

Interactive comment on “Soil-atmosphere exchange of CH₄, CO₂, NO_x, and N₂O in the Colorado Shortgrass Steppe following five years of elevated CO₂ and N fertilization” by A. R. Mosier et al.

Anonymous Referee #1

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General comments

This manuscript discusses the exchange of CO₂, CH₄, NO_x and N₂O from a site that had been exposed to elevated CO₂ levels for the previous five years. It discusses the effects of water addition and nitrogen fertilization on trace gases from these sites. Water additions led to increased CH₄ uptake rates and decreased N₂O fluxes in the elevated CO₂ sites. Adding water and nitrogen caused an increase in CO₂ emissions and CH₄ uptake rates, while decreasing NO emissions from the elevated CO₂ site. This paper presents some very interesting results and takes full advantage of the previous long term elevated CO₂ experiment. The topic of this manuscript is suitable

for Atmospheric Chemistry and Physics and should be published after some changes (discussed below) have been made.

The title of the manuscript ("Soil-atmosphere exchange of CH₄, CO₂, NO_x, and N₂O in Colorado Shortgrass Steppe following five years of elevated CO₂ and N fertilization") suggests that the study investigates trace gas emissions from a site that was previously exposed to elevated CO₂ and N fertilization for five years. In the methods it describes in detail the experimental setup of the previous elevated CO₂ experiment that took place on this shortgrass steppe, however, nowhere does it suggest that the sites were fertilized with N during this period. This manuscript discusses the effects of N fertilization on fluxes at the previously elevated CO₂ sites. It would be a case of rewording the title perhaps to something like: "Soil-atmosphere exchange of CH₄, CO₂, NO_x, and N₂O in Colorado Shortgrass Steppe following five years of elevated CO₂: Effects of water addition and N fertilization".

The study discussed in this manuscript follows on from the previous elevated CO₂ study. Therefore I understand that there needs to be some detail about the long term elevated CO₂ experiment. However, after reading this manuscript it appears that much of the paper is dedicated to the previous experiment and only a small section actually discussed the methods and results of this study. It is almost at the point at which the reader may think that this paper is about the previous elevated CO₂ study. Therefore I suggest a bit more discussion around the results of this study and how they relate to other studies - give more substance to this study and make it clear what was done in this study. Some further suggestions dealing with this issue are given in the "specific comments" below.

Specific comments

Abstract

Generally the abstract is fine, although the first few sentences about the previous elevated CO₂ experiment could be reduced. For example: Pg2692 line2: "An open-top-

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chamber.....shortgrass steppe between April 1997 to October 2001 to determine the effects of elevated CO₂ (....) on plant production, photosynthesis, water use, soil N and C cycling and trace gas exchange. Results of this study showed that During early summer...."

Introduction

Pg 2693 line 9: It states that "The impact of elevated CO₂ on shortgrass steppe..... has not been previously addressed." But it has been addressed in the previous five years in the elevated CO₂ experiment has it not? This is again going to the fact that the elevated CO₂ study has already been done and should be treated as a previous study. Similarly with the second paragraph (starting pg 2693 line 20) the authors give some information about possible effects of elevated CO₂ but then in line 26 it says "From these we hypothesized." and on pg 2694 line 4 the authors write "To test these responses...." and gives some details of the previous elevated CO₂ experiment. This is past data and should be spoken of in terms of results only, don't discuss why you did a previous study. I would suggest that much of the first part of the second paragraph be taken out and go straight to the second part of the paragraph where the results of the long term study are discussed. Mention these results, along with other study results, then from these results build up to why the authors did this study - what was hypothesized based on data from the long term study, or other studies for that matter. What is important are the dates of the previous experiment and when this "after" experiment began as the reader then knows how long the environment had to "recover" before this experiment began. This can either be mentioned in the introduction or in the methods. Further more I think that the third person should be used.

Materials and methods

Pg 2695 section 2.1: In this section the experimental site is described as it was before the long term study was done. This information is important, however I wonder if the conditions at the end of the long term experiment shouldn't be described. As these

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conditions would be the more likely starting point for this project. For example in table 1 the authors have total N and C, but did these not change under ambient and elevated CO₂ conditions during the long term experiment? It would be useful then to add to table 1, or create a second table, where the soil N, C and moistures are given for the control, ambient and elevated CO₂ sites.

Results section

Pg 2698 line 15: In section 3.1 it is important and relevant to mention the average fluxes found in the long term elevated CO₂ study, but the rest of the section can be reduced as it is repetition. I would even suggest doing away with section 3.1, and incorporating the average fluxes from the long term section into sections 3.2 and 3.3. I also suggest including the average long term values in Table 2 and adding in more discussion about these values in relation to the new results in the relevant sections.

Pg 2698 line 10 (NO and N₂O emissions): These first few sentences do not make much sense. In the first line it is suggested that NO emissions increase when irrigated and we are referred to table 2. Now in table 2 it only shows us irrigated data as the treatments are 'water only' and 'water + N'. Therefore table 2 does not show us that NO increases with irrigation, rather it shows us that NO emissions increase with N fertilization. This is shown in Figure 1 as stated in line 13. Further more the first sentence also states that 'N₂O emissions were significantly lower' - in the context of the rest of the sentence this is suggesting that N₂O emissions are lower when irrigated. Once again this is not reflected in Table 2. Table 2 shows us that N₂O emissions are significantly lower in the irrigated plots that had been exposed to elevated CO₂. Therefore this whole first sentence of this section needs to be rewritten and check that what you say is reflected in the table.

Pg 2698 line 12: It is the fact that N₂O decreased with 'water only' in the elevated CO₂ soils that reflects the N depleted state of these soils, however NO emissions do not show the same decrease. If the soils were N depleted would you not expect NO to

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decrease as well?

It is interesting to note that NO and N₂O seem to have almost opposite responses in that NO_x doesn't change with water addition under ambient or elevated conditions but N₂O does; further, NO_x responds to water + N under ambient and elevated conditions but N₂O doesn't. Any further comments on this?

There is much discussion about the N depleted state of the soils under elevated CO₂. Did the authors of this paper measure soil N? Were the elevated CO₂ sites still N depleted during this study?

Pg 2699 line 26: The authors discuss wetter soil conditions under elevated CO₂ in the semiarid grassland - I assume they are talking about the Colorado shortgrass steppe here. Please make this clear. This is the place where the authors can refer to the Ferretti et al. 2003 instead of in section 3.1.

Pg 2700 line 1: The last few sentences from Hu et al. (2001) to the end of the paragraph don't really seem to fit in here. It seems the discussion went from CH₄ consumption to microbial decomposition and soil respiration. I suggest these sentences are moved to the first paragraph of section 3,3 where respiration is discussed.

Technical corrections

Introduction

Pg 2694 line 13: the term "probably somewhat" needs to be replaced - be more specific. Pg 2694 line 14: the wording "moister weather" needs to be fixed. I suggest replacing it with "more moist".

Methods

Pg 2696 line 7/8: should be "Morgan et al., 2001" not 2001a.

References

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Pg 2701 line 13: I do not see a reference in the text to Hunt et al., 1988. Please check this.

Figures

Pg 2706 Figure 1: It is assumed that the bars represent the irrigation and precipitation events in graph (e) but it is not actually mentioned.

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