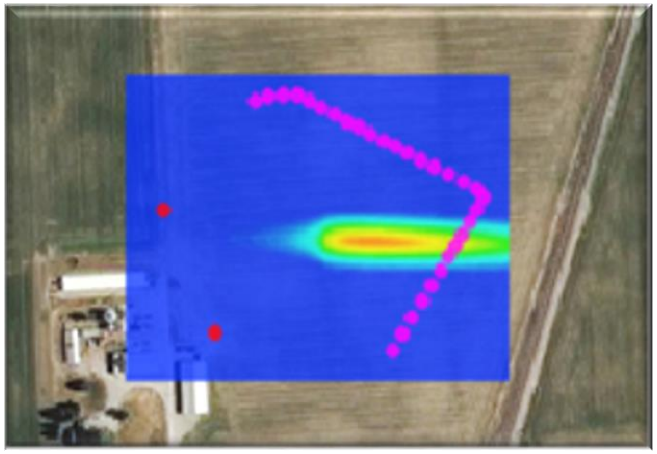
Persistent wide-area monitoring of CH_4 and CO_2



GreenLITE

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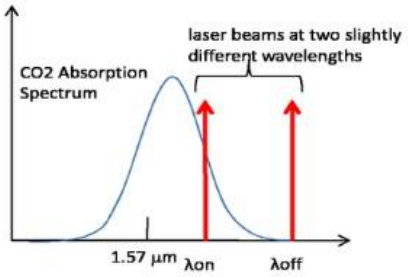
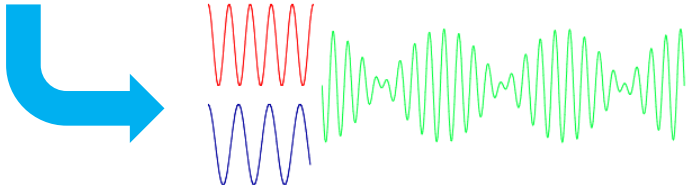
Intensity-Modulated Continuous Wave Technique

The intensity-modulated continuous wave (IMCW) lidar technique

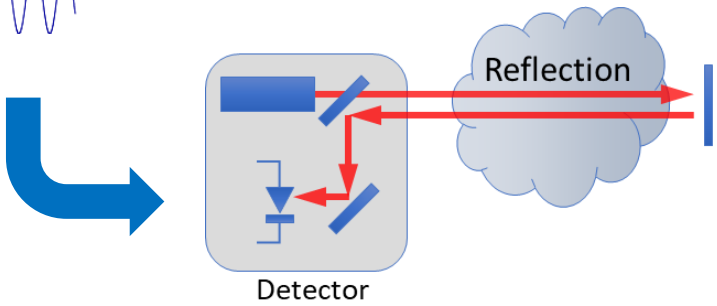
- Leverages highly reliable fiber telecom lasers in a unique way
- Developed for a NASA Mission for monitoring CO_2



- Two wavelengths chosen (~25 to 75 pm separation)
- One is absorbed by the target gas, and the other is not



- Both wavelengths are uniquely encoded and combined into a single amplitude modulated waveform

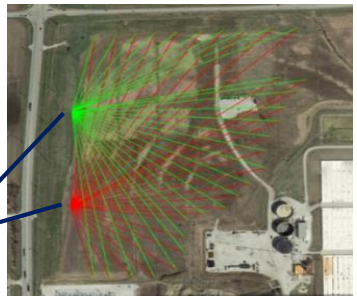


- Combined waveform is propagated to a target, reflected back, and is collected by a single telescope and common detector
- Ratio of normalized signals is proportional to the number of gas molecules present through a Beer-Lambert retrieval

Simultaneous transmission and reception of multiple wavelengths allows for full cancelation of multiplicative noise in the ratio, leading to increased measurement precision and less susceptibility to scintillation.

