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Year-to-year variations of Southern Ocean primary productivity driven by sub-seasonal forcing

Channing Prend[1], Madhavan Keerthi[2], Marina Lévy[2], Olivier Aumont[2], Sarah Gille[1], and Lynne Talley[1]

[1]University of California San Diego, Scripps Institution of Oceanography, La Jolla, United States of America (cprend@ucsd.edu)

[2]Sorbonne Université, CNRS, LOCEAN-IPSL, Paris, France

Primary productivity in the Southern Ocean plays a key role in global biogeochemical cycles. While much focus has been placed on phytoplankton seasonality, interannual fluctuations exceed the amplitude of the seasonal cycle across large swaths of the Antarctic Circumpolar Current. Interannual variability of surface chlorophyll, a proxy for phytoplankton biomass, is typically linked to changes in the ocean circulation associated with the Southern Annular Mode (SAM). However, it is important to note that variations in annual mean chlorophyll may reflect processes occurring across a broad range of timescales from sub-seasonal to multi-annual. Here, we apply a timeseries decomposition method to satellite-derived surface chlorophyll in order to separate the low-frequency and high-frequency contributions to the interannual variability. Throughout most of the Southern Ocean, interannual variations are dominated by the sub-seasonal component, which is not strongly correlated with the SAM. The multi-annual component, while correlated with the SAM, only accounts for about 10% of the total chlorophyll variance. This suggests that year-to-year variations in annual mean chlorophyll are related to high-frequency events driven by intermittent forcing at small scales, such as storms and eddies, rather than low-frequency climate variability. Consequently, interannual variations of primary productivity are highly localized and do not remain correlated over large regions.