Lagrangian pathways and residence time of warm Circumpolar Deep Water on the Antarctic continental shelf

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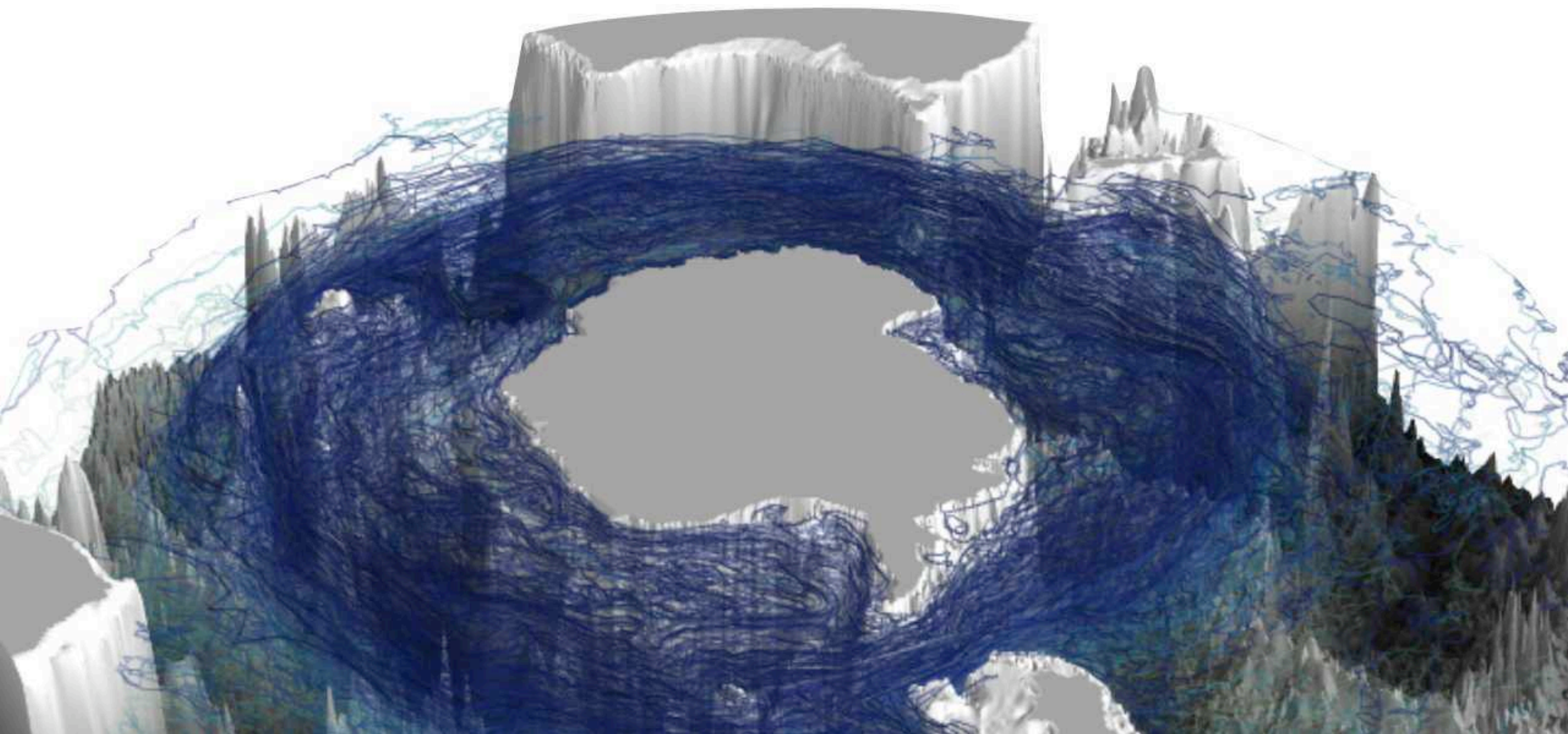
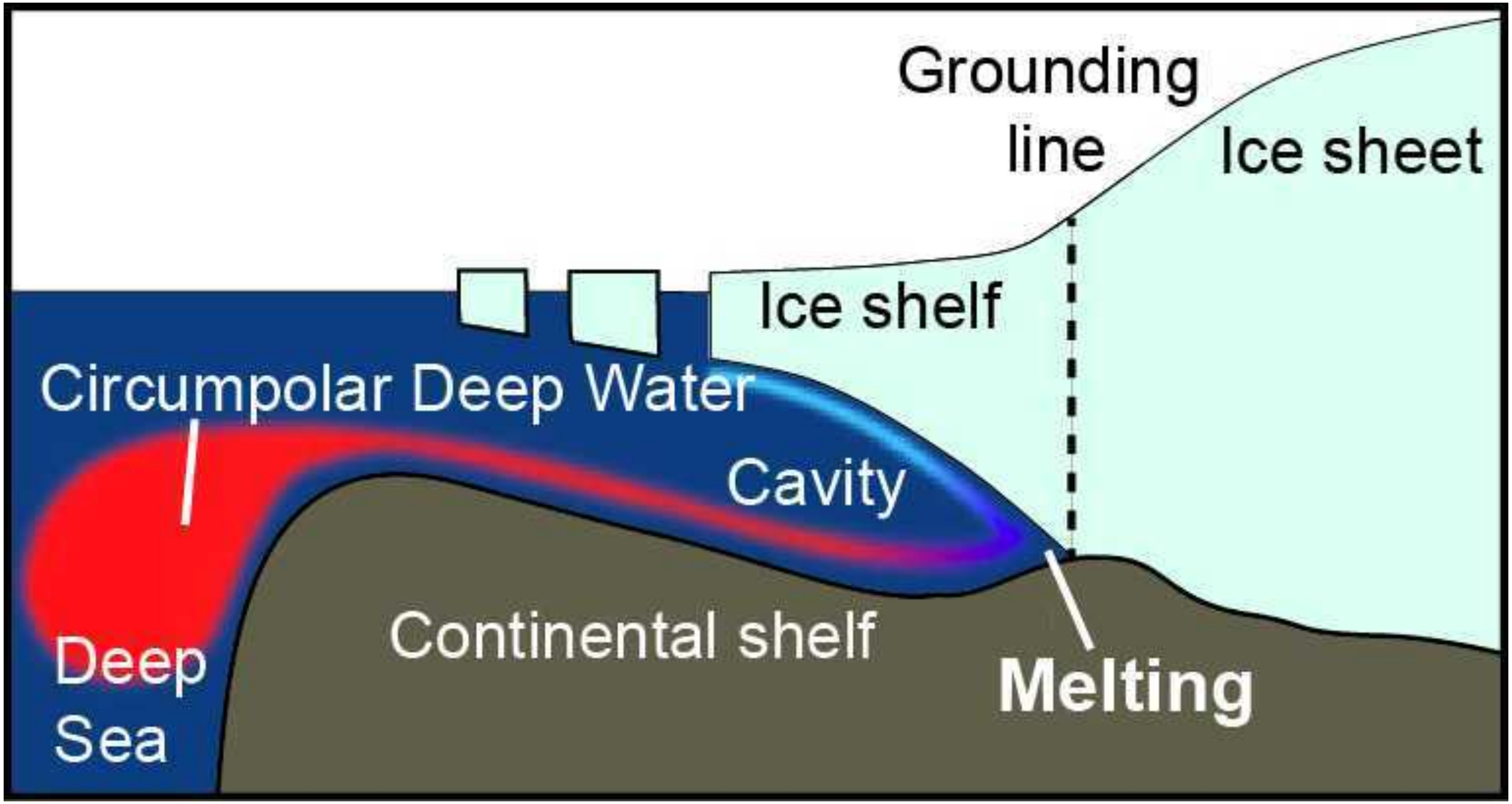
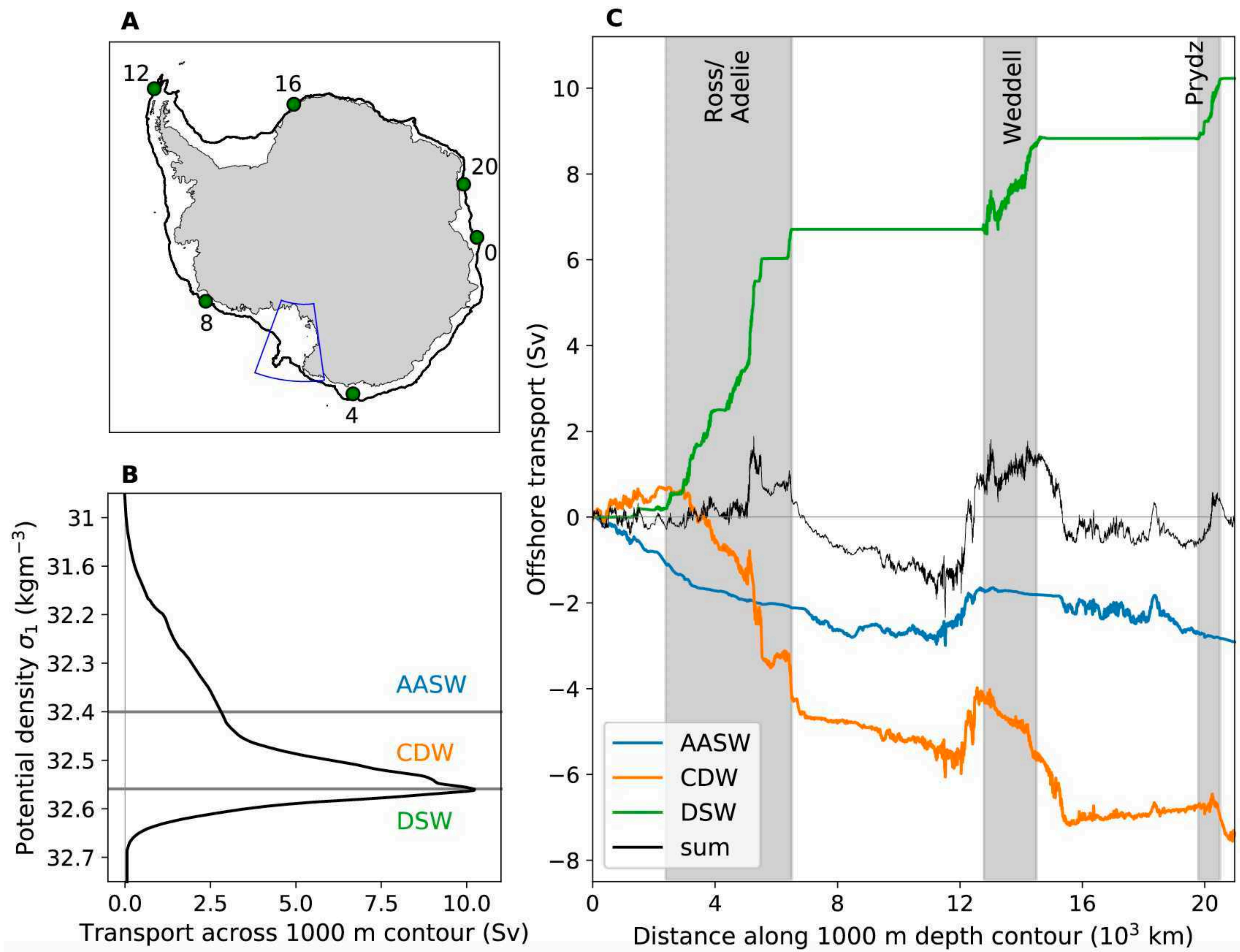


