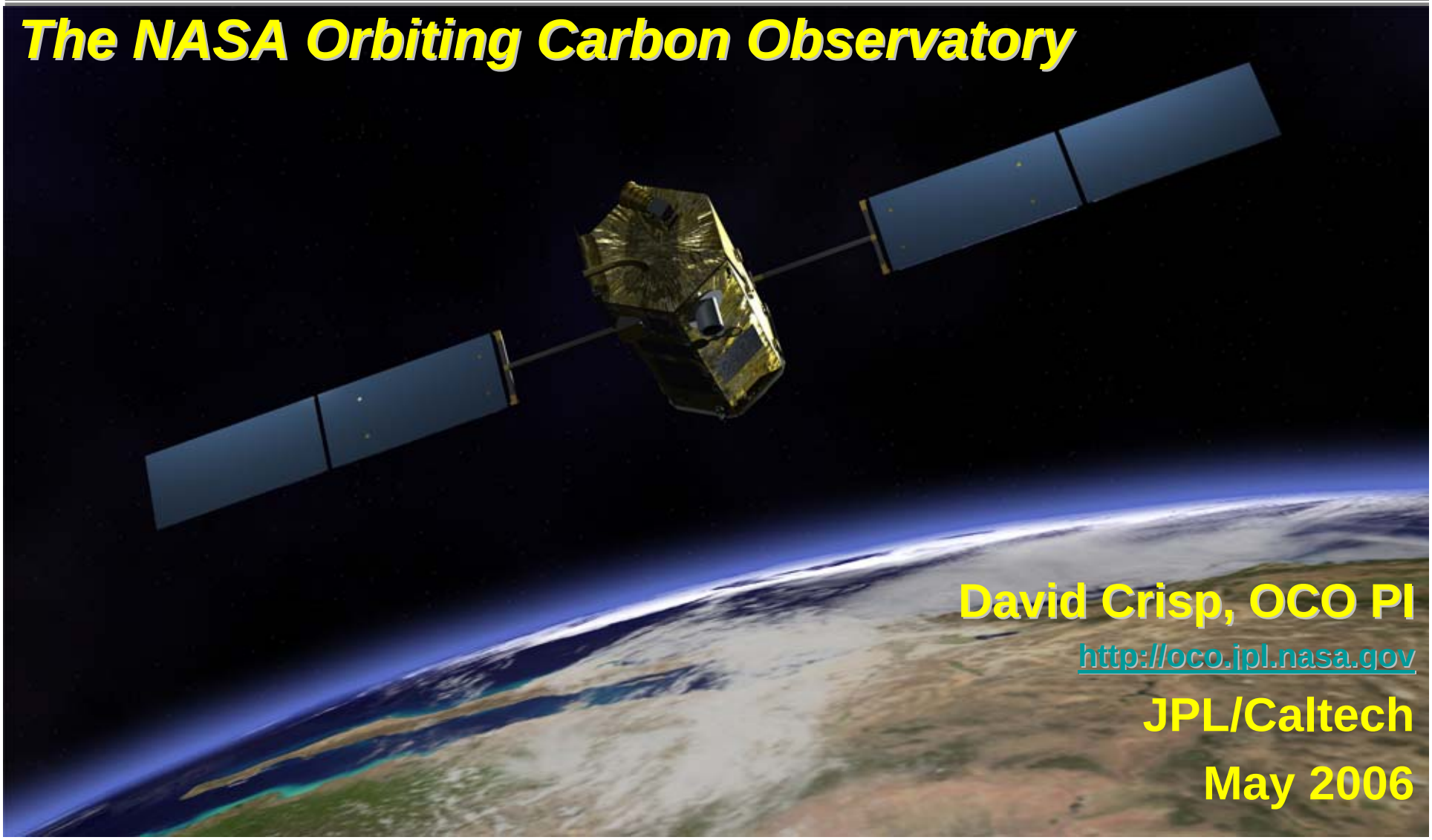
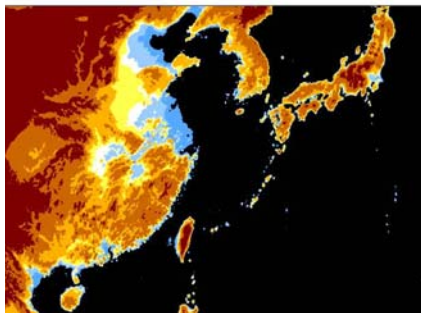
The NASA Orbiting Carbon Observatory



