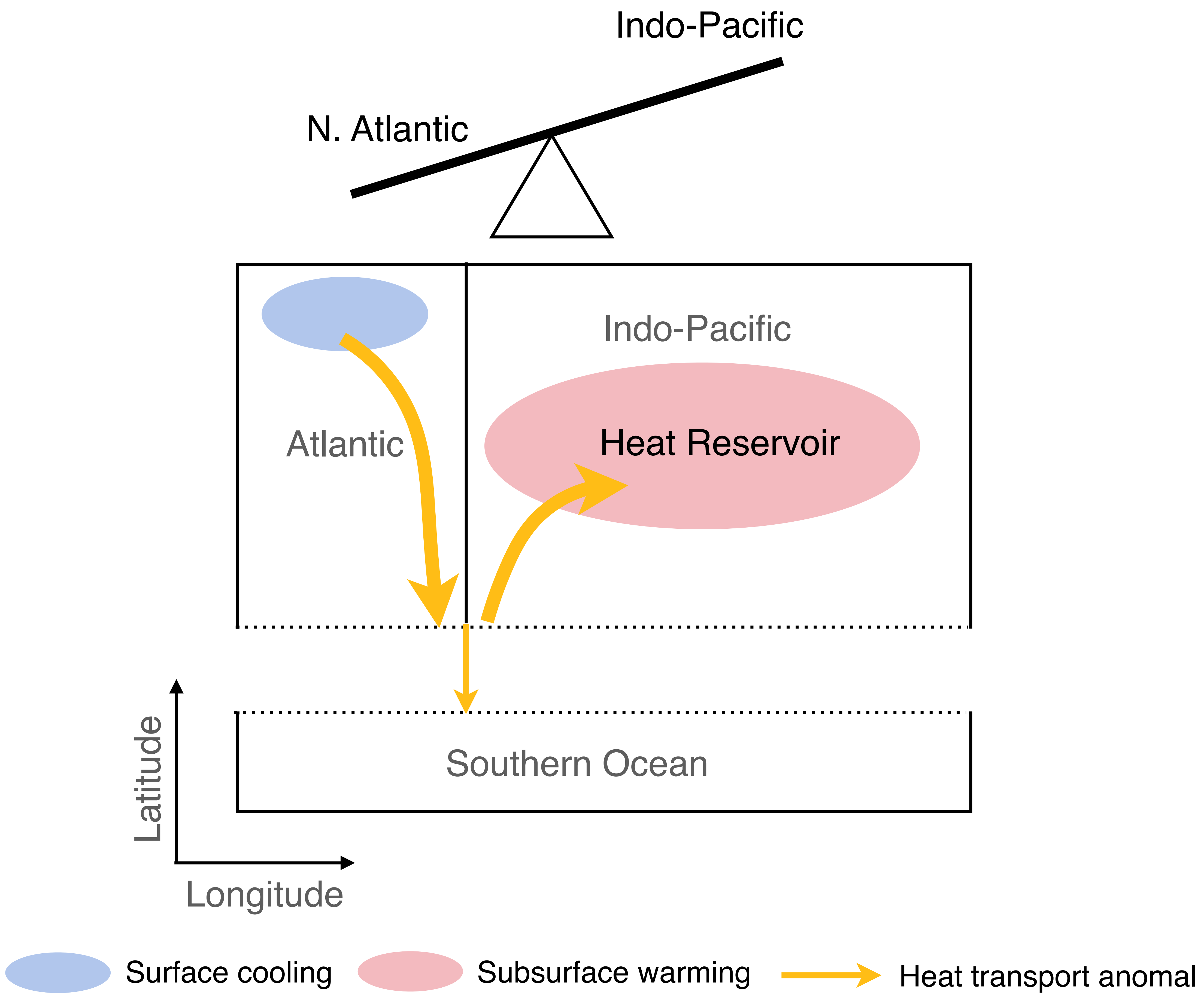
Interbasin redistribution of heat and nutrients due to AMOC changes

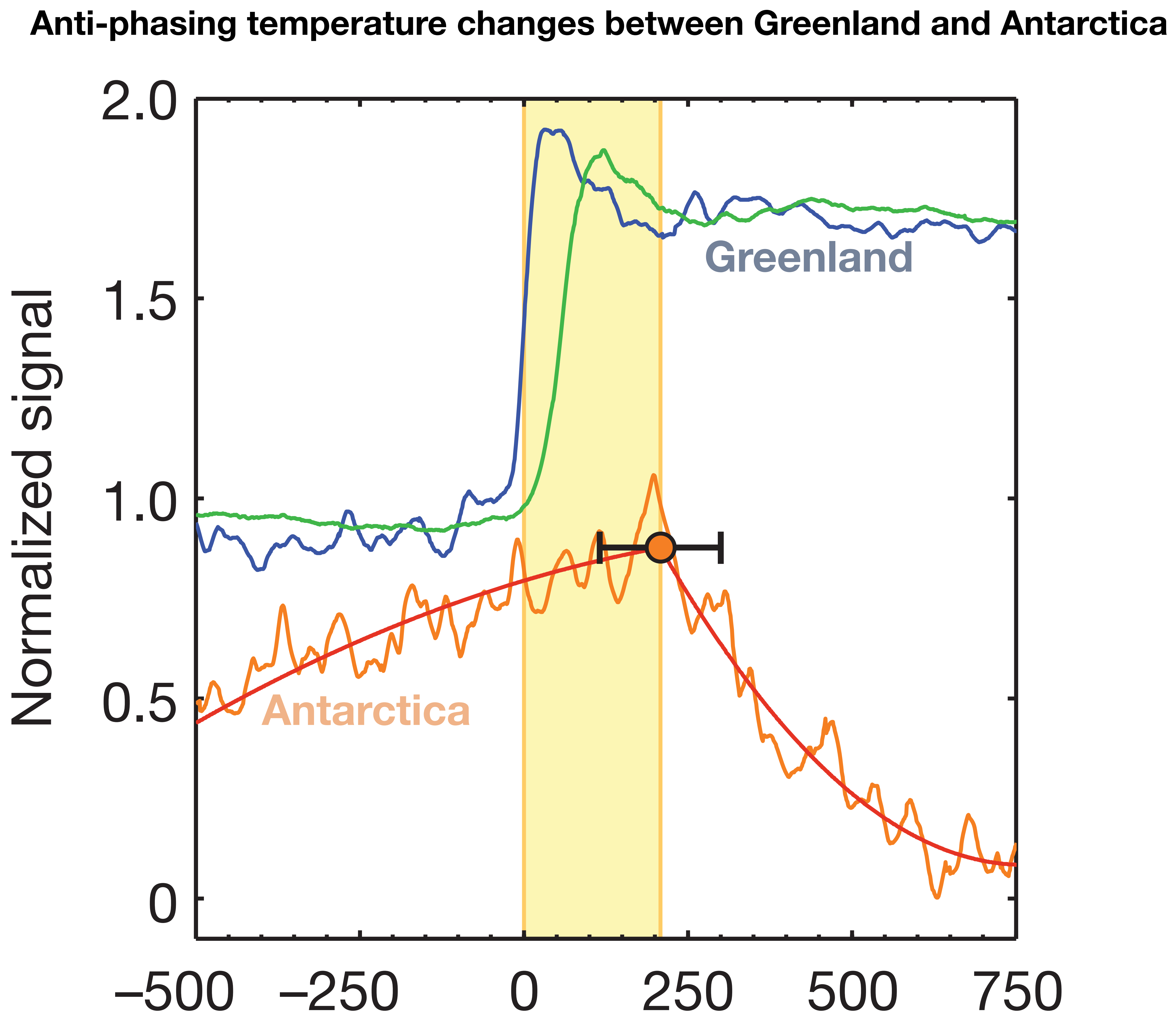
Shantong Sun and Andrew F. Thompson
California Institute of Technology

