Thermohaline feedbacks and multiple equilibria in the adiabatic regime

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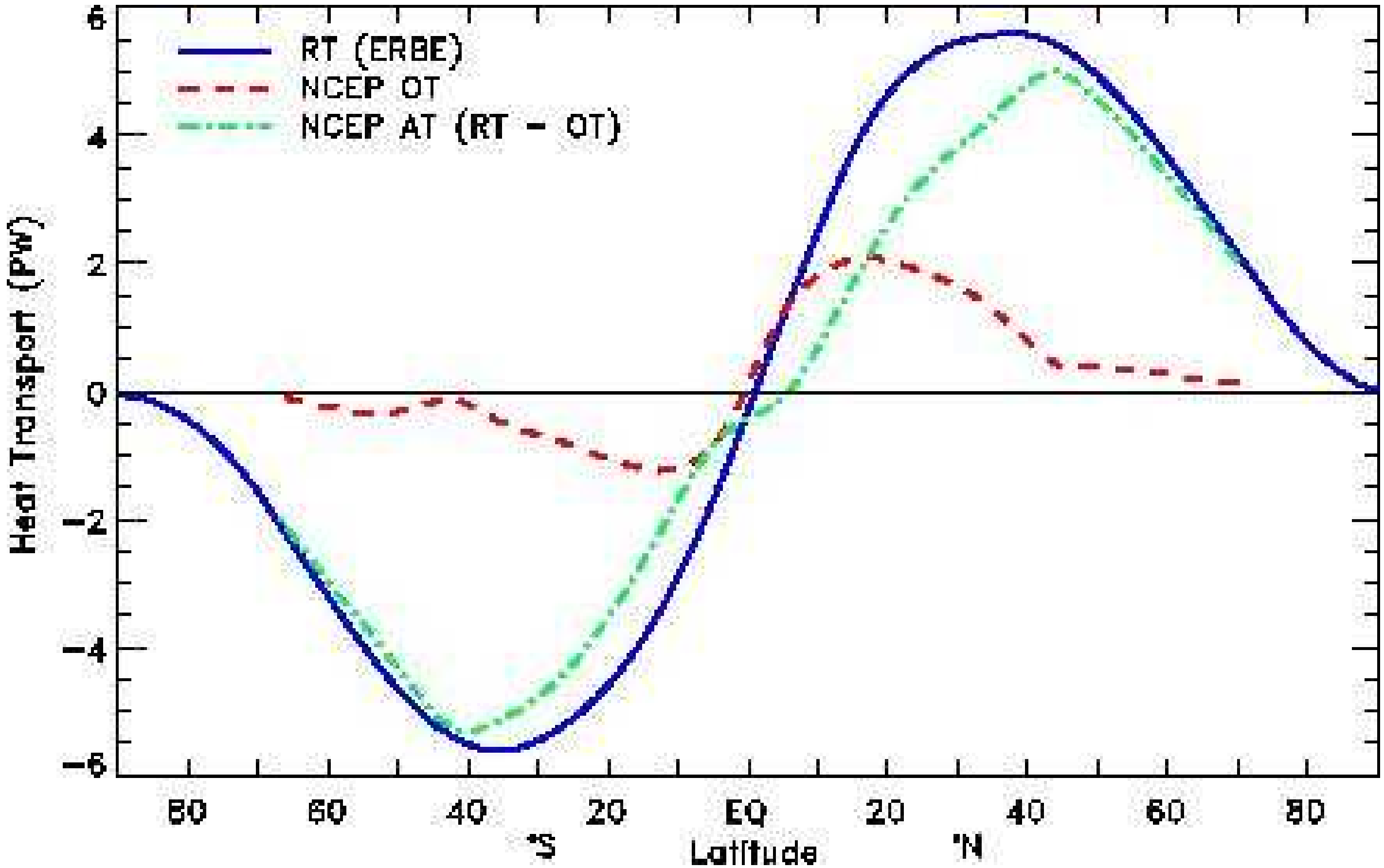
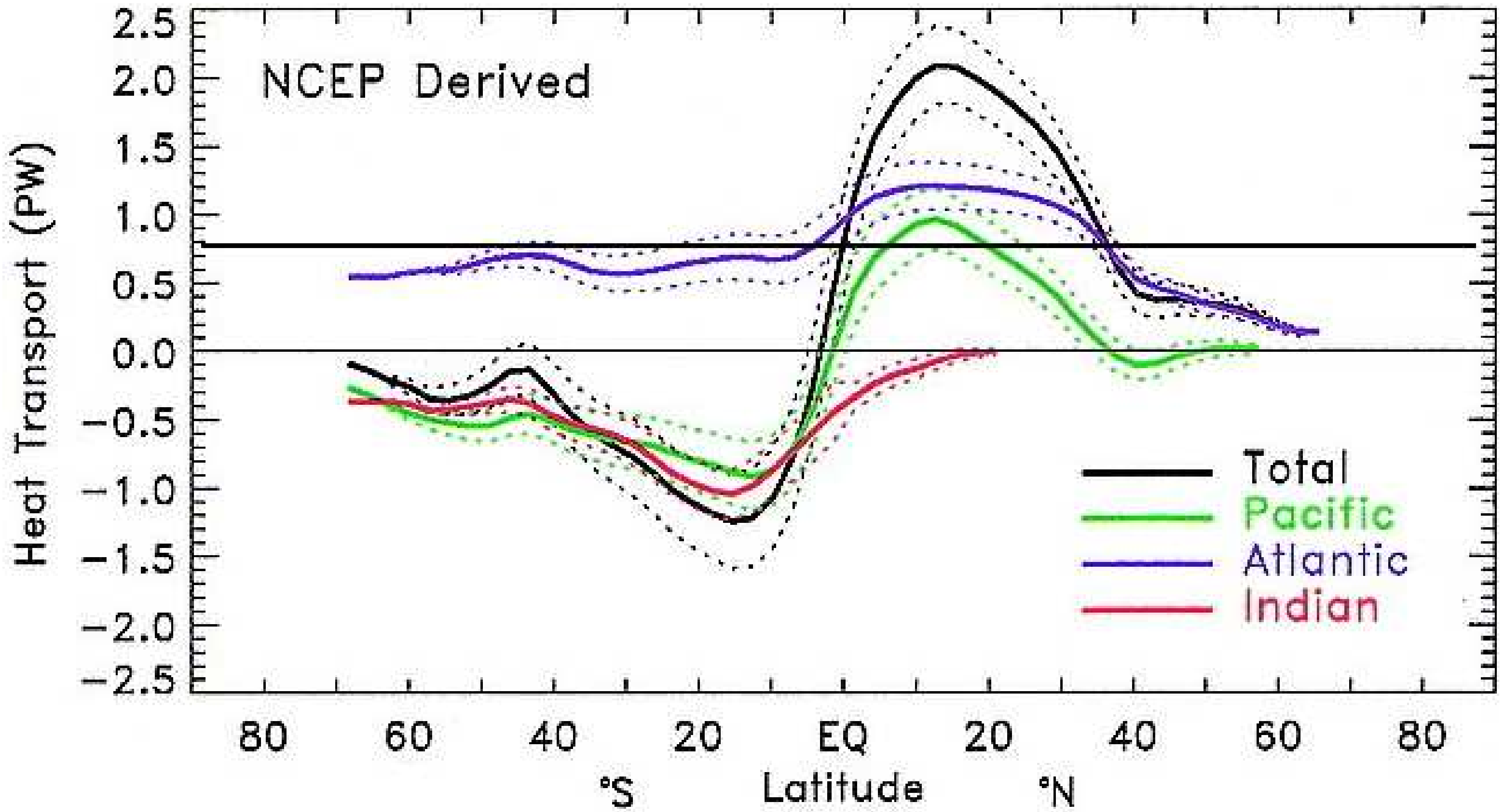
The zonally integrated heat transport