David Crisp, OCO PI
http://oco.jpl.nasa.gov
JPL/Caltech
May 2006

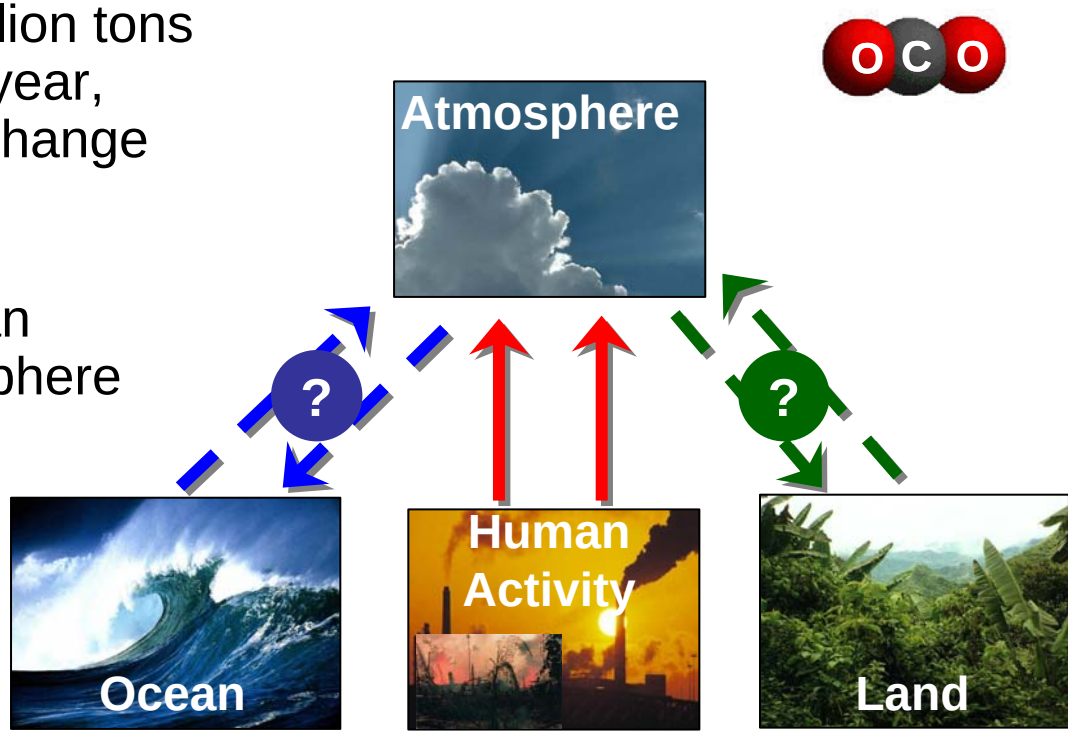
Carbon Dioxide

- Carbon dioxide (CO_2) is:
  - An essential ingredient of life on Earth
  - The main man-made greenhouse gas



