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Notes and Correspondence

Corrigendum: Radar scattering by aggregate snowflakes

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1. Correction to form-factor estimates

In our paper 'Radar scattering by aggregate snowflakes' (Westbrook *et al.*, 2006), the Rayleigh–Gans approximation was used to calculate the radar back-scatter of the ice-crystal aggregates simulated by Westbrook *et al.* (2004a, 2004b). More recent work by the first author has brought to light a numerical error in those scattering calculations, which led to an underestimate of the form factor f for size parameters $2kr \gtrsim 0.5$. The corrected form factor for our simulated aggregates is shown in Figure 1; this replaces figure 4 in our original paper. Our conclusion that the Guinier approximation $f \approx 1 - \frac{1}{3}(2kr)^2$ is acceptable to within about 10% for size parameters up to $2kr \approx 1$ still stands, as do the conclusions drawn from that assumption throughout the paper. However, in our original analysis we concluded that the form factor for a spherical particle overestimated f for $0.5 < 2kr < 2.5$. Our revised figure shows that this is not in fact the case: the form factor for a sphere shows good agreement for values of $2kr$ up to about 2. At size parameters larger than 2, the sphere increasingly underestimates f, and has a null at $2kr \approx 3.5$, which is not reproduced by our model aggregates. The suggestion is, however, that an air–ice sphere with radius of gyration matched to that of the aggregate is likely to be an acceptable approximation over a rather wider range of size parameters than previously thought (maximum dimensions of up to 4 mm at 35 GHz, and up to 1.5 mm at 94 GHz), provided an appropriate prescription for the permittivity of the sphere is used (so as to match the back-scatter to the Rayleigh formula in the limit of small kr). Matching the diameter of the sphere to the maximum dimension of the aggregate (e.g. Hogan *et al.*, 2000) would give a sphere that is too large, leading to an underestimate of f for a given aggregate size.

The above correction follows through to the average form factor for the whole distribution of aggregates.

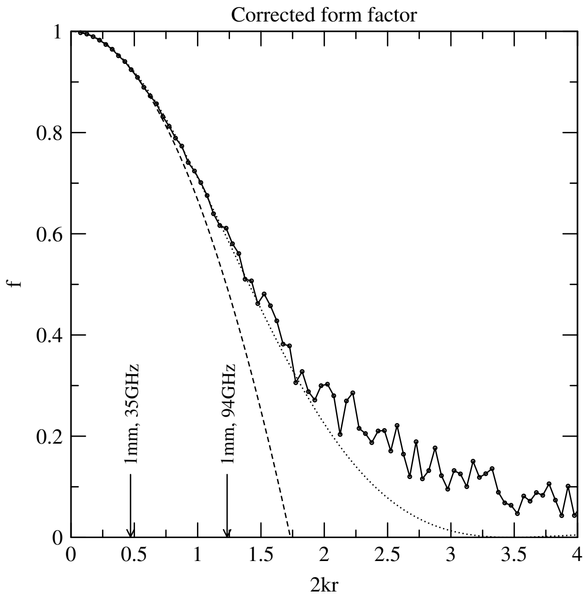

Figure 1. Corrected form factor f (solid line with circles) calculated from aggregate simulations. The dashed line corresponds to the Guinier formula $f = 1 - \frac{1}{3}(2kr)^2$; the dotted line corresponds to the form factor for a sphere.

Figure 2 shows the corrected m^2-weighted form factor as a function of $2kr_{\text{av}}$; this replaces figure 5 in our original paper. Equation (16) in our original paper is still a good fit to the data (shown as a solid line in Figure 2) if the coefficient c_2 is adjusted to a value of 4.5.

The correction has also been applied to our dual-wavelength ratio estimates for 35/94 GHz radars. These are shown in Figure 3, which replaces figures 7 and 8 in our original paper. The conclusion from these revised plots is that an air–ice sphere with matched radius of gyration is likely to be an acceptable approximation to ice-crystal aggregates for sizes up to $r_{\text{av}} = 0.5$ mm (equivalent to a maximum dimension of about 1.7 mm, i.e. particles typical of well-developed cirrus). Matching the sphere diameter to the aggregate's maximum dimension leads to significant overestimates of β. The Guinier approximation shows reasonable agreement for particle

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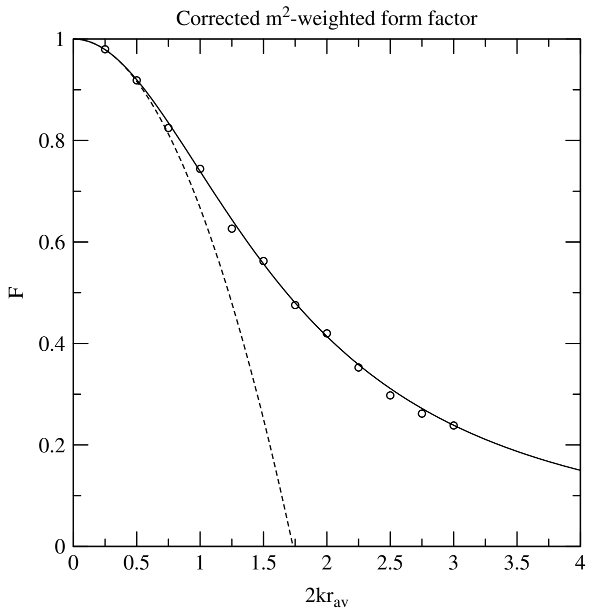

Figure 2. Corrected m^2-weighted form factor (circles) calculated from aggregate simulations. The dashed line corresponds to the Guinier formula; the solid line shows the corrected fit with $c_1 = 12.7$ and $c_2 = 4.5$.

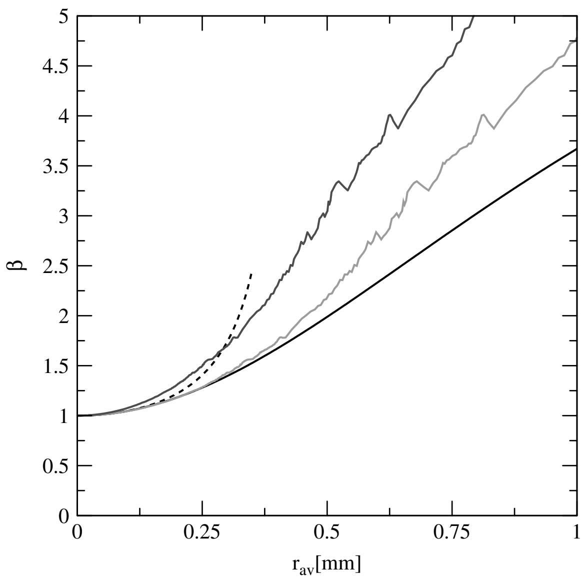

Figure 3. Corrected plot showing dual-wavelength ratio β as a function of r_{av} for 35/94 GHz radars. The black solid line shows the aggregate fit; the dashed line corresponds to the Guinier approximation; the light grey line corresponds to the sphere approximation with sphere radius matched to the radius of gyration of the aggregate; the dark grey line corresponds to the sphere approximation with sphere diameter matched to the aggregate maximum dimension.

sizes up to $r_{av} \approx 0.25$ mm, before diverging rapidly from the aggregate curve.

There is also a typographical error in equation (A.1). It should read:

$$r = \left[\frac{\int_v |\mathbf{r}|^2 \mathrm{d}v}{\int_v \mathrm{d}v} \right]^{\frac{1}{2}}, \qquad (1)$$

Where $\mathbf{r}$ is the position of the volume element dv relative to the centre of mass of the aggregate.

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