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Seasonal Variation in the Correlation Between Anomalies of Sea Level and Chlorophyll in the Antarctic Circumpolar Current

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The Antarctic Circumpolar Current has highly energetic mesoscale phenomena, but their impacts on phytoplankton biomass, productivity, and biogeochemical cycling are not understood well. We analyze satellite observations and an eddy-rich ocean model to show that they drive chlorophyll anomalies of opposite sign in winter versus summer. In winter, deeper mixed layers in positive sea surface height (SSH) anomalies reduce light availability, leading to anomalously low chlorophyll concentrations. In summer with abundant light, however, positive SSH anomalies show elevated chlorophyll concentration due to higher iron level, and an iron budget analysis reveals that anomalously strong vertical mixing enhances iron supply to the mixed layer. Features with negative SSH anomalies exhibit the opposite tendencies: higher chlorophyll concentration in winter and lower in summer. Our results suggest that mesoscale modulation of iron supply, light availability, and vertical mixing plays an important role in causing systematic variations in primary productivity over the seasonal cycle.