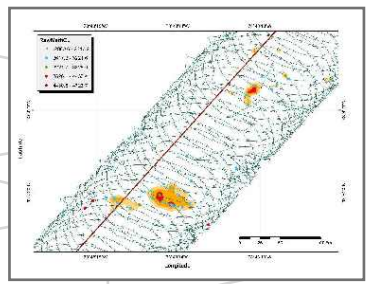
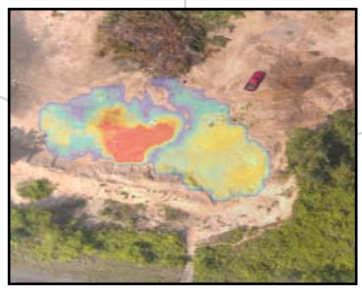
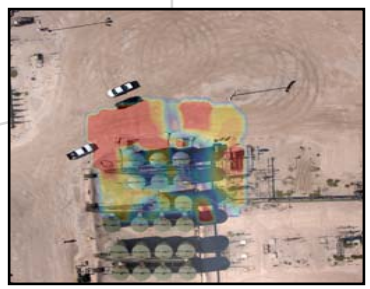
EPA Gas STAR Program – Annual Implementation Workshop

Detection and Measurement of Fugitive Emissions Using Airborne Differential Absorption Lidar (DIAL)







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25 October 2005

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ITT Industries – Corporate Overview

ITT Industries: ~$7.0 Billion (annual revenue)

- **ITT Defense:** ~$3.0 Billion (annual revenue)
  - Supplier of sophisticated military defense systems and provider of advanced technical and operational services to government customers.
- **ITT Industries Space Systems Division**
  - Over 50 years as a national leader providing innovation and quality in the design, production and development of Remote Sensing, Meteorological, and Navigation satellite systems.

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Hydrocarbon Gas Detection: Active Remote Sensing

Definition

– A remote sensing system that can emit its own electromagnetic energy at a target and then record the interaction between the energy and the target.

Application

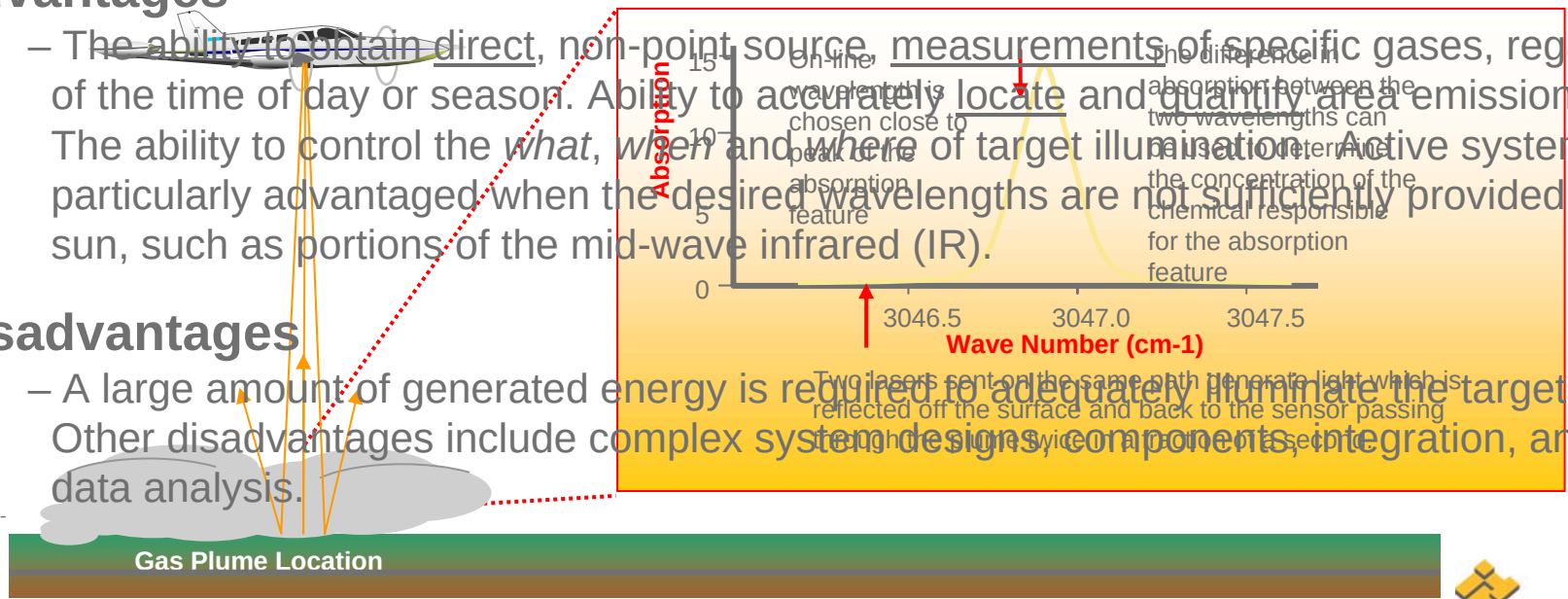
– DIAL (Differential Absorption Lidar) is an example of an active remote sensing technology. A DIAL system sends out controlled pulses of laser energy and then measures the interaction between the laser energy and the target.

