Atmospheric
Measurement
Techniques

Supplement of

Comparison of TROPOMI/Sentinel-5 Precursor NO_2 observations with ground-based measurements in Helsinki

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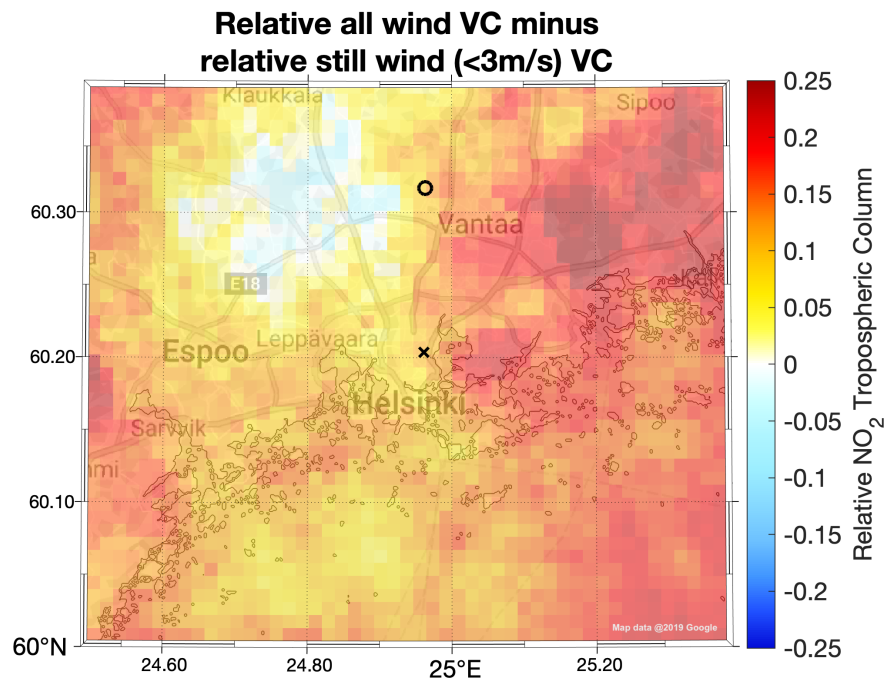
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Figure S1. Difference between the relative NO$_2$ tropospheric columns for all wind conditions and those with a wind speed less than $3\,\mathrm{m\,s}^{-1}$ ("still" winds). The map has been created by projecting spherical Earth coordinates (latitude/longitude) onto a $1\,\mathrm{km} \times 1\,\mathrm{km}$ resolution grid using the transverse Mercator map projection centred at Helsinki. Tropospheric TROPOMI NO$_2$ retrievals (pixels) during the period 15.4.–30.9.2018 falling to either wind scenario have been binned and averaged to their respective map grids, and then normalised to the corresponding maximum values within each grid. Finally, the resulting normalized maps have been subtracted from one another to create the final map (all winds minus still winds). The wind speed corresponding to each TROPOMI pixel was estimated by interpolating ECMWF ERA5 wind data on the 1000, 975, 950, and $925\,\mathrm{hPa}$ pressure levels to the pixel's overpass time and the coordinates of its corners and centre, and averaging the results. Only TROPOMI data with a QA value >0.75 were considered.
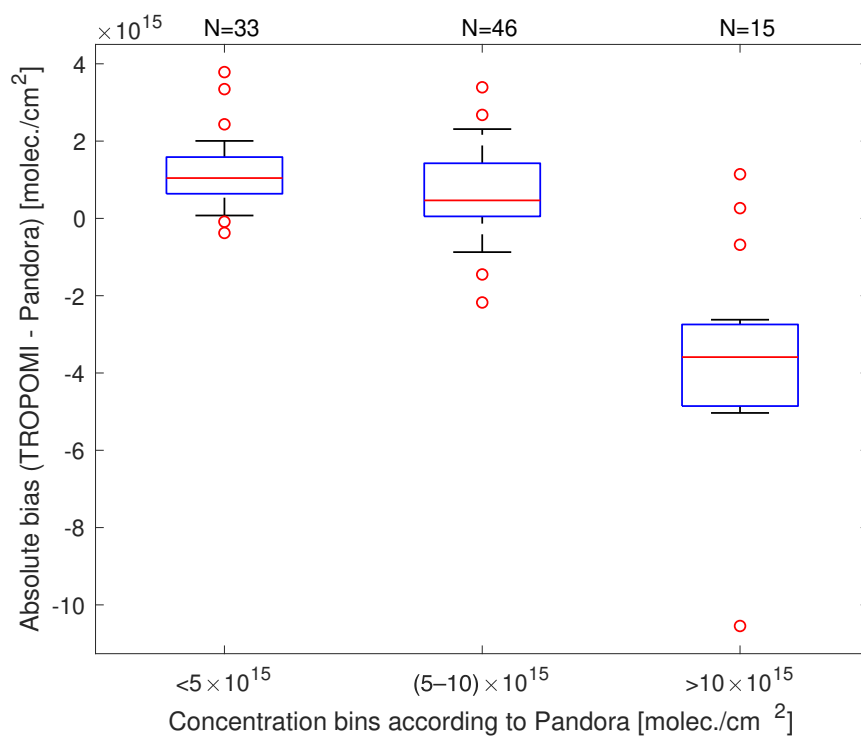
Figure S2. Box plot of the absolute differences between co-located Pandora and TROPOMI NO$_2$ total columns between 15 April and 30 September 2018 for three concentration bins with increasing values of Pandora total columns. The blue boxes indicate the range between the first and third quartiles, the red lines inside the boxes mark the medians, the black whiskers mark the fifth and 95th percentiles, and the red circles mark data points that are outside the range of the whiskers.
