Influence of ice particle size and shape retrieval biases on polarimetric radar variables

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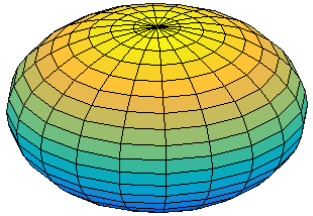
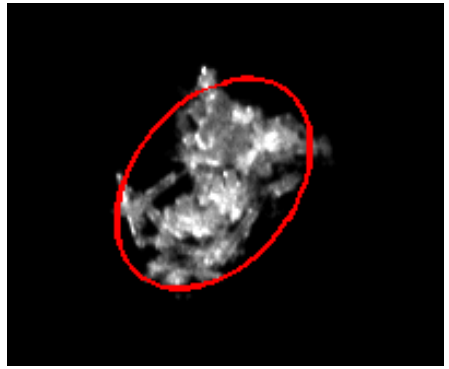
What is the shape of ice aggregates?

Oblate spheroid with
0.6 aspect ratio





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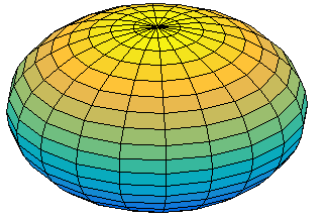

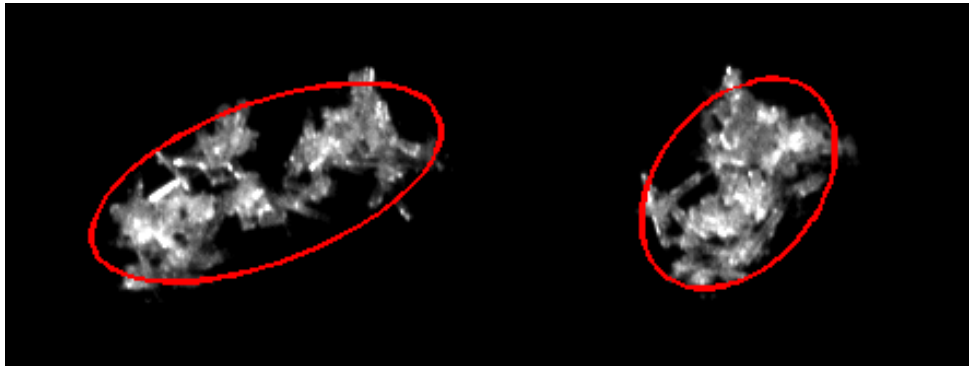

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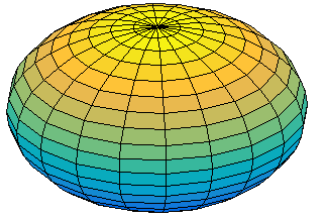

