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Interactive comment on "Photopolarimetric retrievals of snow properties" *by* M. Ottaviani et al.

Anonymous Referee #2

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Analyses of the polarimetric measurement of snow by the Research Scanning Polarimeter (RSP) instrument aboard NASA ER-2 aircraft are reported. Substantial revisions are necessary before the manuscript in its present form is accepted for publication. Below are some specific comments for the authors' consideration.

1) The quality of figures needs to be improved. In particular, the font size for the figure legend of Figure 1 is too small and essentially illegible.

2) For remote sensing applications, the asymmetry factor is not very useful. To simulate polarized radiative transfer in the earth-atmosphere coupled system involving snow surface, the complete scattering phase matrix is needed. For the revisions, the phase matrix associated with the retrieved asymmetry factor should be presented.

3) In terms of ice crystal habit model, the manuscript largely cites the work by a coauthor, Dr. van Diedenhoven, assuming hexagonal ice crystals. Over the years, Dr. Bryan

Baum and colleagues have extensively considered the effects of various ice crystal habits. However, those studies are completely ignored in this manuscript. Overall, the selection of the references in this manuscript is largely biased.

4) Section 3 "Methodology" needs to be improved. To be more specific, the description of the technical approach used in this study is not clear although the Ottaviani et al. (2012) is cited. A brief summary of the method developed in the previous study will help the reader to better understand this paper.

5) In the conclusions, the term " a novel analysis" is used. Is the novel method significantly different from the method developed by Roger (2000)? At several places, the word "novel" is used, which should be justified.

6) Please define the "roughness parameter" used in Figure 2 in a quantitative manner (e.g., by using an equation). Because the ray-tracing code developed by Macke et al. (1996) is used, the effect of surface roughness is approximately simulated by randomly titling a particle facet for every incident ray impinging on the facet. This is a statistical approach. The "roughness parameter" for uniformly tilting the facet and that for tilting the facet based on Gaussian distribution are different. Thus, without a clear definition of the "roughness parameter", this quantity has little practical value for downstream applications. Furthermore, when the facet is substantially tilted, the shadowing effect and the effect associated with rays' re-entries into the particle are not considered. Thus, a large "roughness parameter" is unphysical and meaningless.

7) Page 3060, "Fresnel kernel . . .for vegetated surfaces. . .": But the indices of air and ice are used (the line below Eq. 3). Furthermore, Fresnel formula is for the reflection and refraction at the interface of two continuous media. However, snow is a densely packed medium. Here (Eq. 3), the application of Fresnel formula needs to be justified. Wonder how much error will be produced if the effective medium theory (e.g., the Maxwell-Garnett mixing rule) is used. Furthermore, polarization state is not considered in Eq. (3). It is confusing how to apply Eq. (3) to the polarized radiative transfer code

(De Haan et al. 1987) that fully considers the polarization state of radiation field.

Interactive comment on The Cryosphere Discuss., 9, 3055, 2015.