Advantages

– The ability to obtain direct, non-point source, measurements of specific gases, regardless of the time of day or season. Ability to accurately locate and quantify area emissions. The ability to control the *what*, *when* and *where* of target illumination. Active systems are particularly advantaged when the desired wavelengths are not sufficiently provided by the sun, such as portions of the mid-wave infrared (IR).

Disadvantages

– A large amount of generated energy is required to adequately illuminate the target. Other disadvantages include complex system designs, components, integration, and data analysis.



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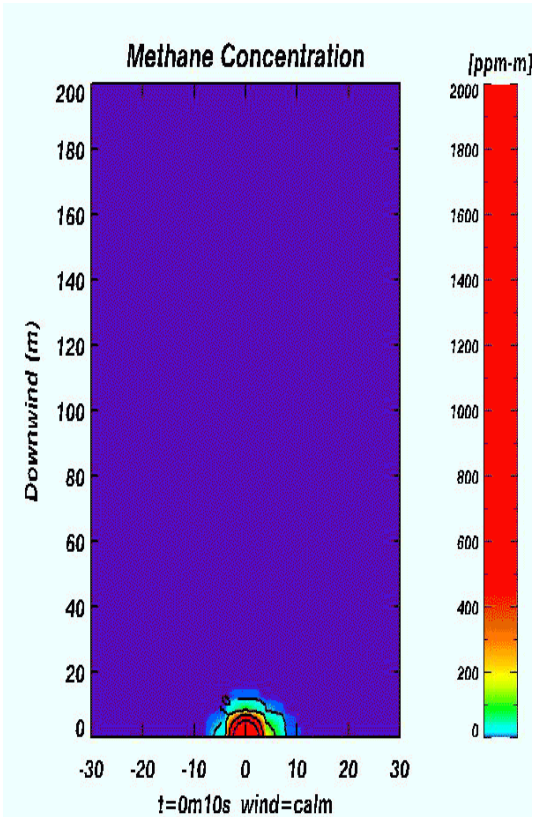
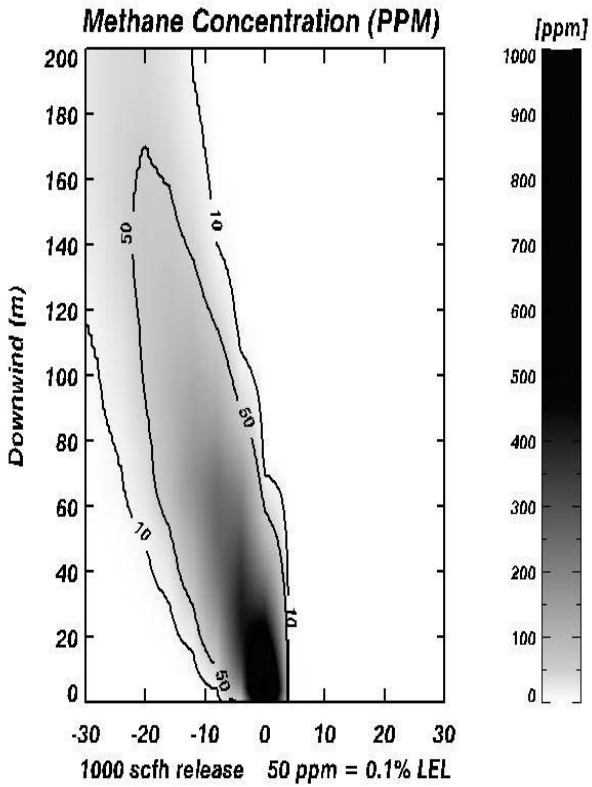
Emission Measurements: Comparison of Concentration (*PPM)* to Concentration-Path-Length (*PPM-m)*

