Response of Antarctic ocean circulation to increased glacial meltwater

A simulation study with the ACCESS-OM2-0.1º ocean—sea-ice model

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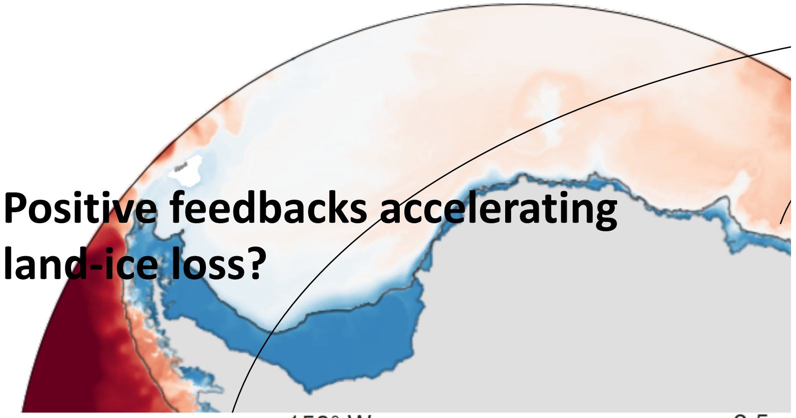
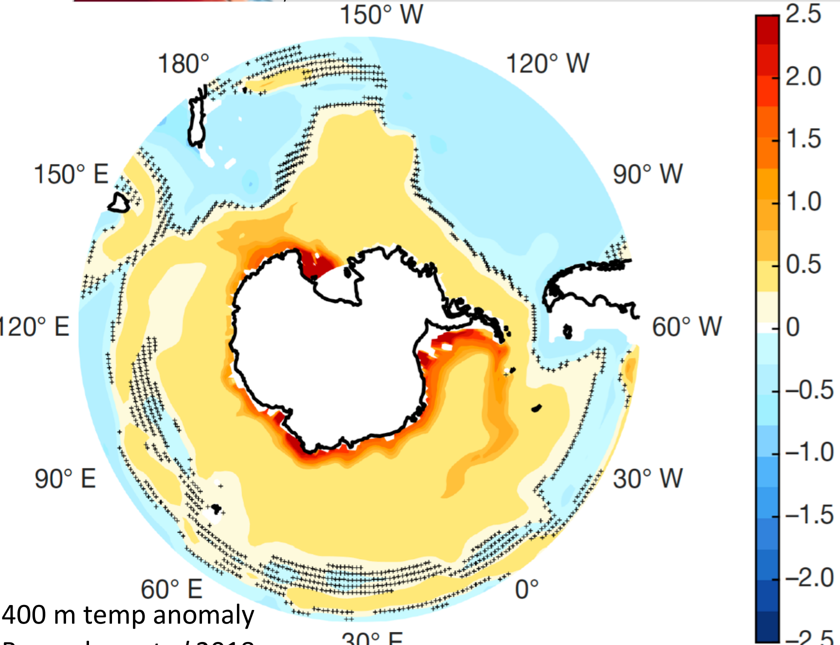
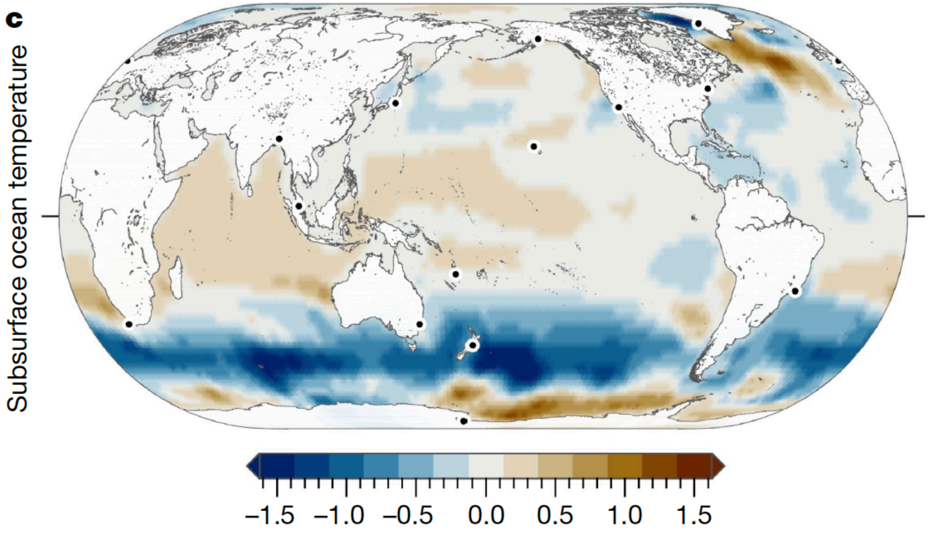
Positive feedbacks accelerating land-ice loss?

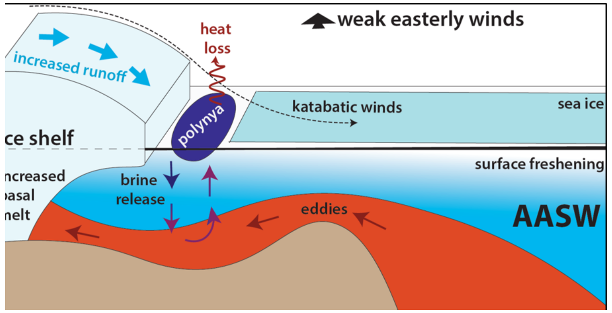


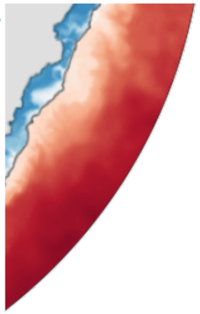


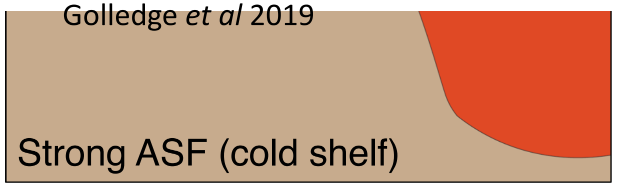
400 m temp anomaly
Bronselaer *et al* 2018

