Overview of Colorado Regulations – Past, Present, and Future

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COLORADO
Air Pollution Control Division
Department of Public Health & Environment

Energy & Environment Symposium
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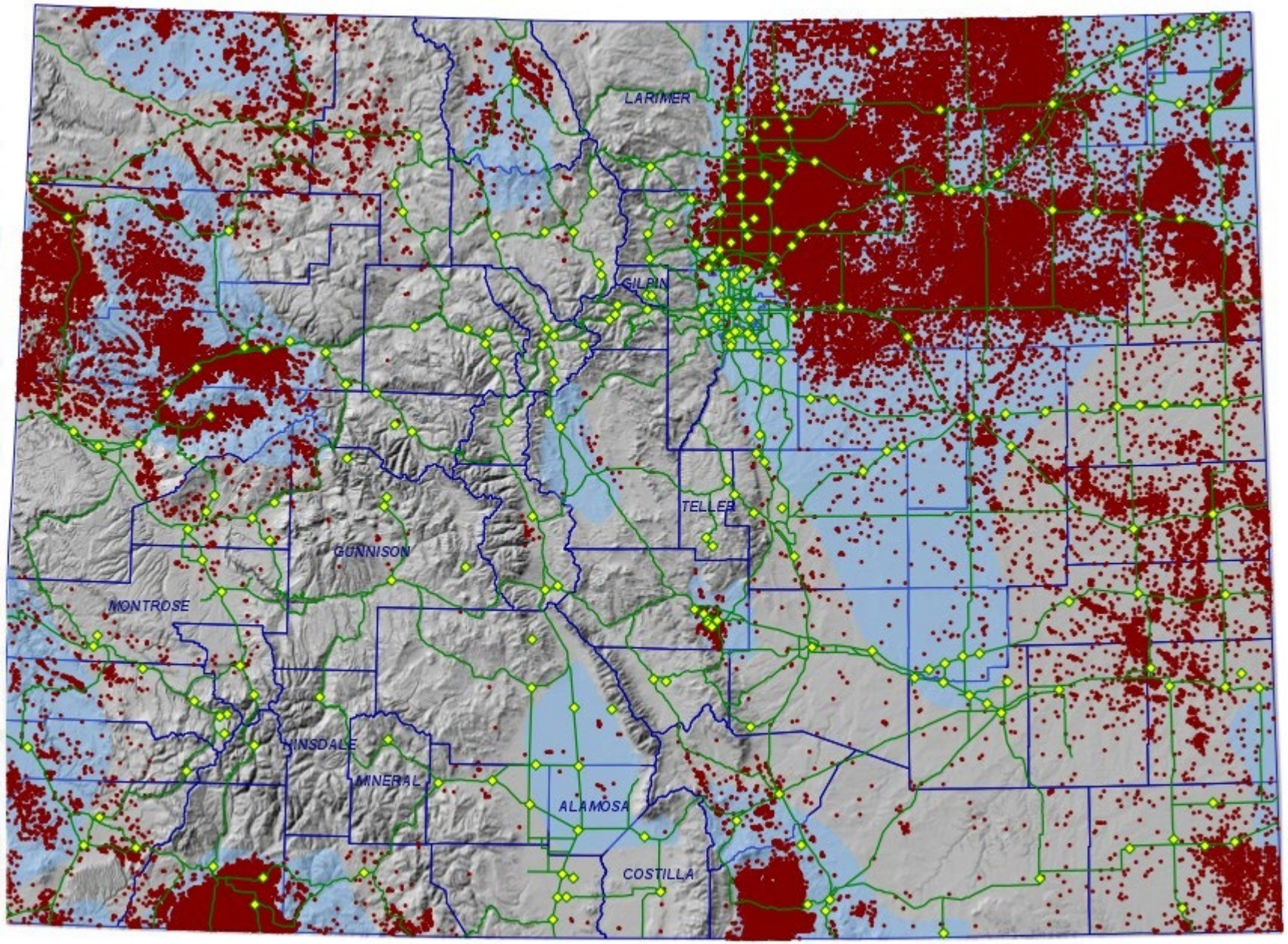
Oil and gas development

- Over 50,000 wells
- Over ½ are in the Denver-Julesberg Basin in NE Colorado
- Near major cities in Colorado
- North Front Range area is an ozone non-attainment area



Legislation

- 2019
  - HB19-1261/SB19-96
  - SB19-181
- 2020
  - SB20-204 (Enterprise)
- 2021
  - HB21-1266
  - HB21-1189

Regulations in 2019 and 2020

2019

- Tank controls
- Proximity-based Leak Detection
- Loadout, Sampling, Gauging

2020

- Engines
- Preproduction Controls
- Preproduction/Early Production Monitoring

Reg. #7: Pre/Early Production Monitoring

- "CONTROL OF OZONE VIA OZONE PRECURSORS AND CONTROL OF HYDROCARBONS VIA OIL AND GAS EMISSIONS" (5 CCR 1001-9)
- Amended September 2020
- Goal:
  - To obtain more information regarding potential emissions from pre-production operations (drilling, fracking, millout, flowback, early production)
  - To determine potential impacts to human health
  - To obtain more information on innovative monitoring techniques
- VI.C. Air quality monitoring
  - Owners or operators of drilling operations that begin on or after May 1, 2021, must monitor air quality at and/or around the pre-production and early production operations
- 3 objectives listed in the regulation:
  - Detect, evaluate, and reduce as necessary hazardous air pollutant emissions
  - Detect, evaluate, and reduce as necessary ozone precursor emissions
  - Detect, evaluate, and reduce as necessary methane emissions

