ATS/CIRA Colloquium

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Cloud physics and chemistry from single droplets and crystals to a few cubic centimeters

Hosted by Sonia Kreidenweis

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ATS room 101; Discussion will begin at 11:15am
Refreshments will be served at 10:45am in the weather lab

To understand Earth's climate and weather, you must understand clouds on scales ranging from the characteristic size of water molecules (a few Angstroms) to synoptic and global circulations (hundreds to thousands of kilometers). Large scale forcing drives processes at the scale of single water droplets and ice crystals while microscale processes feed back and affect the larger scales. In this talk I will span the first six orders of magnitude in that cascade.

To begin, I will discuss a particular mode of heterogeneous ice nucleation – contact freezing. We have developed a method to measure contact nucleation triggered by submicron aerosol particles and have found that most substances (e.g. mineral dusts) catalyze freezing of supercooled water droplets in approximately one event out of every thousand interactions at -20 ºC. At -15 ºC, that probability falls to 10-4 or less. Though the freezing probability is low, it is higher than the probability of freezing in the immersion mode at the same temperatures. We have also shown that particles that will initiate freezing in the contact mode need not be effective in the immersion mode; we have shown that soluble salt will act as contact ice nuclei. Time scales for diffusion of ions, diffusion of the heat of dissolution, and the propagation of the mechanical disturbance through the test droplet allow us place a limit of ~ 1 ns on the time scale for formation of the critical ice embryo.

Transitioning from the scale of single droplets and ice crystals, I will introduce a new facility developed at Michigan Tech. The Π Chamber, so-called because of its internal volume of 3.14 m3, is capable of generating cloud conditions through adiabatic expansion and turbulent mixing. In the latter case, we can sustain cloud conditions indefinitely. I will outline the Chamber's technical specifications and discuss some of our first experiments in the chamber. Taking advantage of the fact that we can hold the boundary conditions constant and thus the thermodynamic forcing, we are performing some of the first (to our knowledge) laboratory explorations of the first aerosol indirect effect. Preliminary results indicate that we see a transition from the first indirect effect to the second as the cloud droplet concentration decreases below a critical level.

Link to colloquium videos and announcement page: http://www.atmos.colostate.edu/dept/colloquia.php