The Expected Performance from the NASA OCO-2 Mission

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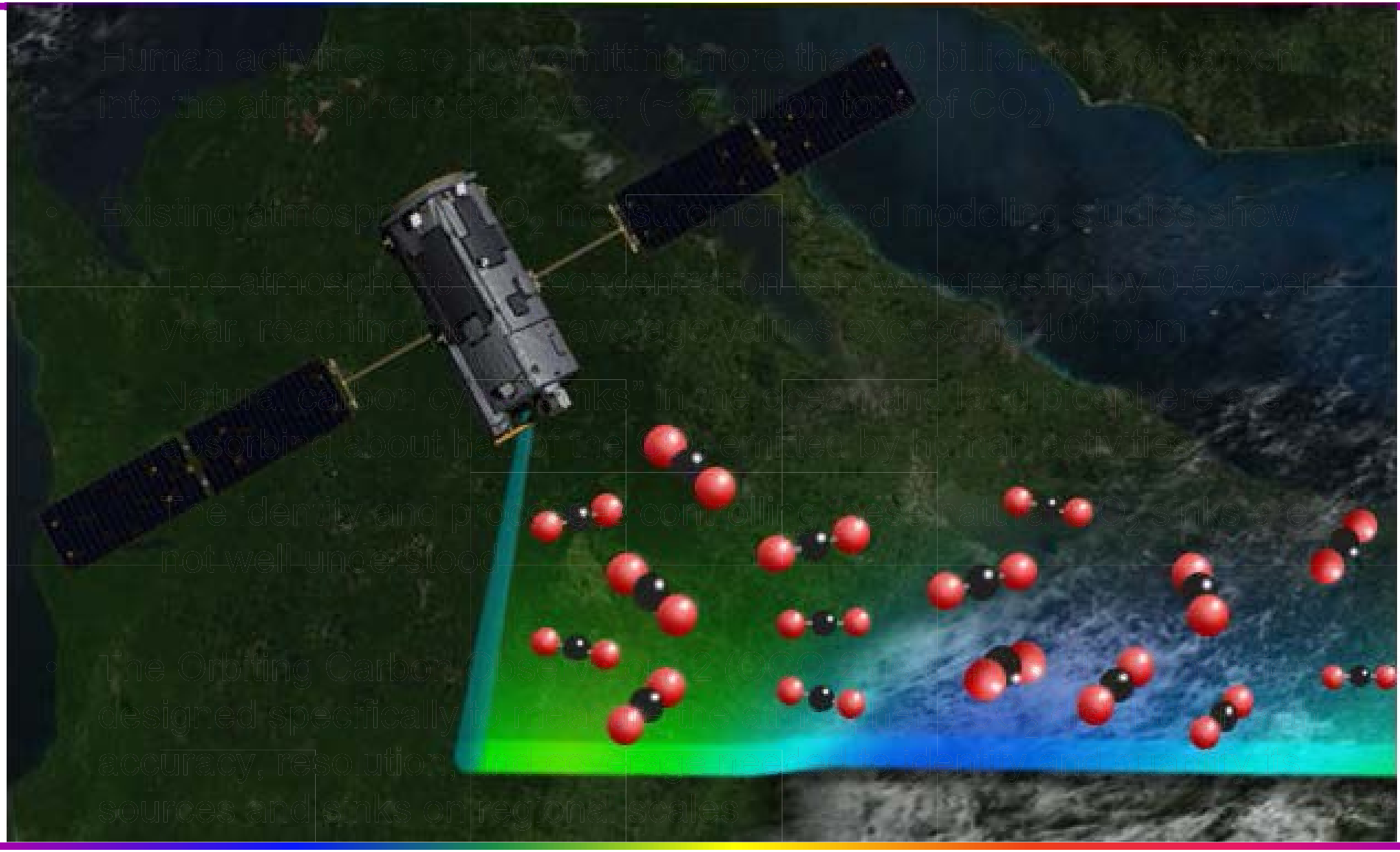
What Controls Atmospheric Carbon Dioxide?

