Inter-basin redistribution of heat and nutrients due to AMOC changes

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Connections between the Atlantic and Southern Ocean are often identified as critical components that enable overturning circulation transitions between different climate states. However, our recent work suggests that the Indo-Pacific plays a leading role in balancing AMOC changes over decadal to multi-centennial time scales, leaving the Southern Ocean overturning largely unperturbed by AMOC changes over these timescales. Additionally, various modeling approaches indicate that this inter-basin overturning response redistributes heat and nutrients between basins and has a critical role in the evolution of global heat budget and ecosystem in a changing climate.

Following a weakening of the AMOC, the Indo-Pacific develops an overturning circulation anomaly that substantially opposes the Atlantic changes, characterized by a northward volume transport anomaly in the upper ocean that is largely balanced by an adiabatic deepening of isopycnals. This inter-basin overturning response induces a southward heat transport anomaly in the Atlantic and a northward heat transport anomaly in the Indo-Pacific. The zonal heat redistribution leads to a surface cooling in the high-latitude North Atlantic and a centennial subsurface warming in the Indo-Pacific: a thermal inter-basin seesaw. Furthermore, the coupling of these interbasin overturning changes to the vertical nutrients distribution leads to a net southward transport anomaly of nutrients into the Southern Ocean following a weakening of the AMOC. This nutrient redistribution decreases nutrients levels in the upper part of the Atlantic and Indo-Pacific basins, leads to a reduction in global primary production on centennial timescales, and may contribute to a positive carbon-climate feedback by modifying air-sea fluxes.