

Interactive comment on “Exploring the differences in cloud properties observed by the Terra and Aqua MODIS sensors” by N. Meskhidze et al.

Anonymous Referee #1

Received and published: 27 January 2009

Review of: Exploring the differences in cloud properties observed by the Terra and Aqua MODIS sensors.

By: Meskhidze et al.

Recommendation: Accept with major revisions.

Summary:

This paper provides a well-written overview of differences between aerosol and cloud properties between Terra and Aqua overpass times. The primary conclusion is that semi-direct effects are likely more important as microphysical indirect effects, especially during the afternoon time period. That may indeed be the case, the evidence for this conclusion is not as clear as the authors’ seem to state throughout the

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paper. There are several important assumptions that are made, which need to be explained in greater detail before the reader can accept the authors' conclusions at face value.

Major Comments:

1. The treatment of atmospheric conditions (or lack thereof) is extremely disappointing. The authors make the assumption early on that averaging over large spatial and temporal scales remove the influence of atmospheric conditions on the results. I strongly disagree with this. Atmospheric conditions can vary significantly in the 3 to 4 hours between Terra and Aqua overpasses greatly influencing cloud properties. You do acknowledge this in the paper, but fail to analyze its importance relative to the aerosol effects. Somehow, you need to quantify the effects of changes in atmospheric conditions have on cloud and aerosol characteristics, which can be independent of any aerosol-cloud interactions. This is a difficult process, but if it can be shown that would greatly enhance the overall impact of this work.

2. The uncertainty in aerosol retrievals in the vicinity of clouds needs to be discussed in greater detail. You do note that greater uncertainties exist, but you need to explain somewhere how these uncertainties would specifically impact the interpretation of your results. In any satellite-based assessment of aerosol and cloud interactions, this uncertainty is a necessary evil. You do attempt to take these into account by removing AOT < 0.8, but I believe you may be introducing further sampling uncertainties by doing this. In essence, you may be missing the highest aerosol concentrations, which would be causing the greatest indirect effects.

3. Throughout the paper, you show important evidence to support your hypothesis that indirect effects differ between Terra and Aqua overpasses. That is fine, but given the degree of uncertainties present and the poor treatment of atmospheric conditions, I don't think the hypothesis has been proved beyond a reasonable doubt. The results and conclusions need to be reworded to state that the results provide important

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evidence for differences indirect effects between morning and afternoon, but further research is necessary to fully assess its importance relative to other factors. (I will highlight several occurrences where wording should be modified to reflect this in the Specific comments below.)

Specific Comments:

P 1489, lines 10-15: The sentence starting with “For the vast areas”; does not seem to make sense. Are you saying that the presence of aerosols double the reduction of cloud fraction and COT compared to other factors? If so, please state this more clearly.

P 1491, lines 19-20: I don’t know if I would use the word “intra-diurnal”. I think it would be better to just say that we are analyzing differences between morning and early afternoon conditions rather than give the read a false sense that any true time-series analysis is being performed.

P 1492, lines 20-28: See major comment #2 concerning the treatment of atmospheric conditions. If you are going to continue with this assumption, please provide some more quantitative assessment of its implications. A single reference to a 10+ year old paper is not enough.

P 1493, line 8: How much data are removed by using the $AOT < 0.8$ threshold? Does this introduce any spatial or temporal sampling biases?

P 1493, lines 17 & 20: Is it really necessary to fill in missing AOT pixels with surrounding data? How much data does this add? I suspect the results would be similar without doing this, and I believe this interpolation opens an unnecessary can of worms. (If the results are significantly different if missing pixels are not filled in, then that is a major problem).

P1494, lines 2 & 3: “Despite this, there are no known large uncertainties”; is a very strong statement, and needs to be backed up by some

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additional references and/or further discussion.

P1496, lines 24-25: Discuss cloud contamination issues in greater detail here.

P1497, lines 2 – 4: Remer in GSRL observed the opposite results, can you explain why yours are different. (I’m not saying you are wrong, I’m just curious where the difference is).

P1497, lines 18 – 28: You need to show whether or not the 20 – 30% difference shown is statistically significant. Even if it is, it does not necessarily indicate that the differences you are seeing in cloud properties between polluted and non-polluted samples is solely a result of the aerosols. Also, the importance of aerosol type and vertical distribution need to be examined in greater detail here. For example, are the aerosols in the polluted case mostly below, in, or above the cloud layers? A case study example or 2 would be useful here.

P1498, lines 1-10: Continuing from the last comment, are you saying that since elevated aerosols in the form of dust are located above the stratus deck, then micro-physical indirect effects are unlikely and semi-direct effects are more likely. This would be true, but I don’t see any evidence in this paper that vertical distributions in each region fits with your conclusions. You may very well be correct, but more detail is required in the portion of the discussion. It is also important to quantify the relative importance seasonal changes in CF, COT and other factors on your results. It is possible that some of these other factors are the dominant signal with indirect effects being only a secondary factor.

P1498, line 26: Which studies are you referring to?

P1501, lines 27-28: AOT and ice cloud fraction both increase from morning to afternoon, but I do not agree that the results in Figure 6 necessarily prove that smoke is increasing convection. Is there a significant relationship between Aqua ice cloud properties and AOT? If your hypothesis correct, there should be.

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P1502, lines 15 – 25: Again the results show that AOT and cloud properties vary in accordance with each other, but it does not necessarily imply that the difference are a result of aerosols interacting with clouds. These changes could also be part of the natural variability of aerosol and cloud properties.

P1503, lines 2-4: Remove :this is the first time…”

Conclusions: One of 2 things needs to be done. Showing that aerosol and cloud properties are related is an important observation, but the evidence shown here does not conclusively show that either indirect or semi-direct effects are being observed. Too many other things may also be occurring. Ideally, the authors’ could be added to atmospheric conditions and aerosol profiles to the analysis, which would significantly improve the importance of this work. Otherwise, the portions of this discussion need to be revised to say something along the lines of “we show evidence for… but cannot unambiguously prove…”

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 1489, 2009.

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