Connecting in-situ aerosol formation to the properties of clouds

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Atmospheric aerosol particles impact human health whilst on regional and global scales they can affect climate patterns, the hydrological cycle and the intensity of radiation that reaches the Earth's surface. In spite of recent advances in the understanding of aerosol formation processes (Kulmala et al. 2013) and the links between aerosol dynamics and biosphere-atmosphere-climate interactions (Paasonen et al. 2013), great challenges remain in the understanding of the role of secondary aerosol formation on a global scale.

Boreal forests, situated in a circumpolar belt in the Northern latitudes throughout the United States, Canada, Russia and Scandinavia, are, of all biomes, among the most active areas of atmospheric aerosol formation (e.g. Tunved et al. 2006). The formation of aerosol particles and their growth to cloud condensation nuclei sizes in these areas are associated with biogenic volatile organic emissions from vegetation and soil (Kerminen et al. 2012).

One of the world's most comprehensive observation sites in a boreal forest environment, measuring atmospheric aerosols, biogenic emissions and an extensive suite of relevant atmosphere-biosphere parameters, is SMEAR-II (Station for Measuring Forest Ecosystem-Atmosphere Relations, Hari and Kulmala (2005)) in Hyytiälä, Finland. To capture the vertical and spatial variability of aerosol particles and clouds, the U.S. DoE's Atmospheric Radiation Measurement (ARM) Program operated ARM Mobile Facility 2 (AMF2) in Hyytiälä. "The Biogenic Aerosols - Effects on Clouds and Climate (BAECC) experiment (Petäjä, 2013) lasted for 8.5 months in 2014.

The figure 1 shows how aerosol number size distribution changes as the air masses spend longer and longer time over land based on in-situ observations at Hyytiälä during BAECC. Here we only consider air masses where new particle formation is favoured (clean Arctic inflow from Northwest). Due to condensation of biogenic secondary aerosol vapors during the aerosol lifetime the particles grow in size increasing their potential to activate to cloud droplets.

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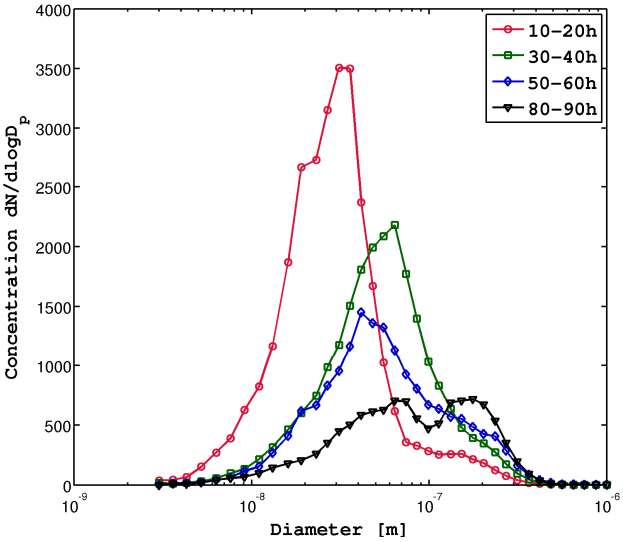

Figure 1. Median aerosol size distribution at SMEAR II station in Hyytiälä corresponding to air masses that had been residing over the boreal environment different times(10 to 90 hours) during their transport to the measurement site. Longer times are associated with larger aerosol particles with lower total number concentration.

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