

## ***Interactive comment on “Arctic aerosol net indirect effects on thin, mid-altitude, liquid-bearing clouds” by Lauren M. Zamora et al.***

### **Anonymous Referee #1**

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#### GENERAL COMMENTS:

Much of this analysis is interesting and relevant. Nonetheless I have some concerns with the paper as it is that primarily relate to the extremely intensive filtering of the data that has happened. The authors are left with only a handful of cases (It's not clear to me exactly how many, maybe thousands) from two years worth of satellite data. Generally the utility of satellite data is found in the large sample volume; an advantage eliminated in this study. Even after throwing out most of the data the authors then proceed to estimate the effect of the aerosol on cloud longwave radiation over the whole arctic. It is very difficult to believe that the handful of cases examined here can be representative of meteorological conditions over the entire arctic and throughout the year. It is not clear to me that this extensive filtering is necessary or even useful. In fact it may introduce undesirable sampling biases.

An example of this over-filtering of the data is eliminating clouds that are detected by CALIPSO but undetected by CloudSat. Many of these clouds will be shallow liquid-only clouds with small drop sizes (exactly the cloud type purported to be studied here) and yet they are thrown away. Wouldn't one interesting test be to determine if these clouds are more prevalent in the polluted conditions. This might be expected from the authors hypothesis. As another example what sense does it make to require the cloud optical depth to be less than 3. Once again don't we want to know if there are changes in the relative frequency of occurrence of these optically thick clouds in the presence of aerosol.

In short I found the justification for the filtering methodology to be lacking and I would really encourage either a convincing justification for why most of the data is thrown out or more appropriately just include include all cloud in the analysis.

Finally, the authors really want to get at the impact of aerosol on the cloud long-wave effect. The CloudSat data products (2B-FLXHR-LIDAR) have already calculated clear/cloudy fluxes for every pixel using combined input from CloudSat and CALIPSO cloud and aerosol profiles. The authors have put a good bit of work into identify clean and polluted conditions. All of this could be put together to simply calculate the aerosol effect for all cloud conditions without all of the filtering. Some more specific comments are below

#### SPECIFIC COMMENTS:

Section 2.1.2: By limiting analysis to cases where both CALIPSO and CloudSat identify approximately the same cloud height the authors throw out a great number of cases where clouds may have radar reflectivities below the detection threshold of the radar but are the thin liquid clouds of interest to the study. Eliminating clouds that have a base height greater than 1 km further aggravates this situation. In fact the authors have chosen a sampling strategy that minimizes the data availability from either instrument because it will be infrequent that clouds have optical depth less than 3 but still have

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a radar reflectivity above the  $\sim -28$  dBZ CloudSat sensitivity. This is why it looks like there are maybe only a few hundred points on figure one. I can't reconcile this with the statement that 95% of the data are included in the analysis. How many pixels are included in the analysis? How many total pixels are there over the two year period?

Page 5, line 31: Why exclude precipitation cases? Don't we expect some aerosol influence on the occurrence of precipitation?

Section 2.3: The authors seem to recognize that the artificial filters that they are applying to the data may well introduce biases. So why not include all the clouds regardless of optical depth or detection by radar?

Fig 3: Where does sea ice data come from?

Fig 3. Does this map include only the filtered data points shown in Fig 1.

Page 11, Line 11: How is precipitation determined? Which product?

Page 11, Line 22: I see Fig 1 differently. To my eye there is a clear clustering of the data with substantially more aerosol cases north of Europe and relatively more clean cases north of Siberia and North America. This statement is not justified by the analysis.

Page 12, Line 8: It is fairly obvious that you won't find an optical thickness difference when you have artificially limited the range of optical thicknesses to less than 3.

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