

I'm pleased to accept your revised manuscript "Highly resolved mapping of NO<sub>2</sub> vertical column densities from GeoTASO measurements over a megacity and industrial area during the KORUS-AQ campaign" for publication in AMT. While the revisions are minor, there are many of them, so please carefully revise your manuscript before resubmitting it.

\* Both reviewers raised several points. Please address each of them in your reply and in the revised manuscript

Again, we sincerely appreciate referees #1 and #2 for their time and critical review of the manuscript which we feel provided an important and neutral perspective on the material presented. As such, the manuscript is much more focused and streamlined. Our point-to-point responses to the reviewer are given below. For clarity, all responses are provided in blue.

\* page 1, line 32, remove "domestic heating"

**Response:** As the referee suggested, we removed "domestic heating" on P. 1, Line 31.

\* page 1, line 35, remove "flash production"

**Response:** As the referee suggested, we deleted "flash production" on P. 1, Line 35.

\* page 3, line 101: ALH. Throughout the manuscript, you use the term "aerosol loading height" where I guess "aerosol layer height" is meant. When you discuss aerosol treatment, you need to explain your assumptions on the vertical distribution of aerosols. So far, I could not find it in the text but it is important for your AMFs and the uncertainty discussion.

**Response:** We modified ALH to APH (Aerosol Peak Height) in terms of confusion. The APL is assumed to be the height of the highest value in the aerosol extinction coefficient simulated in CMAQ. We added this sentence to P. 9, Line 250-252.

\* page 3, line 111: "under Jeju" => ""over Jeju"

**Response:** P. 3, Line 108 was revised as the referee suggested.

\* Table 1 and elsewhere: As pointed out by the reviewers, your definition of the VZA is unclear

and does not seem to be in line with usual definitions.

**Response:** We had a calculation error. The VZA in Table 1 has been modified.

\* **Figure 2: The fitting window given here is not in agreement with the text**

**Response:** Figure 2 has modified the manuscript on P. 6, Line 175.

\* **Page 7, line 185: As pointed out by the reviewers, information on your reference measurement is given: How many measurements have been averaged? Which slant column has been assumed over this region (you mention the VC from the model). Also, I'm missing a description or formula how you use this SC<sub>0</sub> - is that added to all measurements? Please add an explanation in the text. What is the contribution to the uncertainty budget? Please at least mention that in the section on uncertainties.**

**Response:** We appreciate the referee's comment. We added the following sentences in the revised manuscript as the referee suggested.

"We used the measured radiances at the reference sector to calculate differential slant column density (dSCD) over the whole domain of the GetoTASO measurements. CMAQ calculation over the reference sector (i.e.,  $6.75 \times 10^{15}$  molecules  $\text{cm}^{-2}$ ) was adopted as the reference SCD ( $\text{SC}_0$ ), which is added to all dSCD values to convert to the SCD. The reference sector is known as a background area but is occasionally affected by the long-range transport of  $\text{NO}_2$  from upwind areas. Considering the standard deviation of the OMI measurements accounts for such effects during the measurement period, we estimate the maximum uncertainties of the  $\text{SC}_0$  can be calculated from this value (i.e.,  $1.33 \times 10^{15}$  molecules  $\text{cm}^{-2}$ ) in addition to the difference of the mean values between the CMAQ and OMI (i.e.,  $1.98 \times 10^{15}$  molecules  $\text{cm}^{-2}$ ). Therefore, our best estimate of the uncertainty of the  $\text{SC}_0$  is the root of the sum of squares of these values (i.e.,  $2.38 \times 10^{15}$  molecules  $\text{cm}^{-2}$ )."

\* **page 9, line 248: Ignoring the contribution of the  $\text{NO}_2$  above the aircraft may be a small error over polluted regions but I frankly don't see why you did that. It would not have been much effort to do the proper calculation.**

**Response:** We appreciate the referee's comment, which we agree with. However, the chemical transport model we used in this study for the AMF calculation (i.e., CMAQ) only simulates the troposphere (surface to 50 hPa), which is why we only consider the  $\text{NO}_2$  below the aircraft. We added the following sentences in the revised manuscript on page 9, lines 261-264.

"However, we calculated  $\text{NO}_2$  VCD $\downarrow$  by dividing  $\text{NO}_2$  SCDs by AMF $\downarrow$  as the CMAQ only simulates the troposphere (surface to 50 hPa). However, as the stratospheric and free tropospheric  $\text{NO}_2$  ( $\text{NO}_2$  VCD $\uparrow$ ) column densities over megacities and industrial areas are much lower than tropospheric  $\text{NO}_2$  column densities, (Valks et al., 2011), we assume that the uncertainties in the AMF without considering the upper atmosphere are negligible in this study."

\* Table 5 and elsewhere in the manuscript: You talk about "NO<sub>2</sub> emission" and "NO<sub>2</sub> emission rates" but most of the NO<sub>x</sub> (NO<sub>2</sub> + NO) is emitted into the atmosphere in the form of NO. Therefore, one usually speaks about NO<sub>x</sub> emissions, not NO<sub>2</sub> emissions. In emission inventories, NO<sub>x</sub> emissions are often given "as NO<sub>2</sub>", but it still are NO<sub>x</sub> emissions. Please check and correct in your text where appropriate.

