

Interactive comment on “Differences in plant cover and species composition of semiarid grassland communities of Central Mexico and its effects on net ecosystem exchange” by J. Delgado-Balbuena et al.

Anonymous Referee #2

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Review of Biogeosciences Discussion manuscript: “Differences in plant cover and species composition of semiarid grassland communities of Central Mexico and its effects on net ecosystem exchange” by J. Delgado-Balbuena, J.T. Arredondo, H.W. Loescher, E. Huber-Sannwald, G. Chavez-Aguilar, M. Luna-Luna, and R. Barretero-Hernandez [MS number: bg-2012-497]

General comments (specific comments follow this section):

The research in this manuscript presents original results that show the effects of plant

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cover and species composition on net ecosystem exchange. This manuscript has the potential to add to the growing arid and semi-arid net ecosystem exchange data set. The current manuscript attempts to compare five different plant communities and how land use changes have influenced the carbon cycle and regional carbon balance. The authors used a method to measure NEE that is scientifically valid and has been used in other ecosystems. There are, however, several places in the methods where it is not clear how particular methods were accomplished. Specific examples of this include how the different sites were classified. The authors describe a “moderately grazed” site but there is no description of how this was quantified. This also holds true for the “high” and “low” plant cover; what method was used to quantify plant cover? How were the dominant plant species determined/quantified? Much more detail on site classification needs to be discussed. Also, the “coat” method that was used to measure ecosystem respiration probably doesn’t yield accurate ecosystem respiration. Although covering the chamber does result in a reduced PPFD, it really doesn’t mimic nighttime. There are still too many carbohydrates around resulting in inaccurate ecosystem respiration, usually an overestimation. The methods used to calculate continuous daytime and nighttime NEE most likely overestimate NEE. Although the method used in this manuscript to calculate continuous daytime and nighttime NEE is probably no worse than using a linear interpolation method, it most likely overestimates NEE during the day and the nighttime. I would like to see some discussion about this and how the method used to calculate continuous NEE could have influenced the results presented here, especially with regard to how different plant species (study sites) respond to PPFD given that “ideal” conditions were assumed. Along these same lines, the calculation of continuous daytime NEE requires air temperature, but I didn’t see air temperature mentioned in the methods section as it pertains to continuous daytime calculations, with the main concern being how temperature was estimated at each site for every day of the year since it doesn’t appear as though each site had its own meteorological instrumentation. Finally, this manuscript needs some significant grammar and sentence structure improvements. There are many sections of the manuscript where the writing style is

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hard to follow making many sentences unclear. The unclear sentences make many sections of the manuscript difficult for the reader to understand. I've mentioned as many grammatical issues as I can in the specific comments section (see below), but the manuscript could benefit from the help of a technical writer. Significant specific comments are discussed in the following section

The following are specific comments:

Abstract:

1. Page 17100, line 3: place a semicolon after the word "changes" 2. Page 17100, line 7: "Five typical plant community types were examined in the semiarid grassland by encasing the entire above-ground ecosystem using the geodesic dome method." Change to "Net ecosystem exchange was measured in five typical plant community types within a semiarid grassland by temporarily enclosing the entire above ground ecosystem using a geodesic dome." 3. Page 17100, line 15: Change "night time" to nighttime. Also do this throughout the entire manuscript. 4. Page 17100, line 17: Change "into" to "to" 5. Page 17100, line 20: Spell out PPFD, then abbreviate.

Introduction:

1. Page 17101, line 1: Change "~17.7%" to "18%"
2. Page 17101, line 10: Do you mean capacity and not capability?
3. Page 17101, line 19: Replace "ex." with "e.g.". Please do this throughout the manuscript.
4. Page 17101, line 20: Change "...directly to the observed grassland patchy landscapes..." to "...directly to patchy grassland landscapes..."
5. Page 17102, line 9: "Exposed bare soil contributes to carbon losses through increased soil respiration and wind and water erosion." Why? Is this due to soil moisture difference between bare and not bare soil? Temperature differences? A combination

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of things? What role does heterotrophic respiration play in bare soils? Also, include a reference for the statement that you made.

