Supplementary Information (SI) for

Increased ozone pollution alongside reduced nitrogen dioxide concentrations during Vienna's first COVID-19 lockdown: Significance for air quality management

Marlon Brancher [§,*]

§ *WG Environmental Health, Department of Biomedical Sciences, University of Veterinary Medicine Vienna, Veterinärplatz 1, A-1210 Vienna, Austria*

* Corresponding author.

✉ Marlon.Brancher@vetmeduni.ac.at

The present SI file includes the following:

- *Figure S1*
- *Figure S2*
- *Figure S3*
- *Figure S4*
- *Figure S5*
- *Figure S6*
- *Figure S7*
- *Figure S8*
- *Table S1*
- *Table S2*
- *Table S3*
- *Table S4*

Figure S1. Frequency of missing values per air quality monitor per year. Pollutant: NO_2.
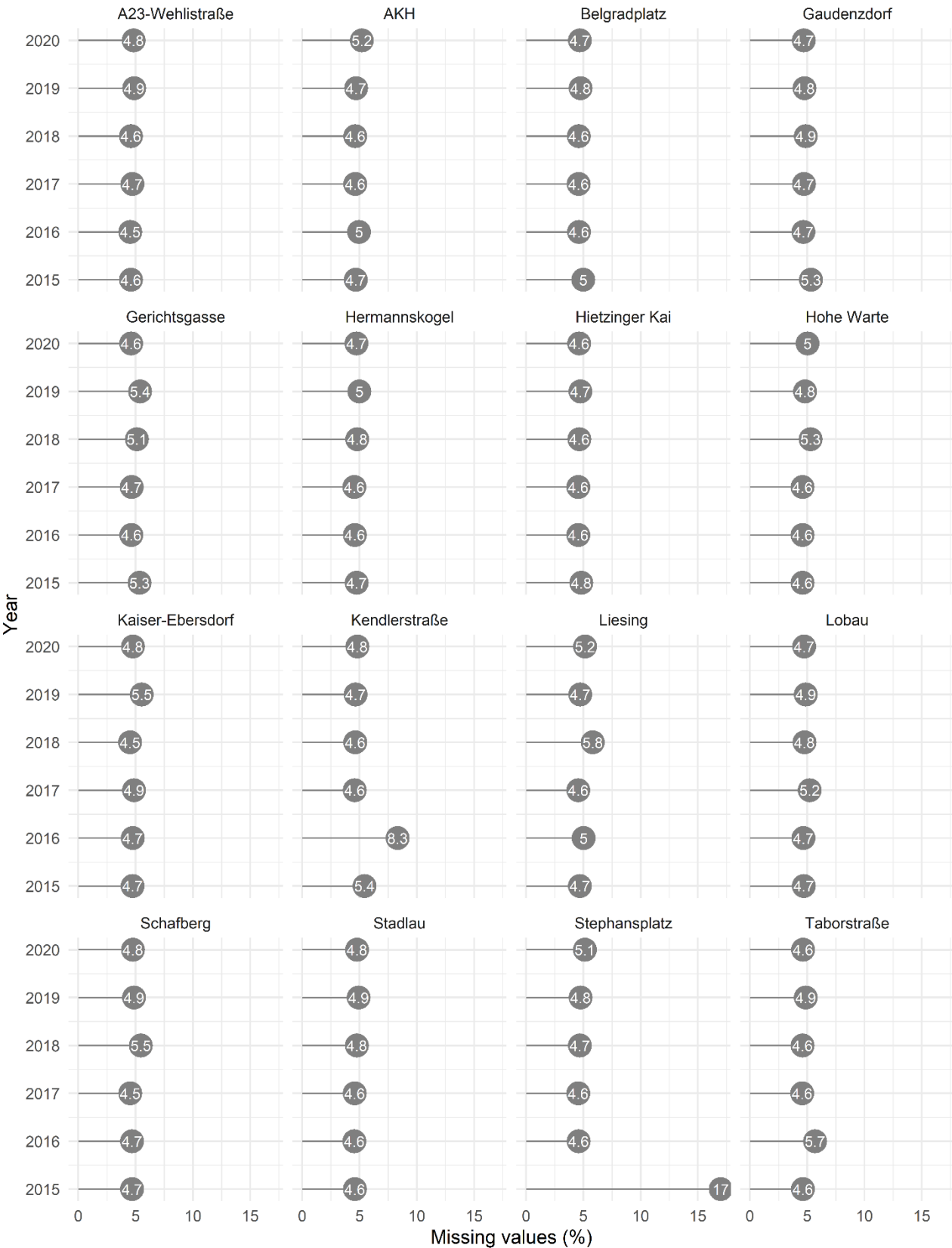
Figure S2. Frequency of missing values per air quality monitor per year. Pollutant: O_3.
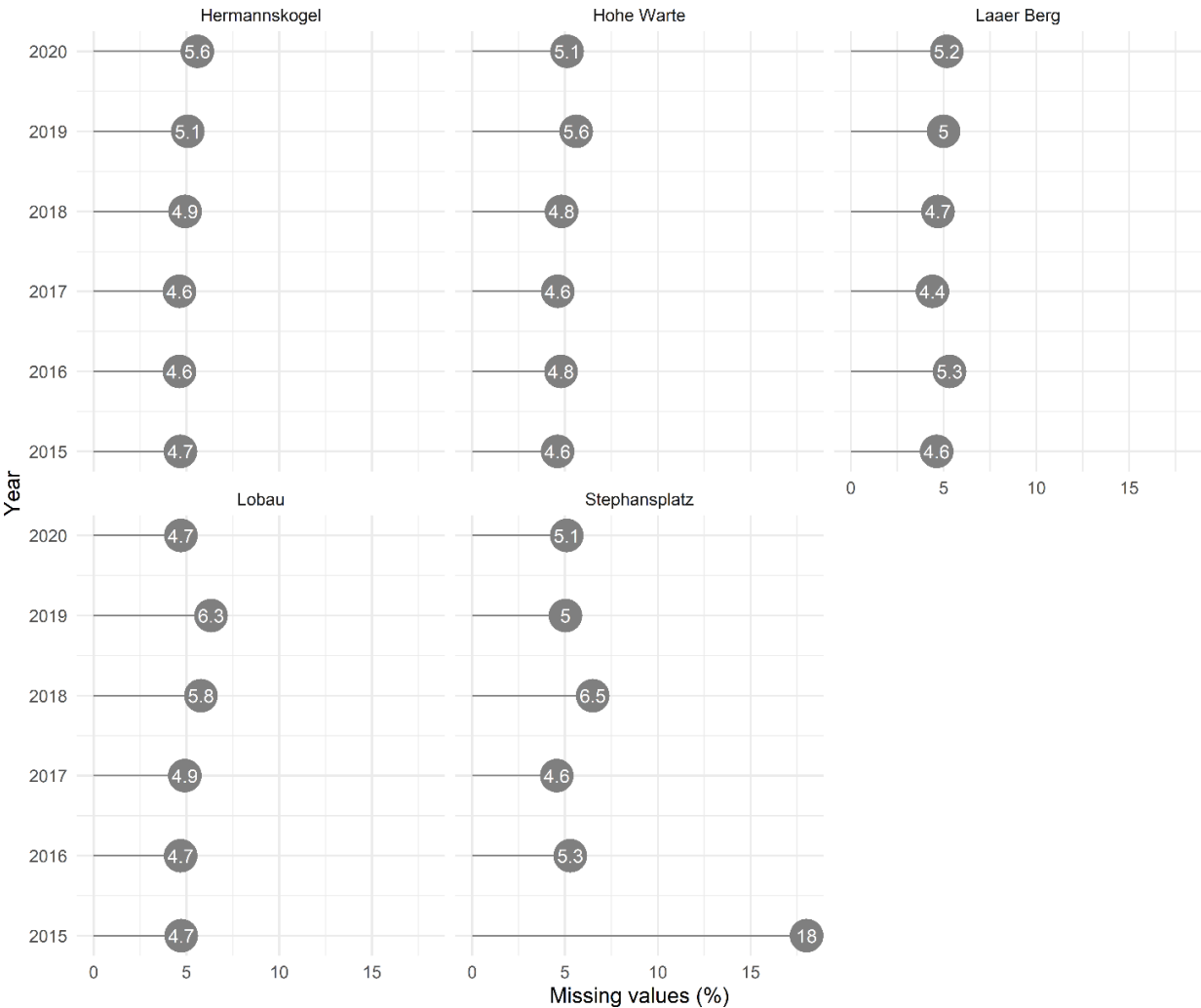
Figure S3. Frequency of missing values per air quality monitor per year. Pollutant: O_x.
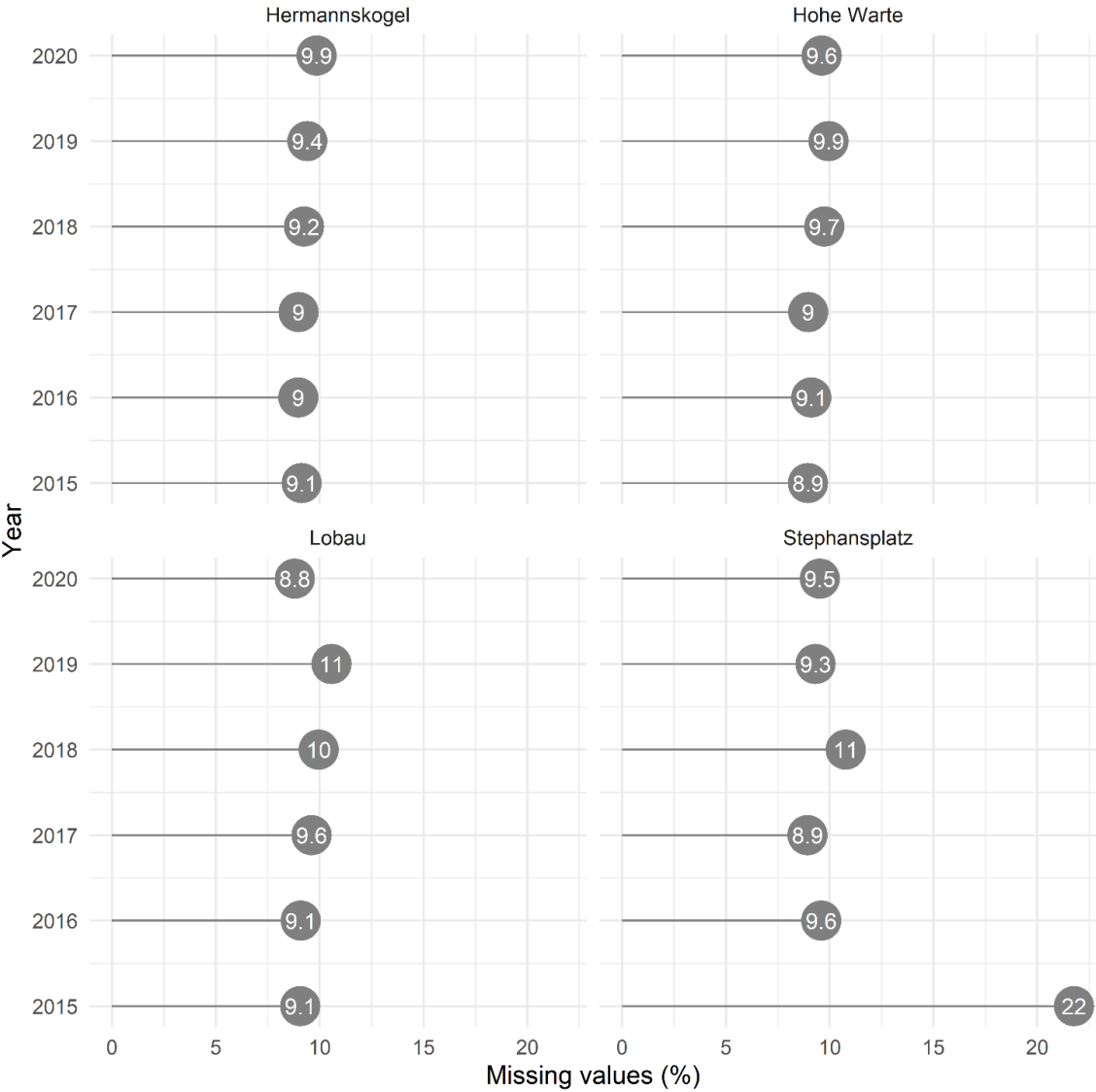
Figure S4. Wind roses for the five selected meteorological stations during 2015–2019. The annotations in green show mean wind speeds and calm wind frequencies. Calm winds were defined as having hourly speeds < 0.5 m s^{-1}. The radial scale denotes the frequency of counts by wind direction sector.

