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Interactive comment on "A two-habit model for the microphysical and optical properties of ice clouds" *by* C. Liu et al.

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It is not my intent to provide a full review to the manuscript submitted to ACPD. There was one important comment that I missed in the previous reviews and I would like to address that in this writing.

The manuscript by Liu et al. presents a two-habit model (THM) for the microphysical and optical properties of ice crystals in ice clouds. The authors show that this model represents the microphysical and remote sensing data rather well in general. This model could be useful for modeling and remote sensing applications. As they state in the manuscript, to better illustrate the advantages of the THM, they also consider a single hexagonal column model (SCM) for comparison. Based on the comparisons

of the optical properties of the THM and SCM to measurements, the authors seem to suggest that a single column model cannot adequately represent the optical properties of ice clouds. However, that conclusion is not supported by the work in this paper.

The SCM used by the authors has aspect ratios that increasingly deviate from 1 with increasing size and does not assume any surface roughness, based on choices made many years ago. These choices of aspect ratio and roughness are largely determining the optical properties. Especially the difference in roughness is determining the differences in optical properties between the SCM and THM. The paper does not show that there are no other choices of aspect ratio and roughness possible that would lead to a similar agreement with the measurements as is reached with the THM. Indeed, Wang et al. (2014) show that the phase function data shown in Fig. 8 is sufficiently well fit by a rough solid column model, at least over ocean. Furthermore, Cole et al. (2013) show the POLDER data shown in Fig. 10 is well fit using a single rough hollow column model.

Thus, in my opinion, the authors should at least make clear throughout that their choice of SCM is a very particular one. Basically all recent literature on ice scattering models agrees that crystal surface roughness is prevalent in natural ice crystals. This paper once again shows that a pristine crystal model does not fit the data, which is not very relevant anymore. However, it does not show that a SCM with adjusted roughness and aspect ratio would not fit the data.

The microphysical data shown in Fig. 4 will likely not be fit as well using a single column model and this is an advantage of using a multi-habit model. However, for remote sensing this is not a concern and if a single particle model with adjusted aspect ratios and roughness produces correct optical properties, it would be adequate for remote sensing purposes.

I suggest removing the SCM results and any statements about the SCM from the paper. Alternatively, the SCM could be renamed "the single pristine column model" (SPCM)

and the THM then should be renamed the “roughened two-habit model” (RTHM). It should then be clearly explained in the text that the differences in optical properties are largely due to the differences in roughness and aspect ratio choices and not because one is a two-habit model and the other is a single habit model. The authors should acknowledge that this work does not prove that there does not exist any SCM (or single plate models) with adjusted aspect ratio and roughness such that it would fit all optical data presented here.

Minor comment: Please change the x-axis label of Figure 6 to “effective particle diameter”.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 19545, 2014.