



LADCO | LAKE MICHIGAN
AIR DIRECTORS CONSORTIUM

LADCO Needs for Satellite Work related to Ozone Formation

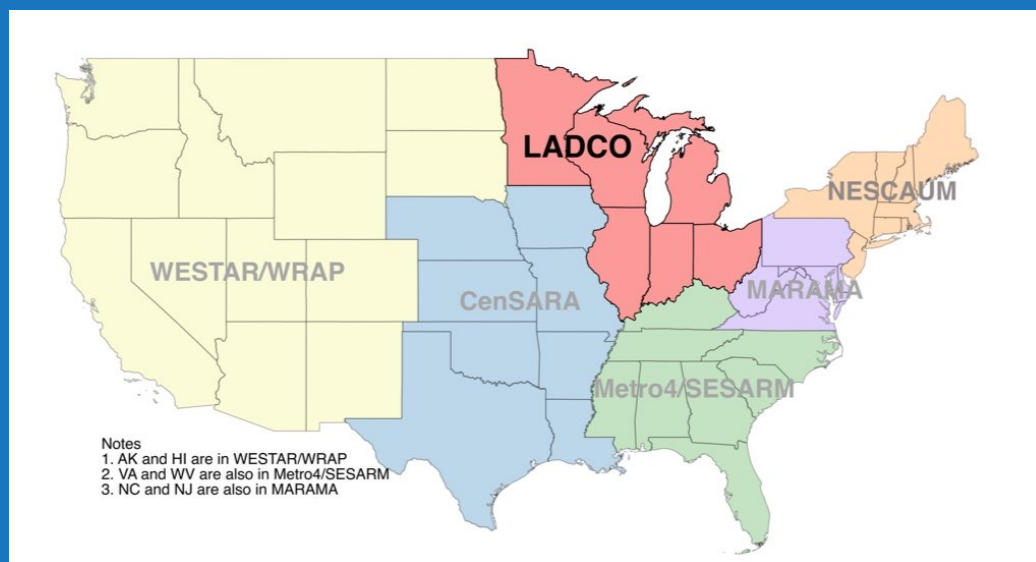
Angela F. Dickens & Zac Adelman

HAQAST St. Louis

November 6, 2025

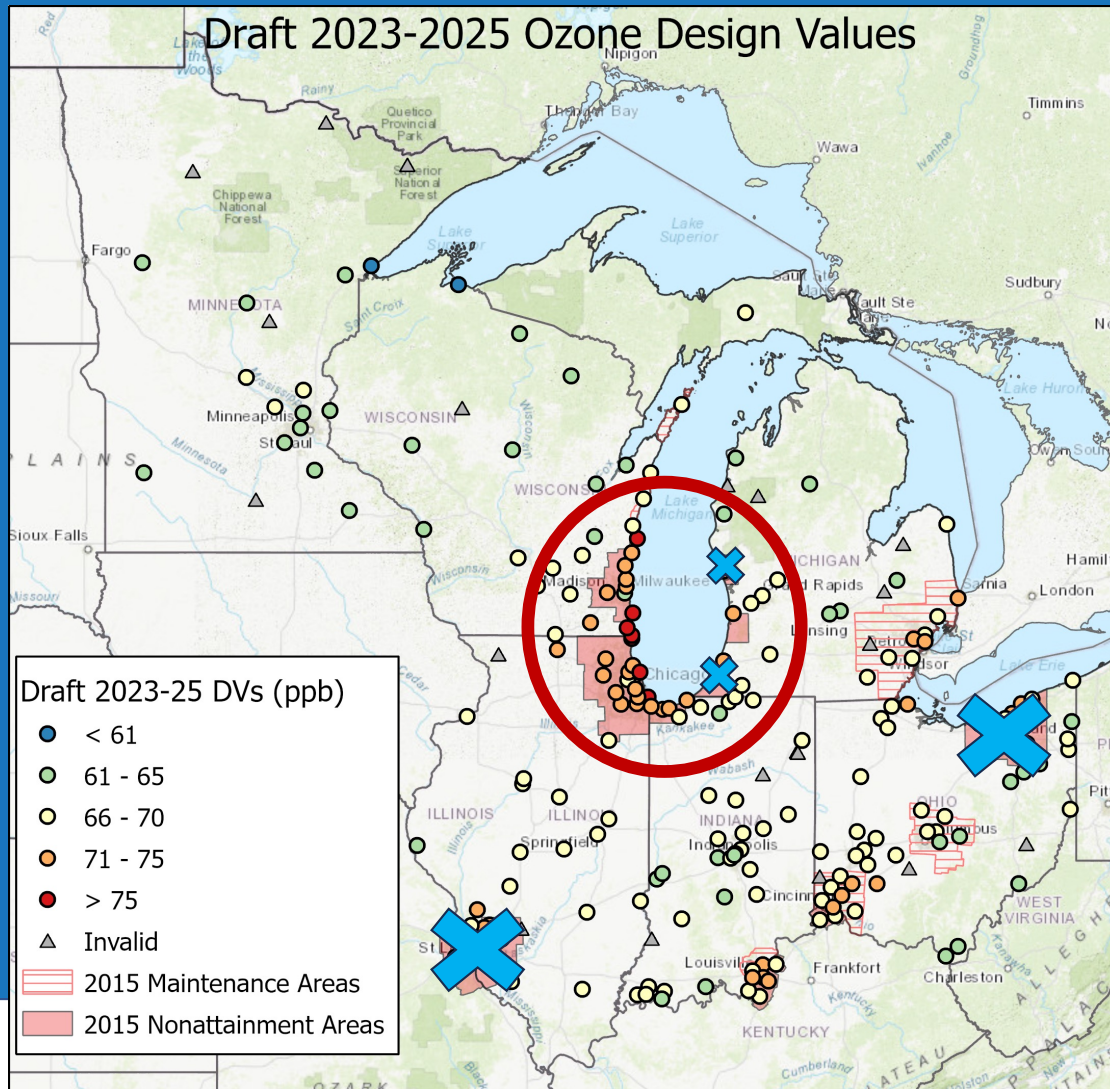
What is LADCO?

Lake Michigan Air Directors Consortium



- Formed in 1989 to bring the Great Lakes states together to address ozone pollution
- Governed by state air agency directors
- Scope
 - Forum for state agency planners
 - Air pollution modeling and data science
 - Including some work with satellite data
 - Training

Draft 2023-2025 Ozone Design Values

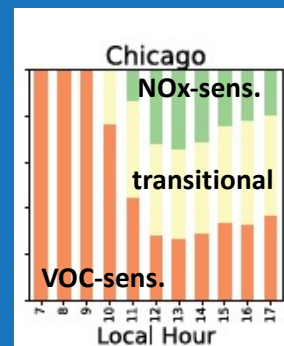


Nonattainment Status

- All nonattainment areas away from Lake Michigan have either been redesignated or have active redesignation requests
- Anticipate our only regulatory obligations will soon be around Lake Michigan
 - The Chicago area is the main emissions source to the region

Importance of VOCs for Chicago Ozone

- Lots of evidence of extensive areas of NOx-suppression (VOC sensitivity) in Chicago
 - Downwind areas around the lake are mostly NOx-sensitive
- Emissions control programs in recent decades have focused on reducing NOx emissions
 - NOx emissions decreased 79%
 - VOC emissions decreased 61%
 - VOC emissions have been pretty flat for the last decade
- Likely to be easier to further reduce VOC emissions than NOx emissions



