Ocean Cooling and Ice Sheet Melting Response

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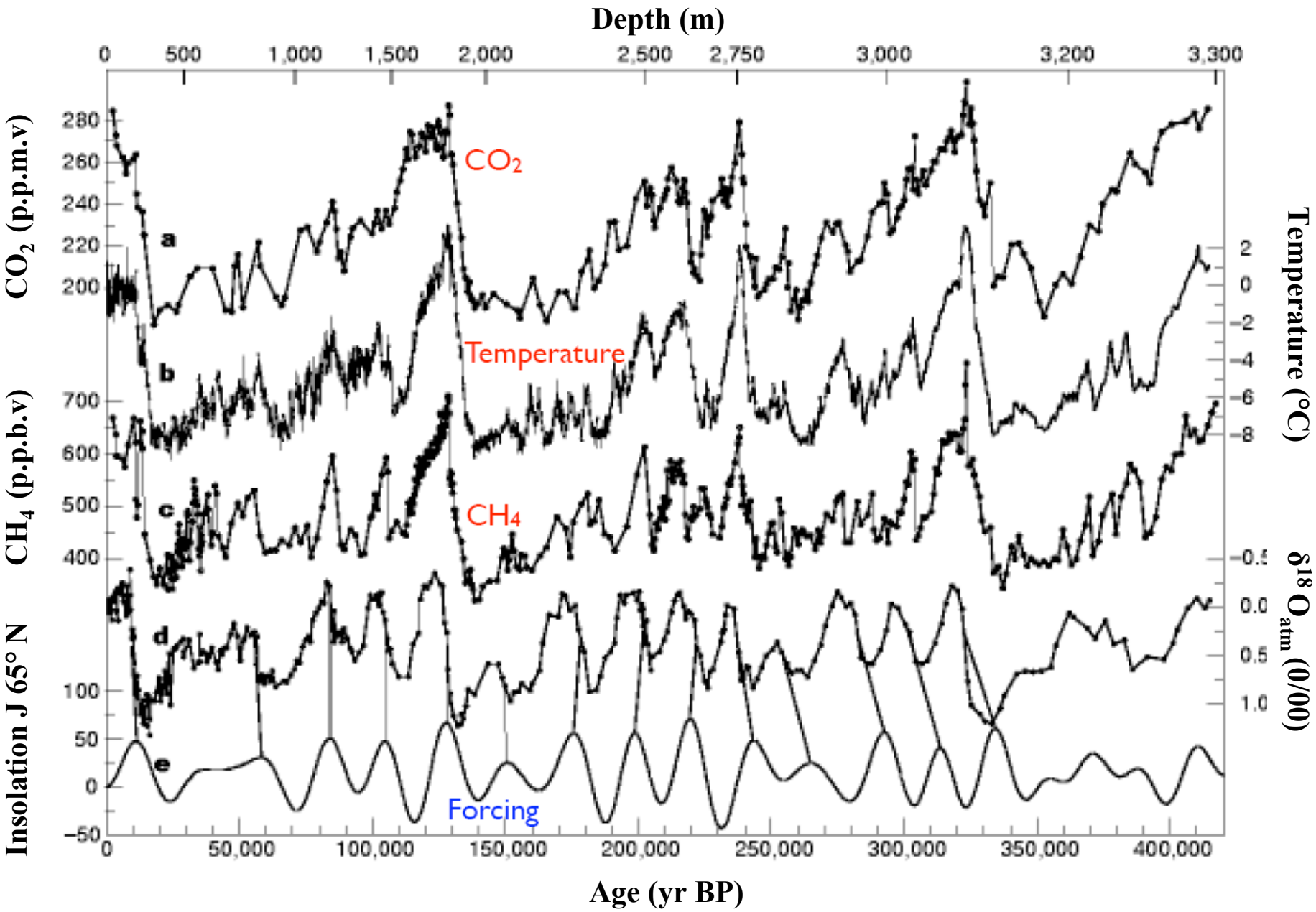
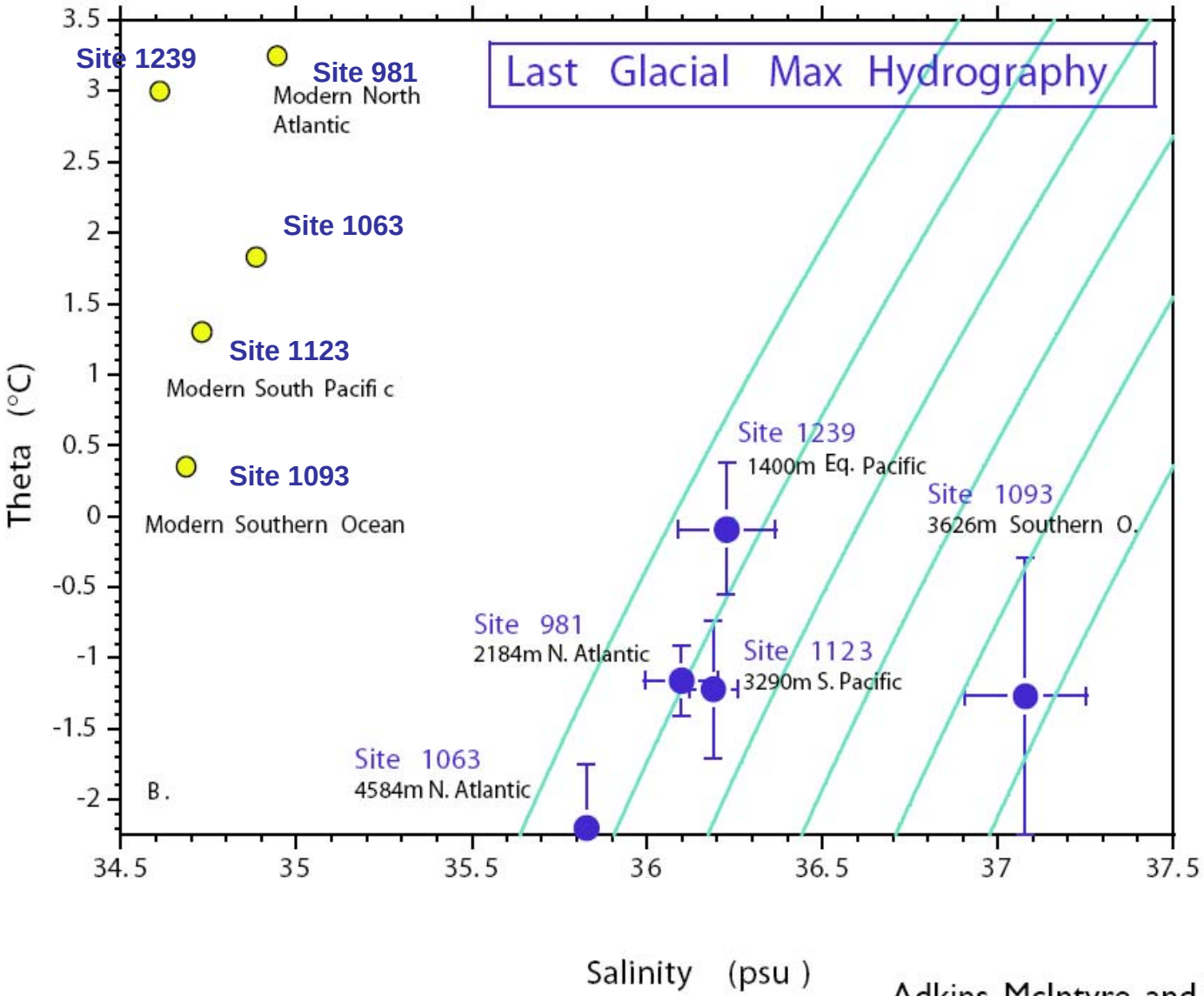
Vostok Ice Core Gases and Temperature (Petit et al. 1999)



