The adiabatic pole-to-pole overturning circulation

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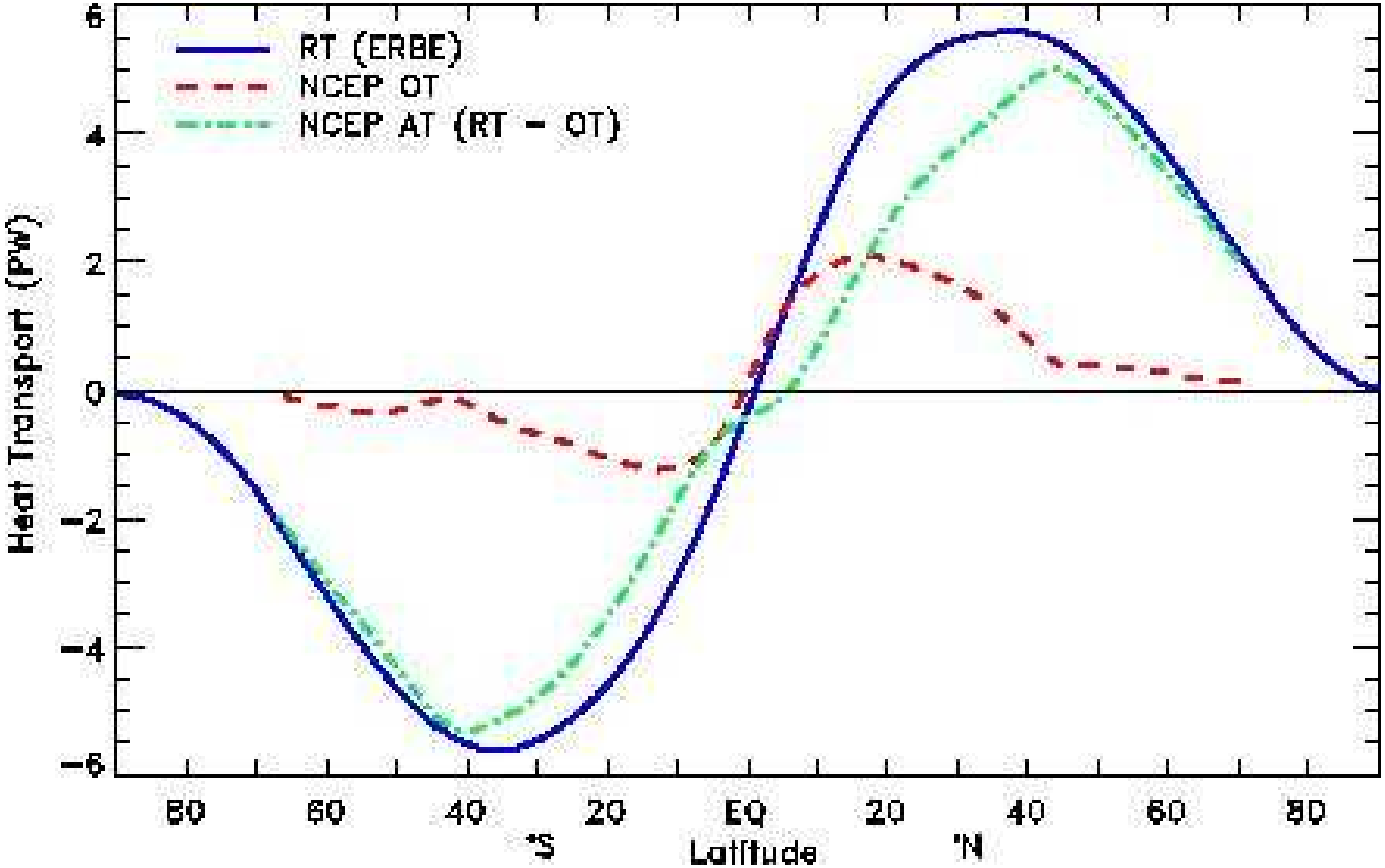
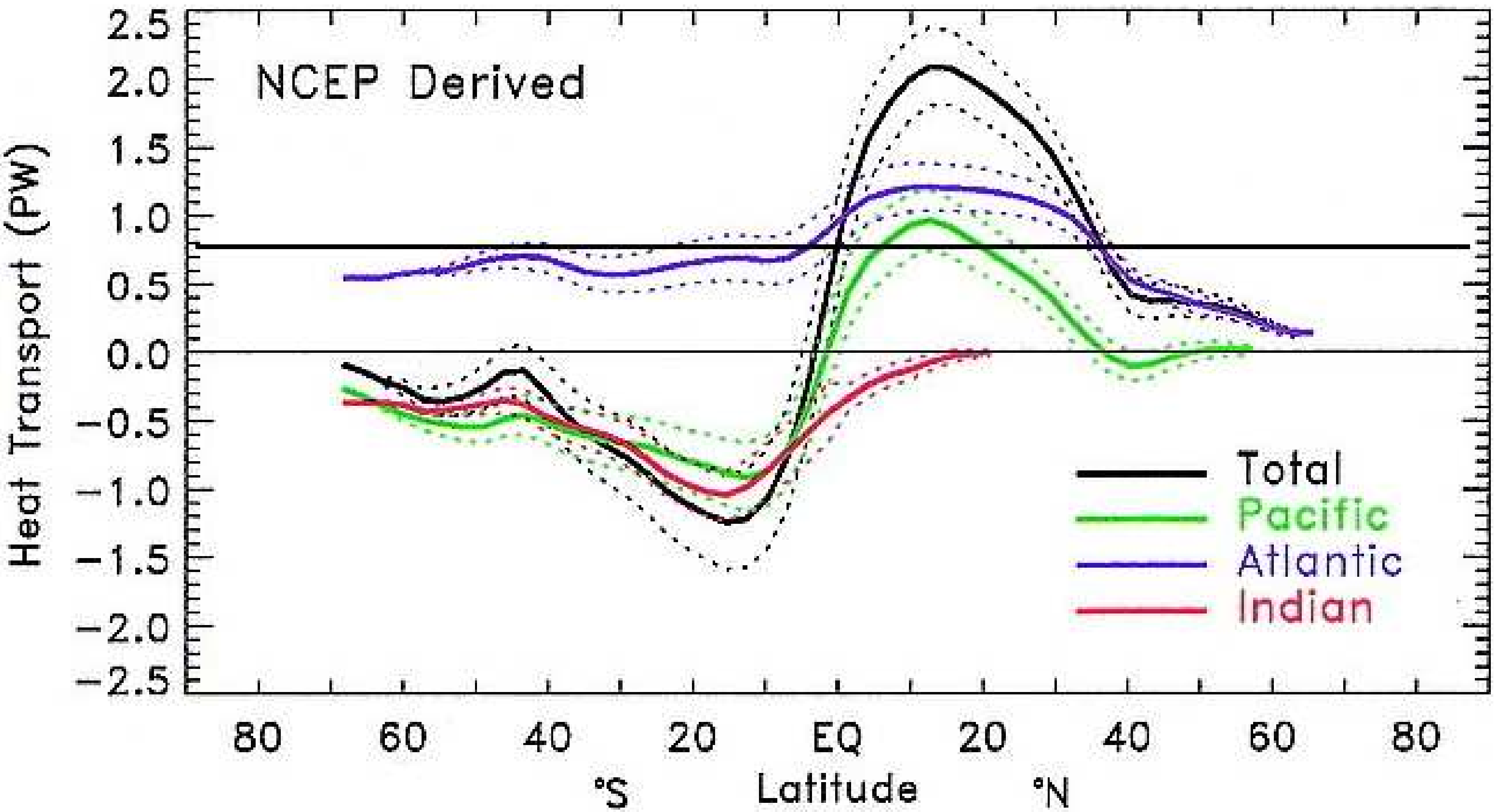
The zonally integrated heat transport



