

Thank you for these new comments. We have now revised the manuscript according to these comments provided by the reviewer. Please find below our reply to those.
DH, YB, MS.

I am in general satisfied with the rebuttal of Hauglustaine et al. to my review. I have re-read the manuscript and supplement, and list some minor comments that I noticed in the revised version. It would be good if these last comments could be taken into account before accepting the paper.

l. 75: Explain what Bauer et al. found- as relevant for this paper.

The nitrate radiative forcing calculated by Bauer et al. with the GISS model for the present and in 2030 are now mentioned.

l. 83 Give numbers between brackets.

The nitrate forcings are now provided for the present and in 2090.

l. 106 irreversible removal ?

Yes, this is now specified.

l. 149-151 Perhaps it is opportune to explain that the small IH mixing time points to relatively vigorous (local) **vertical** mixing. Perhaps the authors can also refer to published radon simulations?

'Vertical' is mentioned and the references provided refer to the simulations of inert and radioactive tracers. 'Radioactive' has been added.

l. 267 Do you refer to a specific ISORROPIA version? Here you mention 'fairly good', in the appendix it is 'excellent'. I suggest to summarize this as follows: an excellent agreement between both model results has been over a range of key parameters currently encountered in the global model version, with some larger deviations (>xx %) at temperatures larger than 295 K.

We used version 2.1 of ISORROPIA, this is now mentioned. The text regarding the agreement has been modified accordingly.

l. 271 this is somewhat slang. Numerically, first photochemistry.

The text has been clarified.

l. 446 It is interesting to see the diurnal variations in the appendix. However, the authors should try to include a somewhat more extensive description of what day-night ratios are found in these regions. I understand you don't want to run into an extensive comparison, but only results from one paper is somewhat meager.

We have revised this paragraph. More references showing the diurnal cycle of nitrates have been added in the main manuscript and in the supplement.

501 As illustrated by Xu et Penner=>do you want to say: to enable comparison with Xu and Penner???

Yes. The text has been modified as requested.

502 I don't understand these negative ratios. Is this something numeric? As it is written in the text the numbers can not be negative. I suggest to avoid confusing language- and figure by modifying the color scale (grey value above a small threshold value, white colors smaller than this threshold). It is probably not important, but should be correct.

Figure 5 shows the free ammonia T_A^* to total nitrate T_N ratio. T_A^* is defined by relation (6) as the total ammonia minus the ammonia needed to neutralize all available sulfate and by definition is negative if $T_A < T_S$. Regions with a negative ratio physically represent regions where ammonia is significantly limited and no excess ammonia is present either due to very low ammonia concentrations or high sulfates concentrations. In these regions all the ammonia is used to neutralize the sulfates and form ammonium sulfate. We added a reference to relation (6) in the text to avoid confusion between T_A and T_A^* .

525 (or 8 &) of all nitric acid formation.

Text clarified.

532 Also mention that loss on liquid (and ice) clouds were not considered. To some extent cloud occurrence puts some lower limit to the N_2O_5 removal- if there is a cloud the reaction is almost certainly fast. The removal rate is then mostly dependent on the statistical probability that air masses are mixed with clouds, timescale in the order of a few days.

This process was not considered either in other studies such as Xu and Penner but this limitation is now briefly mentioned in the text.

559 If the authors agree I propose upgrading of this statement (towards conclusions/abstract) as the number has not often been recalculated since Dentener/Crutzen and Lee et al paper.

D.S. Lee, I. Kohler, E. Grobler, F. Rohrer, R. Sausen, L. Gallardo-Klenner, J.G.J. Olivier, F.J. Dentener, and A.F. Bouwman, Estimations of global NO_x emissions and their uncertainties, *Atmos. Environ.*, 31, 1735-1749, 1997.

The reference to Lee et al. (1997) and to their estimate of the N_2O source has been added in the main text. However, we prefer not to mention this statement in the conclusion and abstract since the focus of the paper is nitrate and their forcing and we found difficult to include the statement as it would appear far-fetched.

606 The description in the supplement of deposition is now somewhat 'widowed', and could refer back to this section (or include some of the main text)

We added a short description of the various plots and of the NMB calculated in the supplement.

722 and further: please check units microgram/cm³=>microgram m⁻³???

Well spotted. The typo in these units have been corrected in the main manuscript and supplement.

757: negative ratios: avoid to introduce this concept.

Please see reply to comment on line 502 regarding the meaning of negative ratios.

Supplementary material:

l. 46 essentially=>hardly anywhere?

Yes. These high concentrations are 'hardly not reached' in the global model grid-cells. The text has been clarified.

l. 50 regions concerned=>regions with fine nitrate formation

Text modified accordingly.

l. 53 dissociate is not the right term. Evaporate?

Sure. Text corrected.

l. 53 A somewhat more extensive linkage to available studies on day night ratios is needed.

We have revised this paragraph and added more examples of studies providing the measured diurnal cycle of nitrates. These all show a buildup of nitrate particles during the night, a maximum in the morning and a decrease and minimum during the day. This general behavior, also found in the model, is now mentioned.

98 there is virtually no choice=>it is not possible to rely on

Text corrected.

110 In Figure S5 etc: does 'world' include or not Europe/North America.

Yes. The captions have been modified to specify that 'world' refers to all data available.

113-116: more is explained in main text. Description here is almost absent.

We added a short description of the various plots and of the NMB calculated in the supplement.

Figures S4-S6: The lettertype is hardly readable, too small in the pdf.

The various panels of former figures S4, S5 and S6 have been enlarged by 50%. Since it was no longer possible to include all regions in one figure, former S4 and S5 have been split in 3 and 4 figures respectively.