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Size-dependent activation of aerosols into cloud droplets at a subarctic background site during the second Pallas Cloud Experiment (2nd PaCE): method development and data evaluation

T. Anttila[1], P. Vaattovaara[2], M. Komppula[3], A.-P. Hyvärinen[1], H. Lihavainen[1], V.-M. Kerminen[1], and A. Laaksonen[1,2]
[1]Finnish Meteorological Institute, P.O. Box 503, 00101 Helsinki, Finland
[2]Department of Physics, University of Kuopio, P.O. Box 1672, 70211 Kuopio, Finland
[3]Finnish Meteorological Institute, Kuopio Unit, P.O. Box 1627, 70211 Kuopio, Finland

Abstract. In situ measurements of aerosol water uptake and activation of aerosols into cloud droplets provide information on how aerosols influence the microphysical properties of clouds. Here we present a computational scheme that can be used in connection with such measurements to assess the influence of the particle hygroscopicity and mixing state (in terms of the water uptake) on the cloud nucleating ability of particles. Additionally, it provides an estimate for the peak supersaturation of water vapour reached during the formation of the observed cloud(s). The method was applied in interpreting results of a measurement campaign that focused on aerosol-cloud interactions taking place at a subarctic background site located in Northern Finland (second Pallas Cloud Experiment, 2nd PaCE). A set of case studies was conducted, and the observed activation behavior could be successfully explained by a maximum supersaturation that varied between 0.18 and 0.26% depending on the case. In these cases, the diameter corresponding to the activated fraction of 50% was in the range of 110 – 140 nm, and the particles were only moderately water soluble with hygroscopic growth factors varying between 1.1 and 1.4. The conducted analysis showed that the activated fractions and the total number of particles acting as CCN are expected to be highly sensitive to the particle hygroscopic growth properties. For example, the latter quantity varied over a factor between 1.8 and 3.1, depending on the case, when the mean hygroscopic growth factors were varied by 10%. Another important conclusion is that size-dependent activation profiles carries information on the mixing state of particles.

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