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Interactive comment on "Estimating the NO_x produced by lightning from GOME and NLDN data: a case study in the Gulf of Mexico" *by* S. Beirle et al.

Anonymous Referee #2

Received and published: 9 December 2005

General Comments: This manuscript contains a very detailed analysis of the production of lightning NOx as observed by the GOME instrument for thunderstorms over the Gulf of Mexico. The analysis takes into consideration the variation in air mass factor due to lightning NOx and clouds, transport of anthropogenic NOx, the effects of aged lightning NOx from other storms, and the fraction of NOx that is in the form of NO2. I have a few suggestions about how these aspects are handled in the specific comments below. Overall, this is a well-organized manuscript that addresses an important problem in atmospheric chemistry. The contribution of lightning to the NOx budget has the largest uncertainty of any source. The results are carefully put into perspective through

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the calculations of uncertainty that are presented. The final result for NOx production per flash (77 moles/flash) and for global production (1.5 Tg N/yr) are near the lower end of estimates in the literature. Other lightning NOx analyses using GOME data by Beirle et al. (2004) and Boersma et al. (2005) have also yielded relatively low values of global production (2.7 and 3.5 Tg N). The authors of this manuscript should address the question of why all of the GOME-derived estimates are lower than the estimates derived by other methods.

Specific Comments:

p. 11297, line 8: change "about some" to "several"

p. 11297, line 21: reword to the following: Further complications arise from differences in the lightning frequency used in the calculations and possibly from differences in NOx production for cloud-to-grounc (CG) and intracloud (IC) flashes.

p. 11297, line 26: Add a couple of sentences referencing Huntrieser et al. (2002, JGR). She made two estimates of global production based on EULINOX data (3 and 4 Tg N/yr).

p. 11299, line 21: ...studies on particular lightning events using GOME data have also....

p. 11300, line 16: ....independent of longitude.... I assume a dependence on latitude is included. If so, this should be mentioned.

p. 11303, lines 15-17: constant e-folding lifetime – how long a lifetime for NOx is used in the model? I think a vertically varying NO/NO2 ratio would be better. Please comment in the manuscript on these issues.

p. 11306, line 26: Table 2 is referenced here. I cannot find it in the paper. Was there a Table 1? The authors need to provide some details on how the Profiles of Pickering et al. (1998) were employed. The profiles are of the fraction of the total lightning NOx that is injected into each 1-km deep layer within a storm. How much actual mass of LNOx

ACPD

5, S4388–S4391, 2005

Interactive Comment

was assumed in this case? How was it partitioned between NO and NO2?

p. 11306, line 28: I don't think "retrieved" is the correct word here. "Computed" would be better since the profiles come from model calculations.

p. 11307, line 3: change "measurements" to "model calculations".

p. 11308, lines 23-26: I would assume that the primary reason for the underestimate is that lightning NOx is not included in this run of the FLEXPART model.

p. 11309, line 4: southwards from the coast

p. 11309, line 28: ...the fraction of the total LNOx that is aged LNOx....

p. 11310, lines 15-16: 11% of the LNOx was aged. You can't assume that the aged LNOx is 11% of the detected NOx. It is really 11% of 90% of the detected NOx, since 10% of the detected NOx is anthropogenic. So, the aged LNOx contribution is 10%, not 11%, and the total of anthropogenic and aged LNOx is 20%, not 21%. Fresh LNOx contributes 80% instead of 79%. Minor difference, but let's get the logic correct.

p. 11310, lines 17-18: Scaling needs to be corrected. It is 100/80 x 80 = 100. So no scaling is actually necessary. The scaling factor is now 1 rather than 0.99.

p. 11312, line 15: Table 4 is referenced here. I cannot find this table in the manuscript. Tables 2 and 4 have been mentioned thus far in the paper. Was there meant to also be Tables 1 and 3?

p. 11313, line 9: I don't think transport should have been neglected for the southern system. This system was older (had been producing LNOx for a longer period of time prior to the GOME overpass) and there is more of a chance that some portion of the LNOx had been transported out of the GOME pixels than is the case with the northern system.

p. 11314, lines 5-6: It is not clear why there would be a shift toward NO with more anthropogenic NOx. NO and NO2 come into equilibrium very quickly after emission of

ACPD

5, S4388–S4391, 2005

Interactive Comment

NO from anthropogenic sources.

p. 11314, line 28: Good to see a large range of NO2/NOx ratios being used. NO2 photolysis rates certainly could be enhanced by a factor of 2 or more in the anvils compared with clear-sky values.

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