Dimethylamine can tremendously enhance atmospheric particle formation

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It has been known for several years that sulfuric acid contributes to the formation of tiny aerosol particles, which play an important role in the formation of clouds. The new study by Kürten et al. shows that dimethylamine can tremendously enhance new particle formation. The formation of neutral (i.e. uncharged) nucleating clusters of sulfuric acid and dimethylamine was observed for the first time.

Previously, it was only possible to detect neutral clusters containing up to two sulfuric acid molecules. However, in the present study molecular clusters containing up to 14 sulfuric acid and 16 dimethylamine molecules were detected and their growth by attachment of individual molecules was observed in real-time starting from just one molecule. Moreover, these measurements were made at concentrations of sulfuric acid and dimethylamine corresponding to atmospheric levels (less than 1 molecule of sulfuric acid per 1 x 10^{13} molecules of air).

The capability of sulfuric acid molecules together with water and ammonia to form clusters and particles has been recognized for several years. However, clusters which form in this manner can vaporize under the conditions which exist in the atmosphere. In contrast, the system of sulfuric acid and dimethylamine forms particles much more efficiently because even the smallest clusters are essentially stable against evaporation. In this respect dimethylamine can act as "superglue" because when interacting with sulfuric acid every collision between a cluster and a sulfuric acid molecule bonds them together irreversibly. Sulphuric acid as well as amines in the present day atmosphere have

mainly anthropogenic sources. Sulphuric acid is derived mainly from the oxidation of sulphur dioxide while amines stem, for example, from animal husbandry. The method used to measure the neutral clusters utilizes a combination of a mass spectrometer and a chemical ionization source, which was developed by the University of Frankfurt and the University of Helsinki. The measurements were made by an international collaboration at the CLOUD (Cosmics Leaving OUtdoor Droplets) chamber at CERN (European Organization for Nuclear Research).

The results allow for very detailed insight into a chemical system which could be relevant for atmospheric particle formation. Aerosol particles influence the Earth's climate through cloud formation: Clouds can only form if so-called cloud condensation nuclei (CCN) are present, which act as seeds for condensing water molecules. Globally about half the CCN originate from a secondary process which involves the formation of small clusters and particles in the very first step followed by growth to sizes of at least 50 nanometers. The observed process of particle formation from sulfuric acid and dimethylamine could also be relevant for the formation of CCN. A high concentration of CCN generally leads to the formation of clouds with a high concentration of small droplets; whereas fewer CCN lead to clouds with few large droplets. Earth's radiation budget, climate as well as precipitation patterns can be influenced in this manner. The deployed method will also open a new window for future measurements of particle formation in other chemical systems.

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