Airdar

Air Detection and Ranging:

Remote Detection and Quantification of Fugitive Emission Sources Using Ambient Measurements

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Outline

- Challenges and opportunities related to air emissions in the oil and gas industry
- Airdar results from 2010 AWMA presentation.
- Airdar can directly measure source emissions using ambient measures.
- Incentivizing (carrots) emission reductions may be less risky than trying to regulate (sticks) them.

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Challenges Facing Oil and Gas Exploration, Development, and Production

- Understanding existing emissions circumstances in areas of proposed development
- Estimating the emission impact of proposed new developments (environmental impact assessments)
- Monitoring projects going forward to ensure that impacts meet expectations
- Resolving unexpected emission issues

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Opportunity

- Directly measure any important emission impacts of a project using common ambient data
- This direct measurement will show background levels and the impacts of other projects in the area
- Provide accurate and actionable information to operations to reduce impacts of these important potential impacts (i.e. don't waste operations time and effort on non-issues while maintaining the capability to act quickly on real issues)
- Increase profitability by efficiently reducing impacts

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What Airdar Can Do

- Airdar can directly measure any emission from a great distance using only ambient data
- Airdar Can:
  - Identify the existence of background or non-background methane emissions or any other emission of interest
  - Determine the location of sources of emissions
  - Measure the source's emission rate

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Remote Detection and Quantification of Fugitive Emission Sources Using Ambient Measurements

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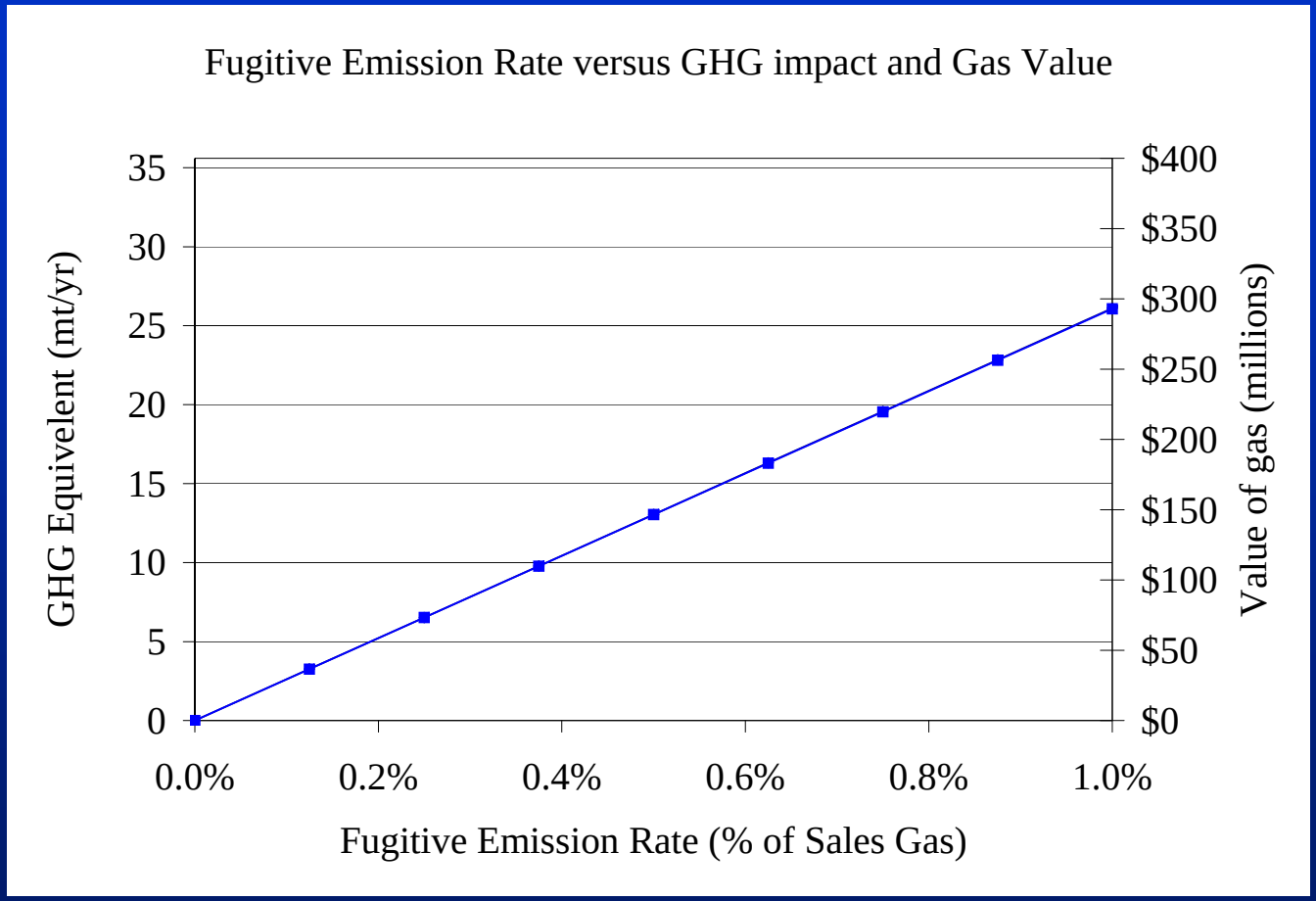
Outline

- Strategy to trade reductions in fugitive emissions of methane for GHG credit
- Air Detection and Ranging (Airdar) Technology
- Keyera Energy’s experience
- Real-Time Airdar Surveillance

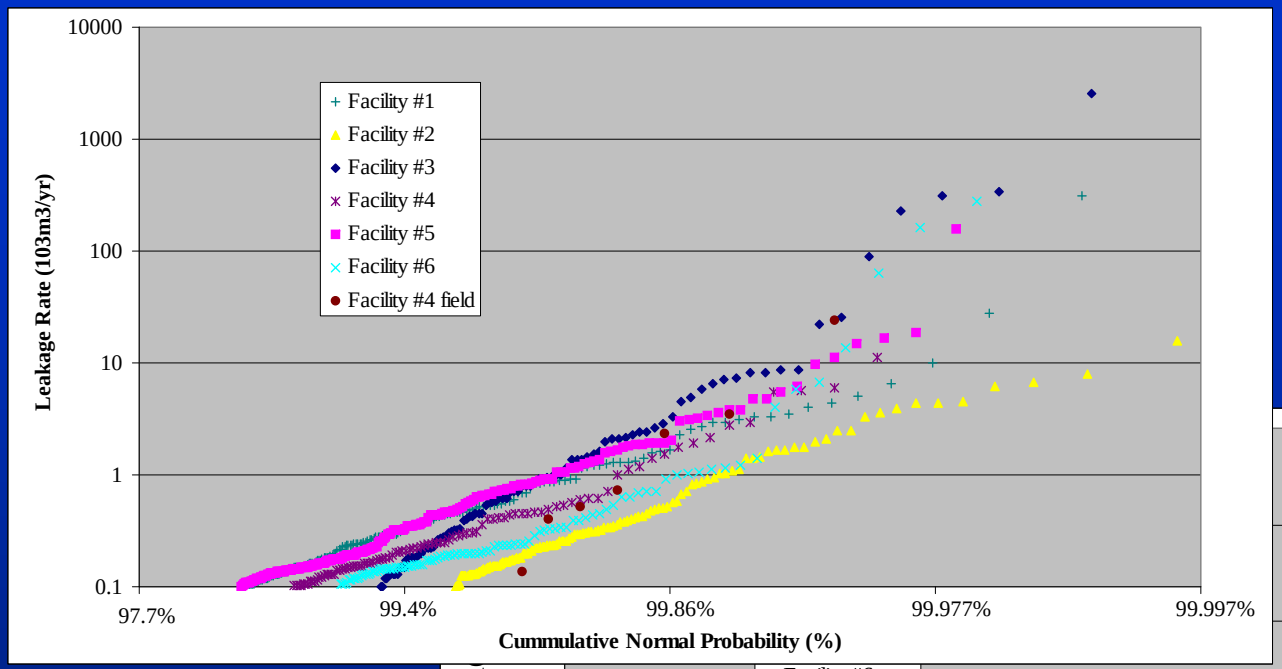
Why? "Size of the Prize"



