



Supplement of

**Peculiar COVID-19 effects in the Greater Tokyo Area revealed
by spatiotemporal variabilities of tropospheric gases
and light-absorbing aerosols**

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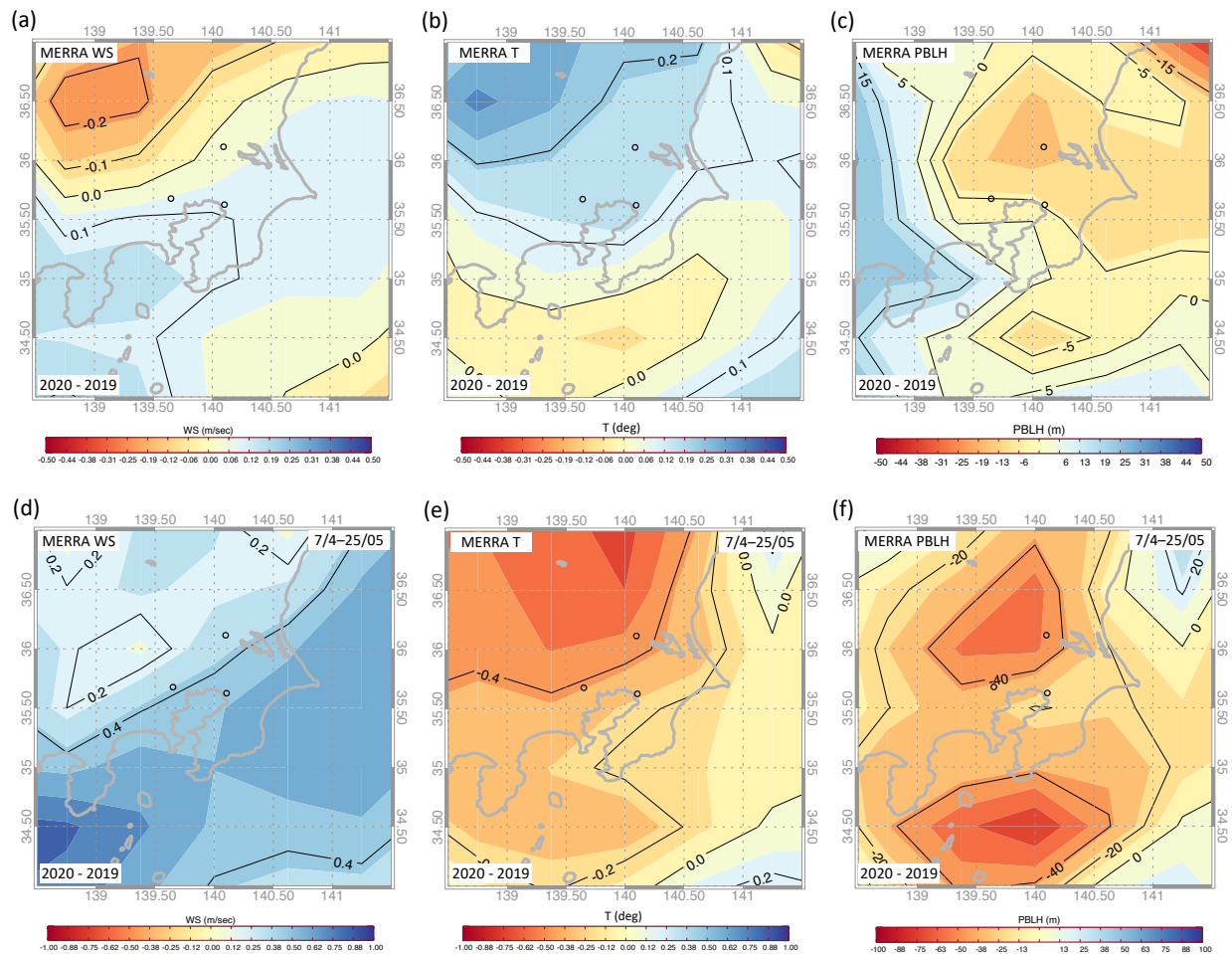


Fig. S1. Spatial distribution of the difference between 2020 and 2019 in wind speed (a), temperature (b) and PBLH (c) as simulated with MERRA-2 reanalysis data. Panels (d–f) are as described in (a–c) but limited to 7 April–25 May (i.e., the state of emergency).

