

Stochastic ice nucleation and its effect on the microphysical properties of mixed-phase stratiform cloud

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Mixed-phase stratiform clouds can persist with steady ice precipitation for hours and even days. The origin and microphysical properties of the ice crystals are of interest. Vapor deposition growth and sedimentation of ice particles along with a uniform volume source of ice nucleation lead to a power law relation between ice water content (wi) and ice number concentration (ni) with exponent 2.5. The relation is confirmed by both a large-eddy simulation cloud model and Lagrangian ice particle tracking with cloud volume source of ice particles through a time-dependent cloud field. Initial indications of the scaling law are observed in data from the Indirect and Semi-Direct Aerosol Campaign (ISDAC). Based on the observed wi and ni from ISDAC, a lower bound of 0.006 m-3s-1 is obtained for the volume ice crystal formation rate.

Results from Lagrangian ice particle tracking method also show that more than 10% of ice particles have lifetimes longer than 1.5 h, much longer than the large eddy turnover time or the time for a crystal to fall through the depth of a nonturbulent cloud. An analysis of trajectories in a 2-D idealized field shows that there are two types of long-lifetime ice particles: quasi-steady and recycled growth. For quasi-steady growth, ice particles are suspended in the updraft velocity region for a long time. For recycled growth, ice particles are trapped in the large eddy structures, and whether ice particles grow or sublimate depends on the ice relative humidity profile within the boundary layer. Some ice particles can grow after each cycle in the trapping region, until they are too large to be trapped, and thus have long lifetimes. The relative contribution of the recycled ice particles to the cloud mean ice water content depends on both the dynamic and thermodynamic properties of the mixing layer. In particular, the total ice water content of a mixed-phase cloud in a decoupled boundary layer can be much larger than that in a fully coupled boundary layer.

In the end I'll present our resent work about the turbulence cloud chamber at Michigan Technological University. Both observational and modeling results show the aerosol effect on cloud droplet size distribution: increasing aerosol number concentration will narrow the cloud droplet size distribution due to reduced supersaturation fluctuations.

This seminar will be webcast live at: http://www.fin.ucar.edu/it/mms/fl-live.htm

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

Thursday, 17 November 2016, 3:30 PM Refreshments 3:15 PM NCAR-Foothills Laboratory, 3450 Mitchell Lane Bldg. 2, Main Auditorium, Room 1022



