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Interannual and Decadal Changes in Salinity in the Oceanic Subtropical Gyres

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There is evidence that the global water cycle has been undergoing an intensification over several decades as a response to increasing atmospheric temperatures, particularly in regions with skewed evaporation – precipitation (E-P) patterns such as the oceanic subtropical gyres. Moreover, observational data (rain gauges, etc.) are quite sparse over such areas due to the inaccessibility of open ocean regions.

In this work, a comparison of observational and model simulations are conducted to highlight the potential applications of satellite derived salinity from NASA Aquarius Salinity mission, NASA Soil Moisture and Ocean Salinity (SMOS), and ESA's Soil Moisture Active Passive (SMAP). We explored spatial and temporal salinity changes (and trends) in surface and subsurface in the oceanic subtropical gyres using Argo floats salinity data, Simple Ocean Data Assimilation (SODA) reanalysis, Estimating the Circulations & Climate of the Ocean GECCO (German ECCO) model simulations, and Hybrid Coordinate Ocean Model (HYCOM).

Our results based on SODA reanalysis reveals that a positive rising trend in sea surface salinity in the subtropical gyres emphasizing evidence for decadal intensification in the surface forcing in these regions. Zonal drift in the location of the salinity maximum of the south Pacific, north Atlantic, and south Indian regions implies a change in the mean near-surface currents responsible for advecting high salinity waters into the region. Also we found out that an overall salinity increase within the mixed layer, and a subsurface salinity decrease at depths greater than 200m in the global subtropical gyres over 61 years.

We determine that freshwater fluxes at the air-sea interface are the primary drivers of the sea surface salinity (SSS) signature over these open ocean regions by quantifying the advective contribution within the surface layer. This was demonstrated through a mixed layer salinity budget in each subtropical gyre based on the vertically integrated advection and entrainment of salt. Our analysis of decadal variability of fluxes into and out of the gyres reveals little change in the strength of the mean currents through this region despite an increase in the annual export of salt in all subtropical gyres, with the meridional component dominating the zonal. This study reveals that the salt content of E-P maximum waters advected into the subtropical gyres is increasing over time. A combination of increasing direct evaporation over the regions with increasing remote evaporation over nearby E-P maxima is believed to be the main driver in increasing salinity of the subtropical oceans, suggesting an intensification of the global water cycle over decadal timescales.