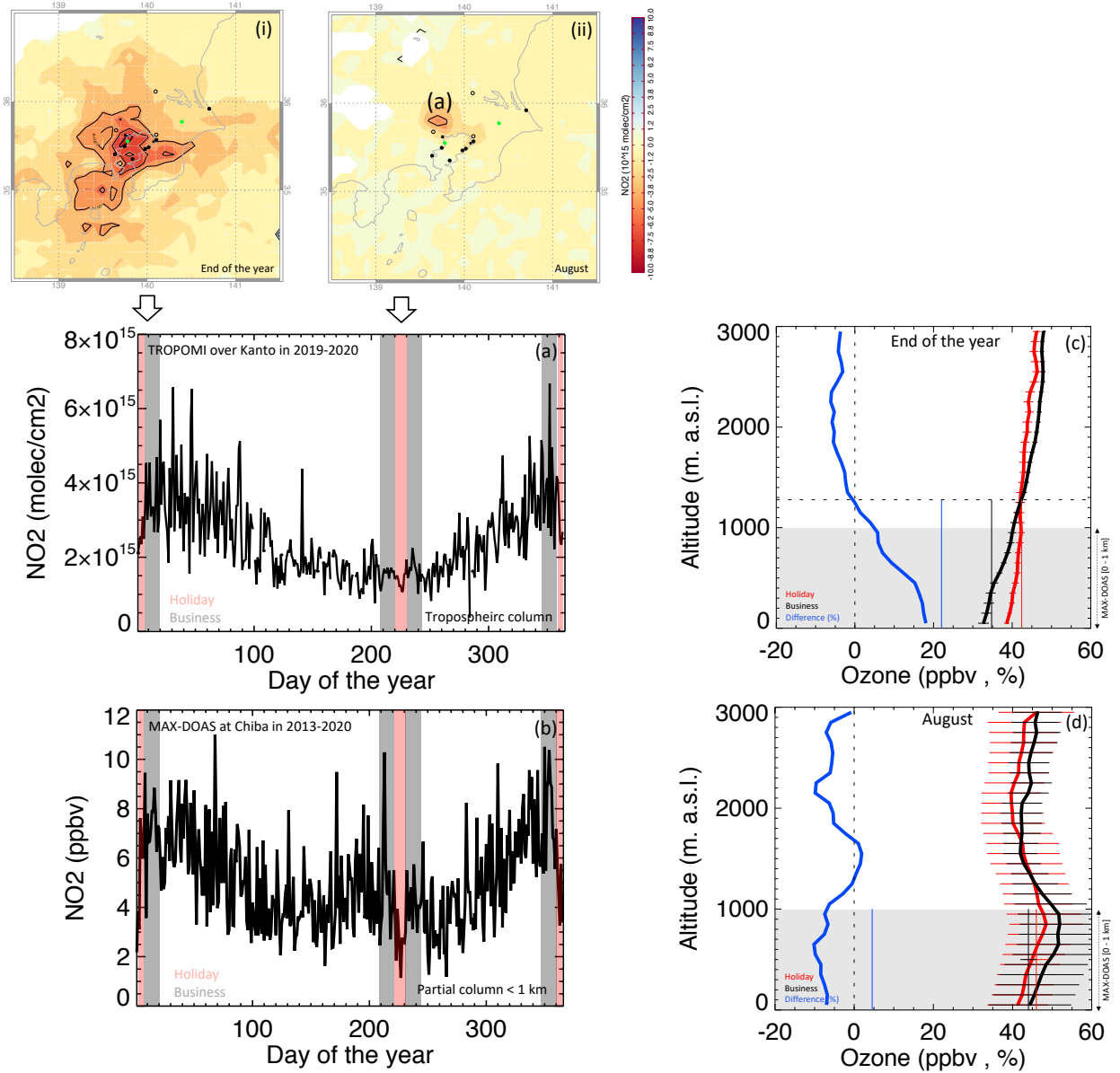


Fig. S2. TROPOMI NO₂ daily climatology over the investigated Kanto region for 2019–2020 years (a). Top insets show the TROPOMI-based holiday effect in NO₂ during the end-of-year (i) and mid-August (ii) holiday periods (the holiday effect is defined as the difference between holidays and business days). Panel (b) is as described in (a) but for MAX-DOAS NO₂ daily climatology at Chiba for 2013–2020. In (a) and (b), holidays (pink) and business days (gray) are