Space-time scales of geostrophic motions and implications for ocean circulation trend detection

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Data describing the general circulation of the ocean are extremely noisy. The extraction of signals from such observations requires a detailed knowledge of the space and time scales of the stochastic variability. We present an empirical, analytical model for the frequency and wavenumber distribution of balanced motion in the ocean. The spectrum model spans periods longer than the inertial but shorter than a decade and wavelengths between 100 and 10,000 km. Assuming geostrophic dynamics, the spectrum model for the streamfunction is constructed to be consistent with a range of observations, including sea surface height from satellite altimetry, velocity from moored and shipboard instruments, and temperature from moorings. The spectrum model is used to discuss uncertainties in climate observations, and in particular the time needed to detect significant trends in meridional overturning circulation.