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

Session Title: Biogenic Aerosols – Effects on Clouds and Climate (BAECC)
Session Date: Thursday, March 19, 2015
Session Time: 10:30–12:30 a.m.
Summary Authors: Tuukka Petäjä, Dmitri Moisseev, Victoria Sinclair, Joel Thornton, Paul Zieger, Daniel Rosenfeld, et al.

Description

During this breakout session, the results obtained during BAECC and associated intensive operational periods (IOPs) were presented. The topics will included:

- Results from ground-based and aircraft IOP of aerosol
- Second ARM Mobile Facility (AMF2) and Station for Measuring Ecosystem – Atmosphere Relations (SMEAR2) aerosol observation intercomparison
- Aerosol chemical composition during IOPs
- Aerosol profiling through a combination of lidar and aircraft observations, cloud and precipitation processes characterization through analysis of multi-frequency radar, lidar, and microwave radiometer measurements
- Detailed snow precipitation IOP.

Main Discussion

Overall, the session was successful in bringing together all aspects related to the AMF2 deployment and ASR activities regarding the BAECC deployment in Hyytiälä, Finland. The session presentations were designed to cover full life cycle of aerosols, clouds, and precipitation.

During the session discussions, integrative aspects were given a high value, which should be considered also in the forthcoming ASR meetings.

Key Findings

The AMF deployment at SMEAR2 in Hyytiälä, Finland was a successful operation providing critical active remote sensing data on aerosols, clouds, and precipitation around the site during 8 months in 2014. In the next step, these data will be compared with the 20-year data set available from Hyytiälä.

With AMF2 capabilities, we collected excellent observations that allow us to connect secondary aerosol formation to the observed properties of clouds. This is the main goal of the deployment. The instrumentation and data have begun to be available for this work.

Several intensive operational periods (IOPs) were presented during the session. Results on aerosol chemical composition during new particle formation events and growth obtained during the spring IOP (e.g., Thornton ASR project, Smith instrument deployment) are consistent with each other. A more detailed comparison is in process.

Detailed chamber experiments mimicking the chemistry and aerosol dynamics in Hyytiälä are planned jointly with Petäjä and Thornton, supported by funding from ASR. The chamber study is scheduled for June 2015 in the Pacific Northwest National Laboratory environmental chamber where relevant

monoterpene mixture aerosol formation from Hyytiälä is explored with a suite of high-resolution mass spectrometers and state-of-the-art aerosol instruments.

An aerosol instrument comparison was performed between AMF2 aerosol observing system (AOS) and SMEAR2. The agreement was good with respect to ozone and dry nephelometers, condensation particle counter, and cloud condensation nuclei particle counter. The wet nephelometer data are not good due to changed settings and variable relative humidity. Zieger et al. presented a study prior to BAECC deployment about columnar optical closure. The main result from this study was that the scattering enhancement in Hyytiälä is consistently quite low. This warrants attempts to acquire the optical closure also during BAECC regardless of the poor wet nephelometer data. This is compensated by a more detailed ground-based active remote sensing capacity of the AMF2 (to assess the role of lofted aerosol layers) and aerosol measurements at two different levels (to assess aerosol losses to the canopy).

Aerosol concentrations with AMF2 condensation particle counter were underestimated due to low detection limit of the aerosol observing system instrument. An aerosol absorption intercomparison needs to be done. Lidar observations in connection with aircraft IOPs (144 flight hours) provides insights into aerosol effects on clouds and helps aerosol typing.

Several interesting case studies, where Weather Research and Forecasting (WRF) modeling and AMF2 observations are intercompared, particularly regarding multi-layer mixed-phase clouds were presented. These studies will increase the understanding on aerosol-cloud interactions. The developed analysis tools can be applied to other AMF data sets.

Biogenic Aerosols - Effects on Clouds and Climate-Snowfall Experiment (BAECC-SNEX) provided over 20 cases of detailed measurements on precipitation microphysics. It was shown that quantitative observations of snow microphysics are possible and due to the measurement setup implemented during the IOP, consistency of the retrieved variables can be checked. The collected data have been demonstrated to facilitate advances in the radar science relevant to ARM and ASR goals. The experiences in the snow measurements can be utilized in the North Slope deployment of the third AMF.

BAECC-SNEX was used to demonstrate a new Doppler spectra processing method that will provide significant value for studies of mixed-phase clouds. More joint analyses of the collected data by the Colorado State University group of Chandrasekar and the Helsinki groups are planned.

Decisions

A joint laboratory campaign at the Pacific Northwest National Laboratory chamber is now scheduled to take place in June 2015 with participants from Thornton's and Petäjä's groups.

Joint analysis of BAECC-SNEX data by the Colorado State University group of Chandrasekar and the University of Helsinki group of Moisseev is planned.

Issues

Data from the wet nephelometer of AMF2 need to be checked.

Needs

A small, targeted workshop bringing together US and European scientists would expedite the integrated analysis.

A test deployment of ground precipitation instrumentation to be deployed in Barrow and Oliktok and in Hyytiälä like the setup used during BAECC-SNEX is proposed. This test deployment will facilitate the knowledge transfer between Finnish and U.S. teams.

Future Plans and Action Items

- Comprehensive positive matrix factorization, taking into account both aerosol chemical composition and aerosol precursor vapor concentrations, are needed to understand the gas phase and aerosol phase partitioning of the relevant vapors.
- Aerosol columnar optical closure (Zieger, Petäjä) and modeling (WRF-Chem), taking full advantage of the AMF2/SMEAR2 radar and lidar capacity, will be performed. The starting point identified case studies (Sinclair).
- An in situ versus satellite derived cloud condensation nuclei concentration intercomparison is needed. This will be done similar to the GoAmazon2014/15 campaign, jointly with the Roselfeld and Petäjä groups.
- A detailed analysis on aerosol chemical composition during secondary aerosol growth will be performed (Thornton, Smith, Petäjä).
- An intercomparison of the European Aerosols, Clouds, and Trace Gases Research Infrastructure Network (ACTRIS) and AMF methodologies for aerosol vertical profiling with lidars is needed.