Review: “Aerosol-mid-latitude cyclone indirect effects in observations and high-resolution simulations”

This revised version of the manuscript explores the impact of aerosols on liquid water path in extratropical cyclones. This new version is more detailed and more convincing that the previous paper, but there are still issues, mostly to do with the presentation of the results and the structure of the paper. The comments below list the various parts were rewriting or modifications are needed to make the paper clearer and more fluid.
Based on the sensitivity of the results to the source of cloud droplet number concentration, the conclusions should be somewhat expanded and in some places toned down.
Otherwise, the manuscript is acceptable for publication after minor but highly recommended revisions.

Detailed comments:

1. The document needs some cleaning and tightening as the current presentation still includes remnants of the previous version. Section 2.3.1 is the only subsection in section 2.3. Similarly 3.1 is the only subsection of this level in the results section 3.
2. In the conclusions, please discuss where the additional variability in cloud liquid water path might come from, as you indicate that 60% (and not 100%) or this variability is caused by the moisture flux and aerosol impact on cloud droplet number concentration.
3. You might want to relate your results to a recent paper by Naud et al. (2017), who explored the co-variations between aerosol optical depth and cloud cover in extratropical cyclones. In particular they examine cold and warm fronts separately, which might help explain better your assertion that the cold frontal region is where the albedo change with aerosols is concurrent with the change in liquid water path and cloud fraction. Also, while cited, the Grandey et al (2013) study who explore the impact of extratropical cyclone strength on the cloud-aerosol relationship could be further discussed in light of the results of this paper in the conclusions. Both of these studies to some extent contradict the statement in the introduction that “aerosol-cloud indirect effects have not been observed in extratropical cyclones” (L25, p2). Although neither study can establish a causal relationship, the fact remains that observations in extratropical cyclones have already been used to explore aerosol-cloud relationships.
4. In the introduction please indicate where these cyclones are. In 2.1 it is specified that they are over the oceans but a latitude range should be specified. I suppose that these are all in the northern hemisphere? Are they found in both Atlantic and Pacific oceans? Are the Mediterranean cyclones also included? At least it is specified for the simulations but at the bottom of page 12, it sounds as if the observed cyclones are sampled in both hemispheres. If indeed this is the case, then “southwest quadrant” is misleading.
5. Section 2.2.3: please add a couple of sentences to explain how the MERRA-2 sulfate mass is used to obtain CDNC.
6. Section 3.1.1: the section on the aquaplanet simulations is very short, and about half of this section is in fact about the relation between the moisture flux and precipitation, which is more general than just about model simulations. The main result here seems to

be that regardless of resolution and aerosol concentration the relationship between moisture flux and precipitation rate is unchanged. No mention of a relationship between CDNC and liquid water path is made. Both figures associated with this section are in the supplemental material. It would be preferable to have these figures in the paper since they do illustrate the discussion. This would be especially useful because in fact this discussion is confusing: on the one hand, it gives the impression that the rain rate vs moisture flux relationship does not change with the aerosol concentration (or resolution). But Fig. S3 suggest that it does. To bring this matter to rest though, the figure should be clarified by either drawing a linear regression per model configuration or constraining the data points so they would have the same WCB value per configuration. Another confusing matter is this: if WCB is kept fixed and LWP changes with aerosols, then surely precipitation should as well, no?

7. Section 3.1.2: again the title of this section is misleading, it says “observed’ cyclone properties and yet the very first sentence is about comparing observations with simulations. It seems that pages 9-11 are in fact part of a single section on the simulations while a new section should be when the work using the observations alone starts (second paragraph p12)
8. Are the three WCB regimes of Figure 2 defined based on the observations? Two questions arise: are the three population very different in the number of members and would sampling issues affect the results? Are the distribution of WCB per region for observations and the different model configurations very different? Why not use the same color scale for all composites in Figure 2?
9. The discussion on why the southwest quadrant is a good place to sample for CDNC could be improved. First this quadrant is dominated by low-level clouds and so MODIS derived CDNC is probably better sampled there. It is not clear however that it would be representative of the entire cyclone, and in particular the warm sector and warm frontal zone that are dominated by high-level clouds and thus CDNC information is missing. Second the warm conveyor belt which is ingesting moisture into the cyclone tends to originate from the south east and is not always found in the southwest quadrant. So it is not clear that the “southwest quadrant is likely to be the source of moisture and aerosol for the cyclone”. Figure S6 is quite important for this discussion and yet once again it is in the supplemental material. The whole discussion on how to best partition the cyclone population based on CDNC needs to be improved, it is quite confusing still. For example, it is unclear what Figure 4 is really telling us.
10. How significant is the separation in Figures 3a and 3b? based on this figure and the tests presented in Figs S7, S8, and S9, it seems that the separation is best for the southwest quadrant possibly because this is where low-level clouds dominate and ice contamination in the satellite observations is less. It seems that the results really target this specific quadrant and that little is known of the clouds that are found in other parts of the cyclones.
11. Discussion of Figure 7: here it might be worth comparing with the results of Naud et al 2017 (fig 10). Also, why not define the three WCB regimes based on terciles of the entire cyclone population? This would alleviate the small number of member issue for the 5 mm/day category?

12. Page 16, discussion on albedo effects: it is quite worrying that the difference between the MODIS and MERRA2 constrained albedo variations with aerosol are this important for low values of WCB which constitute the largest number of cyclones. This should probably be said somewhere. Unrelated: the whole discussion on albedo could probably be presented in its own subsection.
13. I do not see how Figure 11 is showing a "stronger increase in CLWP for a given increase in CDNC_SW in more pristine storms". Either there is an error in the sentence or the caption of Figure 11 needs rewriting.
14. Conclusions: last sentence. Given the observations at your disposal and the disagreements between MODIS and MERRA-2 constrained relations, I would tone down this last sentence, as I am not convinced that this is a demonstration, but rather the observation of co-variations in accordance with the expectation of the sort of effect aerosols should have (as demonstrated with the simulations though).

Typos:
Line 21, p 3: replaced "is" with "area" between "composite" and "located"
Line 17, p9: write what "CMIP" stands for.
Line 16, p14: "extent" is misleading as this is a term often used for vertical extent. "fraction" or "cover" might be more appropriate.
Line 5, p15: add "s" to "support"
Line 21-24: this sentence is too long and is missing a verb towards the end.
Line 13, p16: replace "can be" by "can display" for example

Reference:

Naud C. M., D. J. Posselt, and S. C. van den Heever, 2017: Observed covariations of aerosol optical depth and cloud cover in extratropical cyclones. J. Geophys. Res – Atmos., 122, 10,338-10,356. Doi:10.1002/2017JD027240.