Background and Motivation



Inflow of Circumpolar Deep Water (CDW) from offshore drives ice shelf basal melt

Background and Motivation



Morrison et al. in revision

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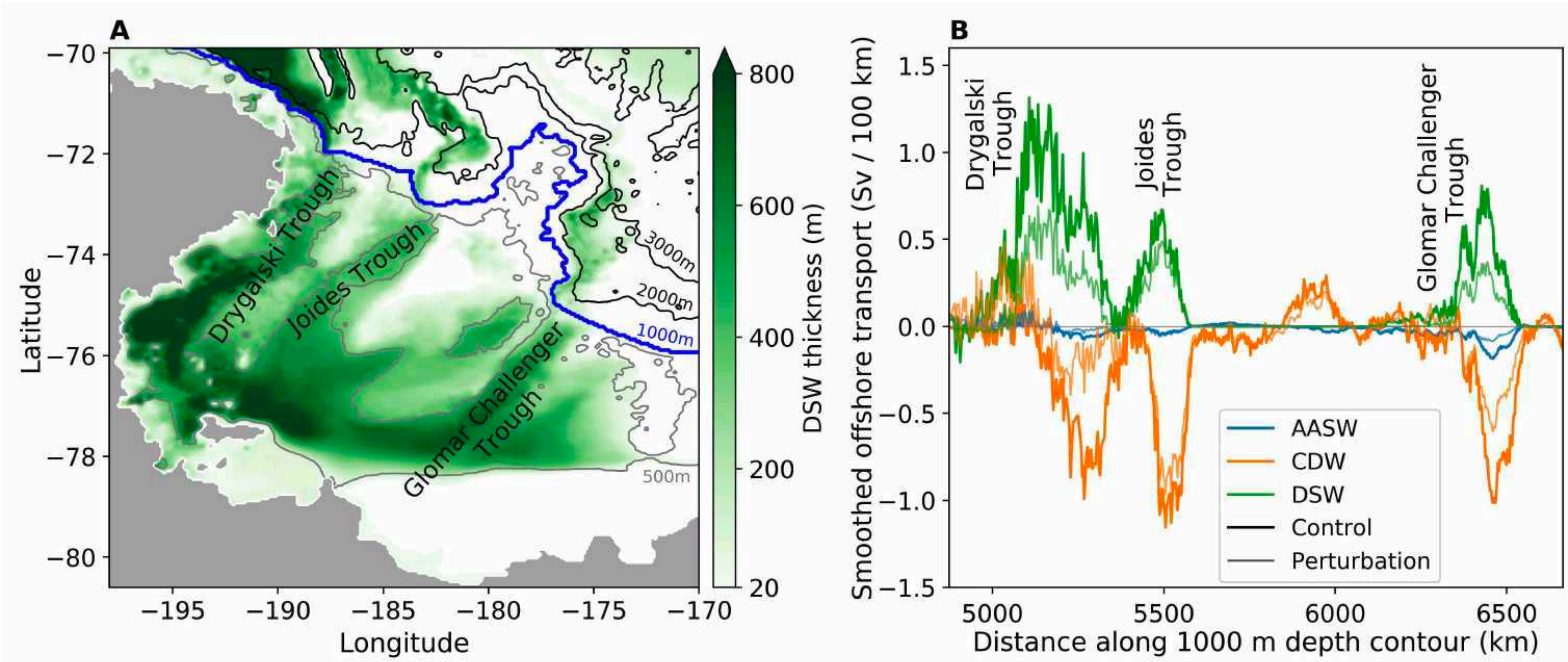

Implies strong CDW inflow in cold shelf regions, not warm regions where CDW is observed to drive ice shelf melt

Morrison et al. in revision

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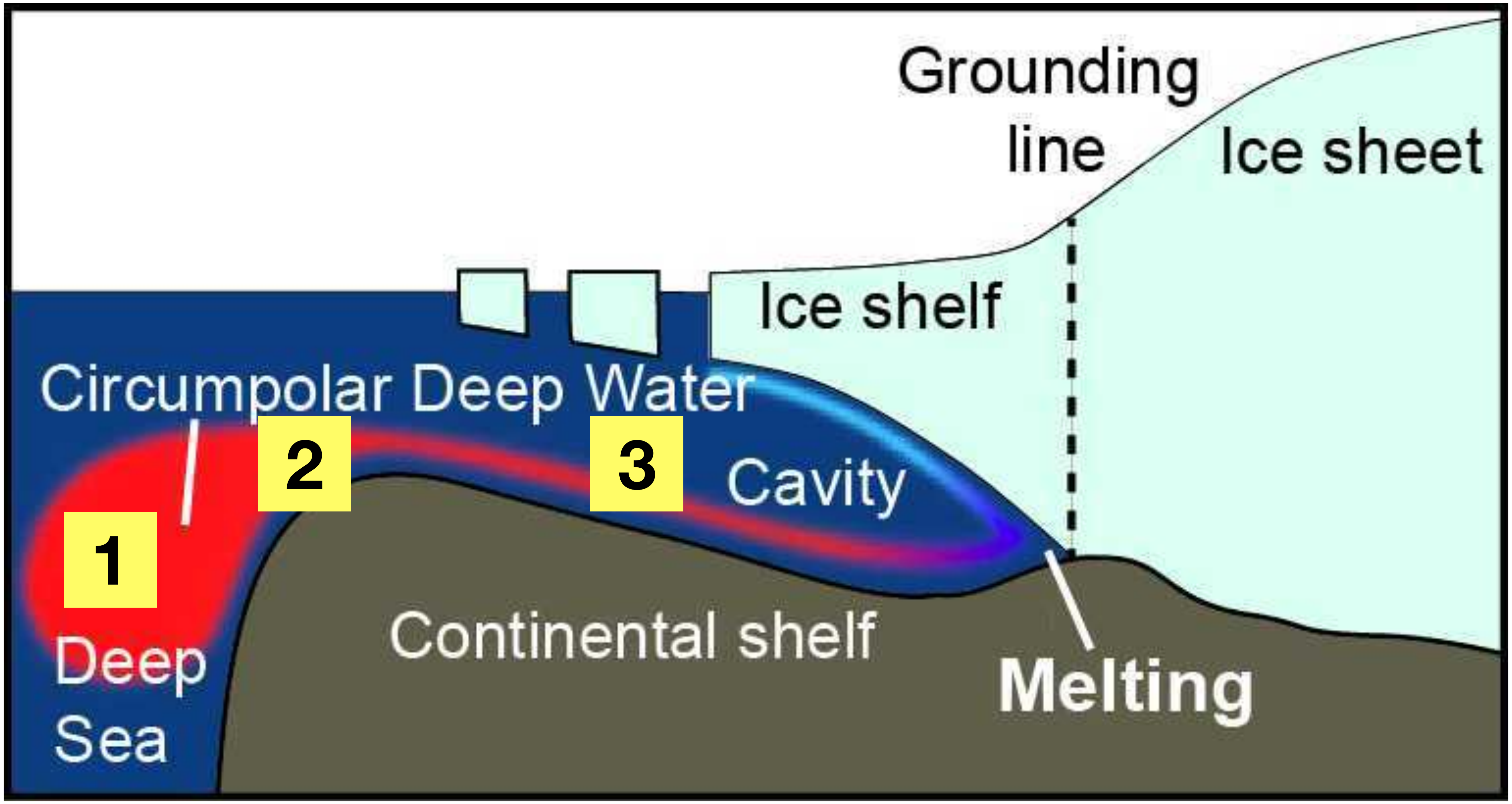
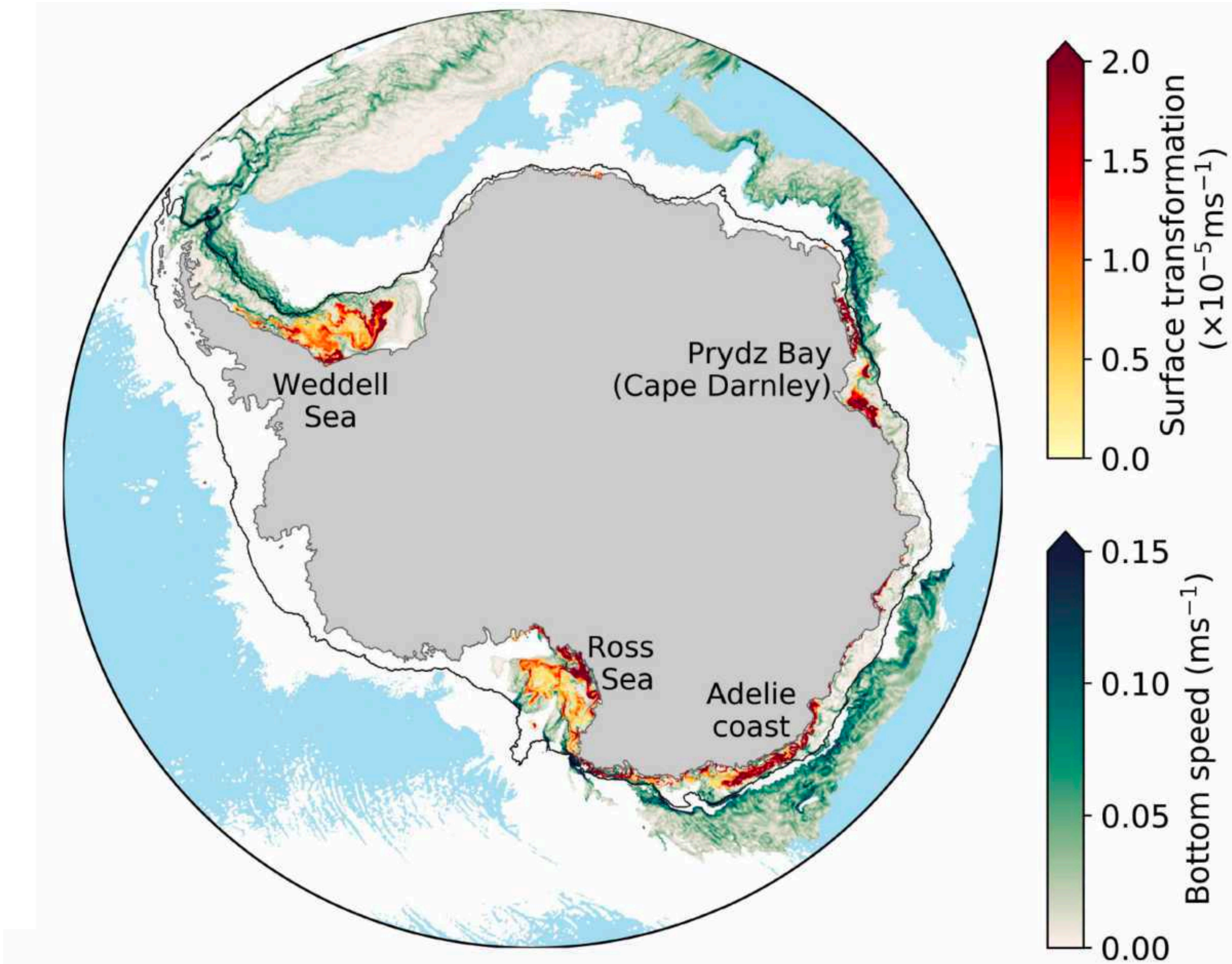


