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Biogeosciences Discussions

Interactive comment on "Wetland succession in a permafrost collapse: interactions between fire and thermokarst" *by* I. H. Myers-Smith et al.

I. H. Myers-Smith et al.

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Interactive comment on Wetland succession in a permafrost collapse: interactions between fire and thermokarst; by I. H. Myers-Smith et al.

Anonymous Referee #1

Received and published: 8 January 2008

Detailed responses to Anonymous Referee #1:

How does it follow from the observations that carbon storage will increase in the collapse (scars)?

Carbon storage will increase in the collapse scars due to the change in community from a black spruce forest to a sphagnum peatland. We measured greater carbon ac-

cumulation in the peatland, greater organic soil depths, and higher total carbon stores. This leads us to predict that carbon storage will increase across the landscape as a whole with expansion of the permafrost collapse.

Is the adjacent Picea forest a peat plateau?

The adjacent forest may be called a peat plateau but in US Classifications, there is not enough organic mat overlying mineral soil to be classified as peat; on average, the peaty topsoil is less than 50 cm.

Is this site is poor fen?

I agree that poor fen may be an appropriate classification for the site. The authors of this manuscript are in some disagreement about the classification. There are no connections of water subsurface, but based on the collapse it is true that water enters the wetland from surrounding landscapes, although our paper demonstrates this occurs episodically.

How much peat there is in the P. mariana forest?; Could be used to estimate how much was lost in the fire.

As is stated in the site description of the organic matter thickness was highly variable (2-40cm) in the burn. The burn scar area was large enough, ˜40 sq km, that we could not find a comparable unburned black spruce forest. We have recently estimated that the carbon lost during the fire is approximately 0.28 gC cm-2.

Harden,J.W., Fuller, C.C., Wilmking, M., Myers-Smith, I.H., Trumbore, S.E., and Bubier, J. 2008. The fate of terrestrial carbon following permafrost degradation: detecting changes over recent decades. In: NinthInternational Conference on Permafrost, D.L. Kane and K.M. Hinkel (Eds.), University of Alaska Fairbanks, Institute of Northern Engineering. (in press)

Do 210Pb and 137Cs agree? Do you assume the bulk 14C ages too old? If so, why? Do you consider Pb210 ages reliable? - There are problems using them for peat dating.

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Interactive Comment

We provide the 14C date for a piece of charcoal in the sylvic peat at the base of the core in figures 3 and 5 and the average of the three age models for the more modern part of the core. The 137Cs ages are somewhat older compared to 210Pb ages, for example 137Cs peak at 32-34 cm represents 1964; while the 210Pb models date this horizon as 1977; however, we believe that this is this sufficient agreement given the overall range of time.

The overall agreement among age dating tools (to within +/- years) indicates that the dating is at a minimum internally y consistent, despite inherent uncertainties. We assume that the bulk 14C ages might be younger than the actual soil layers owing to root and dissolved organic carbon inputs from younger layers above. We have the highest confidence in the charcoal date from 56 cm depth in the core. This is why we include this date in figures 3 and 5. Note that the 210Pb and 137Cs derived ages for the modern part of the core do not align well with the 14C date for the sylvic soils; however, there is a gap where soils were older than the 210Pb and 137Cs models, yet too young for radiocarbon dating. Because of this gap we do not report a combined age model for the entire core.

These accumulation values are uniquely high.

Thank you for noticing ! We believe that carbon accumulation rates are high in this peatland although uncertainties are also high. These carbon accumulation rates are similar to those reported for permafrost inception (Oksanen et al. 2001).

You are not sure the substrates are younger. Could you not have dated this core too? Is the moat same thing as post 2001 collapse? But it was a collapse scar even earlier?

The moat core was collected from 12 m along the transect, which was not the margin of the collapse (16 m) but at the edge of the Sphagnum mat, which we consider to be the margin of the moat.