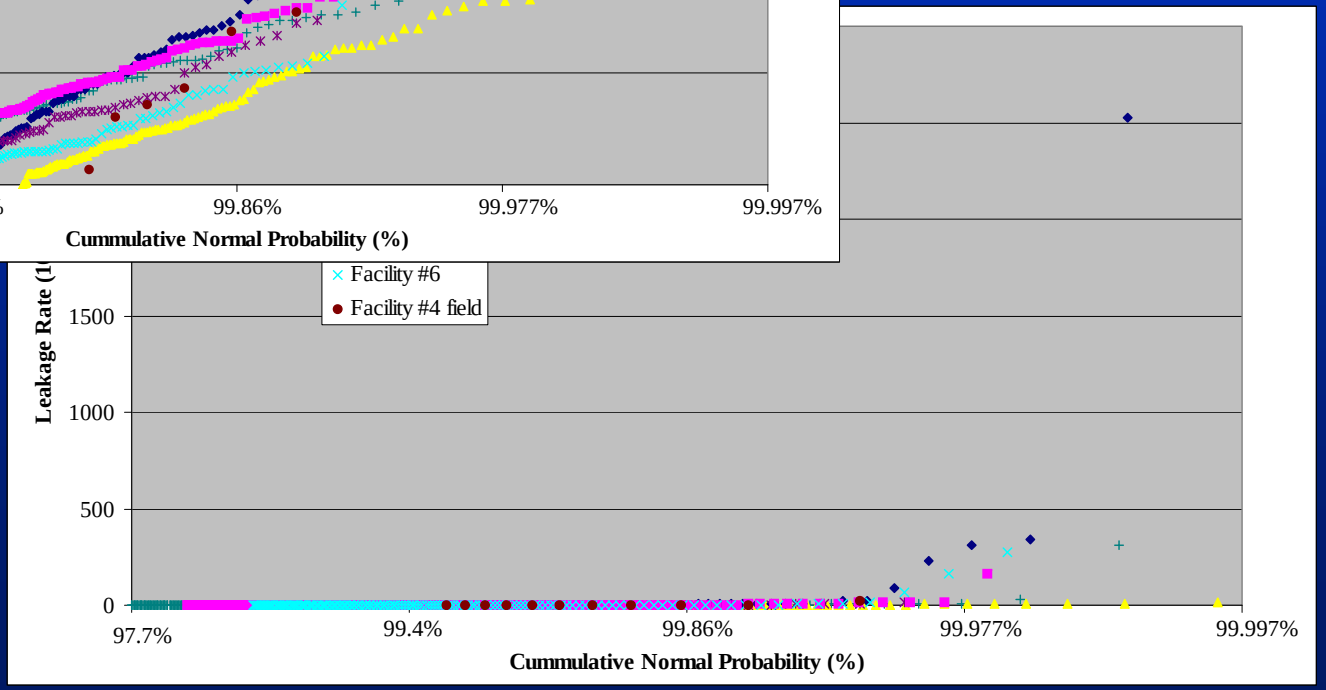
Note: Based on annual Canadian gas production of 174 billion m3/yr (NEB, 2007) with energy value of 37.4 MJ/m3 and dollar value of $4.50/GJ.

Due to their nature, total fugitive emissions is unknown. In Canada, Environment Canada estimates 66.8mt/yr CO2e (8.8% of National GHG emissions).

The Nature of Fugitive Emissions



Logarithmic Scale



Linear Scale

CETAC-West, 2005

Summary of roughly 90,000 fittings in 6 gas plants

Requirements of a Strategy

- MUST demonstrate with certainty that the emission was actually there
- MUST demonstrate with certainty that the emission was stopped or reduced
- MUST demonstrate with certainty that the emission did not come back
- MUST detect all NEW or increasing sources
- MUST be able to accurately measure or estimate the actual amounts emitted/avoided

Key Concepts being Incorporated

- **Complete Coverage**
  - Required due to changing emission sources
  - Most reporting & regulation done on a site basis
- **Direct Quantification**
  - Required due to changing emission rates
  - Monitoring frequency, randomness, and independence must be sufficient to ensure unbiased and verifiable results

We believe "virtually continuous" monitoring will have to be adopted.

Available Technologies

Technology	Direct Quantification	Virtually Continuous	Complete Coverage
Point Source Leak Detection Methods.	No	No	No
Point Source Quantification Methods.	Yes	No	No
Area Source Leak Detection and Quantification Technologies.			
1. Differential Absorption LIDAR (DIAL).	Yes	No	Yes
2 Air Detection and Ranging (Airdar).	Yes	Yes	Yes
3 Open Path, Path-Integrated Optical Remote Sensing (PI-ORS).	*No	Yes	Yes
3.1 Open Path Tunable Diode Laser Absorption Spectroscopy (TDLAS).	*No	Yes	Yes
3.2 Open Path Fourier Transform Infrared (FTIR) Spectroscopy.	No	Yes	Yes
3.3 Radial Plume Mapping (RPM).	*No	Yes	Yes

*** Evaluated in 2007 as not a direct quantification**

Reference: "Review and Update of Methods Used for Air Emissions Leak Detection and Quantification" Prepared for TEREE committee (PTAC), February 5, 2007

Alberta Protocol

- A protocol developed over two years that adopts this GHG credit trading strategy is at the final stage of approval in the Alberta offset system
  - *(update 2014…Protocol was not approved… GHG credit is not our focus but was explored to secure added value to our clients for complete emissions monitoring…)*

Airdar Background

- How can an elephant smell a lion from miles away?
- They need three things to do this:
  - A definable plume
  - A detector (nose)
  - A brain to collate and remember information (i.e. Airdar)