Figure S5. Seven-day rolling mean of NO₂ observations (*in blue*) against business as usual counterfactual predictions (*in red*). Shaded areas are the models' standard error. The time course in this figure is from February 16 to September 30, 2020. Dashed vertical lines indicate the LOCK-2020 period.
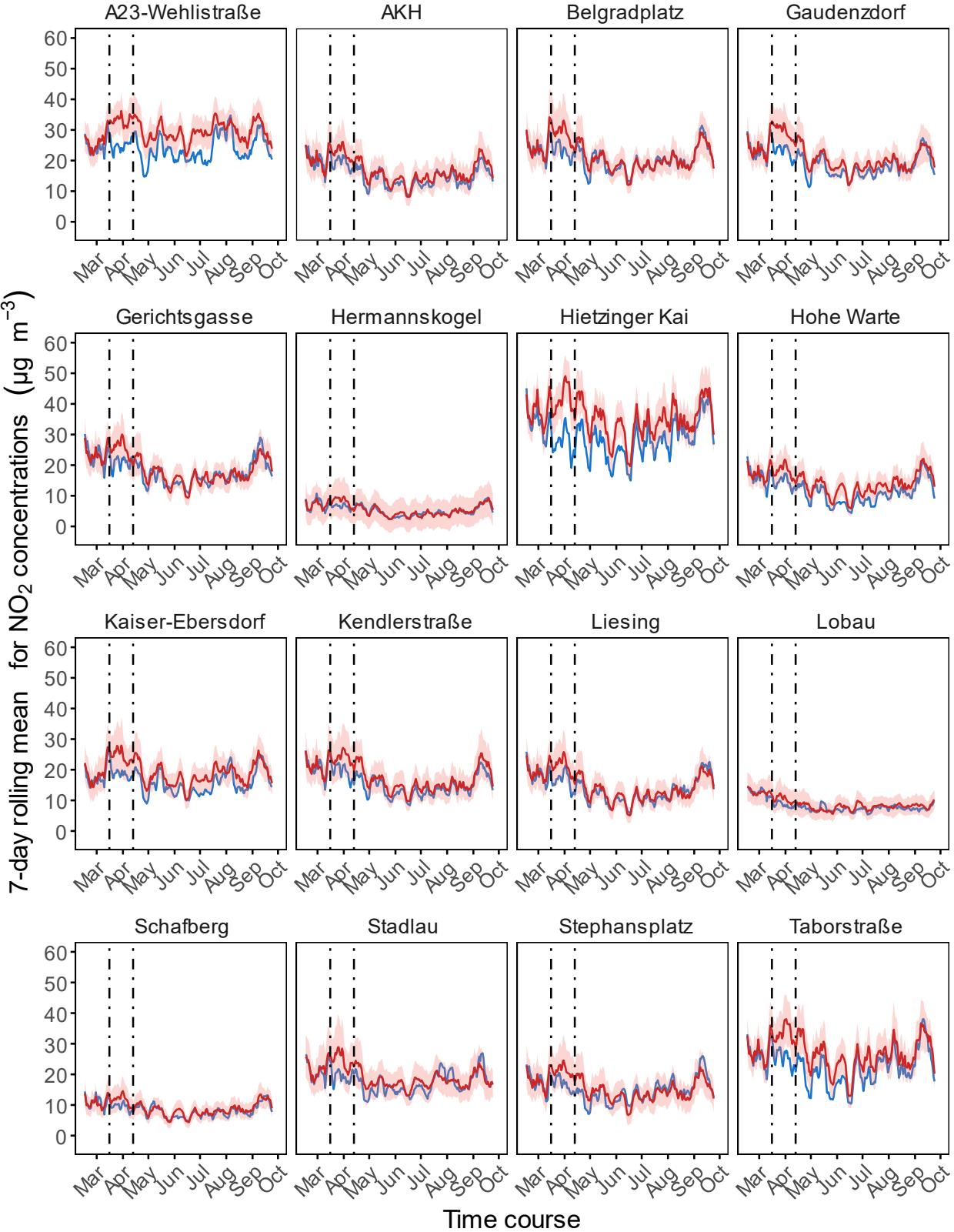
Figure S6. Seven-day rolling mean of O₃ observations (*in blue*) against business as usual counterfactual predictions (*in red*). Shaded areas are the models' standard error. The time course in this figure is from February 16 to September 30, 2020. Dashed vertical lines indicate the LOCK-2020 period.
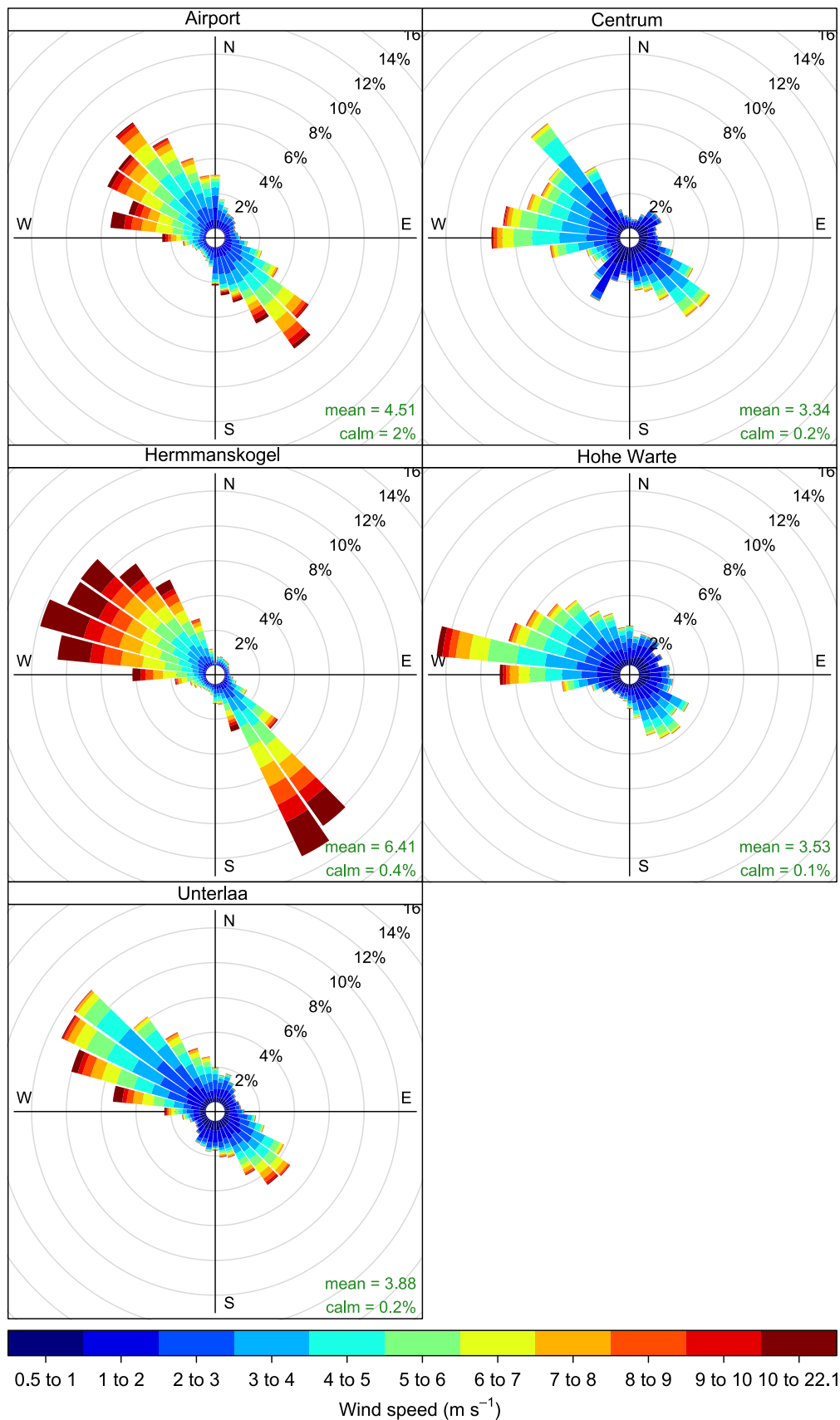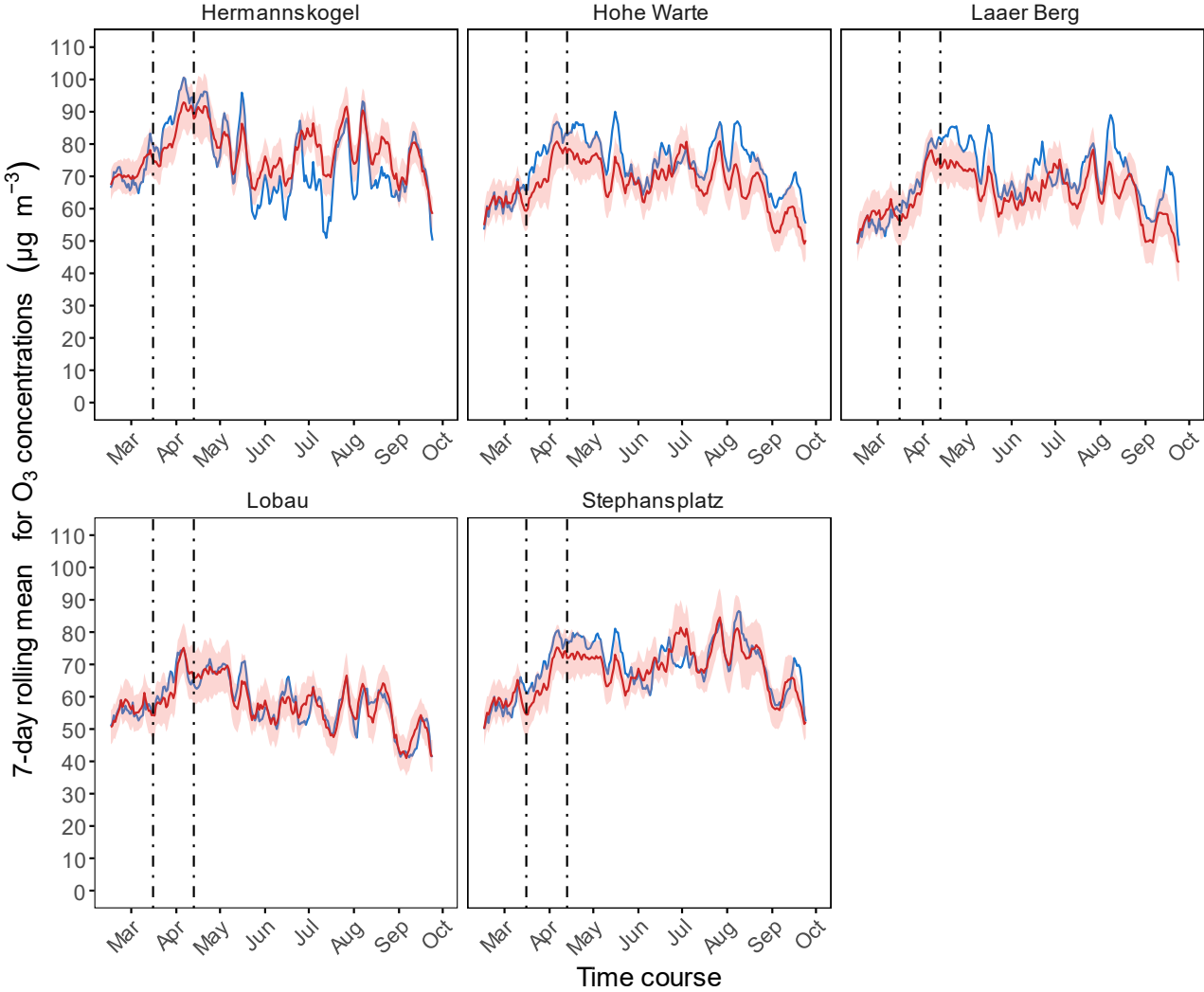
