REVIEWER 1:
Comment:

In this paper, the seasonal evolution of a mountain snowpack's physical state is analyzed over a 72-year period by means of a physics-based snowpack model to assess long-term changes in its capacity to buffer runoff from liquid water input. The manuscript is well-written and I only have a few minor comments.

Abstract:

Comment:

- 12: I recommend to mention the model that is used already here by name.

Proposed Action:

 We added the model name to the sentence.

Introduction:

Comment:

- 67 - 69: „Broad regional-scale": can you specify what size you mean with this?

Is your „large Columbia headwaters basin" of this size, or larger/smaller?

Does „… not only computationally impractical but may obscure the importance of transient and localized processes" also apply to the latter, or not? Please clarify.

Response:

The authors agree that the definition of 'Broad regional-scale' is nebulous. In our context, the term could apply to the northern Rocky Mountains, the western United States, or even Western Montana. There exist many papers that analyze changes in snowpack properties, usually limited to SWE, over regions such as 'the western US' or 'the pacific northwest' or 'the Alps'. The high computational demand of Alpine3D modeling on the sub-kilometer gridding needed to capture snowpack variations in mountainous regions makes such large-scale studies impractical.

We have changed the wording of the paragraph to reflect that studies conducted over the entire western US with gridding on the scale used in this study would be computationally prohibitive.

Our 'large Columbia headwaters basin" is orders of magnitude smaller than what we would define as a 'broad regional-scale' area.

The scale of the gridding used in this paper (800 m x 800 m) captures variations in LW_{bc} properties on the kilometer scale. The 6914 grid points used in this study allow us to model the snowpack with high resolution without being computationally prohibitive. The description of the scale of the basin is in section 2.1.

Proposed Action:

We will remove the ambiguous language, replacing it with more precise language.

Methods:

Comment:

- 78: What Do you mean with „undeveloped" forest?

Response:

The forest in this region has undergone very limited logging and there exist only two permanent structures within the basin. Approximately 2/3 of the basin is in wilderness designated areas.

Proposed Action:

We will remove the word 'undeveloped' from the sentence.

Comment:

- 93: Maybe better begin new sentence with „With this resolution …".

Proposed Action:

We will make the change as suggested.

Comment:

- 94: Maybe better insert „snow allocation and surface hydrology **model**".

Proposed Action:

We will make the change as suggested.

Comment:

- 95: The Swiss meteo data processing tool's name is „**MeteoIO**".

Proposed Action:

We will correct the spelling mistake.

Comment:

- 125: Which values did you obtain for the irreducible water saturation?

Response:

The calculated irreducible water saturation varies by pixel and year of model run, thus there are almost 500,000 values. The range of values for all locations over all years is between 0.1 and 15.4 percent by weight. The average of all locations over all years was 5.2 percent by weight. The minium value at each location throughout all years ranged from 0.1 to 3.9 percent by weight. The maximum value at each location throughout all years ranged from 6.5 to 15.4 percent by weight. The average value at each location throughout all years ranged from 4.5 to 9.2 percent.

This means that each pixel had at least one year where our calculated value was less than the laboratory derived estimates of irreducible saturation, but most of the values were within the range published in Coléou and Lesaffre (1998).

The physical analog of the low values would be a warm, new snowfall that has just become ripened in a location that has runoff. Runoff in Alpine3D is calculated for the soil layers with input from the snowpack as well as adjoining pixels. This means that runoff can occur in a pixel that does not have snow on it.

Proposed Action:

We will add the range and average value of calculated irreducible water saturation to the text.

Results:

Comment:

- 226/Figure 5: Here you mean „Late accumulation period", right? Better replace „Early Spring".

Response:

The reviewer is correct.

Proposed Action:

We will make the changes as suggested

Comment:

- 230: Better replace „fall" with the term you defined earlier (159 - 161): „Early Accumulation".

Response:

The reviewer is correct.

Proposed Action:

We will make the changes as suggested

Comment:

- 231: „Early Accumulation" should be „Late Accuumulation" here, right? And the dates, as defined earlier: March 9 to April 17. Better stay consistent (see 159 - 161).

Response:

The reviewer is correct.

Appendix:

Comment:

- Figure A1: Add units to (a) and (b).

Comment:

- 503: Refer to method mentioned earlier (regression, Pan et al., 2003), or insert again here so that the origin of the factor becomes clear.