Keyera Energy's Experience and the Airdar Technology


AIR QUALITY
MONITORING LAB

Equipment in MCC Building

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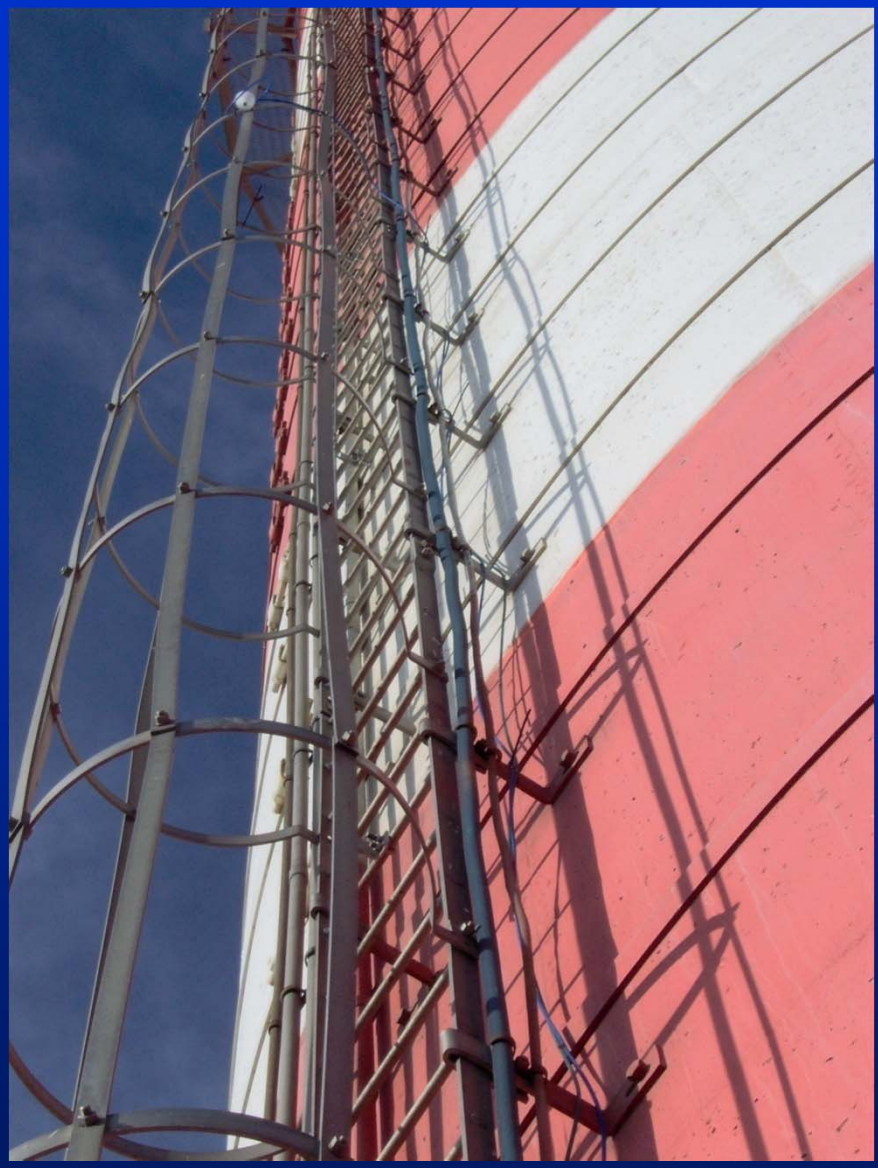

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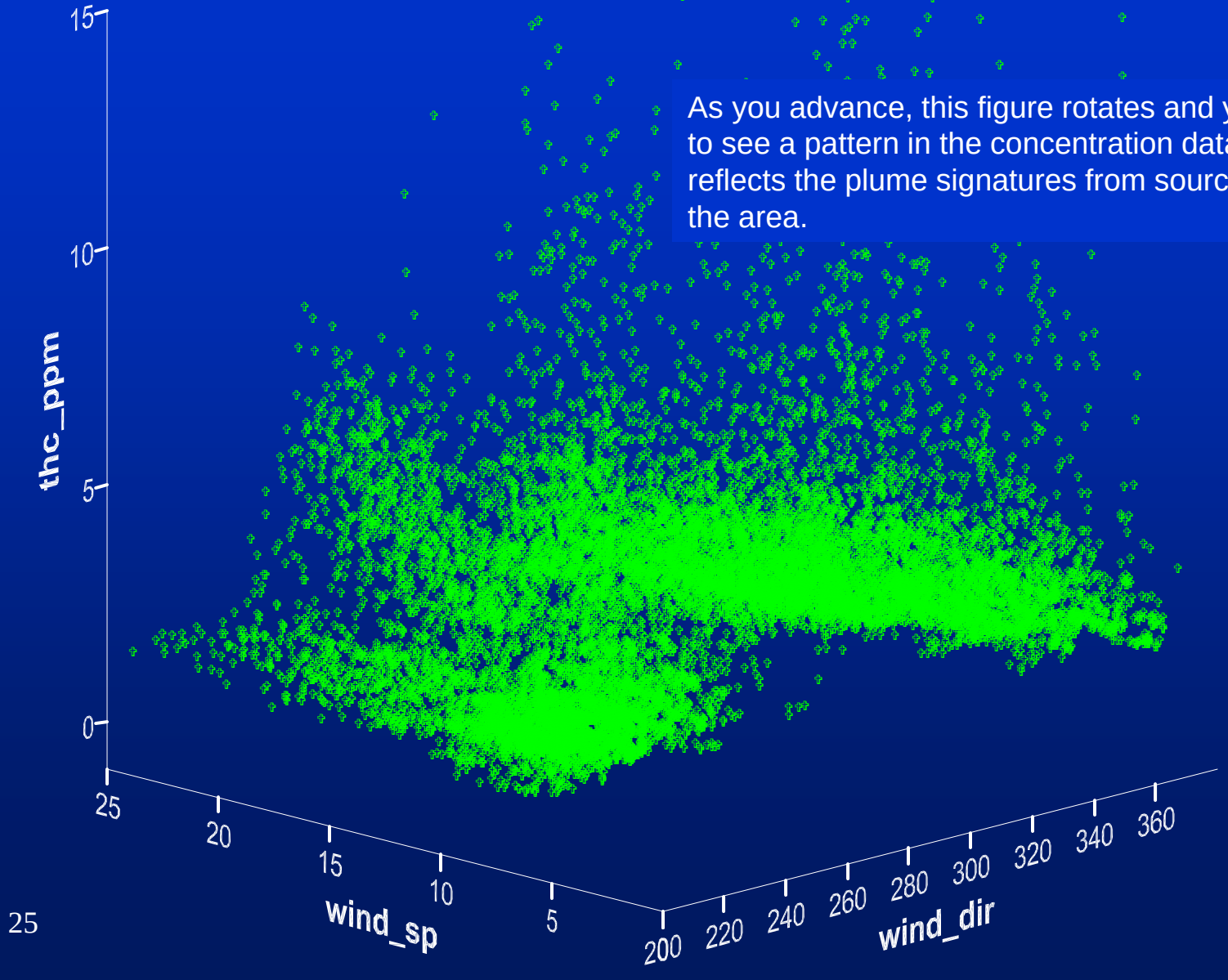
Plume Signatures in Ambient Data with Airdar Technology