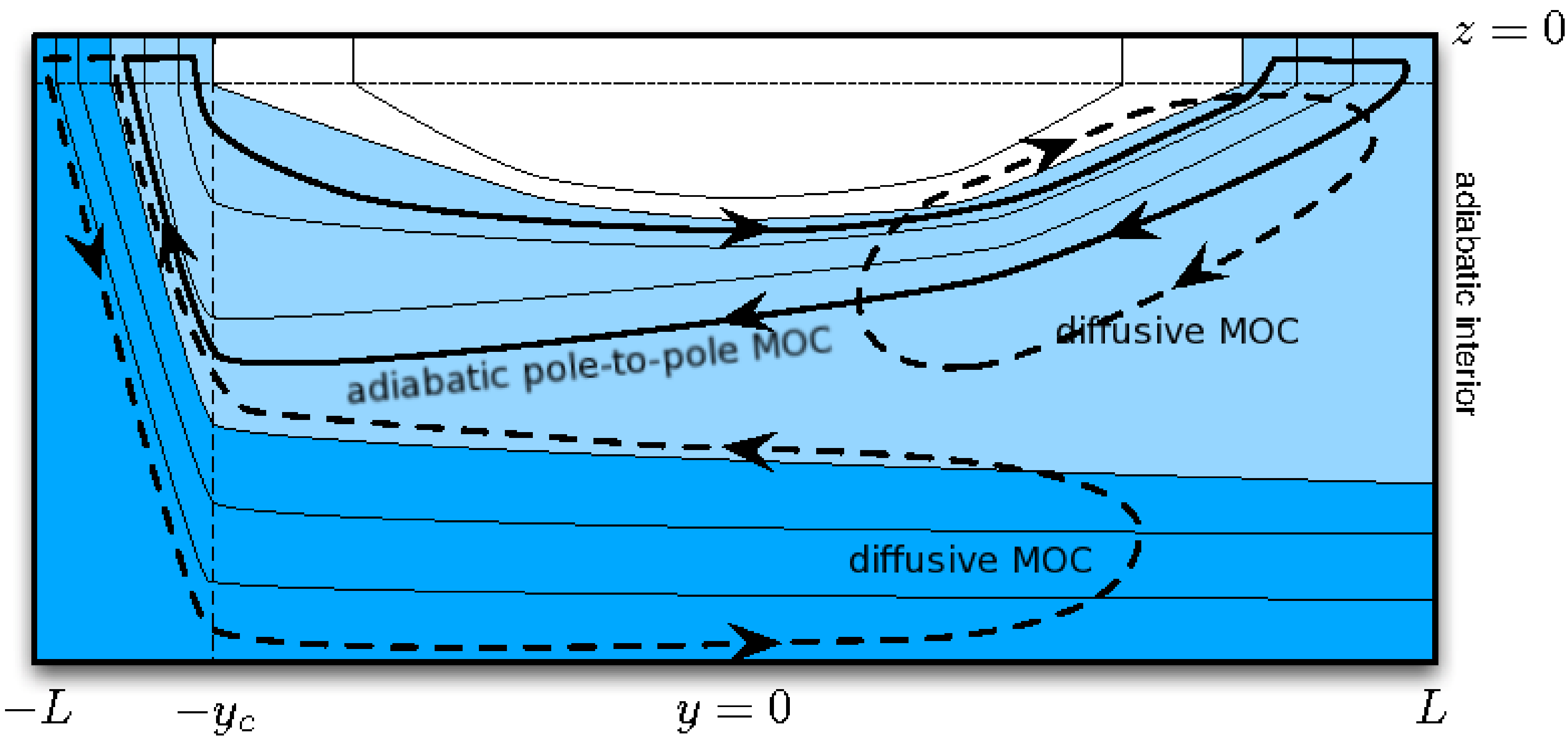
- Total oceanic transport is larger in the NH.
- The atmospheric transport compensates the asymmetry.
- ITCZ shifted to the NH.