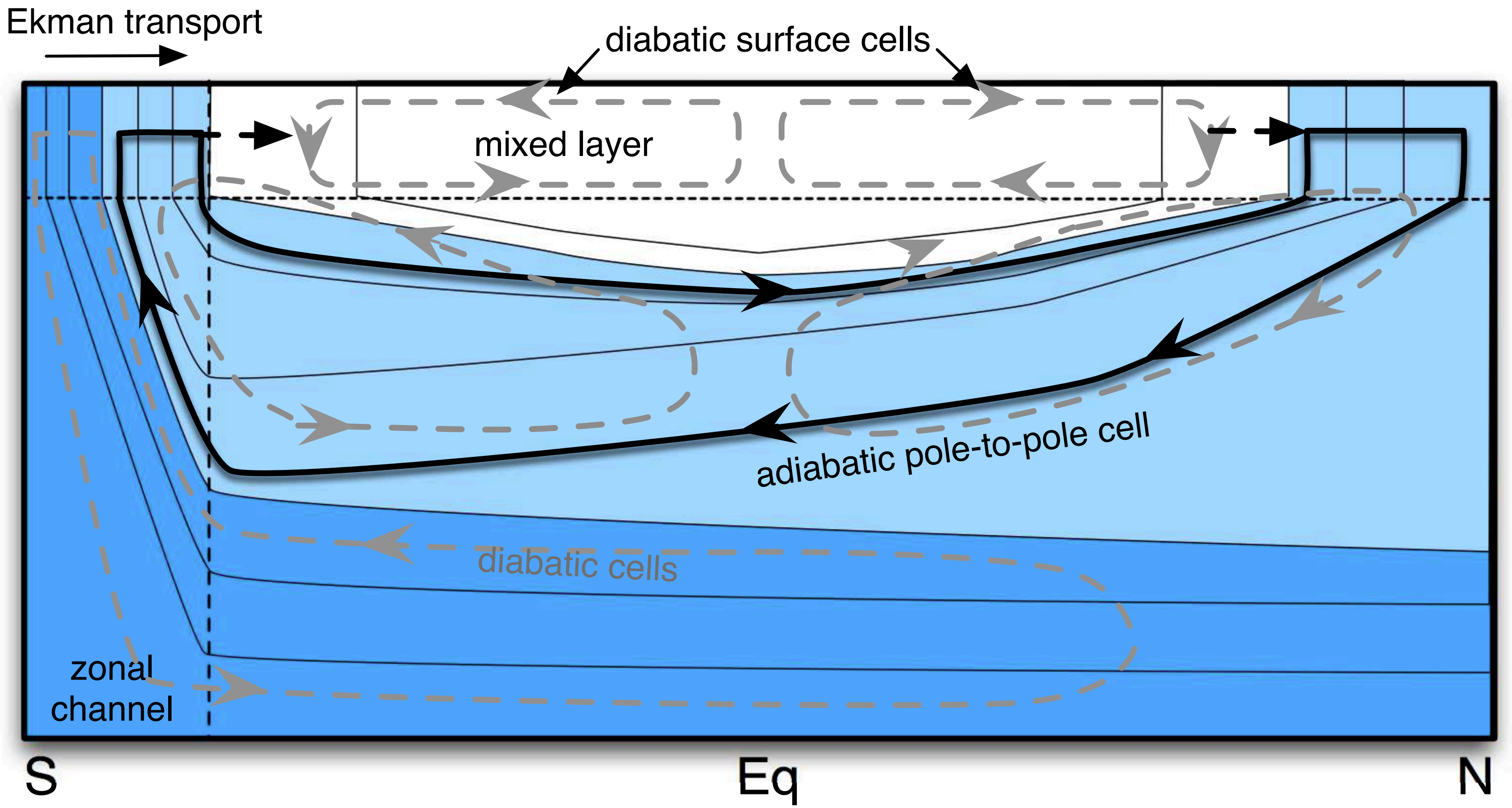
- Total oceanic transport is larger in the NH.
- The atmospheric transport compensates the asymmetry.
- ITCZ shifted to the NH.

