New particle formation in the polluted atmosphere of the North China Plain

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New particle formation (NPF) are the major source of atmospheric particles and may contribute up to 50% of particle number concentrations and cloud condensation nuclei (CCN), both of which affect cloud–climate interactions. Thus, the NPF has important impacts on climate and air quality at both regional and global scale. A lack of quantitative understanding of NPF processes is responsible for the largest uncertainty in global climate models, of which NPF processes under polluted conditions are the least understood.

Under the complex air pollution conditions in China it was found the new particle formation and subsequent growth resulted in haze pollution, especially in the North China Plain (NCP) areas, where nucleation rates (J) ware 1–2 orders of magnitude higher than in relatively clean regions.

A near-complete closure between NPF observations over the North China Plain and a corresponding cluster-aerosol dynamics modelling was conducted to understand NPF mechanism. The model combines mechanisms for explicit representation of H_2SO_4-NH_3 cluster dynamics and condensational growth by highly oxygenated organic molecules from aromatic hydrocarbons and terpenes. Under NH_3 and H_2SO_4 rich conditions (>10 ppb NH_3; >10^7 cm^{-3} H_2SO_4), the simulated and measured nucleation rates are within the same order of magnitude. The particle (1-10 nm in diameter) volume growth can partially explained by the condensation of H_2SO_4 (23%), oxidation products of aromatics (9%), monoterpenes (19%), and isoprene (9%), the remaining products (40%) need to be further resolved. The study reveals the increasing importance of NH_3 and volatile organic compounds for NPF under current air quality policies in relatively polluted regions.

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