The Orbiting Carbon Observatory (OCO)

http://oco.jpl.nasa.gov

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(JPL/Caltech)

February 2006

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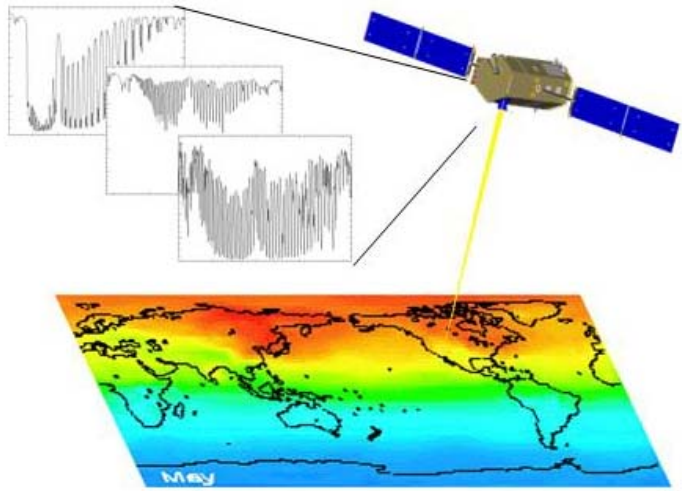
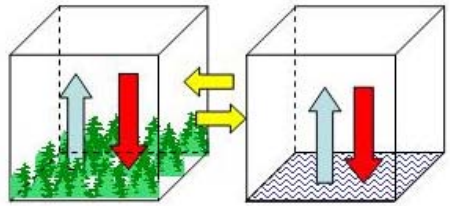
OCO will acquire the space-based data needed to identify CO_2 sources and sinks and quantify their variability over the seasonal cycle

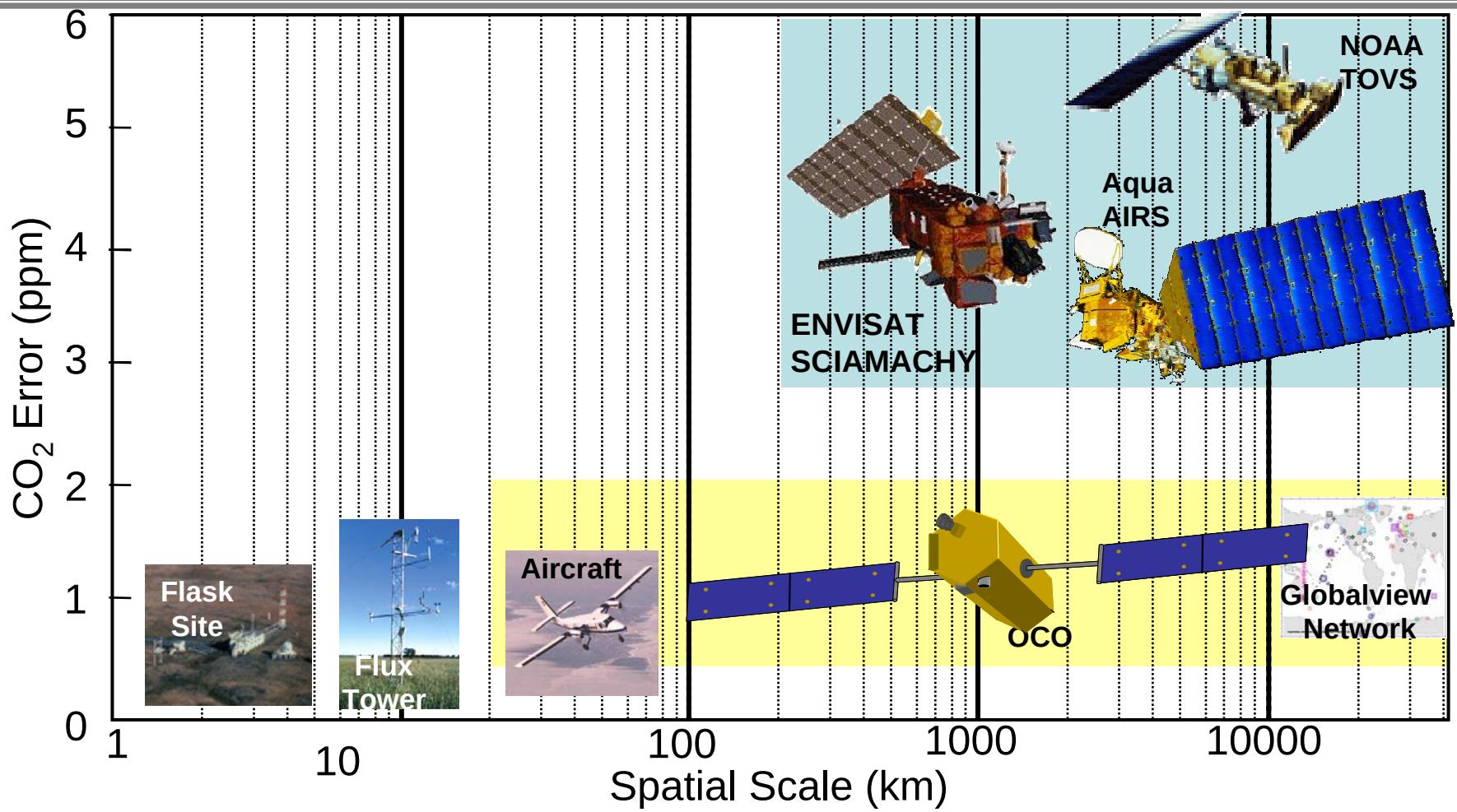
Approach:

- Collect spatially resolved, high resolution spectroscopic observations of CO_2 and O_2 absorption in reflected sunlight
- Use these data to resolve spatial and temporal variations in the ***column averaged CO2 dry air mole fraction, X_{CO2}*** over the sunlit hemisphere
- Employ independent calibration and validation approaches to produce X_{CO2} estimates with random errors and biases no larger than 1 - 2 ppm (0.3 - 0.5%) on regional scales at monthly intervals



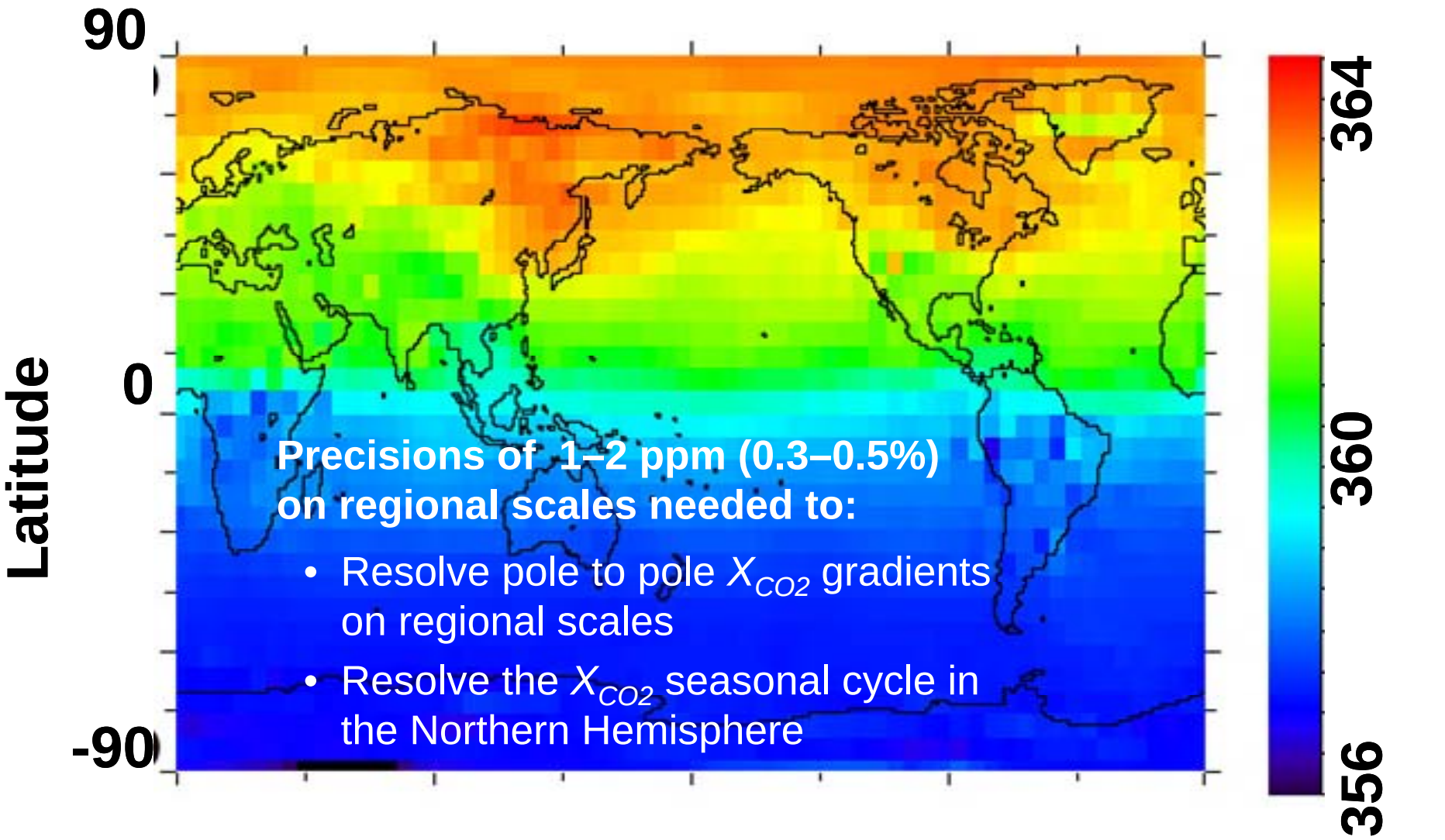


OCO Fills a Critical Measurement Gap



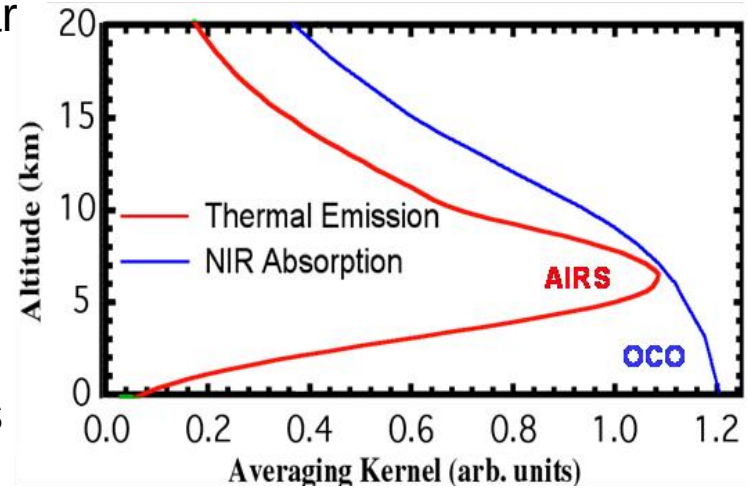
OCO will make precise global measurements of X_{CO2} over the range of scales needed to monitor CO_2 fluxes on regional to continental scales.

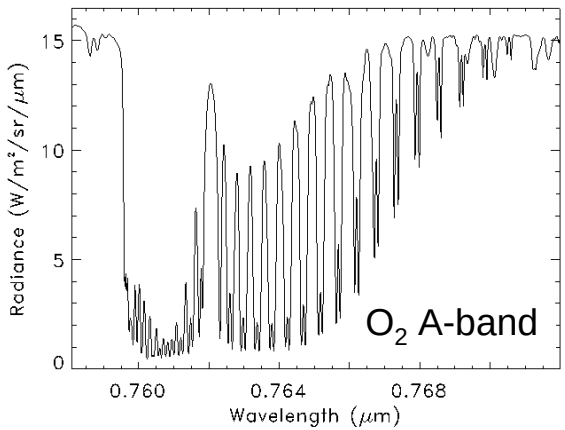
Precise CO_2 Measurements Needed to Constrain Surface Fluxes



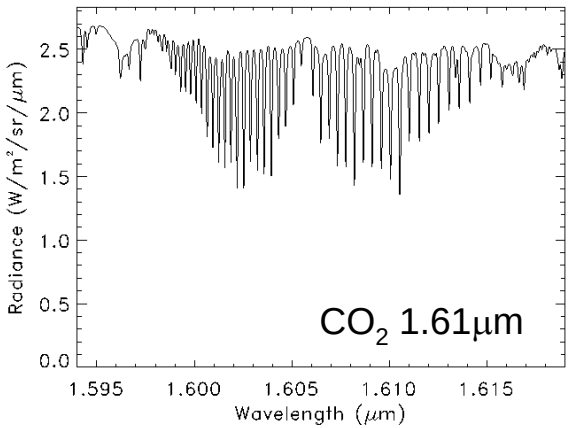
Making Precise CO_2 Measurements from Space

- High resolution spectra of reflected sunlight in near IR CO_2 and O_2 bands used to retrieve the column average CO_2 dry air mole fraction, X_{CO2}
  - 1.61 μm CO_2 bands – Column CO_2 with maximum sensitivity near the surface
  - O_2 A-band and 2.06 μm CO_2 band
    - Surface pressure, albedo, atmospheric temperature, water vapor, clouds, aerosols
- Why high spectral resolution?
  - Enhances sensitivity, minimizes biases