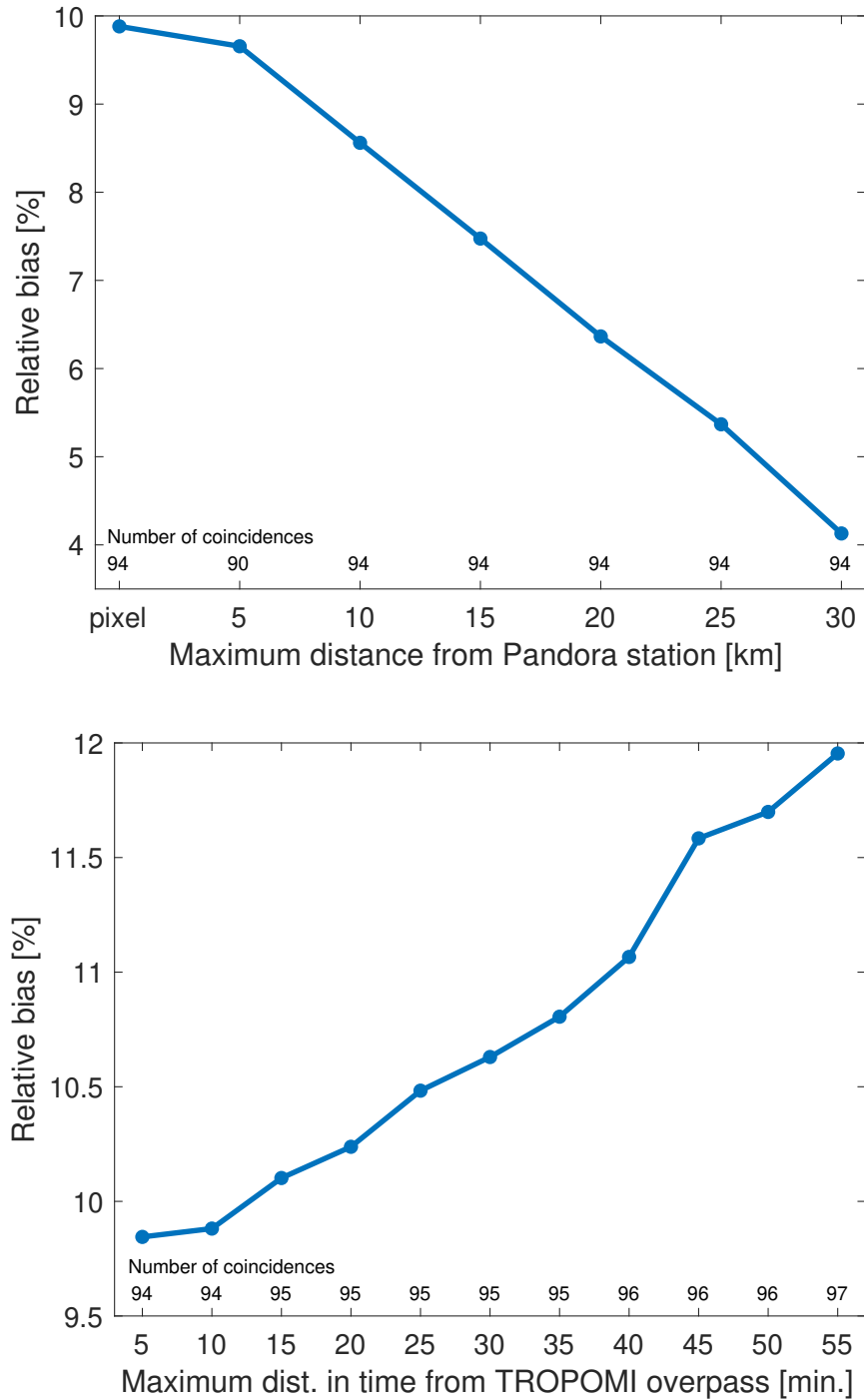
Figure S3. Mean relative difference between TROPOMI and Pandora total columns as a function of the maximum distance between the centre of the pixel and the ground-based station (upper panel) and as a function of the maximum time difference from the TROPOMI overpass (lower panel). The number of coincidences for different collocation criteria are shown above the x-axis.
