Hydrology and Earth System Sciences Discussions

Hydrol. Earth Syst. Sci. Discuss., referee comment RC2
https://doi.org/10.5194/hess-2022-273-RC2, 2022

Comment on hess-2022-273

Anonymous Referee #2

Referee comment on "Canopy structure, topography, and weather are equally important drivers of small-scale snow cover dynamics in sub-alpine forests" by Giulia Mazzotti et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-273-RC2, 2022

In the paper, the authors mainly presented an application of a new snow cover model FSM2 in a sub-alpine forest, and tried to understand the snow spatio-temporal distribution and its drivers mostly with the modeled results. Given still lacks wonderful snow models that can perform the complex snow dynamics for the mountainous terrain, especially with high resolution simulations, the topic in this paper is very interesting and important. The authors integrated the datasets of four observed snow depth data, Lidar-based canopy structure and elevation with the 2-m grid cell simulated results for 6 winters, and examined the snow energy balance affected by canopy cover and tograph. The paper fits with the scope of HESS and the results are overall well presented, however, the paper missed a lot of information on the study site, and the methods and modeling approaches are not clear. I have some following issues for the authors to consider.

1. Canopy structure:
Canopy structure refers to horizontal canopy cover and vertical canopy distribution (such as vertical layers, leaf area index LAI). Here in the study, the authors only focused on the canopy cover fraction, but did not pay a lot attention to other structure factors, such as canopy height and LAI. To avoid the confusion, I recommend the authors use 'canopy cover' to replace the word 'Canopy structure'. Did the authors find the impacts of canopy height and LAI on the snow interception? It is better to provide that information in the revision. I am not familiar with the sub-alpine forests. If you can provide more site information on the tree species (coniferous or deciduous species?) and forest structure (such as canopy layer and understory structure), it will help the readers better understand the background of the canopy cover and LAI.

In addition, the simulation of snow dynamics in forests mainly depends on the radiation transfer model of canopy. In the paper it seems that the canopy radiation transfer model used is a single layer canopy model. Since the canopy height can be 5-35m mentioned in your supplement, the single-layer hypothesis will probably cause the model bias, especially for the understory snow dynamics. The authors should clarify those uncertainty and limitations.

2. Wind:

In this paper, the authors mostly considered the meteorological factors of air temperature and solar radiation. However, for mountainous terrain, wind is widely recognized as one of the dominant controls of snow accumulation and distribution, including the alpine regions. Wind patterns interacting with topography determine the patterns of final snow distribution on the landscape, while the surface wind and turbulence also control the snow sublimation and melting processes via energy exchange. Unfortunately, I didn't find any relevant results and discussions in this paper. The authors should provide the above corresponding content in their revision.

3. Topography:

The authors used elevation, slope direction to represent the impacts of topography on snow dynamics. This is generally sound, however, in very steep terrain in particular, topography mostly can affect the evolution of snow water equivalent SWE, and thus patterns of meltwater generation. How did the author consider the gravitational snow redistribution during winter? I recommend the authors also provide the site information on slope angle to help the readers understand this.

Specific comments:

Methods
1. What's the time step or temporal resolution of your simulation? How did you intercept the data for your periodic results?
2. How did you define the water year?
3. How about the uncertainties caused from the input datasets in your study?
4. Section 2.4, Regarding the SWE and Snow cover, were they the total of canopy interception and through canopy snowfall? Did you distinguish opening and canopy areas when identifying the SWE peaks and changing periods?

Results and Discussions:
l159: What is the data collected frequency?
L159-165: Which place does the snow depth data represent for forests? On the top of the canopy or for the whole ecosystem?
L163, What does ASO stand for?
L263, Please provide the supporting materials for the statement on under canopy vs open vs gap areas.
L268, Please provide the supporting materials for the statement on correlation.
L308-309, Please clarify how did you conduct the canopy structure and topographic settings specifically?
L406, How did you define 'semi-open conditions'?

L410, What is the exact range of canopy cover?
L427, Here the citation of fig 10a may be not correct.
L505-506, Snow water input is also affected by the slope angle in the mountain regions..

Figures and tables:
All figues: Please point out if the data is from observatiosn or simulations.
Fig 1, What does SLF stand for?
Fig 2, What do SSD,PSD,SDD stand for?
Fig 3, It will be better to add an ANOVA test for fig3e. Why didn't you also show the south-exposed slope for Fig3e ? In fig3f, what are the differences between left and right panels?
Fig 6a, The last two legends have the same titles.
Fig 8, What do SWR, LWR, SHF, and LHF represent?.
Fig 10b-d, I didn't find any legends.
Fig11a, Does it refer to the total melt depth or melt rate.