The peculiarity of Atlantic heat transport



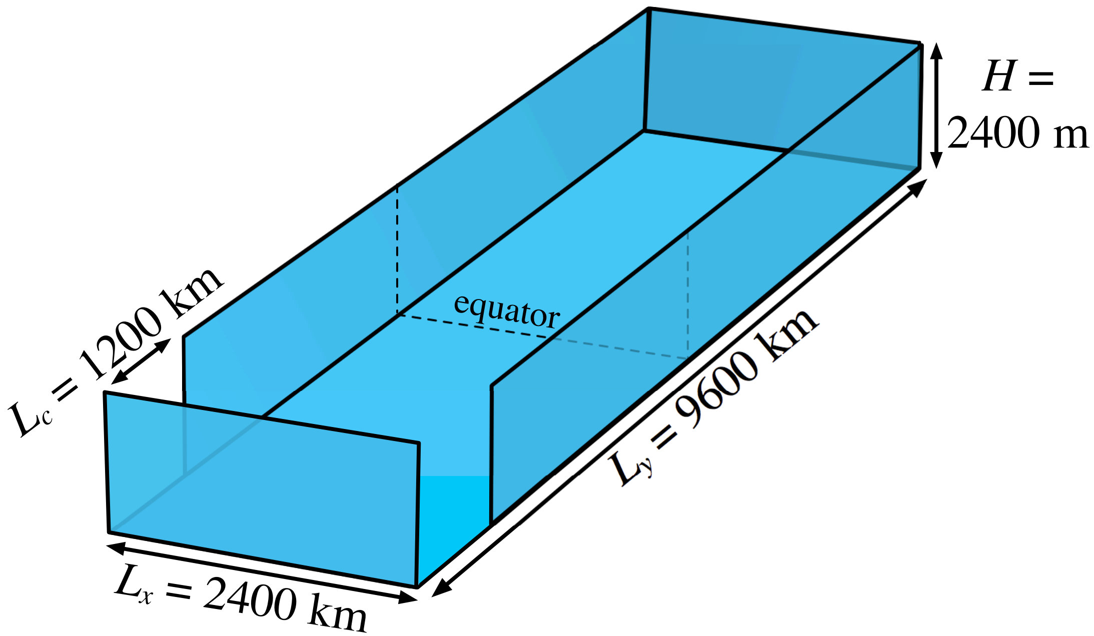
- The Atlantic HT is northward everywhere.
- Upgradient of the mean temperature in SH.
- Pacific and Indian do not compensate fully.
- Pole-to-pole HT is about 0.8PW.

