Response to reviewers and description on the revised manuscript

First, we thank the reviewers and editor for taking the time to review our work. We appreciate the constructive comments made to improve the manuscript.
The manuscript has been thoroughly and carefully revised in line with the evaluations received.

Our point-by-point responses (in magenta, unformatted text) following the referee's comments (in black) can be found below.
The previous text version is in blue and corrections applied to the manuscript appear in **bold magenta**.
Please note that the lines mentioned refer to the newly submitted version.

Reviewer 3:

This is an interesting paper on present-day and future impacts of NH3 emissions. After careful reading I find the study also somewhat limited. The big sales-argument of the study is the new CAMEO agricultural emission module- and the authors spend a lot space to demonstrate that the overall model performance using CAMEO derived emissions compared to CEDS emissions is better. The model is consequently used to explore some future SSP-like scenarios- unfortunately without contrasting to the impacts of the NH3 emissions from the more well-known existing SSP marker scenarios that have e.g. been assessed in Chapter 6 of the AR6 WG1 report. On a first glance- at least for global totals- the IPCC WG future SSP emission ranges (e.g. Figure 6.18) look quite similar to the CAMEO emission changes reported in Table 1- and a valid but unanswered question is to what extent the exploration of the future impacts (aerosol burden, deposition, N2O production) would have looked very different if the scenarios used by the CMIP community would have been used. Is this study new, or confirming existing results?

We thank Reviewer 3 for taking the time to carefully read our manuscript and for the insightful comments.

It is important to note that, this is the first time that future agricultural NH_3 emissions, influenced by climate change, livestock management, and nitrogen fertilizer use, are used to explore their impact on atmospheric chemistry and climate.
It is not straightforward to compare our results with previous studies (from Aerchmip for instance) because of the unicity of the present experiments in which future agricultural emissions for ammonia have been isolated from other future changes. It is likely that the differences arising from a comparison with other versions of the model or previous studies would not inform us on the NH_3 emission impacts purely.

We suggest, however, to include, the relevance of land surface modelling of future NH_3 emissions against CMIP6 inventory (the emissions presented in Chapter 6 of the AR6 WG1 report) for atmospheric chemistry impact analysis as a part of Section 2.2 “Future emission scenarios”.

Beaudor et al. (2024) demonstrate a global agreement between agricultural ammonia emissions developed by the IAMs and simulated with CAMEO. The global estimates from the IAMs inventories are, respectively, 50 and 66 TgN.yr−1 under SSP5-8.5 and SSP4-3.4, compared to 50 $TgN.yr^{-1}$ and 68 $TgN.yr^{-1}$ for CAMEO. In this previous work, three interesting advantages are highlighted in favor of the use of CAMEO emissions:

– The consideration of environmental conditions and therefore climate change (i.e. soil temperature and humidity, CO2 increase, vegetation changes).

