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Seasonality of the Mesoscale Inverse Cascade as Inferred from Global Scale-Dependent Eddy Energy Observations

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Oceanic mesoscale motions including eddies, meanders, fronts, and filaments comprise a dominant fraction of oceanic kinetic energy and contribute to the redistribution of tracers in the ocean such as heat, salt, and nutrients. This reservoir of mesoscale energy is regulated by the conversion of potential energy and transfers of kinetic energy across spatial scales. Whether and under what circumstances mesoscale turbulence precipitates forward or inverse cascades, and the rates of these cascades, remain difficult to directly observe and quantify despite their impacts on physical and biological processes. Here we use global observations to investigate the seasonality of surface kinetic energy and upper ocean potential energy. We apply spatial filters to along-track satellite measurements of sea surface height to diagnose surface eddy kinetic energy across 60-300 km scales. A geographic and scale dependent seasonal cycle appears throughout much of the mid-latitudes, with eddy kinetic energy at scales less than 60 km peaking 1-4 months before that at 60-300 km scales. Spatial patterns in this lag align with geographic regions where the conversion of potential to kinetic energy are seasonally varying. In mid-latitudes, the conversion rate peaks 0-2 months prior to kinetic energy at scales less than 60 km. The consistent geographic patterns between the seasonality of potential energy conversion and kinetic energy across spatial scale provide observational evidence for the inverse cascade, and demonstrate that some component of it is seasonally modulated. Implications for mesoscale parameterizations and numerical modeling are discussed.