highlighted. The vertical ozone distributions obtained from the ozonesonde (profile) and box model simulation (vertical lines) for holidays and business days during the periods highlighted in

(a) and (b) are presented in panels (c) and (d) for the period of 2013–2020 (see Sect. 2 for details). Panel (c) is analogous to Fig. 6c and has been shown for the sake of clarity.

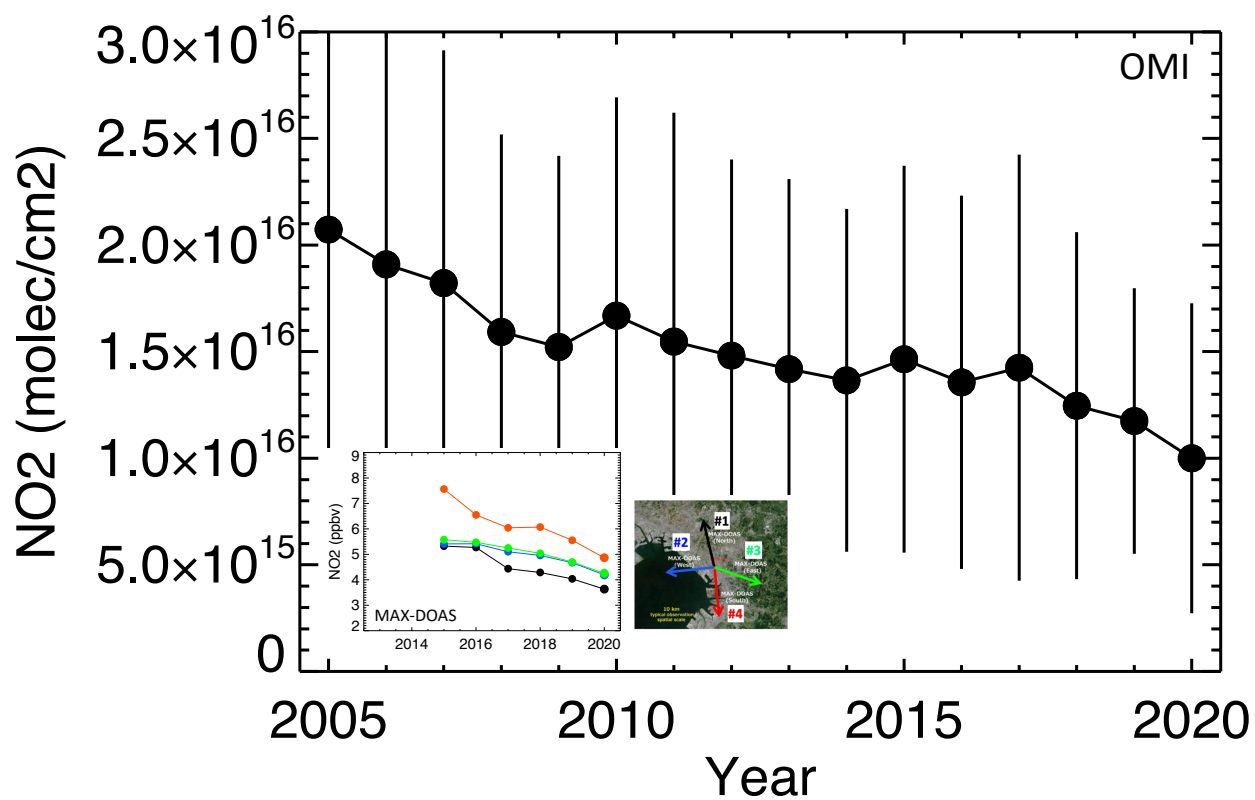


Fig. S3. Main panel: annual mean OMI NO₂ tropospheric column data at Chiba in 2005–2020.

