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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Cluster analysis of an impact of air back-trajectories on aerosol optical properties at Hornsund, Spitsbergen" *by* A. Rozwadowska et al.

Anonymous Referee #3

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Rozwadowska et al present look in their study on the optical properties at Hornsund and how they are affected by atmospheric transport. To this aim they perform a cluster analysis of backward-trajectories arriving at the measurement site. The topic of the study is interesting and will certainly be appreciated by the readership of ACP. However, the presentation of the research results is missing some clarity and needs some substantial improvement. Only with a thorough revision of the text it is acceptable for publication. I would like to focus the authors' attention to the following points:

1) Data and methodology:

This section presents the data sets, the backward trajectory calculations and the clus-

tering analysis. In all three sections I miss essential pieces of information.

Data (2.1): What is the Angstroem exponent? What does the number 500 mean in AOT(500)? What is AOT_fine and AOT_coarse standing for? In addition to these basic questions, I would appreciate some information about the temporal resolution and the accuracy of the measurements. Is ist furthermore correct that the aerosol optical thickness is dimensionless? It is quite clear that the authors have some experience in this field, but it would help the non-experienced reader a lot if some further details are given. Then, on line 29 (page 15428) it is written that "the original spectra obtained from ERONET were additionally cloud screened". Please explain why this is the case! For a dynamicist interested in optical properties these minor details help a lot.

Backward trajectories (2.2): This description needs some important improvements. It is not sufficient to say that "the reanalysis" data base was used. Which reanalysis? What is the horizontal and the vertical resolution of the reanalyis? What is its temporal resolution? Note that these aspects have a considerable impact on the quality/accuracy of the backward trajectories? Furthermore its has to be considered that one single trajectory is very often not representative for the air mass arriving at one specific site. Often this shortcoming is overcome by running backward trajectories not only at the measurement site, but also at horizontally displaced starting points. This allows to assess the coherence of the air streams arriving at the site. Please comment on this aspect of the backward trajectory calculation.

Cluster analysis (2.3): It is stated that "the distortion related to the projection had a secondary impact on the classification". I am not completely convinced that this is the case. This is obviously the case for short-time trajectories. However if the backward trajectories extend for several days into the past and hence cover a large horizontal distance, the projection might become important. Have you really checked that the distortion due to the projection can be neglected? I also wonder how As a further point: You are identifying a huge number of clusters ("cluster numbers ranged from 30 to 5")? How statistically significant are the individual clusters? In particular, how to you

justify to keep clusters with only one member? Finally, I do not see why you are mixing different levels in your distance measure (equation 1)?

2) Results:

At the moment th whole paper is strongly focused on the statistical aspects of the clustering, i.e. the clusters are used to determine how the relative variance of rel_VAR(AOT) is reduced. I would appreciate very much if some further refinements on the meteorology of the clusters themselves can be included. Actually, I would propose a restructuring of the whole results section into four distinct parts:

- part 1 only introduces and discusses the different clusters. Here, some additional information about the meteorology associated with the clusters could be given, e.g. source region, number of members, coherence. Note also that the average of a cluster might sometimes be misleading. So how strong is the spread around the cluster averages?

- part 2 would introduce the importance of the aerosol transport in aerosol AOT variability. It essentially coincides with section 3.1 of the submitted manuscript (with the adjustments suggested below in minor points).

- part 3 discusses how the individual clusters impact on the AOT. This part essentially coincides with section 3.2 of the submitted manuscript. As a specific question to this section: Why are now all cases included, even the extreme ones. This was not the case for section 3.1. How does this affect the whole analysis?

- part 4 finally present the link to the ASTAR campaign (present section 3.3).

At the moment, the reader get somewhat lost in to many details. Therefore, some improvment on the structure might be helpful.

In summary, I would like to see some further interpretation of the results in context of meteorology. This is a major deficiency of the paper: it needs to go one step further than pure statistics and discuss the results. I think it is no surprise that the clustering

technique will reduce the relative variance of AOT, although it is nice to see how much. The real benefit would come from a thorough interpretation of the results. Some further improvments in this direction would be very welcome.

Note also that the number of clusters is quite large and looks arbitrary. How is the number of clusters determined? What about the statistical significance of the clustering results? Stated in another way: If you repeated your analysis for some other time period, would you expect the same results?

2) Minor points:

- The abbreviation rel_VAR(AOT) is not a very lucky one. It looks "bulky" and I would suggest to define a "lighter" one, e.g. rv(AOT) or ...

- page 15430, line 14: "Figure 1 shows temporal variations of AOT during measurement years in Hornsund station": Why is this sentence in this section 2.3. It has nothing to do with the clustering? Additionally: as far as I can see there is no detailed discussion of this Figure in the text!

- The first three paragraphs of section 3.1 (up to line 17, page 15431) introduce the relative variance of AOT. I would strongly suggest that this definition of the rel_VAR(AOT) becomes a fourth subsection in the data and methodology section. Note, here you are not discussing a result but are defining a quantity which will be used throughout the paper. Furthermore, the newly defined quantity rel_VAR(AOT) would be easier to understand if some basic statement was added. Why not state that low values of rel_VAR(AOT) are found if atmospheric transport, as specified by the clusters, is able to explain the variance. The formula is clear and it can be understood, but some helpful comment make life easier for the reader!

- A question to Figure 3: Why is the combined variance (in yellow) smaller than the separated ones (in red an black)? Is this obvious?

- I would suggest to pass the whole manuscript to a native Englsih speaker who

then could improve some complicated sentence structures. Being myself not a native speaker, I don't feel really able to make many suggestions in this respect.

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