4.206 Temperature-dependent drivers of summer surface-level ozone: Insights from a chemical transport model within the Eastern United States.

Early Career Scientist

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Abstract:

Temperature is an important and well-documented driver of extreme ozone (O_3), and over the Eastern United States, regional-scale O_3 responds nearly linearly to temperature changes by 1.48 ± 0.34 ppbv K^{-1} during the summer. What is unclear, however, are the relative roles of temperature-dependent processes such as emissions and photochemistry. For instance, on hot summer days, anthropogenic NO*x* emissions from power plants increase with greater air conditioning demand, and biogenic emissions of isoprene and other VOCs also increase. At the same time, high ambient temperatures alter chemical lifetimes and increase photochemical reaction rates.

In this study we first compare modeled O_3-NO*x*-VOC chemistry from a control run of NASA's Global Modeling Initiative (GMI) chemical transport model (CTM) with *in situ* measurements of trace gases from the U.S. Environmental Protection Agency (EPA) Clean Air Status and Trends Network (CASTNet) and Air Quality System (AQS). In doing so, we establish a baseline for model performance.

We then present the results of sensitivity simulations aimed at disentangling the roles of the aforementioned temperature-dependent processes. The first such simulation uses observed industrial emissions from the EPA's Continuous Emissions Monitoring System (CEMS) to derive the sensitivity of industrial NO*x* emissions to temperature (5.4% K^{-1}) and thereafter introduces daily-varying emissions to the CTM to isolate the role of temperature-dependent emissions. An analysis of this simulation indicates that the implementation of daily-varying emissions results in only nuanced changes to daily O_3 variability. Finally, our second simulation fixes time-varying temperatures to monthly mean values within the CTM's chemical mechanism to isolate the role of temperature-dependent photochemistry.

Our work clarifies the pathways that link temperature with O_3 and suggests the ways in which increasing global temperatures could impact surface-level O_3. Moreover, our work provides the strengths and limitations of sensitivity simulations of a global CTM on surface-level trace species.