A Comparative Analysis of Ocean Reanalysis in the South Atlantic

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Abstract

The Atlantic Ocean plays a crucial role in the formation of deep and bottom waters, which are integral to the Atlantic Meridional Overturning Circulation (AMOC). The AMOC transports heat northwards across the Atlantic, making the South Atlantic Ocean unique compared to other ocean basins. Due to its role in global heat and salt redistribution, the variability in AMOC is believed to impact the climate. This variability may originate or be regulated in the South Atlantic through water mass mixing and exchanges between ocean basins, highlighting the importance of studying this region.

This study aims to evaluate five ocean reanalysis datasets in the South Atlantic Ocean to investigate their representation of key oceanographic features and the vertical structure of the ocean. The reanalysis datasets include GLORYS4 (1/4° resolution) and GLORYS12 (1/12°) from Mercator Ocean (France), BRAN (1/10°) from CSIRO (Australia), GOFS (1/12°) from the Naval Research Laboratory (USA), and FIOCOM (1/10°) from the First Institute of Oceanography (China).

For surface analysis, different ocean databases were used to calculate the mean BIAS, RMSE, and MAE for sea surface temperature (SST), sea surface salinity (SSS), sea surface height (SSH), and mixed layer depth (MLD). Additionally, temperature and salinity climatology from WOA23 were used for in-depth comparisons in three transect regions: the equator, 25°W, and 34°S. Accumulated and integrated transport related to water masses were also calculated for 34°S.

The results showed that all reanalysis datasets had difficulties in accurately representing high variability areas such as the Brazil-Malvinas Confluence and Agulhas Retroflection, especially in SST and SSH. Regarding SSS, the datasets struggled to represent the ocean near large river systems since SSS satellite data are not assimilated. The MLD tended to be overestimated in high latitudes, likely due to overestimation of westerlies in atmospheric forcing, leading to deeper MLD.

Overall, GLORYS12 presented the lowest errors, especially in time series analysis. For in-depth analysis in the transects, GLORYS4, GLORYS12, and GOFS were closer to climatology. The transport of Antarctic Bottom Water (AABW) was underestimated in most reanalysis, likely due to low resolution in the deep ocean. However, FIOCOM, with more levels near the bottom, showed a transport for AABW of 4.6 Sv, close to the literature. For other water masses, all reanalysis datasets tended to overestimate water masses transport in the upper ocean (South Atlantic Central Water and Antarctic Intermediate Water) and better represent the North Atlantic Deep Water.