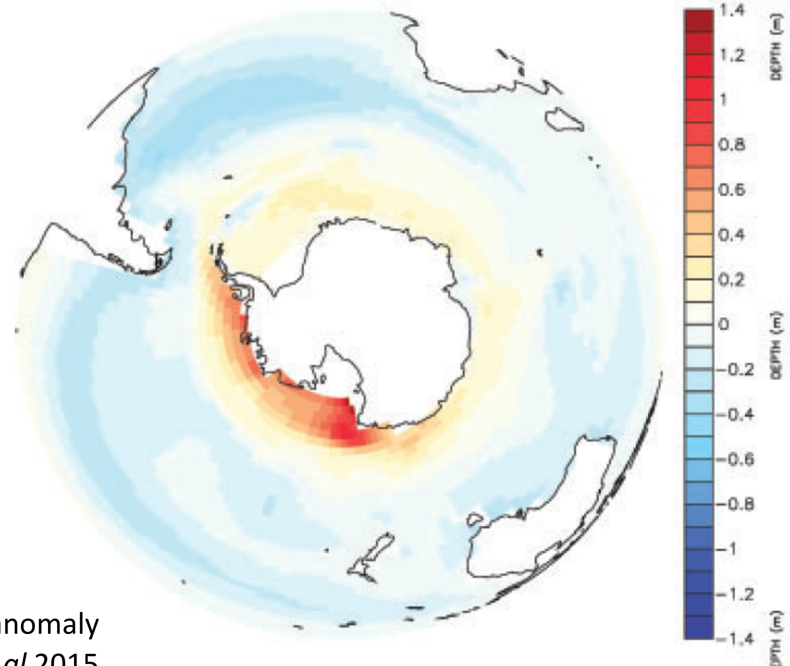


Golledge *et al* 2019



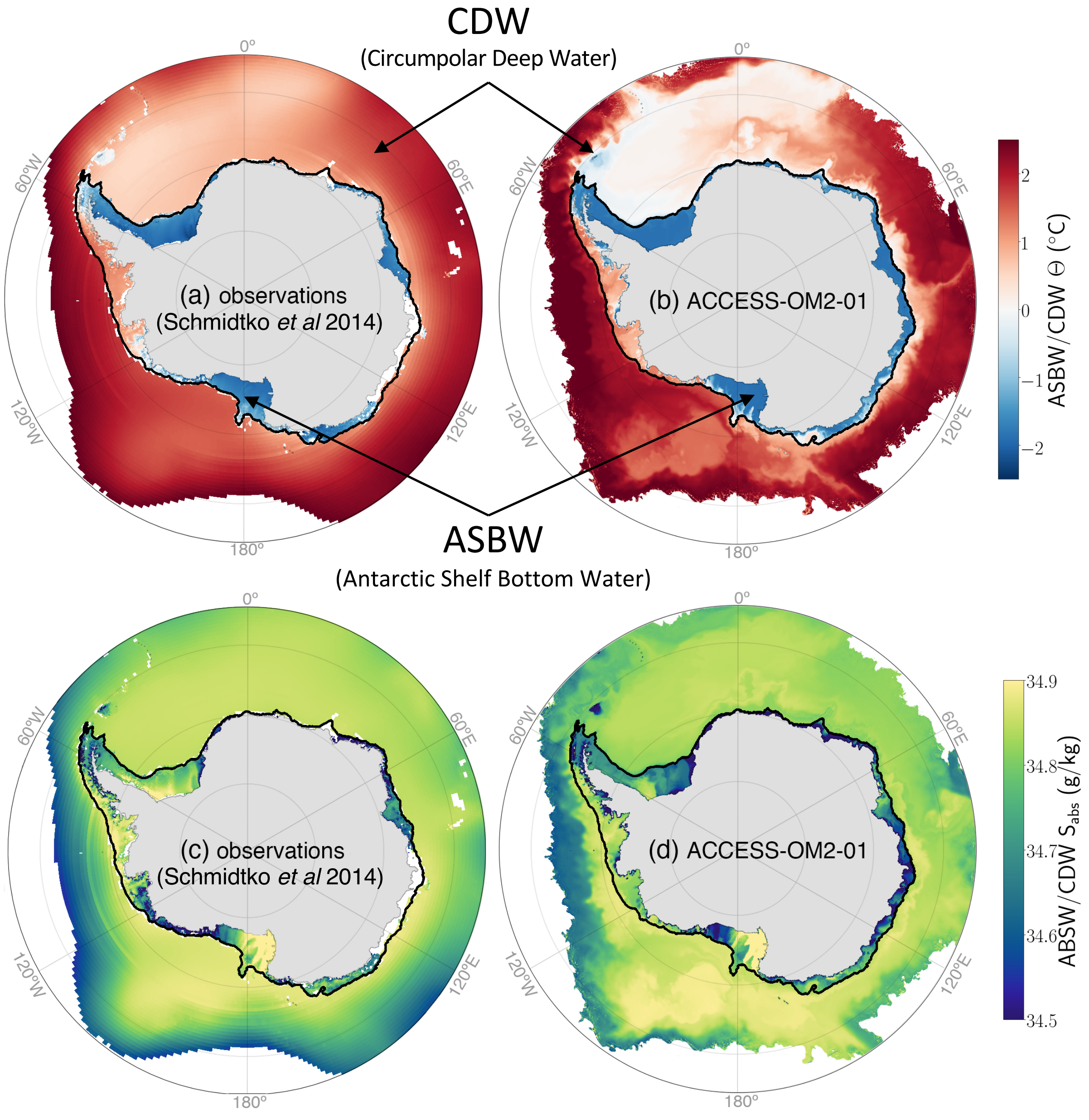




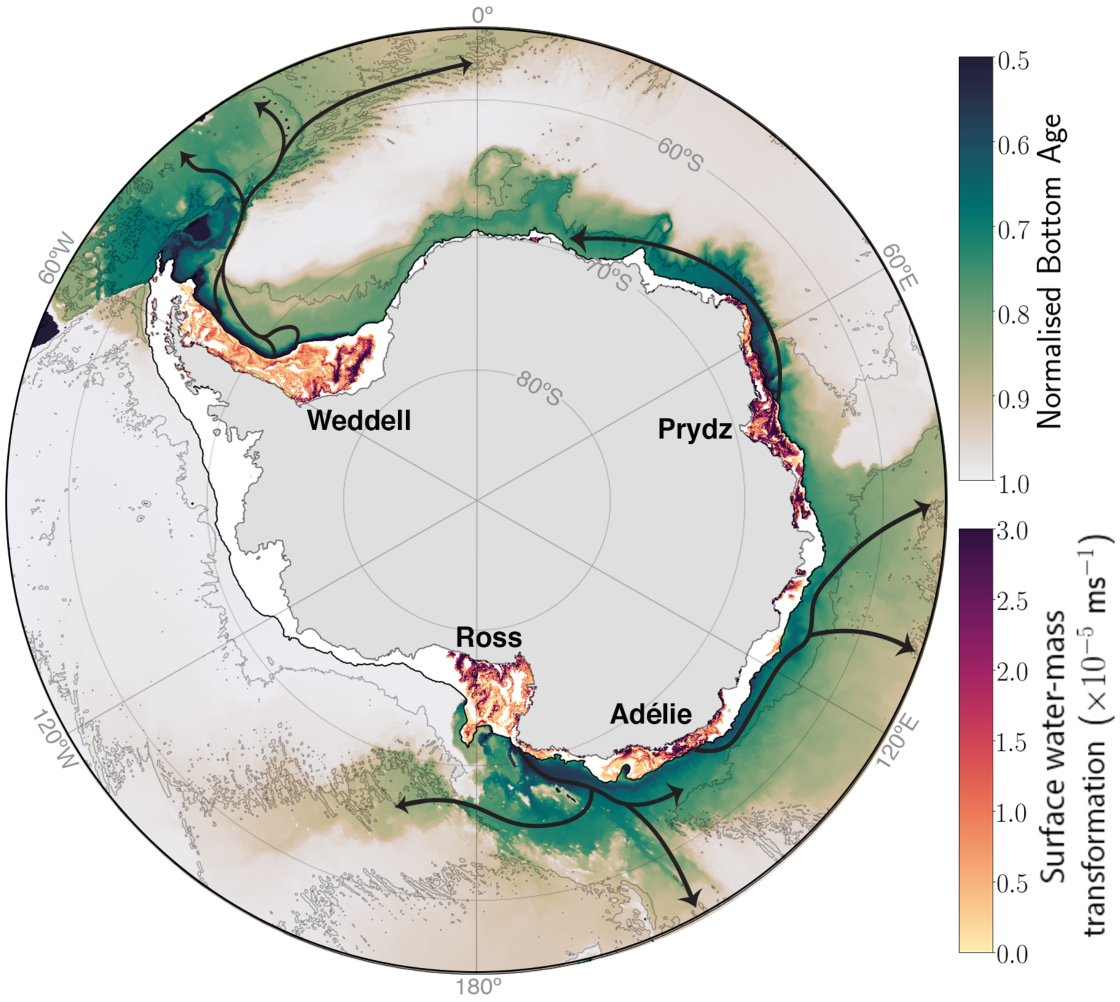


37 years of spinup)

400 - 700 m mean temp anomaly
Fogwill *et al* 2015

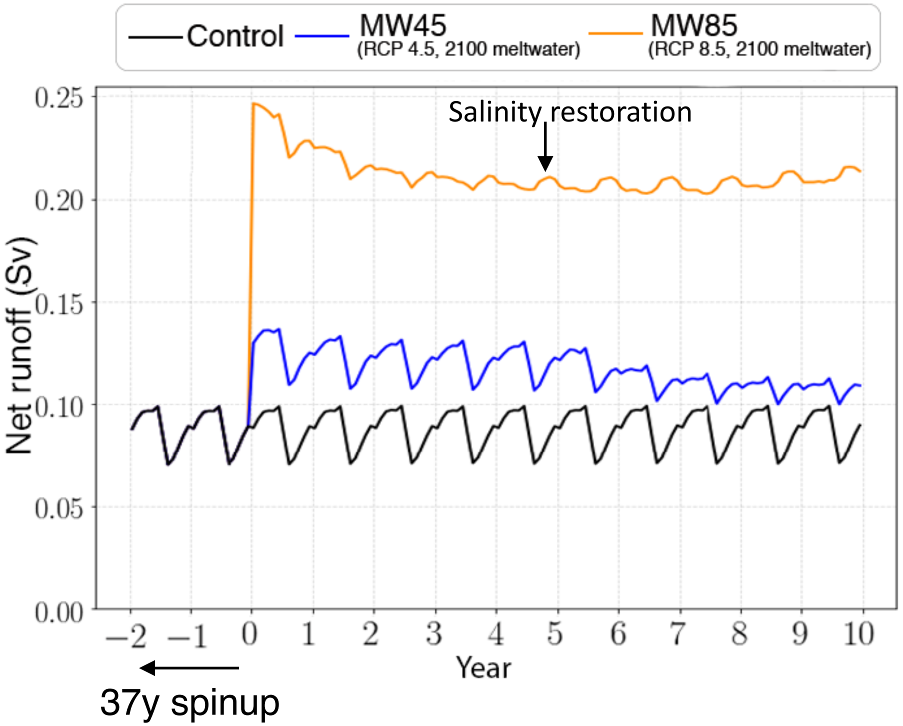


ACCESS-OM2-01 Repeat Year Forced (1984-85) output (following 37 years of spinup)



- 2.2-5.5 km grid on Antarctic shelf (Rossby radius ~ 4 km)
- Accurately simulates mechanisms of AABW formation (unlike most models, Heuze *et al* 2013)
- Antarctic water-mass properties (CDW, ASBW) are well captured

- JRA55-do repeat year (1984-1985) atmospheric forcing
