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Supplement of

Multi-year observations of variable incomplete combustion in the New York megacity

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Supplemental Table

Table S1. Annual and monthly Emissions Database for Global Atmospheric Research (EDGAR) v6.1 CO emissions for the New York City Metropolitan Area (NYCMA) study domain and New York City (NYC) subregion. The NYCMA area is 46.7×10^3 km^2. The NYC area is 2.81×10^3 km^2 (6.0% of NYCMA).

	Annual	Jan	Feb	Mar	Apr	May	
NYCMA	1.68	1.95	1.96	1.80	1.65	1.52	Total Emissions [Gg CO d^{-1}]
	35.9	41.8	42.0	38.5	35.3	32.6	Mean Emissions [mg CO m^{-2} d^{-1}]
		+16.4	+17.0	+7.09	–1.81	–9.15	Difference from Annual [%]
NYC	0.409	0.449	0.462	0.422	0.409	0.387	Total Emissions [Gg CO d^{-1}]
	145	160	164	150	145	138	Mean Emissions [mg CO m^{-2} d^{-1}]
		+9.77	+12.9	+3.09	–0.10	–5.28	Difference from Annual [%]

Supplemental Figures

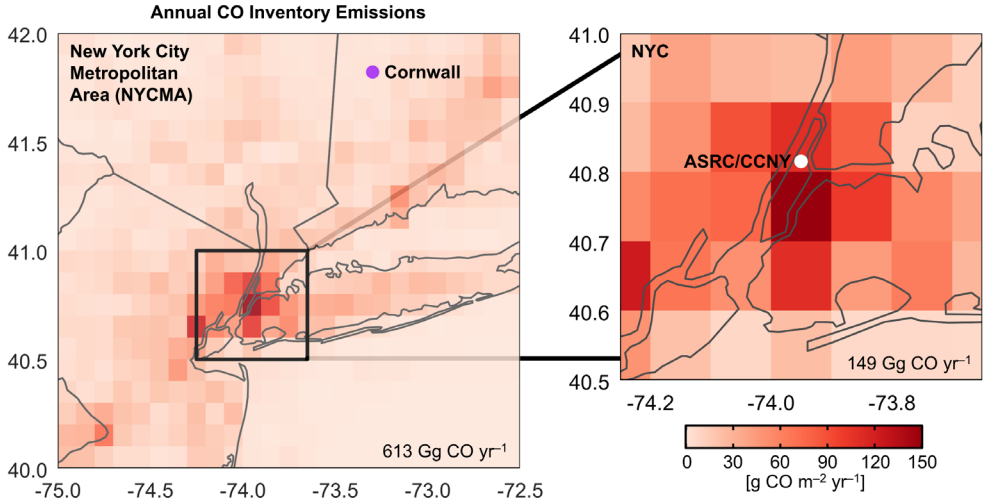

Figure S1. Map of the annual mean CO emissions flux from EDGAR for the NYCMA (left) and NYC (right) domains and the locations of the Advanced Science Research Center and the City College of New York (ASRC/CCNY; white circle), and Cornwall (purple circle) observations sites used in the study. The annual total CO emissions for each domain are shown in the lower right.

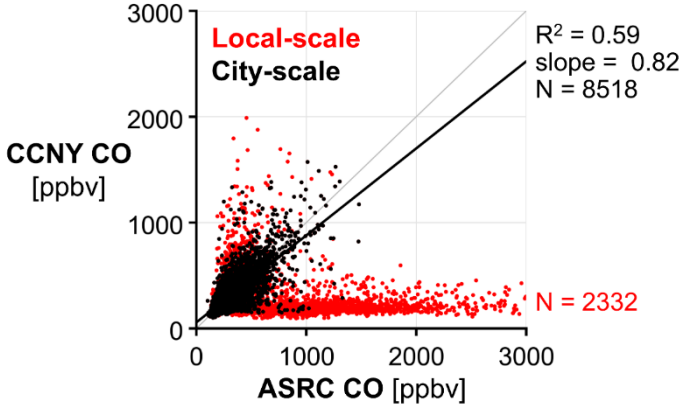

Figure S2. Comparison of hourly CO observations at the ASRC and CCNY sites as in Fig. 1 categorized as city-scale (black) and local-scale (red). The linear best fit line, the slope determined by ordinary least squares, and the coefficient of determination (R^2) are shown for the city-scale points. The number of observations considered (N) are shown for both sets. The 1:1 line is shown in dark gray.