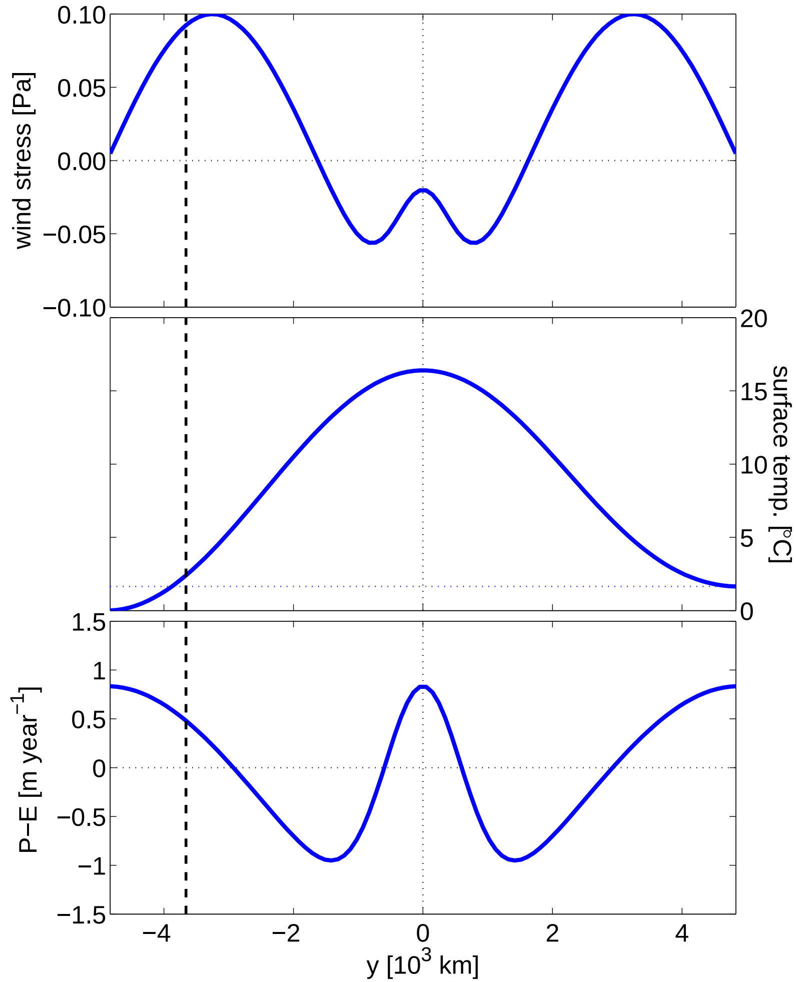
The quasi-adiabatic Atlantic overturning



- The adiabatic pole-to-pole cell flows along the isopycnals outcropping in the channel and the NH.
- Diapycnal fluxes are mostly confined to the mixed layer.
- Diabatic cells reinforce (weaken) the adiabatic cell in the NH (SH).
- How can we have freshwater fluxes into the ocean at both ends of the overturn?

