Reply to Referee #2

February 1, 2025

We thank the reviewer for his insightful and useful comments. We will address them to improve the manuscript. Below, you will find the reviewers comments in red and our reply in black.

1 Referee #2: Minor Comments

1. p3, line 63 - The authors refer to a snowfall rate in mm per hour. Is this liquid equivalent? If so, please be specific.

   Yes, it is water equivalent. We will specify it in the text.

2. p3, line 70 - Here you report an angle of 38 degrees, but above you report an incidence angle of 42 degrees. Please resolve this apparent discrepancy.

   38 degrees is the off-nadir angle, computed with respect to the nadir direction. Instead, 42 degrees is the incidence angle, computed from the zenith direction in the point where the boresight intersects the Earth's surface. Both are correct. We will specify there that 38 degrees is the off nadir angle.

3. pp4-5, lines 88-103 - Do you draw uncertainties from a Log-normal distribution because of the assumed power law relationship? Please add more detail as to how you include this noise. Do you run a Monte Carlo experiment? If so, how many samples do you use?

   We assumed S is log-normal distributed in order to have Z in dBZ normal distributed. Yes, it's like we ran a Monte Carlo experiment, where, for each point of the hourly LatLon grid, we sampled one value of S from the lognormal distribution. If we would have repeated the experiment many times, the samples of S would have been log-normal distributed.

4. pp4-5, lines 88-103 - Would you expect there to be bias in the Z-S relationship?

   Yes, typically, the Z-S relationship is biased, and literature tries to find unbiased relationships. However, Z-S cannot be unbiased in all applications, contexts and regimes. They need to be tuned for the specific appliations. The Z-S being unbiased is a strong assumption we made, but we assume that unbiased Z-S relationships can be found for specific regimes and locations via ground validation campaigns or complementary satellite observations.

5. pp4-5, lines 88-103 - The distributions in Hiley et al., 2011 were generated by sampling multiple crystal shapes and also allowing a limited range of PSD variability (via the temperature dependence of the Field et al. 2005 parameterization). Can you comment on whether there might be other sources of uncertainty (e.g., the fact that rimed aggregates and graupel were not considered in the scattering calculations)?

   Yes, as the Hiley Z-S relationships are retrieved at specific regimes (e.g. no riming and graupel is considered). Outside those regimes, (e.g. in presence of riming, presence of supercooled particles, presence of other particles shapes, ...) other sources of uncertainty might exist but WIVERN will also have a radiometric mode that could identify the presence of riming and/or supercooled layers.

6. pp10-11, lines 187-196 - Is there also an effect of the increased attenuation / path length due to 38 degree view angle (vs nadir view from CloudSat) on the WIVERN snowfall estimates?

Yes, there will be an effect due to the increased attenuation of WIVERN with respect to CloudSat due to the slant view angle which has not been included in our analysis but this contribution will only marginally reduce the SNR at very high snow rates. We will include this comment in the text.

7. pp. 14-18 - Discussion/Conclusions: A significant advance in WIVERN is the Doppler capability, providing both horizontal and vertical (line of sight) motions. I imagine that the combination of cloud structure (and snow mass retrievals) with dynamics could improve snow estimates even further (above the already substantial benefit of improved sampling). I suggest including some text along these lines.

   Although WIVERN Doppler measurements will provide the horizontal dynamic structure of snow-producing storms we believe that these measurements will not improve substantially snow estimates. Instead, the radiometric mode might help in doing this by, for instance, providing information on the presence of supercooled droplets.