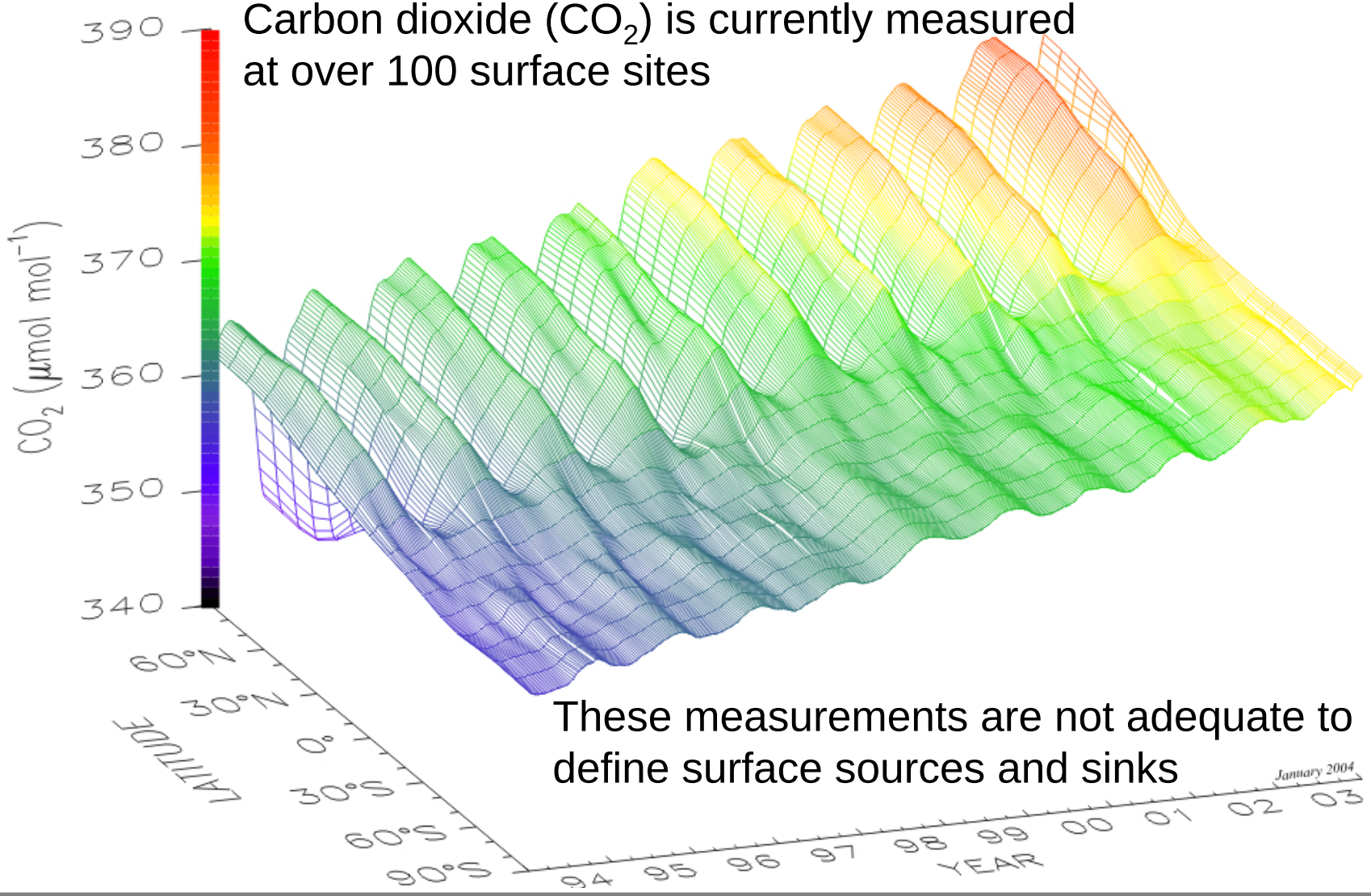
- Human activities add about 7 billion tons of CO_2 to the atmosphere each year, raising concerns about climate change

- Only 58% of the CO_2 from human activities is staying in the atmosphere
  - The rest is absorbed by:
    - Oceans?
    - Land Plants?



What Processes Control Atmospheric CO_2?