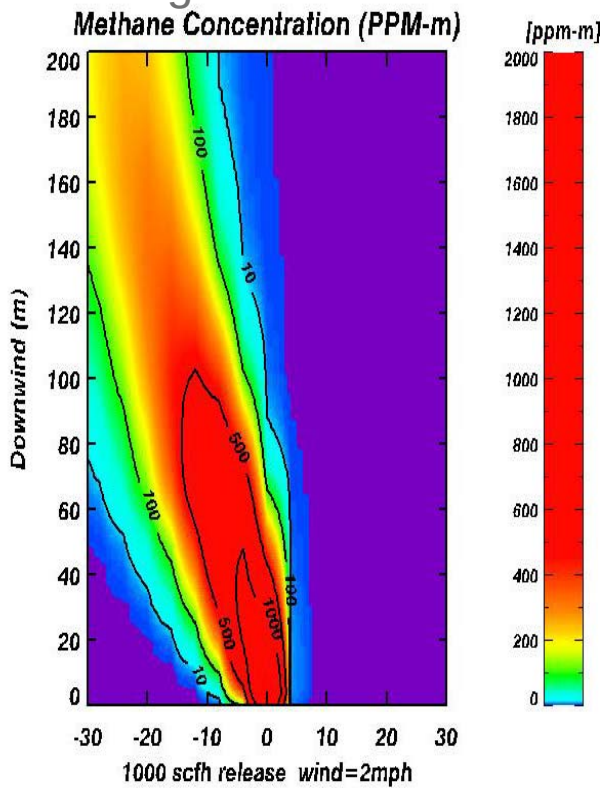
Complex Hazardous Air Release Model (CHARM®)



Ground Level



Integrated Plume



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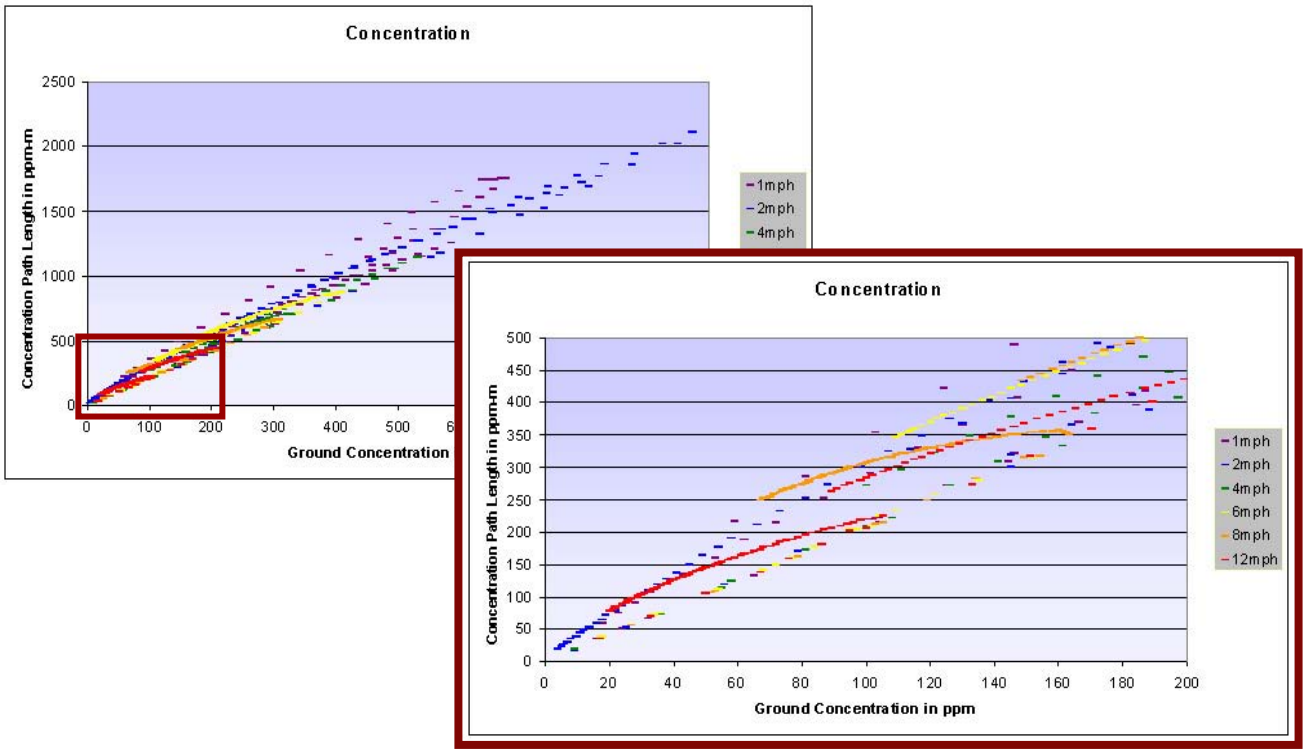
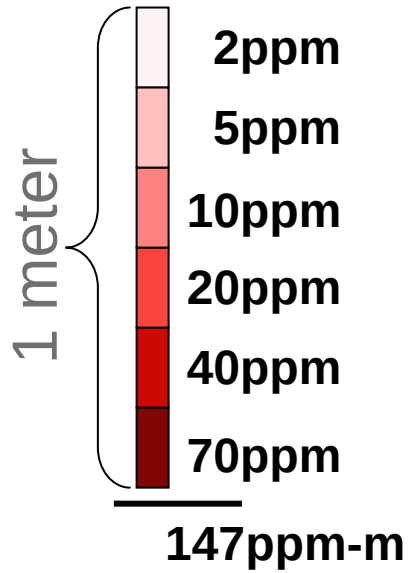
Emission Measurements: Linear trend between Concentration (*PPM*) and Concentration-Path-Length (*PPM-m*)

Depending on conditions, a 150ppm-m CPL will have a ground level concentration ranging from 45ppm to 70ppm.





