

Interactive comment on “Space-based evaluation of interactions between pollution plumes and low-level Arctic clouds during the spring and summer of 2008” by K. Tietze et al.

Anonymous Referee #1

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In their study, the authors use a relatively new technique of combining satellite observations of cloud and carbon monoxide estimates from an off-line tracer transport model as a proxy for cloud-active aerosol to study the possible effects of pollution on low-level Arctic clouds. CO is used because it is itself unaffected by cloud processes. They find that the indirect effect (regression of CO) on cloud optical depth is four times larger than for cloud droplet radius.

This is an interesting finding because cloud optical depth is suggested to be controlled by cloud droplet radius in the first aerosol indirect effect hypothesis. It would be in support of two recent studies suggesting that either dynamical cloud-radiative feedbacks

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(Garrett et al. 2009) or drizzle-aerosol effects (Mauritsen et al. 2010) might be more important, at least in the Arctic, than the first aerosol indirect effect suggested in earlier studies.

The paper is well-written, as I found only minor glitches pointed out below, albeit a bit long in my taste, while figures are in a good state. My major concerns with this study is the linkage from correlation to causality and the quality itself of the data analysis upon which the main conclusion of the study is drawn. How come the indirect effect estimates for LWP and cloud optical thickness is much larger when including all data as opposed to sub-dividing it into greybody and blackbody cases? See Figure 6 a-c). Note that the sum of cases in the two sub-divided categories is the same as when all cases are included.

I suspect part of the answer is that spurious correlations occur because large-LWP cases might come from certain regions or under certain meteorological conditions and low-LWP cases from others. That is, the high indirect effect estimate on cloud optical thickness when looking at all cases may be the result of processes which have little to do with pollution. If the authors would base their conclusion on Figures 6 b) and c), rather than a), they would say the enhancement is only a factor of two. If they had sub-divided the data further, the enhancement might have been even less.

Minor comments:

Why do the authors use POLDER to derive cloud top height, when CALIOP is available in the A-train?

On several instances the authors discuss how MODIS cloud top heights have trouble due to surface temperature inversions. It is well-known that the lower troposphere exhibits a semi-permanent inversion, which is most likely due to transport of warm air from the south at mid-levels, while the surface or the boundary-layer clouds loose heat to space from below. This causes the atmosphere to be nearly the same absolute temperature in the lowermost 2-3 kilometers. See e.g. Kahl et al. (1996).

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Page 29115, line 19, I think it would be appropriate to cite Stevens and Feingold (2009) here.

What is the rationale for removing CO after exactly 20 days? Might one not just as well use a general inert tracer?

Page 29121 line 29, the use of the SWIR abbreviation does not make sense here. Also, do you really mean 'near-infrared' instead of 'shortwave infrared'?

Page 29122 line 13, replace 'and produces' with 'was set up to produce', unless this is fixed of course.

Page 29125 line 1, I don't think clouds can lie. Maybe something is missing in this sentence.

Page 29127 line starting at 14 is very long and difficult to read.

Same page, line 21, I would suggest to insert 'roughly' before 'near'.

Page 29128 line 8, the sentence needs some rewriting.

Page 29131 line 15, here and in several other places I get the impression that the authors interchange cloud optical thickness and LWP. Please check through the entire manuscript to ensure consistence.

Page 29131 line 24, I would cite Mauritsen et al. (2010) here.

Page 29132 line 3, replace 'is' with 'could be'.

Page 29132 line 23, this sentence seems a bit too general to serve a purpose here, alternatively you need to cite some far older papers.

Page 29133 line 15, this sentence needs rewriting.

Page 29133 line 20, I would consider omitting 'strongly'.

Page 29134 line 25, in the the first aerosol indirect effect hypothesis LWP is assumed

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to be unaffected by aerosol. Hence the last sentence here is self-contradicting.

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