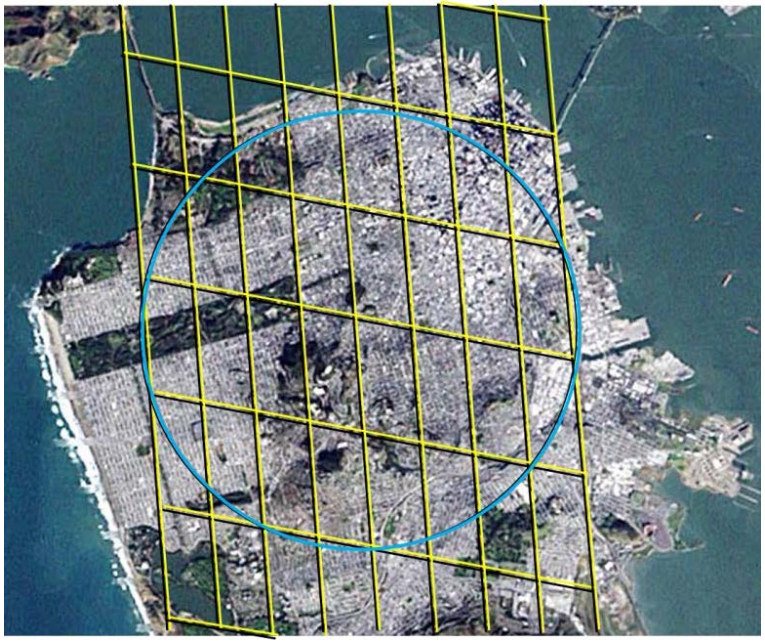


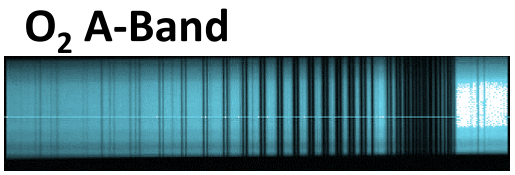
- Human activities are now emitting more than 10 billion tons of carbon into the atmosphere each year (~37 billion tons of CO_2)
- Existing atmospheric CO_2 measurements and modeling studies show the atmospheric CO_2 concentration is now increasing by 0.5% per year, reaching monthly average values exceeding 400 ppm
- Natural carbon cycle "sinks" in the ocean and land biosphere are absorbing about half of the CO_2 emitted by human activities
- The identity and processes controlling these natural CO_2 sinks are not well understood
- The Orbiting Carbon Observatory-2 (OCO-2) mission was designed specifically to measure the atmospheric CO_2 with the accuracy, resolution, and coverage needed to identify and quantify CO_2 sources and sinks on regional scales

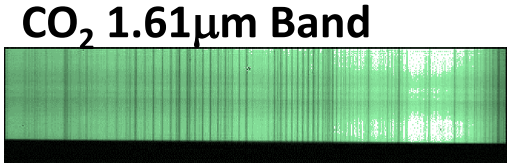
The OCO Instrument – Optimized for Sensitivity

