

Interactive comment on “Carbon dioxide transport across the hillslope–riparian–stream continuum in a boreal headwater catchment” by F. I. Leith et al.

Anonymous Referee #2

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Overview:

Leith et al present a well-conducted observational and modeling experiment to evaluate the contribution of dissolved CO₂ from both a hill slope and riparian ecosystem to the stream environment. This work was conducted within the Krycklan Catchment, an extremely well studied and parameterized small boreal watershed. Had this work been conducted elsewhere, there would have been concerns regarding on the ground knowledge of flow paths, and soil characteristics. However, the methods and assumptions used herein are well supported by past research in the same systems. The presentation of results is clear, and the finding that riparian corridors can be the dominant and controlling source of CO₂ to stream systems is important, and timely for efforts attempting to understand across larger system what total aquatic carbon fluxes may be.

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In that regard, the authors should spend a few more sentences within the discussion placing the findings in a broader context. There is mention that even the Krycklan system is not representative of boreal ecosystems (pg 15603, lines 10-15). This should be expanded upon both in the context of boreal systems, but also in terms of the diversity in headwater systems that exist. A 4m riparian zone on each side is relative large for many headwater systems, and it is conceivable that hill slope soil CO₂ will contribute consistently more as the riparian area decreases. This cannot be tested here, but discussed. Also, I point the authors to a recent article that supports these finding even in larger tropical rivers [Abril et al., 2014].

Another interesting finding from this work is the observation that the largest exports are both a function of season, and discharge – which are not necessarily linked here. The notion that you can have a large spring pulse from snowmelt moving high volumes of water through relatively low CO₂ environments, contrasts with the episodic nature of infrequent storm events moving overall smaller volumes of water through very high CO₂ environments. This should be highlighted more, with a discussion regarding how the community should better constrain annual estimates of carbon evasion and lateral export across scales. A few sentences to this effect could broaden the work beyond the Krycklan system.

A more minor comment is in regard to the description of the hydrologic modeling component of the work. More detail within the description on page 15595 would help resolve some confusion as to how the water was modeled, and how hill slope and riparian portion of the total stream input are separated. Presumably the hill slope is added to the riparian water profiles? In addition, some description regarding how periods when sensors were not submerged were handled within the modeling would be helpful. Finally, it is mentioned that the export of soil CO₂ and hence the evasion proportion of the total aquatic carbon flux, was not estimated during storm events however the findings from this work suggest that these could be hotmoments for carbon removal (15605 – lines 15-20). I would like to see the authors comment briefly on this. As

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written, they suggests that the stream was under-saturated or that the residence time of water through both soil environments could not be distinguished from overland flow (not included in the model chosen) thereby not allowing an evasion estimate. Minor comments: very few

15588 – 23, check this value of 205,000 Tg-C yr. That would be HUGE!!

15588 – 15589 – why would these fluxes be underestimated? They could be completely overestimated!

15593 – can you explain / cite what a dipwell is?

15595 – 25-26 differences in soil moisture content at 60cm depths are really not significantly different – SD on some of these numbers would be appreciated.

15601 – please explain in more detail what transmissivity feedback is.

15606 – The conclusion points 1&2 are actually not things measured by the work presented. It is understood that these are inferred by changes in concentration and water level. No exchange with the atmosphere was actually quantified. Arrange the conclusion to better match the paper.

References: Abril, G., et al. (2014), Amazon River carbon dioxide outgassing fuelled by wetlands, *Nature.*, 505(7483), 395-398.

Interactive comment on Biogeosciences Discuss., 11, 15585, 2014.