Atmos. Chem. Phys. Discuss., 13, C8952–C8953, 2013
www.atmos-chem-phys-discuss.net/13/C8952/2013/

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

Anonymous Referee #2

Received and published: 8 November 2013

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°x1° 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 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

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Interactive Discussion
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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 mis-interpreting the correlations as cause-effect relationships. Several possible caveats are tested and excluded.

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?

l22942: similar to Lee et al.

Fig. 2: MACC AOD instead of MACC AI

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