

Review of “Thin ice clouds in the Arctic: Cloud optical depth and particle size retrieved from ground-based thermal infrared radiometry” by Blanchard et al.

### General comments

This paper reports on the development and testing of new LIRAD method that utilizes thermal infrared bands available on the CIMEL CE-312 radiometer, which is considerably cheaper than the AERI. The latter has been used in the recent past to provide the thermal components to retrieve COD and Deff from the surface. The implicit motivation for this study seems to be that the LIRAD method can be used more often if the CIMEL-312 could be used instead of the AERI, since it is attempting to do the same things that AERI already provides. The explicit motivation is that the ability to discriminate between small and large Deff values would help the study of aerosol/cloud interactions in polar regions, especially regarding aerosol influence on precipitative cooling and (as inferred from the DLGRF computations) on radiative heating of the surface. The writing is of average quality, but has some grammatical issues. The paper is scientifically sound in its approach, but the results and method do not appear to be particularly new.

The algorithm is new in that it uses specific bands not previously employed in the AERI-LIRAD approach. However, they are not all that different from the AERI microwindows. Except for lacking the wavelengths longer than 14  $\mu\text{m}$ , this is essentially the same algorithm. If not, then it needs more contrasting with the MIXCRA. It relies on the phase being known already, whereas, I believe, the longer wavelengths used in the MIXCRA were primarily for phase discrimination. It is not surprising then that the results are quite close to those from the MIXCRA. The bottom line that I believe the authors should address is “how many wavelengths are actually needed to replace the 19 microwindows of MIXCRA having  $\lambda < 13 \mu\text{m}$  to perform the retrieval?” Could you do it with 2 or 3 channels? There appears to be a lot of information redundancy in the bands that were used.

The validation effort includes the comparisons with MIXCRA (noted above) and with lidar for COD. This begs the question: If the lidar is *required* for the LIRAD method and it produces a reliable COD (it is used as a reference), why then is the IR method used to estimate COD? Why not simply estimate Deff using the IR data and the lidar COD as input? Lidar retrievals of COD are quite common for most lidars deployed for surface observations. What am I missing? How will phase be determined if this approach is implemented elsewhere?

I think this paper can be published, but it needs some major revisions to provide better justification as to why it is necessary and to flesh out the analysis by addressing the questions above.

### Minor comments

P1, L24: “temperatures” does not belong here

P3, L4: “ aerosols acting as ice and water cloud nuclei, cloud microphysics, precipitation and radiation” **does** not make any sense. Please reorder this so that aerosols do not appear to act as cloud microphysics.

P3, L14: You may want to modify the sentence with "could possibly lead to" or something similar, since the “dehydration greenhouse feedback” is only a proposed mechanism.

P4, L3: Please “COD” for singular and “CODs” or “COD values” for plural here and throughout the paper

P4, L9: “northern most” should be one word

P4, L14: if the same summary is given by both references, then leave one out. If two different summaries are provided, then change everything to the plural form.

P4, L17: “in the order of” should be “on the order of”

P5, L24-25: The <2% refers *only* to downwelling radiation viewed at the zenith. It can be up to 10% for other viewing conditions, particularly for upwelling radiation (e.g., Minnis et al., JAS 93). The viewing limitation should be highlighted again when referring to the 2%.

P7, L16: COD can only have an amplitude if you are referring to its oscillation with time or space. Otherwise, please refer to it as magnitude or value.

P8, L3-6: Sentence should be broken up for clarity.

P8, L16: cloud altitude and thickness uncertainties do not have amplitudes in this context. See comment above.

P10, L1: Here and elsewhere, the form of the modifier does not need to match that of the noun. Should be “ice cloud retrievals”.

P11, L10: “mean’t” appears to be a typo.

P12, L12: “produces gives”, please use one or the other

P12, L18: should be “hydrometeor diameter”

P16, L4-5: “ommission” has only one “m”