Evaluation and improvement of the parameterization of aerosol hygroscopicity in global climate models using in-situ surface measurements

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Aerosol optical properties are strongly dependent on ambient relative humidity. Depending on their size, composition and the ambient humidity, atmospheric particles will take up varying amounts of water, thereby altering their optical properties and impacting their contribution to aerosol radiative forcing. Along with particle size, this humidity dependence also plays an important role in the life cycle of atmospheric particles including their growth into cloud droplets and wet deposition processes removing them from the atmosphere.

Global models use a variety of schemes for implementing hygroscopic growth. The representation of hygroscopic growth in models may result in predicted aerosol optical properties being quite different from observations. To date the ability of global models to predict hygroscopic growth has not been rigorously evaluated against in-situ measurements due in part to the lack of harmonized and globally available hygroscopicity data.

Here we propose to use harmonized high-quality, in-situ measurements of aerosol hygroscopicity made both at long-term DOE/ARM sites and during many of the ARM Mobile Facility (AMF) deployments, as well as measurements from the NOAA collaborative network and the European ACTRIS project. These measurements represent a variety of aerosol types (e.g., clean marine, polluted continental, biomass burning and desert dust).

Modelers involved in the AeroCom project (Aerosol Comparisons between Observations and Models; http://aerocom.met.no/), including the NCAR/DOE CAM5 model, have been requested to generate model output of aerosol optical properties and composition as a function of relative humidity. The models will utilize identical anthropogenic emissions and run with constrained meteorology, thus minimizing differences in the anthropogenic sources and large scale atmospheric transport. The model output will be sampled at the location of the in-situ measurements.

The models and measurements will be compared to determine (i) how well model simulations represent the observations of aerosol water uptake; (ii) whether differences between the models and measurements can be explained by the model parameterizations of hygroscopic growth; (ii) if there are biases which may be related to region or aerosol type. Comparisons among the model output will also be investigated to determine effects of the model assumptions about hygroscopicity.

These analyses may help to identify whether there are additional perturbations to the model which might help diagnose/ameliorate model biases. Effort will be made to determine if there are model parameterizations which appear to perform better or worse in representing water uptake. Potential improvements to model parameterizations of aerosol hygroscopicity will be suggested, thus improving simulations of aerosol life cycle in models.