Comments on *Light absorbing particles and snow aging feedback enhances albedo reduction on the Southwest Greenland ice sheet* by Isatis Cintron-Rodriguez et al.

General comments

The authors describe the snow and light absorbing particles (LAPs; black carbon and dust) measurements taken at five locations on the southwestern Greenland ice sheet in May 2017. They then assess the direct and indirect (through the effect of LAP-snow aging feedback) effects on snow albedo by using the SNICAR model.

The authors have presented a well-written and coherent manuscript on a topic that fits the scope of The Cryosphere well. Reporting and gaining understanding of LAP concentrations on the Greenland ice sheet is an important step towards improving snow albedo representation in (regional) climate models and towards more accurate projections of surface ice melting and sea level rise.

I have noted some minor comments below, the most important of which pertain to the discussion section. I would be great to see a bit more discussion of the limitations of the measurements, the methods, and the conclusions you can draw from this analysis. It would for instance be good to describe what effects other LAPs (not included in the measurements, such as algae, brown carbon, and volcanic dust) could have on the LAP-snow aging feedback and the albedo reduction in general.

Specific comments

<u>General</u>
Consider writing in the present tense instead of the past tense. It could make the text a bit more active.

L12: add algae to the list of LAPs.
L15: explain briefly what the SNICAR model is.
L20: do you mean *enhance* albedo reduction 4 to 10 times more?
L31: elaborate a little bit more on "Greenland's summer albedo". Do you mean of the ice sheet in general, of the snow, or of the ice?
L36: consider adding "global" before climate regulator.
L39: is temperature a direct regulator of snow albedo or does it change albedo by changing the grain size/shape and water content?
L43-44: remove "causing surface darkening". This aspect is covered in this sentence by "LAPs in snow reduce albedo".
L51-52: consider rewriting this sentence. It is not immediately clear to me what this means. Also make it clear that you are talking about CO2 and CH4 in the atmosphere, not in the ice/snow.
L62: elaborate on why the 20-30 micrometer is important.

L69-71: is it 16% of the average total mass loss (including dynamic losses)?
L76: which LAPs did Lewis et al. consider?
L79-83: make sure the leap from “snow effective radius growth” to “snow aging” is clear. Right now it is not clear what “snow aging” is.
L93-95: consider rewriting this sentence and elaborating a little bit on what SNICAR is and how you would use it to estimate this effect.
L108: MAR is a regional climate model, not a reanalysis model.
L120: what happened at site G?
L148-149: elaborate on what refractory BC is. Why can it be used as normal BC here?
L155: most of this is already mentioned before.
L157-158: what are the optimized operating parameters?
L163: what does “adhering to outside of the detection range” mean? What are the particles adhering to?
L180: is the 0.01mg the uncertainty?
L188-189: the first part of the sentence is already mentioned before.
L195: mention the correlation coefficient in the main text.
L203: what effects (due to LAPs) do you expect to see in the near infrared spectrum? Is it reasonable to not include this in your analysis? If so, show (with a reference) why.
L206-215: 415-575 km is a long distance and the meteorology and climatology can be very different between these locations. How do you know the situation is comparable?
L234: consider merging figures 4 and 5. Right now figure 5 has almost all the information embedded in figure 4, except for the elevation which you could add in the caption.
L242: is it winter snow grain shape or from May 2017?
L250: consider moving table 1 to earlier in the manuscript, when it is first referred to.
L266: does BC_{tot} relate to the BC concentration in a vertical slice in the snow pack, given that the unit is ng cm^{-2}? If so, consider elaborating on that. It was not immediately clear to me.
L269: does average snow density refer to the density in each layer? If so, consider rewriting this sentence to make that clearer. It now seems like you take the average density of the entire layer.
L301: consider rewriting “that snow … albedo reductions are”. It is not immediately clear to me what you mean here.
L350: elaborate on the BC concentrations in southeast and southwest Greenland. These regions are very different and might not be easily comparable. Given what you know about the sources and transport routes of BC to Greenland, elaborate on what differences/similarities would you expect to find between BC concentrations in southeast Greenland vs what you found in southwest Greenland? Take into account the general environment, elevation and topography of the sample locations in southeast and southwest Greenland. e.g. what side of the ridge of the GrIS each location is on and what is the general wind pattern from source to deposition location. Could local sources be affecting the BC concentrations (such as for dust at Dye-2)?
L405: briefly repeat the results of Lewis et al. 2021 here.
L413-415: move this to results. Also explain how you get the value 1.18.
L417-419: This statement is not immediately clear to me. If half of the measurements were under clear-sky conditions (and, thus, the other half under (partly) overcast conditions), would this not mean that your results do *not* solely apply to clear-sky conditions?
L421-422: what do you mean exactly with this? Are you talking about interannual variability of albedo reduction? If so, that cannot lead to greater albedo reduction over summer, it would the other way around.