Figure S7. Seven-day rolling mean of O_x observations (*in blue*) against business as usual counterfactual predictions (*in red*). Shaded areas are the models' standard error. The time course in this figure is from February 16 to September 30, 2020. Dashed vertical lines indicate the LOCK-2020 period.
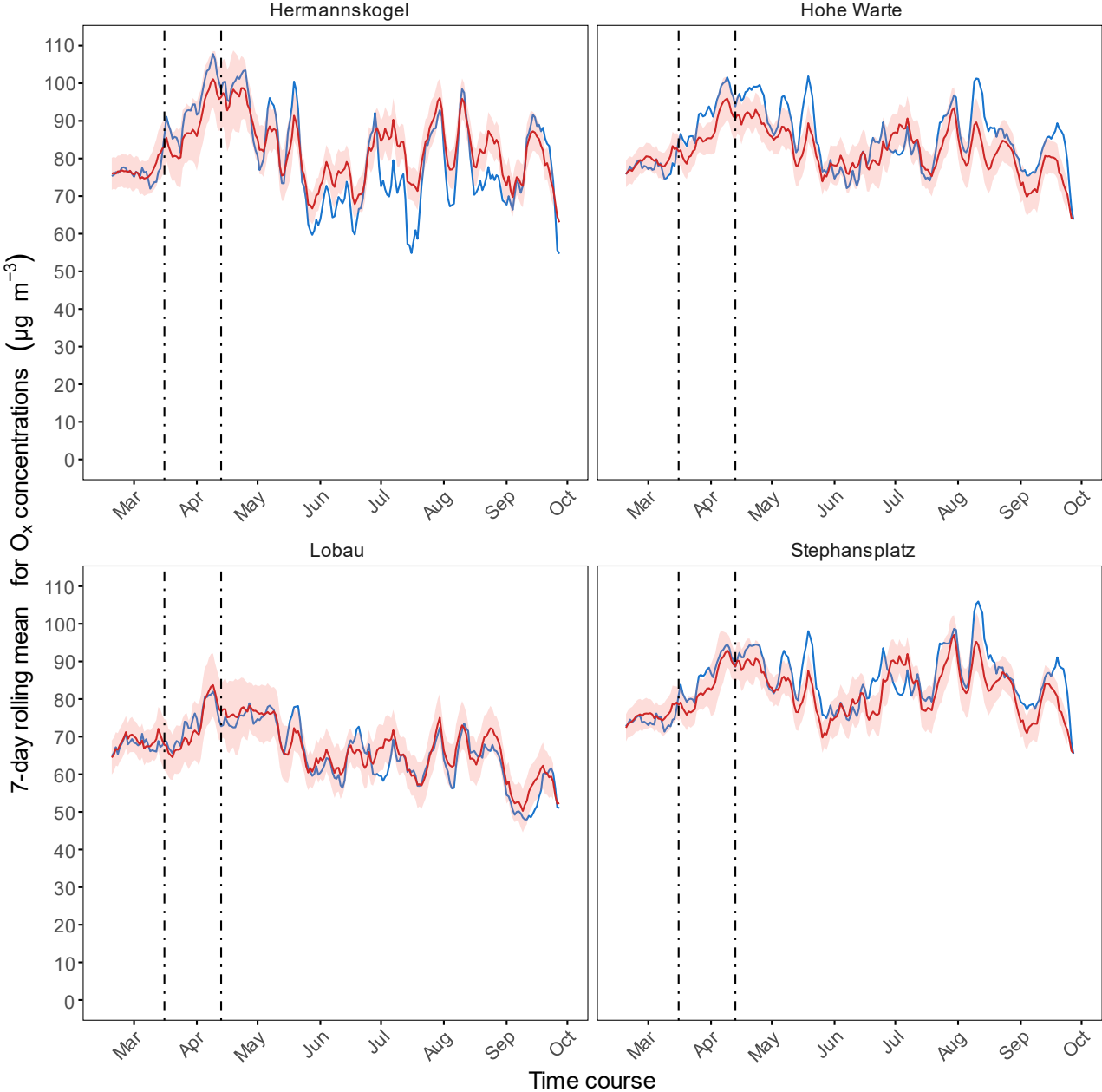
Figure S8. Austria's total anthropogenic NMVOC and NO$_X$ emissions, historical and projections, for the so-called 'fuel used' category. Scenario considered for the projections: with existing measures. Note that the separate plots were deliberately produced because the latest available projections are not based on the most up-to-date historical inventory. The references for the data sources used in this Figure are given in the main text of the publication.

