

## Review of Cairo et al., 2022

The goal of this paper is to use in-situ and remote sensing measurements to test computations of optical properties of polar stratospheric clouds (PSCs). These computations are complicated since PSCs are composed not only of different sizes of particles, but also external mixtures of particles of different composition, phase and shape. This manuscript is based on a prior one that was reviewed but not accepted. One of those reviewers suggested a different modeling approach—employing a T-Matrix approach applicable to non-spherical particles. The authors have used that technique for the larger PSC particles (more likely to be aspherical) in this revised paper. While the results are not ideal, with some additional exploration and revision as discussed below, I believe the paper could make a useful contribution to the scientific community.

### Major Comments:

A comparison of calculated to measured backscatter and depolarization yields disappointing results for depolarization. While some possible explanations are put forth, they are not well explored or connected to the characteristics of the PSCs sampled. The paper is relatively short, so there is plenty of room for more exploration and discussion. For example, the depolarization plots (Fig 5) do sometime show good agreement at low backscatter and high depolarization—it would be useful to examine these particular cases and see what is different. Under these conditions, what is really happening physically? Are these primarily large or small particles and what is the predominant phase/composition/ temperature that is contributing to agreement with the model? Likewise for the cases with poor agreement. For those cases, could a change in phase/shape/AR for some particles bring things into better accord? Plots of backscatter and depolarization for varying cases with associated size distributions (see below) could be helpful in determining what is causing the variations in model success. This would be useful for guiding future work by this group and others.

I also suggest that the authors show some particle size distributions to give an idea of the actual distribution of particles within the sampled PSCs. How well are they represented with a unimodal or bimodal lognormal distribution? Could differences in the fit contribute to some of the errors in calculated results?

What is the uncertainty in the size distributions themselves (as well as in the other measurements)? These are likely to have significant error as well, particularly for larger, aspherical particles. By including the measurement uncertainties and combining them with the model uncertainties such as in refractive index, you could add error bars to Figures 4 and 5 and have a better idea how the model is really performing.

Figs 4 and 5: Calculated vs measured backscatter coefficients are shown but there are no regressions to evaluate the goodness of fit. The plots at top and bottom of Fig 4 look identical except at low backscatter—is this correct? Also, the caption for Fig 5 says backscatter coefficient, when what is plotted is depolarization.

In addition, there were many spelling and grammar errors noted that should be corrected before publication. Some but not all are listed below.

### Minor Comments:

Line 40/41 “viable solutions” should be “viable solution”.

Line 63: “attempts with simple empirical models to use it to mimic depolarization from aspherical particles does a very poor job” should be “do a very poor job”.

Line 104: “thoroughful revision” should be “thorough revision”.

Line 124: “a total of 141 data point from the Antarctic and 332 data point from the Arctic flights”. “Points” instead of “point”.

Line 143: “fraction” is misspelled.

Line 163: “single scattering properties by randomly oriented spheroids” should be “single scattering properties of randomly oriented spheroids”.

Line 190-192: “The backscattering itself reproduces the Mie results for size parameters below unity, then is progressively reduced to values that can even be one third of the Mie value when the particle size parameters is above ten, again this reduction depends in no simple way on the value of AR.”

“parameters is” should be “parameter is”.

“Again this reduction depends in no simple way on the value of AR” should be a separate sentence.

Line 220: “the analysis do suggest to maintain” should be “the analysis does suggest to maintain”.

Line 221: “contrains” should be “constraints”.

Line 262: “asimptotic value” should be this “asymptotic value”.

Line 282: “all solid partiles” should be “all solid particles”.

Line 285: “match” is misspelled.

Line 286/7: “Albeit it cannot be excluded a defective accuracy in depolarization data that prevent to fully demonstrate the validity of our model” is very awkward and should be reworded. In addition, some evidence that this is a reasonable statement should be included—were there problems with the depolarization data? What is its uncertainty?

Figure 1, 4 and 5 captions: “We reports data points” should be “We report data points”.

Figure 6 caption: “hisoram” should be “histogram”.

Figure captions: Sometimes “color” is used and sometimes “colour”. In the text, “colour” is used.