

Revisions – round 2

Reviewer 1

In my opinion the authors did a very good job to address the major concerns expressed in my initial report. Including the appendices is a very good approach making the manuscript easier to read. Some appendices may even be moved to the supplement (e.g. A1 or A5) to reduce the length of the manuscript? The authors may further consider the suggestions for technical corrections below.

Reply: We once again thank the reviewer for their helpful comments.

Rockies should be replaced by Rocky Mountains throughout the manuscript.

Reply: The word “Rockies” is used in the names of two arbitrarily defined subregions used in this study: The Northern Rockies and the Southern Rockies. We use these names because they are relatively shorter than “Northern Rocky Mountains” and “Southern Rocky Mountains,” and they are colloquially referred to as the “Rockies” We leave these names alone for now, but we have changed “Rockies” to “Rocky Mountains” in the manuscript where these subregions are not being referred to per this comment.

Chapter 2.5 Observational data: It is difficult to see in Fig. 1, but I assume that most of the IMPROVE observations are from relatively low elevation sites? Maybe the range of elevation of the used IMPROVE sites could be mentioned in the last paragraph of this chapter. This may be important since the bias between observed and simulated BC and dust may be higher at higher elevations.

Reply: Correct, and this is a very good point. Sites are typically at higher elevations; the mean elevation of our IMPROVE sites is right around 2200 m, ranging from 1195 m to 3413 m. The following has been added to P2 of Sec. 2.5: “These sites are at relatively high elevations (mean elevation 2,221 m) with the lowest station located at 1,195 m and the highest at 3,413 m.”

L. 599: “...[dust] is still underpredicted by 43%.”

Reply: Corrected.

Some sentences are somewhat awkward and should be revised, e.g. line 558 “Larger, more dust aerosols dim sunlight, effectuating a negative surface RE.”, line 554 “Only in Greater Idaho is CNT able to explicitly meltout snow;...”, line 565 “...move up the meltout date by 4 days.”, line 566ff “Painter et al. (2007) simulated a dust SDE that melted snowpack completely more than 20 days earlier than a simulation without dust-snow-albedo effects, a result of much larger magnitude than ours.”, line 588 “However, by (3), it is clear that..”, or line 662 “... dust ARI could actually incite a positive surface RE.”

Reply: Corrected. The first referenced sentence was missing a word. In the second, “meltout” should be two words and has been corrected. In the third, we have changed “up” to “forward,” as we are trying to indicate that the meltout date is occurring 4 days earlier due to LAP effects. The fourth referenced example now reads, “Painter et al. (2007) simulated a dust SDE that accelerated snowpack meltout by more than 20 days compared to a simulation without dust-snow-albedo effects, a result of much larger magnitude than ours.” The fifth referenced clause now reads, “By (3), it is clear that when f_a is negligible...” The final clause now reads, “...dust ARI could incite a positive or a positive surface RE...”

Typo in line 563: “...between SDE and ARI shifts”

Reply: Reworded to: “...and we note that AIR and SDE-induced anomalies in meltout do not add linearly...”

Caption of Figure S1: Use the same denominations for the four sub-regions as in the rest of the manuscript and the supplement.

Reply: Corrected

Reviewer 2

The manuscript has improved a lot in terms of organisation, clarity in discussions and presentation of the results. The authors have addressed my comments and included discussions towards explaining the differences seen due to interplay between radiative differences of BC and dust over the snow surface. I recommend publication of this work with minor comments.

Reply: We thank the reviewer for their helpful comments

1) I found that the numbering of Figures is wrong in the submitted version.

Reply: We have ensured that all figures are numbered and referenced properly.

2) Figure 9-13, show spatial mean values but do not have a standard deviation. Could be included for details.

Reply: With nearly 10 time series per subpanel, adding SD values makes the figures overly noisy and distracts from the main message. We can add the SD values if absolutely necessary though.