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Internal-gravity wave structures in the ionosphere with shear flow

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A study is made of the generation and further evolution of internal-gravity wave (IGW) structures in the dissipative ionosphere in the presence of a nonuniform zonal wind (a sheared flow). The efficiency of the linear amplification of IGW structures in their interaction with a nonuniform zonal wind is analyzed. When there are sheared flows, the operators of linear problems are non-self-conjugate and the corresponding eigenfunctions are nonorthogonal, so the canonical modal approach is poorly suited for studying such motions and it is necessary to utilize the so-called nonmodal mathematical analysis. It is shown that, in the linear evolutionary stage, IGW efficiently extract energy from the sheared flow, thereby substantially increasing their amplitude and, accordingly, energy (by several orders). As the shear instability develops and the perturbation amplitude grows, a nonlinear self-localization mechanism comes into play and the process ends with the self-organization of nonlinear, highly localized, solitary IG vortex structures. The system thus acquires a new degree of freedom, thereby providing a new way for the perturbation to evolve in a medium with a sheared flow. Depending on the shape of the sheared flow velocity profile, nonlinear structures can be either purely monopole vortices or vortex streets against the background of the zonal wind. The accumulation of such vortices can lead to a strongly turbulent state in an ionospheric medium.