05 April 2020

COVID Air Quality Study (COVID-AQS)

U.S. Urban Air Quality During the COVID-19 Outbreak and Future Implications

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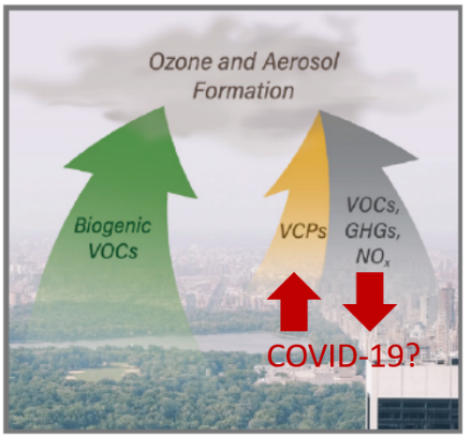
Statement of Opportunity

The COVID-19 outbreak is a never before seen health crisis that has completely disrupted our way of life. It provides an unprecedented opportunity to assess changes in U.S. emissions and urban air quality due to decreased traffic and economic activities.

The **current reduced traffic activity offers a glimpse into a potential future of urban air quality**, due to the ongoing electrification of the U.S. transportation fleet, which would reduce emissions of urban greenhouse gases (GHG), nitrogen oxides (NO_x), carbon monoxide (CO), and gasoline-related volatile organic compounds (VOCs). This change will cause other emission sectors to have a greater relative impact on air quality. For example, volatile chemical products (**VCPs) could dominate urban VOC emissions**. Cleaning product, disinfectant, and personal care product usage will likely stay the same or possibly increase during the COVID-19 outbreak. After decades of improvements to vehicular emissions, VCP VOC emissions already have emerged to roughly equal those from the transportation sector. Other regional emissions, such as from oil&gas, industry, and agriculture, might also change during the outbreak, while biogenic emissions should remain unchanged. Therefore, air quality changes during the COVID-19 outbreak will provide unique insight into a potential future in which decarbonization and emission reductions take place in U.S. cities to mitigate a changing climate.

Experimental Plan

In recent years, the NOAA Chemical Sciences Laboratory (CSL) has led research on the impact of VCPs on air quality by developing VCP and transportation emission inventories, performing intensive field measurements, and using box and 3D computer models for local and US air quality studies. For example, we found that local ozone formation in New York City during a heatwave was 60% due to mobile sources and 40% due to VCPs. Here, we propose to utilize NOAA CSL's capabilities to assess how VOC and NO_x emissions are changing during the COVID-19 outbreak and what that means for air quality in U.S. cities.



Measurements during COVID-19

Detailed in-situ VOC measurements are essential to document the change in VOC emission sources. VOC, CO and NO_x measurements were started at the NOAA ESRL facility during the COVID-19 outbreak and will continue until normal urban activities resume. VOCs are measured with a Proton Transfer Reaction Time-of-Flight Mass Spectrometer (PTR-ToF-MS) and a Gas Chromatography Mass Spectrometer (GC-MS). CO and NO_x are measured with commercial instruments from Los Gatos Research (LGR) and Thermo

Scientific, respectively. The process of starting and maintaining the measurements was designed to have minimal impact on the health of NOAA personnel. Continuous Scanning Doppler Lidar measurements are being made from the third floor of DSRC. These measurements provide estimates of mixed layer height and horizontal wind profiles every 15 minutes. The CSL TOPAZ lidar measures ozone (O_3) mixing ratio and aerosol backscatter vertical profiles from near the surface to 6 – 8 km above ground level (AGL) every 8 minutes. The lidar also measures the same parameters along a horizontal path over south-central Boulder. Currently, TOPAZ measurements are performed usually twice per week on clear or partly cloudy days, for several hours each. In addition, surface O_3 and temperature, humidity, wind speed and direction, as well as barometric pressure are measured continuously from the TOPAZ truck.

