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Assessment on the differences between climate models and in-situ measurements of aerosol optical hygroscopic growth

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Aerosol optical properties are dependent on particle size and chemical composition, which are in turn influenced by the relative humidity (RH) of the surrounding air. Aerosol hygroscopicity, or a particle's ability to take up water, will therefore have an effect on the aerosol-radiation interaction and will affect how much particles absorb or scatter solar radiation. Within this work, we use a global dataset of measured particle light scattering at various elevated RH and compare these measurements to calculations of six global climate models (GCM). This allows to assess on how well GCM's represent aerosol optical hygroscopic growth.

In this study, we make use of a recently developed aerosol hygroscopicity dataset comprised of measurements from 26 sites with a wide global coverage. Measurements from each site were re-analyzed following an identical data treatment process, creating a benchmark database that is publicly available via EBAS (http://ebas.nilu.no/). Many of the stations which provided data are part of active measurement networks such as ACTRIS or NOAA.

We show a comparison between the global aerosol hygroscopicity in-situ dataset and model output from six GCM's. Modelled and measured scattering enhancement factors f(RH) (defined as the ratio between particle light scattering coefficient at a given RH, 85% for this study, and at dry conditions) were compared for 20 sites, representative for a range of aerosol types. Annual cycles and median values show that all models tend to overestimate f(RH) for all aerosol types. Relative differences between models and measurements vary from 25% to 75%, with the differences being larger for urban and rural sites and smaller for desert and Arctic sites. Results show significant variations depending on the definition of the dry value of light scattering coefficient. While it is likely that imperfect temporal and spatial collocation may play a major role in the comparison, these results indicate that this approach shows potential for constraining simulations of aerosol/water interactions and may lead to improved GCM radiative forcing estimates.