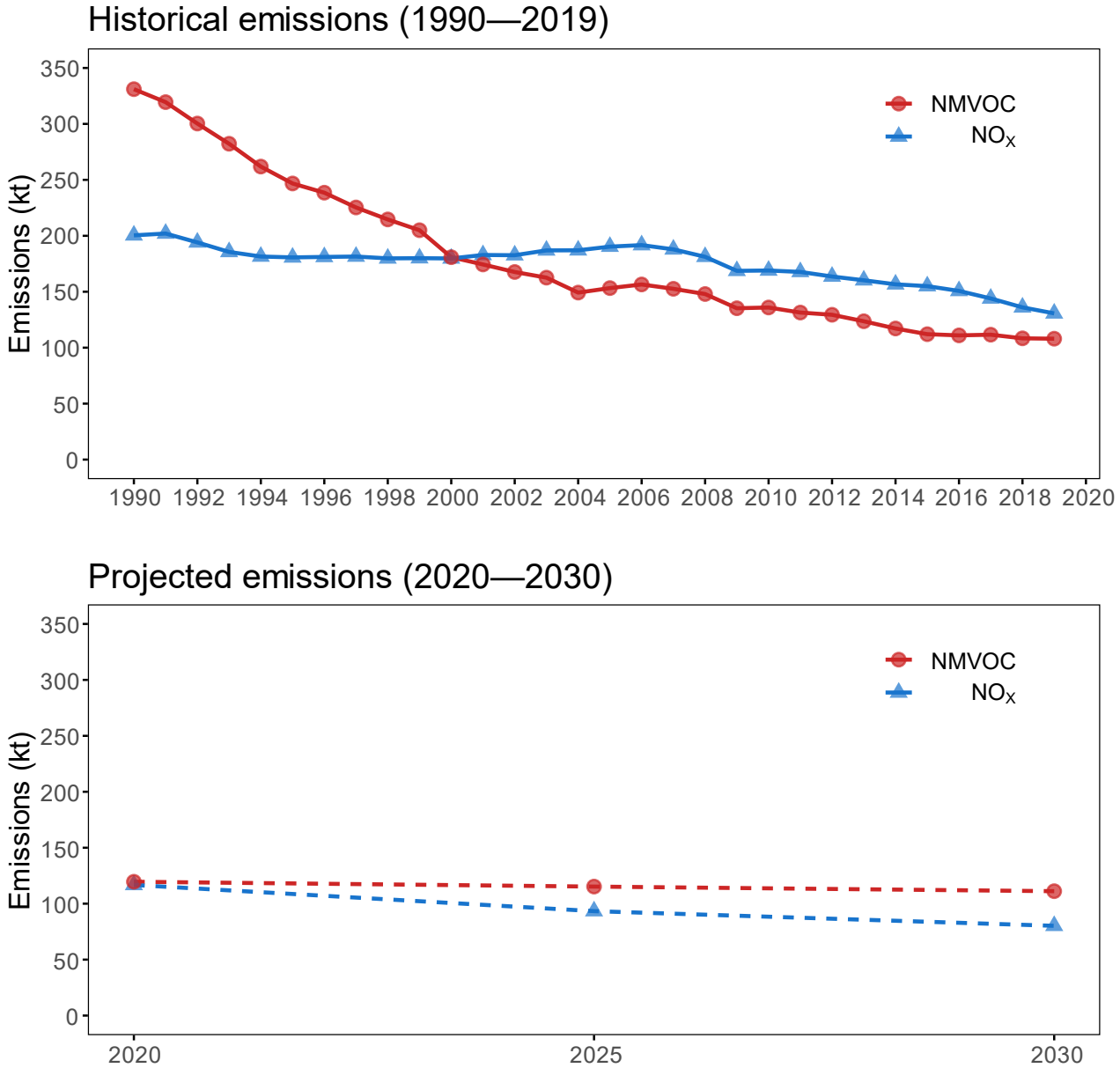**Table S1.** Selected meteorological stations to match the air quality monitors.

