Geophysical Research Abstracts,
Vol. 11, EGU2009-9189, 2009
EGU General Assembly 2009

Ground-based remote sensing of cloud-radiation interaction

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For a better understanding of the complex processes from increased anthropogenic aerosol production to changes in cloud albedo the relevant aerosol, cloud, radiation and atmospheric parameters are required. The synergy and the high spatial and temporal resolution of ground-based remote sensing measurements enable long-term observations of these properties and therefore the detection of the aerosol effect on cloud microphysics and radiation changes can be achieved. The greatest difficulty within this strategy is the quantification of the first indirect aerosol effect, which requires an improvement of the various cloud property retrieval techniques in order to elucidate the physical processes behind. The introduced retrieval technique in this work provides droplet concentration, effective radius and optical extinction on the basis of cloud radar, microwave radiometer and ceilometer observations in combination with a vertical cloud model. The model assumptions are related to a sub-adiabatic approach, where cloud mixing processes are predefined. The greatest uncertainty in the retrieval products is related to the model assumptions and the errors in the surface observations, which lead to difficulties in the quantification of the impact of cloud properties on the surface radiation budget. In previous studies the optical retrievals have been proved by a radiative closure experiment, which compares radiation observations with simulations based on the retrieved optical properties. This paper presents the application of the introduced retrieval technique on water cloud cases, whereas the results and the sensitivity will be analyzed in comparison to results of similar ground-based retrieval techniques in order to improve the model assumptions and the quality of the measurements. The intercomparison of different cloud retrievals will demonstrate the accuracy of various retrieval techniques, which could lead to an improvement of the quantification of the complex processes involved in the first indirect aerosol effect.