MICHIGAN DEPARTMENT OF
ENVIRONMENT, GREAT LAKES, AND ENERGY

Ozone Attainment in Southeast Michigan

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EGLE

4^{th} highest monitored O_3 concentrations in Southeast Michigan during 2018

Change in attainment status ('bump up") possible in 2021 based on DVs computed from monitored concentrations in 2018, 2019, and 2020.

Controlling Monitor in SE Michigan

Oak Park Monitor (ppb)				
Maximum Daily 8-hr average	2018	2019	2020	Average
Highest	86	77	78	-
2nd highest	82	72	77	-
3rd highest	78	67	76	-
4th highest	77	66	74	72
Deviation from 70 ppb standard	-	-	-	+2

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What Will Happen if Southeast Michigan is "Bumped Up"?

- If attainment not achieved by 2021, SE Michigan will be "bumped up" **from Marginal to Moderate Non-attainment**, which will require:
  - Vehicle Inspection and Maintenance (I/M)
  - Increased offsets (1.15:1 ratio instead of 1.1:1)
  - Reasonable Available Control Technology (RACT) for VOCs and NOx
  - 15% VOC Reasonable Further Progress (RFP) reductions.
- An attainment demonstration must also be delivered by early 2023, to show ozone attainment by 2024.

Control Strategy Stakeholder Groups

- Primary emission sources of formaldehyde / RACT for VOCs and NOx
- Natural gas leaks
- Intermodal transportation emissions associated with the Port of Detroit or other major source regions

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Formaldehyde (HCHO)

- HCHO is a **Volatile Organic Compound (VOC)** that is a powerful ozone precursor due to its ability to generate new, unrecycled radicals that fuel $NO \rightarrow NO_2 \rightarrow O_3$.

- **Primary HCHO** is emitted by human activities, mostly incomplete combustion.

- **Secondary HCHO** is the by-product of the chemical degradation of other VOCs already in the atmosphere, including those of biogenic (natural) origin.

