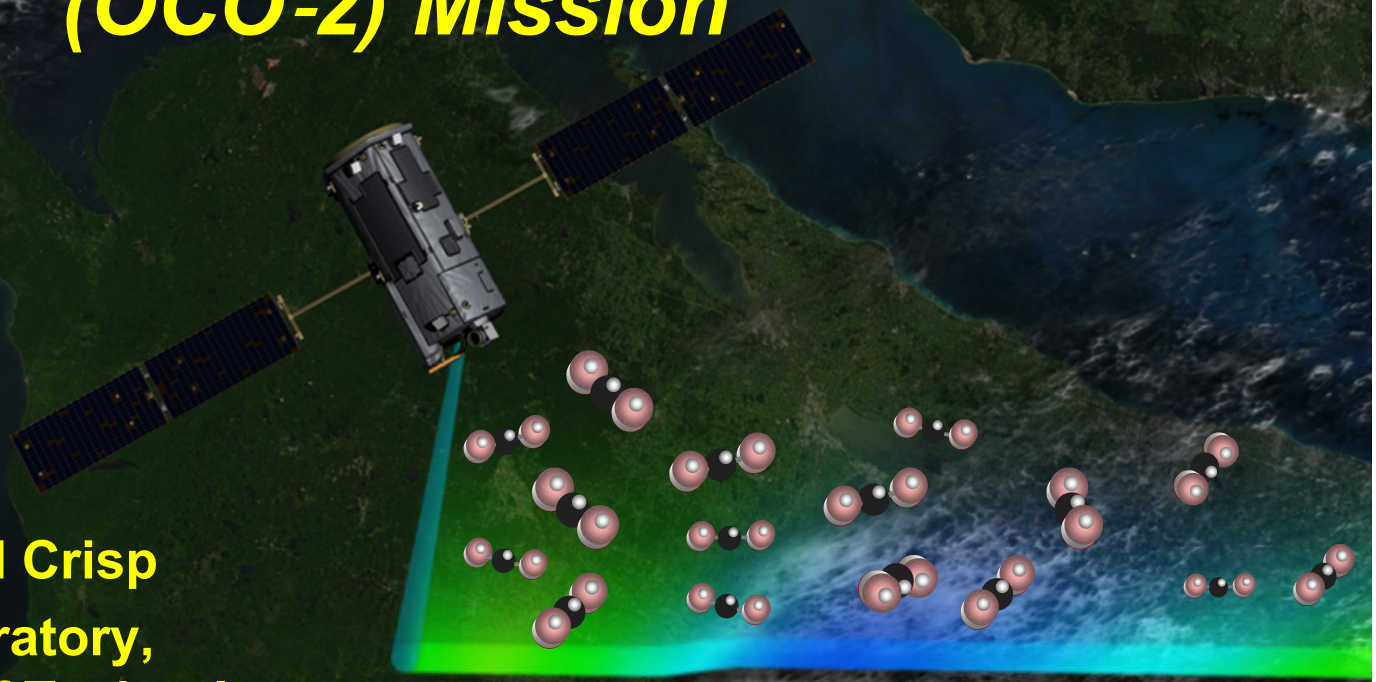
Presentation to Rockwell Collins Deutschland GmbH

The NASA Orbiting Carbon Observatory – 2 (OCO-2) Mission



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May 2012

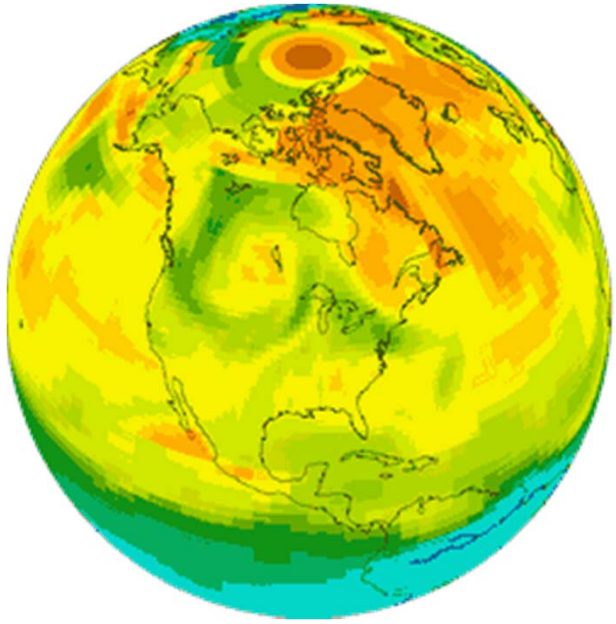
Global Measurements from Space are Essential for Monitoring Atmospheric CO_2

To limit the rate of atmospheric carbon dioxide buildup, we must

- Control emissions associated with human activities
- Understand & exploit natural processes that absorb carbon dioxide

