Authors' Response to RC-2

The reviewer's comments are in Cambria font.

> The authors' responses are in blue Calibri font and are indented.

Line 151: How do you compute slope and aspect based on a radial mask? Could you give an example ideally with some illustrations? Do you "divide" the snow surface into numerous hollows that the "slope" is the slope of each hollow?

> We treat the rough surface in a similar way that we would consider a digital elevation model (DEM) over mountainous terrain, except in our case, the lidar gives us a DEM at ~1 cm grid spacing. For each point, we calculate the gradient (slope and aspect) along with the angles to the local horizon around the 360° range of azimuths (because some points will be shaded by nearby points). From these values, we calculate the local illumination angle and the sky view factor, the fraction of the overlying hemisphere open to the sky (Dozier, 2022 shows the equations). The "radial mask" is the footprint of the downlooking radiometer; the slopes and aspects vary with the topography **within** the radial mask.

Line 154: It seems surface roughness only accounts for the distribution of slopes? What about the aspect? Given a mask, could you provide an example of how to count the distribution and compute surface roughness?

> Unfortunately, we used the term "roughness" to describe generically the rough topography, and then we also defined a specific "surface roughness" in line 154. We will eliminate that sentence and also fix line 273 and lines 279-280 in the caption to Figure 7.

Line 159: Are downwelling direct irradiance B and diffuse irradiance D used here measured or modeled?

> Their ratios to total $I_{\downarrow}$ are measured by the SP1N Sunshine Pyranometer and then applied to the PSPs (which have a slightly different wavelength range).

Line 162: What is a "generic ablation hollow", how is this defined in this work?

> Instead of "a generic ablation hollow," we should clarify that we mean any generic point on the surface, which has an elevation, a gradient (slope and aspect), and a sky view factor.

Line 164 - 166: Similar to the illustration of surface roughness, it is valuable and helpful to provide a figure on illumination angle.

> We can, although this equation for illumination angle is standard. We think if we specify something like "adjoining elevations," we can eliminate the confusion we caused by our phrase "generic ablation hollow."

Line 198-202: The description of the method is confusing here. For example, what is the modeled average $\overline{\alpha_{spatial}}$?

> $\alpha_{spatial}$ is modeled at every point in the 1 cm topographic grid. $\overline{\alpha_{spatial}}$ is the mean of those values over the field-of-view of the downlooking radiometer, and it compares with the measured albedo from that radiometer.

Line 204: The authors describe the spectral albedo simulations here, while the "simulated albedo" has already been mentioned multiple times in the previous text. Consider rearranging the text so readers understand what is simulated albedo before its being used.

> We should use "modeled" rather than "simulated."

Line 205-206: Why assume San Juan dust with an effective radius of 3 microns?

> Among the values for the complex refractive index of dust in the SNICAR model, the San Juan dust is the one in the western U.S. The 3 μm radius corresponds to samples we collected and measured by a colleague at the Desert Research Institute. We are working on a separate paper involving those measurements.

Figure 4: This is an interesting Figure that requires some details. Mainly, what caused the spread of initial albedo in the x-axis? Snow depth? Grain size? Impurities? Spectral distribution of downwelling flux? What is the roughness of this case?

> The spread in the *x*-axis covers the range of values of the intrinsic albedo we encountered during the experiment, as governed by the grain size and concentration of the light-absorbing particles.

Please also discuss why the albedo increase is more significant when initial albedos are roughly within 0.68-0.80.

> We probably have to look at the details of each step in the re-reflection to address this. We speculate that this range of albedo values has a large range of spectral albedos that cause it. With each reflection, the lower spectral albedos are absorbed.

Section 2.1: how often did one adjust the adjustable arm for measurements? Was the goal of each adjustment to maximum the snow coverage in the field of view?

> In measuring the reflected radiation, two artifacts must be minimized. If the downlooking radiometer is too far above the snow, the field-of-view is too large (nearly 9×*h*, where *h* is in meters) so other, darker elements like the tower itself and trees, will cause the albedo to be too low. Conversely, if the radiometer and its arm are too close to the snow, they will cast a shadow that will also cause the albedo to be too low. By experiment, we found that the combination of these two artifacts is minimized when the radiometer is ~1 m above the snow, so as the snow depth changes, we maintain the radiometers' height.

Line 281: It seems Figure 6 is discussed after Figure 7; please consider swapping the Figure label.

> Our error. The reference to Figure 5 on line 260 should be to Figure 6.

Reference cited in the Response

Dozier, J.: Revisiting the topographic horizon problem in the era of big data and parallel computing, IEEE Geoscience and Remote Sensing Letters, 19, 8024605, https://doi.org/10.1109/LGRS.2021.3125278, 2022.