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Reduction in GHG emissions in the U.S. North East Corridor due to COVID-19 lockdowns as measured by the East Coast Outflow Experiment

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On March 11th , 2020, the World Health Organization (WHO) characterized the COVID-19 respiratory disease caused by the coronavirus (SARS-CoV-2) as a world wide pandemic which led to a massive slowdown in anthropogenic activity as people attempted to "shelter in place". In response to this slowdown NOAA's Global Monitoring Lab (GML), in collaboration with the National Institute of Standards and Technology (NIST), University of Michigan, University of Maryland, Stony Brook University and NOAA's Chemical Science and Atmospheric Resource Laboratories, launched a campaign to measure CO_2, CH_4, and CO emissions from five major cities along the northeast corridor of the US (Washington, D.C., Baltimore, MD, Philadelphia, PA, New York, NY, and Boston, MA). The month-long campaign which lasted from April 16 to May 16 of 2020 mirrored a campaign that was completed exactly two years prior in April and May of 2018 and which enabled direct comparison of CO_2, CH_4, CO emissions from these five cities before and during SARS-CoV-2.

In this work, we used a Bayesian multi-resolution tiered inversion framework to quantify the CO_2, CH_4 and CO emissions from these urban areas. We used the HYSPLIT atmospheric transport and dispersion model to calculate the sensitivity of our aircraft observations to surface fluxes (footprints) using three meteorological drivers (NAM, ERA5 and a custom WRF); using three driver models allowed us to account for uncertainties in the transport. To account for biospheric influences on atmospheric CO_2, we used a year-specific VPRM simulation that allowed us to isolate the fossil-fuel contribution and solve for it alone. In addition, we also solved for total CO_2 and show that not accounting for biogenic activity in lower latitude urban areas could have led to an overestimation of the observed reduction due to biogenic flux differences between the two years.

Results show that systematic reductions in CO_2 and CO emissions for the five urban areas occurred in April 2020 with signs of recovery in May 2020, which had larger emissions than April 2020. The observed reductions and evolution are consistent with bottom-up estimations based on mobility metrics, which showed the lowest mobility in April with progressive recovery in May. Fuel use from tax records indicates similar reductions. In addition, we show that changes are not homogeneous in space within the urban metropolitan areas and that CO_2 and CO emissions reductions are collocated, showing the largest drops in urban centers and roads. While CO_2 and CO estimated reductions and evolution are systematic in all cities, CH_4 does not show a clear reduction or consistent pattern among cities during the COVID-19 lock-downs. In fact, all the measured changes for CH_4 were lower than the standard errors of the differences, implying that the observed changes in CH_4 are not significant. Last, we note that since the same prior emissions, constant in time, were used in all the inversions, the anomalous decrease in posterior emissions and subsequent recovery in CO_2 and CO observed during the COVID-19 lock-down period are driven by the atmospheric observations and not by temporal changes in the prior emissions.