The Greenhouse gas Laser Imaging Tomography Experi~~ment~~ence – GreenLITE™

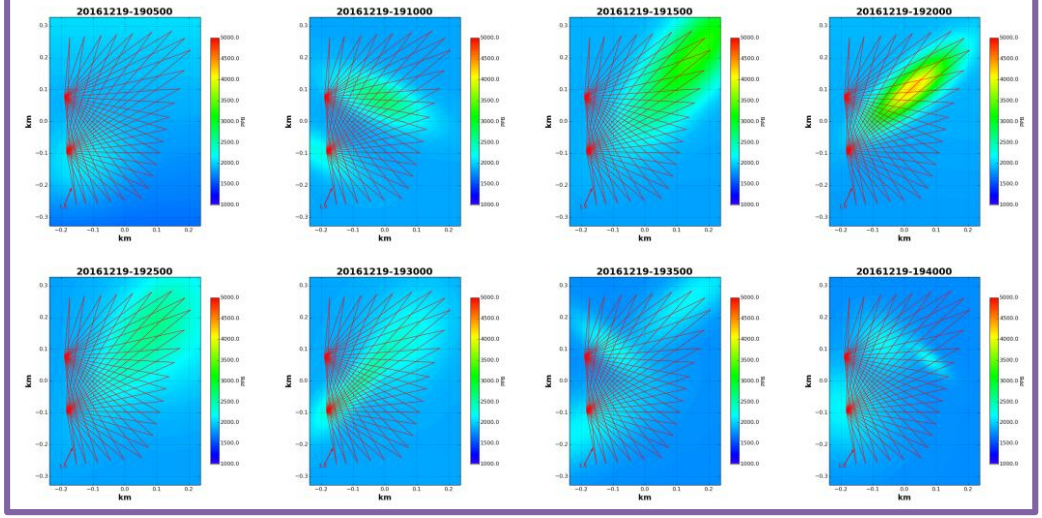
Data collected over area of interest & transmitted wirelessly to server



Laser transceiver units

Retroreflector network

2-D concentration maps at 5 min. intervals during a 40 min. controlled release test



System consists of laser transceivers, retroreflectors, and scanning hardware

Transceivers cycle through each retroreflector, acquiring a differential absorption measurement over each path, or "chord"

Absorption measurements saved to the Cloud and converted to total column concentration using local temperature, pressure, and water vapor mixing ratio

Using sparse tomography algorithms, individual chord measurements are used to estimate near real-time 2-D gas concentration maps over the area of interest

Estimates emission/flux can be derived from successive maps using a box model approach in conjunction with knowledge of wind speed & direction and the measurement geometry

GreenLITE™ offers direct measurement coverage up to 25 km^2 versus standard point sensors or short-range stand-off detection methods

