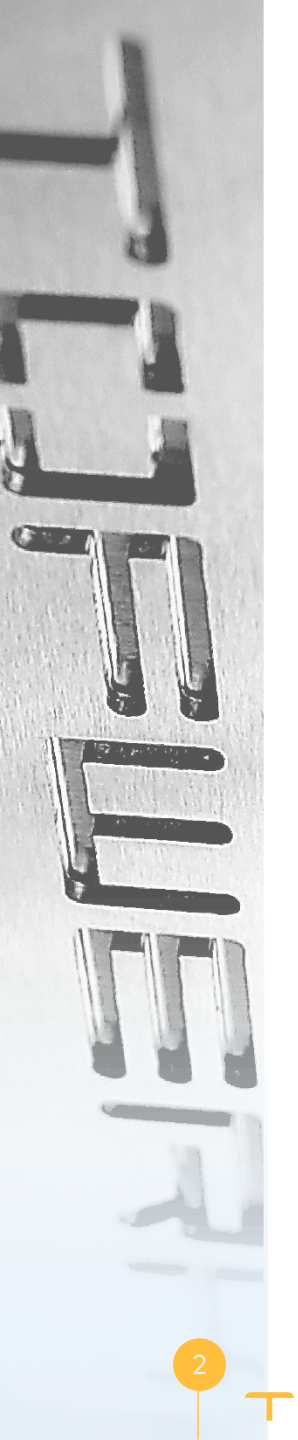
MOBILE VOC MONITORING ON VEHICLE AND AIRCRAFT PLATFORMS

Maya Abou-Ghanem, Abigail Koss, Omar El Hajj, and Veronika Pospisilova
August 5th, 2024, Environmental Measurement Symposium, Anaheim CA



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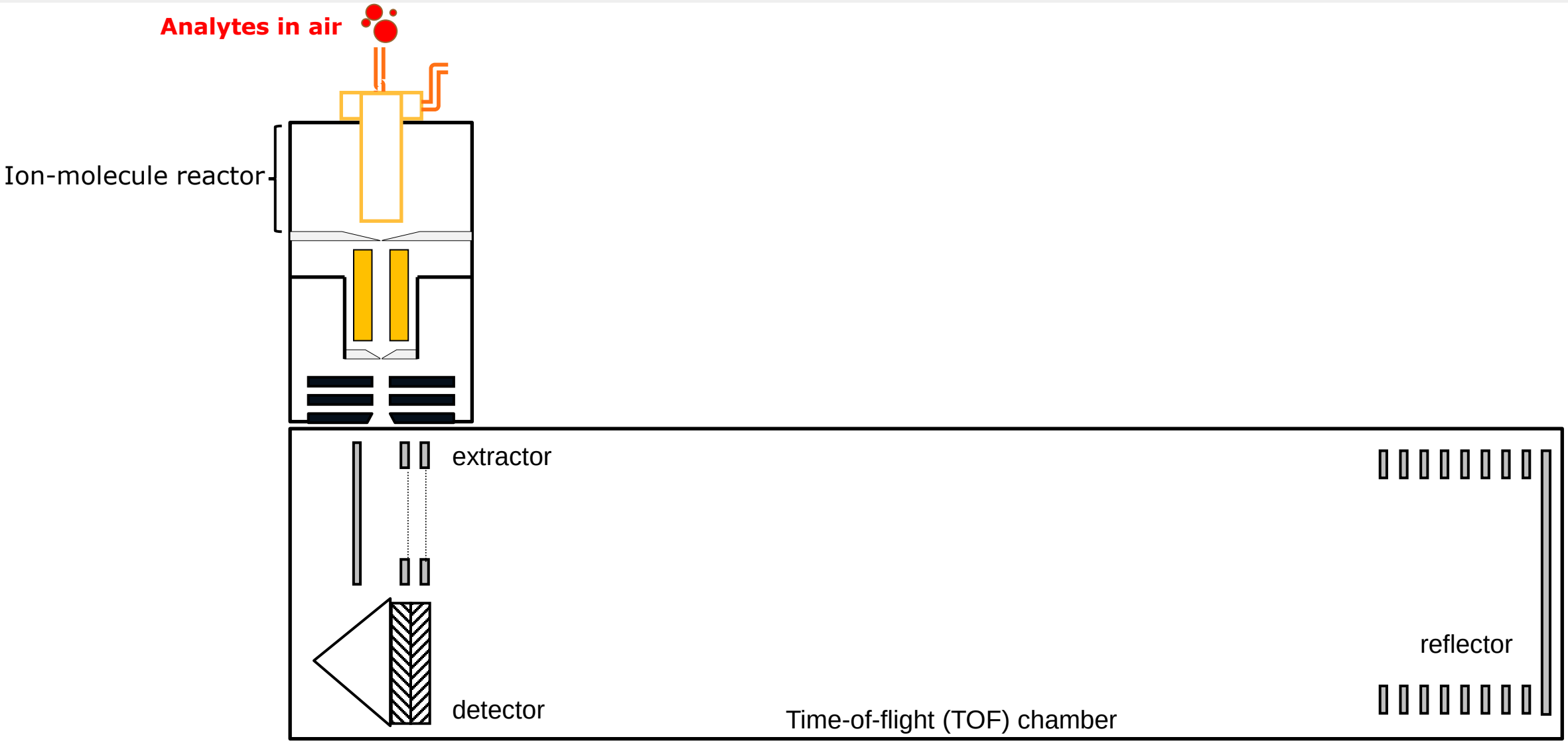
Our tool: Chemical Ionization TOF Mass Spectrometry



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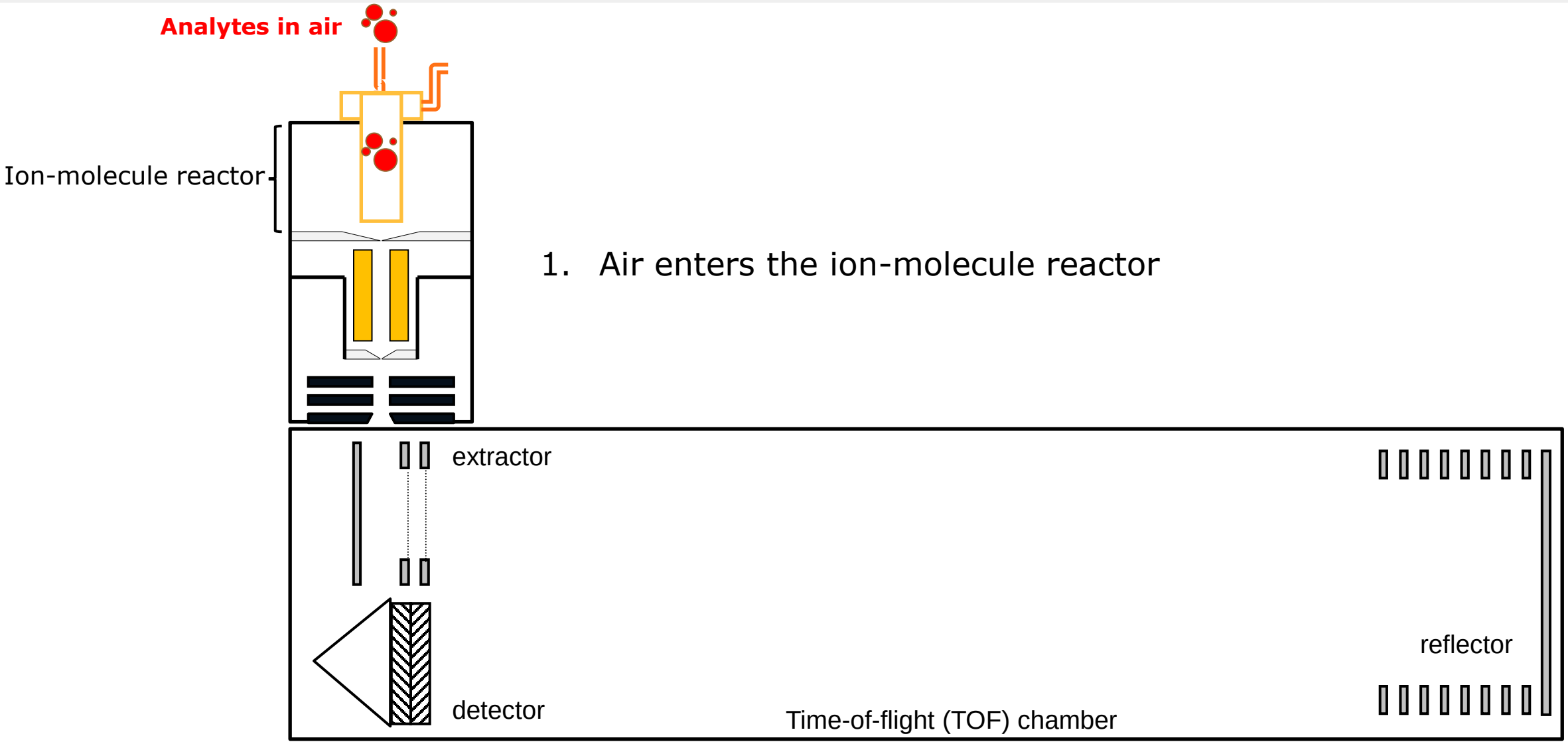

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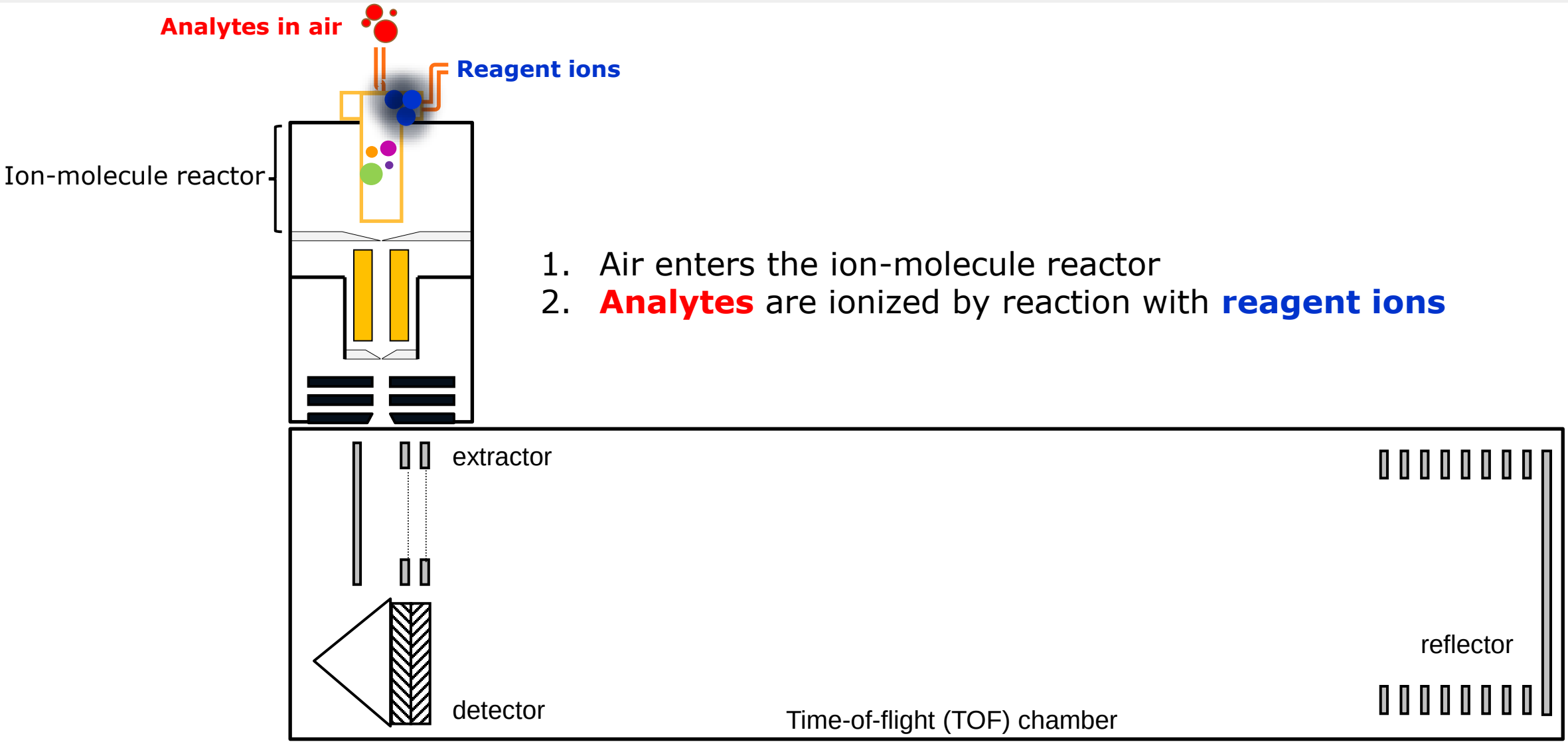

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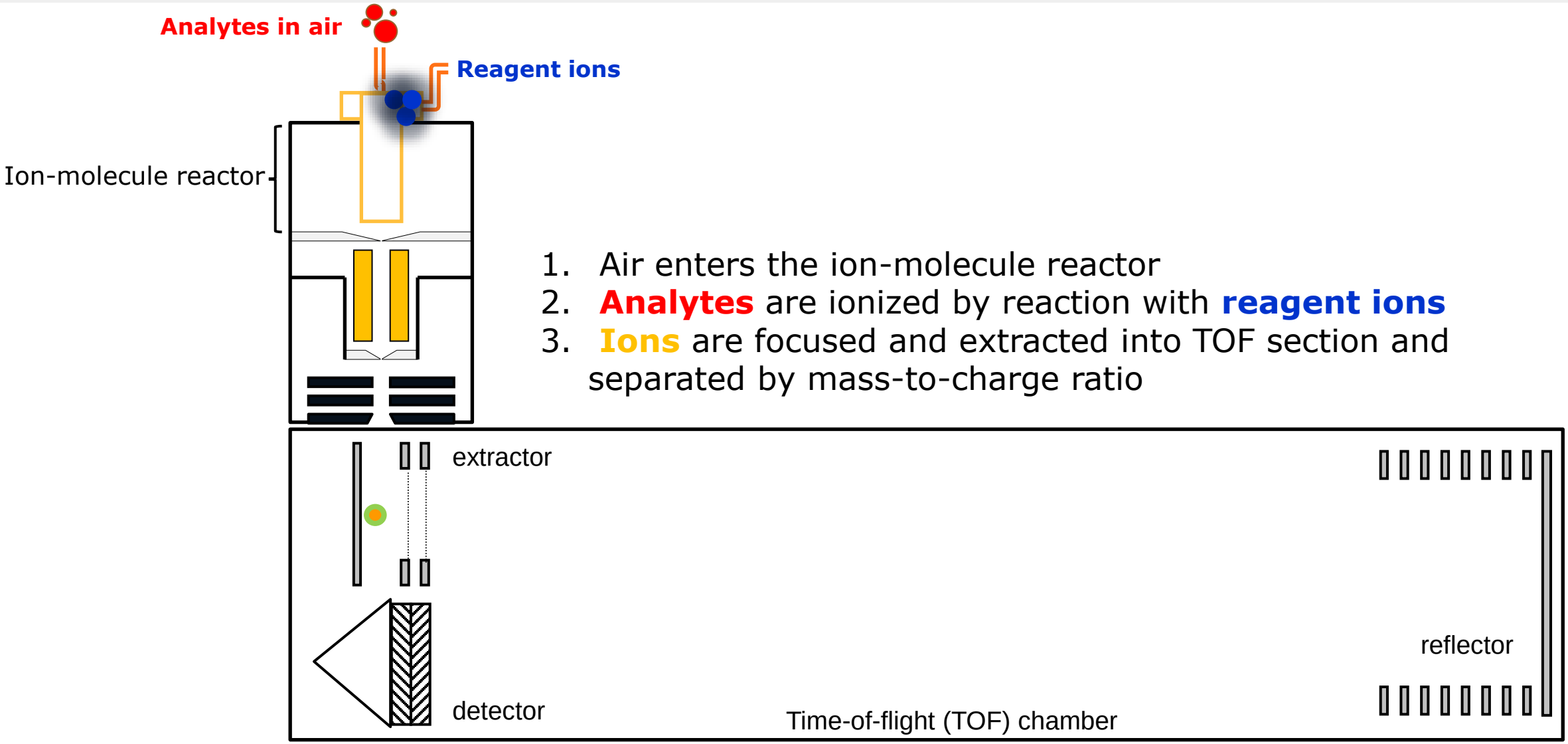