Insets: annual mean MAX-DOAS partial column values at Chiba in 2015–2020 for the MAX-DOAS systems pointing in four directions (north: black, south: red, west: blue, east: green; © Google Maps 2019).

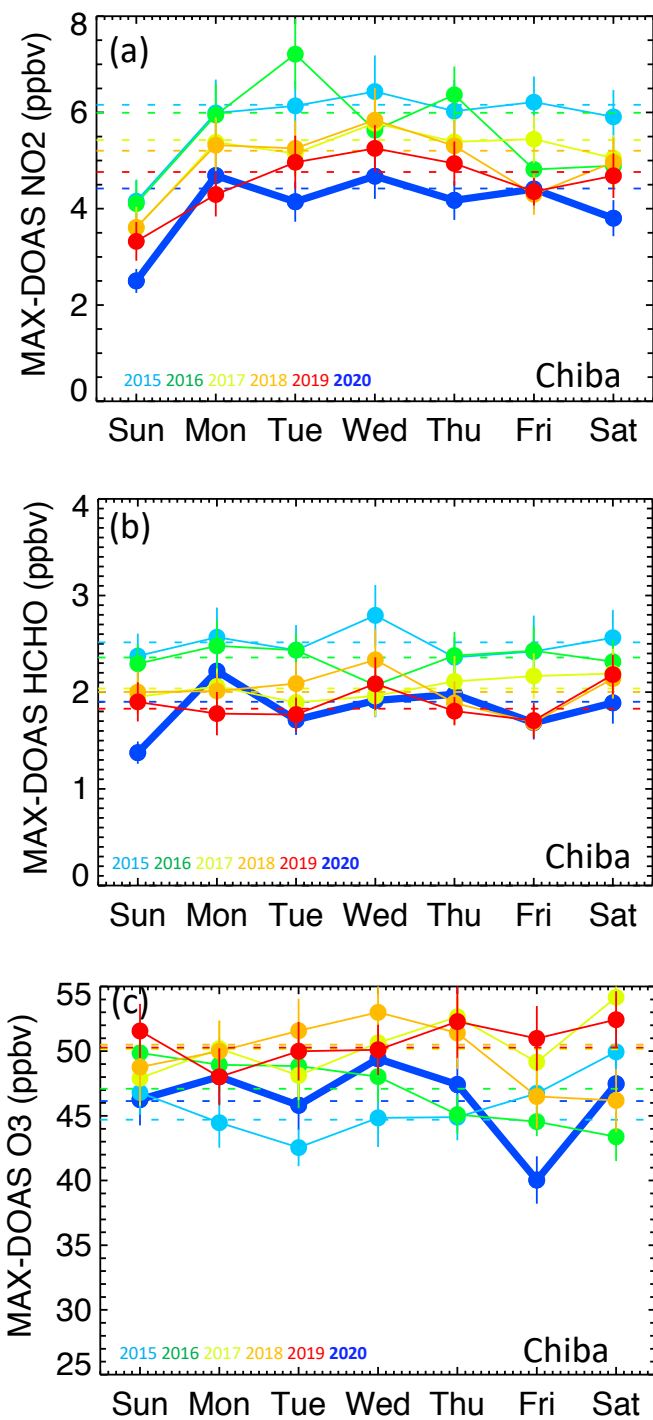


Fig. S4. Weekly cycle of MAX-DOAS partial column NO₂ (a), HCHO (b) and O₃ (c) concentrations at Chiba for 2015–2020. Error bars show 1-sigma error of the mean.

