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Editorial: Atmospheric aerosol particle formation and growth

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Editorial on the Research Topic
Atmospheric aerosol particle formation and growth

New particle formation (NPF) is a secondary aerosol formation process via gas-to-particle conversion and represents the major source of aerosol numbers in the terrestrial atmosphere (Kerminen et al., 2018; Lee et al., 2019). NPF involves an initial step of forming a thermodynamically stable cluster (diameter <1–2 nm) by nucleation of gas-phase precursors and the subsequent growth of nucleated clusters to large-size particles. The competition of condensational growth and coagulation scavenging of newly formed particles to pre-existing particles determines the fate of these small molecular clusters. NPF can occur over a spatial scale of a few hundred kilometers and a temporal scale over several days, and over such a spatio-temporal scale, the newly formed particles can grow larger (>50–100 nm) and act as cloud condensation nuclei (CCN). Observations show NPF enhances CCN concentrations by a factor of 0.5–11 (Kerminen et al., 2018; Kuang et al., 2009; Laakso et al., 2013; Rose et al., 2017; Yu et al., 2014; Yue et al., 2011), thus significantly influencing air quality, cloud properties, and Earth's radiation budget. The goal of this research topic was to improve our understanding of the chemical and physical mechanisms involved in aerosol formation and growth. Within the current topic, four articles were published on this research topic.

Kulmala et al. presented low-intensity NPF events, which the authors referred to as "quite NPF" events. This type of NPF has been overlooked by conventional NPF detection techniques. This finding can have an important implication in atmospheric aerosol loading, which has implications for air quality, particularly in urban areas where the air is most often inadequate due to an exceedingly high number of concentrations of aerosol particles.

Sofio et al. carried out laboratory experiments to investigate the effects of precursor molecular structures on the formation of secondary organic aerosol (SOA) on sulphuric acid nanoparticle seeds and estimated the SOA yield. They found that large and cyclic compounds such as β-caryophyllene have the highest SOA yields, followed by C_{10} species with double bonds such as α-pinene and β-pinene, while the SOA yields of linear alkanes and isoprene were the lowest among all the precursors investigated. The authors concluded that the placement of a double bond on the molecule is critical for SOA yield.

Lee provides a perspective on recent measurements of reduced nitrogen compounds (NRC) in the atmosphere with recently developed state-of-the-art techniques such as high resolution time-of-light chemical ionization mass spectrometer (HR-ToF-CIMS) and single particle mass spectrometers. The measurements of reduced nitrogen compounds are technically challenging and costly. This article recommends the development of low-cost, portable, and miniaturized size instruments to be deployed in developing countries and regions that are not easily accessible.

Zhang et al. provided a review of online detection techniques for the chemical composition of atmospheric molecular clusters and sub-20 nm particles. Direct techniques based on mass spectrometry are superior in quantitatively measuring chemical composition, whereas the indirect techniques based on differential mobility analyser (DMA) and condensation particle counter (CPC) can derive the chemical composition of small particles. It is recommended that future development should focus on obtaining simultaneous measurements of particle physical and chemical properties.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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