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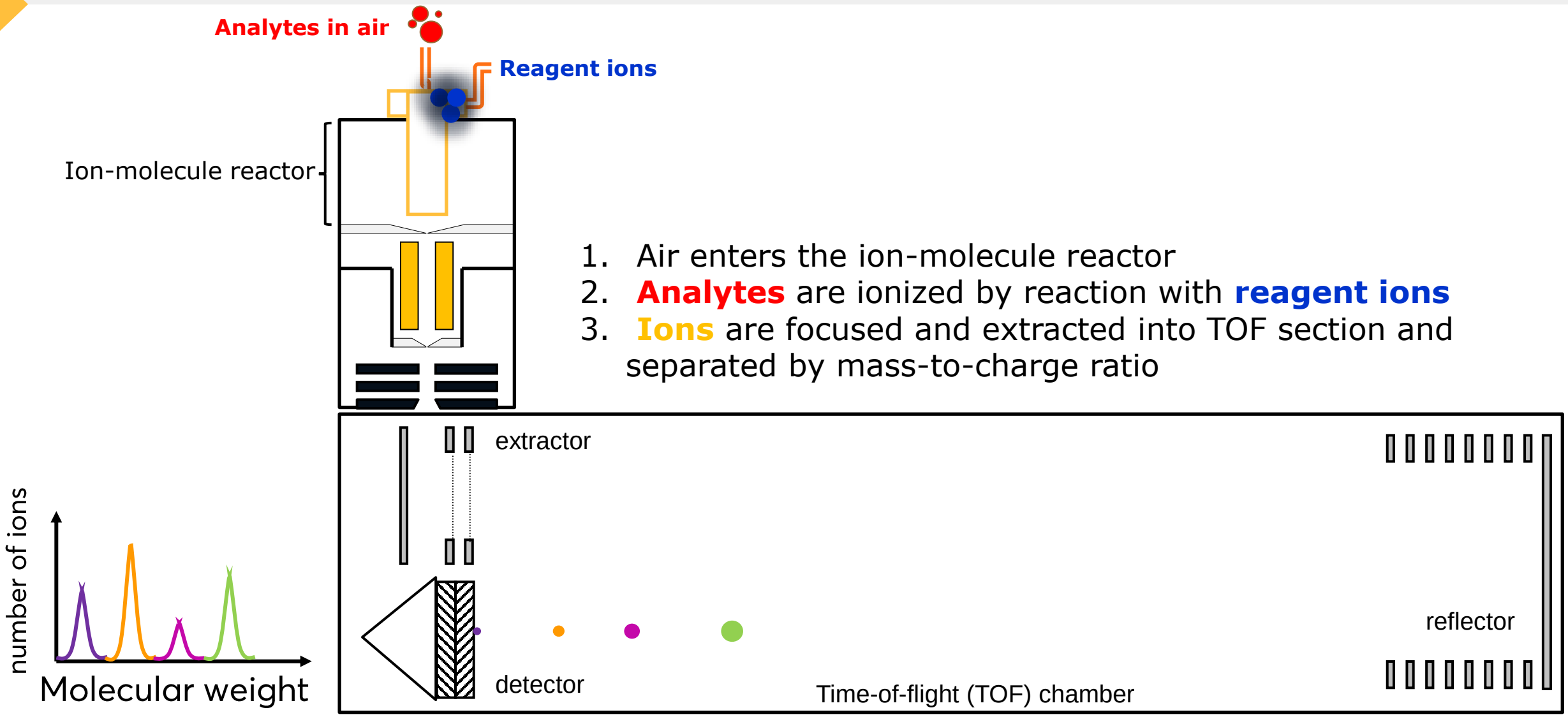

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Different CI Configurations Target Specific Chemical Families

PTR NO+ O2+ Iodide Nitrate NH4+ Acetone+ many more…

H3O+ "PTR"
General-purpose
BTX, oxygenates, alkenes…

Iodide PFAS
Inorganic acids
Organic acids

O2+ Alkanes
BTX
CFC

Benzene+ Solvents
Terpenes

NO+ Alkanes
CFC
Alcohols

Acetone+ Ammonia
Amines

NH4+
NO3-
Br-
Acetate

TOFWERK

Suncor Refinery, Commerce City (Denver), Colorado

Image source: Suncor

Suncor Refinery, Commerce City (Denver), Colorado

NEWS: ENVIRONMENT

Colorado hits Suncor with landmark $10.5 million settlement and tougher monitors for air pollution

State says the refinery action is the largest-ever penalty against one facility, over violations from 2019 to 2021

Michael Booth *Published: 11:59 AM MST on Feb 5, 2024*

Original Reporting | Subject Specialist | The Trust Project

Suncor Energy's Commerce City plant is seen Feb. 17, 2023. (Olivia Sun, The Colorado Sun via Report for America)

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COVID-19 POLITICS MONEY ARTS

ENVIRONMENT NEWSLETTER SUPPORT CPR

Suncor Energy's Latest 'Opacity Event' Prompts State Air Quality Monitoring And Investigation

By Allison Herrera · Mar. 19, 2020, 10:59 am

SHARE:

Kevin J. Beaty/Denverite

The Suncor oil refinery, Commerce City, Colo.

The Colorado Sun ≡ Menu

CLIMATE, ENVIRONMENT, HEALTH, NEWS, POLITICS AND GOVERNMENT

Colorado's toxic emitters revise their leakage numbers below tough thresholds in law

Companies say earlier reported levels were inaccurate. But lack of independent monitoring means what polluters say, goes, and environmental advocates are furious

Michael Booth

3:20 AM MDT on Mar 25, 2021

Credibility: Original Reporting | Sources Cited

Image source: Suncor

TOFWERK

Suncor Refinery, Commerce City (Denver), Colorado

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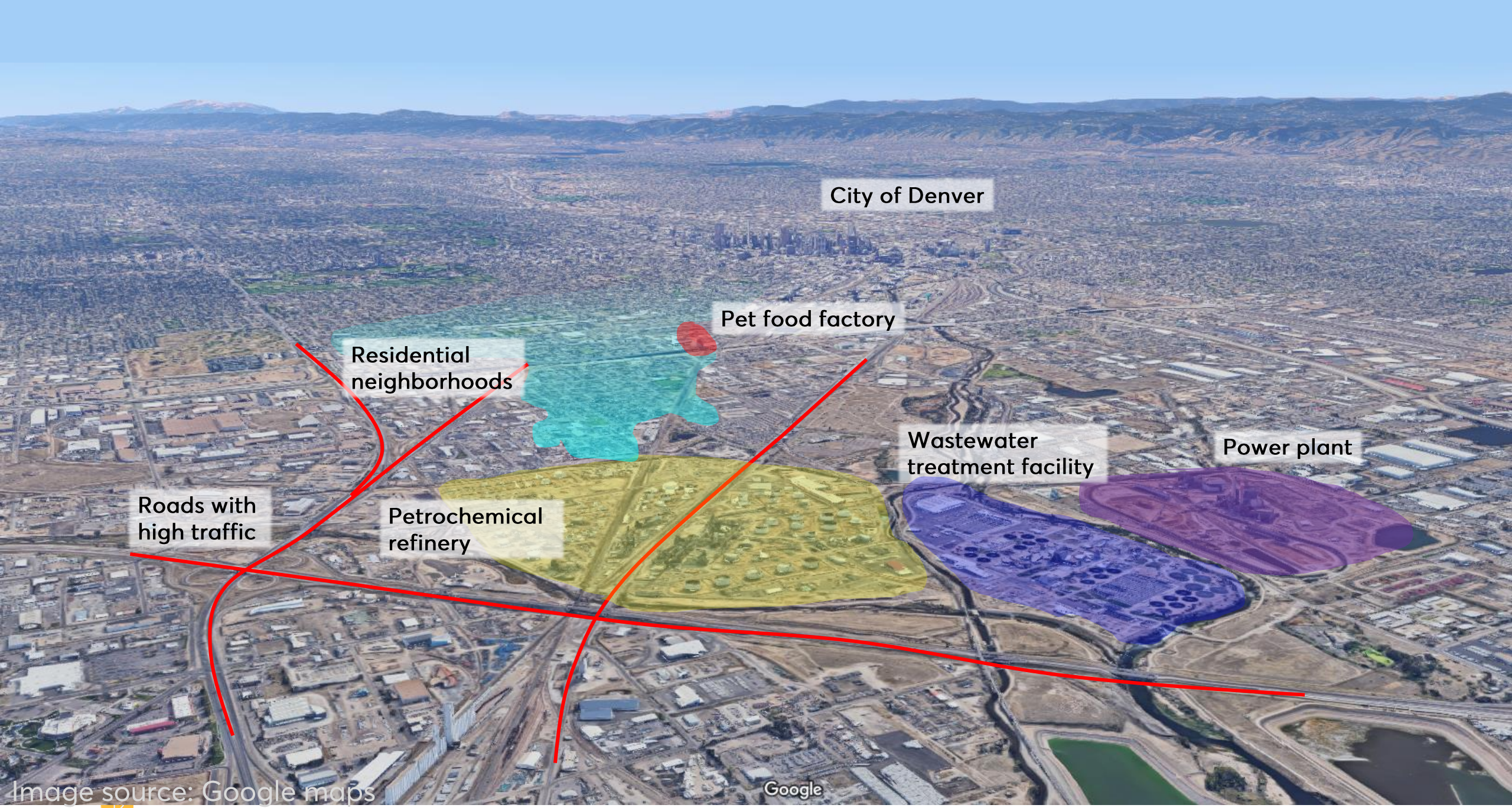

Image source: Google maps

Instrumentation

Portable Vocus "Elf" proton-transfer-reaction mass spectrometer (PTR-MS)

- Mass resolving power: 900 m/dm FWHM
- Sensitivity: 500 cps/ppb xylene (1 minute LOD = 20 ppt)

- Very small: 38 x 50 x 65 cm
- Fits in a car
  - Shock mounted
- <400 W power
  - 3 hrs independent run time with UPS + boat battery
- 55 kg

Abigail Koss (Tofwerk)
Madison Rutherford (U Colorado Boulder)

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Gill MaxiMet anemometer + bike roof mount

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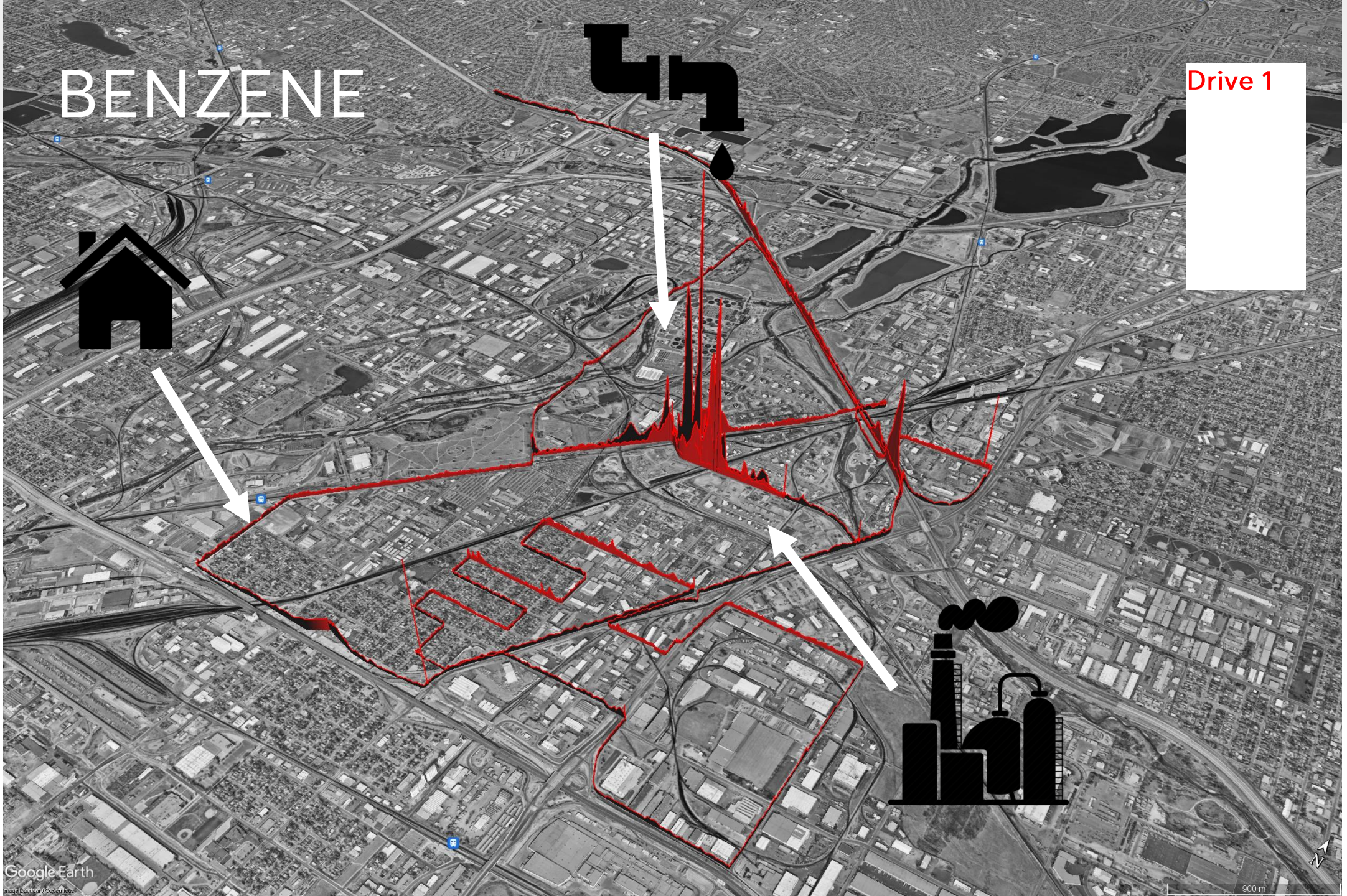
BENZENE



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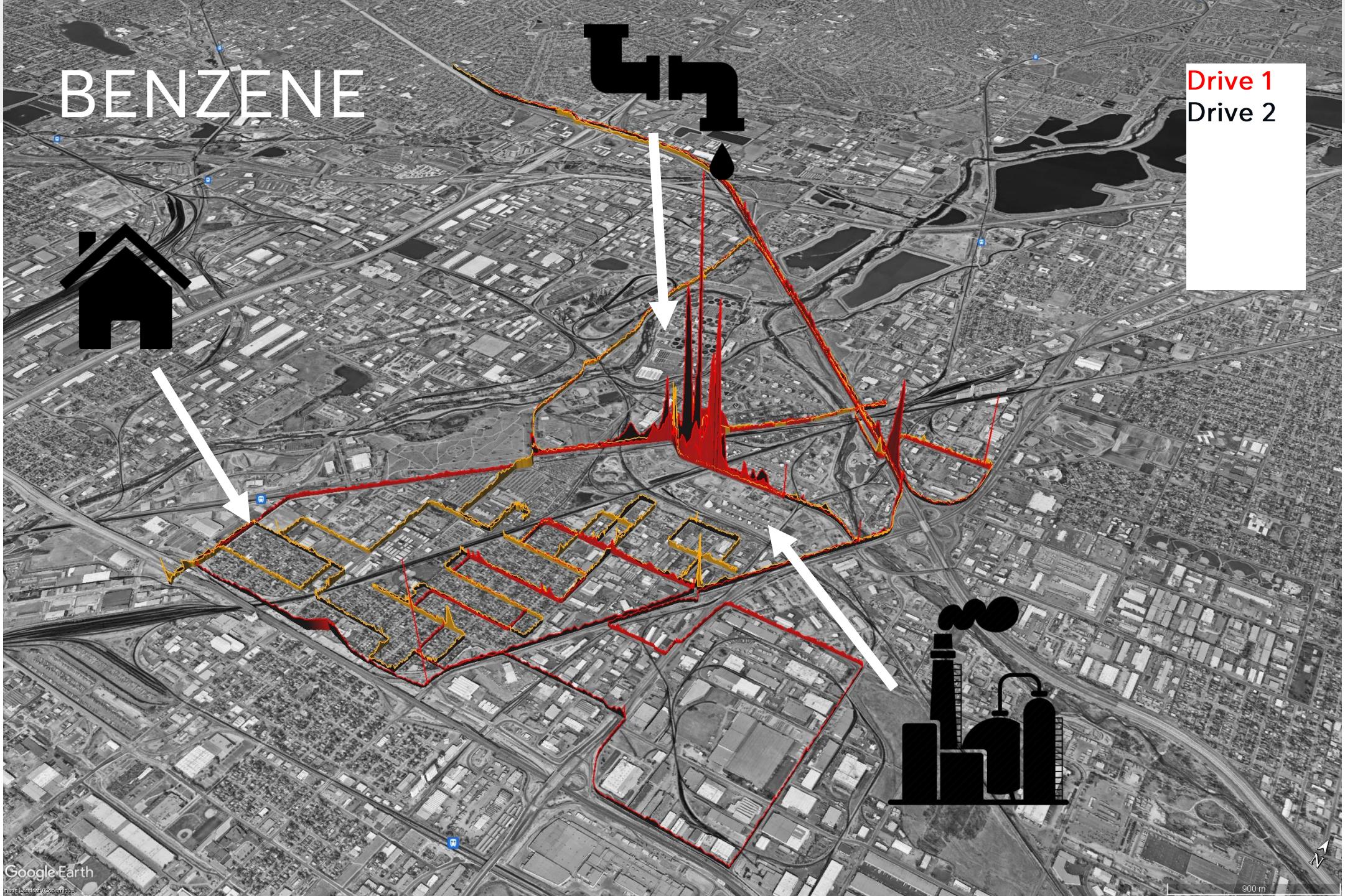

