Near-inertial and multiple-inertial internal waves trapped by negative-vorticity regions in the Subpolar Front of Japan Sea

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In this study, we investigated the interaction between internal gravity waves and mesoscale features near the frontal region in the Sea of Japan. A moored ADCP current record deployed in the central pathway of meandering flow in the Japan Sea is analyzed. The data analyses showed that in a mesoscale feature of negative vorticity, massive strength of near-inertial internal waves (NIWs) were found to propagate in the upper water (<300 m). Near the critical depth, where background vorticity diminishes nearly to zero, the amplification of NIW reached > 50 cm s-1 in root-mean-square magnitude. The mid-depth NIWs were characteristically concurrent with the emergence of super-inertial oscillations, peaking at frequencies of multiple inertial (MI), i.e., double, triple, quadruple, other than the near-inertial one (see a spectral plot). The MI oscillations are considered to arise through the nonlinear resonance of NIW, which is proposed by Danioux et al. (2008). By analyzing reanalysis surface wind, it turns out that a fast-moving cyclone passing over the site would be the primary energy source for the NIW generation. In conclusion, we obtained the following picture of the kinetic energy flow in the Japan Sea ––the stormy event initially provides the energy into the oceanic surface layer, resulting in the generation of NIWs; the NIWs are trapped by anticyclonic vortices, with negative vorticity, and then transferred its energy into the MI oscillations; they ended up to mostly dissipate into turbulence.

Keywords: Japan Sea , Trapping of internal gravity waves , Relative vorticity , Overtone harmonics , Nonlinear resonance

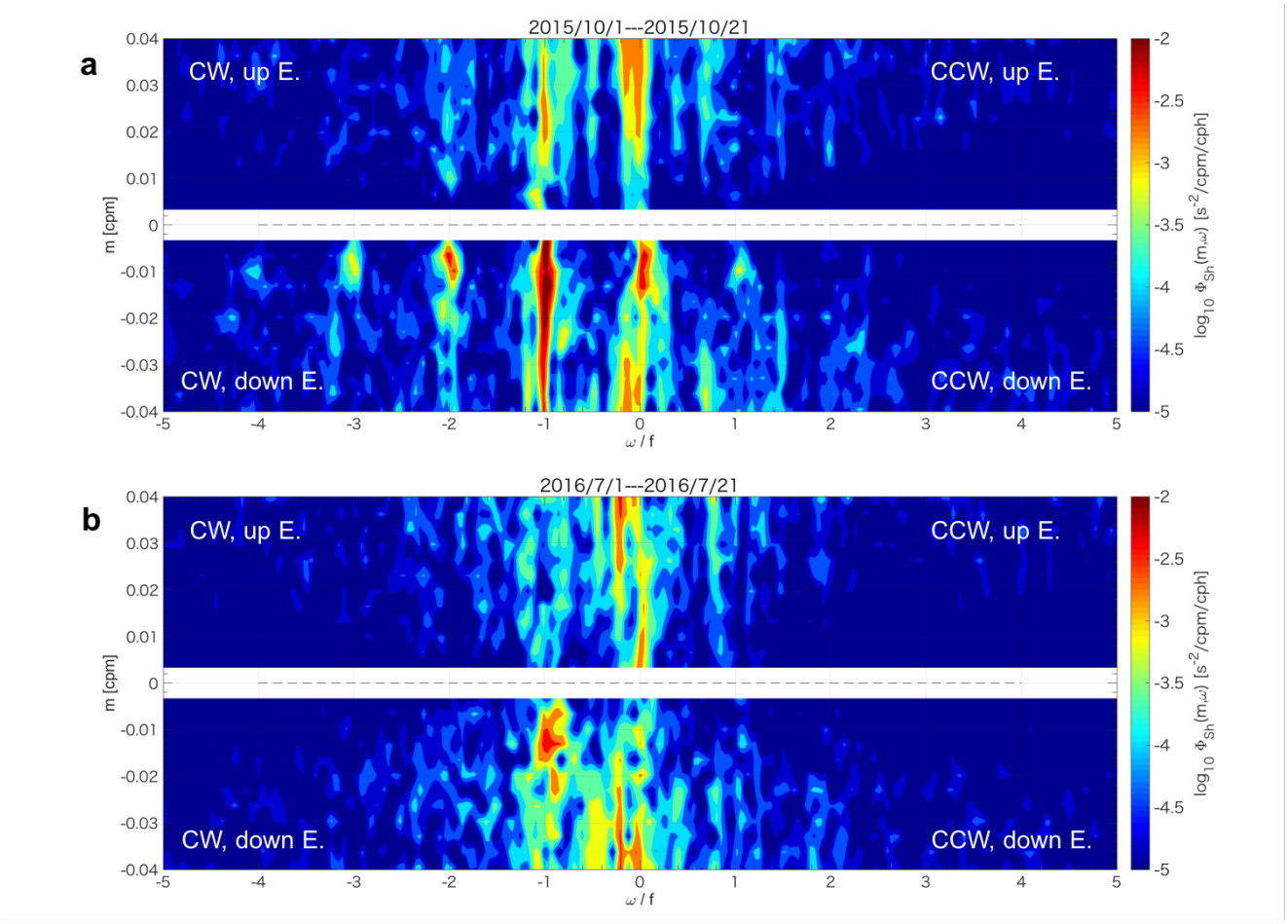

Figure: Two-dimensional Fourier spectra of vertical shear for normalized frequency, *ω/f*, and vertical wavenumber, *m*: (a) the case of overtone harmonic internal waves peaking at multiple inertial frequencies in the third quadrant (clockwise & downward energy propagation); (b) normal case of wind-induced internal waves, having a single peak near the local inertial, f, in the third quadrant.