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Batchelor's corrections in atmospheric turbulence

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We generalize Batchelor's parameterization of the autocorrelation functions of turbulence in a form involving a product expansion with multiple small scales. The richer small scale structure acquired this way, compared to the usual Batchelor function, is necessary so that the associated energy spectrum approximate well actual spectra in the universal equilibrium range. We propose that the generalized function provides an approximation of arbitrary accuracy for actual spectra of isotropic turbulence over the universal equilibrium range. The degree of accuracy depends on the number of higher moments which are determinable and it is reflected in the number of small scales involved. The energy spectrum of the generalized function is derived, and for the case of two small scales is compared with data from high-resolution direct numerical simulations and also with atmospheric measurements. We show that the compensated spectra (which illustrate the bottleneck effect) and dissipation spectra are encapsulated excellently, in accordance with our proposal. The calculated stresses and the corresponding mass fluxes are in close agreement with the measurements and reveal an increase to the production of vertical mass transfer which may modify effectively the evaporation and the precipitation mechanisms in atmospheric models.