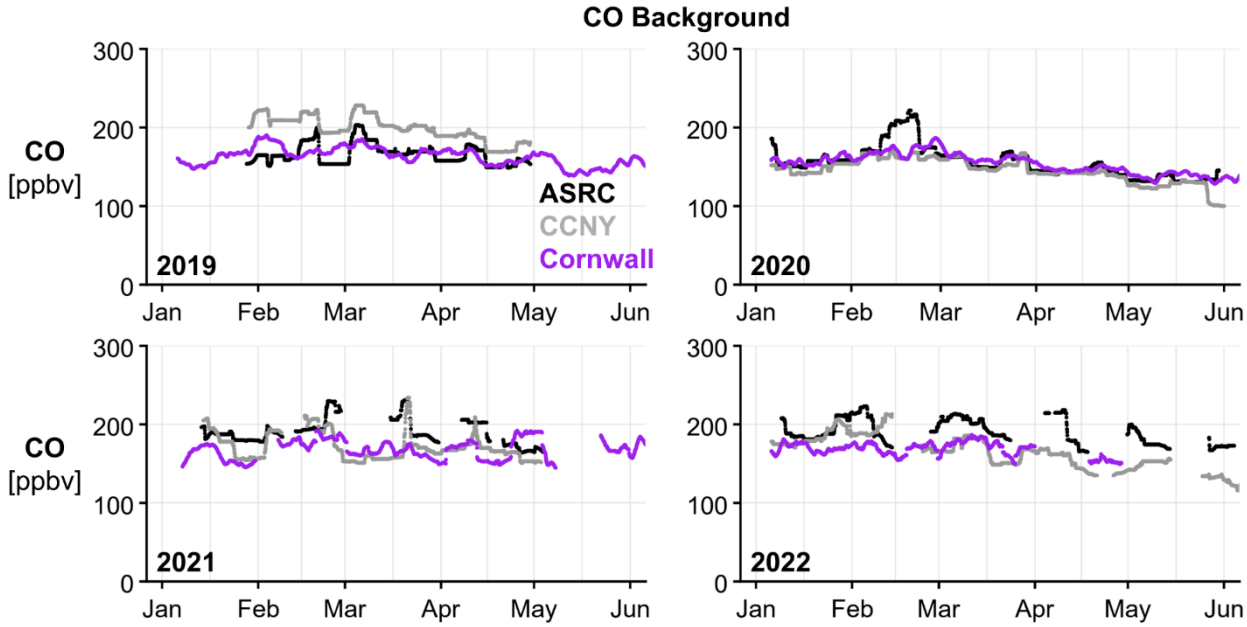

Figure S3. Timeseries of the CO backgrounds to the NYCMA for 2019-2022 using the 5th percentile method at the ASRC (black) and CCNY (grey) sites and as the 10-day mean of observations at the Cornwall site (purple).

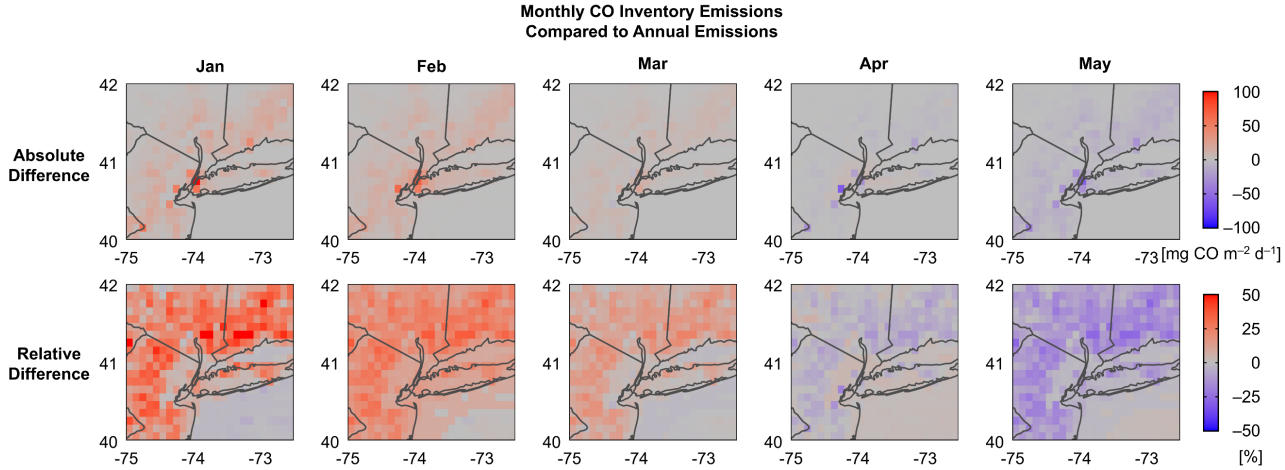

Figure S4. Monthly (January-May; left to right) EDGAR CO emissions compared to the annual mean EDGAR CO emissions for the NYCMA. The absolute difference (monthly–annual) is shown in the top row, while the relative difference (monthly/annual) is shown in the bottom row.