1. Reservoir of heat available offshore

2. Heat transport across shelf break

3. Transformation of inflowing waters on the shelf

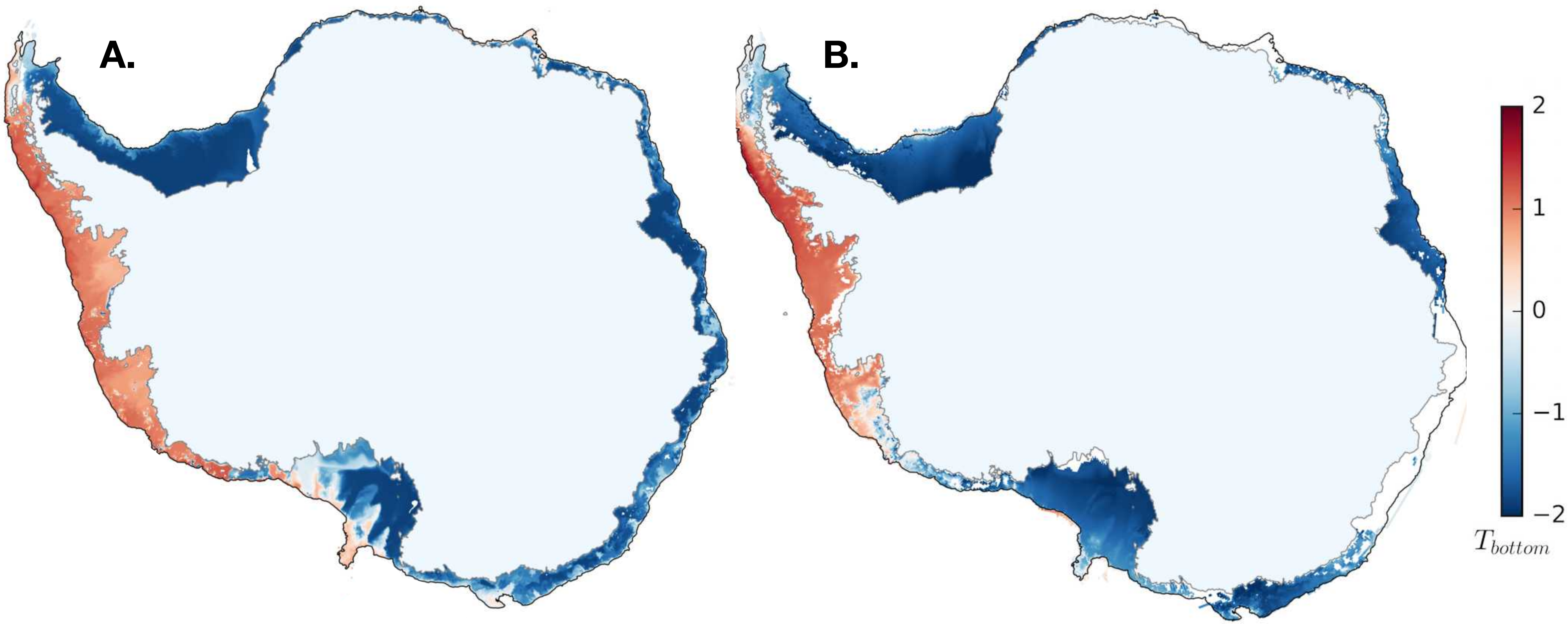
Model



- MOM01 ocean-sea ice model
- Forced with CORE Normal Year Forcing (no interannual variability)
- 0.1° horizontal resolution and 75 vertical levels (2.6-5.5 km along Antarctic continental slope)
- 10 years of daily averaged velocity output (following 80 year spin-up)

Morrison et al. in revision

Model



Shelf bottom temperature from model (left) and observations (right, Schmidtko et al. 2014). Model biased warm in Ross Sea

Tamsitt et al. in prep

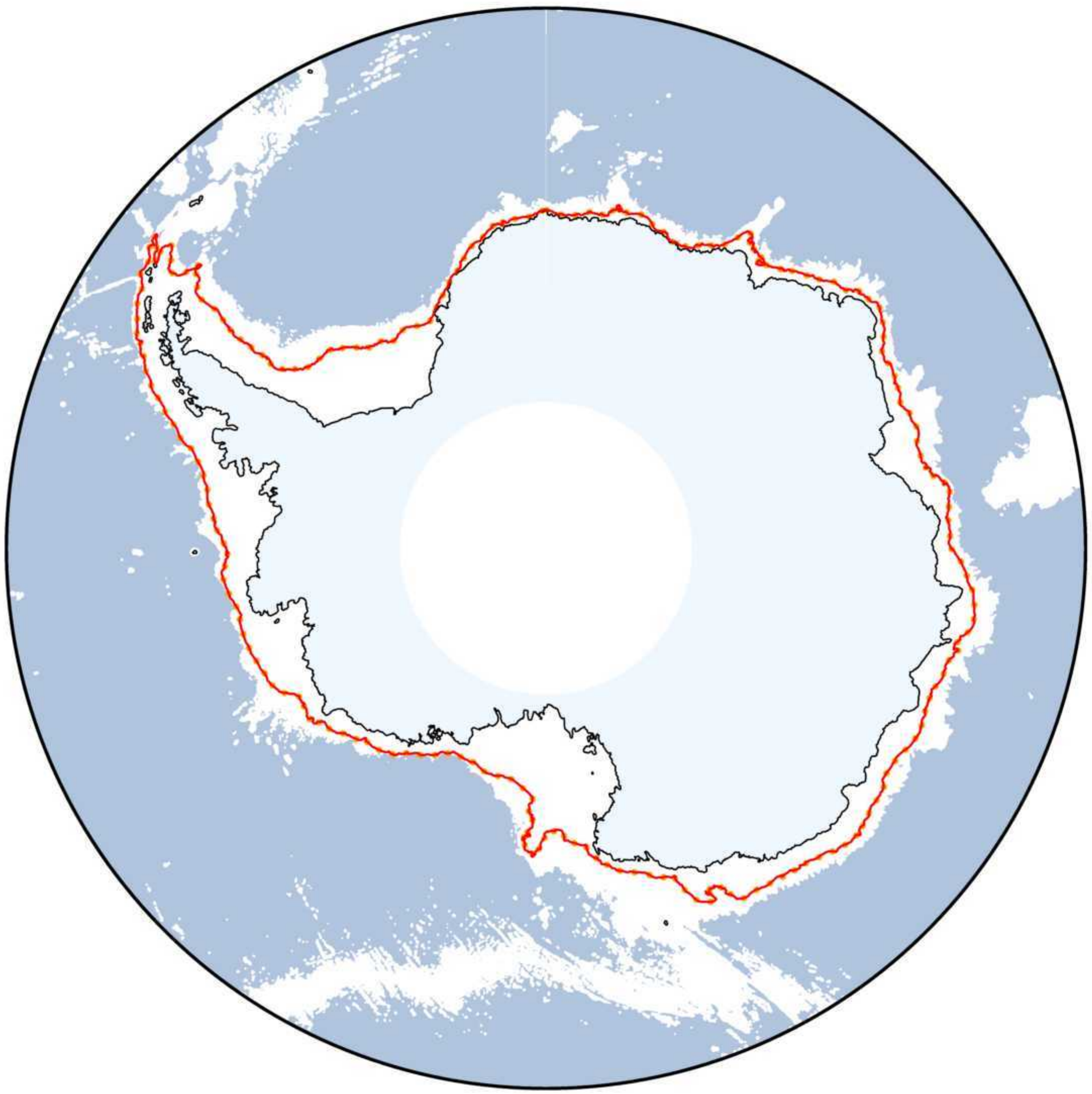
Lagrangian experiment

- Release particles spaced evenly in depth (every 20 m) from the surface to 1000 m at 100 km intervals along the 1000 m isobath on the continental slope

- Repeat release every 5 days for a year (total >300,000 particles), then track for 5 years

