Geophysical Research Abstracts
Vol. 12, EGU2010-8874, 2010
EGU General Assembly 2010

Treatment of multiple size-distributed populations of CCN and IFN in a 2-moment microphysical scheme of the cloud-resolving model MesoNH

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This study focuses on the role of 3D fields of polydisperse aerosol particles on the microstructure of mixed-phase clouds at fine scale. Aerosol particles are partitioned into several multimodal populations with different physico-chemical properties. Once initialized from inhomogeneous profiles, aerosol particles are advected at cloud scale and mixed by turbulence. Then depending on local conditions, some aerosol particles are activated, forming cloud droplets or ice particles by heterogeneous nucleation. Aerosol particles may be scavenged by raindrops.

In order to determine the main impact of aerosol particles on cloud microphysics, a highly resolved approach with the French mesoscale model MesoNH is used. Developments regarding the heterogeneous nucleation of droplets and ice crystals, via aerosol particles, were implemented in the 2-moment microphysical scheme available in MesoNH. The novel aspects are:
1.A multimodal extension of the Twomey's theory proposed by Cohard et al. (JAS, 1998) to discriminate several sources of Cloud Condensation Nuclei (CCN) with different activation properties.
2.An adaptation of the advanced heterogeneous nucleation parameterization of Phillips et al. (JAS, 2008) with: first, the nucleation of primary ice crystals by deposition/condensation/immersion freezing from insoluble Ice Forming Nuclei (IFN); second, the effect of immersion freezing of aged coated IFN, serving first as CCN to nucleate droplets.
3.An impaction scavenging module of aerosol particles by falling raindrops (Berthet et al., AR, 2009) following Slinn's parameterization (Slinn, 1983).

The net effect of secondary sources of CCN and IFN that modify the microstructure of preexisting clouds (i.e. formed from background aerosol particles) is assessed. These aspects will be illustrated by simulating the formation of shiptracks in warm cumuli and by studying the effect of a midtropospheric plume of dust particles impinging onto a deep convective storm.