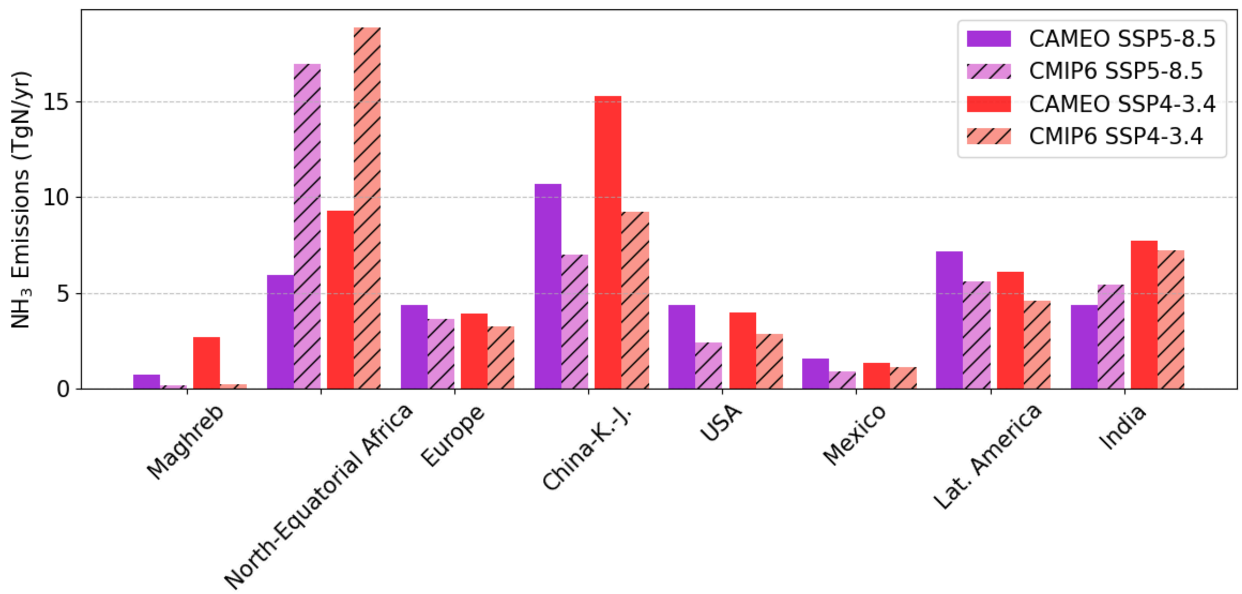
– The consistent consideration of the key ammonia emissions drivers (i.e. N input, meteorology, livestock, and land use) among all future SSPs which is the result of the use of a single process-based model.

– The spatial heterogeneity is driven by environmental conditions and not kept constant over time within predefined regions using the information from the historical period.

– Incorporating CAMEO into the land component of the IPSL ESM ensures better consistency throughout the various components, including LMDZ-INCA, paving the way for advancements in our understanding.

Considering the constraints of IAMs in precisely reflecting the primary factors influencing ammonia emissions, exploring their effects on atmospheric chemistry and climate beyond a global level appears unconvincing. We propose a hypothetical comparison based on the regional differences observed in the IPCC emissions and the CAMEO emissions projected for 2100.

Figure S3 (Supplementary Material) highlights the major regional differences between CMIP6 and CAMEO emissions in 2100 for the two considered SSPs (SSP4-3.4 and SSP5-8.5). The most distinguishable region is Africa, specifically North Africa's savanna combined with Equatorial Africa, where the CMIP6 emissions for both SSPs are more than twice as high as those for CAMEO (>15 TgN.yr−1). The primary explanation for this pattern lies in the simplified downscaling strategy adopted by the IAM method for projection. The approach applies a constant factor across the entire African continent over time, based on historical emissions, neglecting to account for regional influences such as livestock raising expansion and changes in fertilizer application. Specifically, the northern Maghreb region is expected to play a significant role in the future, particularly under SSP4-3.4, as projections indicate an expansion in cultivated lands and fertilizer application, likely driven by the cultivation of bioenergy crops. As a consequence, one of the most expected differences between CMIP6 and CAMEO emissions impact would be a more enhanced production of aerosol formation and NOy and NHx deposition under [434-370] where NOx and SO2 emissions are projected to increase compared to the present-day in Africa. In contrast, in China, the smaller emission fluxes predicted by the IAMs under both SSPs compared to CAMEO indicate that we can expect a limitation / decrease in the formation of ammonium-related aerosols and therefore the resulting deposition, which would be stronger under [434-126].



The second limitation, acknowledged by the authors, is the use of present-day climate conditions to explore future NH3 emissions (and impacts). To my opinion, this aspect is of particular importance (along with the inclusion of compensation point approaches), where the use of CAMEO could represent a step forward. The authors promise to develop a separate study on this aspect- I understand the material could be too much for a single publication- but it does undermine undermine the relevance of the 'future' evaluation in this paper.

The first objective of this paper is to investigate the impact of present-day and future CAMEO emissions on atmospheric chemistry and climate.
It is critical to note, that the future ammonia emissions from CAMEO do include the impact fo climate change and has been explored more in details in the following study: (https://essopenarchive.org/doi/full/10.22541/essoar.170542263.35872590/v1)
We acknowledge and apologize that this aspect was not clearly stated.
We hope to have addressed this more clearly by mentioning it in the introduction as:
For the first time, we propose to investigate how future agricultural NH_3 emissions, influenced by climate change, livestock management, and nitrogen fertilizer use, will impact atmospheric chemistry and climate (kept at present-day conditions).

