Reviewer: Please replace the term “scattering phase function” where it refers to the camera observations by a more correct description, e.g. “sky radiance corrected for the relative airmass contribution”.

Authors: We previously approached two acknowledged world experts in different fields to seek their unbiasedopinion and they have supported our usage in the present context. We can also cite the following publication, Hoyningen-Huene, W., Dinter, T., Kokhanovsky, A., Burrows, J., Wendisch, M.,Bierwirth, E., Müller, D., Diouri, M.: Measurements of desert dust optical characteristic at Porte auSahara during SAMUM, Tellus B, 61, 206-215, doi:10.1111/j.1600-0889.2008.00405.x., 2009, to further back our usage. We now cite this at page 2, line 30, after: “We will henceforth refer to this quantity Scattering Phase Function as the corrections applied to the measured radiance are intended to provide an approximation to the angular dependence of the unnormalized (1,1) element of the scattering matrix. This use of the term is consistent with previous practice (e.g. Hoyningen-Huene etal., 2009).”.

Editor: Sorry, no! This paper is not correctly referenced in my opinion.

Hoyningen-Huene call the observed quantity "normalized sky brightness" (as was suggested before by one or both reviewers), see figure 3 of Hoyningen-Huene, and a number of occurrences in their text. The "normalized sky brightness" is defined in their equation (8). Hoyningen-Huene do not assume that this is the scattering phase function. Instead it is stated more than once in the text that the scattering phase function is retrieved using an iterative technique: "For the retrieval of the phase functions from almucantar and spectral AOT the CIRATRA approach (Wendisch and von Hoyningen-Huene, 1994; von Hoyningen-Huene and Posse, 1997) is used." The derived scattering phase function is shown in Figure 4. It looks similar to the normalized sky brightness in the logarithmic diagrams, but not identical. As far as I can see, there is only one occasion in the text where they use the single scattering approximation, and this is in the forward peak of the aureole (which might be justified because the first order scattering contribution is much larger than the higher orders in this narrow angular region).

This is also related to the next point.

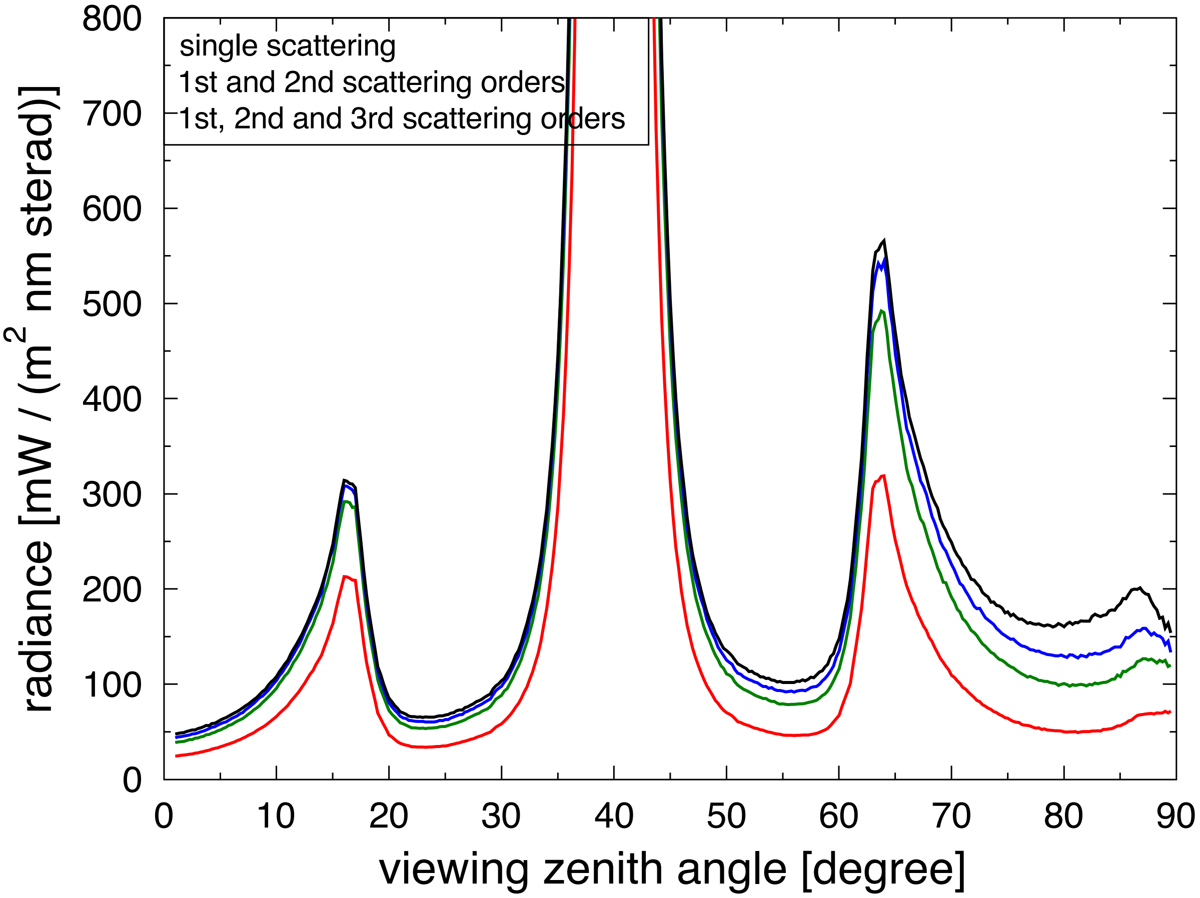
Authors:
As we are looking at cirrus the assumption of low optical thickness (i.e. single scattering approximation) is legitimate. This is already stated at page 8, line 18: “In this context we will be assuming single scattering approximation.” For greater clarity we reinforce this point in our reply to the reviewer comment two points further down.

