The global sink of available potential energy by mesoscale air-sea interaction

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Oceanic eddy potential energy (EPE) generation is proportional to the positive covariance between sea surface temperature (SST) and net air-sea surface heat flux (NHF). The NHF arises from contributions due to short wave, long wave, and turbulent sensible and latent heat fluxes. A recent study with a regional coupled model of the Kuroshio Extension that explicitly resolves mesoscale eddies shows that air-sea feedbacks dominate EPE destruction, which amounts to more than 70 percent of the EPE extracted from the Kuroshio Extension (Ma et al. 2016). However, it is possible that the air-sea feedbacks associated with mesoscale eddies are exaggerated in this modeling study. Here we use both high-resolution observations (J-OFURO3) and output from a fully coupled high-resolution global climate simulation (CESM) to assess the EPE generation term and its time and space scale dependence. The air-sea feedbacks generated by mesoscale eddies do act as a sink of global EPE available to be converted to eddy kinetic energy in a Lorenz energy cycle rather than a source, which had been previously proposed in von Storch et al. (2012). The traditional definition of an "eddy" as a deviation from the time mean does not accurately reflect their true essence, which is compromised in regions of the ocean with a large seasonal cycle and deceptively appears as a source of EPE. We find consistent results between model and observations that dissipation is largest in the midlatitude Southern Ocean and northern hemisphere as well as the tropics where SST variability is highest globally. By successively smoothing the data sets spatially and temporally we find that dissipation is largest at time scales less than a year and at length scales less than 100 km, within the mesoscale band. This sink of EPE diminishes at longer time and space scales reflecting what is missing in standard low-resolution climate simulations that don't resolve mesoscale eddies.