



EGUsphere, author comment AC1
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Reply on RC1

Maureen Beaudor et al.

Author comment on "Global agricultural ammonia emissions simulated with the ORCHIDEE land surface model" by Maureen Beaudor et al., EGU sphere, <https://doi.org/10.5194/egusphere-2022-626-AC1>, 2022

We thank Reviewer1 for his comments on our manuscript and the time spent on his reviews. Please find below a detailed point-by-point reply to the comments and suggestions to reviewer #1.

Our responses to the reviewer follow the arrow. The text added in the revised version of our manuscript is in italics and the line numbers correspond to the first version of the manuscript.

Reviewer1

Specific comments:

- Modeling set-up: I think it would be very helpful to have a more detailed description of the model run set-up in the supplementary showing how the tested parameters are integrated in the model.

--> We agree it is important to indicate where the parameters are integrated into the model, and for that, we suggest to add a column in Table 5.

In this additional column, we precise the equations and the sections in which the parameters are tested.

When the parameters are not involved in any equations, we rather add a description of the parameter in the main text, and the parameters are referenced by its corresponding Section in Table 5.

This sentence has also been added for clarification:

L.266 It is worth noticing that $input_{fert}$ is given as the ammonium content of the total N mineral fertilizer applied (the parameter $Frac_{nh4,fert}$ is the fraction of ammonium content of the N fertilizer used to make the conversion, this parameter is tested in the sensitivity analysis).

- L672: fertilizer types are available from IFASTAT so I am not sure this statement is true "In addition to the ammonium content, the pH and the type of fertilizer used are hardly available in the literature."

--> We agree fertilizer types are available. We suggest another formulation:

In addition to the ammonium content, the pH used is hardly available in the literature.

- L328: sensitivity not sensibility : --> done
- Table 5: time steps : --> done
- L354: TRENDY (Le Quere et al., 2018) : --> done
- L347: sheep : --> done
- L380: Have you compared total C production? Maybe showing this comparison would be helpful when arguing that the C:N ratio is the main difference. And could there also be an issue with legumes in grassland that you cannot represent in ORCHIDEE?

--> We thank the reviewer for this interesting comment regarding the grassland C productivity estimated by the model.

This data is indeed hardly available in the literature; none of the references used to evaluate our intermediate variables report estimates of C content. They mostly focus on N quantification.

However, Figure 11.9 from the AR5 report of the IPCC (Climate Change; Smith et al., 2014) mentions total grass biomass grazed/harvested of around 1.95 PgC yr⁻¹ (after a conversion from dry matter to C assuming 0.5 as a conversion factor).

In our approach, we estimated global grazed biomass of around 1.2 PgC yr⁻¹ which also suggests a significant underestimation of the grass productivity in C (~40%).

Nevertheless, a C:N ratio model overestimation is also a plausible reason for underestimating N grass biomass productivity since we have shown, based on the literature, a much stronger underestimation in the case of N biomass productivity, compared to the C productivity

It is also worth noticing that the N content in grassland vegetation estimated in previous studies such as in Billen et al., 2014, can present some uncertainties.

Billen's global estimate (80 TgN yr⁻¹) is in fact based on an indirect calculation resulting from a simple difference between livestock ingestion and available crop feed resources.

Therefore, it is likely that N grass biomass is underestimated in our model, due to an overall underestimation of biomass productivity (C and N), and possibly to an overestimation of the C:N ratio. However, it is hard to quantify what can be the contribution of the C:N ratio in the overall N biomass underestimation. As the reviewer suggested, a better representation of the legumes for instance, could help in providing more N through the BNF into the ecosystems and reaching lower C:N ratios.

In addition, we are aware of some regional gaps where the grassland area is low in ORCHIDEE, as in India, which may also lower our global model estimate of the N grass biomass production

We suggest to add these 2 sentences:

L378: By doing so, uncertainties from several components (crop production, net import of vegetal proteins, and human consumption of vegetal proteins) are accumulated.

L381: However, if the grass N production is largely underestimated by ORCHIDEE, our grass C production estimate of 1.2 PgC yr⁻¹ is close to the value of 1.95 PgC yr⁻¹ reported in the IPCC AR5 report (Climate Change; Smith et al., 2014). In this respect, an overestimation of the C:N ratio may also explain part of the grass N production underestimation.

- L381: I do not quite understand how your excretion rate can be smaller than the values given by Paustian et al. (2006). Looking at (5), it seems like you took the excretion rate from Paustian et al. (2006).

--> It is true we compared a regional indicator as an excreted biomass per 1000 kg of animal (from Paustian et al., 2006) and we also took as input for the model an excretion rate expressed as a percentage of the ingested biomass (both from Paustian

et al., 2006).

We agree that our comparison of the excretion rates can be confusing for the reader and since only regional information is provided in Paustian et al., 2006 we prefer removing this comparison point from the section where only global budgets of N are presented.

Thus we remove these 2 sentences in the main text (L377 and 381). In addition, the lines corresponding to ER in Table 6 and 8 have been removed.

- L385: As far as I understand and as I can see in Table 8, what you describe as manure production (66Tg) is manure application. If this is the case, I would not compare it to global estimates of manure N excretion but rather to estimates of N application as well. If this is really manure application, I would also rephrase this sentence: L384: 'In our calculation the manure produced is directly applied to soil'

--> We agree with the reviewer; we should only consider from the literature the manure which is applied to the soil since in our approach we do not consider any other pathway for the final stored manure.

We suggest the following reformulation for sentence L384:

Because we assume that all of the manure stored is then applied to soil, we only consider for the evaluation phase literature data which estimates manure application rate.

In addition, Table 8 has been modified in order to keep only the variable corresponding to the applied manure.

- L431: agricultural NH₃ emissions : --> done
- L432: half instead of twice lower : --> done
- L478: soil pH instead of just pH might be better for clarification.

--> We corrected it by mentioning 'manure pH'.

- There are question marks where references are supposed to be throughout the paper. Please check and add the respective references. --> done