This brief communication documents the root cause of an erroneous "hook" observed in the visible wavelengths of measured snow reflectance spectra from airborne and satellite imaging spectrometers, which is often mistaken for dirty snow. This phenomenon has been documented in recent papers and is something I have observed and documented in aerial Airborne Coastal Observatory data collected over rugged terrain using ATCOR4 atmospheric/topographic correction (Donahue et al., 2023). To my knowledge, this is the first paper that specifically investigates the cause of this issue for aerial and satellite platforms and breaks it down into multiple possible components. Specifically, I find the results shown in Figure 2 to be a valuable contribution and visualization for the community. Given the numerous current and forthcoming spaceborne imaging spectrometer missions, this is a timely communication that will help raise awareness of and provide solutions for this commonly observed artifact. The communication is well-written, and the modeling methods are sound.

We thank Chris Donahue for this review and for reiterating the prevalence of this problem. We would add a reference to Donahue et al. (2023), but we are already at the 20 reference limit.

I recommend publication following consideration of the following comments.

1. In cases where hooking is caused by the atmospheric correction algorithm, a few more details are needed to describe how the background snow reflectance spectra is used to correct downwelling and upwelling radiation. It is noted that the background snow spectrum is spectrally varying, while the dark reflectance is spectrally constant. Given this, I would expect to see differences in Figure 2 beyond 900 nm for the two error cases (dashed lines) when compared to the two unflawed spectra (solid lines), but the spectra appear to overlap each other.

It's a good point. We will test, but we expect little difference to the path radiance term from changes to the background snow grain size. This is because wavelengths > 900 nm are less sensitive to atmospheric scattering.

   I would also expect possible differences into the SWIR region which is not shown in the figure. Does the commonly used constant background reflectance cause artifacts in other regions of the spectra that could be a concern? Also, how does one select an appropriate background spectrum?

See above

2. NASA's goal, as stated in the introduction, is to accurately measure/model absorption within 10%. How much error could this hooking artifact introduce to a broadband albedo measurement? A brief quantitative assessment of this impact would increase the impact of the brief communication. Since solar irradiance is lower in the 350-450 nm range—where the hook is steepest—the resulting

broadband albedo error, when convolved with spectral irradiance, would be smaller compared to error in longer visible bands.

Good point. Total error will depend on each of the three factors and their magnitude (e.g., slope aspect and angle), but we can estimate what we think the average and maximum errors would be.

3. I appreciate the inclusion of the ice optical property case for completeness; however, it's important to note that this issue is not the result of a flawed airborne or satellite measurement, nor is it due to atmospheric or topographic correction. This should be acknowledged in the manuscript.

We will rephrase. The point is that newer ice refractive index measurements, including those from Warren and Brandt (2008), indicate no hook for clean snow, so its presence in an airborne or satellite measurement for clean snow is an error.

4. Need to define mu in equation 2

It's defined on L 75, so we will move this definition.

5. Consider adding subsection numbering to section 3 for each case.

We will do this.

References

Donahue, C. P., Menounos, B., Viner, N., Skiles, S. M., Beffort, S., Denouden, T., ... & Heathfield, D. (2023). Bridging the gap between airborne and spaceborne imaging spectroscopy for mountain glacier surface property retrievals. *Remote Sensing of Environment*, *299*, 113849.

References

Warren, S. G. and Brandt, R. E.: Optical constants of ice from the ultraviolet to the microwave: A revised compilation, Journal of Geophysical Research: Atmospheres, 113, 10.1029/2007JD009744, 2008.