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Hydrology and Earth System Sciences Discussions

Interactive comment on "Controls on the temporal and spatial variability of soil moisture in a mountainous landscape: the signatures of snow and complex terrain." *by* C. J. Williams et al.

C. J. Williams et al.

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Final response of authors to anonymous Referee #2 minor comments on "Controls on the temporal and spatial variability of soil moisture in a mountainous landscape: the signatures of snow and complex terrain" - C. Jason Williams, James P. McNamara, and David G. Chandler

(Reviewer comments in italics, author responses in normal text with text changes noted in bold, all referenced page numbers and figures are to the on-line version of the discussion paper)

1) *Page 1931, Line 19: list the catchment properties*

The authors prefer not to list all of the catchment properties here given the total would unnecessarily lengthen this section. We opine the main point is conveyed in the current form.

2) *Page 1933, Line 15: Were these surface soil samples? Samples from the top 30 cm? Give the depth of the samples? What was the size of the soil samples?*

The soil samples were core samples taken over the first 0 to 30 cm depth of the soil profile. Average sample size was 4.7 grams.

Page 1933, Lines 14 - 15 - Revised to read, **"The percent coarse (>2.00 mm), sand (<2.00 m and >0.05 mm), and fine (<0.05 mm) soil fractions over 0 to 30 cm soil depth were determined by sieving core soil samples (mean sample size 4.7 g) from each point."**

3) *Page 1935, Line 19: How many plots?*

Time stability on each sampling date was calculated based on samples from each point along the study grid, $n = 57$ for each sampling date. No changes were made to the manuscript.

4) *Page 1934, Line 29: How did you deal with the snowpack? Did you remove the snow before inserting the soil moisture sensor? Or did you extend the rods of the soil moisture sensor so that they could be inserted through the snowpack? Or are all the measurements that occurred when there was a snowpack excluded from the analyses? This is not clear in the current methods section.*

Snow was removed from the immediate sampling area and the TDR probe was inserted into the soil profile without the presence of snow on the surface.

Page 1934, Line 26: After, "...soil profile." we inserted the following, **"When a snowpack was present, snow was carefully removed from the immediate sampling area soil surface. Snow removed from the sampling area was replaced following sampling and allowed to accumulate between sampling dates."**

HESSD

5, S1928–S1934, 2008

Interactive Comment

5) *Page 1934, Line 5: Was this an average snow year? Or a dry year?*

Page 1934, Line 7, following "...Judd sonic depth sensor." - We inserted, **"Rainfall and snowfall during the study year were approximately 116% of average recorded from 1999 through 2006."**

6) *Page 1935, Line 16: Insert *the relative difference (dij)* before equation 2. Now it looks like equation 2 is the mean relative difference not the relative difference.*

Page 1935, Line 16, following the text, "...was calculated as the time average of ..." we inserted **"the relative difference" (δ_{ij})"**

7) *Page 1937, Section 4.1: It seems that this section could equally be well moved to the site description.*

The authors have considered this recommendation and have chosen to leave section 4.1 in results since the material is results in the context of this study.

8) *Page 1940, Line 16-18: Explicitly mention what the numbers in the parentheses represent.*

Page 1940, Line 15 - After the text, "...weakly, correlated..." we inserted "...(positive [+] or negative [-]; number of significant observations)..." The final text for Lines 13-16 reads, **"Other variables that were significantly, although weakly, correlated (positive [+] or negative [-]; number of significant observations) with soil moisture at least 10 times include snow density at time of maximum depth (+; 20), elevation (-; 19)..."**

9) *Page 1940, Lines 27-28 and Page 1941, Lines 1-2: Insert at the end of the sentence "except during the wet-up period" as you write on L3-4 of P1940 that this is not the case during autumn rains.*

Page 1941, Line 2 - After text "...site average soil moisture content..." we inserted **"...except during the wet-up period."**

HESSD

5, S1928–S1934, 2008

10) *Page 1941: I really like the idea and calculation of the rank change index (RCI). It would be good to add a figure showing the spatial distribution of RCI. This will make the spatial variability/spatial pattern in RCI much clearer to the readers.*

We have added a spatial map of the RCI to Fig. 2 as Fig. 2d.

Figure 2 caption changes to **"Fig. 2. Kriged maps (calculated with Surfer 8.0, Golden Software) of soil depths (a), snow depths at maximum accumulation (b), percent sand contents of the soil (c), and the rank change index (RCI, d) for the changes in the rank of soil moisture mean relative difference measured at 57 points of the Treeline study grid."**

11) *Page 1942, Line 28: It is important to stress here that the soils are a lot shallower there.*

Page 1943, Line 2 - After the text, "...of early snowmelt sources..." we inserted **"...at the base of steep slopes underlain by shallow soils (< 30 cm depth)."**

12) *Page 1947, Line 11: State explicitly that the spatial pattern of soil moisture (and relative difference) does change during this period.*

The text on page 1947, Line 11 - After the word "unchanged" we inserted **"until the next spring wet-up period."**

13) Page 1947, Line 14 and Lines 17-18: Again, state that this is only for the wet-dry period as on P1939 you state that it is not the case for the wetting up period during fall rainfall events.