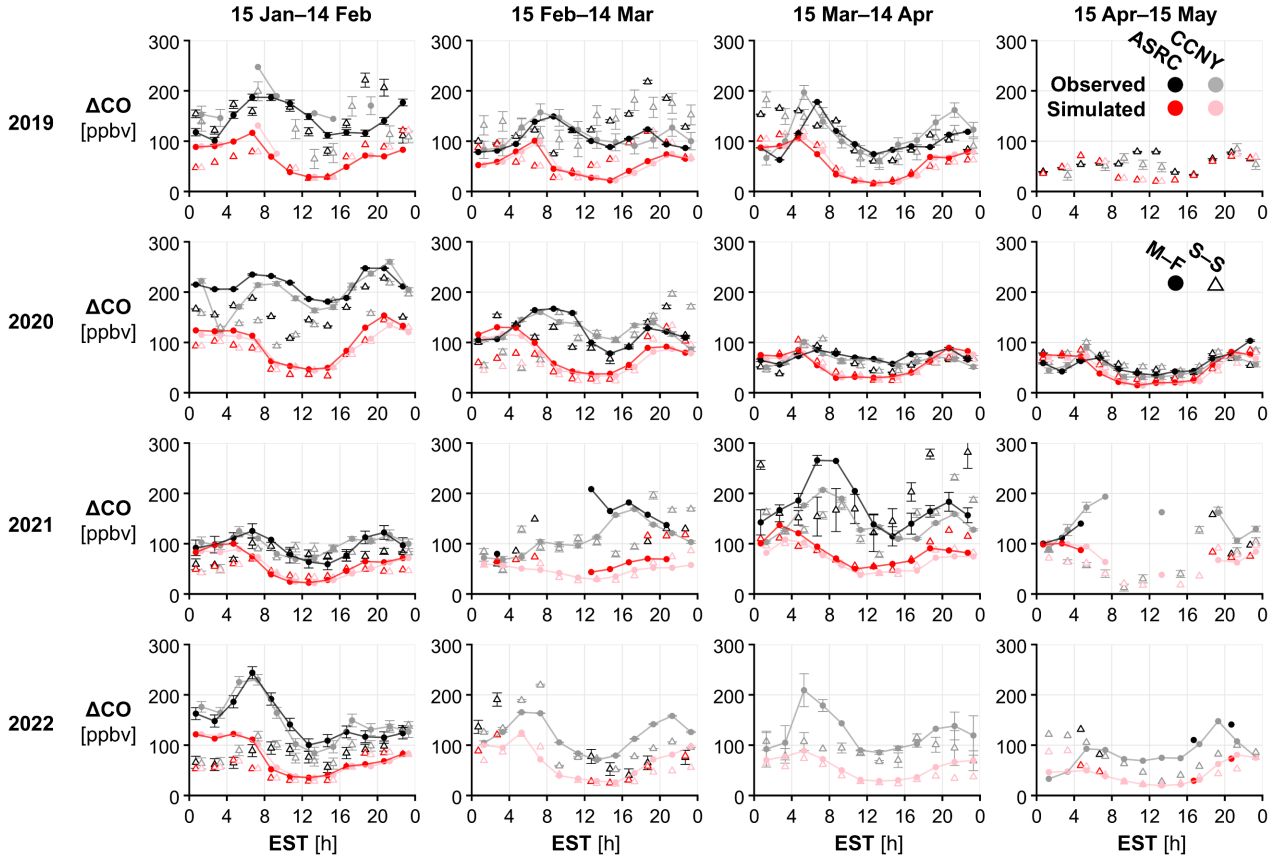

Figure S5. Diurnal time series of mean observed (black/grey) and simulated (red/pink) ΔCO for the NYCMA domain at the ASRC (black/red) and CCNY (grey/pink) sites as in Fig. 3 for the time periods as shown: 15 January–14 February, 15 February–14 March, 15 March–14 April, 15 April–15 May (left to right) for 2019–2022 (top to bottom).