6. Page 17102, line 12-15: Suggest adding soil moisture to this list (i – v)
7. Page 17102, line 12-18: "...have contributed to conform a patchy grassland..." this is a confusing statement. What do you mean by "conform"? Or do you mean to just say have contributed (omitting conform) to a patchy grassland?
8. Page 17103, line 13: Define PPFD in Abstract (see point 5 above) and just use PPFD in this location of the text.
9. Page 17103, line 14: "Therefore, NEE should reach maximum rates faster and sooner at sites with low plant cover relative to sites with high plant cover (H2)." What do you mean by "maximum rates"? Maximum uptake? Maximum release?
10. Page 17103, line 19: "To test these hypotheses, NEE fluxes of the most common plant communities found in a patchy landscape of semiarid grassland were examined in responses to site-specific biotic (LAI) and abiotic (Ta, PPFD, and SWC) controls." It's not clear what this sentence means. Do you mean that you looked at the relationship of NEE and biotic and abiotic factors (whether these factors modulate/control NEE)? Why only the common plant communities, why not all of them, don't they all play a role in NEE? Finally, change "responses" to "response".

Materials and Methods:

1. Page 17104, line 1: Change "Chihuahua" to "Chihuahuan".
2. Page 17104, line 9: "Winter rains account for only <5%..." omit "only"
3. Page 17104, line 10-12: "Mean annual temperatures are 17.5 ± 0.5 °C (m, ± 1 SE), with mean monthly temperatures ranging between 1.6 °C for the coldest and > 18.0 °C for the warmest months (dataset from Sitio Experimental Vaquerias, INIFAP)." How much greater than 18 °C? Please give exact mean high temperature for the warmest

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months. >18 C is too vague.

4. Page 17104, line 20-23: "The plant cover was classified as either high (maximum reported for the region 35–38% of soil covered by vegetation; Table 1, Aguado-Santacruz and Garc'Ása-Moya, 1998), or low plant cover (< 8% of ground covered by vegetation; Table 1)." It's not clear how the plant cover was classified for each site? Using reported values are OK if they were done at your exact site, if not, what method did you use to determine plant cover at each site? The way this sentence is currently written it sounds like cover was just estimated at each location. If so, this doesn't seem accurate enough.

5. Page 17104, line 26-27: "The five site types examined were; (i) a moderate grazing site that was a recovered grassland (~60-yr) to tillage and overgrazing,..." What constitutes moderately grazed and how was it quantified? Also, does the 60 years refer to the number of years the site was grazed or no tillage or over grazing for the past 60 years? Please clarify.

6. Page 17105, line 3: "(ii) the exclosure site is a 30 yr-old cattle exclosure characterized by a high plant cover dominated by *B. gracilis* (> 80% abundance);" Change to "(ii) a 30 yr-old cattle exclosure site characterized by a high plant cover dominated by *B. gracilis* (> 80% abundance);". Also, how was the high plant cover determined?

7. Page 17105, line 4: (iii) the overgrazing site (Table 1) had a low plant cover 5 (< 8%) with *B. gracilis* as the most abundant species;" change to "(iii) an overgrazing site (Table 1) with a low plant cover (< 8%) with *B. gracilis* as the most abundant species;" How was it determined that the site was overgrazed and had a plant cover of <8%? Also, <8% is vague. A single canopy cover or range would be more appropriate than stating <8%.

8. Page 17105, line 5: "(iv) the shrub encroachment site is also an overgrazed site with low plant cover (< 8 %) having co-dominance with a native shrub *Isocoma veneta* (Kunth) Greene and an exotic Mediterranean perennial herb *Asphodelus fistulosus* L.;"

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change to "(iv) a shrub encroachment site which was also an overgrazed site with low plant cover (< 8 %) having co-dominance with a native shrub *Isocoma veneta* (Kunth) Greene and an exotic Mediterranean perennial herb *Asphodelus fistulosus* L.;" How was plant cover estimated?

9. Page 17105, line 8: "(v) the crop site, a shortgrass steppe field converted to rain-fed agriculture to produce oat (*Avena sativa* L), that is covering the soil for around 4 months during summer." Change to "(v) a crop site, previously a shortgrass steppe field converted to rain-fed agriculture to produce oats (*Avena sativa* L). The oat crop covers the soil for approximately four months during summer."

10. Page 17105, line 16: "When measurements were made, this chamber was sealed to permanent iron bases. . ." change to "When measurements were made, the chamber was sealed to permanent iron bases. . ."

11. Page 17105, line 18: "Iron bases were installed and allowed to equilibrate with the ground for 2 months prior to the beginning of this study." Change to "The iron bases were installed and allowed to equilibrate with the ground for two months prior to the beginning of the study."

