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Discussions

Interactive comment on "High resolution record of carbon accumulation rates during boreal peatland initiation" *by* I. Florin Pendea and G. L. Chmura

Anonymous Referee #1

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General comments

This paper is interesting because of the discussion of peat carbon accumulation rates in a largely unexplored boreal region (northeastern Canada) and the proposed extrapolation of observed tendencies to a global scale to partly explain rapid carbon sequestration during the early Holocene. Nevertheless, the authors have ignored one of the major complications encountered when reconstructing and comparing carbon accumulation rates, which is the quantification of aerated layer (acrotelm) decay rates. The authors have calculated "apparent" rates of carbon accumulation as is common on decadal to millennial-scale peatland carbon sequestration. The authors state then that the reconstructed carbon accumulation rates are very high over a recent accumulation of minerotrophic peat of 25 cm covering the past five years. However, they did

not consider decomposition processes in the acrotelm and therefore the reconstructed accumulation rates cannot be compared to rates from even slightly longer time intervals. Clymo (Suo, 1992) found that 80-90% of the litter mass that is deposited on the acrotelm is lost when entering the catotelm, which implies that apparent carbon accumulation rates are reduced to $\sim$10-20% of that of the uppermost sample once it becomes engulfed by the catotelm. Moreover, as minerotrophic peatlands typically have both high production and high decomposition rates, acrotelm decomposition may even be higher than 90% in such ecosystems. In comparison, Turunen et al. (2004) measured carbon accumulation rates from top sections in southern bogs in Quebec and found rates varying from 40-117 g m-2 yr-1 over 150 years of accumulation with important decreases down into the catotelm, stating "that the age of the peat column is an important predictor of C accumulation rate". This indicates that the accumulation rates quantified by Pendea and Chmura may not be quite so exceptional, unless they can provide evidence that decomposition rates of even the uppermost part of the sequence are negligible. This is a major concern, as the main point of this paper is based on the supposedly exceptionally high carbon sequestration rates.

Linked to these comments, it could be useful to have some information on present-day approximate water table positions and fluctuations, and local vegetation. The depth of the acrotelm is a good indication of the lower limit of rapid (aerobic) decomposition and thus rates calculated for peat in the catotelm should be more appropriate for comparisons with other regions and peatland types.

Another main point is the use of the model to infer chronologies from 210Pb activity. The authors used the CRS model, yet this model assumes that the 210Pb flux has remained stable through time. The CIC model may be more appropriate for ecosystems that are subjected to mineral input from sources other than the atmosphere, as fens and marshes (see Ali et al., 2008, who found the CIC model more appropriate in James Bay fens). Although results may be similar using the two models, I would like to see more arguments for the use of the CRS model here to guarantee the quality of the

chronology as rates of accumulation are very sensitive to even slight changes in age-depth models.

Specific comments

Line 11: although the two sections of the phrase are individually correct, the link is not evident at all. Please add some information that makes clear that there is a potential for an important feedback on climate (as peatland carbon cycling is sensitive to environmental change).

Line 24: “the atmospheric CO2 flux”. “Decreasing atmospheric CO2 concentrations” would be more accurate in my opinion.

Line 174: where did you find the 32% carbon content of organic matter in fens? Several studies indicate mean C content in organic matter, especially in herbaceous peats, of well over 50% (Beilman et al., 2009; Borren et al., 2004; synthesis by Turunen et al., 2002), which would mean that the peat accumulation rates from Ali et al. were at least 25-190 g m-2 yr-1.

Lines 179-184: I agree that carbon accumulation rates may be higher in young fens, but this cannot be shown with apparent carbon accumulation rates as evidence. Besides, the nutrient status can indeed accelerate rates of peat production as stated on line 183, yet high amounts of nutrients are also likely to positively influence decay rates and therefore this phrase is purely speculative.

Lines 187-191: For comparisons with atmospheric CO2, apparent rates of carbon sequestration cannot be used, as decay is a continuous process. Unless the authors can assure that long-term decay is negligible, the statement made on lines 189-190 is hazardous: rapid (but relatively short-term) acrotelm decomposition and very slow (but long-term) catotelm decomposition hamper comparisons between actual and past accumulation rates.

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