Biogeosciences Discuss., 9, C3802–C3806, 2012
www.biogeosciences-discuss.net/9/C3802/2012/

Biogeosciences Discussions

Interactive comment on "Comparison of soil greenhouse gas fluxes from extensive and intensive grazing in a temperate maritime climate" *by* U. Skiba et al.

Anonymous Referee #2

Received and published: 5 September 2012

General comments:

The paper presents the measurements of GHG fluxes of two NitroEurope supersites in Scotland run by CEH. Both sites are grazed grassland systems with a large difference in grazing intensity and fertilizer input. The presentation of site specific papers is important as these data are further used in up scaling and validation and verification of different models.

The paper presents a synthesis GHG fluxes on the field scale of the four year 2007 – 2010 corresponding to the duration of NitroEurope with the focus to compare the annual GHG budgets of two sites. Annual budgets are expressed in CO2 equivalents

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Discussion Paper

per m2 and year of the experimental fields. The GHG fluxes are dominated by the CO2 exchange. The cumulated annual NEE represents the net C exchange of the fields. A negative number means that the ecosystems gain carbon during the specified year.

Whereas the Auchencorth Moss (AMo) data seems consistent and are perfectly within the expected range of low input systems, the Easter Bush (EBu) data are inconsistent. Due to the sparse information on the management it is difficult to chase reasons for the inconsistency. More detailed information is needed on the variability of the stocking density and the management over the last 10 years. As the EBu field was part of previous major program such information must be available.

The cumulative NEE at EBu are much higher in the years 2009 and 2010 compared to the two previous years. As the authors stated themselves this can hardly be explained. The management do not show any major changes over the four years. Only the stocking density was reduced by approx. 20% over the last two years. The dry weather conditions in spring 2009 rather would point to a reduced productivity and a reduced NEE in contradiction with the presented results.

The EBu field is largely dominated by a Lolium perenne. Such a system has a potential high yield (over 10 t DM per ha and year) with optimal management and good meteorological conditions. The high NEE of the last two years approximately corresponds to a yield of 12t DM per hectare. That is on the upper limit of perfectly managed Lolium perenne systems under a mown management according to the English guide for fertilization (Fertiliser Recommendations for Agricultural and Horticultural crops7th edition ISBN 0 11 243068 9). The management in EBu is suboptimal as the animal intake only uses up to a third of the potential productivity. Consequently “old grass” is produced over the years that will negatively influence the productivity and will not be eaten any more by the animals. In such situation a usual procedure of farmers is to cut the field to maintain the productivity.

I see possibilities to check whether the sudden increase of the NEE values from 2008 to 2009 is plausible. These are:

Compare diurnal variations of NEE measurements between 2008 and 2009 on days with similar temperature, radiation and soil humidity. An amplitude shift could give a hint of a potential scaling error. Compare temperature dependence of nocturnal EC fluxes with soil respiration chamber values, are these consistent over the four years? Compare cumulated NEE with vegetation parameters such as LAI, canopy height, potential yield based on enclosure cages.

It is important to check the reliability of the NEE data also in relation to the N2O fluxes. E.g. if the cumulated N2O flux is expressed as fraction of the yield, the years 2009 and 2010 do have a very low emission factor and the two years before a very high emission factor. This could be a pure random effect, as the chamber measurements are extremely variable and also have a high variability among the chambers. It is also possible that in the last two years fertilizer induced peaks are underrepresented, while in the first two years they are over represented by the chosen gap filling algorithm.

I cannot recommend the paper for acceptance in BG as the data analysis and the interpretation have major deficits.

A selection of specific details:

Abstact: The authors are using this sign convention inconsistently. In the abstract the average GHG budget is positive, while in Table 2 a negative value is given.

page 10059 lines 17-20. At least a brief summary of the management history of the EBu field must be given. Have been there cuts and/or plowing over the last 20 years?

page 10059 lines 24-26. The description of the stocking density is unclear. The average density is given as LSUha-1, then the range of the animal numbers are given as an absolute number. The range must be indicated as LSU per hectare. It would be important to have more information on the temporal variation of the stocking density. Could the animals freely move over the whole field or was it a kind of a rotational grazing established?

page 10061 lines 18 – 24. Most important is to give the precision and not the detection limit for the GC measurements. The fluxes have been evaluated from the linear increase in the headspace. For N_2O as criterium r^2= 0.96 was taken. Our own analysis based on a reevaluation of the chamber data with the HMR algorithm (Pederson et al, 2010, European Journal of Soil Science, December 2010, 61, 888–902) show on average an underestimation of roughly 30% if the r^2 = 0.96 criterion is used. The same holds for the CO_2 chamber measurements. Such an analysis is very crucial as a 10% underestimation of the respiration flux is equivalent to the annual NEE derived from EC measurements for the years 2007 and 2008.

page 10064 lines 1-4. An overview should be included showing data coverage and precise criteria how malfunction of the LICOR device were filtered out. This is important as animals in the footprint can cause rapid fluctuations of the concentrations that are real and eventually filtered out.

page 10064 lines 6-10. There is a hole in the precipitation series from EBu shown in Figure 1a. The reasons seems to be snow disrupting the measurements. Most mean diurnal temperature are clearly above zero degree in this period, so snow seems for EBu seems the wrong reason for the malfunction.

lines 14-15. Average N_2O fluxes of N_2O at EBu are 507 times larger than at AMo. This is a strange ratio, as AMo fluxes are +- zero and the ratio is undefined.

page 10066 lines 12-14 The scaling of Figure 4 must be wrong. Figure 4 shows a mean emission around 20% of the applied fertilizer or roughly 40 kg N ha^{-1} $year^{-1}$ in contradiction to the values given on page 10069 line 13.

page 10070 lines 8 -10 the authors stated that annual cumulative precipitation and average annual temperature explained 85% of the interannual variation in respiration rates. I doubt whether it is meaningful to indicate an explained variability for four data

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point and two variables. There are not many remaining degree of freedom in this regression analysis.

Interactive comment on Biogeosciences Discuss., 9, 10057, 2012.