The Expected Performance from the NASA OCO-2 Mission

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Human activities are now emitting more than 10 billion tons of carbon into the atmosphere each year (~37 billion tons of CO₂).

- Existing atmospheric CO₂ measurements and modeling studies show the atmospheric CO₂ concentration is now increasing by 0.5% per year, reaching monthly average values exceeding 400 ppm.

- Natural carbon cycle “sinks” in the ocean and land biosphere are absorbing about half of the CO₂ emitted by human activities.

- The identity and processes controlling these natural CO₂ sinks are not well understood.

- The Orbiting Carbon Observatory 2 (OCO-2) spacecraft is a NASA mission designed specifically to measure the atmospheric concentration and fluxes of CO₂ with high accuracy, resolution, and spatiotemporal detail, identifying and quantifying CO₂ sources and sinks on regional scales.
The OCO Instrument – Optimized for Sensitivity

3 co-bore-sighted, high resolution, imaging grating spectrometers

- Resolving Power 17,000 - 20,000
- Collects 24 soundings / sec over a narrow (0.8°) swath (10^6 soundings / day over the sunlit hemisphere)
OCO-2 Pre-Flight Instrument Characterization and Calibration

- Pre-flight testing quantified key Instrument performance parameters
  - Geometric
    - Field of view, Bore-sight alignment
  - Radiometric / Polarimetric
    - Zero-level offset (bias)
    - Gain, Gain non-linearity
  - Spectroscopic
    - Spectral range, resolution, sampling
    - Instrument Line Shape (ILS)

What did we learn?
The OCO Instrument Performance

Req: > 290  
Meas: 302 – 361

Req: > 270  
Meas: 369 - 441

Req: > 190  
Meas: 267 - 350

The measured signal to noise ratio exceeds the requirements.  
The OCO-2 ILS (RGB) is broader, but has higher contrast than GOSAT (black)
Verifying End-to-End Instrument Performance

Observations of the sun with the flight instrument taken during TVAC tests provide an end-to-end verification of the instrument performance.

1.6 μm CO₂

TCCON FTS

21 April 2012
The Next Steps – Complete Integration and Test, and then Launch!

3-Channel Grating Spectrometer (JPL)  Dedicated Spacecraft Bus (OSC)  Delta-II Launch Vehicle (ULA)

Data Product Generation (JPL)  Data Downlink to NASA NEN (GSFC)

Formation Flying in the A-Train Constellation

Crisp: OCO-2 Mission
OCO-2 Spatial Sampling Approach

The OCO-2 Orbit:
- 705 km altitude, 98.2° inclination
  - 16-day ground track repeat cycle
- 98.8 minute period: 14.57 Orbits/day
  - ~25° longitude offset between consecutive orbits
  - 1.5° longitude offset between orbit tracks after 16-days

Latitude Coverage
- Nadir: ±85° Solar zenith angle
- Glint: ±81° Solar zenith angle

Sampling Rate
- 24 samples/second along track
- 10-20% of the soundings expected to yield useful $X_{CO_2}$ estimates

OCO-2 collects samples continuously along a narrow track with much coarser sampling from track-to-track.
Nadir vs. Glint Coverage

- OCO-2 will collect ~380 Soundings/degree of latitude (>10^6 soundings/day)
- OCO-2 will obtain Nadir and Glint observations of the sunlit hemisphere on alternate 16-day ground track repeat cycles.

Nadir observations provide better coverage over continents
Glint observations provide better coverage over oceans
Conclusions

• The OCO-2 implementation is progressing on schedule, < 7 months before its planned 1 July 2014 launch date.
  – At delivery, the OCO-2 flight instrument performance exceeded many of its stringent requirements
  – Observatory and Launch Vehicle development are ongoing

• The OCO-2 Retrieval Algorithm performance continues to improve
  – The ACOS/GOSAT collaboration provided valuable insight and a critical validation of the OCO-2 algorithm

• Once in orbit, the NASA OCO-2 mission is expected to demonstrate the measurement precision, coverage, and resolution needed to:
  – Quantify CO₂ sources on the scale of an average-sized nation
  – Find the natural “sinks” that are absorbing over half of the CO₂ emitted by human activities