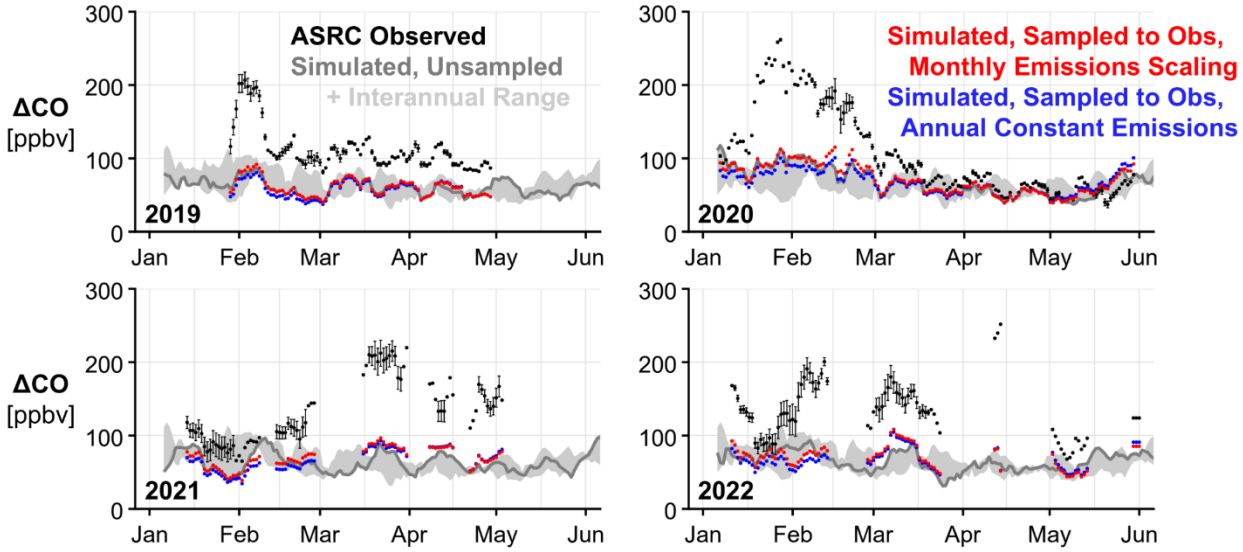

Figure S6. Time series of 10-day mean observed (black) and simulated (red) ΔCO for the NYCMA domain at the ASRC site as in Fig. 2. Additional simulated ΔCO versions are shown: (i) without sampling to valid CO observations (dark grey) and the interannual range throughout the study period (light grey) and (ii) with sampling to valid ASRC observations using annual mean EDGAR CO emissions (blue).

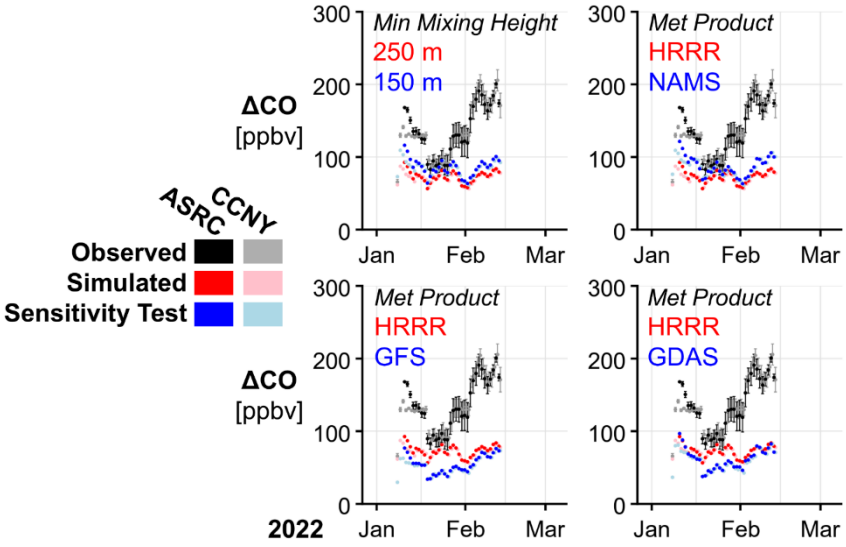

Figure S7. Timeseries of 10-day mean observed (black/grey) and simulated (red/pink) ΔCO for the NYCMA domain at the ASRC (black/red) and CCNY (grey/pink) sites as in Fig. 2 during January–February 2022. Additional simulated ΔCO from various sensitivity tests of STILT shown for the ASRC site in blue and the CCNY site in light blue: reducing minimum mixing height from 250 m to 150 m (upper left), using the NAMS (North American Mesoscale Forecast System) meteorological product to drive STILT instead of HRRR (High-Resolution Rapid Refresh) (upper right), using GFS (Global Forecast System) meteorology (lower left), and using GDAS (Global Data Assimilation System) meteorology (lower right).