- Track particles that travel onto continental shelf

- Save T and S along particle trajectories



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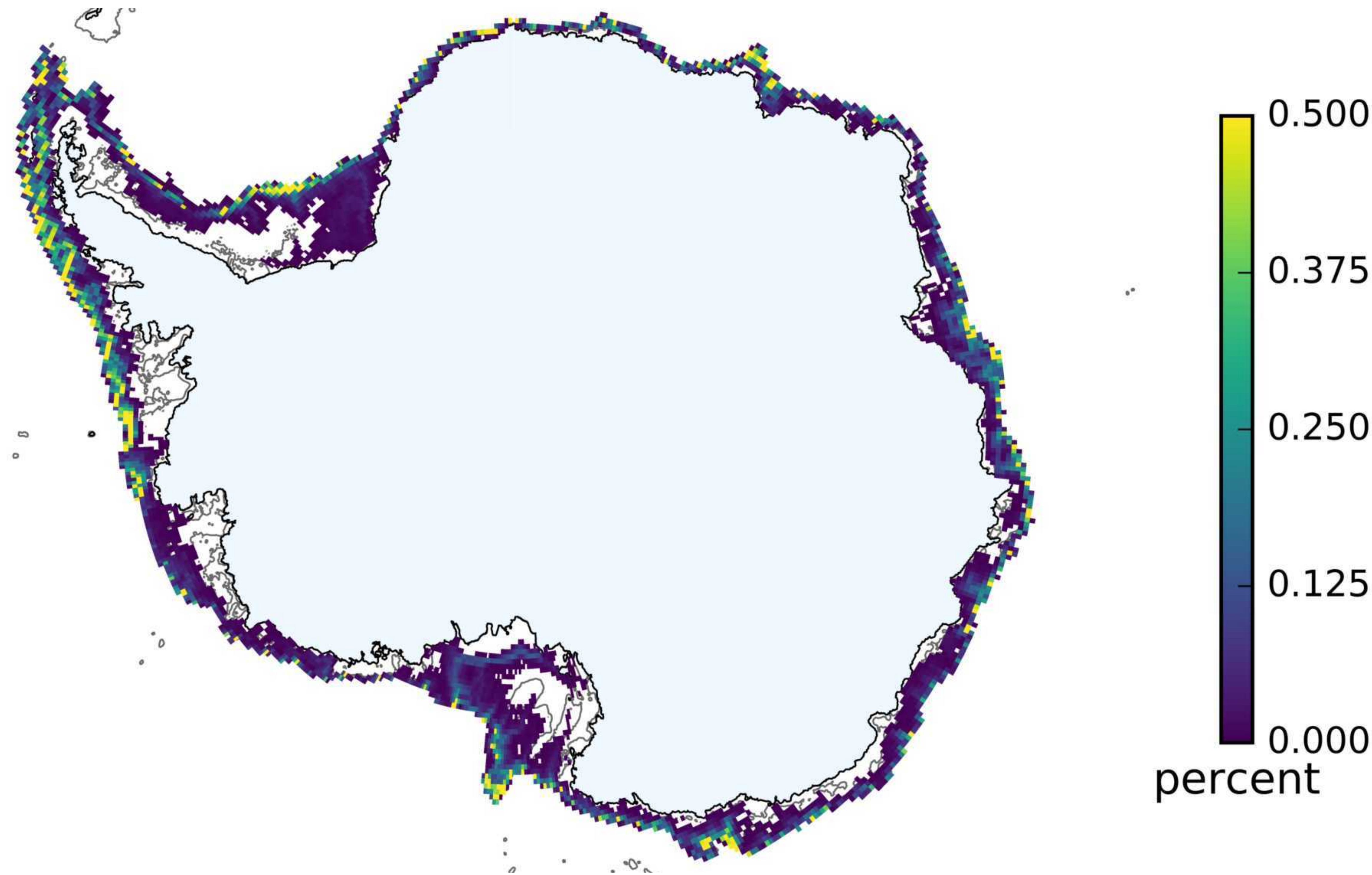
CDW pathways on the shelf



Cumulative particle pathways on the shelf until transformed out of CDW density range or exited shelf

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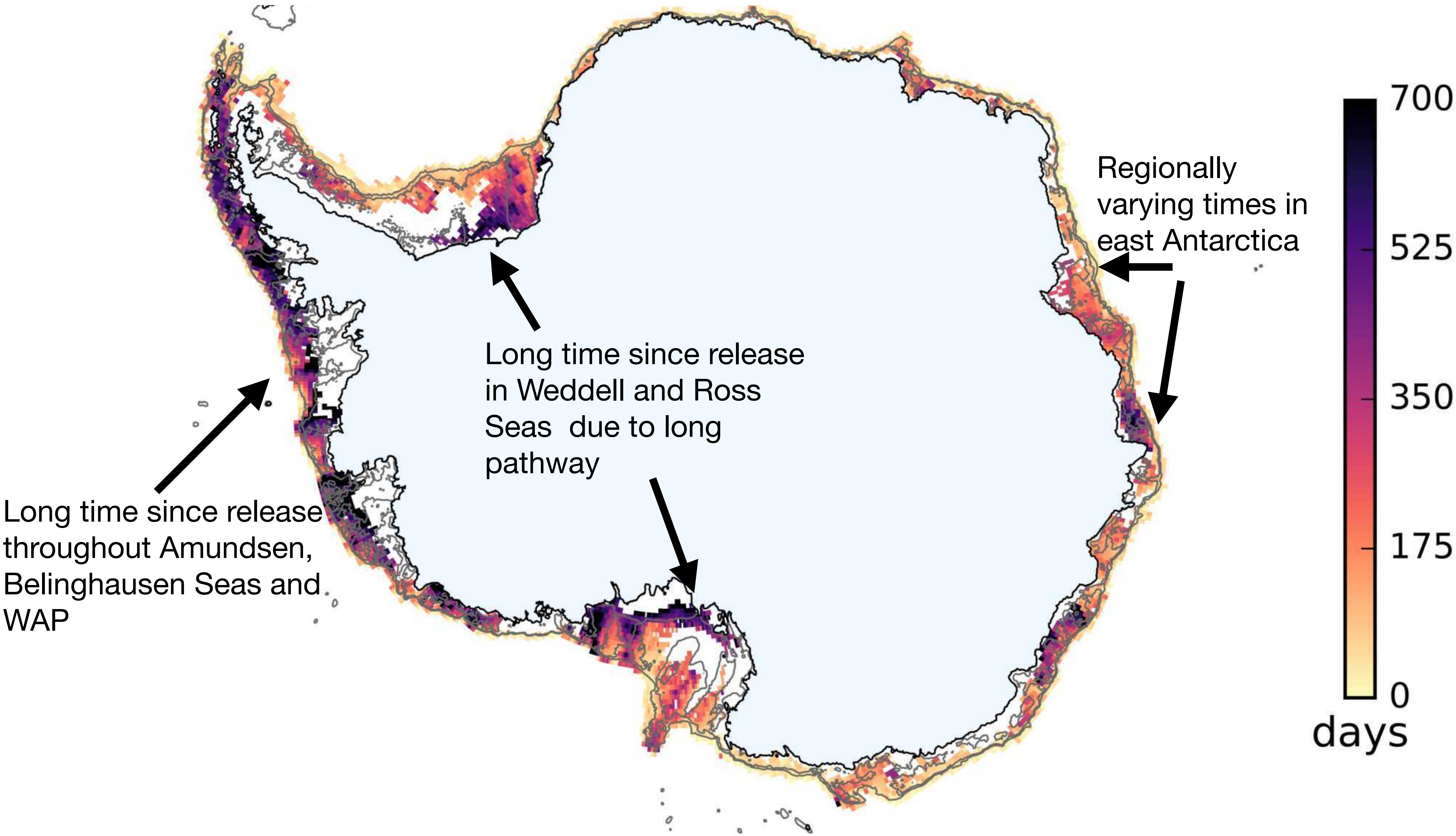
CDW 'age' on shelf



Mean time since release on the shelf until transformed out of CDW density or exited shelf ranges from ~1 month to >2 years

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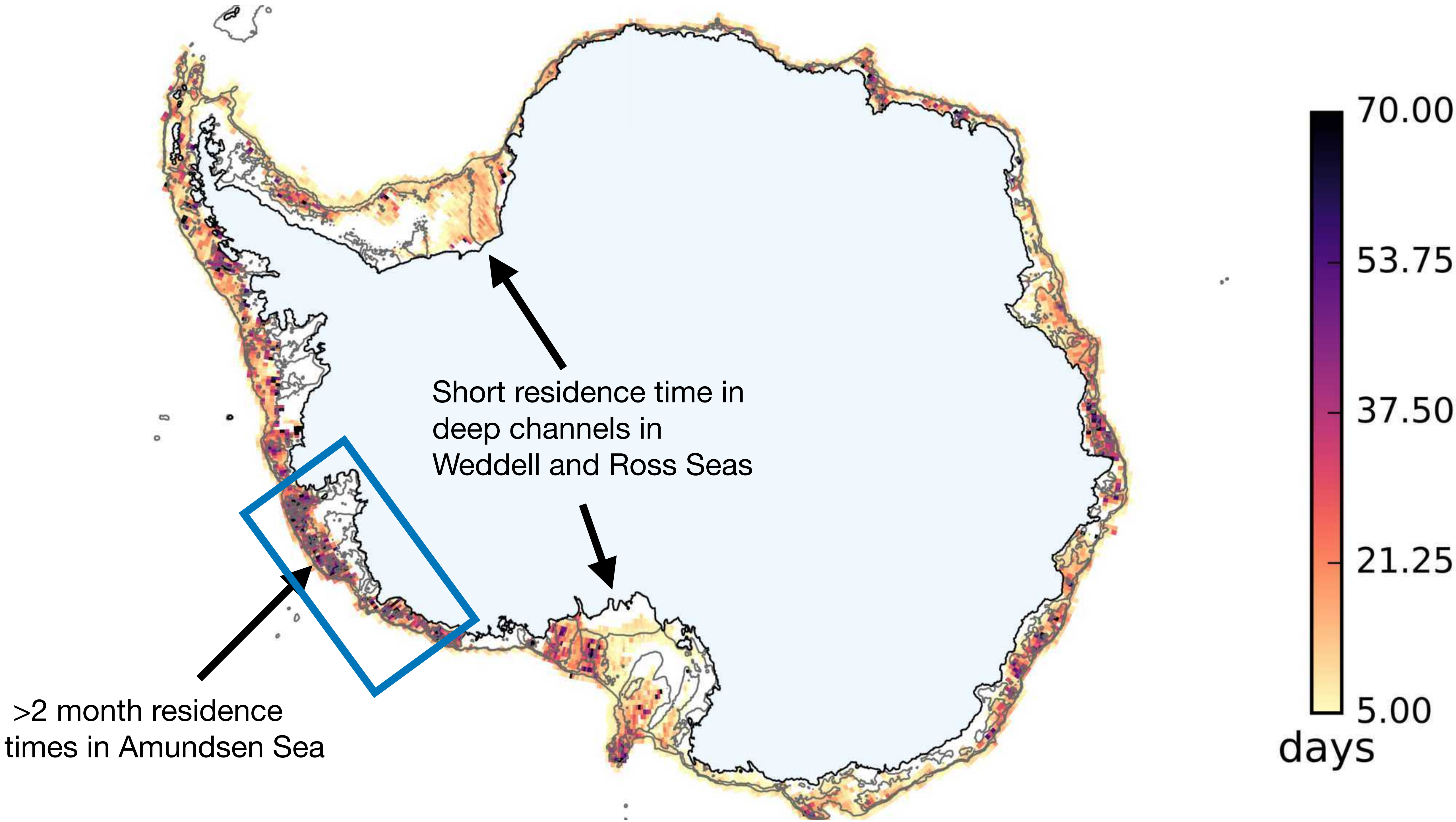
CDW residence time