The idealized Atlantic ocean



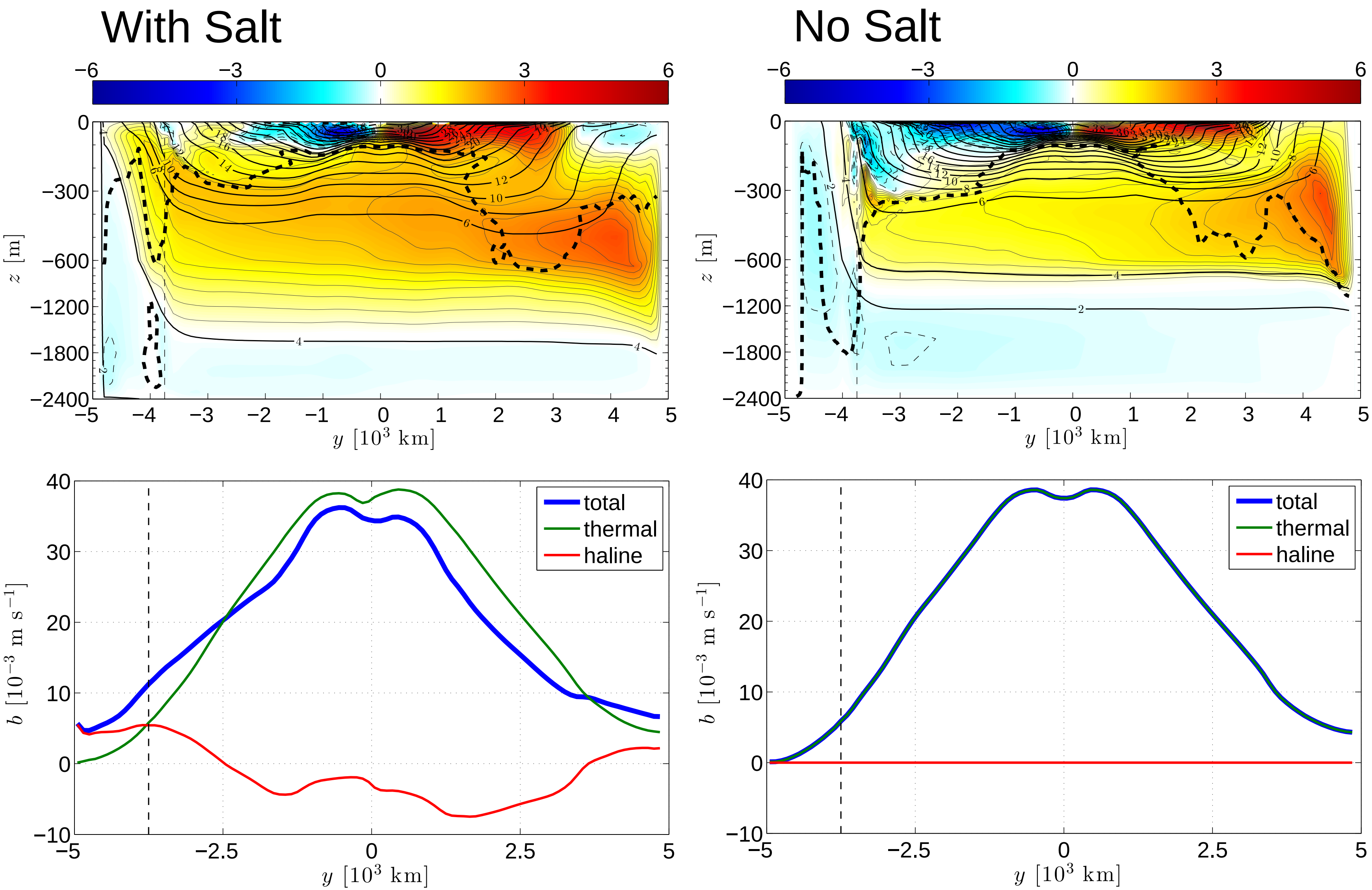


increase • Half-sized basin in a notched box

- Hydrostatic MITgcm at 100km grid
- Linear EoS: $b \sim \alpha T - \beta S$
- Parametrized eddies and ML
- $\kappa = 2.5 \times 10^{-6} \mathrm{m}^2 \mathrm{s}^{-1}$

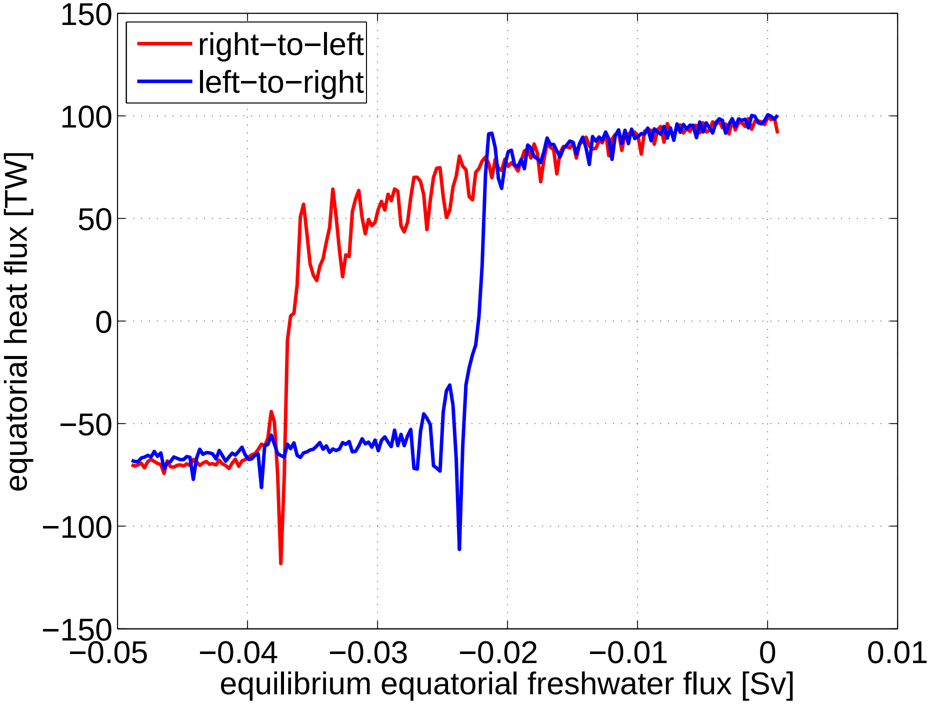
Wind-stress and freshwater flux are symmetric around equator in reference case.
Surface temperature is warmer in NH high latitudes.
All forcing depend on latitude only.