Climate is kept at present-day climate conditions, only for the impact atmospheric chemistry and climate (i.e., aerosol formation, deposition and nitrous oxide formation), in our study. This allows us to disentangle the different complex drivers at play and focus on the direct impact of the additional NH_3 produced by the agricultural sector under different regional levels of aerosol precursor emissions.
We are aware that climate change constitutes a critical aspect of future atmospheric chemistry and we suggest a new extended section dedicated to future perspectives:

In this study, the simulations are designed to isolate the impact of emission changes by keeping meteorological conditions fixed at present-day levels during 2090-2100. Climate change is anticipated to influence atmospheric chemistry through multiple interrelated factors, such as altered mean and extreme precipitation patterns impacting deposition, warming that could shift some aerosol precursor reactions, and wind variations that may affect aerosol transport. In a subsequent study, additional simulations will explore the combined impact of both emissions and climate change by incorporating future meteorological conditions.

Ass the paper stands it relies qstrongly on the evaluation of the model system with satellite and in-situ data. Obviously the authors have done a substantial and commendable effort, and I am not always convinced how relevant and constraining the comparisons are. In addition the addition the manuscript is very lengthy, and the length of the model evaluation section is contributing to this. My suggestion is to move a lot of detailed evaluation material to supplementary material and instead making an effort to better summarize and discuss the signficance of these evaluation findings in the main manuscript. An example of where better discussion is warranted is the discussion of the match of seasonal cycles (vs annual average) - where it is not made very clear why the effort is done, and what we can learn from this.

Thank you for the recommendation, as also proposed by Reviewer #2, we decided to move to the SI, the scatterplot figures presenting the evaluation of surface concentrations using ground-based measurements.
We also applied a letter labelling on the relevant Figures and added more references in the text. Regarding the suggested discussion, we improved this aspect by adding this paragraph at the end of the evaluation section:

The main takeaway from the evaluation of NH_3 columns and surface concentrations is that using CAMEO emissions results in a significant improvement in the spatial and temporal patterns, particularly in the seasonal cycle, compared to CEDS, except in the US and Europe. It is still important to note that, CAMEO improves the ground spatial variability of NH_3 in the US as highlighted by measurement comparison. The skill functions shown in the Taylor plots indicate that CAMEO emissions can more accurately capture the temporal variability of emissions in hotspot regions when compared to IASI observations.

It is important to focus on matching seasonal cycles rather than only comparing annual averages for multiple reasons. Seasonal cycles provide insights into the variations in emissions and atmospheric pathways throughout the year, which can be linked to meteorological conditions (air temperature and precipitation), seasonal activities (like fertilizer application or manure handling) and specific events (like biomass burning). Understanding these patterns allows for more accurate predictions of air pollution and climate impacts. The effort to improve emission estimates, particularly in regions where discrepancies exist, such as Europe and the US, highlights the importance of utilizing process-based approaches that lets room for considering the bi-directionality property of ammonia.

Bringing it back to my earlier comment- what is the difference of this study with earlier efforts: The relevance of the better performance for future climate impact could then focus on showing that the changes (e.g. in Africa and South America) make a sizeable difference for the overall global results.

We thank the reviewer for sharing this interesting point.
We addressed this point conjointly with the first Reviewer's comment as a new section about the relevance of land surface modelling of future NH_3 emissions against CMIP6 inventory for atmospheric chemistry impact analysis.

Lastly, I recommend proofreading by a native speaker, in particular I noticed space for improvement in the abstract- the entry point for most readers. I made some suggestions for abstract and introduction, but the manuscript would benefit throughout from a proper proofreading.

We are thankful for the careful reading and the constructive suggestions for improving the manuscript understanding.
The manuscript has been proofread by a native speaker.

Below I provide detailed comments- I have spent less effort to discuss details of the model evaluation section.

L1: are responsible for a major source=>English. Are a major source or responsible for a major fraction of emissions. It has been corrected.

