

Interactive comment on “Evaluating Sentinel-5P TROPOMI tropospheric NO₂ column densities with airborne and Pandora spectrometers near New York City and Long Island Sound” by Laura M. Judd et al.

Anonymous Referee #2

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This paper by Judd et al. compares satellite-based TROPOMI tropospheric NO₂ measurements with airborne- and ground-based Pandora measurements in the New-York City/Long Island Sound region. It contributes to the Sentinel-5P TROPOMI validation and is the first validation paper for the new satellite instrument with airborne campaign measurements which have a more spatially representativity than ground-based measurements. In addition, long-term ground-based Pandora measurements are used and compared to the airborne and satellite based NO₂ measurements. The strength of both reference measurements are used to evaluate TROPOMI tropospheric NO₂ col-

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umn densities.

The evaluation found a low bias of the TROPOMI tropospheric vertical column (TrVC) compared to Pandora and aircraft tropospheric vertical column, more pronounced for aircraft than Pandora measurements. Although using a higher resolution a priori vertical profile for the TROPOMI data improves the low bias, there is still a low bias, especially for more polluted cases and further investigations are needed in future studies. Cloud retrieval effects are discussed. A new quality criterion was introduced which excludes pixel where the difference between retrieved cloud pressure and surface pressure exceeds 50 hPa to exclude pixels where cloud shielding occurred over cloud free scenes. These pixels compensate partially for the TROPOMI TrVC low bias but lower the correlations with reference measurements.

The paper is well written and of significance for the validation of the new satellite Sentinel-5P TROPOMI tropospheric NO₂ measurements. Therefore, I recommend publication in AMT with minor revisions.

Specific comments:

Line 197: “All reference spectra were co-located with total column NO₂ measurements from Pandora spectrometers: $5.6 \cdot 10^{15}$ molecules cm^{-2} at MadisonCT on June 30th, $5.7 \cdot 10^{15}$ molecules cm^{-2} at MadisonCT on July 2nd, and $6.2 \cdot 10^{15}$ molecules cm^{-2} at WestportCT on August 5th, with values estimated to be over 50% stratospheric.”
What is done with the collocated Pandora measurements? How is the 50% stratospheric estimated?

Line 292: What is the spatial coincidence criterion for Pandora comparisons to TROPOMI? Is it the nearest pixel, a mean, is the viewing direction considered?

Line 254: “All Pandora data are converted from total vertical columns to TrVCs by subtracting either the airborne or TROPOMI retrieved stratospheric columns for comparison purposes.”

Is the Pandora converted with TROPOMI retrieved stratospheric column used for

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TROPOMI comparisons and Pandora converted with airborne for airborne comparisons? How is the airborne stratospheric column retrieved?

Line 450: Why was this feature only seen by this excluded Pandora?

Line 571: Is there an explanation why the slope is much better and the correlation much worse when comparing TROPOMI and Pandora instead of TROPOMI and aircraft measurements?

Line 675: Lorente et al. did not use Pandora spectrometers for validation, they also found a low bias but with in-situ measurements.

Technical corrections:

Line 99: LISTOS is defined and used already in line 21 and 36.

Line 283: "TROPOMI NO₂ columns"

Better TrVC to be consistent to the other TrVCs in the sentence.

Line 372: "(Table S1, compare Row I to Row B) slightly improves the correlation (r^2 increases from 0.93 to 0.94)"

Row I is 0.94 and row B 0.92. Value 0.93 should be changed to 0.92 and order of "compare Row I to Row B" should be changed to "B to I" to make it consistent to the values order.

Line 420: "with large sub-pixel variation as indicated by the horizontal whiskers in the plot" There is a better explanation but some lines later (Line 433). This one could be replaced by the later one.

"The horizontal bars in Fig. 6 show the standard deviation of the subpixel airborne TrVCs within each TROPOMI pixel."

Line 556/Figure 9: Statistics are only listed in the table. It would be helpful for a better reading to have at least the statistics of the LISTOS time period data in the figure especially because these are much more discussed in the following than the statistics

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of the long-term TROPOMI-Pandora comparison.

Line 651: r^2 of 0.89 should be 0.88 corresponding to the figure.

Line 714: r^2 of 0.84 should be 0.88

Line 722: and

Table 2: kg instead of lbs

Table 3: Short explanation for shaded boxes

Figure 1: Nine Pandora spectrometers instead of spectrometer.

Figure 2: Explanation to horizontal and vertical bars with "variability at the time of measurement" is missing in figure caption.

Figure 10: The period (LISTOS or extended long-term) of the used data is missing.

Figure 12: (a) Also for the LISTOS comparison only the extended stations are used

Supplement Line 53: "to remove the estimated of loss of sensitivity"

First "of" can be removed

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