Page 1947, Line 14 - Following the text "...tend to remain drier than average..." we inserted **"...except during autumn wet-up."**

Page 1947, Lines 17-18- Replace the following the text "...through the hydrologic year..." with **"...from snowmelt through the annual dry period."**

14) *Figure 2: What method was used for the interpolation? It would be better to show*

HESSD

5, S1928–S1934, 2008

the actual measurement locations as well. Finally, it would be helpful if the figure would be a bit bigger.

Figures 2a - 2c were derived through kriging using Surfer 8.0 based on measurements at the 57 sample points along the study grid (Fig. 1). We produced a sizeable figure, but it was reduced in the production process. A new figure, inclusive of RCI is included for minor comment #10 above.

The caption for Fig. 2 has been amended to reflect the interpolation as follows: **"Fig. 2. Kriged maps (calculated with Surfer 8.0, Golden Software) of soil depths (a), snow depths at maximum accumulation (b), percent sand contents of the soil (c), and the rank change index (RCI, d) for the changes in the rank of soil moisture mean relative difference measured at 57 points of the Treeline study grid.**

15) *Figure 3: It would be helpful to plot the snow depth as well.*

The authors agree plots of snow depth would augment the data presentation. However, consistent snow depth data in time series format are not available for the study year due to sporadic failure of Judd sensor used to record snow depth.

16) *Figure 6: It would be easier to see the points if the figure was split into 2 parts (a with the time stability and b with the other correlations). Also, the figures would be clearer if the lines showing the representative states would span the whole plot as in figure 3 and not just the data range.*

The authors have considered splitting Fig. 6. The figure remains in its original style given the tradeoff of additional space required to produce the split figure. We have amended the figure to include one additional date (11 Nov 2003 added to Fig. 5) representative of the wet-up hydrologic state. We have also adjusted the lines representing hydrologic states to span the whole plot as suggested by Referee #2.

Responses to minor editorial comments:

1) *Page 1928, Lines 18-21: this sentence does not flow very well. Rewrite.*

HESSD

5, S1928–S1934, 2008

The original text read, "We suggest that the static properties in complex terrain (slope, aspect, soils) impose first order controls on the spatial variability of snow and consequent soil moisture, and that the interaction of dynamic (timing of water input) and static properties propagate that relative constant spatial variability through the hydrologic year."

The existing text was amended to read, **"We suggest that the static properties in complex terrain (slope, aspect, soils) impose first order controls on the spatial variability of snow and resulting soil moisture patterns, and that the interaction of dynamic (timing of water input) and static influences propagate that relative constant spatial variability through most of the hydrologic year."**

2) *Page 1928, Line 21: Insert "that" between "demonstrate" and "snow"*

The above recommended changes were made on Page 1928, Line 21.

3) *Page 1928, Line 22: Insert "we" before "infer"*

We have changed the word "infer" to **"suggest".**

4) *Page 1929, Line 4: Replace "while also is a" by "while it is also a".*

The above recommended changes were made on Page 1929, Line 4.

5) *Page 1931, Line 9: Replace "declines on 1 April" by "declines of 1 April".*

The above recommended changes were made on Page 1931, Line 9.

6) *Page 1931, Line 19: It is clearer if you replace "scales" by "changes with"*

The above recommended changes were made on Page 1931, Line 19.

7) *Page 1938, Line 17: Replace "to a depth" by "at a depth"|*

The above recommended changes were made on Page 1938, Line 17.

8) Page 1939, Line 20: Insert "(MRD)" after "Mean relative difference"

HESSD

5, S1928–S1934, 2008

The above recommended changes were made on Page 1939, Line 20.

9) Page 1939, Line 21: Replace "MRD" by "dijbar"

The authors have declined to make changes relative to this comment.

10) Page 1940, Line 7: Replace "soil moisture content" by "mean relative difference" (soil moisture content is always a positive number)

The above recommended changes were made on Page 1940, Line 7.

11) Page 1942, Line 5: Insert "During" before "A wet"

The above recommended changes were made on Page 1942, Line 5.

12) Page 1947, Line 19: Insert "that" between "suggest" and "snow"

The above recommended changes were made on Page 1947, Line 19.

13) Page 1947, Line 21: Replace "mountain" by "mountains"

The above recommended changes were made on Page 1947, Line 21.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 5, 1927, 2008.

HESSD

5, S1928–S1934, 2008

Interactive Comment