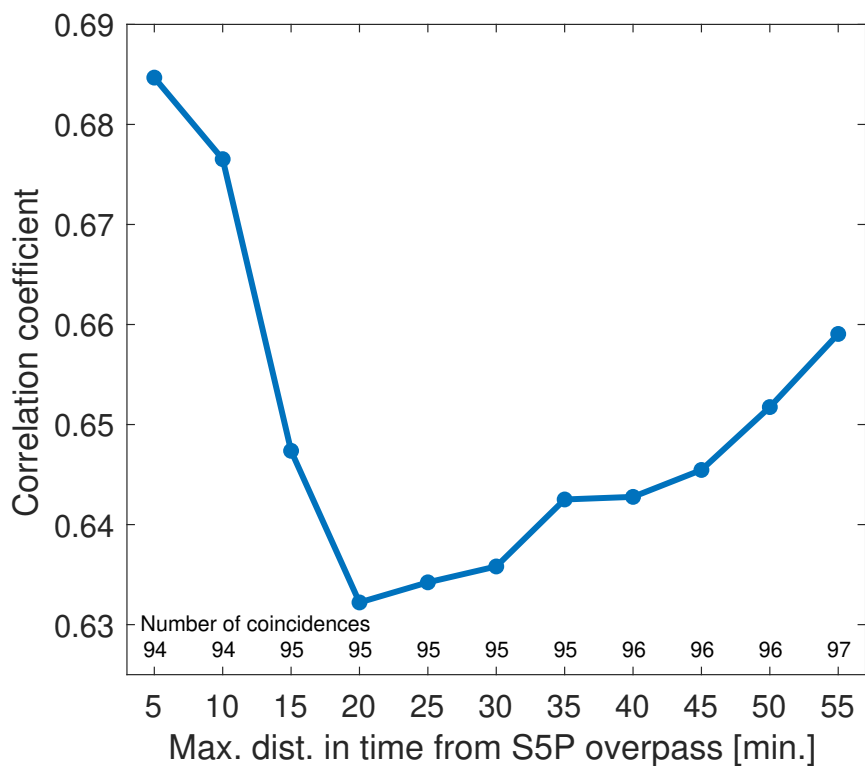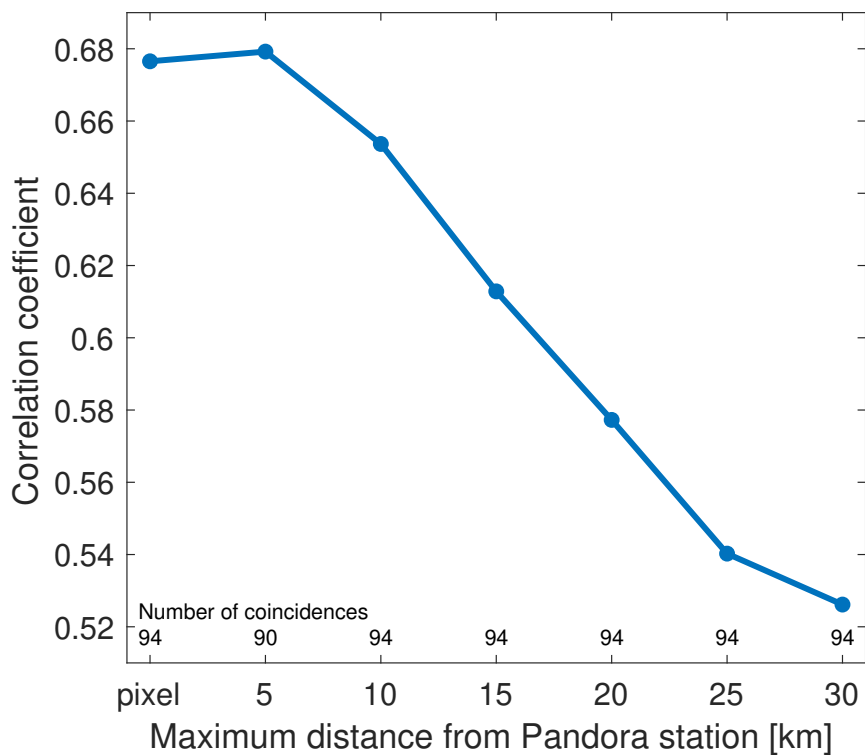
Figure S4. Correlation coefficient between TROPOMI and Pandora total columns as a function of the maximum distance between the centre of the pixel and the ground-based station (upper panel) and as a function of the maximum time difference from the TROPOMI overpass (lower panel). The number of coincidences for different collocation criteria are shown above the x-axis.