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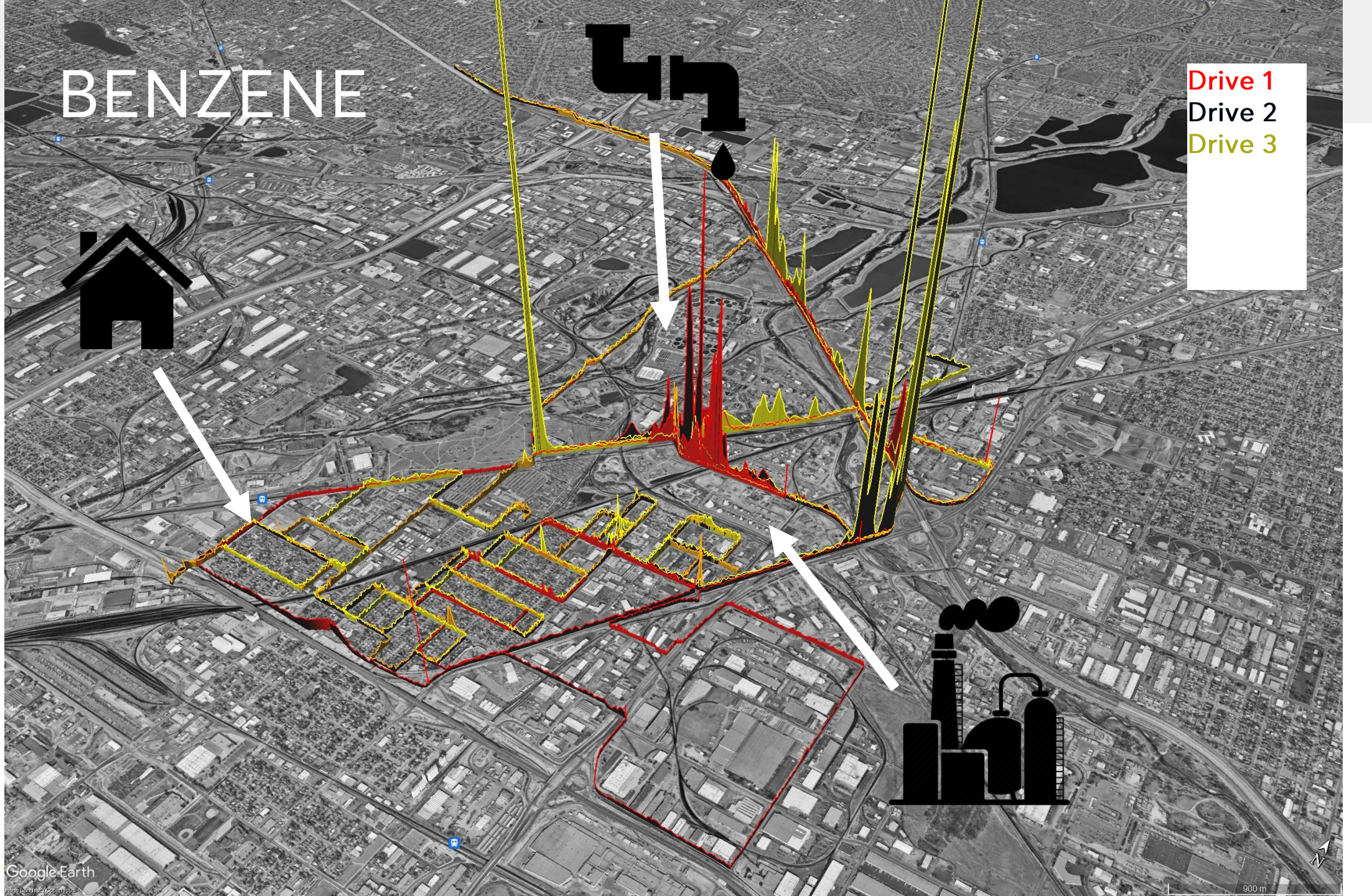

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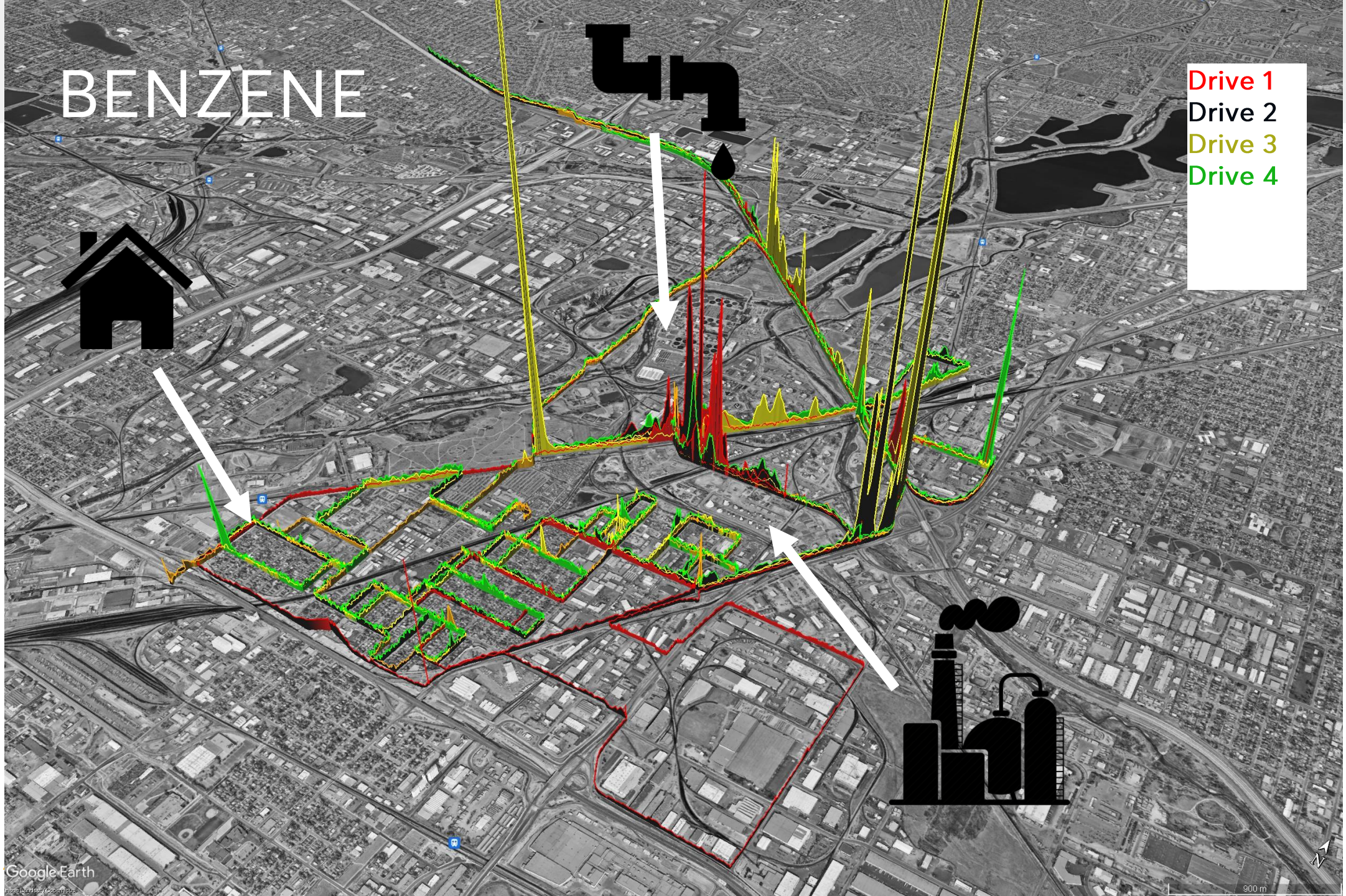

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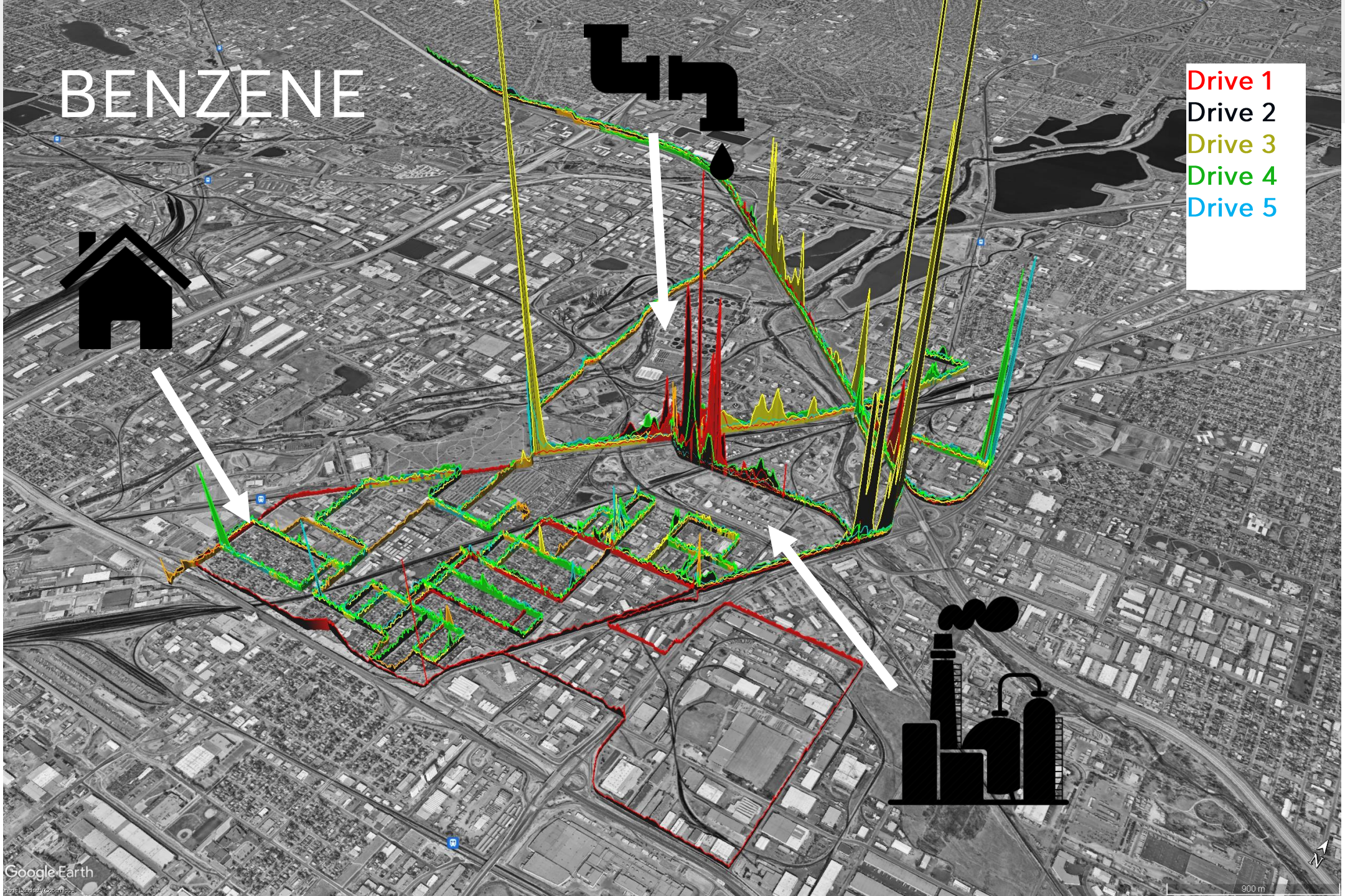

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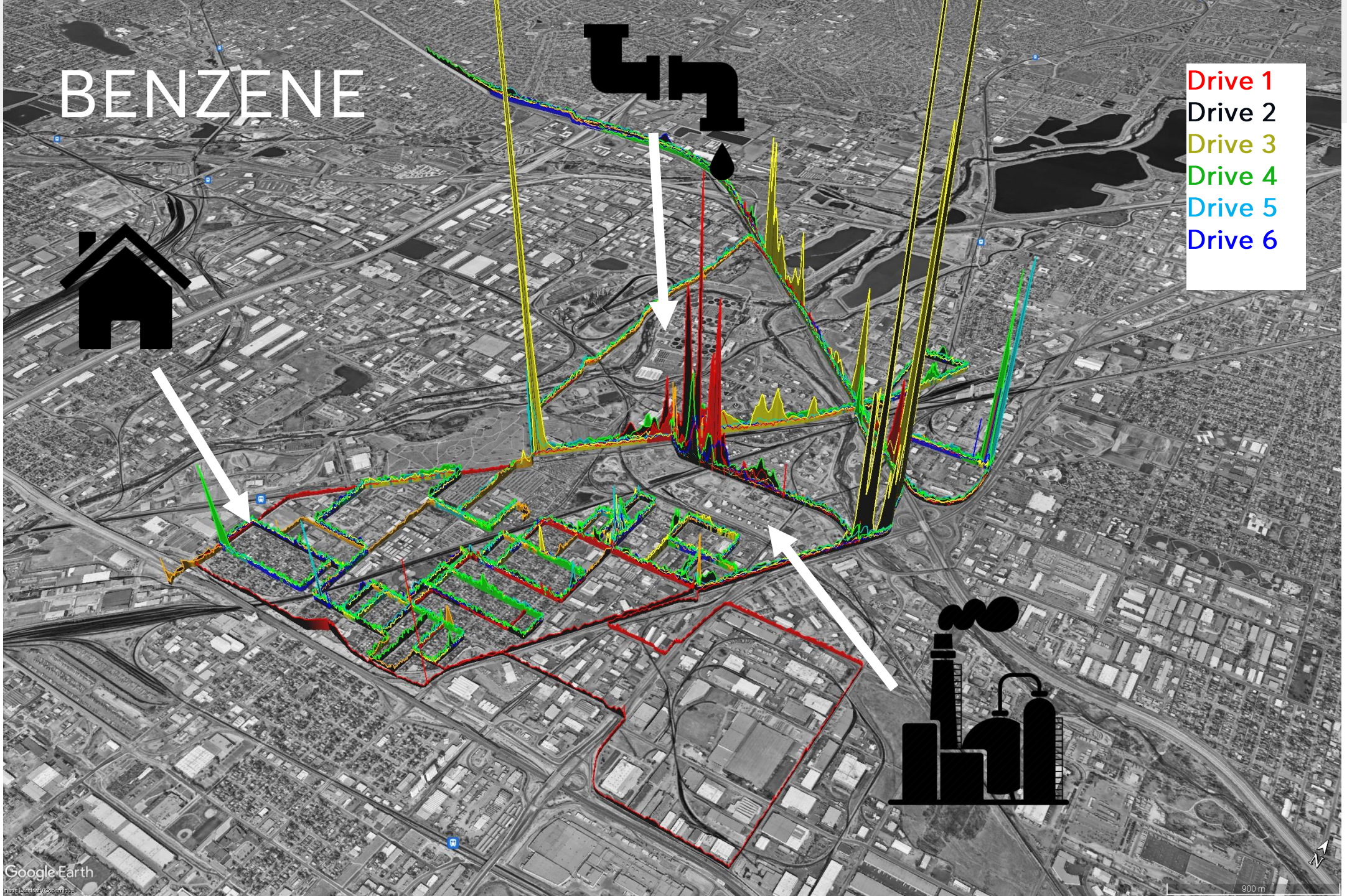
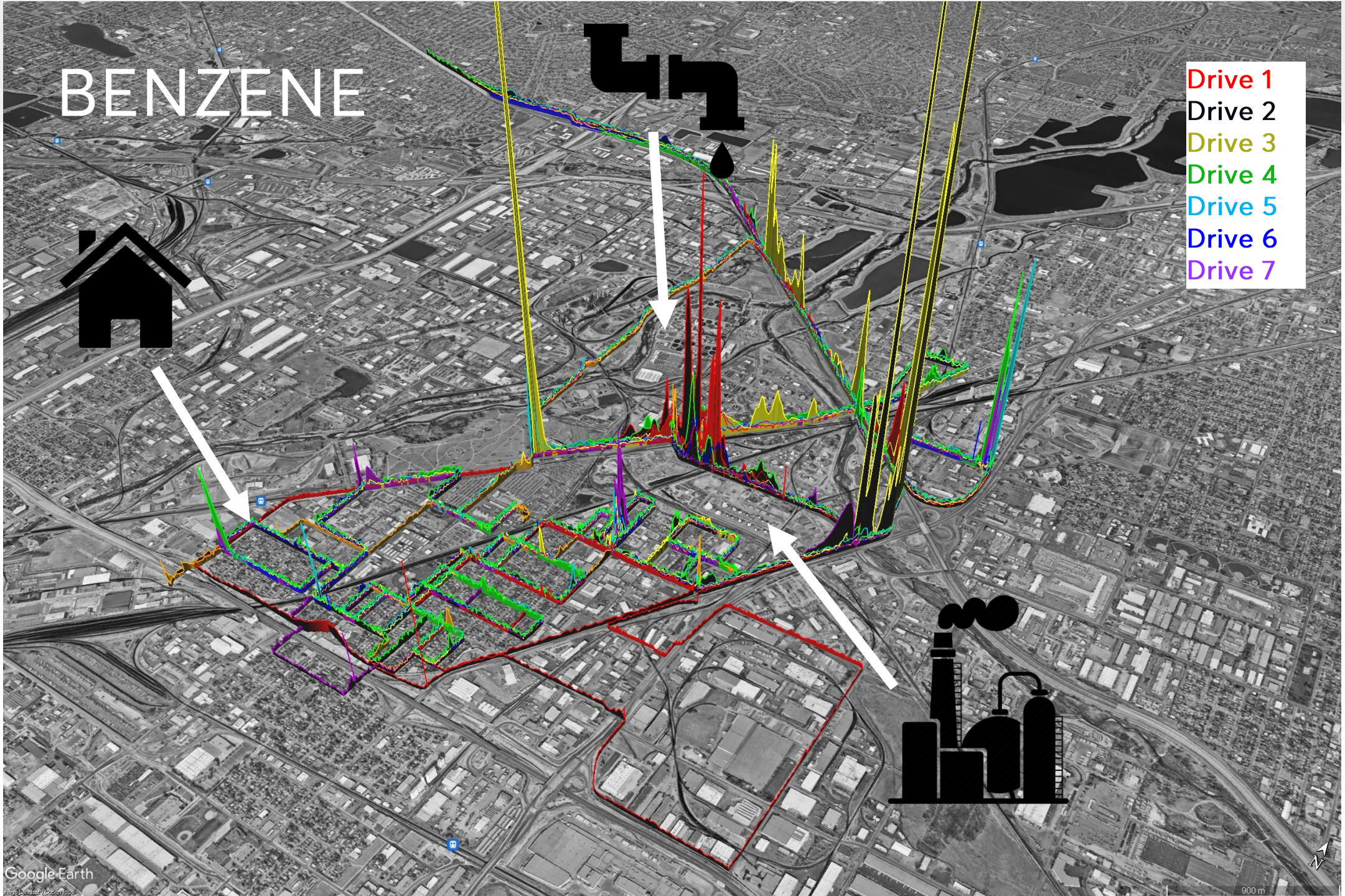