Reg. #7 monitoring

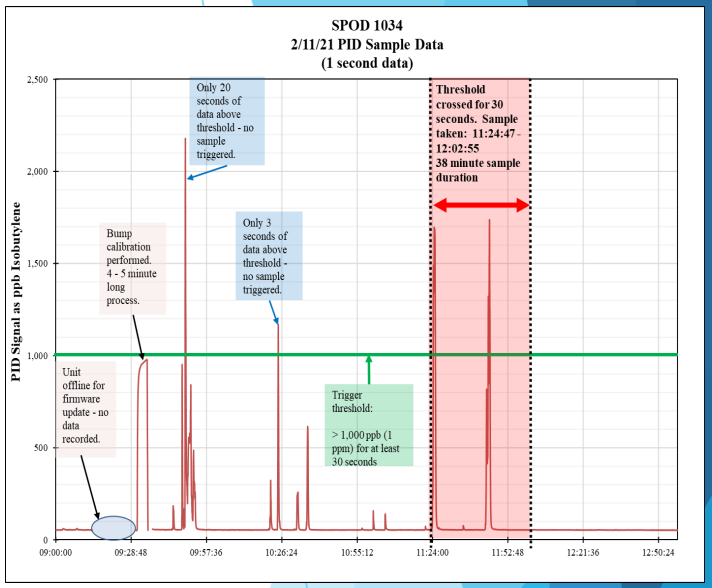
- Pollutant(s) and other parameters to be monitored must include at least one of the following:
  - Total VOCs, methane, benzene or BTEX (benzene, toluene, ethyl benzene and xylenes) or other indicator of hydrocarbon emissions
  - Meteorology
- Owners or operators must submit an air quality monitoring plan at least sixty (60) days prior to beginning air quality monitoring
  - Within 14 days of receiving the plan, the Division will consult local governments within 2000' as part of the review process
  - Owners or operators must receive approval from the Division of the air quality monitoring plan prior to beginning air quality monitoring
- Owners or operators must keep records for a minimum of three (3) years, unless otherwise specified, and upon request make records available to the Division
- Owners or operators must submit monthly reports of monitoring conducted to the Division by the last day of the month following the previous month of monitoring

Reg. #7 monitoring plans must include:

- A description of the monitoring equipment to be deployed
- A description of the meteorological monitoring equipment to be deployed
- The number of monitors and/or sensors to be deployed
- The location and height of the monitoring equipment, including for each phase of operations if location and height of the equipment will change
- A topographic map and plan of the site
- A description of how the placement of monitoring equipment minimizes surface disturbances
- An explanation of how the number and placement of monitoring equipment will be adequate to achieve the desired air quality monitoring objectives
- The standard operating procedures that will be employed
- The quality control and quality assurance procedures
- The data system and operating protocol to be used for data collection
- The methods for collecting and analyzing speciated or other samples of chemical constituents

Reg. #7 records and reporting must include:

- Monthly reports and the data necessary to inform the monthly reports
- The phase of operation
- Activity logs
- For a period of one year after the monthly report, the underlying raw data associated with each monitor
- API number of the well(s)
- Location of the operations
- The date, time, and duration of any monitoring equipment downtime
- The date, time, and duration of operations malfunctions and shut-in periods or other events investigated for influence on monitoring
- A summary of monitored air quality results, including time series plots as hourly or higher time resolution and a statistical summary
- A description of responsive action(s) taken as a result of monitoring results
- Owners or operators must notify the Division and the local government within forty-eight (48) hours of responsive action(s) taken as a result of recorded values in excess of the response level



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Reg. #7 operator monitoring plans/reports

- To-date, 131 monitoring plans have been submitted for review/approval
  - Some using template, some using own format
- Most plans are using sensors for total VOC's (TVOC)
  - One is utilizing a rotating FLIR camera
  - Some also include PM2.5
  - Typically 1 meteorological sensor per wellpad
- Some are adding triggered canisters to get speciated data in plumes
- Some are adding passive tubes for 2-week exposures
- Typically 3-6 sensors per wellpad, including predominant wind directions or nearby residences
- Typically within 150' from edge of pad
  - Tall soundwalls can create airflow issues
- Now over 300 monthly reports have been received
- Reports posted on OnBase at https://oitco.hylandcloud.com/CDPHERMPublicAccess/index.html