Deep Ocean T/S at Last Glacial Maximum



Adkins, McIntyre, and Schrag, 2002

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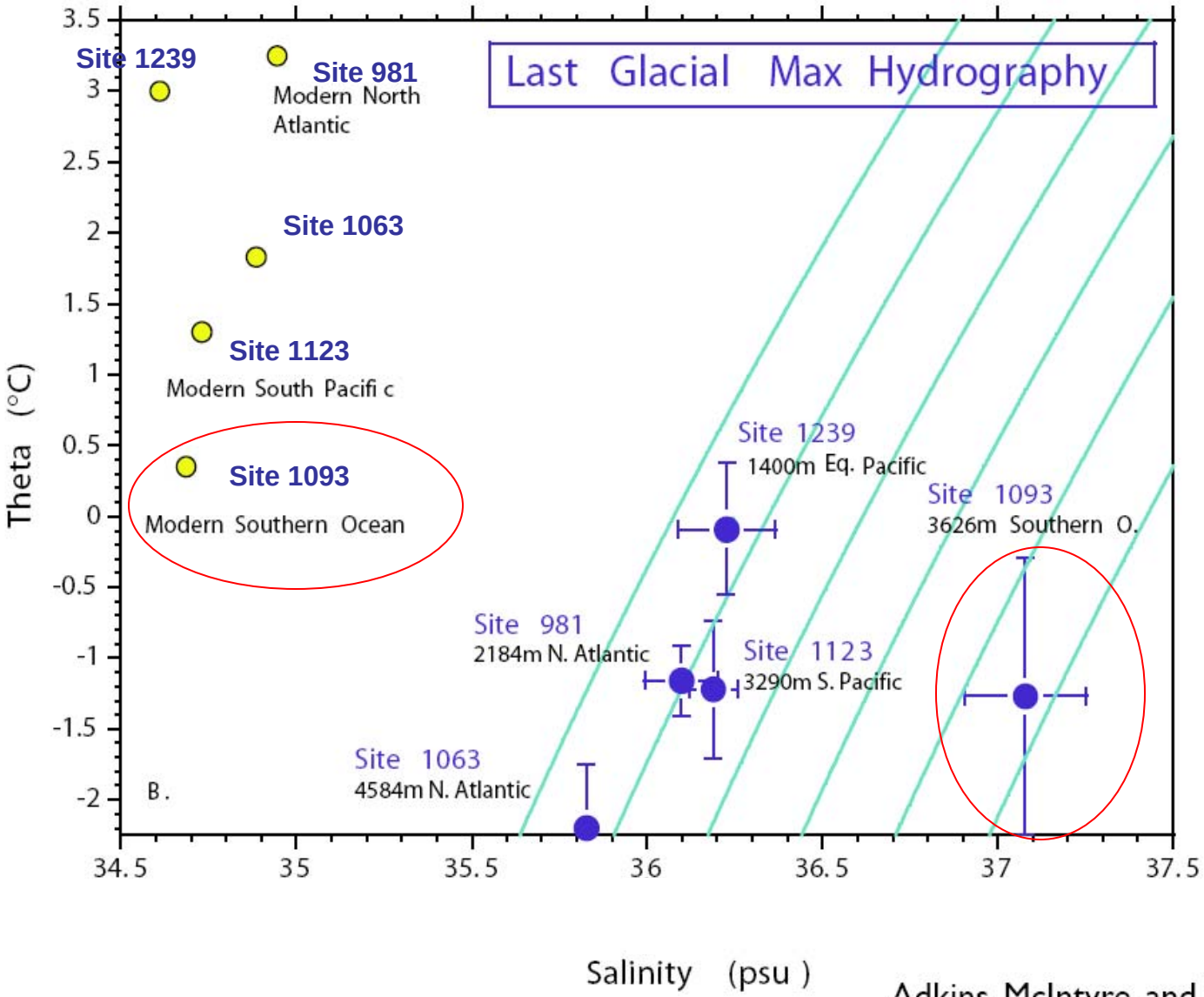


