Understanding ocean effects on the response of the atmosphere to Arctic sea-ice loss using a hierarchy of ocean models

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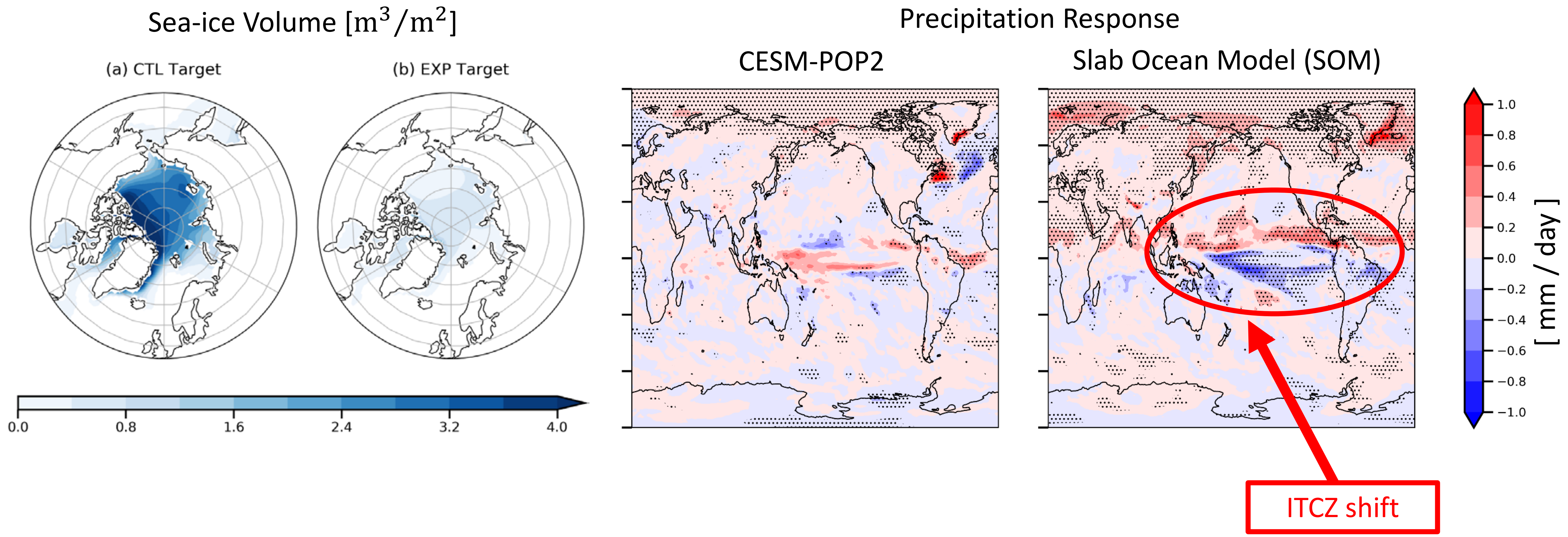
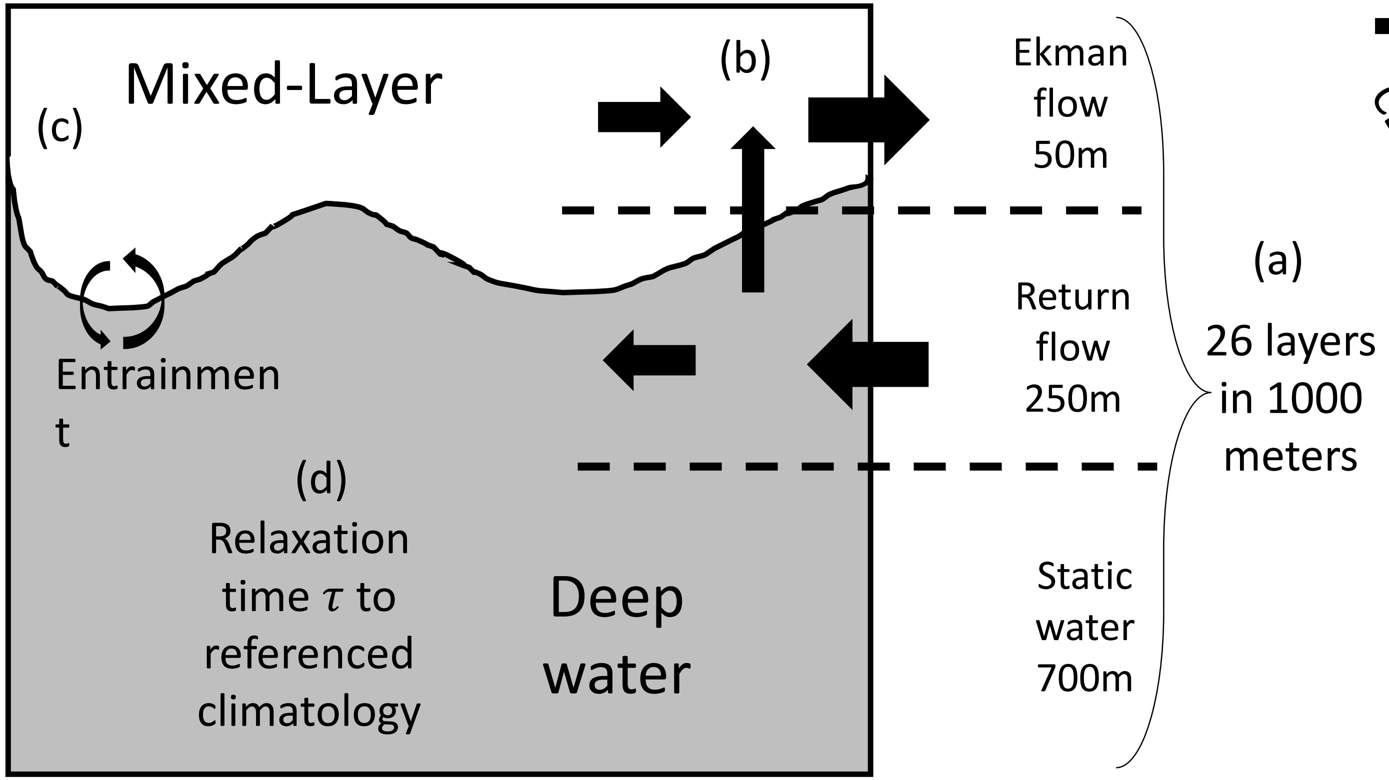
Motivation: Sea-ice melting → Tropical Response in a coupled framework



