

Supplement of

Long-term variation in the tropospheric nitrogen dioxide vertical column density over Korea and Japan from the MAX-DOAS network from 2007 to 2017

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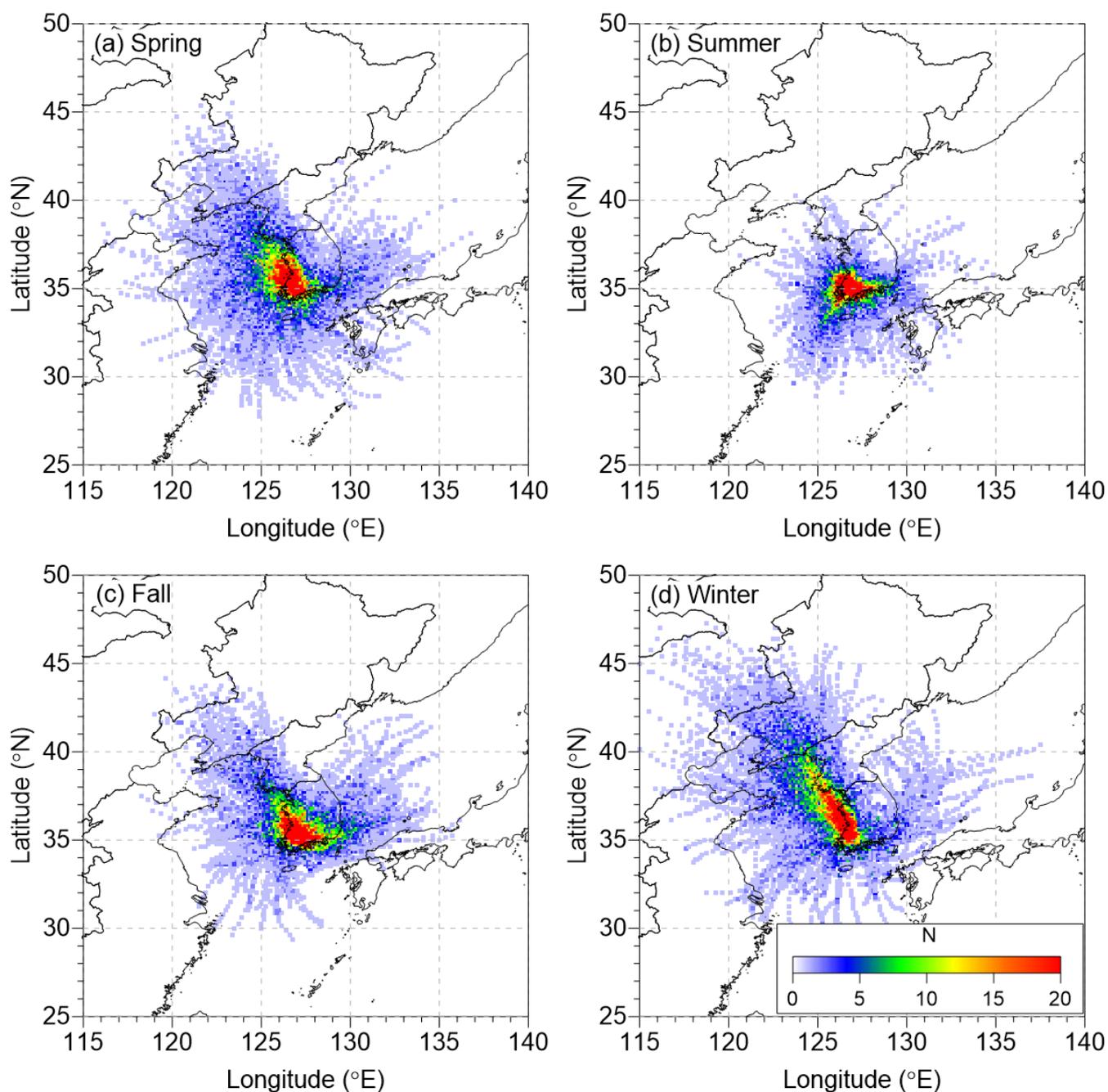


Figure S1. Footprint of the total number of backward trajectory endpoints for a $0.25^\circ \times 0.25^\circ$ grid cell depending on the seasons at Gwangju, Korea when assuming different seasonal lifetimes of NO_2 (24 h for winter, 18 h for spring and summer, and 12 h for summer). The backward trajectory was calculated from Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) and the starting altitude and time were 500 m above ground level and three times per day (08:00, 12:00, and 16:00 LT), respectively. For more details, see the main text.

