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An evaluation on the parameterization schemes of the aerosol activation process for stratus/stratiform clouds in ECHAM5-HAM GCM

A. Yiran Peng (1), B. Johann Feichter (1), C. Johannes Quaas (1), D. Ulrike Lohmann (2), E. Philip Stier (3), F. Silvia Kloster (4)

(1) Max-Planck-Institute for Meteorology, Germany, (2) Institute for atmospheric and climate science ETH, Switzerland, (3) California Institute of Technology, USA, (4) Joint Research Centre, Italy

The aerosol activation process in a global climate model (GCM) directly links the chemical and physical characteristics of aerosol at cloud base to the properties of stratus/stratiform clouds. A parameterization of the activation process is a key to estimate the global water budget and the cloud radiative forcing realistically. The presently available activation schemes were developed from empirically retrieved observational data (e.g., Lin and Leaitch 1997), or traditional microphysics theory (e.g., Abdul-Razzak and Ghan 2000), or small-scale and meso-scale cloud model results (e.g., Kuba and Fujiyoshi 2006). A coupling of the activation scheme with the detailed aerosol module in ECHAM5-HAM appropriately simulates the interaction between different aerosol species and clouds.

The three activation schemes are implemented to run in a single column version of the ECHAM5-HAM GCM by nudging to the in-situ experimental data obtained during ACE2 (the Second Aerosol Characterization Experiment) and ARM (the Atmospheric Radiation Measurement Program) campaigns. The simulated cloud properties are compared with the corresponding measurements in order to evaluate the behavior of different activation schemes. Sensitivities of the predicted cloud droplet number concentration (CDNC) to aerosol characteristics and the updraft velocity are investigated for the individual scheme.

The global model of ECHAM5-HAM is run with the three activation schemes. The simulated microphysical and radiative properties of stratus/stratiform clouds (large-

scale clouds) are evaluated by comparing to the data from several satellite observations. Analysis is emphasized on the global distribution of liquid water content in clouds, number concentration and size of cloud droplets, as well as the cloud radiative forcing. In addition, sensitivity of the aerosol indirect effect to the different activation schemes is studied.