Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2020-918-RC2, 2020

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Characterisation and surface radiative impact of Arctic low clouds from the IAOOS field experiment" *by* Julia Maillard et al.

Anonymous Referee #2

Received and published: 22 October 2020

Arctic low clouds are a key climate feature of the atmospheric boundary layer over the Arctic Ocean. Arctic low clouds are important because of their strong influence on the amount of solar and infrared radiation that is incident on the surface. In the meantime, they can strongly modify the low-level heat, moisture and momentum fluxes. This paper quantified the seasonality and surface radiative impacts of Arctic low clouds from the Ice, Atmosphere, Arctic Ocean Observing System (IAOOS) field campaign. It is a very important topic as the Arctic is a data-sparse region. Moreover, both passive and active remote sensing products have their limitations on polar cloud retrievals. Therefore, the information obtained from this five-year campaign is very valuable. Overall, this paper is well written, but the structure needs to be improved. I recommend it to be accepted after following issues being addressed. Please find my specific concern as below.

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Discussion paper

Overall: The current version contains too much information. I find it a bit difficult to follow because of the paper's structure, which is not well organized and logical. The section 4.1.4 is tightly connected with section 4.3. The author also mentioned that "The reasons for this are explored in Sect. 4.3 by investigating the summer radiative balance." (line 362-363). Is it better to combine these two sections together? From my perspective, a better structure would be the seasonality of cloud properties, impact of cloud on surface temperature and radiation budget, and followed by the comparison of ERA5 to surface in-situ measurements. And I am quite sure how to combine section 4.4 with other sections. Also, I believe the authors need to add transitional sentences and paragraphs to connect these sections in a more logical way. Line 5-6: "Cloud frequency is globally at 75%, and above 85% from May to October." Why the cloud frequency is globally? Not in the Arctic? Line 59-60: I think you could also mention that CALIPSO satellite product has limitation on temporal coverage, which is only available after 2006. Figure 4: There are no (a) and (b) in the figures. Section 4.1.4 and Table 3: How many cloudy and cloudless profiles are there for each moth? For example, you may rarely get cloudless profiles in summer as low cloud frequency is pretty high. Does this issue affect your results? Section 4.1.4: The clear-sky LW flux also exerts large influence on surface temperature. In most of cases, the magnitude of clear-sky LW flux is larger than that of cloud longwave radiative effect. We usually believe that the high pressure tends to reduce clouds and associated cloud warming effect. However, the high pressure in the upper troposphere could also increase the clear-sky LW flux and enhance surface warming. In addition, the authors tried to investigate the impacts of clouds on surface temperature by using lidar profiles with and without low clouds. Then how to make sure other conditions (e.g. large-scale circulation) remain same between two groups? I understand that this may not easy to be addressed. But authors should treat this issue more carefully. Reference: Ding, Q., Schweiger, A., L'Heureux, M., Battisti, D. S., Po-Chedley, S., Johnson, N. C., ... & Steig, E. J. (2017). Influence of high-latitude atmospheric circulation changes on summertime Arctic sea ice. Nature Climate Change, 7(4), 289-295. Line 425: "This may ultimately

be due to an error in the satellite data that is assimilated by the ERA5 reanalyses." Which satellite data is assimilated by the ERA5? Can you be more specific about this bias? Line 464-467: Is N-ICE second period from April to June? Since you used a fixed surface albedo 0.8, which excludes the impacts of reduced multiple reflections between surface and clouds with sea ice melt, particularly from April to June. Can you comment on that? Line 480: "This translates into a total shortwave cloud forcing that ranges between -20 to -60 W m-2, assuming an albedo of 0.8." Again, I believe that surface albedo plays an important role in determining the shortwave flux at the surface. Assuming a surface albedo of 0.8 could totally ignore the multiple reflections between clouds and melting surface. Reference: Wendler, G., Moore, B., Hartmann, B., Stuefer, M., & Flint, R. (2004). Effects of multiple reflection and albedo on the net radiation in the pack ice zones of Antarctica. Journal of Geophysical Research: Atmospheres, 109(D6). Line 522: "Low cloud cover (i.e., with a base beneath 2 km) is found to be 76% globally over the course of the campaign." What it is globally?

Please also note the supplement to this comment:
https://acp.copernicus.org/preprints/acp-2020-918/acp-2020-918-RC2-supplement.pdf

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