Supplemental Information for

Revisiting the high tropospheric ozone over Southern Africa: overestimated biomass burning and underestimated anthropogenic emissions

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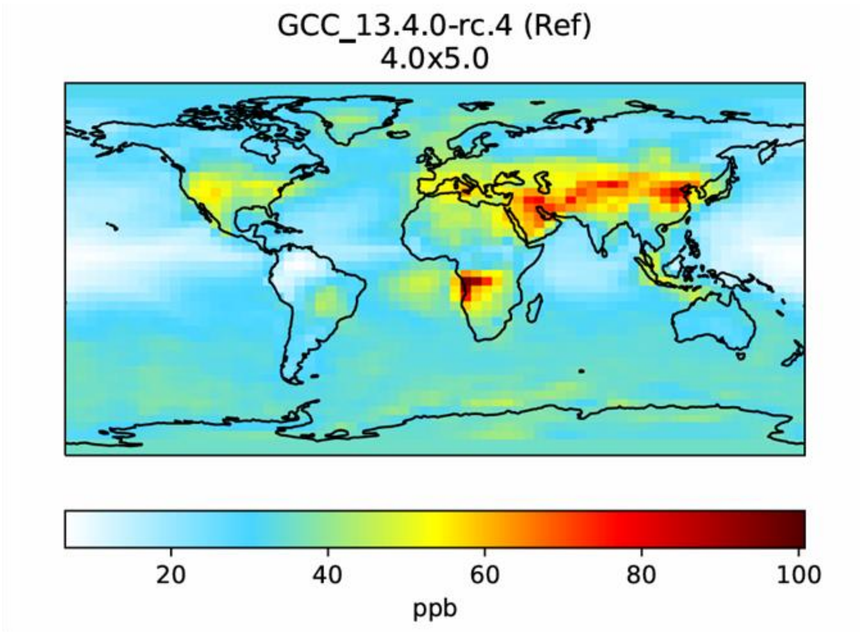

Figure S1. GEOS-Chem modelled surface ozone concentration obtained from the July 2019 benchmark experiment (downloaded from https://ftp.as.harvard.edu/gcgrid/geoschem/1mo_benchmarks/).

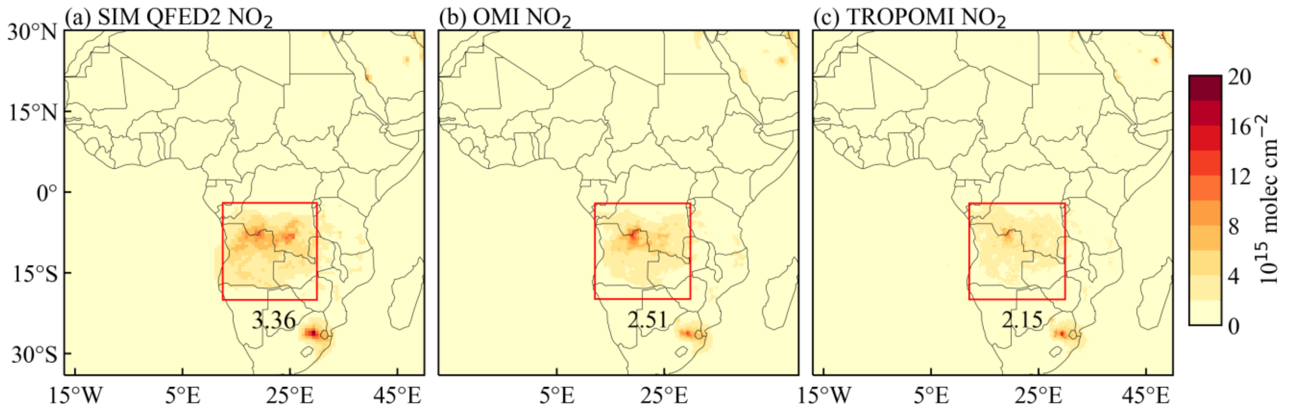

Figure S2. Comparison of the GEOS-Chem simulated NO_2 columns in Africa in July-August 2019 using the QFED2 inventory (a) with OMI (b) and TROPOMI (c). Numbers below the red boxes indicate the regional averages.