We can only manage what we can measure

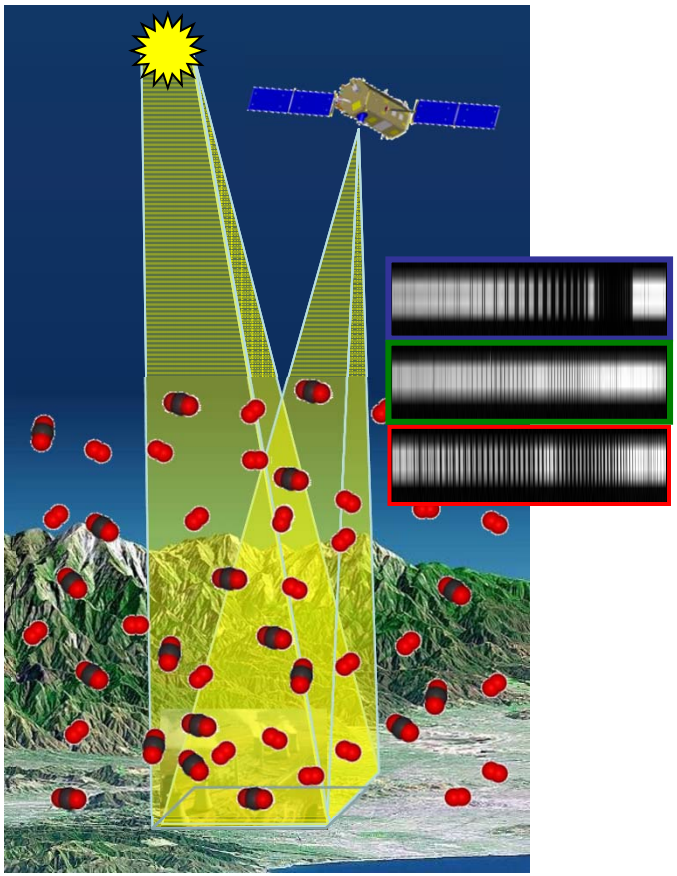
Plumes from medium-sized power plants (4 MtC/yr) elevate X_{CO2} levels by ~2 ppm for 10's of km downwind [Yang and Fung, 2010].



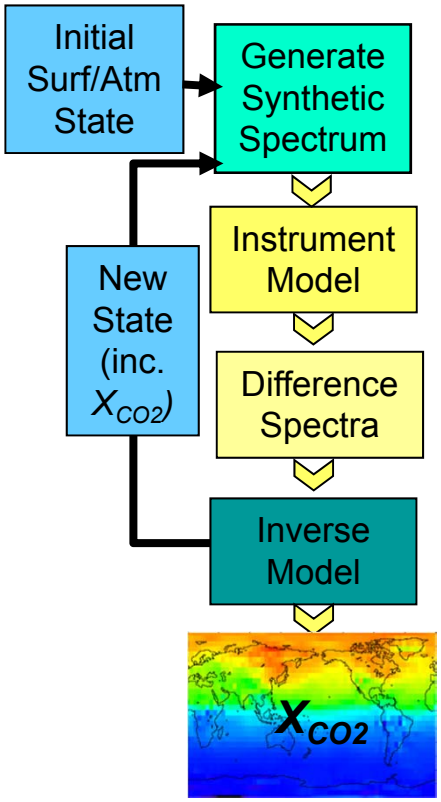
These variations are superimposed on a background of "**CO_2 weather**"

How do You Measure CO_2 from Space?

- **Record** spectra of CO_2 and O_2 absorption in reflected sunlight



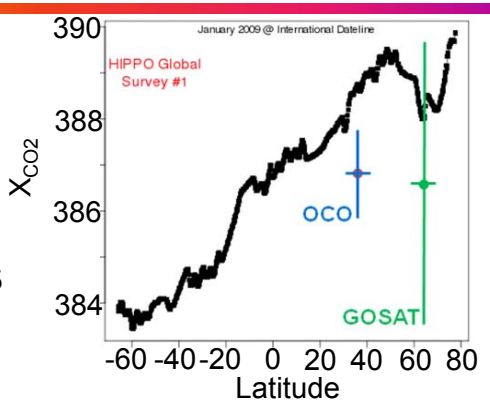
- **Retrieve** variations in the *column averaged CO_2 dry air mole fraction, X_{CO2}* over the sunlit hemisphere

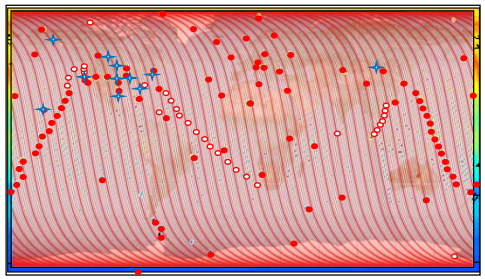


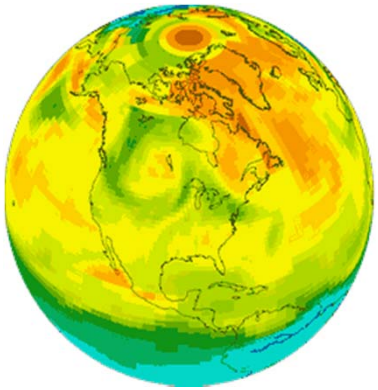
- **Validate** measurements to ensure X_{CO2} accuracy of 1 - 2 ppm (0.3 - 0.5%)

