

Biogeosciences Discuss., author comment AC2  
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## Reply on RC2

Vasileios Myrgiotis et al.

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Author comment on "The carbon budget of the managed grasslands of Great Britain – informed by earth observations" by Vasileios Myrgiotis et al., Biogeosciences Discuss., <https://doi.org/10.5194/bg-2021-144-AC2>, 2021

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## Reply on general comments

We would like to thank the reviewer for his comments. We would also like to apologise for some "?" seen in the document. These were caused by the LaTeX-based software used to produce the submitted pdf but failing to find certain references and links to tables/figures.

Indeed the identification of grazing and (particularlry) cutting instances is not definite. Identifying grazing and cutting timing and intensity from EO data is an outstanding issue. However, this does not reduce the value of the presented reserach. In this respect, we arue that : (1) the use of earth observation (EO) data to identify these events and use them as drivers of model-based predictions is superior to e.g. using generic dates and biomass removal intensities based on agricultural calendars or data from a limited number of monitored fields, which is what most large-scale model-based studies depend on; and (2) the use of an approach that mixes process-level understanding of grass growing, and grazing and cutting patterns (i.e. a biogeochemical model) and EO data is more robust than relying solely on applying machine learning and time series-decomposition analyses on the EO-based time series.

The concern about the unclear description of how data and modelling is used in this study is shared among the three reviewers. We propose to incude three new figures/schematics that explain the methodology more clearly (figs attached here) and revise the relevant text.

## Replies on specific comments :

**Comment (1)** : it may be more proper to replace the "constrained" used in the title "The carbon budget of the managed grasslands of Great Britain constrained by earth observations" with "adjusted" or "estimated".

**Reply** : We understand the point of view of the reviewer on this issue. The world "constrained" is more widely used in studies that involve observational data assimilation. We believe it is more appropriate than adjusted/estimated mainly because it conveys the message in a way that will be familiar to many readers.

**Comment (2)** What were included in the managed grasslands? Did they include rough-grazing grasslands in the context of three UK grassland types – temporary, permanent

and rough-grazing ?

**Reply :** When we refer to managed grasslands we refer to all of these three types of grasslands : rough grazing, temporary and permanent. To our knowledge there is no geo-dataset that shows the type of specific fields across the UK. The Land Cover Map that was used to sample the fields that were simulated does not discriminate between these three types which it collectively refers to as "improved grasslands". It is not possible to know the type of grassland of a simulated field before simulating it but we can infer the type based on the annual yield (cut + grazed biomass) since we know the UK-average yield for each of these three types of grasslands.

**Comment (3) :** It was said that there were 1855 fields selected for simulations across GB in 2017 and 2018. How many fields were selected in 2017 and 2018, respectively? How many fields were grazed only, how many fields were cut only and how many fields were both grazed and cut? What were the total areas for 1855 fields and in each management grassland type? It would be good to make a box plot showing the size distribution of selected 1855 fields.

**Reply :** The the same 1855 were simulated for 2017 and 2018. There were no cut-only fields among the simulated fields. This is probably an artefact of the sampling process because only fields 6-13ha in size were included in the sample (see section 2.2.1 in the manuscript and line 356>). 75% of the simulated fields were grazed-only and 25% were both cut and grazed (Line 259). We will provide information on the total simulated area and the distribution of field sizes in the revised manuscript.

**Comment (4) :** When selecting fields to be included, the passing criterion was 50% overlap limit. What did the overlap measure specifically? It was also necessary to know how many fields were ignored when simulations were compared with LAI from EO data.

**Reply :** The overlap shows the percentage of simulated leaf area index (LAI) data points (mean predicted LAI) that are within the the uncertainty limits of the corresponding observational data points (i.e. satellite based LAI at 20m resolution -- mean value across the simulated field). For 12% of the initial dataset of 2108 simulated fields, our analysis failed to generate a simulated-vs-observed LAI overlap > 50% (Line 242). As we do not have a dataset of ground-measured LAI time-series across a range of fields we cannot use a data-based method to determine the overlap % that should be used as a limit. Based on our experience with visually examining the fit between observational and simulated LAI time series we argue that 50% is a fair limit.

**Comment (5)** The manuscript was not cleanly finalised before it was submitted to the journal website because there were many places that had unanswered question marks in the manuscript.

**Reply :** We would like to apologise again for this and clarify that these "?" are not unanswered questions but references that for some reason the software used to produce the submitted pdf was unable to find as/where it should.

**Comment (6) :** Flow of information between models used in the coupled MDF algorithm framework was not clearly presented. So, an added diagram may be helpful.

**Reply :** As stated in our reply to general comments we understand that the materials and methods section was not as clear as it could have been and we will revise accordingly.

**Comment (7) :** The "Removed biomass" item in Table 1 was 220 in 2017 and 280 in 2018. If 2018 was extremely hot and dry summer, why was there more biomass for removal because of limited pasture herbage yields? What was included in the "Removed

biomass”?

**Reply :** This is a very interesting question that we do not discuss in the manuscript. We will include discussion text on this issue in the revised manuscript. Briefly, the 2018 summer heat wave affected all areas of GB but not with the same severity. The southern 1/3 of GB was significantly affected but it is also an area with smaller grassland coverage than e.g. Wales, southwest England, northwest England and Scotland. Also, climatic conditions in winter, spring and autumn 2018 were more conducive to higher seasonal (non-summer) yields in areas outwith that southern third of GB. This explains the increased GB-average yield but the possible role of drying on the assimilated satellite based LAI data should also be considered. A drying grassland turning yellow in colour results in a decreasing EO-based LAI. It is possible that as the drought started affecting GB and its grassland fields this reduction in LAI (caused by colour/reflectance change) was simulated by DALEC-Grass as biomass removals and not as leaf drying. However, the model has simulated the impact of drought on leaf production and LAI, and, therefore, the aforementioned process could not have had but a minor impact on the predicted yields

### **Reply to specific points**

We will ensure references to tables and literature will not appear as "?" in the revised document

On the issue of livestock units. As it not possible to infer the type/age/weight of grazing animals using EO data we use generic literature-based values for beef/dairy cattle and sheep when : (1) converting simulated grazed biomass-C to manure-C, CO<sub>2</sub>-C and CH<sub>4</sub>-C (see DALEC-Grass schematic in attachments) and (2) calculating livestock units from MDF-predicted grazed biomass (line 217).

On comparing predicted livestock units with census data. We refer to the issues arising from the fact that census data for England are from 2010 while the study examines 2017-2018 (Line 256). Livestock density (total numbers ÷ total area) has been decreasing (albeit slightly) in England and the UK in general. We argue that the negative bias between predicted and census-based data reflects that fact (fig 3). Also, significant changes in the spatial distribution of livestock across the UK has not been reported in the relevant literature. We argue that it is also not possible due to the fact that the zone of naturally highly-productive grasslands has not changed (i.e. western third of GB). Therefore, the comparison of MDF-predicted and census-based data (Figs 3 and 4) is -- despite its discussed limitations -- a good way to assess if the MDF framework "translated" the EO-based LAI time-series into biomass utilisation in a way that (generally) reflects what is known to be happening on the ground (i.e. relative livestock density at local/regional scale).

Please also note the supplement to this comment:

<https://bg.copernicus.org/preprints/bg-2021-144/bg-2021-144-AC2-supplement.zip>