Reply to reviewer RC1

We thank the reviewer for very helpful and constructive comments. We have done our best to address the suggestions and will improve our manuscript accordingly. Our responses and the actions we will take are detailed below, embedded in the text of the reviews. Line numbers refer to the version that was submitted for review.

Belke-Brea et al. present interesting work on the difficult subjects of measuring and modelling light transmission in snow with buried shrubs. The introduction makes shrubs sound rather like invasive species that have only recently arrived in the tundra; they are actually natural (albeit expanding) components of tundra biomes. Trapping of snow by shrubs is likely to have more influence on the insulating properties of a snowpack, but absorption of light by buried branches clearly does have an influence and has received less attention. The title to could be modified to reflect that a lot of this paper is about the influence of soot.

Yes, a lot of the paper is about soot, but this really is not our focus. It would also be strange and probably confusing to mix shrubs and soot in the title, although we do recognize that part of the take-home message of the paper is about soot. At this point, we admit there must be some arbitrary character in choosing the title.

A wind rose would be a nice addition to Figure 2 in place of the wind direction arrows, if the AWS can provide.

Thank you for this good idea. The AWS provides both wind speed and direction and we will add a wind rose to Figure 2.

Do you have any information on the frequency and volume of waste burning in winter?

No, unfortunately not. The importance of the waste burning in winter emerged only when we started analyzing the data. Monitoring waste burning activities was thus not part of our measuring protocol in 2015. In any case, waste burning at Umiujaq is a random process without any precise organization.

The measured absorption coefficients in Figure 4 clearly cannot be fitted well by adding dust to the snow, but Figure 4(b) does not look like the best possible fit for 400-450 nm (a negative bias could be removed).

We verified our calculations and in Figure 4(b) the best-fit was indeed performed for the spectral range 350-450 nm instead of 400-450 nm. We will correct for that error and update Figure 4(b) with the corrected data.

How close together and how comparable were the sites for snow pits without shrubs?

The snow pits without shrubs were within a range of ~15 m from each other, and as the topography and wind exposure of all snow pit locations were similar, the snow pits were comparable. We will add this information in line 135.

Table 1 shows that snow depth increased by 7 cm between 22 and 28 November. Doesn't that mean that the clean snow in ZOI4 on 28 November was already on the ground when the snow was judged to be dirty on 22 November?

No, this is not necessarily the case because the Arctic snow cover is highly dynamic. Snow that accumulated on 22 November was probably re-distributed by strong winds, which are frequent in autumn, or melted partly or completely due to warm spells. It is thus very difficult to date the deposition of a given snow layer and the snow we measured on 22 and 28 November was most likely not the same. For more clarity we will add in the discussion section in line 354 that snow height at a given site may vary differently from snow height at a similar-looking site 15 m away, and that the snow layers measured on 22 and 28 November were most likely not the same layer.

Comparing with Figure 5, I think that the ZOI depths in Table 2 are wrong.

Thank you for highlighting this. Indeed, we made a mistake in Table 2 and will correct the ZOI depths there.

Above 700 nm, the increased grain size of depth hoar will have an effect of decreasing absorption coefficients. Could the large grains and voids in the snow around shrub branches act as pipes for transmission of near-infrared light (just to make modelling radiative transfer even harder)?

Light travelling in the air-filled voids around shrub branches would indeed be less absorbed compared to light travelling through snow. It is thus possible that more radiation reaches deeper snow layers than would be the case in a snowpack without voids. We would expect that this effect is very difficult to measure but it could be simulated with a full-3D Monte Carlo modelling approach.