

Interactive comment on “Estimates of Lightning NO_x Production based on High Resolution OMI NO₂ Retrievals over the Continental US” by Xin Zhang et al.

Anonymous Referee #1

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Xin Zhang et al. Estimates of LNO_x Production based on high resolution OMI NO₂ retrievals over the Continental US.

Overall Summary

Will be solid addition to the literature on LNO_x Production

General Comments

A new satellite-based approach is used to estimate the production of NO_x by lightning.

I believe the section describing the impact of differences in model profiles on the production efficiency to be of great use because it is novel.

C1

When revising the manuscript, the authors should emphasize why they believe their approach is less sensitive to the tropospheric background than other approaches and why it may be more suitable over polluted locations.

They also need a more clear rationale for how they determined what detection efficiency to use for the ENTLN flashes.

Finally, there are a number of minor technical corrections that are needed for readability.

Specific Comments

L10: Put a positive spin on your method as opposed to a negative spin on others work, i.e. mention that your method reduces sensitivity to the background and includes much of the below-cloud NO_x

L30: Why does an increase in lightning lead to a net positive forcing but a decrease in lightning as no net effect?

L63: “Since they assumed NO₂ above the clouds are all NO_x”. I think this is misleading. Pickering et al. did not assume all NO₂ above the clouds was LNO_x. They assumed it included LNO_x and BL NO_x from pollution. They subtracted off a tropospheric background to account for the latter.

L68: The 3-30% value is an estimate of LNO_x/(LNO_x+NO_x from other sources). It is not an estimate of the uncertainty. Move the 3-30% parentheses to after “background NO_x”.

L72: What do you mean by “weighted”?

L73: You need to specify whether the 15% adjustments were positive or negative also the “lofted pollution” was not corrected the “LNO_x production” was corrected.

L86: You may want to add that “Pickering et al. then subtracted off an estimate of the tropospheric background to obtain the LNO_x Production.

C2

L93: The bias of AMF relative to what?

L106: Verify whether you used v3.0 or v3.1 of the NASA standard product

L110: The bias with respect to what is subtracted off?

L127: What region did Rudlosky analyze?

L121-131: Are you using ENTLN flashes or flashes from a combined ENTLN/NLDN data set?

L121-131: Are Rudlosky's value for CG, IC, or combined flashes?

L121-131: The DE values found by Rudlosky of 35% or so need to be reconciled with the 88%/45% values found by Lapierre.

L121-131: Why is the NLDN DE of IC pulses relevant?

L121-131: You may want to include a plot showing the mean ENTLN flashes during MJJA of 2014

L174: LNO_x is regridded. At this point in the manuscript it is unclear how you generated pixel level values of LNO_x that were regridded. Start paragraph by saying how you determined LNO_x and then mention regridding method. Is it as simple as multiplying VLNO_x by area?

L181: Why does choosing the 350-400 hPa layer avoid biases in the simulation of high clouds?

L193: I don't think "not polluted much" is appropriate for a 50% threshold. Simply state that more than half of the NO_x must have an LNO_x source

L216-220: Why do you think the production is relatively insensitive to the CRF threshold? Wouldn't you expect it to decrease as the CRF is increased due to less BL contamination?

L228: 10-80% range is so wide as to be useless. In addition to this range include the

C3

mean and standard deviation

L266: Are the differences between NO₂Vis production and LNO₂Vis production larger over polluted grid boxes?

L271: Not sure what you mean by "trend". Please re-write this sentence more clearly.

L295-L230: State clearly why the difference is larger for LNO_x (25%) than for LNO₂ (11.5%)?

L300: I'd suggest deleting Figure 10. It is discussed in passing and the most important numbers from that Figure are already included in the text.

L334: Would the profile uncertainty be less than 13/26% for the LNO₂Clean approach, although the latter (apparently) has more uncertainty due to the tropospheric background?

L335-338: Why don't uncertainties in the tropospheric background contribute to uncertainties in the production?

L335-338: How would biases in the modeled NO/NO₂ ratio contribute to uncertainties in the production of LNO_x?

L392: Expand on why this approach can be used in polluted regions? Is this different than other approaches?

L391-409: Minimize the use to lesser known acronyms in the conclusion section. Many readers will only read the abstract and conclusions. For e.g., TL and ratio and LNO₂Clean

L401-402: The last sentence of the 2nd paragraph of the conclusion section is poorly written. Please re-write to make its meaning clear.

Figure 1 caption. Please specify what is plotted here. Also, did you choose this domain or is this a standard domain used by EPA or others (e.g., US1 or US2 domain)? How

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many east-west and north-south grid points in domain

Table 1: Capitalize entln

Table 2: under different conditions > for different thresholds

Figure 3: May not be needed. Consider removing.

Technical Corrections

L5: based on the program of new > that uses the

L15: surface is > surface are

L16: originate largely > originates largely

L27: method and the commonly used the widely used cloud-top > method versus the commonly used cloud-top

L27: As lightning > While lightning

L28: have reported 5-16% increases > is predicted to increase by 5-16%

L41: qualified > quantified

L50: it is > this study

L50: without the contribution > and did not consider the contribution

L53: Replace sentence beginning with "The threshold of"> Their analysis was restricted to 30 x 60 km² satellite pixels where the flash rate exceeded 1 flash km⁻² hr⁻¹.

L54: But the results of LNO_x production are highly > But they found LNO_x production to be highly

L72: removed by the weighted > removed by subtracting the weighted

L72: CRF criteria but has > CRF criteria required to be considered deep convection

C5

but has

L76: at those locations > at some locations

L77: On another hand > On the other hand

L79: by strokes > using mean values of strokes

L80: NO₂ can be "seen" > NO₂ that can be "seen"

L94: we focused on > we focus on

L99: examines different sources of the uncertainty of > examines the effect of different sources of uncertainty on the

L128: and the detection > and found the detection

L128: are 88% > to be 88%

L130: corrected by 88% and 45% > divided by 0.88 and 0.45

L137: was used to generate > were used to generate

L170: part of the NO₂ originated from lightning > part of the NO₂ within the cloud originating from lightning

L180: convections > convection

L184: properties of cloud > cloud properties

L187: box-1 are chosen > box-1 per 2.4 hour time window are chosen

L191: sources except LNO₂ > sources in addition to LNO₂

L208: search of NO₂ > search of the NO₂

L206-210: When referring to combinations use the abbreviations given in Table 1.

L225: productions are > production values are

C6

L275: 0.8 to 0.2 while the cloud is higher (smaller pressure value) > 0.8 to 0.2 as the cloud pressure decreases from 600 to 300 hPa. Note: Please correct my pressure ranges if incorrect.

L279: we can not derive that higher LNO₂ production relates to higher clouds > we cannot derive the relationship between LNO₂ production and cloud pressure

L284: larger than normal > larger in anomalous than normal

L292: chose the same method > chose the same value

L313: relative distribution > relative distributions

L314: is similar > are similar

L315: the unrealistic > an unrealistic

L319: carefully in our research > carefully into consideration

L321: are involved > are important

L401: find that the regionally > find a regionally

L403: pollutions than > pollution than

L409: level > scales

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