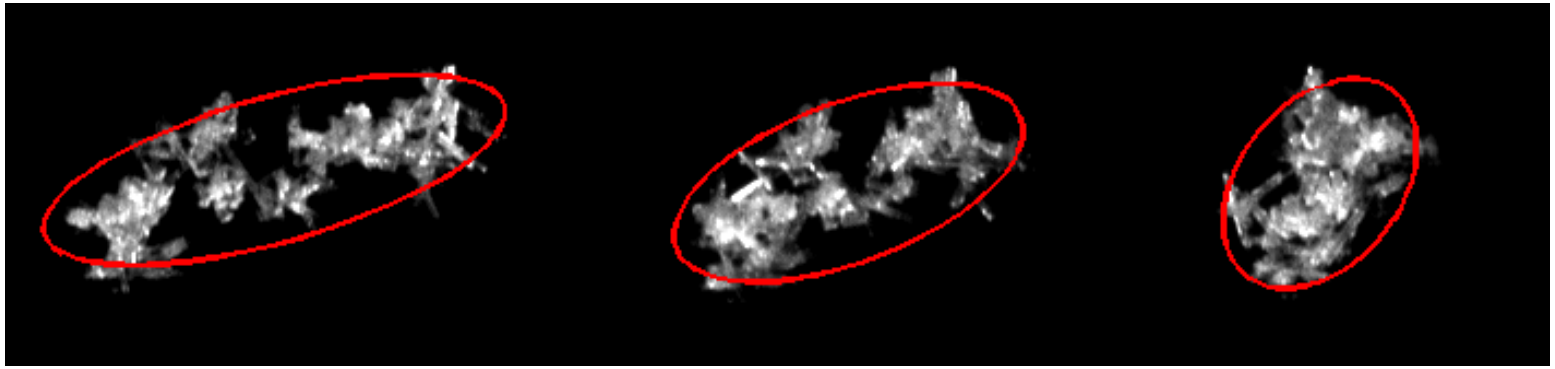

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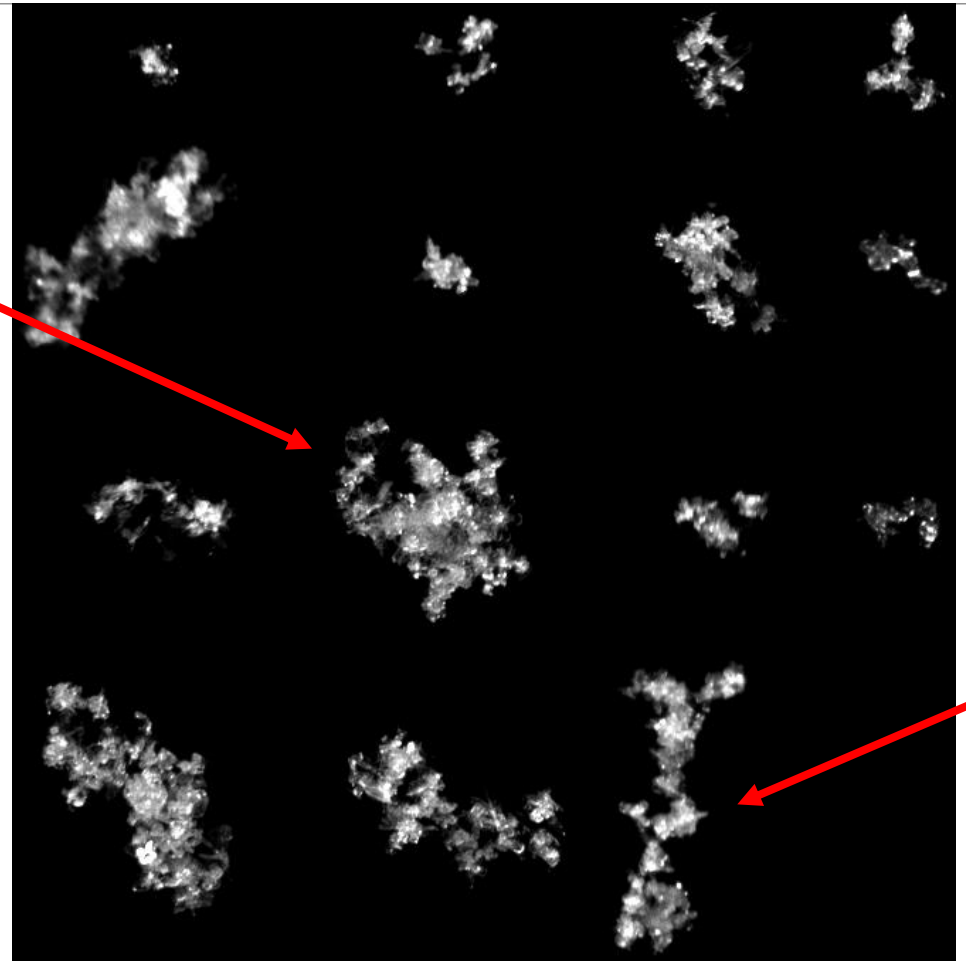