- Meltwater input from land-ice loss included in atmospheric forcing as runoff into the surface ocean (no cavities, no freshwater input at depth) - Antarctic runoff pattern from Depoorter *et al* (2013)
- Step change in Antarctic runoff – two 10y experiments (+ 10y control)
- Spatial pattern informed by Paolo *et al* (2015)
- Magnitude set to 2100 RCP 4.5 and RCP 8.5 runoff (Golledge *et al* 2019)

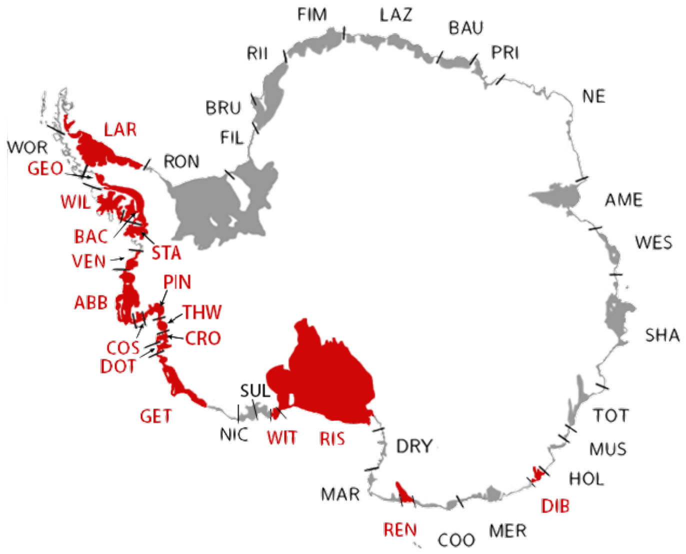


MW85 : RCP 8.5 at 2100
+ 0.16 Sv (x 2.7)

MW45 : RCP 4.5 at 2100
+ 0.04 Sv (x 1.5)

Control : Depoorter 2013
0.09 Sv

1. How does Antarctic dense water production respond to freshening by ice shelf melt?
2. Can this freshening warm or cool Antarctic coastal waters (creating positive or negative feedbacks to melt)?