Drive 1
Drive 2
Drive 3
Drive 4
Drive 5
Drive 6
Google Earth
900 m

BENZENE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Drive 6
Drive 7
Google Earth
900 m

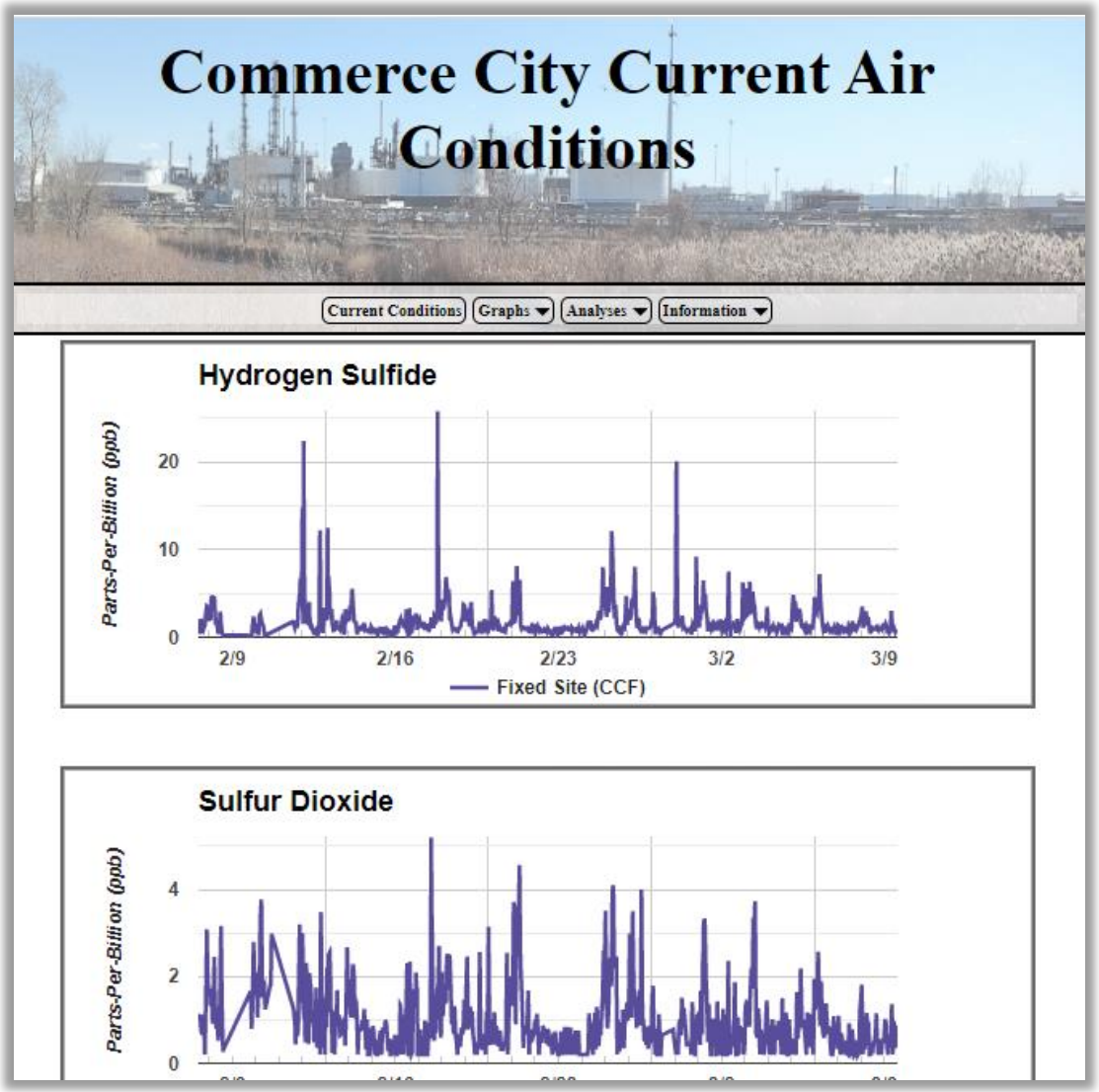
Monitoring Efforts and CDPHE Mobile Lab

Cultivando / Boulder Air

- NGO non-profit
- Two fixed-site monitoring stations with GC, optical sensors
- Citizen science initiative distributing air monitors

Colorado House bill 21-1189:

- Requires facilities to conduct real-time fenceline monitoring of covered air toxics and to publicly report results
- Provides funding for a mobile air-quality monitoring van to use for community-based monitoring (CDPHE, Colorado EPA)



TOFWERK Project Goals

TOFWERK goals (led by Abigail Koss)

Support our customer

- Test software/equipment
- Which instruments do we need to put in the CDPHE mobile lab?
- Which target compounds should we include in the fast-track list?
- Which compounds do we need to include in calibration gas?
- What does the air chemistry "landscape" look like in this area? → scientific support

CDPHE goals (customer)

Understand air pollution

TOFWERK Project Goals

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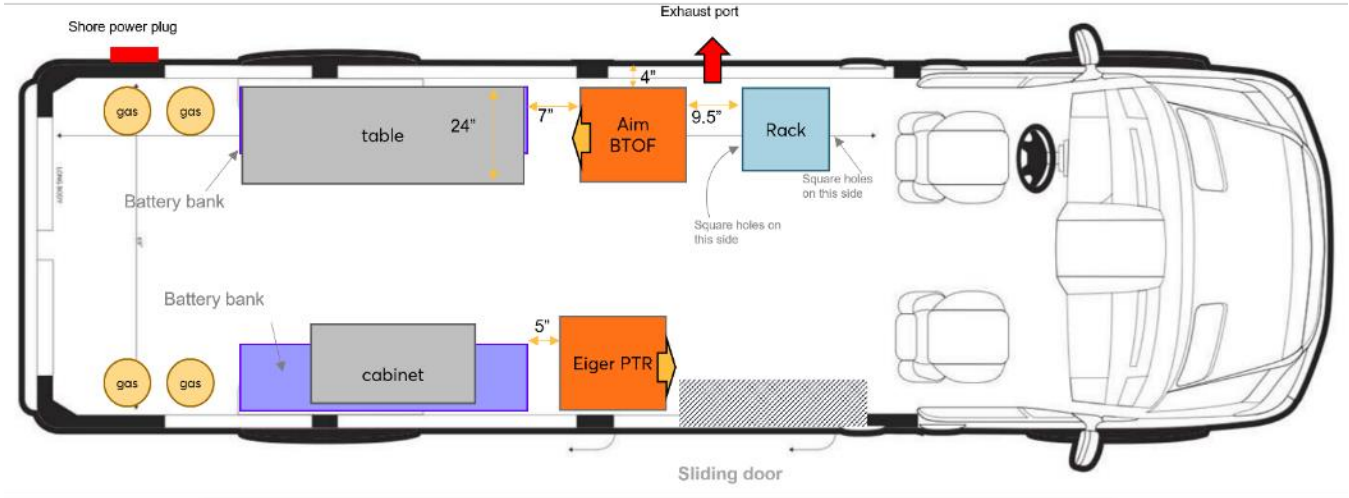
CDPHE goals (customer)

Understand air pollution

- Who are the major emitters in this area?
- What are they emitting? (and how much, and when)?
- What chemicals and chemical concentrations do local residents experience?
- What physical location do pollutants come from, and where do they end up?
- What sources are there that we don't know about?

Colorado Dept. Public Health and Environment: Custom Mobile Lab



Colorado Dept. Public Health and Environment: Custom Mobile Lab

Vocus Eiger

Benzene, Toluene, sum of Xylenes and Ethylbenzene, other VOC, odor-producing compounds

Colorado Dept. Public Health and Environment: Custom Mobile Lab

Vocus Eiger

Benzene, Toluene, sum of Xylenes and Ethylbenzene, other VOC, odor-producing compounds

Vocus B

HCN, inorganic acids, amines, highly oxygenated molecules, chlorinated and fluorinated species

Colorado Dept. Public Health and Environment: Custom Mobile Lab

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Benzene, Toluene, sum of Xylenes and Ethylbenzene, other VOC, odor-producing compounds

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HCN, inorganic acids, amines, highly oxygenated molecules, chlorinated and fluorinated species

Picarro G2204 CaRDS

H_2S, methane

Colorado Dept. Public Health and Environment: Custom Mobile Lab

Gill MaxiMet GMX500

Temperature, Pressure, RH, GPS, Wind speed and direction

Vocus B

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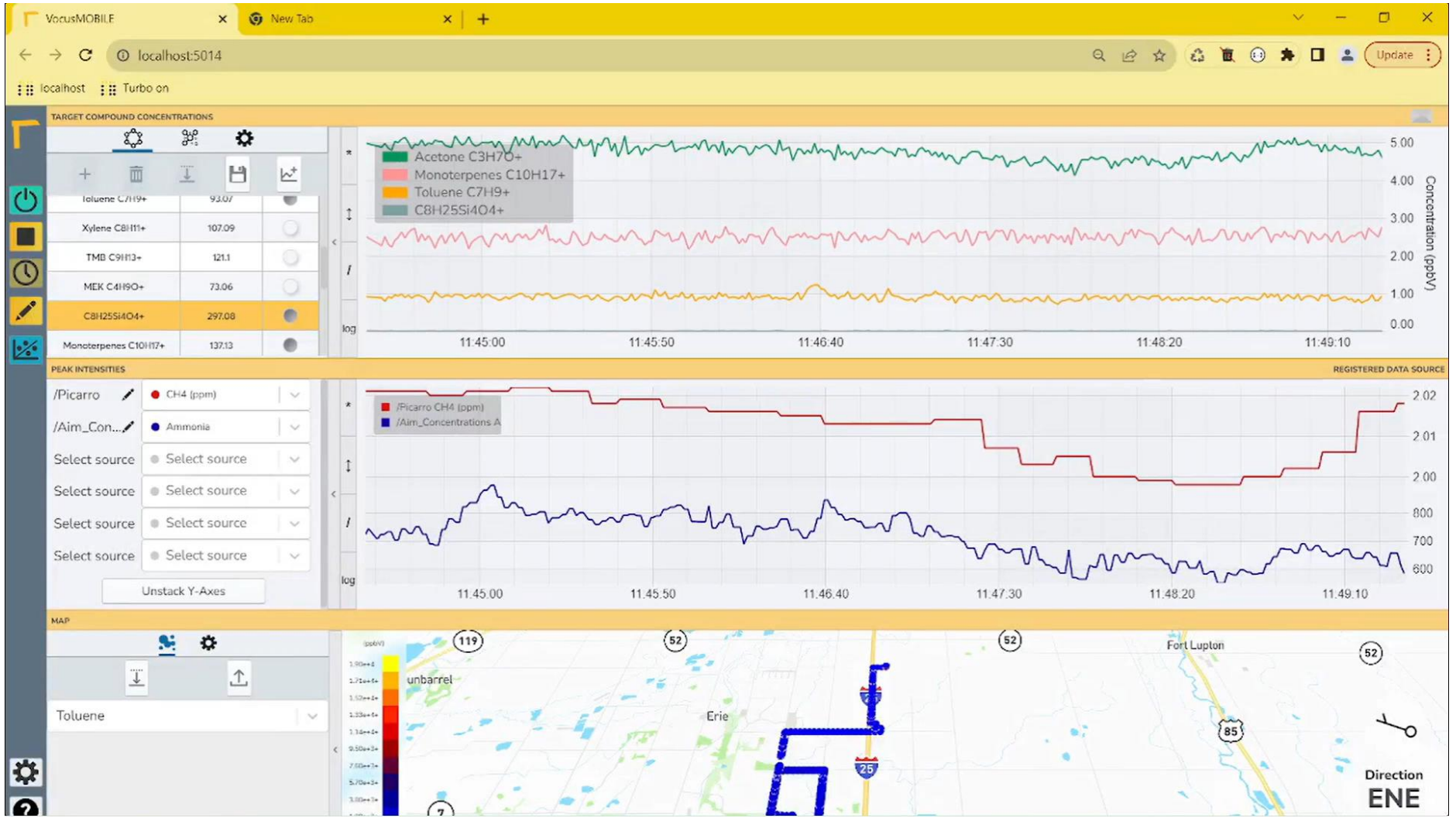
Picarro G2204 CaRDS

H_2S, methane

Consolidated single data stream
Calibrated, background-corrected data automatically to CSV
Custom real-time mapping software

Landfill Odor Survey with CDPHE Mobile lab

Consolidated Single Data Stream for Mobile Measurements using TOFWERK Software



Vocus Eiger PTR-TOF

Picarro G2204 CaRDS

Vocus Aim "B" CI-TOF

Gill MaxiMet GMX500

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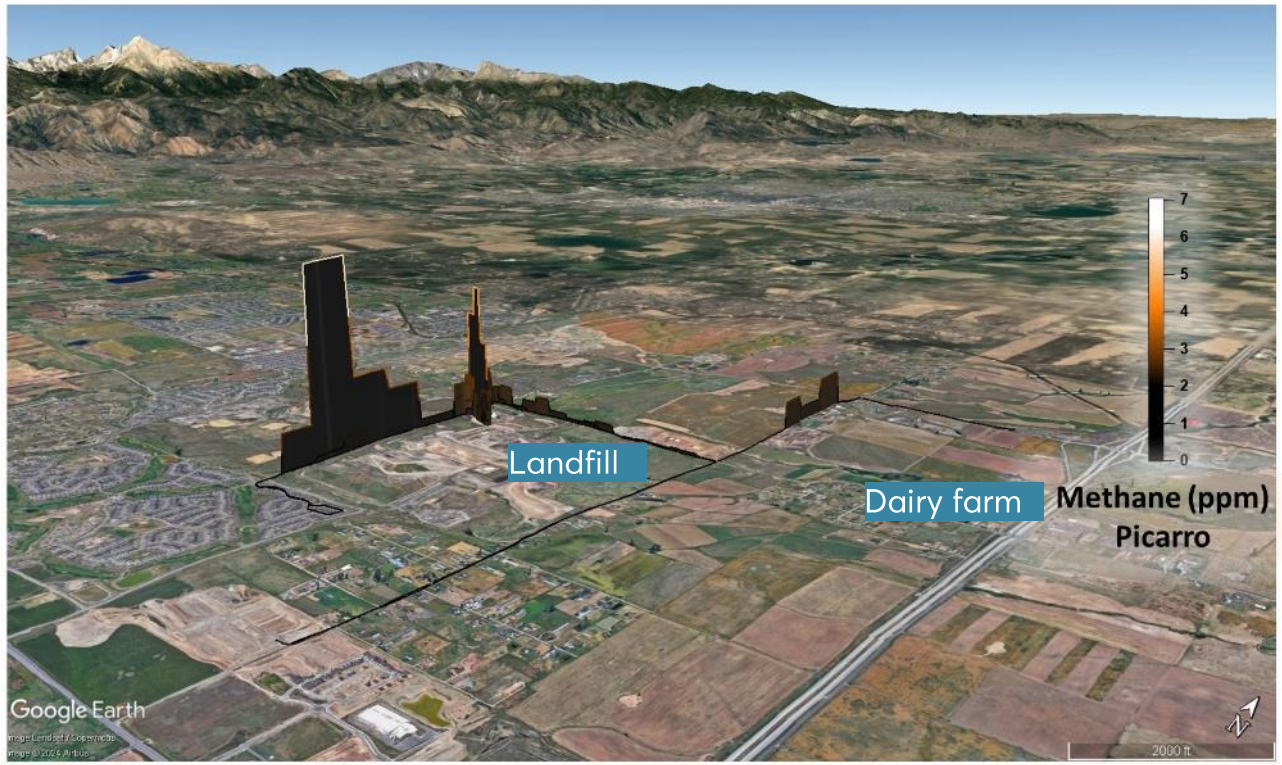
Test drives: Disentangling Methane Source Emissions Using Trace Gas Data from CDPHE Mobile Lab