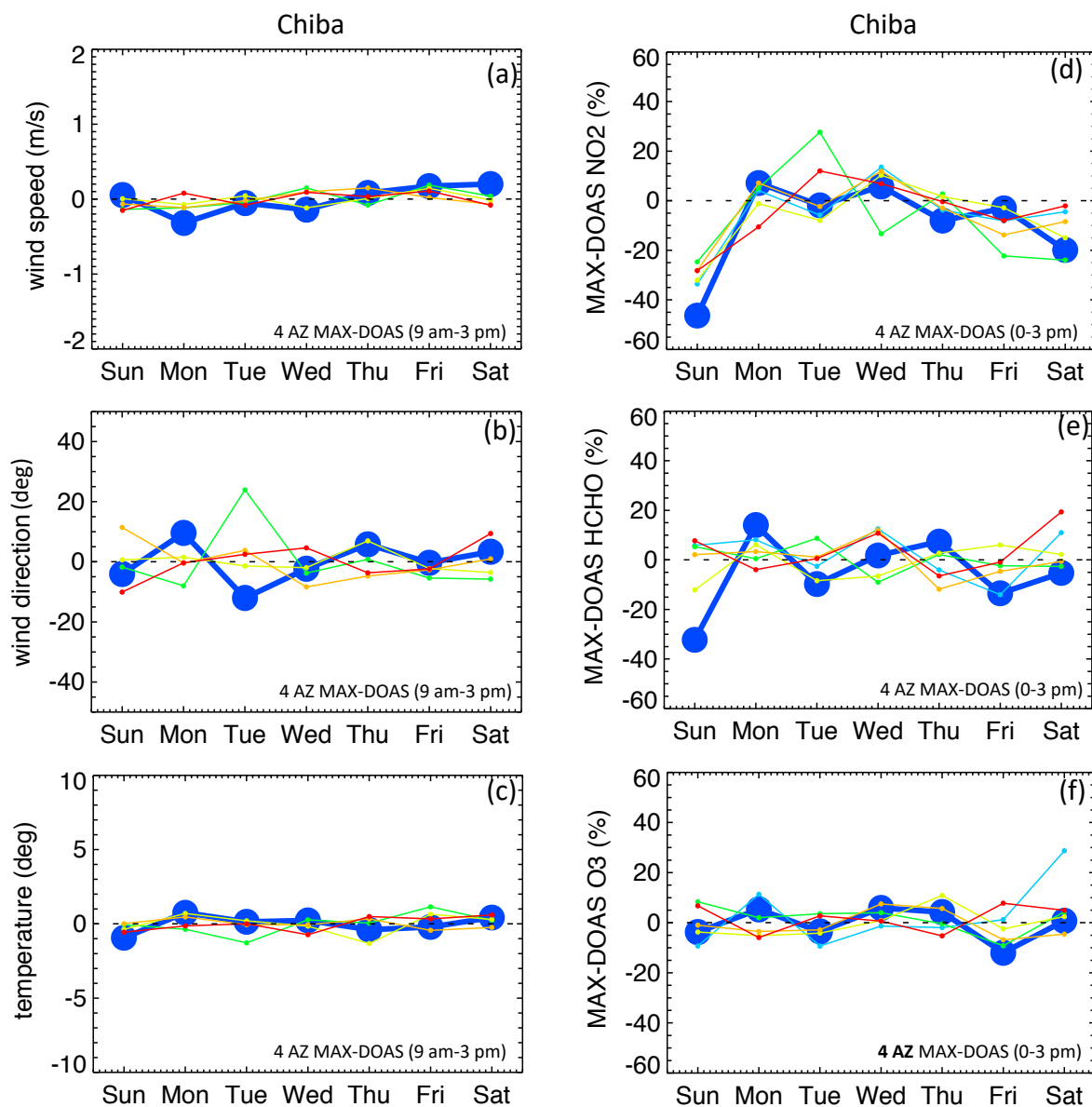


Fig. S5. Left panels: Weekly cycles of wind speed (a), wind direction (b) and temperature (c) as observed at the weather station of Chiba University at 9 am–3 pm. Right panels: Weekly cycles of MAX-DOAS partial column NO₂ (d), HCHO (e) and O₃ (f) at Chiba University in the afternoon (0–3 pm). Period: 2015–2020.