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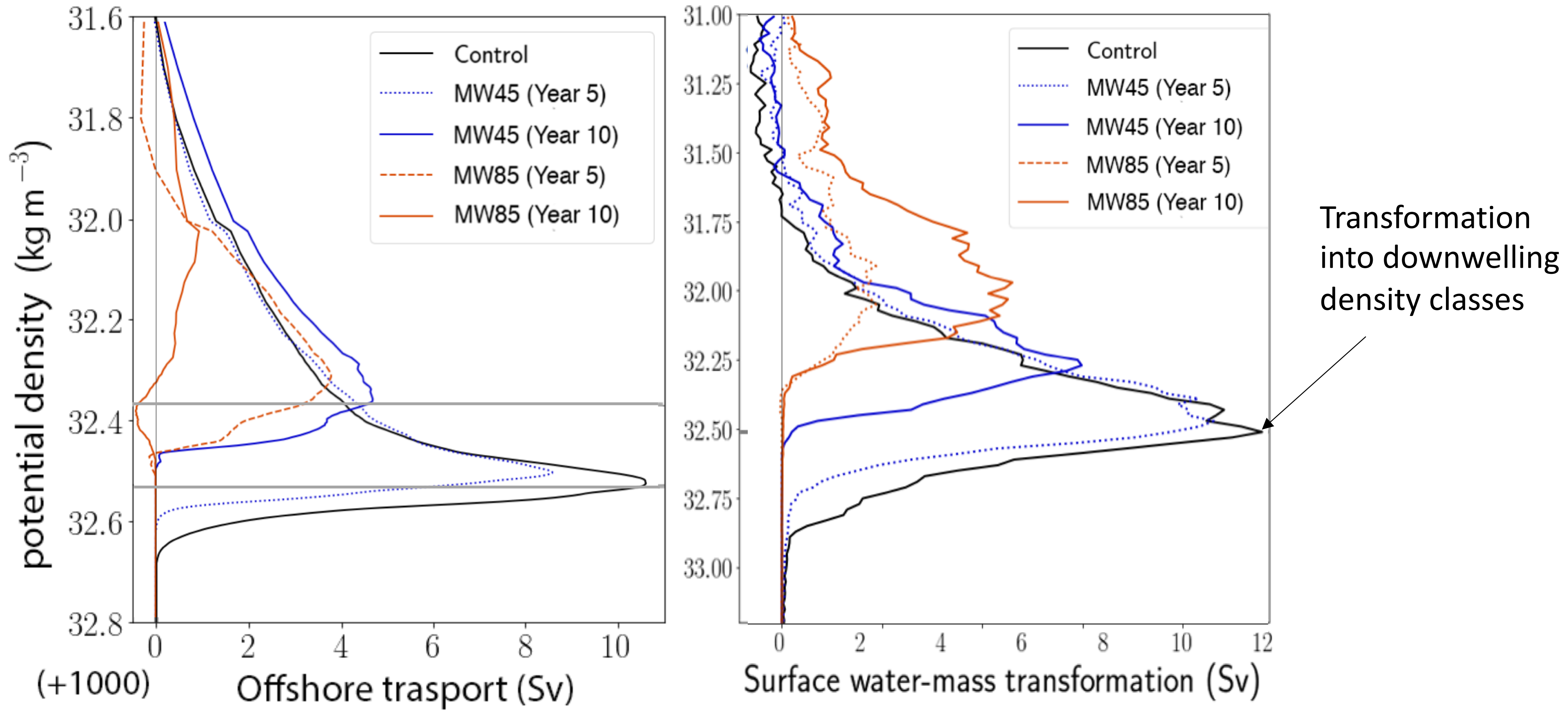
Within 5 years of RCP 8.5 (2100) forcing, and 10 of RCP 4.5 (2100) forcing, no waters dense enough to reach the abyssal ocean (DSW) are exported off the shelf (circumpolar signal).



