

First reply to RC1 comment of Anonymous Referee #1 on the ACPD paper “Satellite observations of aerosols and clouds over South China from 2006 to 2015: analysis of changes and possible interactions” by Nikos Benas et al. (Referee comments are repeated in italics).

General statement:

This study used multi-source data to investigate the aerosol and cloud properties over South China and discussed the potential mechanism. This work is meaningful; however, it lacks innovation in technical regard and some conclusions/discussions are incorrect. From the satellite remote sensing, the authors may misunderstand the definition of CALIPSO aerosol type (see major comments). I also find some flaws/errors. The specific comments are as following:

Reply:

We thank the Referee for reviewing our manuscript. As we tried to explain in the paper (e.g., page 2, lines 8-13), we consider that its innovativeness lies more in the combined usage of different satellite-based data sets, and the examination of their potential and limitations for explaining the observed changes in aerosol and cloud properties, rather than in technical aspects, since rather standard methods were adopted. We plan to emphasize this innovative aspect further in the abstract of the revised manuscript. Following are our replies to the major and specific comments:

Major comment:

Major comments: The author listed three CALIPSO aerosol types in section 3.1: smoke, polluted dust, and dust. Aerosol type is related to the optical properties of aerosol. Although “polluted dust” is the mixture of dust and smoke, “polluted dust” is a type of aerosol, not the simple integration of “smoke” and “dust”. However, it seems that authors regarded “polluted dust” as the simple integration of dust and smoke, and on this basis, they made conclusions/discussions in Section 3.1, e.g., deduced “the decrease in polluted dust AOD can also be attributed to biomass burning aerosols” and “the changes in polluted dust should also be attributed to reductions in biomass burning aerosols”. For example, if dust and smoke did not change, but total AOD and polluted dust decreased. In this case, how to explain?

Reply:

Based on Omar et al. (2009), who describe the CALIPSO aerosol classification algorithm, “polluted dust” is an aerosol type considered separately from the “smoke” and “dust” types, as the Referee also explains. In that study it is stated that the polluted dust model “is designed to account for episodes of dust mixed with biomass burning smoke”, and also “for instances of dust mixed with urban pollution”. In our study we also analyze the “polluted dust” AOD as an independent aerosol source, which may contain aerosols from biomass burning. In this context, we agree that the statement in page 4, lines 25-26 (“Since no significant change is found for pure dust aerosols, the decrease in polluted dust AOD can also be attributed to biomass burning aerosols”), repeated in page 4, lines 33-34, can be misleading, since it implies a direct connection between “dust” and “polluted dust” aerosols. Although a decrease in biomass burning aerosols is a possible explanation for the decrease in polluted dust AOD, corroborated by the similarity in the corresponding changes in GFED emissions (Figs. 3b and 3c), it is not the only one. This will be clearly stated in the revised manuscript. In our opinion, however, this point does not affect significantly the relevant conclusions and discussions. Specifically, the large decrease in polluted dust AOD in November (Figure 3b),

combined with the corresponding shape of the AOD profile change (Figure 8c), and the fact that the polluted dust model is a combination of a desert dust and a biomass burning mode, as explained in Omar et al. (2009), still point to a concurrence of changes in an absorbing aerosol type and low (mainly Stratocumulus) clouds (based on Figure 9c). This concurrence led to the relevant discussion on possible explanatory mechanisms (Section 3.3.3).

Specific comment 1:

Page 3 line 4-10: please point out the scientific dataset's name for cloud data.

Reply:

In the revised manuscript we will include a table containing the scientific dataset names of all cloud variables used from MODIS and CLARA-A2.

Specific comment 2:

Page 3 line 22-25: please rewrite this sentence. "initial and final" may cause misunderstanding.

Reply:

The sentence will be rewritten to avoid misunderstanding.

Specific comment 3:

Page 3 line 24-26: why not use slope of the regression line to examine the change?

Reply:

The methodology suggested by the Referee is analogous to the one described in the manuscript. We opted for the latter in order to provide our results in terms of absolute or percent changes during the exact period examined. Using the slope of the regression line would be more useful if changes were presented on a per year or per decade basis. The reason for selecting this method will be added in the revised manuscript.

Specific comment 4:

Page 3 line 35: rewrite this sentence. Biomass burning is not the only aerosol source in South China.

Reply:

This sentence was phrased using the term "include" to indicate the Referee's point: that biomass burning is not the only aerosol source in South China. We will rephrase it in the revised manuscript, in order to emphasize this point further.

Specific comment 5:

Page 4 line 8-10: please explain why the differences in March and April reached the maximum?

Reply:

An explanation of this point is not straightforward. Based on our analysis, there is no apparent characteristic of either aerosols or clouds appearing in these two particular months, that could help explaining these differences between MODIS and CALIPSO. Hence, further investigation is required for providing a definitive explanation of these differences, which would be beyond the scope of the present study. Instead, we provide a general description of known reasons that cause differences between MODIS and CALIPSO AOD.

Specific comment 6:

Page 4 line 28: not recommend cite an ACPD paper. A paper which is under review may have errors. There are other papers, like Ma Z. et al (2016) and He Q. et al (2016).

Reply:

We thank the Referee for this recommendation. The suggested papers will be included in the revised manuscript.

Specific comment 7:

Page 4 line 40-44: what is "C" emissions? It means GFED? Why GFED partially agrees with the total AOD change pattern can infer aerosols over the study area is transported from neighboring region? There is no any other type of emission? All aerosols in South China come from biomass burning?

Reply:

"C" is the total mass of carbon particles (given in Tg), available from the GFED data set. The discrepancies in changes between biomass burning emissions and satellite-derived AOD could indeed be caused by aerosols transported from other regions, or by other types of emissions not included in GFED (e.g. sulfates), as the Referee suggests and we also mention in page 4, lines 14-15, or by both. Our analysis, however, does not imply that biomass burning is the only type of aerosol emissions in South China. In fact, as we describe in other parts of the manuscript, based on findings from recent studies (page 3, lines 35-39 and page 4, lines 1-2), biomass burning constitutes one of the main aerosol sources over the area, originating from different activities with different seasonal characteristics, with domestic burning being the main contributor in autumn and winter. Our point here is that if a change in aerosols from biomass burning (smoke aerosols in our case) is not well captured by the biomass burning emissions data set, it is likely that this change occurred in a nearby region. We plan to rephrase these lines in the revised manuscript, trying to clarify this point.

Specific comment 8:

Figure 1: the horizontal axis may start in July and ends in June.

Reply:

We thank the Referee for this point. The Figure 1 caption will be corrected accordingly.