Biogeosciences Discussions

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"Carbon budgets for an irrigated intensively-grazed dairy pasture and an unirrigated winter-grazed pasture" **by J. E. Hunt et al.**

Author Response to Anonymous Referee #2

-Overall-

The article titled "Carbon budgets for an irrigated intensively-grazed dairy pasture and an unirrigated winter-grazed pasture" documents (1) how the annual NECB of the irrigated, intensively-managed pasture was quantified, (2) how it differed from that of an adjacent unirrigated pasture, (3) uncertainties of the annual NEP and NECB, and (4) how the management practices influenced both NEP and NECB. This research is important for assessing economic and environmental sustainability of the intensification of grazed grasslands in New Zealand. I think that this study can be an example of climate smart agriculture (http://www.fao.org/climate-smart-agriculture/72610/en/). In general, the manuscript is well written and the figures are nice presentations of the data. The experiment was well designed to quantify the NECB of pasture reliably. The topic will likely be of interest to the readers of OzFlux special issue in BG. After careful consideration of all points raised in this review, I am favorable to recommend publication of this study in BG.

Reply: Thank you for these endorsing comments. They show that our intentions have been understood correctly.

-General comments-

1. I think the ultimate goal of this study is to answer questions regarding economic and environmental sustainability of intensification of grazed grasslands through application of irrigation and fertilisers. Economic and environmental sustainability and carbon (i.e., CO2 and CH4) uptake/emission of pasture are directly related to the concept of climate smart agriculture. Climate-smart agriculture promotes production systems that sustainably increase productivity, resilience (adaptation), reduces/removes GHGs (mitigation), and enhances achievement of national food security and development goals (http://www.fao.org/climate-smart-agriculture/72610/en/). Please consider including this concept in the introduction, and adding that the management practices in this study site can be an example of climate smart agriculture in the conclusions. My only concern is that irrigation is economically and environmentally sustainable practice for this grazed pasture.

Reply: New Zealand's agricultural industry would probably be happy to brand themselves as "climate-smart" (if justified). We will consider whether to mention this as an aspirational goal. However, we feel we would be overstretching the interpretation if we suggested on the basis of one year at one site that such a goal had been achieved.

2. The authors selected 0.12 m s-1 of sigma_w as the low turbulence filter threshold and the NEP was quantified using 0.12 m s-1 of sigma_w threshold. The lower threshold results in the lower proportion of gaps as well as the overestimation of NEP. The results from Fig. 8 can be expected without this kind of assessment. I think that the uncertainty should be assessed using the NEP only from the higher thresholds than 0.12 m s-1 of sigma_w (i.e., the dependency of the measured nighttime CO2 flux on sigma_w was negligible). Actually, the difference between the NEPs from 0.12 m s-1 and 0.15 m s-1 of sigma_w thresholds was relatively small. In that sense, the threshold-dependent uncertainty in this study can be overestimated.

Reply: With all due respect, our interpretation differs from the reviewer's. Firstly, we are not aware of any published graph combining sigma_w- and u_star-thresholds in this fashion. We found it intriguing that the proportion of gaps appears to be a parameter collapsing these onto the same line, and this was not expected. Secondly, the reviewer suggests to use the higher sigma_w threshold because the observed dependence is expected to flatten out as the threshold is increased further. That is the theory. However, our figure, including the u_star-thresholds, indicates this might not be the case in practice, and so does our Fig. 3, where the ER dependence on either threshold variable does not quite reach a "plateau" in any of the panels. Similar behaviour has been reported elsewhere, with perhaps the most striking examples in Anthoni et al. (2004), including 4 different sites. Therefore, we believe that caution is warranted and our estimate of threshold-related uncertainty should not be reduced.

-Specifics-

C2Line 8, page 5: What is "N"?

Reply: N = Northern. Will be spelt out in revision.

Line 21, page 8: The process-based gap-filling method of Barr et al. (2004) is important because its results are used for estimating the uncertainties from the gap-filling procedure. Therefore, please explain more details about the method.

Reply: Our opinion was that the reference would suffice, where the interested reader can look up the full details of the Barr et al. method. We will consider whether to add a couple of sentences stating the main features, but do not find it warranted to allocate more space than that.

Line 29, page 12: How did the authors get those numbers (i.e., 22 g C m-2 yr-1 and 38 g C m-2 yr-1 of the total uncertainties). Please explain the derivation.

Reply: The total uncertainties are obtained as the root of the sum of the squares of the uncertainty contributions in Table 2 (excluding footprint bias).

Line 7, page 13: Please cite a reference for '5% of annual ET.'

Reply: The value of 5 % is our own estimate. It was obtained with the following considerations. The selective-sampling bias for ET is likely to be larger than for CO_2 flux because 1) tube attenuation for water vapour fluctuations is larger than for CO_2 fluctuations (hence, spectral correction more likely to be somewhat in error) and 2) since ET is positive during the day and near-zero at night, such bias not cancelling for daily means. Our estimate is compatible with the degree of closure of the energy budget (Appendix A).

Line 25, page 13: What is "SE"?

Reply: SE = standard error. Will be spelt out in revision.

Line 14-19, page 17: Please briefly compare weather/climate of the site in this study with that in Ammann et al. (2007).

Reply: Annual precipitation and mean temperature are quite similar, however at our site there is typically very little or no snow cover, unlike the Swiss site of Ammann et al. Thank you for making us aware of the similarity. We are happy to include a statement about this in the revision.