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ITT Airborne Natural Gas Emission Lidar (ANGEL) Service Aircraft: DIAL Sensor System and Supporting Hardware

DIAL Sensor

Digital Video Camera

High Resolution Mapping Camera

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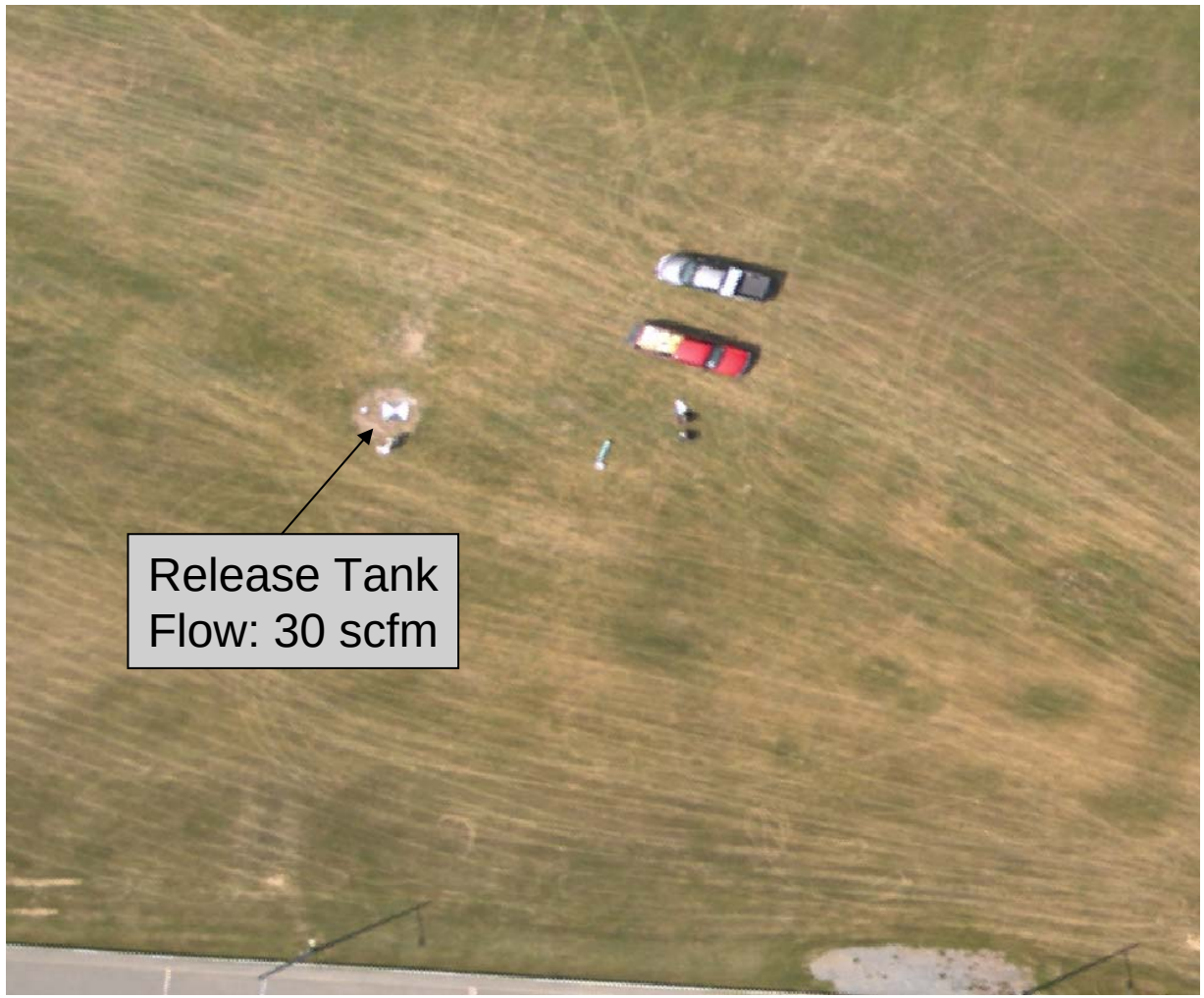
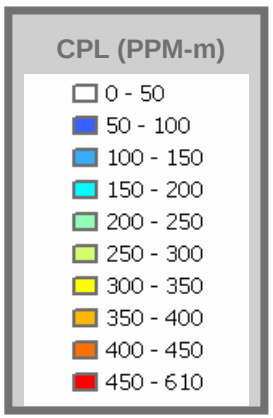
Detection and Measurement of Hydrocarbon Gases

