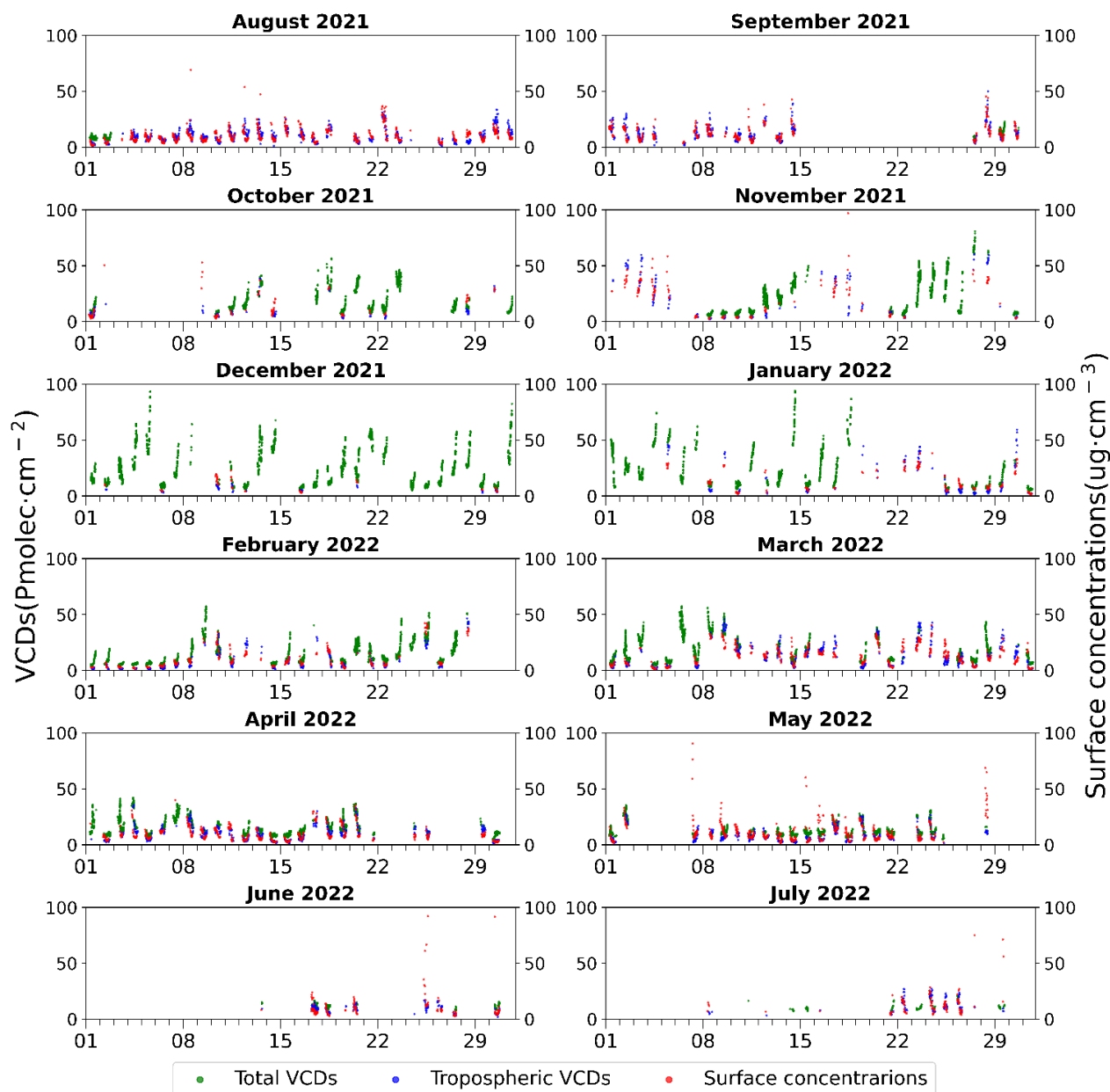Atmospheric
Measurement
Techniques

Supplement of

Evaluation of the first year of Pandora NO_2 measurements over Beijing and application to satellite validation
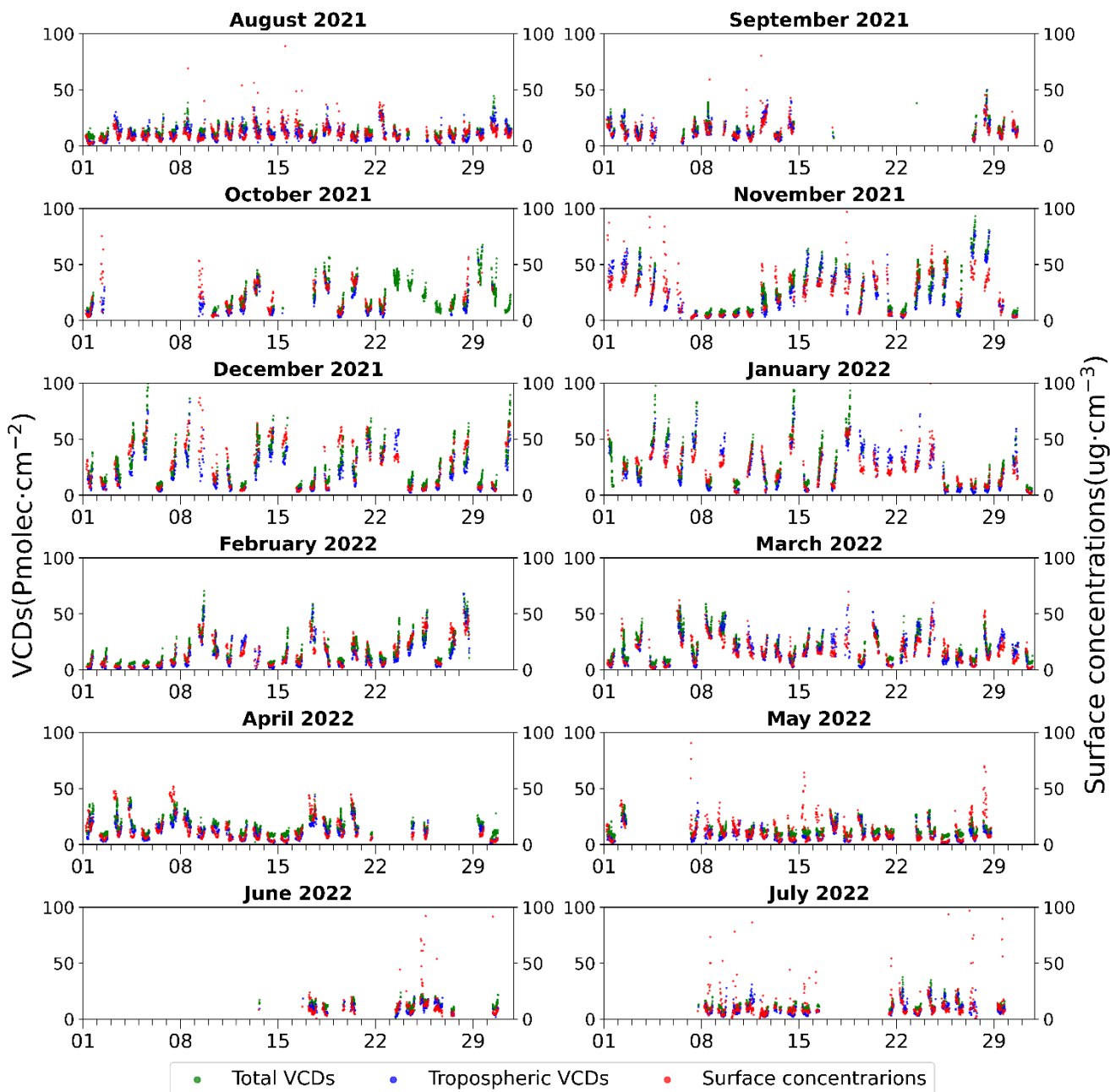
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Figure S1: Overview of NO₂ data measured with Pandora at the Beijing-RADI site, as time series during each month from August 2021 to July 2022: total VCD in green and tropospheric VCD in red (both on left vertical axes in Pmolec.cm⁻²) and surface concentrations in red (plotted on the right axis in µg.cm⁻³) Only data with DQ0, DQ1, DQ01 and DQ11 are plotted. Note that the surface concentrations scale has been chosen such that they are plotted at the bottom of the VCDs.

Figure S2: Overview of NO₂ data measured with Pandora at the Beijing RADI site, as time series during each month from August 2021 to July 2022: total VCD in green and tropospheric VCD in red (both on left vertical axes in Pmolec.cm⁻²) and surface concentrations in red (plotted on the right axis in μg.cm⁻³). All available data are plotted, i.e., in addition to the data in Figure 2, also data with DQ2 and DQ12 are included. Note that the surface concentrations scale has been chosen such that they are plotted at the bottom of the VCDs.

