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Envelope Solitons in Geophysical Flows

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While not as widely discussed as long wave soliton models of atmospheric and oceanic phenomena, envelope soliton solutions to the nonlinear Schrödinger equation have been proposed to describe events such as mid latitude planetary scale dipole blocks, Rossby wave breaking in the extratropical tropopause and equatorial Rossby-gravity ocean waves. Despite these applications, most studies have been limited to the case of constant zonal shear, and little work has been done on the effects of baroclinicity or variable shear on these weakly nonlinear structures. This talk will discuss the effects of variable shear, stratification and topographic forcing on small amplitude oceanic envelope solitons at mid latitudes, as derived analytically from perturbation analysis, and observed numerically in a semi-Lagrangian, spectral element model of a layered quasi-geostrophic ocean. While meridionally varying shear is found to primarily modify the range of unstable wave numbers and their growth rates subject to edge wave instabilities, the coupling of a thin upper layer to a deep lower layer is found to modify the group velocity of the upper layer disturbance.