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Hydrology and Earth System Sciences
Discussions

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

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Variability in landscapes is a challenge for understanding how landscapes influence water chemistry in space and time. By developing a sampling design based on a hypothesis about how water is flowing through the riparian zone, this study has provided new insights into the hydrobiogeochemical structures that shape the connection between landscapes and waters. This has practical implications for the design of buffer strips that are widely used in water management. As such this paper can be a valuable contribution to the literature. I think its value would be enhanced if a few points in the paper got further attention.

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Discussion paper

Answer: Thank you for providing this short comment, we will incorporate the points in our revised manuscript. Below we answer the comments one by one.

One concerns the distinction drawn between DRIPs and the confluences of ephemeral streams on page 5, lines 19-21. The text here was not clear. I think the authors are trying to say that such confluences are not included in their definition of DRIPS since DRIPS do not have clear channels. It would be good if this could be clarified.

Answer: We will clarify this section. We agree that emphemeral stream and DRIPs differ from each other by the presence of a clear channel in the case of emphemeral streams, while this is not the case for DRIPs. In practice it can occur that DRIPs have a small channel-like appearance within the very last meter when it merges with the stream, for example when there is bank height difference.

A second point I suggest that the authors address concerns the discussion of relative contributions from DRIPs and Non-DRIPS to stream chemistry under different flow conditions (page 10, lines 29-34). This part of the discussion talks about the contrasting chemistries coming from DRIPS and non-DRIPS. But the effect of chemical differences in the source waters on stream chemistry depends on the proportion of water coming from the different source waters. Is there some assumption underlying this part of the discussion about how much water comes from DRIPs relative to non-DRIPS during high and low flow conditions? Clarification of that would help make the points in this part of the discussion more persuasive.

Answer: Thank you for moving this discussion further. In terms of flow conditions, the speculations were related to high flow conditions during a hydrological event. In the sentences before this section, we presented that 57% of the Krycklan catchment drains through DRIPs, which connect to only 12% of the stream network. These numbers happen to be similar to the distribution of DRIPs in the studied headwater catchment of Krycklan where our well network is located (Leach et al., 2017). However, since we have reported earlier that detectability of DRIPs changes throughout events and

seasons (Ploum et al., 2018), this assumption can be argued against and it is very likely that DRIP/non-DRIP contributions vary over time.

In the lines 29-34 we speculated that the distribution of the DRIPs in other headwaters of the Krycklan catchment might differ, which would lead those headwaters to have different young/old water fractions. This suggestion was based on the idea that due the high storage state of DRIPs, their activation is much faster compared to non-DRIP riparian zones, which lead to our suggestion that young fractions are mobilized quickly, contrary to non-DRIP areas. Moreover, this line of thought had the underlying assumption that the chemical characteristic of DRIPs and non-DRIPs would stay the same (low EC, high DOC for DRIPs and high EC, low DOC for non-DRIPs), but that the landscape organization might be different in different headwaters (more or less DRIPs). It is very likely that this chemical contrast between DRIP and non-DRIPs is not consistent over the entire catchment. Although this is an interesting discussion, we suggest that based on the many underlying assumptions and the comments of the referees #1 and #2, we will scale down this section of the discussion. Instead we will more focus on the context of DRIPs in groundwater flow to streams in boreal till landscapes, considering the RIM and DSL concepts (Ledesma et al., 2015; Seibert et al., 2009).

Furthermore, if the DRIPS do not include the confluences of intermittent streams with the perennial stream channel, it would be important to mention what these ephemeral streams are doing to contribute to the high-flow stream chemistry being talked about in the discussion.

Answer: We agree that intermittent streams should be included when evaluating high-flow stream chemistry. A clean channel-like feature might respond faster to hydrological inputs compared to DRIPs. That being said, relative to non-DRIP riparian hillslopes, the responsiveness of shallow subsurface runoff generation of DRIPs possibly falls in the same order of magnitude as intermittent streams. Similar to the comment above, we suggest that due to the speculation in our discussion we scale down this part of the discussion. In the DRIP definition in the method section we will clarify how DRIPs

relate to intermittent streams.

One final question, the concept of a ”DRIP initiation threshold” is mentioned on page10 line 35, but a definition of what this means is not given. Please explain the term.

Answer:The initiation threshold is the TWI threshold referred to in line 6 page 5 (2ha). This is a subjective threshold, but further supported by the flow accumulation model of the stream channel. We will clarify this in the text.

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