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Interactive Comment

Interactive comment on "Satellite observations of cloud regime development: the role of aerosol processes" *by* E. Gryspeerdt et al.

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Gryspeerdt et al. investigate aerosol-cloud interactions by a statistical analysis of satellite data. As done increasingly, they define individual cloud regimes. The method chosen has been developed in the context of analysis of cloud-climate feedbacks, defining cloud regimes by a clustering approach for cloud properties summarised in the "ISCCP"-histogram, the joint histogram of cloud top pressure and cloud optical thickness. Seven cloud regimes are defined in the Tropics at a 1° x 1° grid, using daily MODIS satellite data. From the full nine-year time series at each grid point, the upper and lower quartile in aerosol index is chosen to define high and low aerosol loading. Satellite-retrieved cloud cover as well

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Interactive Discussion
Discussion Paper

as lower-tropospheric stability, mid-tropospheric vertical wind and 10 m wind speed from daily-mean reanalysis data are sampled at each grid-point from the time series in a way that the PDF of these quantities is equal in low- and high-aerosol conditions. This analysis is performed for the Terra satellite (overpass time at about 10.30 am). At each data point then the assigned cloud regime for this time step is compared to the regime at the corresponding Aqua overpass time (1.30 pm). If not the same, a transition is identified. These transitions are interpreted in the paper. It is found that more often for high aerosol than low aerosol conditions, the shallow cumulus regime declines in frequency of occurrence, whereas mid-level, transition and stratocumulus regimes more often increase in occurrence. This finding is consistent with aerosol-cloud lifetime and aerosol-convective invigoration hypotheses. Some in-depth analyses show that in-cloud liquid water path increases, cloud cover increases and cloud-top pressure decreases, all consistent with the hypotheses. Some covariation with some meteorological ancillary data is found, e.g. for LTS and 10-m wind speed, for which some interpretation is provided. The results are not very sensitivity to whether advection is taken into account or not and also not to the product used for aerosol definition (MACC reanalysis aerosol optical depth vs. MODIS aerosol index) or cloud data (MODIS vs. ISCCP).

The study is very well written, with excellent figures and description. It carefully avoids overly strong conclusions and points to the possibilities of misinterpreting the correlations as cause-effect relationships. Several possible caveats are tested and excluded.

We would like to thank the reviewer for their comments; their specific points are addressed below.

I recommend publication with just three technical modifications:

L22937: More information is needed on the reanalysis data used. Why is daily-

mean resolution considered sufficient? At which level is the relative humidity defined? Also, LTS is from the same reanalysis, I assume?

We have expanded the section in the methods where the reanalysis data is introduced, providing more detail on the pressure levels used and the calculation of the LTSS. We have also added a sentence explaining how the reanalysis data is re-sampled to the 1030 LST satellite overpass, which wasn't covered the draft version. This paragraph now reads:

For atmospheric relative humidity at 850 hPa*, 10* m *wind speed, 500* hPa *vertical velocity* (ω_{500}) *and low troposphere static stability (LTSS - calculated from the temperature profile (Klein and Hartmann, 1993)), we use data from the full resolution ECMWF ERA-Interim dataset re-gridded to a 1 by 1 grid (Dee et al. 2011). The meteorological properties are re-sampled to 10:30 LST by taking a weighted average of the properties at the two closest times provided by ERA-Interim.*

L22942: similar to Lee et al.

Amended

Fig. 2: MACC AOD instead of MACC AI

Also amended

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 22931, 2013.