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Interactive comment on "Modeling vegetation and carbon dynamics of managed grasslands at the global scale with LPJmL 3.6" *by* Susanne Rolinski et al.

Anonymous Referee #1

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Review of "Modeling vegetation and carbon dynamics of managed grasslands at the global scale with LPJmL 3.6", GMD.D, 2017-26

#Overview

This manuscript describes the implementation of 3 new grassland management options into the dynamic vegetation model LPJmL. The new grassland management options were set up in order to model the major ways of how grasslands are managed worldwide. These options were parametrized using reference values from the literature. Then, global simulations of LPJmL over the period 1901-2009 with a daily time step are conducted. The results show global maps of simulated grass growth (NPP), harvest and soil carbon values for the different grassland management options. Then,

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observed grassland harvest data for Europe were used for comparison to simulated values. Lastly, a sustainable potential livestock density map is drawn, depicting the optimal livestock unit density which allows maximum simulated harvest. In the last section (discussion), global results are discussed and compared to other findings in the literature, and perspectives for global simulations are presented.

The paper is nicely written and well structured. It is well-sourced with relevant references in the introduction, the methods (where references values are used for designing the management options) and in the discussions. Figures are well done, although a better choice of some colour scales could be made. It presents new interesting features for grassland modelling with LPJmL, and for the wider DVGM community. Beside the particular issue of the calibration/validation, this paper is nearly ready for publication in GMD.

#General comments

No calibration/validation: This paper presents an implementation of grassland management techniques but no calibration of the model parameters is presented. Though a database of direct observations of grassland productivity at the global scale is not existing, some indirect global products may help to somehow calibrate and validate the approach. For instance, LSUmax densities appears too optimistic in arid areas compared to existing database on livestock densities (see next remark). In particular, a global map of grassland areas (from Globcover for instance) might be used to validate the extent of grassland in arid areas. Validation is presented but only for Europe and only for one of the grazing options. This should be addressed or better discussed in the manuscript.

Figure 14 & Sustainable potentials: I'm rather surprised of the LSUmax densities values in the global map of Fig. 14. It seems that LSUmax densities are overestimated in many arid regions. For instance, all of Morocco area has a LSUmax value around 1, while this country is partly covered by arid deserts where no cattle grazing is possible

(except in small irrigated areas). IMHO, LSUmax values seems also overestimated in Lybia, central Australia & Saudi Arabia. I understand that the LPJ simulations do not take into account all processes involved in land degradation (such as historical overgrazing) but the grasslands production in arid regions seems clearly overestimated. In order to quantify this, it would be interesting to compare grassland production and/or livestock densities with other database. Robinson et al. PloS One, Mapping the Global Distribution of Livestock, 2014 and the companion website http://livestock.geo-wiki.org/ provides livestock densities data worldwide. I understand that Fig. 14 presents a potential maximal LSU (i.e., with 100% of land use affected to grasslands), but a comparison of your findings to the geo-wiki database (or others) would allow to somehow validate your findings about sustainable potentials. Maybe your model parameters should be adapted in order to reflect a better view of grass production in arid areas.

#Specific comments

P3L1: Title of section 1.2 (Representation of managed grasslands in DVGMs) is misleading because the section only states about representation of managed grasslands in LPJ and ORCHIDEE (that partly originates from LPJ). There are no discussions about how this is done in other DVGM, if any.

P3L8: There is no adequate description of the way managed grassland was simulated so far in LPJ. The statement “It has been represented as grassland ecosystem with human management” is too vague.

P3L15-19: At this stage of reading, there is a contradiction about the number of management options that were implemented: is it 3 or 4? The reader understands only later that there 3 new options + 1 default option.

P3: The objective(s) of the manuscript is (are) explained on L27-32 but they could be more clearly defined, maybe using bullets points. Is it to test/calibrate/validate the implementation of new functionalities in the simulation of managed grasslands? To evaluate the importance of accounting for grassland management in NPP global esti-

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mation?

P6L24-30: The way the model reacts after an harvest event is central to the modelling of mowing. More details or explanations on the feedbacks could be interesting. For instance, how much time does it takes to the photosynthetic activity to recover from the cut (in general)? Is some transfer of C from roots to leaves after a cut simulated?

P6L27 or eq. (3): SLA units are missing.

P7L8-10: IMHO, many pastures worldwide cannot be mowed (by machines) because of impractability (very steep pastures, presence of stones/trees, non-portable soil because it is too wet, . . .).

P10 & Fig. 2: What are the rationales behind this climate classification? Why not using classical classification such as the one of Köppen?

P23 L29-30: I suggest to move this sentence at the beginning of the section 4.1.

P23 L33: I would not say that the comparison with European grassland data showed "good agreement".

P25 – 4.3 Further developments: This paper lacks of further validation. I would suggest to add in this section as a perspective a short review of literature about the use of remote sensing data to further validate the implementation of grassland management options. For instance, although I did not find adequate references, change detection techniques based on remote sensing data can detect hay mowing. More well-known is the use of vegetation indices derived from remote sensing data to estimate standing biomass.

P 26 - 5. Conclusions: The "Conclusions" section is short and does not present key numerical results. This could be improved.

Fig. 3: Suggestion: The colour scale of figure 3 is a divergent colour scale but should be changed into a sequential colour scale, as in Fig. 12. Sequential colour scale might

be easier to interpret, are color-blind & black/white print friendly, and fits to the grass harvest, NPP and soil carbon variables, which are sequential variables. However, the divergent colour scales in Figs. 5 b-c, 7 b-c, 10 b-c are OK since differences in NPP and soil carbon between options are divergent variables.

Fig 4: Incoherence of scales: Fig. 4 a) scale for grass harvest is from 0 to 500 gCm-2 while Fig. 3 a) scale is 0-800 gCm-2.

#Editorial comments

P3L21: ". . . to that in (Bondeau et al., 2007), ..." should be ". . . to that in Bondeau et al. (2007), ..."

P3L29: Suggestion (not sure): "...we compare the data with..." should be ". . . we compare the simulations with..."?

P17L7: Seems there is a space missing between "manure." and "When".

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