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Vortex-based Models of Quasigeostrophic Turbulence

Takeshi Miyazaki, Qin Wei, Yingtai Li

Department of Mechanical Engineering and Intelligent Systems, University of Electro-Communications, Tokyo, Japan

A vortex-based model of the quasigeostrophic turbulence is developed, based on the fact that the vorticity field develops coherent vortex structures and that their interactions dominate the dynamics of the turbulence. Each coherent vortex is modeled by an ellipsoid of uniform potential vorticity embedded in a 'locally uniform shear field' induced by other vortices (Meacham's ellipsoid). The equations of motion are derived following the procedure of Hamiltonian moment reduction. The degree of freedom of N interacting vortices is 3 N, and even a two-body system shows chaotic behavior. The validity of the ellipsoidal moment model is assessed by performing direct numerical simulations based on the CASL-algorithm. It is shown that the model captures the merger of co-rotating vortices well but that it fails to predict the robustness of a counter-rotating vortex pair. A possible way to refine the model is suggested.

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