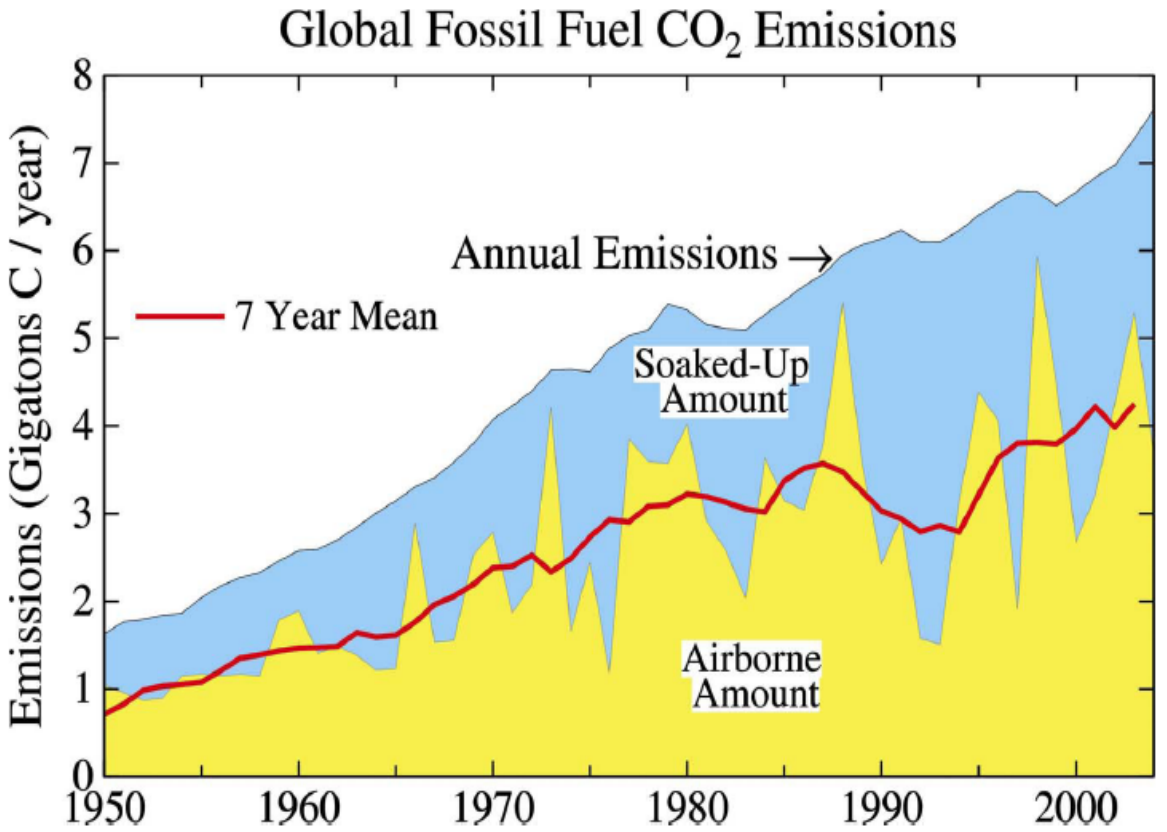
Carbon dioxide (CO_2) is currently measured at over 100 surface sites



These measurements are not adequate to define surface sources and sinks

Outstanding Mysteries

- Where are the ***sinks*** that absorb almost half of the CO_2 that we emit?
  - Land or ocean?
  - Eurasia/North America?
- Why does the CO_2 buildup vary dramatically with nearly uniform emissions?
- How will CO_2 sinks respond to climate change?



Global fossil fuel CO_2 emissions with division into portions that remain airborne or are soaked up by the ocean and land.

Source: Hansen and Sato, *PNAS*, **101**, 16109, 2004.

