Breakout Session Report
ARM/ASR User and PI Meeting
March 16-20, 2015

Session Title: New Particle Formation
Session Date: Monday, March 16, 2015
Session Time: 3:30 p.m.
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Main Discussion

Roughly half the time during the breakout session was devoted to "open mic" presentations of research on new particle formation (NPF) and growth. During the other half we discussed ways that we can move the science forward through improved collaborations. Many important questions emerged and were discussed during the session:

- **Model development:** What are the current modeling activities relating to NPF within the Aerosol Life Cycle community? What do the models require from lab and field observations?
- **Field Observations:** What are observations from recent campaigns such as NPFS and GoAmazon telling us about NPF and how can we take advantage of these datasets to achieve our objectives of modeling and predicting atmospheric aerosol formation and growth? What future opportunities for field studies should we pursue?
- **Laboratory studies:** What are current activities and how can we coordinate, or at least better communicate, laboratory activities that relate to NPF?

Key Findings

In a theoretical study, Bob McGraw, Brookhaven National Laboratory, reported the development of Extended Fletcher Theory (EFT), a version of classical nucleation theory that is in excellent agreement with measurements of the heterogeneous condensation of water on Ag nanoparticles, which showed unusual temperature dependence at low temperatures. The theory shows that the cause of this "anomalous" temperature dependence is that interactions between seed and substrate can be sufficiently strong that the cluster energy is actually lower than same number of molecules in bulk. In modeling research, Jeff Pierce, Colorado State University, discussed recent progress in modeling regional NPF events. Jeff stated that we know that a "large" fraction of SOA acts as if it has a very low volatility. In addition, an additional ~100 Tg/yr are required for the models to reproduce measured size distributions. The source of these low volatility compounds and the missing SOA in the models were discussed.

In addition, several exciting NPF observations were reported from recent field campaigns and lab studies. Qi Zhang, University of California, Davis, reported on measurements of size-resolved particle chemical composition during CARES. During CARES, regional NPF events were observed almost daily. The HR-ToF-AMS measurements showed that the growth of new particles was driven primarily by oxygenated organic species and, to a lesser extent, ammonium sulfate. New particles were fully neutralized during growth, consistent with high NH3 concentration in the region and amine concentrations were enhanced during events. Tuukka Petäjä, Univ. of Helsinki, reported on recent results from different field campaigns and experiments at the CLOUD chamber. An example of the latter is a theoretical and experimental study of the formation of highly oxidized organic compounds from the oxidation of cyclohexene. Joel Thornton, University of Washington, showed recent measurements from the FIGAERO during BAECC that show individual molecular markers of compounds contributing to growth during NPF. Jim Smith, National Center for Atmospheric Research, showed recent observations of the composition of nanoparticles formed from amine and sulfuric acid using TDCIMS. Those particles were much more acidic than what one might assume based on solution thermodynamics arguments, suggesting that mass transfer in nanoparticles may be limited by the phase of matter in those particles. Finally, Alla Zelenyuk, Pacific Northwest National Laboratory, presented chamber studies at PNNL that showed that NPF from a-pinene ozonolysis is dramatically enhanced by adding ppb levels of pyrene to the chamber, which suggests another mechanism by which anthropogenic compounds may enhance biogenic NPF.

The breakout ended with two new instruments being developed under the SBIR/STTR program: a mass spectrometer-based instrument is being developed to detect gas phase amines at ppt levels in the atmosphere (Aerodyne, Inc.) and an aerosol charger that can efficiently charge and concentrate nanoparticles, thus improving sensitivity of chemical and physical analysis instruments (Aerosol Dynamics, Inc.).

Needs

The breakout identified several needs, some of which are currently being addressed as discussed above. There is still a need to better understand the chemistry of NPF and growth. Field and lab observations require instrumentation capable of measuring particles < 10 nm and stable clusters (e.g., Nano-SMPS, APi-ToF, TDCIMS) and key gas phase species (e.g., amines). In addition, laboratory studies are needed to assess how the interactions between biogenic and anthropogenic pollutants affect new particle growth.

Future Plans

A joint laboratory campaign at the PNNL chamber is scheduled to take place in June 2015 to study nanoparticle formation from organics. Participants will include the Thornton group and Petäjä group. A workshop will also take place at PNNL on “New strategies for addressing anthropogenic-biogenic interactions of organic aerosols in climate models.” That workshop will have, among its goals, exploring ways of transferring insights gained from the latest measurements on anthropogenic-biogenic interactions of SOA, such as those discussed above from NPFS, CARES, and BAECC, to global climate models of interest to DOE in the short term (3-year).

Experiments are currently underway at NCAR to understand the observations from CLOUD that showed unusual acid-base chemistry for 10-40 nm diameter particles. Concurrent with that, the Pierce group plans to complete its analysis of observations from NPFS at the ARM SGP site in 2013. Modeling efforts in the Pierce group will also focus on nanoparticle growth from acid-base chemistry.