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Ice nuclei measurements at a high altitude remote station in the Northern Apennines

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During a field campaign of the PEGASOS (Pan-European Gas-AeroSOls-climate interactions Study, http://pegasos.iceht.forth.gr/) project in June 2012 we have made daily ice nucleus measurements on top of the Monte Cimone (44.18° N, 10.70° E, 2165 m asl) in the Northern Apennines at the "O. Vittori" Climate Observatory. Samples were taken at this GAW-WMO Global Station in a six hour rhythm (4 a.m., 10 a.m., 4 p.m. and 10 p.m.) and at increased frequency during specific events (e.g. dust transport episodes).

Ice nuclei were measured by an offline technique. Aerosol particles of 40 liters of air were collected by electrostatic precipitation on a silicon substrate. Subsequently the ice nuclei were analyzed in the vacuum diffusion chamber FRIDGE [Klein et al. 2010] (FRankfurt Ice Nuclei Deposition FreezinG Experiment) by exposing the particles to supersaturation with respect to ice (106 % to 119 %) at -8 ˚C, -13 ˚C and -18 ˚C. In our setup ice nuclei are activated in deposition and condensation freezing modes. A camera detects and counts ice crystals grown on ice nuclei. Every ice crystal counted is assumed to represent at least one ice nucleus.

The mean IN concentration at Mt. Cimone was 60 IN per liter (at -18 ˚C and 119% relative humility over ice), significantly higher than a longstanding mean at Mt. Kleiner Feldberg (30 IN/l), Germany for June. A mean active site density (IN per surface area of large aerosol particles) of 2.3 * 10^9 m^{-2} was calculated. The origin of the air masses sampled was established based on backward trajectories. With more than 100 IN/l on average (at -18˚C and 119% relative humility over ice) the samples originating from North Africa were highest, and activated fractions were 4 to 20 times higher than for other transport sectors. An intensive event of dust transport was recorded by several instruments in the middle of June. At its peak in the morning of the 21^{st} of June large aerosol surface and mass concentrations were observed by an optical particle sizer. A clear increase of submicron particles was noted during the passage of the dust plume. The heavily dust loaded air had high IN concentrations up to 270 IN/l . The maximum fraction of large aerosol particles activated as ice nuclei during this dust event was one ice nucleus in 1250 aerosol particles.

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References

[Klein et al. 2010] Klein, H. ; Haunold, W. ; Bundke, U. ; Nillius, B. ; Wetter, T. ; Schallenberg, S. ; Bingemer, H.: A new method for sampling of atmospheric ice nuclei with subsequent analysis in a static diffusion chamber. In: Atmospheric Research 96 (2010), p. 218 – 224.