The manuscript "Evaluating present-day and future impacts of agricultural ammonia emissions on atmospheric chemistry and climate" by Beaudor et al. examines the impacts of ammonia (NH_3) emissions on atmospheric chemistry and climate. The authors used the chemistry-climate model (CCM) LMDZ-INCA to simulate present-day and future atmospheric processing of NH_3 (atmospheric concentration, aerosol formation and deposition), while also evaluating the climatic consequences (changes in radiative forcing RF and aerosol optical depth AOD) under different shared socio-economic pathways (SSPs). The novelty of the study lies in the incorporation of a new NH_3 emission input from a global land surface model, ORCHIDEE-CAMEO to the CCM. The model results were compared with satellite observations and ground-based measurements, demonstrating good agreement. This study contributes to adding knowledge of future projections of atmospheric chemistry and climate, with an emphasis on the role of NH_3 emissions. The manuscript aligns well with the scope of Atmospheric Chemistry and Physics, and I recommend publication after the authors address a few points.

General comments:

1. A key improvement the authors could make is to explain why the CCM was used to simulate the period from 2004 to 2014, but the model results were compared with ground-based measurements from 2015. It seems less convincing to compare modelled outputs averaged over 11 years to a different year that is not included in the simulation period. I understand the same-year comparisons might not always be possible because of insufficient data, but this does not appear to be an issue for this study. The emission model (Beaudor et al. 2023 GMD) provides NH_3 emissions from 2005 to 2015, and meteorological input from the ERA-interim reanalysis for 2015 should be accessible. Measured datasets of annual surface NH_3 concentrations in year 2010 are available as shown in Fig. 4 in Ge et al. (2021 GMD). This also raises the question of why NH_3 concentration comparisons for 2010 were not included in the analysis.

   I think it is important for the authors to either:
   A) Extend the CCM simulation by an additional year, incorporating the corresponding emission input, so that year 2015 can be included and directly compared with the observations from the same year.
   B) Provide a clear justification for comparing model outputs with measurements from different years, along with a discussion of the uncertainties and

implications associated with this approach, particularly given that there is inter-annual variability in NH_3 emissions.

Regardless of how the authors choose to address this question, I strongly encourage to include an evaluation for the year 2010, i.e., by adding annual NH_3 comparisons for different regions to Fig. 4 to 6.

2. It would be helpful to provide more details in the Method section. I find it unclear on the description of how RF and AOD are calculated.
3. It would be interesting to see a full NH_3 budget. E.g., I would like to see the authors show how much NH_3 contributes to the formation of N aerosols, in addition to what has been reported in Table 5.

Specific comments:

Line 87: The authors can provide a timeseries of the new NH_3 emissions that were used for the modelling. This figure can be put to the Supplementary materials, and readers can learn the inter-annual variability in the emissions.

Line 100: Why estimated agricultural NH_3 emissions were reported to be 44 Tg N per year from 2005 to 2015 in the emission paper (Beaudor et al. 2023 GMD), but it turns to 35 Tg N per year for 2004 to 2014 in this study? Why is there such a big difference?

Line 125: Is the emission resampled to fit the resolution of the CCM?

Line 154-161: Which meteorological variables were used for the modelling? What is the spatial and temporal resolution of the meteorological inputs? Another question is since LMDZ-INCA is a CCM, what is the reason for not using the weather fields generated by itself?

P9: Regarding Fig. 1, please consider showing the percentage difference for map (d) CAMEO – IASI.

Line 224-225: By what evidence can the authors claim that IASI observations does not reveal a “unique peak” which is a modelled feature?

Line 235-236: I see CAMEO shows the peak in the same months as CEDS for India (Fig. 3). Can you check?

P11: Figure 3 shows that CEDS performs better in EU than CAMEO.

Line 245: Why not compare annual NH_3 concentrations in 2010?

Line326: Why LMDZ-INCA uses a low constant? What is the implication?

P20: As suggested, it would be interesting to show the aerosol formation in Table 5.

Line 359-360: I think there is a problem with the calculations. E.g., for CAMEO[585], the increase is (0.27-0.17)/0.17 = 0.59, 59 % rather 37 %. Please do check the numbers in the following text and in the abstract.

Line 388: Why H_2SO_4 is not included for T_S in Equation 1?

P23: I think it is helpful to explain why look at different pressure levels.

Line 404-405: Please restructure the sentence "It is explained by the reduced amount of NH_3 ..." to improve the clarity.

Line 416-418: Why is there a shift from nitrate-rich to ammonia-rich at 900 hPa, while the chemical domains at the surface does not change much?

Line 425-426: The sentence is not very clear to me. The effect of what?

Line 426-428: TBH, I barely see the difference between 434-126 and 434 over India, Europe and the US...

Line 440: What does "levels" mean here? Emissions?

P25: I feel there is a need for better referring to figures in this whole section. Sometimes it is difficult to follow the text without looking at the figures, but there is no clear referring.

Line 448: Delete "Finally,".

Line 458: CAMEO[434-370] or CAMEO[585]? Please check Fig. 13.

Line 412-413: Why attribute the same NO_y deposition between CAMEO and CAMEO[434] to identical NOx emissions? Figure 10 shows that there are higher [NO_3^-] over EA.

Line 472-474: This is a long sentence. I suggest split into short sentences to improve readability.

Line 478-479: Why nitrate AOD is mostly increase in CAMEO[434-126]?

Line 503: How is the value 1.6 $Tg(N_2O)yr^{-1}$ calculated? Same question for the value of 2.9 in line 508.

P1 in SM: I think the authors should consider using maps that show the differences between emissions from future and present-day.