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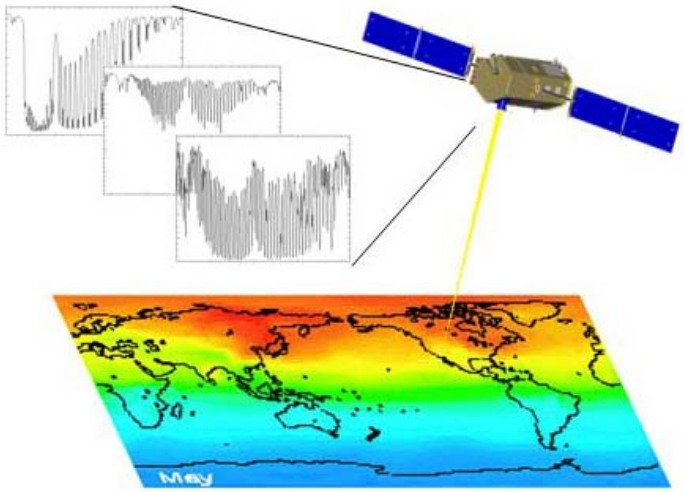
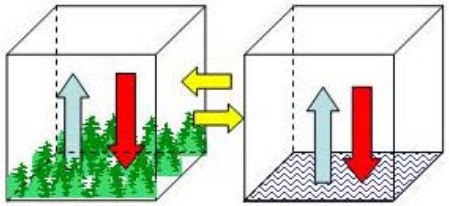
The Orbiting Carbon Observatory (OCO)

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



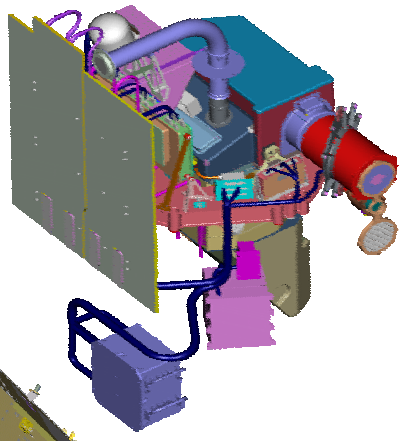
Approach:

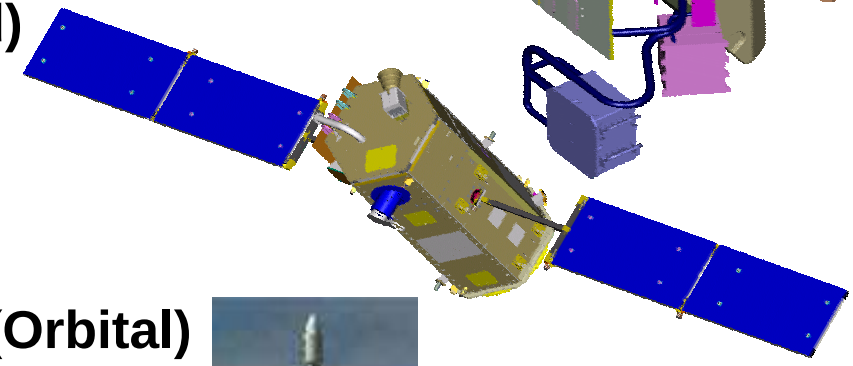
- Collect spectra of CO_2 and O_2 absorption in reflected sunlight
- Use these data to resolve variations in the ***column averaged CO_2 dry air mole fraction, X_{CO2}*** over the sunlit hemisphere



- Validate measurements to ensure X_{CO2} accuracies of 1 - 2 ppm (0.3 - 0.5%) on regional scales at monthly intervals

OCO Mission Approach





Project Management (JPL)

Single Instrument (Hamilton Sundstrand)