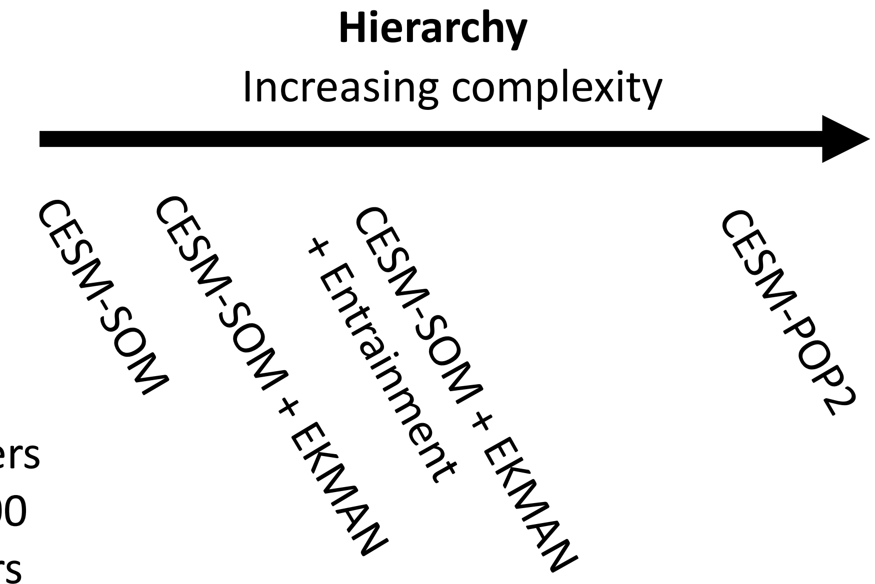
Possible damping mechanisms in CESM-POP2 (not included in the SOM):