https://drive.google.com/open?id=19886A73cOl0zLrH5KMluWk44cO4GXkkQ

3D ellipsoidal shape retrieval from MASC

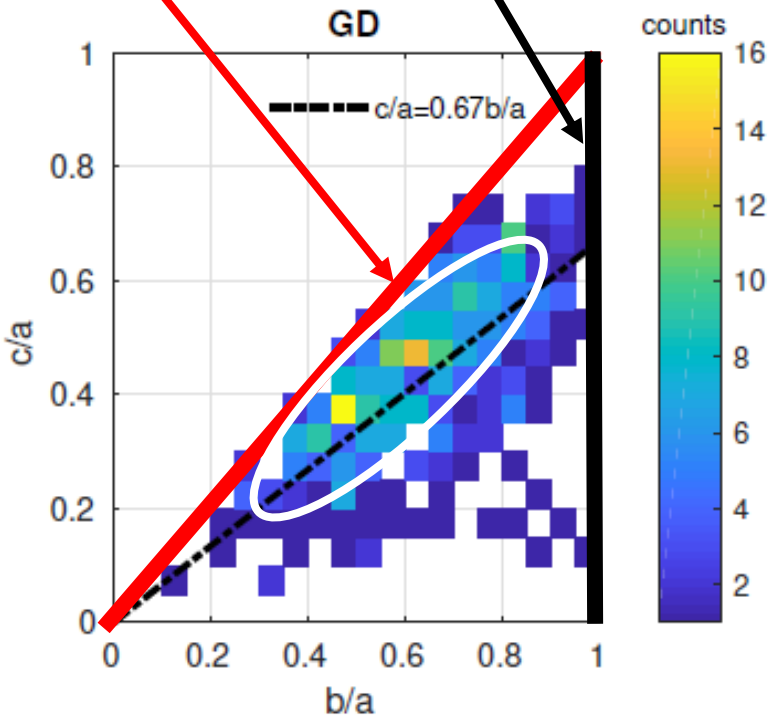
Prolate

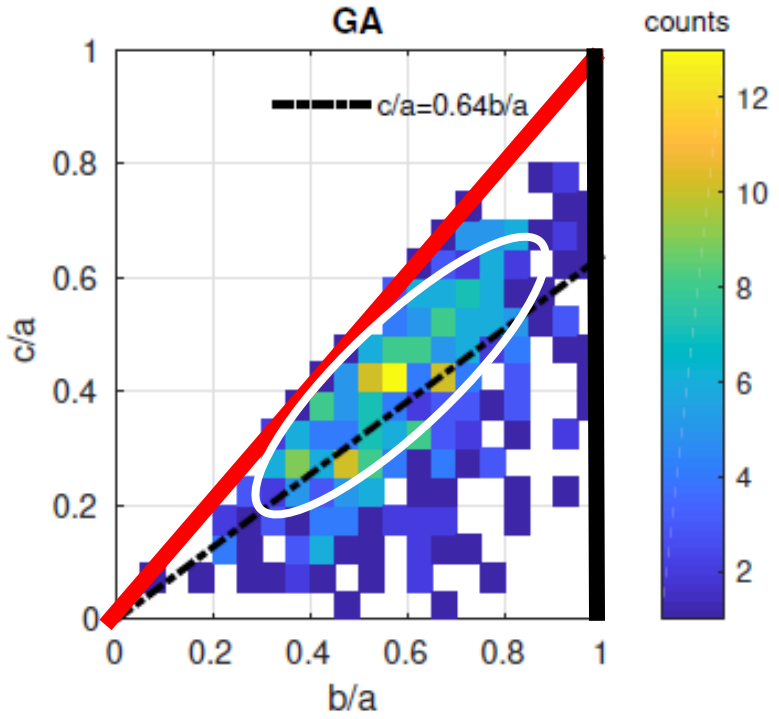
Oblate

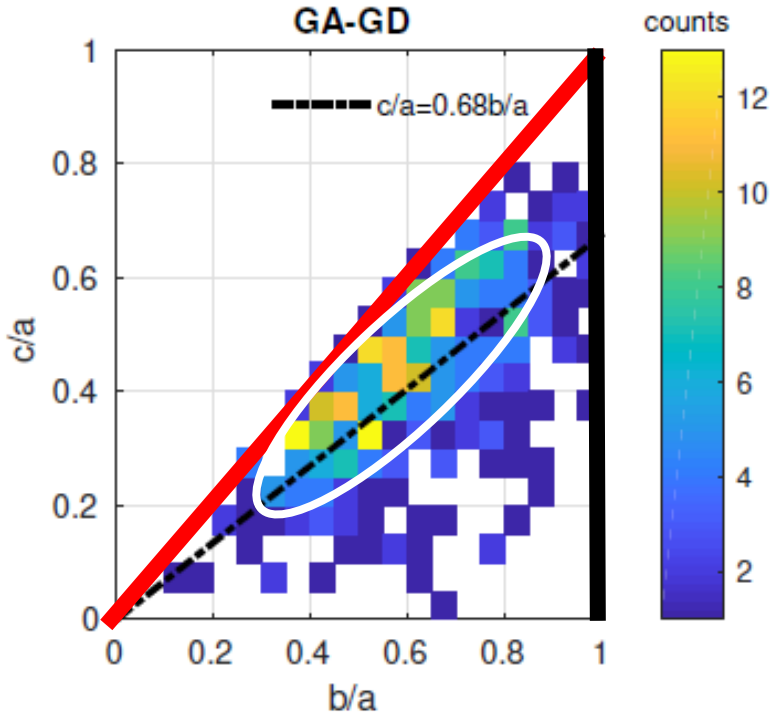
Semi-axis:
c ≤ b ≤ a

$$\frac{c}{a} = \frac{2}{3}\frac{b}{a}$$

[Jiang et al., in prep.]

