Geophysical Research Abstracts,
Vol. 11, EGU2009-7860-2, 2009
EGU General Assembly 2009

The characterisation of the interaction between atmospheric aerosol and water vapour

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Organic matter is not particularly hygroscopic. However, many classes of organic compounds are known to suppress surface tension. Surface tension suppression plays a more important role as the environmental saturation ratio increases (Wex et al., 2008) thus the incorporation of organic material into existing inorganic particles will reduce the supersaturation required to activate in a cloud and hence alter the number of Cloud Condensation Nuclei (CCN) formed.

It has been hypothesised that a particles size far outweighs the of importance of composition when referring to the activation potential of an aerosol particle (Dusek et al., 2006) which has led to the adoption of a simplified Köhler equation, incorporating a term kappa, κ (Petters and Kreidenweis, 2007) that takes all the composition information and assigns it a value dependent on the particle size and growth factor. Whilst the κ-Köhler approximation works reasonably well for inorganic salts such as sodium chloride, κ-Köhler theory makes assumptions regarding the behaviour of multicomponent solution properties as one extrapolates from hygroscopic growth to CCN activation, which may potentially lead to erroneous prediction of CCN properties.

In order to probe the κ-Köhler approximation, measured particle sub and supersaturated water uptake have been compared using a variety of instrumentation.

A Hygroscopic Tandem Differential Mobility Analyser (HTDMA) was used to probe the aerosol (dry diameter 26nm<Dp<250nm) water uptake behaviour in the subsaturated regime, typically at 90% RH. Humidigrams were also performed, where the aerosol is subjected to interval steps in RH between 10% and 90%, to better understand the water uptake characteristics.

For a similar range of dry diameters as the HTDMA, a Cloud Condensation Nucleus counter (CCNc) was used to examine particle water uptake behaviour in supersaturated environments, between 0.07% and 1% SS.

The κ-Köhler 'forward' model predicts critical supersaturations for particles of a given diameter, given their growth factor at a given RH. Data are presented from a collection of field campaigns including marine, European continental and tropical continental, showing a systematic difference between measured and predicted data, likely indicating apects of water uptake behaviour as yet unaccounted for in the current k-Köhler model technique, thus limiting its capabilities with respect to global extrapolation.

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