Salt Feedbacks and multiple states in the Quasi-Adiabatic Pole-to-Pole Circulation

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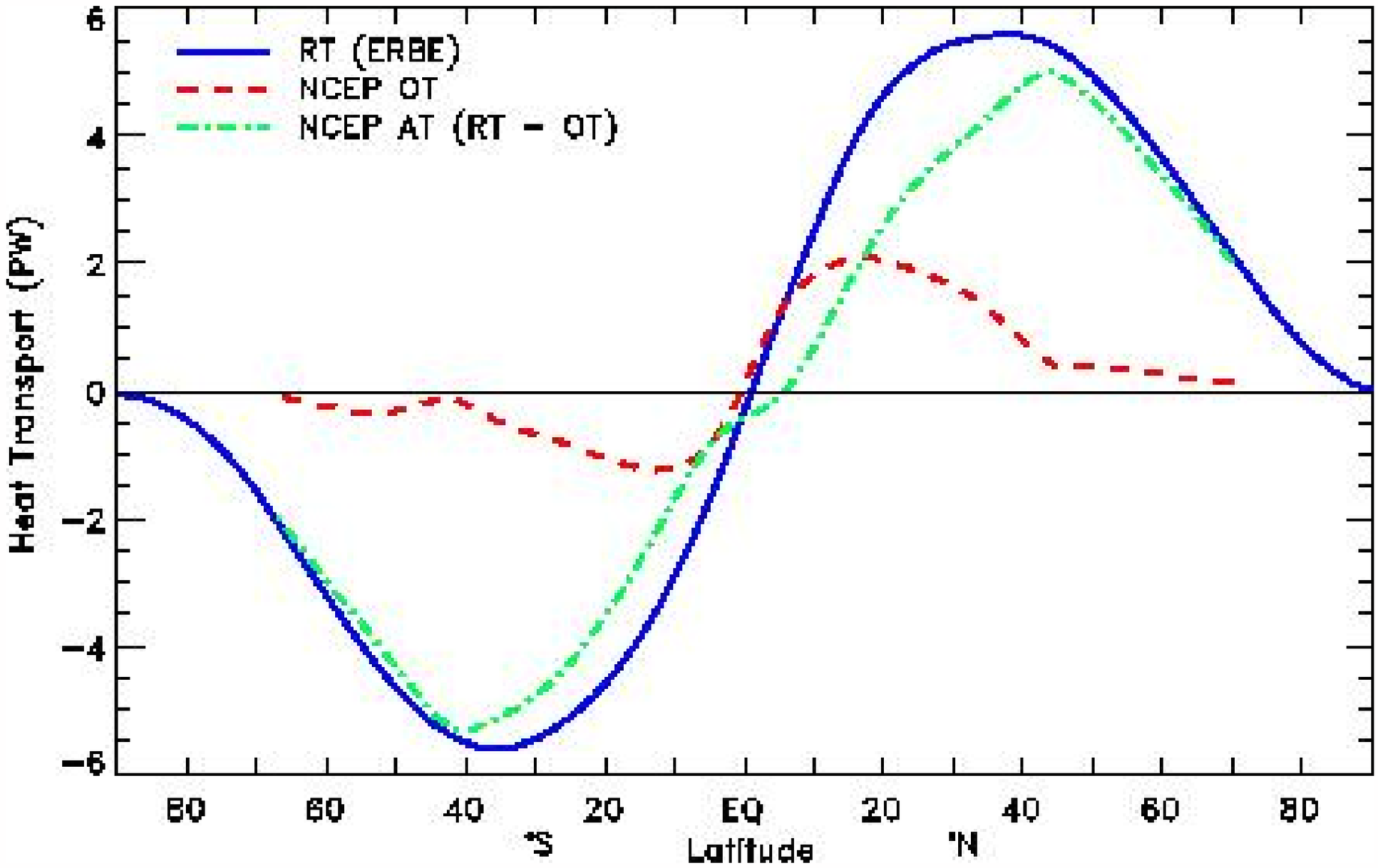
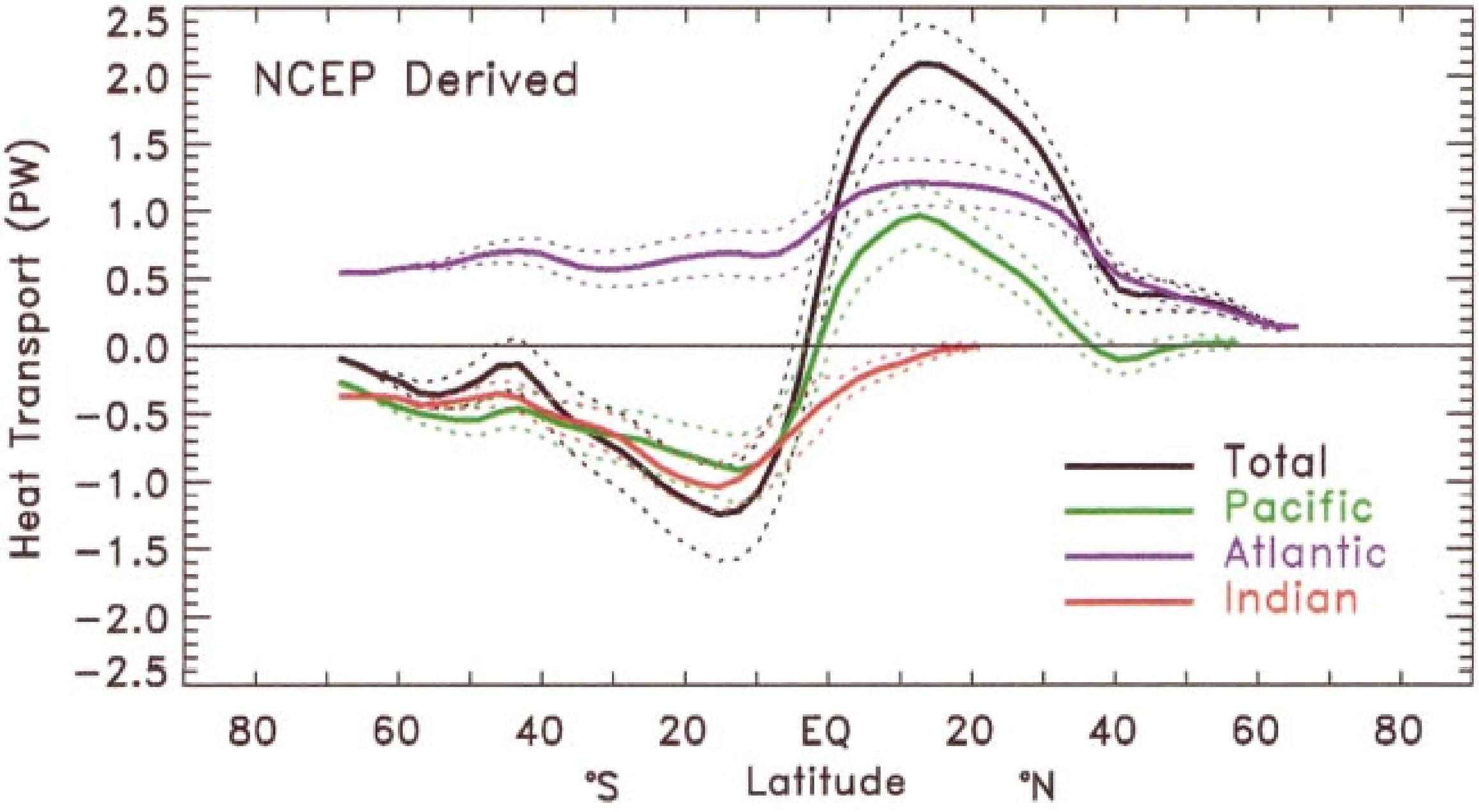
The zonally integrated heat transport



