

## ***Interactive comment on “A comparison of light backscattering and particle size distribution measurements in tropical cirrus clouds” by F. Cairo et al.***

**Anonymous Referee #2**

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The objective of this paper is to publish the results of a comparison of backscatter coefficient measurements in tropical cirrus in three different regions. A direct measurement by a dedicated instrument (a backscatter sonde) is compared to a calculation using particle size distribution measurements by a FSSP-100. This is a valuable data set, different from the study of De Reus 2009 who considers only measurements of the particle number density and only one campaign in Australia. Therefore it is worth to be published in AMT. However the text is not always very clear and the quality of the data presentation (figure captions, numerous typos, sometimes unnecessary information) could be improved before the final publication. The paper is presented as a step

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forward for forthcoming lidar data analysis, but the link is not so straightforward as true lidar measurement volumes are not similar to the data presented in this paper and true lidar measurements include the effect of particle extinction along the optical path. This should be considered in the introduction and in the conclusion. I also ask myself why the 1064 channel from the backscatter sonde is never used as it is sensitive to different particle sizes. The comparison of the FFSP with the backscatter coefficients at two different wavelengths could help in the discussion of the effects of undetected particles.

Specific comments:

p. 4063 l. 23 What is the uncertainty for the 1064 channel ? What is the uncertainty on C532 and C1064 ?

p. 4064 l.1 Discuss here also the time resolution of the FSSP. Is it comparable to the 5s of the backscatter sonde ? The authors do not say anything about the shattering effect related to the particle sampling. This may underestimate the number of large crystals and overestimate the number of small crystals seen by the FSSP. What is the expected error?

p. 4065 l.21 typo in “variabilities”

l. 14 I do not see the added value of figure 1 to document the characteristics of cirrus clouds encountered during the 3 campaigns. Table 1 serves this purpose much better and is probably enough.

p. 4067 l. 6 How do the authors know that scattering is dominated by particles above 4  $\mu\text{m}$ ?

l.21 Panel F of Fig. 2 shows little differences between the raw binning and the use of lognormal fits. I am not sure why it is necessary to come back again to the error related to the binning. If this is kept it should be discussed early in section 2.2.

p.4068 l. 14 What is the reason for using a factor of two in the number of undetected particles? Why not more or less?

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I. 21 I am not sure how we must interpret the expected difference by a factor of 2 or 10 in the backscatter coefficient from this study. A difference by a factor of 10 is a real problem to discuss results from the comparison of FSSP with the backscatter sonde. A lower limit of the expected difference would be more appropriate.

p. 4069 I. 25 What is the added value of the JPDF? It is not really used in the discussion of the differences between the two instruments. The scatter plot seems to be the main source of information. Specify what  $i$  and  $j$  are. Do the authors take the JPDF into account when calculating the linear fit between the bulk parameters  $N$ ,  $S$ ,  $V$  and the backscatter?

p. 4070 I. 13 the AMMA data are probably dispersed because they are sparse. Are there any changes in the results if you remove the AMMA data?

I. 21 I am wondering if the right panel of figures 5 brings really new information compared to the scatter plot in the left panel where the linearity problems are already clearly visible.

p.4072 I.1 and I.3 typos "between" and "parameters"

I.5 Not sure how you derive uncertainties of 5 for  $N$  from figures (which figures ?). Specify values for  $S$  and  $V$ .

I.21 Estimated uncertainties are larger for  $N$ , but we expect more problems with the relation between backscatter and  $S$  or  $V$  according to De Reus. This means that we know that FSSP cannot derive  $S$  or  $V$ . Is it worth then discussing the use of backscatter for an estimate of  $S$  or  $V$  if we do not start with a good reference?

p. 4073 In the conclusions, say something about (i) the limits of the relation established and (ii) the possible difficulties to use the results for a "true" lidar measurements where extinction terms play also a role.

Fig. 5 Draw the diagonal of the scatter plot to highlight the non linearities. It is not mentioned in the caption that the JPDF is plotted on the left panel. Exponential are

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difficult to read in  $x$  and  $y$  axis.

Caption in Fig. 6 to 9. Backscatter sonde data are not plotted on the vertical axis

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