Driving Requirements for Space-based CO_2 Measurements

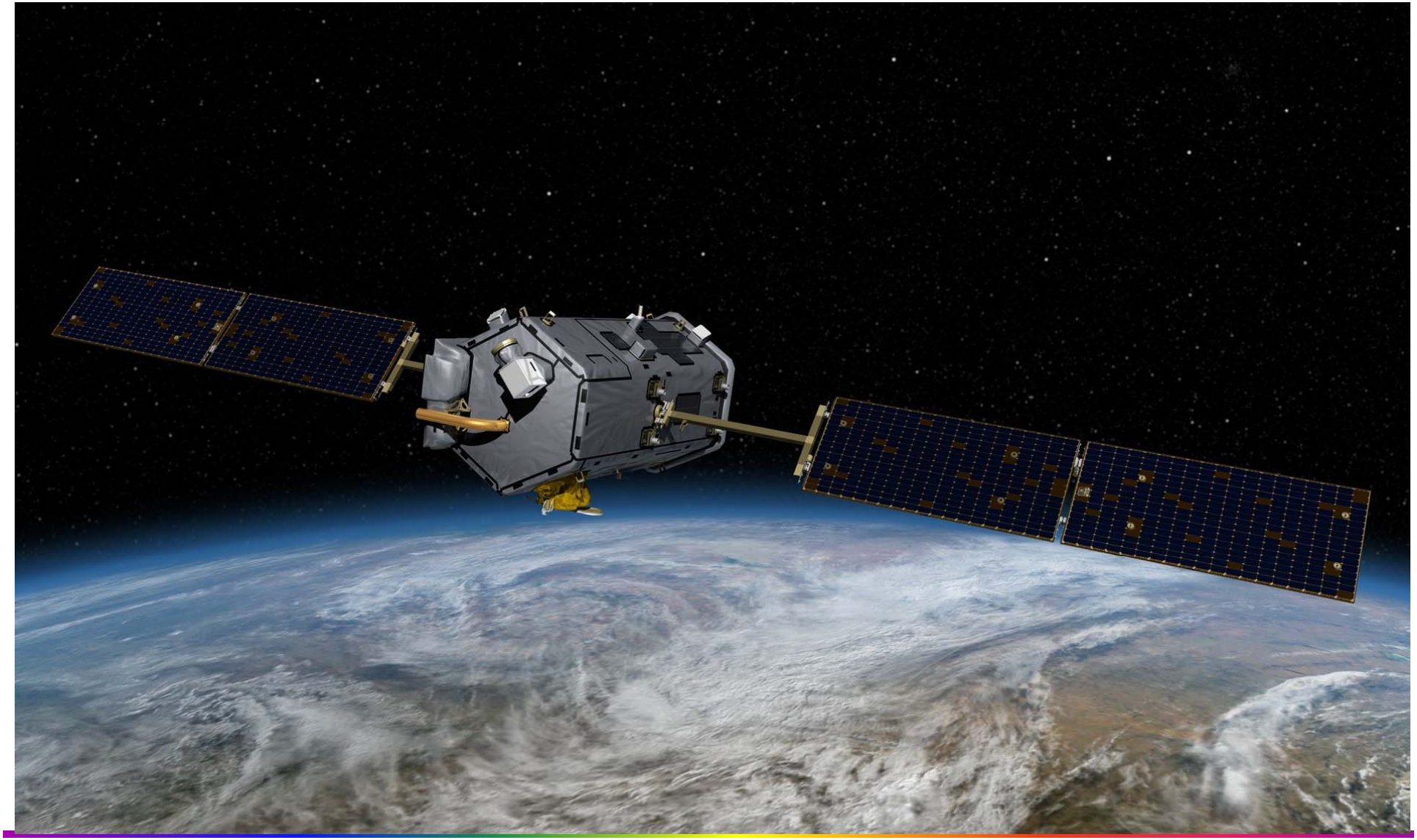
- Precision and accuracy
  - High precision required to resolve small (0.2-0.3%) variations in CO_2 associated with sources and sinks
  - High accuracy essential to avoid regional-scale biases
- Spatial coverage
  - Nadir and glint observations are needed to yield useful observations over both continents and ocean
- Spatial resolution and sampling
  - Sensitivity to point sources scales with area of footprint
  - Small measurement footprints reduce data losses due to clouds
- Temporal sampling
  - Monthly measurements required over > 1 year to resolve seasonal and inter-annual variability in CO_2





