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*Supplement of*

## **On the microwave optical properties of randomly oriented ice hydrometeors**

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This supplement complements the main article by reporting results for absorption and scattering extinction for some additional frequencies. First of all, Fig. 4 of the main article is repeated for 90 GHz (Fig. 1 below), in order to show that the pattern between the mixing rules discussed in the main text is not specific for 183 GHz. The frequency 90 GHz was selected as it is the lowest frequency covered by the Hong database.

Secondly, Figs. 2-7 below report normalised absorption and scattering cross-sections for frequencies between 10 and 664 GHz. These figures complement Fig. 7 of the main article, to cover the full range of microwave frequencies considered for cloud ice mass retrievals. The figures show that these absorption and scattering ratios appear relatively similar between over the frequency range, if studied as a function of size parameter ( $x$ ).

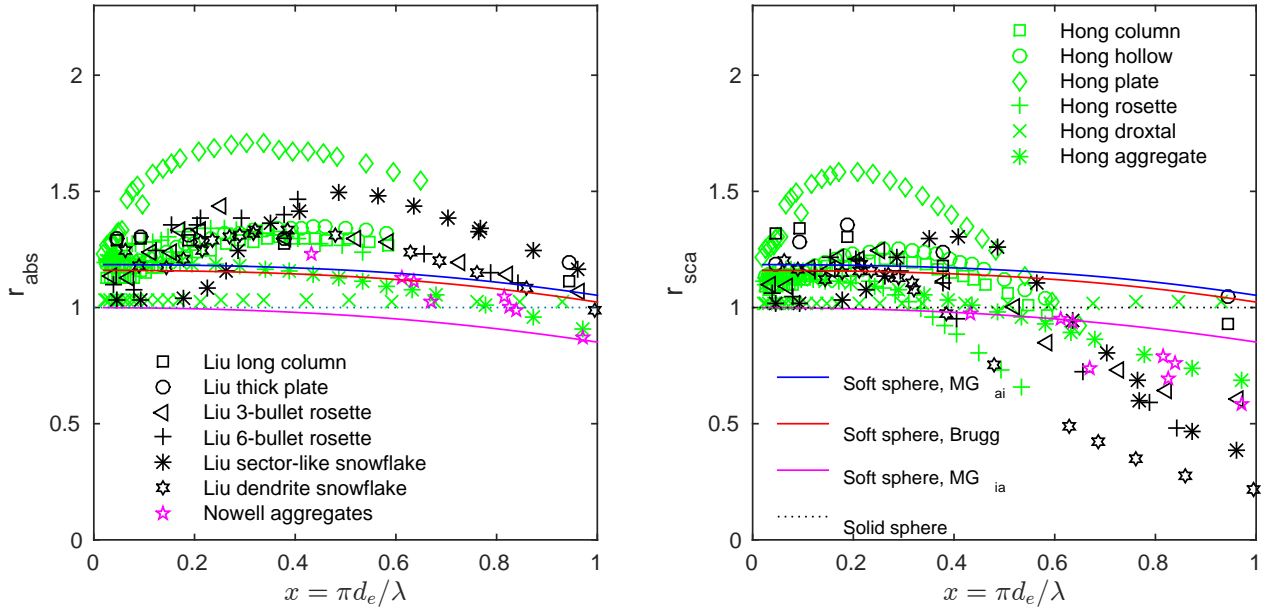


Figure 1: As Fig. 4 in the main article, but including data at 90 GHz. That is, the cross-sections are reported as the ratio to the corresponding cross-section of the equivalent mass sphere, with the same refractive index as used for the preparation of the DDA data. Hence, the dotted straight line at  $r = 1$  represents solid ice spheres. The soft spheres have an air fraction of 0.25, where results for three different mixing rules (MG<sub>ia</sub>, Bruggeman and MG<sub>ai</sub>) are included (solid lines).