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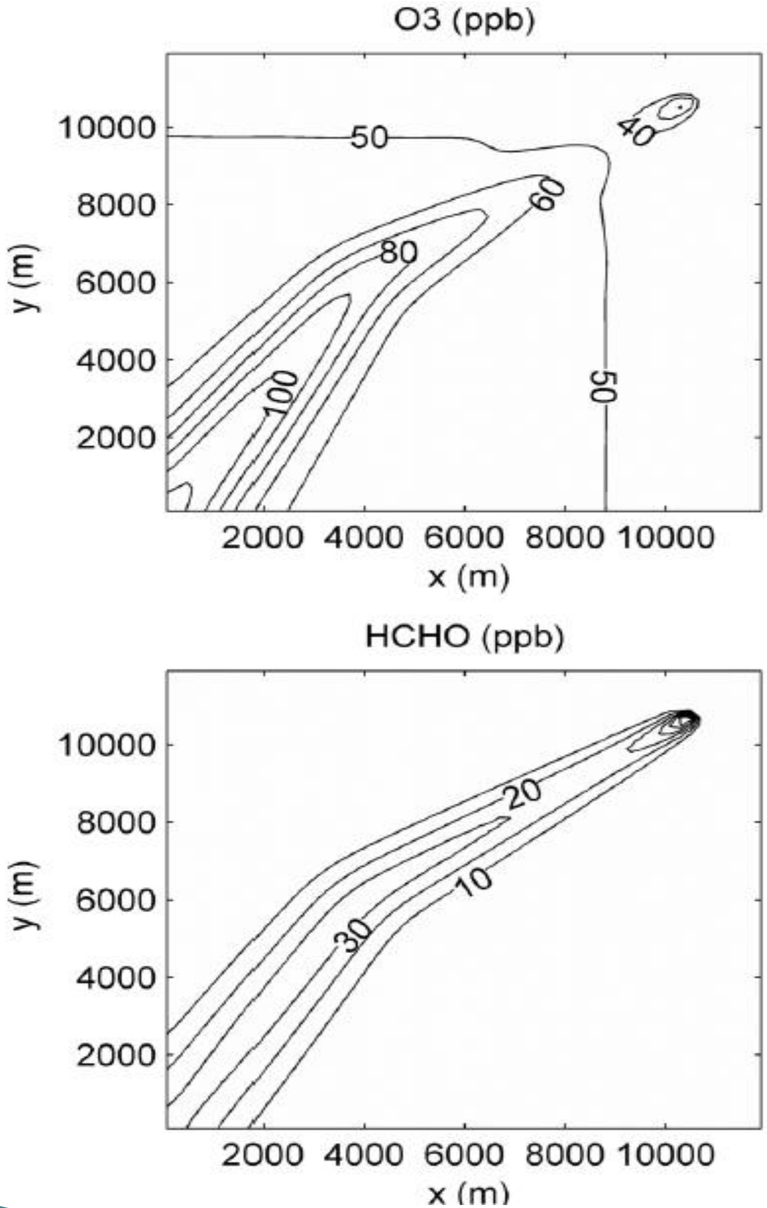
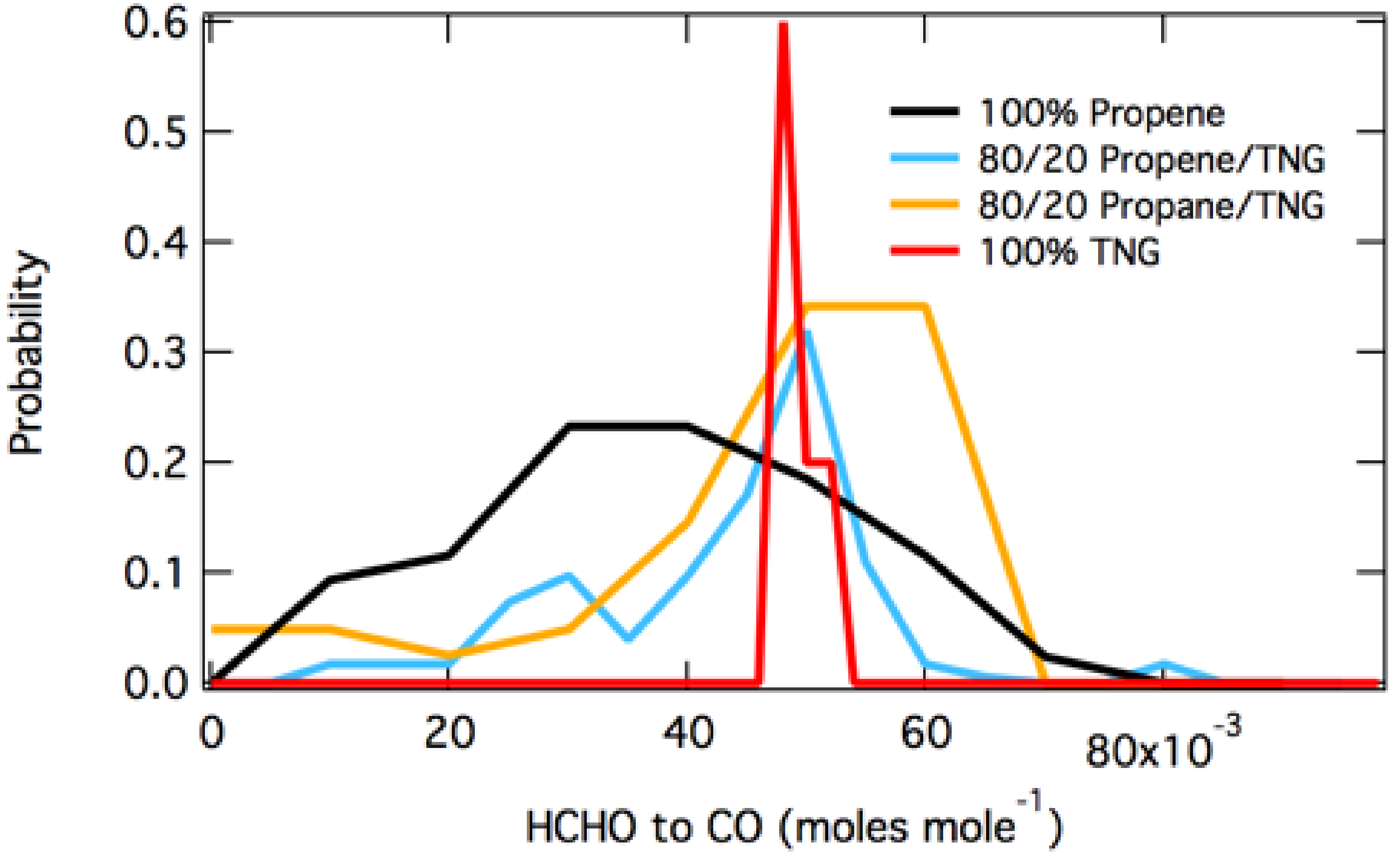


Concentration isopleths of ozone (upper figure) and formaldehyde (lower figure) generated by a large olefin flare after 3 hours (9 am – 12 pm, LST) of constant flare emissions, as simulated by Olaguer (2012) at **200 m resolution**.

