Modeling of cloud microphysics. Can we do better?

Wojciech W. Grabowski

Mesoscale and Microscale Meteorology Laboratory, NCAR

Representation of cloud microphysics is a key aspect of simulating clouds. From the early days of cloud modeling, numerical models have relied on an Eulerian approach for all cloud and thermodynamic and microphysics variables. Over time the sophistication of microphysics schemes has steadily increased, from simple single-moment bulk warm-rain schemes, through double- and triple-moment bulk warm-rain and ice schemes, to complex bin (spectral) schemes that predict the evolution of cloud and precipitation particle size distributions. As computational resources grow, there is a clear trend toward wider use of bin schemes, including their use as benchmarks to develop and test simplified bulk schemes. We argue that continuing on this path brings fundamental challenges due to the complexity of processes involved (especially for ice), the multiscale nature of atmospheric flows that Eulerian approaches are not able to cope with, conceptual issues with the Smoluchowski equation that is solved by bin schemes to predict evolution of the particle size distributions, and numerical problems when applying bin schemes in multidimensional cloud simulations. The Lagrangian particle-based probabilistic approach is a practical alternative in which the myriad of cloud and precipitation particles present in a natural cloud is represented by a judiciously selected ensemble of point particles called super-droplets or super-particles. Advantages of the Lagrangian particle-based approach when compared to the Eulerian bin methodology will be explained and illustrated with computational examples. Prospects of applying the method to more comprehensive simulations involving clouds, for instance targeting deep convection or frontal cloud systems, will be discussed.

Thursday, 10 October 2019, 3:30pm

Refreshments 3:15pm

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

This seminar will be webcast live at:
http://ucarconnect.ucar.edu/live

Recorded seminar link can be viewed here:
https://www.mmm.ucar.edu/events/seminars