What Drives the Wind Stress Curl Over the Weddell Sea?

C. Grant[1], A. L. Gordon[2], X. Yuan[2]

[1]Department of Earth and Environmental Sciences, Columbia University, [2]Lamont-Doherty Earth Observatory of Columbia University

Antarctic Bottom Water (AABW) ventilates the deep ocean with cold, oxygenated water. The Weddell Sea Bottom Water (WSBW) is a major component of the AABW. In recent years (2015-2017) the WSBW underwent an anomalous change in salinity, ultimately attributed to a spin-up of the Weddell Gyre over the Weddell Sea (Gordon et al. 2020). The Weddell Gyre is driven by the cyclonic wind stress curl between the polar easterlies and the westerlies. The objective of this project is to better understand what influences the wind stress curl over the Weddell Gyre, both in the Southern Ocean, and in the tropics. A possible tropical link is suggested by a similarly timed anomaly in the Makassar Strait component of the Indonesian Throughflow (ITF), which is mainly associated with ENSO events (Gordon et al. 2019). Using ERA5 reanalysis climate data and climate index time series, the wind stress curl in the Weddell region is correlated and an empirical orthogonal function (EOF) analysis is applied in order to identify larger-scale local and remote drivers of wind stress curl. The westerlies over the Southern Ocean are found to be the largest drivers of the wind stress curl over the Weddell Gyre. SAM and Zonal Wave 3 constitute the first EOF mode, exerting a year-round influence and explaining 26.8% of the data. The second and third EOF modes each explain 6.6% and 6.1% of the Weddell curl data (for a total of 12.7%) and correlate with tropical Pacific sea surface temperature variability indicative of ENSO. There are significant correlations between Nino 1+2 and Nino 3+4, and the second and third EOF principal components, respectively. The correlations depend on the season with the greatest values during austral spring and fall, respectively. By connecting the wind stress curl over the Weddell Gyre to its regional and remote influences (especially ENSO), we can better understand the larger climate processes that can change the recipe of the WSBW, and by extension, the deep ocean ventilation.