Geophysical Research Abstracts
Vol. 12, EGU2010-6941, 2010
EGU General Assembly 2010

Formation and Processing of Secondary Organic Aerosol from Catechol as a Model for Atmospheric HULIS

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A particular fraction of the secondary organic aerosol (SOA) termed HUmic Like Substances (HULIS) attracted attention only recently in atmospheric aerosol, initiating a discourse about their aromaticity and other properties, such as reactivity and hygroscopicity. A major portion of HULIS originates from volatile organic compounds, which are formed by abiotic oxidation reactions involving mainly OH radicals, ozone, nitrogen oxides and possibly halogens. Subsequently, the particles provide surface for heterogeneous reactions with atmospheric trace gases. Thus, aerosol smog-chamber studies with appropriate precursors are needed to generate SOA with HULIS qualities in situ inside the smog chamber and study their possible interactions. Catechol and guaiacol were chosen as aromatic precursors for synthetic HULIS production.

The SOA was produced in a 700 L aerosol smog chamber, equipped with a solar simulator. SOA formation from each precursor was investigated at simulated environmental conditions (humidity, light, and presence of oxidizers) and characterized with respect to HULIS properties by particle classifiers, Fourier Transform IR spectroscopy (by long-path absorption and attenuated total reflection), UV/VIS spectroscopy, high-resolution mass-spectroscopy and temperature-programmed-desorption mass-spectrometry. High-resolution imaging was obtained using Field Emission Gun Scanning Electron Microscopy (FEGSEM). After HULIS formation the aerosol particles were exposed to atmospheric halogen species to study their processing with those trace gases, released by sea salt-activation.

Those investigations show that aromatic precursors like catechol and guaiacol are suitable to form synthetic HULIS for laboratory-scale measurements with physical and chemical properties described in literature. However, sunlight and relative humidity play a major role in particle production and composition of functional groups, which are the anchor points for heterogeneous atmospheric chemistry. Possible reaction pathways of those synthetic particles with atmospheric halogen species could be identified forming gaseous and solid halogenated compounds.