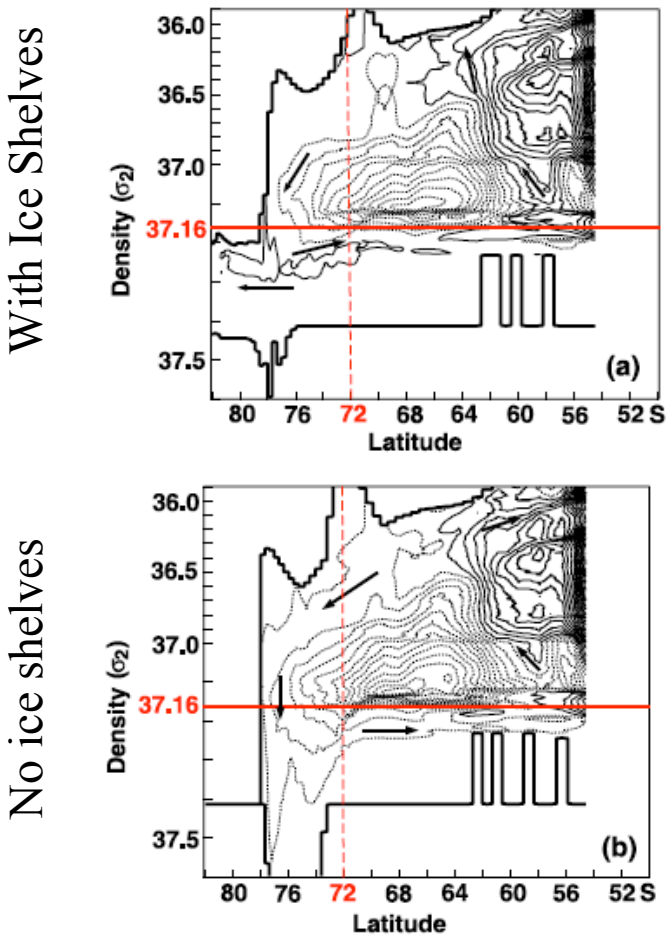
Adkins, McIntyre, and Schrag, 2002

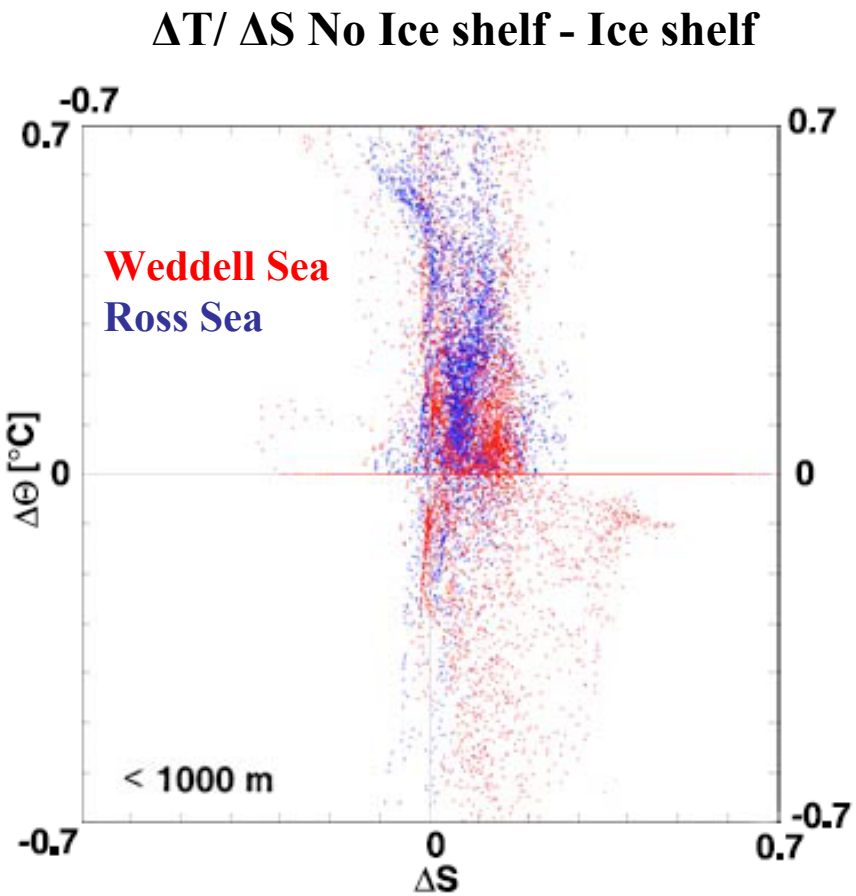
Hellmer (2004): What happens if there are no ice shelf cavities?

-Removal of fresh cold water from shelves → warmer, saltier shelf water

-Salinity dominates EOS at low T → denser shelf waters

-Bottom water (> 1000 m) becomes saltier and denser





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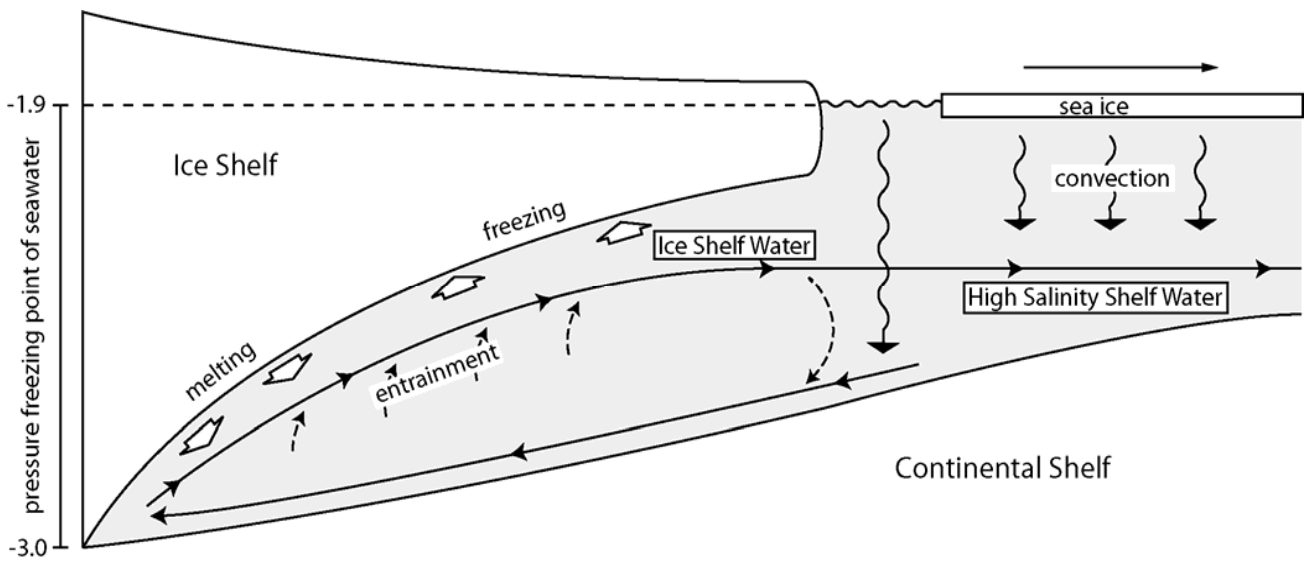

