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
April 23-25, 2024 Lewes, DE
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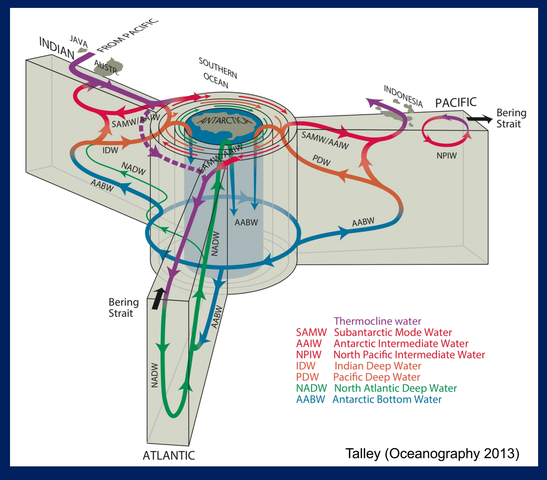
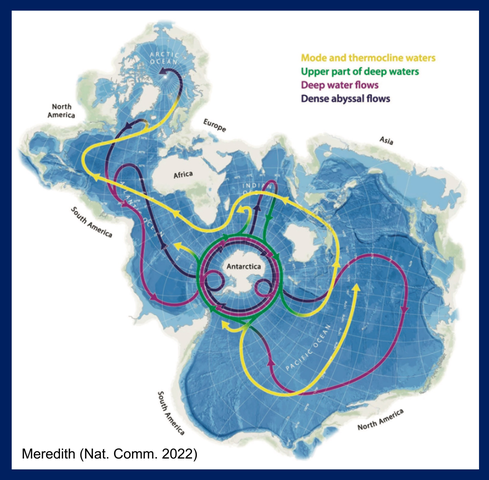
Thanks to V. Tamsitt, R. Abernathey, C. Prend, M. Mazloff, A. Morrison, H. Drake, H. Chen, A. Haumann, A. Gray, K. Johnson, J. Sarmiento

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.

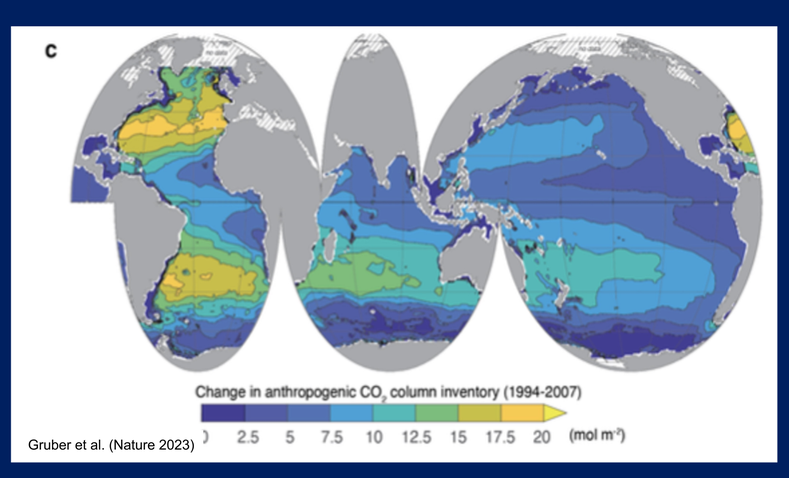
OVERVIEW and MOTIVATION



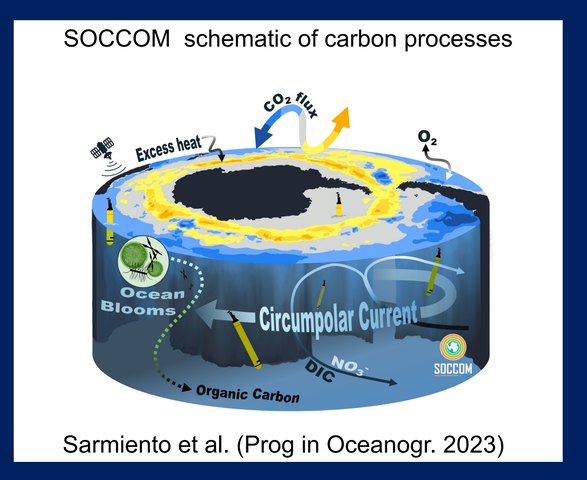
Talley (Oceanography 2013)



