General comments

The manuscript “A climate-dependent global model of ammonia emissions from chicken farming” from Jize Jiang et al., describes a model of ammonia volatilization from chicken farming: AMCLIM-Poultry.

The model is based on a simple approach were urea hydrolysis to ammonium and ammonia is implemented for emissions in buildings, in field applied with chicken manure and in farm backyards. A resistance approach is used and specific resistance parameterisation is used for buildings. A simple mass balance approach is used to treat manure water content.

The model is compared to measurements in a few US farms and applied to evaluate worldwide emissions from chicken farming, based on FAO statistics.

The issue is of great interest for the scientific community as ammonia emission is a key component of air quality prediction and environmental impacts and emissions from chicken farming is still not well developed. The presented study is based on the work of Elliot and Collins (1982) for hydrolysis and combined with a resistance approach. The application of the model at the global scale is of great interest, and especially the analysis of the humidity and temperature dependent NH3 emissions as well as the dataset constructed for that purpose.

This manuscript should be published provided some the authors answer some comments on the model design.

- Model: The model is key in this manuscript and it is both very simple but it accounts for the most important processes about the environmental conditions, which makes it effectively very useful. The presentation of the model may however be improved by first exposing clearly, right at the beginning, the hypothesis behind it, second condensing the description in the material and methods only, whereas it is now split between sections, and third, better explicating the model for manure spreading in the field.
    - Regarding model hypothesis, I found several hypotheses that were not always explicit: i)there is no transfer resistance in the litter itself (eq. 7); ii) ammonium is considered the only form of TAN in the liquid phase (eq. 6); iii) the pH is considered not influenced by the UA hydrolysis; iv) NH4+ is consider to be completely free in the litter and soil and not to be bound to soil or litter particles; v) the system is considered to be litter only but no soil; vi) No exports are in the equations but the model is initialised at each house cleaning; vii) there no litter evaporation is considered in the houses, rather an equilibrium is considered.
    - Regarding the description of the model, it would be much easier to read if the whole model could be defined at once in the material and methods: factors affecting UA hydrolysis should be presented in the material and methods. Watch out that the TAN is sum of NH3l+ NH4 and you should justify NH4 >> NH3.
    - Regarding the manure spreading, it is unclear how VH2O is calculated in this situation, and the description of run off is quite unclear.
- UA hydrolysis fitting to RH and TA: Did you try fitting on vapour pressure pvap = RH/100*psat(Ta) ? In addition, did you try fitting on both Ta and RH together?
- Literature: I feel that some important papers may be lacking. In particular, on ammonia emissions data and models from land spreading manure or urea hydrolysis. The literature is much more abundant on dairy cow or pig manure, but I was wondering if and why it would

not be possible to refer to these when building up the model for chicken manure. Some examples given here

  - Ammonia Volatilization after Surface Application of Laying-Hen and Broiler-Chicken Manures. By: Miola, Ezequiel C. C.; Rochette, Philippe; Chantigny, Martin H.; et al. JOURNAL OF ENVIRONMENTAL QUALITY Volume: 43 Issue: 6 Pages: 1864-1872 Published: NOV-DEC 2014. Typos: please check thoroughly the text for typos.
  - The molecular processes of urea hydrolysis in relation to ammonia emissions from agriculture By: Sigurdarson, Jens Jakob; Svane, Simon; Karring, Henrik. REVIEWS IN ENVIRONMENTAL SCIENCE AND BIO-TECHNOLOGY Volume: 17 Issue: 2 Pages: 241-258.
  - Modeling and measurements of ammonia from poultry operations: Their emissions, transport, and deposition in the Chesapeake Bay By: Baker, Jordan; Battye, William H.; Robarge, Wayne; et al. SCIENCE OF THE TOTAL ENVIRONMENT Volume: 706 Article Number: 135290 Published: MAR 1 2020
  - Semi-empirical process-based models for ammonia emissions from beef, swine, and poultry operations in the United States By: McQuilling, Alyssa M.; Adams, Peter J. ATMOSPHERIC ENVIRONMENT Volume: 120 Pages: 127-136 Published: NOV 2015

- Consider shortening the discussion. I found the discussion a bit long with a few redundancy and repetitions.
- A comparison with existing emission factors would be very interesting
- Typos and English. I suggest double-checking the spelling and phrasing of the manuscript.

Detailed comments

P2.L17-18: Could you be more specific on which parameters were tested?

P3.Eqns (1-3): In these two equations, the export flux of excretion by removal during house cleaning is not considered. It would be clearer to add it. This would allow all Mexctretion, MUA and MTAN to get down to zero when the house is cleaned.

P4.L1: FTAN is not a conversion rate but a flux. Please consider revising.

P4.L11: and eq. 4: it would be good to give expression of K here rather than in the results section.