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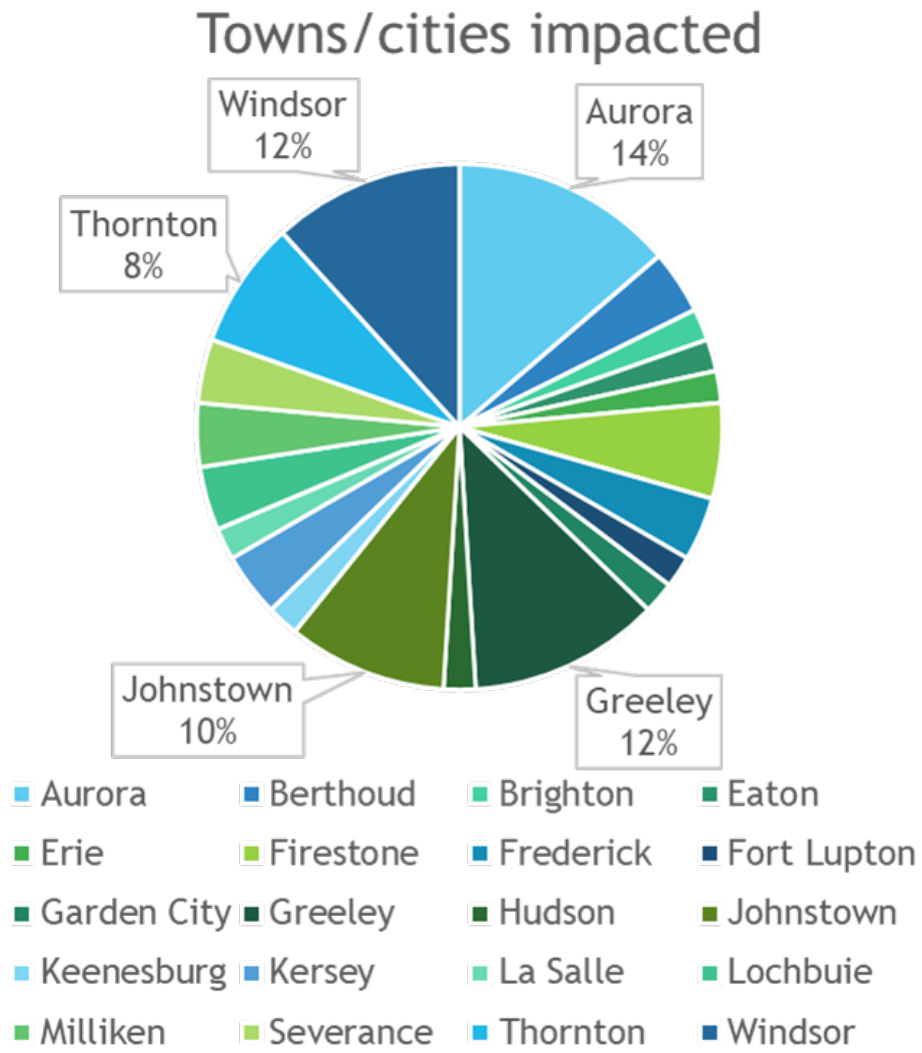
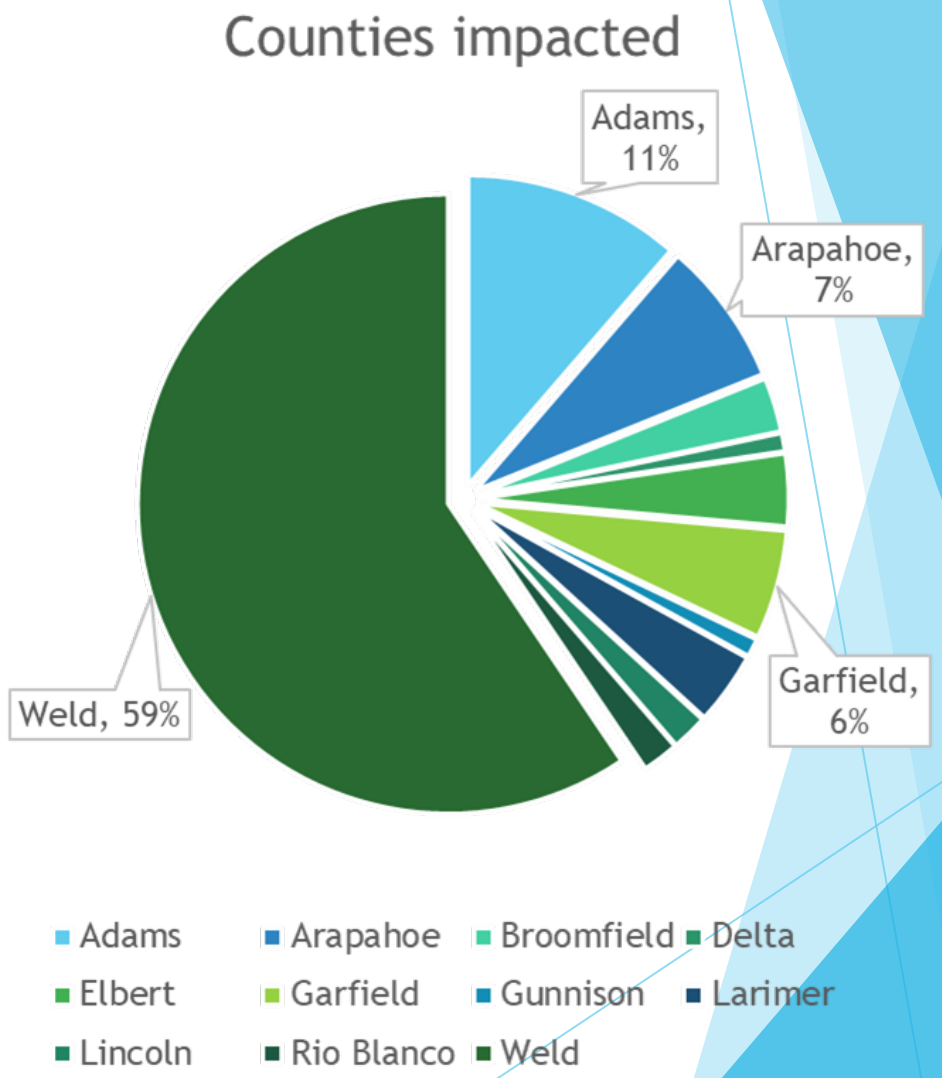
Reg. #7 operator plans submitted