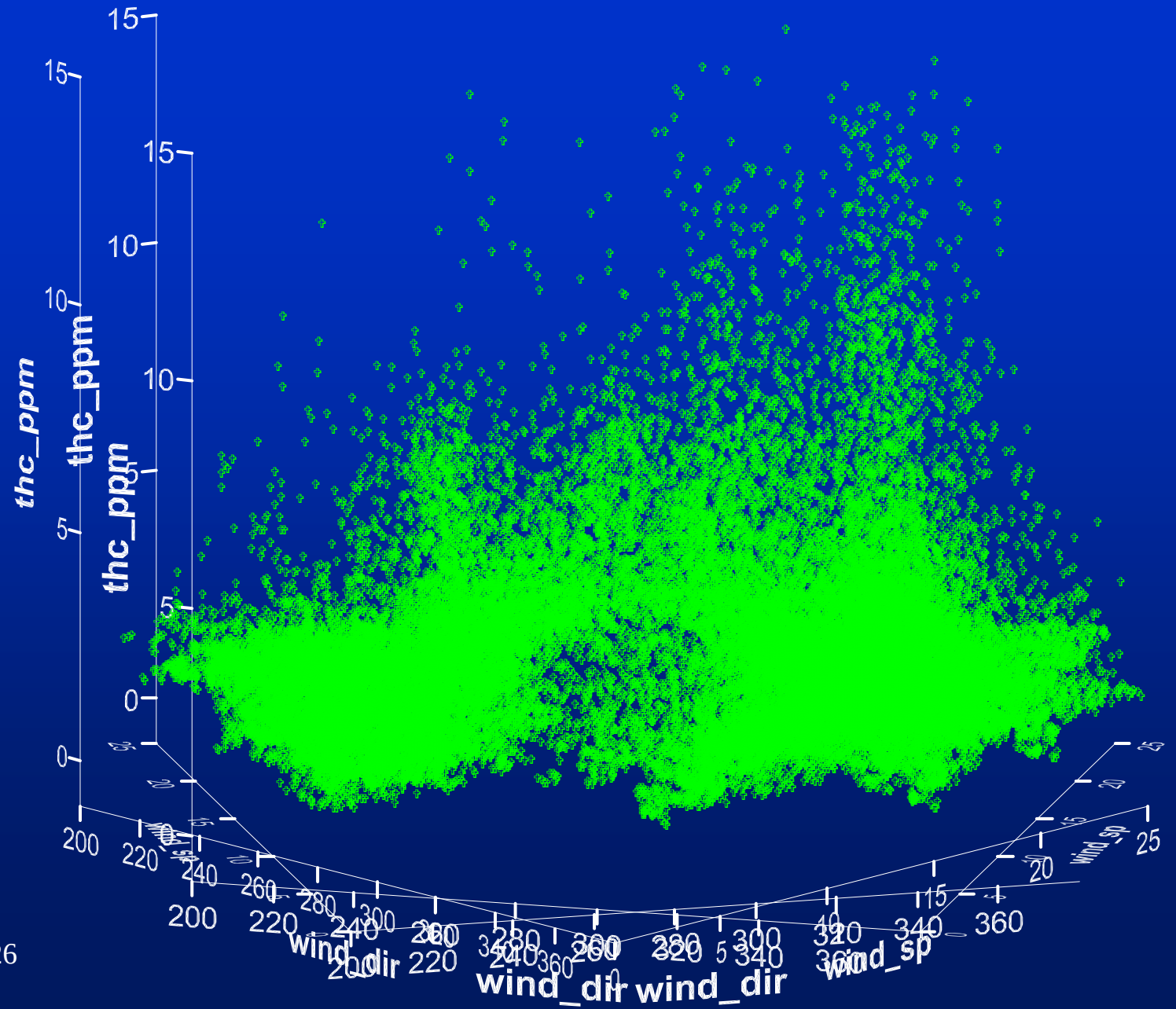
This figure shows ambient THC concentrations from a single sampling inlet plotted against wind speed and direction. Figures like this one exist for each sample inlet.

There are 10s of thousands of points in this figure. Each point represents a ten second average THC concentration measured at one position over a four week period of time.

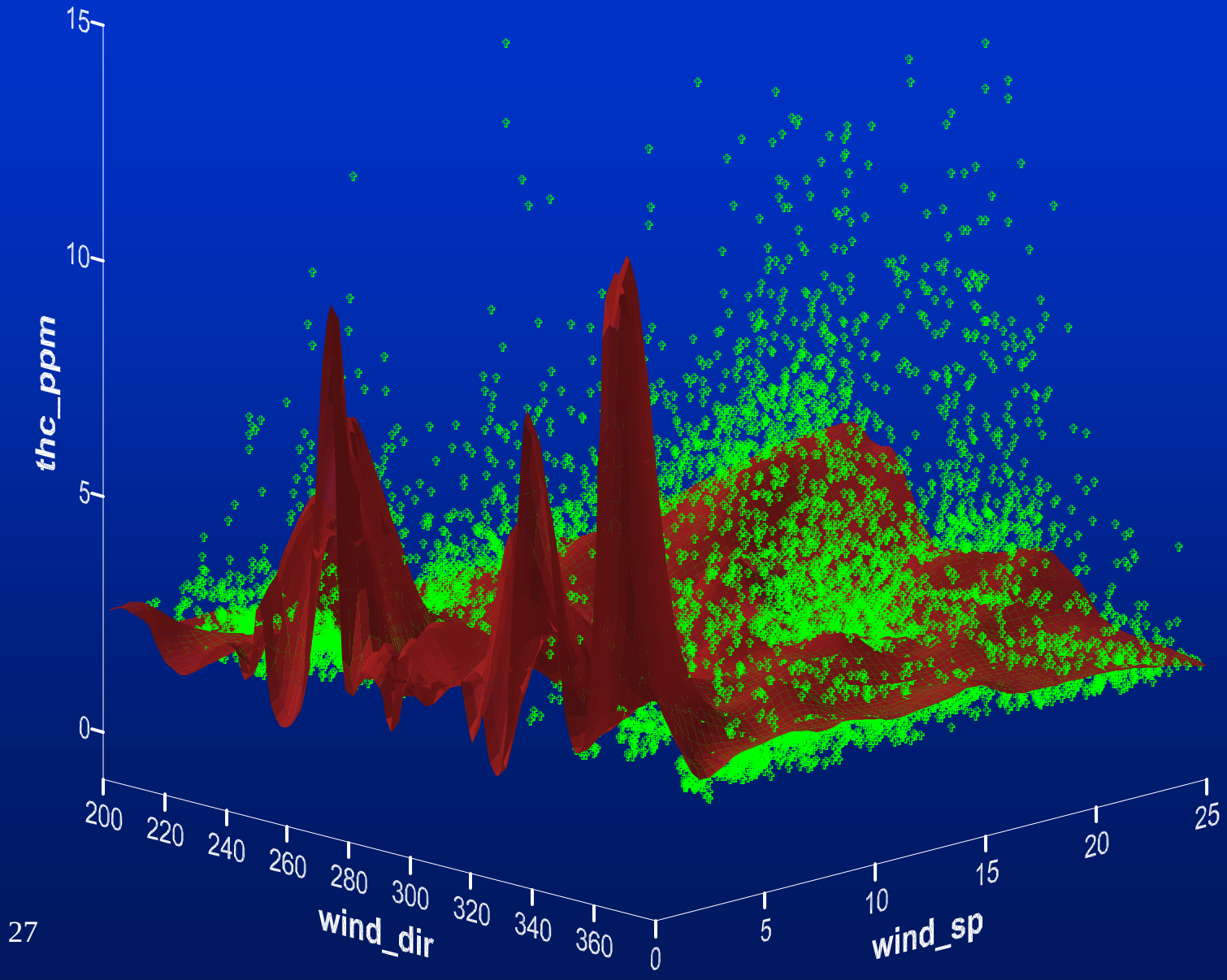


As you advance, this figure rotates and you can start to see a pattern in the concentration data that reflects the plume signatures from sources of THC in the area.