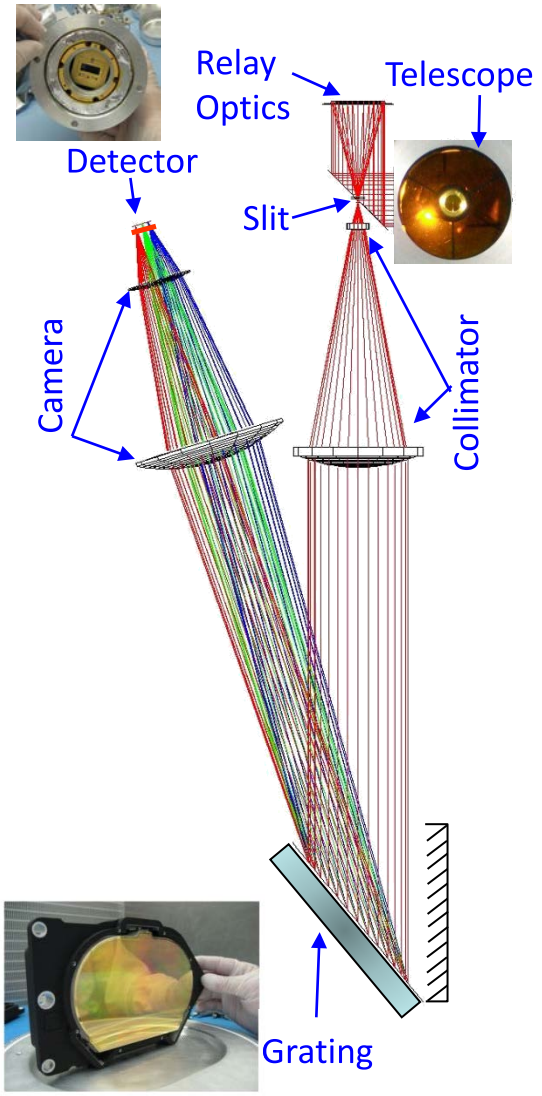
3 co-bore-sighted, high resolution, imaging grating spectrometers

- Resolving Power 17,000 - 20,000
- Collects 24 soundings / sec over a narrow (0.8º) swath (10^6 soundings / day over the sunlit hemisphere)