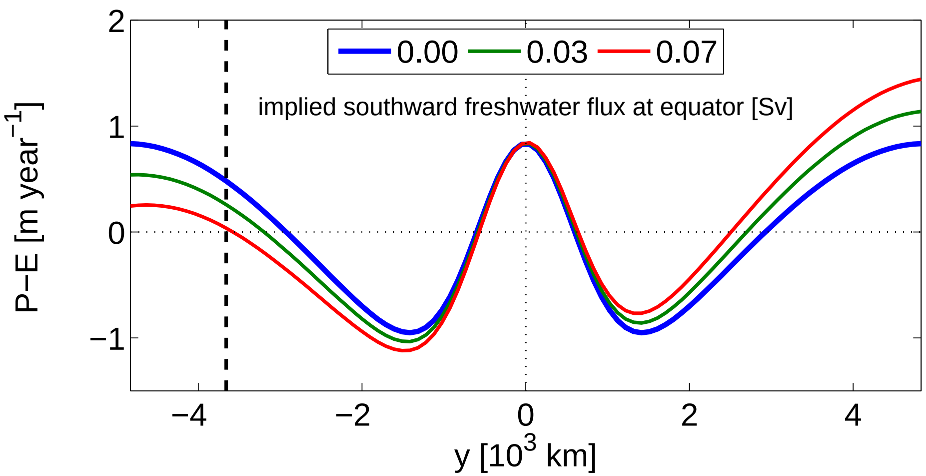
Effect of salt: more shared surface isopycnals and stronger ROC

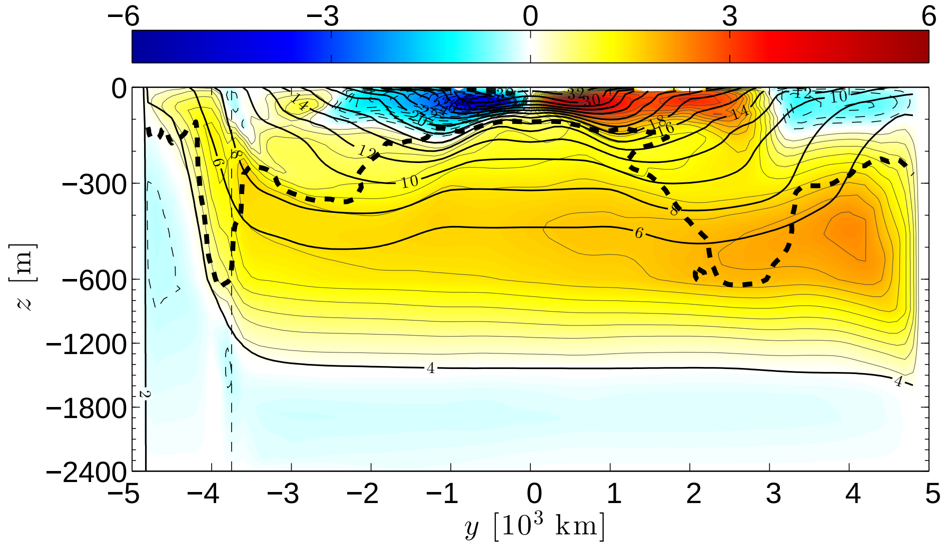


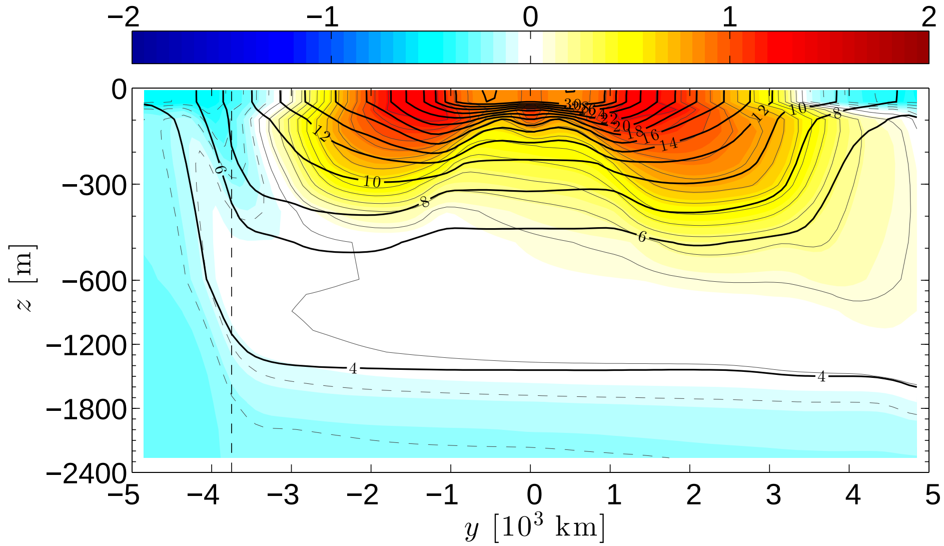
The salt feedback increases the ROC by 47%, by widening the shared surface buoyancy window.

