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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Using satellite observations of tropospheric NO_2 columns to infer long-term trends in US NO_x emissions: the importance of accounting for the free tropospheric NO_2 background" *by* Rachel F. Silvern et al.

Anonymous Referee #1

Received and published: 26 March 2019

This manuscript is very well written and makes an important contribution to the understanding of NO2 trends over the United States. The authors have succeeded in reconciling the different trends seen in OMI NO2 tropospheric column data and surface NO2 mixing ratio observations. The analyses in the manuscript indicate that a better understanding of tropospheric background NO2 is needed to interpret satellite NO2 observations in terms of trends. The authors show that the GEOS-Chem model well simulates the surface NO2 trends compared with AQS and SEARCH observations, but fails to simulate the flattening of the tropospheric NO2 column seen in the

OMI observations. Improvement of the model column trend in the winter is achieved in a sensitivity simulation by adding additional free tropospheric NO2. However, the authors do not recommend any particular model modifications to remedy this situation. The manuscript could be strengthened by adding some recommendations in this regard. I recommend publication after minor revisions.

Specific comments: p. 6, line 2: I think the word "steady" should be removed here, as you indicate later on this page that the downward trend does become smaller after 2009.

p. 7, line 31: for nitrate wet deposition and tropospheric column NO2 is similarly weaker.....

p. 9, line 12: at the end of this paragraph it would be appropriate to mention your earlier findings (Silvern et al., 2018) that an alternative hypothesis for why the model NO/NO2 ratio is too large compared with observations is that there may be errors in the model cycling of NO, NO2, and O3. You showed that adjusting the rate constant for the NO + O3 reaction and the NO2 photolysis rate can lead to improved NO2 results.

p. 10, lines 8-9: higher lightning flash rates are observed in tropopause penetrating storms and these type of storms may have increased in frequency. However, the Lightning Imaging Sensor (LIS) data do not seem to show any long-term trend in lightning over the US. This should be mentioned here.

p. 10, lines 11-12: It would be good to explain that even at 0.5 x 0.625 degree resolution the model is too coarse to resolve convective overshoots.

p. 10, line 31: remove "steady"

p. 11, lines 13-14: Can you recommend modifications to GEOS-Chem to better represent NO2 background?

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