Z216b Flow induction by inhomogeneous turbulent helicity

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A prominent effect of turbulence is transport enhancement through eddy viscosity, eddy diffusivity, turbulent magnetic diffusivity, etc. However, in a system with broken symmetry, turbulence may also contribute to transport suppression. Turbulent dynamo against the turbulent magnetic diffusivity is one of such examples. In this work, the effect of kinetic helicity (velocity–vorticity correlation) on turbulent momentum transport is investigated. The turbulent kinetic helicity (pseudoscalar) enters into the Reynolds stress (mirrorsymmetric tensor) expression in the form of a helicity gradient as the coupling coefficient for the mean vorticity and/or the angular velocity (axial vector), which suggests the possibility of mean-flow generation in the presence of inhomogeneous helicity. This inhomogeneous helicity effect, which was previously confirmed at the level of a turbulence- or closure-model simulation, is examined with the aid of direct numerical simulations of rotating turbulence with non-uniform helicity sustained by an external forcing. The numerical simulations show that the spatial distribution of the Reynolds stress is in agreement with the helicity-related term coupled with the angular velocity, and that a large-scale flow is generated in the direction of angular velocity. Such a large-scale flow is not induced in the case of homogeneous turbulent helicity. This result confirms the validity of the inhomogeneous helicity effect in large-scale flow generation and suggests that a vortex dynamo is possible even in incompressible turbulence where there is no baroclinicity effect.