REPLY to REVIEWER 1

We thank the reviewer for the insightful comments.

Here after you will find the reviewer comments in bold and our replies in italic.

One thing that could aid understanding could be a brief description of different types of radar models. As I understand it, the model described here simulates mean quantities and uncertainties, followed by generation of noisy samples (see my comment below). Perhaps a discussion of why this is used versus simulation of, for example, received amplitudes from collections of point scatterers. Another possible discussion would be validation of the model. Besides the one example in Section 3, were there other tests, either similar to Section 3 or perhaps idealized cases?

Yes indeed the model simulates mean quantities and errors as computed from theory for polarization diversity pulse pair. These errors proposed by Pazmany et al, 1999 have been confirmed by an airborne field campaign (Wolde et al, 2019). There are other simulators that compute I and Q time series like in Battaglia et al., 2013. This solution is quite demanding in terms of computational costs. There are no other simulators for conically scanning polarization diversity W-band spaceborne radars to our knowledge. We have tested our model with simple 1D scenes but a thorough validation is not that straightforward.

Are there plans to go beyond Mie theory?

Indeed the code accept look-up-tables (LUTs). Some of our LUTs are already computed with Rayleigh-Gans approximation, so there is no hurdles to include e.g. DDA computations. For preferentially oriented hydrometeors and dichroic media things are more complicated and they require a polarization-dependent treatment of backscattering and extinction. This is planned as future development (see Table 2).

Antenna pattern – for example, a sinc function would be approximated as a Gaussian main beam plus sidelobes?

Yes we have now implemented an antenna pattern with sidelobes. An example will be included in the revised version.

On page 12, line 20 "convoluted" is maybe better "convolved".

Corrected

My understanding from pp. 15-16 is that the theoretical uncertainties are used to generate properly distributed noise that is combined with the calculated means. Is this correct? Does the code also output the underlying means and uncertainties?

Yes exact, we will try to provide some more convincing examples in the revised version.

Maybe more details could be provided on the simulated brightness temperature, such as bandwidth, integration time, and resulting uncertainty. Are the brightness temperature samples computed the same way as radar observations, namely, by generating means and then adding noise?

Yes correct. Bandwidth and integration time are relevant for the computation of uncertainty. We will add the noie uncertainties to the TB plot of Figure 15.

I initially got confused by the text at the bottom of page 18, which mentions "Panel B" and Figures 11A and 11B. As stated it's all correct, but, for clarity, perhaps the discussion of Figure 8 could be its own sentence. This could be followed by new sentence, such as "For this full scan circle, Figure 11 shows the antenna weighted hydrometeor water content, as computed using the following".

Amended.

In Figure 12, why is the surface Doppler (height 0) in the lower right panel so weakly modulated by azimuth angle?

There is no azimuthal dependence expected for the Doppler velocity of the surface, which is assumed to have zero velocity. Note that the satellite velocity along the boresight direction is always subtracted out.

P. 21, around line 12 – not sure I understand the comment that "the ghosts are significantly smaller over land than over ocean". The effects in Figure 14 seem larger over land.

Thanks for pointing it out. Of course the sentence should read: that "the ghosts are significantly smaller over ocean than over land".

p. 25, line 10 – "20 full revolutions" – is this the same mean reflectivity and velocity but different noise or this is 20 different scenes from the full track?

20 different scenes. We will make it clear