Air quality monitor				Selected meteorological station	
Name	Pollutant(s)	Environment	Elevation (m)	Name	Distance to monitor (km)
A23-Wehlistrasse	NO_2	Urban traffic	162	Schwechat	14
AKH	NO_2	Urban traffic	199	Centrum	3
Belgradplatz	NO_2	Urban traffic	218	Centrum	3
Gaudenzdorf	NO_2	Urban traffic	179	Centrum	2
Gerichtsgasse	NO_2	Urban traffic	164	Hohe Warte	3
Hermannskogel	NO_2, O_3	Suburban background	488	Hermannskogel	0
Hietzinger Kai	NO_2	Urban traffic	194	Centrum	5
Hohe Warte	NO_2, O_3	Urban background	200	Hohe Warte	0
Kaiser-Ebersdorf	NO_2	Suburban industrial	158	Schwechat	9
Kendlerstrasse	NO_2	Urban traffic	236	Centrum	4
Laaer Berg	O_3	Urban background	251	Unterlaa	3
Liesing	NO_2	Suburban traffic	217	Unterlaa	9
Lobau	NO_2, O_3	Suburban background	155	Schwechat	7
Schafberg	NO_2	Suburban background	319	Hohe Warte	4
Stadlau	NO_2	Urban background	159	Schwechat	15
Stephansplatz	NO_2, O_3	Urban background	172	Centrum	1
Taborstrasse	NO_2	Urban traffic	162	Centrum	2

