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Ice Nucleation properties of Air-Plane Soot Surrogates Using Vibrational Micro-spectroscopy: a preliminary study

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Aircraft emissions have been studied extensively since the late 1960s and the interest was mainly driven by their direct and indirect effects on climate and the generation of contrails [1-4]. Emissions of solid-state particles (soots) from engine exhausts due to incomplete fuel combustion are considered to influence ice and liquid water cloud droplet activation [4]. The activity of these aerosols would originate from their ability to be important centers of ice-particle nucleation by promoting ice formation above water homogeneous freezing point. While some experiments focused on ice nucleation on soot particles did not yet reach definitive conclusions, soot are reported to be generally worse ice nuclei than mineral dust, nucleating at higher ice-supersaturations for deposition nucleation and at lower temperatures for immersion freezing. However, there are still numerous opened questions on the ice nucleation properties of soot particles [5], most likely due to the lack of information on the abundance, on the physico-chemical properties (structure and chemical compositions) of these aerosols, competition between different ice nucleation modes and dynamical factors that affect ice nucleation. Furthermore, the soot emitted from aircraft may be associated with soluble components like sulphate that can act as heterogeneous ice nuclei and initiate freezing at supersaturation of only 120-130% [6].
Therefore, more detailed studies of aerosol nucleation activity combined with throughout structural and compositional analyzes are needed in order to establish any association between the particles' hygroscopicity and their physico-chemical properties.
In the present preliminary work, nucleation activity of air-plane soot particle surrogates is monitored using a temperature-controlled reactor in which the sample's relative humidity is precisely measured with a cryo-hygrometer. Formation of water/ice onto the particles is followed both optically and spectroscopically, using a microscope coupled to a Raman spectrometer. Vibrational signatures of hydroxyls (O-H) emerge when the particle becomes hydrated. Careful calibration of the sample's surface temperature was performed beforehand while monitoring the deliquescence and efflorescence of micrometer-size NaCl crystals at various temperatures. The ice nucleation potential of different soot surrogates can be studied. A correlation with their physico-chemical properties via FTIR, Raman and mass spectrometry analyses is underway.

[1] Anderson et al., Geophys.Res. Lett. 25, 1689-1692, (1998)
[2] Hyashida et al. Fuel. 128, 148-154. (2014)
[3] Popovicheva & Starik. Atmospheric and Oceanic Physics. 43, 121-141. (2007)
[4] Manninen et al. Boreal Environment Research. 19, 383-405. (2014)
[5] Hoose & Möhler. Atmospheric Chemistry and Physics. 12, 9817-9854. (2012)
[6] Haag et al., Atmos. Chem. Phys., 3, 1791-1806 (2003)