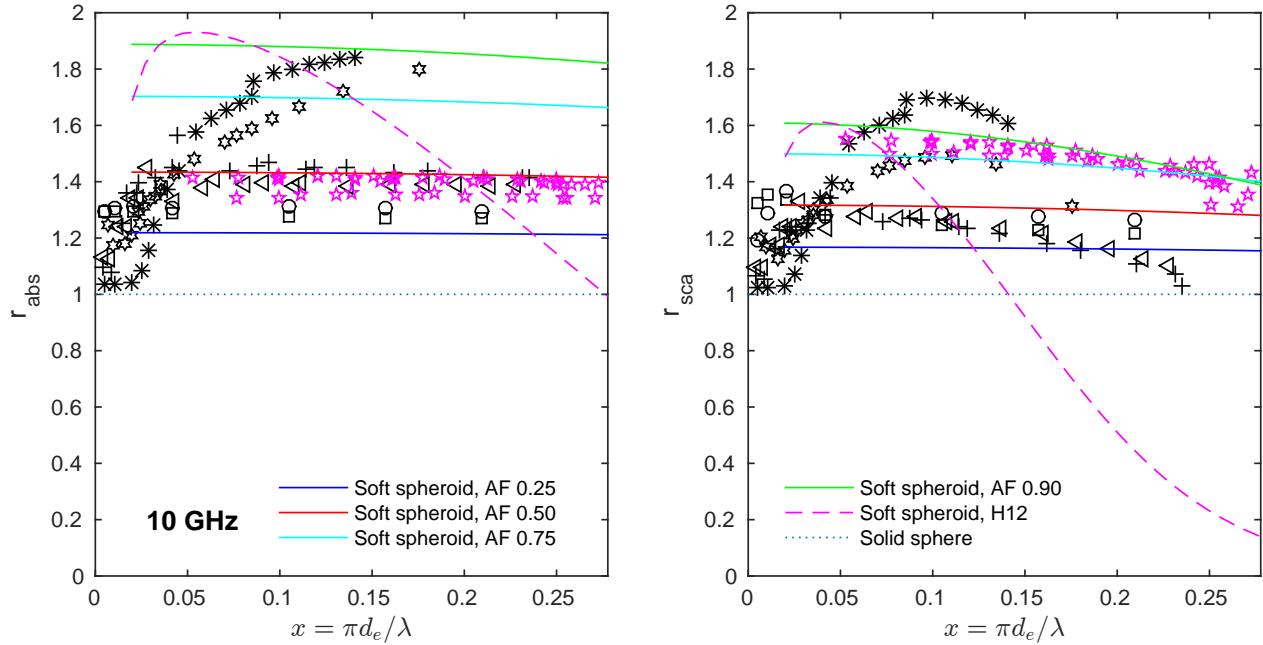


Figure 2: Normalised absorption (left) and scattering (right) at 10 GHz. Normalisation and plotting symbols used for DDA data as in Fig. 1 of this supplement. Only the Liu and Nowell databases cover this frequency.