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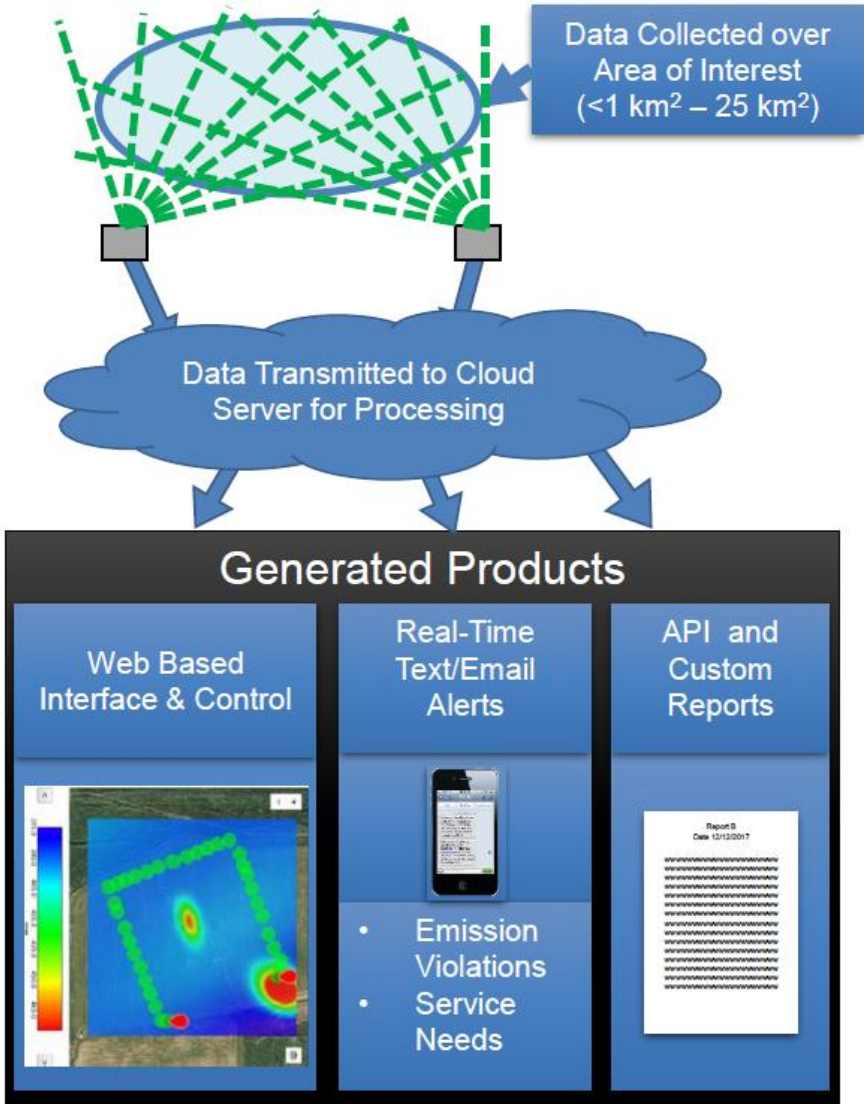
GreenLITE™ Technology

CH_4 & CO_2 Real-Time Monitoring Solution

- Data Collected every 2-10 sec
- 2-D maps every 2-10 min
- Remote, autonomous operation
- Low maintenance
- Simple web-based user interface
- Automated real-time notifications/warnings
- Summary reports

Key Technology Differentiators

- Sensitivity (<15 ppb CH_4; <1ppm CO_2),
- Long-range measurements (5 km x 5 km)
- Near real-time 2-D mapping
- Robust all-fiber optic implementation
- End-to-end sensor to products
- Environmental sensitivity with dynamic range for leak detection



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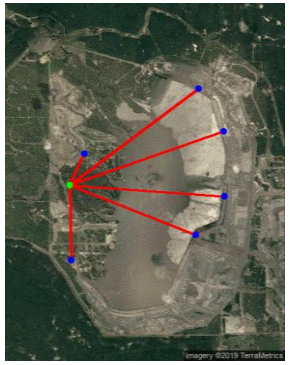
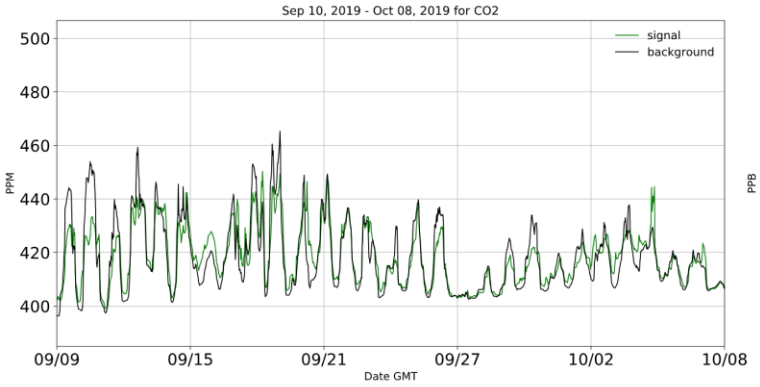
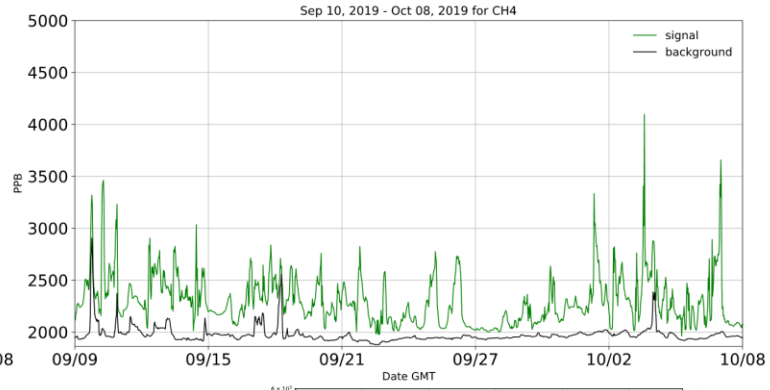
Example Applications

