Geophysical Research Abstracts
Vol. 16, EGU2014-3230, 2014
EGU General Assembly 2014

Weakly nonlinear dynamics and fully nonlinear simulations of trapped waves on jet currents

Alexey Slunyaev (1,2) and Victor Shrira (3)

(1) Instutute of Applied Physics, Nizhny Novgorod, Russian Federation (slunyaev@hydro.appl.sci-nnov.ru), (2) Nizhny Novgorod State Technical University, Nizhny Novgorod, Russia, (3) Department of Mathematics, EPSAM, Keele University, UK (v.i.shrira@keele.ac.uk)

The asymptotic modal approach developed in Shrira & Slunyaev (2014) for waves trapped by an opposing jet current is extended by examining the weakly nonlinear dynamics of trapped waves due to four-wave resonances. Evolution equations governing dynamics of an arbitrary number of wave packets have been derived. In particular, for a single mode the asymptotic procedure yields the integrable one-dimensional nonlinear Schrodinger equation (NLS). The NLS describes the evolution of modes along the current, while the modal structure is specified by the corresponding boundary value problem (BVP). When the current is weak in comparison with the wave celerity, the BVP reduces to the classic stationary Schrodinger equation with conditions of decay outside the jet, which allows exact solutions for a number of model current profiles. This enables us to find analytically the interaction coefficients in the dynamic equations. Thus, to the leading order a variety of analytic solutions to the evolution equation and the BVP specifying the trapped modes is readily available.
A few such asymptotic solutions are tested in numerical simulations of the Euler equations. The equations are solved by means of the adapted High Order Spectral Method (West et al, 1987). Single trapped mode solutions are simulated: the uniform waves train, modulated wave train, and solitary wave packets. The weakly nonlinear theory is shown to be a reasonable first approximation to the solution even in the case of rather steep waves. Solitary patterns of trapped waves were found to be robust, though an insignificant radiation is observed in the course of their propagation, which suggests that the solitary wave patterns represent important elements of nonlinear dynamics of gravity waves on jet currents. Their presence in the stochastic wave field may result in significant deviation from the Gaussianity, and increase the extreme wave probability.

Shrira, V.I., Slunyaev, A.V. Trapped waves on jet currents: asymptotic modal approach. J. Fluid Mech. 738, 65-104 (2014).
West, B.J., Brueckner, K.A., Janda, R.S., Milder, D.M., Milton, R.L. A new numerical method for surface hydrodynamics. J. Geophys. Res. 92, 11803–11824 (1987).