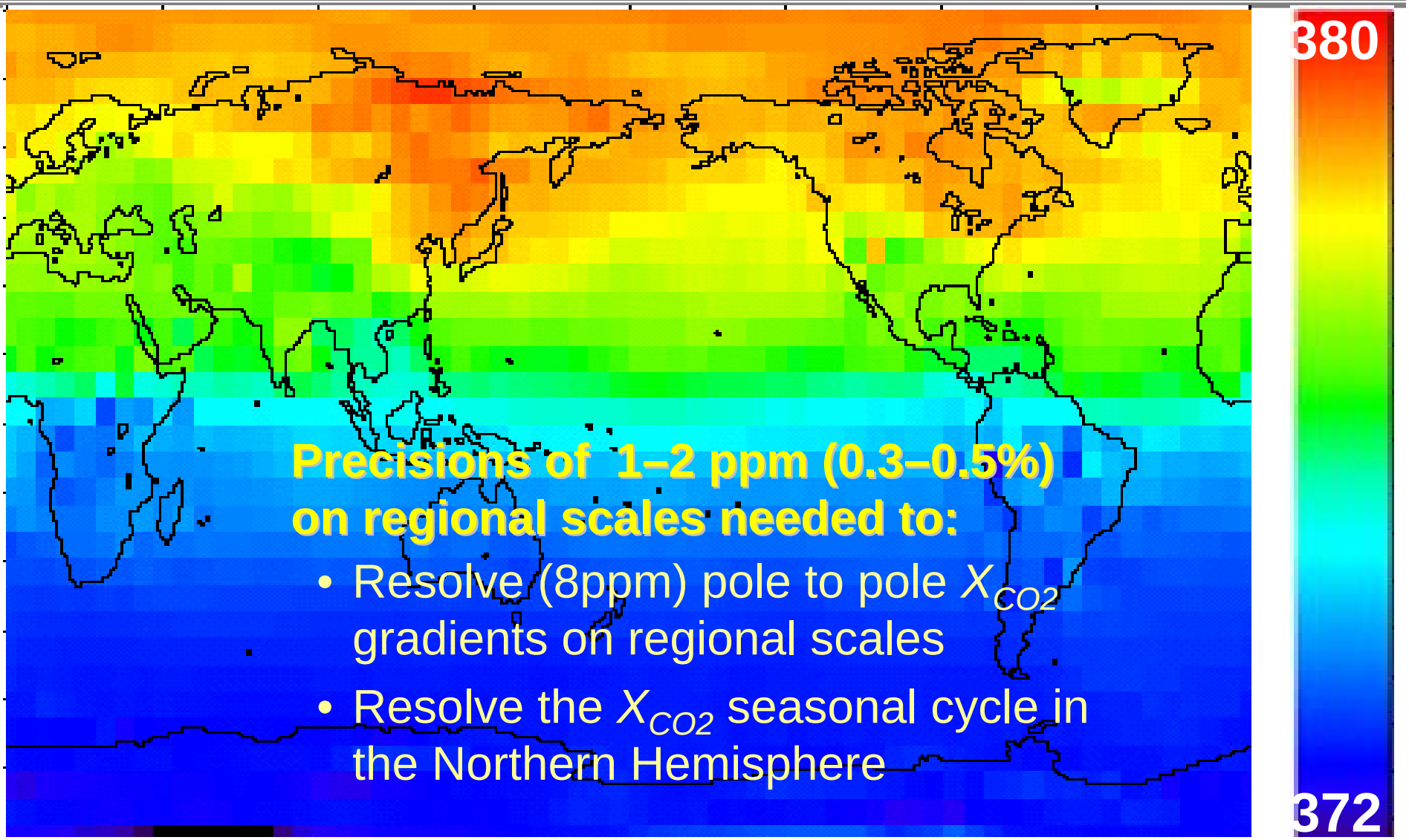
Dedicated Bus (Orbital Sciences)

Dedicated Taurus 3110 Launch Vehicle (Orbital)

Mission Operations (JPL/Orbital Sciences)