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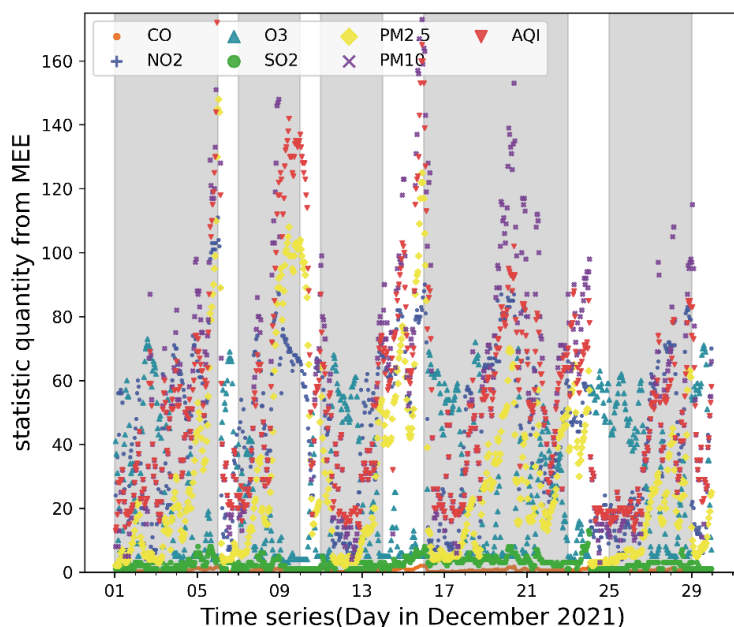
Figure S3: Time series of in-situ concentrations of trace gases (see legend) measured by the national air quality monitoring site in the Olympic Forest Park in Beijing in December 2021, and the air quality index derived from these data. The grey areas indicate episodes with bad air quality discussed in the text in section 3.1.1.
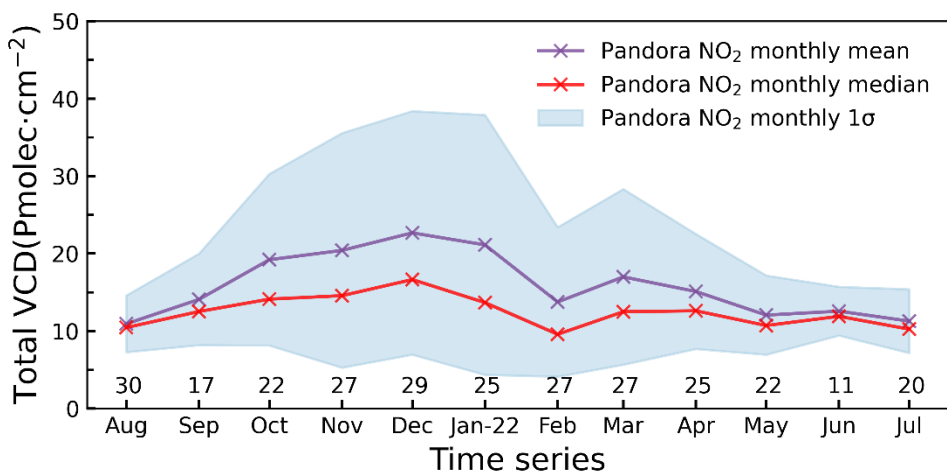
20
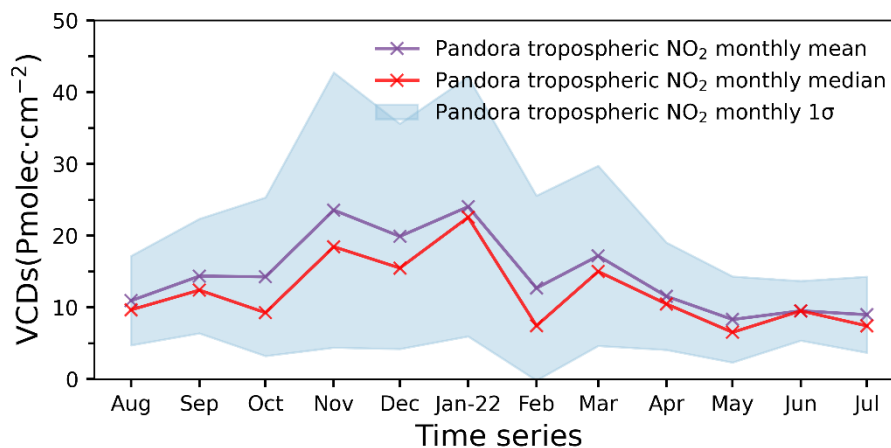
Figure S4: Time series of the monthly mean and median NO_2 tropospheric VCDs over Beijing from August 2021 to July 2022. The blue shaded area indicates the standard deviation for the monthly mean data. This plot includes data with DQ2 and DQ12, in addition to the data presented in Figure 3. The inclusion of these data results in the availability of data for almost all days during the study period, but with lower confidence. Comparison with the data in Figure 3 shows that the main deviation occurs in December, where the number of high-quality data is reduced to 9 which causes a dip in the curve.

