

Interactive comment on “Are hydrological pathways and variability in groundwater chemistry linked in the riparian boreal forest?” by Stefan W. Ploum et al.

Anonymous Referee #1

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General comment This is a concise paper that compares groundwater chemistry in sub-catchments of the Kryckland observatory and asks questions about chemical variability in relation to hydrological pathway. The paper is written in a clear and concise way with not much to complain about in the introduction and results. The paper clearly shows and describes the variability of groundwater chemistry in relation to its hydrological activity. This is a very relevant result that is worth being published in HESS. However, I have some point of criticism that should be addressed: Groundwater was sampled with fully screened wells which means that there is an unknown integration of water quality over depth potentially changing between sampling campaigns. The authors should carefully discuss the pros and cons of this approach. Later on in the

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text there seems to be a not-outspoken assumption of vertical homogeneity of ground-water quality and a high weight on lateral heterogeneity. This needs to be made more clear and concise as this new DRIP-concept seems to stand against the former RIM- (Seibert et al. 2009) and DSL-concepts (Ledesma et al. 2015) that were derived from the same study site. The authors used linear mixed-effect models (LMM) to analyze spatiotemporal patterns of groundwater chemistry. There should be some effort in the text to justify the choice of this method and also on the choice of predictors. One could argue that the authors did not look hard enough to include other predictors (e.g. local TWI) but instead chose a method which can handle random effects from unaccounted factors. Finally, I have a major concern with the discussion section that is rather an implication section centered on the question what the varying groundwater quality would mean for stream chemistry. However, this was not part of the study design. So the discussion should rather be focused around the question, why the measured groundwater quality was different in different parts of the riparian zone.

What came into my mind here: Aren't DRIPs just an extension of the fractal stream network into the catchment. DRIPs are along topographic depressions funneling water flow in the same way as the stream network. The major difference is that they are not (permanent) pathways of surface flow but rather pathways of shallow subsurface flow. Maybe I missed that connection in earlier studies that were cited here. I however very much like the idea to refine the view on riparian zone by that type of concepts focused around major flowpaths. In essence I support this manuscript but ask for a substantial revision of the discussion section and a better justification of field and statistical methods.

Specific comments

Abstract:

L13: This sentence is potentially misleading. What is meant by chemical variability in the riparian boreal forest? The linkage of riparian groundwater as described before

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and forest is not clear.

L20: The pairing of hydrological connection and groundwater condition cannot be understood here. Can you find a more telling factor name?

L20: The water provided by DRIPS – is that surface water discharging from the DRIP or groundwater within the DRIP?

L23: “chemically more stable” may be misleading. Do you mean spatially and/or temporally homogeneous?

Introduction

P2L1: While I in general like such comparisons the idea of headwaters as “capillaries” was not immediately clear to me.

P3L10-13: These two sentences need some references.

Methods

Fig. 2: The catchment delineation is somewhat distracting. I suggest to limit the catchment boundaries to the catchment with studied DRIPs/ nonDRIPs. What determines the catchment outlet? A gauging station? Maybe show them to make clear that this was not completely arbitrarily chosen.

P5L6: TWI units are not [ha] – what do you mean by “topographic wetness index (2 ha threshold)”?

P6L1: Can you specify the wells in terms of diameter and material? What is the meaning of a groundwater sample taken in a fully screened well? Do you expect this to be a representative sample from all depths or rather a sample from the most conductive depth? In the latter case the depths where most water is coming from may change over time with changing groundwater levels. I would like to see a critical evaluation of your sampling design and drawbacks (assets?) of the chosen methods! The methods chapter is likely not the right place.

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Results

P7L4: I don't understand why you jump in directly with that statement in the second sentence already.

P7L26: Did you expect more distinct differences? Keep in mind that the pH is a logarithm of concentrations and small changes can mean a lot compared to DOC and EC.

P8L16: When you talk about seasonality you mean factor TIME, right? It would be helpful to stick to those factor names and provide it in brackets if other words such as seasonality are used.

Fig. 4: I suggest that you indicate if the mean is significantly differing in individual panels. That would improve readability here. Same is true for Fig. 3 and 5

Discussion

The discussion make strong links of groundwater spatial variability to stream chemistry temporal variability. But this is not what was shown in the results. I miss a discussion of why groundwater quality was as it was measured and presented above. All the discussion is rather focusing on implications.

P9L23 to P10L3: I have problems following the argumentation here. Why does the contrasting chemistry of DRIPS and non-DRIPS explains why pre-event water is quickly mobilizes? Do we really need DRIPS and non-DRIPS to explain temporal variability of stream chemistry within an event? That is also covered by vertical chemical heterogeneity (taking Seibert's RIM for instance).

P10L26: The generalization (that totally make sense) of your findings to the larger scale of the Kryckland catchment is a selling point. I suggest to base the statement made here on DRIPS in catchments on a sound and reproducible analysis and not on a personal communication.

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