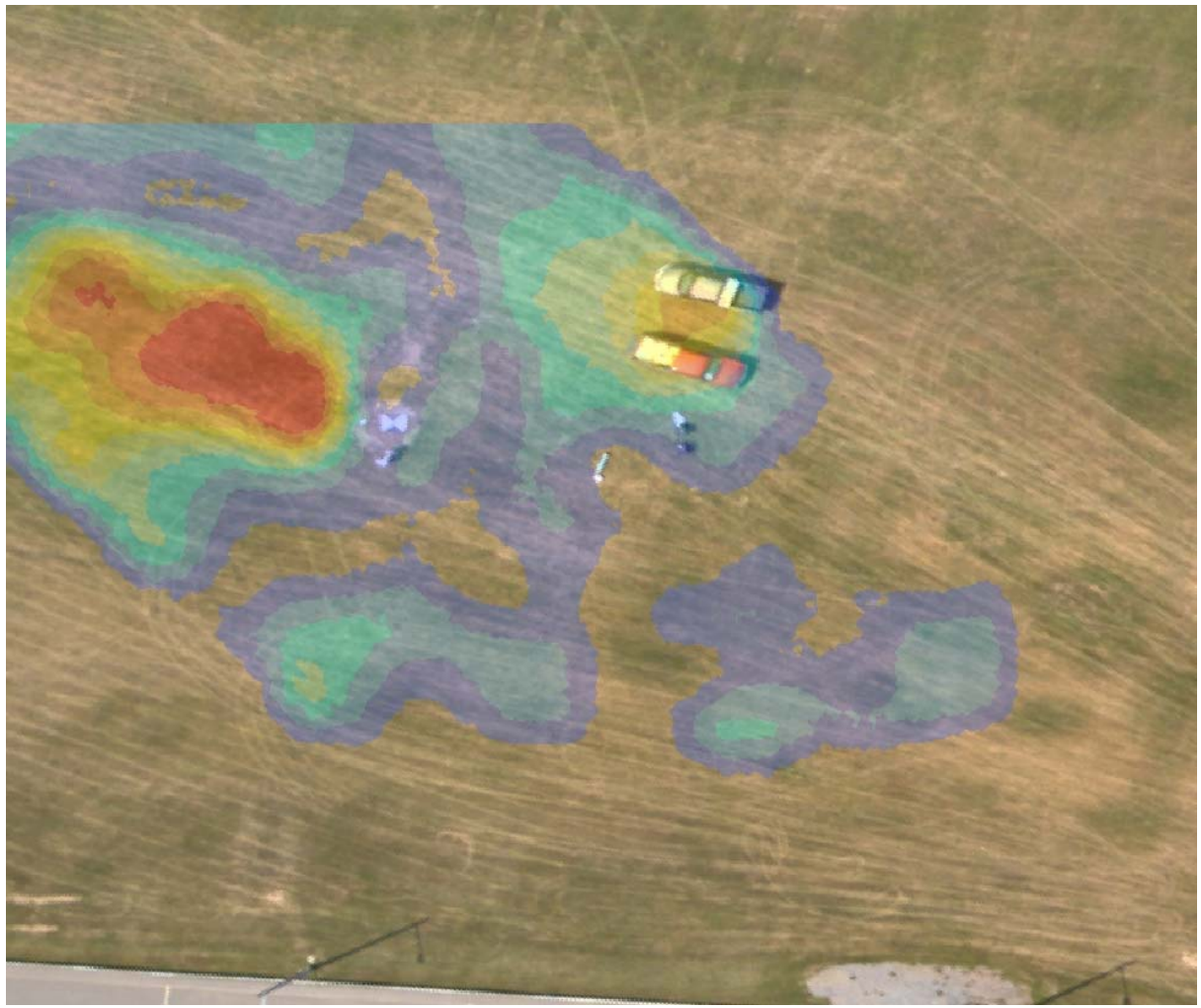
Example #1: Open field release



Detection and Measurement of Hydrocarbon Gases

Example #1: Open field release – DIAL results



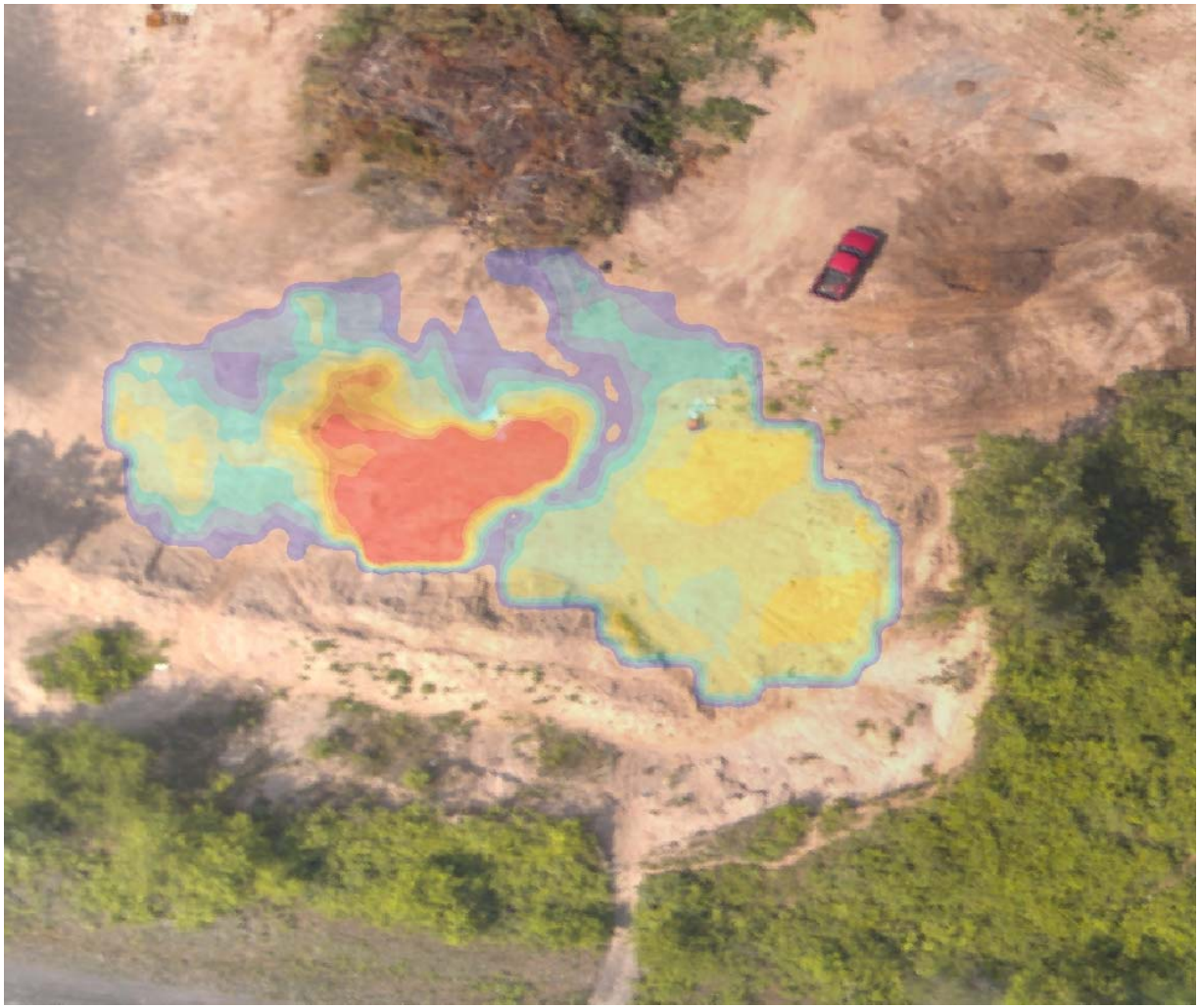


Detection and Measurement of Hydrocarbon Gases

Example #2: Embankment release

Detection and Measurement of Hydrocarbon Gases

