Response to comments by associate editor

We thank the associate editor for the insightful comments which are prefixed with "AE" and given in italics in what follows.

The authors' responses are prefixed with "AR" and highlighted in blue.

AE: Abstract: As written, it lacks a concluding statement describing the implications of the study, and does not link well to the stated hypotheses. Please condense some of the details in order to provide one or two sentences placing this study into a broader context.

AR: the abstract has been amended and does now contain a clear summary of the main findings. The results of the study have also been placed in a wider climate change context without being speculative.

AE: Introduction: Much of the writing could be explained more succinctly. For instance, remove extra wordiness:
P3, Lines 16-19, shorten to: In contrast to the variability exhibited by these sites, a sub-arctic permafrost mire in Northern Sweden was relatively stable over the period 2001-08 (-18 46 g C m-2 yr-1) (Christensen et al 2012).

AR: We acknowledge that the introduction was verbose in places and it has now been shrunk by ca. 20%.

AE: Please re-cast the hypotheses to make them more useful and insightful, and then re-structure the discussion to address the hypotheses. Final acceptance of the manuscript will be based partly on appropriately improved hypotheses and discussion.

1) Peatlands release more CO2 to the atmosphere under drier and warmer conditions.
AE: Drier and warmer than what? Is seasonality implied? Was this really tested? It is more of a prediction than hypothesis.
2) The length of the growing season has a significant impact on annual NEE.
AE: What sort of impact? At least give an expected direction
3) Plant productivity during the growing season is affected by the preceding winter's meteorological conditions and can exhibit significant inter-annual variability.
AE: affected in what way? What is considered to be "significant" inter-annual variability? Why is this important?
4) Autotrophic processes dominate heterotrophic processes at well-watered, vegetated sites.
AE: What is meant by "well-watered" and "vegetated"? Were non-vegetated sites investigated? The inter-site comparison does not distinguish these categories, nor does it distinguish autotrophic vs. heterotrophic processes.

AR: the hypotheses have been reduced, reformulated and refined as requested and are now:

- Colder than average winter temperatures affect the ecosystem's phenology and reduce summer GPP and NEE.
- Ecosystem respiration is related to water table depth and the peatland releases more CO_2 to the atmosphere during dry spells.
- Annual NEE is positively correlated with the length of the growing season.

AE: Methods section: You seem to be missing a section explaining the statistics involved in testing your hypotheses and describing the curve fits, etc. In particular, please justify the use of (weak) non-parametric statistics (Spearman rank correlations) compared to stronger parametric statistics (ANOVA).

AR: A new Section 2.4 describing the statistical tests used (Spearman's rank correlation and ANOVA) has been added to the methods section.

AE: P.5, line 31, do you have a citation for the drainage history?

AR: The following reference was duly added:

Leith F.I., Garnett M.H., Dinsmore K.J., Billett M.F**.**, Heal K.V.: Source and age of dissolved and gaseous carbon in a peatland-riparian-stream continuum: a dual isotope (^{14}C and δ^{13}C) analysis, Biogeochemistry, 119, 415–433, doi:10.1007/s10533-014-9977-y, 2014.

AE: Additional details regarding the modelling of the Reco and GPP data are required as outlined below. P.7, line 26-29, please provide the model fit statistics, and include a plot of predicted vs. observed (PvO) Reco as a supplementary figure.

AR: The paragraph "*Gapfilling of net ecosystem exchange (NEE) measured by eddy-covariance and partitioning of the gapfilled half-hourly fluxes into ecosystem respiration (R_{eco}) and gross primary production (GPP) were achieved using an online tool developed at the Max Planck Institute for Biogeochemistry, Jena, Germany[1] (Reichstein et al., 2005). In this flux partitioning approach, daytime R_{eco} is obtained by extrapolation of the night time parameterisation of NEE on air temperature (using an exponential relationship of the form given in equation (1)) and GPP is the difference between ecosystem respiration and NEE.*" was moved from section 2.2 to 2.3 in order to clarify that the gapfilling and flux partitioning is based on Eq. 1. Full description of the flux partitioning and gapfilling procedure is given in the reference cited in the manuscript (Reichstein et al., 2005). Quality flags are provided for each half-hourly data point used in the regression which makes it difficult to summarise

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[1] http://www.bgc-jena.mpg.de/~MDIwork/eddyproc/upload.php

the gapfilling statistics, especially for a long dataset such as the one presented. As a compromise, the new Fig. S2 of the Supplementary Material illustrates the performance of Eq. 1 applied to monthly values of R_{eco} and air temperature. Furthermore, a table summarising annual regression statistics and Q_{10} is now provided in the Supplementary Material.

