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Aerosol-Cloud Interactions in the South-East Atlantic

Hendrik Andersen and Jan Cermak
Ruhr-Universität Bochum, Germany (hendrik.andersen@rub.de)

In this contribution, a satellite-based study on aerosol-cloud interactions (ACI) in the South-East Atlantic with explicit consideration of meteorological conditions is presented.

Aerosol-Cloud Interactions remain difficult to quantify and contribute the largest uncertainty to global radiative forcing. These uncertainties make them one of the most important factors for anthropogenic climate perturbations. Interactions are highly complex as microphysical and macrostructural cloud adjustments to aerosol perturbations do not transpire in a black box but are highly dependent on a variety of factors like cloud regime, meteorology and aerosol properties. To gain understanding of the processes that govern ACI in order to increase accuracy of climate models and predictions of future changes in the climate system is thus of great importance.

This process study uses multiple statistical approaches to untangle the various influences on ACI. Stratocumulus clouds in the South-East Atlantic are investigated over a time span of 10 years using daily Terra MODIS L3 data for aerosol and cloud parameters. Together with ERA-Interim reanalysis data of cloud-relevant meteorological parameters, statistical relationships between aerosol and cloud properties are derived for different weather types on the basis of a kmeans cluster analysis, in addition to bivariate relationships. Also, the influence of aerosol loading on aerosol-cloud relationships is investigated.

Relationships between aerosol and cloud microphysical properties are established. Macrostructural cloud adjustments are more ambiguous, as the observed positive relationship between aerosol and cloud liquid water path (LWP) is inconsistent with the Albrecht hypothesis (more cloud water due to drizzle suppression). Adjustments of cloud optical thickness (COT) to aerosol perturbations are negligible as COT is highly dependent on LWP. Strong relationships between aerosol and cloud fraction are identified, but might be spurious and thus not very credible (aerosols and cloud fraction correlate with the same meteorological parameters).

The markedness of ACI is strongly dependent on the weather type. Of the examined meteorological parameters, lower tropospheric stability (LTS) seems to have the biggest impact on the statistical relationships between aerosol and cloud properties. A low LTS and the accompanied enhanced vertical transport of air masses seems to cause stronger ACI. Aerosol loading also impacts the strength of ACI, with low aerosol loadings generally associated with stronger cloud adjustments. This implies a saturation of ACI with high aerosol concentration.