12. Page 17105, line 24: "One fan was oriented horizontally, while the other was vertically oriented, both had a flow rate of 54.3 m³ h⁻¹ CO₂ and H₂O concentrations and atmospheric pressure inside the dome were measured using an open-path infrared CO₂/H₂O gas analyzer (IRGA; Li-7500, Li-Cor Inc., Lincoln NE) located in the center of the plot and also mounted 0.5m a.g.l." Split this sentence up into two separate sentences. First sentence: "One fan was oriented horizontally, while the other was vertically oriented, both had a flow rate of 54.3 m³ h⁻¹. Second sentence (with modifications to the original): "Carbon dioxide and H₂O concentrations, and atmospheric pressure inside the dome, were measured using an open-path infrared CO₂/H₂O gas analyzer (IRGA; LI-7500, LI-COR Inc., Lincoln NE) located in the center of the plot and also mounted 0.5m a.g.l."

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Also, was the LI-7500 “white box” inside the dome? The white box contains the pressure sensor. The pressure sensor is not on the IRGA “sensor head”. If the white box was not in the dome, then pressure changes inside the dome during a measurement were not being recorded properly. Please mention this in the manuscript. Finally, 0.5 m a.g.l. was probably a good height, but how did you determine this height? Were there lab test to determine that proper air mixing was occurring with a fan at 0.5 m a.g.l.? Please explain fully in the manuscript.

13. Page 17106, line 8: “Meteorological sensors were used inside and outside the chamber during each measurement” Which sensors (the ones you list after this sentence) were used inside the chamber and which sensors outside the chamber?

14. Page 17106, line 9: “PPFD, (PARLITE, Kipp and Zonen, Delft, Holland), Ta, (PRT type, RTD-810, Omega Engineering Inc., Stamford CT) with a linearizer (OM5-IP4-N100-C, Omega Engineering Inc., Stamford CT), and SWC (Mini Trase, SoilMoisture Equipment Corp., Santa Barbara CA).” Soil water content (SWC) is listed but really it’s not a meteorological measurement. Also, were there soil moisture sensors at every measurement plot? How deep were the soil moisture sensors? Did the soil moisture sensors measure continuously or was this a spot measurement? Much more detail is needed here for all the sensors to indicate how often the sensors measured, how high or how deep they were installed.

15. Page 17106, line 16: “. . .and to examine for potential chamber effects.” change to “. . .and to determine potential chamber effects.”

16. Page 17106, line 22: “The duration for each chamber on the iron base, defining the sampling period was ~120 s during daytime and ~180 s during night time.” Change to “During each flux measurement, the chamber was placed on a plot for ~120 s during daytime and ~180 s during nighttime.” Also, “dome” is sometimes used and then “chamber”, please select either dome or chamber and use this consistently throughout the manuscript.

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17. Page 17106, line 25: “. . .data for NEE calculations however, were only used after the first 20 s, i.e. once a constant rate of [CO₂] change inside the dome was observed.” Did you use all of the data after 20 seconds or was data at the end of the measurement also omitted? Typically in chamber measurements, the rate of change in CO₂ tends to level off before 120 seconds has elapsed due to water vapor dilution. Did you only take the linear portion of the slope or the entire slope after 20 seconds? This needs to be clearly discussed and explained in the manuscript. If you used the entire 120 seconds and the rate of change in CO₂ was not linear the entire time, then your flux measurements are not accurate.

18. Page 17107, line 20: “Daytime and nighttime NEE were analyzed separately because they differ in their controls and the way they were influenced.” Influenced by what? Is the “influence(s)” different than the controls? This needs to be clarified.

19. Page 17108, line 9: Missing minus sign in front of the subscript “2000 $\mu\text{mol m}^2 \text{s}^{-1}$ ”. Should be “2000 $\mu\text{mol m}^{-2} \text{s}^{-1}$ ” please check that minus signs are present in superscripts (where needed) throughout the manuscript, it is an issue in several other places.

20. Page 17108, line 11: “For the period from March to May, an exponential function was used to describe the relationship between NEE_{daytime} and air temperatures.” Change “temperatures” to “temperature”.