Editor: The single scattering approximation is valid for optical thicknesses much smaller than 1 (with an emphasis on „much“), see e.g. Stamnes and Thomas, "Radiative Transfer in the Atmosphere and Ocean", page 232: "This expression shows that it is permissible to use first-order scattering provided that omega0 * tau << 1". To illustrate what that means, I asked an acknoledged world expert in radiative transfer modeling (that is, our model http://www.libradtran.org) which allows separating different orders of scattering using the Monte Carlo approach. I assumed moderate conditions – optical thickness 0.5, solar zenith angle 40°, pristine hexagonal columns, Rayleigh scattering, no aerosol. The results are shown in the figures below. The top figure shows the radiance in the principle plane. Forward scattering peak (at 40°) and the halo are clearly visible. Obviously, in this case only 50% of the signal are caused by single scattering. First and second order scattering account for about 90% of the signal and if one adds the third scattering order then the signal is more or less explained. Since the brightness is normalized anyway, the interesting question is if the ratio of single to multiple scattering shows any structure, which is shown in the 2nd plot. The ratio clearly shows signatures of the halo which implies that the shape of the single scattering contribution (= phase function) differs from the measured brightness distribution, even if corrected for the airmass. By the way, as indicated above, in the aureole region the signal is much more dominated by single scattering which justifies the above mentioned simplification by Hoyningen-Huene.