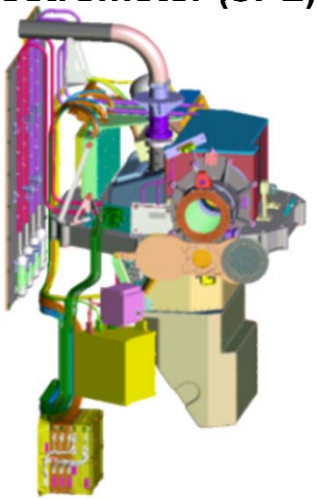


The OCO-2 Mission

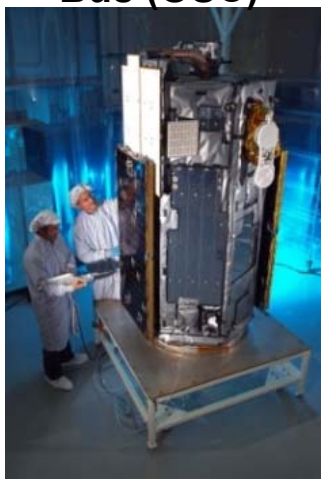


The OCO-2 Mission is Under Development

3-Channel Spectrometer (JPL)



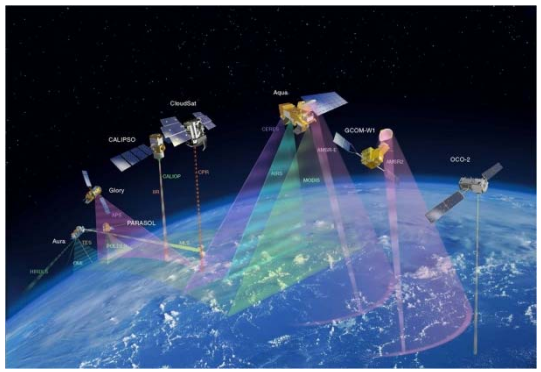
Dedicated Spacecraft Bus (OSC)



TBD Launch Vehicle

NASA NEN (GSFC) and SN (TDRSS)

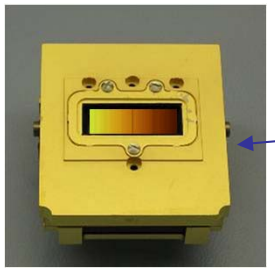
Formation Flying as Part of the A-Train Constellation

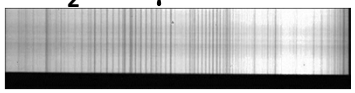


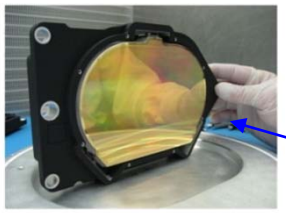
Mission Operations (OSC)

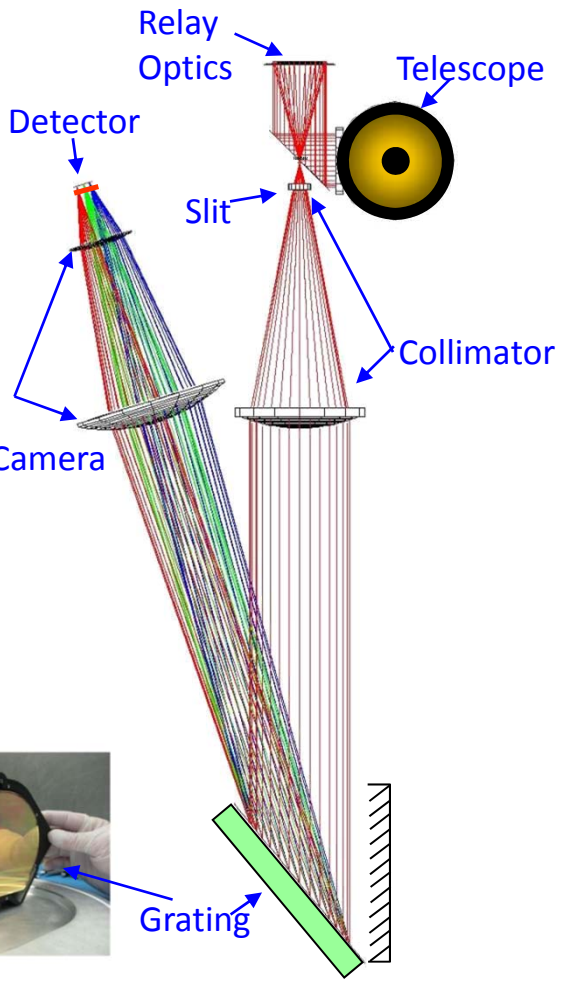
The OCO Instrument – Optimized for Sensitivity

- 3 co-bore-sighted, high resolution, imaging grating spectrometers
  - O_2 0.765 μm A-band
  - CO_2 1.61 μm band
  - CO_2 2.06 μm band