L2. Intensification is usually used I the context of agricultural production methods. The drivers are growing population and increasing food demand leading a.o. to intensification. It has been corrected.

L4 Surface deposition feedback is not clear. Feedbacks of the carbon cycle to increased N-deposition? We clarified.

L6 ammonia and ammonium pathways. Reduced nitrogen pathways? We corrected it.

L9 explain what is the CAMEO module about. Emissions,deposition, bidirectional? Note that the journal may require first-use explanation of acronyms. We defined it.

L10 And what about the climate- was also for 2100 conditions, or remained present day?
The climate for the emissions was also taken for 2100 conditions.

L11 What is meant with ammonia representation? Comparison to observations (from satellite, in-situ?). We detailed the sentence as follows:

We demonstrate that this novel emission set enhances the spatial and temporal variability of atmospheric ammonia in regions such as Africa, Latin America, and the United States in comparison to the static reference inventory (Community Emissions Data System; CEDS) when assessed against satellite and surface network observations.

L12 Higherammonia emissions in Africa, as simulated by CAMEO compared to other studies, reflect enhanced present-day reduced nitrogen (NHx) deposition flux.This sentence is not clear: I suspect that the authors indicate that the emissions are also reflected in higher deposition fluxes, which is logical, and even more logical if these are confirmed by observational evidence.

We clarified the sentence:

The CAMEO simulation indicates higher ammonia emissions in Africa relative to other studies, which is corroborated by increased current levels of reduced nitrogen deposition NHx, a finding that aligns with observations in West Africa.

L14 At this place a sentence introducing the scenario framework of this study would be needed; as there are probably more implementations. Also explain that apart from the magnitude of emissions changes, an important parameter is the ratio of NOx/NH3 emissions, and also SO2 emissions.
We incorporated these aspects in the abstract as recommended.

L 19 In climate sciences the word Overshoot is used in a very specific climate scenario context, related to emission pathways. Suggest: Overcompensate? We corrected it.

L20 could be useful to include here how much this is as a fraction of the current best estimate of the overall N2O budget. We incorporated the fraction of future anthropogenic emissions in the abstract as highlighted in the main text.

L24 the issues wrg nitrogen deposition are mostly biodiversity loss (and climate)- maybe for abstract to mention these rather than nitrogen deposition. It has been newly mentionned.

l 29 surface deposition processes. Wet deposition is not a surface deposition process, but still important. Indeed, we corrected it.

l32 account for 85 % of anthropogenic atmospheric NH3 emissions. I would doubt that this statement holds to NH3 abundance in general. The reviewer is right, we corrected it.

l39 very good agreement (can you add one sentence what you mean with this? The following sentence has been completed:
CAMEO-based seasonal variation of NH_3 emissions which depend on both meteorological and agricultural practices highlights very satisfying correlation scores with satellite-based emissions as demonstrated in Beaudor et al., 2023 and Beaudor et al., 2024.

l45/48 clarfiy whether is this still referening to Hauglustaine 2014? We added the reference for this part.

L49 not sure what is meant with ‘removal treatments’ ? Oxidation of NH3?
We reformulated as follows:
RCP scenarios have also been exploited to study the importance of future atmospheric NH_3 on chemistry and climate with a special focus on atmospheric NH_3 losses including oxidation processes

L55 Can you clarify shortly (and in later section somewhat more extenstively how the livestock distribution differ, and whether this study is using Beaudor, SSP or both?

This new paragraph has been added to the introduction:
In the first place, SSP4-3.4 represents the scenario with the weakest evolution of livestock, while SSP5-8.5 shows the most significant increase among all Shared Socioeconomic Pathways (SSPs) according to Riahi et al., 2017.

