Geophysical Research Abstracts,
Vol. 11, EGU2009-2838, 2009
EGU General Assembly 2009

Aerosol effects on clouds and rainfall during a heavily polluted episode over Indonesia

H.-F. Graf, J. Yang, and T.M. Wagner
University Cambridge, Geography, Cambridge, United Kingdom (hfg21@cam.ac.uk)

In 1997/98 a severe smoke episode due to extensive biomass burning, especially of peat, was observed over Indonesia. This episode was simulated using the limited area model REMOTE driven at its lateral boundaries by ERA40 reanalysis data. REMOTE was extended by a new convective cloud parameterization (CCFM) mimicking individual clouds competing for instability energy. The model allows for the explicit interaction of aerosols, convective and large scale clouds and precipitation and the simulations were analyzed by multi-dimensional statistics.

Results show that both large-scale and convective clouds' microphysics are influenced by aerosols and monthly mean convective precipitation is diminished at nearly all places with enhanced aerosol loading. At some areas with high background humidity precipitation from large-scale clouds may over-compensate the loss in convective rainfall.

Since aerosols are washed and rained out by rainfall, high aerosol concentrations can only persist at low rainfall rates. Hence, aerosol concentrations are not independent of the rainfall amount. In the mean, maximum absolute effects on rainfall from large scale clouds are found at intermediate aerosol concentrations. For large-scale as well as for convective rain negative and positive anomalies are found for all aerosol concentrations. The mean precipitation from large-scale clouds is less reduced than rain from convective clouds. This effect is due to detrainment of cloud water from the less strongly raining convective clouds and because of the generally lower absolute amounts of rainfall from large-scale clouds. With increasing aerosol load both, convective and large scale clouds produce less rain. At few individual time steps cases were found when polluted convective clouds produced intensified rainfall via mixed phase microphysics. However, these cases are not unequivocal and opposite results were also simulated, indicating that other than aerosol-microphysics effects have important impact on the results.

The results suggest that it is not sufficient to study the aerosol-radiation-precipitation effects of only large scale clouds. It is also not sufficient to use simple one-dimensional statistics like aerosol concentration versus precipitation anomaly. Only the investigation of the combined effects of aerosols of different types, varying CAPE and moisture supply on both, large scale and convective, clouds' radiative and microphysics properties and precipitation will allow assessing the indirect effects of aerosols on climate. This will require improvements of current climate models on the process level.