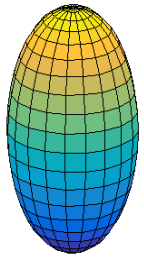




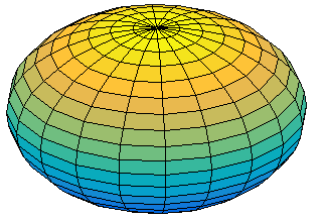


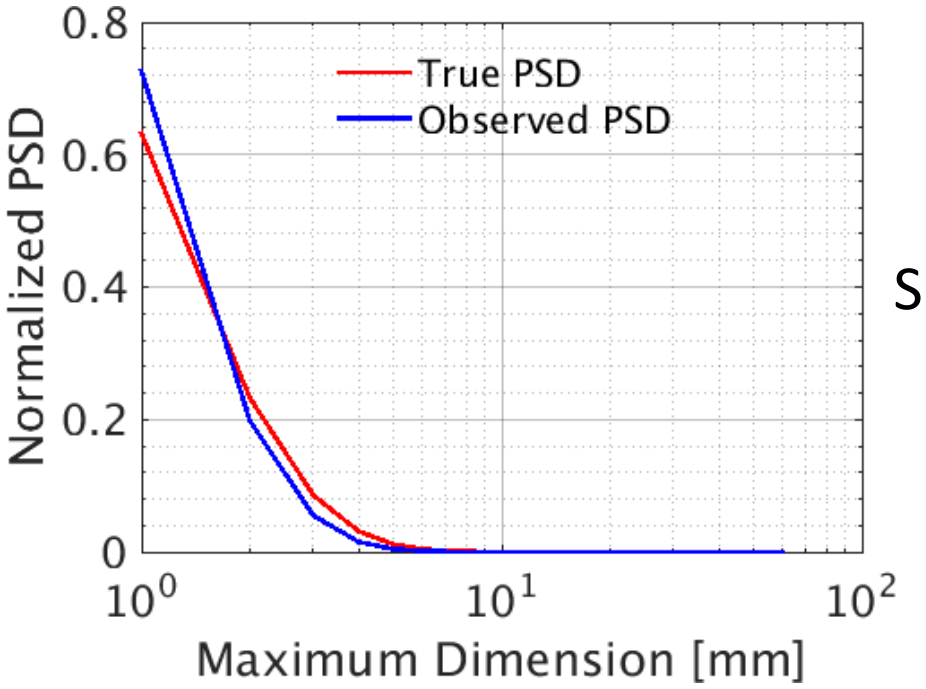
Use prolate spheroids instead of oblate

A distribution of prolate spheroids



Oblate spheroid with 0.6 aspect ratio

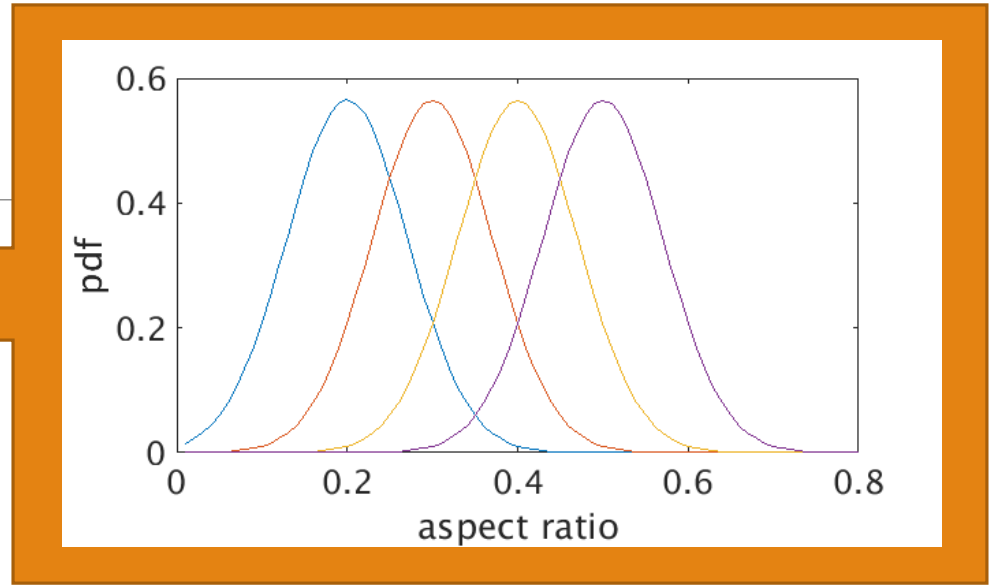




Size is underestimated using images!!!

Parameter Setup

Shape of real ice particles
- Mean aspect ratio: 0.2, 0.3, 0.4, 0.5



Orientation distribution
- Standard deviation of canting: 1°, 10°, 20°, 30°

Particle Size Distribution (PSD):
- Exponential distribution (mean size changes from 0.05mm to 5mm)

Mass-Dimensional (M-D) relation:
- M-D relation from Mitchell et al. (1990)

Frequency of radar:
- Ka-, X-, S-bands

Note: T-Matrix code from Mishchenko (2000) is used for the scattering calculations.

