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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Forest impacts on snow accumulation and ablation across an elevation gradient in a temperate montane environment" *by* Travis R. Roth and Anne W. Nolin

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Reviewer #1 comments:

1) "Modeling of the surface energy balance (EB) is also performed with several assumptions, and the paper would be improved if the effects of these assumptions were discussed and additional comparisons with other studies were made." The reviewer gives examples of roughness length, forest floor albedo, canopy temperature and transfer coefficients as potential assumptions to be discussed.

Author response: Within our model we deferred to the published literature for any assumed parameter, including those for roughness length [pg. 8, lines: 28-29], forest

floor albedo [pg. 6, line 27], canopy temperature [pg. 8, lines: 5-6], and transfer coefficients [pg. 8, lines: 23-25]. We recognize that parameter assumptions can have significant effects on the energy budget and their value choices clearly defined, especially in cases were a specific outcome is novel. This paper identifies longwave radiation as significant driver of the forest energy balance and therefore provided analysis on various longwave radiation algorithms. To provide this level of analysis for all parameter choices within the model is beyond the scope of this study.

2) Can we "expect the same relationships between forest and air temperature forests with different SVF?"

Author response: The SVF for each site was measured using hemispherical photographs and Gap Light Analysis software [pg. 5, lines: 16-20]. Therefore, SVF is not a "tunable" parameter but rather a physical forest characteristic specific to each site within our network. How this specifically changes any relationship is inherent within the longwave radiation calculation, e.g. Eq. 7 [pg. 8, line: 1].

3) "The Pomeroy and Gray (1990) study regarding threshold wind velocity for saltation of snow refer to wind velocity at 10m, are you using the same measurement height?"

Author response: No. Our meteorological stations are $\sim$2m above the snow-free ground surface and during the winter are < 2m above the surface due to snow accumulation. The High-Open site exceeds cited 7-10 m s-1 a full 9.9% [pg. 13, line: 11] of the entire record and if measured at 10m this exceedance percentile would increase due to the logarithmic relationship between wind speed and height above ground.

4) "Unloading of snow from the branches does not seem to be discussed."

Author response: We note that snow unloading from the canopy is likely with wind the likely main influence [pg. 13, line: 6]. Snow unloading from the canopy was not directly measured in this study and therefore any substantial discussion would be qualitative and based on the author's experience within these forests, not rooted in quantitative analysis.

5) “The study sites were chosen with regard to slope aspect. What about curvature, which also might influence the accumulation?”

Author response: The study sites were chosen not based on slope and aspect but rather through a binary regression tree analysis that classified the basin in terms of basin peak SWE. This binary regression tree analysis identified elevation, vegetation type, and vegetation density as significant predictor variables [pg. 5, lines: 5-11]. While slope and aspect were not used to specifically identify potential sites we did try to choose sites with minimal slope and similar aspect. Curvature was not considered. A full description of the site selection methodology is outlined in Gleason et al. 2017 (cited [pg. 5, line: 7]).

6) “Snow courses were performed from open areas into forested areas. Were measurements at the forest edges avoided? Otherwise prevailing wind direction might influence the accumulation pattern there.”

Author response: In designing our snow courses we took into account that forest edges can influence SWE measurements and therefore maintained a ∼50m buffer from a SWE measurement and a forest edge. This will be clarified within the text.

7) “The open sites had less than 20% canopy cover; did the cover differ between the open sites? If so, how might this have influenced results?”

Author response: Canopy cover between open sites did differ. Table 2 [pg. 18] shows forest characteristics of each site, including DBH, height, crown diameter, forest density, and SVF. Forest density is a principle result we present in the paper, specifically how forest density significantly influences the radiation budget and snow accumulation processes [pg. 11, lines: 22-24; pg. 12, lines: 20-32; pg. 13, lines: 1-5].

8) “This paper would also be improved if studies from maritime snowy Japan and Spain were cited and the earlier studies by Leaf from the Rocky Mountains who discusses

the effect of wind on canopy interception.”

Author response: The author is familiar with the works of Lopez-Moreno and agrees that this paper would benefit from inclusion of citing his important work. The revised manuscript will reflect this. The works of Nakai et al., (1999 and 1999) and Ohta et al., (1999) are meaningful works that help to provide clarity on the complex interplay of forests and snow processes. However, these studies are constrained to the energy balance above the canopy whereas this paper focuses on the sub-canopy processes primarily.

9) The reviewer “would also appreciate clear information about how events with mixed rain/snow were separated from pure snowfall events.”

Author response: This study was focused on forest impacts on snow accumulation and ablation processes from the rain/snow transition line into the seasonal snow zone. As such, this study was implicitly designed to understand the impacts of temperature (elevation) on sub canopy snow processes. The separation of mixed phase (or rain on snow events) from pure snowfall events was not a focus of this study and therefore not considered. The only criteria for snowfall events was a >3cm daily snowfall accumulation depth [pg. 5, lines: 28-31].

10) Technical and typographic corrections cited by the reviewer will be addressed and corrected as requested.

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