

## ***Interactive comment on “Modelling land atmosphere daily exchanges of NO, NH<sub>3</sub>, and CO<sub>2</sub> in a semi-arid grazed ecosystem in Senegal” by Claire Delon et al.***

### **Anonymous Referee #1**

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The authors investigate daily exchanges of NO, NH<sub>3</sub>, and CO<sub>2</sub> in a semi-arid grazed ecosystem in Senegal. Three different models (STEP-GENDEC-NOflux, Zhang2010 and Surf atm) are used to simulate daily fluxes during the years 2012 and 2013. Model results are evaluated against experimental results acquired during three field campaigns. Despite the vast extent and importance for global C and N cycling, studies from semi-arid regions are underrepresented in the literature mainly due to challenging conditions for acquiring robust field data. Hence, this study tackles an important topic by testing the suitability of different models to study the land surface-atmosphere exchange of NO, NH<sub>3</sub>, and CO<sub>2</sub>.

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The manuscript is within the scope of BGD, it is mostly well-written, has a relatively clear structure, and it presents new and important data. In principle, it has the potential to be a good contribution; however, the authors have shown little care in the description of the methods, and I unfortunately fail to recognize any interest in ensuring reproducibility of the results. Attention to detail and scientific rigor is rather underwhelming and not up to the standards of the journal. Additionally, some conclusions about NH<sub>3</sub> exchange are drawn on a temporal scale that is not warranted by concentrations measured with passive samplers on a monthly basis. I recommend addressing these issues and expanding the discussion in a major revision.

General remarks and major issues:

1) Typesetting is very sloppy. Subscripts are missing, there are periods in units where spaces should be, variables are not slanted and therefore indistinguishable from descriptive subscripts, captions are missing periods, etc.

2) The manuscript unfortunately suffers from a lack of units, written variable descriptions, and necessary information in general, both in the main text and the appendix. E.g. Table A5, while generally important and potentially useful, is entirely useless in its current state. It is downright impossible to extract any kind of meaningful information from it unless the reader already knows the model anyway. Time scales are often missing from figures.

3) The authors need to carefully address the consequences of using monthly concentration data as input data for a model that is being executed at a 3 hour time step. There needs to be an effort at convincing the reader that the conclusions they draw about the exchange of NH<sub>3</sub> are valid, given that the flux is directly driven by Ca-Xcp, and Ca is only available at a 1 month resolution, whereas Xcp is calculated every 3 hours and bound to be variable throughout the day and over the course of a month, due to its exponential dependence on temperature. Part of their first modelling goal is to investigate daily NH<sub>3</sub> fluxes, so this is crucial to their objectives.

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4) Another one of the three modelling goals is to compare the two NH<sub>3</sub> models; however, only for one of them the component fluxes (F<sub>veg</sub> and F<sub>soil</sub>) are analysed separately. Even then, there is no further differentiation into stomatal and cuticular fluxes. Why? This is where you learn the most about when exactly the models behave differently.

Specific comments:

- P3L17: 2nd objective is unclear, more detail needed.
- P3L31-32: Please check sentence. How can rainfall be on average 356 mm for 2013? Or does “average” relate to the period 1951-2013?
- P4L11p., P8L14p., P8L28, and other parts of the manuscript: What is the reason for the use of 3 h averages instead of a higher resolution, if all the forcing variables except NH<sub>3</sub> concentrations are available every 15 min?
- P4L15: Which Gill sonic model exactly?
- P4-5: (How) were the different measurement heights (meteorology, sonic and IRGA, passive sampler concentrations) considered in the modelling studies?
- P4L16: Why was an outdated version of EddyPro used? There have been lots of bug fixes since 2013.
- P7L6: Add parentheses around Eq. reference.
- P7L7pp. / Eq. (1): Units are missing. Move number to right margin.
- P7L29: Fix typesetting of Eq. Remove “equation” in “(equation 3)”. Move number to right margin.
- P8L19: Typo in “Surface”.
- P8L27: Typo in “Hansen”
- P8L30: (How) was LAI measured?

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- P9L3pp.: Are surface values of T and RH used for the calculation of Rc and compensation points, and if yes, were the parameterisations adapted to it in any way? I assume most of them were originally developed using ambient values at a certain reference height?
- P9L6pp.: This section needs to be significantly expanded. It is completely unclear what was done. p-values need a null hypothesis.
- P9L11pp.: Correlations alone are not really helpful in determining the accuracy of the models, please report offsets and slopes of the regressions as well.
- P9L26: Decimal point missing.
- P10L1pp.: Sign convention needs to be mentioned somewhere.
- P10L28: Was the ANN trained on data from similar ecosystems?
- P12L6-8:  $p=0.2$  is not “weakly correlated”, it is simply not significantly correlated. There is no such thing as “almost significant” in null-hypothesis significance testing.
- P12L13-15: “Indeed, canopy compensation point and ambient concentration values are quite similar” How do you know if you compare 3 h modelled compensation points with 1 month ambient concentrations? This needs to be discussed.
- P12L25-26: Again, how do you know that the concentration decreases within a single month if you only have one data point?!
- P13L6p. and P14L29pp.: Soil temperature at which depth?
- P13L9pp.: How exactly was the model selection done? Have you thought about using an information criterion, such as AIC? Also note that most of these variables are inherently correlated through overlapping diurnal cycles.
- P13L15p.: I can’t really follow this, please elaborate.
- P13L21: This should also be possible with Zhang2010 since both Zhang2010 and

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Surfatm follow a similar structure after Nemitz (2001). I don't understand why this was only done for Surfatm.

- P14L14p.: "Indeed, Zhang2010 model was specifically designed to address [...] average temporal scales [...]" See above, I don't think you can predict more than average temporal scales from your input data.

- Appendix A: Typesetting of Tables is wildly inconsistent. A1-A4 look completely different from A5. A5 is absolutely impossible to follow, because not a single variable is explained.

- Appendix C / P28L11: Typo "Penman"

- Table 1: Numbers come out of the blue. Please add sources. Add period at the end of caption.

- Table 2: See above, why only  $F_{total}$  for Zhang2010?

- Figure 1: Questionable use of Comic Sans in a professional setting.

- Figure 3: Remove white space (put the subplots next to each other). What is the temporal scale (I assume 3 hour averages)? 1:1 line and regression are hard to distinguish, I advise plotting one as a dashed line. The systematic mismatch for LE in the 20 - 60 W m<sup>-2</sup> region is a little suspicious, do you have an idea what is happening there?

- Figure 4: See above re: whitespace. 4a is also a good example why I asked for slopes and offsets in section 3.

- Figure 6: NH<sub>4</sub><sup>+</sup> is not ammonia. Same error appears in the text when the figure is referenced.

- Figure 9: Caption mentions error bars, I don't see any.

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