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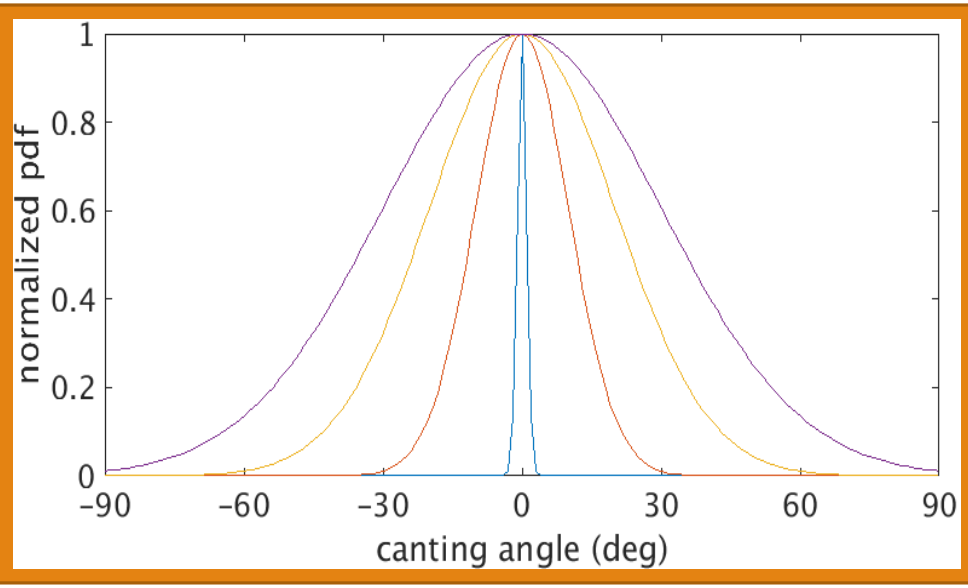

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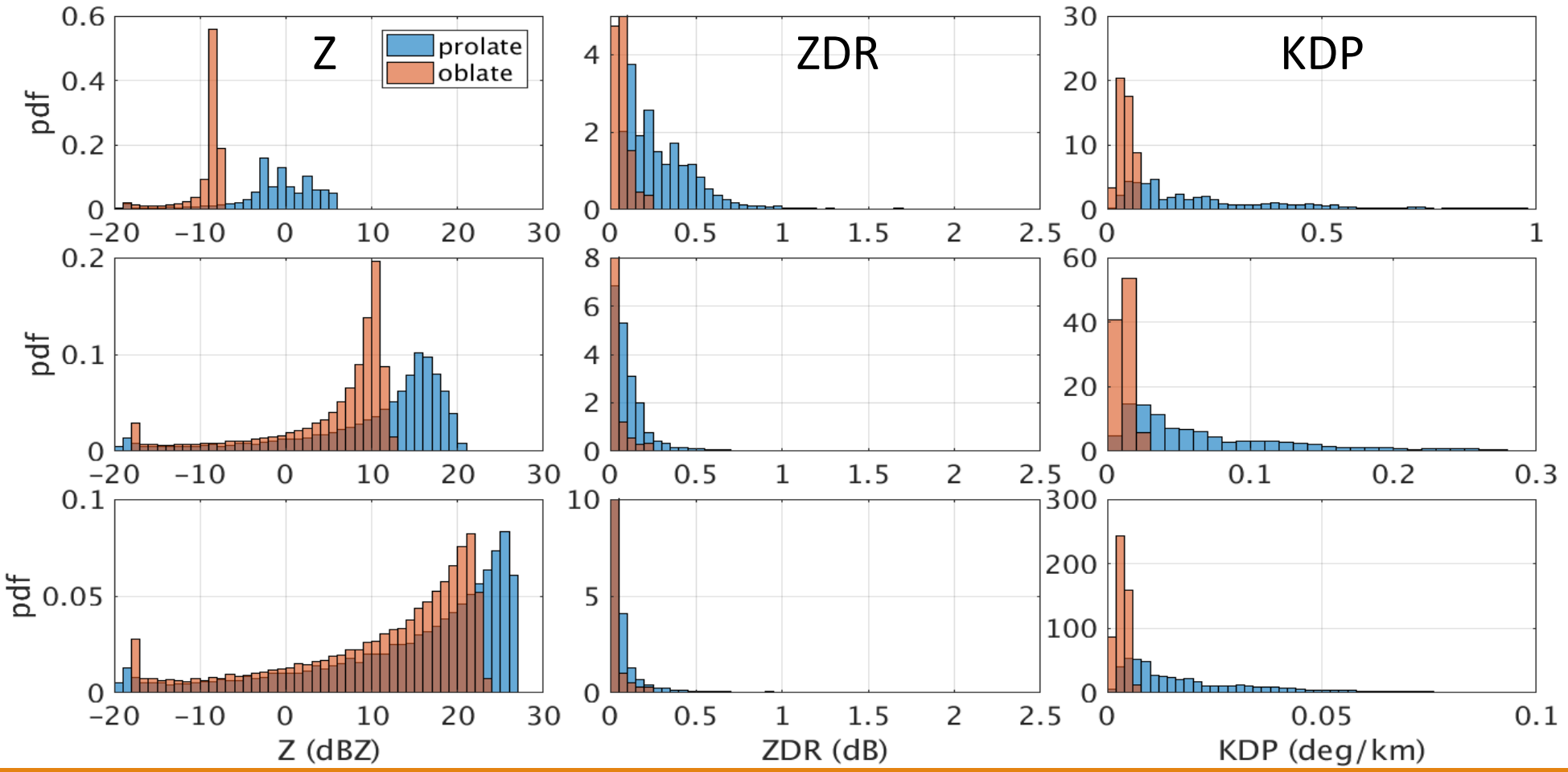
Prolate VS Oblate

