# Urban Ozone Forecasting and Policy Recommendations Through Photochemical Modeling and Machine Learning

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In the troposphere, ozone is a harmful secondary pollutant formed by chemical reactions between nitrogen oxides (NOx) and volatile organic compounds (VOCs). In 2020, COVID-19 lockdowns brought on some of the lowest air pollution levels seen in years across the world. While ozone precursor pollutants such as nitrogen oxides (NOx) drastically decreased, ozone increased in many cities. Ozone's unexpected behavior can make it difficult for policymakers to know which pollutant(s) should be reduced to limit ozone concentrations. To determine whether to reduce emissions of NOx or VOC, three approaches were developed: a simple photochemical box model, a complex photochemical box model, and a machine learning model. Both box models were derived from a set of chemical reactions that lead to seven differential equations. The simple model assumes steady-state conditions and results in a single equation for ozone production. The complex model solves differential equations in time for a more dynamic and realistic simulation. For each of these models, the conditions in Mexico City in 1997 and then 2017 were set as inputs for the models to see which policy choices would be most effective. Data analysis and machine learning were conducted on hourly data from the past 30+ years and were also used to investigate the shift of limiting factors of ozone formation over time. Quality 48 hour ozone forecast models were also developed to test the effects of varying NOx and compared to the results of the photochemical models. It was found that since the 1990s, Mexico City has been a VOC-limited city, and should aim to reduce VOC emissions. All models and historical data do not support Mexico City's “No Drive Day” policy to reduce NOx since doing so can even increase ozone to dangerous levels.

**Awards Won:**

Third Award of $1,000

American Meteorological Society: Honorable Mention of $125

National Oceanic and Atmospheric Administration - NOAA: Taking the Pulse of the Planet First Award

University of Arizona: Renewal Tuition Scholarship