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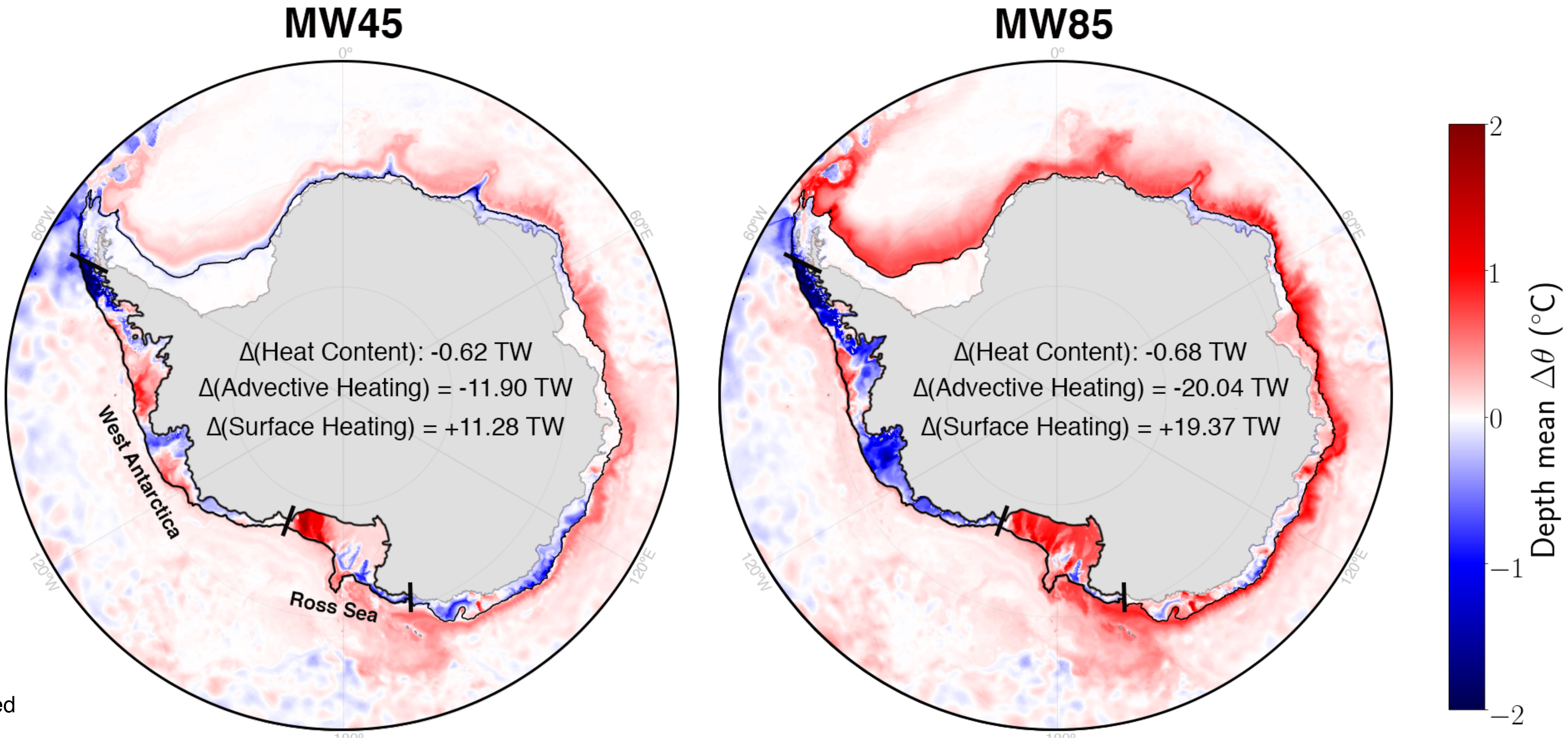

Temp transports are 0°C referenced

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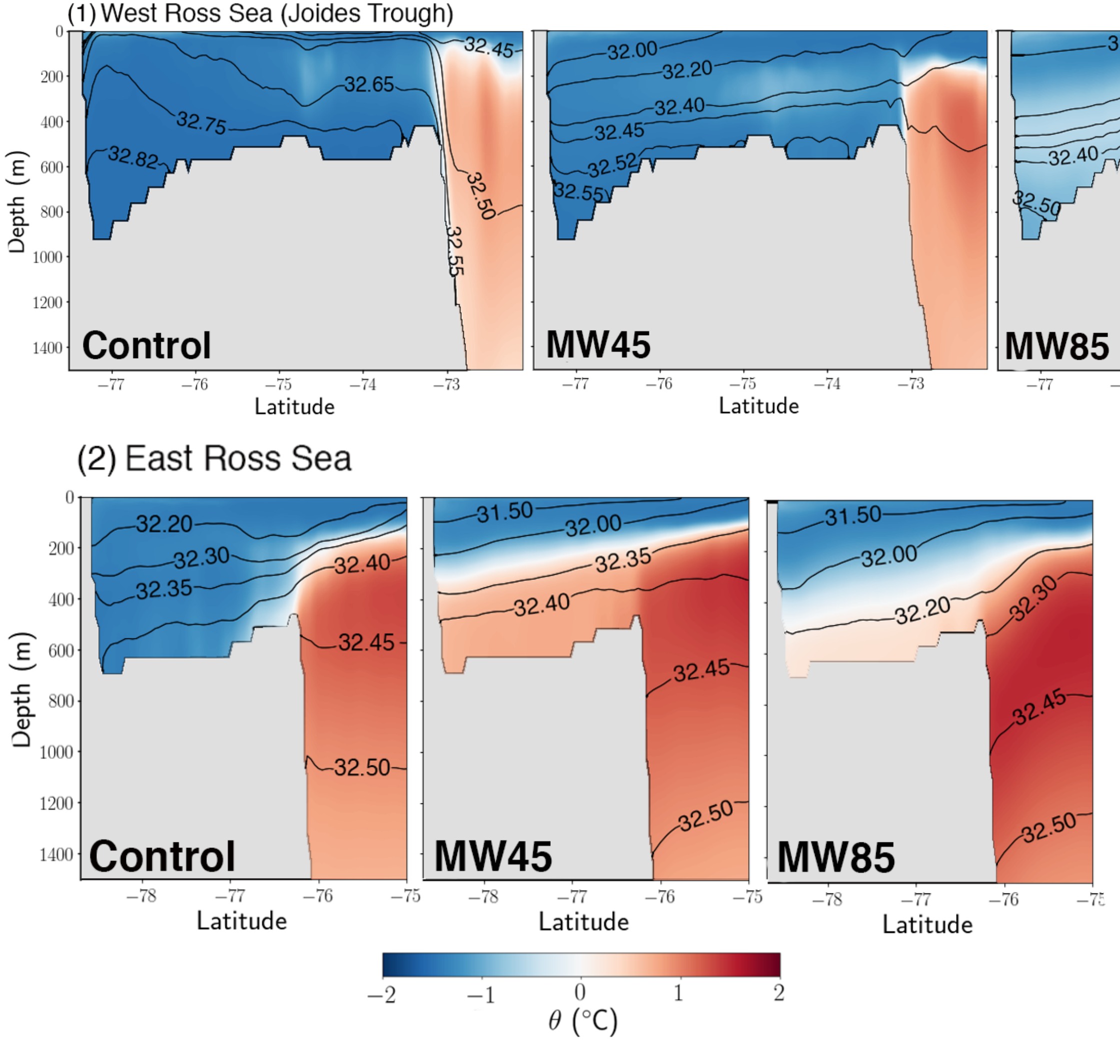
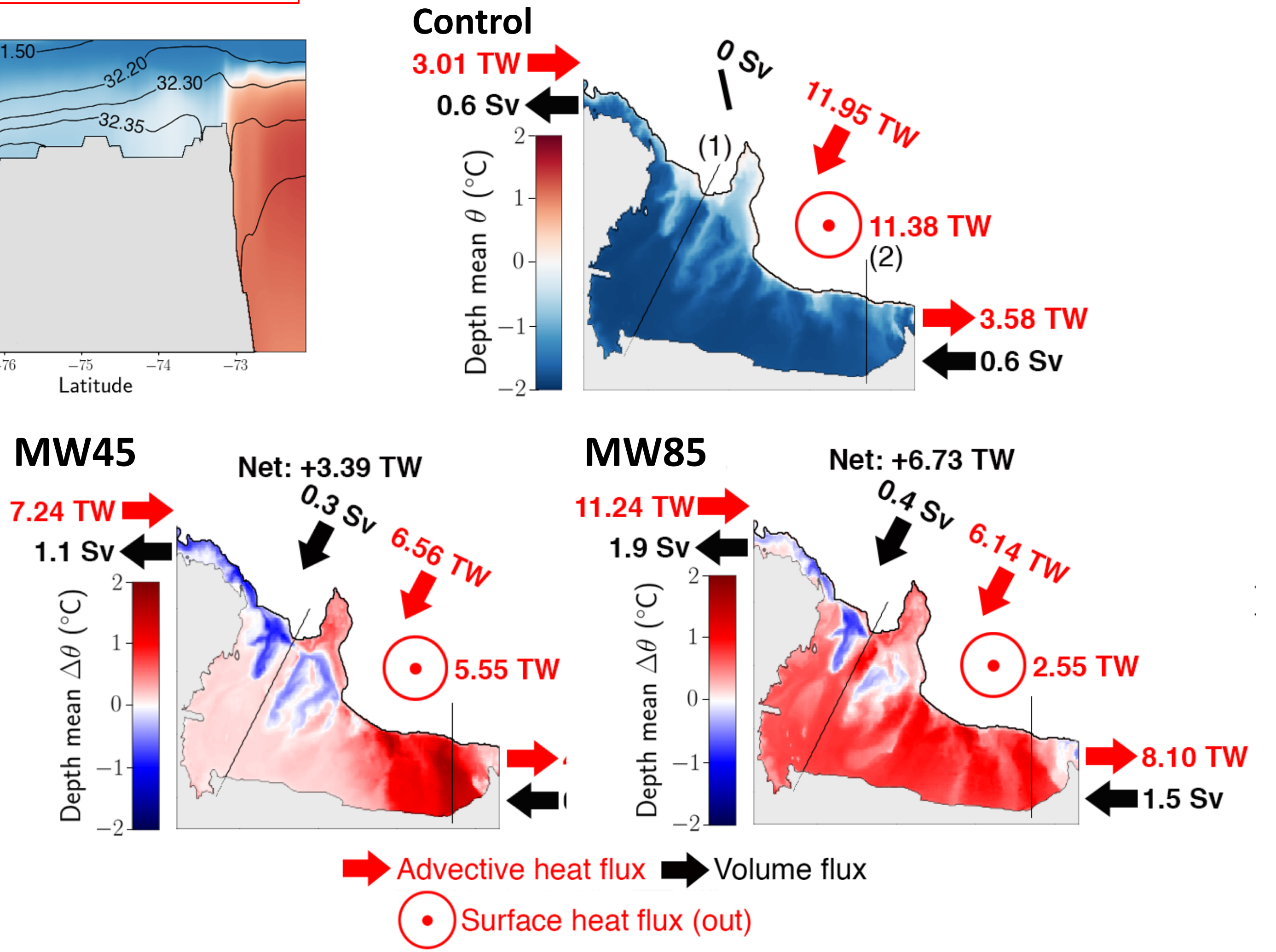
Positive feedback to melt (DSW convective shutdown)