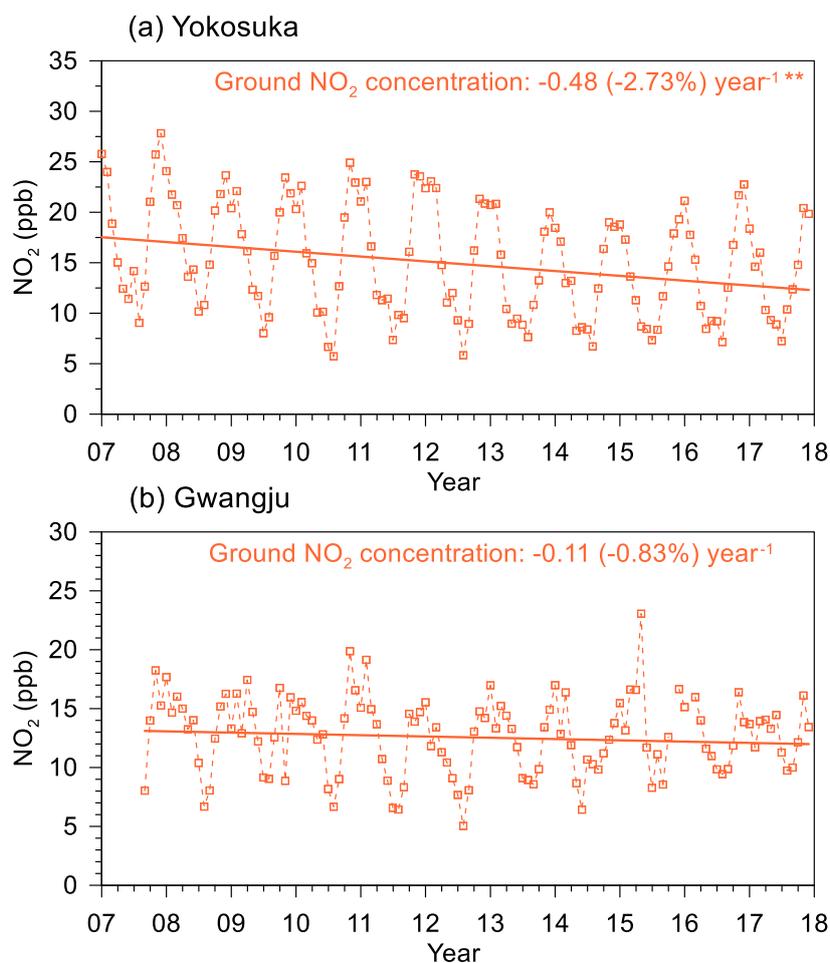


Figure S2. Long-term variations in the monthly mean ground-level NO₂ from 2007 to 2017 at (a) Yokosuka and (b) Gwangju. Orange symbols with dashed lines and solid lines denote the monthly mean and Theil-Sen slope of NO₂ from air quality monitoring sites nearby, respectively. The slopes and percent changes are shown in the upper right corner along with the p-value: ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$.