Meredith (Nat. Comm. 2022)



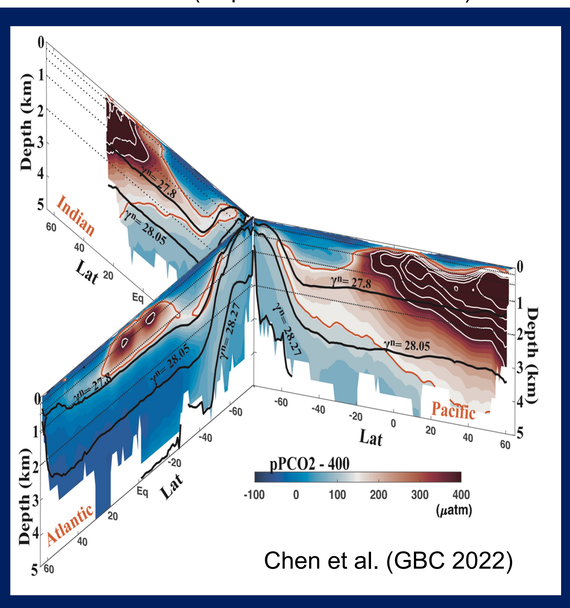
Gruber et al. (Nature 2023)



Sarmiento et al. (Prog in Oceanogr. 2023)

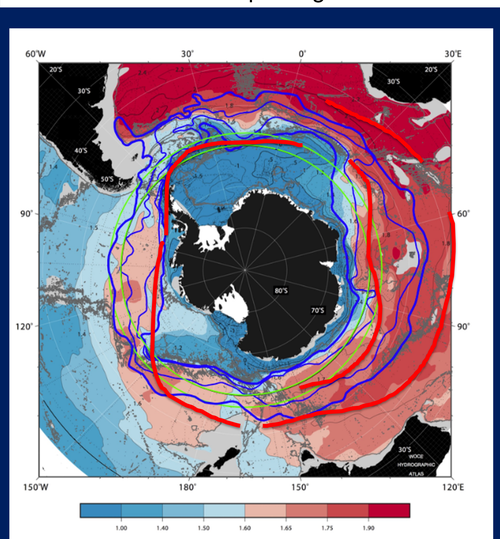
ZONALLY ASYMMETRIC INFLOW AND UPWELLING OF DEEP WATERS (ATLANTIC, INDIAN, PACIFIC) AND CARBON OUTGASSING

High carbon Deep Waters reach surface in Southern Ocean (ship obs. and BGC floats)



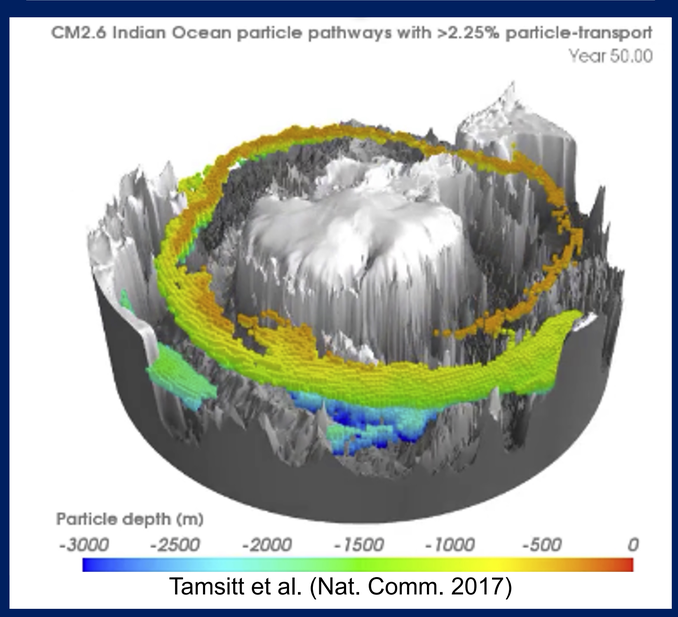
Chen et al. (GBC 2022)

