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Project CESAM: A new multiphase simulation chamber for studies of secondary organic aerosols formation and cloud generation

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It is now well established that heterogeneous chemistry has a dramatic impact on the composition of the troposphere. The complex physico-chemical process involved in this chemistry including phase exchanges, surface reactions, reactions in condensed-phase followed by transferring to the gas-phase, has to be quantified in order to develop reliable atmospheric models, and have a better understanding of the tropospheric chemistry. Integrating heterogeneous physico-chemical parameters, such as kinetic constants, accommodation coefficients, and so on, requires a new tool designed to perform the chemical experiments in conditions as close as possible to the natural ones. This is why a simulation chamber is needed for the atmospheric chemistry study.

A new indoor environmental chamber facility for the study of atmospheric process leading to the formation of secondary organic aerosols, and the study of cloud generation, has been constructed and characterized. This new instrument is called CESAM (Multiphase Atmospheric Experimental Simulation Chamber), is designed for atmospheric chemical mechanism determinations at low reactants concentrations under the well controlled environmental conditions. It consists of one 4m3 stainless steel reactor, equipped with a high power dry pump, which provides a special capability for atmospheric chemistry study: generation of the cloud. Solar radiation is simulated with three 4kW XBO lamps, which exhibit a similar spectrum structure as the one of the sunlight measured at the ground level. Thank to a water IR-filter, and a double-layer

wall cooling system of the reactor, all experiments are expected to be performed in the chamber at a constant temperature.

Results of the initial characterizations are presented here:

A simplified model (FACSIMILE) has been used to simulate the photolysis chemistry comparing with experiments performed with NOx levels as low as 50 ppbv, for a better understanding on the decay due to the photo-chemistry or due to the wall.

Secondary organic aerosols have been generated in the chamber by ozonolysis of sabinene at about 100 ppbv. And generation of clouds by an adiabatic expansion of humid air have been performed in the chamber. The results indicate that this chamber can provide an aerosol lifetime about 5 days, and a cloud lifetime about 15 minutes for one adiabatic expansion, so that we can study on the atmospheric aerosol particle aging processes.

Overall, results of several initial experiments for secondary organic aerosols formation via heterogeneous reaction of gaseous sabinene and indene, carried out in a dry condition, are expected to have a high quality SOA formation data at a low reactants concentration, such as the reproducibility and the yield.