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Interactive comment on "Carbon accumulation in a drained boreal bog was decreased but not stopped by seasonal drought" *by* Kari Minkkinen et al.

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The referee is right in pointing out the importance of gap filling and emphasizing the scarcity of measured data in summer 2006. However, we can show that this does not have that dramatic effect neither on the uncertainty of the annual balances nor the conclusion that the site remains as a CO2 sink also over the dry year. As an answer to the criticism related to the long data gaps in 2006 and the resulting implications, we present the following points:

1. The title will be changed. We acknowledge that the original title "Carbon accumulation in a drained boreal bog was decreased but not stopped by seasonal drought",

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which emphasized the dry year (2006) and its C balances, was a bit misleading and we will change it. The actual main messages of the paper are: i) we present the full C balance of the ecosystem and its components, employing several methods and models; ii) the forest ecosystem acted as a quite steady CO2 sink even though it is a drained peatland, and the sink persisted even during a year with an exceptionally dry spring/summer and exceptionally high precipitation in autumn; iii) the drought decreased not only GPP but also respiration. By reformulating the title to 'Persistent carbon sink at a boreal drained bog forest' we want to emphasize that our aim was to study the processes that explain this sink capacity during several years, rather than focusing on a single, dry year.

2. We have plenty of good data from the driest month, i.e. August 2006. Concerning referee's comment on the missing data during the growing season of 2006 ('the only year where there are no eddy covariance measurements during the growing season was the year of the significant drought – 2006'), we would like to point out that the situation was not that bad. There were long data gaps in June and July in 2006, as we have clearly admitted in many places in the text. However, there were still valid NEE observations in both June and July (225 and 74, respectively). In August and September, when the deepest water table levels took place (Fig. 2), the problems with electricity were overcome and there is a plenty of high-quality EC data available, the monthly data coverage being 50 and 66% in August and September, respectively. Even though the coverage was significantly lower in June and July, the NEE model was still able to produce estimates of Rs0, GPmax and alfa for each month (Fig. 5 in the MS, which was redrawn to include also June and July, see Fig. R1 below). This will replace Fig. 5 in the original MS. To save space the response curves were deleted, and for this reason the related text on p. 7 (lines 19-21) was changed.

3. The actual gap-filling model was dynamic and therefore tuned for drought conditions. The gap-filling algorithm (explained thoroughly in Appendix A) is based on fitting A2 and A3 to the measurement data using a data window of a varying length, to produce daily

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parameter values. In places with a long gap in the data, parameter values are linearly interpolated. Although the monthly parameters shown in Fig. R1 are not exactly those used in the gap-filling model, they reflect the dynamic and data-derived nature of the model. This means that gap-filling was always adjusted to measured data and the parameters reflected the current conditions as far as possible. As can be seen from Fig. R1, the GPmax parameter was significantly reduced in July, August and September in 2006, most likely because of the drought. Thus the response to water availability does not 'come through the VPD function', as the referee suggests. Similarly, the respiration parameter Rs0, obtained by fitting the temperature-response model to the data, showed reduced values in August (even though the difference to other years was not statistically significant). Thus we can conclude that, because all the fits were done dynamically to measured data, the drought is evidently reflected in the parameter values. However, the long gaps introduce an additional error to the gap-filled fluxes, which is addressed below.

4. Although the uncertainty in the gap-filled NEE of summer 2006 is high, we can ensure that the annual NEE was negative. We admit that, due to the long gaps in the NEE data, the uncertainty in the CO2 balance of June-July 2006 is high and have already highlighted this in several places in the original manuscript (p. 7, lines 17-19; p. 10, line 3; p. 33, lines 27-31). Because our gap-filling model fills the long gaps by linear interpolation, the outcome depends on the somewhat 'random' selection of the start and end points of the interpolation. This has already been discussed and taken into account in the error estimate (Appendix B). However, as a further sensitivity test, we estimated the most conservative range for the NEE uncertainty. This was done by assuming different parameter scenarios during the longest gap in the parameters (13 June – 4 August, during which there were only 212 valid NEE observations available). In one scenario, a parameter had the starting point value during the whole gap, while in the other it dropped immediately to the level at the end point and stayed there over the whole gap. The annual NEE was calculated for each combination of different Rs0 and GPmax dynamics. Selecting the two most extreme cases (either both Rs0 and