We dated the core with 3 radiometric techniques, Cs, Pd, and C radioisotopes, an

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approach that was recommended by a thorough review of dating peats (Turetsky et al, cited). Although more radiocarbon data on more layers and more components (macrofossil) of the core might provide a more clear stratigraphy, it is clear that age dating of these cores is complex for a number of physical and chemical reasons and indeed may have remained imperfect. It is therefore, correct that we do not know that the substrates are younger, yet it is our interpretation at this time.

Have you considered the possibility of missing layers here?

We think missing layers are not the most likely explanation for the different in the stratigraphies between the cores from the centre and edge of the peatland. We know that the sedge and Sphagnum peat layers were consistently thinner at the edge of collapse from the descriptions of the other 32 cores harvested from the site (Myers-Smith et al. 2007) that are not reported in this study.

Why at 46 cm a local fire; what is the difference to the two other charcoal layers?

There is no measurable difference between the charcoal layer at 46cm and the two other charcoal layers apart from the age and type of substrate in which they occur; however, the dating indicates that this charcoal layer at 46 cm was deposited at around the same time as when the trees were established in the forest surrounding the peatland. I think the tentative phrasing indicate that we can not say for certain whether this was a localized fire.

line 21. Why fire leads to lateral expansion? Due to decreased evapotranspiration? How do you know the collapse scar was not expanding already prior to the fire?

We can estimate the amount of permafrost degradation prior to the fire by looking for compression wood in the trees surrounding the collapse (see Tree Rings section). We found more compression wood during certain periods in the last century, but ground thaw does not seem to have accelerated prior to the fire. After the fire the trees are dead; however, we were able to observe first had the expansion of the moat region

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surrounding the collapse. The fire darkened the surface of the forest adjacent to the peatland, reduced evapotransiration by killing the trees, and burned away insulating organic soils. All these factors may have resulted in enhanced permafrost degradation after the fire.

You do not discuss possible initial lose of peat in the collapse stage.

I am not sure what sort of peat loss to expect in the collapse stage. While a possibility, there are not data to support this. Our C flux data (Myers-Smith et al, 2007) suggest that methane emissions are slightly greater in the moat but that C accumulates over the growing season (in not only the moat, but the other systems as well). The terrestrial forest soils would become waterlogged and may decompose at slower rates, resulting in less carbon loss than in the surrounding terrestrial soils. Moreover, the collapse would be likely be isolated from lateral water flow as it is in the modern day, and so significant losses through erosion or dissolved organic carbon would not be expected.

line 8. Very high accumulation rates are reported from incipient permafrost conditions in northern Europe: 40-100 gC/m2/yr (Malmer & Wallen 1996, Oksanen et al. 2001, 2003, Oksanen 2005, 2006). Compared to common rates from mature peat plateaus (2-8 gC/m2/yr) these are extremely high. Your figures are even higher. Are you quite sure the 210Pb-137Cs model is not too young? There seems to be a gap in accumulation or missing layers if the 14C date from the sylvic peat layer is correct.

The charcoal date is correct within a 200 year margin; bulk peat ages for 4 other samples from the sylvic peat range from 165 to 500 yrs BP, the youngest age being consistent with the Cs-Pb model; however, the charcoal date does not indicate the age of the sylvic peat at the time of the collapse, rather, The sylvic soils would have been experiencing some cryoturbation, organic matter loss through fire and mixing from root growth. This could represent an older part of the soil. There could be much lower accumulation rates in the older sedge peat which would be consistent with the higher bulk density and lower C:N at 32 cm and below. It is difficult to know when the collapse

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was initiated or what carbon accumulation rates might have been.

Is the 1418 age calibrated C14 date; the calibration method is not mentioned in the methods.

The 1418 age is the 585 ybp sample TFBC 26.56, a piece of charcoal from the sylvic peat.

Calibration of radiocarbon ages to tree ring and marine samples (see http://www.calpal-online.de/) were in agreement within the error terms reported for radiocarbon ages.

Interactive comment on Biogeosciences Discuss., 4, 4507, 2007.