Mean time in each lat/lon bin on the shelf until transformed out of CDW density or exited shelf

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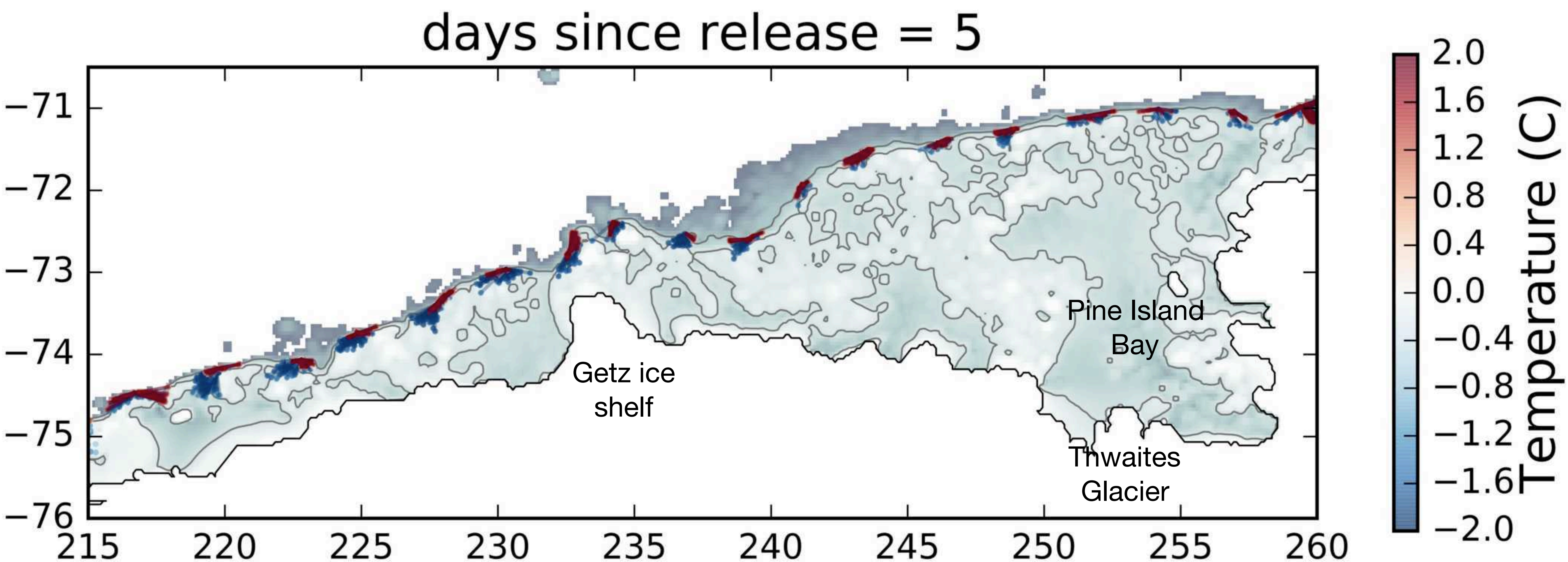
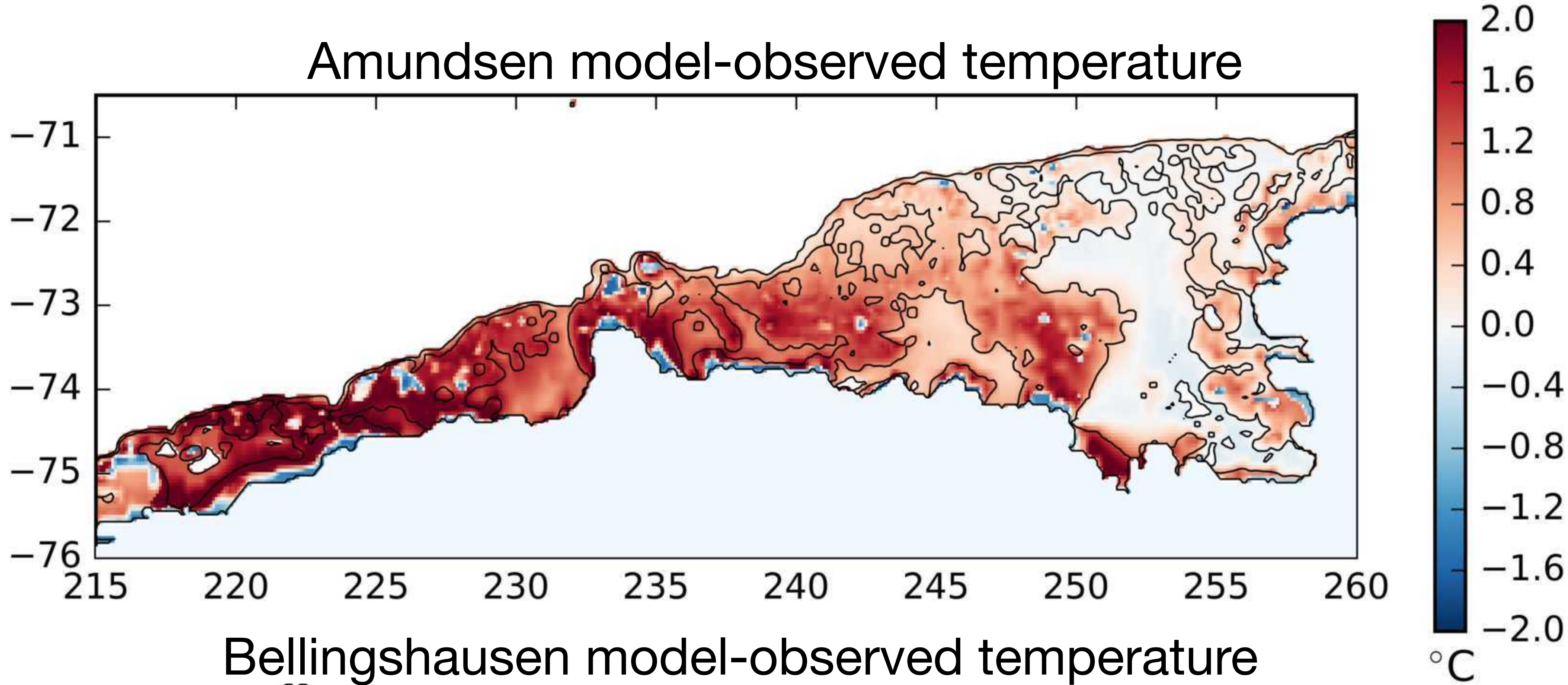
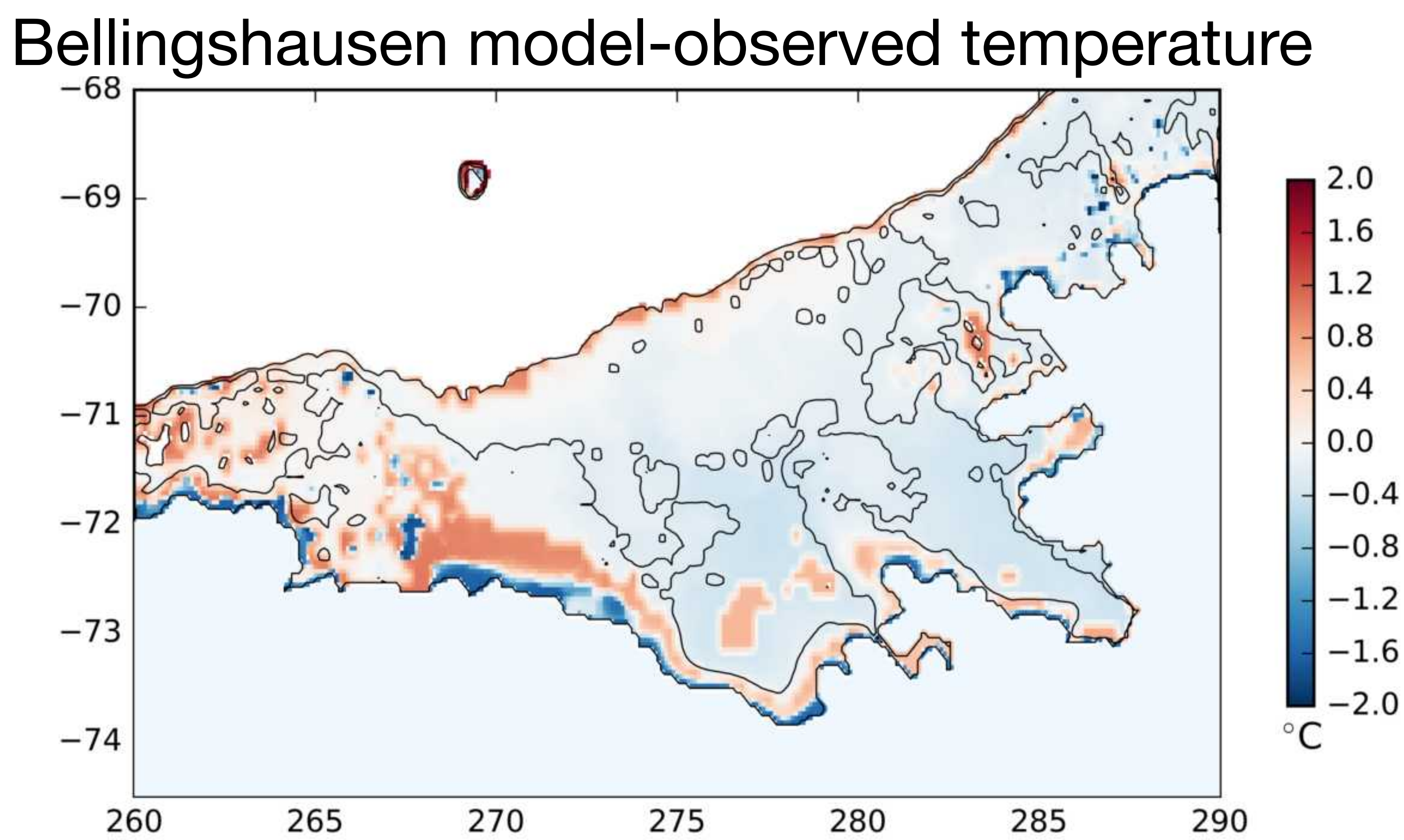
CDW in the Amundsen Sea



