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EINLADUNG

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CPG Vortrag von

Prof. Dr. Nadine Borduas-Dedekind

Department of Chemistry, University of British-Columbia, Vancouver, Canada

Cool cloud chemistry: Photochemistry of organic aerosols and its effect on mixed-phase cloud formation

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Dienstag, 08. Juni 2021, um 5:30 PM

Zoom-Meeting beitreten:
https://tuwien.zoom.us/j/99156537498?pwd=SHJmWkxyMlpZTkQ1Mmx1dnFTSGNCdz09
Meeting-ID: 991 5653 7498- Passwort: Sq5Z78fp

Abstract

Aerosol-cloud interactions play a key role in the earth's energy budget, yet contribute to the largest uncertainty in radiative forcing in climate model estimates. Aerosols are impacted by photochemistry during their lifetime of days to weeks in the atmosphere, altering their chemical and physical compositions. Indeed, in the time interval between where organic aerosols are emitted and/or formed and where they act as cloud condensation nuclei (CCN) and as ice-nucleating particles (INPs), they will undoubtedly be exposed to sunlight and thus undergo atmospheric processing through photochemistry. Yet, the effect of photochemistry on the propensity of organic matter to participate in the initial cloud-forming steps is difficult to predict, in part due to the chemical complexity of the aerosols.

To explore the effect of photochemistry on organic matter in cloud water conditions, we explored three different types of samples: (1) field-collected dissolved organic matter from lakes and rivers relevant for lake spray aerosols, (2) humic substance standards, (3) lignin, as a subcomponent of organic matter, (4) firewood smoke, (5) ammonium sulfate methyl glyoxal brown carbon solutions, and (6) lab-generated secondary organic aerosols.

Our group's research aims to better understand how direct and indirect photochemistry impact the hygroscopicity and ice nucleating ability of atmospheric organic matter. Our organic matter samples were dissolved in water and subjected to photochemical reactions in a photoreactor. Subsequently, the samples were (1) aerosolized and analyzed using a cloud condensation nuclei counter and (2) measured using our home-built drop freezing ice nuclei counter, for their ability to activate clouds. We correlate changes in hygroscopicity, using the kappa parameter, with changes in chemical composition including, total organic carbon (TOC), pH, UV/Vis absorbance, and CO, CO_2, acetic acid, pyruvic acid and formic acid production. Importantly, we find that the kappa of organic matter of all six samples tested increase substantially upon photo-oxidation, up to a factor of 2.5. This result is consistent with a photomineralization mechanism where the organic carbon is mineralized to CO_2, and where carbon mass is lost. On the other hand, the ice nucleation ability changes upon photoirradiation does not follow a consistent trend among sample types and remains difficult to predict. Our running hypothesis is that the size of the macromolecules may be playing a role in their ability to template ice. In all, photomineralization can alter the aerosol-cloud radiative effects of organic matter by modifying the supercooled liquid water-to-ice crystal ratio in mixed-phase clouds with implications for cloud lifetime, precipitation patterns and the hydrological cycle.