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Atmospheric Chemistry and Physics Discussions

Interactive comment on "3-D polarised simulations of space-borne passive mm/sub-mm midlatitude cirrus observations: a case study" *by* C. P. Davis et al.

C. P. Davis et al.

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We stand by the aim of the paper stated in the Abstract: "Although the main purpose of the work was to demonstrate the capability of accurately simulating observations of this type,...". The reviewer suggests that the capability of ARTS-MC was demonstrated in Davis et al., 2005a. To an extent this is true. However, the simulations presented in the submitted manuscript far surpass those shown in Davis et al 2005a in terms of the realism of the cloud scene, and the modelling of realistic instrument FOV. In addition to the FOV modelling, there have been several efficiency improvements in the code, since the 2005 articles submission. Given the current interest in a dedicated mm/sub-mm cloud ice instrument (e.g. SIRICE, CIWSIR). The fact that there is a freely available code capable of such simulations should be of considerable interest.

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The paper demonstrates the code's capabilities for a variety of viewing geometries corresponding to operational and proposed instruments. These few simululations, where the viewing directions are chosen completely arbitrarily, also clearly demonstrate the beamfilling effect, and significant polarisation effects for non-spherical particles, and also a beamfilling effect with regard to polarisation. We believe, despite the preliminary nature of this work, that these issues should be flagged, as they are of consequence to proposed mm/submm sensors. A contribution of actual 3D radiative transfer effects has not been found in these few instances, but it is premature to rule them out on this basis. Similarly, a more complete quantification of the beamfilling effect and polarisation for a given instrument requires a dedicated separate study involving many midlatitude and tropical cloud scenes, and as the reviewer suggests, many more viewing directions. We believe the suggestion to include many more viewing directions with the single scenario used here would not greatly increase the scientific value of the paper, since the scenario was derived from statistics for a single continuous cloudy period of one day observed at Chilbolton. Many more scenarios should be used in order to make general conclusions regarding 3D and polarization effects for a given instrument. Such work is intentionally beyond the scope of this paper, but definitely planned for the near future, particularly with regard to the conical scanning instruments.

We therefore propose to soften the text in the concluding sections to avoid over-interpretation of results.

The reviewer states that the ice particle assumptions used in the manuscript are very poor. In particular, the choice of spheroids, which were considered to be solid ice. The prediction of bulk optical properties in the mm/sub-mm for a given IWC and T field is extremely challenging. The T-matrix method is very efficient and accurate for the calculation of Mueller matrices for spheroidal particles, including the higher Stokes elements. Efficiency is particularly important when trying to represent a realistic polydispersion. At least the optical properties (phase matrix, extinction matrix, absorption coefficient vector) used in this study are physically valid. A leading alternative, perhaps

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allowing more realistic crystal shapes, would be to use the DDA method of Draine and Flatau. Recent experience with an ESA funded study, has highlighted that this method is extremely expensive comparatively, and has poor accuracy for the higher Stokes elements. So, one could concievably calculate optical properties using assumed habit distributions and (still idealised) particle shapes using the DDA method, but there is not much evidence that this will produce optical properties closer to reality than a polydispersion of spheroids with some "effective" aspect ratio. For downlooking cases, where the signal is dominated by extinction, and the polarization by dichroism, the two most important parameters are the diagonal, and K12 elements of the extintion matrix, and these two parameters can be most easily reproduced by choosing a horizontally aligned oblate spheroid with an appropriate aspect ratio.

The 1D profile is extracted along the slant path. The description of the IPA calculations is poor and will be improved with the help of a diagram (as suggested by another reviewer) in the revised manuscript. The two technical corrections will also be implemented.

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 12701, 2006.

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