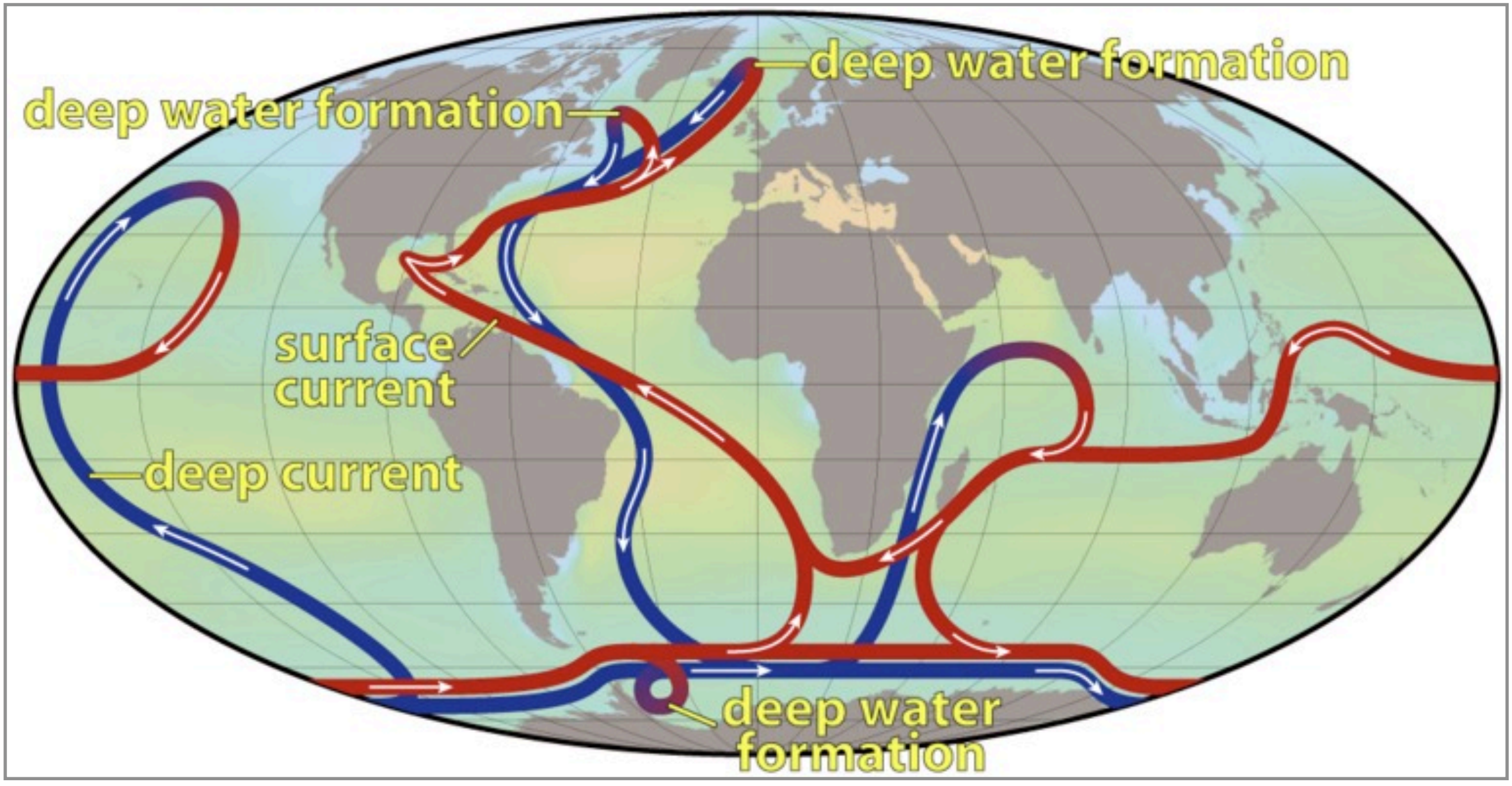
- Oceanic heat transport (OT) is larger in Northern Hemisphere
- Atmospheric heat transport (AT) compensates asymmetry
- ITCZ shifted to Northern hemisphere

