Developing of the Next Generation Miniaturized Laser Heterodyne Radiometer

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Overview

• What? Why?
• The Instrument
• Summer work
• Future work
• Questions
What? Why?

- Miniaturized Laser Heterodyne Radiometer (LHR)
- CO₂ and CH₄ measurement
- Low-cost
- High-portability
- Interfacing with existing systems
What? Why?

- Greenhouse gas contribution to climate change
  - CH₄ level-off in 90’s/00’s
- Global anomalies
- Absent data in Asia, Amazon, and Polar Regions
The Instrument

- **Next-Gen Mini-LHR**
  - Ground based
  - In conjunction with Aeronet systems in place worldwide

- **LHR Cube**
  - Cubesat version
  - Focus on polar regions
  - Verify larger satellite missions
The Instrument | How It Works

Sunlight that has undergone absorption by the trace gas is collected with collimation optics connected to an AERONET sun tracker.

Signals are mixed in a fast photoreceiver (an InGaAs detector) to produce a beat signal.

The mole fraction of the trace gas in the atmospheric column is proportional to the beat signal amplitude – measured on a lock-in amplifier.

Sunlight is superimposed with laser light at a near-by frequency in a single mode fiber coupler.

The beat signal is amplified, filtered, measured with an RF detector, and further amplified.
The Instrument
The Instrument | Solutions

• Reduction of component size, removal of chopper & lock-in amps
• No lock-in amps in 2\textsuperscript{nd} generation device
• Recent atmospheric correction algorithms yield \(\sim 6\text{ppm}\) difference
Summer Work

• Development of a rapid-scan
• Miniaturizing the mini-LHR
  – Simplifying RF signal chain
  – Laser control with DAQ card
  – Removal of optical chopper
• Construction of Satlink station for remote data acquisition
• Data analysis program written
• NextGen breadboarded and tested
Current/Future Work

- Solar array construction for complete off-grid data collection
- Design and manufacturing of parts using 3d printing technology
  - Cubesat and NextGen
- Finalize construction of NextGen
- Alaska this summer!
  - With next generation device
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