1. Ekman response of oceanic subtropical overturning circulation (Green and Marshall 2017; Schneider 2017)
2. Atlantic meridional overturning circulation (AMOC) modulation (Yu and Pritchard 2019)

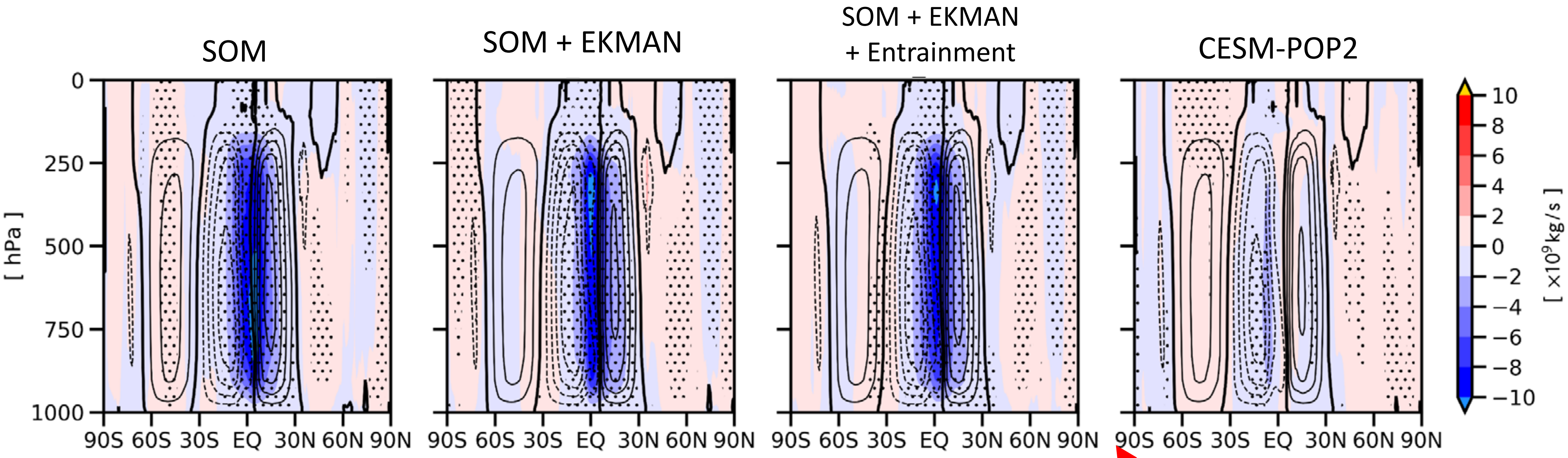
Method: Hierarchy of Simplified Ocean Models



Ekman Mixed-Layer Model (EMLM)



