Ongoing Development and Applications of the Grell-Freitas Cumulus Parameterization

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We will present some recent improvements to the GF parameterization. These include two features that were added to the Grell-Freitas (GF) Cumulus Parameterization to improve the representation of the particle size distribution and to allow parameterized deep convection to propagate. These also include the treatment of tracer transport, wet scavenging, and aqueous phase chemistry, and improvements on interactions with aerosols. A more complete implementation for transport and treatment of atmospheric composition variables was necessary to complement recent new developments at NOAA/ESRL coupling chemical modules within the NWP model.

Estimates of cloud water and ice crystal number concentrations are added to GF base on the water-friendly aerosol content, temperature, and the cloud water and ice crystal mixing ratios. This modification is designed to diminish the artificial modification of the particle size distribution that occurs when the single moment cumulus schemes are used with the double-moment microphysics schemes. Simulations demonstrate that the addition of GF ice number concentrations substantially increases ice content aloft in the tropics, which shifts the outgoing longwave radiation distribution towards colder brightness temperatures.

The key modification used to enable the propagation of parameterized deep convective is the addition of an advected scalar that represents the cloud base mass flux associated with GF downdrafts. Our implementation of this advected scalar allows the impact of downdrafts from previous time steps to foster propagation. Evaluation and tuning of the new downdraft mass advection term is ongoing.