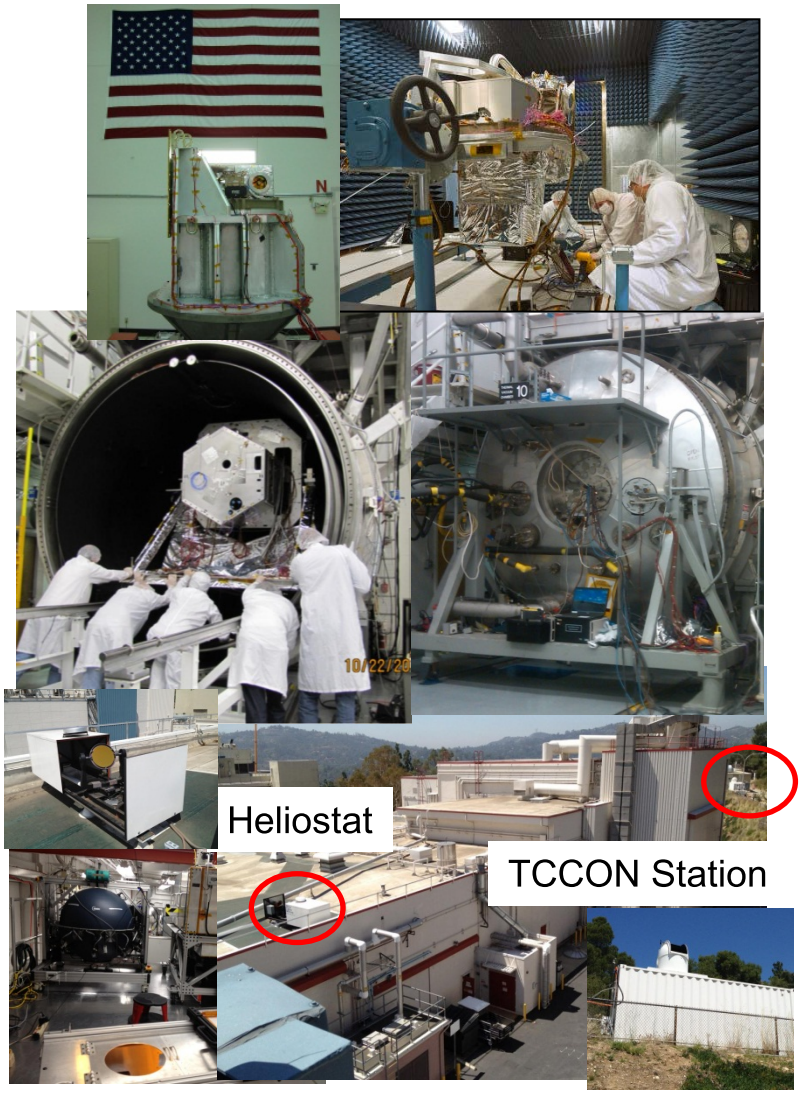




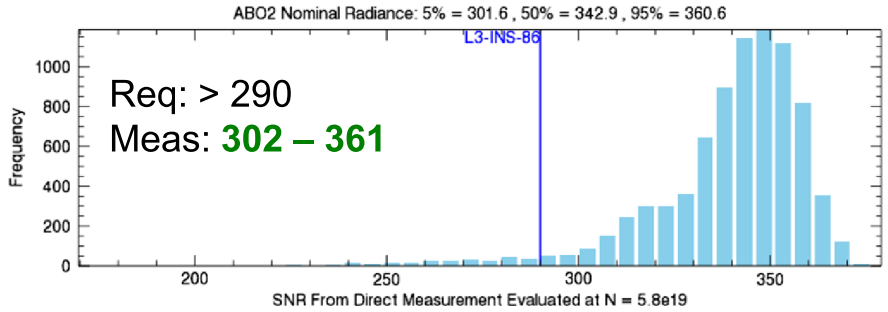
OCO-2 Pre-Flight Instrument Characterization and Calibration

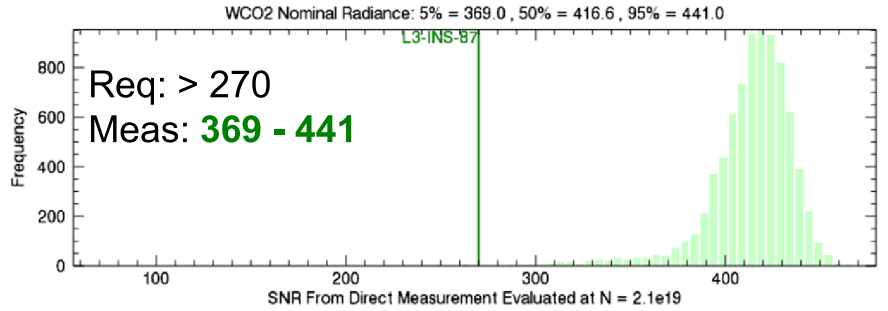
- Pre-flight testing quantified key Instrument performance parameters
  - Geometric
    - Field of view, Bore-sight alignment
  - Radiometric / Polarimetric
    - Zero-level offset (bias)
    - Gain, Gain non-linearity
  - Spectroscopic
    - Spectral range, resolution, sampling
    - Instrument Line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

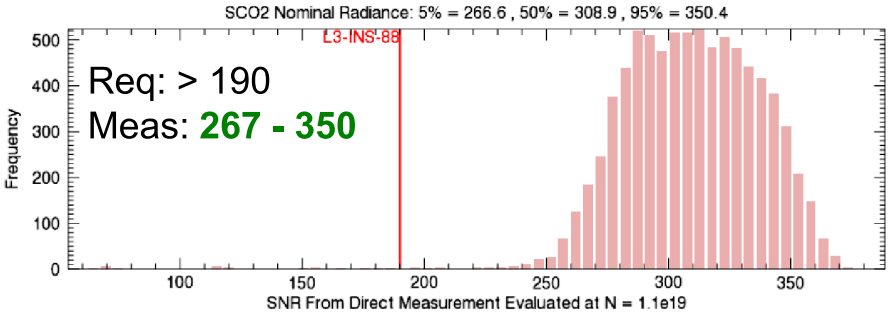
What did we learn?



