Weekly CEAFM Seminar: Spring 2018

JOHNS HOPKINS
Center for Environmental
& Applied Fluid Mechanics

Date: **Friday, February 9, 2018**

Time: 3:00 PM (New Time)

Location: Gilman Hall # 132

Speaker: **Prof. Raymond A. Shaw** (Michigan Technological University)

Title: ***"How Turbulence Influences Cloud Optical Properties and Precipitation: Laboratory Studies of Turbulent Moist Rayleigh-Benard Convection"***

Abstract

Aerosol particles, such as sea salt, dust and anthropogenic pollution, influence the optical properties of clouds and the tendency of a cloud to form precipitation through droplet collisions. We have investigated cloud droplet growth in a turbulent environment under varying levels of aerosol concentration. The results reveal a surprising role of turbulence in cloud droplet growth that leads to two regimes: a polluted cloud regime in which thermodynamic conditions are rather uniform and cloud droplet sizes are similar, and a clean cloud regime in which thermodynamic conditions are highly variable and cloud droplet sizes are very diverse. The narrowing of droplet size range under polluted conditions introduces a new stabilizing factor by which increased aerosol concentration can suppress precipitation and enhance cloud brightness.

Cloud droplet growth in a turbulent environment is studied by creating turbulent moist Rayleigh-Benard convection in a laboratory chamber (the Pi Chamber). Cloud formation is achieved by injecting aerosols into the water-supersaturated environment created by the isobaric mixing of saturated air at different temperatures. In steady state, the injection and activation of aerosol particles to form cloud droplets is balanced by cloud droplet growth through vapor condensation and loss by gravitational settling. A range of steady-state cloud droplet number concentrations is achieved by supplying aerosols at different rates. As steady-state droplet number concentration is decreased the mean droplet size increases as expected, but also the width of the size distribution increases. This increase in the width is associated with larger supersaturation fluctuations due to the slow droplet microphysical response (sink of the water vapor) compared to the fast turbulent mixing (source of the water vapor). The boundary between the two regimes can be identified with a cloud Damkoehler number of order unity.