Final 2020 Ozone Exceptional Events Analysis for the District of Columbia

MWAQC-TAC

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DEPARTMENT OF ENERGY & ENVIRONMENT

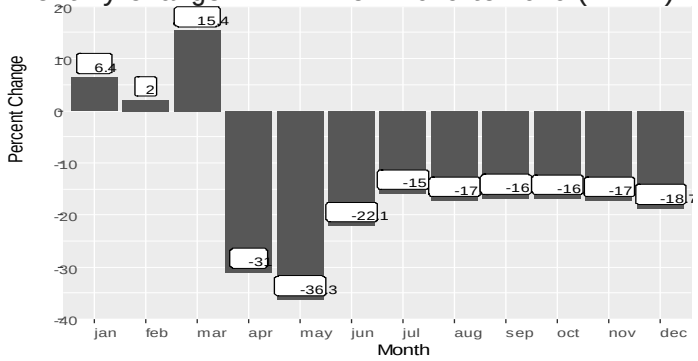
GOVERNMENT OF THE DISTRICT OF COLUMBIA
MURIEL BOWSER, MAYOR

Covid-19 Health Emergency Exceptional Event

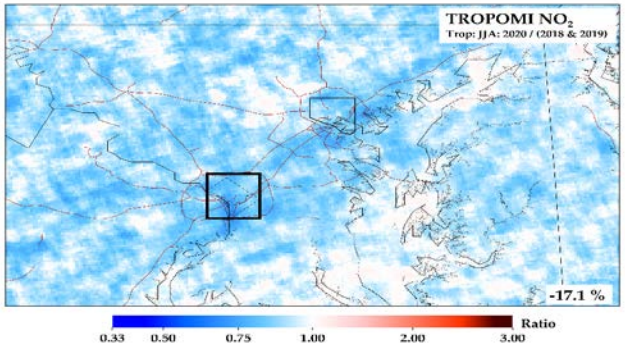
- District has been consistently measuring above the ozone NAAQS for several years
- In 2020 the District saw:
  - 77% decrease in congestion
  - 21% decrease in nitrogen dioxide (NO_2)
  - 7% decrease in O_3
- DOEE is considering the ozone values from Mar 16 To Dec 31 to be the result of “unusual traffic congestion”
- DOEE published its proposed demonstration for public comment on August 20, 2021 (no comments were received): https://dcregs.dc.gov/Common/NoticeDetail.aspx?NoticeId=N112394

Exceptional Event – Data Story

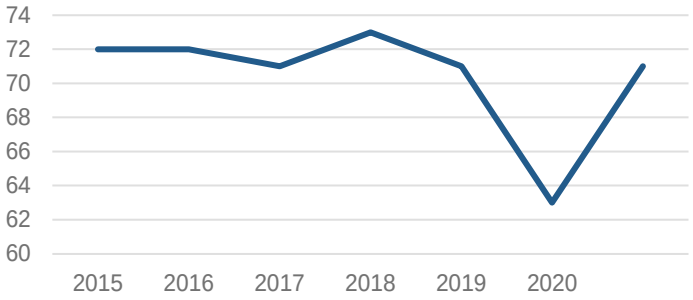
Monthly Change in VMT from 2019 to 2020 (FHWA)



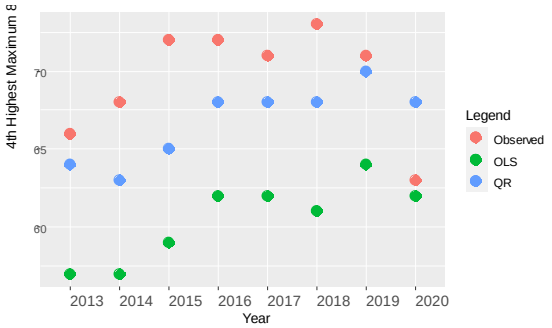
Observed change in regional NO2 (TROPOMI) (Dan Goldberg, PhD)



Monitored 4th High 8-hr Ozone from 2015 to 2020 at McMillian



Forecasted 4th High 8-hr Ozone from 2013 to 2020 at McMillian



Exceptional Event – Why?

