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KE cascade and wavenumber spectra within the ocean mesoscale inertial range.

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Kinetic energy wavenumber spectra provide information on the regime of turbulent energy exchanges across scales in the ocean. This is why a lot of efforts have focused on assessing how the slopes of ocean surface kinetic energy wavenumber spectra compare with the slopes predicted by simplified models of ocean dynamics (QG, SQG) in the quasi-two dimensional turbulence inertial range. Analyses of high resolution ocean circulation models suggest that the slopes of ocean surface kinetic energy wavenumber spectra lie between the prediction of QG (k^{-3}) and SQG (k^{-2}) models with strong spatial variations modulated by the levels of surface eddy kinetic energy. Analysis from altimetry also show constrasted results, within the limits set by the resolution capability of current generation altimeters. In this study we focus on quantifying the rate of turbulent kinetic energy exchange and the inverse cascade of energy through advective nonlinearity in the mesoscale inertial range. Our analysis is based on model output from a kilometric grid resolution, North Atlantic, sub-mesoscale permitting ocean circulation model configurations based on NEMO. The novelty of this study is to focus specifically on kinetic energy exchanges within the inertial range, which is defined as the scales between the dominent energy containing scale (integral scale) and the models effective resolution (where numerical dissipation becomes significant). Our results show that north of 30°N the energy containing scale of mesoscale eddies decreases with latitude following the first Rossby radius of deformation (Rd) while the nonlinearity of eddies (ratio of the Rhine scale Rh to integral scale) increases with latitude. Within the inertial range, we find that surface kinetic energy wavenumber spectra show slopes close to k^{-3}. Model turbulent regimes are therefore comparable with QG predictions in most of the North Atlantic Ocean north of 30°N, in both high and low eddy kinetic energy regions. Analysis of KE transfers due to advective nonlinearity further show that, in most of the North Atlantic, KE is injected at scales close to Rd and cascades towards larger scales. In regions of weak nonlinearity this inverse cascade is arrested close to the Rhine scales (Rh). Our result also show that estimates of KE transfers based on geostrophic currents significantly underestimate the inverse cascade, which questions our ability to infer oceanic energy cascade from altimetry and the future SWOT mission.