NCAR | ATMOSPHERIC CHEMISTRY OBSERVATIONS & MODELING

Virtual ACOM Seminar

A large source of formic acid in the atmosphere mediated by cloud droplets

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ABSTRACT

Formic acid (HCOOH) is a pervasive trace gas and the most abundant carboxylic acid in the troposphere. It is known to enhance cloud droplet activation and to contribute to the acidity of clouds and rainwater. Despite updated photochemical sources and revised emissions, knowledge and representation of formic acid remain incomplete as state-of-the-art models fail to reproduce the measured concentrations and considerably underestimate its burden. This indicates that major key sources still elude our understanding. Here we present experimental evidence and theoretical predictions of how formic acid is efficiently formed by oxidation of hydrated formaldehyde, methanediol (HOCH2OH), outgassing from cloud droplets. By representing explicitly these relevant processes in the global atmospheric chemistry model ECHAM5/MESSy (EMAC), we estimate that the amount of formic acid produced via this multiphase pathway could be 2-4 times larger than all the known chemical sources combined. Making use of worldwide observations provided by IASI/Metop satellite and ground-based FTIR instruments, we show that this additional production of formic acid can bridge the gap between model predictions and remote-sensing measurements. Moreover, it leads to an increase of the acidity of cloud and rainwater, in particular over the continents. The representation of this multiphase mechanism is important for advancing our understanding of the fate of organic carbon in the atmosphere. We also explore this oxidation pathway applied to higher carbonyl compounds, which could lead to the formation of more complex organic acids such as acetic and pyruvic acid.

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