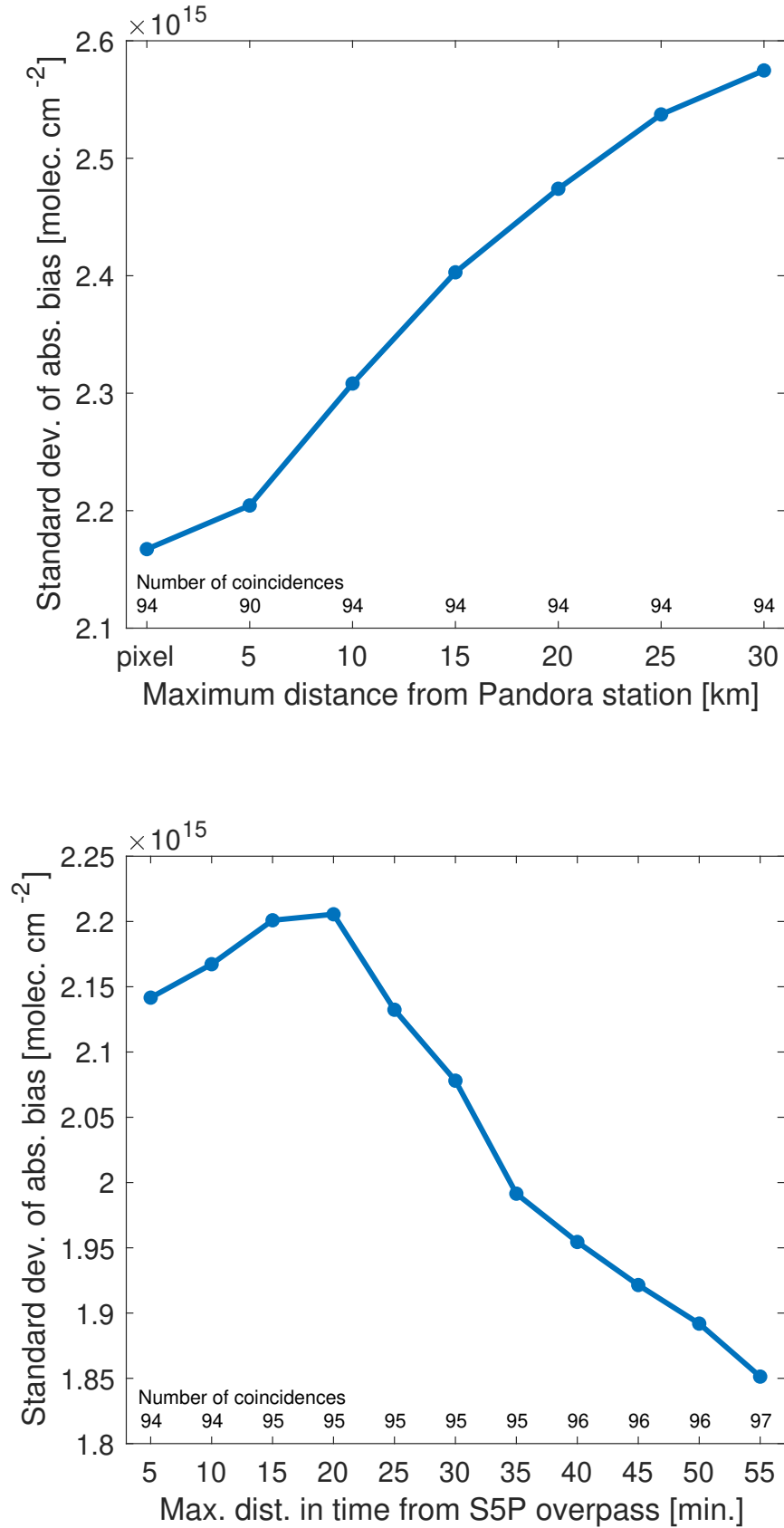
Figure S5. Standard deviation of the differences between TROPOMI and Pandora total columns as a function of the maximum distance between the centre of the pixel and the ground-based station (upper panel) and as a function of the maximum time difference from the TROPOMI overpass (lower panel). The number of coincidences for different collocation criteria are shown above the x-axis.
