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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.

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1 General Comments

The article addresses cloudiness in the Arctic and highlights the strong difficulties faced in cloud assessment in this region. The article explains the problems faced in detecting clouds using active, and passive instruments. ERA-interim model data, and data from active and passive instruments are compared to data from the SHEBA campaign.

The dataset based on passive instruments (VIS/NIR/IR measurements), the CMSAF cloud product, has severe difficulties detecting clouds during the winter months. This can be attributed to the lack of information available for cloud detection from the short

wave channels (because of the night time conditions), and also because the semi-persistent strong surface inversion hampers cloud retrievals based on the IR channels.

The authors use the CloudSat 2B-FLXHR dataset to assess the cloud radiative impact in Arctic. This dataset is not optimal for Arctic conditions, and therefore strong assumptions need to be made, especially since the underlying surface in the product is open water. Furthermore, low level clouds, which are common place in the Arctic, add further uncertainty. As mentioned several times in the article, CloudSat can not be used to detect low level clouds. The article reports that Calipso measurements may help to detect such clouds, but these are not included in the CloudSat 2B-FLXHR dataset.

I think the article tackles a difficult region, makes a contribution to our state of knowledge on cloud detection in the Arctic, and is an overall good article. I think it still needs to address some weaknesses, and in general elaborate more on the methods used in the study, and motivate the assumptions made more clearly.

2 Specific comments

On page 31505, lines 9–12, it is explained that the Arctic skies are dominated by low clouds that can not be detected by CloudSat. For me this is a very strong caveat to using the 2B-FLXHR dataset within the Arctic region, considering it relies only on CloudSat data. Please elaborate more on why this dataset can is useful in the Arctic nonetheless, and on how large the offset the impact of the problem is on the results.

Since the 2B-FLXHR dataset does not include sea ice, an approach is devised to emulate a more realistic surface albedo. I think the albedo values chosen (45-75% if SSM/I sea ice $> 15\%$) need more motivation. For instance, if the sea ice is covered in snow, especially fresh snow, the albedo will be much higher. How good is this approximation?

On line 3 on page 31502 it is explained that changes in the longwave surface fluxes from the ocean are not taken into account. Does this mean that for the longwave flux calculations the surface is always assumed to be open ocean? If so, I would expect a bias of at least around 30 K in the pack ice regions, especially during the winter months. Please clarify either way.

I need additional convincing that the assumptions made to enable the use of the CloudSat 2B-FLXHR dataset in the Arctic are valid, and that the dataset can be used at all (especially in the Arctic) since many of the radiatively important low clouds are not detected.

The article states that the region chosen for the study should have conditions representative to the central Arctic ocean. I feel that this could do with some more clarification. What do central Arctic ocean conditions entail? e.g. pack ice, a mixture of open ocean and ice, open ocean? I'd like some more information on this. Naturally, the overlaying atmosphere, especially the lower atmosphere, may have very different conditions depending on the underlying surface. Instinctively one might think that the "central Arctic's" surface consists of only of pack ice. Also, sticking to regions of pack-ice might match the conditions of the SHEBA experiment more closely since it was on a floating ice sheet. See below for some technical comments related to the region of study.

I am also missing some cloud definitions to assert if the cloud amount from ERA-interim can be directly compared to the observational datasets in this context.

Finally, the conclusion that ERA-interim gives us the best cloud approximation overall in the Arctic seems hasty and insufficiently motivated.

3 Technical comments

- On page 31498, line 29; is the central Arctic equal to "over the pack ice only", i.e. no open ocean? This is not obvious. If so, this region of stable atmosphere should vary with ice extent and nearly cover your entire region (not just the central Arctic) during winter.
- Line 5 on page 31504; results from over land are reported, yet on line 17 on page 31500, it is stated that only data over oceans and sea ice are analyzed.
- It is mentioned on line 22–24 on page 31497 that clouds might occasionally be warmer than the surface, due to the semi-permanent inversion in the Arctic. I think this is not as rare as the sentence implies, especially not during the Arctic winter when the inversion is very strong.
- line 12-14, p31503. I suggest to add some suggestions/explanations to why the dataset based on passive instruments detect so few clouds in December and January here.
- line 23 on page 31506, short wave cloud radiative effect depends to a lesser extent on the presence of "mixed-phase or ice clouds". I would say on "cloud particle phase", otherwise it tends to read that ice clouds or mixed phase clouds have little effect on the short wave radiation.
- Line 2 on page 31509; A bit harsh I think, the dataset based on AVHRR measurements does not fail to detect clouds completely as in implied here, albeit it does leave many clouds undetected.
- Line 2–4 on page 31510, This doesn't make sense to me: From that sentence I read "CloudSat detects clouds that are too optically thin". Do you mean the opposite?

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 31495, 2011.