Table S1: Statistics of the Pandora-derived monthly mean NO$_2$ tropospheric VCDs. Data with DQ0, 1, 2, 10, 11 and 12 are included.

	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Mean (Pmolec.cm^{-2})	10.94	14.36	14.27	23.56	19.90	24.04	12.69	17.18	11.55	8.32	9.53	8.98
Median (Pmolec.cm^{-2})	9.67	12.41	9.27	18.45	15.48	22.56	7.45	15.01	10.48	6.53	9.52	7.43
Minimum (Pmolec.cm^{-2})	0.08	1.55	2.72	0.16	2.24	1.47	0.77	0.60	1.00	1.08	1.77	0.46
Maximum (Pmolec.cm^{-2})	34.74	50.06	65.11	79.88	83.35	77.82	68.12	55.53	42.88	37.03	20.50	31.13
1σ (Pmolec.cm^{-2})	6.22	7.97	11.04	19.17	15.70	18.08	12.87	12.55	7.47	5.99	4.15	5.30
Number of days data	31	18	19	30	31	31	28	31	25	23	12	21

Figure S5: Time series of the monthly mean and median NO$_2$ total VCDs over Beijing from August 2021 to July 2022. The blue shaded area indicates the standard deviation for the monthly mean data. This plot includes data with DQ2 and DQ12.

Table S2: Period of high NO$_2$ concentration during north-westerly winds during winter.

