

Interactive comment on “Shallow soil moisture - ground thaw interactions and controls - Part 2: Influences of water and energy fluxes” by X.J. Guan, C. Spence and C.J. Westbrook

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Response to Referee #2 Comments (in bold font)

We thank Referee #2 for the comments posted on 12 March 2010. We acknowledge the Referee’s constructive and helpful suggestions. We will address these suggestions in the final paper.

Response to specific comments:

This paper describes the differences in the water and energy fluxes of a peatland, valley, and wetland site in order to explain the observed differences in ground thaw depths and soil moisture. The spatial patterns in ground thaw and soil moisture and the correlations between the two are described in the accompanying paper. The main result of this paper is that the different interactions between ground thaw and soil moisture for the three sites were due to differences in the presence of surface water. Another key result is that the transfer of latent heat that accompanied lateral surface runoff caused the wet areas in the peatland and wetland sites to be the locations of deepest thaw. This paper provides enough new and addition information and is structured in such a way that it does deserve to be a stand-alone paper. The methods, the modified pecelet number, and results are described very well. Unfortunately, there are no uncertainty estimates for many of the water balance components so that it is not clear what the uncertainties of the calculated fluxes and pecelet numbers are and how these uncertainties compare to the differences for the three sites. Therefore it is not clear how these uncertainties affect the results. This is my main concern about this paper (see also specific comment 1 below). There are a few minor typos in the text but overall the paper is very well written. Due to the large number of equations for the water and energy balance components, the large number of symbols and subscripts is sometimes a bit confusing. This would be alleviated by including a list of symbols in an appendix at the end of the paper.

- **More information on the error estimates, assumptions and limitations related to the water budget and Pecelet estimates are added and stated more explicitly in the paper.**
- **An appendix will be included with the final paper to make the symbols and abbreviations clearer.**

Specific comments:

1) Methods: for the first water balance components (e.g. snow survey and melt) uncertainty estimates are given. These estimates are missing for the other components and should be included so that the reader has some idea of the uncertainties and can interpret the results accordingly. If there is no information of this error/uncertainty for a certain water balance

component, then the authors should give a best estimate. These uncertainties should be mentioned when the different water and energy balance components for the different sites are compared and should also be used in the calculations of the modified pecelet numbers. That way the readers will have some sense of how these uncertainties compare to the observed differences for the three sites and what the uncertainty of these modified pecelet numbers is.

- **More error estimates, assumption/limitation statements for the water budget and the Pecelet number are added to paper to give readers more information on the uncertainties.**

2) P73L8: could this “missing flux” term not just be an error term as well? And isn’t this term set to zero when the difference in storage is used to calculate “Qs”? If you mean “Qs” with the “missing flux term”, then rewrite or expand this section so that it is clearer what is meant here.

- **This section has been expanded to clarify this and the associated limitations are added (e.g. error also transferred to estimated Qg).**

3) P76L15: the wording of the piezometer pipes is a bit awkward/confusing. Until line 17 it is not clear what the C-pipes are. It would be easier to understand if they were just called ‘shallow (0.20 m), deep (0.50m)’ in L14 and ‘very deep piezometers’ or ‘extra deep piezometers’ in L15 instead of ‘A, B, C pipes’.

- **Thanks for pointing this out. It is fixed now.**

4) P77L15: How many days were there with missing or suspect data and how big was the difference between the discharge calculated from the water balance residual and the actual measured discharge?

- **Information added. At the peatland site, some measured surface discharge values were a magnitude lower than the estimated due to water flow through the thick moss cover above the gauge point.**

5) P80L1: At what depth were the Ech2o-te sensors installed? At multiple depths or just one depth? Where were they installed? Please provide more information about these measurements.

- **Added more information.**

6) P80L12: Give information on how the specific yields were determined.

- **Added.**

7) P85L18: How do the observed changes in storage or the storage changes calculated with Eq 12 compare with those calculated with Eq1? This would give the reader a better sense of the uncertainties (see also comment 1).

- **The plan was to use the storage values from the two approaches to determine an estimated uncertainty. However, as P73L8 noted, various missing fluxes needed to be filled in (cannot be measured/estimated for various reasons, e.g. surface outflow from wetland site during earlier part of season because of extensive sheetflow). Using the observed storage change twice in the water balance would have created a circular calculation. To provide a sense of how much uncertainty is involved in other ways, more accuracy/error values, assumption and limitation notes have been added to the paper.**

8) P88L10: I think that this section should be expanded and especially this statement should be clarified as it is not totally clear what is meant here if the reader only reads this paper (and not the accompanying paper).

- **Fixed, clarified this paragraph.**

9) Figure 1: When this figure is printed in black and white, it is hard to see the contour lines. Make them a bit darker (and maybe the contour labels a bit lighter).

- **Will update to make the lines/labels clearer.**

10) Figure 4: I found this figure hard to read when it is printed in black and white as there were so many lines. It would be easier if some of the line types were shown different in the legend or if more distinct line types (or thicknesses) were used. For example ET seems to be almost a solid line in the legend but it is not in the figure. It would also be better if surface inflow and outflow were just plotted on a different (2nd y-axis) rather than scaled on the same figure.

- **Will update to make it more legible.**

11) Figure 5: what day was taken as zero cumulative surface water input? Why do the lines not start at zero? It would be interesting if there was an error bar or error band that highlighted the uncertainty in these sums.

- **Fixed to start at zero. We agree error bars will highlight the uncertainty in the total sum, but the bars make this graph very crowded and blocks off the key information. Relating to a previous comment, additional error estimates have been included in the methods section and those would help solve this comment.**

Minor technical comments:

- **Thank you. All accounted for now.**