Disentangling inertial waves from eddy turbulence in a forced rotating turbulence experiment

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Abstract

We present a spatio-temporal analysis of a statistically stationary rotating turbulence experiment, aiming to extract a signature of inertial waves, and to determine the scales and frequencies at which they can be detected. The analysis uses two-point spatial correlations of the temporal Fourier transform of velocity fields obtained from time-resolved stereoscopic particle image velocimetry measurements in the rotating frame. We quantify the degree of anisotropy of turbulence as a function of frequency and spatial scale. We show that this space-time-dependent anisotropy is well described by the dispersion relation of linear inertial waves at large scale, while smaller scales are dominated by the sweeping of the waves by fluid motion at larger scales. This sweeping effect is mostly due to the low-frequency quasi-two-dimensional component of the turbulent flow, a prominent feature of our experiment which is not accounted for by wave turbulence theory. These results question the relevance of this theory for rotating turbulence at the moderate Rossby numbers accessible in laboratory experiments, which are relevant to most geophysical and astrophysical flows.

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