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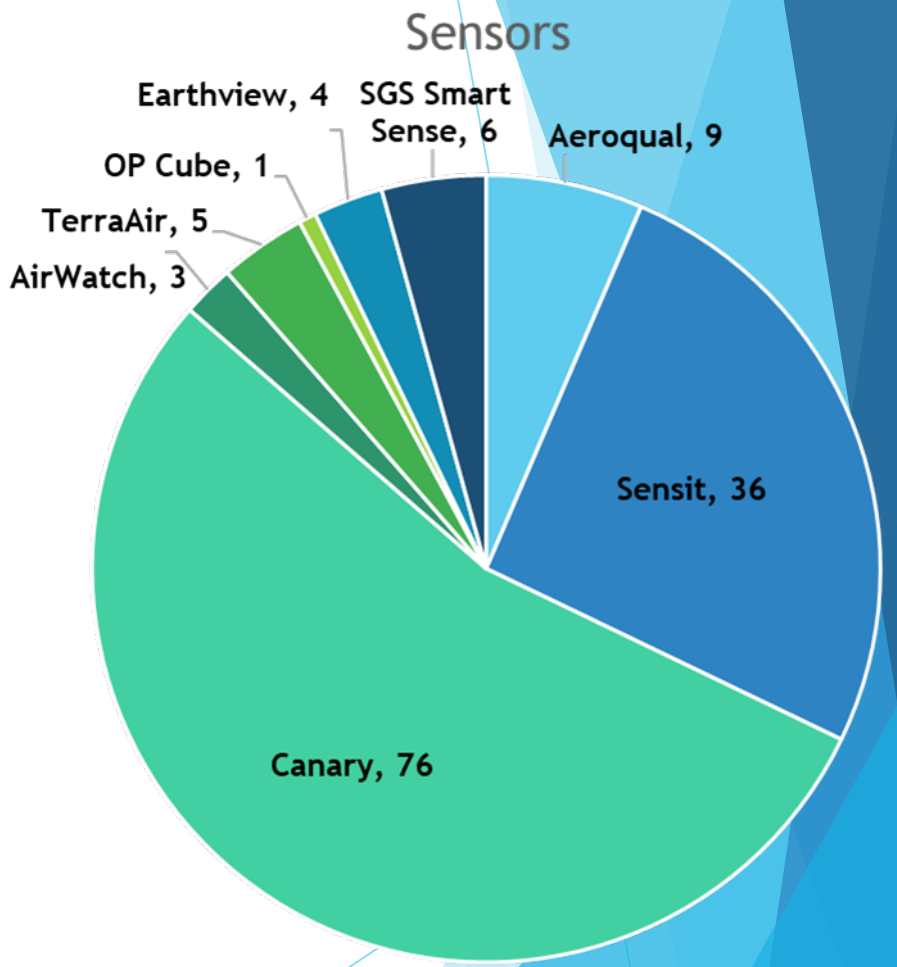
Reg. #7 monitoring being performed

- Total VOC with photoionization detectors (PID)
  - Canary S
  - Sensit SPOD
  - Aeroqual AQS1
  - Earthview BluBird
  - SGS Smart Sense
  - Praxis/OP Cube
- Total VOC with metal oxide sensors (MOx)
  - WSP Airwatch (now retired)
  - Terra AirGuardian
  - Field Geoservices
- Whole air canisters for VOC analysis
- Sorbent tubes for benzene analysis
- Meteorological sensors



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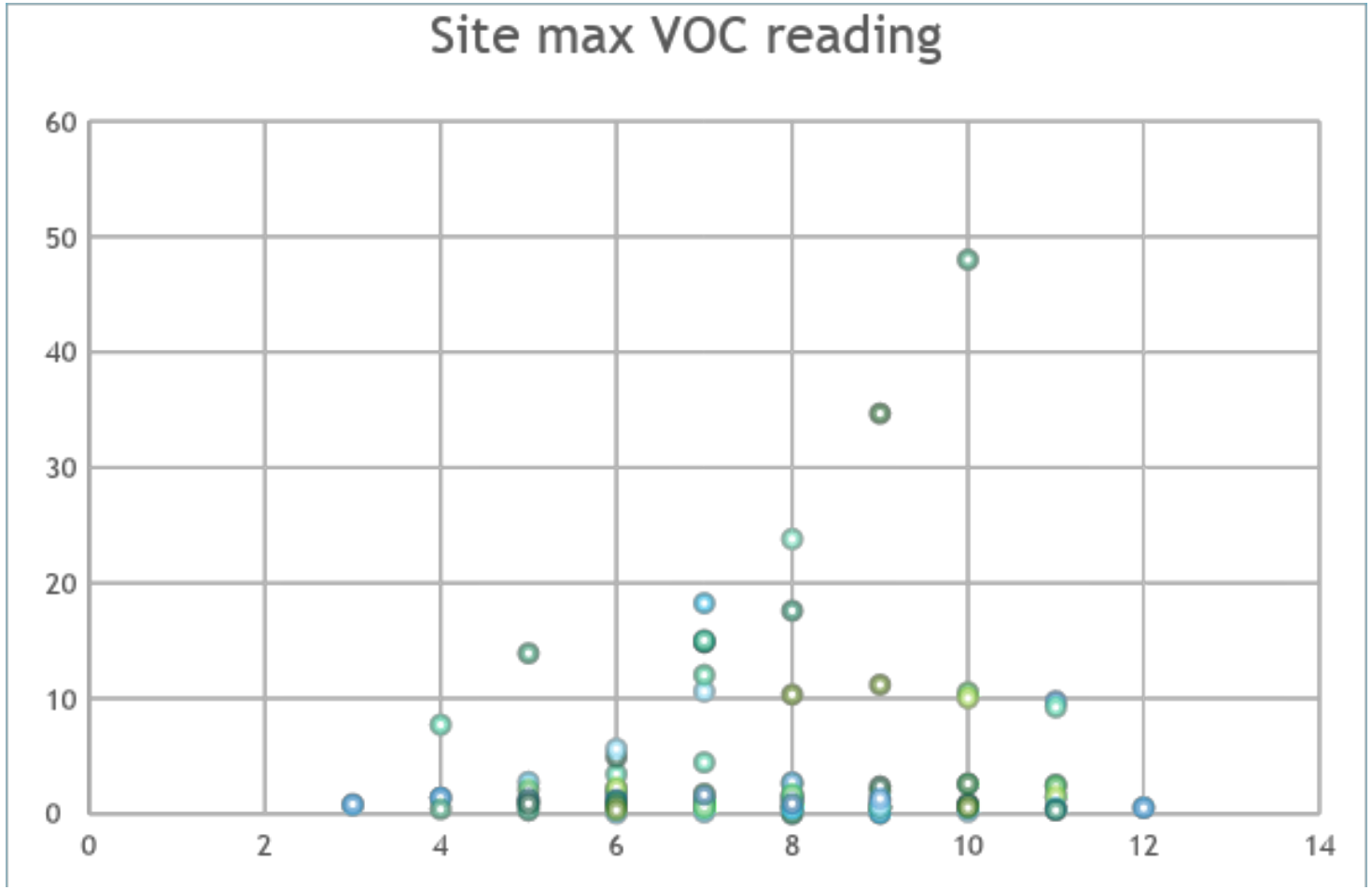
Monitoring data results



