Biogeosciences Discuss., 7, C2731–C2735, 2010
www.biogeosciences-discuss.net/7/C2731/2010/

Biogeosciences Discussions

Interactive comment on "Long cold winters give higher stream water dissolved organic carbon (DOC) concentrations during snowmelt" *by* A. Ågren et al.

A. Ågren et al.

anneli.agren@seksko.slu.se

Received and published: 6 September 2010

We want to thank the anonymous referee for the comments which we believe have greatly improved our manuscript. We have now changed the scope of the manuscript, and performed additional analysis. The new analysis strengthens the previous results and also highlights the ecological significance of our study. Detailed answers to Referee comments are found below.

Anonymous Referee #3 Received and published: 17 August 2010 The manuscript by Ågren et al. describes an analysis of long-term data on DOC concentrations in a small forested catchment in northern Sweden. By controlling for the effects of discharge, the

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

authors were able to identify other mechanisms that affect the peak concentrations of stream water DOC during snowmelt. This is a nice effort to extend the information derived from the monitoring data and a manipulative soil-frost experiment. The weighted PLS result that long, cold winters generated higher stream water DOC is certainly plausible and provides insight into below ground biogeochemical processes.

Comment: I am less convinced of the importance of this work from the perspective of ecosystem dynamics. While peak DOC concentrations are increased by long, cold winters, what is the impact on DOC flux from the watershed? From the list of variables in Table 1 it appears that this information is available and it certainly would be useful to know if higher peak DOC concentrations also yield higher total flux of DOC.

Answer: We now explain the ecosystem relevance of this manuscript. To do so we have also performed additional PLS and MLR analyses on DOC export as well as on pH. In the result section we write:

"The PLS model showed that the DOC export was related both to the amount of the exported water and the concentrations during snowmelt. A complimentary MLR analysis showed that 79% of the variance was explained by the total amount of water draining during snowmelt (Q tot) and 15% of the variance in the DOC concentrations during maximum discharge (DOCF) (R2=0.94, p<0.000)."

In the discussion we write: "We found a large inter-annual variation in the spring flood DOC concentrations (Fig. 4) [Fig 1 here]. DOC exports from a catchment are important as a carbon source for the stream and downstream lake/sea heterotrophic community, and thus affect the carbon balance (Cole et al., 2007; Ågren et al., 2008; Nilsson et al., 2008). The organic carbon also controls much of the export of metals and organic pollutants (Bergknut et al., 2010). Here we found that even though most of the variance in the DOC exports during snowmelt was controlled by the amount of water draining, the DOC concentration during peak snowmelt (DOCF) still explained 15% of the inter-annual variability in DOC exports. The DOC concentrations have also been

BGD

7, C2731–C2735, 2010

found to be important for stream pH during snowmelt (Laudon et al., 2000). The annual minimum pH in this stream was also found to be significantly correlated to maximum DOC concentration (DOCM) (MLR: R2=0.30, p=0.04, not shown). During snowmelt the acid neutralizing capacity (ANC) is diluted with low base cation (BC) melt water and the increasing concentrations of organic acids (DOC) along with anthropogenically derived acids cause pH to drop, and a pH drop with 1-2 pH units are not unusual during snowmelt. This short but extreme period, with respect to pH, controls the distribution of acid sensitive aquatic species (Holmgren and Buffam, 2005; Fölster et al., 2007; Laudon and Buffam, 2008). For example, in the study stream, the survival of brown trout was strongly correlated to stream pH (Serrano et al. 2008). Stream DOC concentration during the snowmelt period is hence important for the stream ecology as a partial control for the DOC exports, but also directly affecting the conditions in the stream and survival of acid sensitive species. "

Comment: Additionally, the discussion on potential impacts of climate change focuses exclusively on winter climate. Given the topic of the research, this is an appropriate focus, but part of the DOC story for this watershed must also be the above and below ground terrestrial primary productivity that provides the C source for the DOC. Some assessment of future scenarios on this supply-side aspect of the DOC dynamics could make the discussion more compelling.

Answer: Yes it is true that primary productivity probably will be affected by a warmer wetter climate (Boisvenue and Running, 2006). However, now that we have included further analysis in our manuscript we have condensed the discussion on the impact of climate change on DOC concentrations, because the manuscript became much longer. We now focus more on the snowmelt and winter regulation of DOC. An increasing length of the vegetation period will affect DOC concentrations, but this was not the scope of this manuscript and we don't have any data to support this.

References

BGD

7, C2731–C2735, 2010

Ågren, A., Berggren, M., Laudon, H., and Jansson, M.: Terrestrial export of highly bioalvailable carbon from small boreal catchments in spring floods. Freshwater Biol., 53, 964-972, 2008.

Bergknut, M., Meijer, S., Halsall, C., Ågren, A., Laudon, H., Köhler, S., Jones, K. C., Tysklind, M., and Wiberg, K.: Modelling the fate of hydrophobic organic contaminants in a boreal forest catchment: A cross disciplinary approach to assessing diffuse pollution to surface waters, Environ. Pollut., 158, 2964-2969, 2010.

Boisvenue, C., and Running, S. W.: Impacts of climate change on natural forest productivity – evidence since the middle of the 20th century, Glob Change Biol 12, 751-920, 2006.

Cole, J. J., Prairie, Y. T., Caraco, N. F., McDowell, W. H., Tranvik, L. J., Striegl, R. G., Duarte, C. M., Kortelainen, P., Downing, J. A., Middelburg, J. J., and Melack, J.: Plumbing the global carbon cycle: Integrating inland waters into the terrestrial carbon budget, Ecosystems, 10, 171-184, 2007.

Fölster, J., Andrén, C., Bishop, K., Buffam, I., Cory, N., Goedkoop, W., Holmgren, K., Johnson, R., Laudon, H., and Wilander, A.: A novel environmental quality criterion for acidification in Swedish lakes âĂŤ an application of studies on the relationship between biota and water chemistry, Water Air Soil Poll., 7, 331–338, 2007.

Holmgren, K., and Buffam, I.: Critical values of different acidity indices âĂŤ as shown by fish communities in Swedish lakes, Verh. Internat. Verein. Limnol., 29, 654–660, 2005.

Laudon, H., and Buffam, I.: Impact of changing DOC concentrations on the potential distribution of acid sensitive biota in a boreal stream network. Hydrol. Earth Syst. Sci., 12, 425-435, 2008.

Laudon, H., Westling, O., and Bishop K.: Cause of pH decline in stream water during spring melt runoff in northern Sweden. Can. J. Fish. Aquat. Sci., 57, 1888–1900,

2000.

Nilsson, M., Sagerfors, J., Buffam, I., Laudon, H., Eriksson, T., Grelle, A., Klemedtsson, L., Weslien, P., and Linderoth, A.: Complete carbon budgets for two years of a boreal oligotrophic minerogenic mire., Global Change Biol., 14, 1-16, 2008.

Serrano, I., Buffam, I., Palm, D., Brännäs, E., and Laudon, H.: Thresholds for survival of brown trout (Salmo trutta) embryos and juveniles during the spring flood acid pulse in DOC-rich stream,. T. Am. Fish. Soc., 137, 1363-1377, 2008.

Interactive comment on Biogeosciences Discuss., 7, 4857, 2010.