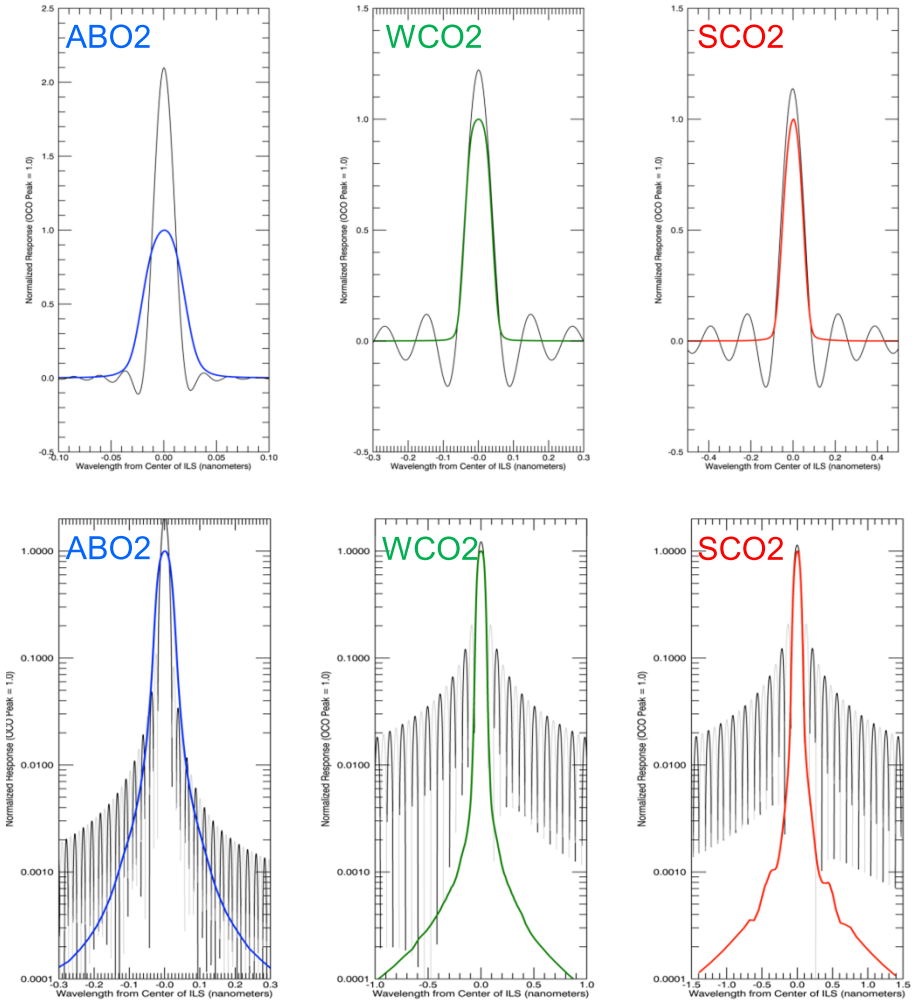
The OCO Instrument Performance







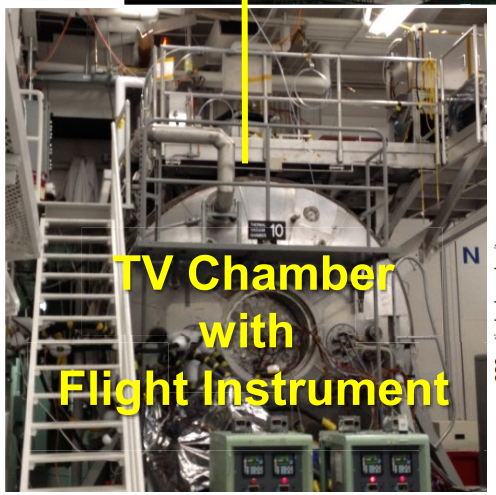
The measured signal to noise ratio exceeds the requirements.

