COVID-19 Induced Fingerprints of a New Normal Urban Air Quality in the United States

S. Kondragunta¹, Z. Wei², B. C. McDonald³, D. L. Goldberg⁴, D. Q. Tong⁵

¹NOAA NESDIS Center for Satellite Applications and Research ²IM Systems Group ³NOAA Chemical Systems Laboratory ⁴Milken School of Public Health ⁵George Mason University

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On-road NOx emissions data from NOAA/OAR (PI: B. McDonald; see paper by Harkins et al., ERL, 2021).

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Objective

In this paper, we tried to answer the following three questions:

- Are changes in NO_x emissions during the lockdown detectable in TROPOMI tropNO₂ data?
- Are the economic indicators consistent with emissions changes?
- Did the NOx emissions and TROPOMI tropNO₂ trends reverse with the lifting of lockdown measures in the major metro areas?



Are changes in on-road NO_x emissions during the lockdown detectable in TROPOMI tropNO₂ data?





- Decreases in TROPOMI tropNO₂ data (blue-green) consistent with NO_x emissions reductions
- Increases in TROPOMI tropNO₂ data (red) due to our double differencing technique not completely accounting for meteorological differences between 2020 and 2019. Modeling studies (e.g., Qu et al., 2021) confirm this finding.

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Are changes in on-road NO_x emissions during the lockdown detectable in TROPOMI tropNO₂ data?

- Weekday (blue) and weekend (red and green) differences noticeable in daily TROPOMI tropNO₂ data;
- Weak correlation with NO_x emissions on daily time scale, even after data are normalized for meteorology using Goldberg et al. (2020) technique
- Improved correlation of normalized tropNO₂ with NO_x emissions when 28-day rolling averages are used





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Are changes in on-road NO_x emissions during the lockdown detectable in TROPOMI tropNO₂ data?

- Changes in on-road monthly mean NOx emissions between 2020 and 2019 for five different cities correlate well (r = 0.68) with monthly mean TROPOMI tropNO₂
- Similar analysis with changes in power plant emissions did not show a strong correlation (r = 0.35)





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Are the economic indicators consistent with emissions changes?







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Did the trends reverse with the lifting of lockdown measures in the major metro areas?

- On-road NOx emissions not fully recovered and ~20% below normal
- TROPOMI tropNO₂ also showing below normal values
- Although the data represent five different cities, trend in TROPOMI tropNO₂ is driven by San Francisco and San Joaquin Valley





Conclusions

- Positive linear correlation between changes in on-road monthly mean NO_x emissions and changes in monthly mean TROPOMI tropNO₂ (r = 0.68) suggests satellite data can be used to study changes in NO_x emissions due to traffic where ground observations are not available.
- Economic activity changes detected in TROPOMI tropNO₂ data
- Analyzing the effect of lockdown on particulate pollution (AOD/PM2.5) not straightforward. Published work thus far has not considered removing biomass burning signals in the aerosol data.



We developed a VIIRS AOD to TROPOMI trop NO_2 ratio method to look for signals of biomass burning. High AOD and low NO_2 implies non-local sources.

