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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Inferring the anthropogenic NO_x emission trend over the United States during 2003–2017 from satellite observations: Was there a flattening of the emission tend after the Great Recession?" *by* Jianfeng Li and Yuhang Wang

Anonymous Referee #2

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There has been many studies in the last years on the recent trends of NOx emissions over the U.S., the main motivation being the apparent important change in NO2 column trend since 2010, which obviously requires careful analysis using the available data as well as using models. The present study is useful, as it clearly shows that there is no significant discrepancy between the NEI emission trends and the different NO2 (surface and column) data, when considering only urban areas. The paper discusses the non-linear relationship between NOx emissions and NO2 abundances.

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Discussion paper

Model calculations using REAM at 36kmx36 km are used to illustrate this point and show that the feedbacks are much stronger at low-NOx than at high-NOx. Although the relevance of NOx natural emissions (which obviously do not have the same trends as the anthropogenic component) is mentioned, the paper does not dwell on it.

In fact, and this is my main comment, I think clarifications are needed in order to sort out the respective roles of chemical non-linearities and the existence of the background. Both natural emissions and chemical non-linearities play their largest role during summer over rural areas, and more so in the free troposphere than near the surface. But it is not entirely clear from the paper how much these two main factors contributed to the apparent discrepancy between the different sets of trends. This should be clarified. Also, although the paper mentions the use of observed NO_3^- deposition trends to further support the declining trend of NOx emissions, it would be useful to incorporate more explicitly this information in the discussion.

Additional (minor) comments:

- l. 34, the total of 0.24 Tg N for natural NOx emissions seems to be very low, where does it come from? I don't think NEI2014 provides this information. Please provide separately the soil, biomass burning and lightning emission information.

- l. 64-65: there are earlier references for the effect of non-linearities on NO2 trends

- section 2.1 on REAM. What is the model domain?

- l. 96: How is meteorology constrained by NCEP?

- l. 100-102 it's a detail, but it seems a little strange that weekday emissions are based on NEI while weekend values are reduced. Isn't NEI an average?

- l. 105 what about lightning emissions?

- l. 148-149 the requirement that RCI $>$ 50% is quite strict. What happens to the trends when you change that?

- l. 184 how many measurements are rejected from this conditions on RCI?

- l. 202 Are the β and γ calculated based on total emissions with or without lightning emissions? Lightning contributes significantly to the total column, but very little to surface concentrations (in part due to the vertical dependence of spaceborne instruments sensitivity).

- l. 229 "such as NOx transport from nearby regions" this is surprising since the calculated sensitivities were said to be purely local

l. 234 there is no "transport effect". β and γ are closer to 1 at 10-11 LT (compred to 13-14 LT) because of the weaker chemical losses.

l. 242 I suppose the "urban" definition depends on anthropogenic NOx emissions on a specific year (and month maybe). This should be specified.

l. 330-332 Note that only 22 AQS sites (out of 179) are rural. Therefore, is the difference between this study and the results of Lamsal et al. and Jiang et al. really due to the selection of urban sites?

l. 349-350 the sentence "They also identified model biases (...) natural emissions" is unclear, please either elaborate or delete.

- l. 378-381 The nonlinear relationship of NOx with NO2 TVCD is important, but so are the effects of properly accounting for the background. The fact that spaceborne instruments have a low sensitivity close to the surface (i.e. the averaging kernels) is also important and deserves to be mentioned in this discussion.

Technical comments:

- in the title, "tend" should be "trend"

- abstract line 15, add the word "bottom-up" (or "estimated') before "anthropogenic"

- l. 89 "mechanistic" (not "mechanical")

- l. 107 replace "measurements" by "sensors"

- l. 109 add "instrument" after "SCIAMACHY"

- l. 116 "These instruments measure transmitted, backscattered, and reflected radiation" is unclear

- l. 126 "OMINO2" (not OMNO2")

- l. 134 "choose" not "chose" (I guess)

- l. 208 add "the" before "model simulation"

- l. 279 -280 "sensitivities (...) to different anthropogenic NOx emissions over the CONUS" is confusing, please rephrase

- l. 325 insert "the" before "decreasing rates"

- References : use journal abbreviations, e.g. Atmos. Environ., etc.

- caption of Figure 5, line 672: specify the year (and month?) of the anthropogenic emissions used to define the groups

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