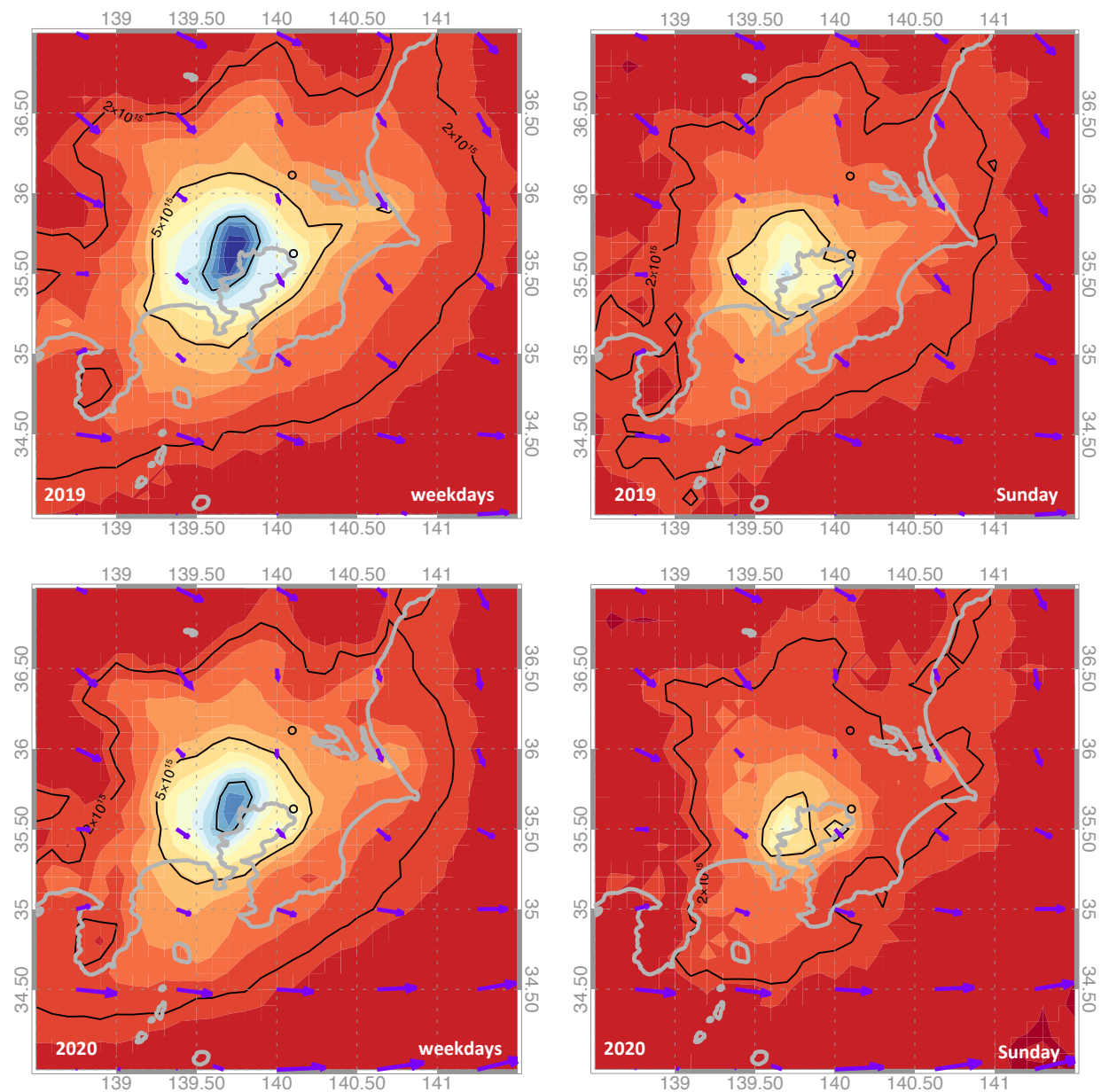


Fig. S6. Spatial distribution of TROPOMI NO₂ for January–December 2019 (top panels) and 2020 (bottom panels) during weekdays (left column) and Sundays (right column). The area enclosed within the 5×10^{15} molec/cm² isoline was reduced by an average of about -27% on weekdays and -67% on Sundays between 2020 and 2019. Arrows show the 10-m wind speed and direction climatology from MERRA-2 dataset.

