

NANO HIGHLIGHT

Clusters to Nanoparticles: Implications for Atmospheric Nucleation

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It is known that new particles formed by nucleation are observed in the atmosphere on about 20% of days [1], and that these particles can grow to sizes large enough to serve as cloud condensation nuclei during the course of a day. Proposed nucleation mechanisms include ion induced nucleation and multicomponent nucleation of electrically neutral species. Existing theories, however, do not accurately predict rates of particle production that are observed in the atmosphere. Because of the likely impact of nucleated particles on cloud cover (and therefore on the earth's radiative energy balance), it is important to have nucleation models that are sufficiently accurate to be used in climate models. This project is designed to provide information that can be used to develop such models. We plan to measure the distributions of electrically neutral clusters and nanoparticles in nucleating systems. The measured cluster masses will also provide information about species contained in the nucleated clusters. These measurements will be used to infer kinetic information on rates of forward and reverse reactions on molecular clusters that ultimately determine nucleation rates. The work involves developing a chemical ionization mass spectrometer for measuring cluster distributions, and using it in laboratory and atmospheric measurements. We also plan to extend aerosol instrumentation to sizes smaller than 3 nm with the eventual goal of bridging the gap between measurements of molecules, clusters and nanoparticles.

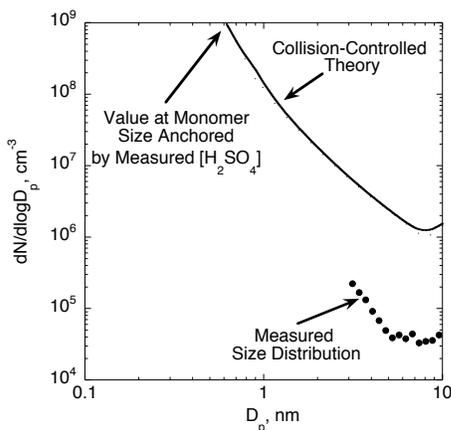


Figure 1.

Figure 1 compares atmospheric nanoparticle size distributions measured during a nucleation event with size distributions calculated assuming that nucleation is collision-controlled (barrierless) [2]. Note that the measurements and theory show a similar functional dependence on size, but the measurements are about a factor of 40 below this theory, which provides an upper limit. (In other cases measurements fall a factor of 10 to 1000 below the theory.) We expect that measurements of molecular clusters at the small end of the size will help to elucidate reasons for such discrepancies.

References

- [1] Kulmala, M., H. Vehkamäki, T. Petäjä, M. dal Maso, A. Lauri, V.-M. Kerminen, W. Birmili, P. H. McMurry, 2004, *J. Aerosol Sci.*, **35**(2):143-176.
- [2] McMurry, P. H., 1983, "New Particle Formation in the Presence of an Aerosol: Steady-State Rates, Time Scales, and Sub-0.01 μm Size Distributions." *J. Colloid Interface Sci.* **93**:72-80.