Atmos. Chem. Phys. Discuss., 11, C165–C170, 2011
www.atmos-chem-phys-discuss.net/11/C165/2011/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Cloud invigoration and suppression by aerosols over the tropical region based on satellite observations" *by* F. Niu and Z. Li

Anonymous Referee #1

Received and published: 11 February 2011

Niu and Li present a study of the statistical correlations of cloud top temperatures and cloud ice water paths, as well as precipitation intensities, with aerosol index over ocean and aerosol optical depth over land. Thanks to the wealth of satellite data from the A-Train constellation, such statistical correlation studies have become very popular in the recent literature. The goal is to gain insights in the role of aerosols in cloud and precipitation developments.

The study by Niu and Li is interesting since it separates the correlations by cloud-base and cloud-top temperature to obtain opposite signs. A rudimentary exploration of the large-scale meteorological context is also provided. It thus contributes to knowledge about how aerosols and clouds/precipitation might be related. The study is certainly

pertinent to Atmos. Chem. Phys, and it is written in a very good English, and has a good choice of figures.

So in my opinion, the study is a very interesting one. However, I suggest the authors re-write the manuscript to choose a more scientific language. The statistical correlations Niu and Li find are interesting enough, and there is no need to describe these as cause-effect relationships which this statistical method cannot establish. So a re-writing in a way that just the results are presented, and not over-interpreted, would in my opinion strengthen, not weaken the study. To put it polemically, one frequently reads correlation studies where, if aerosol optical depth is positively correlated with cloud cover, a “cloud lifetime effect”, and in the opposite case, a “semi-direct effect” is postulated. Similarly, if AOD is positively correlated with cloud-top temperature, a “drizzle effect”, and otherwise, an “invigoration effect” is postulated. Now I accept that Niu and Li put forward arguments which may corroborate this claim. Still, in my opinion, it is sufficient, and of better scientific style, to choose a more careful language. I provide a suggestion for a revised title and abstract at the end of this review. A revision of the text in a similar way would be needed for the rest of the manuscript.

Other major comments

The effect of wet scavenging of aerosols is not discussed enough. Why is there no negative correlation between AI/AOT and precipitation (at least for “mixed-phase”)? AI and AOT are retrieved only where there are neither clouds nor precipitation. Does this play a role?
The assessment of the meteorological context is rudimentary. Most important is for both cloud formation and aerosol swelling/ increased AOT in the vicinity of clouds is

ACPD
11, C165–C170, 2011

the relative humidity and its small-scale fluctuations. At least a discussion of this would be necessary.

Specific comments

p5006
l5: It would be good to recall the reader that at daily resolution, only a “curtain” of Cloudsat data are available within each 1°x1° grid-box
l6: Choosing the Tropical region does not ensure that the dominant cloud type is convective. Also in combination with the other criteria (in particular, cloud base temperature), this is not assured, and given that a typical LTSS is $>$ 20 K (Fig. 4d), this would most certainly be stratiform clouds.
l10: Specification is needed on how these temperatures are computed. Are they computed for the CloudSat cloud base heights as obtained at original resolution? Or rather, after averaging the curtain over 1°? If the latter, the temperature criteria would not necessarily define the temperature very well. It would be useful to check the claim using the CALIPSO or MODIS cloud-top phase retrieval.
l15: How are the bins chosen?

p5007
l3: The latent heat release by freezing is a main assumption if a cause-effect relationship shall be proven. Is there a way to use the re-analyses or CALIPSO to assess this?
l11 and elsewhere in the manuscript: It might be a better choice to say “high-aerosol” (or maybe “polluted”) rather than “dirty”.
l22: the wording here should be revised to be more careful about causes for the correlations found

ACPD
11, C165–C170, 2011

l25: also in practice.
l28: this is not necessarily the case. The scavenging depends on precipitation intensity, frequency, droplet size distributions, mixing of aerosol into the cloud and below cloud. These characteristics may well be very different for the different cloud types.

p5008
l14: the most important quantity is relative humidity and its fluctuations at the cloud scale.
l17: this does not seem to be true for liquid clouds?
l24: don't the meteorological data include data assimilation?

Table 1: precipitation intensity is missing from the table.

Captions Fig. 1, 2, 4: It would be necessary to explain the statistical quantities at the upper right of each figure. Are these computed from the entire dataset, or from the binned data?

Fig. 1, 2, 4: It would be necessary to show the amount of data within each bin of AI/AOT

Fig. 1: Why is R^2 = 0.54 so large for liquid given the curve is rather flat (and given also

ACPD
11, C165–C170, 2011

the author's interpretation of it)?

Fig. 2: It would be necessary to explain the difference between 2b and 1a in the caption. Is it just that 2b selects only cases where the Cloudsat-retrieved precipitation rate is > 1 mm h^{-1}?

Fig. 4: The substantial variation in LTSS for "liquid" clouds is interesting and needs discussion.

Suggestions for a revision in a more careful language:

Title: Correlations of satellite-retrieved cloud-top temperature and precipitation intensity with column aerosol concentration for different clouds over the Tropics

Abstract, starting p5004 line 7: ...we identified two distinct correlations of clouds and precipitation with aerosol loading. Cloud-top temperatures are significantly negatively correlated with aerosol index (AI) over oceans and aerosol optical thickness (AOT) over land ...; no significant correlations were found for liquid clouds. The distinct correlations might be explained by two mechanisms... Aerosols may invigorate... Precipitation rates are found to be positively correlated with AI for mixed-phase clouds, but negatively correlated for liquid clouds. If the correlations are due to a cause-effect relationship where the aerosol influences cloud and precipitation, these effects...

ACPD
11, C165–C170, 2011

A similar revision would be needed for the Conclusions section.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 5003, 2011.