Geophysical Research Abstracts
Vol. 12, EGU2010-2555, 2010
EGU General Assembly 2010
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Sensitivity of cloud state to airborne dust in semiarid Africa

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Satellite observations of the years 2004-2008 are used to assess the influence of mineral dust on statistical parameters of cloud properties in semiarid Africa. Both in the West African Sahel domain and in Semiarid Southern Africa (SSA domain) the dust influence is observed by changes in cloud property histograms and changes in mean values with respect to seasonality and air mass. Although dust levels are much higher in the Sahel domain than in Southern Africa, airborne mineral dust is a common feature also of the SSA domain.
From the statistical analysis alone similar sensitivities of cloud parameters to airborne dust could be estimated, although the signs of the effects sometimes differ. In Southern Africa for example an increase of cloud cover is observed under dust entrainment, while dusty conditions mainly lead to a cloud cover reduction in the Sahel. Also the effect of the dust on cloud top temperature is mainly decreasing in Southern Africa while decreasing and increasing effects of much lower magnitude are observed in the Sahel. Thus the cloud state in both regions responds different to the influence of airborne mineral dust.
In order to estimate the different sensitivities of the both regions, multi-parametric stochastical modelling is used for generating climatological timeseries representing the cloud parameter statistics response to an artificial forcing of increasing dust levels. Also the effectiveness of a self-enhancing feedback between dust level and cloudiness and precipitation is tested by the stochastical model by including a feedback loop as often suggested in the literature.
From the stochastical modelling the differences in sensitivity of cloud property statistics to mineral dust forcing are clearly evident for the both regions in semiarid Africa. While in the Sahel domain cloud cover and ice phase fraction are the main cloud observables being affected by the dust, the influence in Southern Africa is generally lower and mainly on cloud top temperature and effective radius. Moreover, cloud cover is significantly reduced in the Sahel in both seasons whereas ice phase fraction is only decreased during dry season. Statistical analysis also uncovers that in the Sahelian dry season cloud effective radius is increased rather than decreased by the mineral dust.
In Southern Africa a decrease of CTT with increased dust load is the most visible effect of the mineral dust whereas effects on cloud cover are not observed.