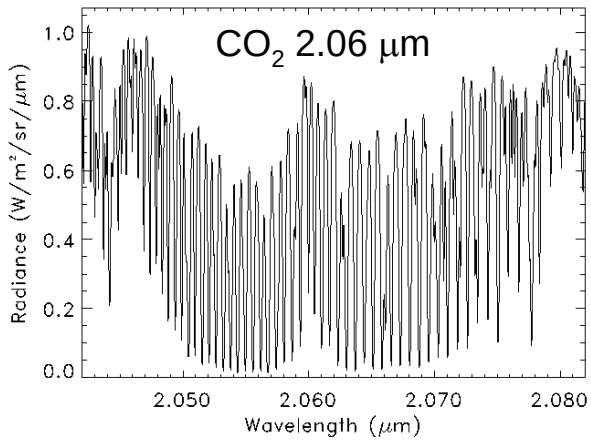




Clouds/Aerosols, Surface Pressure

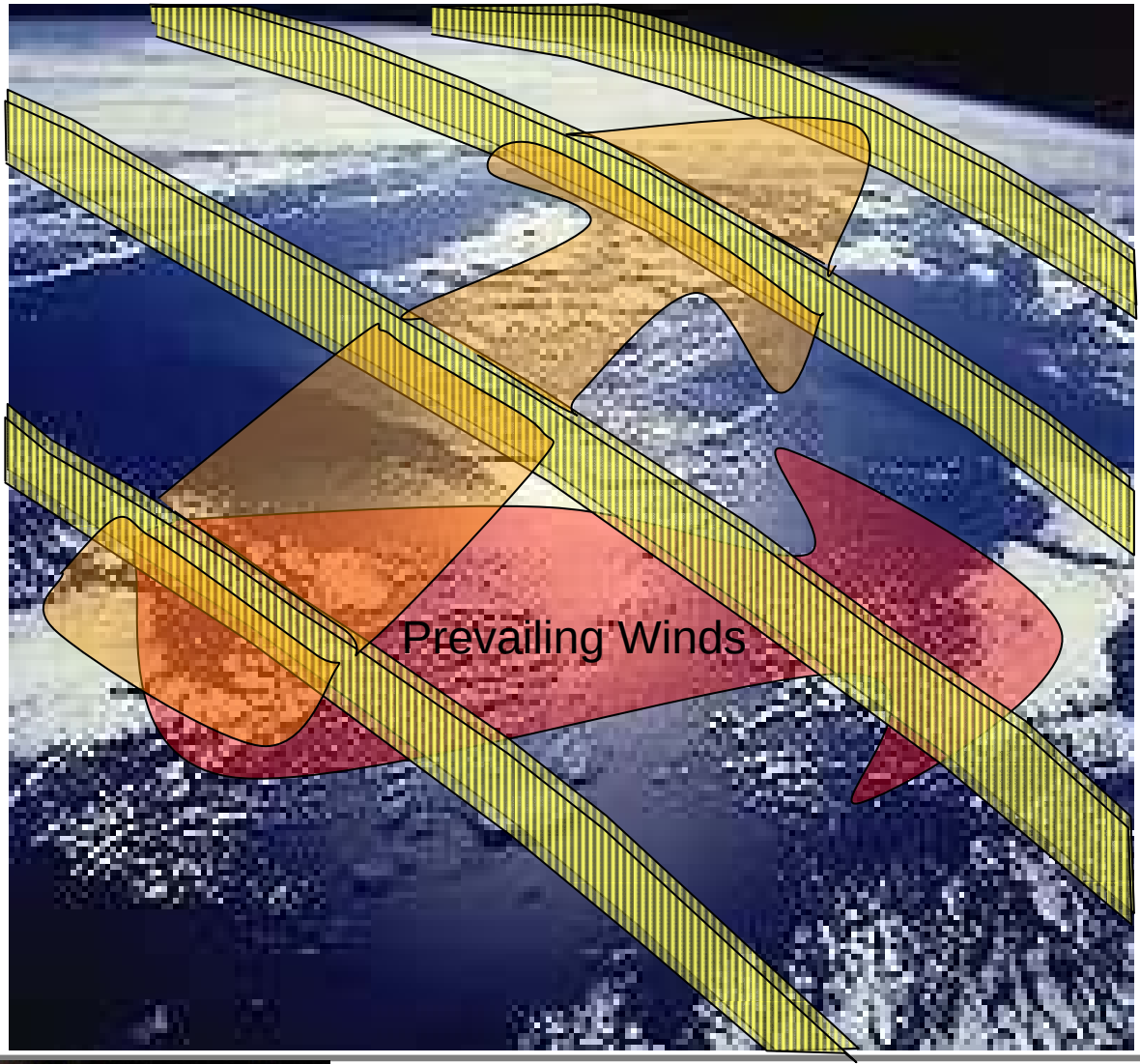


Column CO_2



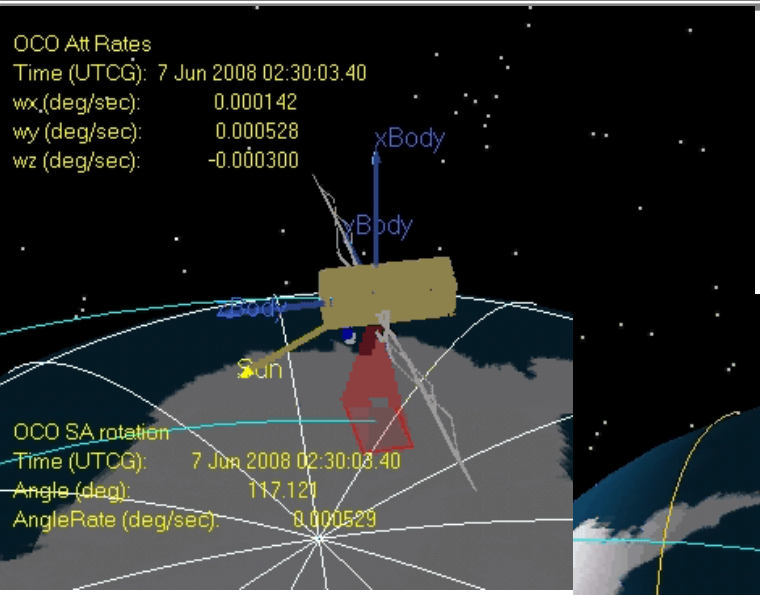
Clouds/Aerosols, H_2O, Temperature

OCO Sampling over a 16-Day Repeat Cycle



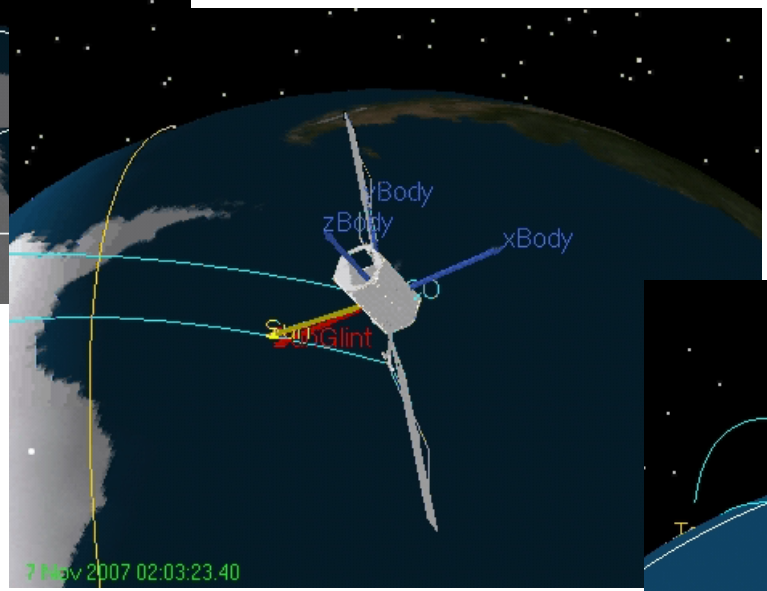