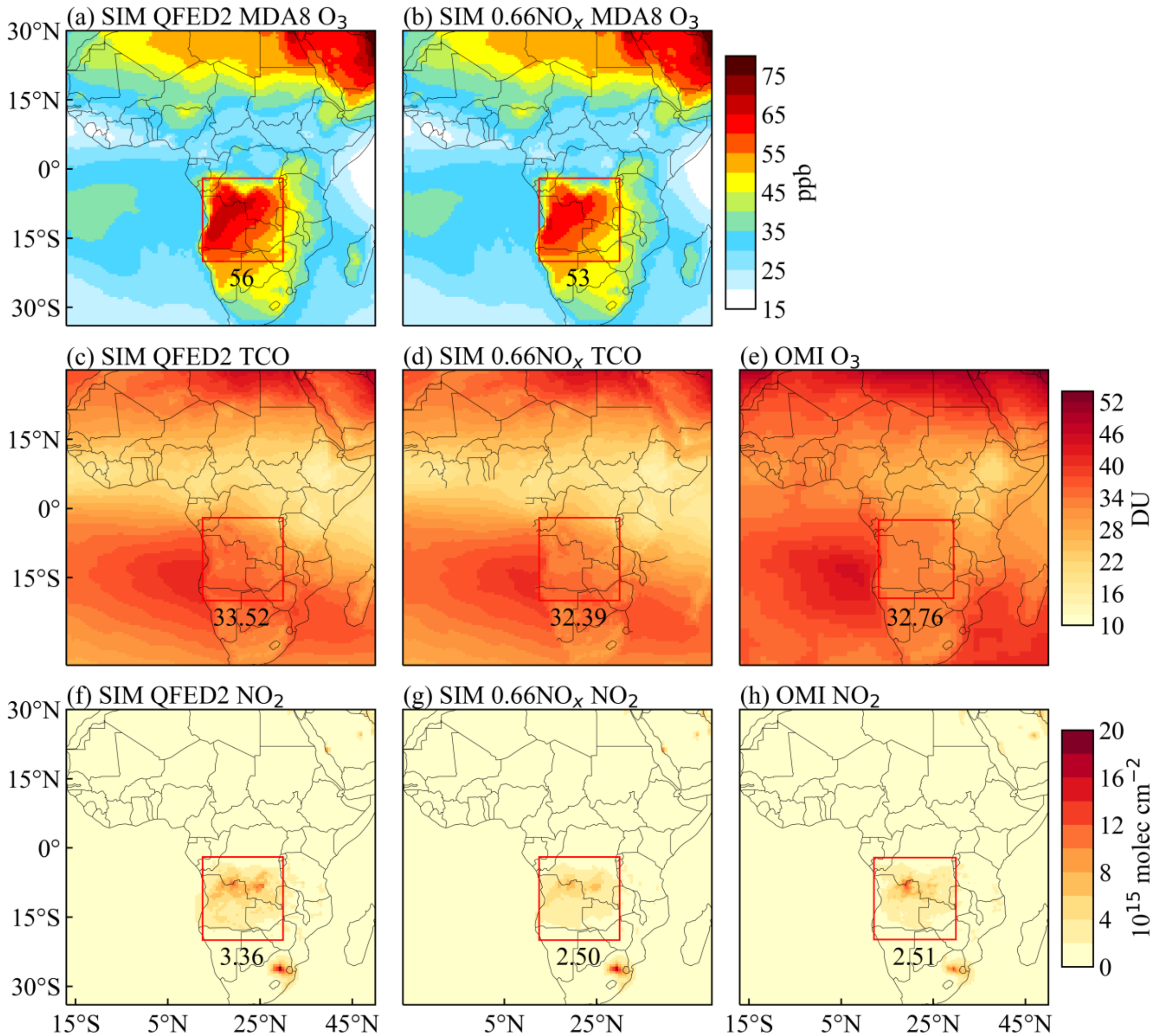

Figure S3. GEOS-Chem simulated surface ozone, tropospheric ozone columns, and NO_2 columns in Africa for July-August 2019 and its comparison with satellite data. The left panels are results from the baseline simulation; the middle panels are results from the simulation with 34% reduction in NO_x emissions from the QFED2 inventory; the right panels are results from the satellite data.