The peculiarity of Atlantic heat transport



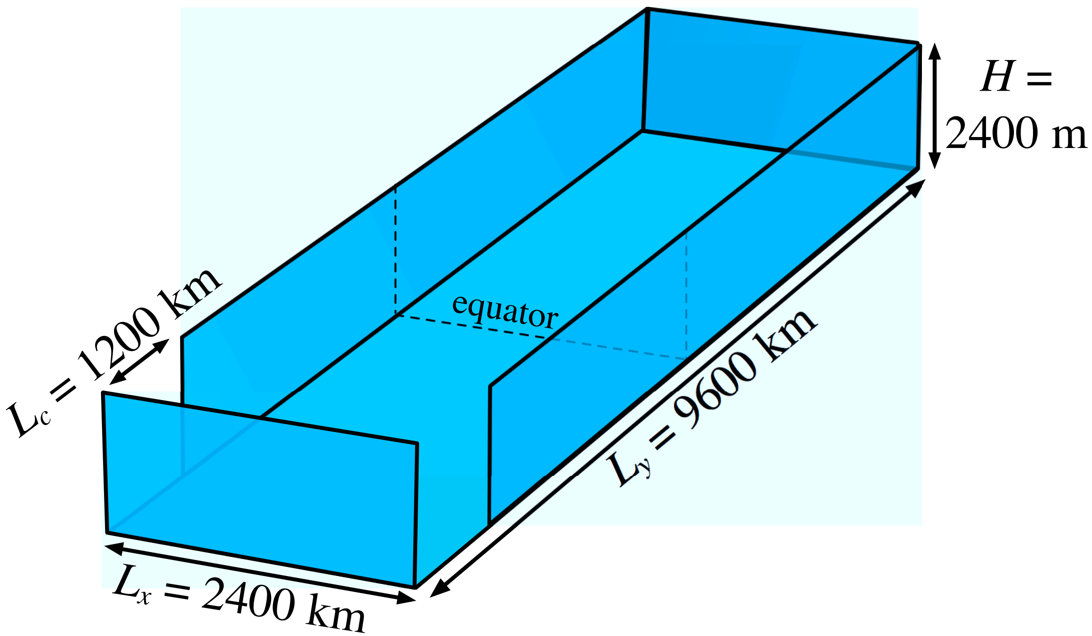
- The Atlantic HT is northward everywhere.
- Upgradient of the mean temperature in SH.
- Pacific and Indian do not compensate fully.
- Pole-to-pole HT is about 0.8PW.

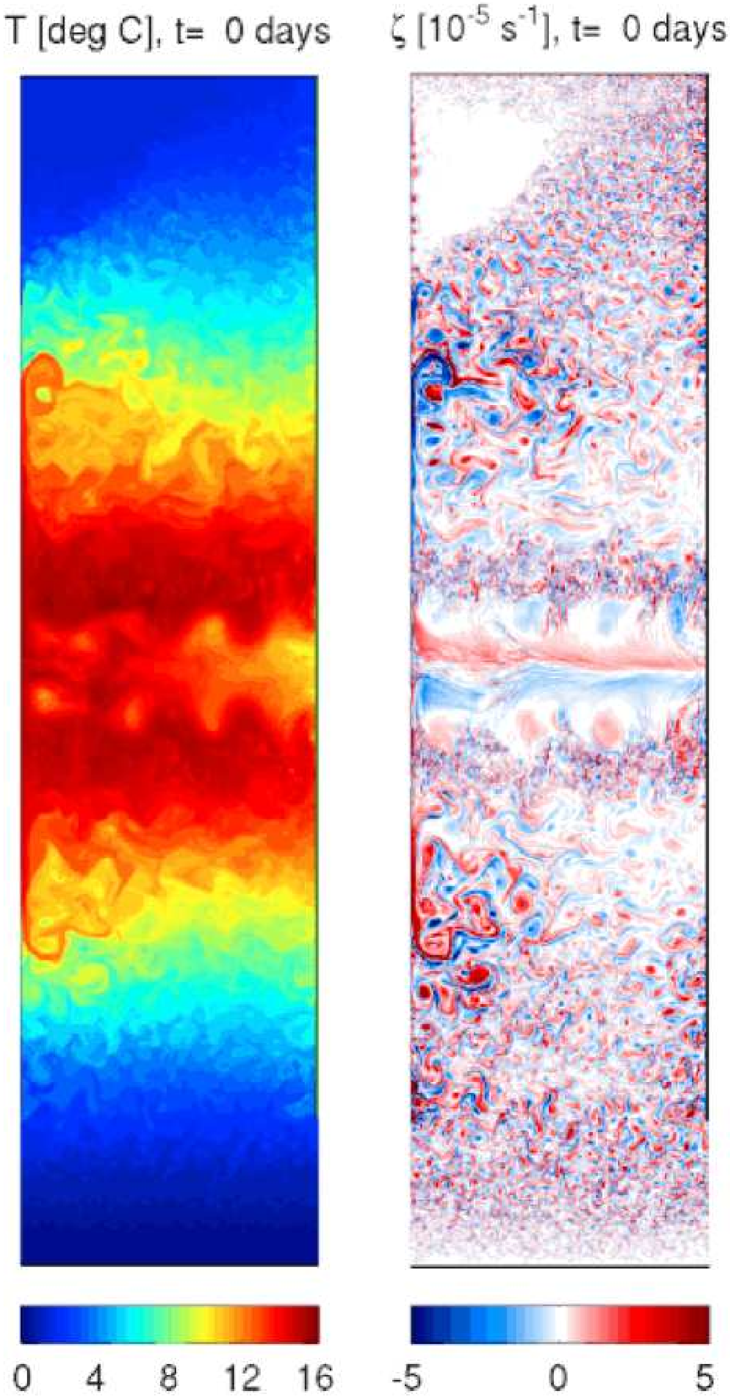
The quasi-adiabatic Atlantic overturning



- An adiabatic pole-to-pole cell is possible along the isopycnals outcropping in the channel and the NH.
- Diapycnal flux are confined to the mixed layer.
- There are also diffusive cells in the abyss and in the NH.

