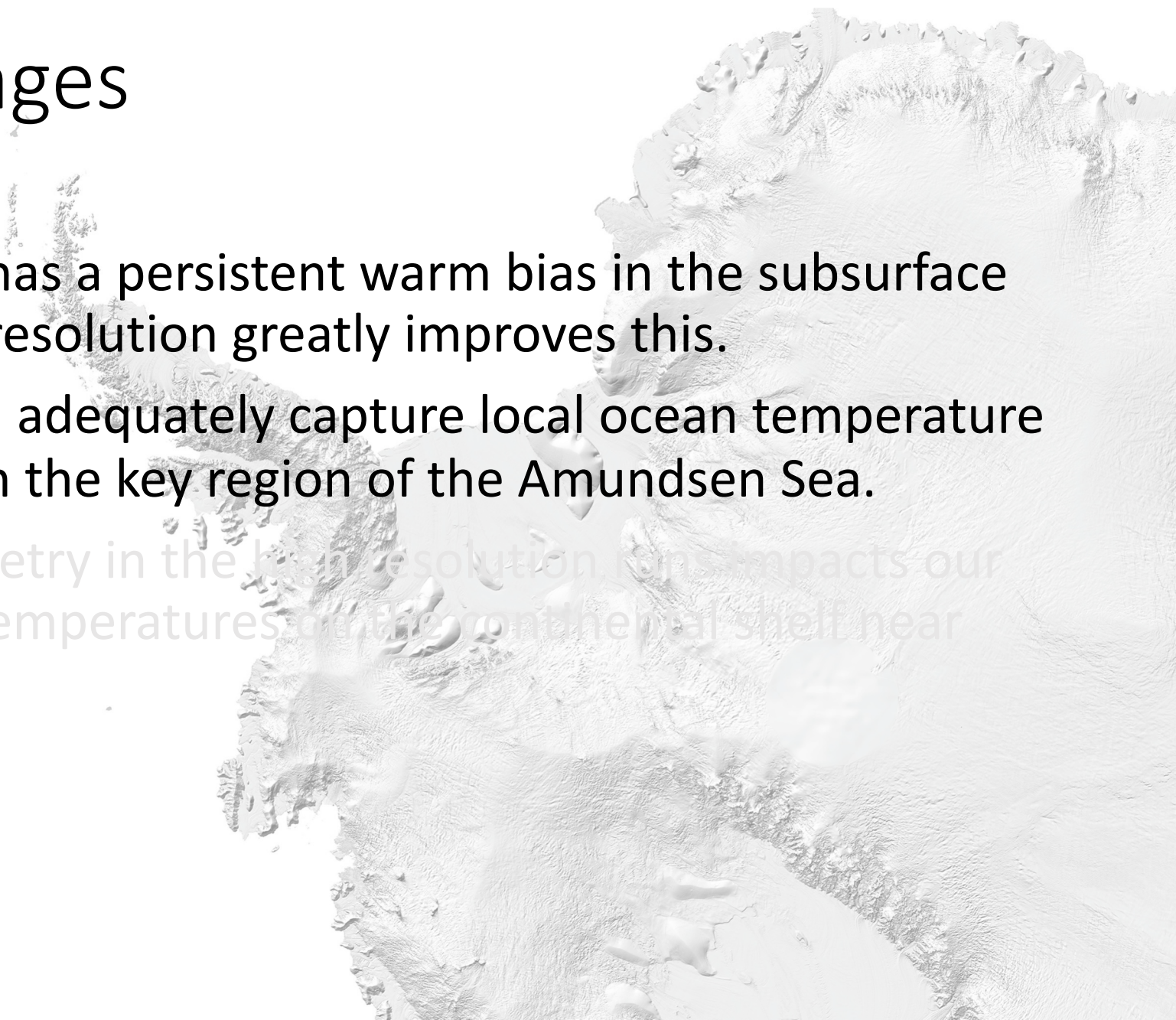
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Contact: mberdahl@uw.edu