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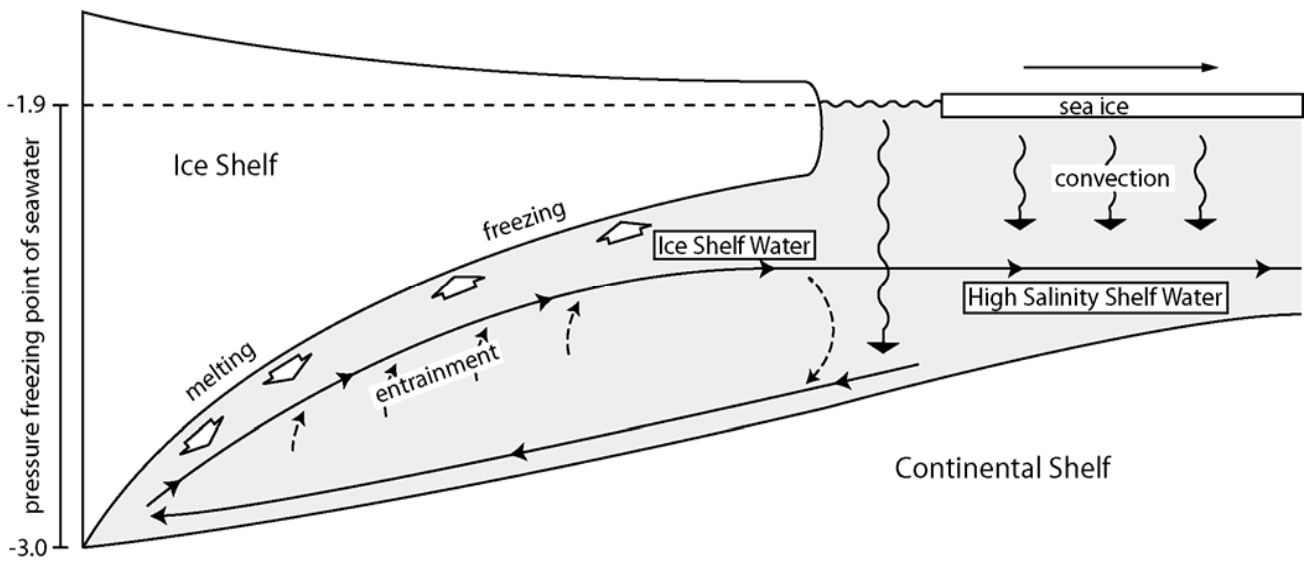
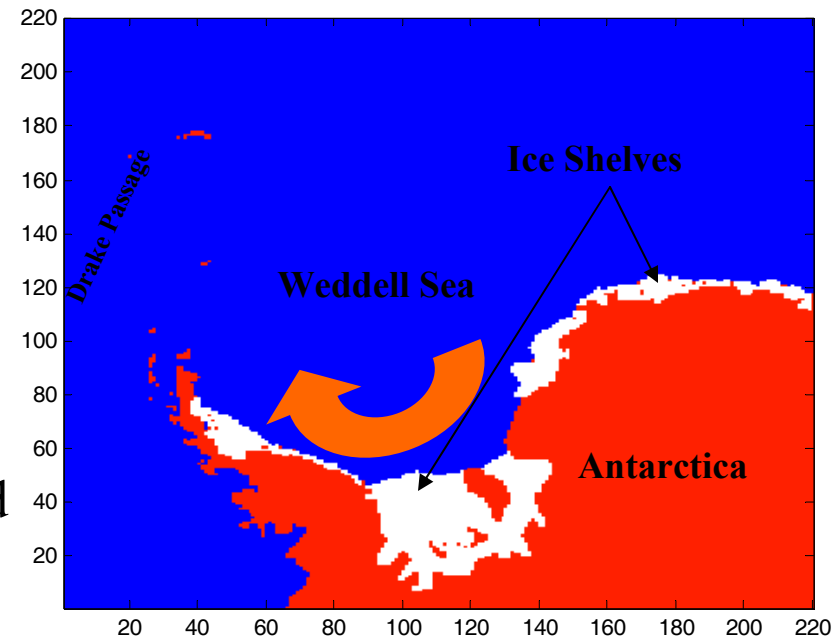


- **What exactly constitutes "making the deep ocean saltier" ?**

MITgcm Setup:



Domain: Weddell Sea

-220x220x50 sub-domain with open boundaries

-Bathymetry includes **ice shelf cavities**

Control BCs:

-Cube 78 year 1994 monthly (water) and daily (sea ice) products

-Cube 78 1994 atmospheric forcing

Test BCs:

-**Case 1**: θ @ boundaries = $\mathbf{0.5*\theta_0}$ for all $\theta > 0$

-**Case 2**: θ @ boundaries = $\mathbf{0.25*\theta_0}$ for all $\theta > 0$

-**Case 1 and Case 2**: S is decreased to make $\boldsymbol{\rho = \rho_0}$ **at boundaries**