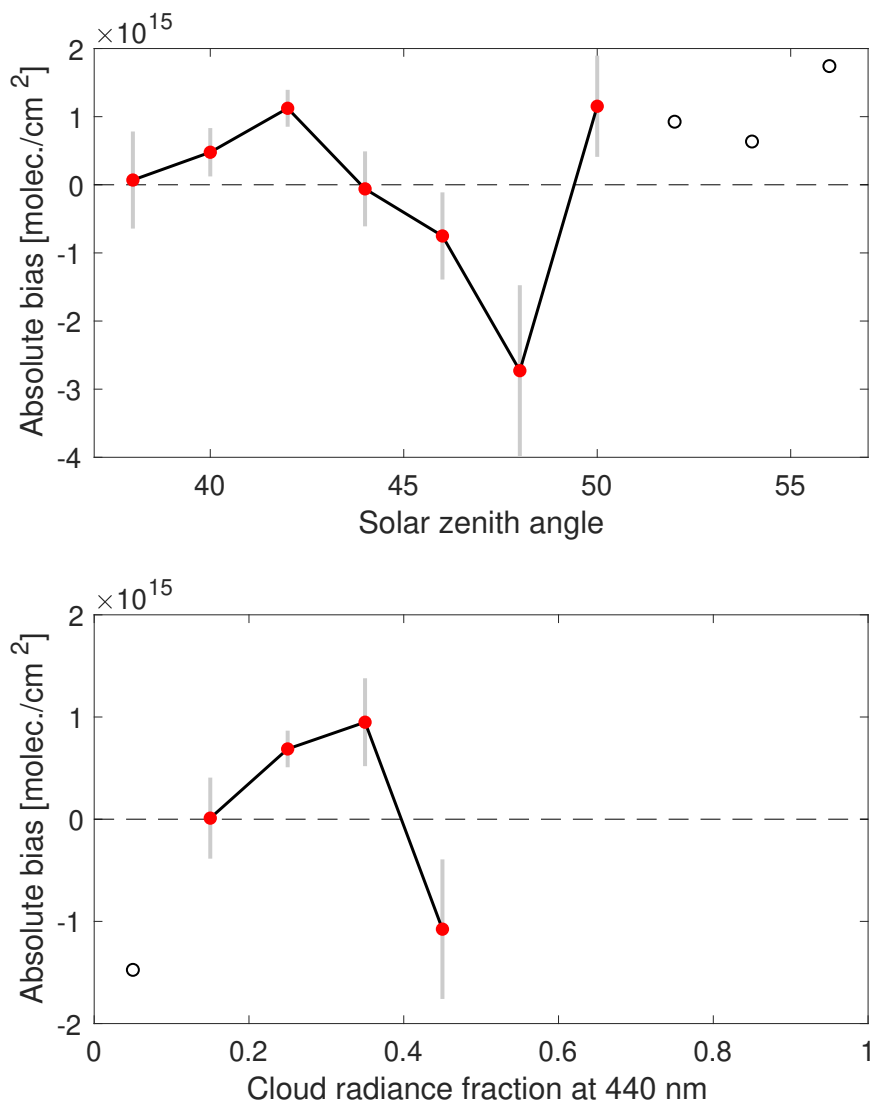
Figure S6. Absolute difference between TROPOMI and Pandora total columns as a function of SZA (upper panel) and of CRF (lower panel). The error bars correspond to the standard error of the mean.