Peculiarity of Atlantic heat transport



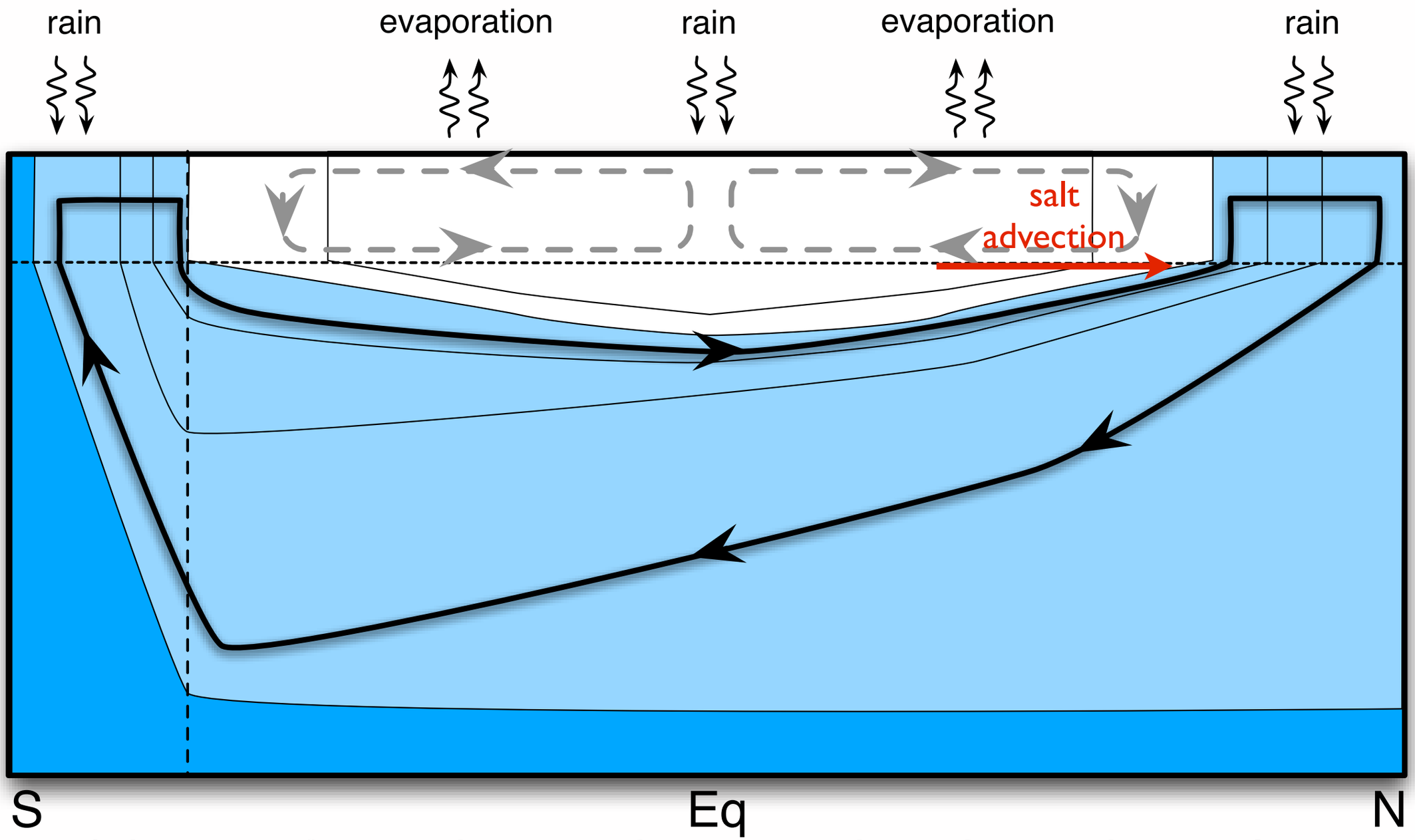
- Atlantic heat transport is northward at every latitude.
- Responsible for northward heat transport across equator