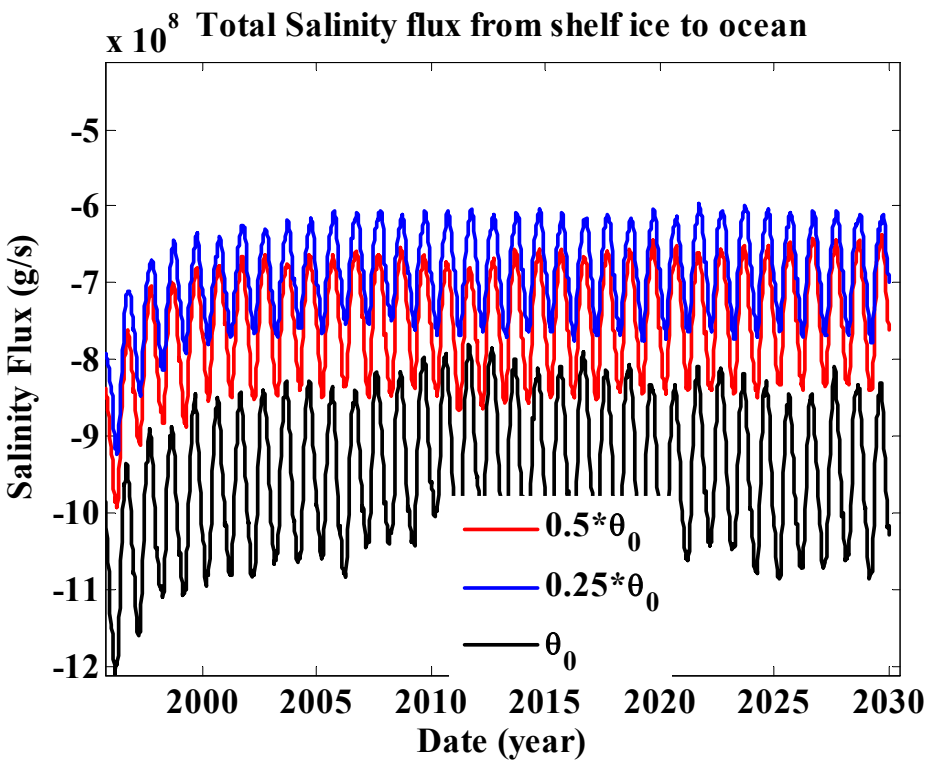
Initial Conditions:

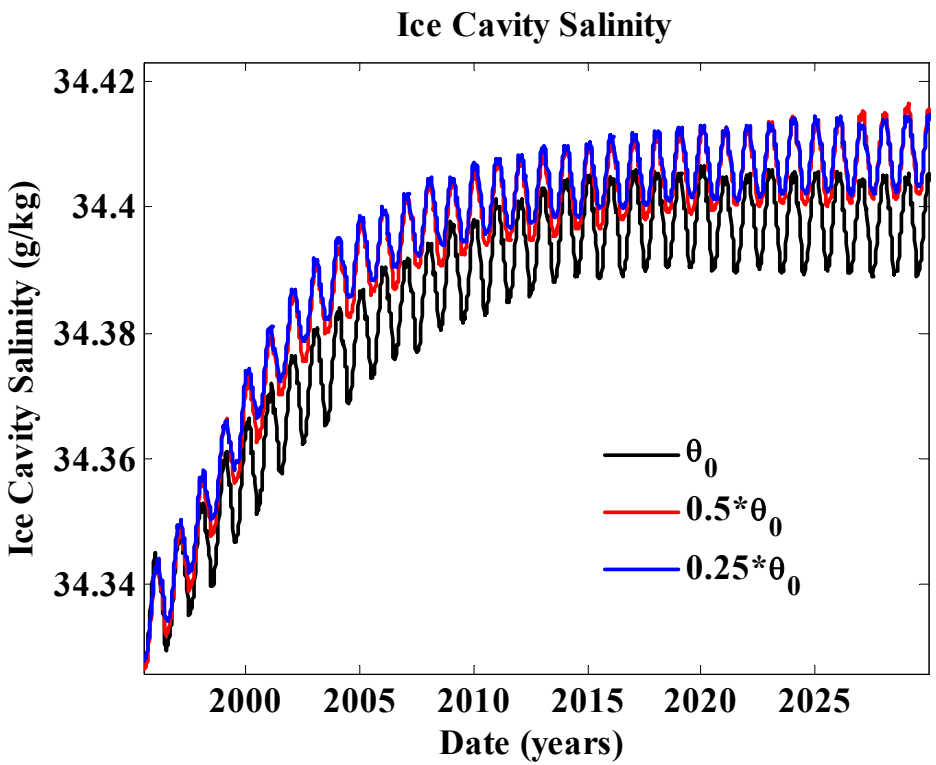
World Ocean Atlas 2005

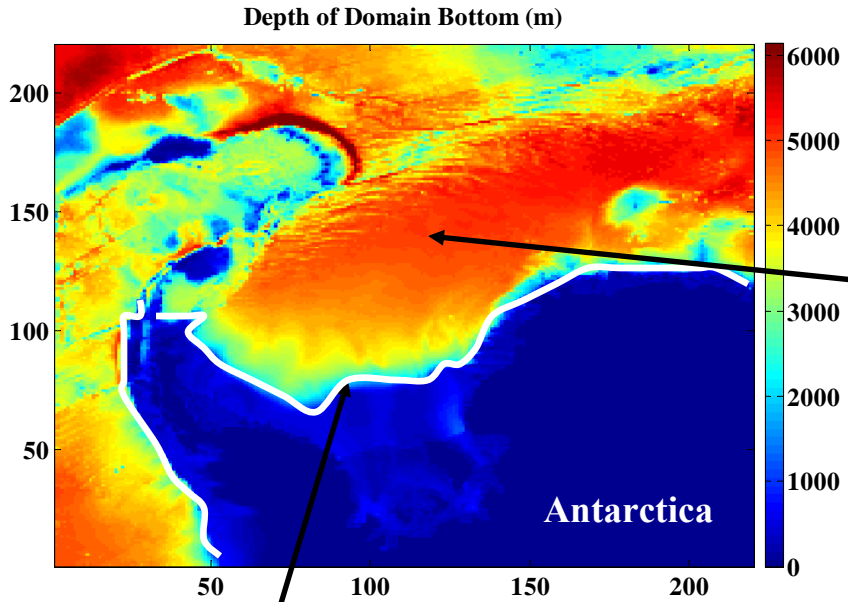
50 year integration from "1992-2040"