Email: shantong@caltech.edu
Website: stsun.github.io

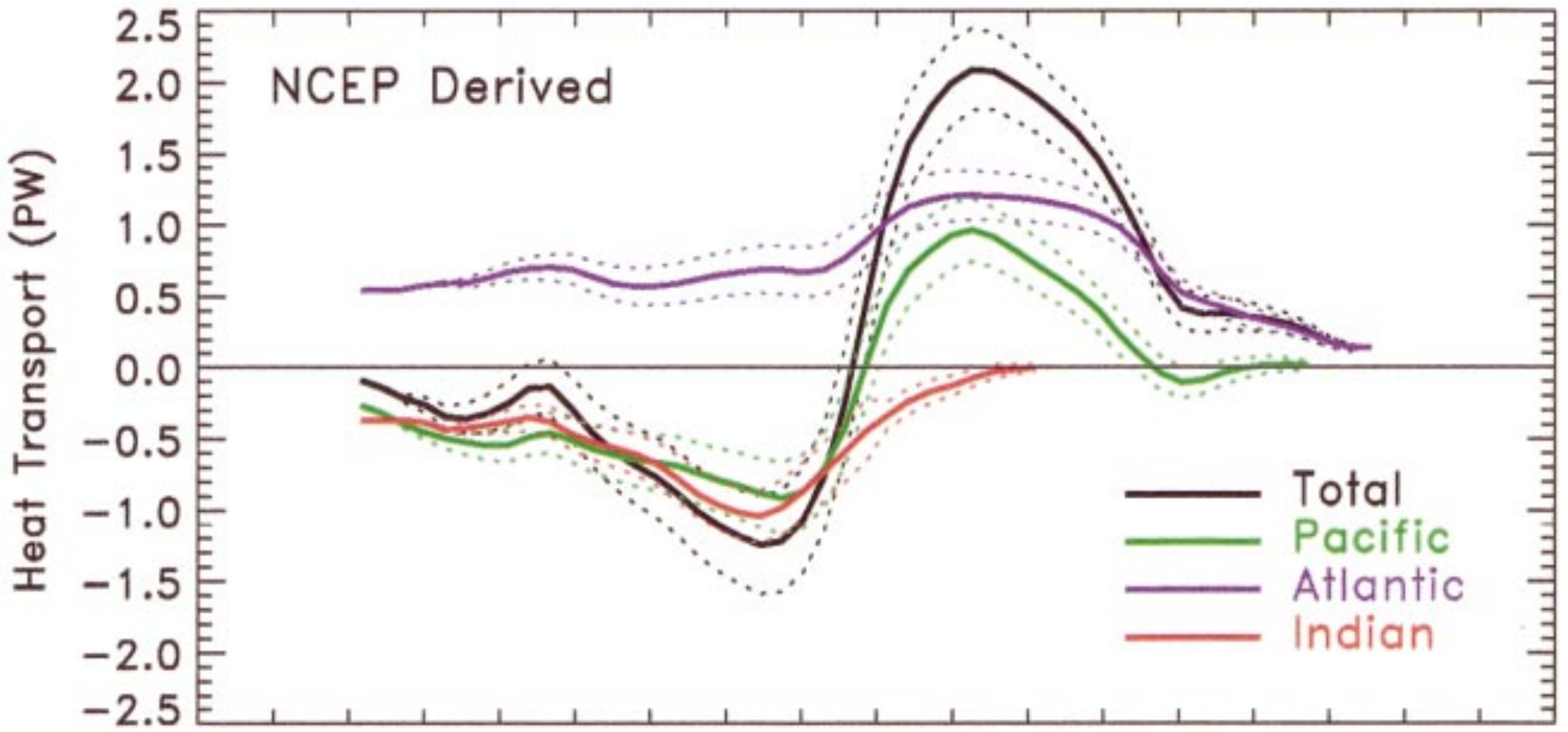


Interbasin heat redistribution following a weakening of AMOC

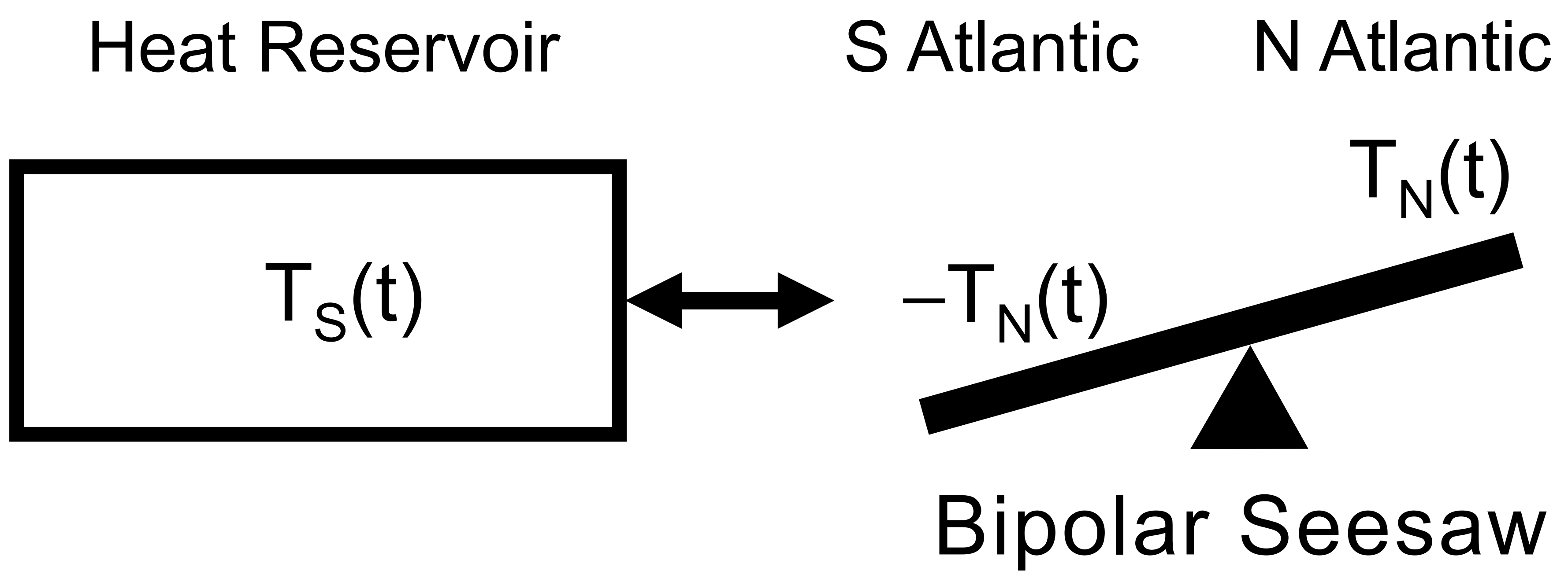
Anti-phasing temperature between hemispheres and bi-polar seesaw



WAIS (2015)



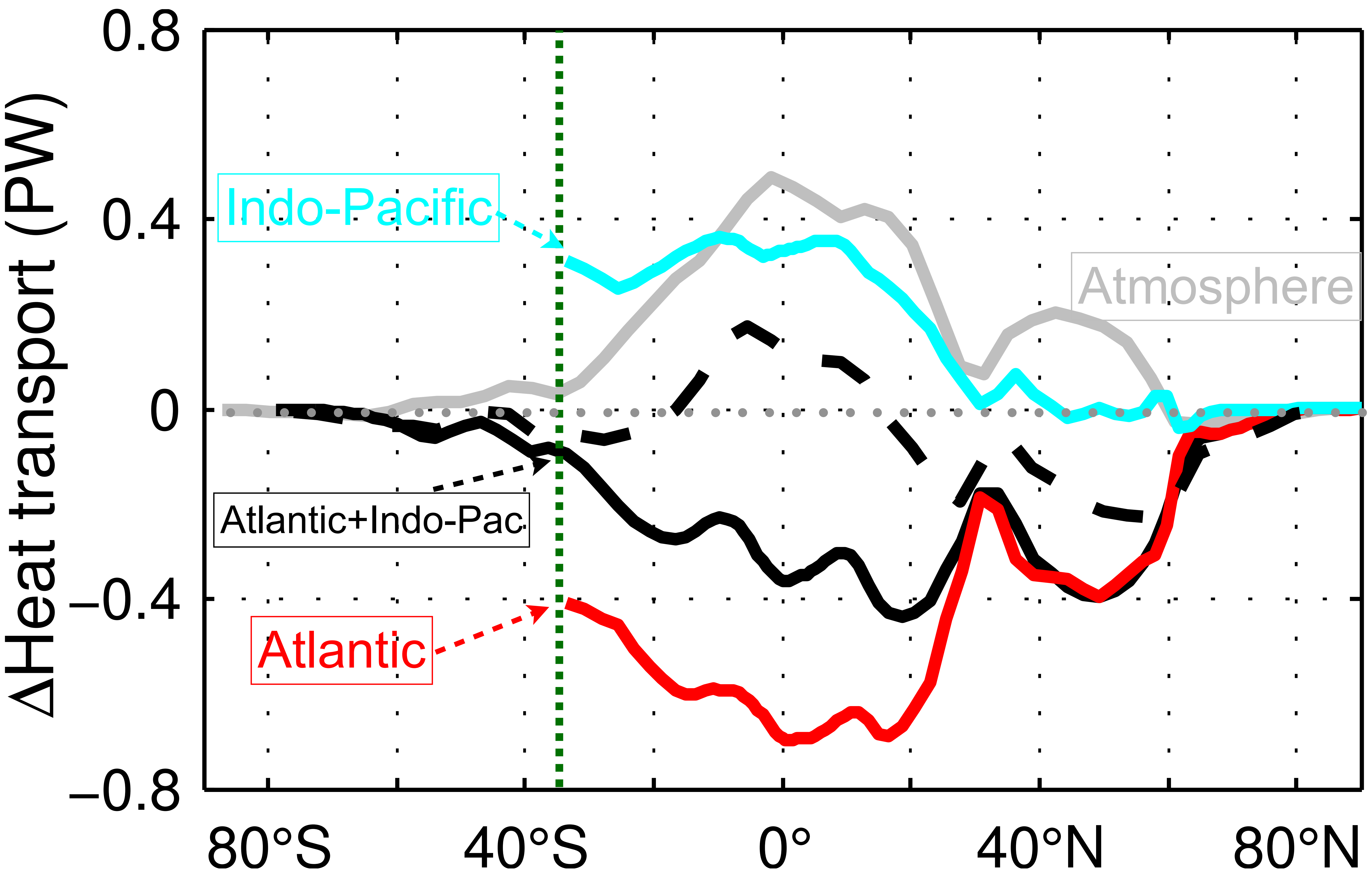
Trenberth and Caron (2001)



Stocker and Johnson (2003)

