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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The contribution of extratropical cyclones to observed cloud–aerosol relationships" *by* B. S. Grandey et al.

Anonymous Referee #3

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Review: "The contribution of extratropical cyclones to observed aerosol-cloud relationships" by Benjamin Grandey and coauthors Stier, Grainger and Wagner.

The paper describes an analysis that seeks to explain the relationship between aerosol optical depth (AOD) and cloud properties (fraction and cloud top height) in the vicinity of midlatitude cyclones as being due to meteorological covariation. To do this they use cyclone compositing approach whereby many meteorological, cloud and aerosol fields are composited based on distance and direction from storm center. I was quite confused on reading the paper about what exactly the authors have done and what hypothesis they are really trying to test. I think that the manuscript will be useful if the authors can make some efforts to improve clarity in the description of the methodology. As they will see below, I am confused about practically every aspect of their analysis,

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and I hope they can mitigate this in a revised version.

I thought that they might test whether the mean/median fields of aerosol and cloud fields are spatially correlated (they are as far as I can tell), since this would in my view be evidence that meteorology is partly driving the correlations. It appears that is not the case. The authors are looking at aerosol-cloud correlations between storms at a given location from the center as a function of the cyclone strength. So as far as I can tell, the authors are testing whether cyclone strength may help drive correlations, not whether the existence or otherwise of a cyclone can produce AOD-cloud covariation. Thus the title is incorrect and should reflect what is being tested, which is not what I first thought was being done.

To illustrate, imagine I have a ground site and I want to examine whether cyclones are helping to explain the correlation between AOD and cloud cover I see. I notice that when the winds are strong there is more AOD, the cloud tops are higher and there is more cloud because a cyclone is passing. This "effect" is not what the authors are testing here, unless I'm mistaken. That needs to be carefully spelled out.

That said, after the third re-read I think I understand the key question they are setting out to test (Line 5, P 11974): "Can relationships between aerosol and cloud-related properties be explained by considering simply the relative vorticity of extratropical cyclones and position relative to the storm centre?". I think they mean "does the correlation between cloud fraction [or temperature] and AOD at a given location relative to the cyclone center change with cyclone strength?"

So I am stumped when it comes to understanding what is plotted in Figure 3. Shouldn't there be one figure for each of the vorticity bins used? Or does this figure not take into account the cyclone strength? Everything was headed toward me expecting to see correlations as a function of vorticity but they never came. I have to admit that I really lost track of what the authors are doing at this point. As such, the paper needs some serious work to improve readability and precision about what's been done.

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Other comments:

There are problems with the abstract. From its reading, it is actually impossible to figure out what the authors did that led to their conclusion that large scale synoptic conditions do not drive cloud top temperature-AOD relationships. Indeed, I'm not even sure I understand what such a statement means. The language is not specific enough and this leads to confusion. Just stating that a "storm centered approach" is used is not enough. I can use a storm centered approach to conclude the opposite: for example, if one looks at the median fields of AOD and cloud top temperature, they are correlated. High AOD values are found in the high winds surrounding the cyclone, and this is where the highest cloud fractions and coldest cloud tops are found. Based on this, one would conclude precisely the opposite of what is stated in the abstract, namely that synoptic conditions so drive relationships between cloud top temperature, cloud cover and AOD.

How much more data is in the "all conditions" composites as opposed the ot the "storm-centric" ones? This would appear to be important if the cyclone domains take up more than 50% of the area. In a recent study [Bodas-Salcedo, personal communication] the storm-centric dataset is approximately half of the total. It would be better to take the storm-centric data and the REMAINING data as the two datasets to make Figs. 3 and 5.

Abstract: How does covariation drive a relationship? What exactly does this mean? I don't really know what the authors are setting out to do.

What is a "statistically-robust explanation". Do you mean a significant correlation?

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 11971, 2013.