The zonally asymmetric overturning circulation of the Southern Ocean and consequences for upwelled, carbon-rich Deep Water

Pathways Connecting Climate Changes to the Deep Ocean Workshop
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Brief Summary. The ACC fronts, which are associated with deep water upwelling, incursion of water southward to the Antarctic shelves, and winter sea ice edge, are strongly controlled by the underlying bathymetry and the location of continents, resulting in zonal asymmetry in processes that affect Southern Ocean water masses, overturning, and biogeochemistry.

ZONALLY ASYMMETRIC INFLOW AND UPWELLING OF DEEP WATERS (ATLANTIC, INDIAN, PACIFIC) AND CARBON OUTGASSING

High carbon Deep Waters reach surface in Southern Ocean (ship obs. and BGC floats)
Potential temperature on NADW isopycnal: warm water spiraling inward
Paths of high carbon spiral inward and upward (SOSE, CESM, ESM6, matching hydrographic data)
Carbon air-sea exchange (SOCCOM BGC Floats)

ZONALLY ASYMMETRIC AABW FORMATION

Freshwater forcing due to brine rejection and sea ice melt central to both the upper and lower cells
AABW formation in 4 places. Outward spiraling flow with strong topographic contraints

ZONALLY ASYMMETRIC DYNAMICS and SUBPOLAR OVERTURN

ACC fronts form scalloped standing meanders with different dynamics in each portion of structure
Topography interacts with ACC: hotspots of upwelling (shown here across 400 m)
4-D overturning circulation in the Pacific sector: bifurcation of SACCF with large variability downstream of topography

DATA: GO-SHIP and Argo

SOCCOM: BGC and under-ice

B-SOSE


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