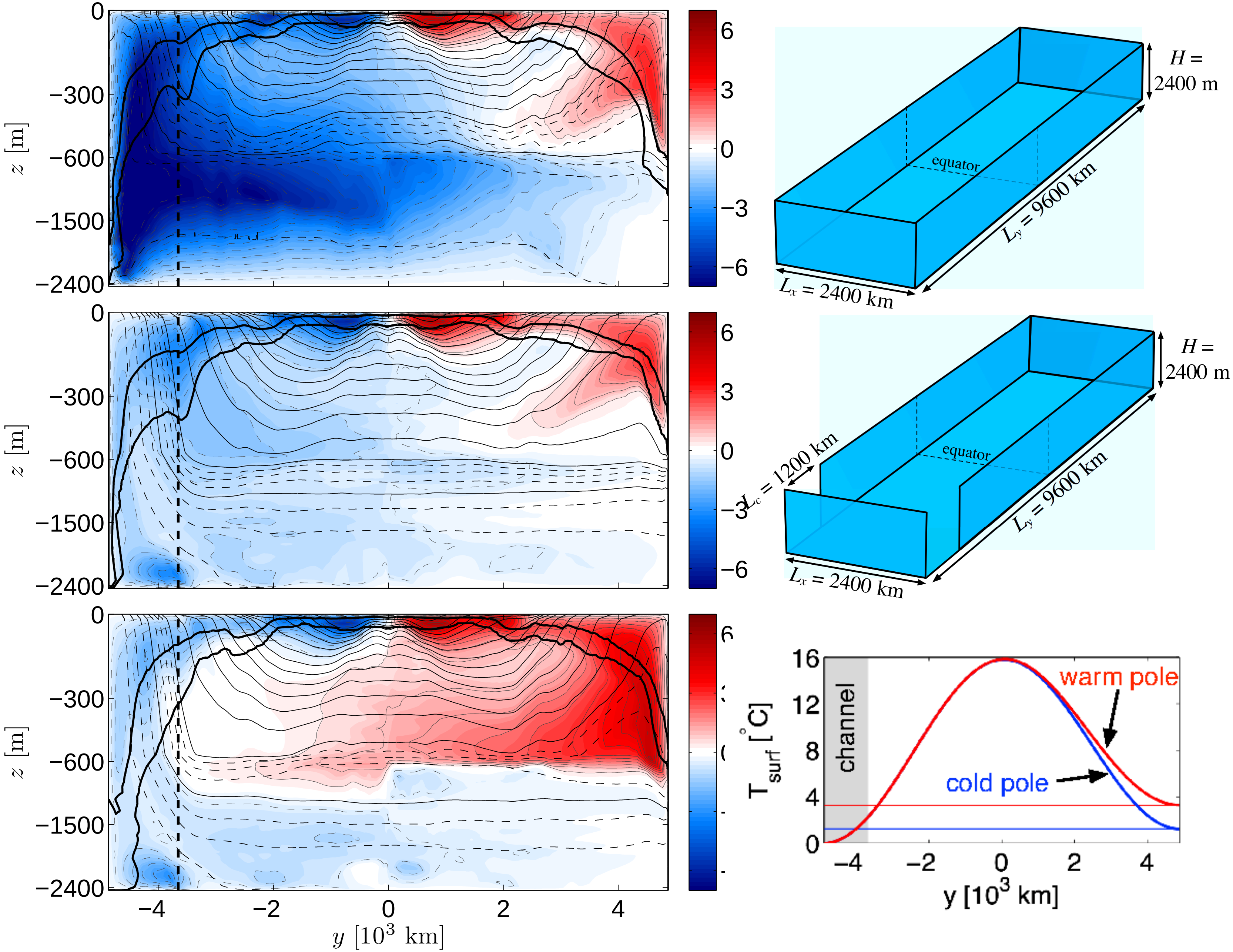
Eddy resolving model



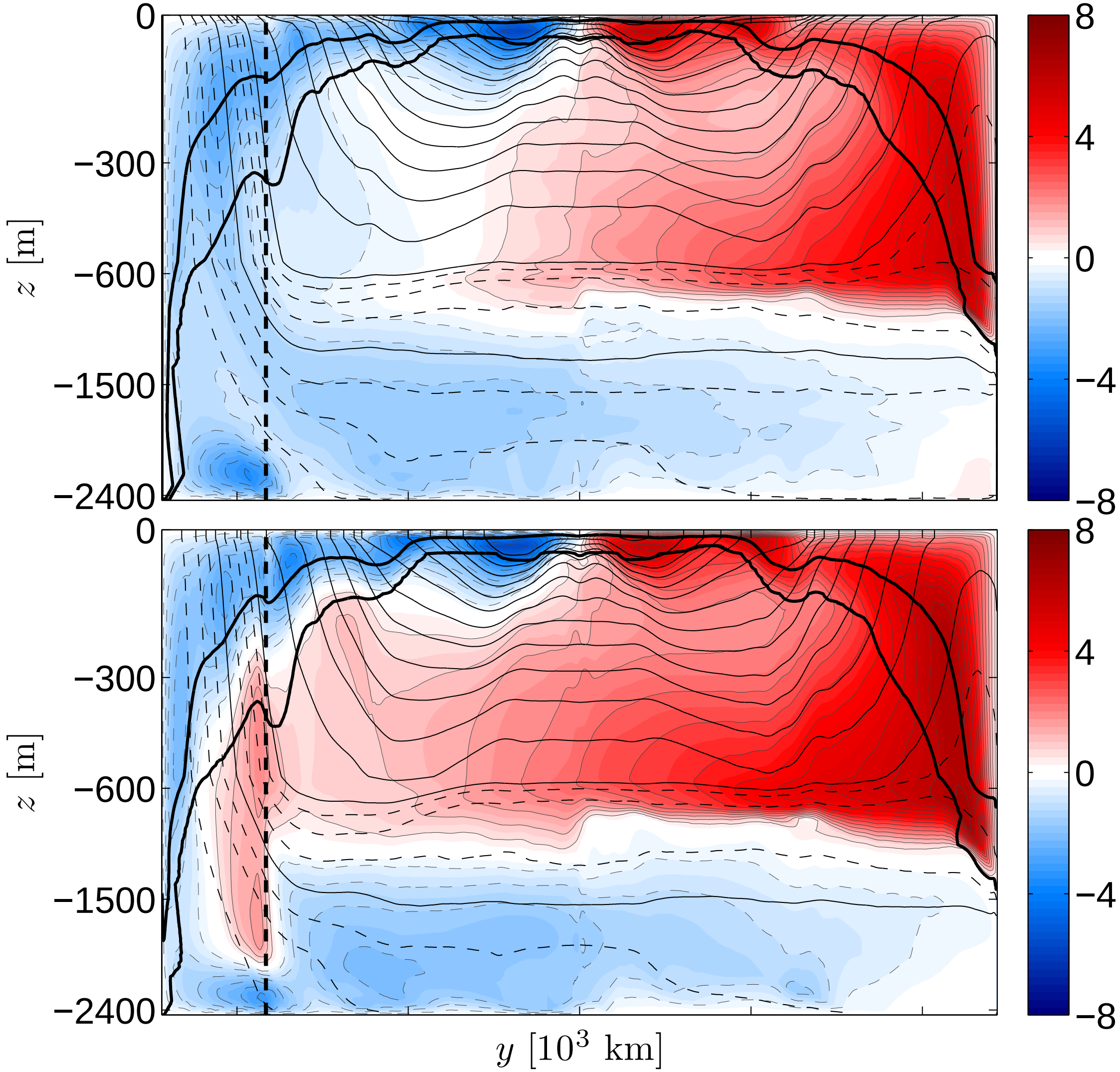


- Half-sized basin in a notched box
- Hydrostatic MITgcm at 5.4km grid
- No salt: $b \sim T$
- No eddy or ML parametrizations
- $\kappa = 0.5 \times 10^{-4} \mathrm{m}^2 \mathrm{s}^{-1}$