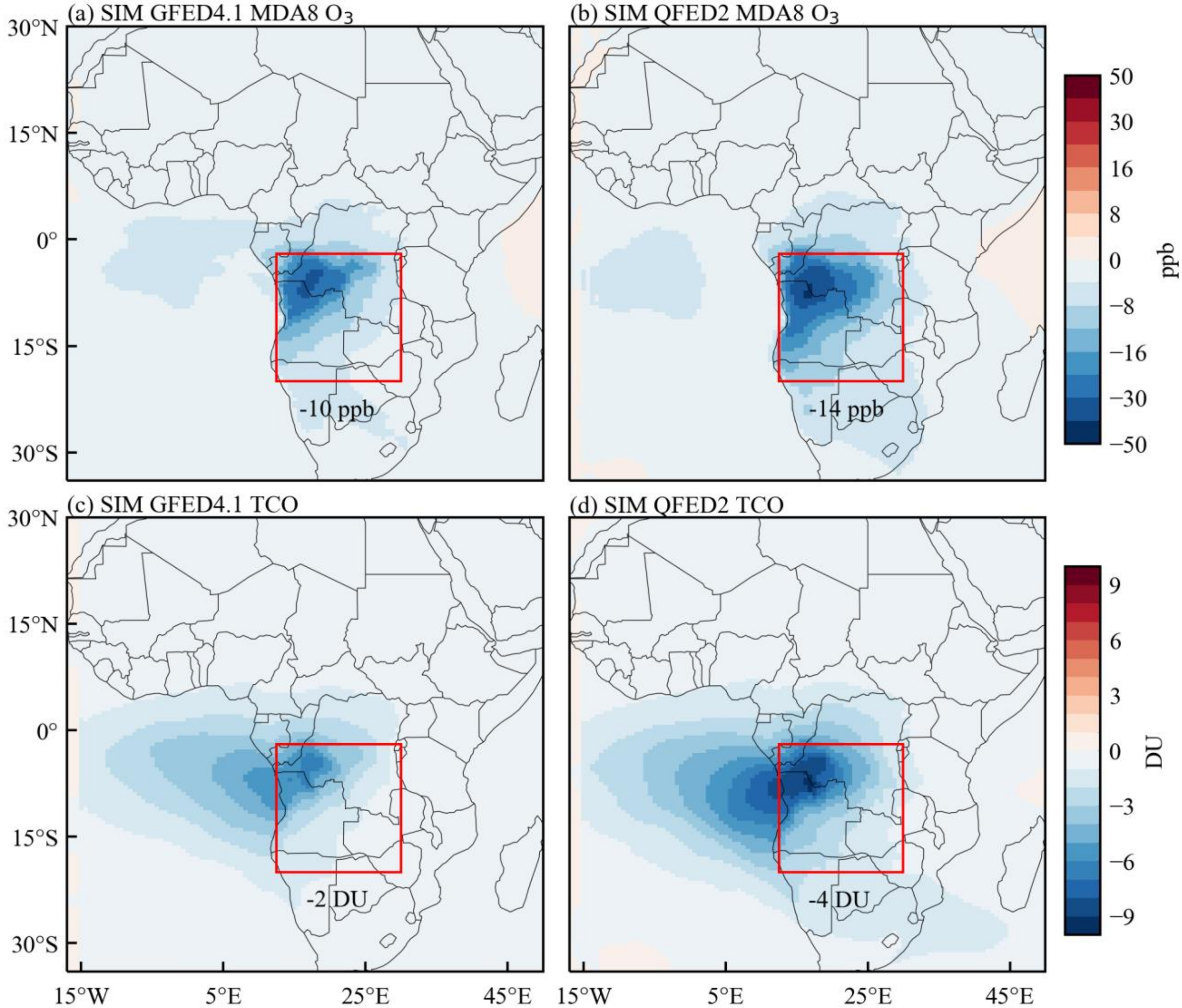

Figure S4. The simulated effects of aerosol chemistry on MDA8 ozone (top) and tropospheric ozone columns (bottom) in July-August 2019 by using the GFED4.1 and QFED2, respectively.

