Answer to Anonymous Referee #1 for the manuscript "Comparison of OMI NO2 observations and their seasonal and weekly cycles with ground-based measurements in Helsinki" by Ialongo et al. (2016)

The authors thank the Referee #1 for the useful comments. The point-to-point answer is provided as follows. The Referee comments are in *Italics*, while the answer by the authors is in **Bold Roman**. Please find the author's changes in the track-changed revised manuscript.

1) Pandora was installed in 2012, but only one year of data was discussed. If more data are available, I suggest the authors use all of them.

Pandora #21 was operational in Helsinki from late 2011 to early 2013. We use the data from the full year 2012, discarding the scattered measurements from other years. Currently, a different Pandora instrument is working at the same place at FMI but the field calibration procedures (requiring measurements during several sunny days) have not yet been completed. We aim at using this new set of data in the near future for validating NO2 retrievals from both OMI and TROPOMI instruments.

2) Pandora is a relatively new instrument. It would be useful to include some technical details in the paper. For example, what spectral window was used for the spectral fitting? Were any attenuation filters used? If so, are the results for different filters consistent? A temperature correction is mentioned on p. 4. How it was done? Is it a part of Pandora's operational software of something developed by the authors.

Pandora NO2 retrievals are based on the operational software as described by Herman et al. (2009). This is why we refer to that paper for the technical details. We updated PANDORA discussion on page 4 including more details as follows:

" The algorithm first derives the relative NO2 slant columns densities (SCDs) by DOAS spectral fitting technique (e.g., Cede et al., 2006) in 370-500nm (see Fig. 5 in Herman et al., 2009) and converts them to absolute SCDs using statistically estimated reference spectrum obtained from on-site PANDORA measurements by Langley-extrapolation technique. Pandora SCD retrieval employs a temperature correction to the cross-sections used in the spectral fitting procedure as described in Eq.1 by Herman et al. (2009), based on modelled monthly average NO_2 and temperature profiles and high-resolution temperature-dependent cross sections by Vandaele et al. (1988), as also for OMI NO2 retrievals."

Cede, A., J. Herman, A. Richter, N. Krotkov, and J. Burrows (2006), Measurements of nitrogen dioxide total column amounts at Goddard Space Flight Center using a Brewer spectrometer in direct sun mode, J. Geophys. Res., 111, D05304, doi:10.1029/2005JD006585.

Vandaele, A. C., C. Hermans, P. C. Simon, M. Carleer, R. Colin, S. Fally, M. F. Mérienne, A. Jenouvrier, *and* B. Coquart (1998), Measurements of the NO_2 absorption cross-section from 42000 cm^{-1} to 10000 cm^{-1} (238–1000 nm) at 220 K and 294 K, J. Quant. Spectrosc. Radiat. Transfer, 59(3–5), 171–184.

3) The authors do not mention any diurnal NO2 total column variations. It would be useful to have some information about them for satellite data interpretation.

We agree with reviewer's comment with the following caveat. The diurnal dependences of NO2 in PBL and stratosphere are different, driven by un-related processes. Since PANDORA measures total column (stratospheric plus tropospheric) the interpretation of the measured diurnal dependence may not be straightforward. The following text has been added in section 3.1:

"Figure 2 also illustrates the measured diurnal variations in NO2 total columns. The daily cycle is highly variable from day-to-day, depending on several factors, such as the diurnal cycle of anthropogenic NOx emissions, NOx photochemistry, relative contribution from stratospheric columns, as well as changing meteorological conditions. Under clear sky conditions, Pandora NO2 total columns show peaks in the morning or in the afternoon (as would be expected from increased car traffic during the rush hours and small contribution from stratospheric columns). Sometimes, very low NO2 total columns are observed throughout the day, as for example on 1 May 2012 (first panel in Fig. 2), probably because of the wind patterns. OMI overpasses occur between 12 and 15:30 local time (outside the rush hours), when relatively low tropospheric NO2 levels are expected."

Specific comments:
1, 2: Change to "NASA standard product (SP) and KNMI DOMINO product"
Corrected

3, 18: What OMI data product is discussed here? SP?
Yes, corrected.

4, 6: "Temperature correction" What temperature data are used for this correction? Climatological? How large is the correction?
See point 2)

5, 3: Figure 2. There are too many dots and symbols on this plot. Perhaps it is better not to show bad data.
Corrected

6, 1: Figure 3. You could add one more panel that shows the difference vs. time using the colorscale that represent NO2 values themselves

Corrected. We also changed the text accordingly.

6, 6: The supplementary material contains only one figure. Add S1 to Figure 3 and drop the supplement.

There is now a second figure in the supplement. We prefer to keep the supplement to avoid redundant information in the main text.

7, : Figure 4. It is very difficult to see overlapping error bars. Shift them slightly or use different thickness for the error bars.

In Fig.5 of the revised manuscript, we removed the surf. con. (DOM) and Pandora (DOM) lines, to be consistent with figure 5 and reduce redundant information. This should also help visualizing the error bars.

7, 1: This sentence is confusing. The difference between individual OMI and Pandora measurements cannot be smaller than the uncertainties of individual OMI measurements. Or, you are talking about systematic differences here?

We removed this phrase while also changed the text to answer to comments from referee #2. We discuss the uncertainty more accurately in the revised manuscript.

7, 9: Figure 3 is not enough for such statement. Could you calculate the standard deviation of the OMI-Pandora difference for small and large OMI pixels?

There is indeed no large improvement in the mean rel. dif. (about 1 percent closer to zero), when removing pixels at the edge of the swath but we further illustrate the effect of the pixel size in Fig. S2 (as requested also by Referee #2) in the supplement of the revised manuscript. We added this sentence in section 3.1:
"For example, the average relative difference between OMI SP and Pandora derived using relatively small pixels (cross-track position 6-55) is (-5±25)%, about one percentage point closer to zero than for the whole data set (-6±25)%."

8, Figure 5. Do you really need SP total and DOMINO total in this figure? Also, you could drop surf.con. (DOM) and Pandora (DOM) since they are very similar to the surf.con (SP) and Pandora (SP)

In Fig.6 of the revised manuscript, we drop the surf.con. (DOM) and Pandora (DOM) lines since they are redundant but we prefer to keep the total column to allow the comparison with Pandora total columns.

10, 12: Be more specific here: "OMI CFs below 0.5 valued give the same cloud-screening results as the ground-based cloud cover below 5/8 condition in more than 80% of the cases."

Corrected