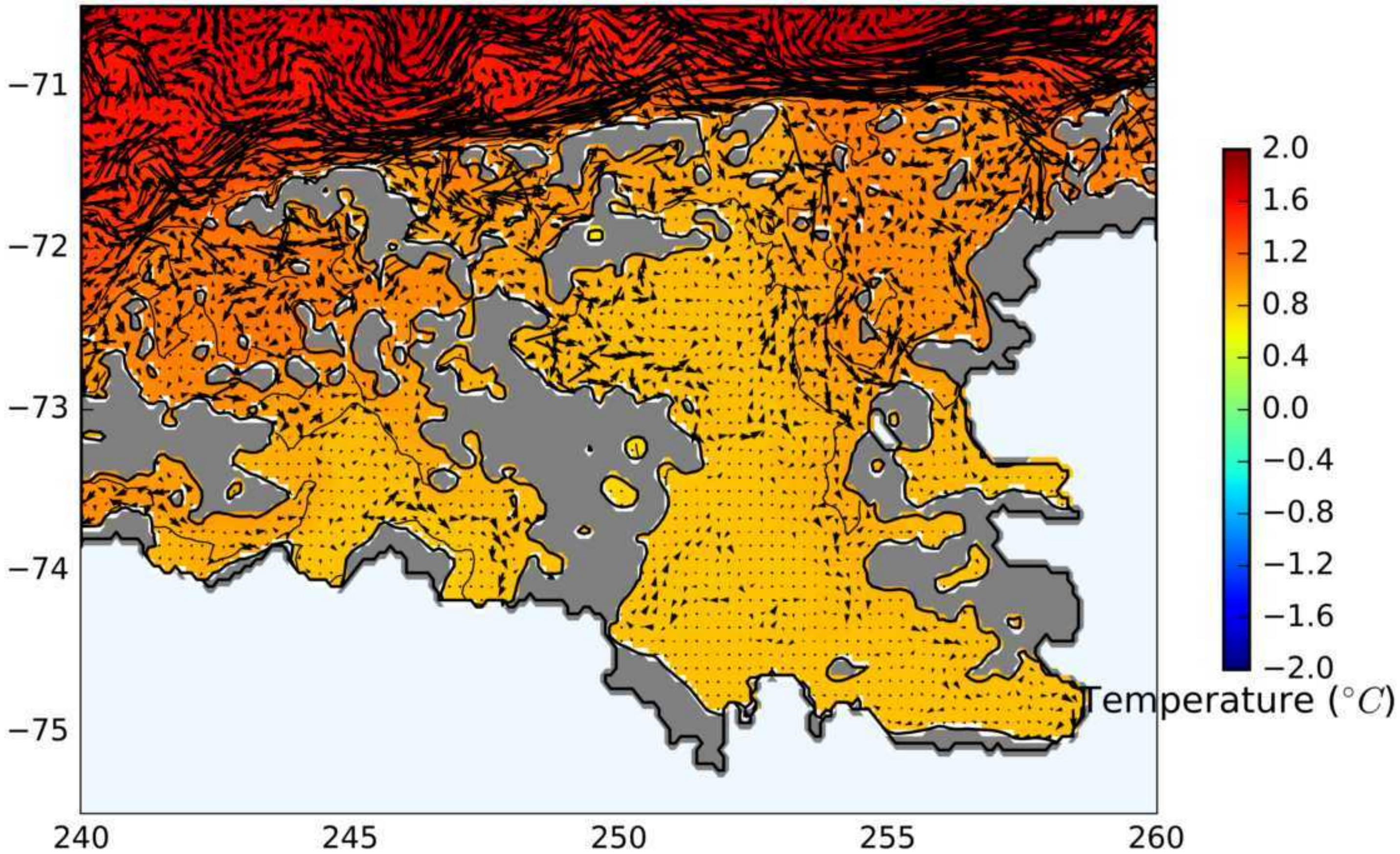
CDW in the Amundsen and Bellingshausen Seas