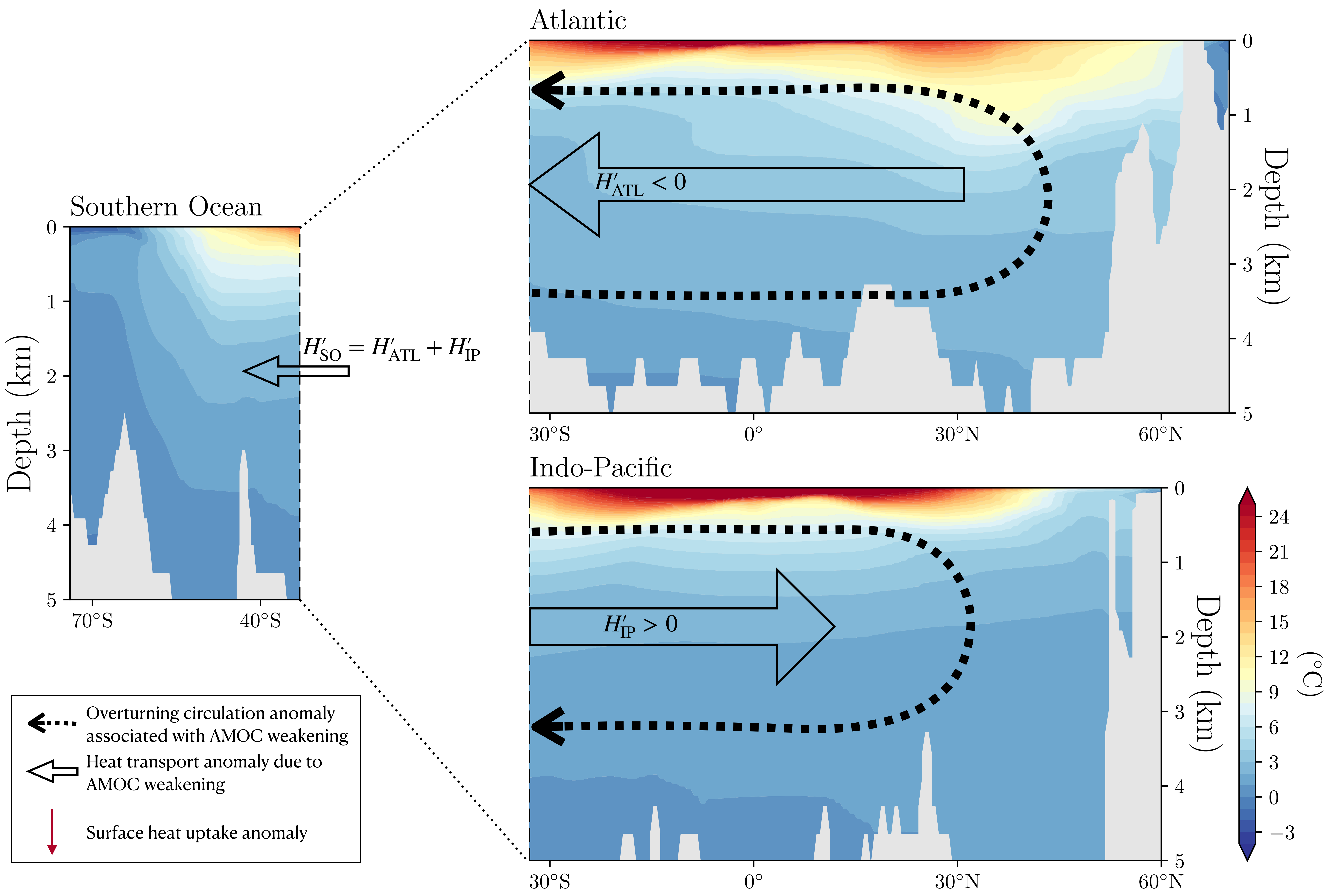
Climate response to AMOC changes not confined to the Atlantic and Southern Ocean

Compensating heat transport responses between the Atlantic and Indo-Pacific at southern boundary following a collapsed AMOC.



Pedro et al. (2018)

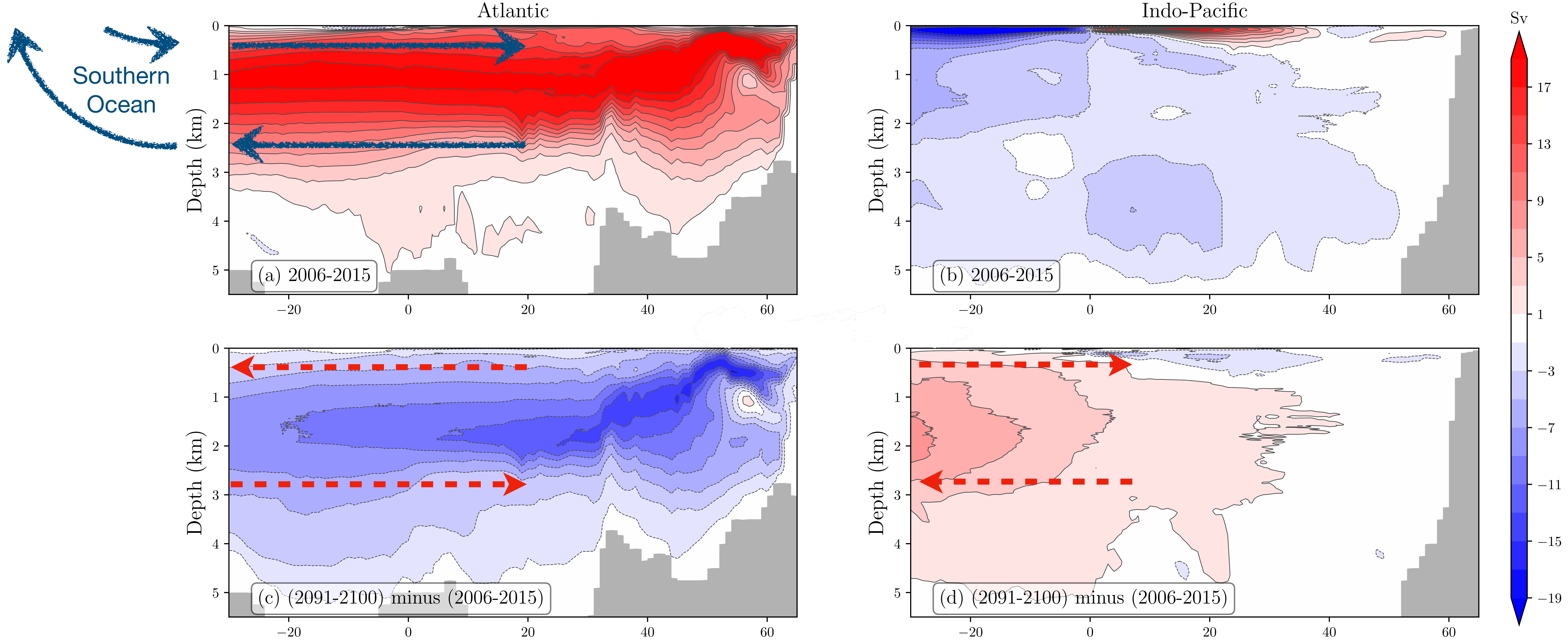
Compensating heat transport due to transient inter-basin overturning compensation



Sun et al. (2020); Sun (2022)

Transient inter-basin overturning compensation between Atlantic and Indo-Pacific

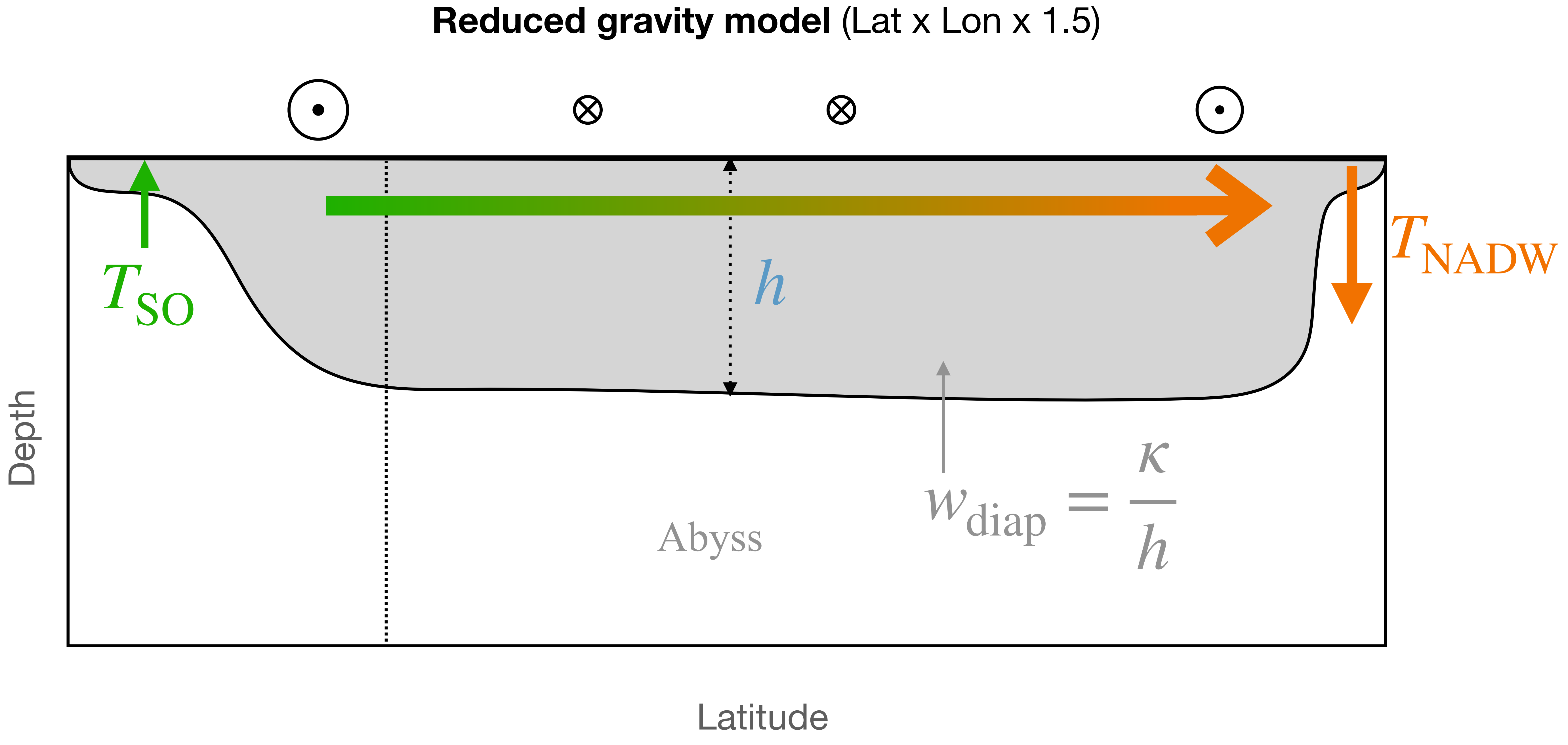
Overturning circulation streamfunction in CESM1 (RCP 8.5)