Meridional Overturning Circulation



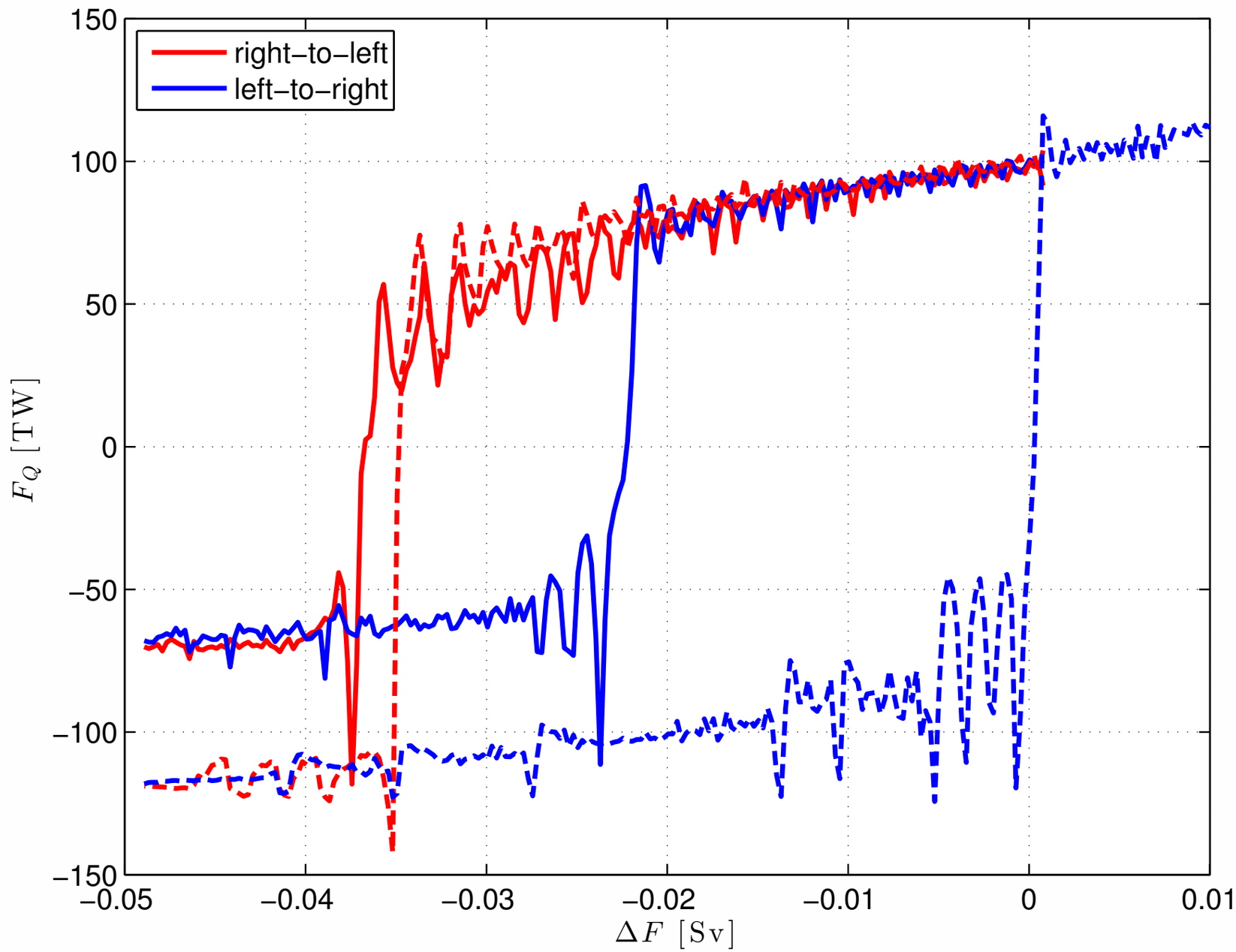
- Asymmetric Atlantic heat transport due to the meridional overturning circulation (MOC).
- Changes in MOC have global ripercussions on atmospheric circulation
- High latitudes (NH and SH) control the MOC