Tab. S1. Global ranking of the weekend effect (Sunday minus weekdays) and holiday effect (end-of-year period minus business days) as shown in Fig. 5a for cities with a population greater than 0.5 million based on OMI NO₂ in 2005–2020. Only cities where weekend changes were larger than 30% were shown.

Name	Country Code	Population	Weekend (%)	Holiday (%)	NO ₂ (mol./cm ²)
Sao Paulo	BR	10021295	-49.6	-32.9	7.87E+15
Santo Andre	BR	662373	-49.6	-32.9	7.87E+15
Sao Bernardo do Campo	BR	743372	-49.6	-32.9	7.87E+15
Osasco	BR	677856	-49.5	-37.7	5.87E+15
Los Angeles	US	3971883	-47.8	-25.8	1.16E+16
Saitama	JP	1193350	-47.7	-41.3	1.42E+16
Santiago	CL	4837295	-47.0	-22.5	6.65E+15
Hachioji	JP	561344	-46.8	-44.9	1.38E+16
Tokyo	JP	8336599	-45.3	-39.5	1.72E+16
Kawasaki	JP	1306785	-45.3	-39.5	1.72E+16
Guarulhos	BR	1169577	-44.8	-19.2	5.22E+15
Madrid	ES	3255944	-44.2	-18.2	6.05E+15
Puente Alto	CL	510417	-43.3	-12.5	5.01E+15
Honcho	JP	560743	-42.5	-38.9	1.73E+16
Barcelona	ES	1621537	-42.3	-25.5	5.35E+15
Yokohama	JP	3574443	-42.2	-38.8	1.31E+16
San Jose	US	1026908	-41.8	-41.1	3.94E+15
Essen	DE	593085	-41.7	-33.3	1.05E+16
Sorocaba	BR	558862	-41.5	-22.6	2.77E+15
Osaka	JP	2592413	-40.5	-46.4	1.12E+16
The Bronx	US	1385108	-40.3	-17.7	1.09E+16
Manhattan	US	1487536	-40.3	-17.7	1.09E+16
Melbourne	AU	4246375	-40.0	-32.4	2.76E+15
Milan	IT	1236837	-39.9	-26.9	9.18E+15
Phoenix	US	1563025	-39.8	-25.7	4.13E+15
Stuttgart	DE	589793	-39.7	-23.2	5.30E+15
Hamamatsu	JP	791707	-39.3	-32.3	6.35E+15
Nagoya	JP	2191279	-39.3	-33.4	9.41E+15
Frankfurt am Main	DE	650000	-39.1	-53.2	7.36E+15
Bogota	CO	7674366	-38.8	-38.8	1.57E+15
Boston	US	667137	-37.8	-34.6	4.86E+15
South Boston	US	571281	-37.8	-34.6	4.86E+15
Chiba	JP	919729	-37.8	-41.0	1.33E+16
Munich	DE	1260391	-37.7	-27.1	3.79E+15
Mississauga	CA	668549	-37.7	-33.5	6.02E+15
Dortmund	DE	588462	-37.6	-36.8	1.04E+16
Sakai	JP	782339	-37.5	-45.9	1.11E+16
New York City	US	8175133	-37.3	-16.2	1.15E+16
Toronto	CA	2600000	-37.1	-36.5	6.11E+15
Portland	US	632309	-37.0	-46.6	2.99E+15
Duisburg	DE	504358	-37.0	-31.1	1.16E+16
Brussels	BE	1019022	-36.6	-33.9	8.63E+15
Turin	IT	870456	-36.3	-34.7	5.63E+15
Rome	IT	2318895	-36.3	-25.6	3.47E+15
Nova Iguacu	BR	1002118	-36.1	-6.8	4.24E+15

