Summary

- In 2017 pulsed lidar made measurements of XCO₂ over long flight lines & in Arctic for 1st time
- Measurements made though diverse set of atmospheric & surface conditions.
- Lidar made height-resolved aerosol backscatter profiles simultaneously
- Analysis of XCO₂ measurements show:
  - Gradients in XCO₂: North-south, East-west & Locally
  - Local features in XCO₂, including one caused by wildfires
  - Analysis of XCO₂ in 36 spirals shows Lidar – in situ: mean bias = 0.42 ppm, std dev. = 0.53 ppm
  - Airborne measurements agree with lidar performance model, enabling space lidar design
- Key laser & detector components ready for space development

ASCENDS/Above airborne campaign

- July 20- Aug 8, 2017
- 8 flights, 55 hours of airborne lidar measurements
- Comparison with in situ XCO₂ at 47 locations
July 27, 2017 flight: California to Alaska via Nebraska

- Very strong (15 ppm) NS gradient from Nevada to Fairbanks AK
- Strong XCO$_2$ drawdown over growing croplands in Nebraska & North Dakota
- Stable & useful XCO$_2$ measurements when flying over Rocky Mountains
August 6, 2017 flight: Northern & western Alaska

- Lidar shows horizontal and vertical gradients in XCO₂
- Clear gradient in XCO₂ in southwest Alaska
- Lower XCO₂ near surface in northwest Alaska
- Higher XCO₂ at beginning of flight, lower during last spiral over Fairbanks
August 8, 2017 Flight: Alaska to California

- Clear NS gradient in XCO$_2$
- Lower XCO$_2$ near surface in Canada
- Clear enhancement in XCO$_2$ when flying near Vancouver BC
- Successful measurements though smoke plume there & over Washington State
- Increased XCO$_2$ over continental US starting in OR
Comparison of Lidar XCO₂ vs in situ XCO₂ in spiral down maneuvers

Aug 5, 2017 Flight

Entire Campaign

Comparison for each spiral > 4 km altitude

Where:
- **Red**: Lidar 1-sec retrievals (mean +/- 1 std dev)
- **Blue dots**: Column XCO₂ from AVOCET using lidar vertical weighting function

Note:
- < 0.5 ppm difference between Lidar & in situ XCO₂ at altitudes >4 km

Stats with Cambridge Bay
Mean = 0.47 ppm
Std Dev = 0.57 ppm
Number = 37

Without Cambridge Bay:
Mean = 0.42 ppm
Std Dev = 0.53 ppm
Number = 36
Scaling the Results & Approach for Space Measurement Model has been verified with Airborne Data

Comparison of the predicted XCO₂ error and the measurements for the 2016 airborne measurements over Edwards CA that used 1-sec averaging.

Predicted XCO₂ error of the CO₂ Sounder model versus surface reflectivity for 1-sec averaging and space.

2.7 mJ laser pulse energy

The diffuse surface reflectivity for RRV is 40%.

Key Laser components have been built & tested