

Multi-wavelength, Integrated Path Differential Absorption Lidar Measuring XCO₂ from Aircraft and from Space



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2017

- Campaign flown on NASA DC-8, carrying:
- Goddard Picarro, in situ
- LaRC AVOCET, in situ
- LaRC DLH, in situ
- LaRC ACES lidar

- Goddard CO₂ Sounder Lidar
- 8 flights, 55 hours of airborne lidar measurements

ASCENDS/Above

airborne campaign

• July 20- Aug 8,

Comparison with in situ XCO₂ at 47 locations

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.

MAA

- 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

2017 Campaigr Ground tracks



July 27, 2017 flight: California to Alaska via Nebraska







August 6, 2017 flight: Northern & western Alaska





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

-2.5

-3

3.5

4.5

-5.5

-6

10^{(m} -6.5

August 8, 2017 Flight: Alaska to California



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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





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%.

Drawing of space lidar based on receiver using 1-m telescope.



Key Laser components have been built & tested