Regulations in 2021

- Control Equipment
  - Metering/Testing
  - Protocol Development Ongoing
- Leak Detection and Repair
  - New frequencies
  - Advanced Screening Workgroup Ongoing (Alt-AIMM)
- Direct Regulation
  - Well Unloading
  - Pigging/Blowdowns
- Midstream Fuel Combustion
  - Steering Committee
- Upstream GHG Intensity
  - How it works
  - Verification Rulemaking

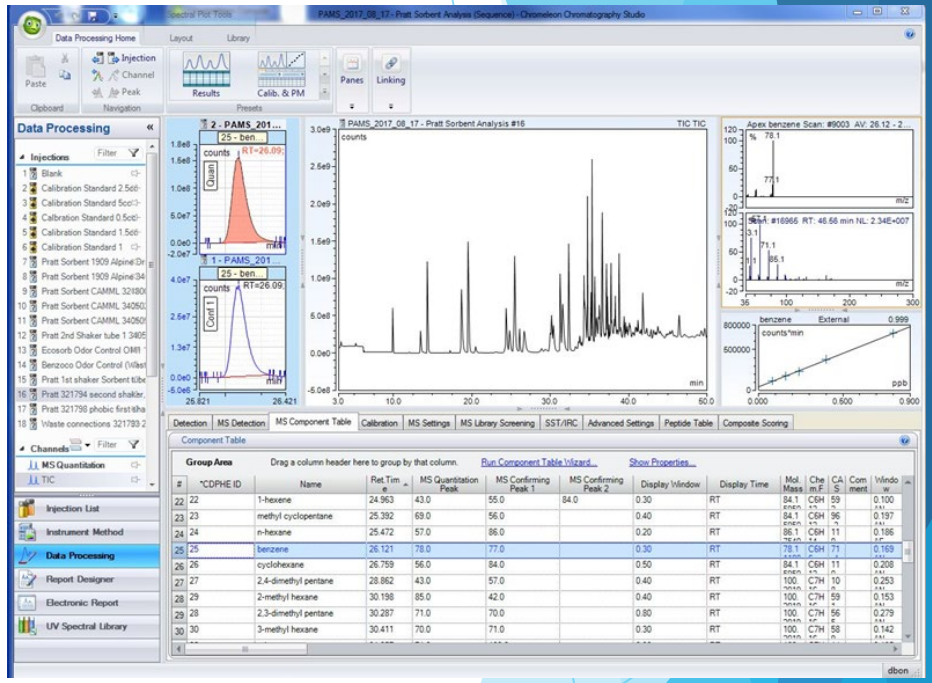
Mobile Monitoring and Aerial Campaigns

Colorado Air Monitoring Mobile Lab (CAMML)

- 2015 Governor's Oil and Gas Task Force Report (Recommendation #31b)
  - Funding for a mobile laboratory that could be dispatched to defined locations to monitor ambient air quality and to help determine potential sources
- First deployed in 2017
- Custom aluminum trailer
- Diesel Generator or Line Power (preferred)
- 1 minute resolution: Ozone, oxides of nitrogen, meteorology, PM2.5, PM10, methane, ammonia, hydrogen sulfide
- Volatile organic compounds (VOCs)
  - Laboratory-grade
  - GC-MS or GC-FID (55 compounds)

CAMML

- Deployments based on public health complaints received, proximity to populations, development activities, other factors
- Ideally:
  - 500-1000’ from sound wall
  - Between industry operation and residential areas
  - Power availability
- 3-4 weeks of measurements per phase of operation
  - Baseline/pre-development
  - Drilling
  - Hydraulic fracturing
  - Flowback
  - Millout
  - Early production
- Data posted at https://www.colorado.gov/airquality/tech_doc_repository.aspx#camml_data
- Summary and risk assessment reports posted at https://cdphe.colorado.gov/oil-and-gas-and-your-health/oil-and-gas-community-investigations

