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Atmospheric Measurement Techniques Discussions

Interactive comment on "NO_2 and HCHO measurements in Korea from 2012 to 2016 from Pandora Spectrometer Instruments compared with OMI retrievals and with aircraft measurements during the KORUS-AQ campaign" *by* Jay Herman et al.

Anonymous Referee #2

Received and published: 10 June 2018

General comments:

The manuscript entitled "NO_2 and HCHO measurements in Korea from 2012 to 2016 from Pandora Spectrometer Instruments compared with OMI retrievals and with aircraft measurements during the KORUS-AQ campaign" presents total vertical column measurements of NO_2 and HCHO with 9 Pandora instruments at 8 sites during a field campaign in Korea in 2016 (May-June) and from 1 to 5 years before, depending on

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Discussion paper

the station. An investigation of the pollution levels at the 8 different sites, the diurnal pattern of NO_2 and HCHO as well as NO_2 long-term trends are presented.

During the campaign, additional measurements of the NO_2 column using the 4STAR airborne sun photometer and of the altitude profile of HCHO using the air-borne CAMS instrument have been performed, which are compared to the columns measured by the ground-based Pandora instruments. On a longer time series of 1 and 5 years, respectively, a comparison to OMI NO_2 satellite measurements is presented. At last, the Pandora HCHO measurements during the campaign are compared to HCHO measurements from OMI.

The paper highlights nicely the importance and advantages of ground-based measurements with a high temporal resolution for the investigation of local, surface near air pollution in comparison to satellite measurements, which cannot capture the diurnal cycle and tend to underestimate local pollution hotspots due to the large averaging area of the ground pixels.

The paper is well structured and the scientific approach is clearly described. However, the objective and aim of the campaign should be declared more clearly in the text and in some cases the interpretation of the results is lacking.

All in all, I believe this paper is in the scope of AMT and should be published, with some minor improvements, based on answering my specific comments below:

Specific comments:

Abstract, line 44: What kind of average is meant by the mentioned "PSI C(NO_2) averages" and "OMI averages"?

Introduction: Please mention that these are direct sun measurements. The objective and aim of the campaign should be declared more clearly in the text. Although the cited reference Spinei et al., 2018 discusses the analysis procedure very extensively, please mention in the introduction at least briefly the retrieval algorithm (DOAS?), what

kind of reference spectrum is used and how the measured slant columns from the direct sun measurements are converted into vertical columns. Since it is mentioned later on in Section 2 for the measurements in Anmyeondo, please discuss briefly the contribution of the stratosphere to the presented total vertical columns. How large is the contribution and does it change over the day? Can stratosphere and troposphere be separated? Please mention briefly what other work on ground-based (DOAS type) Korean/Asian air pollution measurements has been published in other studies in the past to put the aim of the campaign/study into context.

Fig. 2a, page 5: The agreement between the instruments is quite impressive. But what happened at 17:30-18:00 local time? Are these real differences or has the Pan27 instrument some missing data gaps and the connected data points convey a wrong impression?

Section 2, line 195f, page 8: See comment on stratospheric contribution above.

Section 3: Please explain in more detail why the observed NO_2 daily patterns fit so well to automobile and power generation emissions. In many of the studies on the NO_2 diurnal cycle in polluted urban regions two NO_2 peaks in the morning and afternoon are observed corresponding to the morning and afternoon traffic rush hour. Do you have an explanation why the morning rush hour is hardly visible in the presented measurements and why the afternoon peak is so pronounced? Do you also observe a weekly cycle in your NO_2 measurements, like it has been been observed in polluted regions and discussed for example in Beirle et al. (GRL, 2003) or Ialongo et al. (AMT, 2016)?

Section 4: About the seasonal cycles: Please discuss briefly why the seasonal cycle of NO_2 has its minimum in August/September and its maximum in winter/early spring. Is there more heating during winter times in Korea or is it just due to less OH radicals because of less light in winter?

Section 4, line 291, page 13: The “strong effect on local air quality” is an improvement of local air quality, right?

Section 6, line 531f, page 27: What is the reason for this seasonal increase during May and June?

Technical corrections:

Line 43, page 2: please add “local time” or LT

Line 48, page 2: please enclose “FOV” in brackets

Tab. 1: The degree symbol is missing for latitude and longitude values

Line 229, page 10: Please round off the values for H_2O and CO_2. Six significant(?) digits are unnecessary here, since this paragraph is only about getting a general impression on the order of magnitude of the emissions from automobiles.

Fig. 6: Between Panel A and Panel B the x axis tick labels A, M, J and J (April, May, June, July) are missing.

Line 298, page 13: please add “local time” or LT

Fig. 9a: Seoul (left panel): Why does the 3-month average (solid lines) show values where around 6 month of data are missing? Or is it just a linear interpolation between the values before and after the gap?

Line 429, page 19 and Fig. 14: The numbers in “Integ(0.026, 7.2)” are given in kilometers?

Tab. 2.: “PSI HCHO” is missing the “DU” (like in “DC8 HCHO DU”)

Line 545, page 29: “. . . very high amounts of urban pollution from NO_2 and HCHO *, and more moderate, but still high values, away from the urban centers.“ *close to the urban centers

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