Potential temperature on NADW isopycnal: warm water spiraling inward



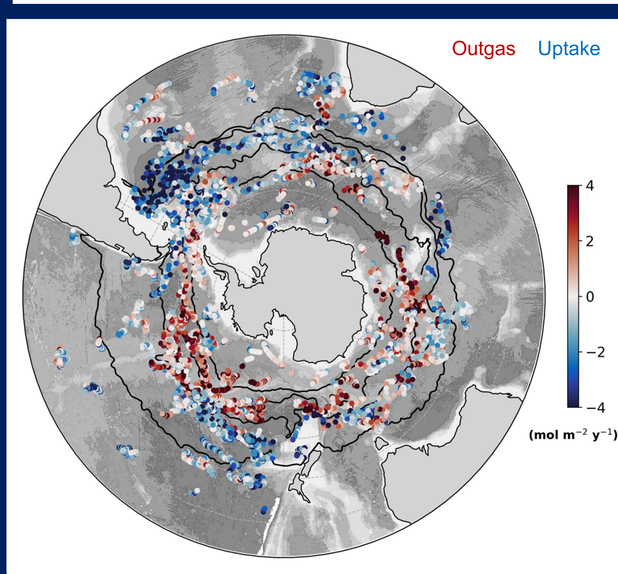
Orsi et al. (WHP Atlas, 2007)

Pathways of high carbon spiral inward and upward (SOSE, CESM, ESM6, matching hydrographic data)



Tamsitt et al. (Nat. Comm. 2017)

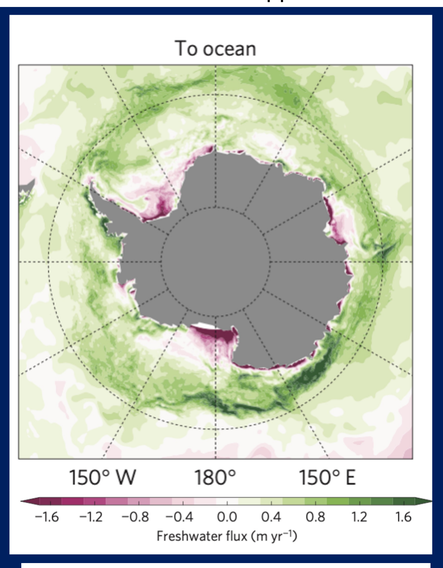
Carbon air-sea exchange (SOCCOM BGC floats)



Prend et al. (GBC, 2022); Gray et al. (GRL 2018)

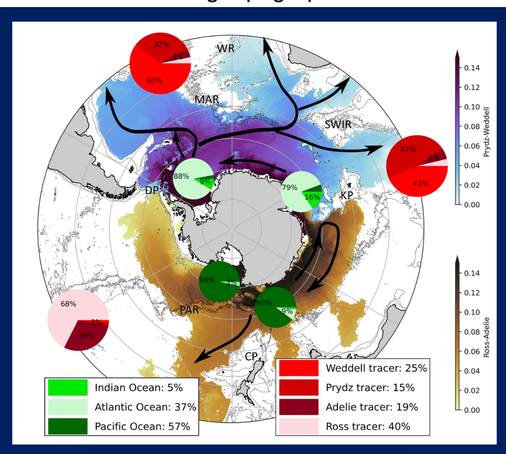
ZONALLY ASYMMETRIC AABW FORMATION

Freshwater forcing due to brine rejection and sea ice melt central to both the upper and lower cells



Abernathey et al. (Nat. Geosci. 2016)

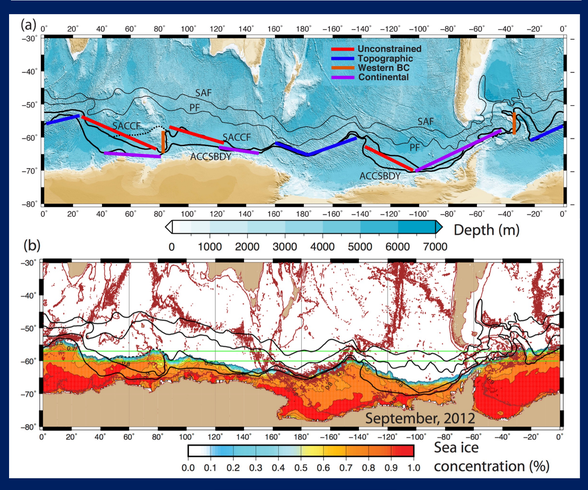
AABW formation in 4 places. Outward spiraling flow with strong topographic contraints



Solodoch et al. (GRL 2022)

