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Interactive comment on "A synthetic data set of high-spectral resolution infrared spectra for the Arctic atmosphere" *by* C. J. Cox et al.

Anonymous Referee #2

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This manuscript describes a synthetic dataset of high-spectral resolution infrared spectra for Arctic atmospheres. The objective is to provide such a synthetic dataset so that developers of retrieval algorithms can use it for evaluation. The manuscript is well written and structured. The objective is very useful. Unfortunately, although great care is taken to use realistic assumptions for some aspects of the simulations, for some other aspects questionable and seemingly unneeded assumptions are made. These assumptions defeat the purpose of supplying realistic synthetic measurements. It seems likely that potential retrieval algorithms have more realistic assumptions in them. Thus, I advise this manuscript to be published only after major revisions to the dataset and the paper. Below I list my three specific major concerns and a few minor suggestions.

1) Page 6: Mie calculations are used for ice crystals, which will lead to unrealistic phase functions. It is stated that "spheres were specifically used for ice to simplify the dataset

and any associated retrievals." As said in my introduction, retrieval algorithms may use more realistic ice optical properties. Although light scattering may be expected to have a relatively small contribution to the IR spectra, I think it is not well known, or at least not discussed in this paper, what the expected errors from using Mie calculations for ice are for IR simulations. In line with the objectives of this dataset, more realistic ice optical properties need to be used. For example, I suggest using ice optical properties from the Yang et al. group (Yang et al., J. Atmos. Sci., 2013 ,doi:10.1175/JAS-D-12-039.1).

2) Page 10: It is stated that the highest clouds in the dataset are unrealistically thick. It is stated that this was done for "simplicity, consistency and computational efficiency." Again this seems to defeat the purpose of this dataset, and retrieval algorithms can be expected to have more realistic assumptions in them. Since these computations need to be run just a single time and not repeatedly as in a retrieval algorithm, computational efficiency seems not to be a priority, nor does "simplicity".

3) It is a bit unclear whether all assumed cloud properties are assumed to be vertically invariant, but this seems the case. All real clouds, and certainly Arctic mixed-phase clouds are vertically inhomogeneous (e.g., Shupe et al. J. Geophys. Res., VOL. 106, 2001). For example, ice sizes generally decrease with height in all ice containing clouds, while drop sizes generally increase with height. Often tops of mixed-phase clouds are dominated by liquid, while ice dominates further below. All of these structures are expected to have substantial effects on retrievals that need to be quantified. One objective of the paper is to provide a dataset for evaluation of retrievals from different viewing geometries and such vertical structures are likely to have very different effects on measurements from either the ground or space. Thus, neglecting these structures leads to a dataset that is not very realistic and its usefulness for evaluation retrieval algorithms is questionable.

A few minor comments:

Equation 1: Please give a definition for effective radius as used here.

Page 6, line 25: I believe “extinction cross section” needs to be “extinction efficiency”.

Page 6, line 26: Are both real and imaginary parts of the refractive index temperature dependent? Please clarify in the paper.

Figure 1: I suggest to only plot the 522 cloud-containing profiles in this plot, since the clear-sky cases are not representative for this dataset.

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