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Understanding Regional Trends in Southern Ocean Eddy Kinetic Energy

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According to the eddy-saturation theory, changing winds in the Southern Ocean will primarily increase turbulence and not overall transport. Many studies using high-resolution models have demonstrated this, but observational evidence is limited. One study recent by Hogg et al. (JGR, 2015) demonstrated a 20-year trend in eddy kinetic energy (EKE), computed from satellite altimetry data, but only after averaging over large spatial areas.

In this study, we examine this problem further. First, we demonstrate altimetry tracks (and crossovers) are sufficient to sample the full EKE variability of the Southern Ocean. This is done sampling a high-resolution state estimate that resolves mesoscale eddies to altimetry tracks and crossover points. We then examine the average EKE from 1993-2018 over smaller regions than used in Hogg et al. (JGR, 2015). We use regions approximately 30° in longitude between northern and southern boundaries that encompass the primary high EKE regions of the Southern Ocean and the principal fronts of the Antarctic Circumpolar Current (ACC).

Our results suggest the conclusions reached by Hogg et al. (JGR, 2015) of observational support for the eddy-saturation theory may be premature. Although there are significant positive trends in EKE in one region of the Southern Ocean, this is primarily downstream of the Kerguelen Plateau, which is known to be an area of high EKE. In other regions where there is no interaction of the ACC jets with bathymetry, EKE does not change significantly. This one region alone can explain the broad Indian Ocean and Pacific Ocean estimates that Hogg et al calculated, suggesting those estimates were biased by regional extremes, and not an overall increase in EKE over the entire Southern Ocean.