Aerosol-cloud-drizzle interactions in a turbulent cloud chamber

Raymond Shaw
Dept. of Physics
Michigan Technological University

We have developed a turbulent cloud chamber (the Pi Chamber, volume 3.14 m^3) that is uniquely suited to addressing aerosol-cloud-drizzle interactions. It is capable of pressures ranging from sea level to ~100 hPa, and can sustain temperatures of +40 to -55 °C. More importantly, we can establish a temperature gradient between the floor and ceiling inducing Rayleigh-Bénard convection and a turbulent environment. The mixing cloud that forms when the boundaries are wet has a constant forcing and the cloud can persist for long times (hours to days). We can thus explore how the microphysical properties respond to aerosol input, and the relative roles of growth by condensation and collision-coalescence.

Clouds that form under strong temperature gradients can achieve liquid water contents above 1 g/m^3 and the droplet size distributions under these conditions exhibit a pronounced large-drop tail reminiscent of drizzle formation. Indeed, calculations suggest that it is very difficult to explain this tail theoretically without accounting for collision-coalescence. This opens the door for controlled, laboratory studies of aerosol-cloud-drizzle interactions. Our initial results show that the cloud droplet effective radius and concentration respond quickly to changes in the aerosol number concentration. Furthermore, if the aerosol in the chamber are not replenished as droplets are removed from sedimentation and collisions with the walls, the fraction of large droplets (> 40 μm diameter) increases, leading to a rapid collapse of the cloud.