From molecular clustering to global climate and air quality

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The formation of new aerosol particles in the atmosphere, starting with the production of molecular clusters and their growth to larger sizes, is a world-wide phenomenon [1], with a significant contribution to aerosol particle number load and indirect radiative effects as well as urban air pollution [2]. Understanding the very initial states of atmospheric aerosol formation requires detailed knowledge of the concentrations of neutral and charged clusters, on their chemical composition, and on the gaseous compounds participating in their formation and growth [3].

The recent development in measurement techniques (atmospheric mass spectrometry like (CI)-APi-ToF, Particle Size Magnifier, air ion spectrometers) and theoretical understanding (cluster dynamics, quantum chemistry, Nano-Kohler theory) has enabled us to study quantitatively atmospheric new particle formation and also find out the links between vapor sources, chemical reactions with different oxidants, cluster and nanoparticle dynamics [3-7]. Actually we are able to give new insight into gas-to-particle conversion, where several new steps have been found out e.g. new oxidants, enhanced particle growth via extra vapour after activation, multicomponent condensation [8]. On the other hand this new knowledge can be applied in different processes in the other scientific and technological fields.

In light of our current understanding, atmospheric aerosol formation is initiated by photochemical reactions in the gas phase, in particular the formation of sulfuric acid and other vapors of very low volatility such as multifunctional organic compounds[6] or iodine oxides. Pre-existing aerosol particles act as a sink for these vapors and nucleated clusters, thus inhibiting atmospheric aerosol. The intensity of solar radiation, atmospheric mixing conditions, and the ambient temperature and relative humidity affect aerosol formation via their influences on the abundance and properties of low-volatile vapors, molecular clusters and pre-existing larger particles [3,8]. It seems that there is always more or less intensive clustering in sub 2 nm size range in the atmosphere but only some fraction of those clusters are able to growth to 3-4 nm and further to cloud condensation nuclei sizes.

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