Specific Analysis Tasks

With a timeseries of continuous VOC and CO measurements during the COVID-19 outbreak, the following analyses will be conducted:

1. Source apportionment of in-situ VOC and satellite NO_x measurements to transportation and VCPs
2. Assessment of satellite NO_2 and formaldehyde columns over urban areas utilizing retrievals from OMPS on Suomi-NPP, Sentinel-5P TROPOMI, and Aura OMI satellite instruments
3. Comparison to extensive past CSL in situ measurements, including VOCs and O_3 and aerosol profiles
4. Updating CSL's U.S. air quality model with newly evaluated COVID-19 emissions
5. Archiving local and regional air quality monitoring data for measurement and model comparison
6. Doppler lidar wind and mixing height observations provide information on transport patterns and the depth of the volume that O_3 precursors are mixed into. In addition, spatially resolved, nearly horizontal, scanning data can be used to determine airmass trajectories for in-situ sensors.

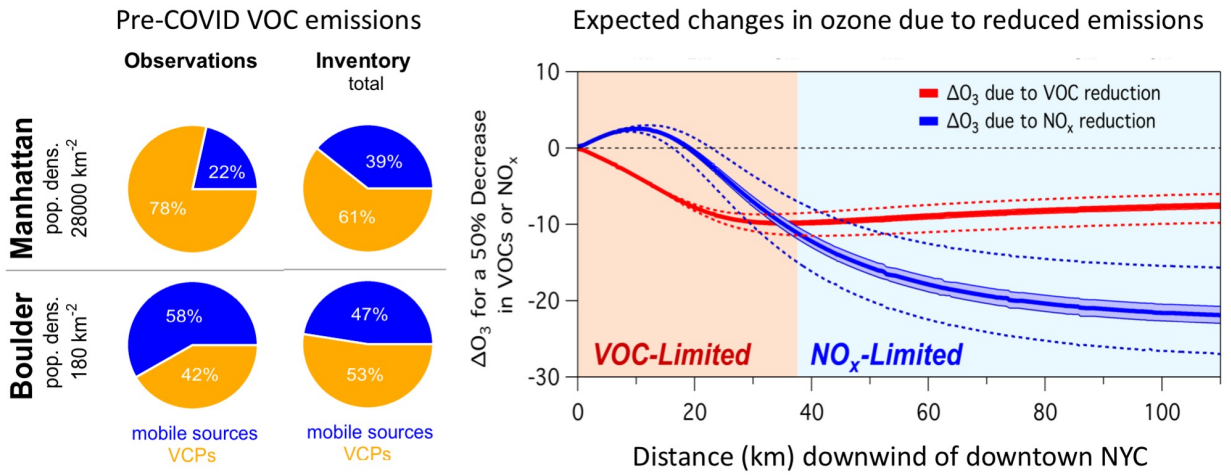


Figure: *(Left) VOCs related to mobile and VCP sources in NYC and Boulder; comparison of measurements and inventory. In cities the main sources of NOx are mobile sources. (Right) Calculated change in ozone downwind of NYC assuming a 50% decrease in NO_x or VOCs.*

CSL Personnel Required for Data Collection and Analysis

The 24/7 measurements initiated in the ESRL building on 30 March required access by one federal employee working for 8 hours.

1. PTR-ToF-MS and CO: no routine maintenance expected, and remote connections used for instrument control, data file collection, and quality assurance.

2. GC-MS: filter change required every other day (conducted by CSL Deputy as part of regular oversight duties), and remote connections used for instrument control, data file collection, and quality assurance.
3. TOPAZ: One operator is required on site for all TOPAZ observations. In situ observations are automated.
4. Doppler lidar: Measurements are controlled remotely.
Initial processing of both data sets is automated. Final analysis is handled via telework.
5. Multiple CSL personnel work together via telework to conduct a range of modeling and data analyses of the new remote sensing and in situ VOC and CO data combined with NOAA CSL's capabilities in evaluating air quality models and emission inventories with satellite remote sensing data.

Expected Outcomes
Provide information to CSL stakeholders concerning the present impacts on U.S. air quality from the COVID-19 pandemic, and from our transportation and energy infrastructure were it to become decarbonized in the future.