Ice nuclei measurements in a rural area and at a high altitude remote station

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The majority of ice in clouds is formed via heterogeneous nucleation involving aerosol particles known as ice forming nuclei (IN). Ice nuclei can form ice through different thermodynamic mechanisms or modes: deposition, condensation-freezing, immersion and contact. It is generally agreed that ice will form on nuclei in response to different kinds of thermodynamic forcing, the primary variables being temperature, and saturation ratio with respect to ice and water (S_{ice} and S_w, respectively). A wide variety of measurement techniques have been developed for detecting IN and measuring their characteristics.

An experimental campaign was carried out at a rural site of S.Pietro Capofiume (SPC), near Bologna, in the period 07-21 February 2014, and on the top of Monte Cimone (MC) in the Northern Apennines (19-28 May 2014, 2165 m asl). Aerosol fractions (PM1 and PM10) were sampled on nitrocellulose membrane filters, by means of sampler heads two times a day at SPC (9 am and 2 pm), while at MC the samplings were uneven. Simultaneous measurements of particle number concentration in 15 different size classes starting from 0.3 μm (Grimm, Mod.1.108) were also performed. Meteorological data were recorded. Concentrations of IN were detected by the membrane filter technique, using a continuous diffusion chamber (Langer and Rodgers, 1975). Measurements were made at S_{ice} = 1.12; S_w = 0.94 (SPC); Si_{ce} = 1.21 and S_w = 1.01 (MC).

In both cases the temperature of the filter was -18°C. Measurements below water saturation should allow the detection of deposition nuclei, while those above water saturation should allow the detection of deposition and condensation-freezing nuclei. Fig.1 shows an example of grown ice crystals on the filter.

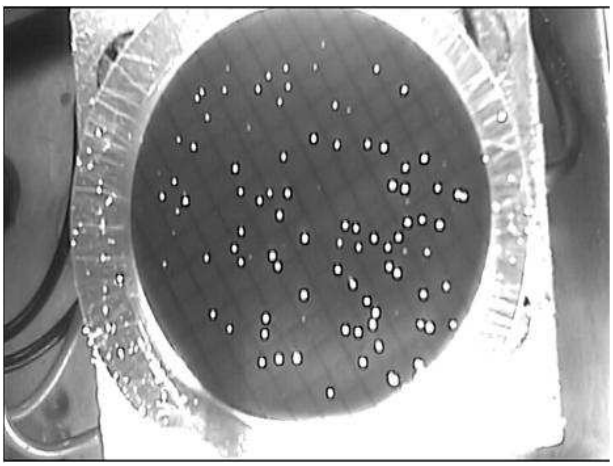

Figure 1. Picture of grown ice crystals

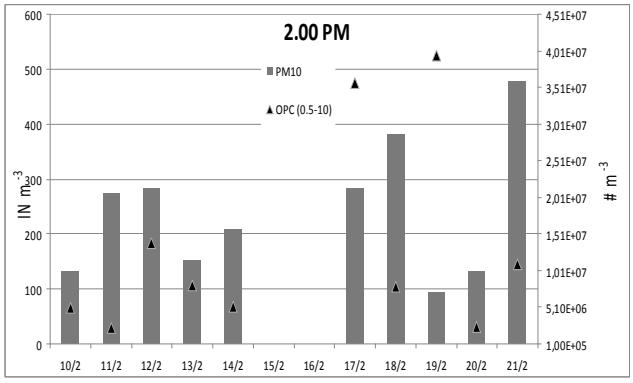

Figure 2. IN and particle number concentrations at SPC

Fig. 2 shows the IN concentration in the PM10 fraction and the particle number concentration in the range 0.5 - 10 μm at 2 pm (SPC). Prevalently the IN and the particle number concentrations are lower in the afternoon with respect to morning values. This can be ascribed to lower values of the boundary layer height in the morning.

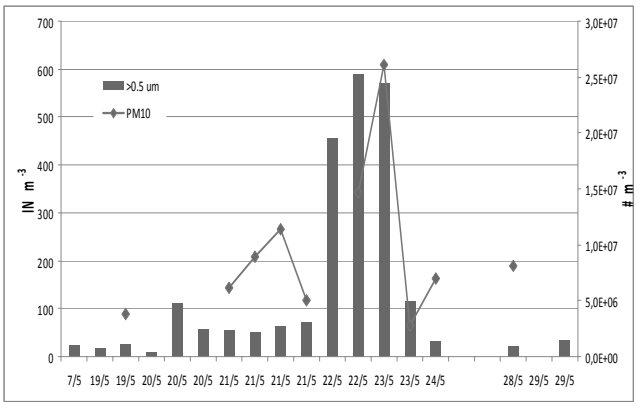

Figure 3. IN and particle number concentrations at MC.

Fig. 3 shows the IN concentration in the PM10 fraction and the particle number concentration in the range 0.5 - 10 μm at MC. The average IN concentrations at SPC in the PM1 and PM10 fractions were 71 m^{-3} and 310 m^{-3}, respectively, and at MC 219 m^{-3} (PM10 fraction).

References

Langer,G. and J. Rodgers (1975). *An experimental study of the detection of ice nuclei on membrane filters and other substrata.* J. Appl. Meteor. **14**, 560-570.

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