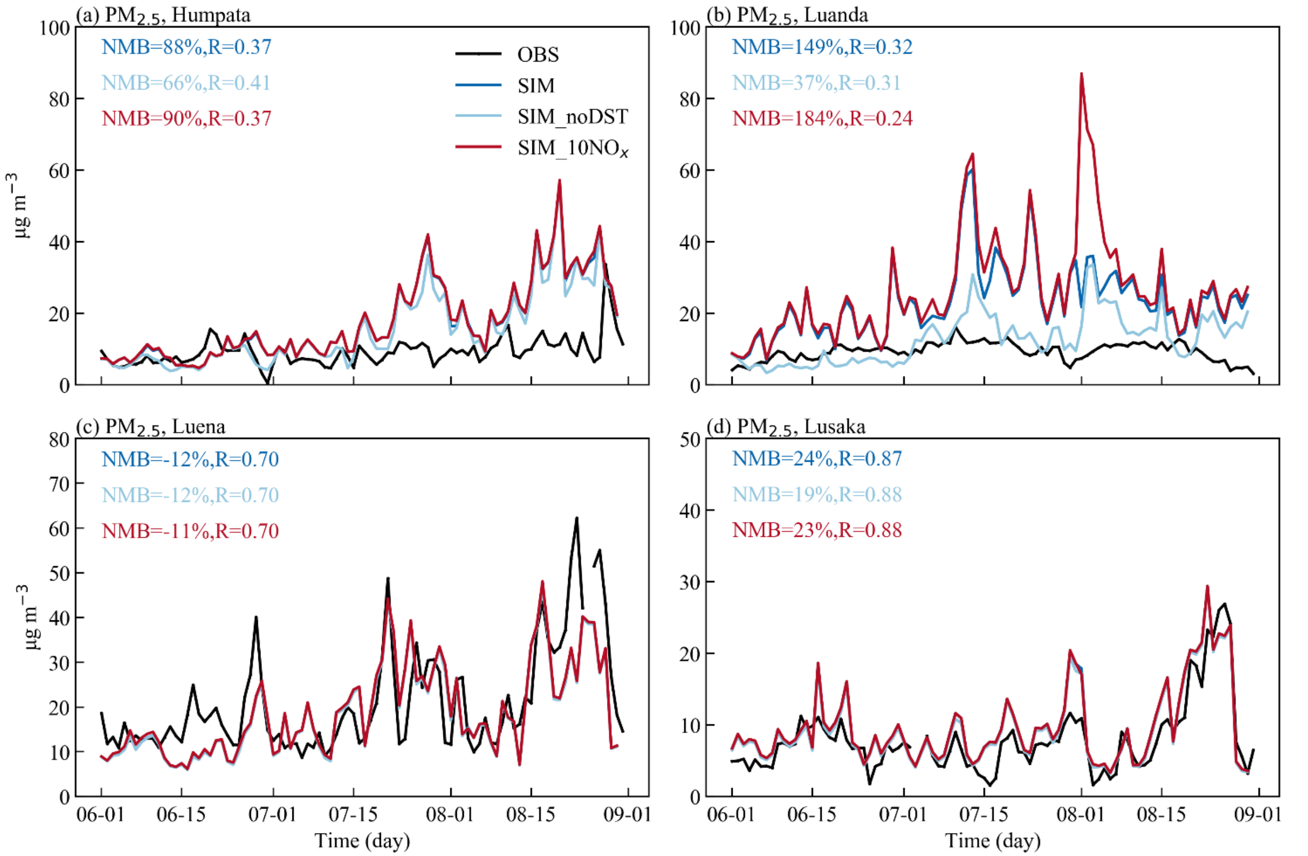

Figure S5. Time series of the simulated and observed (black) median daily $PM_{2.5}$ concentrations for June-August 2023. a-d are for Humpata, Luanda, Luena, and Lusaka, respectively. The plots labelled by the "SIM_noDST" and "SIM_10NO_x" are the $PM_{2.5}$ concentration after removing dust aerosols and the $PM_{2.5}$ concentrations when anthropogenic NO_x emissions were increased by a factor of 10 in CEDSv2.

