Observational and Numerical Studies on Turbulent Entrainment-Mixing Processes

Chunsong Lu

Atmospheric Sciences Division, Brookhaven National Laboratory (BNL), New York, USA 11973 and School of Atmospheric Physics, Nanjing University of Information Science and Technology (NUIST), Jiangsu, China 210044

Turbulent entrainment-mixing processes are critical to many outstanding issues related to clouds, including aerosol indirect effects and warm-rain initiation. Regarding entrainment-mixing processes, we have to answer at least the following three questions: (1) How fast is dry air entrained into clouds? (2) How does cloud microphysics respond to the entrained dry air, homogeneous mixing or inhomogeneous mixing? (3) How to represent homogeneous/inhomogeneous mixing in models? For the first question, a new approach is developed to estimate entrainment rate in cumulus clouds, which has several advantages compared with the tracer-based approach. For the second question, stratocumulus and cumulus clouds are examined using a combined approach which includes microphysics, dynamics and thermodynamics; the effect of dynamics is represented by a new transition scale number. For the third question, three measures of homogeneous mixing degree are newly defined; the relationship between homogeneous mixing degree and transition scale number is explored with a parcel model where mixing processes are explicitly represented; based on the relationship, a parameterization of turbulent mixing processes is advanced.

In collaboration with Yangang Liu[1], Shengjie Niu[2], Steven Krueger[3], Seong Soo Yum[4],Satoshi Endo[1], Timothy Wagner[5]

[1] Atmospheric Sciences Division, Brookhaven National Laboratory (BNL), New York, USA 11973

[2] School of Atmospheric Physics, Nanjing University of Information Science and Technology (NUIST), Jiangsu, China 210044

[3] Department of Meteorology, University of Utah, Salt Lake City, UT, US 84112

[4]Department of Atmospheric Sciences, Yonsei University, Seoul 120-749, Korea

[5]Department of Atmospheric Sciences, Creighton University, Omaha, NE, US, 68178