Jin et al. (2025) *GRL*

Importance of VOCs for Chicago Ozone

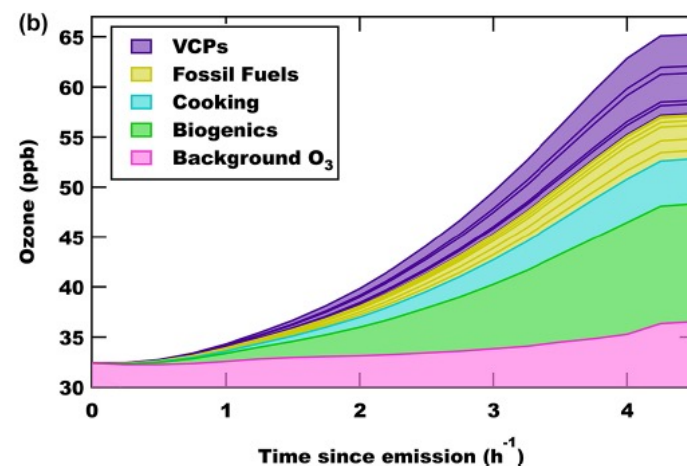
- Increasing evidence of the importance of overlooked sources of VOCs
 - Volatile chemical products (VCPs), cooking emissions, etc.
 - Stockwell et al. (2025) estimated VCPs & cooking each contributed 3.4-5.2 ppb O₃ in LA →
 - Rogers and Bertram (2025) found that terpenes from VCPs were disproportionately responsible for VOC reactivity in Chicago

- Understanding VOC reactivity & emissions is important to effectively reducing O₃ in the Chicago area!

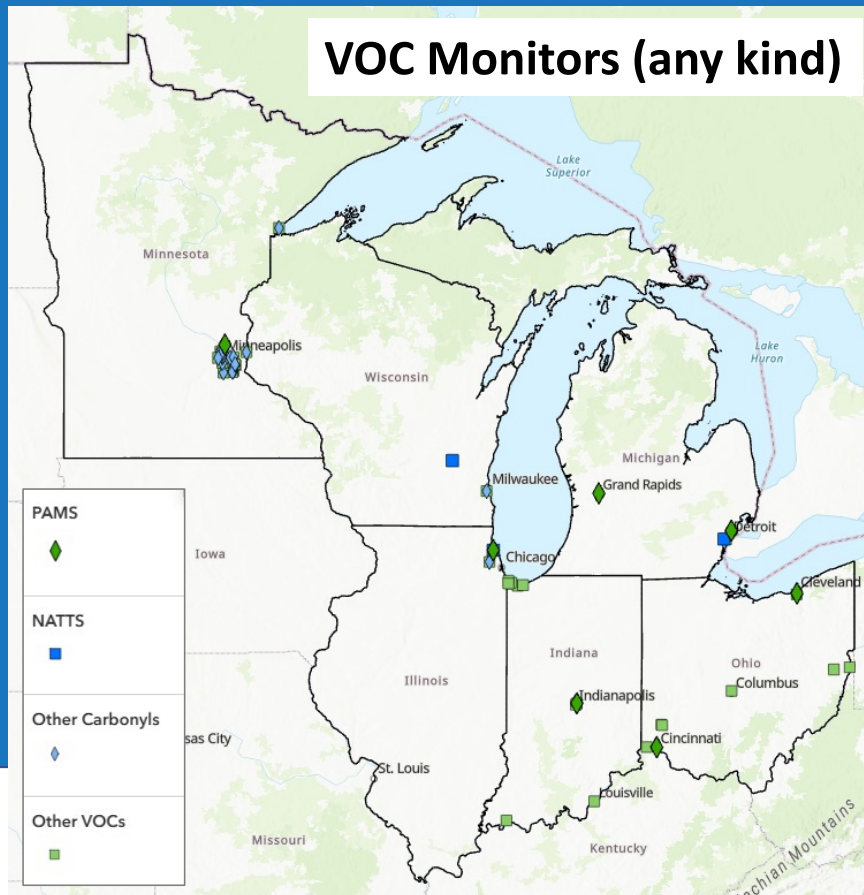
LADCO's current focus

VOCs are also important SOA precursors and air toxics

C. E. Stockwell et al.: Urban ozone formation and sensitivities



How can satellites help?

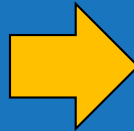


- VOCs are extremely difficult and expensive to monitor
 - Our ground monitoring network is very sparse → We really don't have good constraints on VOC distribution or chemistry
 - I'm currently working with the available ground data, starting with PAMS data
- Satellites are good at filling in gaps in monitoring!
 - But...