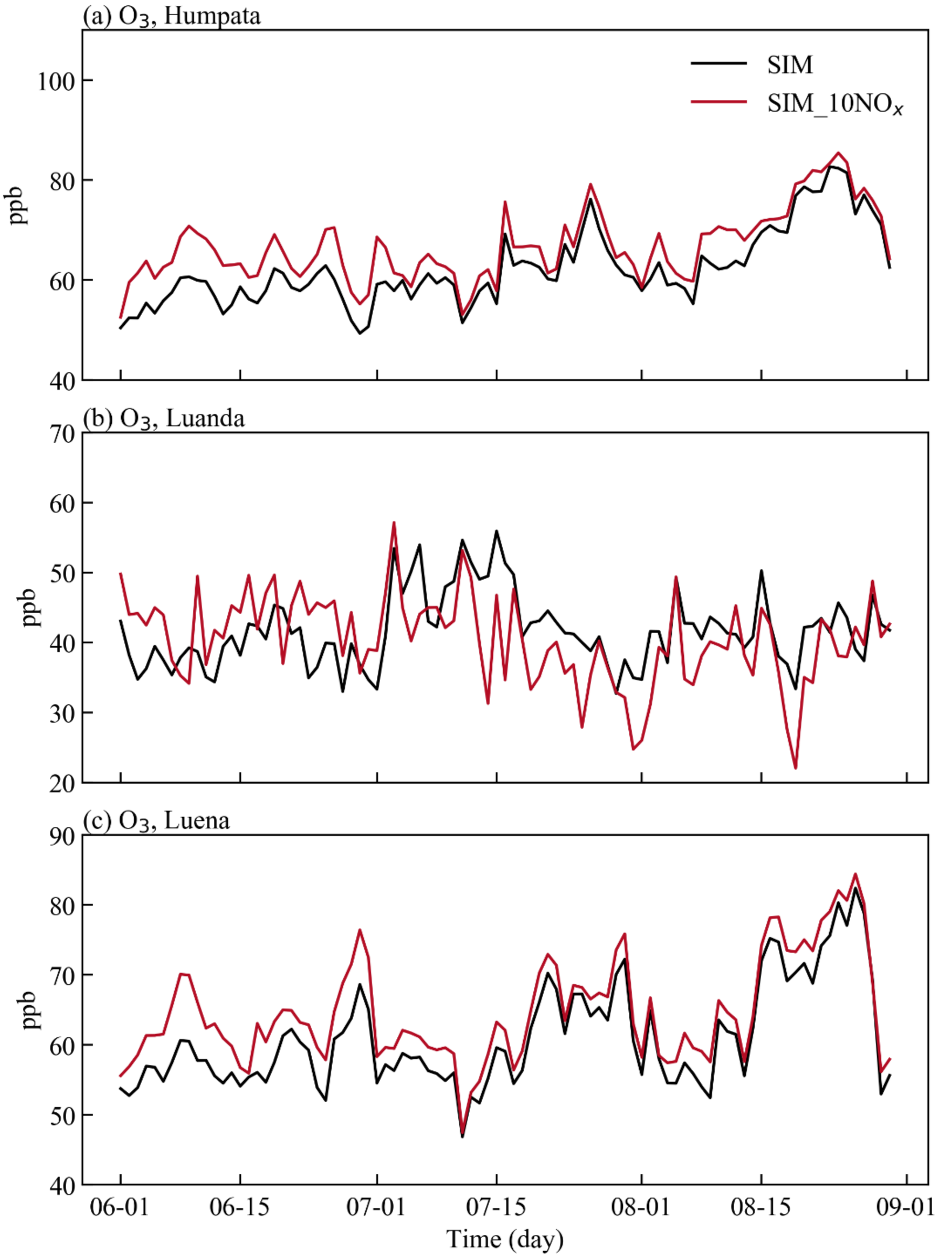

Figure S6. Time series of simulated June-August 2023 surface MDA8 ozone concentrations from the baseline simulation (black) and the sensitivity simulation (red) in which anthropogenic NO_x emissions were increased by a factor of 10 in CEDSv2.

