

Interactive comment on “Annual carbon gas budget for a subarctic peatland, northern Sweden” by K. Bäckstrand et al.

P. Wookey (Referee)

pw9@stir.ac.uk

Received and published: 15 September 2009

This paper represents a bold attempt to provide a carbon gas budget for Stordalen mire in northern Sweden and to relate this to permafrost dynamics and vegetation change between 1970 and 2002/07. It is important and novel in three key respects: (1) it explicitly considers gas fluxes throughout the ‘snow season’, (2) it includes CO₂, CH₄ and NMVOCs, in order to calculate global warming potential, and (3) it addresses the decadal dynamics mentioned above.

Issues of gap-filling are handled openly and robustly, and the data are presented and interpreted sensibly. There is possibly scope to reduce the length of the paper somewhat, but this is not a serious issue. Furthermore, the summary conclusions could probably be presented more clearly, possibly as a simple bar chart showing annual C2008

flux data for CO₂, CH₄ and NMVOC components separately, and then as the sum in warming potential, for each dominant vegetation community, as well as for the mire as a whole in 1970 and ca. 2000, reflecting the changes in permafrost and vegetation. This would help to distil much of the text in the Discussion, and to provide a very clear impression of what is happening now, and how this differs from 1970.

I have tried to make some suggestions for edits/corrections in the list below. The more important science aspects that I think merit further consideration are as follows:

On page 5709 the authors note that they ‘have measured the C gas exchange at three localities that reflect the range of plant species distributions typical for three levels of moisture, nutrient and permafrost status found at the mire’. I have no criticism of this, especially bearing in mind that automatic chambers were used to measure gas fluxes between 2002–2007. What I think would be useful to know more about, however, is whether these three localities genuinely do span the full spectrum of conditions on the mire. On page 5716 it is stated that the aerial extent of the mire is 16.5 ha in total, comprising 8.3, 6.2 and 2 ha, respectively, of the *palsa*, *Sphagnum* and *Eriophorum* communities. So the whole area has therefore been categorised as one or other of these three plant community/landscape types. Is this genuinely valid? I know that the chambers could not be easily deployed in *palsa*/thermokarst ponds, for example, but some comments on this would be welcome. There must surely also be transition communities between the three sampled here, and it would be useful to have some more information on this. Indeed it is noted on page 5721 (line 16) that the ‘wettest fen’ parts of the mire might have contributed ebullition CH₄ fluxes not easily sampled by the chambers. This implies a heterogeneity greater than that encompassed by the three community/landscape types sampled post-2000.

For CH₄ flux measurements there are eddy covariance data to complement the chamber sampling: This gives extra weight to the results for CH₄ from the chamber measurements. Are similar measurements across the mire available for CO₂? If this is the case then it would be really valuable to discuss this.

As a point of clarity, there are times in the text where the sign of the flux (specifically negative fluxes; indicating net ecosystem uptake) and the phrasing of the sentence describing it, become slightly confusing. For example on page 5714, lines 19-21, the authors write 'The palsa site had an average uptake of CO₂ that corresponds to -184 mg C m⁻² d⁻¹'. To me the use of uptake and the minus sign simultaneously is a little unsatisfactory; a negative uptake suggests emission. Perhaps where the direction of the flux is stated explicitly then the sign becomes unnecessary. Is this maybe something for the editor and authors to consider together?

Finally, the list below gives suggestions for more minor edits that I hope will improve the clarity and the flow of the narrative:

- Page 5706, line 3: correct to 'stable', and delete 'that';
- Page 5706, line 3: amend 'shift' to 'shifting';
- Page 5706, line 15: correct 'were' to 'was';
- Page 5706, line 21: briefly define GWP100;
- Page 5706, lines 22-23: amend 'Conclusively' to 'in conclusion';
- Page 5707, line 5: amend '...which is at least the double of the...' to '...which is at least double the...';
- Page 5707, line 13: correct to 'stable';
- Page 5708, line 1: delete 'the';
- Page 5708, line 5: delete 'balance';
- Page 5708, line 14: correct 'are' to 'is';
- Page 5708, line 23: correct to 'the green season';
- Page 5708, line 24: correct 'has' to 'have';
- Page 5709, line 12: correct 'were' to 'was';
- Page 5709, line 21: insert a comma to give '...green season C exchange, and CO₂ data...';
- Page 5709, line 26: I suggest amending 'conducted' to 'achieved';
- Page 5709, lines 27-29: This sentence is clumsy. I suggest modifying to 'It is important to take into consideration changes in permafrost distribution, and the associated

