

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 #3

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This paper presents a comprehensive evaluation of the TROPOMI satellite NO₂ product v1.2 for the New York City/Long Island Sound region, where the NO₂ TrVC has high spatial and temporal heterogeneity. The NO₂ TrVC measurements from both airborne and ground-based Pandora spectrometers are used to compare with the TROPOMI NO₂ products. While Pandora spectrometers provided continuous long-term measurements, airborne spectrometers provide observations with more spatially representative of the satellite measurements. The effects of the cloud retrieval and a priori profile on the biases in TROPOMI NO₂ product are analyzed. The study is interesting and

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provides a welcome addition to the literatures on the measurements of the NO₂ TrVCs from satellite, airborne and ground-based spectrometers. The manuscript is well written and the presentation looks good. I would recommend acceptance for publication after the following comments have been addressed.

Specific comments:

What are the exposure time for each scan of GeoTASO and GCAS during the flight and corresponding distance the airplanes flew? I did not find this information in Sect. 2.2.

The definitions of the tropospheric column seem to be different for satellite (L141-142), airborne (L229-230), and ground-based measurements. In other words, different ‘tropopause altitudes’ are used to derive the TrVCs of NO₂. Considering that NO₂ concentrations in the upper troposphere near the tropopause may be sufficiently large, could these differences in the definition affect the comparisons among the three data sets? How is the airborne stratospheric columns of NO₂ retrieved (L268-269)?

L78-79: In addition to the gradient-smoothing effect, the aerosol-shielding effect may also make a contribution to the uncertainties in the validation of satellite products by ground-based spectrometer, particularly in high-aerosol-load areas (e.g., Ma et al., 2013; Jin et al., 2016). How about the typical aerosol levels over the investigated region? Can the aerosol shielding effect be large enough to affect the comparison of Pandora with TROPOMI and airborne spectrometer measurements?

Technical issues:

L21-23: please rephrase the first sentence in the Abstract. It should be stated that the measurements were made or the measurement data were collected. Better to describe more clearly which coincided with the early measurements from the Sentinel-5P TROPOMI instrument?

L37: change ‘biggest’ to ‘largest’.

L124: the words ‘to be’ can be deleted.

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L153: how is the qa_value defined?

L163: what does the dynamic range of NO₂ refers to?

L74: please check the phrase 'through June 30'. Did Hu25 fly only one day?

L187: please give the pressure altitude in hPa.

L790: 'This is the first work that airborne spectrometer measurement dataset has been used to ...'?

Figure 2: please add $\times 10^{15}$ to the labels of both x-axes and y-axes.

References

Ma, J. Z., Beirle, S., Jin, J. L., Shaiganfar, R., Yan, P., and Wagner, T.: Tropospheric NO₂ vertical column densities over Beijing: results of the first three years of ground-based MAX-DOAS measurements (2008-2011) and satellite validation, *Atmos. Chem. Phys.*, 13, 1547-1567, 10.5194/acp-13-1547-2013, 2013.

Jin, J., Ma, J., Lin, W., Zhao, H., Shaiganfar, R., Beirle, S., and Wagner, T.: MAX-DOAS measurements and satellite validation of tropospheric NO₂ and SO₂ vertical column densities at a rural site of North China, *Atmospheric Environment*, 133, 12-25, <http://dx.doi.org/10.1016/j.atmosenv.2016.03.031>, 2016.

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