Cluster dynamics in different environments: from the boreal forest to megacities

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New particle formation (NPF) by gas-to-particle conversion occurs frequently in many different environments around the globe (Nieminen et al., 2018). NPF is the major contributor to the global cloud condensation nuclei budget (Gordon et al., 2017) and also impacts urban air quality (Guo et al., 2014). It is therefore crucial to understand how the newly formed particles can survive and grow to larger particles under different environmental conditions. Depending on the environment different condensable vapours and also different aerosol dynamics govern the NPF process.

In order to investigate the dynamics of aerosol growth in the sub-10 nm regime, where the newly formed particles are most vulnerable for losses to pre-existing aerosol, we tested several combining instrument inversion approaches. This allows to combine the measurements of several different particle sizing instruments in the sub-10 nm range, where each instrument offers different benefits and weaknesses. If the instruments are combined during the inversion, this could significantly reduce the error of the inferred particle size-distributions. Model results show that the regularization approach proposed by Wolfenbarger and Seinfeld (1990) yield the most stable inversion for data heavily influenced by measurement errors.

We than apply the tested inversion techniques to measurements in three different environments where an array of different state-of-the-art sub-10 nm sizing instruments was deployed: The SMEAR-II station in Hyytiälä, Finland, representative for a rural boreal forest background site, the SMEAR-III station in Helsinki, Finland, representative for a medium-polluted middle-scale European city, and at the Beijing University of Chemical Technology, China, an urban site in a global megacity.

We demonstrate that the combining instrument approach can enable a more detailed analysis of the cluster dynamics, e.g. by the application of size- and time resolving growth rate analysis tools (Pichelstorfer et al., 2018). This will lead to a better understanding of the role of coagulation and condensation in the particle growth process and will help to explain the different dynamics which lead to NPF in fundamentally different environments.

References:

Gordon, H. et al.: Causes and importance of new particle formation in the present-day and