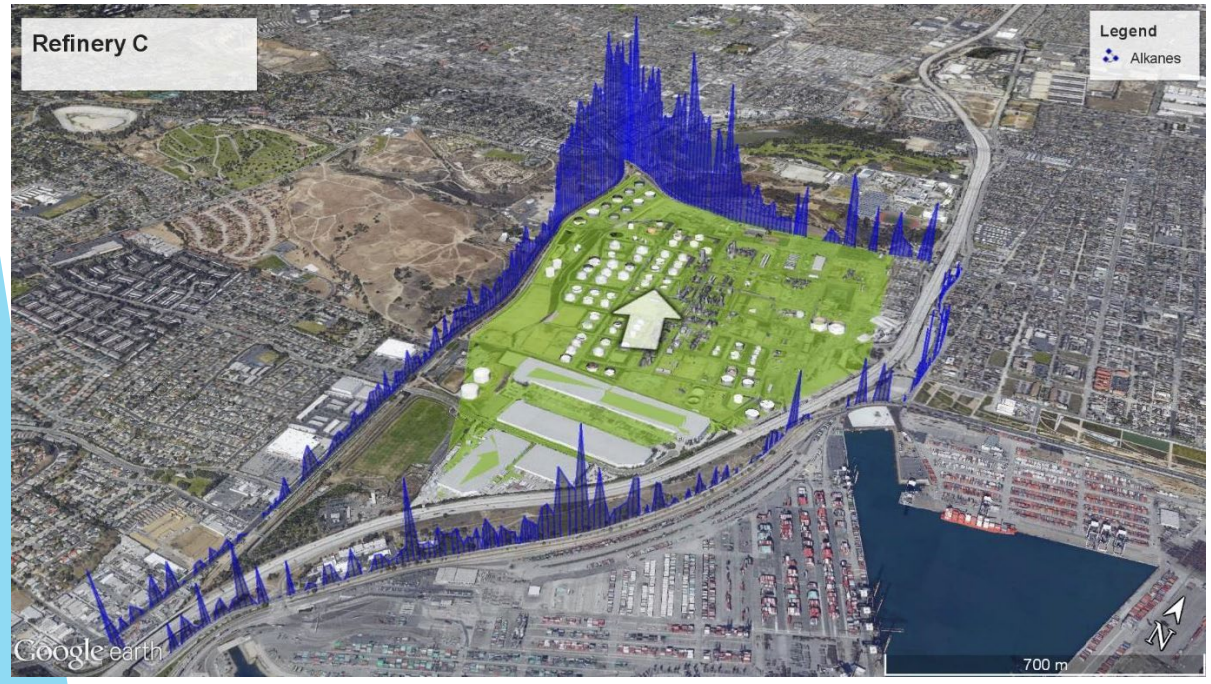


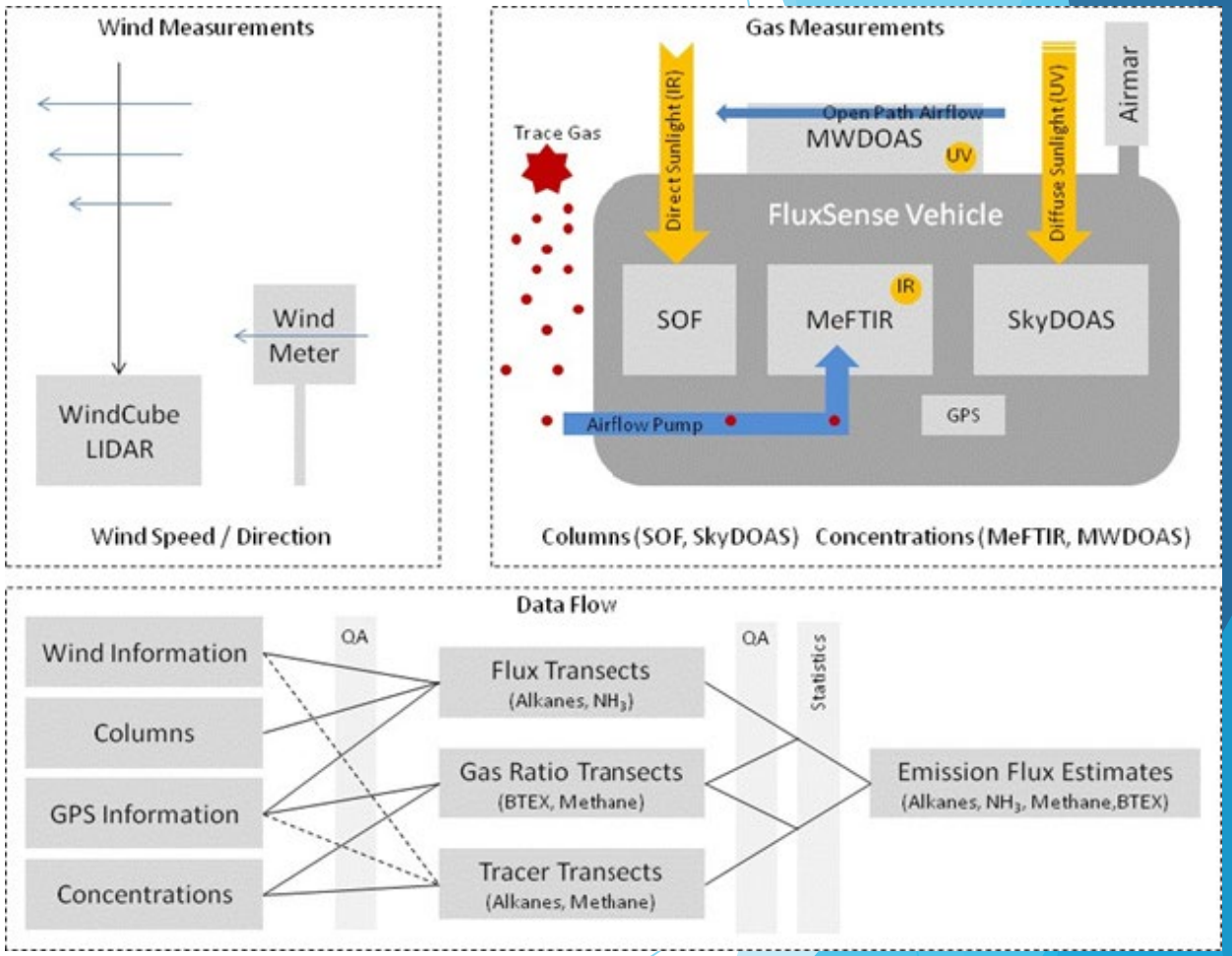
Mobile Van – MOOSE (Mobile Optical Oil and Gas Sensor of Emissions)

- Obtained as part of Mark Martinez and Joey Irwin Memorial Public Projects Fund ("Firestone Settlement")
- First deployed in August 2021
- Ground-level measurements (low ppb detection, 5-15 second):
  - FTIR (Fourier-Transform Infrared spectrometer) for methane, alkanes, alkenes, ammonia, formaldehyde, carbon monoxide, carbon dioxide
  - DOAS (Differential Optical Absorption Spectrometer) for benzene, toluene, ethylbenzene, xylenes, sulfur dioxide
- Vertical/column measurements (low mg/m3 detection, 1-5 second):
  - SOF (Solar Occultation Flux spectrometer) for total alkanes, alkenes, ammonia
  - SkyDOAS for nitrogen dioxide, sulfur dioxide, formaldehyde
- Other measurements:
  - Wind speed, wind direction, GPS

MOOSE

- Combination of measurement types allows for not only detection of emissions, but also flux calculations to estimate the rate of emissions
- Potential leaks that are found will be shared with the operators





Mobile Van – CAT (Colorado Air Toxics)