The next advance will add a surface to this figure that represents the average THC level for each combination of wind speed and direction during the four week monitoring period.

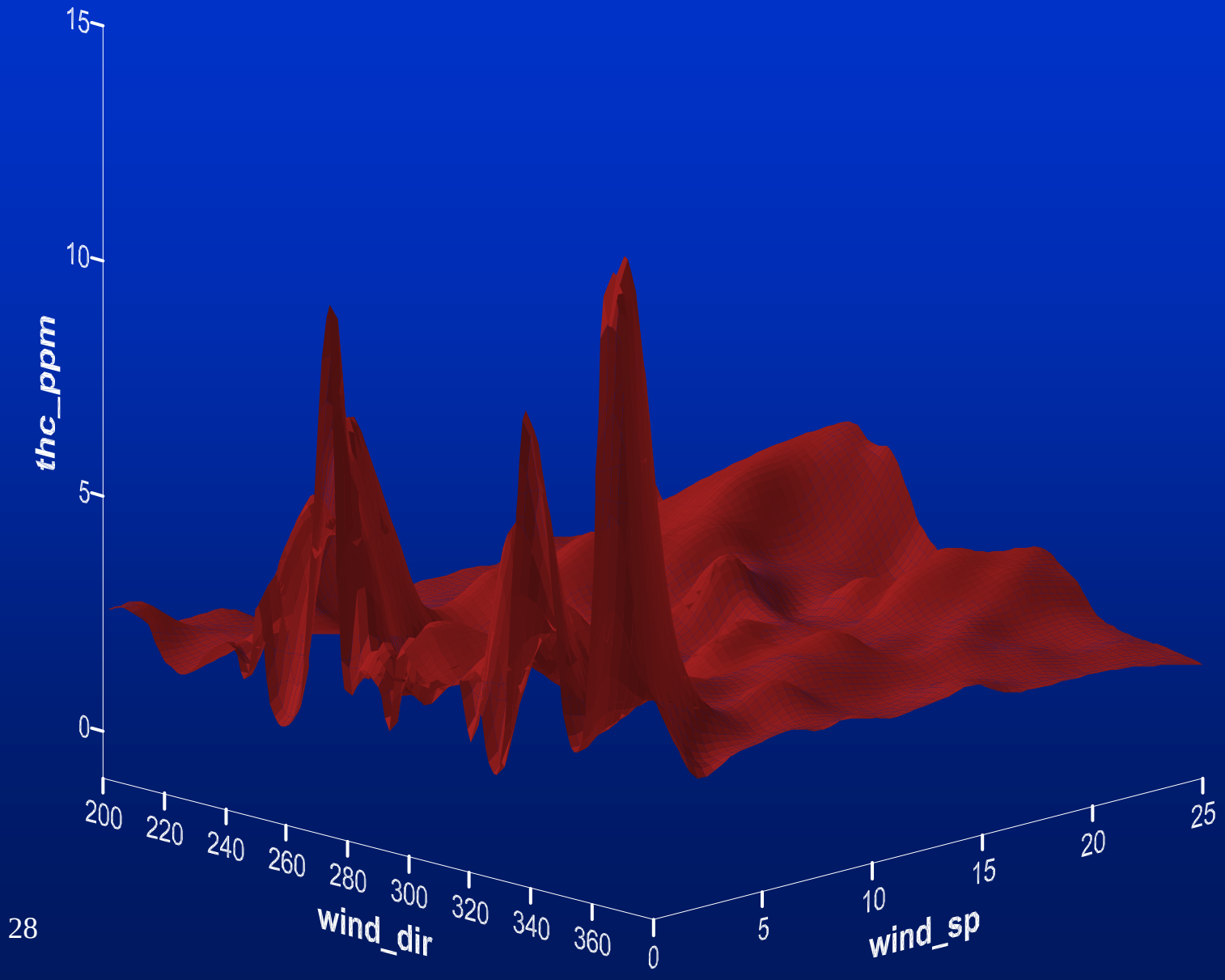


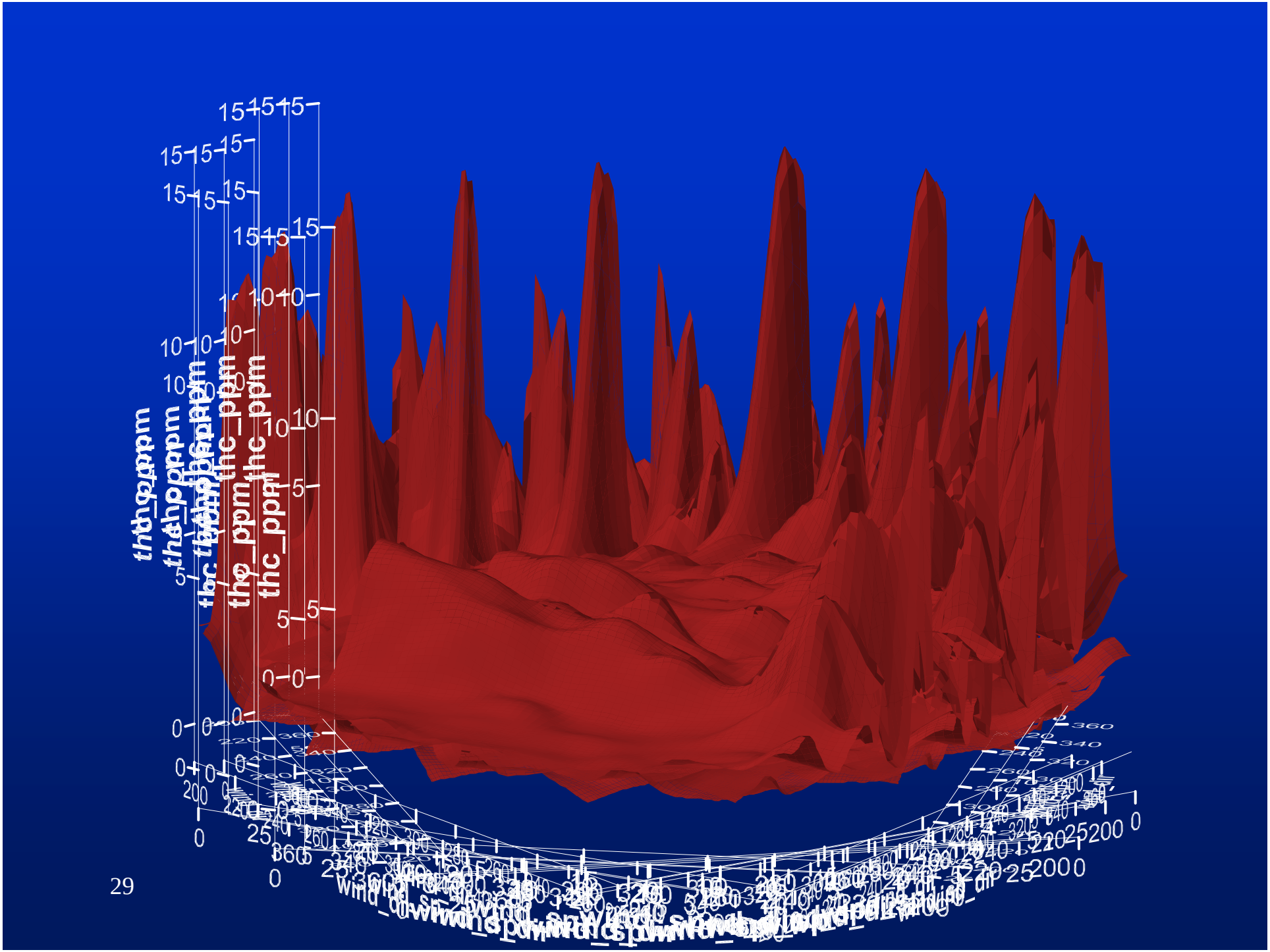
The next advance will remove the cloud of points and show the surface more clearly.



