Biogeosciences Discuss., 9, C73–C78, 2012
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Biogeosciences Discussions

Interactive comment on "Root biomass responses to elevated CO₂ limit soil C sequestration in managed grasslands" *by* W. M. A. Sillen and W. I. J. Dieleman

Anonymous Referee #1

Received and published: 10 February 2012

Report BGD "Root biomass responses to elevated CO2 limit soil C sequestration in managed Grasslands." The manuscript provides a meta-analyse of 69 grassland manipulation experiments (published between 1998 and 2008) on elevated CO2 and N fertilisation. Meta analyses comprised a gradient of fertilser application (between zero and 560 kg N ha-1 yr-1) and fertiliser types (i.e. urea-N, NPK, KSO4, MgSO4, P), management disturbance (i.e. non, cut, burning, grazing) and irrigation. The manuscripts aimed to summarize overall outcome of those 69 grassland experiments in terms of aboveground biomass, root and microbial biomass ans soil C content. e effect of CO2 an N by taking also into account the management practise(i.e. irrigation, dose of fertiliser applied, defoliation). The manuscript is interesting, synthetic and summarises

nicely main effects (biomass, SoilC) of FACE experiments published in the last 10 yrs.

- At some points (MM, Results), however, the manuscript is a bit too synthetic and I would have preferred to have further details on data acquisition, variables tested (see also comments). Along the same lines, -Figs /Table legends would need some clarification to help reader though the significant results (see also comments). The discussion, needs to my opinion, to be synthesised to avoid repeating of results and interpretation. Nevertheless, the manuscript is worth to be published. I recommend (minor) revisions before publication.

General comments

My first comments involve several points which would need more detail or to be changed in the whole manuscript.

- To what is shown here, the manuscript does not deal with C sequestration, as soil C content is not C sequestration. However, as this variable was not explained in the MM section I did not know what authors tested. Most likely, studies (i.e. 69) mentioned changes in soil C during their experiments. In this case I accept that authors used C storage throughout manuscript. If this is not the case, this needs to be changed.!

- Along the same lines, I wonder why soil texture was not tested. I suppose, depending on soil (Cl/Sa/Si) an experiment was carried out, effects of N and CO2 will be more or less pronounced. May Authors comment on this.

-The same for rain/irrigation, authors tested irrigation but not annual precipitation neither temperature. May Authors comment on this. Also, biomass (and C storage) depends on water availability and temperature, So, I would have expected to see climatic variables (rain, soil moisture) in the tests.

-I also would assume that length of experiment plays a role on obtained results. Short term vs long term effects of elevated CO2. There may be a first year effect which is levelled out doing CO2 fumigation over 5 yrs. Here again the climatic variable will have

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an effect. May Authors comment on this.

Title. I suggest, changing title and running title as the root biomass (and C storage) is a bit misleading to the overall subject of the paper. Ex: Responses to elevated CO2 and fertilization in managed grasslands – a meta analyses on limits of C sequestration potential

Running title: managed grassland under elevated CO2 Outset hypothesises are very long and do not need (to my opinion) an introduction of forests. Hypothesis. Reading through hypothesis reader gets impression to read through results and discussion. Moreover, hypothesise highlight variables which were not tested in this study (i.e. LAI, nutrient depletion). I suggest to shorten and reword (see below).

-MM, authors used weighted means for experiments with data from different years. I suppose that inter annul variability has an effect on biomass ect (see comment on other variables above).

-I suggest detailing 2.1 Data acquisition and criteria used for tested variables (Csoil is not described here). I also recommend to add a list of variables this would help reader going though results and reduce length of legends (Example Tab3 is not clear at all what is CF, Cf, pureC ect). However, I agree that most of site-information should be kept in the supplementary material.