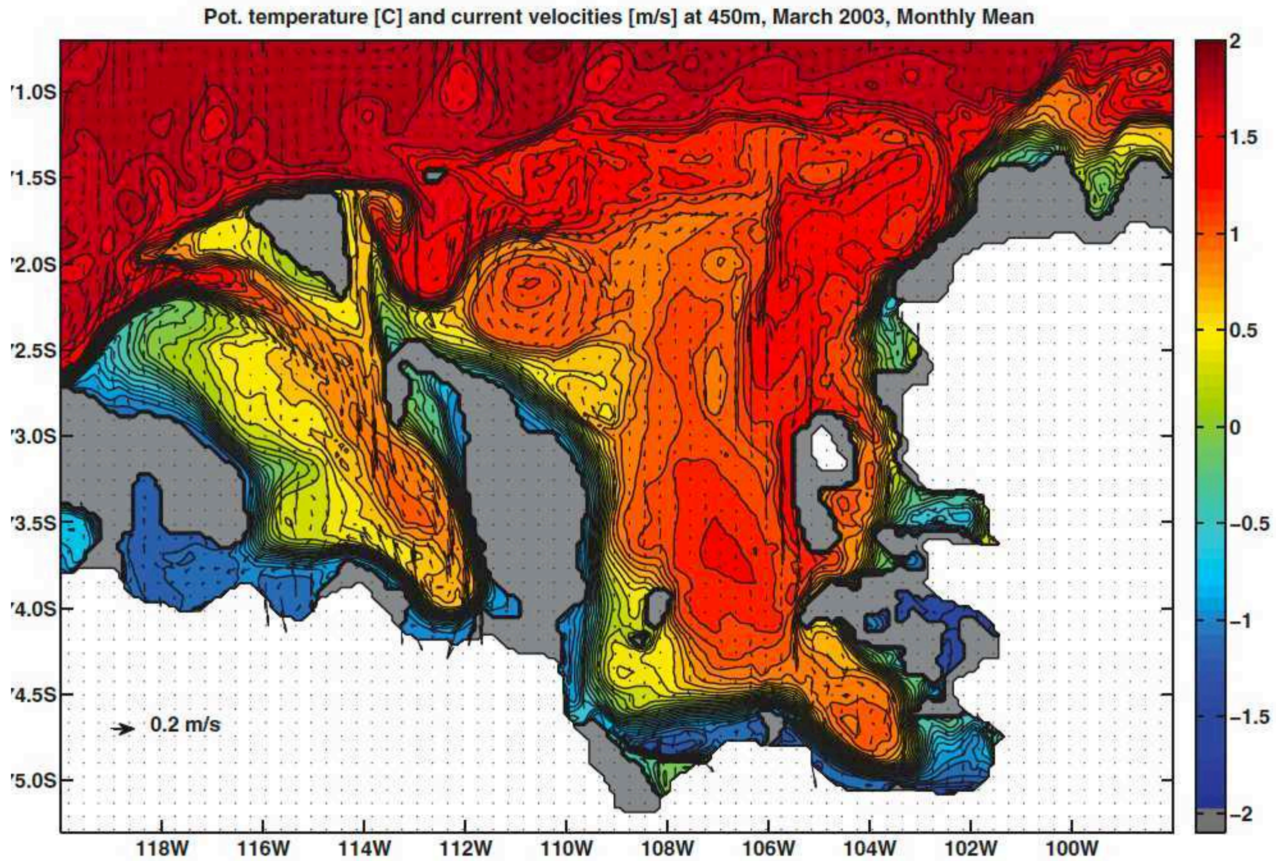


CDW in the Amundsen and Bellingshausen Seas

Model March monthly mean temperature and velocities at 450 m



MOM01

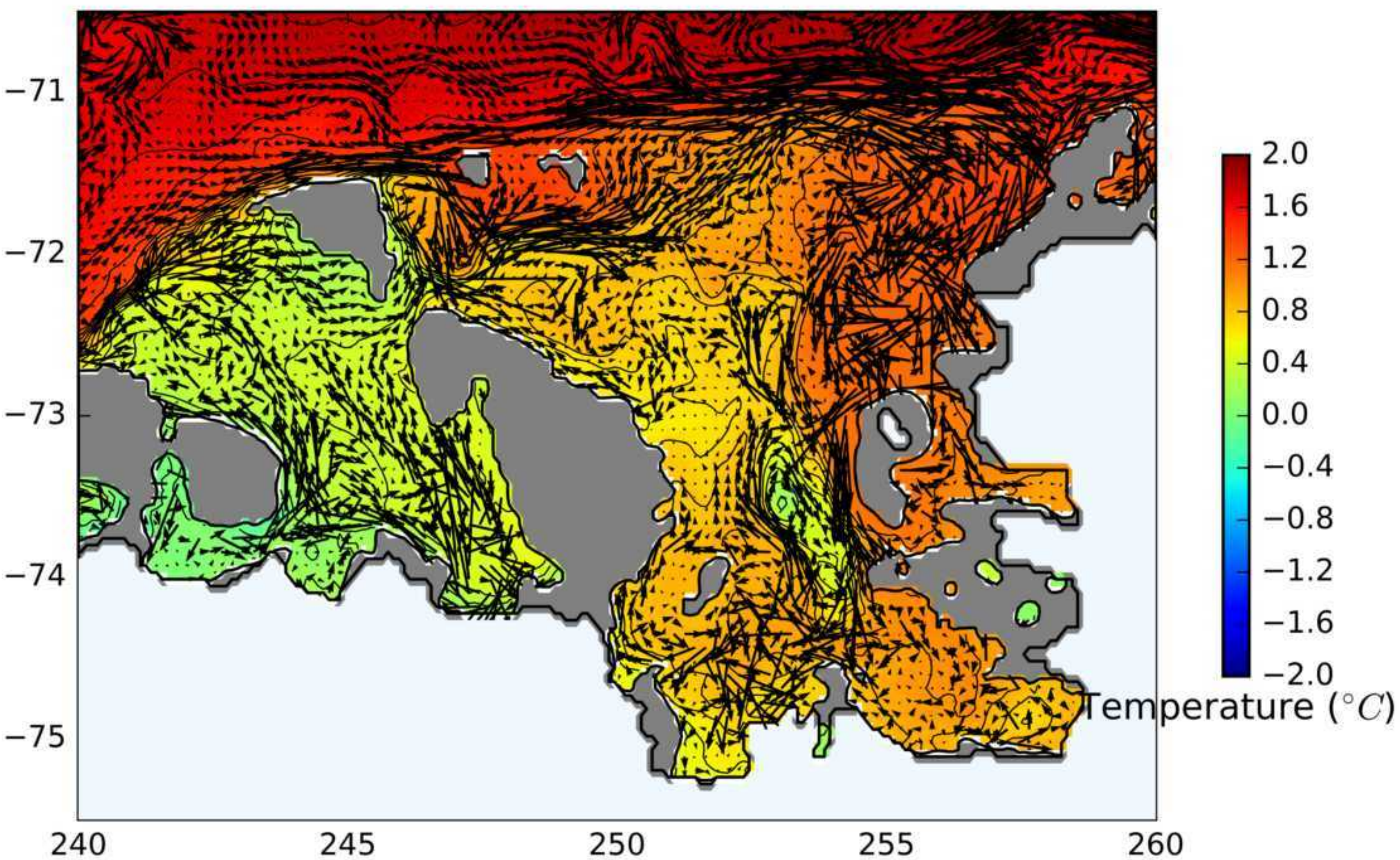


Assmann et al. 2013 regional MITgcm

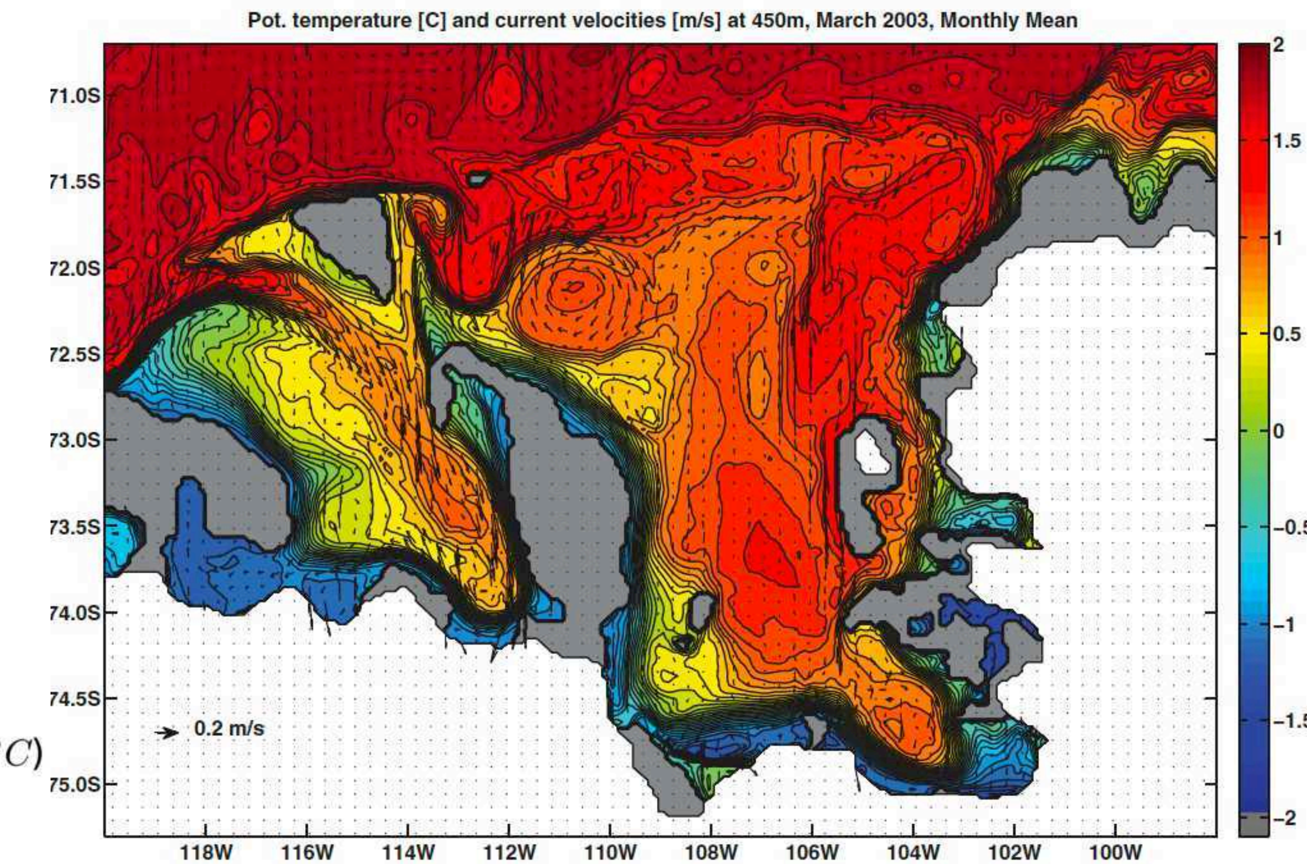
Model topography may be playing an role in inhibiting CDW access to the shelf in some regions

