MMM SEMINAR SERIES

Development and Evaluation of a Stochastic Subgrid-scale Mixing Scheme for Application to the Convective Grey Zone

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Models run within the convective “grey” zone (i.e. 1-3 km horizontal grid spacing) are unable to resolve the spectrum of updraft sizes produced by large eddy simulations (LESs). This deficiency results in updrafts in km-scale models being too wide, and since lateral mixing is inversely proportional to updraft width, leads to reduced dilution. Addressing this issue is becoming increasingly important as global models approach convection-permitting resolution but global LES remains intractable. Since shortcomings associated with the model’s effective resolution are inevitable, more sophisticated parameterizations are necessary to overcome the mixing problem. In this work, we allow for enhanced but variable mixing in time and space by applying a stochastic framework within a Smagorinsky-type first order turbulence closure. Specifically, a stochastic multiplicative factor is applied to the closure’s horizontal eddy diffusion coefficient, which controls lateral mixing. Conceptually, this framework allows some updrafts to mix vigorously with mid-level environmental air while also allowing other updrafts to remain relatively undilute.

The stochastic scheme is used to simulate a quasi-idealized squall line using a sounding from the pre-convective environment of an observed mesoscale convective system (MCS) that occurred during the Midlatitude Continental Convective Clouds Experiment (MC3E). Comparisons are made between stochastic simulations at 1-3 km grid spacing, baseline simulations using the standard Smagorinsky-type (non-stochastic) closure at the same grid spacing, and a LES run at 125 m grid spacing. These comparisons show that the stochastic scheme alters vertical profiles of mass flux and vertical velocity as well as other key squall line features such as cold pool strength and condensate mass spatial structure. Moreover, the stochastic scheme alters these features and structures in a manner not capable by simply diagnostically applying constant multiplicative factors to the diffusion coefficient. Finally, scale adaptability is discussed along with potential expansion of the scheme to non-idealized frameworks.

Thursday, 15 August 2019, 3:30pm

Refreshments 3:15pm

NCAR-Foothills Laboratory, 3450 Mitchell Lane, FL2-1022, Large Auditorium

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