GPmax were reduced for the whole gap, or both were increased) produced an annual NEE of –377 and –844 g CO_2 m^{-2} s^{-1}, respectively. These can be considered as the most conservative estimates of annual NEE, and thus we can safely conclude that the annual NEE was negative in 2006, i.e. the ecosystem acted as a CO_2 sink even during the exceptionally dry year. We will add this sensitivity analysis to the Appendix B "Uncertainty analysis of NEE".

5. The autumn respiration was exceptionally high in 2006. It is important to note that the higher annual NEE (lower uptake) in 2006 was not solely due to the reduced GPP and Reco during the summer but also was strongly influenced by the clearly higher respiration in autumn. The period of low precipitation continued in September, and the soil temperatures (particularly at 30 cm depth) were high in September and October. The high rainfall in October, combined with high soil temperatures and reduced respiration in the previous months resulted in very high respiration rates for the rest of the year (Fig. 4b). We have already pointed this out in the original manuscript on p.7, lines 16 and 26–28: 'The higher RECO in autumn months after the drought and heavy rains in October (Fig. 2) furthermore increased the difference to other years: the cumulative NEE in October-December in 2006 was 320 g CO_2 m^{-2}, while in other years it varied from 130 to 190 g CO_2 m^{-2}.' The main message here is that the lower NEE in 2006 cannot be attributed only to the summer when the amount of measured flux data was low, as clearly explained in the original manuscript.

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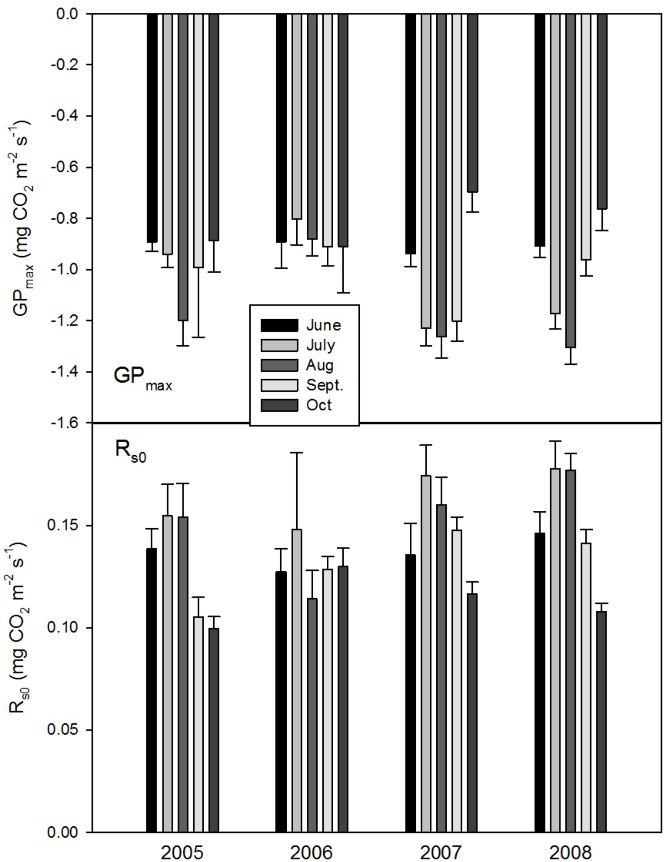

Fig. 1. Monthly parameters GPmax (top panel) and Rs0 (bottom panel) (±95% CI) from Eqs. A2 and A3 of Appendix A), derived from the measured NEE data for the June-October period in 2005-2008.

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