**Response:** We appreciate the referee's comment, and we revised the manuscript as suggested. "NO<sub>2</sub> emission" has been replaced with "NO<sub>x</sub> emission".

\* Figure 7, upper plot: Should there be wind arrows also in the upper plot?

**Response:** We took a wind arrow to show the wind direction in Figure 7. Due to the resolution of the UM data, only one arrow (126.67°E, 36.985°N) was represented in that domain.

\* Table 6: As pointed out by both reviewers, the uncertainties given for the reflectance are unrealistically small. Also, the contribution of the NO<sub>2</sub> vertical distribution uncertainty, the uncertainty from the assumption on the background column SC<sub>0</sub> and the uncertainty from ignoring the NO<sub>2</sub> above the aircraft in the AMF calculations should be mentioned here.

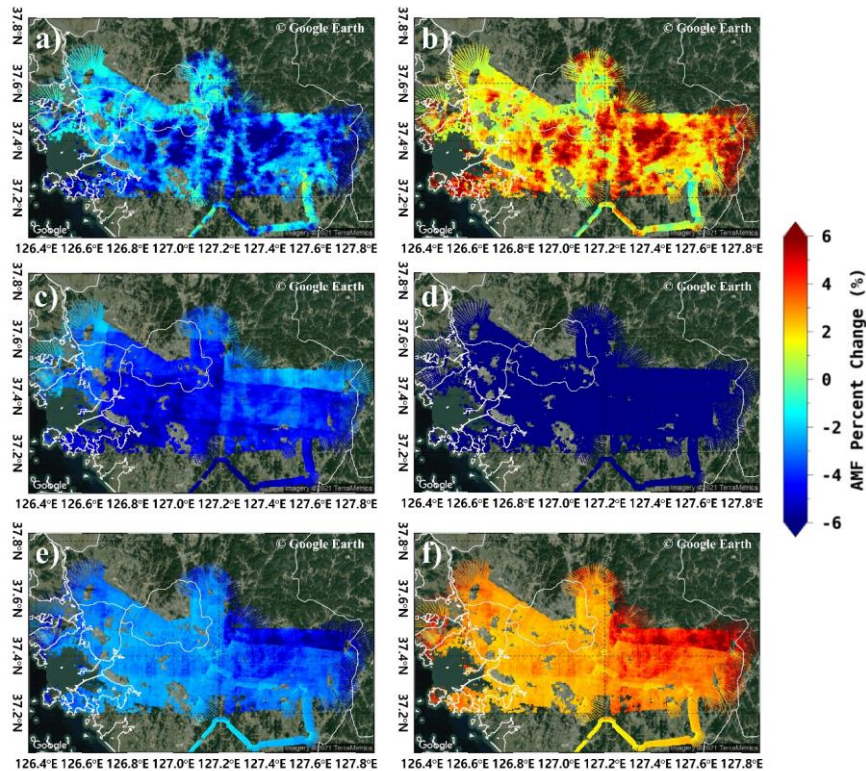
**Response:** The authors modified and added the following sentences in the revised manuscript (P. 17, Line 432-444) to mention the four uncertainties pointed out by both reviewers (1. Unrealistic reflectance error, 2. NO<sub>2</sub> vertical distribution uncertainty contribution, 3. An assumption on the background column SC<sub>0</sub>, 4. Uncertainty from ignoring NO<sub>2</sub> above the aircraft in the AMF calculations)

\* Figure 9: At least in my PDF file, the colour bar does not show exactly the colours used in the figure

**Response:** We think it looked different because we drew the color with a transparent function. The modified figure shows the transparent function removed.

\* Figure 9: The change of colour ranges between the figures is confusing. Please use the same range for all sub-plots (-6..+6%)

**Response:** We thank the referee's comment. However, when we use the same color range, the figure seems harder to understand (please find the below figure). Therefore, we finalized figure 9 as in the revised manuscript rather than the figure below, which are using the same color range.



\* Figure 9 caption: What is the meaning of "20%" after e)?

**Response:** We have deleted "20%" on P. 18, Line 450.

\* Page 18, line 438: SFR is not part of the aerosol properties. Please separate.

**Response:** "(AOD, SSA, ALH, and SFR)" has been replaced with "(AOD, SSA, and APH), and SFR" on P. 18, Line 454.

\* Figure 10: Please put GeoTaso data always on the x-Axis

\* Figure 10: Please always use the same range on x and y-axis, indicate 1:1 line and make the figures quadratic.

**Response:** We fixed the x-axis with GeoTASO data, and expressed 1:1 line as a solid red line on Fig. 10.

\* Figure 10: Which quantity is shown for the Pandora - tropospheric or total column? If it is total column as I assume, this needs to be made clear in the text. The neglect of the

stratospheric contribution here and in the AMF calculation may also explain part of the low correlation for small NO<sub>2</sub> columns.

**Response:** The NO<sub>2</sub> VCD for Pandora is a total NO<sub>2</sub> VCD and has been modified in the manuscript (P. 19, Line 481).

\* Page 21, line 532: 91 => 0.91

**Response:** P. 21, Line 546 have been modified.

The paper also needs another round of English proofreading - in parts it is very well written, but some sections are difficult to read.

**Response:** We corrected the entire manuscript in English.