Geophysical Research Abstracts, Vol. 7, 06975, 2005
SRef-ID: 1607-7962/gra/EGU05-A-06975

A Numerical Study of Aerosol Effects on the Dynamics and Microphysics of a Deep Convective Cloud in a Continental Environment

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In this paper, the effects of atmospheric aerosols on a deep convective cloud in a mid-latitudinal continental environment are studied using an axisymmtric cloud model with detailed microphysical processes and aqueous-phase chemistry. Simulations are conducted using observations during the Cooperative Convective Precipitation Experiments (CCOPE). The isolated cloud occurred in an atmosphere of relatively dry in the mid- and upper troposphere. By varying the accumulation mode of the size distribution of aerosols, the simulated cloud exhibited different properties. The overall impact as the aerosol concentration increased is that (1) the cloud development was inhibited; (2) the precipitation was suppressed; (3) the maximum values of liquid water content was decreased, but the maximum values of droplet number concentration was increased before the dissipating stage, and (4) a clear tendency was found for ice crystals to be larger and less numerous in the anvil cloud. In the relatively dry environment in the mid-troposphere, the Wegener-Bergeron-Findeisen mechanism played an important role in the upper part of the clouds. The latent heat release of immersion freezing became important in the development of the cloud. Immersion freezing was a few times vigorous in the base simulation than that in the double mode simulation. It is also found that there was a significantly reduction of the inflow in the lower 2 km of the atmosphere when the amplitude of mode two of the log-normal number distribution of aerosol was doubled. Less latent heat release and insufficient inflow together impeded the cloud development. Doubling the amplitude of mode two of the log-normal number distribution of aerosol brought to a halt of the cloud growing during 30-40 min. The results of the paper indicate that the processes, which affect aerosol-clouds

interaction, are more complex in real atmosphere than in idealised environment.