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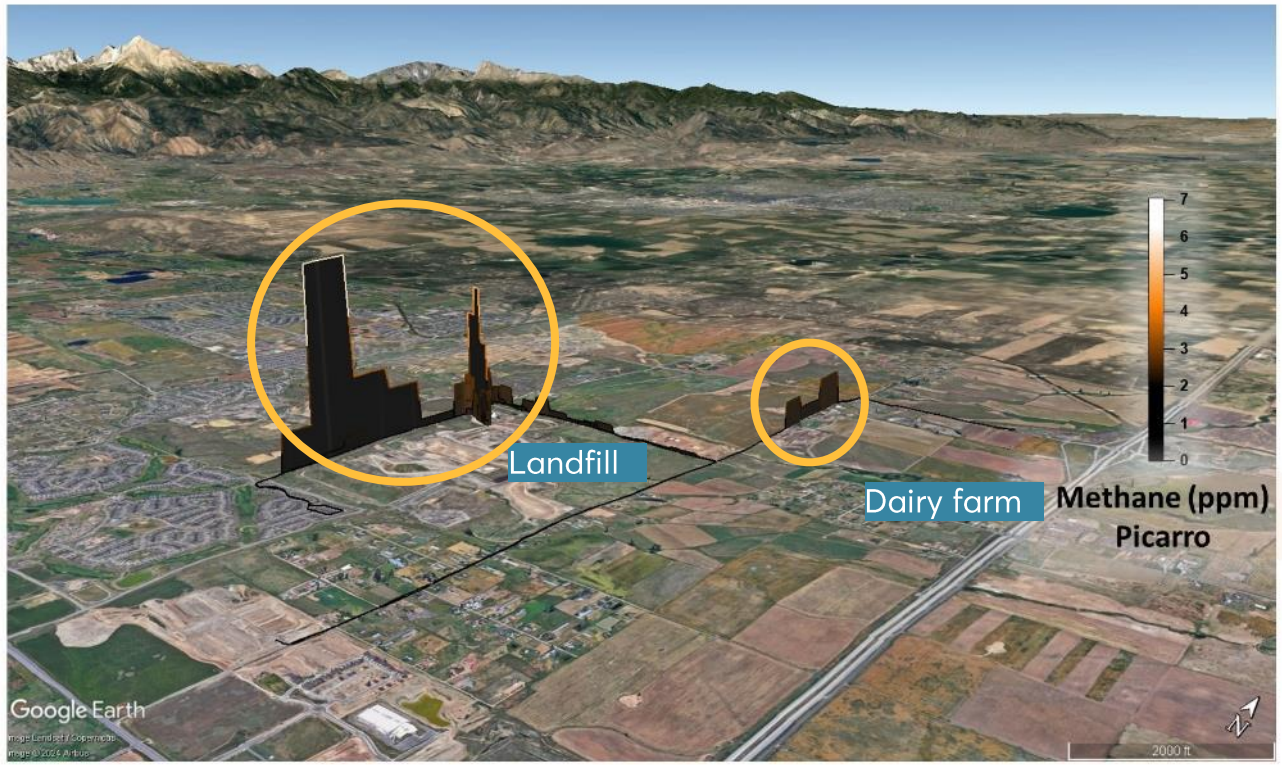

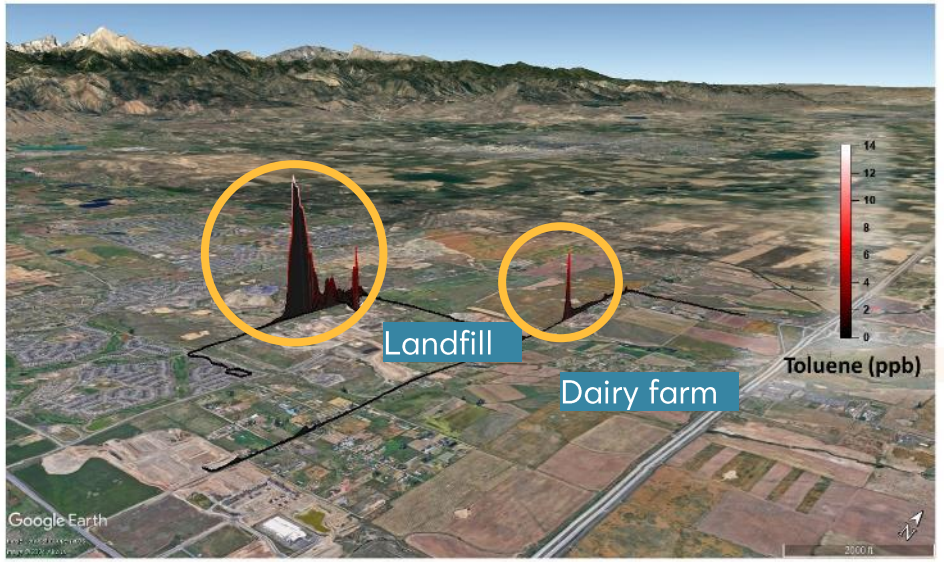

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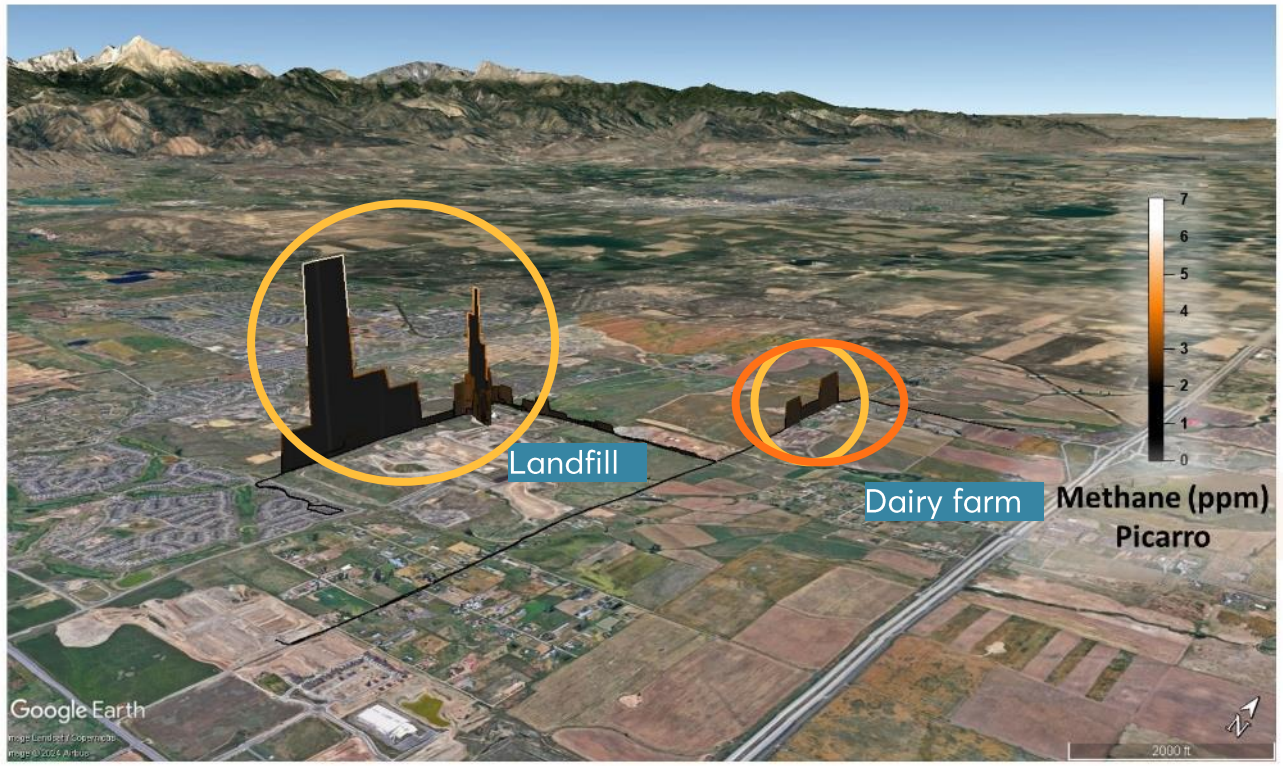

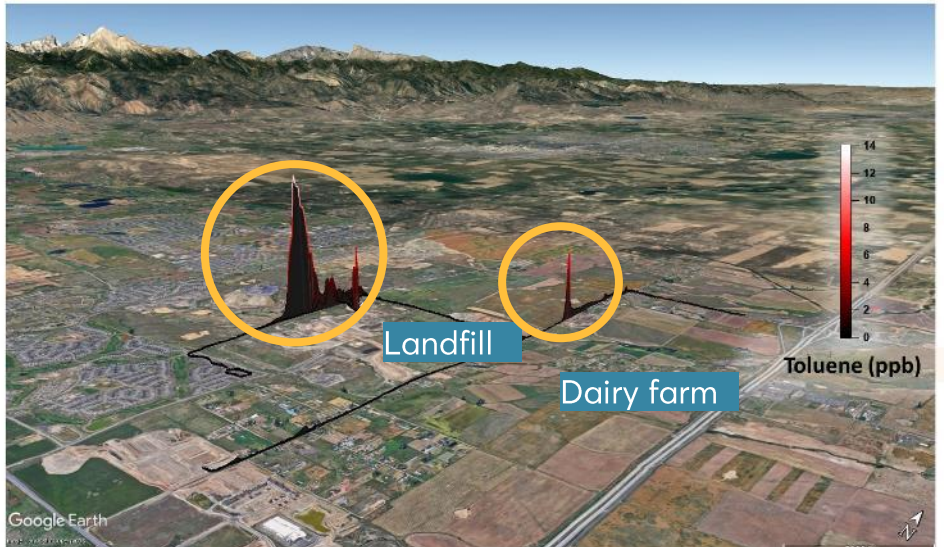

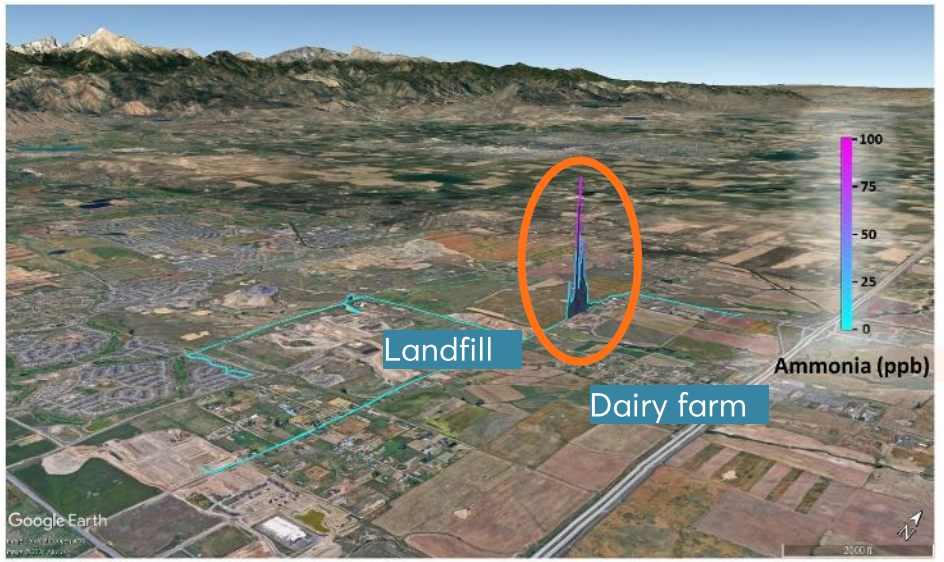

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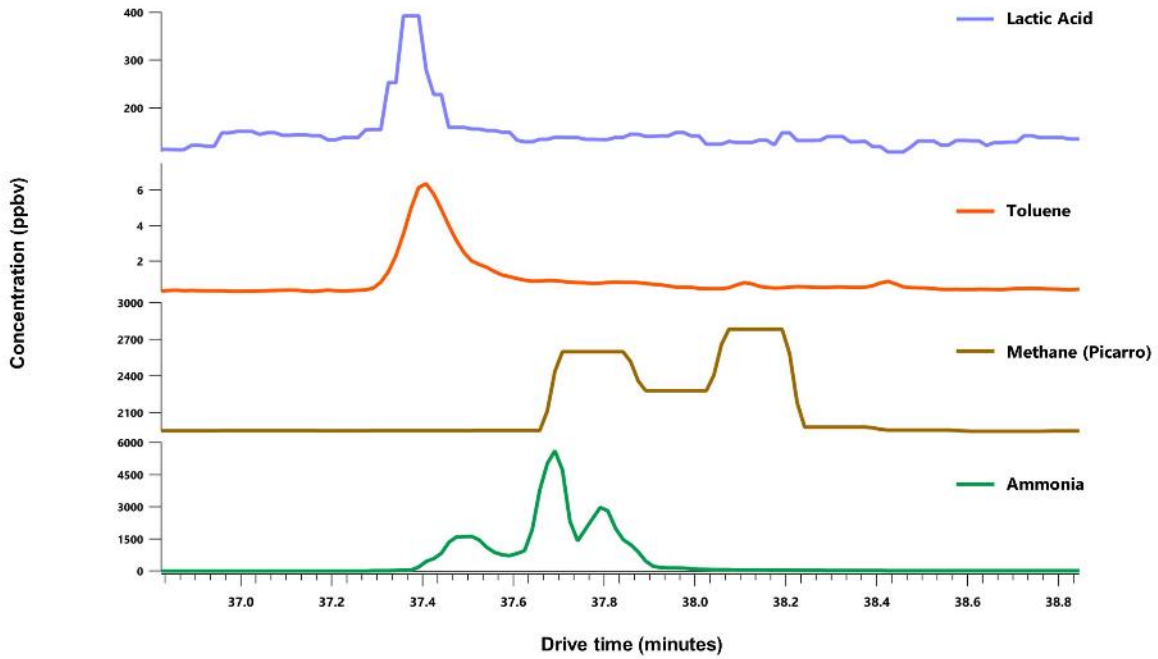
Test Drive: Dairy Farms Emissions with CDPHE Mobile Lab


Photo: The Denver Post



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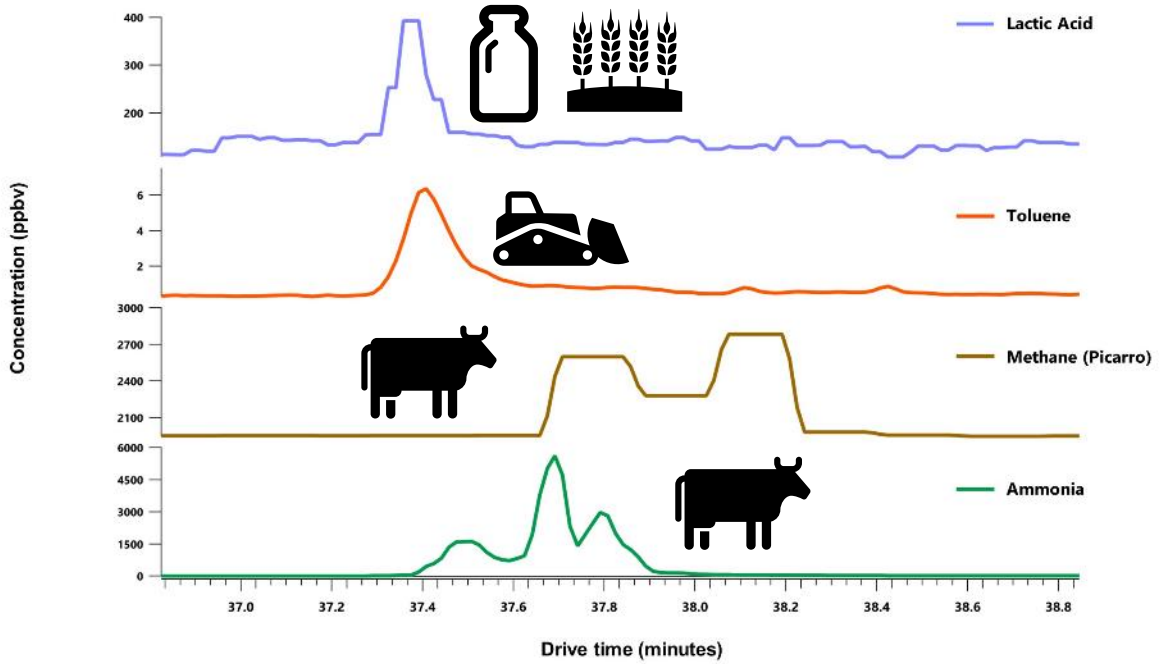