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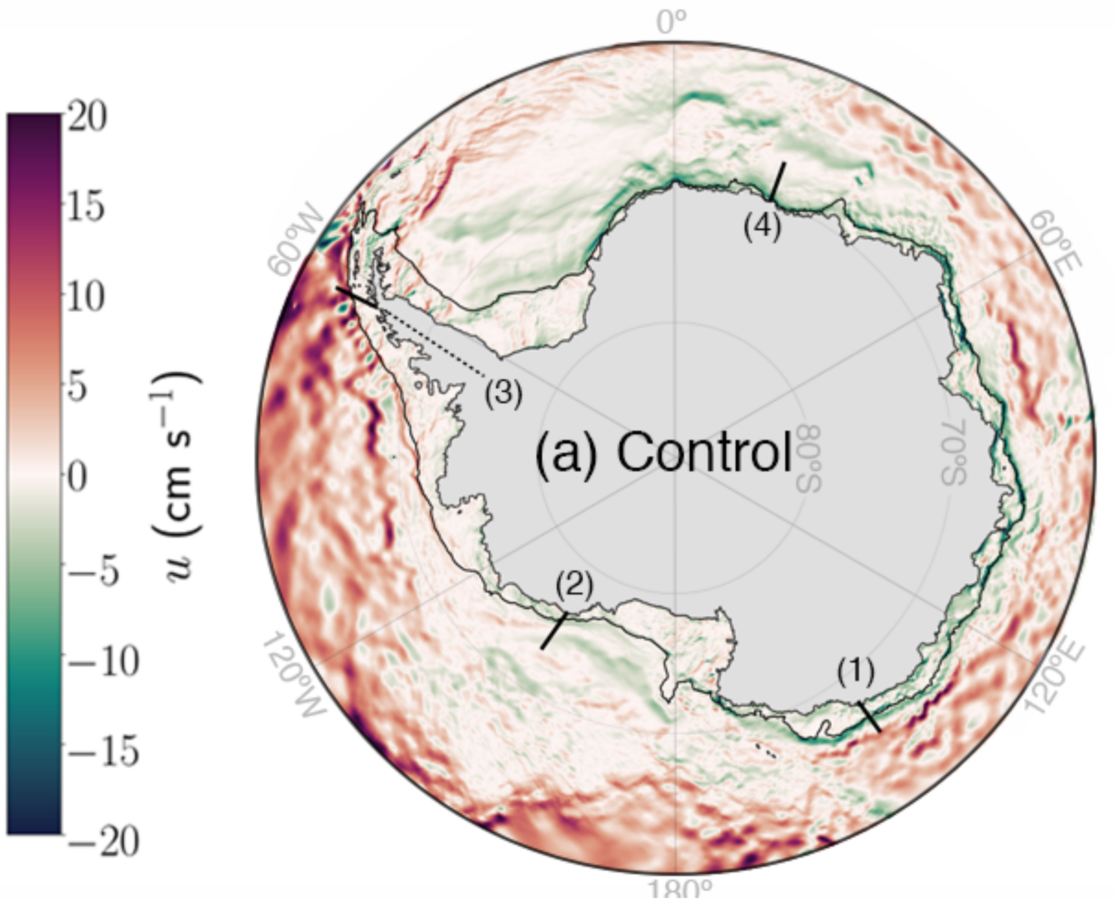
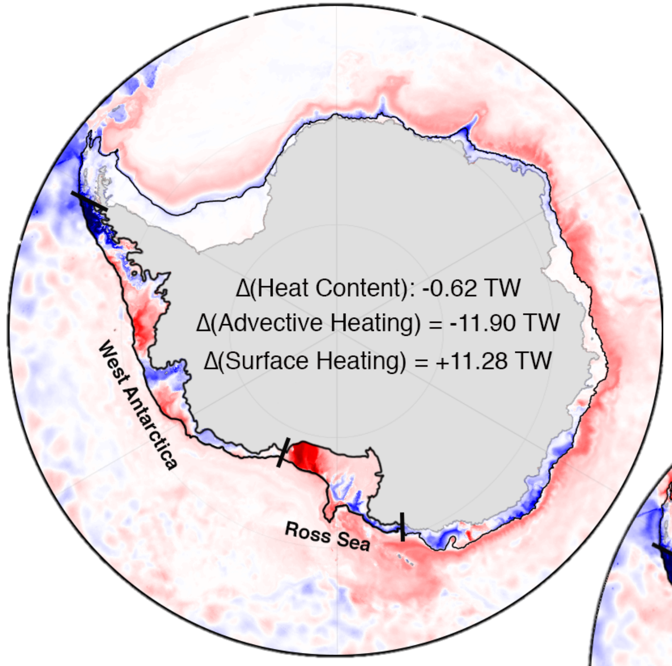
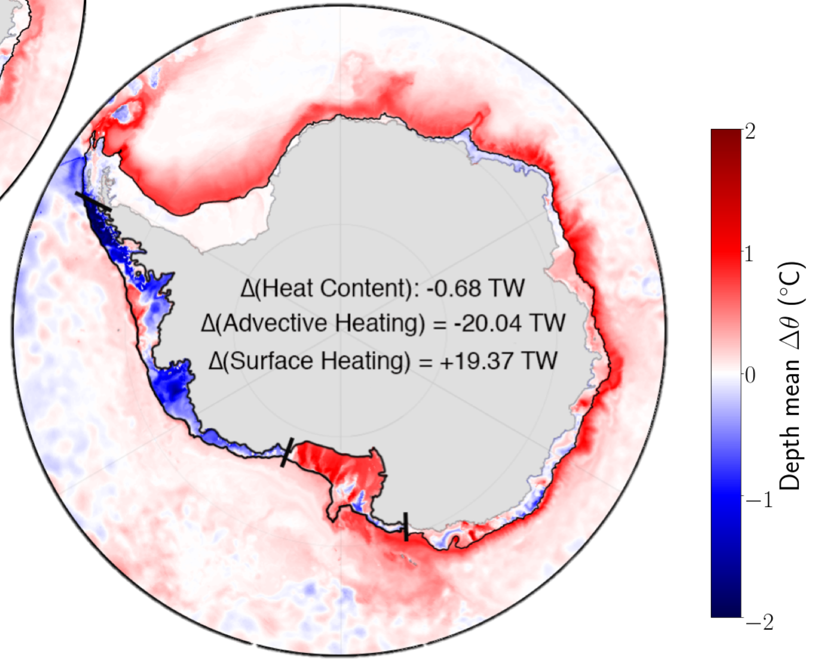
Not a ubiquitous response - strongest where ASF/ASC weak or absent