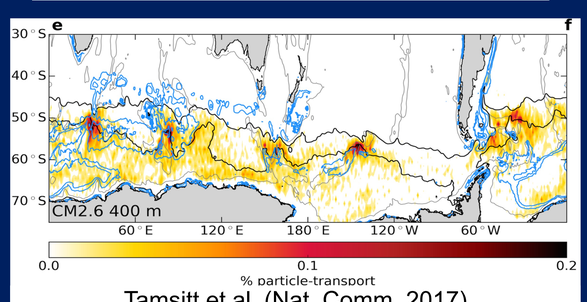
ZONALLY ASYMMETRIC DYNAMICS and SUBPOLAR OVERTURN

ACC fronts form scalloped standing meanders with different dynamics in each portion of structure



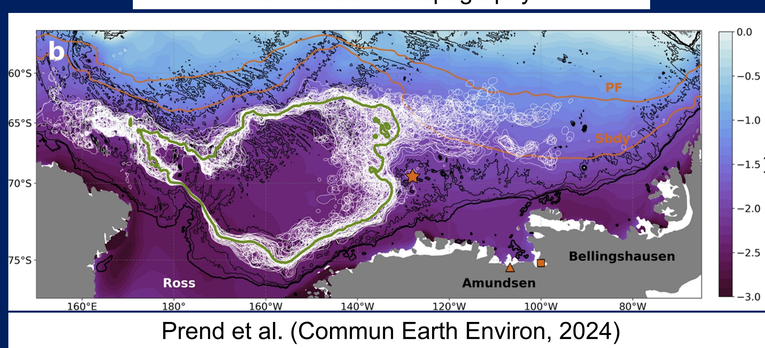
Talley (in prep)

Topography interacts with ACC: hotspots of upwelling (shown here across 400 m)



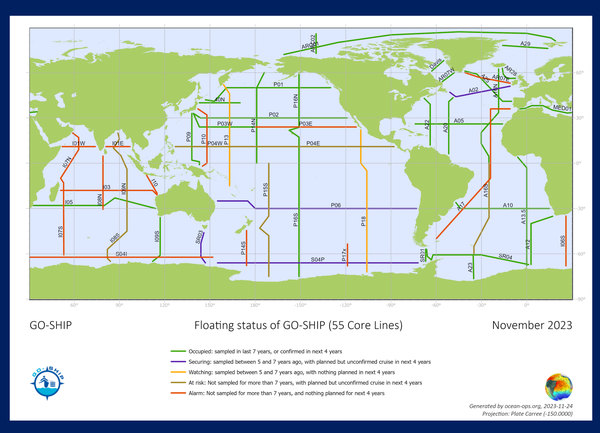
Tamsitt et al. (Nat. Comm. 2017)

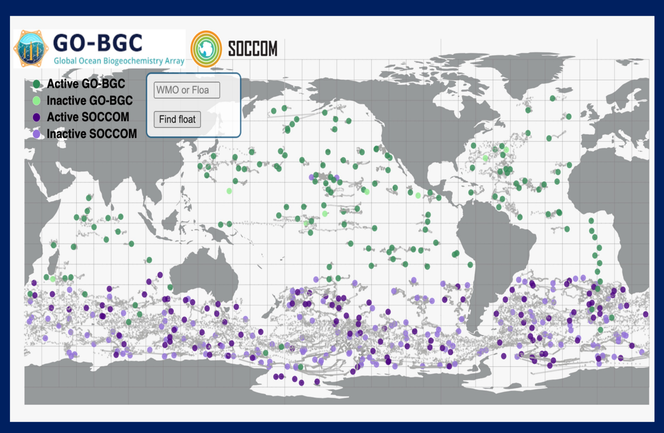
4-D overturning circulation in the Pacific sector: Bifurcation of SACCF with large variability downstream of topography

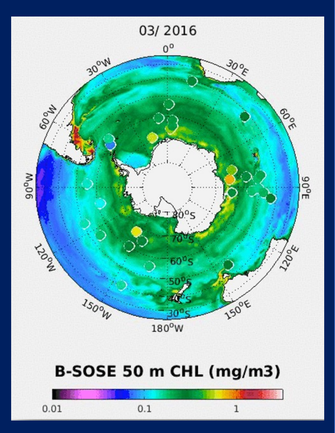


Prend et al. (Commun Earth Environ, 2024)

DATA: GO-SHIP and Argo SOCCOM: BGC and under-ice B-SOSE







ROUGH! Sketch April 2024