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Potential Vorticity Dynamics and Models of Zonal Flow Formation PEI-CHUN HSU, PATRICK DIAMOND, CASS and Department of Physics, UCSD — We describe the general theory of anisotropic flow formation in quasi-2D turbulence from the perspective on inhomogeneous potential vorticity (PV) mixing. The aim is to develop a vorticity transport operator, for use in modelling codes. The general structure of PV flux is deduced non-perturbatively using two relaxation models: the first is a mean field theory for the dynamics of selective decay based on the requirement that the mean PV flux dissipates potential enstrophy but conserves kinetic energy. The analyses show that the structure of PV flux has the form of a sum of a hyper-viscous and a viscous flux of PV. In the relaxed state, the ratio of the PV gradient to zonal flow velocity is homogenized. The homogenized quantity sets a constraint on the amplitudes of final-state PV and zonal flow. The second relaxation model is derived from a joint reflection symmetry principle, which constrains the PV flux driven by the deviation from the self-organized state. The form of PV flux contains, in addition to viscous and hyper-viscous terms, a nonlinear convective term, which can be generalized to an effective diffusion, on account of the gradient-dependent ballistic transport in avalanche-like systems. For both cases, the transport coefficients are calculated using perturbation theory.

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