Application of Clymo Model

What we wish to emphasize is that the site we studied is a rare (we suspect the first) record of the initiation of a fen from a tidal system that can be examined at the temporal resolution of a decadal scale. Thus, our focus was not on the future of this deposit and its decomposition, but on what levels of atmospheric carbon dioxide were being fixed during the period that extended from tidal marsh to early fen. Annual records of carbon dioxide in ice cores will reflect the sequestration of C by these transitional systems along with the net carbon dioxide exchange from existing systems on the early landscapes.

As **noted by both Reviewers 1 and 2**, to appropriately address carbon dynamics of "peatlands" one must consider both sites of active carbon sequestration, the acrotelm (a 10-50 cm thick layer where carbon fixed during photosynthesis is first stored, but where decomposition rates are high), *and* the lower layers where decomposition of accumulated organic matter is slower, the catotelm. Although the concept of acrotelm and catotelm as applied by Clymo (1984) is relevant to bogs and nutrient poor fens (the wetlands commonly referred to as "peatlands"), we cannot directly apply this same dynamic to tidal wetlands, due to the difference in hydrological regime dominated by tidal fluctuations and predominance of vascular vegetation.

There are significant differences not just in plant species between "peatlands" and tidal wetlands, but in plant morphology and physiology. The carbon in the "peatland" substrate is fixed primarily by mosses (*Sphagnum* sp. and brown mosses). Clymo (1984, page 608) notes that in peatlands "Plant mass is added to the surface. When plants die they begin to decay, mainly in aerobic conditions. In contrast, the primary source of carbon in tidal wetland substrates (soils) is from vascular plants (e.g., grasses and sedges) which fix atmospheric carbon dioxide and translocate much of the fixed carbon to their roots and rhizomes. [Most of the vascular plants found in wetlands have aerenchymous tissue that serves as a conduit transporting oxygen to their rhizomes (e.g., Burdick 1989; Colmer and Flowers 2008) which enable this plant tissue to survive even within flooded soils.] This living belowground biomass can penetrate as far as 40 cm into the soil (e.g., Connor and Chmura 2000), so that carbon accumulation occurs throughout this zone. In tidal wetlands there is more live biomass in the soil than above it, with ratios of live belowground (roots and rhizomes) biomass to aboveground biomass as high as 11 (e.g., Connor and Chmura 2000, Darby and Turner 2008, Chmura 2009).

Newly sequestered carbon in tidal wetlands is less prone to decomposition as compared to "peatlands." In "peatlands" new carbon generally is introduced directly to oxidized soil layers. Despite the oxidized rhizospheres, the soil surrounding the living biomass generally has a redox potential that falls below the threshold at which anaerobic respiration, which is less efficient than aerobic respiration, predominates. In tidal wetlands carbon is directly introduced to the anaerobic soils further decreasing rates of decomposition. The soil chemistry of tidal wetlands also contributes to slower decomposition rates. The salinity of the soil presents an osmotic stress to microbes responsible for decomposition. Thus, decomposition rates are lower in saline soils (e.g., Setia et al. 2011).

In "peatlands" the water table is dominated by seasonal fluctuations, whereas in tidal wetlands the water table fluctuates daily, rising and falling with the tides (Nuttle and Hemond 1988). At the site where our core was collected water table was approximately 3 cm below the surface during a period of low tide in August. We must assume that the water table here responds in the same manner as other tidal marshes, increasing as the tide rises. ***Reviewer #1 suggested information be added regarding water table, and we will include these details. Reviewer #1 also suggested including details on vegetation - these actually were present in the original manuscript***.

The record we present is one of a wetland in the first stage of transition from tidal marsh to fen. The fen is an incipient one, which started barely 10 years before our collection, and with a water table still affected by tides. The system is too young to have developed an acrotelm and catotelm. Eventually, it will be appropriate to apply the Clymo model, and what is the really intriguing question - is when?

Responses to other comments of Reviewer #1

Sediment Dating

Reviewer 1's statement that "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." is contrary to the broad scale findings that the CRS model has consistently been the most reliable dating model for lake sediments - systems which commonly receive sediments from runoff of watersheds. Sediment does not come from the atmosphere, but the lead-210 does. Our radionuclide measurements and dating model were supplied by Appleby who notes that the choice of model should be based on an assessment of the radionuclide (lead-210 and cesium-137) records rather than any a priori assumption.

The dating model used in our study was chosen following an assessment of the lead-210 and cesium-137 records determined for this core. Use of the CF:CS (constant flux: constant sedimentation rate) model was precluded by the presence of several significant deviations from a simple exponential decline in unsupported lead-210 concentrations. Use of the CIC (constant initial concentration) model was precluded by the presence of two significant non-monotonic features (one at the top of the core between 0-5 cm and the other much deeper between 18-25 cm). Mixing as a cause of the surficial non-monotonic feature was precluded by the presence of a well-resolved cesium-137 peak. Calculations using the CRS model alone placed 1963 at a depth of 16.5 cm, in relatively good agreement with the depth of 13.5 cm suggested by the cesium-137 record. The discrepancy is most probably due to changes in the lead-210 supply rate associated with the transition from highly compacted clay sediments below 16 cm to low density peaty deposits above. Corrections to the CRS model were however made using the well-defined 1963 cesium-137 date as a reference point (Appleby 2001).

line 11

Actually, our intention was to encompass all change including autotrophic ones, and we fell to revise that statement as suggested would misrepresent our meaning.

line 24

Yes, decreased atmospheric concentrations would be more accurate and we will incorporate this revision.

line 174

The statement of 32% carbon content was an error. However, as we reviewed our manuscript we realized that, considering the nature of our work, it was inappropriate to make any assumption regarding carbon content of the La Grande Riviere fen peat. To do so would employ circular reasoning. Thus, we intend to delete the text which makes comparisons of carbon accumulation rates at La Grande Riviere and our site.

line 187-191

We assume that decay over the short life-span of this wetland has been negligible. It may not be in the future, and the eventual transformation of the emergent tidal marshes to fen and bog would then contribute to the increase of carbon dioxide concentrations in the atmosphere. However, we are concerned with the effect this element of the landscape has on the contemporaneous atmospheric concentration of carbon dioxide.

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