Table S2. Performance evaluation of the business as usual-related random forest models for the individual NO$_2$ air quality monitors. *Test* represents the metric results during the model training and development phase (1/Jan/2015–15/Feb/2020). *Verif* represents the metric results during the verification phase (16/Feb/2020–29/Feb/2020). Temporal resolution of data: hourly.

Monitor	FAC2		MB		RMSE		r		IOA	
	Test	Verif	Test	Verif	Test	Verif	Test	Verif	Test	Verif
A23-Wehlistrasse	0.96	0.86	0.3	4.7	10.0	10.6	0.84	0.76	0.76	0.65
AKH	0.96	0.85	0.2	3.0	8.3	12.4	0.87	0.75	0.79	0.68
Belgradplatz	0.97	0.91	0.2	3.8	8.4	10.5	0.87	0.82	0.78	0.71
Gaudenzdorf	0.97	0.91	0.2	2.4	8.2	11.1	0.87	0.80	0.78	0.72
Gerichtsgasse	0.94	0.89	0.1	−0.7	9.8	13.1	0.84	0.70	0.76	0.67
Hermannskogel	0.93	0.79	0.1	1.9	4.2	4.4	0.89	0.82	0.81	0.67
Hietzinger Kai	0.97	0.88	0.2	3.4	10.9	12.8	0.91	0.85	0.81	0.75
Hohe Warte	0.94	0.87	0.1	0.8	7.6	10.0	0.86	0.78	0.79	0.74
Kaiser-Ebersdorf	0.95	0.87	0.0	2.1	8.1	8.4	0.85	0.78	0.76	0.70
Kendlerstrasse	0.95	0.89	0.1	3.4	8.0	10.7	0.86	0.79	0.77	0.69
Liesing	0.94	0.75	0.3	3.5	7.9	11.5	0.88	0.79	0.79	0.71
Lobau	0.94	0.82	0.1	3.8	5.1	6.4	0.82	0.68	0.74	0.53
Schafberg	0.91	0.80	0.0	2.1	6.4	7.3	0.86	0.73	0.79	0.68
Stadlau	0.95	0.88	0.2	3.6	8.5	11.2	0.85	0.73	0.77	0.66
Stephansplatz	0.95	0.85	0.1	4.3	8.8	10.8	0.86	0.78	0.78	0.67
Taborstrasse	0.97	0.93	0.0	2.9	9.5	9.8	0.88	0.87	0.80	0.75