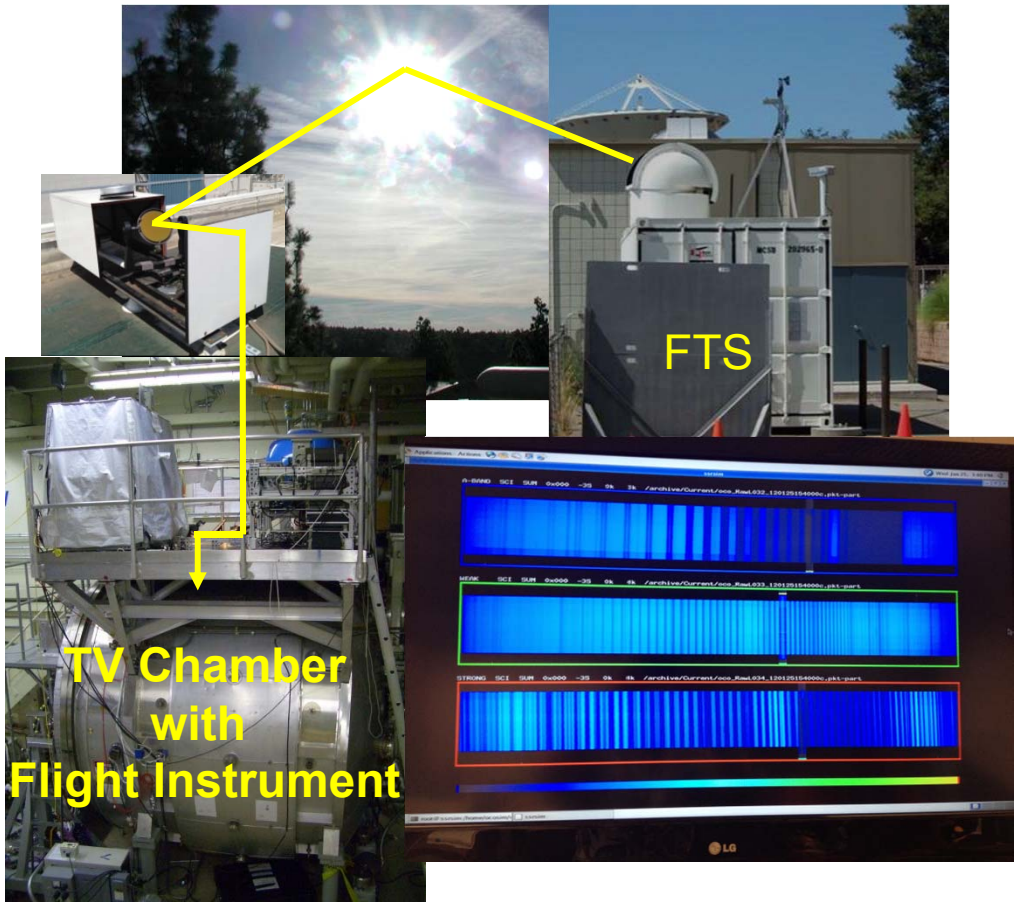






Pre-Flight Instrument Qualification and Characterization

Observations of the sun with the flight instrument taken during the thermo-vacuum tests provided an end-to-end test of the instrument performance.



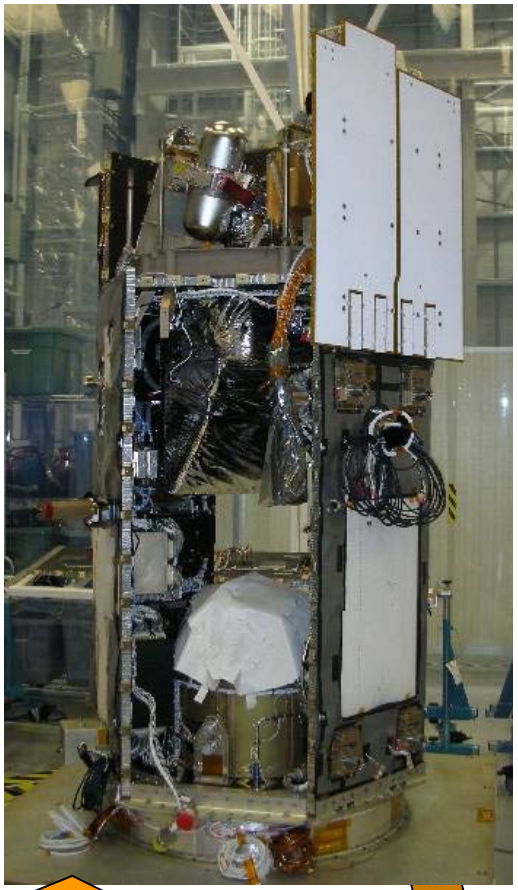
The OCO-2 instrument was tested in a special space simulation chamber at JPL, which was modified to facilitate atmospheric observations.

