<u>**tc-2023-147**</u>

General Comments

As Reviewer 1 of the initial submission, I want to start off by sincerely thanking the authors for their efforts in revising their manuscript in response to the comments they received. Overall, I found this updated version of the manuscript much clearer and more straightforward to follow. Most of the comments I have on this updated version are technical issues with only a few minor comments related to specific points. Once addressed I believe the manuscript would be ready for publication within TC.

Specific Comments

Lines 249-252: Would one expect σ, and therefore the illumination pattern contribution in Equation 3, to evolve through the ATM swath as the incidence angle changes? The manuscript seems to imply that σ is a constant for the wide (1.0 ns) and narrow (0.2 ns) swath. But wouldn't σ be the same for overlapping wide and narrow swath incidence angles (i.e., in the 2.5° incidence angles around nadir)? I am also missing the connection between the quantified σ values (1.0 and 0.2 ns) and the 0.7 m ATM footprint. Could the authors elaborate a bit more on how they arrive at these values?

Line 485: Here the authors suggest the larger incidence angle as a possible reason for the larger wide-swath grain sizes in Figure 7. Does Figure 7 not represent a point-to-point comparison of the narrow and wide swath grain sizes? If so, I would have expected the only points where this type of comparison is possible to all lie within the overlapping strip near nadir and where the wide and narrow swath incidence angles are equal. Is there something I am missing with how the authors are comparing the two ATM datasets? How are the authors comparing grain sizes from the extreme ends of their wide swath dataset (i.e., the largest incidence angle) with the narrow swath data that don't extend to the same crosstrack extent?

Section 4.5: I still have trouble following exactly what is happening in this section. For example, on Line 564 where the authors write "… the ICESat-2 bias predicted based on OLCI measurements as a function of ATM-derived grain size.". To me, this reads as though the authors are using ATM grain sizes to calculate OLCI grain sizes to calculate ICESat-2 biases, which I have trouble following the logic behind. Maybe it is the use of "… as a function of …" that is causing the confusion and could "… compared to …" be used to equivalent effect? I would also suggest the authors consider revising the y-axis labels in Figure 12 as, as far as I understand, it is not OLCI or ATM biases they are plotting but modeled ICESat-2 biases based on OLCI and ATM grain sizes (i.e., for Figure 12b, essentially combining and turning the y-axes from Figure 11 into a range bias). I think this may also help clarify things.

Technical Comments

Line 44: doubled Harding et al. (2011) citation

Line 68: missing space after the Fair et al. (2024) citation

Line 102: "ATM (the Airborne Topographic Mapper) make**s** laser**-**altimetry…"

Equation 1: I don't think r_{eff} is ever explicitly defined in the text

Line 246: "… whose normal makes an**d** angle …"

Lines 247 and 249: φ versus ϕ. I would recommend standardizing the notation

Equation 4: the r_{eff} notation used up to this point seems to have been replaced with r_o

Line 329: do the authors mean when the SNR is *low*? It appears they are pointing to the upper right portion of Figure 3 and the similar error bars between the $P_{max}=225$ (high SNR) and $P_{max}=90$ (low SNR) scenarios.

Line 355: here h_li notation is used whereas on line 338 it is h_{li}. The h_li notation appears at other points in the manuscript as well (e.g., Line 388).

Line 361: Is "Over" meant to be capitalized?

Line 403: "… values of B_0 and r_{thr} **that** minimize …"

Line 418: Scambos et al. (2012) does not appear in the reference list

Line 423: "… (Fig. 5**c**) …"

Figures 9 and 10: I thank the authors for homogenizing AVIRIS and AVIRIS-NG in their revised manuscript, but I would suggest also carrying this through the x-axis labels in these two figures.

Line 545: "… (**F**ig. 11a) …"

Line 561: "… (Fig. **4**) …"

Line 565: should there be a unit give to $10^{0.25}$? Perhaps μm?

Figure 13: In the caption, two different fonts and font sizes are used when referring to Equations on Line 611 and Line 615.

Line 632: Missing space prior to the Fair et al. (2024) citation.

Lines 735-736: "… satellite-driven grain-size estimates of providing estimates that would …" could the phrasing here be improved?