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Comment

## ***Interactive comment on “Joint spatial variability of aerosol, clouds and rainfall in the Himalayas from satellite data” by P. Shrestha and A. P. Barros***

**Anonymous Referee #1**

Received and published: 23 April 2010

General Comments:

In this paper, the authors studied the variability of aerosols, clouds, and rainfall based on the EOF analysis and SVD analysis. The main goal is to identify the region of joint space-time variability of aerosols, clouds, and rainfall. The authors described the first two modes of EOFs and SVDs. The authors suggested that the first mode of aerosols is highly influenced by the orography in northern India and the southern slope of Himalayas. The authors argued that the second mode of EOF analysis of AOD shows a spatial pattern associated with the pronounced aerosol-cloud-rainfall interactions.

The comprehensive description of the annual cycle of aerosols over India and its relation with the annual cycle of cloud and rainfall might be an interest to many readers.

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But the manuscript is not acceptable for publication in ACP as it stands. I recommend a major revision.

1. The description is limited to the annual cycle of aod and associated seasonal variation of cod and rainfall. In this regards, I do not see the merit of using EOF. As shown in the timeseries (EC), the first and second modes of EOF are associated with not only annual cycle but also the interannual variation. So, it may be beneficial to separate original timeseries into seasonl (annual and semi-annual) and interannual variation.

2. To identify the relations between aod and cod(or rainfall), the authors 1) calculate the lead-lag correlation between ECs and 2) use SVD computation between two variables. I found the approach is little confusing, especially when we have two different spatial patterns of cod that are associated with the same aod pattern (See Fig. 8 and Fig. 11. I'd like to suggest to use only the first two EOF ECs of AOD to calculated the regression map (with time lag(or lead)) with other variables (cod and/or rainfall) to show lead-lag relation between aod and cod(or rainfall).

3. In their abstract, the authors claimed that they found, based on EOF analysis, that the areas where the indirect effect of aerosols are dominant. But, the authors did not provide adequate evidence and/or hypothesis to support the argument.

4. On page 4385, the authors interpret the lead-lag correlation between ECs as cause and effect. ECs are supposed to be orthogonal each others, so the peak correlation can be found at a quarter of the period (3-month for annual cycle, or 9-month).

5. Often, the authors refer their earlier works and emphasize that the current results are consistent with their earlier works. It would be nice for a reader to know what variables/aspects the authors are referring to, without reading all of their previous works.

6. Wind fields shown in Fig. 2 should be masked out where the surface pressure is less than pressure level, especially for 900hPa winds. And 900hPa may be too low to discuss transport and convergence/divergence in northern India.

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7. During summer, AOD measurement may have a fair weather bias. And AOD can not be collocated with COD. The limitation of the MODIS/AOD measurement during active monsoon periods should be considered in interpreting the results.

#### Other Comments:

1. Page 4374, line 22: It is not clearly documented what "the region of spatial overlap of the modes of variability" is.
2. On page 4376: Liu et al. (2009) is not listed in the reference section.
3. Page 4380, line 15: Can you elaborate how the spatial mean is calculated? Rather than fill the gap, the authors should consider repeating analysis with the deep blue product from Aqua. Another way is to use MODIS with missing over Tibetan Plateau. The variability of AOD over Tibetan Plateau will be very small anyway.
4. Page 4384, lines 19-21: How do the signs of EOF related with the robustness of the mode?
5. The last sentence on Page 4384 (starting from line 27): It is not shown. Citation?
6. Page 4385: This is the most confusing part. The authors' description may be right, but it is hard for me to draw the same interpretation based on the results(i.e. EOFs and ECs) shown in this paper. Few examples are:
  - 1) we don't see the northward propagation from EOF, it just jumps when the sign of EC change.
  - 2) Line 13: Is the correlation length defined as the time the correlation become zero? If so, shouldn't it be around 3-4months?
  - 3) Lint 14: "the same large-scale dynamics"? It could be since they all have annual cycle as a dominant component in ECs. But, as shown in SVD analysis, the first EOF of cod may not related AOD and/or rainfall.

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- 4) Lines 20-22: EC2 of AOD is dominated by the annual mode while EC2 of rainfall and COD are mostly semi-annual mode. I am not sure whether we can get any further information from the lead/lag correlation.
- 5) Line 27: Can you elaborate how the lag correlation suggests cloud-aerosol interaction?
7. Page 4386, Line 10: Cross-correlation doesn't necessary mean causal relationships.
8. Page 4386 lines 24-27 & Page 4387 lines 15-18: There are little too far-fetched.
9. Page 4387 line 21: "landform" doesn't have temporal variability.
10. Page 4387, line 24: COD is listed twice.
11. Page 4388, lines 1-3: I am sure that the orography in this region plays important role in forming monsoon rainfall and circulation as well as aerosol distribution. But it is hard to draw this conclusion based on the results from the current study.
12. Page 4388 lines 4-8: This statement is not based on the current study.

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Interactive comment on Atmos. Chem. Phys. Discuss., 10, 4373, 2010.

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