Example #2: Embankment release – DIAL results



Detection and Measurement of Hydrocarbon Gases

Example #3: Gathering field pipeline repair

Detection and Measurement of Hydrocarbon Gases

Example #3: Gathering field pipeline repair – DIAL results

Detection and Measurement of Hydrocarbon Gases

Example #4: Light Crude Tank Farm

Detection and Measurement of Hydrocarbon Gases

Example #4: Light Crude Tank Farm – DIAL Scan Pattern

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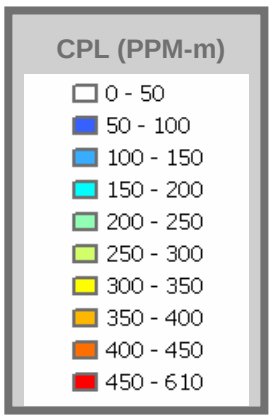
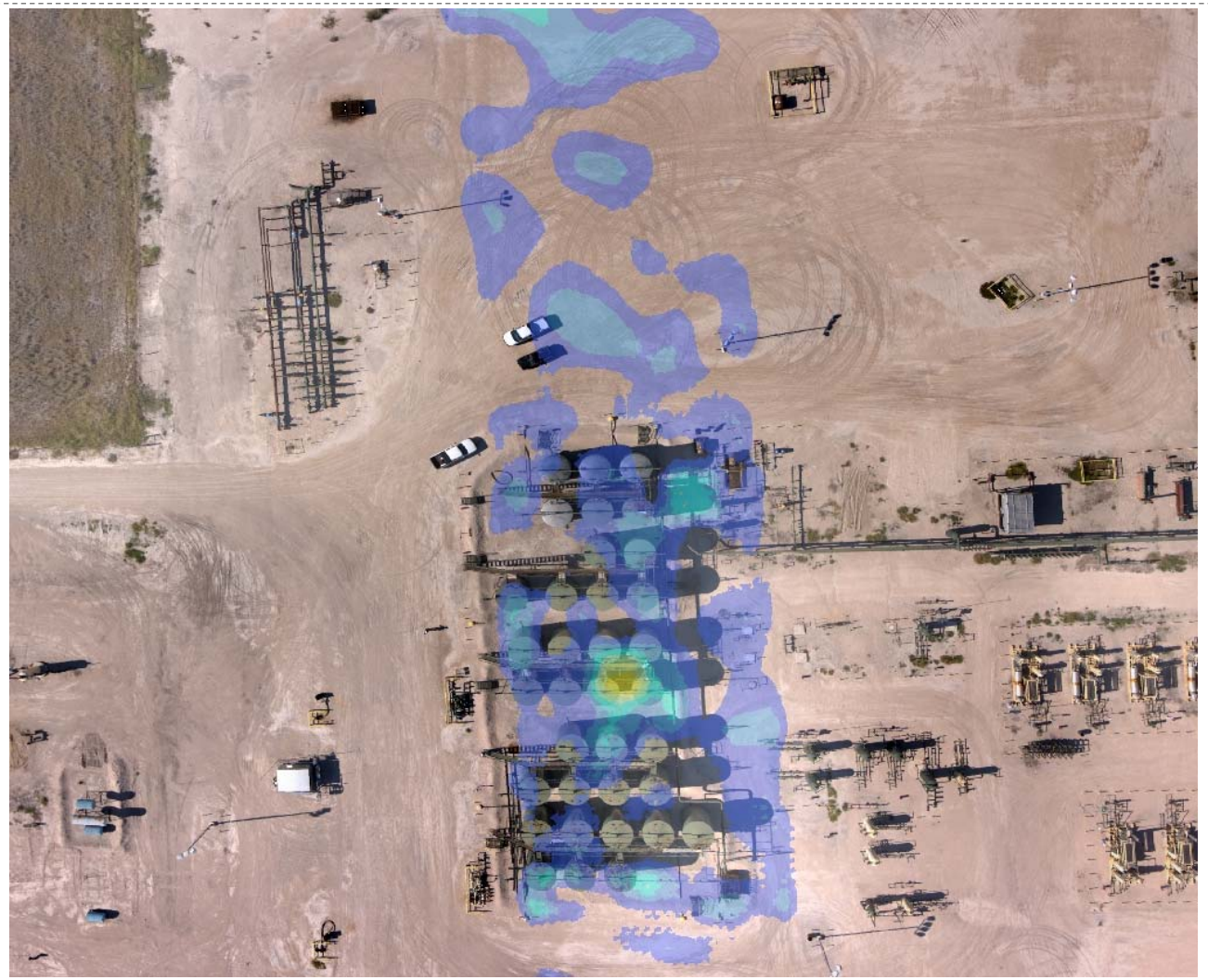
Detection and Measurement of Hydrocarbon Gases