Number concentration is set as 1000 m^{-3}

Ka:

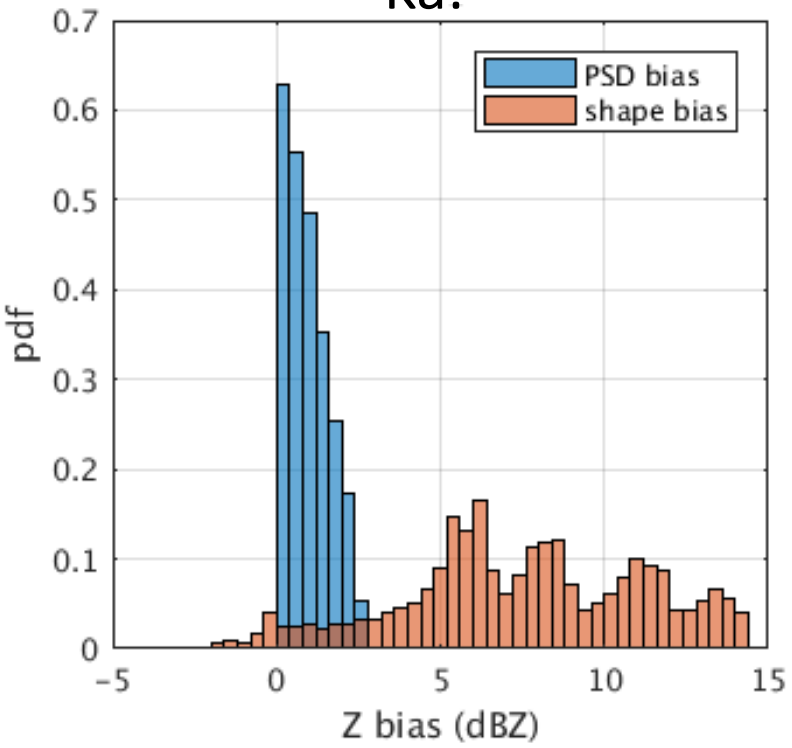
X:

S:

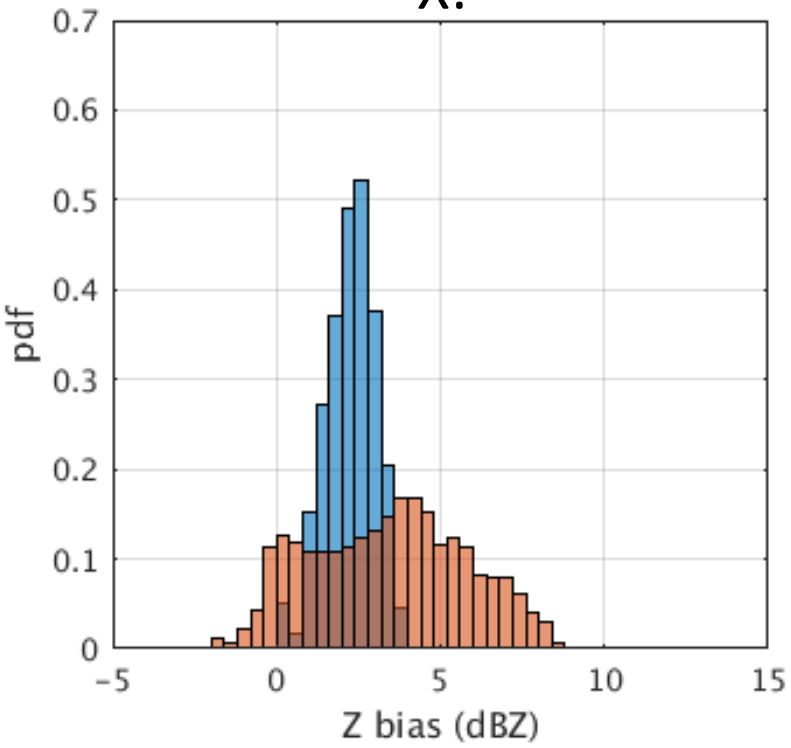


Size bias VS Shape bias

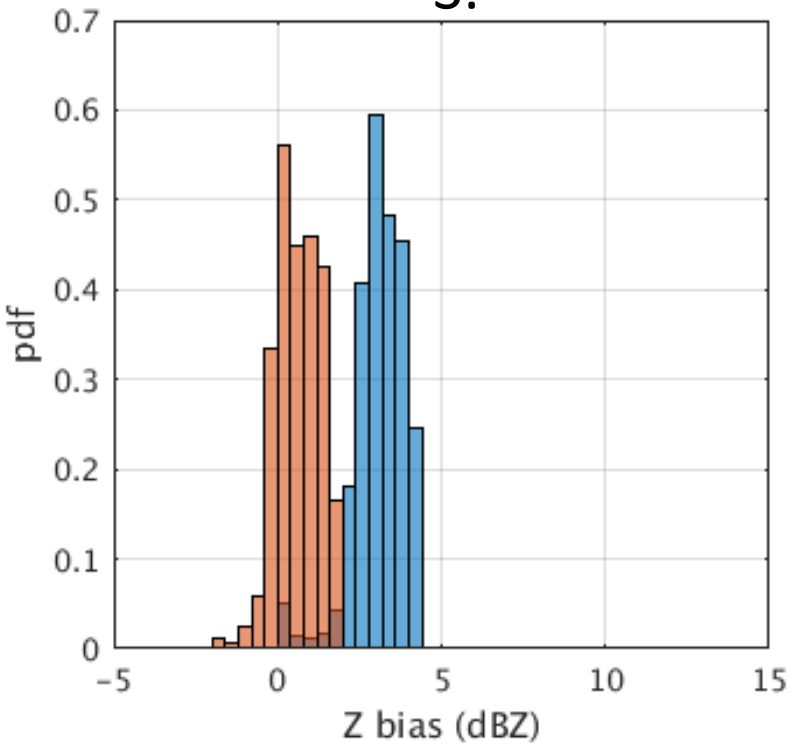
Ka:



X:



S:



Summary

1. Treatment of aggregates needs to be improved, and this brings in errors in radar forward simulator.
   - A method to retrieve the 3D ellipsoidal shape of aggregates using MASC measurements is developed.
   - It is found that aggregates are more of prolate shape rather than oblate shape.
2. Prolate spheroid is used to represent aggregates, and compared with oblate:
   - The bias in Z can be large (~10 dBZ).
   - Prolate spheroid present a larger range of Z_{DR} and K_{DP}, which cannot be covered by oblate spheroids.
   - The bias in Z due to shape dominates at smaller radar wavelength, whereas the bias due to size dominates at larger radar wavelength.

Backup

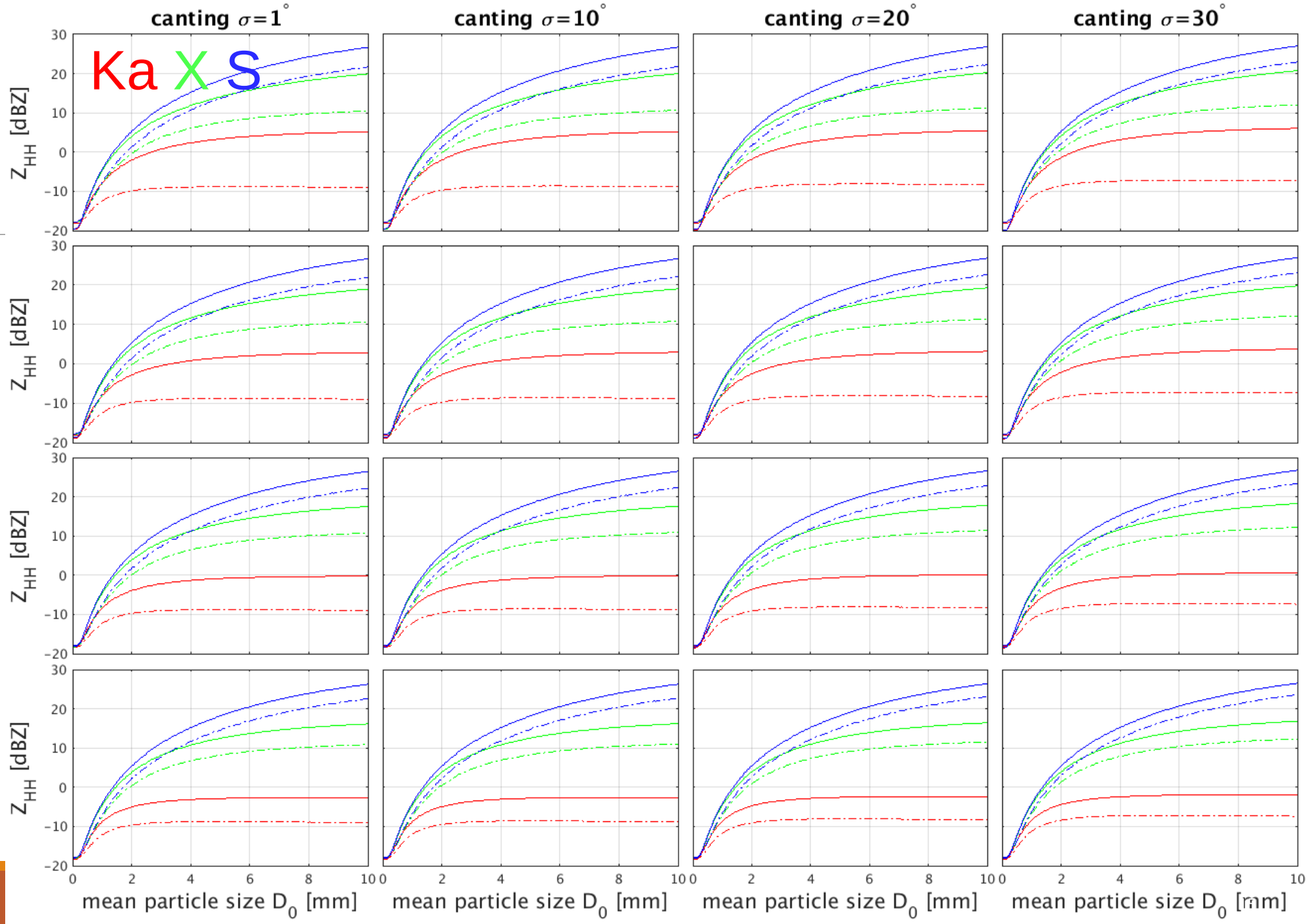
Mean AR:

0.2

0.3

0.4

0.5



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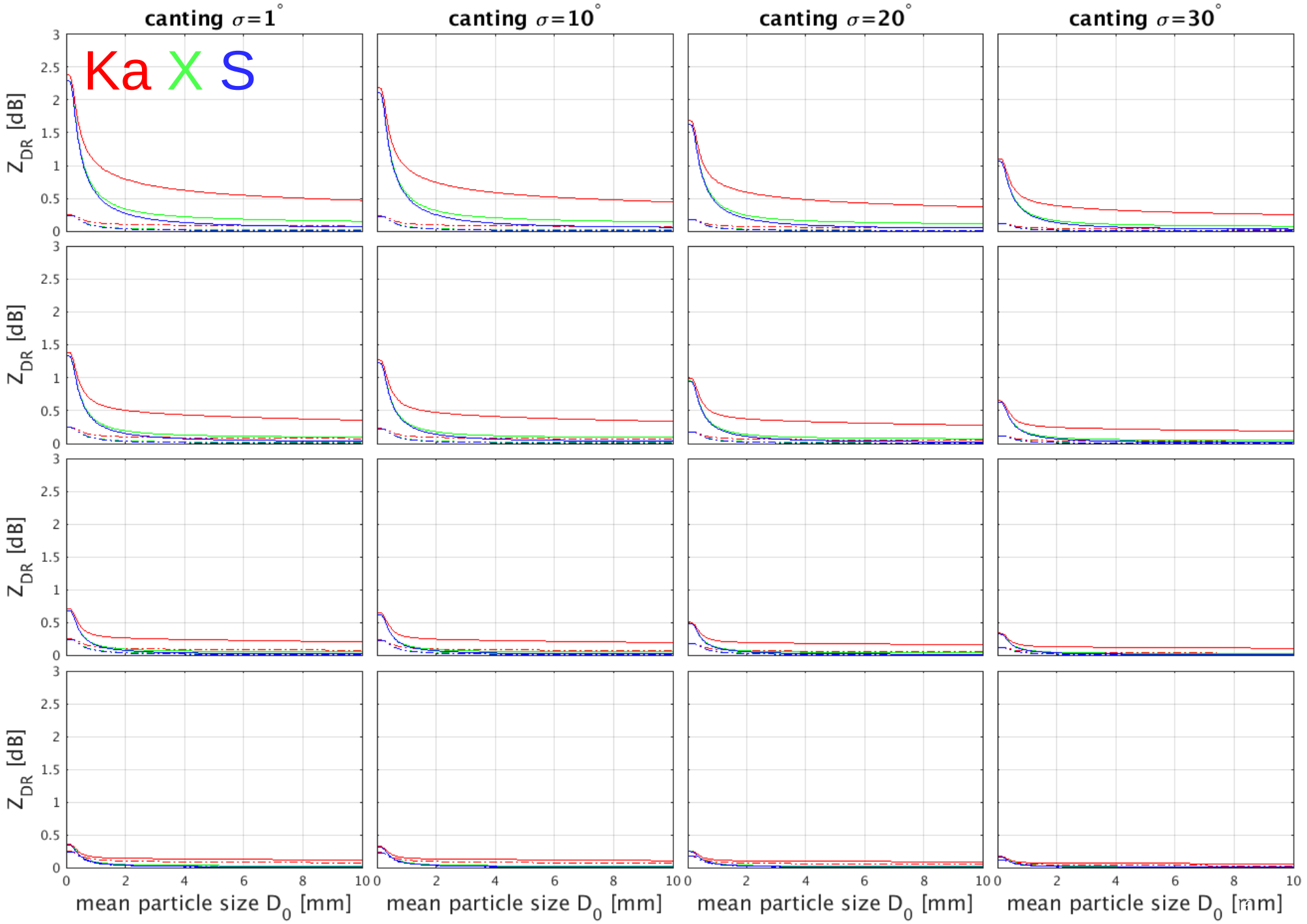

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