Title

Cross-scale interactions and turbulent cascades in the North Atlantic Ocean.

Abstract

The dynamics of the ocean at a scale < 100km (fine-scales) is currently not well known. This is due to the lack of sufficient observational datasets at this scale-range in the ocean. There are suggestions from recent studies that classes of motions at this scale-range impacts the distribution and exchanges of kinetic energy in the ocean and that balanced submesoscale motions (<50km) and unbalanced internal gravity waves can play an active role in fluxing kinetic energy towards dissipative scales in the ocean.

To better understand fine-scale motions, the Surface Water and Ocean Topography (SWOT) satellite with the task of providing an unprecedented view of the ocean down to a wavelength of 10-15km is been assembled and expected for launch in 2021. In anticipation of SWOT, numerical ocean models capable of resolving fine-scales has been designed and implemented. In this study, we use three of these simulations to investigate (i) the spatial, temporal and depth variability of oceanic eddies at fine-scales down to 10km scale, (ii) the cross-scale kinetic energy exchanges at fine-scales in a regime of active submesoscale motions and externally forced internal gravity waves.

Our results show that the distribution of oceanic fine-scale eddies undergoes strong seasonality that is associated with submesoscale turbulence in wintertime. Further analysis showed that submesoscale turbulence also affects the exchanges of kinetic energy by providing a route for kinetic energy dissipation both at the surface and in the interior of the ocean. Interestingly, this cascade in the presence of externally forced internal gravity waves is increased by a factor of 3 in summertime due to enhanced wave activity by tidal forcing. Our result also shows that not accounting for the ageostrophic flows in the calculation of cross-scale kinetic energy exchanges might underestimate the true magnitude of the forward cascade of energy.