Forcing with yearly cycle repeated 50 times

Cooler domain temperatures decrease freshwater flux from ice shelves to ocean → Ice shelf cavity salinity increases

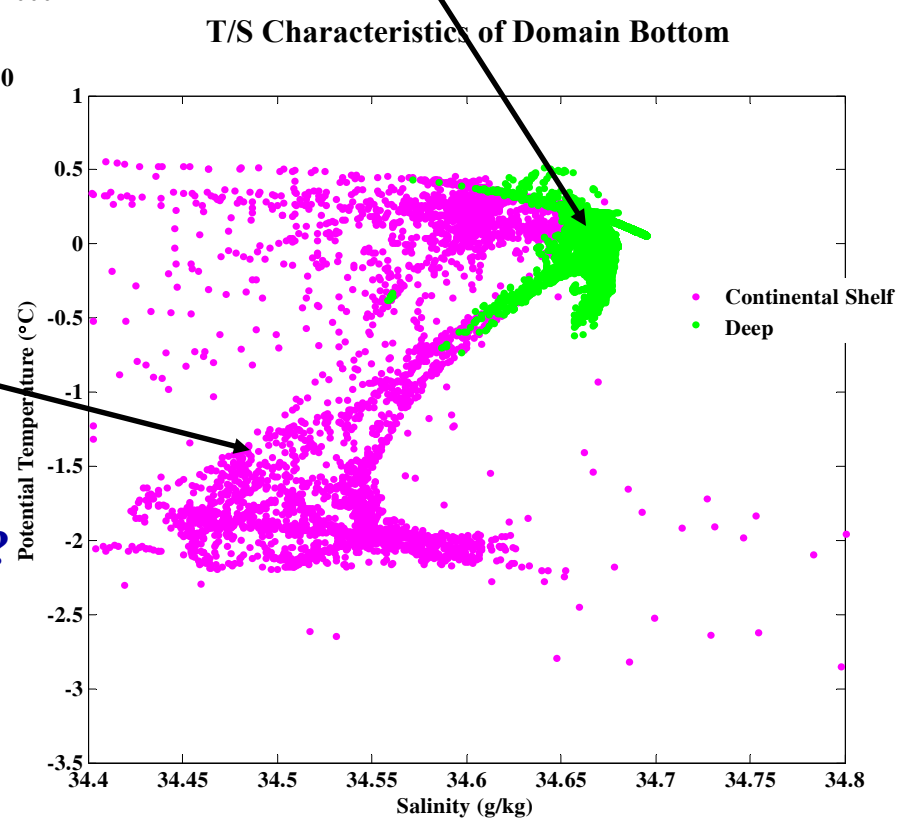






