

## ***Interactive comment on “Estimates of Lightning NO<sub>x</sub> Production based on High Resolution OMI NO<sub>2</sub> Retrievals over the Continental US” by Xin Zhang et al.***

**Anonymous Referee #3**

Received and published: 22 January 2020

Zhang et al. present estimates of lightning NO<sub>x</sub> production from satellite observations of NO<sub>2</sub>. They provide a formalism which considers both lightning and background NO<sub>x</sub> and discuss the impact of the latter. The study derives LNO<sub>x</sub> estimates plus uncertainties for the continental US. The paper is generally well structured and comprehensible. It matches the scope of AMT and should be published after dealing with the issues raised below.

The authors derive equations for LNO<sub>x</sub> by treating clouds as reflecting surfaces. This simplification is required for many radiative transfer models which can not handle multiple scattering in 3d clouds. Thus, several previous studies follow this approach. How-

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ever, the authors should still be aware of this simplification and state this clearly in the manuscript. Formulations like "NO<sub>2</sub> above/below the cloud" are misleading, as for thick thunderstorm clouds, most of the LNO<sub>x</sub> is WITHIN the cloud, with a high sensitivity from OMI at the cloud top, gradually decreasing towards the cloud bottom. In this context, the authors should discuss what the "cloud top" derived from OMI O<sub>2</sub>-O<sub>2</sub> measurements actually means for a thunderstorm cloud.

There is one crucial omission which might require major revisions: The derived AM-FLNO<sub>x</sub> will strongly depend on pcloud (e.g. eq. 2). But this key input parameter is missing in the error budget in table 3. This has to be revised and the uncertainties caused by pcloud have to be discussed accordingly.

Minor corrections:

5: Skip "program of"

130: must be square km

146: The concept of defining an "AMF" for converting SNO<sub>2</sub> into LNO<sub>x</sub> was also used in Beirle et al., AMT 9, 1077-1094, 2009, (see eq. 9 therein).

268: I recommend to extend "Production" to "Production estimates"

395: "we find that the regionally dependent effect" - unclear, please revise.

Fig. 1: Please make the legends clearer and remove cryptic labels ("crf90\_entin\_tl")

Figs. 2 and 9: Please use less, but larger labels on x-axis.