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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Super-cooled liquid fogs over the central Greenland ice sheet" *by* Christopher J. Cox et al.

Anonymous Referee #1

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This article provides some interesting datasets about the physical nature of fogs and their radiative forcing that are worthwhile of publication. Aside from technical and scientific concerns outlined below, the primary criticism is that the writing quality is of poor quality, and this obscures the potential impact of the results. It suffers from "rambling", lacking concision that leads the reader clearly from the introduction to the conclusions. It contains many sentences that are nearly impossible to follow, statements that lack justification, and the sin of using non-quantitative descriptors like "very" and "quite". It is not clear that anyone other than the lead author read the manuscript in detail.

Specific items

1. p.2 l. 19. "liquid more efficiently absorbs and emits longwave radiation than ice likely increasing the forcing from liquid fog per unit mass compared to ice fogs or clear-sky

ice precipitation". Avoid words like "likely". Otherwise, what does this mean without stating the wavelength band? Is this really true? Does it even matter that much given the size of particles is the dominant consideration determining the specific absorption?

2. p.4 l. 26 No mention is made of size ambiguities by forward scattering probes to the assumed shape of particles. The relationship between integrated intensity in angular regime considered as a function of size is a strong function of ice crystal shape model and can result in uncertainties in measured size much greater than 100%.

3. I generally cannot follow the writing or justifications for the methods outlined in Chapter 3. This section in particular needs careful editing.

4. p. 6 l. 25 How is it known that the clouds are single layer?

5. p. 7 l. 16 I do not see any reference in Shupe et al. (2013) to justify the systematic statement that reflectivities >-5 dBz are indicative of snow.

6. What justification is there to support that blowing snow does not extend above 300 m?

7. What is the "lofting parameterization"?

8. When observations are mentioned, mention the instrument used. Presumably it is the FM100 that was used to observe particles in the lowest 10 m? Say so.

9. "Recall from Figure 3 that the threshold for identification used to construct Figure 5 is small (10-3 cm-3). Figure 3 also shows that the threshold at which events begin to be missed, and the rate at which missed events increase, is different for each class. For example, as expected, low density types such as snow also require a low threshold to be captured while high density types such as the fogs are relatively insensitive to the threshold." Completely incomprehensible.

10. p. 7 l. 4 "Snow occurred more often without significant blowing snow" ??? Writing

11. Case studies. An allowance needs to be made for observed changes in atmo-

spheric and fog state being due to advection into the observation region rather than the apparent default assumption that the changes are evolutions within the region due to local physical processes.

12. p. 10 “Thus, while the fog was likely induced by radiation initially, it was maintained, and ultimately continued to grow without additional infrared loss at the surface driving saturation in the air column” The sentences that follow are generally incomprehensible but I do not understand how it could be that cloud top continued radiative cooling would not be able to maintain and deepen the fog layer. If the boundary layer cools, then the saturation mixing ratio decreases and the condensate mixing ratio increases.

13. p. 12 l. 25. Referencing Hansen and Travis (1974), while correct, is a bit unnecessary given how far removed that paper is from this one. Just mention the effective diameter as being the ratio of moments of the size distribution.

14. The fog bows are interesting. The physics should be described, noting in particular that the presence of fog bows does not exclude the presence of ice, only requiring the presence of liquid.

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