Development of a Third-order Closure Turbulence Parameterization for Partly Cloudy Boundary Layers

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Abstract

Despite the increasing resolution of cloud-system-resolving models, boundary layer clouds and turbulence remain unresolved phenomena and require parameterization. One approach that is commonly adopted utilizes higher-order closure to solve for turbulent fluxes of momentum, heat, and moisture together with a PDF-type subgrid-scale condensation parameterization to diagnose fractional cloud cover within the boundary layer. Such a scheme allows for interaction between boundary layer clouds and turbulence through the buoyancy terms of the higher-order moments’ predictive equations. A new turbulence parameterization using this approach has been developed and tested as a single column model using cases from the GCSS Boundary Layer Cloud Working Group.

The parameterization uses full predictive equations for 10 second-order moments and algebraic diagnostic relations for 28 third-order moments, extending the work of Cheng et al. (2005) to facilitate boundary layer cloudiness. Buoyancy terms are calculated using an “effective cloud fraction” that interpolates between their dry and cloudy limiting values after Lewellen and Lewellen (2004). Results using the new parameterization are compared to those from an ensemble of LES participants for each test case.

References