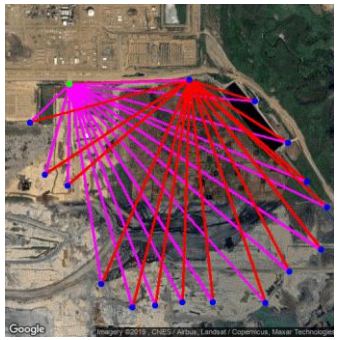
Emissions for large diffuse sources

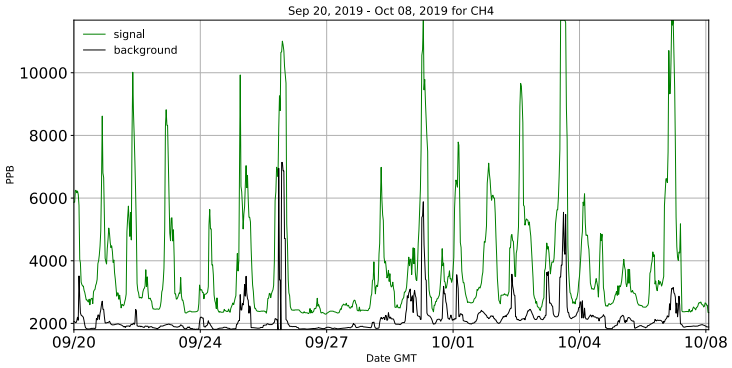


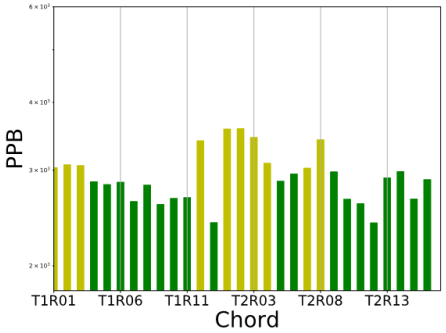


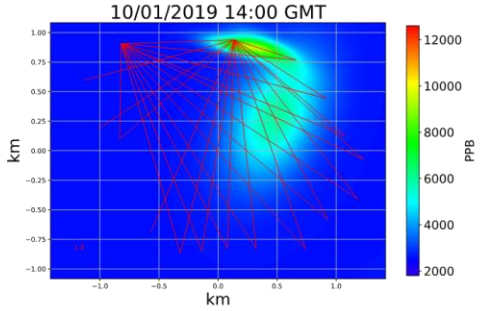


Spatiotemporal monitoring for complex sources (mines, storage, production, well fields, offshore, etc.)









Long- or short-term autonomous real-time monitoring capabilities for CH_4 and CO_2, expandable to other species

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For more information about GreenLITE™, S3, or our other technologies see me in the exhibit area

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