ABSTRACT

Field and laboratory measurements using cloud chambers have been used to understand the atmospheric abundance of droplet and ice nucleating particles and to, in turn, construct parameterizations for mixed-phase and completely glaciated clouds in weather and climate models. This seminar investigates measurements of which particles act as the nuclei for droplets and ice crystals and how we can then mimic those particles in the laboratory to understand how clouds form in our atmosphere. We show here that assumptions about the source of the particles as well as uncertainty in the laboratory and field measurements propagate into uncertainty in our understanding of the Earth’s climate and the chemistry of our atmosphere. When we consider cloud chambers, uncertainty is likely inherent to varying degrees in all instruments and is caused by a variety of factors including exposure of particles to different humidities and/or temperatures than predicted from theory. This can result in a variable underestimation of reported droplet and ice concentrations. This is a critical issue for models which rely on these data for correct parameterizations of cloud formation. For ice clouds in particular, we find that simulated long wave ice-bearing cloud forcing in a global climate model can vary up to 0.8 W/m² and can change sign from positive to negative within the experimentally constrained bias range.

Daniel Cziczo, Associate Professor
Department of Atmospheric Chemistry, MIT

It has been known for over a century that greenhouse gases such as carbon dioxide and methane warm the planet by trapping heat. What is not as well known is that particles can cool the planet by reflecting sunlight into space and by acting as the seeds on which clouds form. Particles and clouds are also of contemporary interest because it has been suggested they might be used to intentionally manipulate the Earth’s temperature. Cziczo’s research group is interested in the interrelationship of particulate matter and cloud formation. His team utilizes laboratory and field studies to elucidate how small particles interact with water vapor to form droplets and ice crystals, which are important players in the Earth’s climate system. Experiments include using small cloud chambers in the laboratory to mimic atmospheric conditions that lead to cloud formation and observing clouds in situ from remote mountaintop sites or through the use of research aircraft. Current specific research interests include chemical composition of atmospheric aerosols with an emphasis on their effect on cloud formation mechanisms, Earth’s radiative budget, and meteoritic debris and clouds in other planetary atmospheres.