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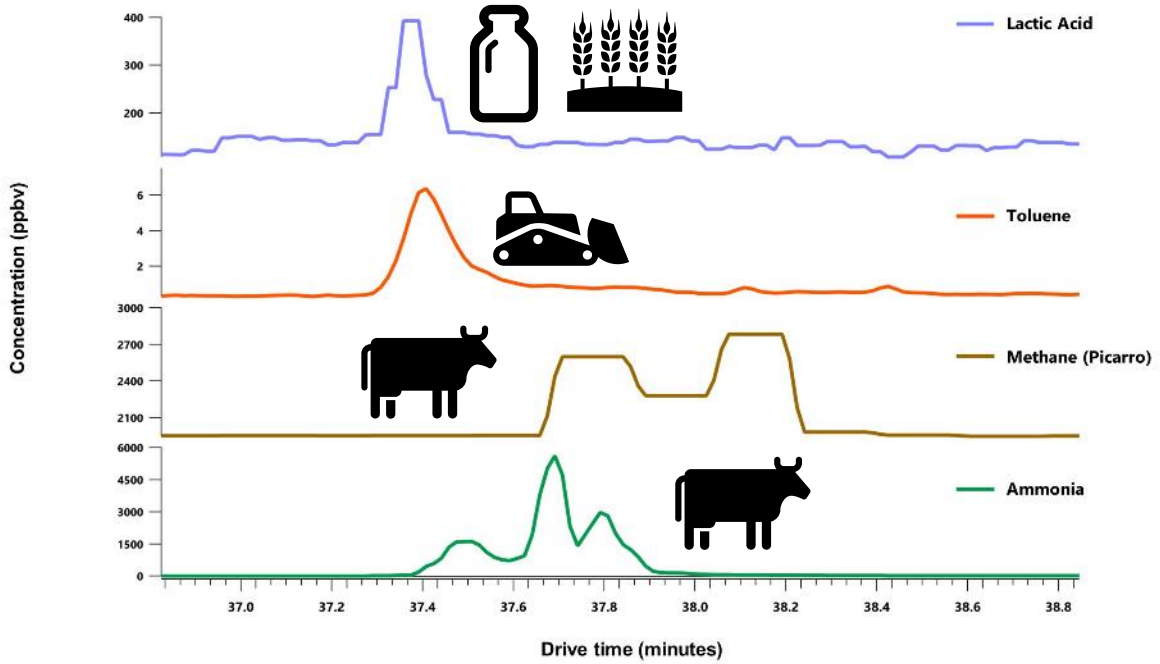
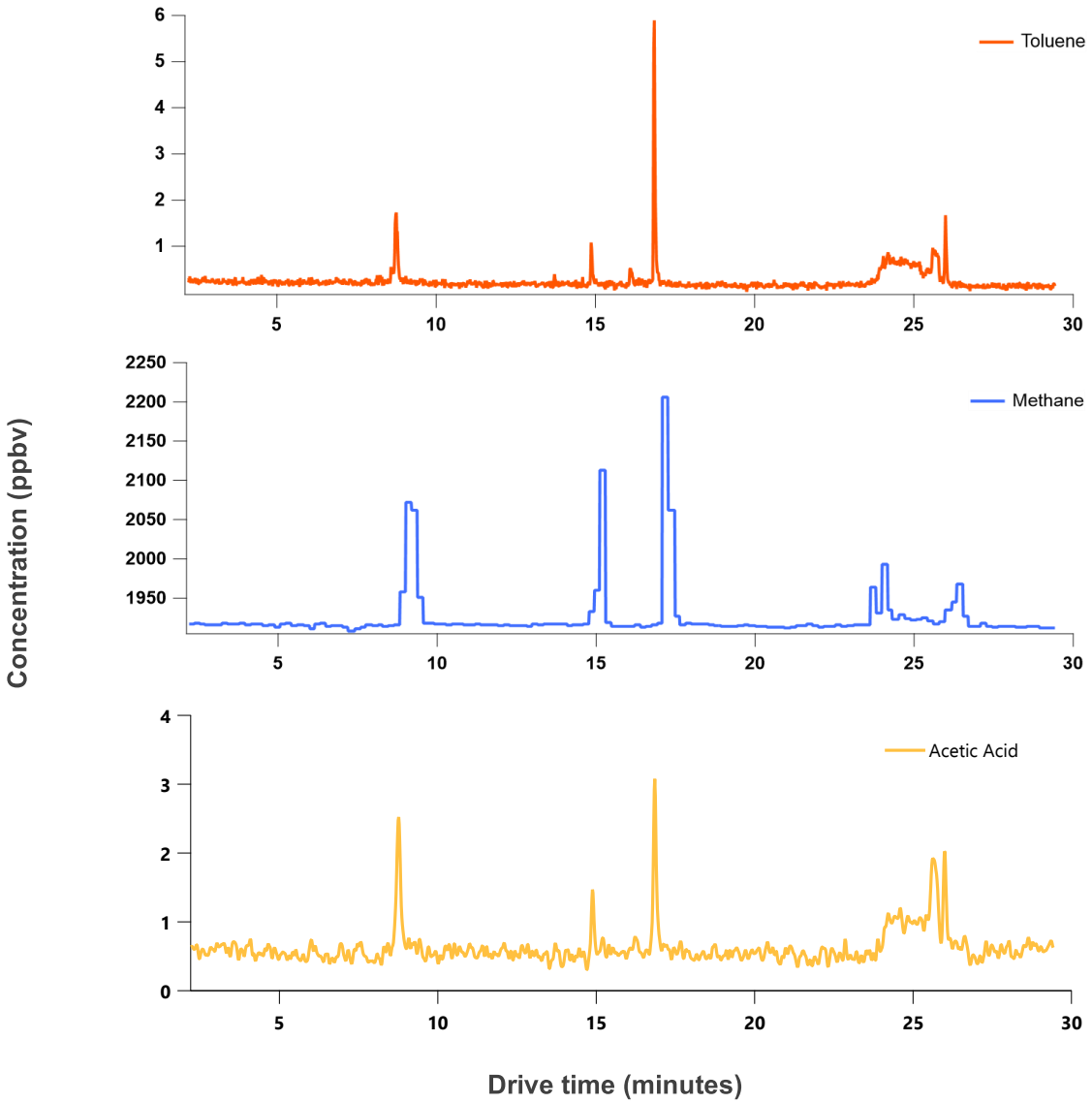


We can identify unique trace gases emitted from dairy farms

Test Drive: Landfill Odor with CDPHE Mobile Lab



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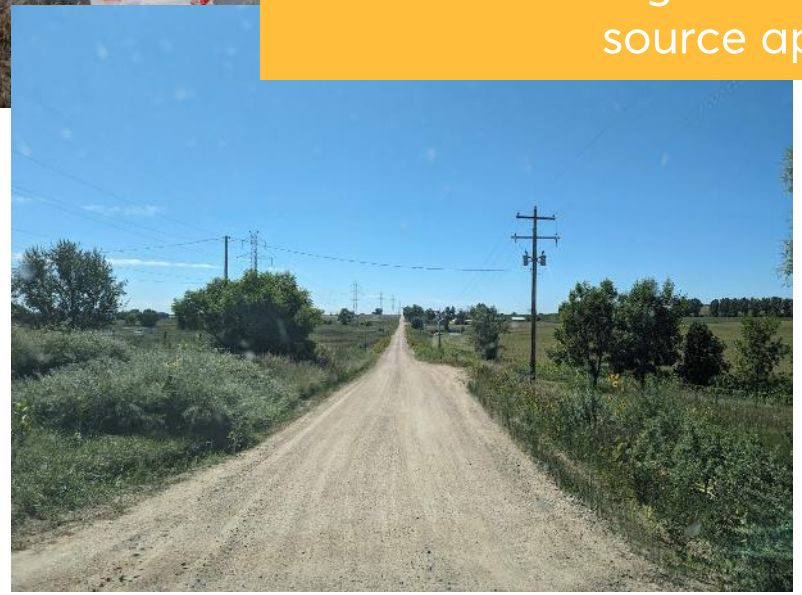
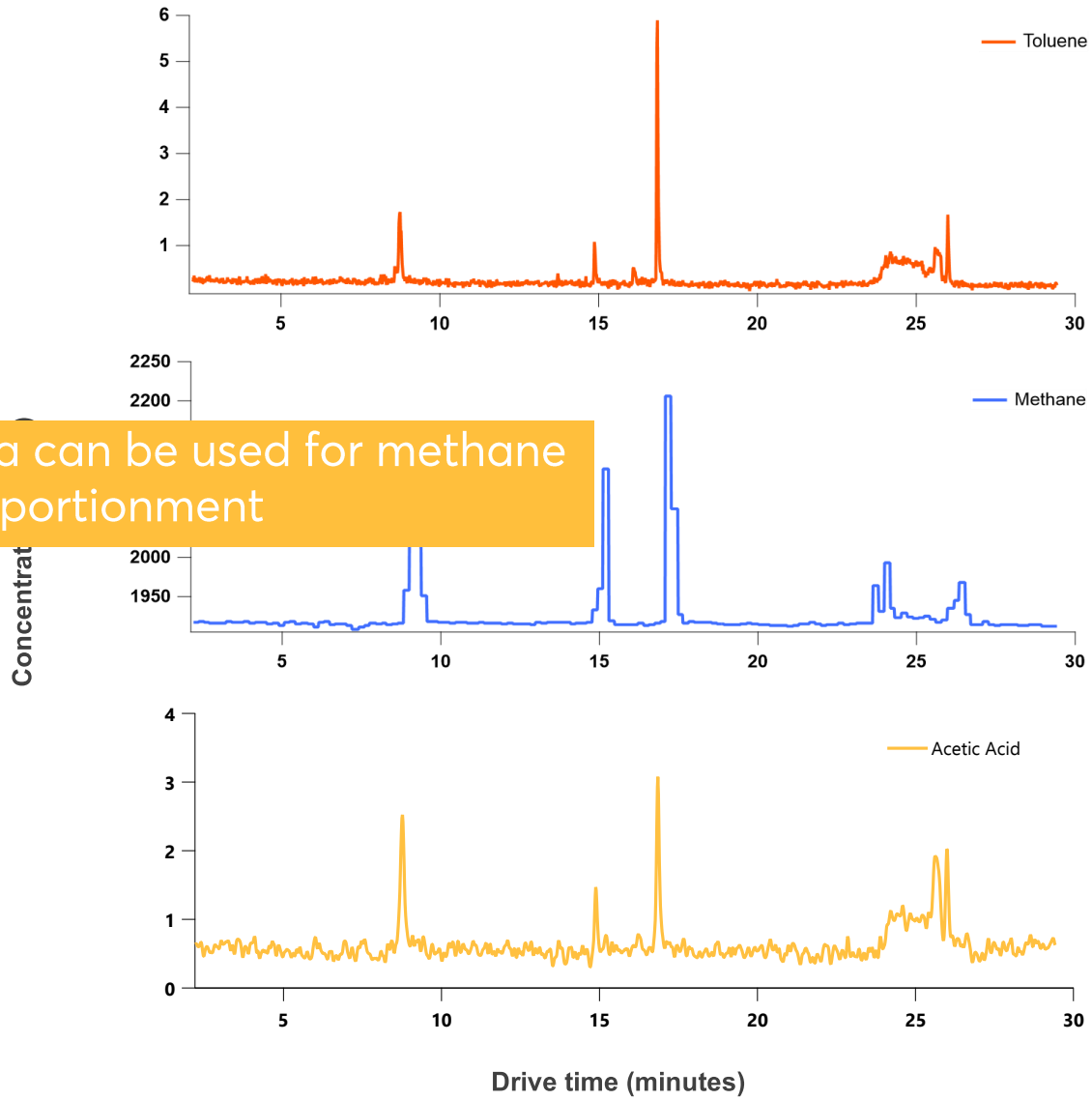


Real-time trace gas data can be used for methane source apportionment



Real-time Mobile Sampling on Aircraft Platforms

Research goal: Determine the methane fluxes from oil and gas operations in the Colorado Front Range

- In collaboration with the Institute of Arctic and Alpine Research (INSTAAR) at CU Boulder and the University of Maryland
- Funded by the Colorado Department of Public Health and Environment

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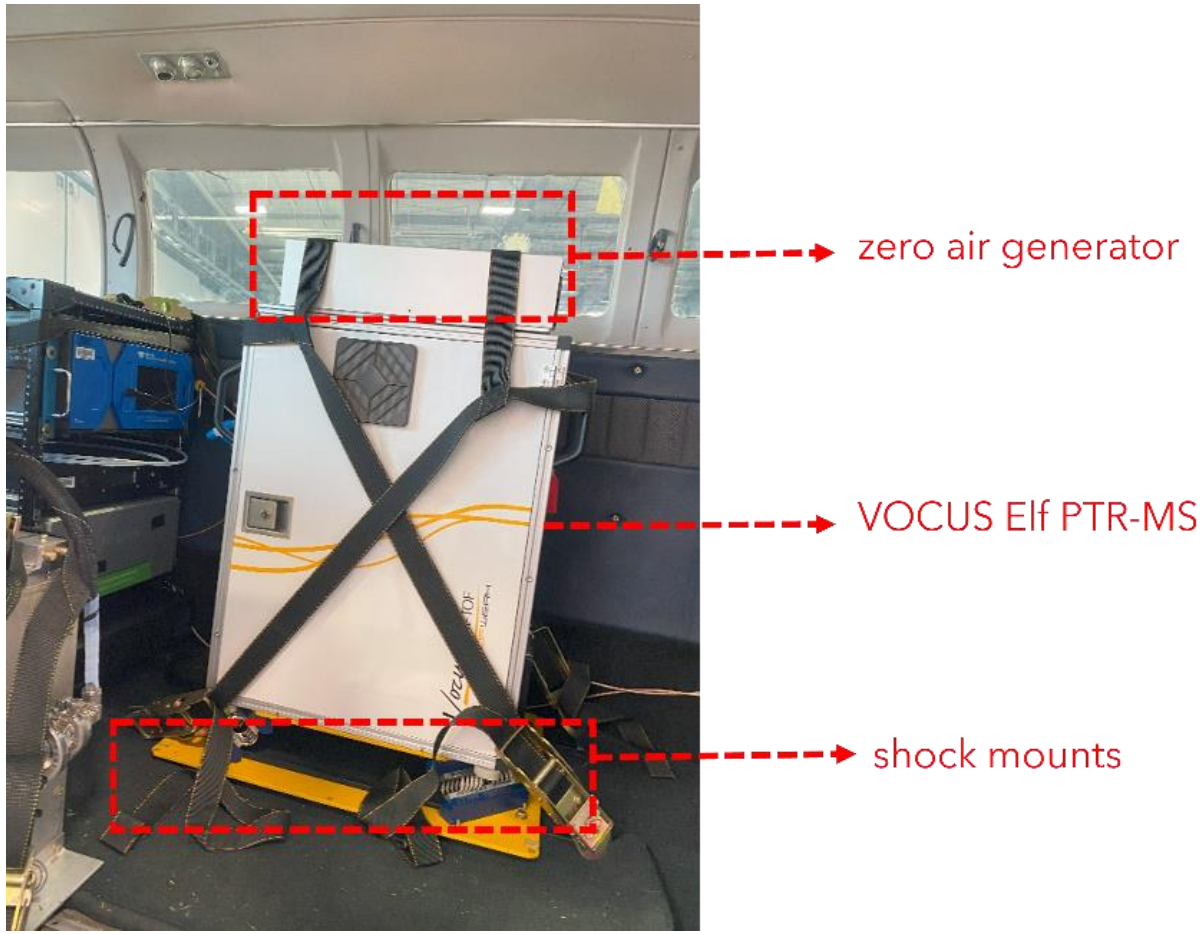
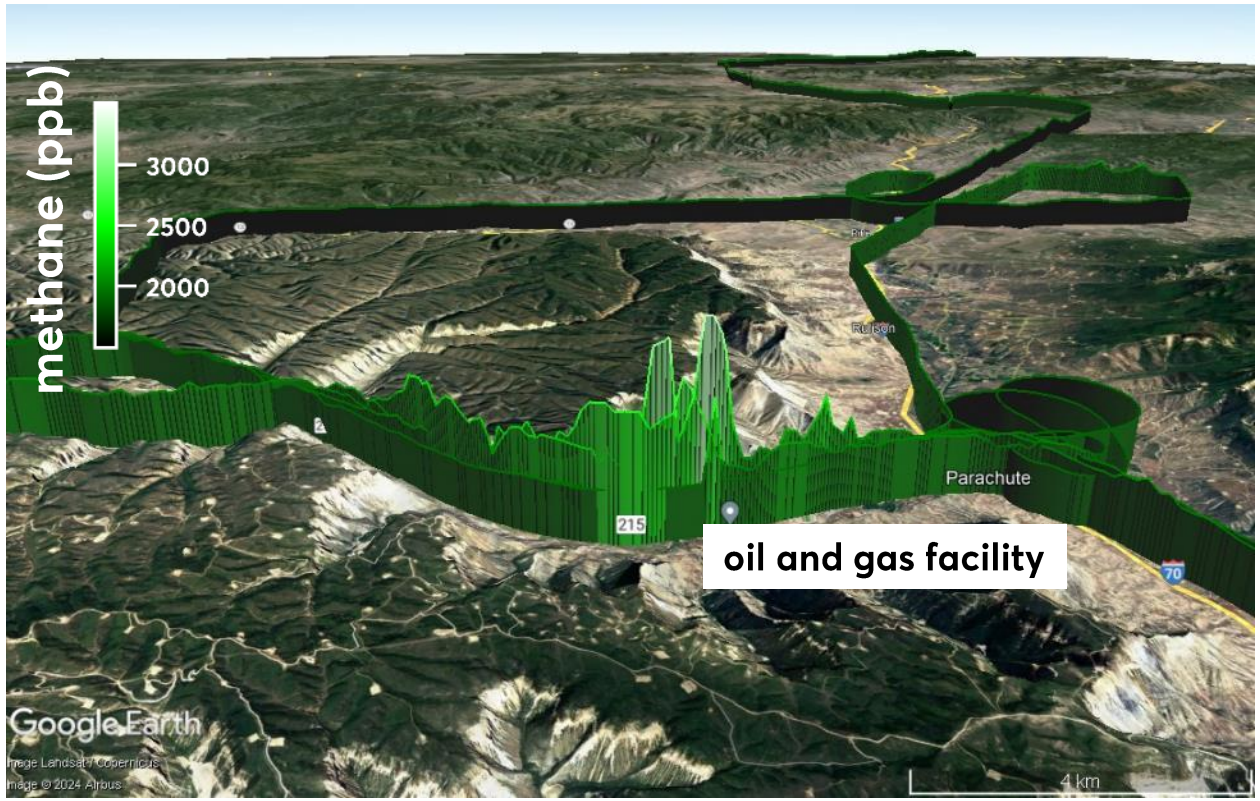
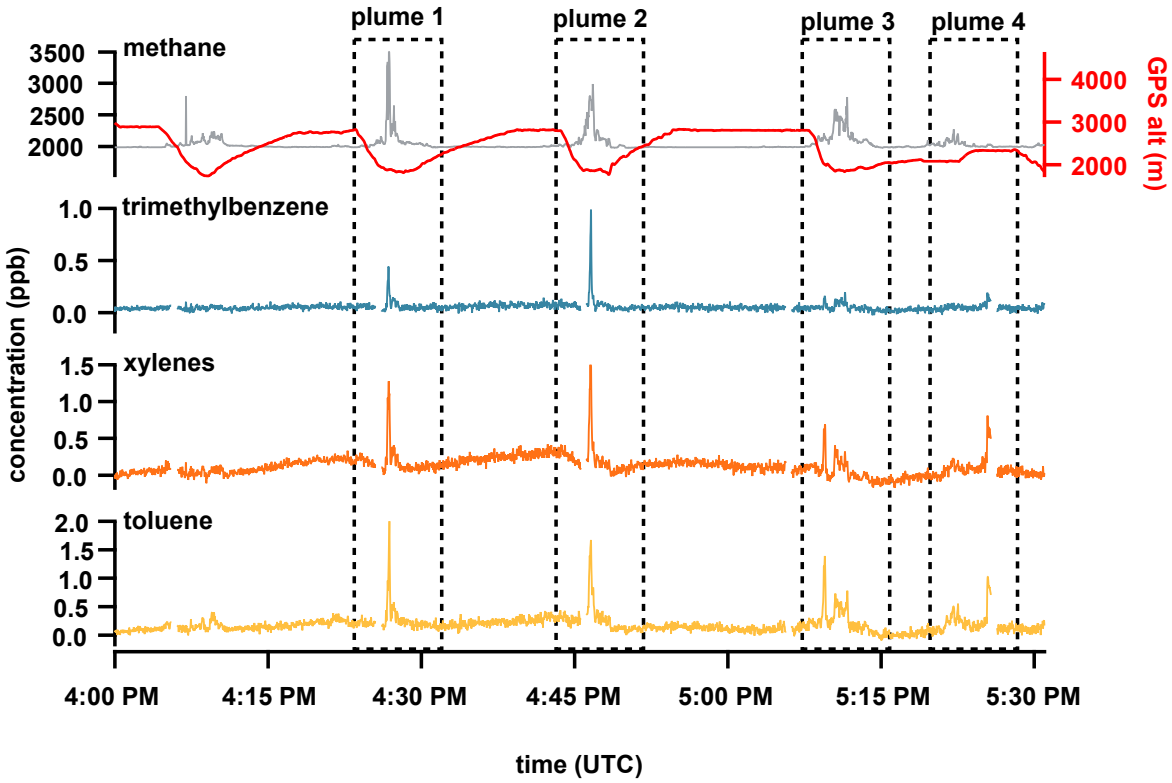
https://www.colorado.edu/today/2021/10/27/hunting-emissions-thousands-feet

