Atmospheric new particle formation from sulfuric acid and amines in a Chinese megacity

With the support by the National Natural Science Foundation of China, Prof. Wang Lin (王琳) and his research group at the Shanghai Key Laboratory of Atmospheric Particle Pollution and Prevention (LAP^3), Department of Environmental Science and Engineering, Fudan University, together with their collaborators from the University of Helsinki, Nanjing University of Information Science and Technology, Shanghai Environmental Monitoring Center, Shanghai Meteorology Bureau, Shanghai Academy of Environmental Sciences and Aerodyne Research company, have revealed the chemical formation mechanism (H_2SO_4-dimethyamine-H_2O ternary nucleation) of atmospheric new particle formation events at a molecular level in a Chinese megacity, Shanghai, which was published in *Science* (2018, 361: 278—281).

Atmospheric new particle formation events significantly contribute to the number concentration of atmospheric aerosol particles and have an important impact on the global climate through the formation of cloud condensation nuclei. Although mechanisms for new particle formation events have been proposed for a few locations with low background aerosol loadings, chemical and physical mechanisms for urban new particle formation events are still a puzzle and one of the most defiant topics in the field of atmospheric chemistry, because of the extreme chemical complexity of the urban atmosphere, especially in a Chinese urban city. *In-situ*, real-time measurements of atmospheric gaseous precursors and critical clusters with a mixing ratio of less than 10^{-12} represent a major challenging in the experimental techniques.

Using the latest-developed nano-particle size magnifier, Prof. Wang and his group conducted 2-year continuous measurements of the number size distributions of atmospheric particles with diameters down to ~1.2 nm, from which the particle formation rate ($J_{1.7}$) and the subsequent growth rate were derived. Additionally, Atmospheric Pressure interface-Time Of Flight-mass spectrometer (APi-TOF) and nitrate-Chemical Ionization- Atmospheric Pressure interface-Time Of Flight-mass spectrometer (nitrate-CI-APi-TOF), respectively, were deployed to detect atmospheric naturally-charged and neutral compounds during new particle formation periods. The highest signals of sulfuric acid dimer ($H_2SO_4 \cdot HSO_4^-$) ever measured in an ambient atmosphere were evident and a series of critical sulfuric acid-DMA clusters were identified. When compared to the Cosmics Leaving Outdoor Droplets (CLOUD) chamber measurements, the observed particle formation rates during their ambient campaign were consistent with that from the H_2SO_4-dimethylamine-H_2O ternary nucleation experiments at CLOUD. This is for the first time that sulfuric acid—dimethylamine—water new particle formation was observed and confirmed in the ambient atmosphere.

This mechanism may be extended to explain new particle formation events in other urban areas in China, which potentially provide scientific evidence for Chinese policy makers to frame regulations to reduce secondary aerosol formation in China. Also, this finding will help to improve the performance of global climate models to better predict future climate change.

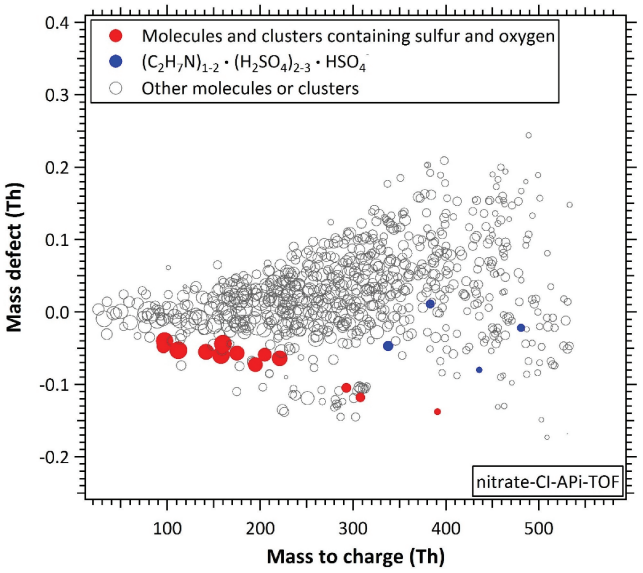

Figure Mass defect plot of molecules and clusters measured by CI-APi-TOF during a new particle formation event.