Sun et al. (2020)

Different from the steady state balance, the Indo-Pacific develops an overturning circulation anomaly that opposes the Atlantic changes, balanced by an **adiabatic** deepening of isopycnals (**not PMOC or interbasin overturning seesaw as discussed in Saenko et al., 2004**).

Overturning circulation in reduced gravity model



Control: NADW formation balanced by Southern Ocean overturning

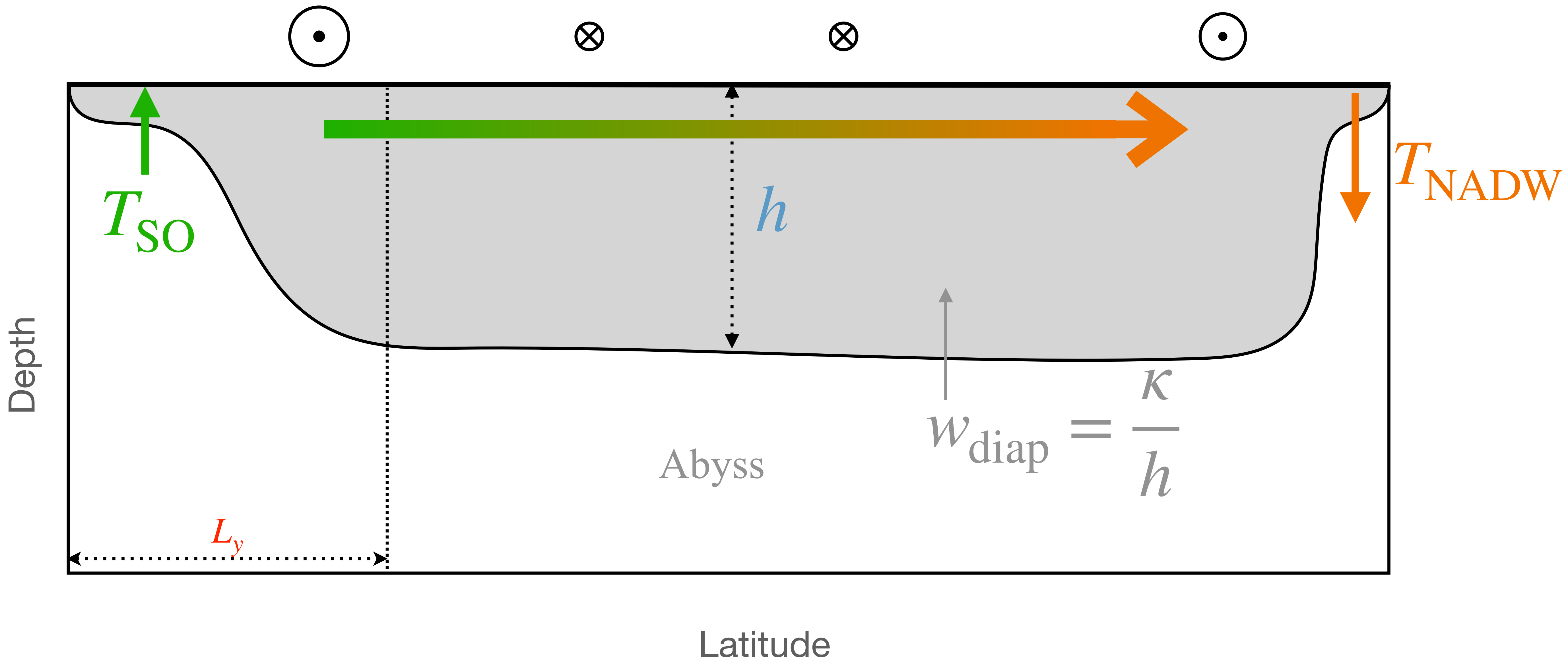
$$T_{NADW} \approx T_{SO}$$

Perturbation: reduced NADW formation leads to a deepening of the interface

$$T_{SO} = \underbrace{-\frac{\tau}{\rho f_s}}_{\text{Wind}} + \overbrace{K_{GM} s}^{\text{Eddy}} \rightarrow -K_{GM}\frac{\overline{h}}{L_y}$$

Overturning circulation in reduced gravity model

Reduced gravity model (Lat x Lon x 1.5)



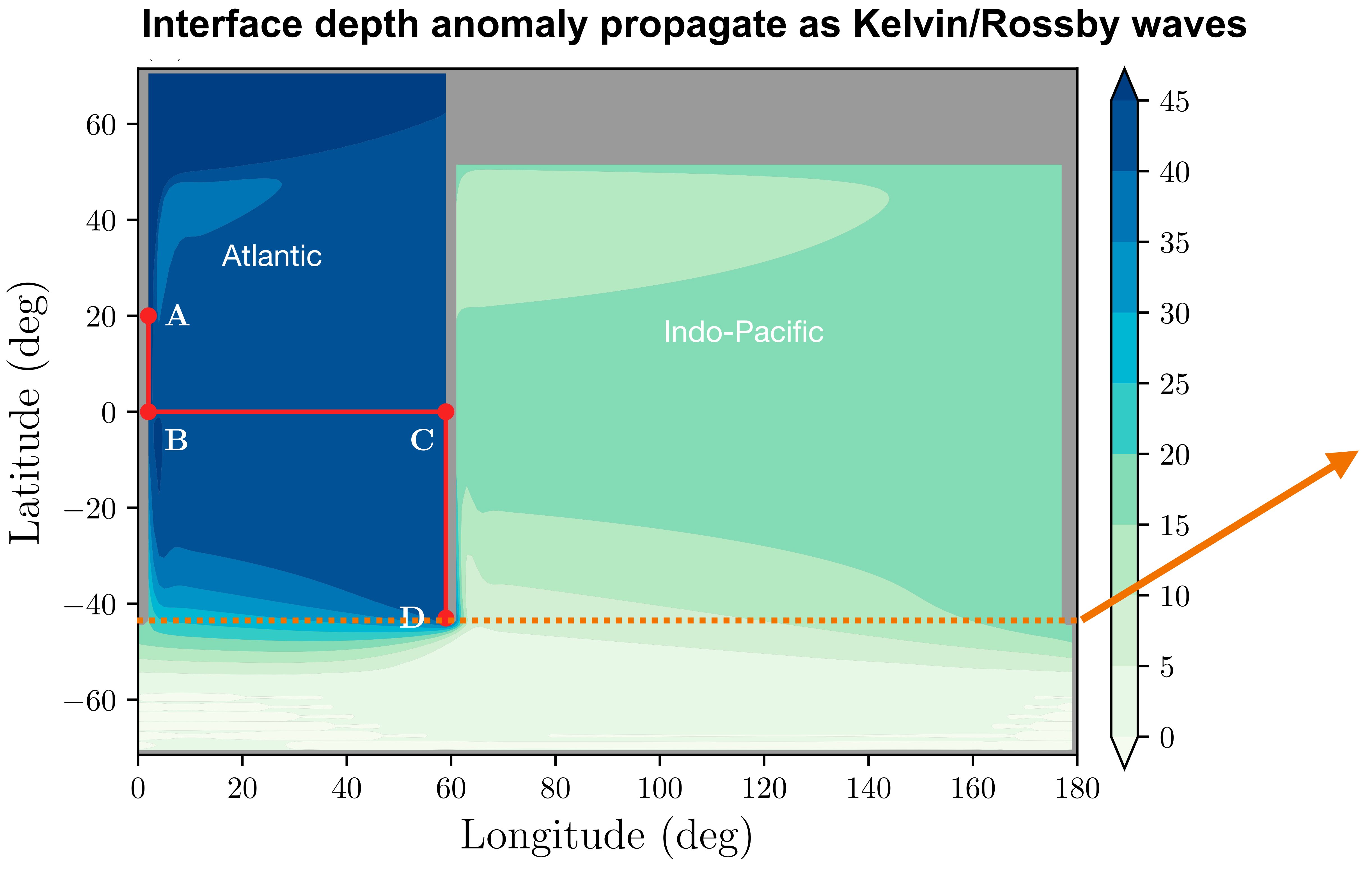
Control: NADW formation balanced by Southern Ocean overturning

