Ice nucleation activity of airplane soot surrogates in deposition mode investigated with the IDroNES set-up

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Atmospheric aerosol particles are involved in numerous physical and chemical processes that have major impacts on our climate (Petzold et al.1998). Therefore, we are interested in studying soot particles from aircraft engines (incomplete fuel combustion) which are likely to favor the formation of ice crystals and droplets by heterogeneous nucleation. Many studies have been conducted over the past few years to better understand this process of nucleation. These studies suggest that the ability of soot particles to activate ice nucleation is probably influenced by their size and their chemical composition, especially functional groups that can form hydrogen bonds with water molecules (Hoose et al.2012, Crawford et al.2011).

In the present work, we investigate the activity of soot particles regarding their ability to nucleate ice. The nucleation is induced directly from vapor deposition, i.e., in deposition mode. Soot samples are produced by either a kerosene flame or a Combustion Aerosol Standard (CAST) burner supplied with various propane-air mixture ratios resulting in a wide range of organic carbon to total carbon ratios (OC/TC). Soot samples are deposited on silicon wafers and further processed in the nucleation chamber.

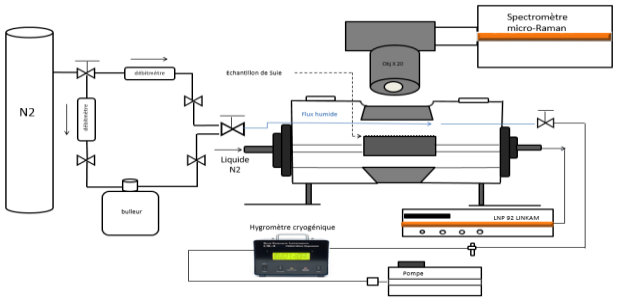

Figure 1. IDroNES Experimental set-up.

To carry out our study, we developed and optimized a new reactor: IDroNES (Ice and Droplets Nucleation Experimental Set-up). It maintains at controlled temperature and pressure the reactor cell that is connected to a cryogenic hygrometer, which measures its relative humidity. A micro-Raman spectrometer coupled to an optical microscope allows the monitoring of ice crystals or droplets formation both optically and spectroscopically through the vibrational signatures of hydroxyls (O-H). In addition, prior to nucleation experiments, laser desorption/ionization mass spectrometry was used to characterize the soot surface, in order to establish a relationship between ice nucleation and the physico-chemical properties of the surfaces.

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Hoose, C., Möhler, O. (2012) Atmos. Chem. Phys. 12, 9817-9854.
Petzold, A., Strom, J., Ohlsson, S., Schroder, F . P. (1998) Atmospheric Research, 49(1), 21-34
Crawford, I., Mohler, O., Schnaiter, M., Saathoff, H., Liu, D., McMeeking, G., Gallagher, M. W. (2011) Atmospheric Chemistry and Physics, 11(18),9549-9561