

## ***Interactive comment on “Controls and characteristics of variability in soil moisture and groundwater in a headwater catchment” by H. K. McMillan and M. S. Srinivasan***

**Anonymous Referee #2**

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Comment on McMillan, H.K. and Srinivasan, M.S., Controls and characteristics of variability in soil moisture and groundwater in a headwater catchment

### **General comments**

This paper addresses the soil moisture and shallow groundwater table response in an experimental catchment in New Zealand. Both soil moisture and groundwater head are sampled at a variety of topographic locations that vary in terms of proximity to stream and aspect. Aspect is found to be a significant driver of difference. Data are analysed both spatially and temporally. Soil moisture and groundwater responses are nominally

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considered together which is a worthwhile objective as such joint analysis has rarely been done. The paper is generally clearly written and most information required is available, although I request a series of clarifications in the specific comments below.

I first have a couple of overall comments to make.

I thought that the paper could be strengthened by analysing the soil moisture responses in the context of the groundwater observations, and perhaps vice versa. At present analyses are carried out by geographic grouping of sites (i.e. lower/upper slope etc) but there is substantial variation in response within each group, showing significant catchment heterogeneity. I feel that it would be informative to group the sites by water table response (shallow/deep, quick/slow) and analyse the soil moisture in the context of those groupings. This might enable more insight into the inter-relationships between soil moisture and groundwater responses, which would make the paper significantly stronger in my view.

I think it would also be worth the authors considering the definition of soil moisture and groundwater briefly in the paper. They are terms we use easily but often people are referring to different things. Soil moisture can be near surface, root zone, profile, at a specific depth, etc. Groundwater can be shallow, perched, regional, etc. Perched water tables in the soil profile might be considered either groundwater or soil water and no doubt there is grey in between. Distinguishing carefully might be useful in interpreting the literature a little more.

The analysis (e.g. in Figure 3) often relies on grouping sites and averaging which is fine but consider showing the spread between sites somehow – it is not clear how “different” these groupings actually are without knowing the within-group variability. The same can be said for other figures.

In the discussion the reasons for the observation that aspect is a strong differentiator of behaviour could be discussed in more depth. Is this a direct effect through ET or is it due to impacts on soil development, issues such as geological bedding (strike-dip

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effects), vegetation differences, etc.

The figures are generally clear but quite a few have lines distinguished by colour but lack a legend. Also the captions could probably give a little more detail to make the figures a little more stand alone.

In the following I use pppp:ll to refer to page numbers (p) and line numbers (l)

### **Specific comments**

9477:24-9478:2. Variation in soil properties is important for similar reasons. It is worth mentioning that it is not just the water status that needs to be thought about.

Section 1.1. The authors would find the following paper interesting for this section (and it does a little comparison of soil water-groundwater interplay too).

Rosenbaum, U., Bogaen, H.R., Herbs, M., Huisman, J.A., Peterson, T.J., Weuthen, A., Western, A.W., Vereecken, H., 2012. Seasonal and event dynamics of spatial soil moisture patterns at the small catchment scale. *Water Resour. Res.*, 48: W10544.

9482:4. I was expecting a section on soil moisture-groundwater inter-relationships here given the promise of the abstract.

9482:13. Is there any orographic effect over the catchment (given the 250m relief)?

9482:23-27. Are these sand/clay fractions specified including or excluding the coarse fraction?

9484:5. How were soil moisture sensor calibrations obtained?

9484:8. Were the groundwater wells open across their whole length? If not what was the screen interval?

9486:1-17. I was unclear about these calculations. The monitoring only covers a very small part of the catchment. Are you implying that you extrapolated to the whole catchment (that seems courageous given the extent of the extrapolation and the fact that

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monitoring seems concentrated on lower slopes) or were you averaging over the monitored area. I would suggest concentrating on the monitored area.

Figure 3. Red and magenta are hard to distinguish.

9487:19. It was mentioned in the methods that you determined saturation thresholds for soil moisture sensors by visually examining the traces. You could and should use the groundwater data to confirm this given that a strength of your study is the co-located measurement of both.

9487:26. Figure 6 – a common behaviour (but not that often reported). It would be nice to see this plotted following Detty and McGuire 201a, Fig 4 with antecedent moisture incorporated.

9488:7. Not clear if the moisture is averaged across sites before counting the events – please clarify.

Figures 7 and 8 don't have upper water table – why?

9488:23+. I think the different datums are used for soil water and groundwater (lowest observed level for groundwater vs zero moisture for soil moisture). How does this affect comparison of absolute values?

9489:4. Which standard deviation – I realised latter that it was spatial but clarify here. Clarify in figure caption too.

9489:7-8. There is quite a lot of literature that shows variability decreases with drying, so I disagree with this statement. See Rosenbaum (2012) referenced above.

9489:12-14. What does this imply about preferential flow?

9489:14-15. This sentence doesn't seem to follow on from the previous "Accordingly..." – I could not see the relationship.

9489:24-25. Yes you saw significant spatial variability in a small part of the catchment

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– and presumably there is in other parts of the catchment – but you can't actually say how large or small that might be from your sampling scheme.

9490. When discussing particular events, please give the rainfall depths.

9491:20-22. Maybe I am misinterpreting comparison of Fig. 10 and 11 but only about half the sites showing saturation had a WT response in summer.

9492:4-5. This observation about gravel should be in the site description.

9493:20. It would be good to see these recessions together with the deeper sensor and groundwater.

**Technical corrections**

9476:18-20. The wording seems awkward.

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