Investigations of Kinetic Growth Limitations during Cloud Droplet Activation

REU Mentor: Tim VanReken

Objective

Those particles in the atmosphere that have the potential to become cloud droplets are called cloud condensation nuclei, or CCN. Whether a given particle can act as a CCN is a complex function of the atmospheric saturation level and the particle's size and composition. In addition to these thermodynamic considerations, theoretical and some laboratory studies suggest that there may be kinetic limitations to the growth of a newly activated droplet.

In 2008 and 2009 our group collected CCN data at three field sites in the United States: the Colorado Rockies, near Boise, Idaho, and in northern Michigan. Preliminary analysis of these data indicates that on some occasions there were significant kinetic limitations to droplet growth. Particle size distribution (from a SMPS) and composition (from a PILS) are also available from these studies, including measurements of water-soluble organic carbon content. The goal of this study is to more fully analyze the CCN data with a focus on the droplet growth kinetics, and to use the supplementary aerosol data to help explain any observed trends.

Preliminary Training

This project will focus on the analysis of existing datasets collected at field locations in the last two years. Most of the preliminary analysis was completed using the Igor Pro software package. Igor is a powerful program, but has a somewhat steep learning curve. Significant time at the start of the project will be devoted to learning Igor Pro.

The kinetic growth analysis will also make use of a CCN instrument model developed by Dr. Athanasios Nenes at Georgia Tech. Using this model will require some familiarity with computing from the command line. Training for these skills will be offered at the beginning of the REU program.

The instrument model requires a detailed characterization of the actual CCN instrument used for the measurements. Moreover, when working with observational data it is always important to understand the underlying data collection techniques and their inherent limitations. To that end, the project will include calibration experiments with the CCN instrument.

Project Tasks

1. Previous REU students have written Igor routines for CCN data analysis. Similar routines are available for visualizing our other aerosol data. These routines will be used heavily and may require modification. The student will become familiar with the routines and make any required modifications.
2. Preliminary droplet growth plots have been produced for most (but not all) of our recent observations. The student will organize these results and identify target areas for more detailed analysis.
3. To obtain the critical instrument parameters for the more detailed droplet growth analysis, the student will perform a CCN counter calibration at some point early in the summer
4. The key project task will be the detailed droplet growth analyses using the Georgia Tech model. Several events from each of the field data sets will be simulated. This effort will take much of the total project time.
5. The student will prepare a poster for the end-of-summer symposium.

References

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