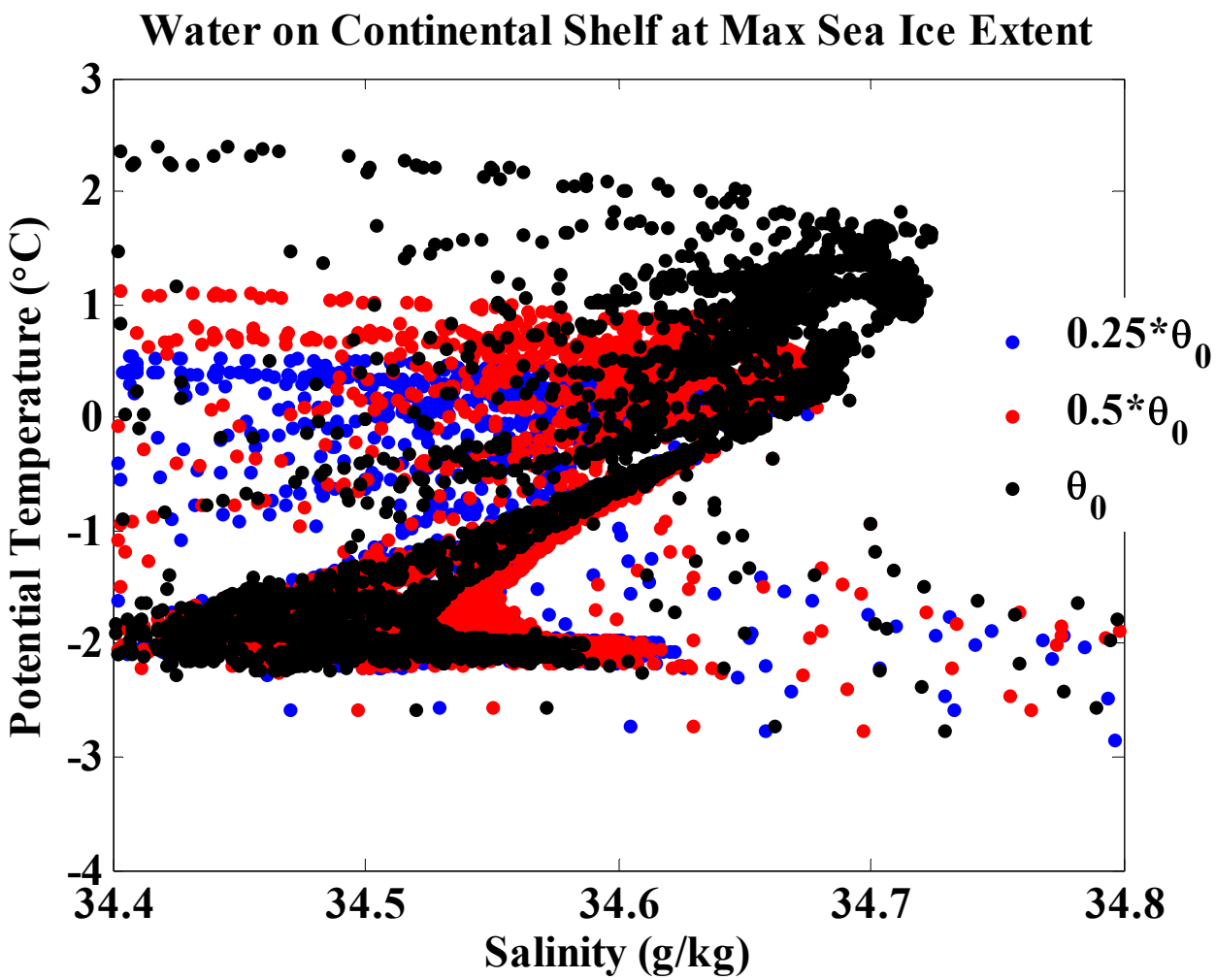
deep ocean

continental shelf break

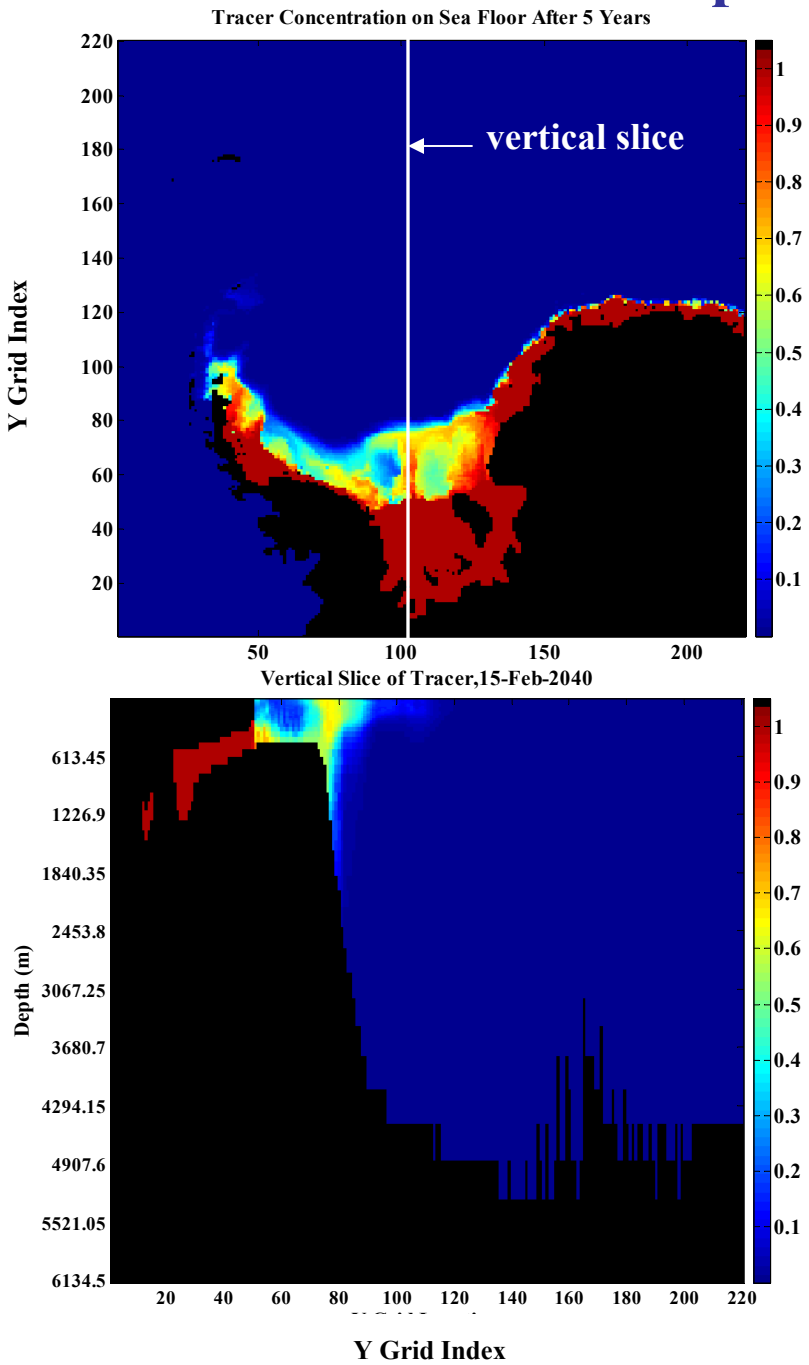


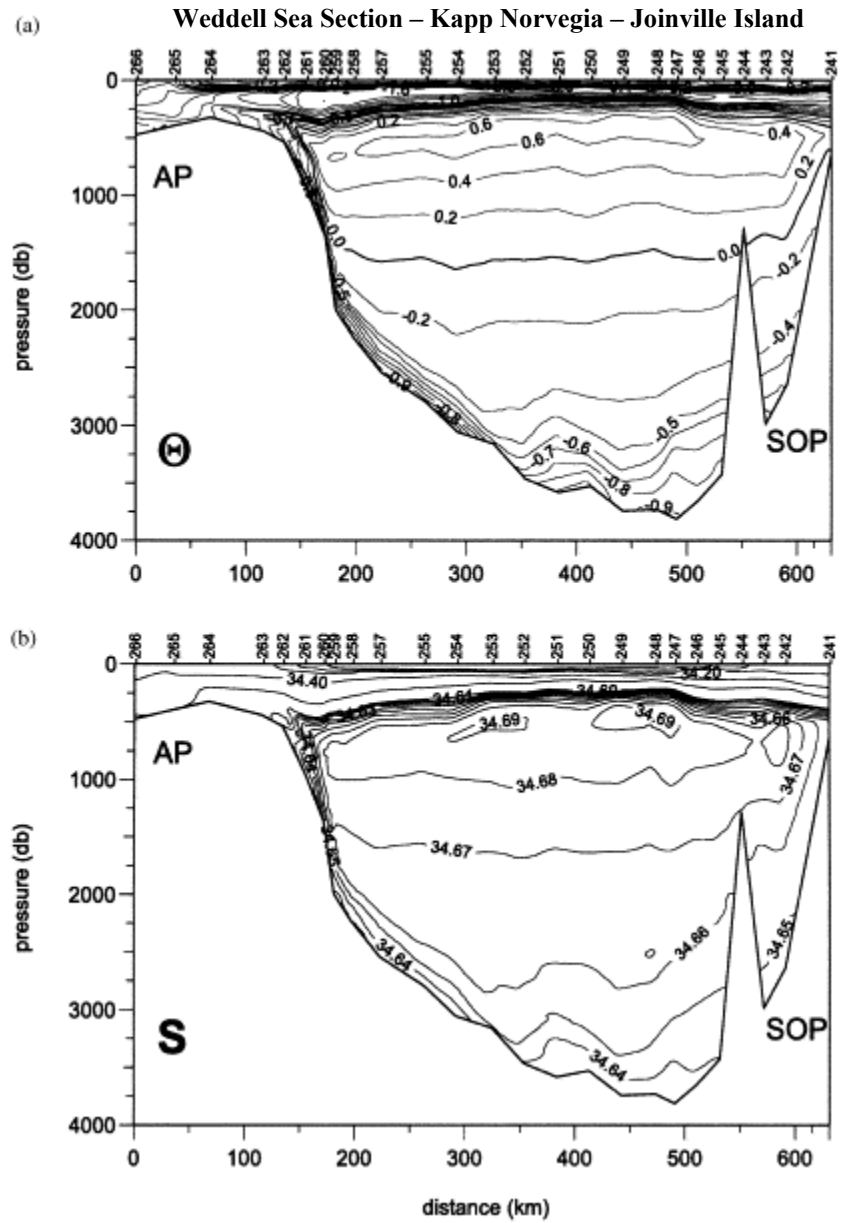
What happens to water on the bottom of the domain as we decrease the temperature?