2010 TCEQ Flare Study



Courtesy of Scott Herndon of Aerodyne Research, Inc.

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OXIDATION CATALYSIS OF NG ENGINES

Engine	CO Emissions (lb/hr)	Average CO Emissions (lb/hr)	HCHO Emissions (lb/hr)	Average HCHO emissions (lb/hr)	Heat input (MMbtu/hr)
Engine 1 (oxidation catalyst)	.13	.15	.024	.030	17.5
Engine 2 (oxidation catalyst)	.17		.026		16.1
Engine 3 (oxidation catalyst)	.07		.019		16.7
Engine 4 (oxidation catalyst)	.24		.049		17.1
Engine 5 (no catalyst)	7.31	7.08	.71	.72	18.1
Engine 6 (no catalyst)	6.94		.74		17.1
Engine 7 (no catalyst)	7.03		.75		16.8
Engine 8 (no catalyst)	7.03		.69		16.9

Data from 8 4-Stroke Lean Burn NG Engines at a New Jersey natural gas processing facility; 4 of the engines have been equipped with oxidation catalysis. The results demonstrate a 98% reduction in CO emissions, and a 96% reduction in HCHO emissions.

After Ratzman (2018)

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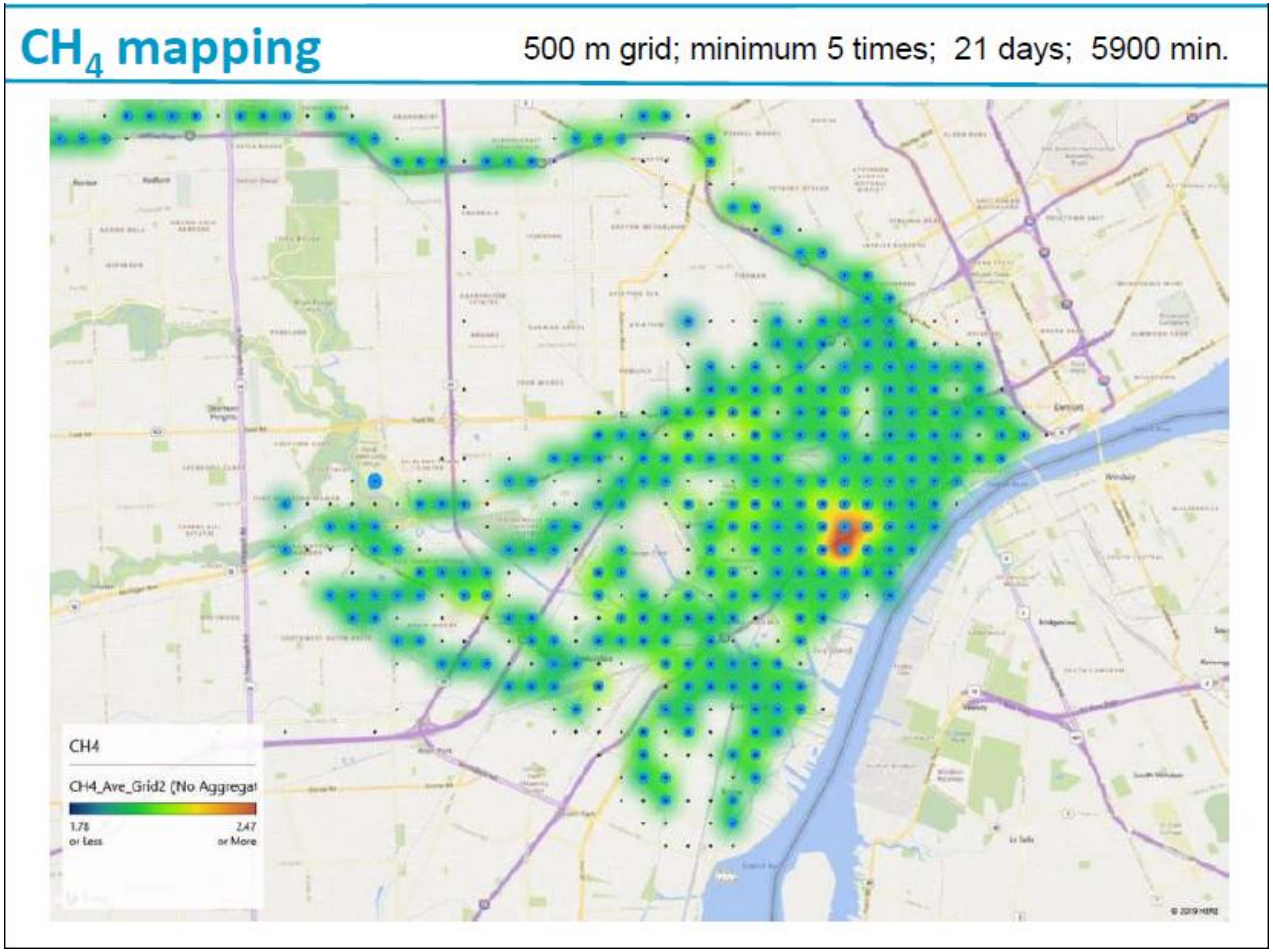
Methane Fugitives