- EPA evaluates compliance with NAAQS based on three-year average
- 2020 pulls down our average well below the NAAQS
- 2021 ozone levels have returning to pre-pandemic violating levels
- Concern that Washington, DC-MD-VA will be complying “on paper,” but air quality problems will persist, and will lose many tools to improve the air

Regressions - Tools

- Literature review suggested three tools to explore:
  - Ordinary Least Squares Regressions (OLS)
  - Quantile Regressions (QR)
  - Machine Learning Algorithms
- Built using 2013-2017 data, tested on 2018 & 2019 data
- Explored the first two since MLA ran up against resource constraints

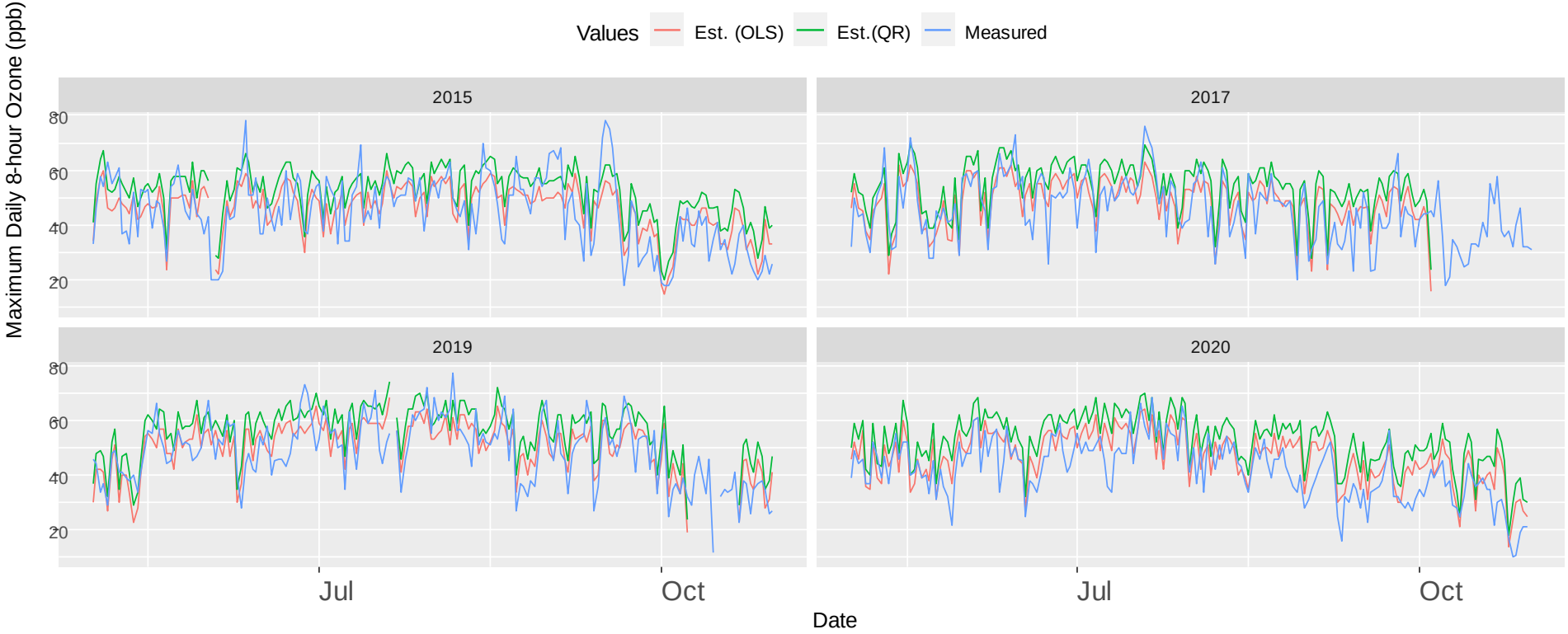
Ordinary Least Squares (OLS)	Quantile Regression (QR)
• Simple model used to estimate a relationship of two variables using a linear relationship • Aims to estimate the mean of a distribution	• Allows for examination of entire distribution (many quantiles). • Allows for explaining outliers.

Regression Formula

$$
\begin{aligned}
\text{Ozone} = \; & \alpha + \\
& \beta_1 * \text{Pressure.Measurement} + \\
& \beta_2 * \text{Temp.Measurement} + \\
& \beta_3 * \text{DayBeforeMaxDailyTemp} + \\
& \beta_4 * \text{TwoDaysBeforeMaxDailyTemp} + \\
& \beta_5 * \text{Humidity.Measurement} + \\
& \beta_6 * \text{Windspeed.Measurement} + \\
& \beta_{7\text{-}13} * \text{Wind.Direction.Factor} + \\
& \beta_{14} * \text{GHI.Measurement} \\
& \beta_{15} * \text{Year} \\
& \beta_{16\text{-}38} * \text{HourOfDay.Factor} + \\
& \beta_{39\text{-}44} * \text{DayOfWeek.Factor} + \\
& \beta_{45} * \text{RainedDayBefore?} + \\
& \beta_{46} * \text{Geopotential.Height.Interpolated.Measurement} + \\
& \beta_{47} * \text{Windspeed.850mb.Interpolated.Measurement} + \\
& \beta_{48\text{-}55} * \text{Wind.850mb.Direction.Interpolated.Factor} + \\
& \varepsilon
\end{aligned}
$$

* This equation is for OLS, QR has 40 of these.