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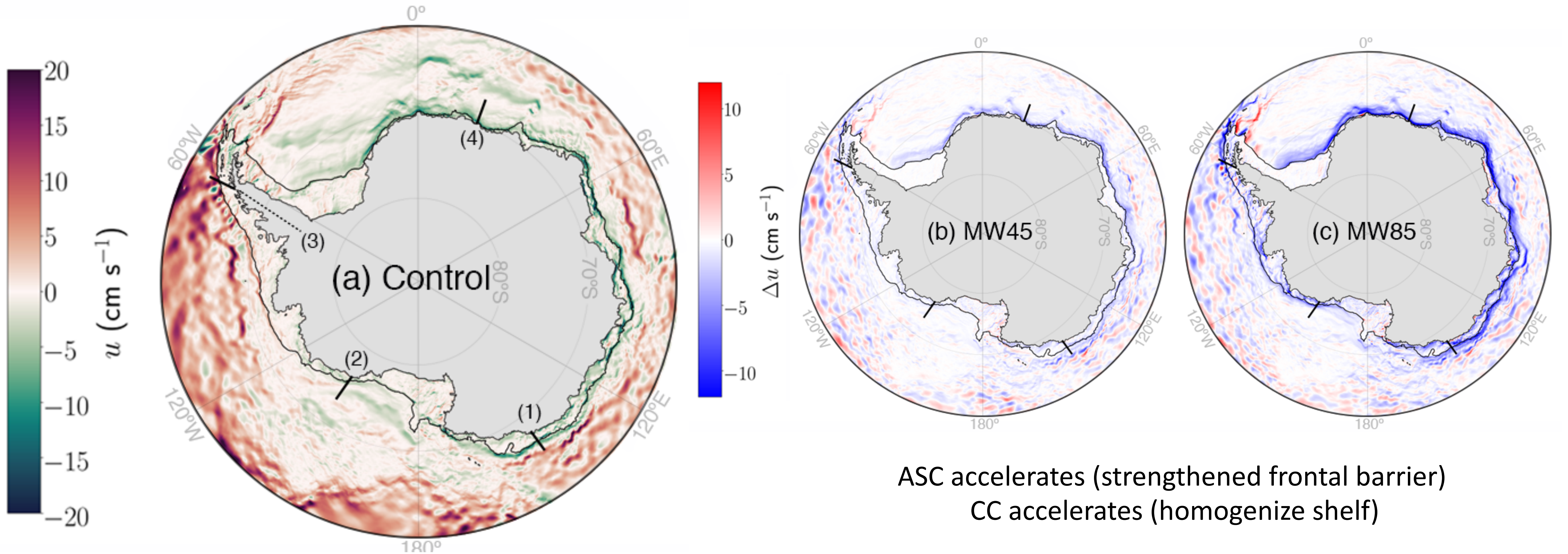
Negative feedback to melt (shelf isolation)

Mixed feedback to melt (shelf homogenization)



ASC accelerates (strengthened frontal barrier)
CC accelerates (homogenize shelf)

