Geophysical Research Abstracts, Vol. 8, 07606, 2006
SRef-ID: 1607-7962/gra/EGU06-A-07606

Observations of Atmospheric Nucleation Events in the Lower Free Troposphere

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Several nucleation events were observed during the latest Cloud and Aerosol Characterization Experiment (CLACE 4) in winter 2005, conducted on the Jungfraujoch high Alpine site (3580 metres a.s.l.). The ambient aerosol size distribution was measured both indoors under dry conditions (due to heating) and outdoors under ambient conditions (temperatures between -28 and -12 degrees C) for approximately 5 weeks. The outdoor Scanning Mobility Particle Sizer (SMPS) measured the size range from 4 to 100 nm diameter, while the indoor spectrum covered the range from 18 to 800 nm (dry) diameter. The indoor measurements were complemented by a nano-SMPS (size range from 4 to 100 nm diameter) on loan from TSI for a duration of 10 days. The total particle number ($D > 10$ nm) was measured both in- and outdoors by TSI 3010 condensation particle counters. The measured size distributions were combined, taking into account the hygroscopic size shift and evaporative losses of particles, prior to data analysis. An Air Ion Spectrometer (AIS) was operated indoors to measure charged clusters and particles from 0.5 to 40 nm diameter.

The combined size distributions were analyzed using a recently developed inverse modelling procedure [Verheggen and Mozurkewich, 2006] to derive empirical particle nucleation and growth rates. Using only these measured size distributions as input, regression analysis of the General Dynamic Equation (GDE) allows the growth rate to be accurately determined. The nucleation rate is estimated by tracking measured particles of a certain size back to their time of formation (where it is assumed that $D = 1$ nm), using the empirically determined growth rates. Particle losses that have occurred between the time of nucleation and the time of measurement due to coagulation are taken into account. The likelihood of ion-induced versus neutral nucleation

mechanisms is evaluated by comparing the measured ion spectrum with that of neutral particles.

Verheggen, B. and M. Mozurkewich, An inverse modelling procedure to determine particle growth and nucleation rates from measured aerosol size distributions, submitted to Atmos. Chem. Phys. Discuss., 2006.