21. Page 17108, line 12: “For the period from March to May, an exponential function was used to describe the relationship between NEE_{daytime} and air temperatures. In this period, since vegetation was senescent there was not active grass leaves (LAI = 0) in all sites, thus no C acquisition at daytime occurred and therefore NEE did not respond to PPFD but only to temperature since the predominant flux corresponded to R_e .” This sentence needs major rewording and is very confusing as it is currently written. Also, were there biological soil crusts at the site? If so, they could be active when plants were senescent. Please discuss the possible role (if there is one) of

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biological soil crusts. Also, why were the plants senescent during March and May? Seems like it would be springtime at this southern latitude during March and May with lots of plants greening up during this time.

22. Page 17109, line 8: "Daytime CO₂ fluxes: to calculate the continuous fluxes for each daylight measurement period (hereafter integrated daytime NEE)..." change to "Daytime CO₂ fluxes: to calculate continuous fluxes for each daylight measurement period (hereafter integrated daytime NEE)..."

23. Page 17109, line 12: "Same latitude (21.7_N) and longitude (-101.6), relative humidity (30%), and altitude (2200m a.s.l.) were assumed in the model for the five sites." According to the clear sky calculator website provided in the previous sentence, it appears that air temperature is also needed for this calculation. How did you estimate air temperature at all sites? Were there air temperature sensors at all the sites? Also, in order to make the model on the website work properly you have to enter every day of the year separately? Did the author manually type in every day of the year to get a PPFD value for each day of the year? Additionally, why assume 30% relative humidity for everyday? Changes in RH, and air T make a difference in the modeled PPFD. There seems to be a lot of assumptions here that then translate into assumptions in the continuous daytime NEE. As this section is currently written it casts doubt on the accuracy of the continuous NEE values.

24. Page 17110, line 4: "...NEE rates and climate was assumed to be representative for..." change the word "was" to "were".

25. Page 17110, line 6: Spell out leaf area index and then abbreviate (LAI).

26. Page 17110, line 7: "...six 0.25m² quadrants, positioned next to- and outside the chamber..." change to "...six 0.25m² quadrants, positioned next to- and outside of the chamber..."

27. Page 17111, line 4: "This allows us to homogenize environmental conditions..."

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change to "This allowed us to homogenize environmental conditions..."

28. Page 17111, line 10: Change the word "estimation" to "estimated".

Results:

1. Page 17111, line 22: "~442 mm yr⁻¹. Why approximately (~)? Why not an actual value? This occurs in several places within the manuscript and should be fixed where appropriate.

2. Page 17113, line 3: "... (p > 0.05, Figs. 3a and 4, Table 2)." The P should be italicized.

3. Page 17113, line 6: "The crop was the only site showing positive NEE flux for November, when exhibited no plant cover." Change to ": "The crop site was the only site showing positive NEE flux for November, when there was no plant cover." I'm assuming when you state positive NEE you mean release of CO₂?

4. Page 17113, line 7: "Still, in July the crop cover showed a positive C flux, but in August it changed to the largest NEE daytime capture (6.08, asymmetric s.e. +4.82, -0.94, gCm⁻² d⁻¹) coinciding with maximum leaf out and grain-filling stages." Does the word "capture" intended to mean CO₂ uptake? Also, in the parentheses there is a number of 6.08, if this is an uptake value then according to your previous definition of negative values being uptake and positive values being release, then the value should be -6.08. Please be careful to maintain your sign convention, otherwise, things get confusing in a hurry and very difficult for the reader to figure out.

5. Page 17113, line 12: "Sites with lowest plant cover (overgrazing and shrub encroachment) showed three months lower C uptake than those found from the other sites." This is a very confusing sentence. Unclear as to what "...showed three months lower C uptake..." means? Do you mean three "times" lower uptake? Please clarify.

6. Page 17113, line 19: "NEE nighttime fluxes in the overgrazed site were the smallest throughout the year (< 0.45 gCm⁻² d⁻¹), resulting in significant lower annual..." Prob-

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ably should not use a < sign here. It leads the reader to wonder how much less than 0.45. A range or a value with an error associated with it would be more appropriate. Also, is this an uptake value or a release? Also, change “significant” to “significantly”.

7. Page 17113, line 22: “The Oat crop site maintained intermediate NEE nighttime rates that were significantly higher than the overgrazed site fluxes.” Not clear what the word “intermediate” is referring to. Are the rates intermediate in relation to the other sites except the overgrazed site? Please clarify.

8. Page 17113, line 24: “We estimated annual rates of productivity, however, data for both December and April were not included due to sampling logistic problems.” Please omit the word “logistic”.