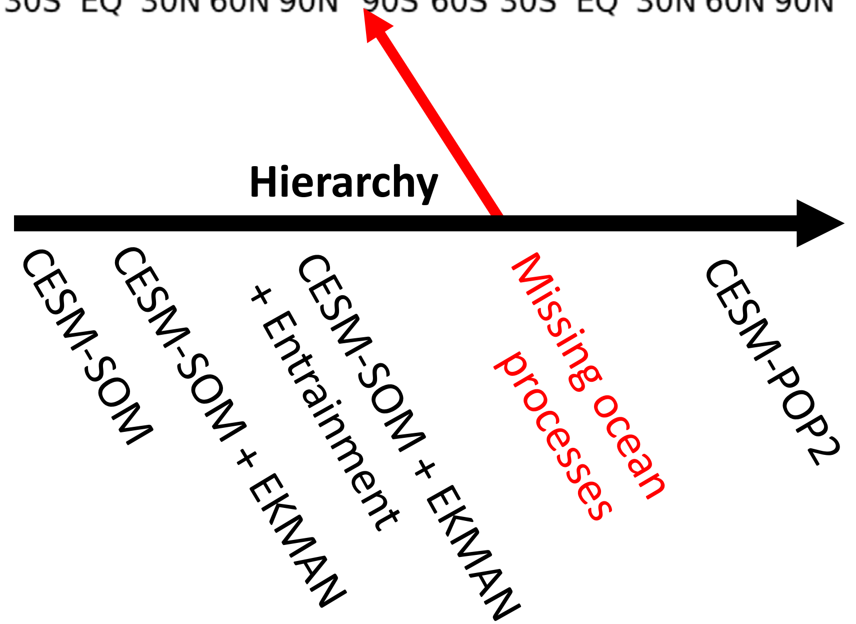
Results: Response of Hadley Cell



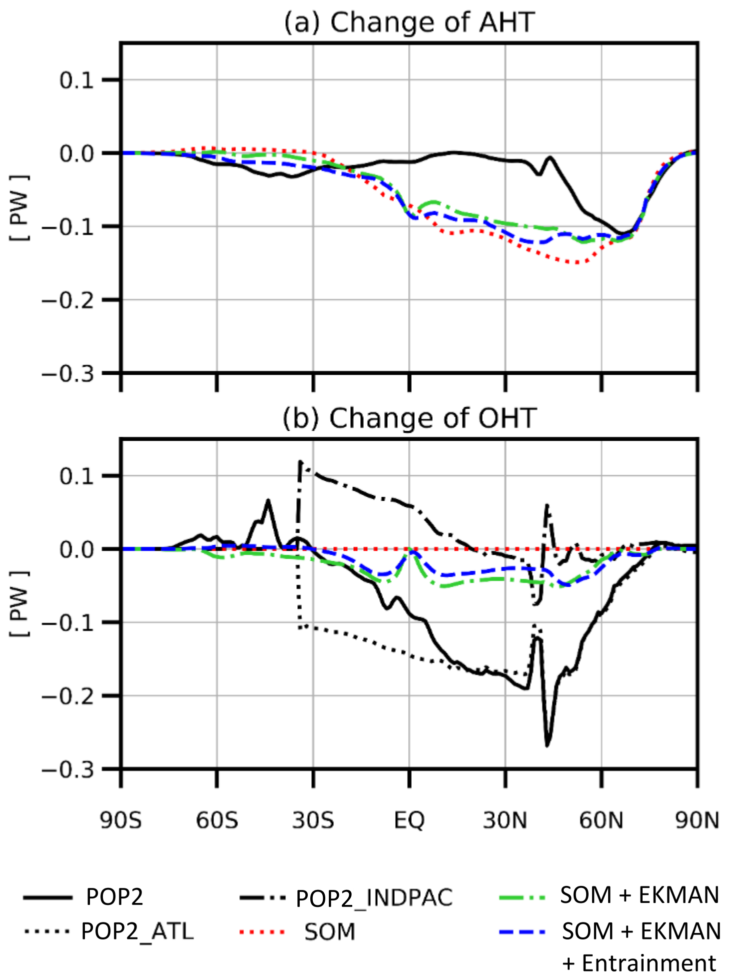
Contours: Climatological overturning stream function *before melting sea-ice* (interval 10^{10} kg/s)