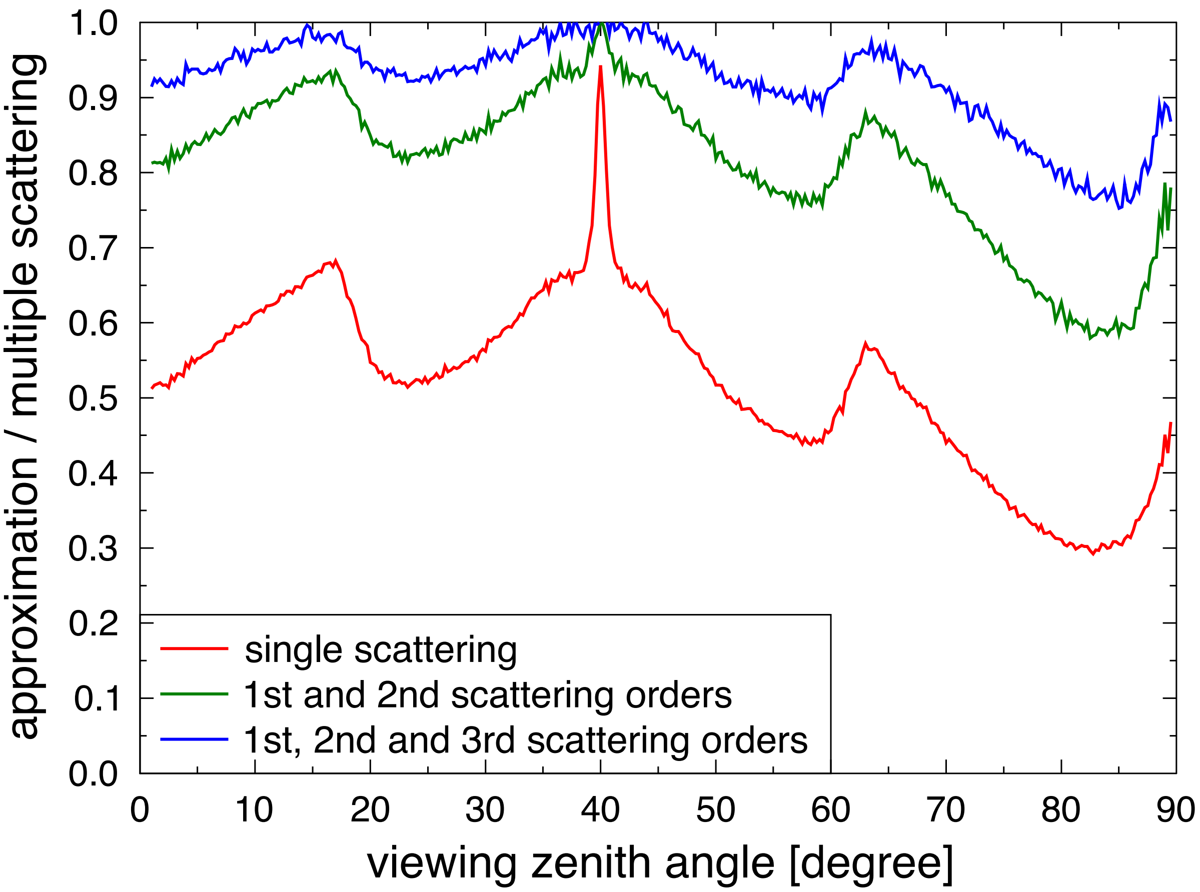
Optical thickness of 0.5 and larger is perfectly realistic for a cirrus cloud. Sassen and Comstock, "A Midlatitude Cirrus Cloud Climatology from the Facility for Atmospheric Remote Sensing. Part III: Radiative Properties", JAS 2001 show in their figure 7 that typical midlatitude cirrus clouds have optical thickness between 0 and 2. And when the sun is low in the sky, the slant optical thickness is even larger by a factor 1/cos(SZA)) which is the relevant quantity for the single scattering approximation.

It was therefore suggested before not to use the term "scattering phase function" because it is misleading. The reader most likely will think that the authors actually found a way to derive the scattering phase function of the ice particles (similar to what Wendisch and von Hoyningen-Huene, 1994 did). I (and the reviewers) find that the sentence „We propose to obtain it from the scattering phase function (SPF) derived from all-sky imaging“ implies too much – why not simply state what you did, rather than implying assumptions and approximations in the 2nd sentence of the abstract?

It is reasonable, though, to state in the text though, that **if the optical thickness is much smaller than 1** then the airmass-corrected brightness distribution is an approximation of the phase function. But since you do not determine the optical thickness, you do not know if the single scattering approximation does apply or not.



single scattering
1st and 2nd scattering orders
1st, 2nd and 3rd scattering orders
radiance [mW / (m2 nm sterad)]
viewing zenith angle [degree]
0
100
200
300
400
500
600
700
800
0
10
20
30
40
50
60
70
80
90



approximation / multiple scattering
viewing zenith angle [degree]
single scattering
1st and 2nd scattering orders
1st, 2nd and 3rd scattering orders
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0
10
20
30
40
50
60
70
80
90