AE: P.8, line 4, what were the reference temperatures you used? Provide the model fit statistics and PvO plot.

AR: the reference temperatures used have been specified in the text, in the sentence following the definition of Eq. 2. Please note that Q_{10} is calculated using Eq. 2 rather than modelled; hence there are no fit statistics to report. R^2 values relating to Eq. 1 are available in Table 1 of the supplementary material.

AE: P.8, line 5, please clarify that GPP was estimated as the difference between measured NEE and modelled Reco (derived from the Arrhenius function in Eq 1). Also again, provide the fit statistics and PvO plot.

AR: The paragraph pertaining to the gapfilling and flux partitioning procedure has been moved from section 2.2 to 2.3. In addition, a table summarising the light curve statistics and regression plots have been added to the supplementary material (Table 2 and Fig. 2). This clarifies the above point.

AE: Results: The paragraph starting on P.10, L11 and going to P.11, L18 is much too long and should be broken down into at least three separate paragraphs. Further, the details of the parabolic relationships between WTD and Reco are not compelling, and should be shortened. I agree with the referee 2 (comment 14) that the sign of the WT level would be easier to understand if reversed, but will leave it up to the authors to decide which direction to take.

AR: We agree that this paragraph was disproportionally large compared with the rest of the results section. As requested, it has been shortened accordingly and broken down into 3 paragraphs to improve readability. The sign of water table depth has been changed throughout the manuscript. Negative values denote water table levels below the surface in the revised version of the manuscript.

AE: Discussion: This section could be improved by starting it with a short paragraph summarizing the main findings of the study with reference to the hypotheses (after revising them). This paragraph can serve as an outline for discussing the most important results in the following sections. Overall, this section could be improved by organizing it around the hypotheses. Each paragraph should discuss

one main idea, starting out with a topic sentence. For instance, the first paragraph moves from PAR, LAI in soybeans to a warming experiment and then freeze-thaw cycles. It would be improved by focusing on the most relevant comparisons with the literature. The paragraph on P.12, L29 to P.13, L19 is an example of a paragraph that is well written, with a more focused message.

AR: The discussion has been reorganised in line with the associate editor's comments and is now organised around 3 sub-sections consistent with the revised hypotheses. These are:

- Effect of winter meteorology on ecosystem response
- Effect of water table level on GPP and Reco
- NEE in Northern Hemisphere Peatland C Budgets

AE: P. 13 L4, Please replace "feedback" with "effect," unless you can demonstrate a specific cause-effect relationship between photosynthesis and WTD that works in both directions. Likewise, on P.12, L.29, and throughout the manuscript. On P.17, L4, the idea of an internal feedback mechanism is unclear as well; rather, it seems like you are simply trying to say that the C balance of the different peatland ecosystems is similar when all flux pathways are considered.

AR: we recognise that the term feedback might have been over-used and have replaced it with "effect" as suggested.

AE: P.14, L3, what does species richness have to do with your hypotheses? The relevance of this paragraph is not clear, and it mainly reiterates results.

AR: the discussion section has been re-organised around the revised hypotheses. We agree with the above comment and have removed the specific paragraph as it brought little to the discussion of the results.

AE: P. 14, L.17-19: "The decrease of the sensitivity of Reco with respect to Tair (Q10) with deepening water table further supports the idea that the contribution of heterotrophic to total ecosystem respiration was enhanced under drier conditions." Please provide a justification and citations for this idea. Overall, the speculations about autotrophic and heterotrophic processes are poorly supported by the available data and should be removed or supported with additional data.

AR: we have strengthened our argument by providing several new references to recent publications.

AE: P.16, L29-31, make sure the sign for NEE (sink strength) is consistent.

AR: all signs have been checked for consistency and amended where needed.

AE: Summary: Please revise in light of your new hypotheses and discussion.

AR: We feel that the Summary is a clear and strong representation of the revised manuscript that is consistent with the hypotheses as modified above. Therefore, we have not made any further changes to this final part of the manuscript.