Cellulose particles as ice nuclei

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Cellulose is the most common biopolymer in terrestrial environments. A time series of the cellulose concentration at a downtown site in Vienna showed average cellulose concentrations between 0.37 µg m^{-3} and 0.75 µg m^{-3} (Puxbaum *et al* 2003).

A recent paper by Hiranuma *et al.* (2015) attempted to investigate the ice nucleation efficiency of cellulose atmospheric particles. The experimental results obtained with immersion freezing mode suggested that ice nucleation by cellulose becomes significant below T = -21°C (temperatures relevant to mixed-phase clouds).

We used a diffusion filter processing chamber (DFPC) to carry out experiments on the ice nuclei freezing efficiency of laboratory-generated cellulose particles in the deposition/condensation mode.

The DFPC is a modified Langer and Rodgers chamber in which supersaturation with respect to water is obtained by air flowing through fine milled ice (Santachiara *et al* 2010). Aerosol particles were sampled on cellulose nitrate membrane filters (Millipore, porosity 0.45 µm). The cellulose ice nucleation particle (INP) concentrations were determined at T = -22°C and a saturation ratio with respect to water equal 1.01. These conditions should allow the detection of deposition and condensation-freezing nuclei.

Cellulose aerosol particles (Cellulose microcrystalline powder, MCC, Sigma Aldrich) were generated by nebulization of a cellulose suspension in deionized water at 1 mg ml^{-1} concentration (Palas, AGK 2000). Aerosol particle number concentration was measured by an OPC (Grimm, 11A model) running in parallel with two sampling lines: one to collect all the particles generated and the other to collect only particles with aerodynamic diameters less than 0.8 µm or 0.4 µm by means of a cyclone (SCC 0.732) running at 2 l min^{-1} and 3.5 l min^{-1}, respectively.

Table 1. Experimental INP activation fraction (**f_{in}**) and averaged ice nucleation active surface-site density (**n_s**) of MCC cellulose aerosol particles (* only one value).

	f_{in} (%)	**n_s** (m^{-2})
Total particles > 0.25 µm	(1.0$\pm$0.4) 10^{-6}	(1.2$\pm$ 0.6) 10^{8}
Particles Cut-off 0.8 µm	(0.8$\pm$0.3) 10^{-6}	(1.4$\pm$0.6) 10^{8}
Particles Cut-off 0.4 µm	0.1 10^{-6*}	0.1 10^{8*}

Results are given in Table 1, while Figure 1 shows an example of the particle size distribution obtained with cellulose aerosol (MCC curve).

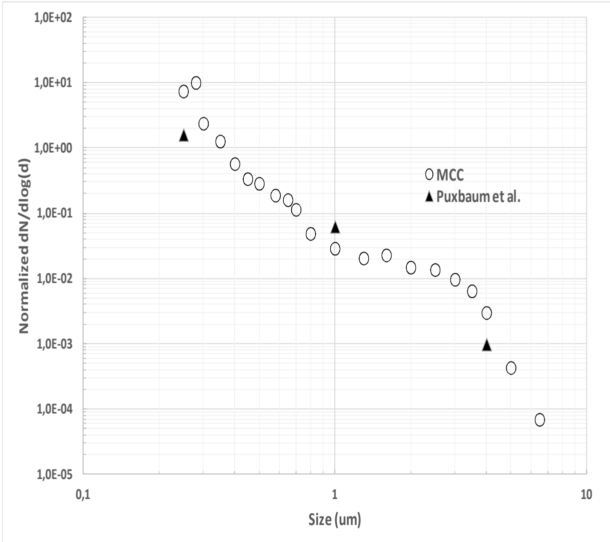

Figure 1. Normalized aerosol size distribution of MCC particles.

The curve obtained is comparable to the experimental one given by Puxbaum *et al* 2003.

In conclusion:

- The chosen cellulose aerosol mode generates particles representative of those found in the atmosphere inferred by Puxbaum *et al* (2003).
- The activation fraction values are in agreement with Hiranuma *et al* (2015).
- No ice activation of MCC particles, produced by liquid atomization, was found at temperatures higher than -22°C.
- The ice nuclei capability of MCC particles decreases for particle size lower than 0.4 µm.

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Hiranuma, N., *et al* (2015) *Nature Geoscience Letters, DOI: 10.1038/NGEO237.*

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