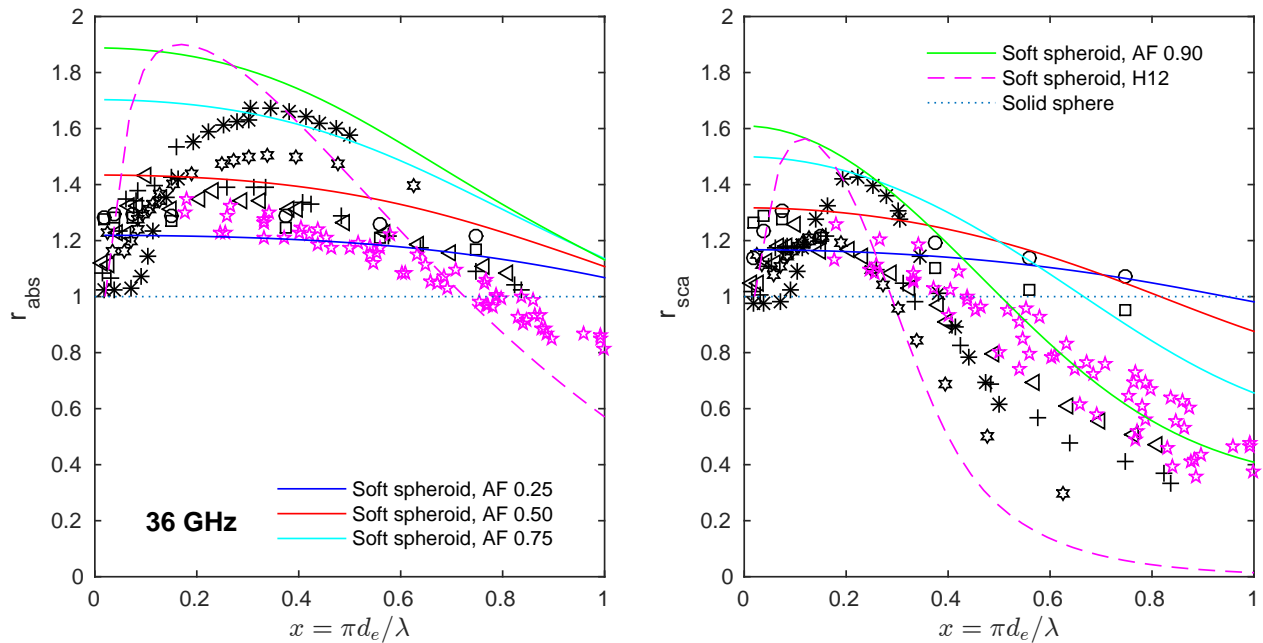


Figure 3: Normalised absorption (left) and scattering (right) at 36 GHz. Normalisation and plotting symbols used for DDA data as in Fig. 1 of this supplement. Only the Liu and Nowell databases cover this frequency.

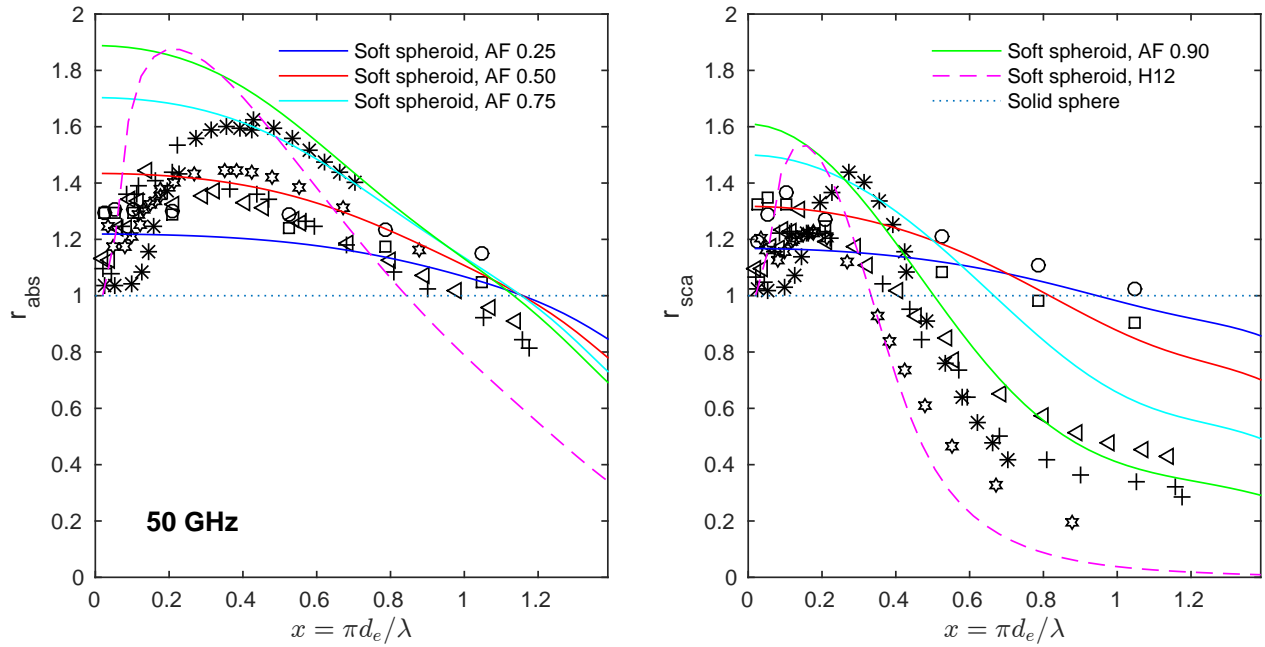


Figure 4: Normalised absorption (left) and scattering (right) at 50 GHz. Normalisation and plotting symbols used for DDA data as in Fig. 1 of this supplement. Only the Liu database covers this frequency.