In addition, the “Future emission scenarios” section has been extended:

In this study, future emissions for different SSPs are used for the 2090-2100 period. CAMEO emissions for SSP5-8.5 and SSP4-3.4 have been exploited for future agricultural and natural NH_3 emissions in the CAMEO[SSPi] (SSPi: 585, 434, 434-126, 434-370) simulations where agricultural sources account for 50 and 68 TgN yr^{-1} (respectively for SSP5-8.5 and SSP4-3.4).
SSP5-8.5 and SSP4-3.4 have been chosen primarily as they represent, respectively, the least and most important increases of NH_3 emissions estimated over 2090-2100 Beaudor et al., 2024.
These datasets have been recently constructed from a newly gridded livestock product and the use of the global process-based CAMEO before being evaluated against CMIP6 emissions developed by the Integrated Assessment Models (IAMs) in Beaudor et al., 2024.

The future livestock distribution has been estimated until 2100, originally, for three divergent SSPs (SSP2-4.5, SSP4-3.4 and SSP5-8.5) through a downscaling method based on regional livestock trends and future grassland areas (the detailed methodology can be found in Beaudor et al., 2024).

L62 could improve the correspondence of modelled concentrations. …. with …
We corrected it.

L70 importance for .. We corrected it.

L87 Two other reference databases that come to mind are EDGAR and IIASA/GAINS. One sentence quoting the numbers for these alternative would help understanding whether the quoted ‘improvements’ apply in comparison to all available databases.
This sentence has been added:

As comparison the EDGARv8.1 inventory (https://edgar.jrc.ec.europa.eu/index.php/dataset_ap81) quantifies for all anthropogenic sectors a total of NH3 emissions of 42 TgNyr^{-1} in 2010 (including 36 TgNyr^{-1} for the agricultural sector).

l99 I guess not only indoor, but important also to understand the manure management aspects.I remember also a rather large contribution from fire emissions in CEDS- can you comment.
It is right, the general term would be “manure management”, and we changed “indoor” for this term.

CAMEO does not include a representation of biomass burning from agricultural practices, the total fire emissions including small fires from cultivated land come from the Global Fire Emissions Database GFED4s inventory (Van der Werf et al., 2017).
This sentence has been added at line 110:

Emissions from biomass burning, including small fires from agricultural waste burning come from the Global Fire Emissions Database (GFEDs) inventory (Van der Werf et al., 2017). NH_3 emissions from fire account for 4.2 TgN/yr for the historical period.

L109. Summarize what you found from this comparison, and why that is important.
This section has been extended as detailed in our answer to the first point raised by the reviewer.

L113 stringent emission regulations, but clarify that this is not necessarily the case for NH3 which is much less regulated.
Indeed, this sentence applies specifically to NO_x and SO_2 emissions due to the sectors which are projected to regulated :

These two SSPs were selected because they represent divergent scenarios for global NOx and SO_2 emissions. SSP1-2.6 represents a "low" scenario with stringent emission regulations, implemented almost worldwide, on various economic sectors such as energy generation, industrial processes and transportation.

L130 22 tracers representing aerosol.There is an extensive discussion of the microphysics, but relevant for this paper, it is not clear to me how the completion for nitrate between coarse and fine fraction aerosol is modelled.

This aspect is brought line 196:

A modal approach for the size distribution is used to track the number and mass of aerosols which is described by a superposition of five log-normal modes (Schulz, 2007). The particle modes are represented for three ranges: sub-micronic (diameter <1 μm) corresponding to the accumulation mode, micronic (diameter between 1 and 10 μm) corresponding to coarse particles, and super-micronic or super coarse particles (diameter >10 μm).

L161 this an important limitation that should be mentioned upfront (i.e. not evaluating climate change influence on the emissions).
This sentence is a mistake. The future simulated emissions by CAMEO do include climate change as assessed in Beaudor et al., 2024. This sentence was inherited from a first draft version of the paper and has been removed.

We apologize for this confusion and understand why the reviewer was not convinced at first by the relevance of our work considering this sentence.
The following sentence has been added instead:

The combined impact of climate change and future agricultural emissions NH_3 on atmospheric chemistry and climate is an interesting topic to further investigate in the future.

L164 The ocean emission estimate is probably an upper limit; e.g. Paulot et al. 2016 give twice lower estimates.
We agree and we acknowledge this difference as follows:

.. which is higher than the estimate from Paulot et al., 2015 (2-5 TgN/yr).