Measured vs. Estimated



Comparison to Ozone Metrics

- QR over-predicts average daily max ozone and OLS predicts very well, but 2020 the tools don't function well
- 2013-2019, 4th highs under-predicted by 3.86 (QR) and 10.1 (OLS) ppb on average
- In 2020:
  - QR tool over-predicted the 4th high 8-hour ozone by 5 ppb
  - OLS tool under-predicted ozone by only 1 ppb
  - Swings of 8.86 and 9.1 ppb, respectively

Legal Justification (CAA § 319(b)

(A)(i) affects air quality;	DOEE clearly demonstrated the impact on air quality
(ii) is not reasonably controllable or preventable;	Covid-19 was not controllable nor preventable and the thus subsequent (positive) emissions changes were neither
(iii) is an event caused by human activity that is unlikely to recur at a particular location or a natural event;	Covid-19 was natural in origin and unlikely to recur
(iv) is determined by the Administrator through the process established in the regulations promulgated under paragraph (2) to be an exceptional event.	1. DOEE makes the case that the Rule unnecessarily limits the rule to only exceedances based on the lack of evidence of that intent in the CAA or the Congressional record 2. DOEE demonstrates that this event meets the portions of the rule not explicitly geared towards exceedances
(B) Exclusions In this subsection, the term "exceptional event" does not include— *(i) stagnation of air masses or meteorological inversions;* *(ii) a meteorological event involving high temperatures or lack of precipitation; or* *(iii) air pollution relating to source noncompliance.*	Does not meet any of the specific exclusions in the Clean Air Act

Conclusions

- 2020 ozone levels were extraordinary
- Successfully demonstrated the relationship between meteorological conditions and ground-level Ozone
- OLS and QR are useful tools to use in tandem to predict Ozone in the District
- QR model was more efficient for forecasting hourly Ozone near the peaks
- Clean Air Act reading points towards DOEE's request being acceptable

- Full Papers are available:
  - Exceptional Event Package (demonstration and regression analysis paper): https://doee.dc.gov/service/exceptional-event-demonstration-2020-ozone-levels

Wrapup

- Thanks
  - Dr. Courtney Grimes (DOEE)
  - Dr. Rama Tangirala (DOEE)
  - Joel Dreessen (MDE)
  - Tom Downs (Maine DEP)
  - Drs. Dan Goldberg and Gaige Kerr (GWU)
  - Bob Day (DOEE)
- Questions
  - Joseph Jakuta Joseph.jakuta@dc.gov

Sources

- Baur, Dirk, Michaela Saisana, and Niels Schulze. "Modelling the effects of meteorological variables on ozone concentration—a quantile regression approach." Atmospheric Environment 38.28 (2004): 4689-4699.
- Chen, L-W. Antony, et al. "Nonuniform impacts of COVID-19 lockdown on air quality over the United States." Science of the Total Environment 745 (2020): 141105.
- Ghazali, Nurul Adyani, et al. "Transformation of nitrogen dioxide into ozone and prediction of ozone concentrations using multiple linear regression techniques." Environmental monitoring and assessment 165.1 (2010): 475-489.
- Goldberg, Daniel L., et al. "Disentangling the impact of the COVID-19 lockdowns on urban NO2 from natural variability." Geophysical Research Letters 47.17 (2020): e2020GL089269.
- Mitra, Subrata Kumar. "An analysis of brand value and its determinants using quantile regression." Academy of Marketing Studies Journal 22.3 (2018): 1-9.
- Munir, Said, Haibo Chen, and Karl Ropkins. "Modelling the impact of road traffic on ground level ozone concentration using a quantile regression approach." Atmospheric environment 60 (2012): 283-291.
- Pires, José CM, et al. "Comparison of several linear statistical models to predict tropospheric ozone concentrations." Journal of Statistical Computation and Simulation 82.2 (2012): 183-192.
- Pishue, Bob. "INRIX 2020 Global Traffic Scorecard."
- Sousa, S. I. V., et al. "Potentialities of quantile regression to predict ozone concentrations." Environmetrics: The official journal of the International Environmetrics Society 20.2 (2009): 147-158.