

Interactive comment on “Belowground in situ redox dynamics and methanogenesis recovery in a degraded fen during dry-wet cycles and flooding” by C. Estop-Aragonés et al.

Anonymous Referee #2

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The authors present a comprehensive report on the changes in concentrations of redox-sensitive compounds (NO_3^- , Fe^{2+} , SO_4^{2-}) and methane and DIC (CO_2 , HCO_3^-) concentrations following in situ natural and enforced drying and flooding in a minerotrophic peat in Germany. In situ studies with high spatial and temporal measurement densities are rare and invaluable in the upscaling of lab processes to field conditions. Nevertheless, in its current form the paper gives too much detail (i.e. 14 figures) to communicate its main conclusions: 1) that methanogenesis occurred above the water table position in the presence of low concentrations of SO_4^{2-} - giving field evidence of the importance of decoupling of redox processes in protected microsites, 2) that only a small part of the electron flows could be explained by changes in soluble

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electron acceptors pointing towards an important role for the solid phase electron acceptors and/or to DOC as alternative electron acceptor at relatively low pH-s, 3) that electron acceptor availability interacted with substrate quality to explain the recovery of methanogenesis after drought.

General comments

The paper would improve by:

A careful selection/recreation of 5 clear figures (max) that support the main findings, with maybe a number of supporting graphs in an appendix.

Application of statistics – even if only some (partial?) correlations. Now ALL conclusions are based on visual comparison of graphical patterns and differences of patterns between plots.

A clearer indication of the new contribution of this paper relative to the other two-three (?) preceding papers (Knorr et al. 2008, 2009, Estop-Aragones et al. 2012). Now the reader is left wondering whether the contribution of this paper is mainly in presenting all data together, particularly since 5 out of 14 papers are reprints.

A stronger emphasis on (dis)similarities between rates/patterns in this study and others (lab/field) and what this tells us about methanogenesis in (fen)peat soils.

One of the main conclusions of the MS is that the size of the electron acceptor pool generated during a given drying did not affect methanogenesis recovery after rewetting. This is contrary to general assumptions and contrary to your own hypotheses as well. For me it is unclear how you arrived to this conclusion. Reading the results (332-345) gives the impression that the conclusion is based on comparison between plots (plots with most electron acceptor generation were not the ones with the most methanogenesis delay). But is this the right way to test the hypothesis? I always thought that this statement implicitly assumed that other conditions (for example substrate availability) were comparable. So wouldn't it be better to look at within-plot-within year compar-

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isons: i.e. comparisons under conditions where the soil physical structure and general composition/ position within the fen are the same. In the latter case we of course assume that the rate-supply of root assimilates by plants are roughly comparable.

Specific comments:

General Please check use of abbreviations throughout paper: I had the impression some abbreviations were not written once in full

Introduction You describe what research has been done so far but not so much what we do not know and how your study provides/will provide this information

77-78: ..it is thus important...to what end is this important? I assume to assess potential impact of weather extremes on methane production, an import greenhouse gas..

84 – replace 'was' with 'is' 85 – please rephrase – be more specific than “it has not been reported for a wide range in..” 92 – add one sentence explaining why we need this knowledge 95 – why a degraded fen – is this representative? 95 – background conditions – can you be more specific?

Methods You used enforced drought and flooding. How do these treatments compare to what is naturally observed in these systems over a longer time span: a drought that happens once every ten years or so? I.e. how representative are these manipulations of the fluctuations that can be found for these sites?

120 - You give a general description of the vegetation of the site: but what about the vegetation in your plots? Was the plant species composition the same between your measurement area's? reason: plant species may have widely different rooting patterns and root exudates

120 Mollinia → Molinia (one el): Note: vegetation suggests to me an acidified situation – what was the pH?

129-130 Where were the measurement points actually situated relative to the plot

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edges? Close or far from the gravel ditches?

How close were the plots relative to the tree-line? I.e. were some plots shaded or not?

129 (and elsewhere): perhaps also give dates for the beginning and end of the measurement periods to help people with the DOY notation.

135: The discharge water – how did it relate to the pore water composition in the fen, particularly in respect to concentration of alternative electron acceptors? Perhaps also indicate the dates of the flooding

150: please include measurement frequency for all measurements 187: please indicate here your assumptions regarding lateral flow of water and concomitant lateral supply of solutes - You indicate the fen is a (moderately) sloping fen (methods), yet lateral water flow was not an issue (Warren et al. 2001 - discussion)– can you please explain this a bit more? A very important assumption that you make with your electron-flow budgets is that your main transport is from above to below, assuming no lateral changes.

211-215: Perhaps split into two sentences

Results:

You describe a lot of concentration/ rate ranges in your results. Perhaps you can consider adding a table with these ranges and focussing on the main message in the text? Such a table also makes it easier to compare the sizes of the different processes taking place.

Figure 12: In my opinion this is too complex: try to keep the message per figure restricted to maybe 2(3) things.

Personally I would prefer more scatterplots with maybe envelope curves (quantile regression) and less “compare pattern of plot so and so between figure x and figures y and z”. In my opinion this facilitates extracting the main patterns/drivers more than the

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current representation.

Discussion:

Please shorten

I suggest to avoid results here as much as possible.

I would prefer more a focus on the broader implications of the results and less a comparison of what has been measured before on this same site – the balance seems a bit off now.

How do changes in plant productivity factor in your results? I.e. more plant productivity means more autotrophic respiration (source of DIC?) but also more root assimilates into the soil → food for the saprotrophs. This likely contributed to the differences between the years as well.

441, 512 – perhaps also express in %, instead of only in mmol equivalents?

492-495 – where is the stats to “prove” this?

548 : Add 'The' to sentence

717: was your site really Carex dominated? Or was carex one of the species present (as the methods suggest?)

Conclusion:

Please shorten.

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