Integration of the Vocus Elf on an Aircraft



VOC Tracers for Methane Emissions near Oil & Gas Facilities





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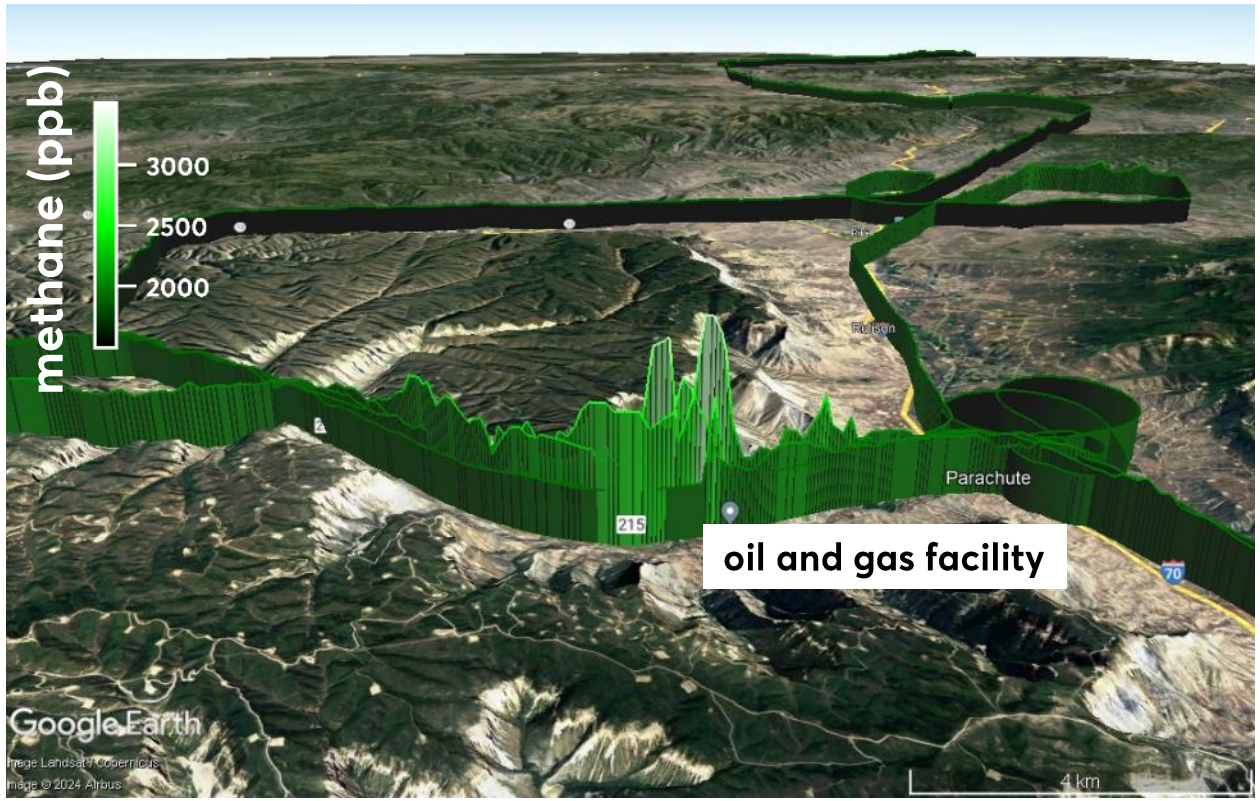

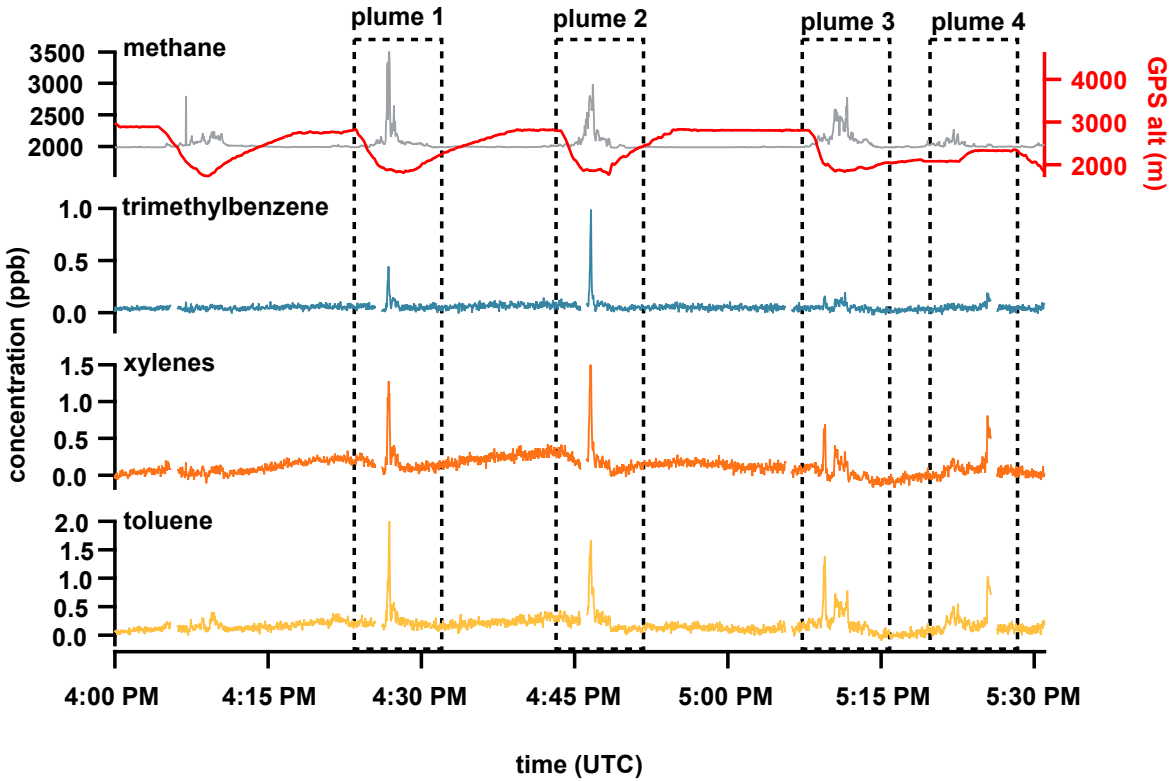

Real-time trace gas data can be used to identify methane emissions from oil and gas operations

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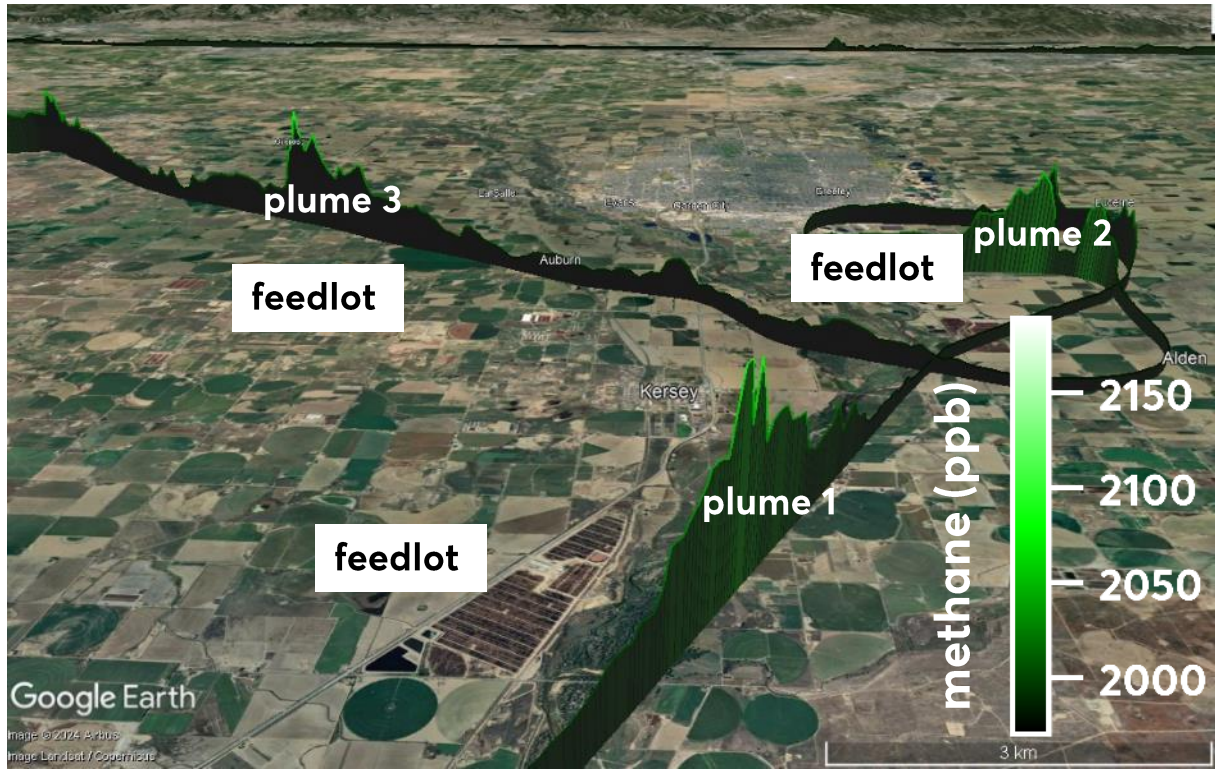
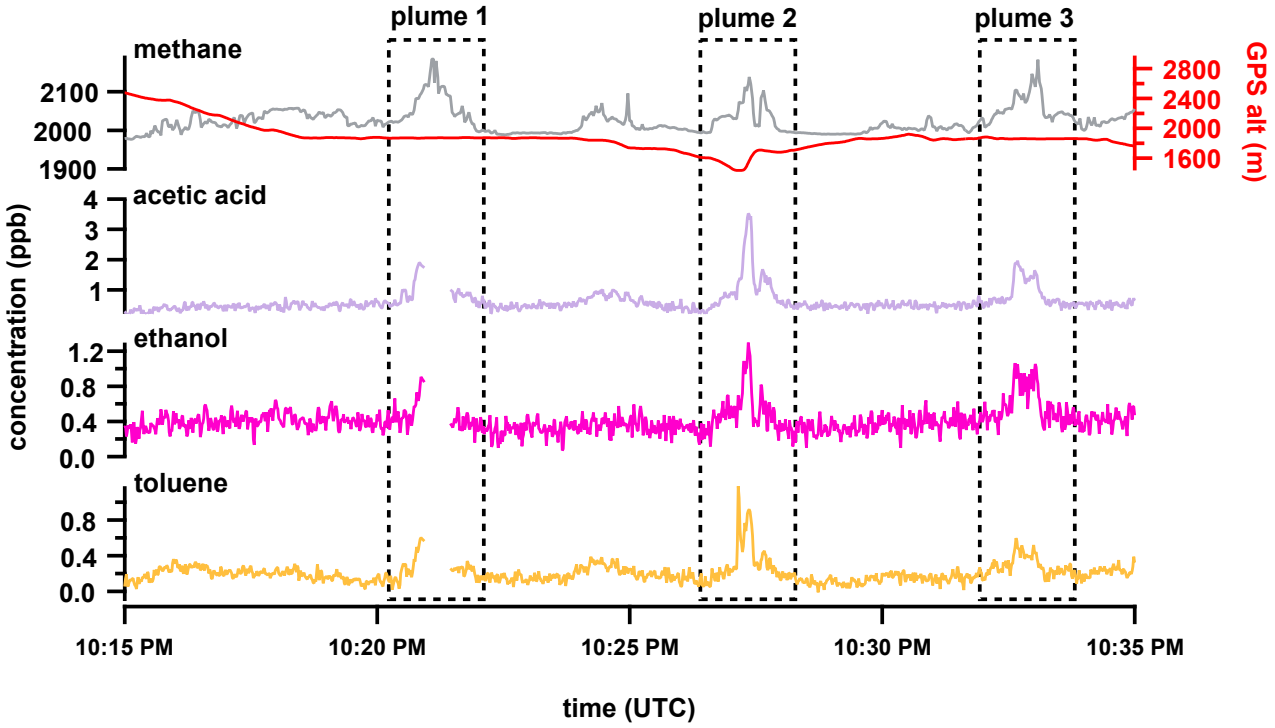
VOC Tracers for Methane Emissions near Concentrated Animal Feedlot Operations (CAFOs)