Duque de Caxias	BR	818329	-36.1	-6.8	4.24E+15
Gustavo Adolfo Madero	MX	1185772	-35.9	-26.8	9.94E+15
Naucalpan de Juarez	MX	792211	-35.9	-26.8	9.94E+15
Cuauhtemoc	MX	531831	-35.9	-26.8	9.94E+15
Mexico City	MX	12294193	-35.9	-26.8	9.94E+15
Ciudad Nezahualcoyotl	MX	1104585	-35.9	-26.8	9.94E+15
Alvaro Obregon	MX	726664	-35.9	-26.8	9.94E+15
Iztapalapa	MX	1815786	-35.9	-26.8	9.94E+15
Coyoacan	MX	620416	-35.9	-26.8	9.94E+15
Tlalpan	MX	574577	-35.9	-26.8	9.94E+15
Shizuoka	JP	701561	-35.6	-35.4	5.31E+15
Montreal	CA	1600000	-35.3	-23.5	3.20E+15
Queens	US	2272771	-35.2	-17.1	1.14E+16
Brooklyn	US	2300664	-35.2	-17.1	1.14E+16
Duesseldorf	DE	573057	-34.8	-37.5	1.08E+16
Kyoto	JP	1459640	-34.7	-36.2	6.44E+15
Paris	FR	2138551	-34.2	-34.7	7.52E+15
Rotterdam	NL	598199	-34.2	-35.0	9.83E+15
Denver	US	682545	-34.2	-29.0	3.47E+15
Sydney	AU	4627345	-34.1	-29.9	3.59E+15
Las Vegas	US	623747	-34.0	-14.7	3.48E+15
Valencia	ES	814208	-33.9	-23.2	3.14E+15
Philadelphia	US	1567442	-33.8	-21.0	7.56E+15
Hamilton	CA	519949	-33.8	-39.7	4.83E+15
Leicester	GB	508916	-33.7	-40.5	5.83E+15
Sevilla	ES	703206	-33.7	-22.5	2.37E+15
Prague	CZ	1165581	-33.7	-20.8	4.42E+15
San Diego	US	1394928	-33.6	-29.4	3.78E+15
Tijuana	MX	1300983	-33.6	-29.4	3.78E+15
Hannover	DE	515140	-33.6	-33.1	5.48E+15
Chicago	US	2720546	-33.6	-30.4	7.94E+15
Campinas	BR	1031554	-33.5	-28.1	3.05E+15
Leipzig	DE	504971	-33.4	-28.1	4.87E+15
Ecatepec de Morelos	MX	1655015	-33.3	-25.6	8.80E+15
Tlalnepantla	MX	653410	-33.3	-25.6	8.80E+15
Vienna	AT	1691468	-33.1	-27.4	4.00E+15
Lisbon	PT	517802	-32.9	-17.0	2.67E+15
Kobe	JP	1528478	-32.9	-44.3	9.71E+15
Rio de Janeiro	BR	6023699	-32.7	-14.0	3.83E+15
Bristol	GB	617280	-32.7	-20.8	3.43E+15
Bremen	DE	546501	-32.6	-36.8	5.40E+15
Koeln	DE	963395	-32.6	-38.5	9.07E+15
Hamburg	DE	1739117	-32.6	-46.5	5.19E+15
Sapporo	JP	1883027	-32.5	14.3	1.93E+15
Birmingham	GB	984333	-32.2	-29.0	5.21E+15
Daegu	KR	2566540	-31.9	-16.4	8.00E+15
San Francisco	US	864816	-31.8	-29.7	3.82E+15
Santa Maria Chimalhuacan	MX	612383	-31.5	-26.3	6.50E+15

Amsterdam	NL	741636	-31.4	-32.4	8.59E+15
Dallas	US	1300092	-31.2	-22.3	4.37E+15
Busan	KR	3678555	-31.1	-13.7	8.46E+15
Incheon	KR	2628000	-30.6	-13.4	1.28E+16
Baltimore	US	621849	-30.5	-22.8	6.42E+15
Buenos Aires	AR	13076300	-30.4	-12.2	6.34E+15
Cheongju-si	KR	634596	-30.1	-12.7	9.87E+15