FAC2:   Fraction of predictions within a factor of two of observations
MB: Mean bias
RMSE: Root mean square error
r: Pearson correlation coefficient
IOA: Index of agreement

Table S3. Performance evaluation of the business as usual-related random forest models for the individual O_3 air quality monitors. *Test* represents the metric results during the model training and development phase (1/Jan/2015–15/Feb/2020). *Verif* represents the metric results during the verification phase (16/Feb/2020–29/Feb/2020). Temporal resolution of data: hourly.

Monitor	FAC2		MB		RMSE		*r*		IOA	
	Test	Verif	Test	Verif	Test	Verif	Test	Verif	Test	Verif
Hermannskogel	0.99	1.00	−0.1	1.2	9.1	9.0	0.95	0.54	0.86	0.59
Hohe Warte	0.93	0.92	−0.1	0.6	11.1	13.0	0.94	0.80	0.84	0.73
Laaer Berg	0.93	0.94	−0.4	3.9	10.5	11.8	0.94	0.74	0.85	0.66
Lobau	0.91	0.97	0.2	1.5	10.1	9.7	0.95	0.82	0.86	0.72
Stephansplatz	0.92	0.93	−0.1	0.9	11.0	12.2	0.93	0.76	0.84	0.69

Table S4. Performance evaluation of the business as usual-related random forest models for the individual O_X air quality monitors. *Test* represents the metric results during the model training and development phase (1/Jan/2015–15/Feb/2020). *Verif* represents the metric results during the verification phase (16/Feb/2020–29/Feb/2020). Temporal resolution of data: hourly.

Monitor	FAC2		MB		RMSE		*r*		IOA	
	Test	Verif	Test	Verif	Test	Verif	Test	Verif	Test	Verif
Hermannskogel	1.00	1.00	0.0	3.5	7.7	7.2	0.96	0.56	0.87	0.50
Hohe Warte	1.00	1.00	−0.1	0.1	8.1	6.9	0.95	0.73	0.85	0.66
Lobau	0.99	0.99	0.1	3.8	9.4	8.5	0.95	0.81	0.85	0.66
Stephansplatz	1.00	1.00	0.0	4.6	7.4	8.3	0.95	0.58	0.86	0.47