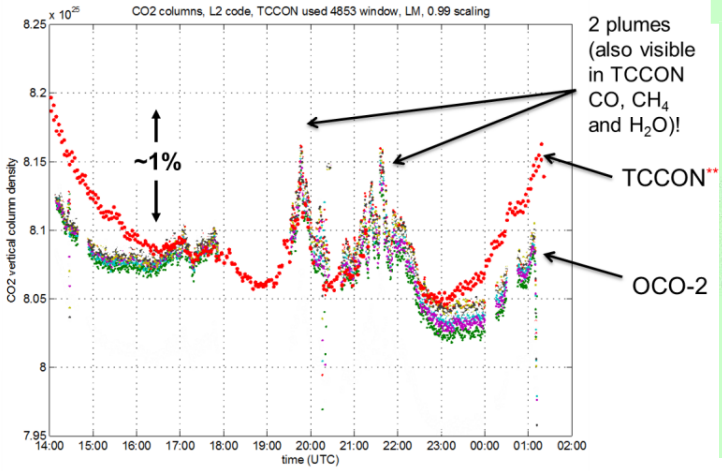


The OCO-2 ILS (RGB) is broader, but has higher contrast than GOSAT (black)

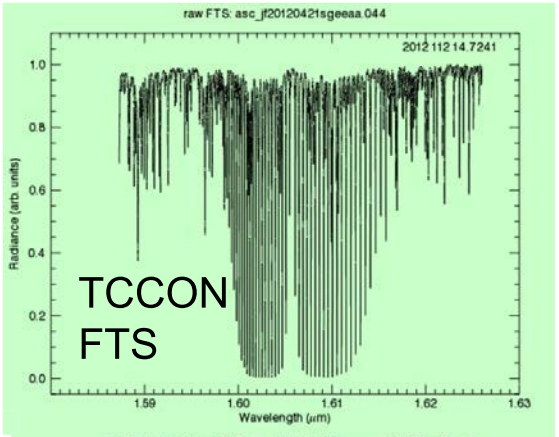
Verifying End-to-End Instrument Performance

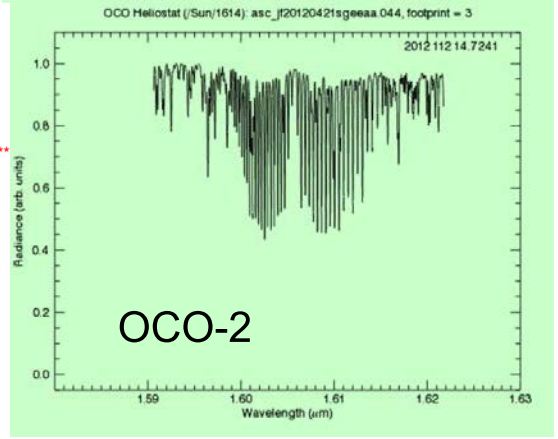
Observations of the sun with the flight instrument taken during TVAC tests provide an end-to-end verification of the instrument performance.





1.6 μm CO_2

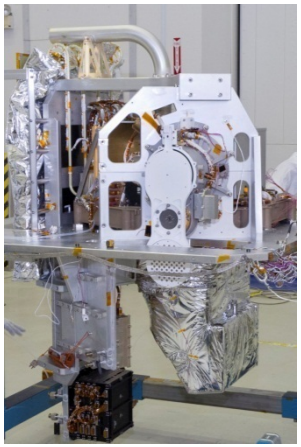




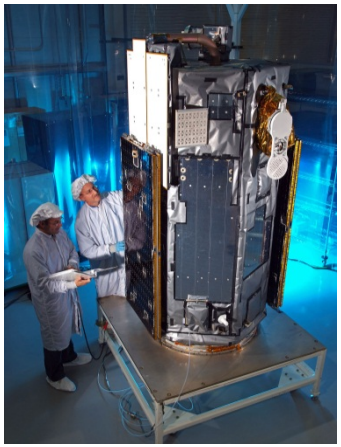
21 April 2012

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

3-Channel Grating Spectrometer (JPL)