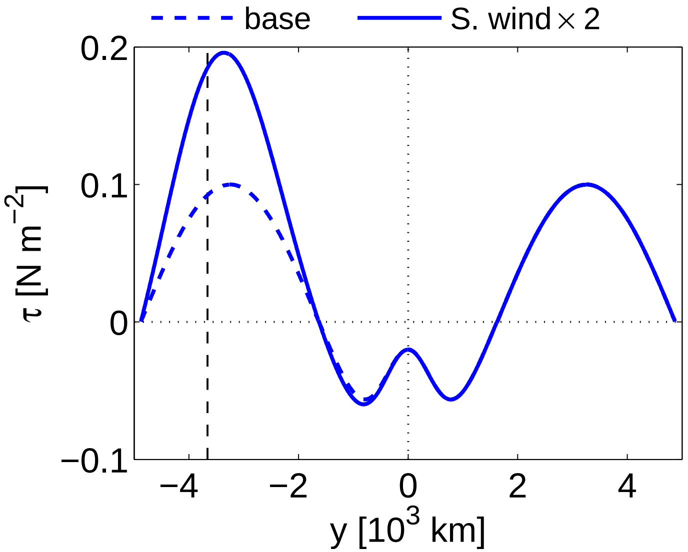
ROC: Effect of channel and buoyancy



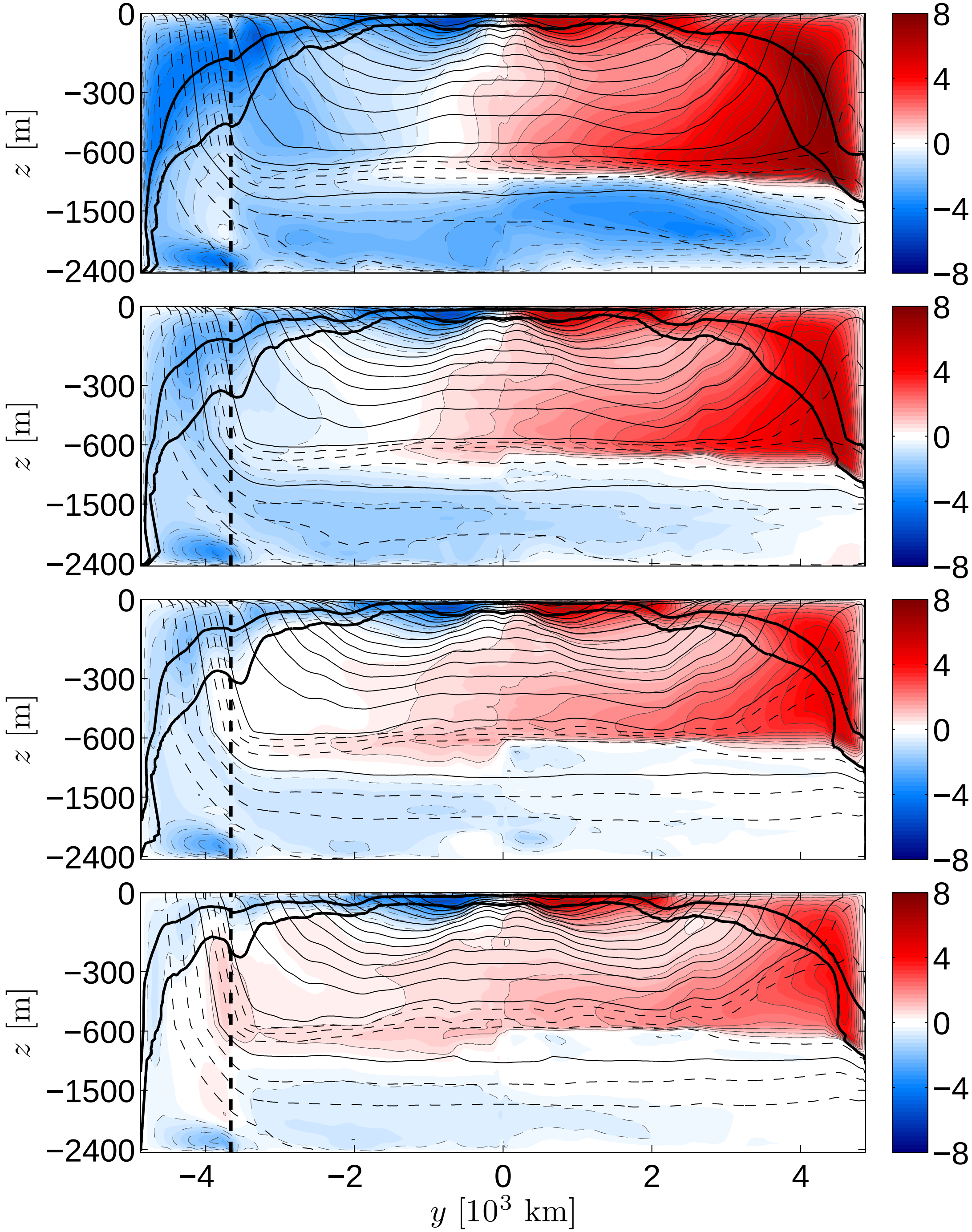
ROC: Effect of winds in the ACC region