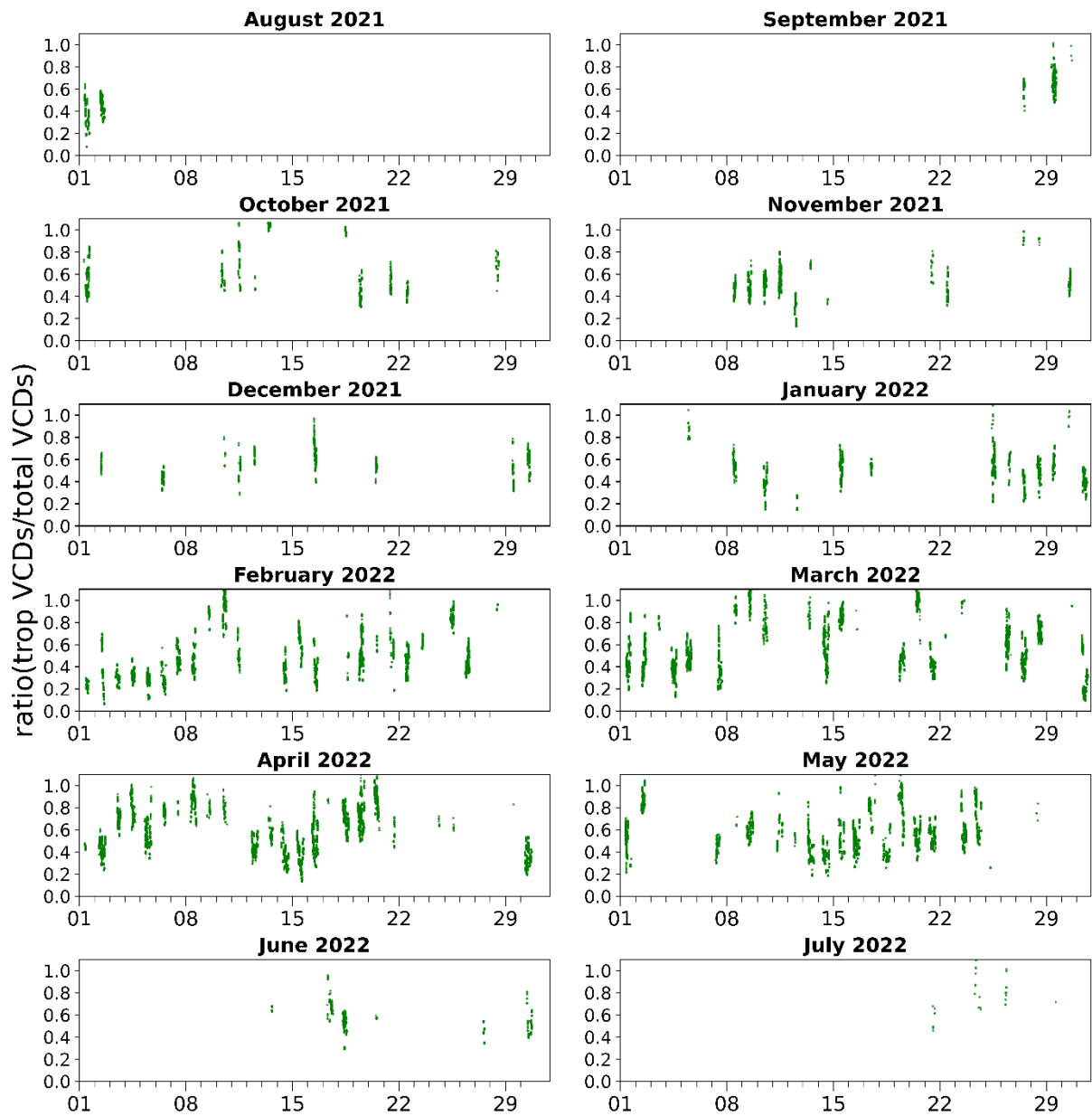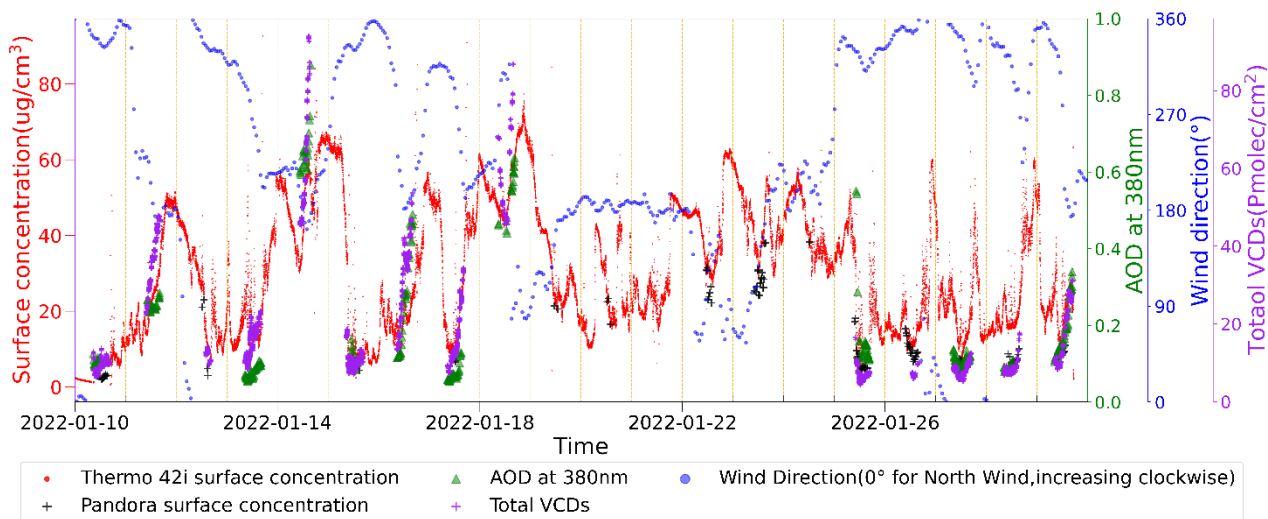| Time	Tropospheric NO$_2$ VCD (Pmolec.cm^{-2})
2021/11/14 12:32:22	32.8
2021/11/17 13:16:32	48.7
2021/11/24 12:44:22	31.7
2021/12/14 11:27:36	41.5
2021/12/14 13:09:05	41.5
2021/12/19 13:15:25	33.1
2021/12/22 12:18:21	29.9
2021/12/28 12:05:44	28.6
2022/1/1 12:31:14	25.1
2022/3/8 11:58:46	29.9

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Figure S6: Time series of the ratios of tropospheric VCDs to total VCDs for each month from August 2021 to July 2022.

Figure S7: Time series of NO₂ surface concentrations measured using the Thermo Scientific 42i-TL Analyzer (red dots) and derived from the Pandora sky data (black crosses), total VCDs (purple crosses), wind direction (filled blue circles) and AOD (solid green triangles) during 20 days: 10 - 30 January 2022. Yellow vertical dashed lines indicate Beijing Time 0:00. Note that the NO₂ total VCDs are plotted on the vertical axis to the far right and scaled to match the Thermo 42i-TL Analyzer surface concentration data.