Science Policy Outreach Task Force at Northwestern University

OVERVIEW ON AIR QUALITY IN THE CHICAGO METRO AREA

SPOTlight: Air quality levels vary in the metro area with most pollutants concentrating over highways and downtown Chicago. EPA monitors are not intended to identify pollution hotspots.

State of air quality in Chicago metro area for Clean Air Act criteria pollutants

- The National Ambient Air Quality Standards (NAAQS) are set for criteria pollutants, which are health-hazardous, outdoor pollutants consisting of ozone (O_3), sulfur dioxide (SO_2), carbon monoxide (CO), particulate matter (PM), lead (Pb), and nitrogen dioxide (NO_2).
- The Chicago area does not meet 8-hour O_3 standards (meaning the O_3 is above 0.75 parts per million averaged over 8 hours) since 2012 but has recently resolved other compliance issues with lead, sulfur dioxide (SO_2), and particulate matter (PM) [1].
- Due to sparse sensor coverage, areas near pollution hotspots may not be adequately monitored and further investigation into specific air quality complaints are warranted.

Key sources of air pollutants in Chicago

- O_3 is formed through secondary processes (i.e. not directly emitted). In urban centers, volatile organic carbons (VOCs) react with nitrogen dioxide (NO_2) and sunlight to create O_3. The majority of NO_2 in cities come from anthropogenic combustion processes (e.g.: cars, power plants).
- Volatile organic compounds (VOCs) come from personal care products (e.g.: soaps, deodorants), homecare products (e.g.: cleaners, paints) and natural sources (e.g.: plants, anything burning).
- In urban areas, nitrogen oxides (NO_x) mainly come from combustion (e.g.: cars, power plants), though some NO_x emissions come from natural sources (e.g.: lightning).
- PM is a mixture of solids and liquids in the air that can be emitted directly or formed with complex atmospheric processes (e.g.: dust from combustion, a secondary reaction from NO_2 and SO_2).

Air quality studies at O'Hare

- A study [2] of particulate matter (PM) exposure near O'Hare airport found that highways contribute ~3 and ~4 times the amount of PM exposure emissions as power plants and aircraft emissions, respectively.
- Although most reactive gases (e.g., VOCs) mainly affected the immediate airport area, more than half of PM exposure occurred more than 50 km away from O'Hare airport.
- The FAA and EPA both track O'Hare air quality and have found it in compliance for criteria pollutants even though the O'Hare area is a major source of pollutants in the region [3].

Sparse sensor network does not provide complete air quality picture

- There are 10 O_3, 3 SO_2, 2 CO, 15 PM, 0 Pb, and 5 NO_2 sensors within Cook county, with most sensors located outside of the city limits of Chicago [4].
- Analysis by the Climate Change Research Group (CCRG) at Northwestern University suggests that there are pollution hotspots in the Chicago region due to a combination of high-emissions sources (e.g.: highways) and meteorological processes (e.g.: wind) that distribute these pollutants. Areas with high values of one pollutant do not necessarily mean that they will have high values of another pollutant (see Fig. 1).
- The CCRG uses an EPA coupled chemistry-climate model called WRF-CMAQ (Community Multiscale Air Quality Modeling System with the Weather Research Forecast Model) at a 1.3 km resolution, which provides a much more detailed picture than the current EPA criteria pollutant monitors.
- Preliminary analysis of NO_2 shows higher values major highways (Fig. 1 *left*), while O_3 (Fig. 1 *right*) shows increased levels over Lake Michigan.
- The model shows that the presence of pollution hotspots requires better monitoring, but the current EPA monitors are not meant to identify pollution hotspots.

- This model can also incorporate potential air quality policies to address emission sources and mitigation solutions, which is an area of active investigation within the CCRG.

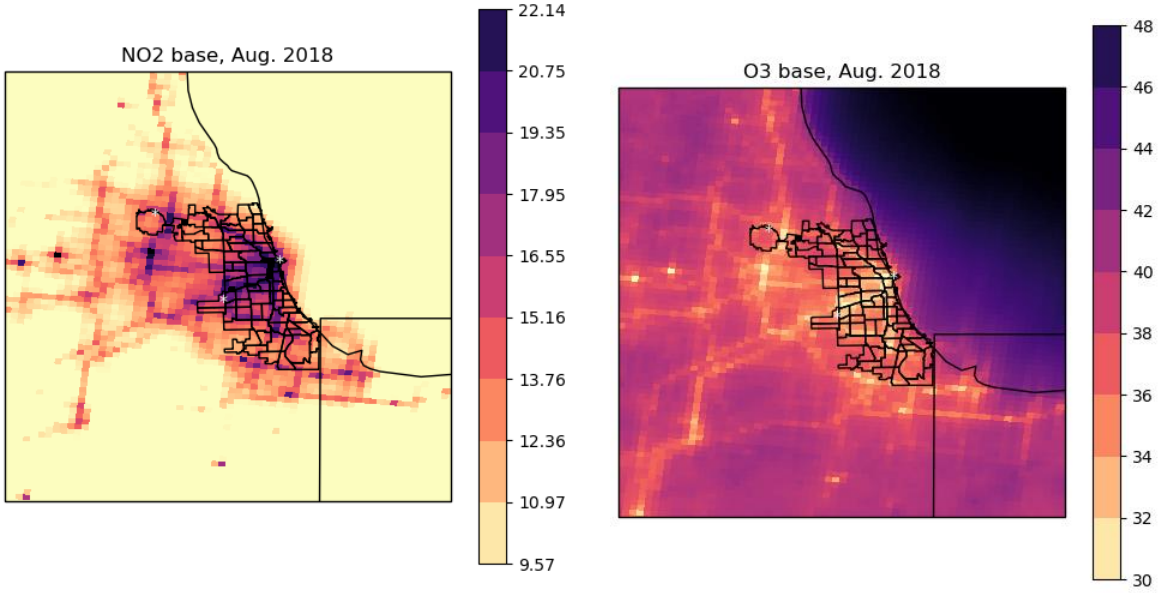

Figure 1. Chicago-area air quality averaged over August 2018. Each panel is a simulated average of (a) NO_2 and (b) O_3. The units are in parts per billion, and the scales are different for NO_2 and O_3. ***Note**: These are preliminary results with known biases, not yet published. These figures are used for demonstrative purposes and are being validated through ongoing research.*

References and additional resources

[1] Environmental Protection Agency, Illinois Nonattainment/Maintenance Status for Each County by Year for All Criteria Pollutants, https://www3.epa.gov/airquality/greenbook/anayo_il.html

[2] Arunachalam et al., 2011, Effect of chemistry-transport model scale and resolution on population exposure to PM2.5 from aircraft emissions during landing and takeoff, *Atmospheric Environment*, **45**(19).

[3] Federal Aviation Administration, Re-Evaluation of the O'Hare Modernization Environmental Impact Statement, https://www.faa.gov/airports/airport_development/omp/eis_re_eval/

[4] Environmental Protection Agency, Illinois Ambient Air Monitoring 2017 Network Plan, https://www.epa.gov/sites/production/files/2017-12/documents/ilplan2016.pdf

The Science Policy Outreach Task Force (SPOT) compiled this document. SPOT is a nonpartisan organization of Northwestern University researchers focused on advocating for science, evidence-based reasoning, and scientifically-sound policy to the voting-aged public and policymakers. This document does not represent an official statement by Northwestern University. It does not contain an exhaustive summary of all scientific issues, but rather is intended to provide background information relevant to the topic.

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