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First direct observation of secondary organic aerosol formation during cloud condensation-evaporation cycles in isoprene photo-oxidation reacting mixtures (CUMULUS project)

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Several field observations, laboratory and model studies suggest a potentially important role of cloud droplets in forming additional secondary organic aerosol (SOA) (Sorooshian et al., 2007; Altieri et al., 2008; Couvidat et al., 2013). While this SOAaq hypothesis seems to be robust and is considered quite established, so far, no direct observations of such a process have been provided. Recently a consortium of five laboratories has joined theirs efforts in a series of experimental simulation experiments to try to bring a direct confirmation of this hypothesis: the CUMULUS project (CloUd MULtiphase chemistry of organic compoUndS in the troposphere).

The aim of the present work is to study SOA formation from isoprene photo-oxidation during cloud condensation-evaporation cycles. The chemistry occurring in the gaseous, particulate and aqueous phases, and the exchange between these phases were investigated through an original multiphase approach in a simulation chamber.

Experiments were performed in the CESAM chamber (Wang et al., 2011) which was designed to investigate multiphase processes under realistic actinic flux, and accurate control of both temperature and relative humidity. A protocol was designed to generate cloud events in the simulation chamber, it has allowed us to generate clouds lasting for ca. 10 minutes in the presence of light and many clouds could be generated in a single experiment.

Connected to the chamber, a large panel of instruments was used to monitor the gas-phase and the particulate phase during experiments. Gas-phase composition was analyzed in-situ via a Fourier Transform Infrared Spectrometer (FTIR) and a Proton Transfer Reaction Mass Spectrometer (PTR-TOF-MS) as well as NO_x and O_3 analyzers. A Scanning Mobility Particle Sizer (SMPS) measured dried SOA size distributions and total concentrations inside the chamber. An Aerodyne High Resolution Time-Of-Flight Aerosol Mass Spectrometer (HR-TOF-AMS) was also used to investigate aerosol composition. Cloud droplets size distributions were measured by a white light Optical Particle Counter (OPC). In each experiment, around 800 ppb of isoprene was injected in the chamber together with HONO under dry conditions before irradiation.

In all experiments, the impact of the cloud generation on the gaseous and particulate phases has been highlighted, suggesting a significant production of SOA from isoprene photo-oxidation by interactions with cloud droplets. The overall results in additional SOA mass production, the dynamic of its mass concentration and some insight of its chemical composition will be presented.

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