Geophysical Research Abstracts, Vol. 7, 06817, 2005
SRef-ID: 1607-7962/gra/EGU05-A-06817

Complexity of the impact of organic aerosols in the cloud droplet nucleation process: observational evidence and numerical simulations

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Organic aerosols comprise a significant fraction of the fine particles in the atmosphere. This species is also observed to be an important composition of biomass burning aerosols. The role of organic aerosols in global model estimates of the aerosol indirect radiative forcing remains uncertain because the effect of organics on the growth of cloud droplets is not understood.

The ability of organic aerosols to act as cloud condensation nuclei (CCN) has been investigated by laboratory works. Combining the experimental results and numerical simulations, Shantz et al., (2003) indicated that the low solubility of organic aerosols leads to an efficient delay of the growth of organic acid particles and result in a reduction of number of cloud droplets nucleated on organics comparing to the ammonium sulfate aerosols.

In-situ measurements of clouds and aerosols were conducted over the Atlantic Ocean during the Canadian Surface, Ocean, Lower Atmosphere Study (C-SOLAS) in October 2003. Simulations of the cloud droplet number concentrations for these clouds are made with a Lagrangian parcel model, initiated with the observations, show different possibilities for the opposite effect of the organics on the number of cloud droplets in marine stratocumulus clouds depending on the updraft speed.

Comparisons between cloud cases characterized with more organic aerosols in the accumulation mode and cloud cases with less organics show different results for the

number of nucleated cloud droplets with different updraft velocities. If the updraft velocity is relatively weak, due to the low solubility of organic aerosols, condensation of water on these particles is inhibited, and the number of cloud droplets is reduced. However, when the updraft velocity is relatively strong and induces a higher supersaturation at cloud base, suppression of the condensation on particles due to the existence of organics decreases the water uptake in the accumulation mode leading to more activation of smaller particles. This results in an increase of the number of nucleated cloud droplets. Therefore, whether the impact of organics on the aerosol indirect effect is positive or negative may well depend on the cloud dynamics. More sensitivity studies in the combination with C-SOLAS cloud cases enriched with organics will be conducted to further address this issue. Influences of organics on the microphysical properties of cloud droplets will be investigated thoroughly and its role in the estimate of aerosol indirect effect will be evaluated.