Drivers of Cloud Condensation Nuclei (CCN) Concentrations and Properties

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It is a great challenge to assign exact numbers to the human influence on climate change. While we know the effect of carbon dioxide emissions quite well, there are anthropogenic emissions of other substances e.g. aerosol particles that effect climate through complex chains of interactions with atmospheric processes, that are not yet well characterized (*Forster et al., 2021*). This lack of knowledge causes uncertainties in the quantification of how human activities influence weather and climate (*Carslaw et al. 2013*).

Aerosol particles of anthropogenic origin can have a variety of sources. They can be formed via gas-to-particle conversion, but also be emitted as primary particles such as soot or ash (*Seinfeld and Pandis, 1998*). Beside that there are natural sources of atmospheric aerosol particles such as volcanic eruptions, dust and sea spray, but they can also be of biological origin like pollen or dimethyl sulfide (DMS). Differentiating between anthropogenic and natural aerosol particles is a major challenge, as even remote locations can be affected by long-range transport (*Tatzelt et al. 2021*).

The influence of atmospheric aerosol particles on the microphysical properties of clouds is complex and depends on the particle number size distribution and on their optical and chemical properties (e.g. *Storelvmo, 2017*). Number concentrations can vary over a wide range (*Schmale et al., 2018*) also in pristine areas depending on location and season (*Asmi et al. 2013, Guy et al. 2021, Wang et al. 2016*).

In this presentation we focus on particles which can serve as cloud condensation nuclei (CCN, *Köhler, 1936*). By their available number, they affect properties such as cloud albedo (*Twomey, 1974*) and cloud life-time (*Rosenfeld et al. 2014*). At which supersaturation an aerosol particle may act as CCN is dictated by its size and chemical composition (*Dusek et al. 2006*).

In recent years a big effort has been made by research groups all around the globe to shed light onto sources of CCN. This has been done campaign wise but also by establishing long-term sites to tackle annual patterns. This presentation attempts to give an overview on what is currently known on regional CCN characteristics around the globe based on in-situ CCN data, CCN sources linked to meteorological information (e.g. back trajectories) and revealing on the chemical composition. And overview on the experimental and analytical methods for identifying sources of CCN is given.

The presentation is meant to discuss the pressing questions on CCN; which are the regions most relevant to understand their effect on the Earth's climate and what are the future research needs for advancing understanding the different aspects of CCN effects in climate change.

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