Salt advection feedback essential in MOC dynamics



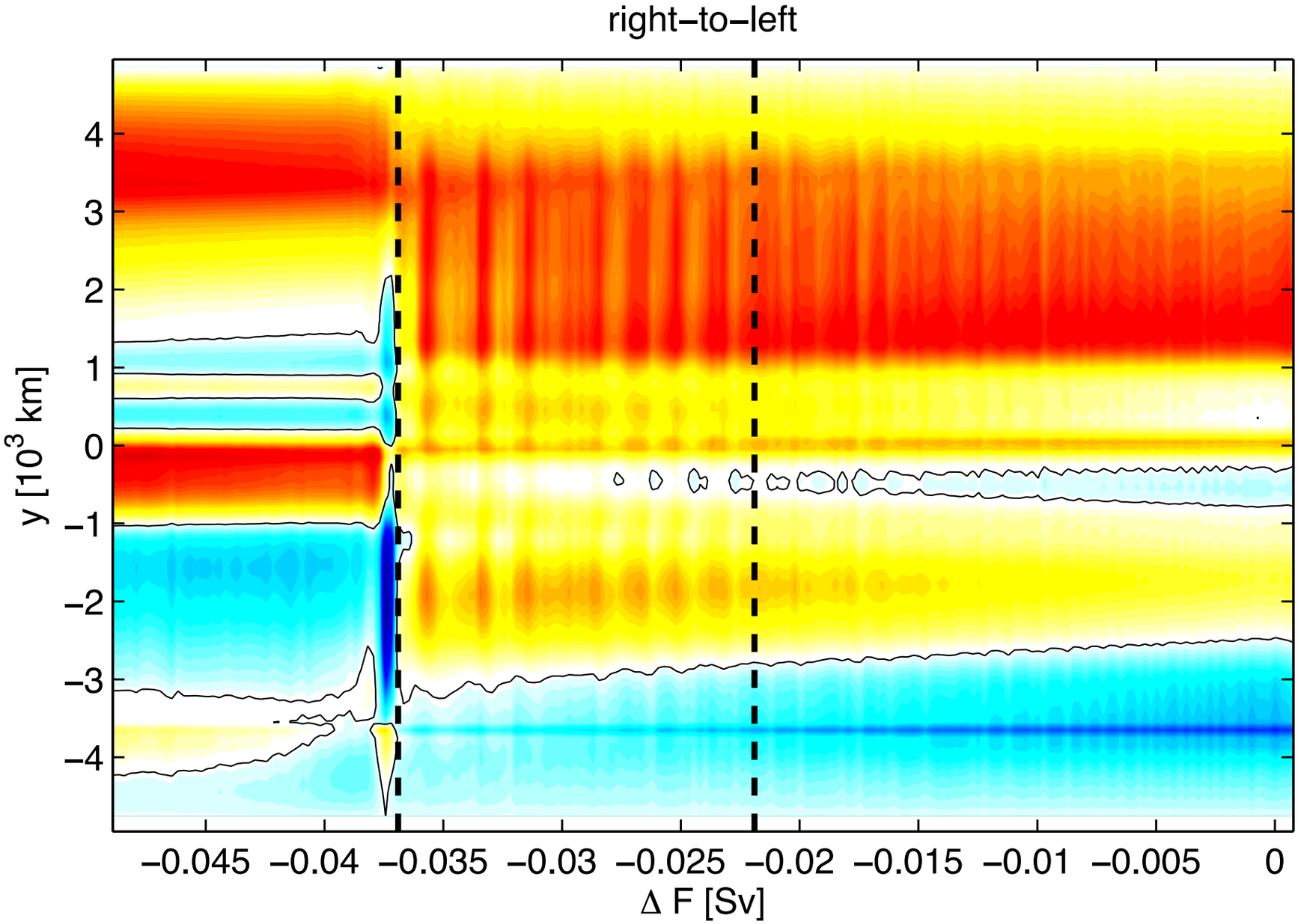
- Advection from subtropics keeps northern hemisphere salty
- Isopycnal window increases, residual overturning strengthens
- Positive feedback that leads to multiple regimes

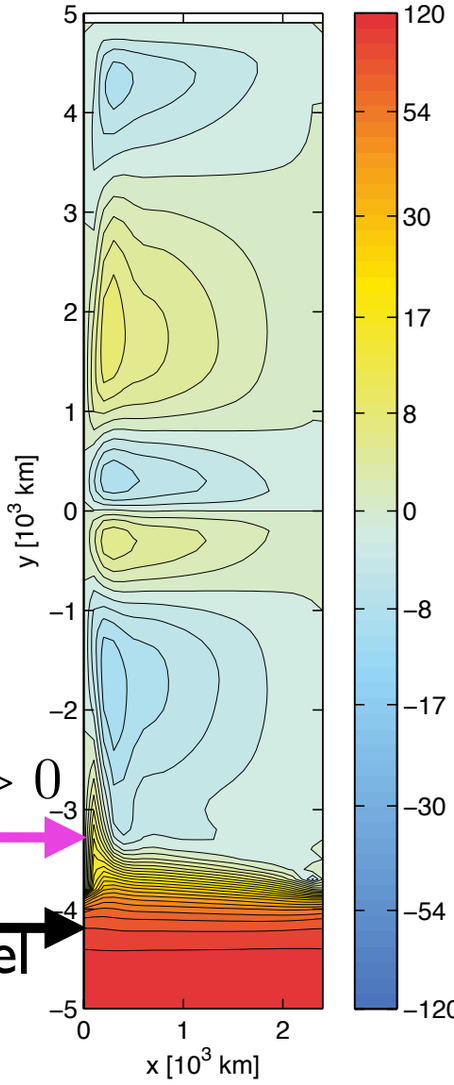
Hysteresis and multiple regimes



- As salt in North Hemisph. decreases, MOC collapses and reverses
- Collapse is preceded by increases in oscillations' amplitude