Multiple equilibria in the adiabatic regime



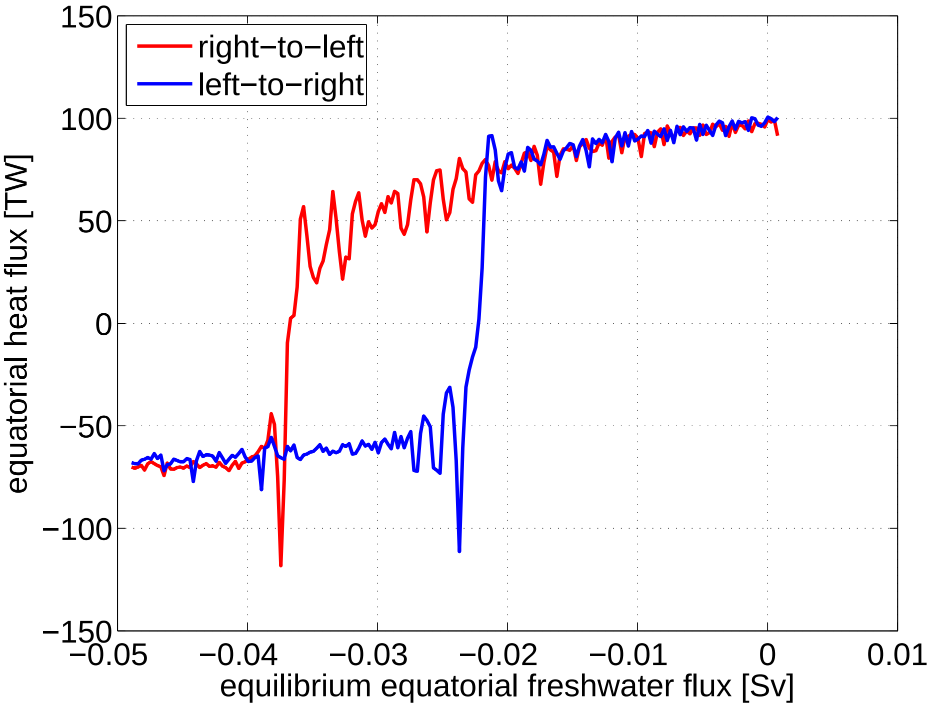


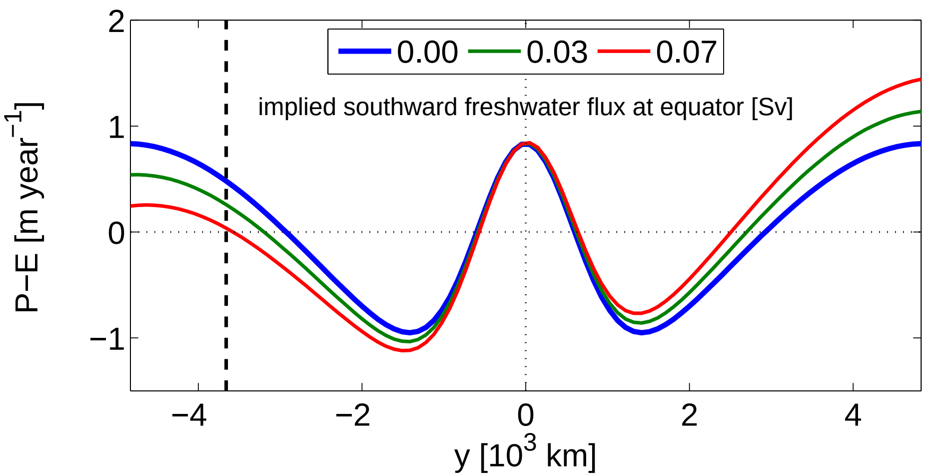


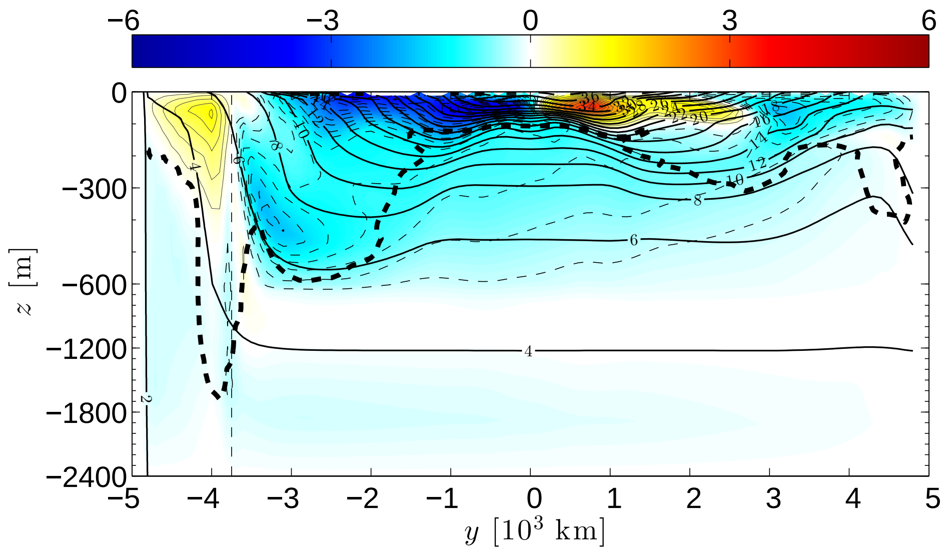


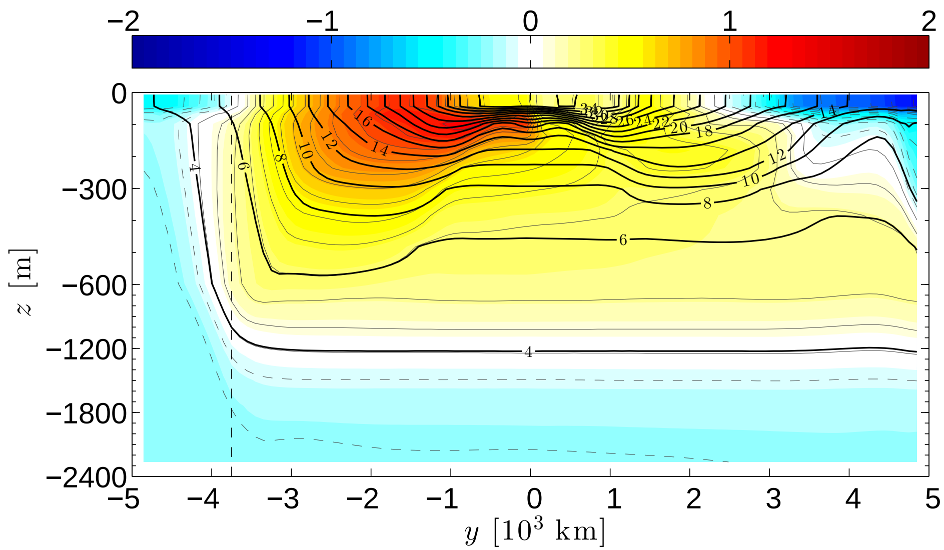
The salt feedback gives a state with a strong pole-to-pole cell, largely adiabatic.

Multiple equilibria in the adiabatic regime



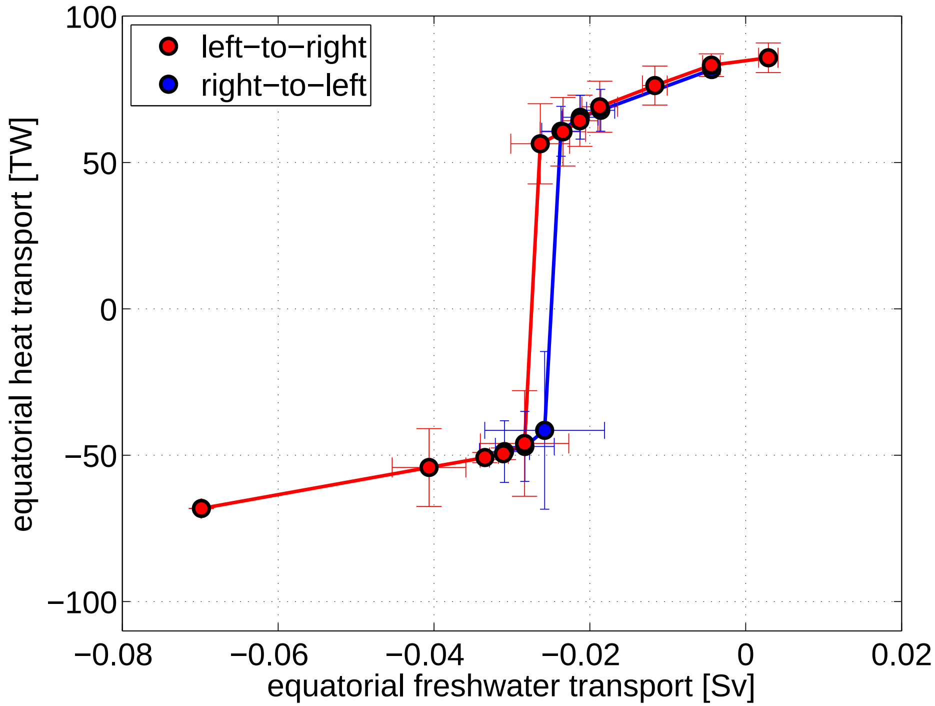






The salt feedback also gives a state with a reversed interhemispheric cell, weaker and more diabatic.

Thermohline variability: low diffusivity



Conclusions

- Freshwater flux provides a positive feedback which increases the ROC and decreases the pole-to-pole density difference.

- In the adiabatic regime the meridional heat transport increases with decreasing pole-to-pole density difference.

- The positive feedback allows for a reversed interhemispheric cell, which excludes the ACC region, more diabatic.

- At low diffusivities, large fluctuations are found around each “equilibrium”, which induce transitions between the two states.

Question

- Is the existence of multiple attracting states robust in the eddying regime?

The pattern of the oscillation