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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aerosol-cloud interaction inferred from MODIS satellite data and global aerosol models" *by* G. Myhre et al.

Anonymous Referee #1

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Review of paper:

Aerosol cloud interactions inferred form MODIS satellite data and global aerosol models by G.Myhre et al

Positives - showing the potential of simultaneous retrievals - clever idea to use the Angstrom parameter to distinguish between swelling and lifetime effects

Concerns - define 'meteorology' or 'meteorological conditions' - many statements are too strong (references?) and not unilateral valid, as statements suggest - MODIS data analysis could have been better (e.g. use provided histograms, focus on water clouds) - there are no satisfying conclusion

General comments

The paper compares on the basis of the daily overpass time the commonly retrieved aerosol parameter (the aerosol optical depth, aod) of MODIS sensor data to spatial associated (on a 1x1 lat/lon grid) MODIS retrievals for water vapor and cloud properties (cloud cover, liquid water content, etc Ĕ). In addition, simulations of two global model (a CTM and a GCM) are analyzed to investigate, if the detected relationships (which are extremely difficult to interpret - correctly that is) are reproduced in global modeling at the right magnitude on a regional basis. To investigate the role of humidification / water-uptake several model simulations are performed with differences to humidification assumptions and to thresholds for max. ambient relative humidity and max cloud cover.

I do not like that, there are not really any good conclusions other than that that those are difficult. On the other hand it demonstrates the potential of associated retrievals of atmospheric properties to provide clues on atmospheric processes (here aerosol-cloud interaction), which can become testbeds for global modeling.

The data-analysis is quite simple and seasonal. I personally learned that (seasonal) correlation fields are quite useful when it comes to looking for responses as function of aerosol type, and that data filtering (e.g. using just the fine mode aod [aod*fine-mode fraction] and/or only looking at cloud properties with cloud-top temperatures above freezing) brings out much sharper correlations (an older poster, which was initially prepared for the AeroCom meeting at Ispra 2004 shows annual correlation fields of property extremes).

It is nice to see data from two different models brought into the pictures. It just would have been even nicer if meteorology would have matched the MODIS data year 2001, which these simulations do not. This is certainly a handicap, as well as these models do not account for interactions from aerosol indirect effects. However, I am not convinced that there are no aerosol cloud-interactions, as there are aerosol removal processes associated with clouds and there is the stronger aerosol water uptake effect near clouds.

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EGU

At the recent workshop Norman Loeb gave a presentation on aerosol-cloud interaction concluding that there was no apparent dependence on large scales meteorological system . Overall, given the many possibilities for interpretation of the presented relationships in this paper, there need to be much can in how things are rephrased and interpreted. Despite probably very unsatisfying conclusions, I think the paper shows some interesting summary of satellite data, and I recommend publications mainly to encourage future efforts in this field. I still hope that this paper will be improved (detailed comments are listed below).

Minor comments

'MODIS' rather than 'Modis'

9352:

Line 10: why the split at AOD $>$0.2?

Line 10: be more specific on what you mean with 'aerosol-cloud interactions'

Line 11: was do you mean with 'meteorology' (synotics?, weather-systems?, frontal passage?)

Line 12: aerosol without water uptake (not very realistic): ALWAYS aot decrease with more cloud cover?

Line 21: I do not see the low cloud-fraction is an reason to dismiss cloud contamination

9353:

Line 14: add "Ěand increased reflectivity of solar insolation. This cloudĚ.

Line 15: delete 'for'

Line 18: can inhibit precip, can Ě (it not necessarily does)

9354:

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Line 2: Kaufman algorithm makes many asumptions and is only produced over oceans!

Line 6: are these all observation or are these model results?

Line 15: 'due to aerosol' how do you know? give a reference for this statement.

Line 16: Lohmann's results are based on a model, which may be wrong (my analysis shows that MODIS aot data correlations with cloud cover are often stronger than those for cloud LWC and that correlation are not necessarily positive, as negative correlations are expected over land, especially in regions/seasons of pollution and biomass burning - probably from s semi-indirect effect) (when introducing results for indirect effect signatures do not always switch between obs and simulations)

9355:

Line 11: mention that you talk about WATER clouds

Line 15-20: Do we care about water vapor or ambient relative humidity. Anyway I am not certain in which way the water vapor (especially on larger scales) would change, given any of the mentioned indirect effects (also it is better to have references when making statements that are not quite clear)

Line 24: what do you mean that there are no aerosol cloud-interactions in models. There certainly is aerosol processing (e.g. removal) and an aerosol aod dependence on relative humidity considered in modeling.

9356:

Line 2/3: I assume you mean the analysis of satellite data (as the previous sentence was about modeling)

Line 8/9: meteorological conditions ? meteorology?