The ACC winds pull the ROC



ROC: Effect of diffusivity



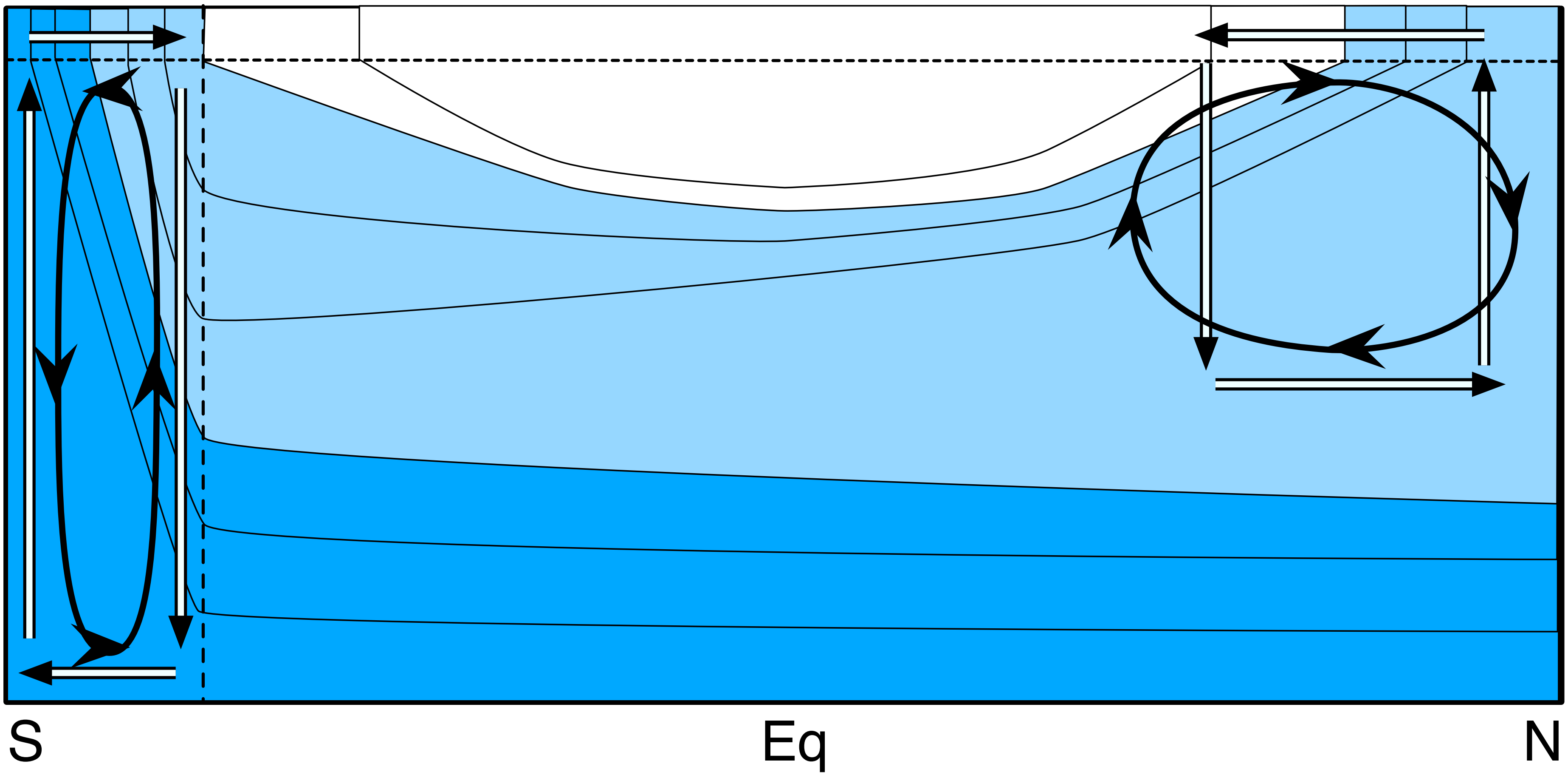
$$\kappa = 1 \times 10^{-4}\mathrm{m}^2/\mathrm{s}$$