$$T_{\mathrm{NADW}} \approx T_{\mathrm{SO}}$$

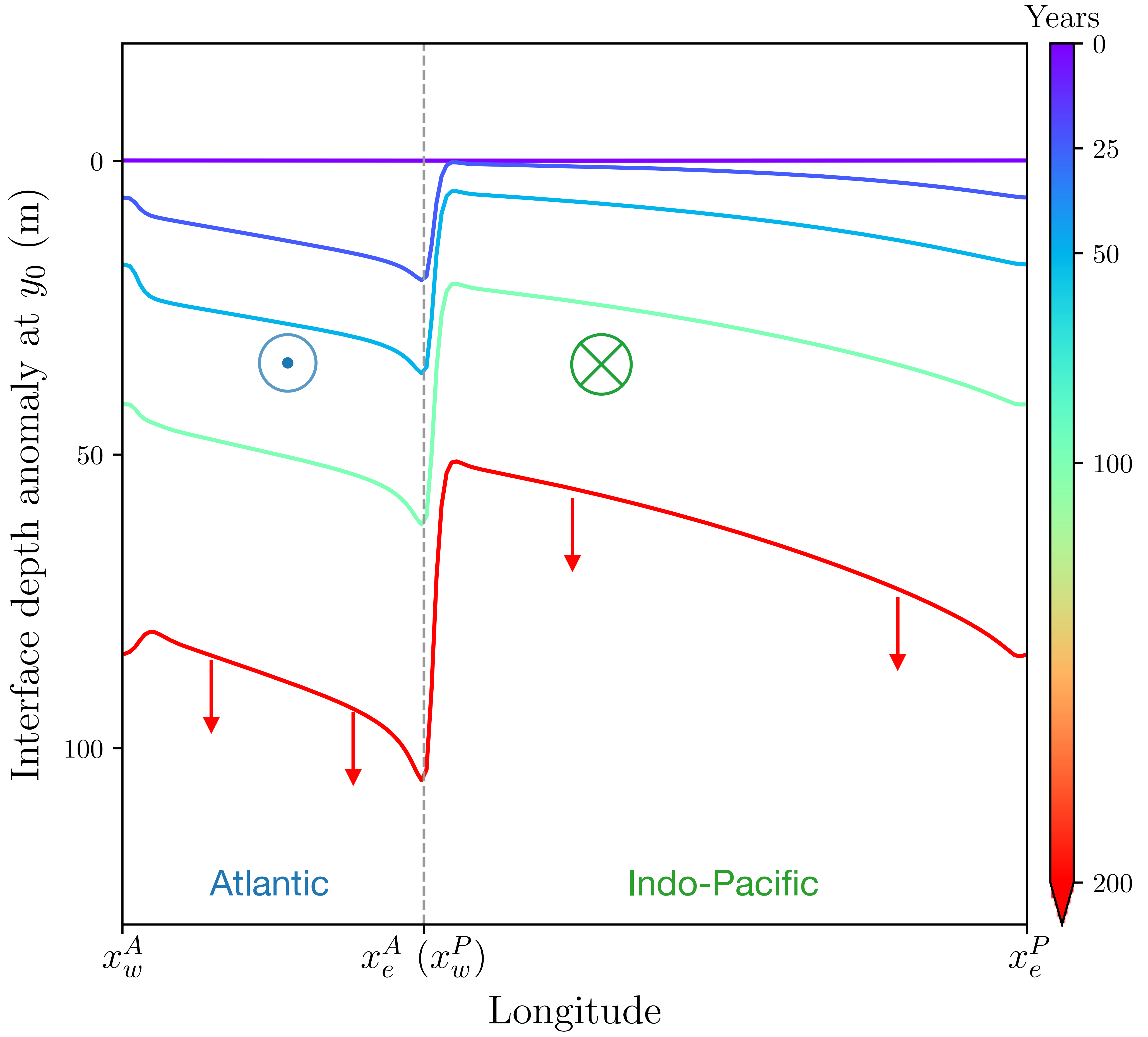
Perturbation: reduced NADW formation leads to a deepening of the interface

$$T_{\mathrm{SO}} = \underbrace{-\frac{\tau}{\rho f_s}}_{\text{Wind}} + \overbrace{K_{\mathrm{GM}} s}^{\text{Eddy}} \rightarrow -K_{\mathrm{GM}} \frac{\overline{h}}{L_y}$$

Overturning responses to reduced NADW formation



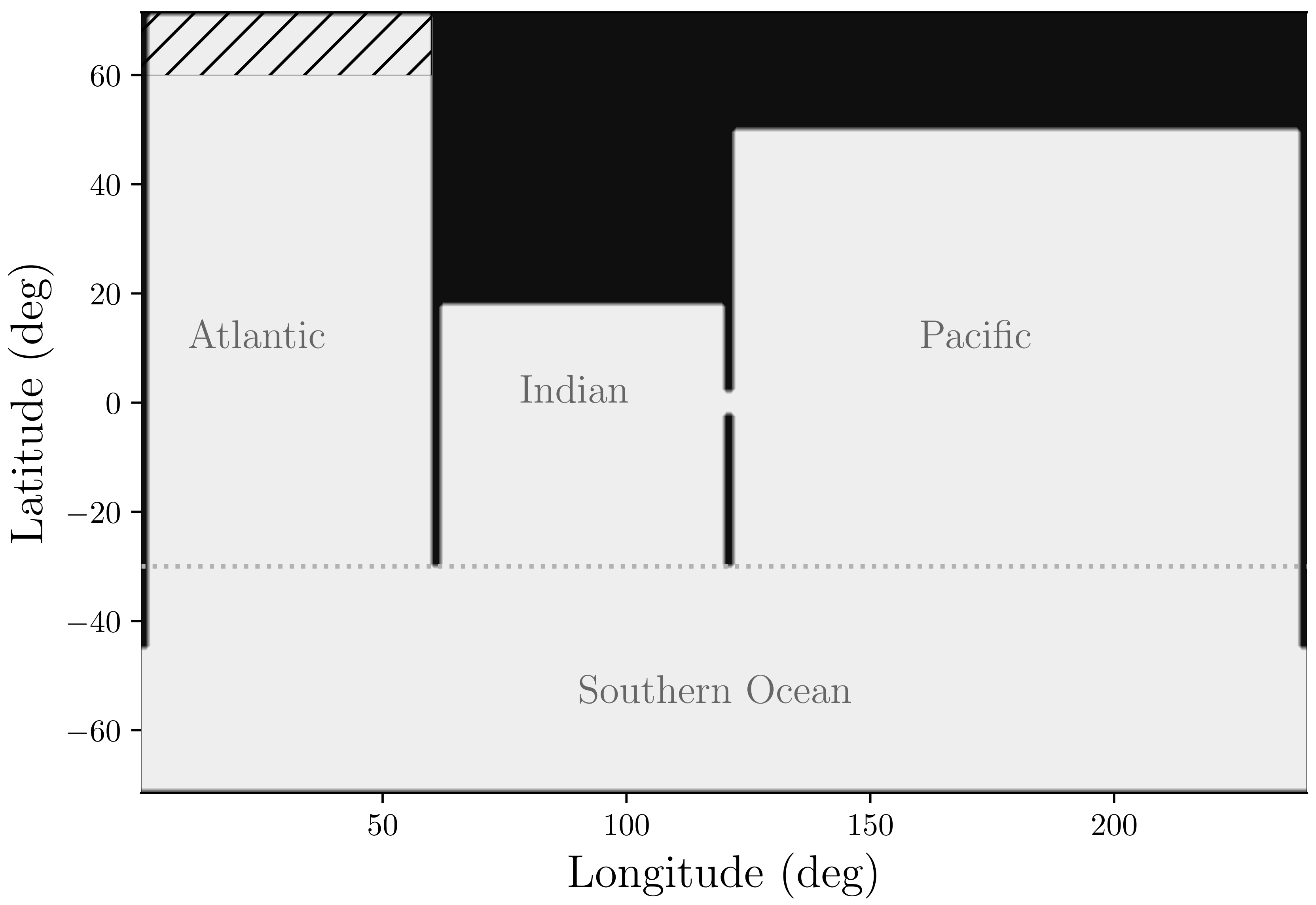
Sun et al. (2020)

