EGUsphere, referee comment RC2
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Comment on egusphere-2022-626

Anonymous Referee #2

Referee comment on "Global agricultural ammonia emissions simulated with the ORCHIDEE land surface model" by Maureen Beaudor et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-626-RC2, 2022

Summary

Estimating ammonia emissions is often challenging due to fertilization and manure production/management varying spatially and temporally over different regions. The paper addresses the challenge through a process-based approach to simulate ammonia emissions from agriculture practices in a global land surface model – ORCHIDEE. Manure management emissions are estimated based on regional emission-factor approach from different animal productions. Soil ammonia emissions are estimated following a flux modeling approach using soil ammonium contents simulated in soil biogeochemical simulations in the system. The feeding and bedding of livestock are associated with crop and grass production simulated from the system. The simulated results are compared and evaluated with two other emission products and IASI satellite derived emissions. Sensitivity simulations to some key parameters are also conducted and evaluated. The research and modeling approach is well described in the paper. The content is well organized overall. Results – average metric over many years, months, or seasons are presented for emission comparisons.

Comments

Areas identified for major improvements in order to be accepted for publication.

- **Indoor ammonia emissions**. Units for equations in this section (pages 8 and 10) need to be clear, particularly TAN related. Emission factors in Table 3 (many > 1) as factor of TAN and it is hard to understand why they are great than 1 from the units provided.
- **Soil ammonia emissions**

- It is hard to understand the $Z_{activity}$ parameter in equation 13 as it is on both side of the equation. How is *TAN(soil,aq)* related to this parameter? I would think deposition is surface application like fertilization despite that some fertilization is applied in deep soil to avoid surface runoff.
- The ammonia flux equation (16) is bi-directional depending on the free-atmosphere concentration which changes seasonally and diurnally. It is too crude to use monthly field averaged over 11 years from the global run (LMDZ-INCA) for its 30min simulation (acknowledged in the conclusion). Although the sensitivity test on this field did not show significant change comparing the change in pH and days of fertilization probably due to averaging evaluation, it does not mean it is not important. Since this is a key parameter in flux calculation, more evaluation is needed. For instance, the paper needs to address how it treats negative and positive flux (16) (average or only count positive flux as emissions). How good is the free-atmosphere concentration – any evaluation comparing ammonia flux field measurement? Or, maybe one year simulation with the free-atmosphere concentration directly from the global run (not averaged) should be conducted to evaluate how it influences the soil emissions spatially and temporally.

- **Constant pH.** Giving the importance of pH in soil ammonia flux modeling – demonstrated in many publication (e.g. *Pleim et al., 2019, JAMES*), it seems that there is no reason to use a fixed pH in this global-scale modeling. Using the soil pH map directly would be a better sensitivity test than just changing it to another constant higher (7 to 7.5) – clearly high emissions expected.
- Figure maps are too small and have color scales difficult to see the regional differences (figures 2, 4, 5, 6, 8, 11, 13 and those in the supplement).

More specific minor comments are listed below:

- Spell out acronyms in the abstract (e.g., ORCHIDEE, USA, CTM, CEDS).
- Spell out acronyms in the main text (e.g., CEDS and EDGAR in line 59, FAN in line 74…, and many others).
- Not all grassland is for grazing or hay production. How does the system differentiate grassland in the grid cell to be natural grassland or for agricultural production? This is related to whether all grassland in the grid cell receive fertilization – both manure and synthetic.
- How does the system constrain each grid-cell's effective crop biomass by the global crop harvested NPP – explain more (lines 175-176)?
- N by plant uptake in the agricultural land is the biggest out pathway for N leaving the field (e.g., *Ran et al., 2019, JAMES*). The paper needs to address how N uptake is handled for fertilized cropland and grassland.
- N fixation is associated with specific grassland (e.g. alfalfa) and cropland (e.g. soybean). Does the data used in the system target the N fixation grassland or cropland (lines 343-344)?
- Many question marks in the text (e.g., lines 415, 417, 613, 618…) – correct them.