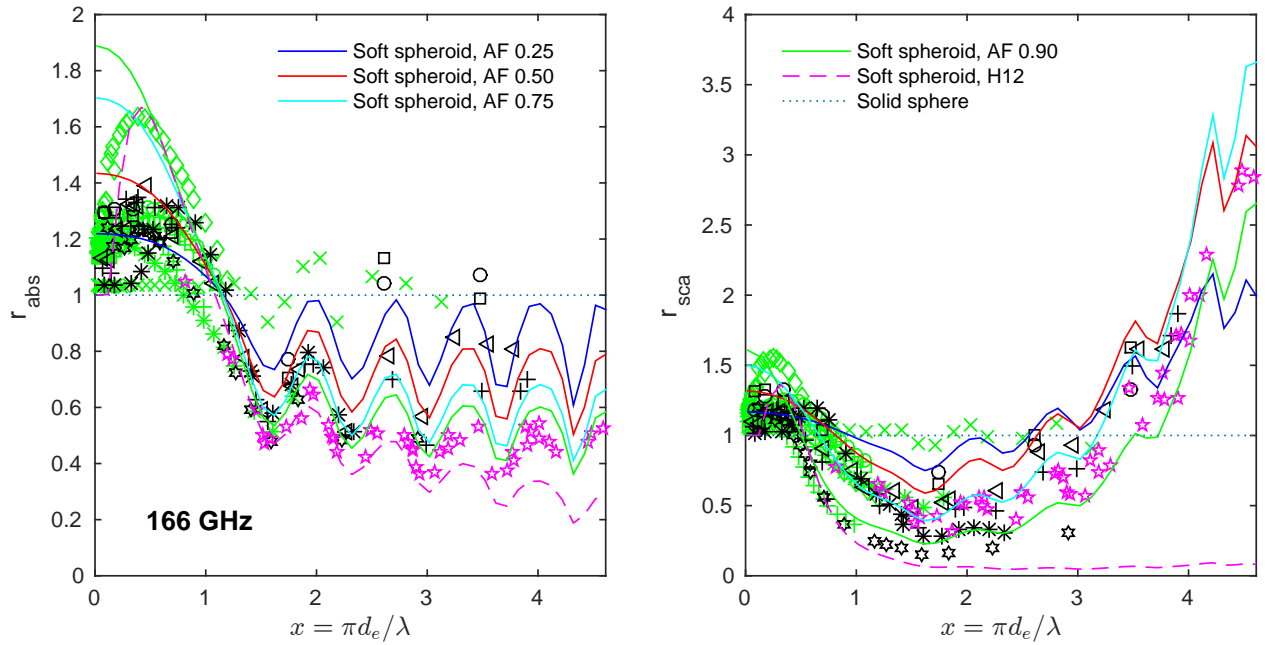


Figure 5: Normalised absorption (left) and scattering (right) at 166 GHz. Normalisation and plotting symbols used for DDA data as in Fig. 1 of this supplement.