OCO-2 Spacecraft Bus is Also Nearing Completion

Orbital Sciences LEOStar-2 Bus

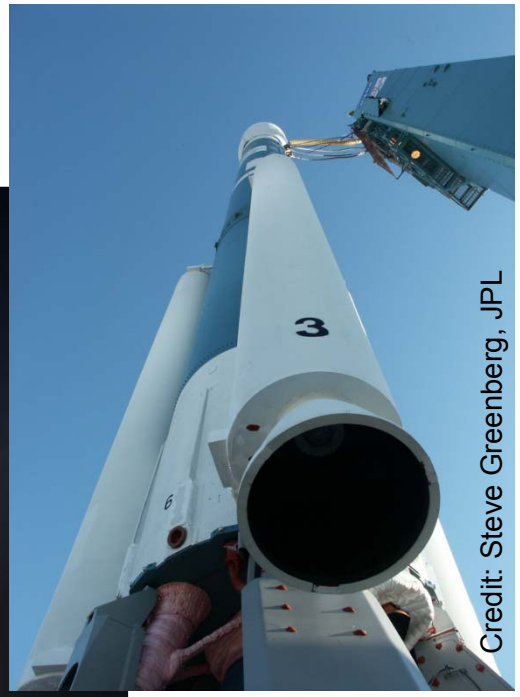
- 0.94 m x 2.1 m hexagonal structure
- 128 Gb of data storage
- 150 Mb/s X-band + 2 Mb/s S-band
- 3-axis stabilized:
  - 4 Reaction wheels + 3 torque bars
- Articulated solar arrays
- Propulsion system for orbit maintenance

Next Steps:
Instrument + Spacecraft Bus = Observatory



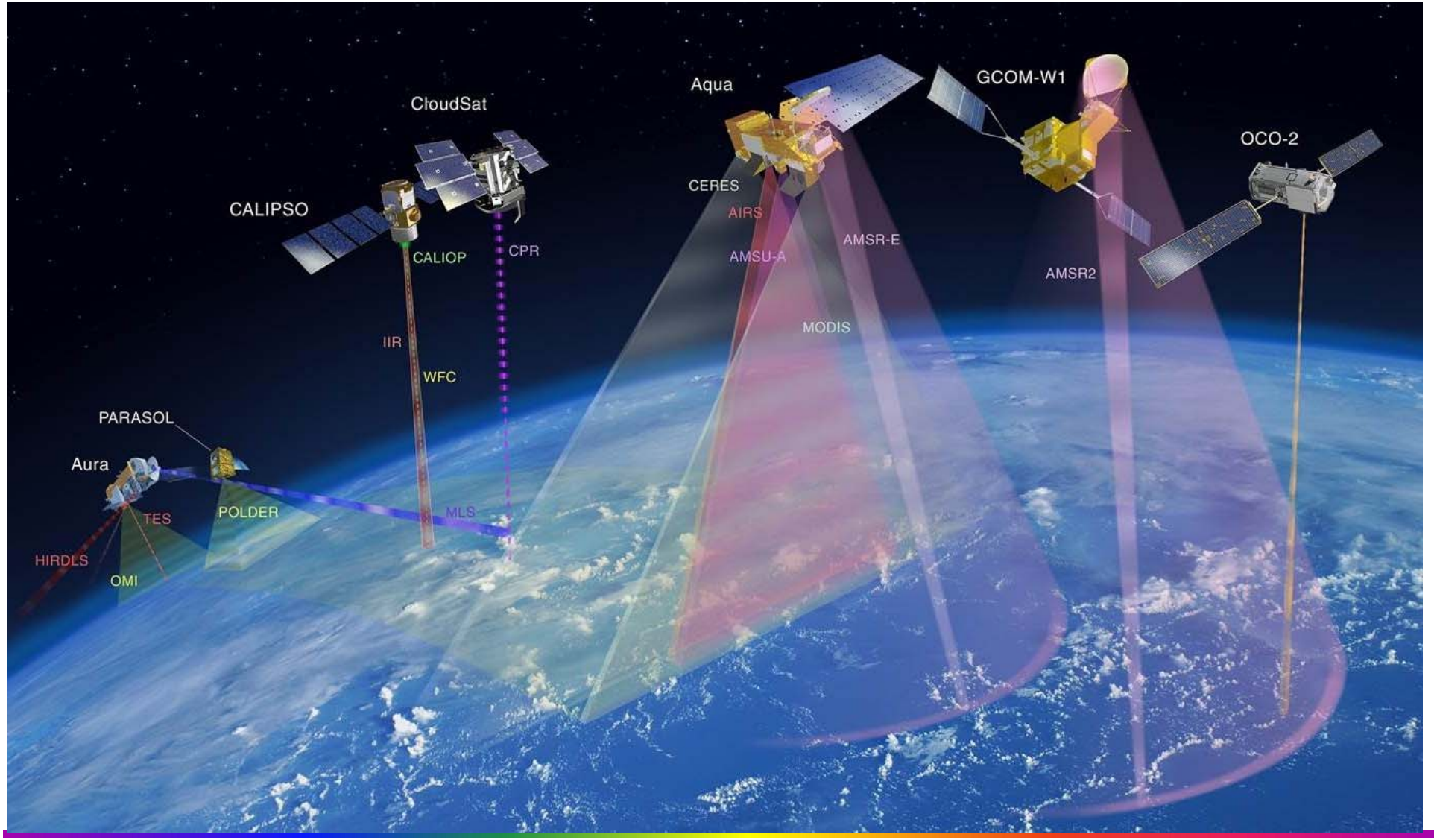
*Launch Date Driven by Launch Service Provider**