- OCO collects ~7-14 million soundings each 16-day cycle
- CO_2 column measurements complement surface measurement network.
  - Total column CO_2
  - Global coverage with 16-day repeat cycle
- Sampling Rate/Coverage
  - 12-24 samples/second collected along track over land and ocean
  - Glint: $\pm 75^{o}$ SZA
  - Nadir: $\pm 85^{o}$ SZA, 3 km^2
  - Longitude resolution 1.5^{o}

Observing Modes



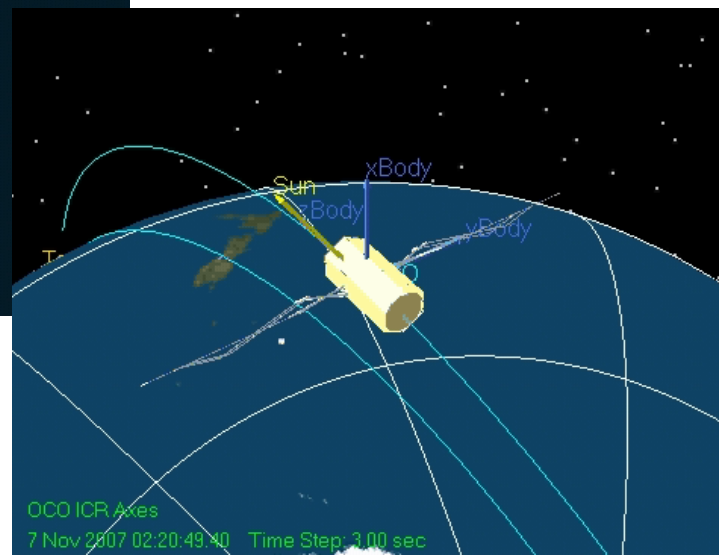
Nadir Observations:

+ Small footprint isolates cloud-free scenes
  - Low Signal/Noise over dark ocean



Glint Observations:

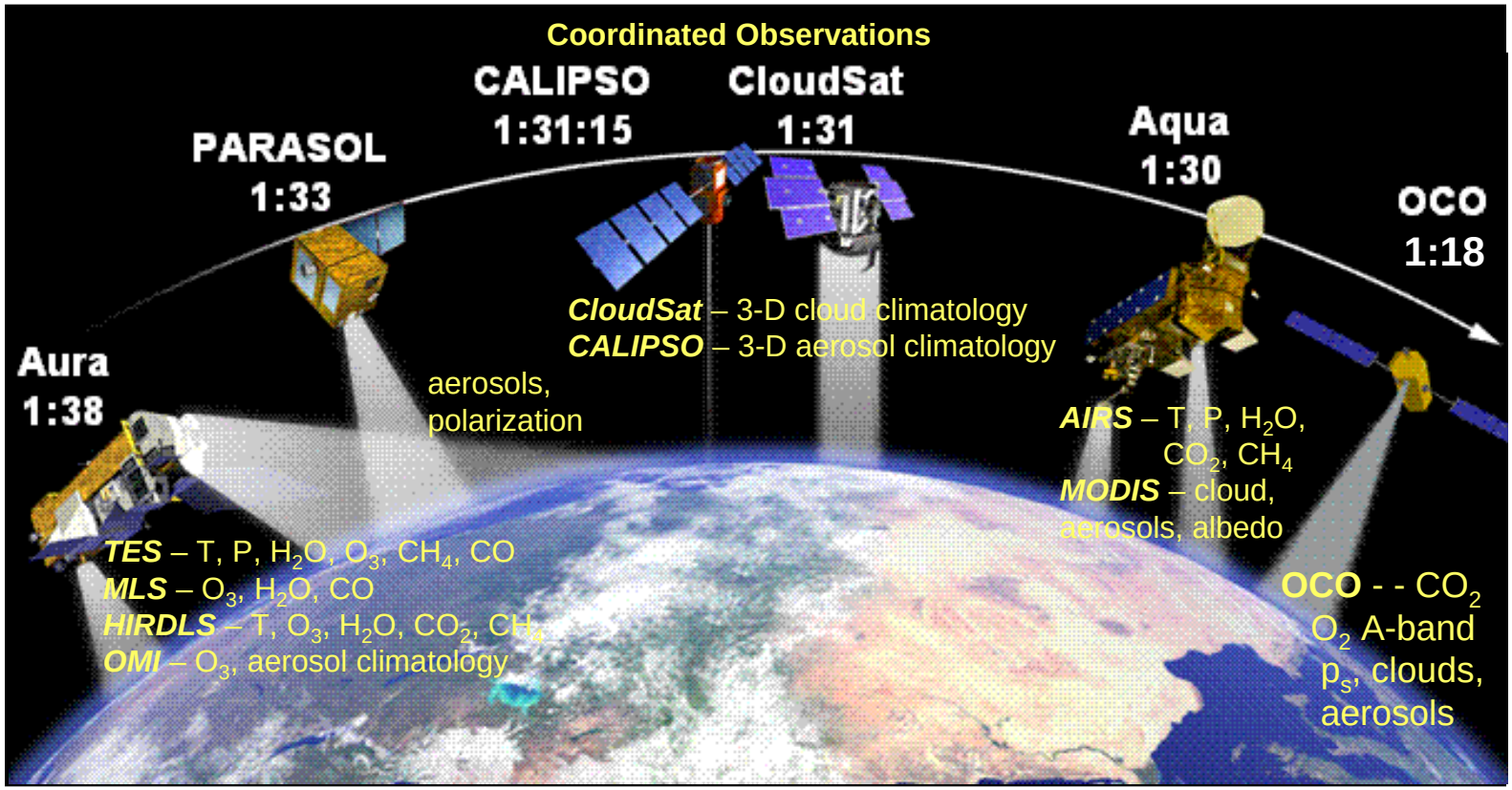
+ better SNR over oceans
  - More cloud interference



