Geophysical Research Abstracts
Vol. 15, EGU2013-12614, 2013
EGU General Assembly 2013

A Consistent Treatment of TKE and Scalar Variance in an Eddy Diffusivity Mass Flux Scheme

Kyle Pressel (1), Tapio Schneider (1), Joao Teixeira (2), Remi Lam (1), Zhihong Tan (1), Colleen Kaul (2), Kay Suselj (2), Marcin Witek (2), and George Matheou (2)

(1) California Institute of Technology , (2) Jet Propulsion Laboratory/California Institute of Technology

Eddy Diffusivity Mass Flux (EDMF) schemes have shown significant utility in parameterizing boundary layer turbulent fluxes and as a basis for unifying the parameterization of boundary layer turbulence and clouds. EDMF schemes are based upon an updraft/environment decomposition of turbulent fluxes. A steady state bulk updraft model is used to represent the updraft, or mass flux, portion of the decomposed fluxes, while the environment component is represented with an eddy diffusivity closure. Typically, the eddy diffusivity closure is formulated as a 1.5 order closure requiring the solution of a prognostic equation for the turbulent kinetic energy (TKE). To date, however, EDMF schemes have not been formulated in a manner that formally separates the TKE in the environment from that in updraft.

We present a new EDMF parameterization that respects the updraft/environment decomposition more formally. Orthogonally decomposing the TKE into updraft and environment components allows the eddy diffusivity closure for the environmental fluxes to be based on a prognostic equation for the environmental TKE. The updrafts interact with the environment by entraining environmental TKE and detraining mean updraft kinetic energy. The environmental TKE is then used to compute the environmental eddy diffusivity. We argue that an EDMF scheme formulated in this manner is more energetically and conceptually consistent. This formalism is then extended to provide a consistent parameterization of scalar variances.

Applying this new formalism has several benefits. First, it removes the need to include the updraft buoyancy flux in the TKE equation, hence conceptually simplifying the EDMF scheme. Second, under relaxation of the requirement that updrafts occupy only a small area fraction, the environmental TKE obeys the limit that as updraft area fraction goes to unity the environmental TKE goes to zero. This second benefit has clear advantages for extension of the EDMF framework to scale dependent parameterization.

The new EDMF parameterization is implemented in a single column model and is shown to perform favorably in comparison to turbulence statistics from large eddy simulations.