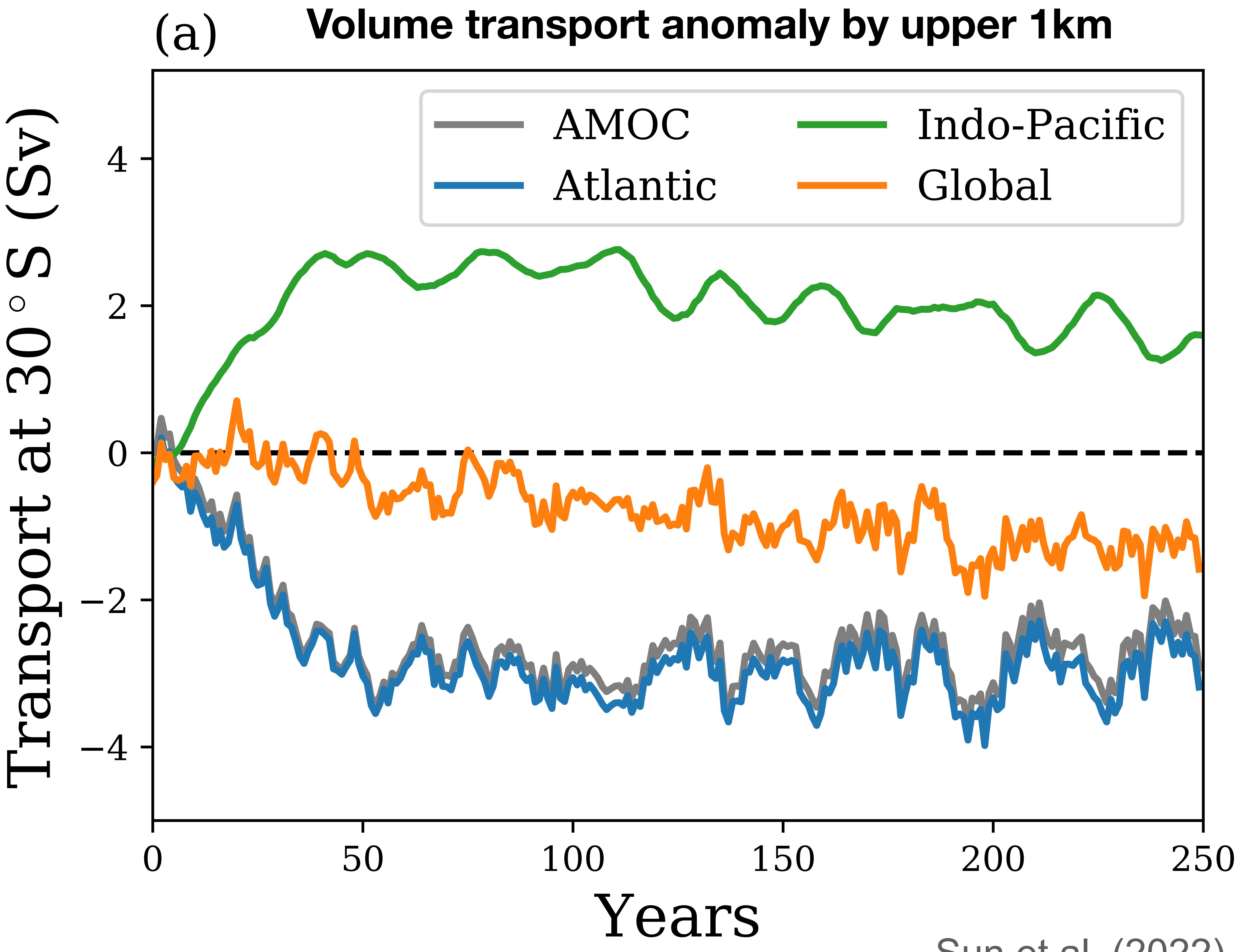


Sun et al. (2020)

Compensating overturning responses between Atlantic and Indo-Pacific

MITgcm ocean-only simulation at 1deg resolution

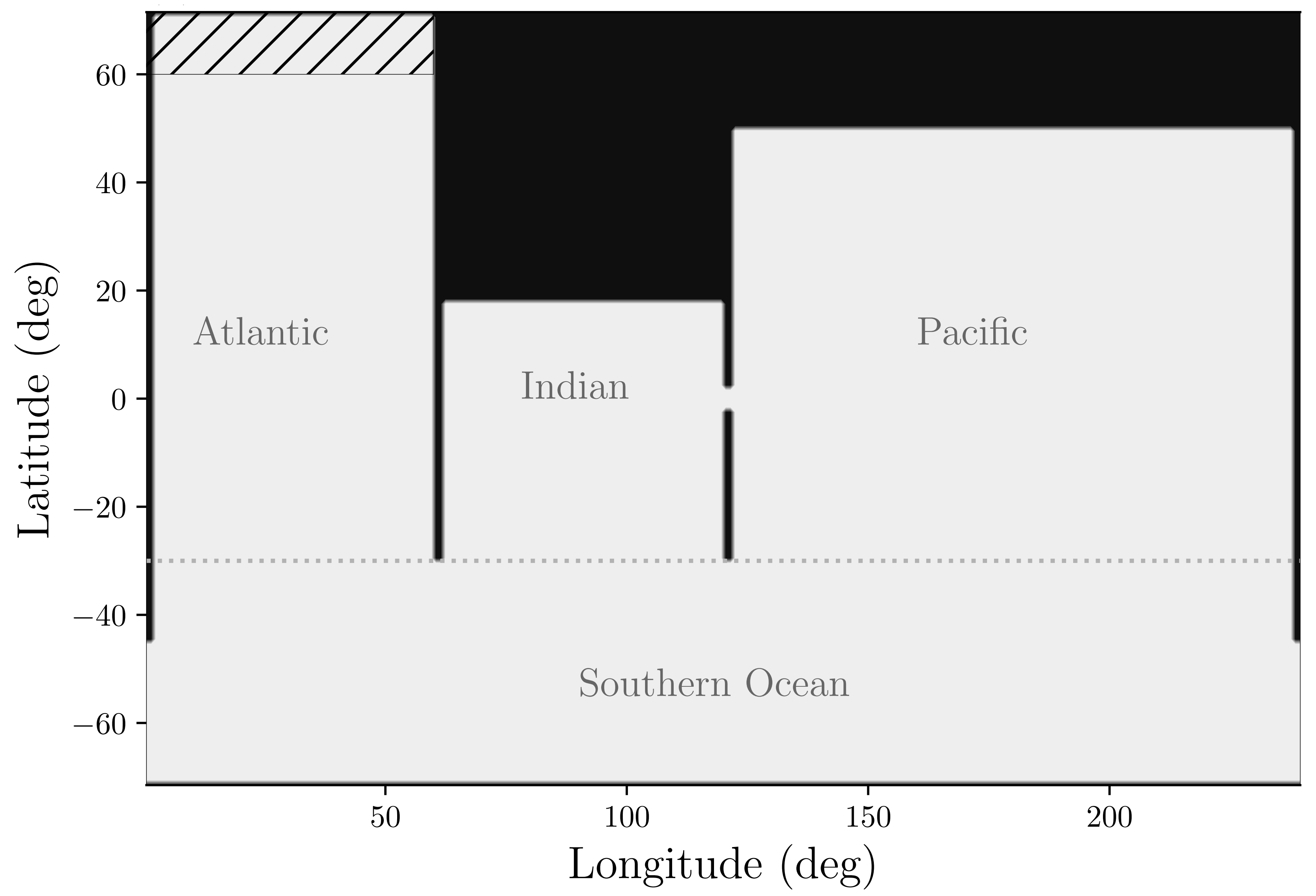


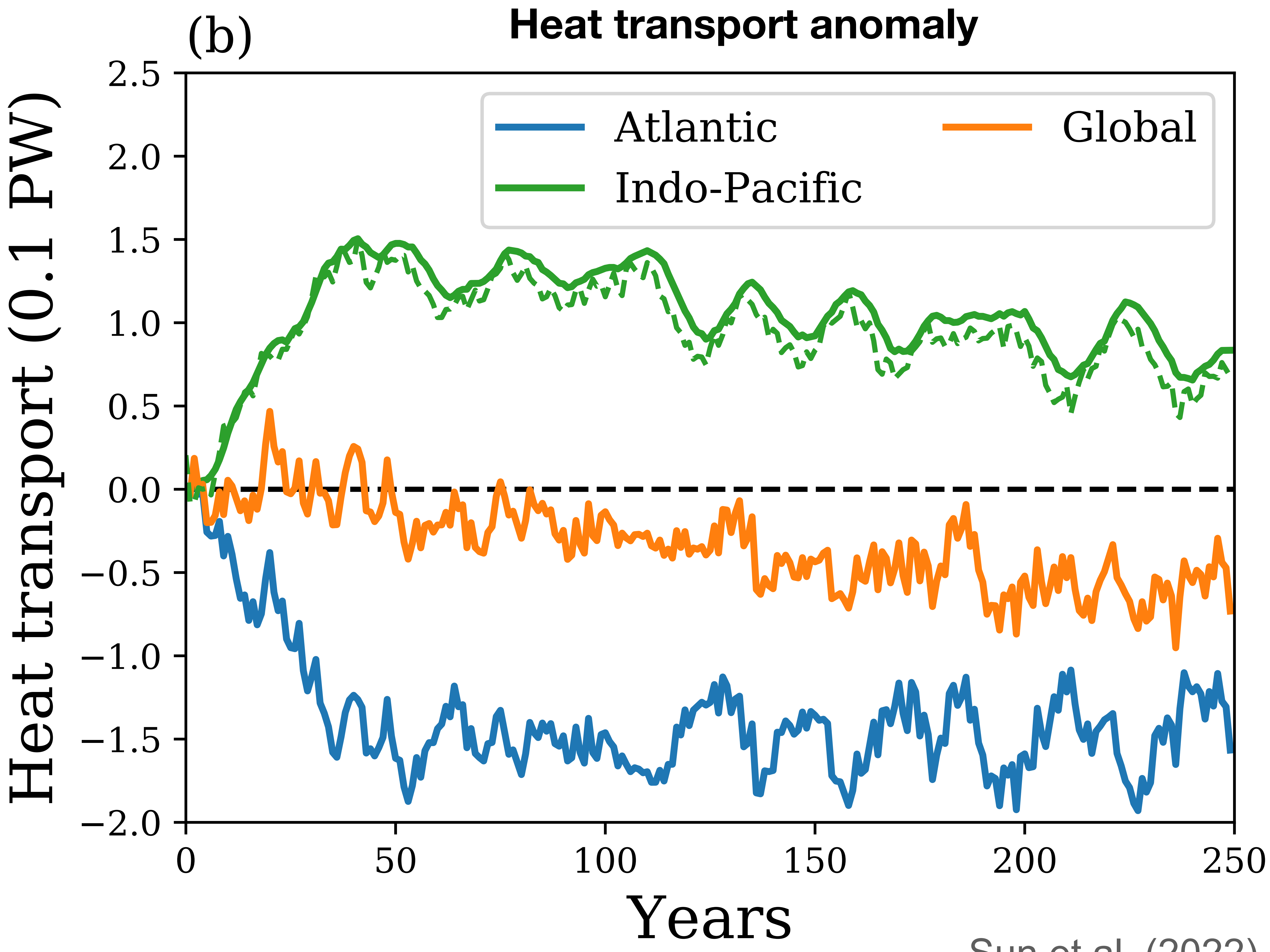


Sun et al. (2022)