The pattern in the surface show the signatures of multiple plumes emanating from multiple sources in the area

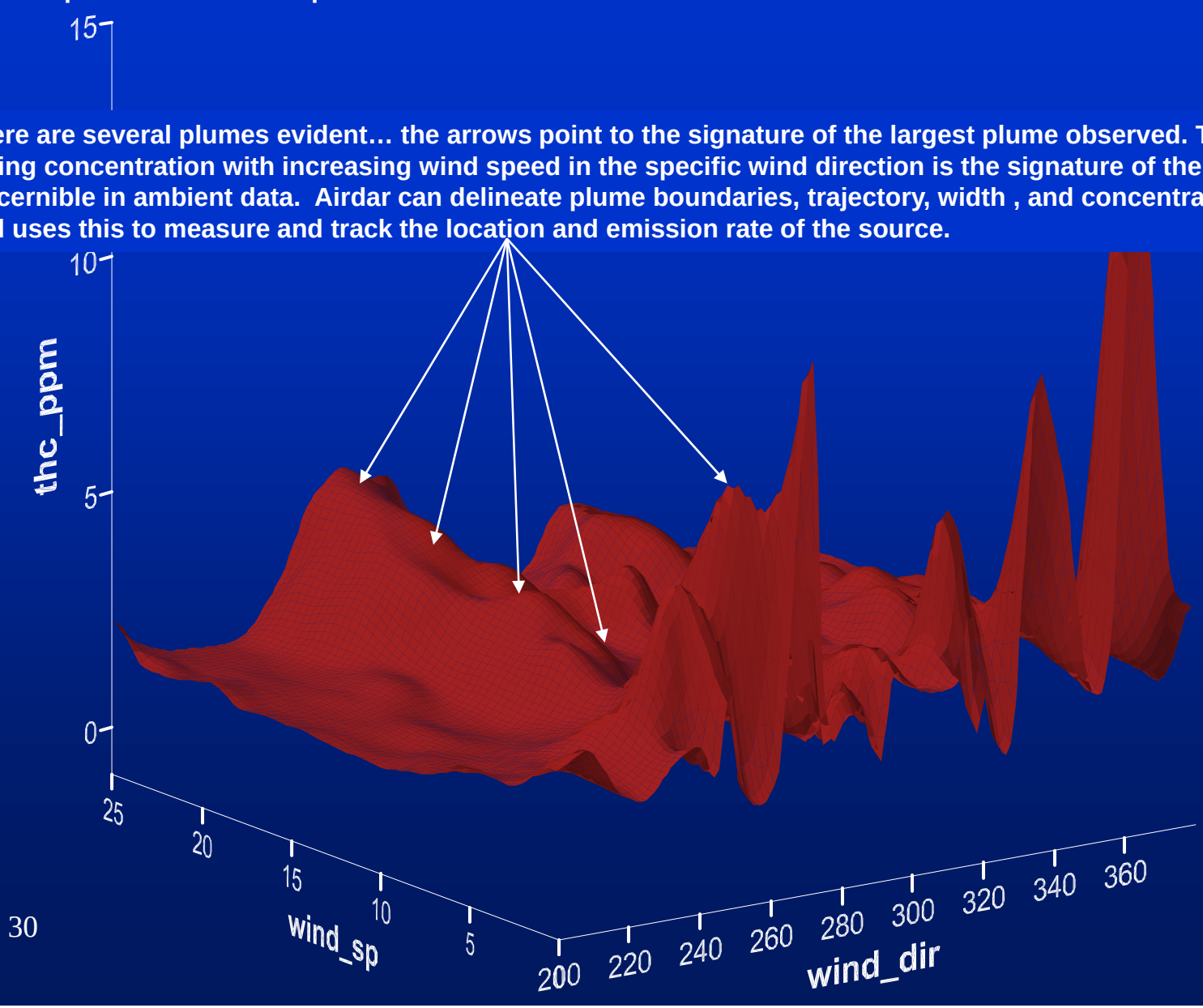
The next several advances will rotate the surface so the plumes signatures are more clearly evident.

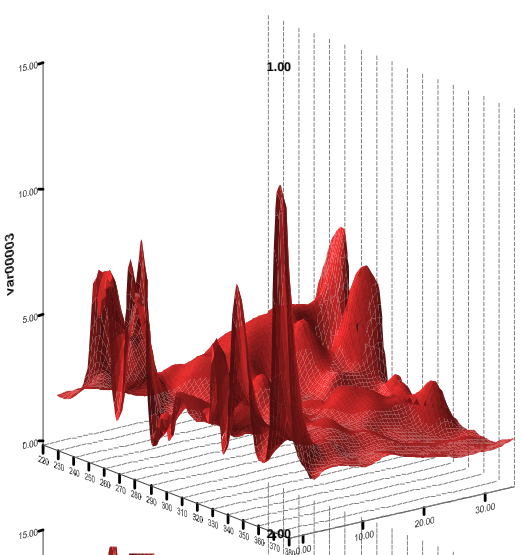




This demonstrates that using only a single point of observation of ambient data, Airdar can discern plume characteristics. If the source location is known then the emission rate can be calculated directly. If the source location is unknown then it must be first determined by triangulation of the plume trajectories observed from multiple observation positions and then quantified second.

There are several plumes evident… the arrows point to the signature of the largest plume observed. The ridge of rising concentration with increasing wind speed in the specific wind direction is the signature of the plume discernible in ambient data. Airdar can delineate plume boundaries, trajectory, width , and concentration profile and uses this to measure and track the location and emission rate of the source.

