Comment on acp-2021-273

Anonymous Referee #3

Referee comment on "Variability of nitrogen oxide emission fluxes and lifetimes estimated from Sentinel-5P TROPOMI observations" by Kezia Lange et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-273-RC3, 2021

The study "Variability of nitrogen oxide emission fluxes and lifetimes estimated from Sentinel-5P TROPOMI observations"
by Lange et al. presents emission and lifetime estimates from TROPOMI NO_2 measurements for a selection of source regions around the world,
and investigates weekly & seasonal cycles as well as the impact of recent lockdown measures.
The manuscript is clearly written, provides a detailed description of method & error calculation, and discusses the results adequately,
also in context with previous studies.
I recommend publication after dealing with the comments below.

- NO_x: x should be subscript throughout the manuscript.
- Line 3: this resolution was not provided in the first months of operation.
- Line 7: "dessert" should be "desert"
- Lines 14&15: 2x "In the atmosphere". I would skip the first one.
- Line 123: Please specify that for the highest latitudes considered here, up to two overpasses are available.
  Three overpasses only occur for higher latitudes.
- Lines 126-129 (up to "Seo et al."): This is off-topic and should be skipped.
- Line 135: Please explain why the difference in resolution is more extreme at the edges.
- Lines 145ff: Please explain why versions up to 1.03 are mixed in your analysis, but 1.04 is excluded.
  Shortly mention what has changed in 1.04 and refer to the discussion of the low bias of tropospheric NO_2
  in section 4.6.
- Line 153: Do you have a reference for 50% CRF ~ 20% GCF?
- Line 154: I am confused by the different time intervals.
  In line 144: March 2018 to November 2020.
  In line 197: March 2018 to February 2020 general
  January 2019 to November 2020 Covid 19
  Why is yet another interval chosen for Fig. 1? Why not March 2018 to February 2020?
- Line 155: The criterion "higher NO_2 than their surrounding" would result in a quite different selection of hot spots visible in the mean map.
  I propose to skip the reference to Fig. 1 in this section, but add it section 3.1, where the selection of source regions is explained in detail.

- Caption Fig. 1: Add a reference to table A1 for further details.
- Line 162: Please quantify "low".
- Section 2.3: Using model input in order to correct for the NO2/NOx ratio is probably an improvement compared to just taking a constant value.
  However, I don't understand why the calculation in Eq. 3 was done for a fixed pressure, since the model would also provide the actual pressure
  at the altitude of interest (probably the same as chosen for the wind vector).
  The considered source regions include some elevated locations like Las Vegas, Medupi, or Colstrip (1 km asl!), where 950 hPa is not appropriate.
- Line 219: How far does the - somehow arbitrary - selection by visual inspection affects the generality of the results?
  Could there be some "selection bias"?
- Line 224: What amount of TROPOMI observations is needed in order to get robust results from this method?
- Line 293: What is "dispersion" meaning in this context?
- Line 294: or the effects of non-linearities in the NOx lifetime.
- Figure 5: This figure is very hard to read. I propose to
  - add one further panel, highlighting the seasonal dependence. E.g. show the lifetime for different locations as function of season.
  - arrange the 4 panels 2x2
  - enlarge
- Line 430: One important difference is that the tropospheric columns also contain the upper tropospheric background, which is removed in the EMG method by fitting the background B.
- Lines 507ff: This section is quite vague. One main reason for the low bias was identified as the FRESCO cloudheight which is biased low
(Compernolle et al., https://amt.copernicus.org/articles/14/2451/2021/) causing high-biased AMFs. This was changed with v1.04 of the operational NO2 product.
Please extend this discussion accordingly.
- Line 613: Please specify "short time periods": how many TROPOMI overpasses are needed?