Compensating heat transport responses between Atlantic and Indo-Pacific

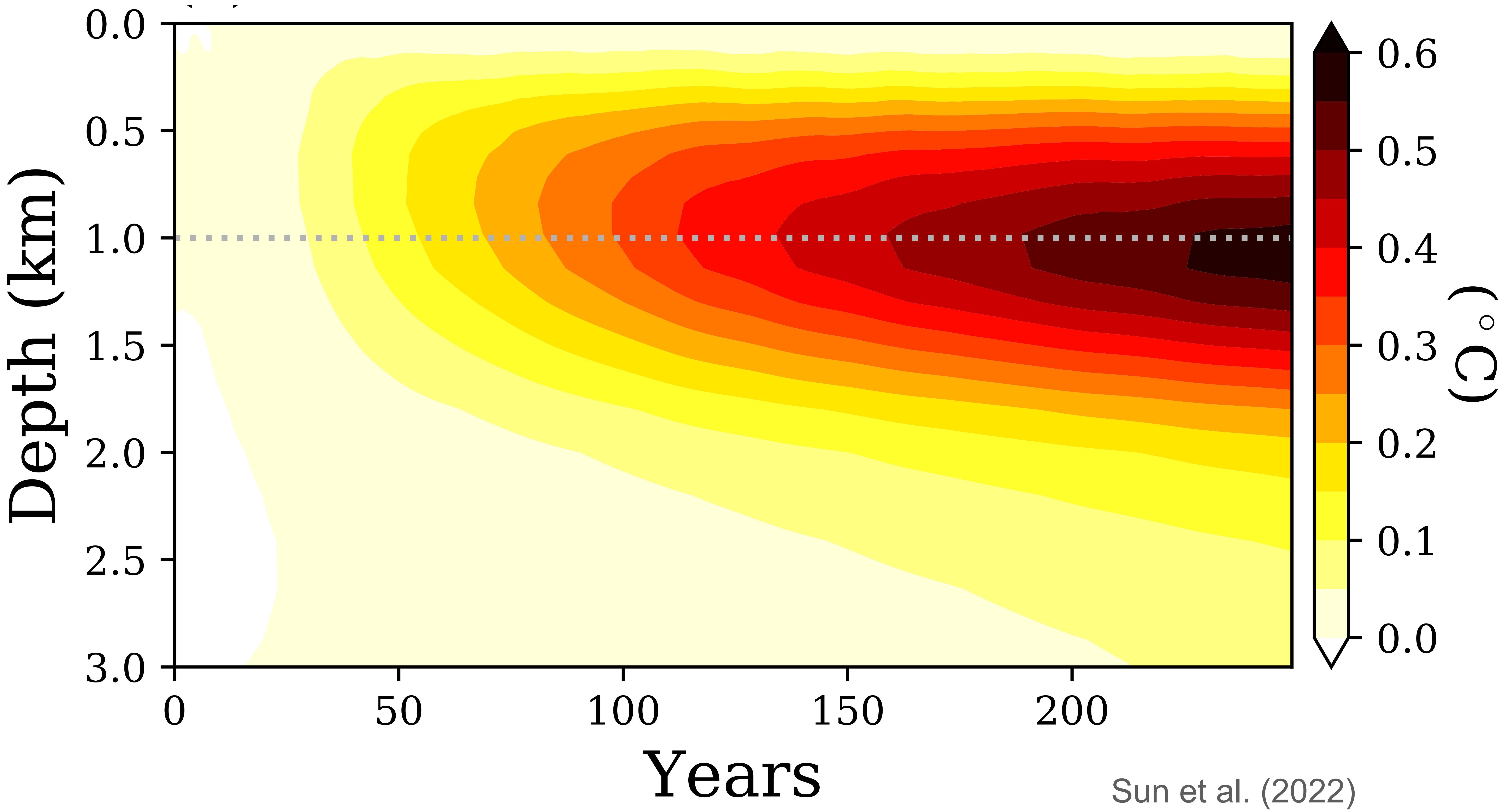
MITgcm ocean-only simulation at 1deg resolution





Sun et al. (2022)

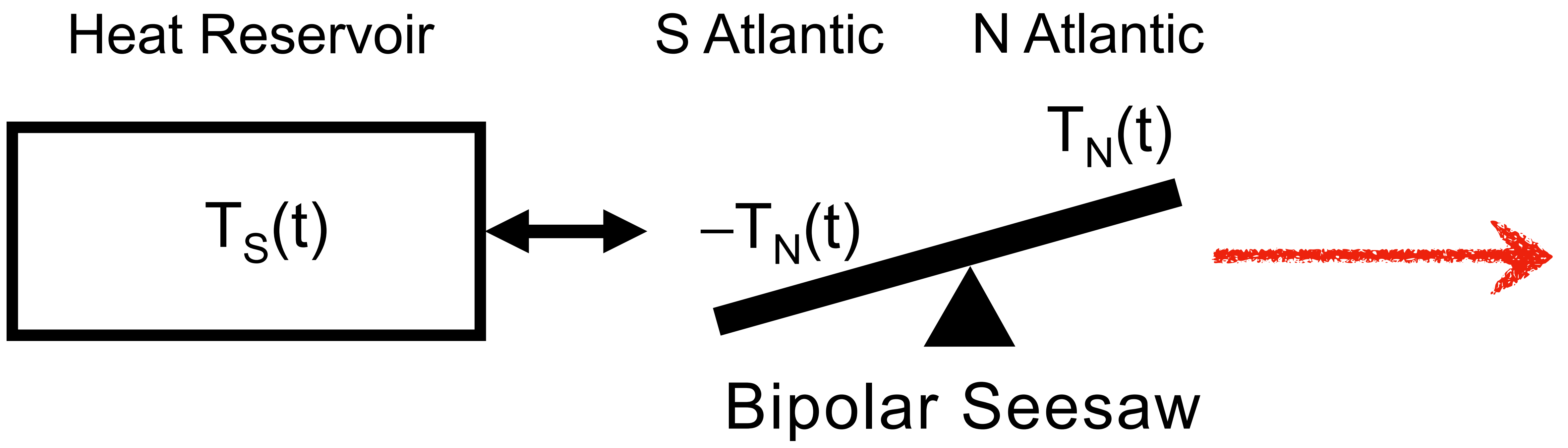
Indo-Pacific subsurface warming due to inter-basin heat exchanges