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LLR Smoother
var00003
15.00
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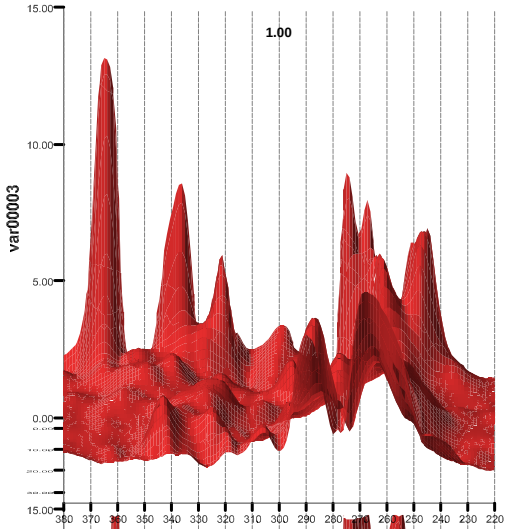
← June →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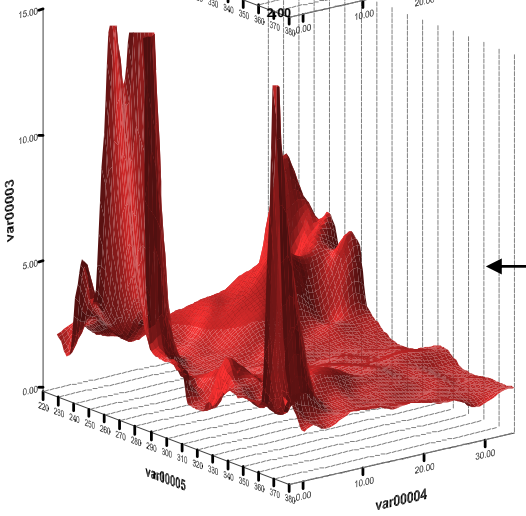
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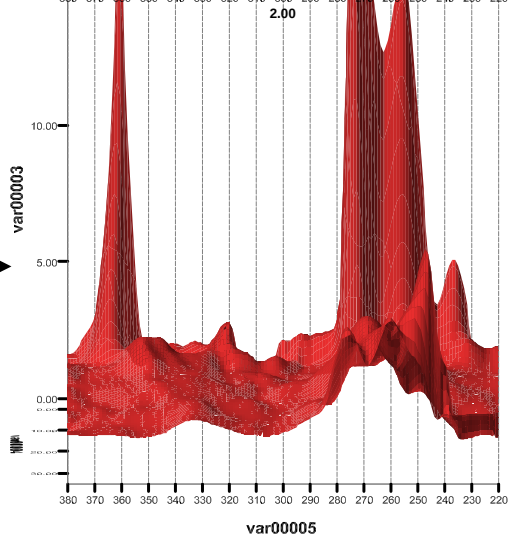
← August →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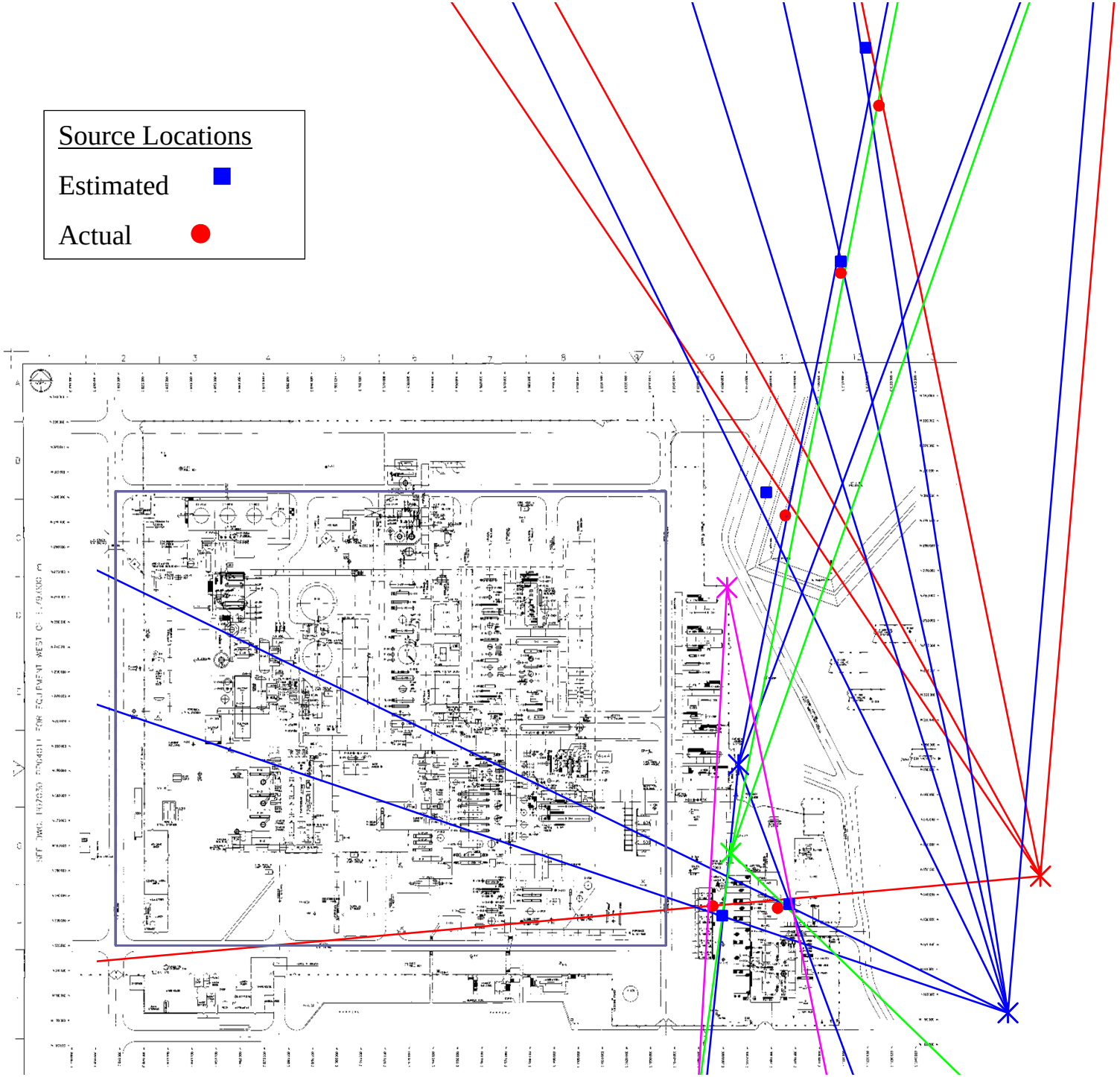
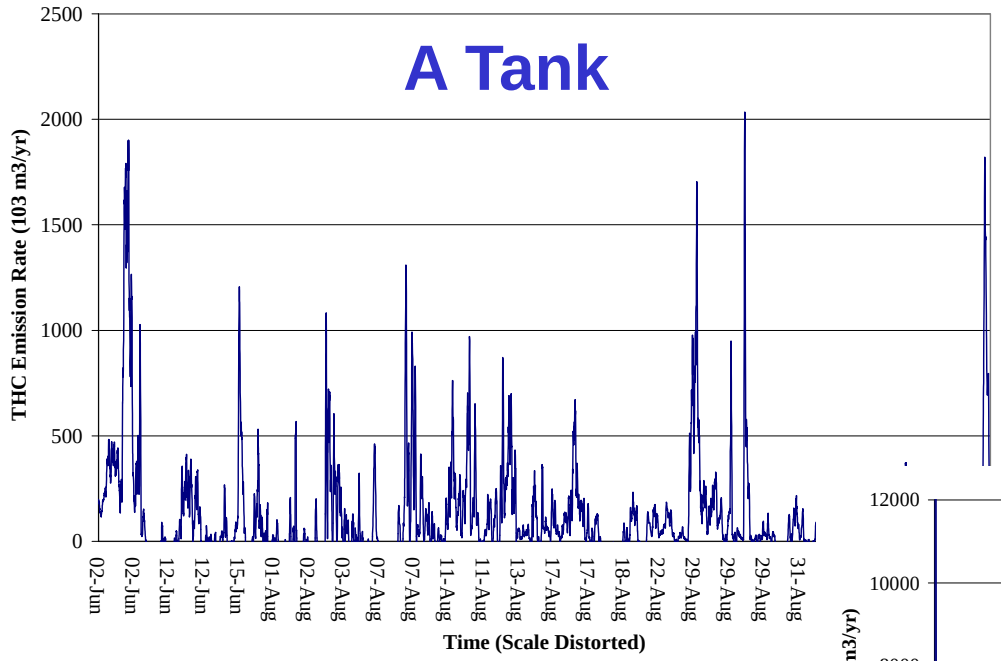
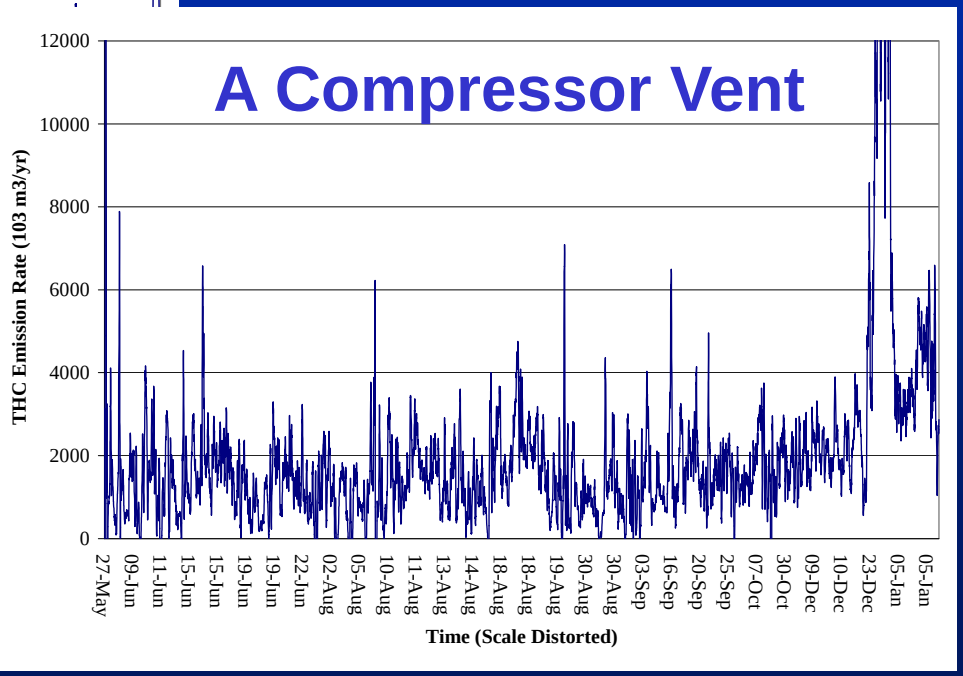