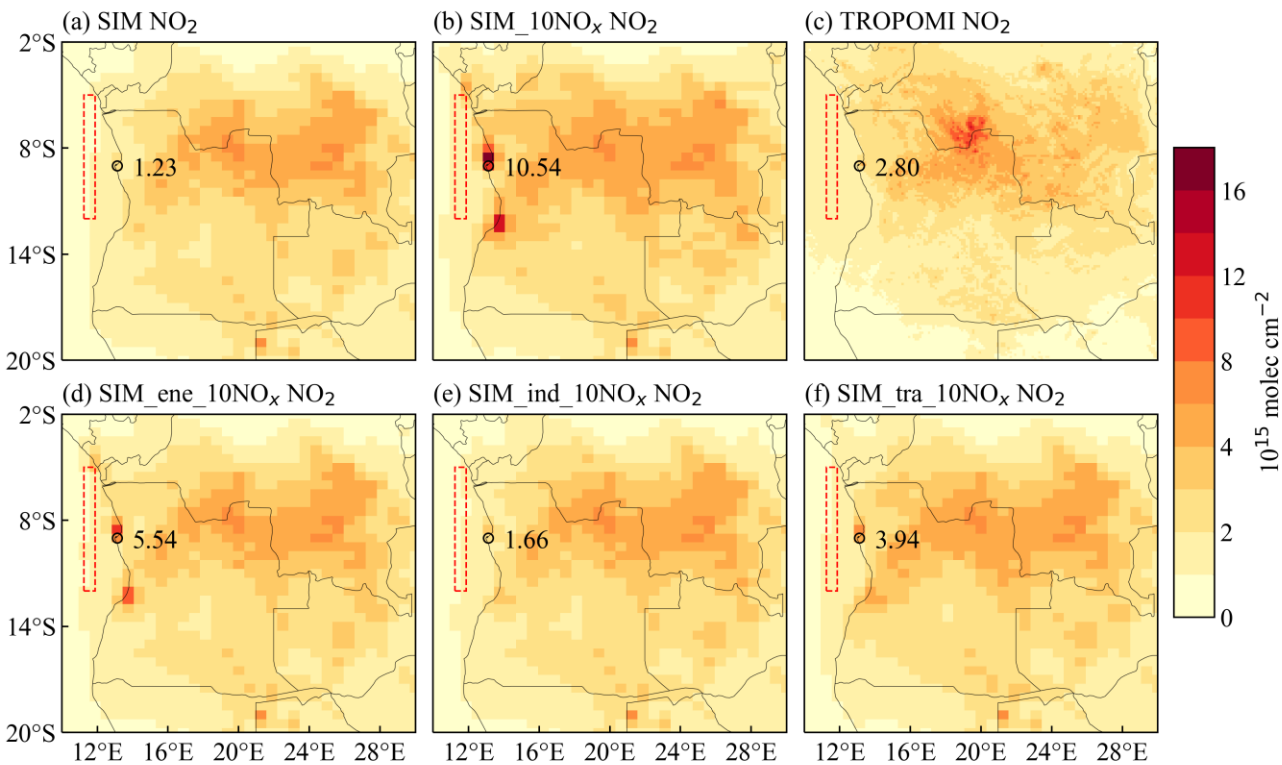

Figure S7. The observed and simulated tropospheric NO_2 columns in June-August 2023. (a) the baseline simulation with QFED2 inventory. (b) the sensitivity simulation with anthropogenic NO_x emissions increased by a factor of 10. (c) TROPOMI data. (d-f) the sensitivity simulations with sectoral NO_x emissions increased by a factor of 10 in energy, industry, and transportation. The numbers in the plots are all the relative NO_2 columns enhancement in Luanda area. The dashed boxes indicate the downwind background area, which is subtracted to obtain the relative NO_2 column concentration in Luanda.