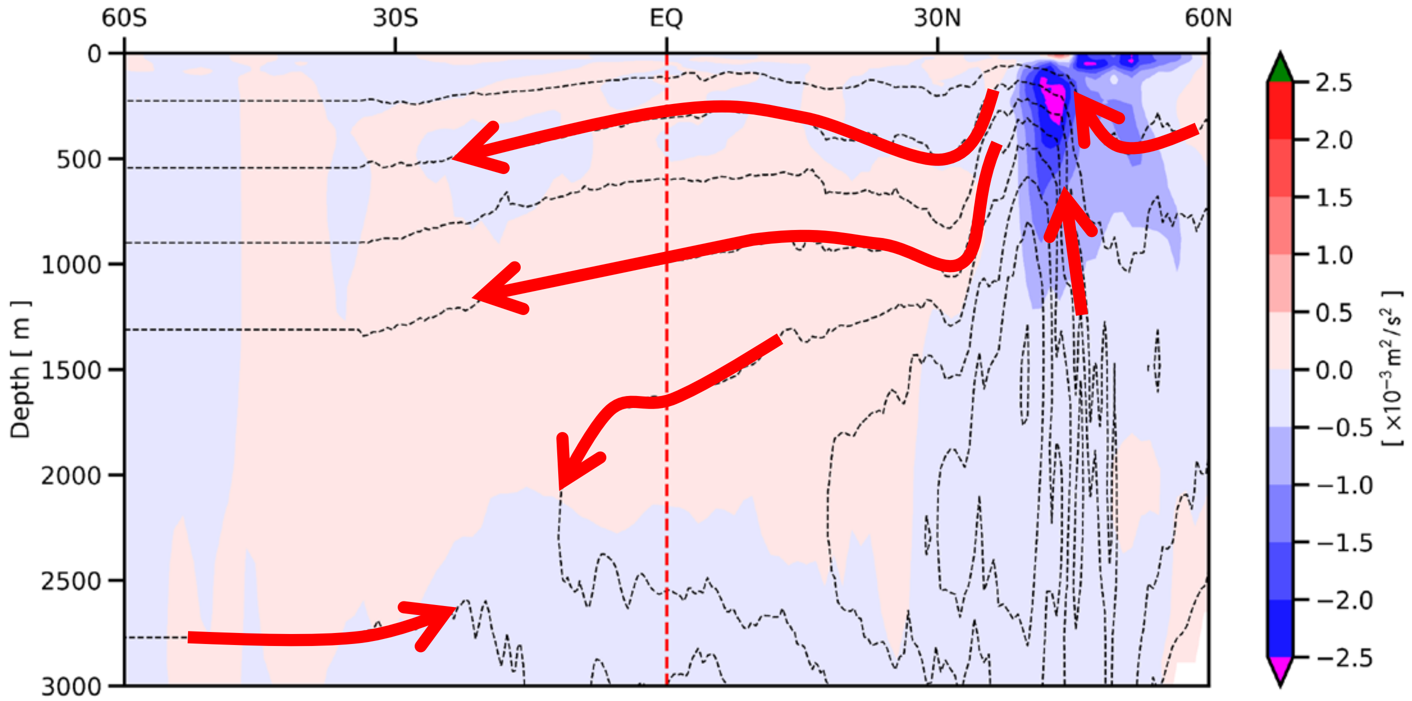
Shading: Anomalous (EXP-CTL) stream function in response to Arctic sea ice loss

Stippling: significant at the 95% level.



Results: AMOC is important





Contour: anomalous streamfunction in the Atlantic ocean
Shading: anomalous East-west buoyancy difference

- 20% decrease of AMOC strength in CESM-PO2 in response to sea ice loss. This is not captured by the hierarchy of simplified ocean models.
- Anomalous ocean heat transport by AMOC is preventing the Arctic signal from propagating to the Tropics. This is potentially sensitive to the spatial pattern of ice-loss forcing.

Implication for future work

- The applicability of our results to the real climate system is potentially dependent on the fidelity of the representation of AMOC in CESM-POP2.   (OSNAP observations: 30 Sv.   CESM-POP2: 35 Sv)

- The impact of Antarctic sea-ice melting should be quite different because it will not produce the east-west buoyancy differences observed in the N. Atlantic. Therefore we might expect less MOC-driven damping of the ITCZ-shift.