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Interactive Comment

Interactive comment on "Lightning NO_x emissions over the USA investigated using TES, NLDN, LRLDN, IONS data and the GEOS-Chem model" *by* L. Jourdain et al.

L. Jourdain et al.

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1. We agree on the reviewer's point of view: our conclusions suffer from the imperfect treatment of the stratospheric ozone contribution. We have added this point explicitly at the end of the abstract. The influence of the stratosphere on tropospheric ozone is also emphasized at the end of the Introduction. We also discuss the limits of our study in the Conclusion section and emphasize that the treatment of the stratospheric ozone flux in global models merits further investigation

It is important to note that we have now removed the Sstrat simulation from the paper. Indeed, we used initially Sstrat as a part of a sensitivity study to show that ozone mixing ratios in the upper troposphere in GEOS-Chem are very sensitive to the treatment of

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the flux from the stratosphere. Reviewer 1 suggested to use Sstrat as the baseline in the paper but we have preferred to remove Sstrat from the paper because we did not want the GEOS-Chem users to think that we have fixed the stratosphere in the GEOS-Chem model. Indeed, it was not clear in the previous figure 3 of the paper but the setting of Sstrat presents some drawbacks. In particular, it leads to an overestimation of the ozone mixing ratios in the uppermost troposphere and lower stratosphere in the model. This point is detailed in the responses to the reviewer 1.

Therefore, in the paper, we now just infer a problem with the stratosphere in the model because the bias between GEOS-Chem ozone and measurements increases with altitude (comparison with IONS ozonesondes in section 2.4) and also with latitude in the upper troposphere (comparison with TES in section 3.1.2).

Please note that we have removed the results for the simulation Sstrat in figures 3 and 7 and have changed the text accordingly.

2. In Slight2 simulation, the NOx production by flash is increased by 2 only in midlatitudes to use the value of 520 mol NO/flash, given by recent studies of thunderstorms over the US. Indeed, it is now thought that midlatitudes and subtropical flashes may produce more NO per flash than flashes in the tropics. This may be due to greater flash lengths in the midlatitudes and subtropics that may result from greater vertical wind shear. This is the hypothesis put forth by Huntrieser et al. (2008, ACP) based on aircraft measurements in Brazil during the TROCCINOX campaign. If tropical flashes make less NO per flash and perhaps 70% of the flashes are in the tropics (based on satellite observations), the global LNOx production would not be as large as 17 TgN/yr but more around 8 TgN/yr which is within the range suggested in the comprehensive review of lightning NOx by Schumann and Huntrieser (2007). We have added : ”Note also that with a NO production of around 520 moles/Flash in midlatitudes, the global LNOx production would be around 8 TgN/yr which is within the range suggested in the comprehensive review of lightning NOx by Schumann and Huntrieser (2007)” in section 2.3 when describing Slighx2.

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3. We agree on the reviewer's comment on Figure 8. As suggested, we now use the approach of Price and Rind (1992) to look at the simulation of the lightning activity by the model. We now calculate the frequencies of spatial matching between the observed and simulated lightning as in Price and Rind (1992). More precisely, the gridboxes having a non-null daily lightning activity are assigned the value 1 and the gridboxes having a null daily lightning activity are assigned a value of 0. If both observations and calculations have a value of 1 or 0, they match spatially. Otherwise, if the values are different, they are not spatially in agreement. The expected frequencies +/- standard deviations due to randomness are also calculated according to Price and Rind (1992). The total number of matching gridboxes varies approximately between 65% and 90%. This number is more than one standard deviation larger than what would be expected under complete randomness.

We changed the figure 8. The text has been changed accordingly at the end of the section 3.2.1 as well as in the figure 8.

4. We changed our title by : 'Lightning NOx simulations over the USA constrained by TES observations and GEOS-Chem simulations' as suggested.

Technical Corrections:

Last sentence of the abstract: corrected as suggested

p1131 line 7, corrected as suggested

p1131 line 9: The production of NOx by lightning of 0.28 TgN in the simulation Slightx2 is for July. The value of 0.45 TgN of Hudman et al. (2007) was the mean over the period of the 1 July to 15 August 2004. Therefore, the 2 values are consistent.

P1133, lines 9-12: we did not drop the sentence, because we want to stress that we focus only on the lightning source even if the stratospheric source could contribute to the bias between GEOS-Chem and the measurements (IONS, TES).

p1134, line 12-14: Theses lines have been simplified. In the section 2.4, the lines

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p1132, line 7-12 have been modified to mention the vertical interpolation onto the TES vertical grid, and that it is done for all the comparisons with TES.

P 1134, line 24: modified as suggested

p1139, line 10: modified as suggested

p1140, line 4: corrected as suggested

last sentence in conclusions : corrected as suggested

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 1123, 2009.

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