9357:

Line 14: you use year 2000 ECWMF data Ě., yet you use MODIS 2001 data. Why

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couldn't it be the same year. This would be much more meaningful.

9359:

Line 10: we know there are snow contamination problems at NH high latitude. Also the high aots in the SH esterlies are likely from contamination with clouds (I suggest to use the new collection 5 to verify that)

Line 14: not surprising as MODIS (coll. 4) data over land have severe accuracy issues if available

Line 12: Figure3: Are the PDFs based on daily data? I suggest to use MODIS equivalent sub-samples from modeling otherwise it could be apples and oranges (e.g. for Africa). Also note that PDF are contaminated by seasonal cycles (e.g. trop. biomass burning)

Line 18: say so: marine aerosol (30°S-20°S), smoke (20°S-5°N), mineral dust (5°N-25°N), and pollution aerosols (30°N- 60°N) do not refer to another paper for definitions

Line 19: the increase in cloud cover with high aots involving hydrophobic dust is a bit surprising as dust loads are higher at dry conditions. This is expected near sources but these regions are far away in off-flow regions where sources of sea-salt are more relevant: so no surprise (e.g. more convection  mode windspeed  more sea-salt spray) , ditto for biomass.

9360:

Line 4: what, if MODIS dust is interpreted as cloud? This cannot be ruled out.

Line 6: I would expect the leveling off as in the model and anti-correlations between aot and cloud cover at high aot events, because these are usually dry conditions (with few clouds). Could this be a retrieval issue?

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Line 6: Is the MODIS tendency a reflection of met. conditions (e.g. dry clear conditions after precip) ?

Line 20: for the Indian Ocean we would expect Monsoon seasonality (polluted +less cloud in dry season as compared to Monsoon time: anticorrelation expectĚ thus it might be better to investigate in terms of seasonality)

9362:

Line 9: when you use the MODIS liquid water path product, did you filter for warm ($>$273K) cloud top T ?

Line 11: these are very general statements. If you look at correlation fields there are differences with respect to aerosol type: over oceans dust-outflow is usually show anti-correlations, while pollution and biomass outflow regions usually are positive correlated. At high latitude storm-tracks there are also anti-correlations but I am worried there about incorrect interpretations from sub-pixel cloud contamination

9363:

General: relative humidity would be much more interesting Ě but this is a 3D field and altitude dependent

9364:

General: if we would only have small particles then the Angstrom parameter would decrease with swelling. However, if the ratio of accumulation/coarse aot gets larger then the Angstrom increases. In many cases the second effect in case of pollution can partially or more than partially offset the the swelling effect

Line 20: the increase in cloud-height should be more thoroughly investigated. Most interesting in terms of The indirect is the altitude of water clouds (and I believe there is hardly any correlation with low level cloud top, which by the way has severe retrieval issues) The idea of invigorated clouds (the Rosenfeld idea) only works if clouds are

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already present, as pollution arrived, yet if there are no clouds to start with there won't be any invigoration rather a suppression to create clouds (semi-indirect).

9366

Line 14: low aot retrievals are strongest impacted by sub-pixel contamination. Small cloud cover does not say anything about the spatial distribution of this cloud cover (many small sub-pixels cannot be ruled out) - so I do not buy the argument attributed to Kaufman and Zhang. I think to advance our understanding on the humidity effect near cloud we need information about the proximity of aerosol near a cloud pixel.

9367:

Line1: I find relatively fewer positive than negative correlations between aot and Angstrom parameter for MODIS data. There is a lot of variations spatially, which make global generalities quite difficult. Also given the problems with AOD land retrievals of MODIS, only the ocean correlations should be considered: Based on outflow regions MODIS data show for biomass/pollution usually positive correlations and for dust dominated regions usually negative correlations

Line 10: these are (I think too) strong statements regarding the semi-direct effect. Again I think it depends, if clouds were there to begin with.

9367: There are other issues with r,eff derivations from MODIS data. Generally there is an overestimation in cloud-droplet size in particular in case of broken cloud fields. The expected anti-correlation is actually seen between aod and low level cloud eff. radius in the MODIS data Ĕ but manily over oceans. If taking the effective radius of all clouds correlations are more frequent, which tells me that relationship of the general sense (without filtering for low level clouds, where most aerosol are expected) are even more difficult to interpret.

9368:

Line 10-15: the conclusion are not very satisfying. Why doing all that work with con-

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cluding that everything may be ‘fictious’?

Line 18+ : it would be nice to discriminate by aerosol type rather than making a global statement Ě. and I fully agree with the last sentence of the paper

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Interactive comment on Atmos. Chem. Phys. Discuss., 6, 9351, 2006.