Impacts of COVID-19 on Air Quality

Andrew Jensen1,2, Barbara Dix1, Tianshu Chen1,4, William Dresser2, Esther Roosenbrand3, Joost de Gouw1,2

1Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, Colorado, 80309, USA; 2Department of Chemistry, University of Colorado, Boulder, Colorado, 80309, USA; 3Environmental Research Institute, Shandong University, Qingdao, Shandong, 266237, China; 4Department of Geoscience and Remote Sensing, Delft University of Technology, Delft, South Holland, 2628 CD, Netherlands

COVID-19 and Air Quality
Following the outbreak of the novel coronavirus disease (COVID-19), many countries underwent large-scale lockdowns in 2020. Travel and work restrictions resulted in reduced emissions of related air pollutants. For example, reductions in nitrogen dioxide columns over Asia, Europe, and North America have been observed by the space-based Ozone Monitoring Instrument (OMI) and Tropospheric Monitoring Instrument (TROPOMI).1–3

These lockdowns and reduced emission conditions present a test-case to bolster the scientific understandings of both pollutant emissions as well as the formation of secondary pollutants (e.g., ozone and PM2.5). Initial studies have highlighted the complexity of these issues as reduced emissions did not necessarily lead to lower secondary pollutants in China.1–3

Emissions over U.S. Oil & Natural Gas Production Regions
- Oil and natural gas production is associated with emissions of NOx, VOCs, and methane.
- NOx and VOCs can lead to ground-level ozone formation.
- NO2, formaldehyde, and methane can be observed from space.

VOC Measurements in Changzhou, Jiangsu Province, China
- TROPOMI data are used to compare VOC emissions in 2020 vs. 2019 lockdowns.
- The modelled average daily maximum ozone increased by ~15 ppb.

Modeling of Ozone Chemistry in Los Angeles, California, USA
- Volatile chemical products (VCPs) are emerging as the largest petrochemical source of urban organic emissions.
- Ozone concentrations in Los Angeles (LA) have exhibited a general increasing trend since 2010.

VOC Measurements in Boulder, Colorado, USA
- A Vocus-28 PTR-TOF-MS was set up to take measurements on the CU Boulder campus during the stay-at-home period (March 26 - April 27).
- Major decreases are noted in the local traffic data and ground-based measurements of CO and NO2 in the region.

Acknowledgements
This work on VOCs in Changzhou was supported by the CIERRES Innovation Research Program.

References

Analysis of VOCs over the Permian Basin
- Emissions of VOCs in the Permian Basin have been assessed using a combination of ground-based and satellite data.

VOCs from Siloxanes
- Siloxanes are common in many consumer products.

VOCs from Aromatic Compounds
- Aromatic compounds are prevalent in gasoline and diesel fuels.

VOCs from Aliphatic Compounds
- Aliphatic compounds are common in industrial processes.

VOCs from Non-Aromatic Compounds
- Non-aromatic compounds are prevalent in many consumer products.

Diurnal variation of ozone concentrations in the Los Angeles basin.
- Ozone concentrations exhibit a clear diurnal pattern, with peak concentrations occurring in the morning.

Variation of ozone in the Los Angeles basin.
- The modelled average daily maximum ozone concentration is shown.

After Adding emissions from VCPs:
1. The modelled average daily maximum ozone concentration is ~15 ppb.
2. Peak ozone production rate increased by 4.3 ppb/h on average.
3. The agreement between the calculated and observed ozone production (ozone, formaldehyde) was excellent.
4. Modelled concentration and trend of HOx and acetone still showed some discrepancy with the data.