The growth of shrubs on high Arctic tundra at Bylot Island: impact on snow physical properties and permafrost thermal regime

Domine, Barrere, Morin

General comments:

The paper provides valuable data on snow height and profiles of snow physical properties measured at multiple sites differing in vegetation structure. Tall shrub vegetation has not only increased snow height, but the snow has also a lower thermal conductivity, both contributing to an increased thermal resistance, which should result in warmer soil temperatures in winter. Unfortunately the temperature loggers were lost or failed (we have some similar experiences). Instead the consequences for ground temperature have been assessed using a model, which shows the importance of vegetation structure and associated snow physical characteristics for ground temperature in winter.

The authors have been requested to pay more attention to shrub impacts in summer, as shrubs can have contrasting effects in winter and summer, e.g. Lantz et al. 2013. I do not agree that the study by Blok et al. (2010) is "contrary to all these previous observations" (line 426). Having been involved in the experiment described in this study, I have to make some remarks. It is correct that the results of the shrub removal experiment cannot be translated to impacts of tall shrubs on thawing, as there are no tall shrubs in the experiment. The dominant shrub species *Betula nana* has a height of 15-20 cm (Table 2 in Blok et al. 2010), which is not taller than the graminoid vegetation. As a consequence snow height is not influenced by the presence or absence of these low shrubs. At this tundra site, generally all vegetation is covered by snow and snow height is determined by topography (see Nauta et al. 2015, Nature Climate Change), similar to what you describe in lines 213-214. The relationship between shrub density and thawing depth (higher shrub density less thawing in summer) was not only a result of the experiment, but has also been observed in undisturbed control plots (Fig. 1 in Blok et al. 2010), and is similar to the result in Lantz et al. (2013) at a site with tall shrubs. They report that their "observation is also consistent with experimental removals of birch cover, which resulted in active layer deepening (Blok and others 2010)." (Lantz et al. 2013, end of Discussion). Your finding of less thaw under shrubs (lines 449-450) is consistent with the earlier studies. Blok et al. (2010) attributed the reduced thawing in dense B. nana vegetation to shading effects, similar to Lantz et al. (2013) and line 422 in your manuscript. Concluding, it is still possible that the impacts of tall shrubs differ from those of low shrubs (e.g. Bonfils et al. 2012, Environmental Research Letters), but I do not see any reason to treat the Blok et al. (2010) study as an outlier.

I do like the manuscript, particularly the influence of shrubs on the snow physical properties, e.g. the depth hoar formation, which is a novel contribution to the research on the effects of shrubs. The manuscript does acknowledge that the winter warming effects of shrubs may be mitigated by summer effects.

Specific comments:

L. 25 suggestion: In shrubs, depth hoar, which has a low thermal conductivity, was observed to … (to make the sentence understandable to a broader audience)

L. 298 I would expect here a short description of the results, as presented in Table 2, to get an answer to the question in the first line of this section. This section does not include any result.