



Interaction between gravity waves and potential vorticity perturbations leading to spontaneous wave generation

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Mechanisms of internal gravity wave generation have been intensively studied because of the role of internal wave energy generation and dissipation in the large-scale atmospheric and oceanic circulation. In this work, we study the interaction among potential vorticity perturbations and gravity waves in a stably stratified, horizontally sheared zonal flow. Our purpose is to clarify the role of potential vorticity perturbations and nonnormal interactions between vorticity and internal wave perturbations in the process of spontaneous wave generation. In the strong stratification limit, an initial vorticity perturbation weakly excites two propagating gravity waves due to the absence of a frequency matching between vorticity perturbations and gravity waves. If stratification is sufficiently weak, a strong coupling between vorticity perturbations and gravity waves is found and spontaneous wave generation occurs. This coupling can be traced to the nonnormal interaction between the potential vorticity and gravity wave manifolds in the weak stratification limit. Vorticity perturbations amplify in energy due to downgradient Reynolds stress when their phase lines tilt against the shear and the large growth attained is transferred to propagating gravity waves. When the flow geometry is such that the excited gravity waves are confined in the vicinity of the vorticity perturbation by their trapping levels, an overall convective collapse of this region can be anticipated. On the other hand, when the flow geometry permits wave propagation, significant gravity wave emission occurs.