Greater albedo reduction in summer leads to interannual variability of albedo reduction. Or do you mean interannual variability of another variable? If so, make clear what you are referring to here.
L423: elaborate what you mean with snow melting processes as a factor leading to albedo variability.
L425: does the 3.0 ± 0.4% refer to the difference between summer and spring albedo reduction? Consider mentioning both average albedo reductions for spring and summer to show the difference.
L425: can part of this albedo reduction difference between summer and spring not be attributed to higher LAP concentrations between the seasons?
L429: what is the water year?

Technical corrections

General
Check double spaces and units throughout the manuscript.

L15: put -1 in superscript in ng g^{-1}. Also check rest of the manuscript for this.
L29: turn “the Greenland Ice Sheet melting” into “melting from the Greenland Ice Sheet”.
L32: turn “deposited in snow” into “deposited on snow”.
L33: turn “melting season metamorphism” into “snow metamorphism induced by melting”.
L34: turn “LAP” into “LAPs”.
L47: turn “is the most efficient LAP at absorbing radiation” into “is the LAP most efficient at absorbing radiation”.
L53: turn “reduce projected” into “reduce the projected”.
L61: add comma after “transport”.
L67: turn “LAP reductions on snow albedo” into “snow albedo reductions due to LAPs”.
L70: consider using “yr^{-1}” instead of “a^{-1}”. The latter is usually used for time backwards.
L77: turn “LAP’s” into “LAPs”.
L78: turn “Snow” into “snow”.
L79: add period after reference.
L100: turn “longitudes” into “longitude”.
L110: remove “gentle and”.
L118: consider rewriting to “from recent snow (i.e. snow from last winter) to firn (snow surviving at least one melting season).”
L124: turn “identical as” into “identically to”.
L127: remove plusminus sign. Same for L131 and L132
L128: add “for” before “stratigraphy”.
L139: turn “2.1” into “2.2”.
L142: capitalize “arctic”.
L148: add comma’s after “that” and “nebulizer”.
L172: add “for” after “accounted”.
L182: turn “room mean” into “mean room”.
L185: consider attaching to previous paragraph and removing the white line. Also remove “described above”.
L193: make sure the superscript in L^{-1} is of approriate size.

L193: add closing parenthesis in x-label.
L211: remove “, its methodology is described elsewhere”.
L212: turn “Lewi’s” into “Lewis’”.
L238: add units of snow grain size in caption.
L250: add period after descriptions.
L251-252: check format of references.
L256: add “at” after “layers”.
L257: turn “except at … follow (Figure 6a, b, c, e)” into “except at site J which exhibits a peak in BC concentrations at 0.2-0.45 m depth (Figure 6)”.
L263: turn “differing blowing snow disturbances” into “difference in snow accumulation”.
L266: turn “x” in equation into dot operator symbol.
L269: add “concentrations” after “BC_{tot}”.
L269: add “at” before “the five sites”.
Figure 7: change “u” into “μ” in the x labels.
Table 2: change “u” into “μ” in the dust row.
L293-294: move this sentence to the beginning of the figure caption.
Figure 8: reverse the order of the legend entries so it matches the order of the lines.
L302: introduce the abbreviation “SA” in the main text.
Figure 8: change “u” into “μ” and put “-1” in superscript in the x labels.
L329-331: double sentence.
L334: turn “this” into “these”.
L335: add “and” after “shape)”.
L350: remove comma before “are”.
L365: remove comma before “also”.
L365: remove “s” in “downwards”.
L368: add comma after “overall”.
L374: check “i.”. Should this be “i.e.”?
L390: turn “on” into “for”.
L410: turn “reff” into “R_{eff}”.
L412: turn “reff” into “R_{eff}”.
L426: remove “G”.
L426: turn “reff” into “R_{eff}”. Or rewrite everywhere to “r_{eff}”. Both are okay, as long as you are consistent.
L436: use a period instead of a comma, or rewrite sentence.
L437: remove “overestimates”?