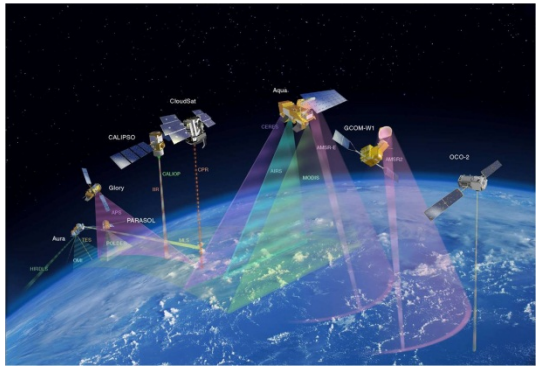


Dedicated Spacecraft Bus (OSC)



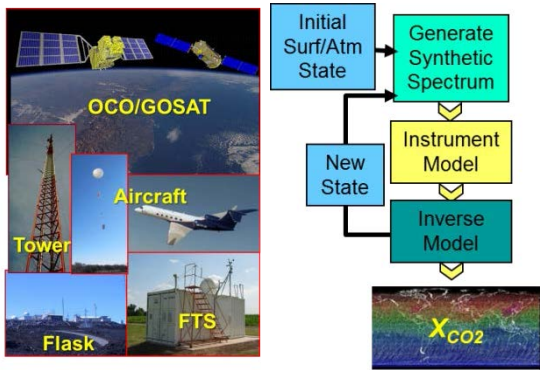
Delta-II Launch Vehicle (ULA)

Formation Flying in the A-Train Constellation



Data Downlink to NASA NEN (GSFC)

Data Product Generation (JPL)