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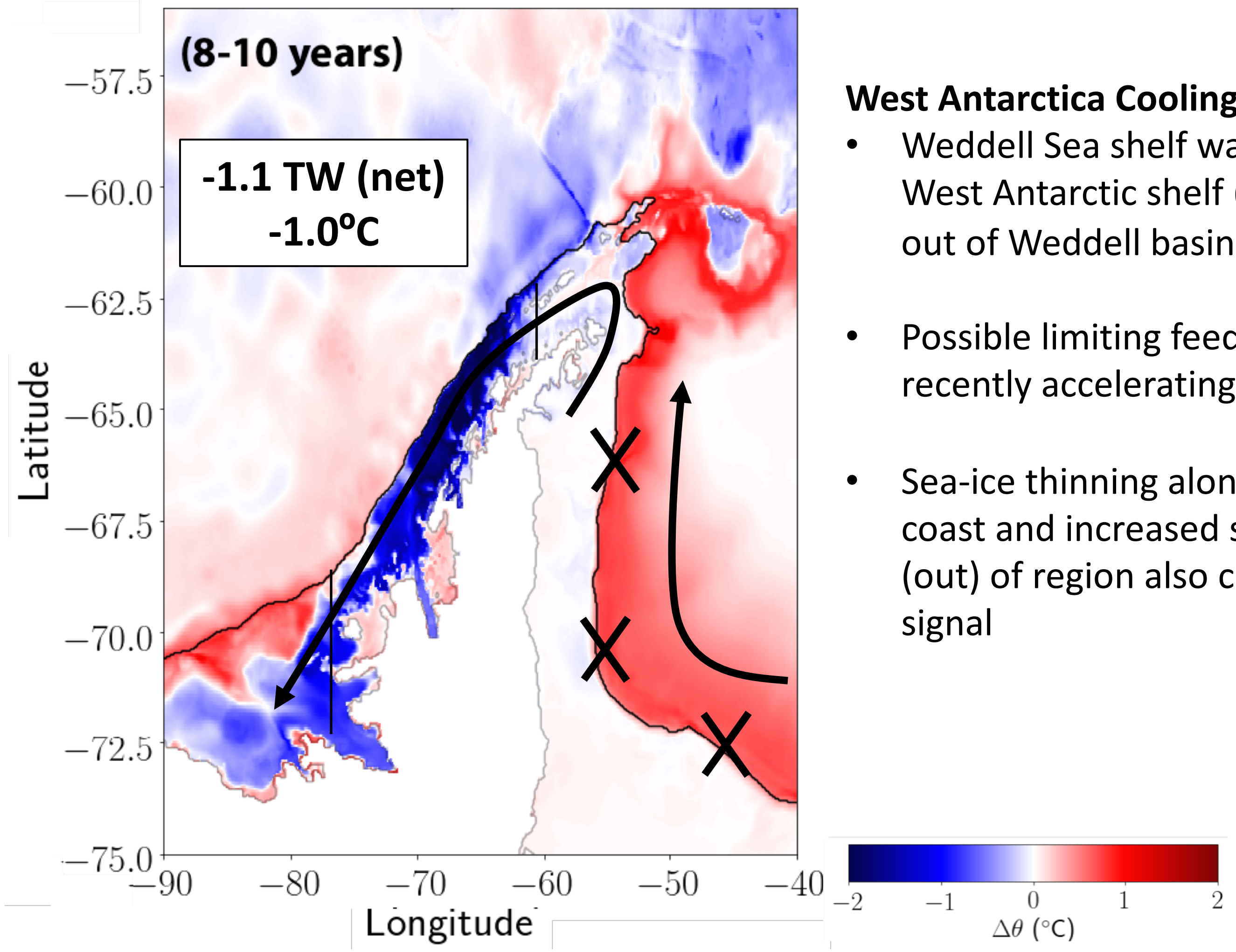
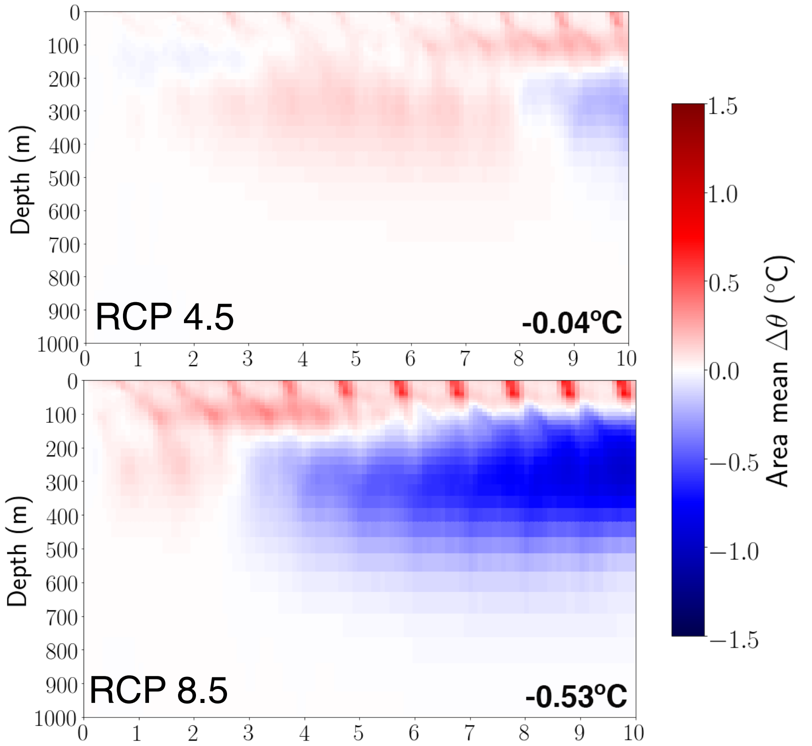


West Antarctica Cooling

- Weddell Sea shelf waters diverted into West Antarctic shelf (cool signal) and out of Weddell basin (warm signal)
- Possible limiting feedback to the recently accelerating WAIS melt
- Sea-ice thinning along West Antarctic coast and increased surface heat fluxes (out) of region also contributes to signal



steric sea-level)

Shutdown of DSW formation

Freshening by ice shelf melt

Large land-ice basin

Ross

West Antarctica

Positive feedback to melt **Stratification**	Negative feedback to melt **Isolation**	Mixed feedback to melt **Homogenisation**
Deep warming in DSW formation regions as convection shuts down.	Increasing strength and prevalence frontal structures reduce poleward advective heat transport.	Accelerating coastal current homogenises shelf waters, drives **remote feedbacks**.