$$\kappa = 0.5 \times 10^{-4}\mathrm{m}^2/\mathrm{s}$$

$$\kappa = 0.25 \times 10^{-4}\mathrm{m}^2/\mathrm{s}$$

$$\kappa = 0.125 \times 10^{-4}\mathrm{m}^2/\mathrm{s}$$

Competition between winds, eddies and gyres



Deacon cell is deeper in channel than in basin

Eddies oppose Deacon cell less than gyres

Stratification is deeper in ACC region

“Pulling” is stronger in ACC region

Conclusions

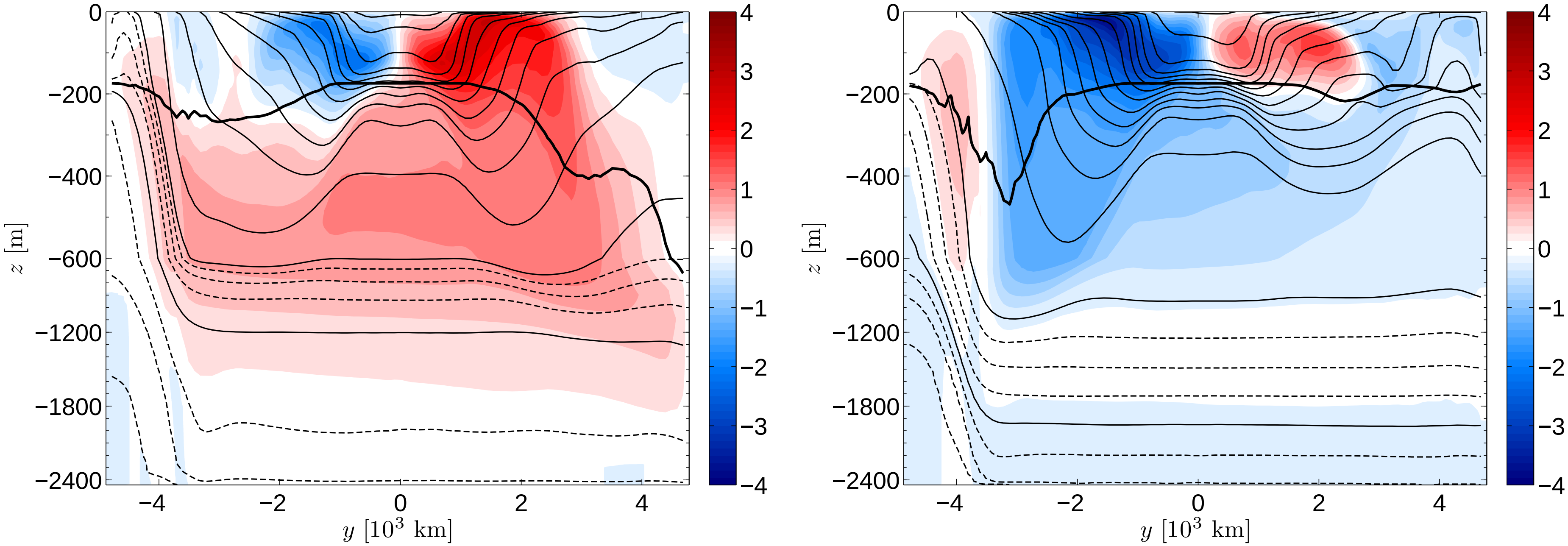
- Mid-depth stratification is set in a reentrant region by the Deacon cell, weakly opposed by eddy-fluxes of buoyancy.
- The channel stratification is communicated along isopycnals by the residual circulation, with little need for diapycnal diffusion.
- A pole-to-pole overturning circulation requires isopycnals that outcrop in both the channel and the NH.
- The Deacon cell in the channel “pulls” the ROC more than in the NH (eddies vs. gyres).
- No need for interior mixing.
- There is remote control of the NH ROC in the ACC region.

Multiple states in the adiabatic regime

With T and S, positive feedbacks can either increase the pole-to-pole ROC or shut it down.

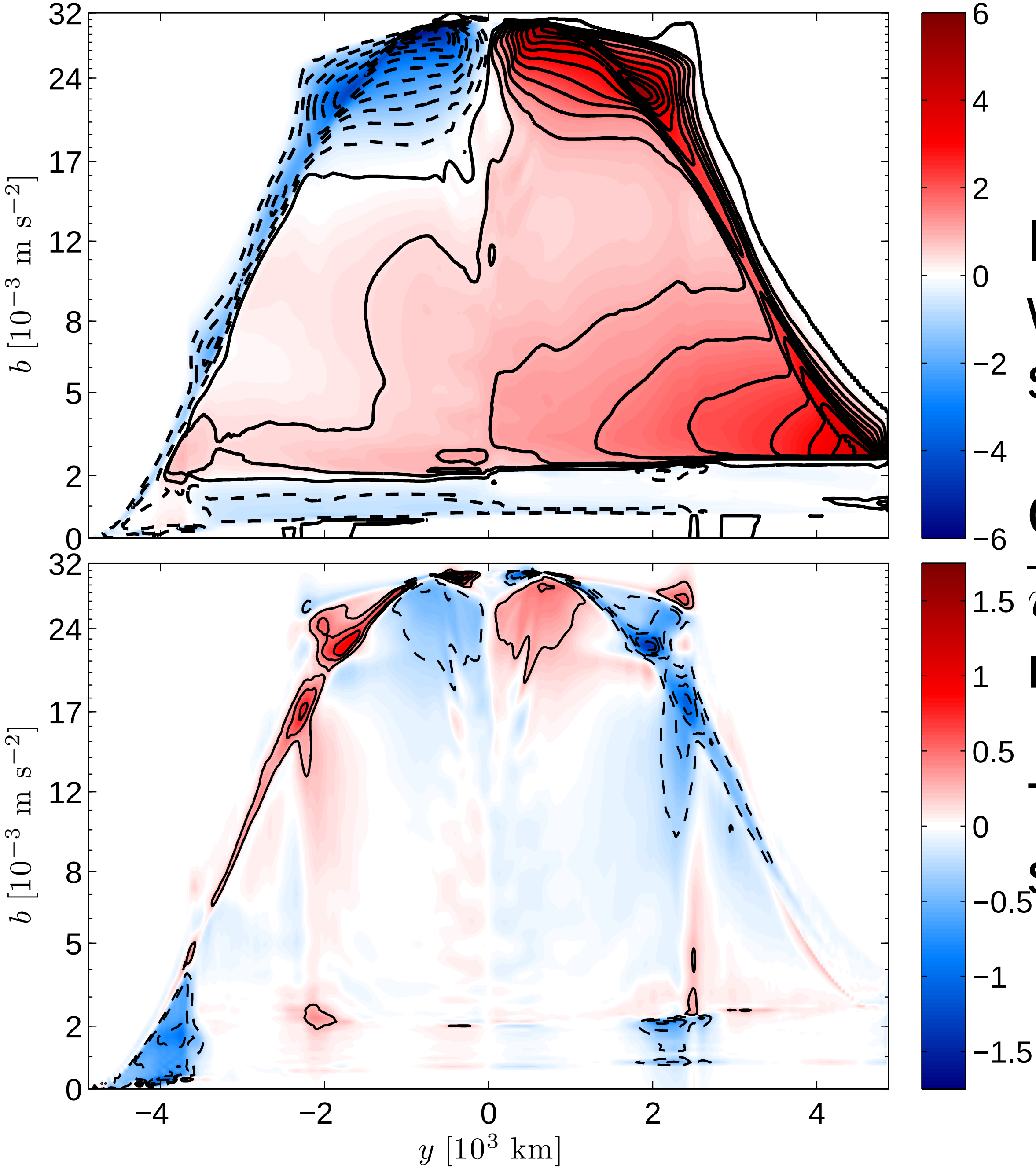
There are multiple states of stratifications and ROC.