-Results, just a little comment. If I have not mistaken the Fig legends, significant differences between different treatments are highlighted by stars. Confidence intervals (CI, results of bootstrapping)) are the horizontal line going through each point. If this line does not go trough the vertical zero(

-It took my quite a while to understand this (2hours). Probably, authors need to clarifier how their Fig were made by putting part of the legend into MM section. Example Tab2 and Fig6 is especially difficult to understand from legend and symbols (-

-Suggest to find another wording for “pure N fertilizers “ -Authors should stick to one

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variable/treatment name throughout the manuscript. Got the impression that (suggest to add a table of apprevations, see above) - elevated CO2 kept changing between C, CO2, - so did CO2 and irrigation with CI/Ci. . ... - CO2 and Fertiliser with CF, CO2 and Fert , Cf . . ... -Is Fig 6 really necessary, as not easy to read. The fig repeats (in a more synthetic way) what was shown in Figs before. I suggest showing only Fig6 RB. (see comments) -Discussion . discussed results are repeated in various discussion chapter (more or less detailed) and paragraphs. I recommend grouping those paragraphs to avoid repeating. -Example:

P364 L25ff Chapter 4.1 was already mention and does not need to be repeated but merged together (i.e limit of non N nutrients) (see also comments to this first section) P365 chapter 4.2 seems to re-dsicussion in tw different was the effect of N on MB and soil C. I suggest to merge the two paragraphs together P366L22-27 re- discusses the same resultes as mentioned above but brings this time priming effect into the play, while reapeting the C storage in long living tissues (already discussed P365L25ff) , P367LFF repeats inhibiting effect of N already mentioned P366L1ff

*Accordingly discussion section may be grouped as followed *Short overwiew of main results *Role of nutrients on C allocation under elevated CO2 - effect of management practise - effect on C storage (Soil C??)

*Specific comments

L 9 . . .. monitors carbon storage potential in grasslands, and considered the influence L16 An important role was attributed to responsive of root biomass to elevated CO2, since this implied higher potential for increases in soil C content when root biomass increased (?). L21 .. but the potential soil C storage limited due to concomitant increase in microbial biomass (?) P359L24ff . However, their study . . .. in C sink strength between both system types. DELET sentences on trees as this study does not compare grass <> tree responds P360 L3ff I suggest to shorten and reword. In the present study we use data from 69 published grassland studies, to investigate whether CO2 eleva-

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tion and/or nitrogen fertilization is likely to change carbon storage potential in managed grasslands. More precisely, we analyse effects of elevated CO2 concentrations and N fertilization (i.e. combined and individually) on above and below ground biomass production, microbial biomass and soil C. We test following hypotheses 1) elevated CO2 will stimulate plant production and will increase allocation of C to root compartments, (2) addition of N solely, will stimulate plant productivity but will leave microbial biomass unaffected due C limitation in below ground (3) the combined CO2 and N treatment will strongly stimulate above and below ground biomass production, which in turn stimulates soil C storage (4) management practices (i.e. defoliation, irrigation) shifts C allocation towards aboveground plant compartments and reduces C soil . P362L23 Pure N is strange wording I suggest to use N fertilisation solely or as a single factor (see also Tab2) L25 root biomass increased more when low high doses of N (i.e. C-H) were applied L363L25 .. and a tendency to increase soil C content . . .is this true??? L364 L2-25 I suggest to restructure to highlight main results. Ex: However, considering CO2 as a single factor we found a decrease in root biomass as a consequence of elevated CO2 concentrations, which is in sharp contrast to most other studies. Interestingly, when excluding experiments that were irrigated or where biomass was removed, root biomass was no longer significantly decreased by elevated CO2 (data not shown). (L10) This offered support to our hypothesis that plants deprived of their shoots by harvest, burning or grazing, allocate proportionally more energy to aboveground biomass for repair and regrowth, which could impair root growth by lowering the amount of C available for belowground biomass. As with irrigation (L13) root biomass tends to decrease, compared to non-irrigated systems as a results of increased WUE which does not necessarily need an extensive root network. In contrast with unfertilized systems, fertilised systems displayed an increase in root biomass in response to elevated CO2 (de Graaff et al., 2006), and showed a clear dependence on N additions (van Groenigen et al., 2006). Table 2 legend has point 1-3 but not the table Table 3 very difficult tu understand, soil C reponses, Pure C, Cf, What is C+Cf+CF?? Fig2 legend CO2 OR N fertilization responses ??? does x-axis means CO2 divided by Fig 6 what is (Ln(E/A)

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