CDW in the Amundsen and Bellingshausen Seas

Model March monthly mean temperature and velocities at 450 m



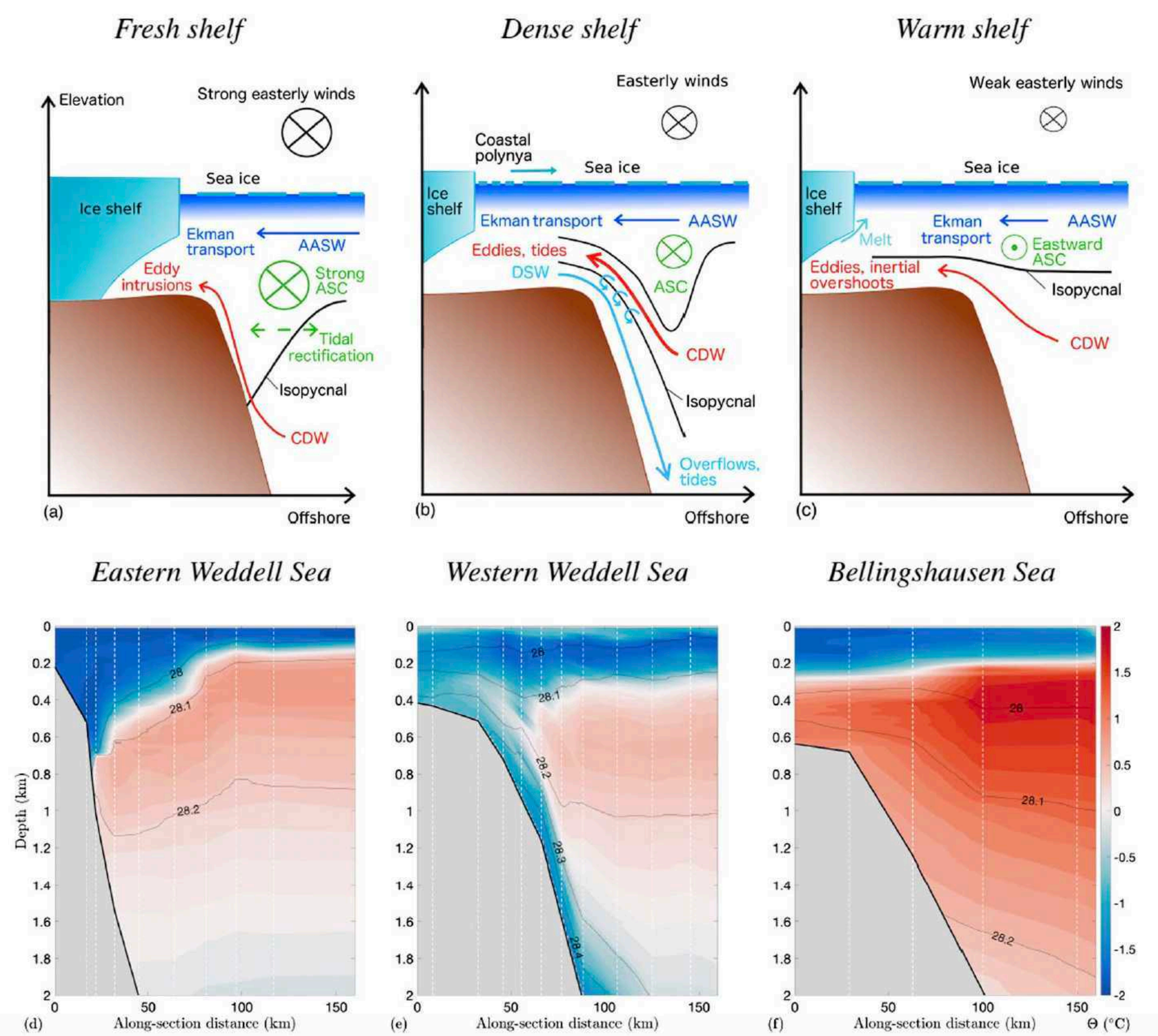
RYF9091

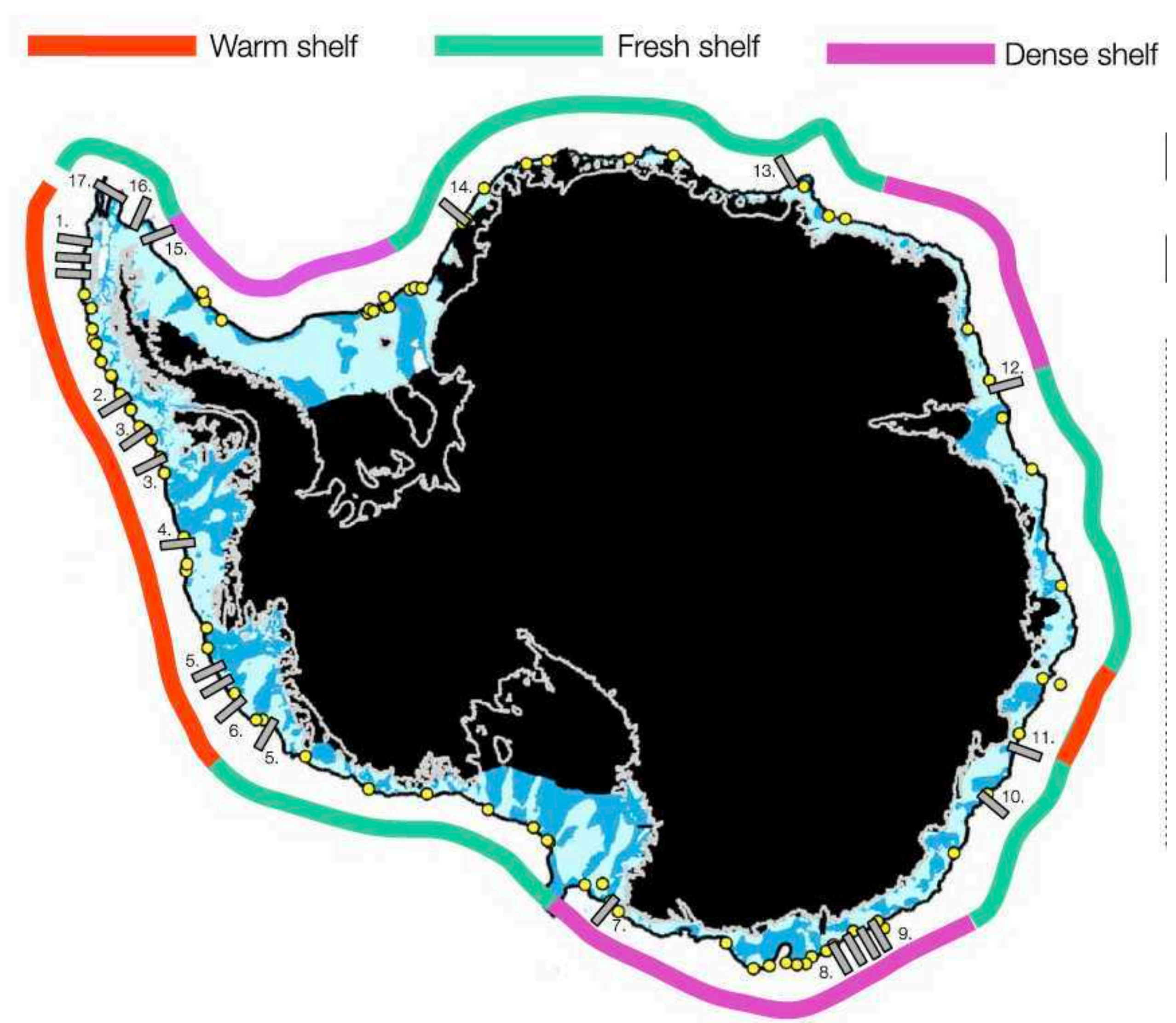


Assmann et al. 2013 regional MITgcm

Model topography may be playing an role in inhibiting CDW access to the shelf in some regions. Updated topography in RYF9091 (same as topo in IAF runs, SAMx etc) looks much better.

CDW water mass evolution on shelf

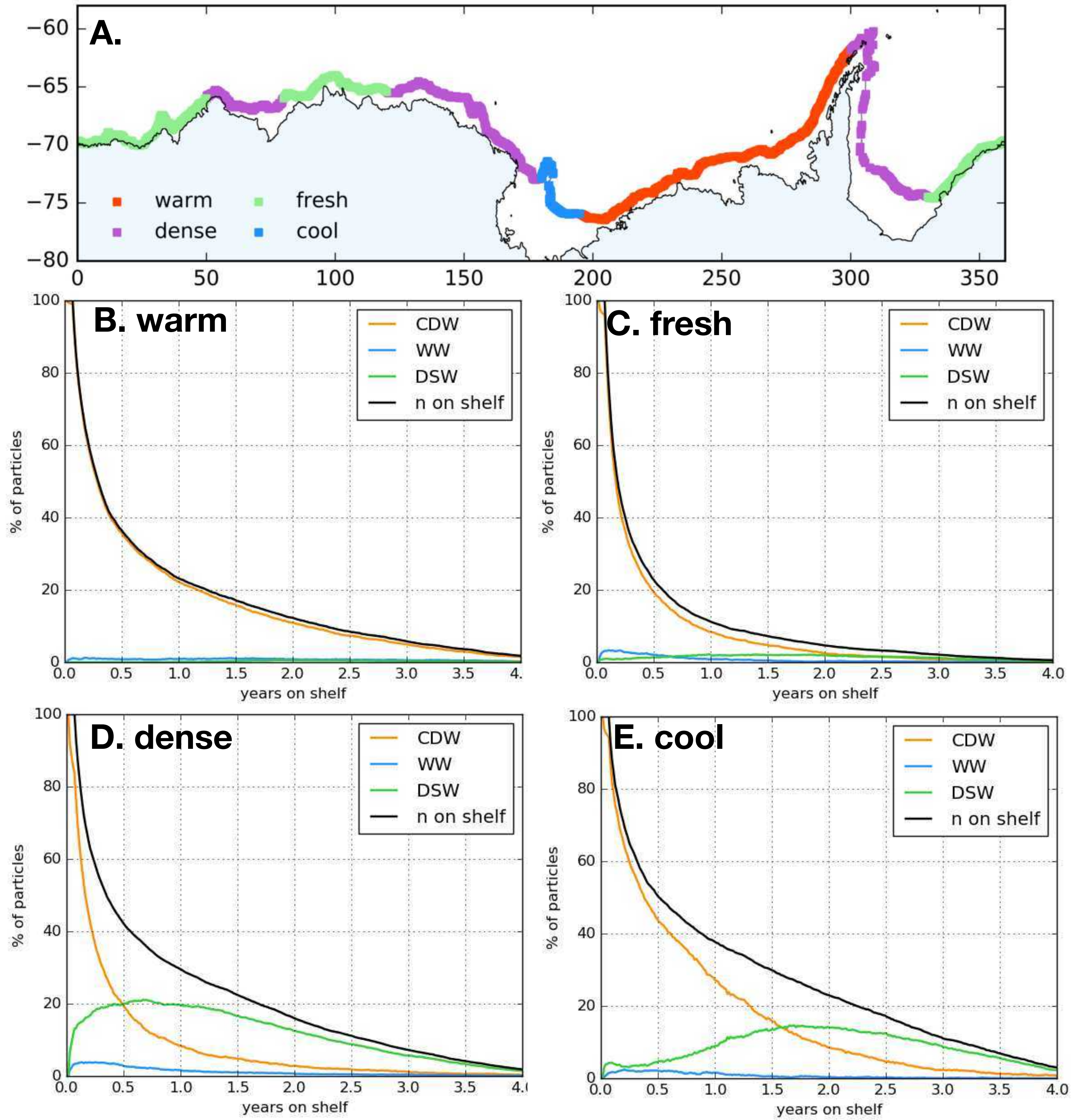




Define shelf slope regimes based on strength of Antarctic slope front and properties

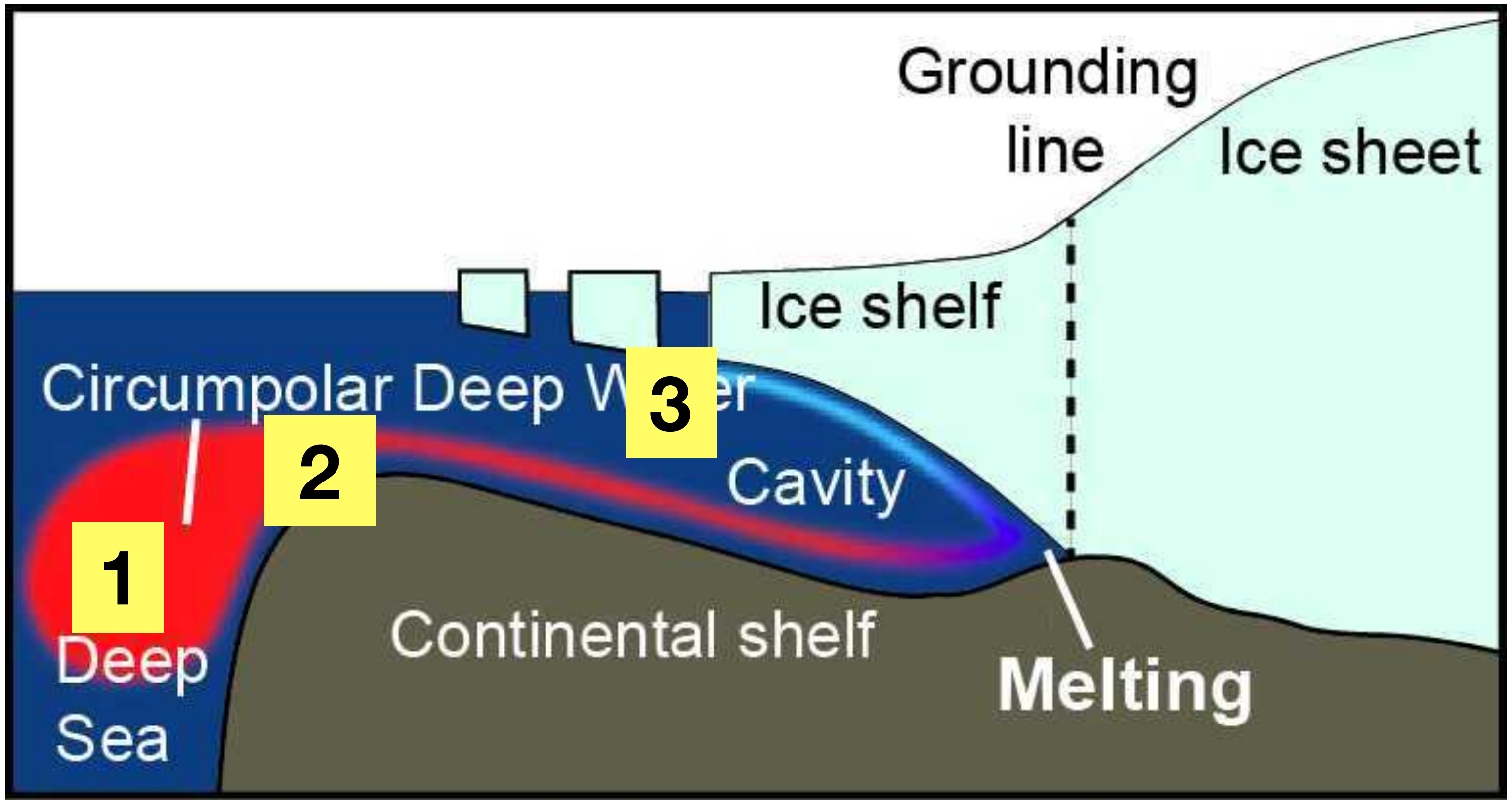
Thompson et al. 2018

CDW water mass evolution on shelf



Tamsitt et al. in prep

Summary



- **Step 3 limits CDW access to ice shelves in dense shelf regions** even when there is strong upslope CDW transport
- CDW is has a **short residence time in dense shelf regions** (Prydz, Ross/Adelie, Weddell), but there are **highly localised spatial patterns**
- CDW in dense/fresh shelf regions undergoes a two-timescale transformation: **isopycnal (cooling+freshening) on the slope followed by diapycnal (cooling+salinification) on the shelf**
- Ongoing work to understand seasonality, variability in response to different forcing (IAF run, SAMx runs etc)