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# Blow-up of subsurface vorticity waves in the ocean under strong winds

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Understanding mixing in the uppermost part of the water column is crucial for modelling air-sea interaction. Specific mechanisms of mixing under strong wind conditions are poorly understood. Under strong winds entrainment of air bubbles into the water caused by intense surface wave breaking leads to the creation of a multiphase flow of "bubbly" fluid adjacent to the surface. This makes the boundary layer in water density stratified. A stratified boundary layer supports gravity wave modes and vorticity mode. Since there are arguments that vorticity mode dynamics is most interesting and important, we focus our attention on weakly nonlinear dynamics of the vorticity mode in a generic stratified boundary layer. To leading order vorticity wave represents just an oscillation of downwind velocity in the boundary layer with the cross wind and vertical components being much smaller. Employing an asymptotic procedure utilizing smallness of the boundary layer thickness to the characteristic wavelength and smallness of the inverse Reynolds number we derive nonlinear evolution equation with a pseudo-differential dispersion term taking into account viscosity and weak stratification effects in the boundary layer. No paraxial approximation has been used, i.e. the transverse spatial scales are of the same order as the longitudinal ones. It has been shown within the framework of the model that a wide class of initial conditions leads to blow-up, that is a (sufficiently large) initial perturbation becomes more and more localized and its amplitude becomes infinite in finite time. In practice, this means an intense mixing and even destruction of the boundary layer. The presence of stratification stabilizes the flow by raising the threshold for the initial perturbations to blow up.