Both hemispheres are involved.



See Christopher Wolfe's poster!

Statistical Transformed Eulerian Mean



ROC can be evaluated with 2nd order eddy statistics

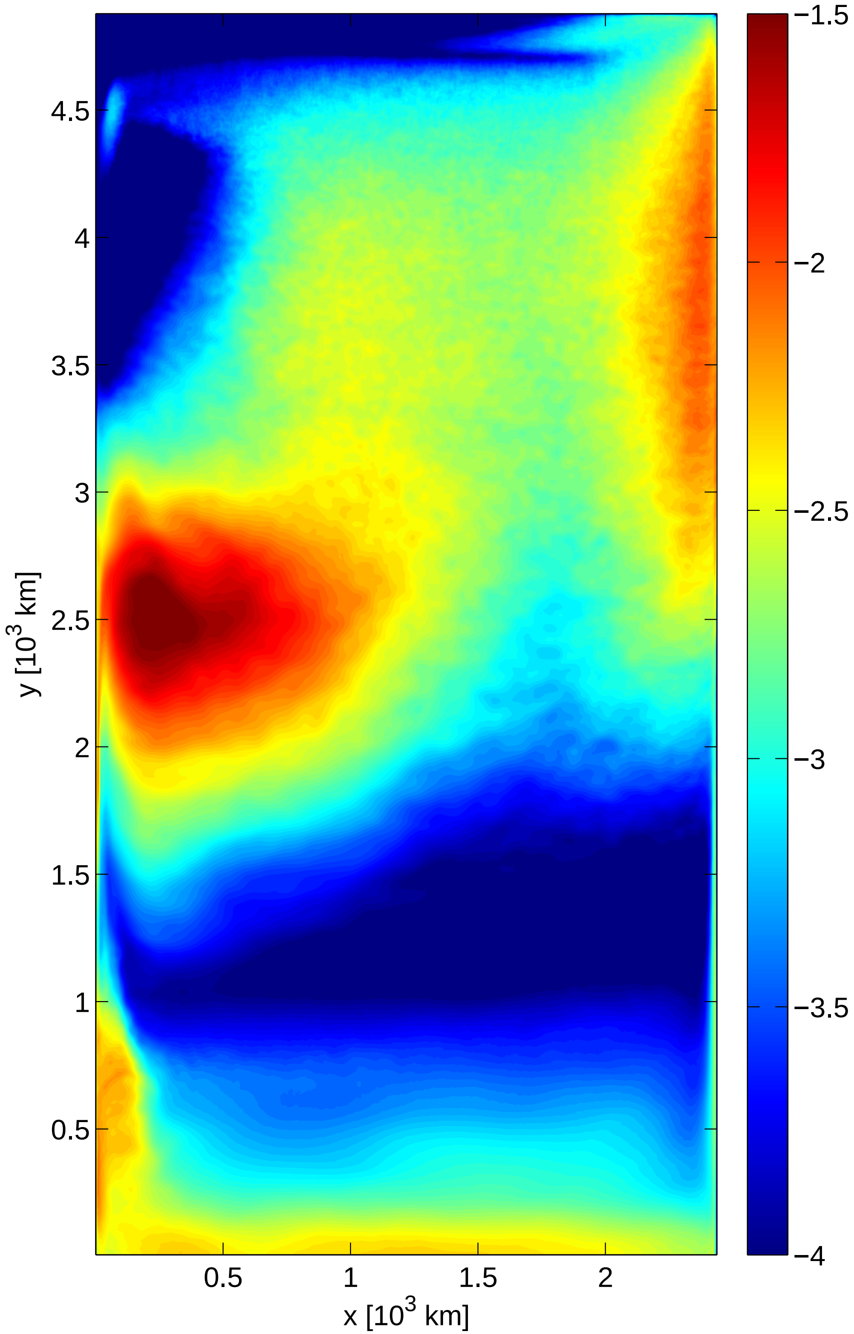
Only need to save $\overline{v'T'}, \overline{T'^2}$, as well as the means $\bar{T}, \bar{v}$

The errors are very small.

Talk to Christopher Wolfe!

Eddy-powered Eastern Boundary Currents

$\log_{10}$(EKE) at 400m depth



V and W at $y = 3000km$.