P4eq. 6 is not strictly speaking true since MTAN = $MNH4^+$ + MNH3. Does this mean you consider MNH3 negligible compared to $MNH4^+$? You could easily express MNH3 as a function of $MNH4^+$ based on the dissociation constant and pH and then get a corrected expression for equation 6 that accounts for the pH.

P4L26-27: the justification of using the same approach for backyard and field may be more developed. Especially, how the interaction with the soil is treated.

P5L7-8: NH3 is removed but also fresh air dilutes NH3 in the building: both process occur.

P5 eqns 8 and 9: From what I understand here, the litter (or excretions) has a humidity, which is in equilibrium with atmospheric humidity in the building (express by RH and T). This is similar to soil surface humidity that is in equilibrium with the atmosphere just above. Could-you explain the process behind equation 9?

P6L1: The pH should be influenced by UREA hydrolysis, isn't? Could you better justify the choice of fixing the pH?

P6L28: I suggest explicitly stating that Qxout has been neglected.

P6 eq 12-13: fundamentally, this equation would also hold for water in buildings: hence, humidity in the building may depend on the rate of air renewal and the surface humidity. This would mean that pvapin = f(pvapout, Q, R*, pvapsurface) but also that there would a removal flux for humidity also. Proportional to Q*(pvapin-pvapout). Could you elaborate on that and justify better, why evaporation from building is neglected?

P7L3-4: I suggest defining clearly, what the "system" is: is it the litter only, or the litter plus a certain depth of soil?

P7L8-9: Could you explain better why the water amount in the system could not be less than that in the excretion? Indeed, since evaporation occur, the water amount may become lower.

P7, section 2.3: The field application is unclear and would need further details: 1) TAN in soil is known to be in equilibrium with clay, explain why this process is neglected. 2) The evaporation equations as well as the expressions of the resistances are not given and should be detailed, in the supplementary at least. 3) How is VH2O calculated in that situation?

P8L28: but evaporation ay also occur in the building. Please comment.

P8L30: "houses were empty in different months". Please rephrase as this is unclear what it means.

P9eq 18: I suggest using the term Navailable instead of Nsoil_poultry. It is also unclear from the text, whether N_total includes manure and mineral nitrogen

P10L21-22: It is unclear when the building temperature is not used, what temperature is then used? Please clarify.

P10-P11: section 3.1.2 should be in the material and methods section and not in the results as it is a model description to me.

P11 eq 23: To me it would be more logical if urea hydrolysis would be dependent on the excretion humidity %me rather than RH. However, the two are linked. Could you comment on that?

P11-L16-17: "emissions were due to unavailable measurements": this sounds weird: could you rephrase?

P12 section 3.3: the model for manure spreading was not tested at all, while the model for housing was tested. Would there be any dataset to demonstrate the quality of the model for outdoor application? Alternatively, would there be any paper to refer to on that?

P14- L6-13: it is actually unclear in the previous part if the papers how RH and Ta are modelled in houses.

P14-L14-20: I would suggest adding a table with durations, temperatures and may be RH conditions for the different chicken houses managements discussed

P14-15 section 4.1: it is a bit confusing here to understand how the RH-dependency of urea hydrolysis is used in outdoor conditions. Please detail.

P16L1-10: the whole paragraph except last sentence is quite unclear. Please rephrase. In the last sentence, it may not be true that sensitivity is negligible though, since R* may be very variable among situations.

P16-L27-33: Could we not say that for very large RH, since UA hydrolysis is so effective, there is a limiting effect due to the non-availability of total nitrogen in the system after a certain time?

P17L8-9: Difficult to understand. Please rephrase this sentence

P18L26: It is unclear why initial water in excretion is not accounted for. Please rephrase.

P18-last paragraph: this section would need sensitivity tests to better demonstrate that R* does not represent a great uncertainty.

P19 section 4.3.2: In this section a sensitivity to pH would be interesting to show to illustrate the possible effect of changing the manure pH by +- 1 point.

FIGURES AND TABLES

Fig 1: explain meaning of arrows

Fig 2: I would suggest adding flows in and out of the farm. In addition, an arrow for dilution through ventilation pointing towards INDOOR NH3 LEVELS may be considered. Watch out that the volatilisation flux is bi-directional. An arrow downwards should be shown.

Fig 3: It is unclear how the UA factors were calculated. 3a: could you give a hint on the significance of the difference between the two curves?

Fig 4d and 5d: I would suggest showing also on the same graph the ammonia concentration at z0 (the compensation point) as it would give ground to better understand the NH3 emissions dynamics.

Fig7: please explicit the fact that the curves are evaluated for yearly datasets. I suggest showing also total UAN remaining before cleaning to show any N-limiting effect on Pv. I also suggest rephrasing: 'NH3 volatilization rate Pv(%) for 4 different RH and Ta regimes….'

Table 1: I would suggest adding percentage of N loss for each production system. In addition, you may consider getting rid of unneeded precision in emission numbers.