- Emissions from natural gas distribution and end use may be 2-3 times larger than predicted by existing inventory methodologies and industry reports (McKain et al., *PNAS, 112: 1941-1946, 2015*).
- Phillips et al. (*Environmental Pollution, 173:1-4, 2013*) identified 3356 methane leaks in Boston with concentrations exceeding up to 15 times the global background level.
- Urban areas with corrosion-prone distribution lines leak ~25-fold more methane than cities with more modern pipeline materials (Fischer et al., *Environ, Sci. Technol., 51: 4091-4099, 2017*).
- Modeling by USEPA suggested that large pipeline leaks of methane in urban areas may lead to significant (a few ppb) increases in local ozone (Dr. Rohit Mathur, USEPA, personal communication).

Possible Methane Fugitive Emissions Detected by UM Mobile Lab



Intermodal Transportation

- Port of Detroit, international bridge HD truck traffic emissions (e.g., certification program, anti-idling)
- Marine vessel emissions (e.g., port speed limits)
- Railroad emissions (e.g., grants for engine retrofits/replacement)
- DTW airport and Selfridge airbase emissions (e.g., General Conformity)

Data and Science Needs for Ozone DV Target Reductions

- Primary HCHO (1 ppb O_3 DV reduction)
  - Rigorous measurements of emissions from flares and stationary engines
  - Cost and effectiveness of oxycat controls and flare minimization strategies
- Methane Fugitives (1 ppb O_3 DV reduction)
  - Baseline leak rates from mobile lab studies
  - Anticipated reductions from planned LDAR activities
- Transportation (1 ppb O_3 DV reduction)
  - Updated emissions estimates
  - Link-based activity data from Port of Detroit and other intermodal transportation hubs

Michigan-Ontario Ozone Source Experiment (MOOSE)

- International / intergovernmental collaboration:
  - **United States:** Michigan EGLE, USEPA, NASA, NOAA, USFS, LADCO
  - **Canada:** Environment and Climate Change Canada (ECCC), Ontario Ministry of Environment, Conservation, and Parks (MECP)
- Summer 2021 field study will deploy:
  - Advanced remote sensing and mobile real-time monitoring techniques
  - Very high spatial and temporal resolution regional and micro-scale chemical transport models

MOOSE Sub-Experiments

- ***Great Lakes Meteorology & Ozone Recirculation (GLAMOR)***
  - Physics of ozone and precursor transport
- ***Chemical Source Signatures (CHESS)***
  - Fingerprints of industrial facilities and source regions
- ***Methane Releases from Landfills and Gas Lines (MERLIN)***
  - Quantification of fugitive emissions of Natural Gas and their impact on ozone chemistry

Tentative Timetable

- **2020**
  - Develop modeling platform and baseline emissions inventory
  - Plan for MOOSE field study in partnership with other institutions
  - Determine an initial set of control strategies in consultation with stakeholders
  - Develop initial rules for RACT and I/M (consult with MDOT)
- **2021**
  - Conduct performance evaluation of modeling platform
  - Conduct MOOSE field study and initial analyses of MOOSE data
  - Submit an exceptional event demonstration and/or 179B petition
  - Finalize list of non-RACT control strategies for analysis
- **2022**
  - Perform modeling analyses of control strategies
  - Conduct formal rulemaking
  - Initial draft of moderate non-attainment SIP
- **2023**
  - Submit moderate non-attainment SIP