Source Locations
Estimated
Actual

Variability Over Time



Changes in operation



Changes in equipment condition

Basis Airdar *2005 Continuous Monitoring*

Emissions & Method Comparisons

Technology	DIAL	AIRDAR	Traditional Leak detection	Bag and Stopwatch
Compound	methane	THC	THC	THC
units	$10^3 m^3/yr$	$10^3 m^3/yr$	$10^3 m^3/yr$	$10^3 m^3/yr$
date	16-Jun-03	Jun-05 to Jan-06	Fall - 05	Fall - 05
Compressor area	1112	2085	18	1035
Separator area	309	79	na	na
Tanks combined	868	522	na	na
Tank 10	-	105	na	na
Tank 11	-	141	na	na
Tank 12	-	276	na	na
Other areas	-	62	na	na
Offsite source	-	40	na	na
Overall plant	2289	2788	na	na

It is very easy to miss sources in an ad-hoc survey !

Real-Time Airdar Surveillance

- Real-time Airdar algorithms quickly recognize new sources by detecting the subtle changes in air concentration that they cause
- Can detect new sources before they become a problem
- Can monitor large areas covering several km depending on compound and background levels
- Provides 24/7 surveillance of new sources with unmanned operation.

Summary

- Remote Detection and Quantification of Fugitive Emission Sources Using Ambient Measurements and Airdar is an important development that can:
  - Remove the uncertainty in fugitive emissions and authenticate reductions
  - Enable a strategy to incentivize fugitive methane emission reductions which may be more effective than proscriptive regulations
  - Make practical 24/7 surveillance of fugitive emissions
  - Provide early actionable information on emerging or changing emission sources with real-time updates of Airdar surveillance

Converting Air Concentrations to Source Characteristics (Emission Rates!!!)

Air Concentration M/L^3 * **Wind Speed** L/T = **Flux per unit cross-sectional area** $M/(L^2T)$

Flux per unit cross-sectional area $M/(L^2T)$ * **Plume cross-sectional area** L^2 = **Source Emission Rate** M/T

Dimensions:
L = length
M = mass
T = time

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Incentivizing Emission Reductions (carrots vs. sticks)

- Famous adage, "*you cannot manage what you cannot measure*" (Peter Drucker, Bill Hewlett, Lord Kelvin) applies to fugitive emissions
- Incentivizing emission reductions (carrots) will require measurement of emissions… resulting in better management
- Regulating emission reductions (sticks) may be risky given the many uncertainties and may result in unintended consequences
- Airdar measures all emissions… takes the "fugitive" out of fugitive emissions so that they are just emissions that can be managed appropriately

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Solutions Enabled by Airdar

- **Track Important Sources:**
  - Use existing ambient monitoring data to quantify emission sources in the area with an Airdar analysis
- **Put a Bounty on Methane:**
  - Incentivize operators to continuously measure and report emission rates from their facilities by offering greenhouse gas (GHG) offset credits for reduced methane emissions
    - *This win-win approach aligns the interests of industry and Albertans on emissions… the alignment of interests is where we have had success in Alberta*

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Airdar Inc. Services

- Emission source characterization using existing ambient air monitoring data
- Continuous monitoring
- Real time Airdar alerts
- Verification of emission reductions (GHG credits)
- Urgent source identification (odors, noxious compounds)
- Mobile Airdar (potentially…cell phone based odour tracking)

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Airdar Inc. Working Relationships

- How we can work with engineering firms and clients:
  - Subcontract with engineering firm
  - Direct contract with client
  - Contract via client's legal counsel
  - A combination of the above

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Conclusions

- Containing emissions has/will result in a significant reduction in methane emissions which is welcome and should be recognized
- A mechanism exists to reward these low authenticated emission rates… GHG offset credits
- A technology exists that can authenticate these low emission rates and provide certainty… Airdar
- The GHG offset credits could pay for the emissions certainty needed to earn them
- The emissions certainty can resolve and provide early warning of future problems
- This incentivization (carrots) solution may be a lower risk approach

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Other Questions

- **Airdar can respond rapidly to a request for information**
- **Contact:**

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