Target Observations:

Tracks a stationary surface calibration site to collect large

OCO Will Fly in the A-Train



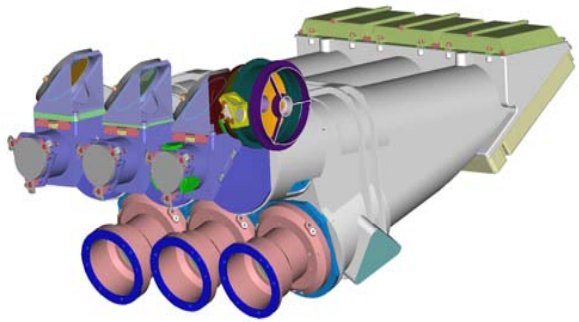
OCO files at the head of the A-Train, 12 minutes ahead of the Aqua platform

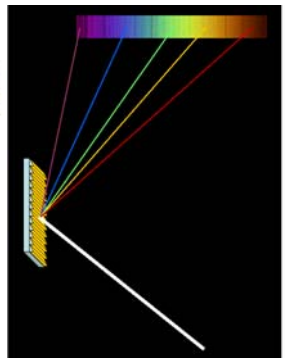
- 1:18 PM equator crossing time yields same ground track as AQUA
- Near noon orbit yields high SNR CO_2 and O_2 measurements in reflected sunlight
- CO_2 concentrations are near their diurnally-averaged values near noon
- Maximizes opportunities of coordinated science and calibration activities

Mission Implementation Approach

Project Management (JPL)

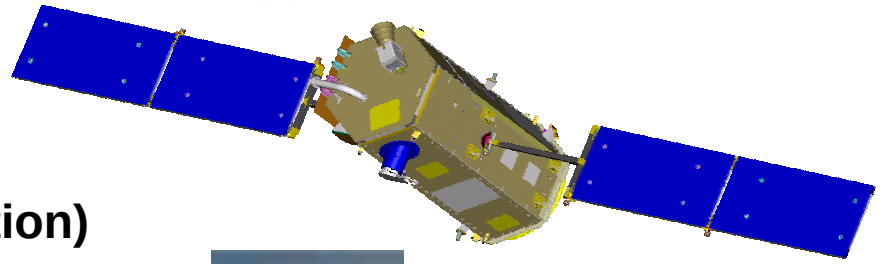
- Science & Project Team Leadership
- Systems Engineering, Mission Assurance
- Ground Data System





Single Instrument (Hamilton Sundstrand)

- 3 high resolution spectrometers



Dedicated Bus (Orbital Sciences Corporation)

- Heritage: OrbView 4, GALEX, SORCE

Dedicated Launch Vehicle (Orbital Taurus)

