

Geosci. Model Dev. Discuss., referee comment RC3
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Comment on gmd-2022-176

Anonymous Referee #3

Referee comment on "Modelling the role of livestock grazing in C and N cycling in grasslands with LPJmL5.0-grazing" by Jens Heinke et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2022-176-RC3>, 2022

General comments

This paper presents the development of a dynamic global vegetation model called LPJmL5.0-grazing, which now includes a simplified representation of the grazing of lactating dairy cows and the fate of the nitrogen and carbon they ingest. Nitrogen is thus partitioned between milk, urine and feces and carbon between milk, urine, feces, respiration and methane. The intake of carbon and nitrogen takes into account the chemical composition of the ingested forage and the digestibility and abundance of these constituents. This refinement is what makes this model original. The model was not evaluated by comparing it to observed situations, which prevents the calculation of statistical error criteria, but by comparing it to an empirical modeling of the fate of ingested nitrogen and carbon proposed by Huhtanen et al. A simulation of the partitioning of ingested carbon and nitrogen is done at several sites and an illustration is given of partitions as a function of animal density that has been optimized to meet a milk production or environmental objective. I recommend that the authors make some revisions to their paper to make it easier to understand and to provide more information on the model itself and its domain of validity. In particular, the reading of the paper is not always easy and some points seem to me to be clarified. The descriptive part of the model would be easier to follow if a scheme linking the different main variables and a lexicon of the different variables containing their abbreviation, their definition and their unit were given to the reader. The discussion of the results is coupled with the conclusion. Few elements are discussed. I think we should go back more to the area of validity of the domain, what is taken into account and what is not.

Specific comments

There is mention of feed or forage. What kind of feed is really simulated for the cows? Are the cows only fed with the grass they graze? Or does the model offer the possibility to take into account a supplementation of the cows during the grazing period? From reading paragraph L327 I have the impression that cows are only well fed with fresh grass and

that this explains why they can find themselves in a situation where this grass is no longer sufficient to cover their needs. If it is indeed grazed grass please use grass instead of feed in the whole paper.

Also, does the chemical composition of the grass/feed ingested by the animals vary during a simulation or is it assumed to be identical during the simulation?

These points seem to me important to clarify and discuss at the end. Because if the cows are only fed with grass and that the quality of the grass remains the same during the simulation these are limits of the model.

Lines 151 to 157. I have the impression that there is an error at this level. Does the variable d correspond to a digestible fraction or to a digestible quantity? If it is a fraction, shouldn't the variables for mass wNFC wCP etc. be in the equations? When using these equations (15a) to (15d) as written in the paper in equation (17) the biomasses in the numerator are squared.

L210. The statement "none of them has been explicitly developed for lactating cows" is false. I encourage the authors to read the publications for instance of Delagarde Remy et al. Concerning the GrazeIn model and modify this sentence to reflect the fact that such relationships already exist.

L337. How was the interval between 0 and 0.10 determined?

L340. What resolution in km or ha does it correspond to?

L344. Can you specify the unit of animal density? is it per hectare of useful agricultural area? Per hectare of main forage area?

Lines 390-393. The descriptive part of the model does not explain how these animal density optimizations are achieved to achieve production or environmental objectives. Please add elements so that the reader can understand how these optimizations are carried out.

Figure 4. How do you explain that the share of leached nitrogen is so important at low animal densities?

Technical corrections

L38. Write cows instead of cattle

L52. Please add « respectively » after $w_{N,CN}$ or move ($w_{C,DM}$) after " the weight fraction of feed in dry matter"

L105. Write « fractions » instead of « factions »

L197. RSE instead of RSA

L231. Write biomass availability instead of biomass viability

L262. MP used to abbreviate «Metabolizable protein » can be confused with « Milk production »

L307. Write $m_{C,intake}$ instead of $m_{C,in}$

L309. Write $m_{C,urine}$ instead of $m_{C,feces}$

L326 If accurate, specify « grass » biomass availability

L325 If accurate, specify «milk » production

Figure 2 (and others). using « WN in feed » leads to confusion. why not use « $w_{N,CN}$ »?

Figure 3. Write « as a function of $w_{N,CN}$ »