

Interactive comment on “Effects of long-range aerosol transport on the microphysical properties of low-level liquid clouds in the Arctic” by Q. Coopman et al.

Anonymous Referee #1

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1 Main review points

This manuscript presents a study on the effect of pollution on Arctic cloud properties using a combination of model and observation data. I expect the paper to be of considerable interest to readers of ACP. The manuscript is well-structured and generally well-written, the illustrations included are useful. In my view, the following (potential) issue requires particular attention before a potential publication:

I am uncertain about the statistical significance and thus reliability of the IE values reported – no p values are reported for the slopes used as the basis for IE, so the

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statistical significance and accordingly physical meaning remains unclear. There is a paragraph pertaining to uncertainties (36-9 and following), but I am not sure if this is related.

2 Details

- Page 31825, line 25 (henceforth 25-25 etc.): In your summary of the IE parameters reported elsewhere for the relationship between aerosol and cloud-droplet effective radius you provide values greater than zero. This appears counter-intuitive as an inverse relationship is expected (radius decreases with increasing number of cloud-condensation nuclei). Please add explanatory detail to this paragraph.
- 25-25: It appears hard to compare the numbers compiled here, as the parameter used as reference (denominator) varies between the studies cited.
- 26-9: Another common assumption is that observed aerosol and cloud exist at the same altitude.
- 27-24: Please explain why you consider these parameters to be of particular importance.
- 28-8: As I understand this paragraph you use level 2 products of cloud properties. If so, please remove “retrievals of” as the inclusion of these words might imply that you yourselves retrieve these properties. In the same vein, the next but one sentence should begin along the following lines: “In the technique applied for computation for the MODIS level 2 product, cloud-droplet effective radius ...”
- 28-10: Do you retrieve cloud top temperature yourselves? If so, please specify how you obtain this temperature based on the 11µm brightness temperature.

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- 28-23: The spatial resolution for MODIS was given as a length; here (and in table 1), an area is provided. Please decide on a uniform representation.
- 32-6: I find it confusing that you call the 0-3 average “03:00 UTC”.
- 32-15: I assume that altitude information refers to cloud top. Please clarify this in the manuscript. Which system is used to determine cloud top height for this classification?
- 32-21: It would be much more interesting to know the area covered by each of your grid cells in your study region. Near the pole the variation in area is likely to be large.
 1. Please provide information on the range of area contained within your pixels
 2. Why didn't you opt for an equal-area grid?
- 33-17: Why would this be the maximum?
- 34-7: “cloud[-]active component” is not clear to me. Please clarify.
- 34-23: I am new to robust linear models. I would assume that, as with any fit, there will be a p value of some kind, providing information on the probability that the fit identified is purely random.
 1. Is this correct?
 2. If so, please provide the p values. Also, if the p value is larger than a significance level identified by you a priori, you should discard the fit as not statistically significant.
- 35-10: “more logarithmically distributed” – what does this mean? Did you perform distribution tests?

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- 35-20: Sub-section 4.1 presents a lot of numerical detail. If all of this needs to be presented, I suggest a tabular format.
- 37-9: I don't understand from this sentence how the five bins/regimes are delimited.
- 37-11: What are the significance levels of the slopes summarized in these figures?
- 38-4: Are all the values summarized here statistically significant at a level predetermined by you?
- 38-7: What type of IE are you referring to here? Effective radius? Optical depth?
- 38-7: I am not convinced that IE values using different parameters in numerator and denominator can be directly compared.
- 38-12: To claim that you found greater pollution-dependence you would have to consider exactly the same time period using your refined methodology. Otherwise differences between years could distort the picture.
- 38-15: Likewise, this comparison is only possible if the same period is considered.
- 40-10: “eightieth percentile bin of 23 K” – I don't understand what you mean here.
- Figure 3: Figure text does not include information on lower bound of cloud altitude range considered here (1000m given in the main text).
- Figures 5 and 6: A two-dimensional binning would be of great use I think – e.g. with LTS on one axis, humidity on the other, and colour codes for IE.

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3 Technical suggestions

- 25-15, 25-28, and many other places in the manuscript: It seems to me that hyphenation is incomplete, please check throughout the document. E.g., long-wave radiation, indirect-effect value, cloud-droplet effective radius, etc.
- 28-7: “measures radiation in 36 spectral bands with central wavelengths from 400 to 14400nm.”
- 29-18: remove “which has been”
- 29-22: version
- 31-23: satellite sensors
- 31-23: “Passive satellites sensors need sunlight” – please use more precise wording
- 31-23: cloud microphysical
- 34-25: equals (remove “to”)
- 35-17: on cloud microphysics
- 36-4: 200 AND
- 37-9: defined
- 38-5, 7 and 9: number of significant figures differs
- 38-9: sentence not correct
- 39-6: LOWER temperatures

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- 40-15: reanalysis data sets
- 40-16: have been → were
- 40-23: “aerosols influence...” → aerosol-cloud interactions.
- 41-3: may someday be
- Figure 2: “at” the top of the map?

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