Shelf water gets saltier and colder…



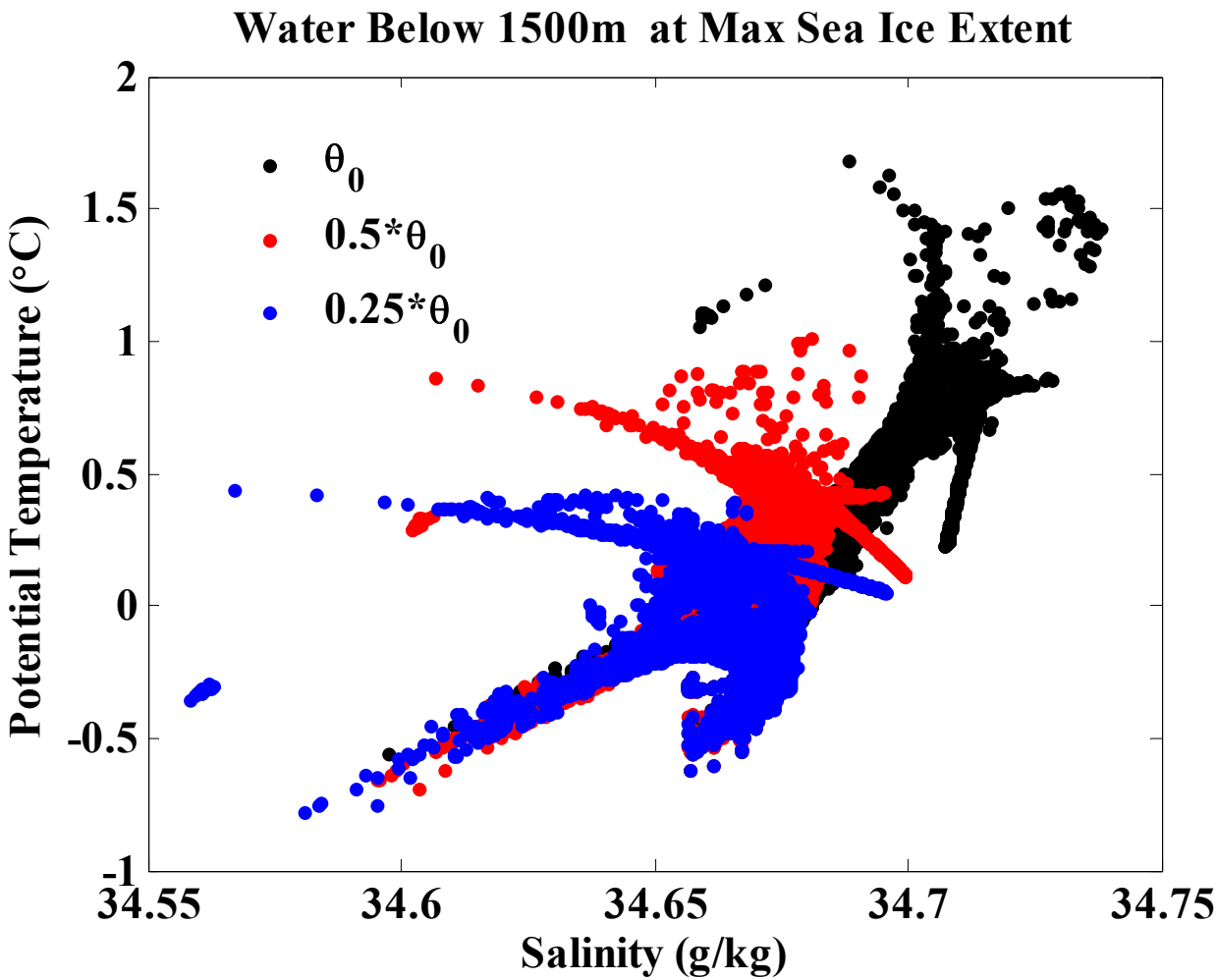
and water from cavities spreads onto shelf





Schröder et al. (2002)

…but deep water gets *fresher* and colder



Conclusions and Next Steps

- **Significant modification in continental shelf salinity through only cooling**
  - -This mechanism is worth investigating further for clues to an explanation of past ocean characteristics

- **Freshening of boundaries obscures results**
  - -Can we learn anything (soon) by just cooling the boundaries?

- **Modeled upper layers don't communicate well with deep ocean**
  - -Increase vertical resolution
  - -Downslope package?

- **Is this important on a regional or global scale?**
  - -Compare regional cooling with ice shelf/no ice shelf results