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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Long term MAX-DOAS measurements of NO_2, HCHO and aerosols and evaluation of corresponding satellite data products over Mohali in the Indo-Gangetic plain" *by* Vinod Kumar et al.

Anonymous Referee #1

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This paper investigates the temporal variation of the vertical distributions of aerosols, NO2, and HCHO and corresponding AOD and vertical column densities (VCDs) retrieved from MAX-DOAS observations performed at Mohali, north-west Indo Gangetic plain. The measurements presented in the study cover the period from January 2013 to June 2017. The different factors driving the seasonal and diurnal variations of the above parameters are identified and extensively discussed. The MAX-DOAS data sets are also used to validate co-located observations from the OMI and MODIS satellite instruments.

This paper is well written, clearly structured, and presents very interesting results which fit well with the scope of ACP. In addition, I would like to say that for me this study is a breakthrough in the evaluation of the air quality in India using ground-based and space-borne remote sensing observations. I therefore strongly recommend the final publication of the manuscript after addressing the following comments:

Specific comments:

Page 3, lines 97-98: It is written that the two stationary MAX-DOAS measurements over India did not report trace gas VCDs? What do they report then? Only aerosol measurements? The locations of those stationary MAX-DOAS measurements are also not clear.

Page 5, lines 160-163: You should add in the legend of Fig D2 to which day those horizon scan results corresponds? Is the steep increase in the measured intensity always centred between 0° and 0.3° during the 4.5 years of measurements?

Page 6, line 176 (Eq. 1): How do you select SCD90? Do you use the zenith dSCD of the scan for correcting all the off-axis dSCDs, or do you interpolate the zenith dSCD at the time of the off-axis measurements of a scan by using the zenith dSCDs just before and just after those off-axis measurements? From my experience, it can have an impact on the resulting off-axis dSCDs, especially in the case of HCHO.

Page 14, lines 447-448 and next paragraphs on page 15: are there any measurements of the boundary layer height at Mohali? It could be an added value to the discussion. If no measurements exists, maybe ECMWF Era-interim BLH could be used.

Page 18, line 562 and page 23, line 723: MAX-DOAS VCD measurements are spatially representative of a few kilometres in the field of view and this horizontal sensitivity strongly depends on the aerosol load. I think it would be useful to have to estimate this horizontal sensitivity for the main sky conditions presented in Figure 3. Numerous studies have also shown that taking into account this horizontal sensitivity in the

selection of the co-located satellite data can have an impact on the agreement with ground-based MAX-DOAS observations. This is especially the case in the present study where MODIS data are given on a 1x1 km2 grid, i.e. at a horizontal resolution which is significantly higher than the typical horizontal distance of several kilometres representative of the MAX-DOAS measurements.

Page 21, lines 646-648: Since satellite total HCHO AMFs and averaging kernels are missing in the files, you could proceed the other way round for eliminating the difference caused by the non-representative satellite a priori HCHO profiles, i.e. recalculating satellite AMFs using MAX-DOAS vertical profiles and dividing the satellite slant column densities by those new AMFs (see e.g. De Smedt et al., Atmos. Chem. Phys., 15, 12519–12545, 2015). Maybe something worth to try.

Page 50, Figure D4: How MODIS would compare to the AERONET sun photometer measurements at these two sites? Angstrom exponent could be used to convert MODIS AOD from 470 nm to 360 nm.

Technical corrections:

Page 1, line 11: 'We investigate the temporal variation and the vertical profiles. . .'. I find the sentence a bit misleading since you also investigate the temporal variation of the vertical profiles (-> see Figure 5). Maybe some rephrasing is needed here.

Page 2, line 59: 'ground based' -> 'ground-based'; There are some other places where this should be corrected too.

Page 5, line 138: Multi Axis Differential Optical Absorption Spectroscopy (MAX-DOAS).

Page 14, line 444: 'diurnal trends' -> 'diurnal variations' ?

Page 28, Figure 1: The names of the cities and the x and y axes labels are difficult to read. Maybe you could use a larger font size.

Page 37, Figure 13: in the legend, it should be 'Daily mean HCHO mixing ratios. . .' and

not NO2 mixing ratios.

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