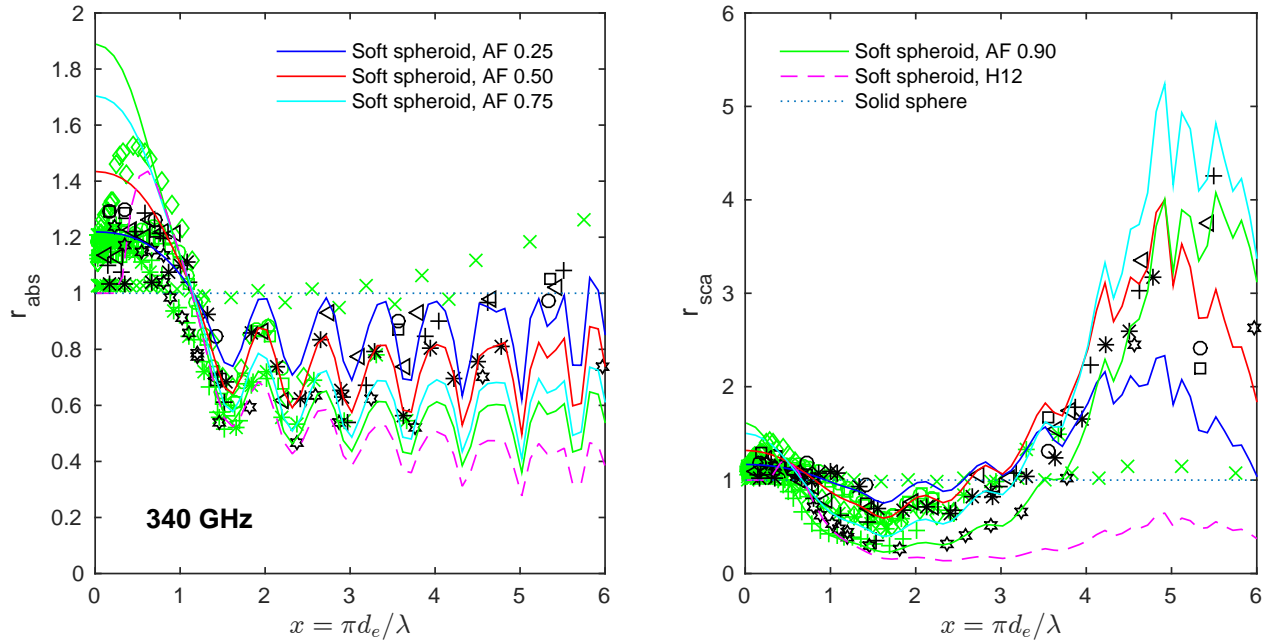


Figure 6: Normalised absorption (left) and scattering (right) at 340 GHz. Normalisation and plotting symbols used for DDA data as in Fig. 1 of this supplement. Only the Liu and Hong databases cover this frequency.

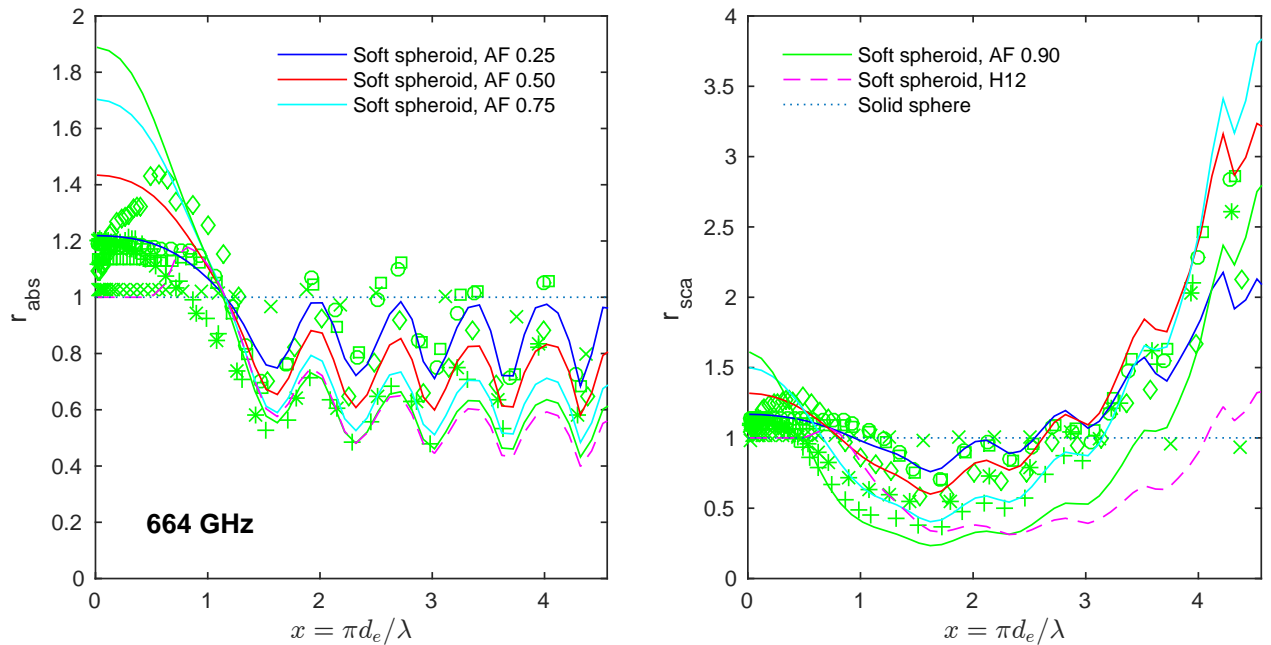


Figure 7: Normalised absorption (left) and scattering (right) at 664 GHz. Normalisation and plotting symbols used for DDA data as in Fig. 1 of this supplement. Only the Hong database covers this frequency.