Coming soon…

- Required as part of HB21-1189 “Air Toxics Act”
- Designed for community monitoring around specific industrial facilities
- Must measure (at a minimum) air concentrations of:
  - Benzene
  - Hydrogen cyanide
  - Hydrogen sulfide
- Facilities are located in Commerce City area (3) and Pueblo (1)
- Must be operational by January 1, 2023

Sensors

- Easy to deploy
- Many are solar powered
- Most have a cellular or wi-fi connection to transmit data in real-time
- Fast data, 1-5 minute averages
- No laboratory analysis need for based measurements
- Some have trigger mechanism so whole air canisters or sorbent tube samples can be taken
  - Canister samples typically for 1-hour to compare to acute health guideline values

CDPHE Sensors

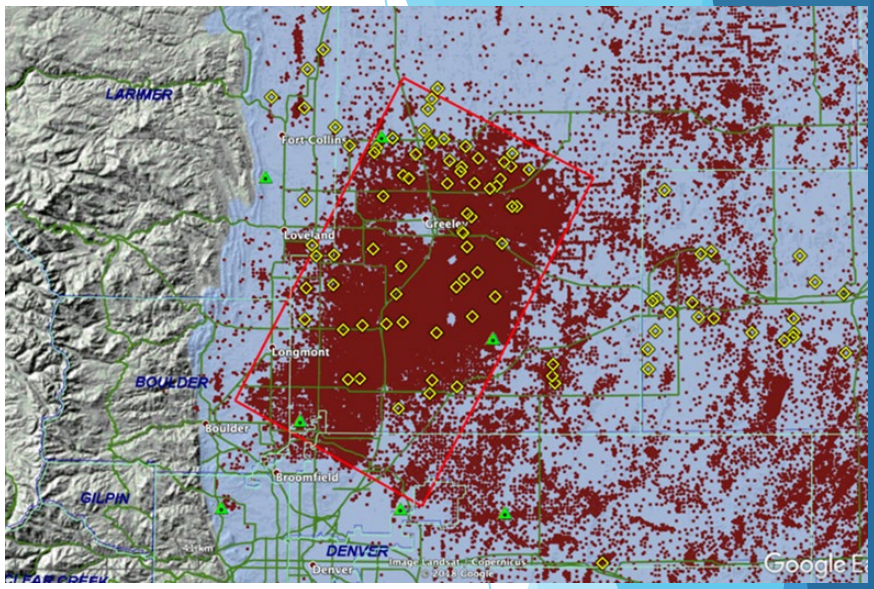
- Sensit SPOD
  - Total VOC PID sensor
  - Meteorological sensors
  - Solar, cellular connection
- Lunar Outpost Canary
  - PM2.5 sensor
  - Total VOC PID sensor
  - Meteorological sensors
  - Solar, cellular connection
- PurpleAir
  - PM2.5 sensor
  - Line power, wi-fi connection
  - Easy-access map

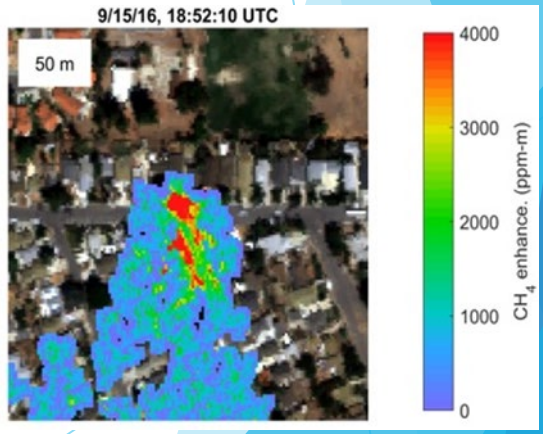
Aerial surveys

- Can cover large areas quickly
- Can see individual sources
- Mass balance flights to get estimates of total amount of emissions in an area
- “Lawnmower” flights to see individual sources
- Instrumentation can include:
  - Methane
  - Ethane
  - VOC’s
  - Oxides of nitrogen
  - Others

Fall 2021 aerial surveys

- Obtained as part of Mark Martinez and Joey Irwin Memorial Public Projects Fund ("Firestone Settlement")
- University of Arizona/JPL
  - Methane
  - Super emitters > 10 kg/hr
- Universities of Colorado and Maryland
  - CAMS-2 fast-ethane measurements
  - PTR-TOF-MS for fast BTEX measurements
  - Methane, NOx, carbon dioxide, meteorology
- Scientific Aviation
  - Flights over 4+ years
  - Flux/Mass Balance efforts for comparison with NOAA efforts
  - Targeted spirals over high emitting facilities
- Colorado State University
  - Compile current inventory and activity data
  - Populate the Methane Emissions Evaluation Tool (MEET)





