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Assessment of aerosol-cloud interactions in the ECHAM6-HAM GCM and the Aerosol_cci/Cloud_cci (A)ATSR dataset

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Aerosol-cloud interactions (ACI) are uncertain and the estimates of the ACI effective radiative forcing magnitude show a large variability. Studies using present day variability in satellite data to infer ACI, or that constrain model parameterizations to better agree with satellite observations find a less negative ACI radiative forcing than purely model based studies. Next to the problematic use of present day variability as a substitute for anthropogenic change, the scale at which the analysis of the responses of cloud properties to changes in aerosol is done could be a reason for the discrepancy in forcing estimates if the analysis/observational scales differ substantially from the process scale. The projects of the Climate Change Initiative (CCI) programme of ESA aim at producing long time series of satellite data of essential climate variables and give the opportunity to produce products for susceptibilities of aerosol properties from Aerosol_cci and cloud properties from Cloud_cci from high resolution datasets. Within the Aerosol_cci project these susceptibilities derived from high resolution (A)ATSR datasets with a nearest neighbour approach are compared to susceptibilities from the global aerosol climate model ECHAM6-HAM. Next to the new satellite products a relatively fine analysis scale is used and the clouds are separated in different environmental regimes to reduce smoothing or spurious effects by aggregation of data.

Susceptibilities and forcing estimates differ between the (A)ATSR datasets and ECHAM6-HAM with the model showing stronger susceptibilities and ACI radiative forcing in agreement with previous estimates in the literature. There is a large difference in susceptibilities between precipitating and non-precipitating clouds in the satellite as well as the model data but there is no decrease in liquid water path with increasing aerosol index as has been reported in the literature for A-train satellite data. The liquid water path susceptibility of ECHAM6-HAM is smaller than in previous model versions but still larger than susceptibilities derived from satellite data.