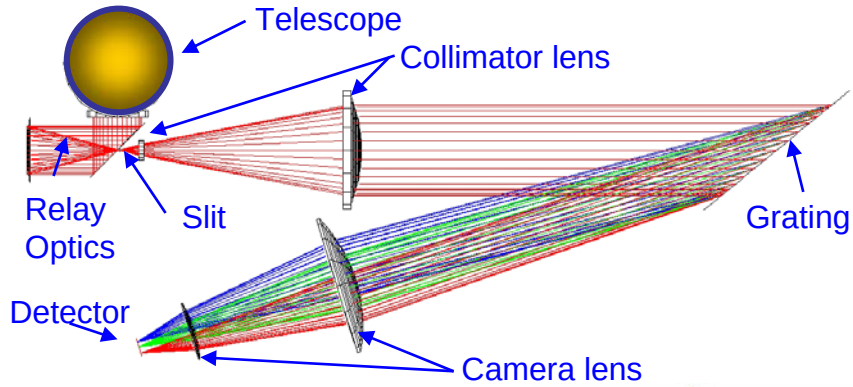
- September 2008 Launch from Vandenberg AFB

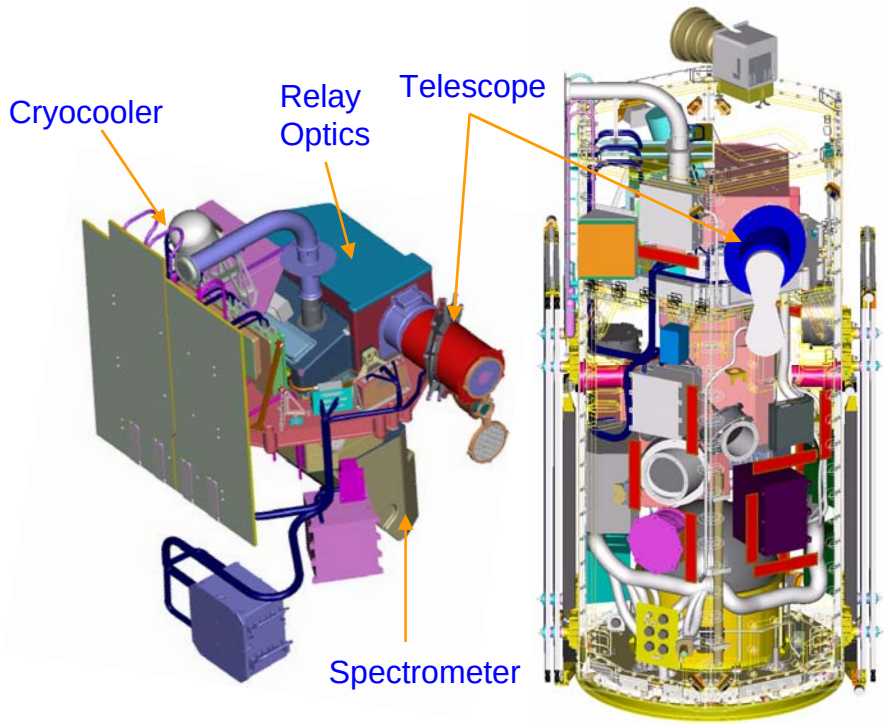
Mission Operations (JPL)

- NASA Ground Network, Poker Flats, Alaska

The OCO Instrument

- **Three bore-sighted, high resolution, grating spectrometers**
  - CO_2 1.61 μm band
  - CO_2 2.06 μm band
  - O_2 0.765 μm A-band
- **Similar optics and electronics**
  - Common 200 mm f/1.9 telescope
  - Spectrometers cooled to <0 ºC
  - Resolving Power ~20,000
  - Common Read-out Integrated Circuits and electronics for focal plane arrays
- **Existing Designs For Critical Components**
  - Detectors: WFC-3, Deep Impact (RSC)
  - Cryocooler: TES flight spare (NGST)
- **Provided by Hamilton Sundstrand Sensor Systems (Pomona CA)**
  - Provided last 4 TOMS instruments

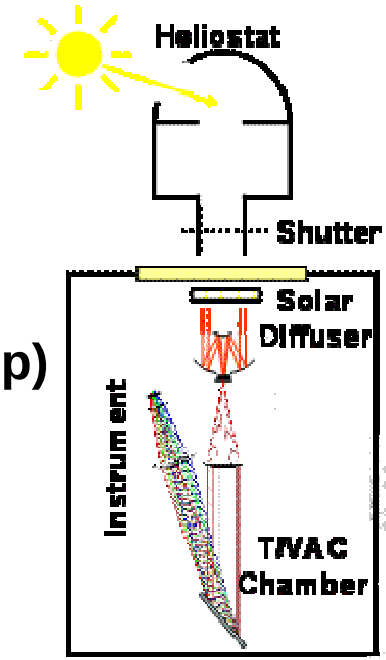


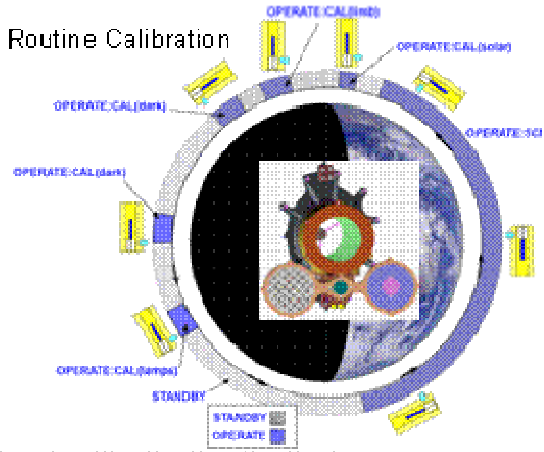


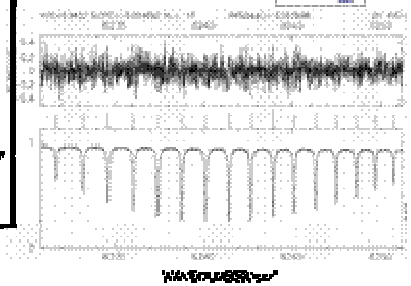
Calibration/Validation Program Assures Measurement Accuracy