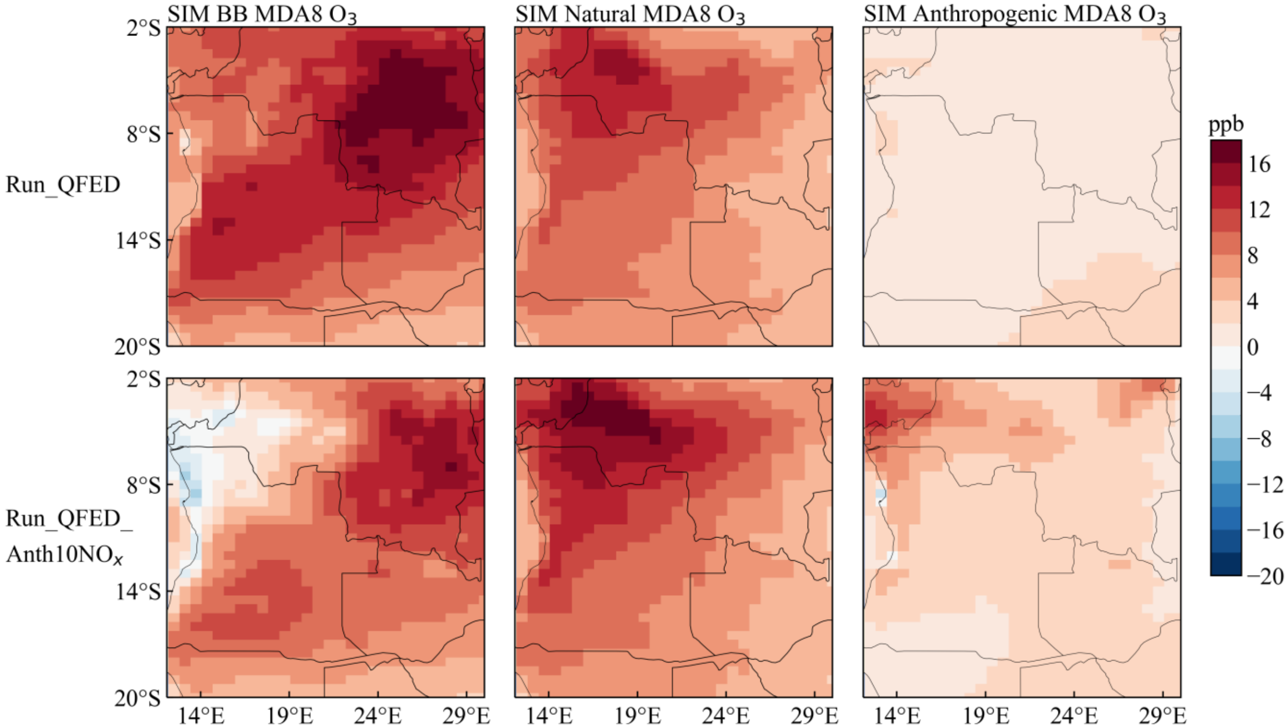

Figure S8. The simulated contributions to surface ozone in July-August 2019 from different sources, including biomass burning emissions (left), natural emissions (middle), and anthropogenic emissions (right), under Run_QFED simulation (top) and under Run_QFED_Anth10NO$_x$ simulation (bottom) where anthropogenic NO$_x$ sources were increased by a factor of 10. Here the natural emissions refer to the biogenic VOC and soil NO$_x$ emissions.

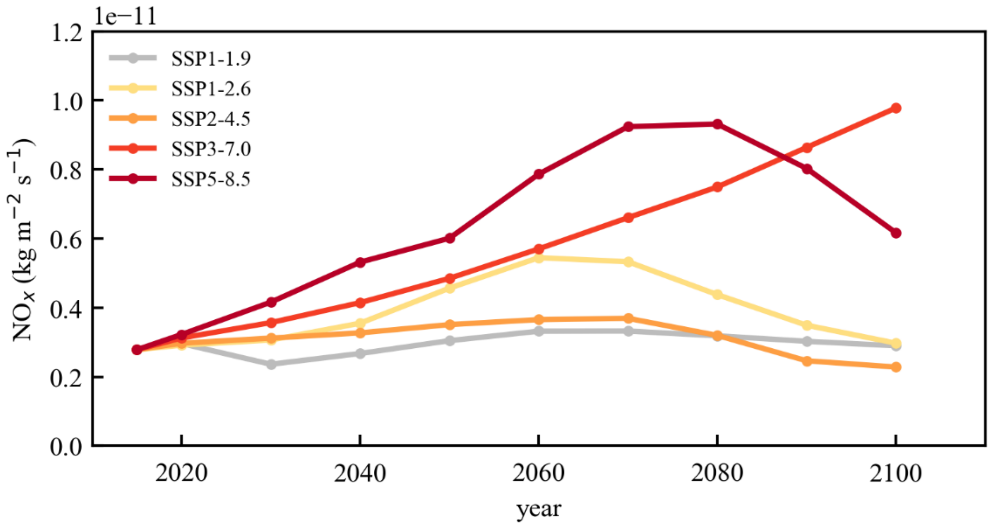

Figure S9. Trends in NO_x emission rates from anthropogenic sources under different future scenarios (Unit: kg m^{-2} s^{-1}).

Table S1: Satellite data used for this study

	Species	Spatial resolution	Time
OMI	O_3	1° × 1.25°	July-August 2019
OMI	NO_2	0.25° × 0.25°	2019-2020
OMI	HCHO	0.05° × 0.05°	July-August 2019
TROPOMI	NO_2	0.125° × 0.125°	2018-2023
MODIS	AOD	1° × 1°	July-August 2019
MOPITT	CO	1° × 1°	July 2019