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Interactive comment on "Derivation of physical and optical properties of midlatitude cirrus ice crystals for a size-resolved cloud microphysics model" *by* A. Fridlind et al.

Anonymous Referee #2

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The research effort reported in the manuscript analyzed ice crystal images in mid-latitude cirrus clouds, towards developing internally consistent ice physical and optical properties for a size-resolved cloud microphysics model. Often reported in the literature, the parameterizations of ice cloud radiative properties and the counterparts of ice cloud microphysical properties are separately developed and thus lack internal consistency. The outcomes of this study represent an important contribution to a better understanding of ice cloud microphysical and radiative properties. Overall, the manuscript is well organized and clearly written. However, some improvements seem necessary before the manuscript is formally accepted for publication. Listed below are the reviewer's specific comments, which are mainly focused on the optical properties of ice crystals.

Several ice crystal habit models (specifically, a bucky ball model, an aggregate model, and a polycrystal model) are investigated in detail. For feasible light scattering calculation, ice crystal morphologies are highly simplified in comparison with realistic counterparts. A common justification for the simplifications is that the optical properties are realistic although ice crystal geometries are simplified and even unrealistic. An important constraint to check whether an ice crystal habit model is reasonable from the optical property perspective is to check the consistency of the corresponding optical properties between solar and infrared bands. The optical property parameterization in this study is largely based on Dr. van Diedenhoven's previous parameterizations. If the reviewer recollects correctly, Diedenhoven's previous parameterizations are developed for the solar bands, for example, van Diedenhoven et al. (2014a). Thus, it is suggested that the consistency of the present models between solar and infrared bands be validated. For the authors' information, a recent study in this regard has been reported: Holz, R.E., S. Platnick, K. Meyer, M. Vaughan, G. Wind, S. Dutcher, S. Ackerman, A. Heidinger, N. Amarasinghe, C. Wang, and P. Yang, "Resolving cirrus optical depth biases between CALIOP and MODIS using IR retrievals," Atmos. Chem. Phys. Discuss., 15, 29455-29495, doi:10.5194/acpd-15-29455-2015, 2015.

The description of the optical property simulations requires clarification. For example, it is mentioned in the manuscript (the second paragraph on page 24) that the anomalous diffraction theory (ADT) was used to compute the extinction efficiency. However, ADT is not applicable to the phase function (thus, the asymmetry factor) computation. How is an asymmetry factor value that is consistent with the ADT simulation derived?

On page 25 it is stated "a roughness parameter sigma as defined as Mack et al. (1996)..." (line 3) and "...we note that assuming plates with sigma=0.5...". In addition, Yang et al. (2013) and Baum et al. (2014) are cited. In Mack et al. (1996), uniformly tilting of ice crystal facets is assumed whereas the Gaussian distribution is assumed in Yang et al. (2013) and Baum et al. (2014). It is explicitly mentioned "Since Baum et al. (2014) and van Diedenhoven et al. (2014b) show that a roughness parameter of 0.5

best fit observations. . .". The same roughness parameter value (0.5) cannot be applied to the aforesaid two roughness definitions. Thus, it is suggested that an explicit definition of the roughness parameter be explicitly defined (maybe, an equation should be provided here). The clarification is important because the degree of surface roughness is a critical factor in determining the radiative forcing of ice clouds as illustrated by the following paper: Yi, B., P. Yang, B. A. Baum, T. L'Ecuyer, L. Oreopoulos, E. J. Mlawer, A. J. Heymsfield, K.-N. Liou, 2013: Influence of ice particle surface roughening on the global cloud radiative effect, J. Atmos. Sci., 70, 2794-2807.

One page 4, acronyms SHEBA and ISDAC should be spelled out.

To resolve small sizes, it is suggested that logarithmic scale is applied to the maximum dimension in Figs. 15 and 22.

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