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spatial shifts in plant communities, when estimating how the C balance of the mire has changed over the decades, and how it may change in the future';

- Page 5710, line 3: delete 'The' at the beginning of the opening sentence;
- Page 5712, line 15: correct to 'represents';
- Page 5713, line 17: 'through out' should be one word, 'throughout';
- Page 5714, line 5: correct 'are' to 'is';
- Page 5714, line 6: correct 'number' to 'numbers';
- Page 5714, line 13: correct 'flux' to 'fluxes';
- Page 5714, line 19: amend 'loss' to 'removal';
- Page 5715, line 8: shouldn't it be '134 d lasting between day 118 and 234' (not 134)?
- Page 5715, lines 12, 15, 16, 19, 20, 23 (and elsewhere): reference is made routinely to gas fluxes in the following general way: '...the palsa site was a source of CO₂ by 30 g C m⁻² and also a small source of THC by 0.52 g C m⁻²'. It would be preferable if the use of 'by' were avoided in this context (this is a common mistake in translation from Swedish to English), and 'of' used in place. So it would be tidier if it read '...the palsa site was a CO₂ source of 30 g C m⁻² and also a small THC source of 0.52 g C m⁻²'. I hope this makes sense.
- Page 5716, line 1: correct to 'contributes';
- Page 5716, line 9: correct to 'results';
- Page 5716, line 26: correct 'as' to 'on';
- Page 5716, line 28: amend to '...whole mire is a CO₂ sink of -425...' (see comments on previous page);
- Page 5717 lines 1-9: again, see comments on the use of 'by' inappropriately;
- Page 5717, line 9: amend to '...by the year 2000';
- Page 5717, line 19: amend to '...green seasons was found to relate to...';
- Page 5718, line 10: replace 'as well' with 'also';
- Page 5719, line 24: hyphenate 'gap-fill';
- Page 5719, line 25: correct to 'collections';
- Page 5720, line 2: correct to 'include';

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- Page 5720, line 11: amend to '...an uptake of -139 g C m^{-2} , all are characterized...';
- Page 5720, line 23: amend to '...productivity between sites cannot, however, be explained in any simple way...';
- Page 5720, line 25: please clarify the meaning of 'Other sites are positioned as north...';
- Page 5721, line 7: correct 'form' to 'from';
- Page 5721, line 20: correct to 'captures';
- Page 5721, line 24: replace 'on' by 'for';
- Page 5722, line 11: amend 'preciseness' to 'precision';
- Page 5722, line 17: correct to 'represents';
- Page 5723, line 10: replace 'for' by 'of';
- Page 5723, line 17: correct to '...CO₂ equivalents have a higher impact...';
- Page 5723, line 18: amend to '...compared to on an annual basis.';
- Page 5723, line 24: correct the first 'have' to 'has';
- Page 5721, line 25: delete 'of';
- Page 5724, line 26/27: amend to '...have been shown...';
- Page 5725, line 10: correct to '...specific peatlands' net C balances...';
- Page 5725, line 18: correct 'are' to 'is';
- Page 5725, line 18: amend to '...that the reduced flux of C compounds...';
- Page 5725, line 21: amend to 'has';
- Page 5732, Table 2 legend. Correct 'greens season' to 'green season';
- Page 5737: Fig. 1. The way the inset is drawn into the main map of Norden gives the impression that the study area is much bigger than it really was. I suggest that the lines connecting the detailed inset converge to a point on the Norden map;
- Page 5728, Fig. 2: The label 'Precipitation' should read 'Green season precipitation'. *Sphagnum* and *Eriophorum* should be *italicized* in the legend, and 'axes' should be corrected to 'axis'.

Interactive comment on Biogeosciences Discuss., 6, 5705, 2009.