Indicators of ROC collapse: M_{OV}

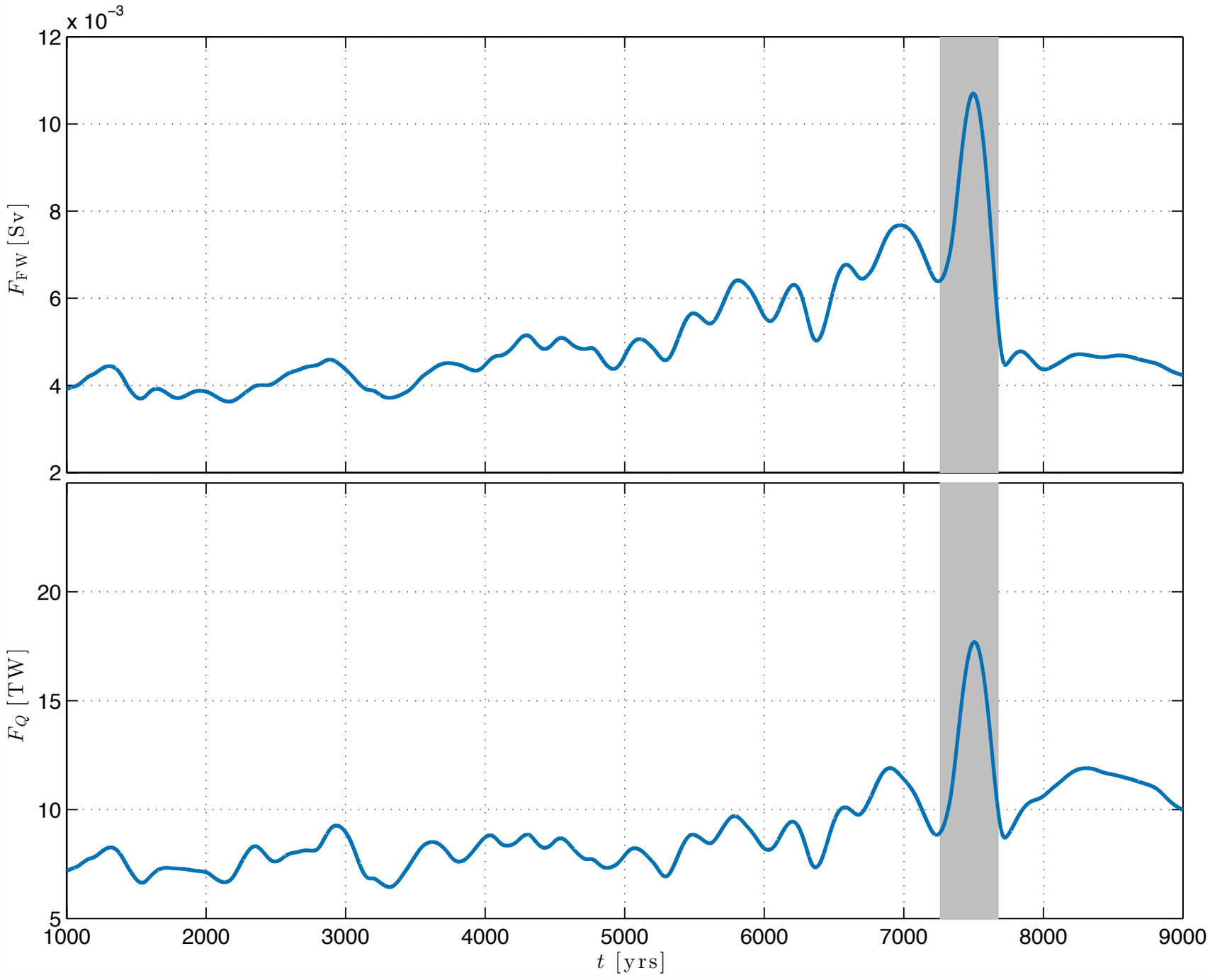




$$M_{OV} \equiv \frac{1}{S_o} \int_{-h}^{\eta} \bar{v}(\bar{S} - S_o)\, dz$$

M_{OV} becomes positive at dynamical boundary of basin, north of channel

Indicators of ROC collapse: flickering



Salt flux across equator

Heat flux across equator

Variance of fluxes increases as the transition is approached: could be used as an indicator of impending collapse

Challenges:

- Is multiplicity of regimes robust in the coupled atm.-sea-ice system?
- Are indicators robust in the eddying regime?
- Are indicators useful in coupled models?
- Is the current observing system adequate at measuring indicators?