Duren, *et al.*, 2019

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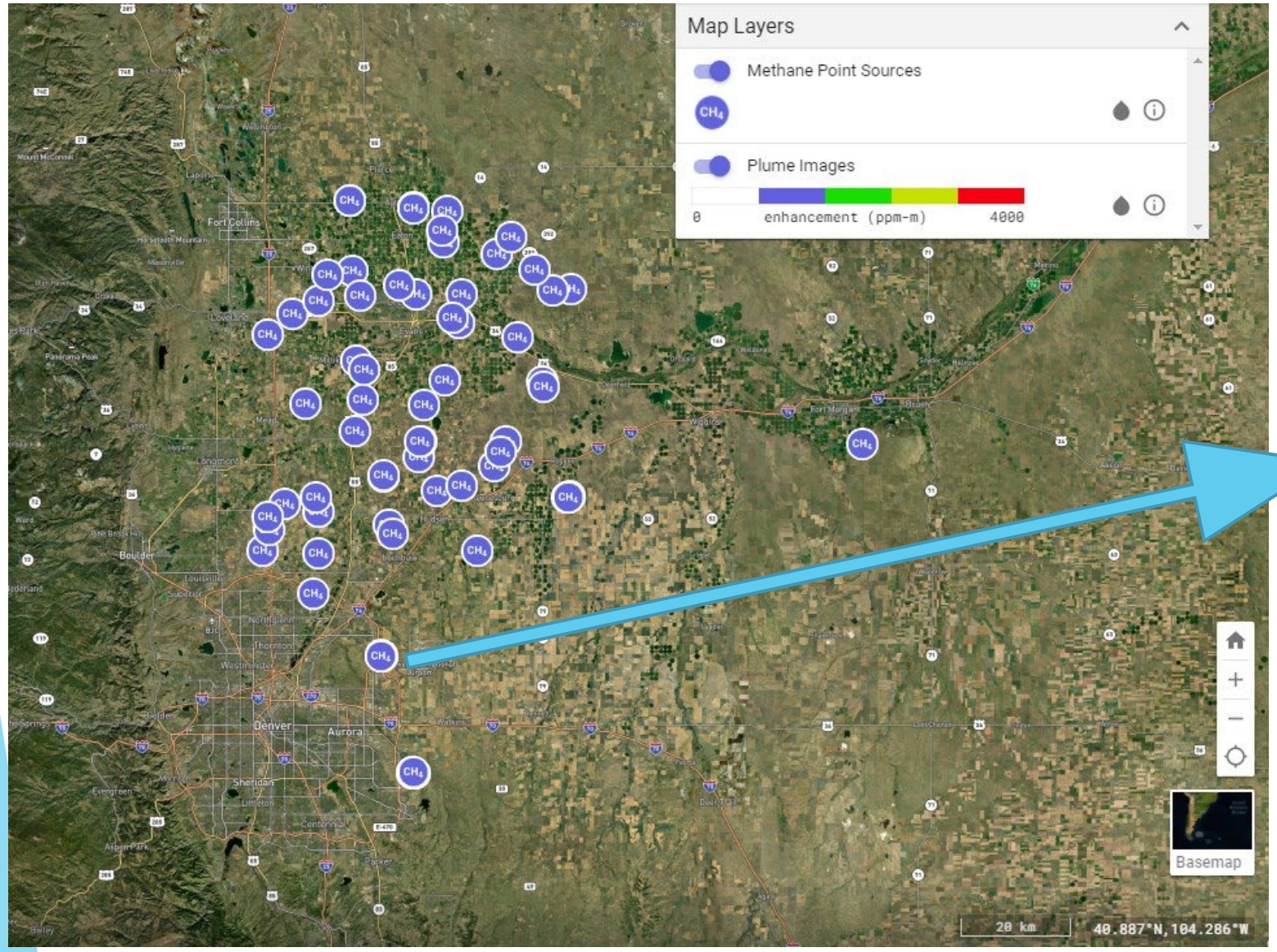
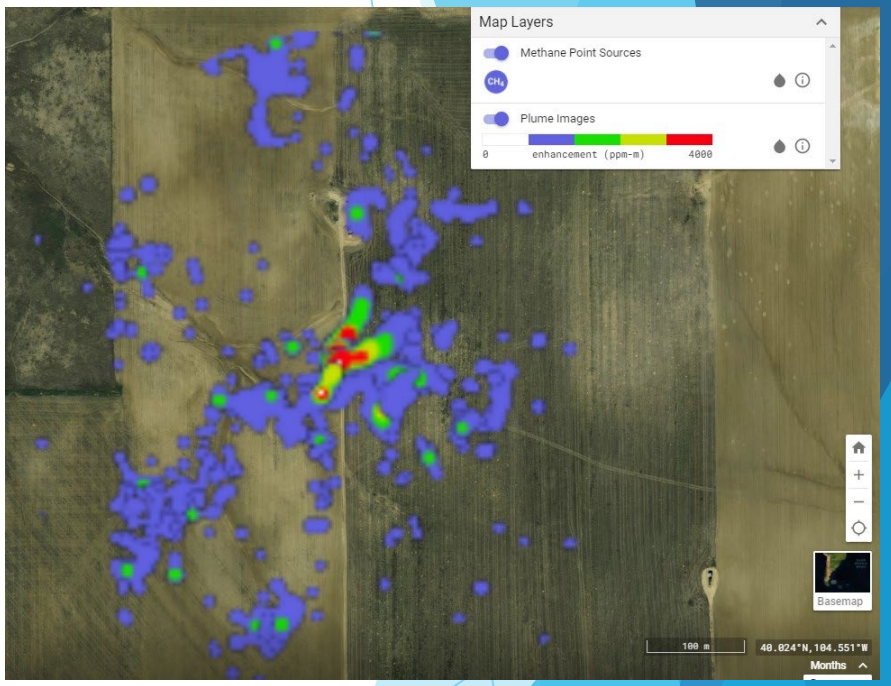
2021 methane aerial surveys



https://carbonmapperdata.org/



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Lessons learned and Next Steps

Lessons

- Different development activities have different emissions
- Drilling fluid being used can be seen on emissions
- Higher emissions when drilling in the producing formation
- Total VOC sensors are a good way to determine if there are high possible emissions from a source
- Sensors are a good way to determine what is the direction to high emitting sources
- Need to have individual compound speciation to look at potential risks
- Seeing some high VOC spikes on industry Regulation #7 monitoring
  - Allows operators to adjust practices to protect public health
- Aerial surveys can see sources where it is hard to get to on the ground
- Aerial surveys can cover large areas quickly and efficiently to see large emitters and leaksg
  - Inform operators to conduct repairs rapidly

Next steps / Future

- Faster data turn-around
- Better data systems
  - View data and reports
  - Download data for analysis
- More aerial surveys
  - Include drones as well as aircraft
- Additional mobile van
- Additional fixed air monitoring sites
  - VOC's
  - Nitrogen oxides
- Legislation
  - HB22-1244 focused on additional air toxics work