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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Application of a diode array spectroradiometer to measuring the spectral scattering properties of cloud types in a laboratory" *by* A. R. D. Smedley et al.

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In response to Referee Comments S3471 point I it is correct that the authors assume the validity of the single scattering approximation. Refering to Mishchenko, Liu and Videen (2007) and taking typical values for the wavelength of 300nm, mean particle diameter of 7μm and particle number density of 300cm^{-3}, results in a particle volume density of 10^{-5}

Regarding point II it is felt unlikely that the forward-scattering intereference phenomenon has been observed in this research. Although a non-regular arrangement of particles was seen to produce this effect in Mishchenko, Liu et al (2007), in the current experiments the measurements occur over a small, but finite time allowing the

cloud particles to change relative positions. This, together with integration of the signals across small wavebands, would cause any intereference signal to be smoothed out and destroyed. A more likely explanation would seem to be the presence of a small amount of condensation on the collecting optics as mentioned in the discussion paper.

Turning to the points made in Referee Comments S4504, and to clarify each in turn:

Abstract, p10768, lines 8-9: The instrument does indeed have a small dynamic range, but it is agreed that the phrasing "lilmited sensitivity" would be more apt here.

Section 2.1, p10771, line 15: The steady state is an attempt to bring the cloud to equilibrium by continually adding steam at one point and drawing out the cloud through the scattering chamber. The aim was to produce cloud environmental conditions that were constant for a longer period than would be achieved by adding a single pulse of steam.

Section 2.3, p10773, lines 12-13: The fact that the solar simulator lamp required 30 mins to warm up was an important consideration: switching it on and making measurements immediately would have distorted the phase functions measured as a function of scattering angle.

Section 2.3, p10774, line 10: The marginal radiance distribution was indeed used to centre the light source along the optic axis (following a line between the entrance and exit ports).

Section 2.3, p10774, line 13: The power of the beam at the scattering volume was calculated from the geometry of the solar simulator together with spectra provided by the manufacturer.

Section 2.4, p10775, line 28: This will be corrected in the final manuscript to read "intensity response of the DASR".

Section 2.4, p10776, lines 11-15: The high pass filters were inserted between the light source and the detection optics. Any stray light from longer wavelengths detected

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by DASR pixels designed to record shorter Wavelengths would be observable as an increase in the signal at wavelengths shorter than the cut off. It would be expected that solely the dark current should be recorded if no stray light is present. Additional signal is attributed to stray light.

Section 3.1, p10776, line 20: This sentence will be rephrased in the final manuscript to clarify.

Section 3.1, p10778, line 1: The unscattered component is the direct unscattered beam that contributes to the signal at the ož scattering angle position. For small optical depths this was found to be significant, making its removal necessary.

Section 3.2, p10778: Ray tracing is applicable at the size parameters found in the clouds produced

Section 3.3, p10780, lines 2-3: The two figures marked as "Figure 2" were originally submitted as Figures 2 and 3. This alteration also affects the original figures 4 and 5 (in the discussion paper marked as figure 3), and hence all subsequent figure numberings. In the final manuscript the original numbering will be used for the figures.

Section 3.3, p10780, line 16: A reference will be added to the final manuscript.

Section 3.3, p10780, line 23: See previous comment regarding figure numbering.

Section 3.3, p10781, line 1-2: A reference will be added to the final manuscript.

Section 3.3, p10781, line 5-6: See earlier comment regarding figure numbering.

Section 3.3, p10781, line 7-8: The obvious difference is the noticeably greater value for the measured data (solid lines) compared with the theoretical results (+ symbols) close to the 1ž scattering angle. The text will be changed to clarify this.

Section 3.3, p10781, line 15: It is felt that P_{11} units are most appropriate as it is a plot of P_{11} against scattering angle. Further as it is a semilog plot, adding error bars would be misrepresentative, unless added for a large number of points. This is especially

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so considering that over both the high and low intensity regions (0 to 13ž, and the remainder), the signal varies by approaching 3 decades.

Section 3.3, p10782, line 8: A definition for the total number concentration, N_0, has been added.

Section 3.3, p10782, lines 9-20: The evidence is the enhancement shown in lower half of figure 3 (originally number figure 5), together with the agreement between the expected scattering angle limits of the effect. No condensation was observed on the lens, but on opening the cloud chamber after an experimental run, condensation was observed on other (unheated) surfaces. The description of the cylindrical lens housing will be clarified in the final manuscript.

Section 3.4, p10783, line 4: The 30

Section 3.4, p10783, line 12: The degree of scintillation is the amount of "sparkle" visible: none when the cloud is entirely liquid, and significant when crystals were present.

Section 3.4, p10783, line 17: Regarding the cloud nucleation method. The pop-gun solenoid was replaced by a tube, with no pulsing action. A continuous air flow was maintained, but throttled, the result of which was a higher proportion of nucleation.

Section 3.4, p10783, line 21 and 27: See earlier comment regarding figure numbering.

Section 3.4, p10783, line 21 and 27: The cyclic behaviour is presumed to be due to a combination of low number concentrations and variations in the PSD, so that the signal is sometimes being lost in noise. From the PSD for mixed cloud 3, it can be seen that the period that corresponds to side scattering also exhibits low and changeable PSDs (the yellow, green and light blue lines in figure 4).

Section 3.4, p10784, lines 24-25: The example images show plates, although due to the aforementioned diffraction effect the shape may have been blurred out a little. If droplets were shown alongside they would only consist of only one or two pixels, rather than tens of pixels for the plates.

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Figure 3: The rainbow feature isn't strongly apparent, due to the small droplet sizes involved. However to improve it's visibility in the final manuscript the figures that constitute figure 3 will be labelled separately (as was originally intended), thus increasing their size.

References.

Mishchenko, M. I., Liu, L. and Videen G.: Conditions of applicability of the single-scattering approximation, Opt. Express, 15, 7522-7527, 2007.

Mishchenko, M. I., Liu, L. , Mackowski, D. W. , Cairns, B. and Videen, G.: Multiple scattering by random particulate media: exact 3D results, Opt. Express, 15, 2822-2836, 2007.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 10767, 2007.