9. Page 17113, line 26: “Day and nighttime NEE rates were > -0.34 and $< 0.43 \text{ gCm}^{-2} \text{ d}^{-1}$, respectively, for winter months (November to March), with net diurnal rates around $0 \mu\text{molm}^{-2} \text{ s}^{-1}$.” Please change “day” to “daytime”. Is the < -0.34 and < 0.43 a range? If so then the $<$ signs are not necessary, just add the word “between” after “were”.

10. Page 17114, line 5: “. . . (net CO_2 uptake of 0.47, 0.26 and $0.08 \text{ gCm}^{-2} \text{ d}^{-1}$, respectively, Fig. 4a, b, or 145, 77, and $25 \text{ gCm}^{-2} \text{ yr}^{-1}$, respectively, Fig. 4a, b). In contrast, the enclosure behaved as a source (net CO_2 loss of $0.085 \text{ gCm}^{-2} \text{ d}^{-1}$, or $25 \text{ gCm}^{-2} \text{ yr}^{-1}$, Fig. 4a, b) whereas the moderate grazing site was carbon neutral ($0.003 \mu\text{molm}^{-2} \text{ s}^{-1}$, or $0.26 \text{ gCm}^{-2} \text{ yr}^{-1}$, Fig. 4a, b).” Errors need to be presented for all of these values, especially the annual values. Also, since all these values are uptake they should have a negative sign in front of them to be consistent with your sign convention. Additionally, why is $0.26 \text{ g C m}^{-2} \text{ yr}^{-1}$ carbon neutral? Granted, it is a small value, but not neutral, zero would be neutral.

11. Page 17115, line 14: “Sites of contrasting plant cover differed respect to what was the main NEE daytime driver.” This is a very confusing sentence. Please reword.

12. Page 17115, line 15: “Thus, while both SWC and LAI explained $> 56\%$ (linear

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relationship) of NEE daytime variation in sites with good cover, the overgrazed and crop sites in contrast showed only a relationship to LAI, but through a quadratic and linear relationship, respectively.” This is a very confusing sentence, Please reword.

13. Page 17115, line 20: “Although data did not allow to perform an homogeneity of slopes test, moderate grazing site showed almost doubled the assimilation rate per unit water stored in soil ($0.1 \pm 0.02 \text{ gCm}^{-2} \text{ d}^{-1} \% \text{ SWC}^{-1}$) than enclosure and shrub encroachment sites (0.0636 ± 0.017 , and $0.062 \pm 0.025 \text{ gCm}^{-2} \text{ d}^{-1} \% \text{ SWC}^{-1}$, respectively).” Reword to “Although data did not allow a homogeneity of slopes test, the moderate grazing site showed almost twice the assimilation rate per unit of water stored in soil ($0.1 \pm 0.02 \text{ gCm}^{-2} \text{ d}^{-1} \% \text{ SWC}^{-1}$) than the enclosure and shrub encroachment sites (0.0636 ± 0.017 , and $0.062 \pm 0.025 \text{ gCm}^{-2} \text{ d}^{-1} \% \text{ SWC}^{-1}$, respectively).”

Discussion:

1. Page 17116, line 1: “Sites were also grouped regarding the proportion of plant cover by empirical parameters of the exponential part of Eq. (6).” Confusing sentence, please reword.

2. Page 17116, line 17: “Comparison of shrub encroachment and overgrazed sites revealed no differences in NEE daytime, neither there were differences in NEE nighttime ($P > 0.05$, Fig. 4).” Reword to “Comparison of shrub encroachment and overgrazed sites revealed no differences in NEE daytime and NEE nighttime ($P > 0.05$, Fig. 4).”

3. Page 17117, line 17: “If we assume belowground mass similar to that found aboveground, there would be 2- to 10-fold greater root biomass of these two sites compared to the sites with low plant cover, and this could account for the observed 3 to $5 \times$ higher Re rates.” This is a large assumption. Please provide a reference for this statement.

Figures and Tables:

1. Table 1: Not sure if comparing sites is what should be done in this study. Consider looking at changes and relationships within a site and not between sites.

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2. Figure 3 and 4: Please edit y-axis title to add a space between “g” and “C”.
3. Figure 3 caption: Change “daily daytime” to “mean daytime”
4. Figure 4: I don’t think the capital “A” is needed in panel (a) since all the bars are statistically similar. Letters are only needed if there are differences. However, it’s not a huge issue so it is an author decision.
5. Figure 5: Please use the alignment feature in your plotting program to properly line up the six different panels. Currently they are not lined up properly.

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