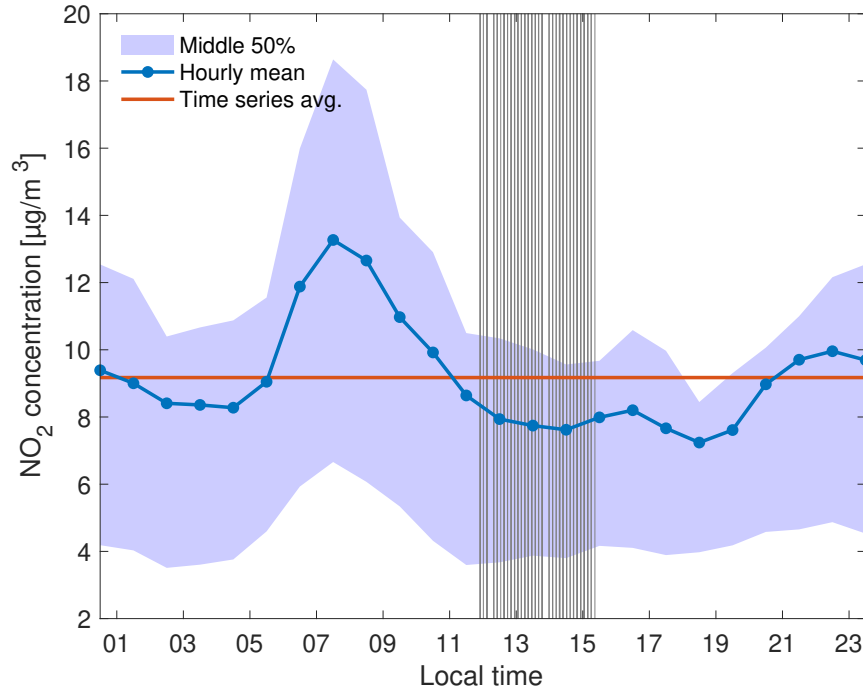
Figure S7. Diurnal cycle of average hourly NO$_2$ surface concentration measurements at the Kumpula air quality station between 15 April and 30 September 2018 and the timing of the S5P overpasses (grey vertical lines) studied in this paper. The blue line indicates the averages of the hourly NO$_2$ measurements, the shaded region the range between their first and third quartiles (i.e. the middle 50 % of measurements), and the orange line the whole time series average.
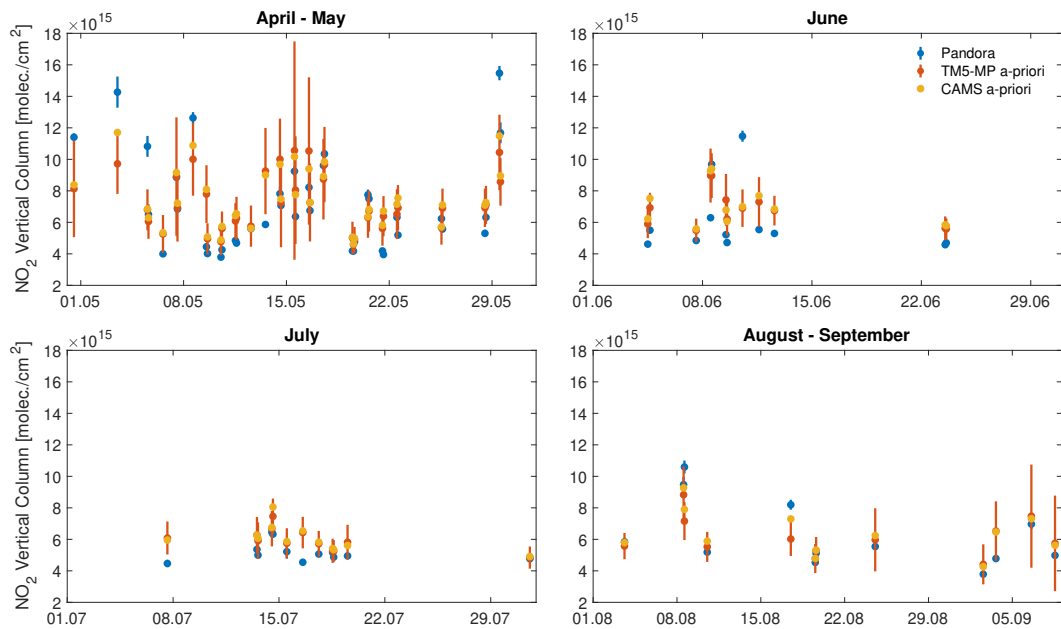

Figure S8. Time series of co-located TROPOMI summed columns derived using CAMS regional (yellow dots) and TM5-MP (red dots) a-priori NO$_2$ profiles, and Pandora (blue dots) total columns from 30 April to 30 September 2018. The error bars correspond to the standard error of the mean value for Pandora and to the retrieval uncertainty for TROPOMI.