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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Arctic clouds and surface radiation – a critical comparison of satellite retrievals and the ERA-interim reanalysis" *by* M. Zygmuntowska et al.

Anonymous Referee #1

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Zygmuntowska et al. compare Arctic clouds and their influence on Arctic radiative fluxes in an early version of the CloudSat 2B-FLXHR dataset and the ERA-Interim. A dataset comparison analysis is publishable if it improves our understanding of the influence of clouds on Arctic fluxes using the best-available datasets and/or it uncovers and fixes substantial unknown biases and explains their climate significance. In its present form, this paper does not meet either of these criterion. This paper does little to advance our understanding of the influence of clouds on Arctic radiative fluxes because of the non state-of-the-art methods that it uses and the resulting unfounded interpretation of the results. For these reasons, I cannot recommend that this paper be published in ACP.

Significant known limitations of CloudSat dataset used in this study:

The authors arrive at ill-founded conclusions about the utility of CloudSat 2B-FLXHR fluxes as compared to ERA-Interim because they use a version of the CloudSat fluxes dataset 2B-FLXHR that has well-known deficiencies for Arctic radiative fluxes. To their credit, the authors re-identify issues with 2B-FLXHR that are already well-known to the CloudSat team and attempt to fix some of them (e.g., variable surface albedo). Unfortunately, the authors do not address the most significant deficiency: the version of the 2B-FLXHR they analyze only uses CloudSat-observed clouds to constrain radiative transfer calculations. Many Arctic clouds are low and optically thin clouds that the CloudSat radar will not detect. Luckily, the co-located CALIPSO lidar can detect many of these clouds. The importance of the lidar clouds to total cloud amounts and therefore radiative fluxes is well known (L'Ecuyer et al. 2008). Specifically in the Arctic, Kay et al. (2008) found that need the lidar to get accurate cloud amounts and therefore accurate radiative fluxes from the 2B-FLXHR algorithms. Kay et al. (2008) is directly relevant to lines 20-28 on page 31505. The impacts of adding CALIPSO to cloud estimates are not "uncertain", but instead known to be significant in the Arctic. It is also straight-forward to quantify the importance of the lidar-observed clouds with the 2B-GEOPROF and 2B-GEOPROF-LIDAR data in hand, something the authors could have easily done. Given the results in the Kay et al. (2008) paper, it is not acceptable to publish Arctic radiative fluxes constrained by CloudSat-detected clouds alone and use it as an estimate of the influence of all Arctic clouds on Arctic radiative fluxes. The under-estimation of 2B-FLXHR cloud radiative impacts when compared to ERA-Interim (Figure 5) is not at all surprising given that it based only on radar-observed clouds.

Of greatest concern, it is not acceptable to use a dataset with known deficiencies to claim that ERA-Interim is more "plausible" than any observationally constrained radiative transfer calculations (last line of the paper on page 31511). This conclusion is especially troubling when ERA-Interim Arctic radiative fluxes are constrained by unvalidated modeled cloud fields. This major conclusion of the paper is not substantiated by

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the evidence that is provided.

An aside: The 2B-FLXHR product is currently being improved for use in the Arctic under a NASA-funded grant. These improvements include the incorporation of lidar observations, variable surface albedo, and full solar zenith angle sampling despite the limited cloud diurnal sampling. At this point, the dataset has not been released to the general science community, but a release will likely happen in Spring 2012.

Additional concerns:

1) Representativeness of SHEBA not discussed

How representative is the SHEBA site of the entire Arctic basin? This is an important question for understanding the relevance of the ERA-Interim/SHEBA evaluations presented in this paper (and in many others) and also a useful question that could be addressed both with the satellite observations and ERA-Interim used in this study.

2) Cloud definition issues not fully appreciated or appropriately described.

Unconstrained cloud definitions are a serious limitation of all of the cloud fraction comparisons presented in this paper (e.g., Figure 2). The satellite cloud community has made major strides forward in addressing this issue with instrument simulators (e.g., see Bodas-Salcedo et al 2011). These state-of-the-art techniques for model-observation comparisons need to be at least mentioned, if not pursued. How do you compare modeled clouds for ERA-Interim with observed clouds from satellite observations if you don't know what a cloud is?

I am concerned that while cloud definition issues are mentioned (page 31498, lines 20-25), the implications for the findings that are presented here are not fully appreciated by the authors. For example – on page 31510, line 4. the authors imply ERA-Interim is better than CloudSat because CloudSat is "detecting too few and/or too optically thin clouds". CloudSat is an instrument. It detects clouds based on the observational capabilities that it has. Saying that it detects "too few" clouds implies that the observational

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method is wrong when compared to a model-based cloud amount from ERA-Interim, which seems very odd.

Technical corrections:

line 16 page 31498. Remove "Clouds are flimsy objects".

line 18 page 31500. This is an error. CloudSat was launched in April 2006, not June 2007.

Is Figure 2 is missing AVHRR data for years 2006-2007, 2009? AVHRR doesn't appear to be plotted correctly in this figure.

References:

Bodas-Salcedo, A. and Coauthors, 2011: COSP: satellite simulation software for model assessment. Bull. Amer. Meteor. Soc., doi: 10.1175/2011BAMS2856.1

Kay, J. E., L'Ecuyer, T., Gettelman, A., Stephens, G., and C. O'Dell (2008): The contribution of cloud and radiation anomalies to the 2007 Arctic sea ice extent minimum, Geophys. Res. Lett., doi:10.1029/2008GL033451

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