Example #4: Light Crude Tank Farm – Hatches CLOSED





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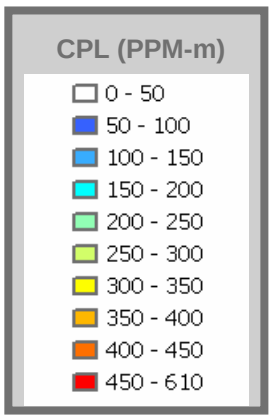
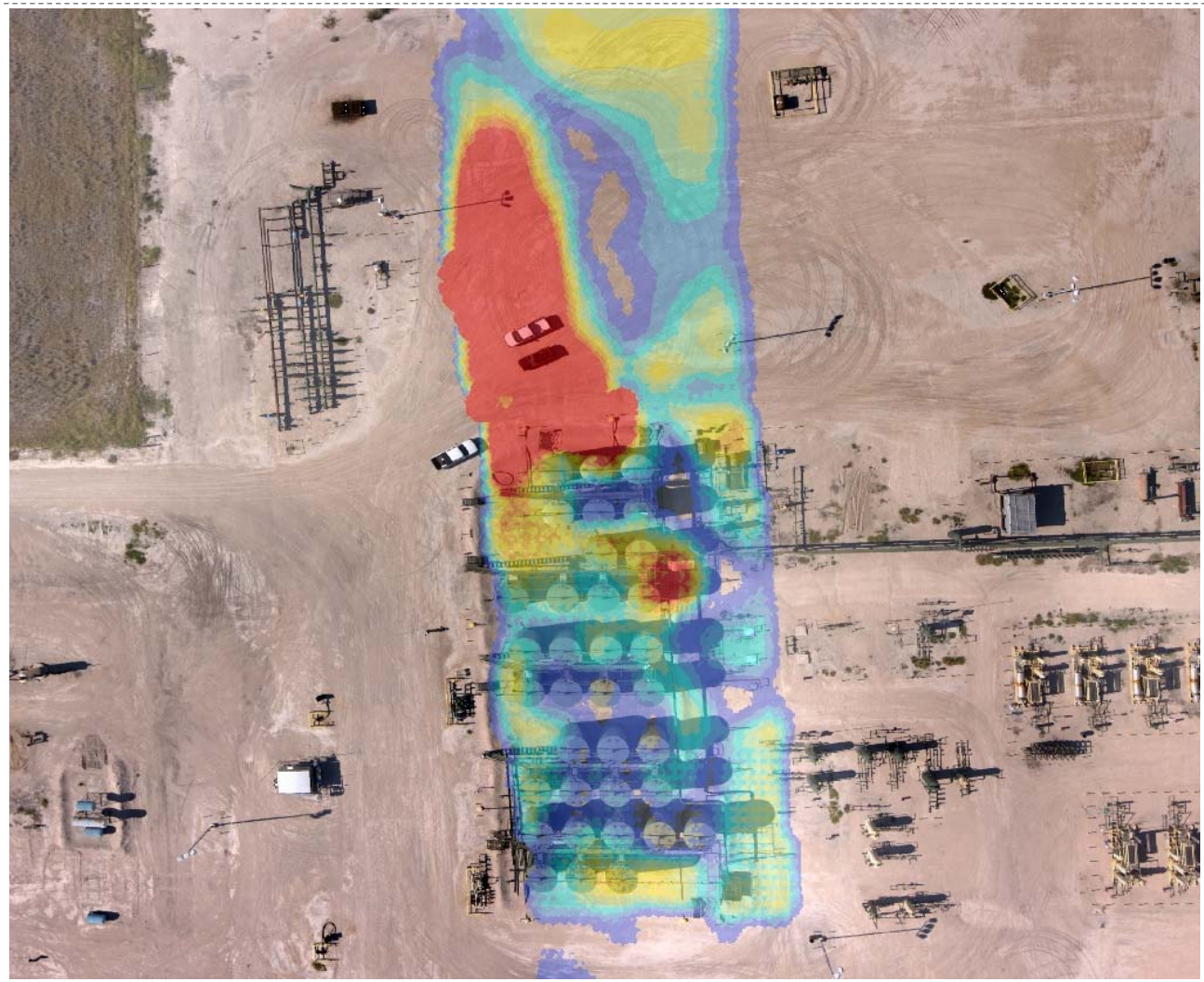
Detection and Measurement of Hydrocarbon Gases

Example #4: Light Crude Tank Farm – Hatches OPEN





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Conclusions — Airborne DIAL can detect and measure fugitive gas emissions

- ✓ Airborne DIAL can provide a unique, comprehensive, and unobstructed view of area emissions.
- ✓ Airborne DIAL can detect specific hydrocarbon gases/vapors (i.e. methane, ethane, propane, gasoline, condensates, etc.).
- ✓ Airborne DIAL can quantify area emissions and provide quantitative information on a plume's size and shape.
- ✓ Airborne DIAL can directly measure the various concentration-path-lengths (ppm-m) within area emissions.
- ✓ Airborne DIAL can operate day or night, and when integrated into a fixed wing aircraft can survey up to 1,000 pipeline miles per day.

Acknowledgements — Funding, Field Research, Facilities

- US Department of Energy – National Energy Technology Laboratory (DOE/NETL)
- US Department of Transportation – Pipeline and Hazardous Materials Safety Administration (DOT/PHMSA)
- Texas A&M University – Corpus Christi, Pollution Prevention Partnership
- BP America, Inc.
- El Paso Production
- National Fuel Gas Company

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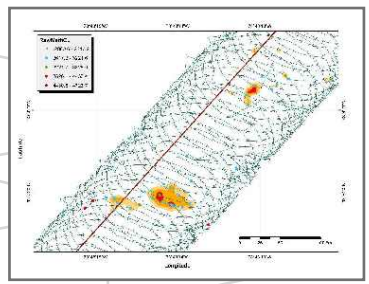
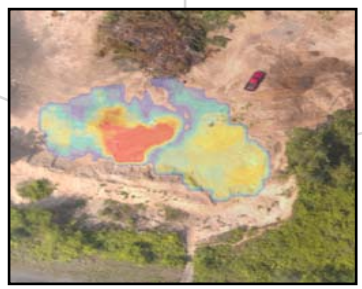
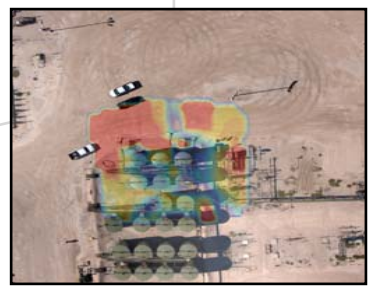
Questions and Answers

Thank you for your time and interest.







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