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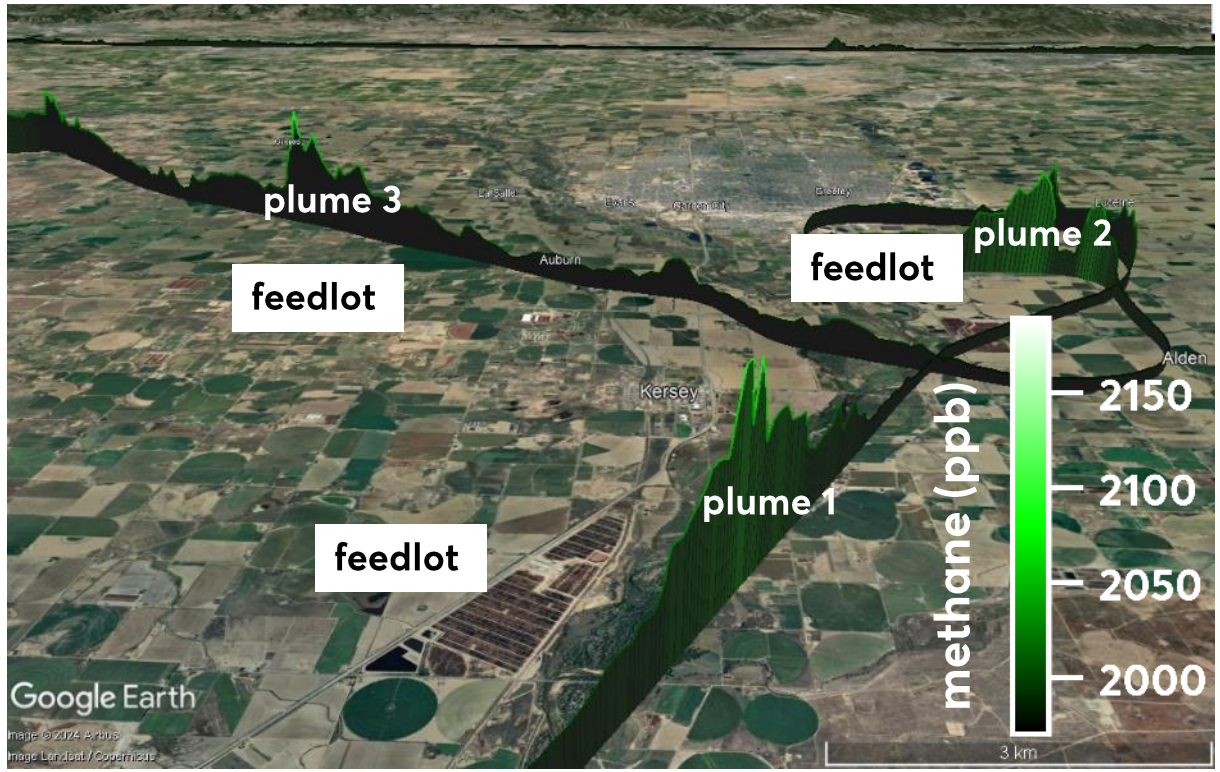

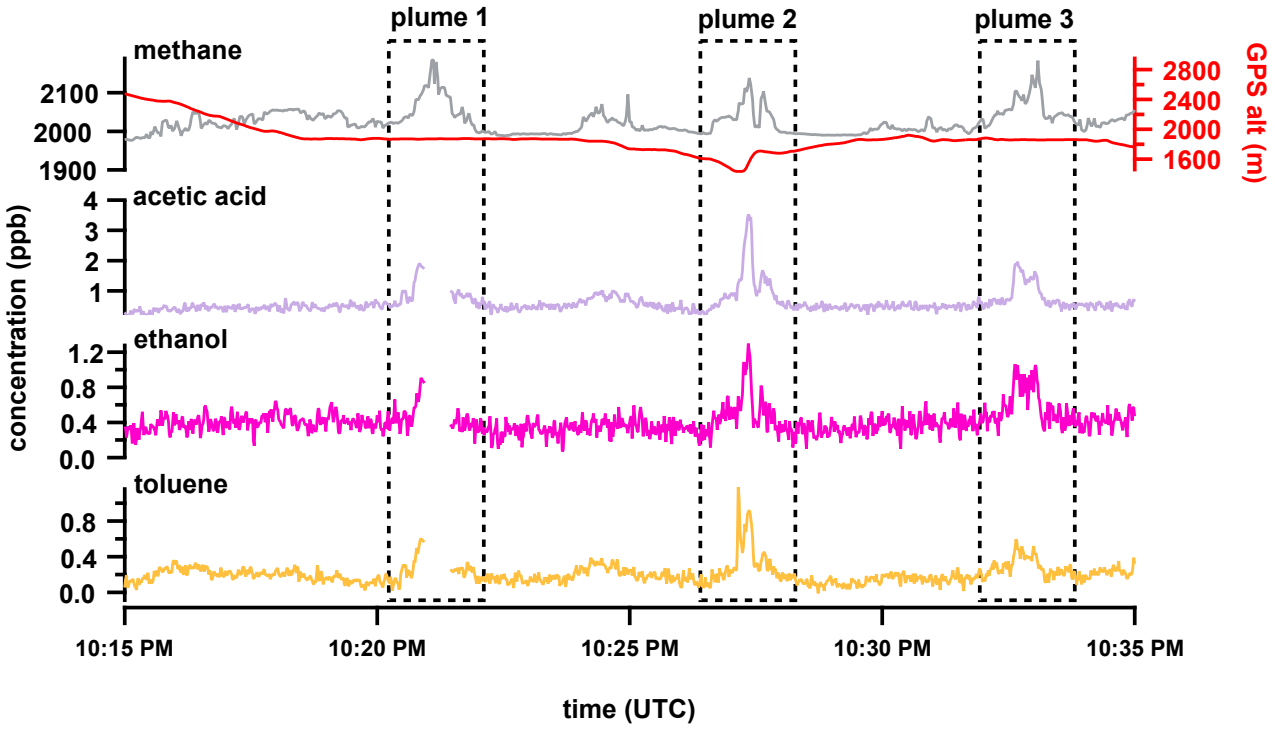

Different CAFOs facilities show similar VOC emissions

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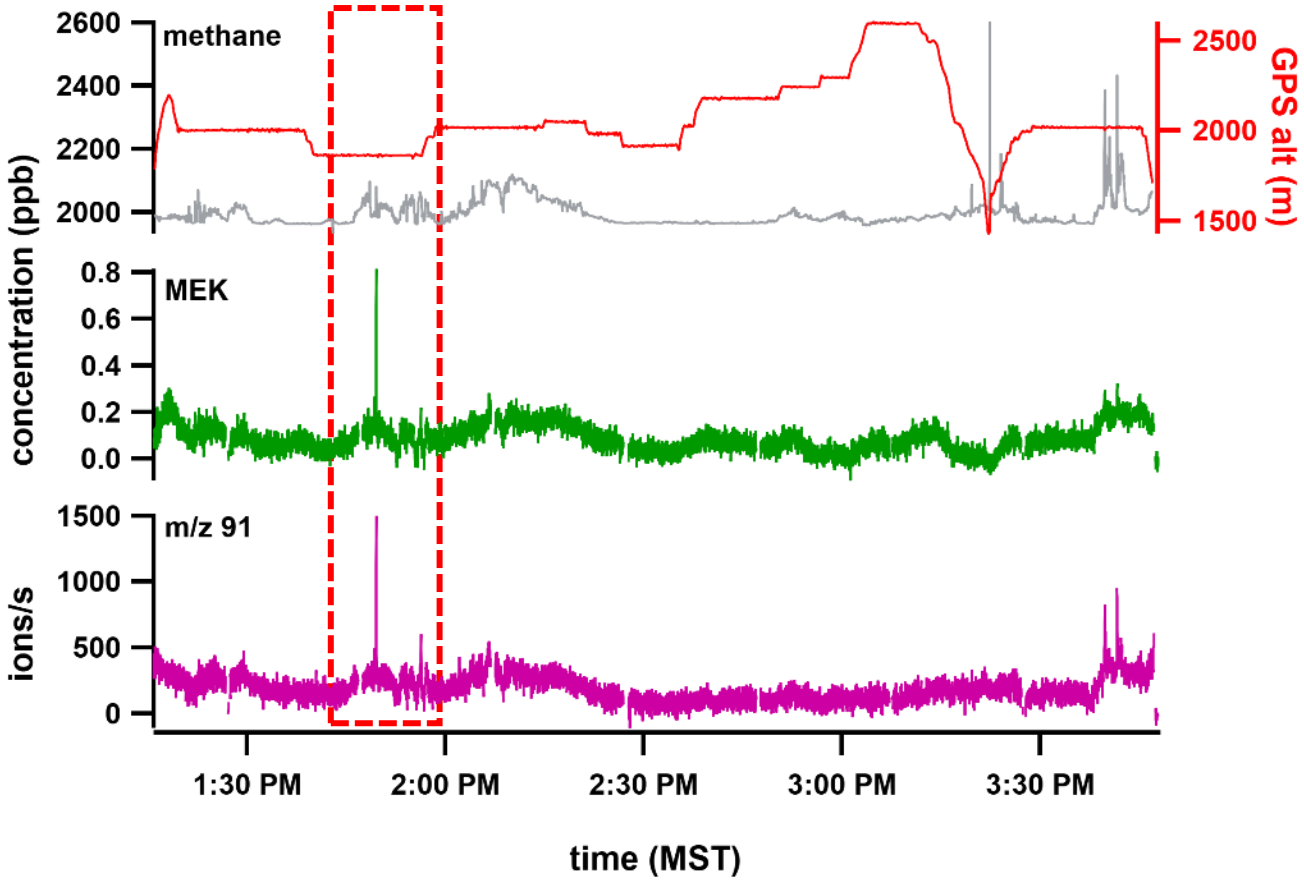
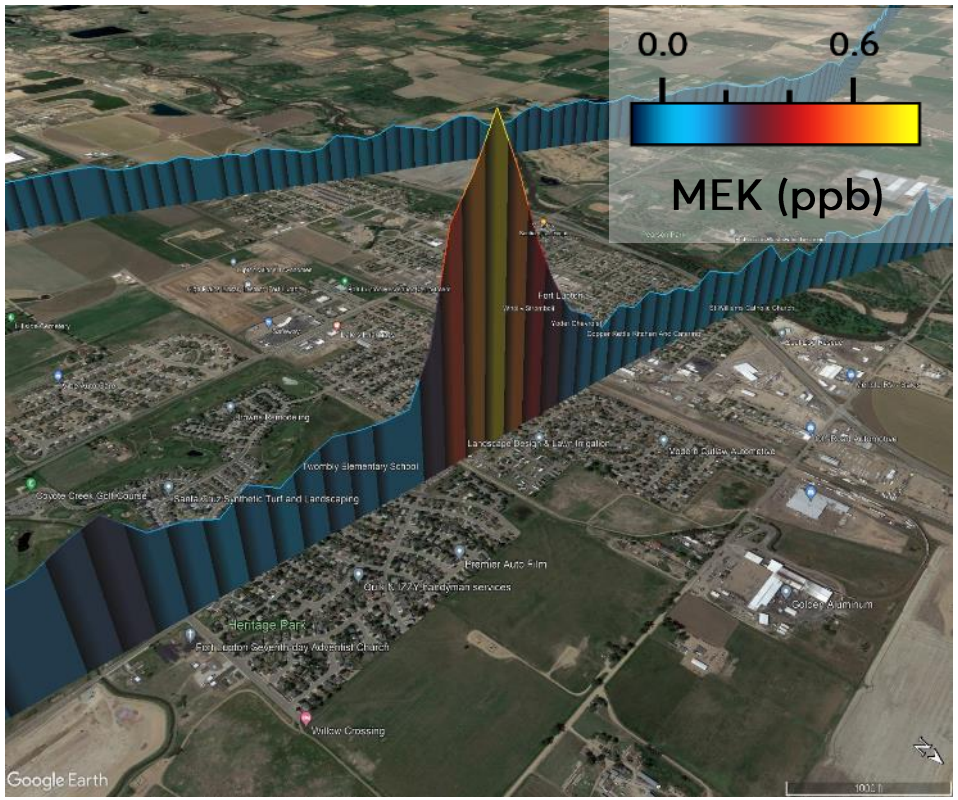
Non-methane related VOC sources can also be detected





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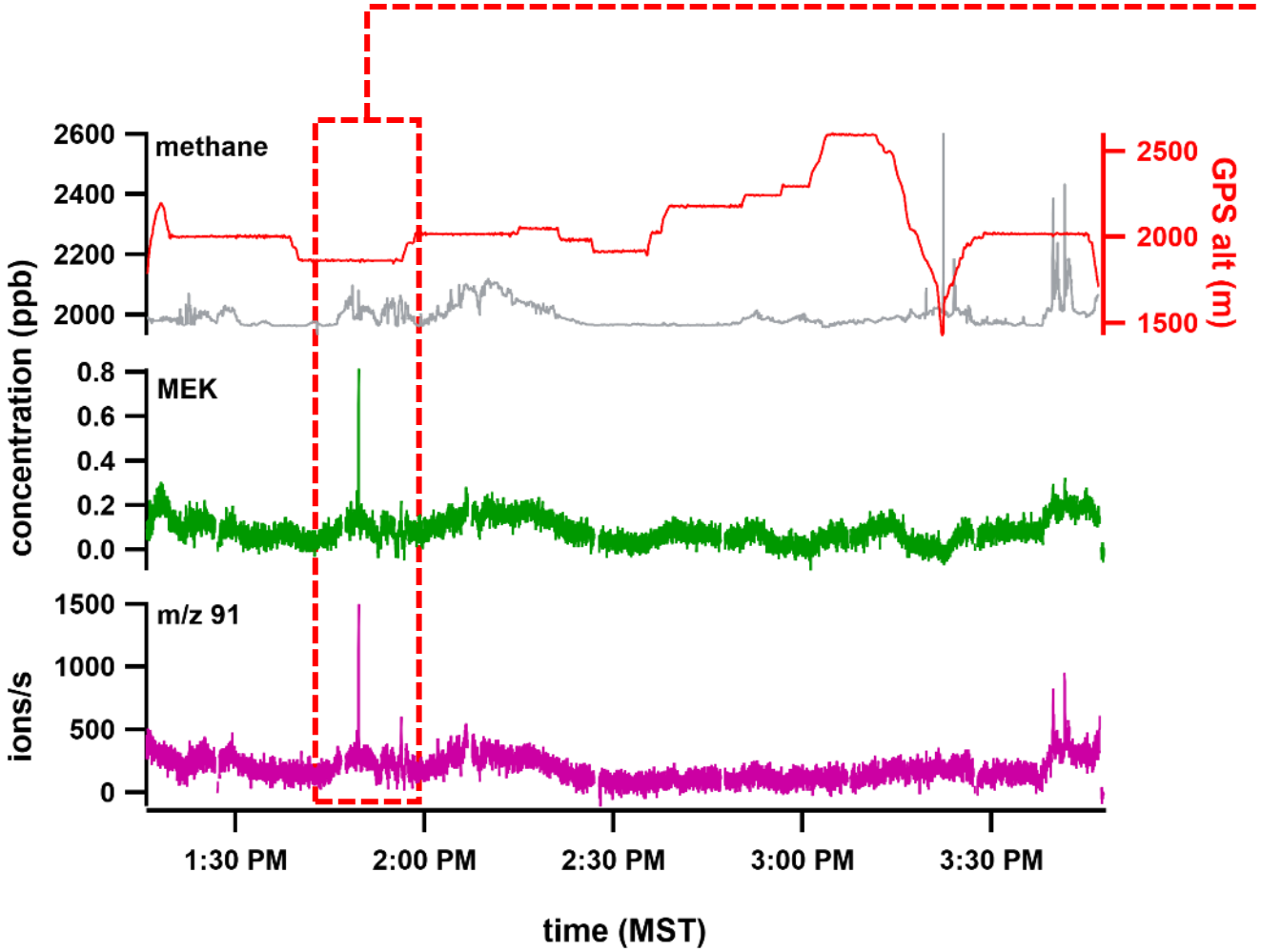

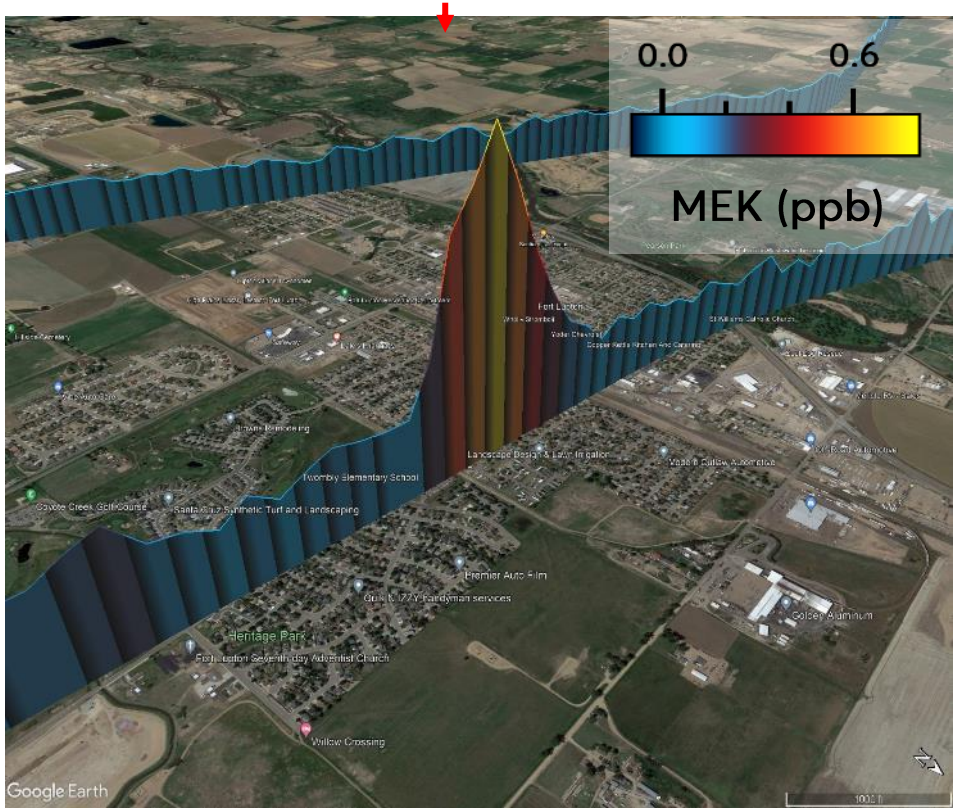

Methyl ethyl ketone (MEK) enhancements in Fort Lupton not associated with significant methane enhancements. Potential emissions from chemical waste?

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Thank you for your attention!

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