- A competitive selection process for the OCO-2 launch vehicle is under way
- A selection decision is expected on or before July 16 2012.
- The observatory must be ready to support a launch readiness date as early as July 1, 2014



*Pre Decisional – for discussion purposes only

Flying in Formation in the A-Train

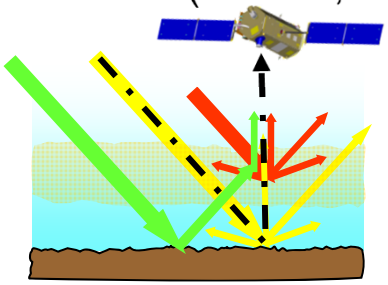


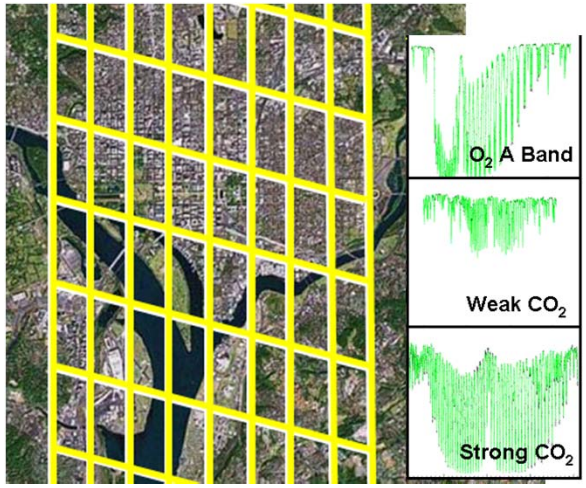
The Spacecraft Points the Instrument

Nadir Observations:

+ Small footprint (< 3 km^2)

– Low Signal/Noise over dark surfaces (ocean, ice)

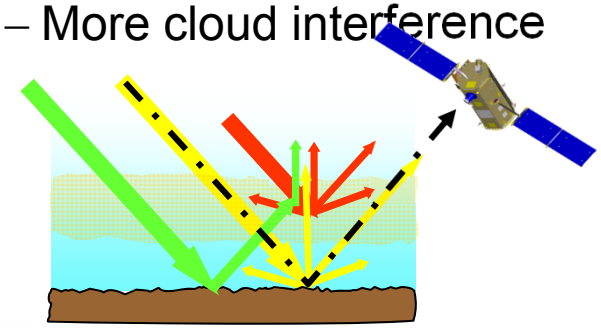


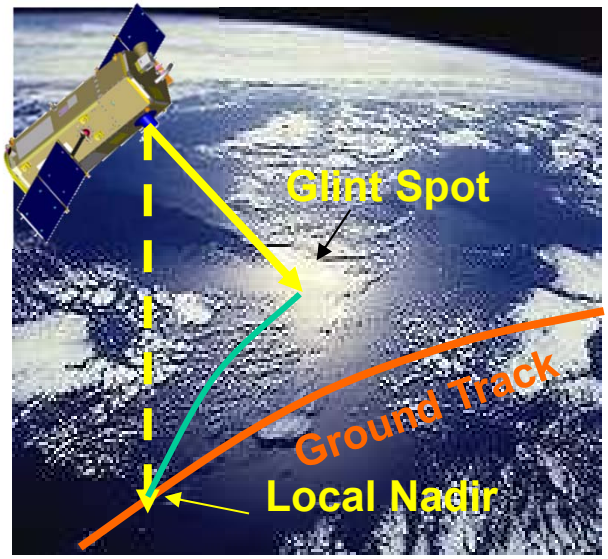


Glint Observations:

+ Improves Signal/Noise over oceans

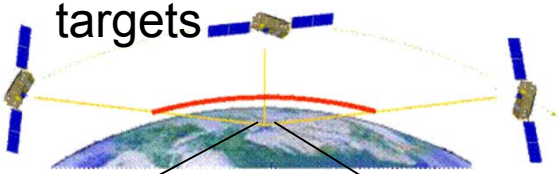
– More cloud interference

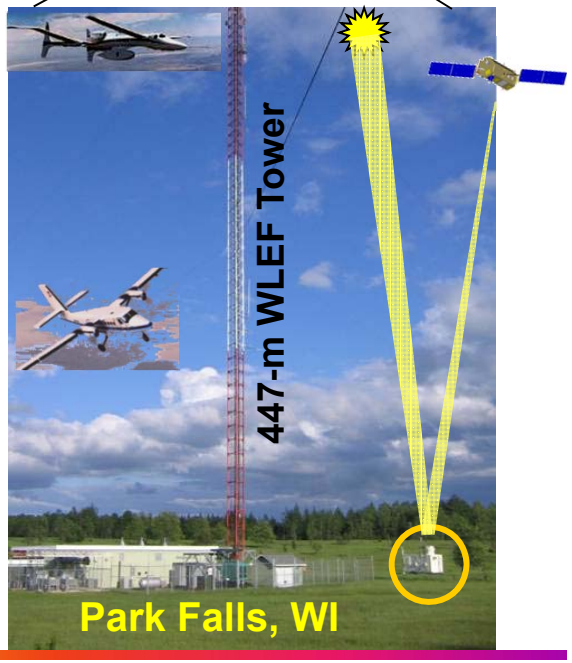




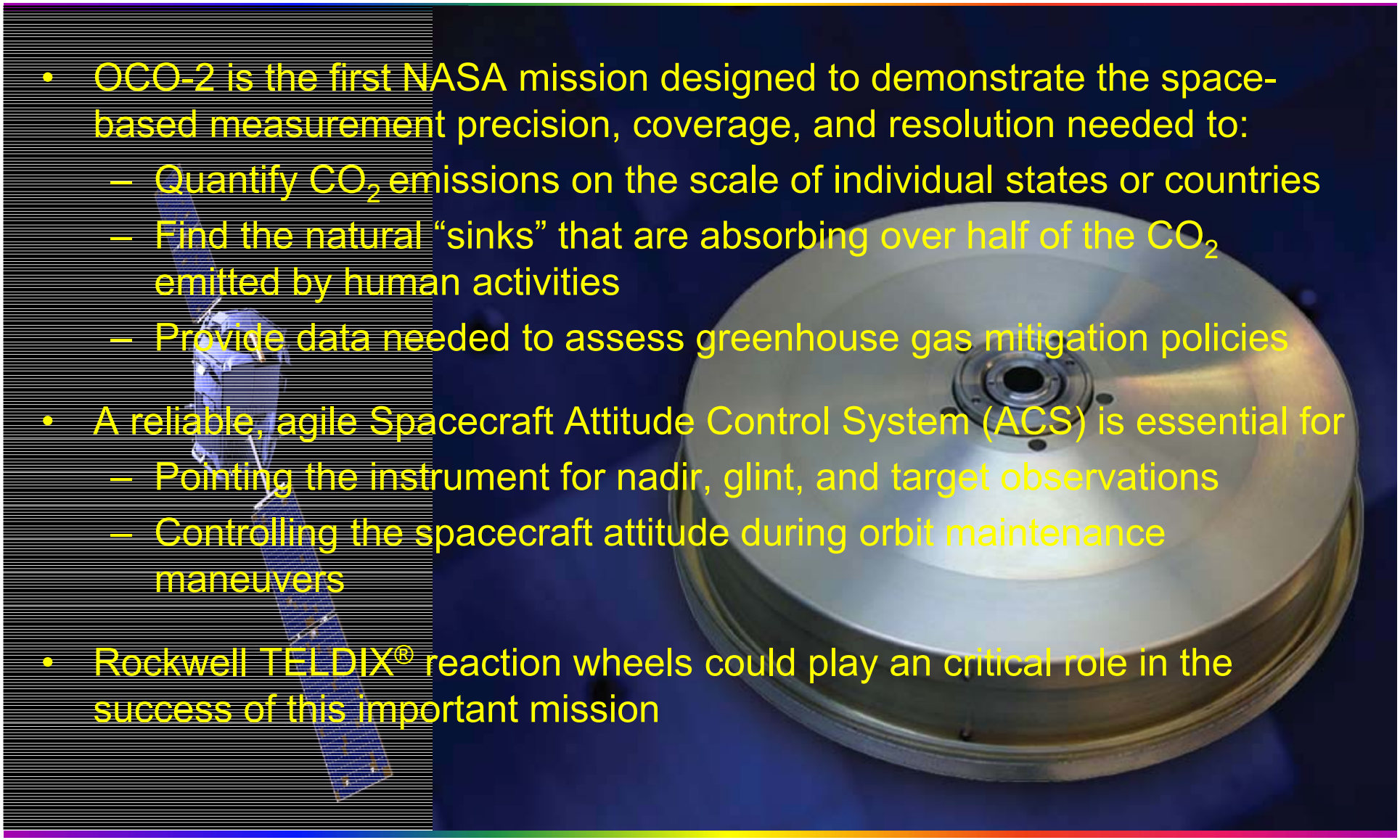
Target Observations:

• Validation over ground based FTS sites, field campaigns, other targets





Conclusions



- OCO-2 is the first NASA mission designed to demonstrate the space-based measurement precision, coverage, and resolution needed to:
  - Quantify CO_2 emissions on the scale of individual states or countries
  - Find the natural "sinks" that are absorbing over half of the CO_2 emitted by human activities
  - Provide data needed to assess greenhouse gas mitigation policies
- A reliable, agile Spacecraft Attitude Control System (ACS) is essential for
  - Pointing the instrument for nadir, glint, and target observations
  - Controlling the spacecraft attitude during orbit maintenance maneuvers
- Rockwell TELDIX® reaction wheels could play an critical role in the success of this important mission