Calibration

- Pre Launch
  - Instrument Subsystem
  - Observatory-level
- On-Orbit
  - Routine (Solar, Limb, Dark, Lamp)
  - Special (Stellar, Solar Doppler)
  - Vicarious

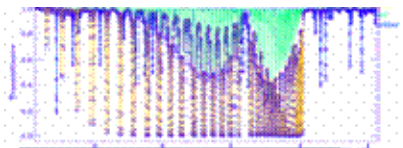






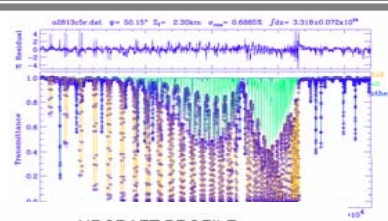
Validation

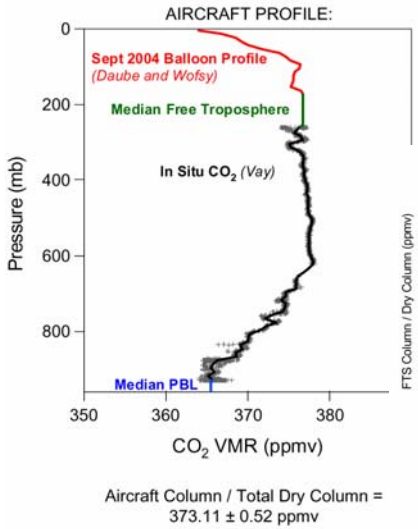
- Laboratory spectroscopy
  - Spectral line databases for CO_2, O_2
- Ground-based in-situ measurements
  - NOAA CMDL Flask/Tower Network
- Solar-looking FTS measurements of X_{CO2}
  - Measure same bands as flight instrument

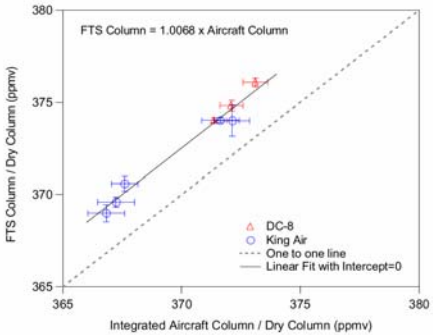


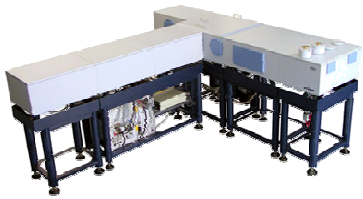
Space-based X_{CO2} Validation Strategy

- Validate space-based X_{CO2} using:
  - Measurements of X_{CO2} from a ground based network of Fourier transform spectrometers (FTS)
  - FTS and space-based X_{CO2} processed using same retrieval code



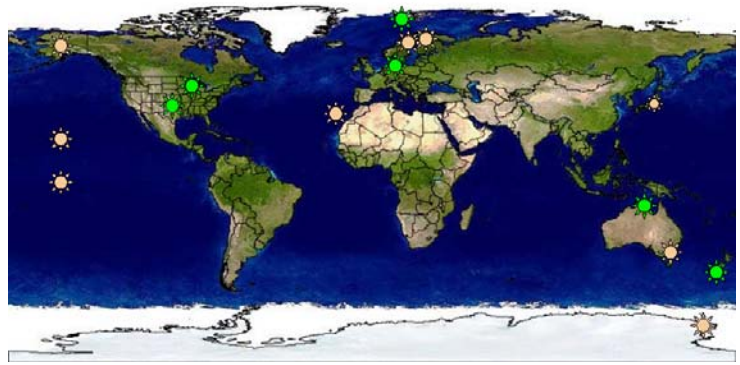






- FTS X_{CO2} compared to
  - Surface in situ CO_2
  - Tall tower in situ CO_2
  - Column CO_2 integrated from in situ aircraft + sondes

- FTS X_{CO2} performance tracked via continuous monitoring of:
  - Instrument Line Shape (HCl gas cell)
  - Pointing (Doppler shift, telluric vs solar features)
  - Surface pressure and temperature



Mission Schedule

OCO Schedule

- 7/2001: Step-1 Proposal Submitted
- 2/2002: Step-2 Proposal Submitted
- 7/2003: Selected for Formulation
- 7/2004: System PDR
- 5/2005: Mission Confirmed for Implementation
- 10/2005: Instrument CDR
- 2/2006: Spacecraft CDR
- 7/2006: System CDR
- 11/2006: Instrument Pre-Environmental Review
- 4/2007: Instrument Delivery
- 9/2008: Launch
- 10/2010: End of Nominal Mission