Impact of Shear Flow on Turbulent Transport in a Neutral Fluid

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Abstract

Numerical simulations of a geostrophic vorticity equation are presented. In large-scale atmospheric flows, the Earth's rotation stratifies the flow, inducing two-dimensional behavior in the flow. The Earth's rotation also stabilizes large-scale flows that would otherwise be unstable to Kelvin-Helmholtz instabilities, similar to the effect of the magnetic field in magnetized plasma flow. We present two types of numerical simulations of two-dimensional geostrophic flow: a pseudospectral model (PSM) [1] and a finite-elemental model (FEM) which uses the FEMLAB [2] software. Previous work using just the pseudospectral model has shown that the straining by a sheared, barotropically stable, large scale jet, leads to a reduction of the cross-flow scale of turbulent flow. This reduction is a result of the combined effect of shear straining by the jet which is dominant at large scales and turbulent decorrelation which is dominant at small scales. This is isomorphic to the reduction of turbulent transport in a plasma by sheared E×B flows. Here, results from the PSM are compared with results from the FEM simulations. Using the FEM method also allows for the possibility of testing the impact of a linear shear flow on turbulent transport (which is not possible in a spectral or pseudospectral code).

[1] A. S. Ware, P. W. Terry, M. H. Hitchman, and D. E. Newman, "The role of shear flow in stratospheric transport barriers", *Proceedings of the 10th Conference on Waves and Stability*, (1994).
[2] FEMLAB