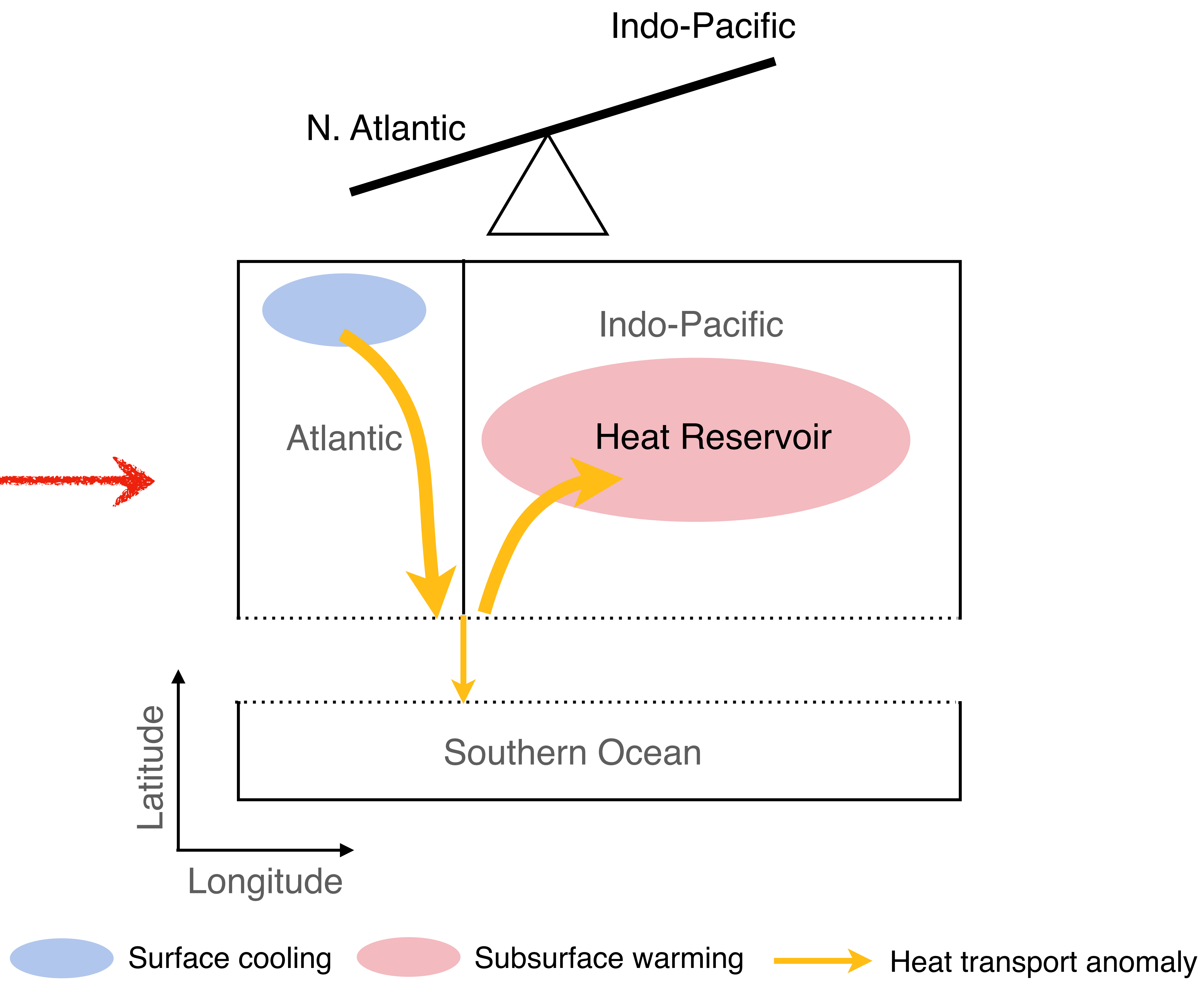
Sun et al. (2022)

- Centennial subsurface warming due to inter-basin overturning (compare with vertical diffusion)
- This is an important heat source for future Indo-Pacific warming on centennial timescales

An update to bi-polar seesaw: a thermal inter-basin seesaw



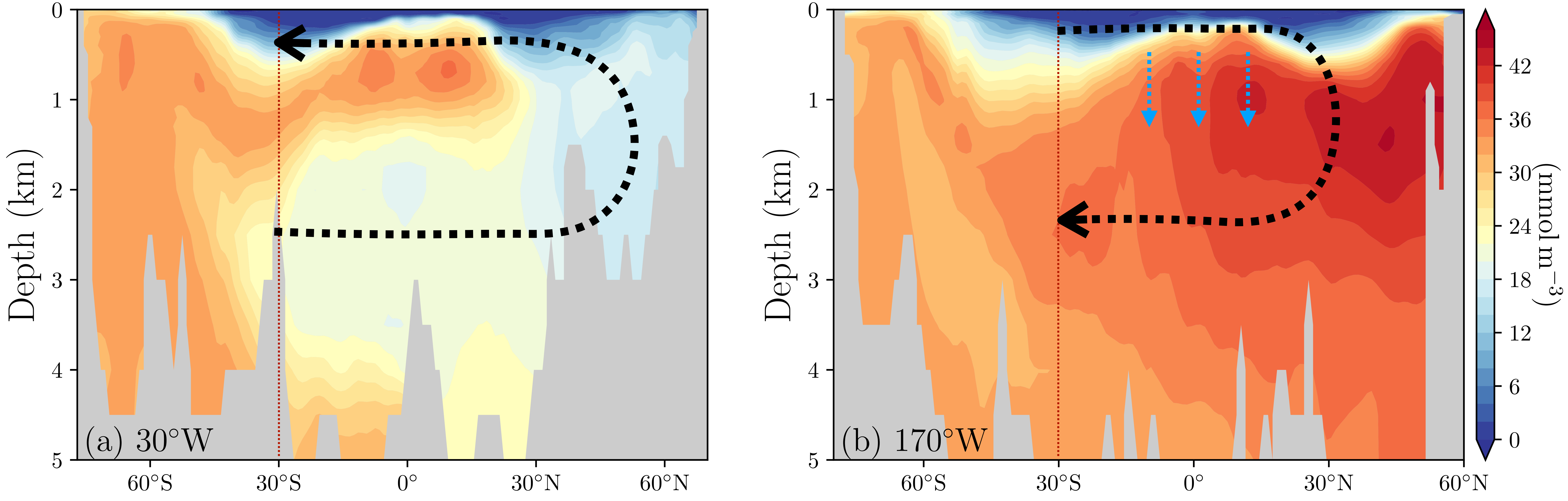
Stocker and Johnson (2003)



Sun et al. (2022)

Nutrient redistribution by the inter-basin overturning responses following AMOC weakening

Nitrate distribution from GLODAPv2



Sun and Thompson, *in prep*

Following a weakened AMOC,

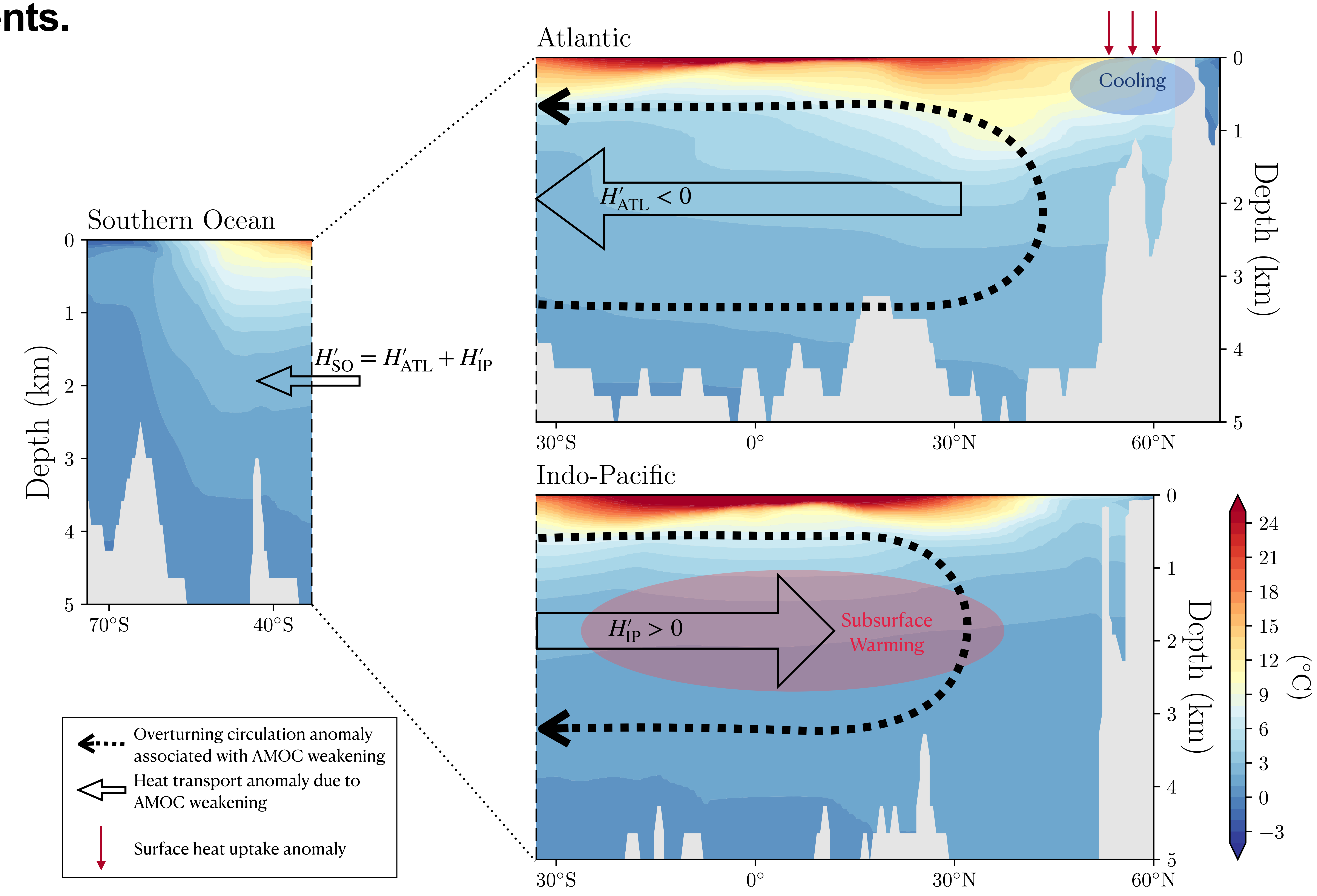
Atlantic: decrease in nutrients supply by the northward AAIW transport

Indo-Pacific: Isopycnal deepening decreases upper ocean nutrient concentration

- Due to different vertical nutrients gradient between Atlantic and Indo-Pacific, this inter-basin overturning response could also drive a net nutrient transport into the **Southern Ocean**.

Summary

The transient inter-basin overturning responses to AMOC changes plays a key role in redistributing heat and nutrients.



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