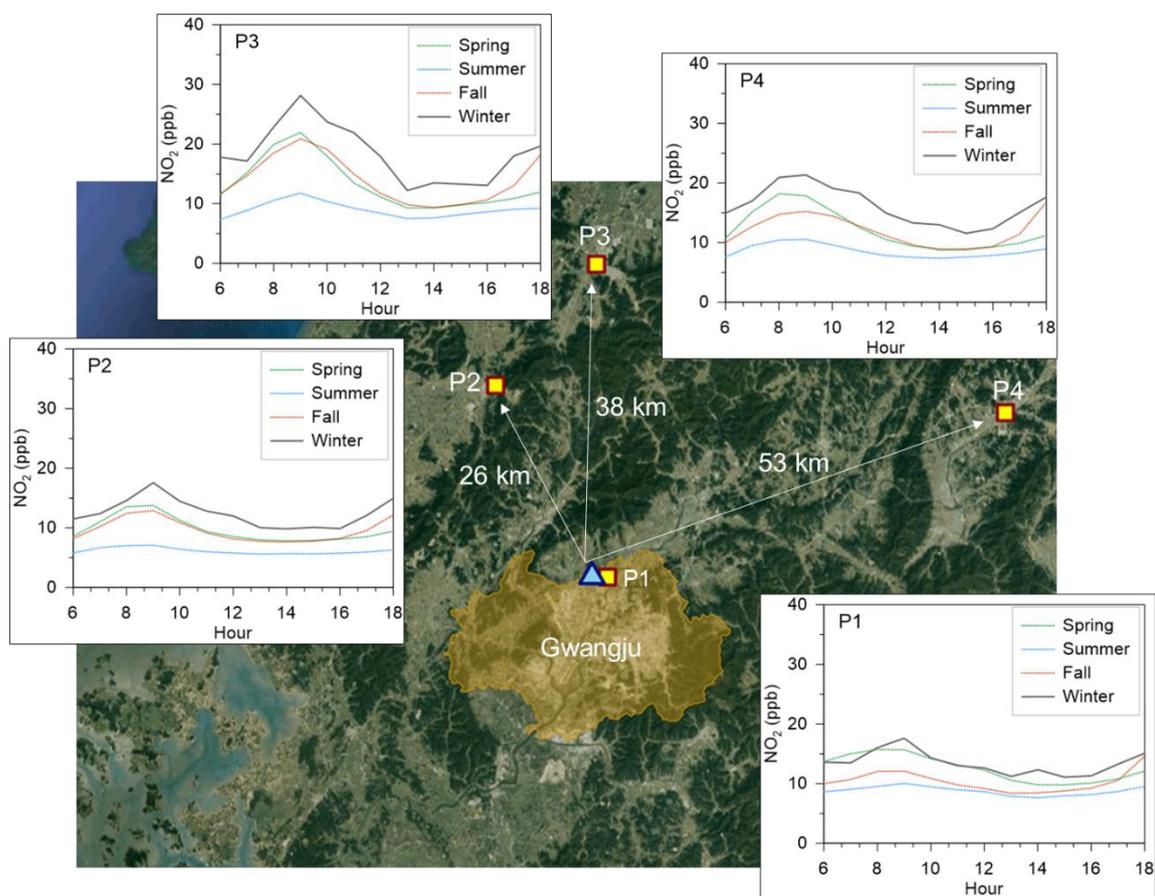


Figure S3. Site location and diurnal variation of ground NO₂ concentrations from air quality monitoring stations (P1 to P4) by season. The blue triangle indicates the Gwangju Institute of Science and Technology (GIST) site where the MAX-DOAS is installed. Each air quality monitoring station measured the ground NO₂ concentration (ppb) using a chemiluminescence instrument equipped with a molybdenum converter.

Table S1. Observed seasonal and overall Theil-Sen slopes of tropospheric NO₂ vertical column density (NO₂ TropVCD; $\times 10^{15}$ molecules cm⁻²) from MAX-DOAS whole data points at four sites and ground NO₂ concentration (ppb) from air quality monitoring station at Yokosuka and Gwangju from 2007–2017. The values in parentheses indicate the percentage of Theil-Sen slopes to the mean NO₂ TropVCD or ground NO₂ concentration corresponding time scale.

	Spring	Summer	Fall	Winter	Overall
(a) MAX-DOAS (whole data points)					
Yokosuka	-0.62 (-3.75 %)**	-0.29 (-2.73 %)**	-1.01 (-4.28 %)**	-1.50 (-4.88 %)**	-0.91 (-4.40 %)**
Gwangju	-0.01 (-0.14 %)	0.11 (1.30 %)**	0.39 (4.46 %)**	-0.56 (-3.93 %)**	-0.08 (-0.82 %)
Fukue	-0.05 (-2.35 %)**	-0.01 (-1.14 %)**	-0.01 (-0.54 %)	-0.25 (-5.31 %)**	-0.06 (-2.42 %)**
Cape Hedo	-0.02 (-2.38 %)**	-0.01 (-1.80 %)**	-0.01 (-0.77 %)**	-0.02 (-1.98 %)**	-0.02 (-1.92 %)**
(b) Ground NO ₂ concentration					
Yokosuka	-0.57 (-4.21 %)**	-0.26 (-2.88 %)**	-0.59 (-3.45 %)**	-0.64 (-3.03 %)**	-0.48 (-3.15 %)**
Gwangju	-0.12 (-0.88 %)*	0.12 (1.25 %)**	0.04 (0.31 %)	-0.10 (-0.67 %)**	-0.11 (-0.86 %)