L171 I would recommend to include a set of simulations that also uses the SSP1. As eluded to previously, the lack of comparison of the community SSP scenarios to the ones from CAMEO, leaves an open question on the novelty of the results.
Adding the CTM simulations for SSP1 is challenging since we did not simulate the agricultural NH_3 emissions with CAMEO for this specific scenario.
For tackling the lack of comparison, we added a hypothetical analysis based on the regional differences observed in the IPCC emissions and the CAMEO emissions projected for 2100 (this aspect is detailed in the first comment).

L200-214 It will be useful to also provide the relative changes in percent to the absolute numbers.

We mentioned relative changes in percent into parentheses when relevant. For instance see, the following sentence:

When the CEDS inventory is replaced by CAMEO in LMDZ-INCA, the global simulated columns are 50% higher (of around 0.04 molecules x 10^{16} cm^{-2}) but closer to the IASI-measured global average (0.15 molecules x 10^{16} cm^{-2}).

L212 Biomass burning inventory of NH3?
This sentence has been added at line 110:

Emissions from biomass burning, including small fires from agricultural waste burning come from the Global Fire Emissions Database (GFEDs) inventory (Van der Werf et al., 2017). NH_3 emissions from fire account for 4.2 TgN/yr for the historical period.

L217 Do I understand correctly that CEDS simulation was run without natural emissions? Isn't that comparing apples and pears?
The CEDS simulation did not run with natural soil emissions while CAMEO dataset does include them. Most of the CTM that investigated NH_3 emissions and aerosol formation up to now were not run with natural soil emissions since this dataset is not easily available. CEDS inventory does not provide natural soil emissions since it is an anthropogenic sources inventory.
Our objective was to analyze the benefit of using process-based emissions for NH_3 (i.e from CAMEO), by adding natural emissions to CEDS, we would not have been able to assess as clearly this aspect.

L225 the S and T markers in the Taylor plots are not terribly well explained- is it discussed somewhere what is evaluated with this?

Explanation has been added L.279

The Taylor plots in Figure 2 represent statistical metrics for both temporal and spatial analyses. The temporal analysis is shown for monthly time steps, using triangle markers with T labels, and involves averaging over the corresponding regions. On the other hand, the spatial analysis is derived by averaging over the monthly time-series from 2011-2014, indicated by plain circle markers with S labels. These plots include metrics such as normalized standard deviation (plotted on the x-y axis, where the observation is normalized to 1), Pearson's R correlation, and a skill function, represented by grey isolines.

L235 the monthly column comparison show indeed improvement of column levels over Africa and S. America, but not really or even contradicting elsewhere. What can we still learn about CAMEO vs GCM modelvs CEDS?

By looking at the Taylor plots, we can see that CAMEO does improve the seasonal and spatial variabilities of the NH_3 columns worldwide except in Europe and the US.
An additional sentence is incorporated to highlight what can be learnt about these results:

While the CAMEO emission prescription appears promising for improving the seasonal cycle of the columns, there is still potential for refinement in the process-based approach, particularly in Europe and the US, where summer emissions appear excessively high. Future advancements in bi-directional flux, accounting for deposition and the compensation point, could address this issue.

Moreover, in Africa, biomass burning emissions significantly impact temporal representation, which is presently derived from an external inventory (Van der Werf et al., 2017).

249 I would say that the 'gold' standard for quality controlled deposition observations is by the WMO GAW program. Vet et al.However, I think that not all data needed for this study where available. It would be relevant to mention this 'lack' of evaluated data in discussion (if considered important).

Thank you for raising this aspect. Deposition observations will be used in the next step of the work, to evaluate the performance of the bi-directional NH_3 fluxes scheme.

Figure 4,5,6 It is hard to get a general picture from the surface concentrations comparison, but overall in particular the measured particulate concentrations of NH4/NO3 seem to be up to a factor of 10 higher than the modelled ones for all networks. What are the possible consequences for this work? Have you considered mismatch of SO4 as one of the root causes for discrepeancies?