How can satellites help? -- TEMPO

- But... HCHO is the only VOC that is readily measured by most air quality satellites

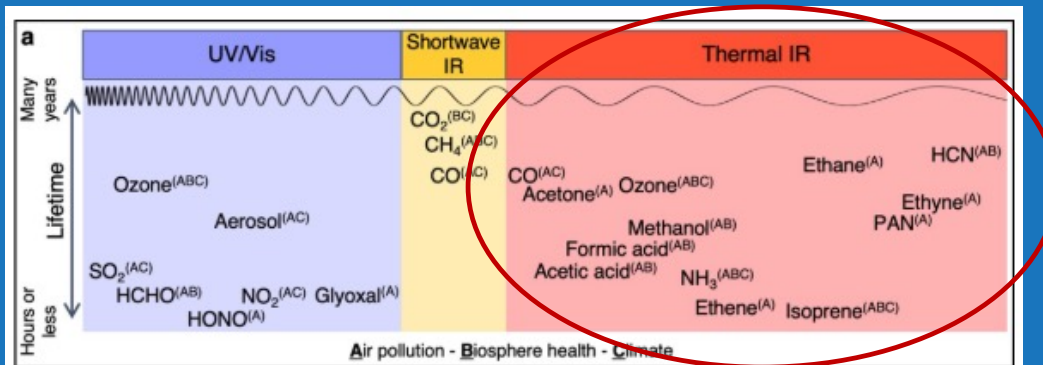
- Very non-specific, derived from many sources (primary and secondary)
- Of limited use for emissions estimates



- Could the temporal resolution of TEMPO help differentiate different sources of HCHO?

- Different sources would presumably have different temporal and spatial patterns
- Could this make the HCHO product more useful for inferring emissions sources and patterns?

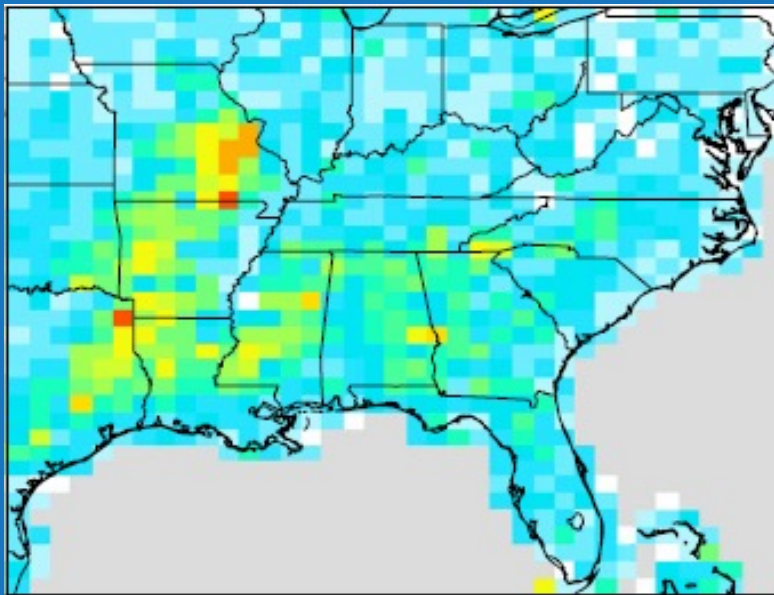
How can satellites help? -- CrIS



Millet et al. (2024) *AGU Advances*.

- New methods to measure VOCs from satellites using thermal IR are exciting!
- Potential to view distributions of many more VOCs

How can satellites help? -- CrIS



0.00e+00 7.50e+15 1.50e+16

Isoprene [molec/cm²]

Wells et al. (2022) *JGR Atmos.*

- Cross-track Infrared Sounder (CrIS)
 - Published work has been at low spatial resolution
 - Work has relied upon machine learning
 - Complicated and difficult/impossible for non-specialists to work with
 - Work is primarily being done by the Millet group
- Expansion of this work and facilitation of its use by stakeholders would be very helpful!

TEMPO insights into NOx Emissions

- High temporal and spatial resolution from TEMPO NO₂ can also help constrain uncertain NOx emissions sources
 - Freight
 - Data centers
 - Energy use at/for data centers



Thank you!

Questions?

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