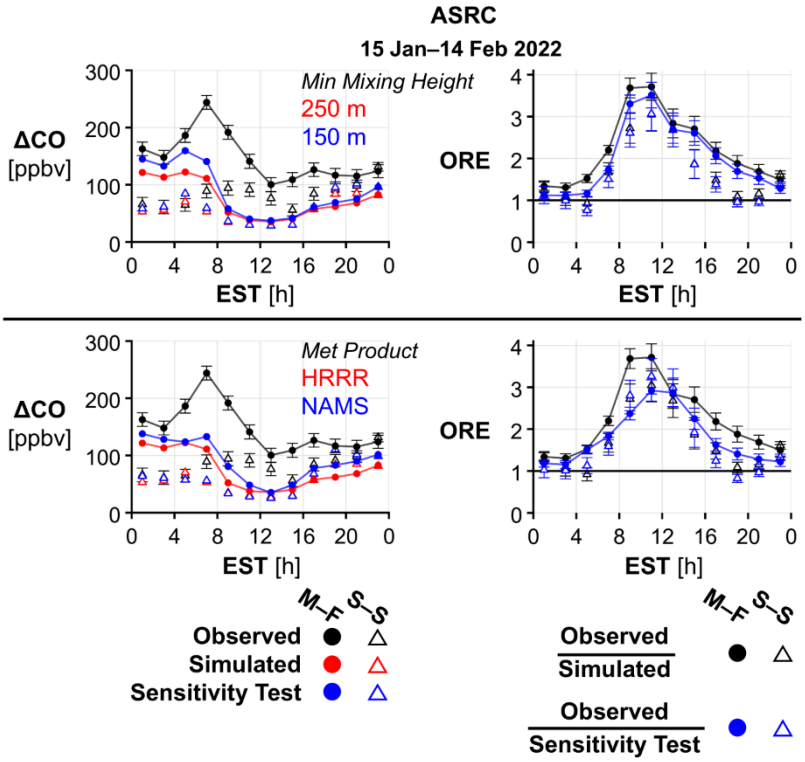

Figure S8. Diurnal timeseries of mean observed (black) and simulated (red) ΔCO (left) and observed relative emissions (ORE, black, right) for the NYCMA domain at the ASRC site as in Fig. 3 during January–February 2022. Additional simulated ΔCO from sensitivity tests of STILT shown in blue: reducing minimum mixing height from 250 m to 150 m (top) and using the NAMS (North American Mesoscale Forecast System) meteorological product to drive STILT instead of HRRR (High-Resolution Rapid Refresh) (bottom). Sensitivity of ORE to these tests shown in blue on right for both the minimum mixing height (top) and use of NAMS meteorology (bottom).

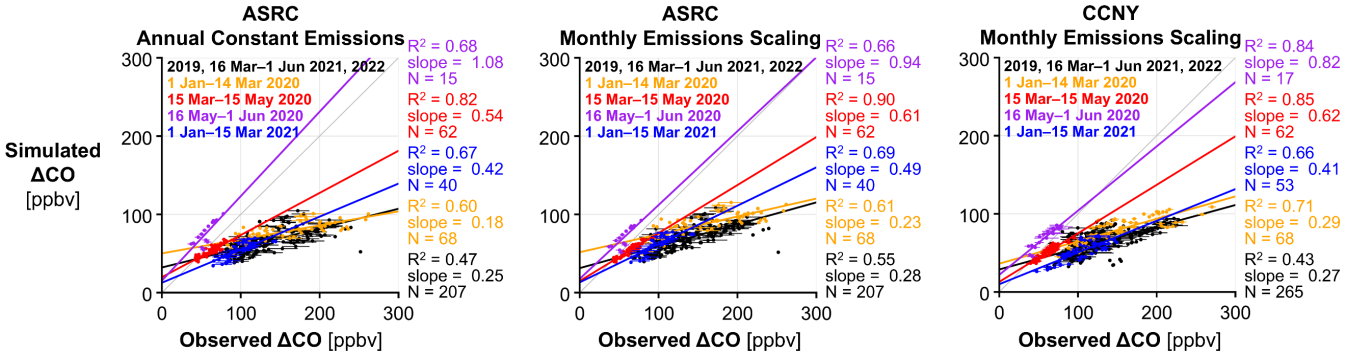

Figure S9. Comparison of observed and simulated ΔCO as in Fig. 4a using: (i) ASRC observations and annual mean EDGAR CO emissions (left), (ii) ASRC observations and monthly EDGAR CO emissions (center, same as Figure 4a), and (iii) CCNY observations and monthly EDGAR CO emissions (right).