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Sea Level Anomalies in the Southern Ocean due to Thermohaline Variability

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The Southern Ocean is responsible for the majority of the global oceanic heat uptake which contributes to global sea level rise. At the same time, ocean temperature does not change everywhere at the same rate and salinity changes are also associated with sea level variability. Changes in heat and salt content drive together variations in the steric height that differ importantly in both time and space. This study investigates steric height variability in the Southern Ocean from 2008 to 2017 by analysing temperature and salinity variations obtained from global ocean reanalyses. The thermohaline variability is decomposed on so-called thermohaline modes using a functional Principal Component Analysis (fPCA). Thermohaline modes provide a natural basis on which to decompose the joint temperature-salinity vertical profiles into a sum of vertical modes weighted by their respective principal components. Steric height was computed in the reanalyses and related to the principal component using a Multiple Linear Regression (MLR) model. Trends in steric height are found to differ significantly between subtropical and subpolar regions, simultaneously which with a shift from a thermohaline stratification dominated by the first "thermocline" mode in the North to the second "saline" mode in the South. The Polar Front appears as a natural boundary between the two regions, where steric height variations are minimized. Since 2008, steric height has dropped close to the Antarctic continent, while subtropical waters farther north have mostly risen due to increased heat storage. While the dominant cause for the significant sea level rise south of 30S remains freshwater discharge from glaciers and ice sheets, thermohaline variability produces sizeable regional variability in the rate of sea level rise.