New trajectory-driven aerosol and chemical process model Chemical and Aerosol Lagrangian Model (CALM)

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A new Chemical and Aerosol Lagrangian Model (CALM) has been developed and tested. The model incorporates all central aerosol dynamical processes, from nucleation, condensation, coagulation and deposition to cloud formation and in-cloud processing. The model is tested and evaluated against observations performed at the SMEAR II station located at Hyytiälä (61° 51' N, 24° 17' E) over a time period of two years, 2000–2001. The model shows good agreement with measurements throughout most of the year, but fails in reproducing the aerosol properties during the winter season, resulting in poor agreement between model and measurements especially during December–January. Nevertheless, through the rest of the year both trends and magnitude of modal concentrations show good agreement with observation, as do the monthly average size distribution properties. The model is also shown to capture individual nucleation events to a certain degree. This indicates that nucleation largely is controlled by the availability of nucleating material (as prescribed by the [H2SO4]), availability of condensing material (in this model 15% of primary reactions of monoterpenes (MT) are assumed to produce low volatile species) and the properties of the size distribution (more specifically, the condensation sink). This is further demonstrated by the fact that the model captures the annual trend in nuclei mode concentration. The model is also used, alongside sensitivity tests, to examine which processes dominate the aerosol size distribution physical properties. It is shown, in agreement with previous studies, that nucleation governs the number concentration during transport from clean areas. It is also shown that primary number emissions almost exclusively govern the CN concentration when air from Central Europe is advected north over Scandinavia. We also show that biogenic emissions have a large influence on the amount of potential CCN observed over the boreal region, as shown by the agreement between observations and modeled results for the receptor SMEAR II, Hyytiälä, during the studied period.

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