A combinaison of factors explain the low simulated nitrate concentrations at the surface.
This version of the model has always shown a strong vertical transport combined with low scavenging in the upper troposphere (Bian et al., 2017);
To some extend, this strong transport of nitrates to the upper troposphere is a robust signal and has been observed in the Asian Tropopause Aerosol Layer region during the monsoon season (Höpfner et al., 2019; Yu et al., 2022);
However, the CAMEO NH_3 emissions are significantly increased compared to CEDS during this period (JJA) over India; more nitrates are produced and subsequently transported to the upper-troposphere in that region and then spread all over the globe due to the high residence time of aerosols in the UT.
This feature of the scavenging is currently investigated in a newer version (79 levels, CMIP6 physics) of the model (PhD N. Février).

This aspect has been incorporated into the manuscript at the end of the model-observation comparison.

L512 Do you mean 'reducing agricultural' emissions- which can be done by e.g. reducing livestock numbers, but also practices (e.g. feed or manure management).
We clarified.

L534 twice higher than the deposition budget of the three alternative estimates. Corrected.

L535 higher NH3 emissions in equatorial Africa (clarify) We clarified.

L536. It is not well explained how wet deposition of NH3 is considered- where NH3 perse has a low Henry's coefficient.

We apologize but it is a confusion from our side, the Henry's law constant has been updated according to Bian et al., 2017.
We corrected this aspect in the manuscript.

L539 what is meant with 'good correlation'; and how are EMEP and CCMI modelling results entering the story? We corrected it for "good agreement".

L542 is deficient? Do you mean absent (i.e. they provide annual numbers)? The CCMI deposition dataset is a crucial… We corrected.

L543 I would agree with this statement, but it raises the question why it was not included (or maybe it is, but not clearly described).In general it should be considered that it is probably to be considered that in the end we are talking about ecosystem emissions, which would included interactions between soil, vegetation and atmosphere.

We included this section at line 700:

Incorporating the nitrogen cycle into Earth System Models (ESM) is a recent advancement, as highlighted by Davies-Barnard (2022). Developing interactions of nitrogen compounds is complex due to the intricate processes involved, necessitating readiness in coupling atmospheric chemistry and land components. The studies by Pleim (2019) and Vira (2019, 2022) provide a foundational step toward bidirectional ammonia handling, though not yet fully integrated into existing ESMs. Vira (2022) notes that FANv2 does not currently feed back nitrogen losses to the nitrogen cycle in the Community Land Model, leaving fertilizer nitrogen availability to crops unaffected. Our approach does include feedback from nitrogen loss affecting available nitrogen for vegetation, even without a bidirectional scheme, yet exploited. Additionally, we uniquely incorporated nitrogen biomass removal from livestock needs, ensuring nitrogen and carbon budget accuracy. Efforts are ongoing to develop nitrogen species exchanges at the atmosphere-surface interface in the IPSL-ESM, aiming to assess chemical and climate impacts through interactive coupling.

L550 clearly state that this is future perspective. We clarified.

L555 for sure future livestock is at the basis of many future emission estimates. It is the combination with ‘interactive’ soils that is probably not explored.
As mentionned, we are not aware of any future product of *gridded* livestock exploited for future ammonia emission projections. It is worth noting that the worldwide IIASA database provide only regional trends of livestock.

L560 (and throughout paper when talking about nitrate do you mean HNO3, NO3- or the sum of the two?
Thanks for bringing it to our attention.
For this specific line, we referred as nitric acid and corrected it to be more precise.
“Nitrate” throughout the text is considered as NO_3^- only.

L595 It is not so clear to me what the Bertagni study is calculating. Still the N2O from atmospheric processes, or e.g. the additional N2O emission resulting from enhance NH3 deposition? Clarify.Agree that this is an important issue in particular if emissions from NH3 as an energy carrier are not well controlled (which it should as it is a quite dangerous and toxic component).
It is an interesting aspect.

Bertagni et al., estimate the same N_2O atmospheric source as we do from the ammonia oxidation. See this quote from their paper referring to the factor they used in their approach: *1% of the nitrogen in ammonia can be converted into N_2O following ammonia reaction with the atmospheric OH radical.*
We made it clearer in the text.

L597-602 I encourage the authors to persue this work, as it is probably going to be quite important.—
We appreciate the positive encouragements from the reviewer and are excited to continue this investigation.