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 after16-days

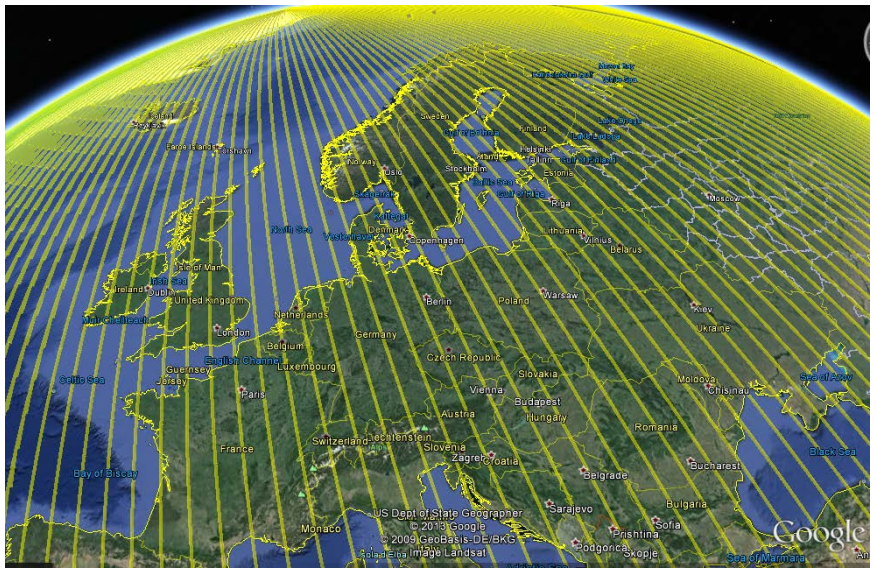
Latitude Coverage

- 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_{CO2} estimates

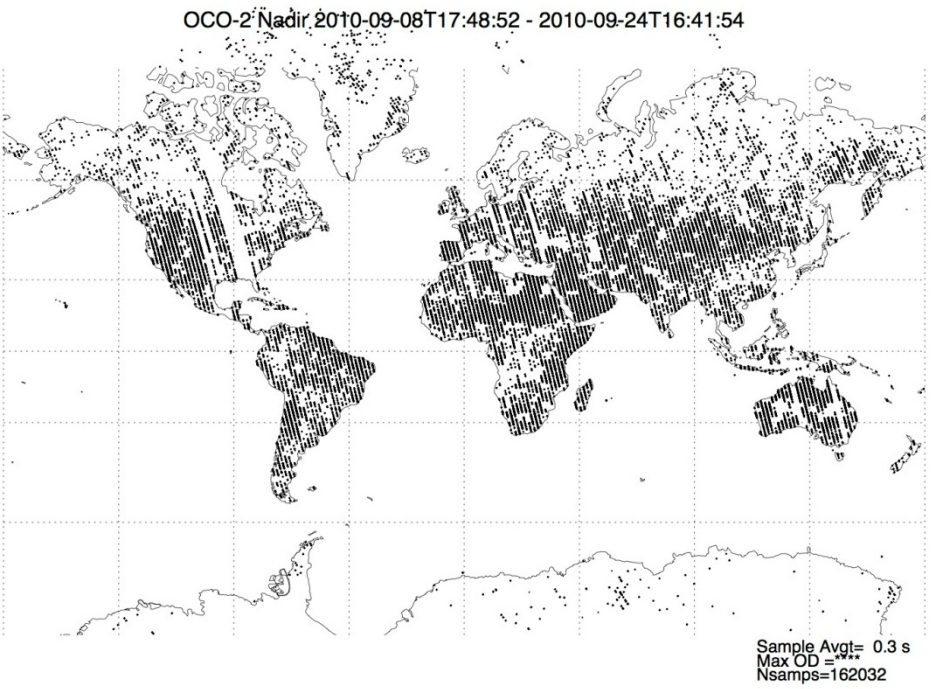
OCO-2 is a SAMPLING system, not a MAPPING system.



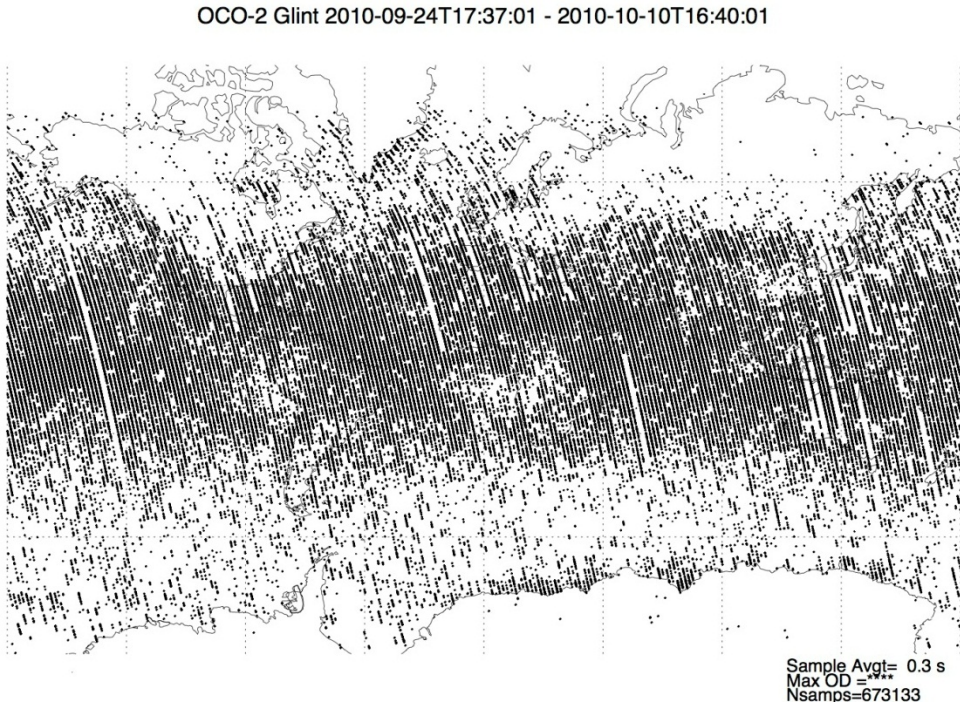
OCO-2 collects samples continuously along a narrow track with much coarser sampling from track-to-track.

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 CO_2 sources on the scale of an average-sized nation
  - Find the natural "sinks" that are absorbing over half of the CO_2 emitted by human activities