September 2008 Launch from Vandenberg AFB

OCO and GOSAT Must Make Precise Measurements to Find CO_2 Sources and Sinks

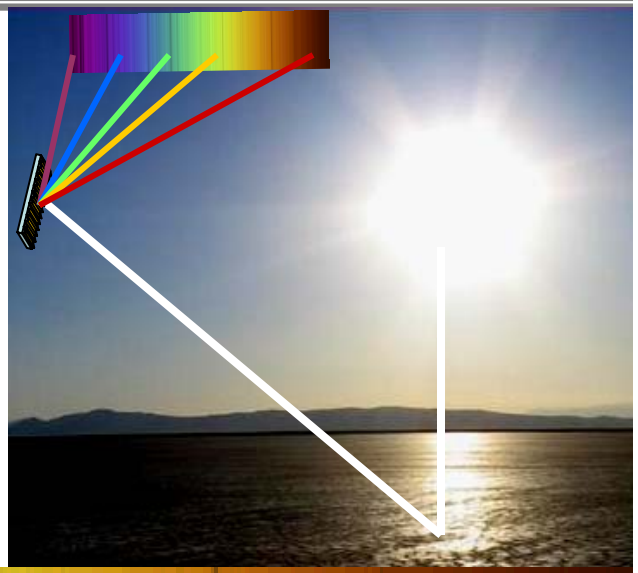


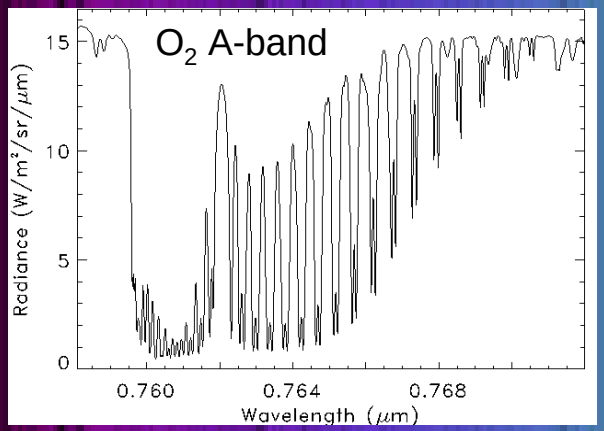
Precisions of 1–2 ppm (0.3–0.5%) on regional scales needed to:

- Resolve (8ppm) pole to pole X_{CO2} gradients on regional scales
- Resolve the X_{CO2} seasonal cycle in the Northern Hemisphere

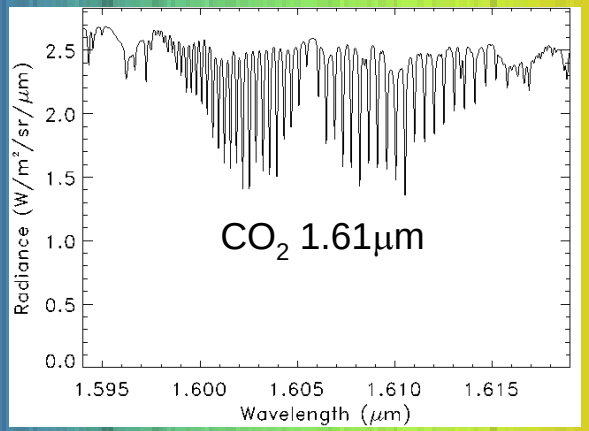
Making Precise CO_2 Measurements from Space

- High resolution spectra of reflected sunlight in 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 band: Column CO_2
  - 2.06 μm CO_2 band: Column CO_2, Aerosols
  - 0.76 μm O_2 A-band: Surface pressure, clouds, aerosols

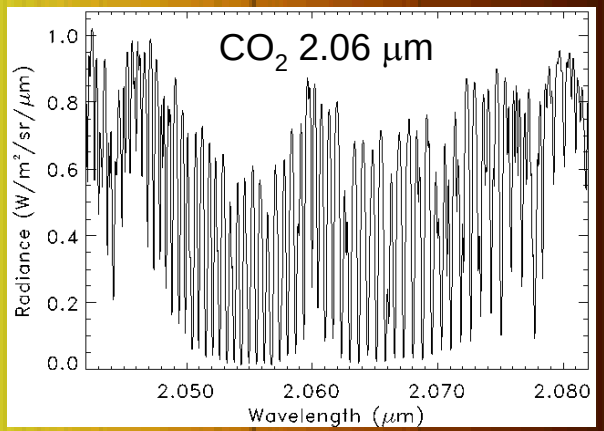




Clouds/Aerosols, Surface Pressure

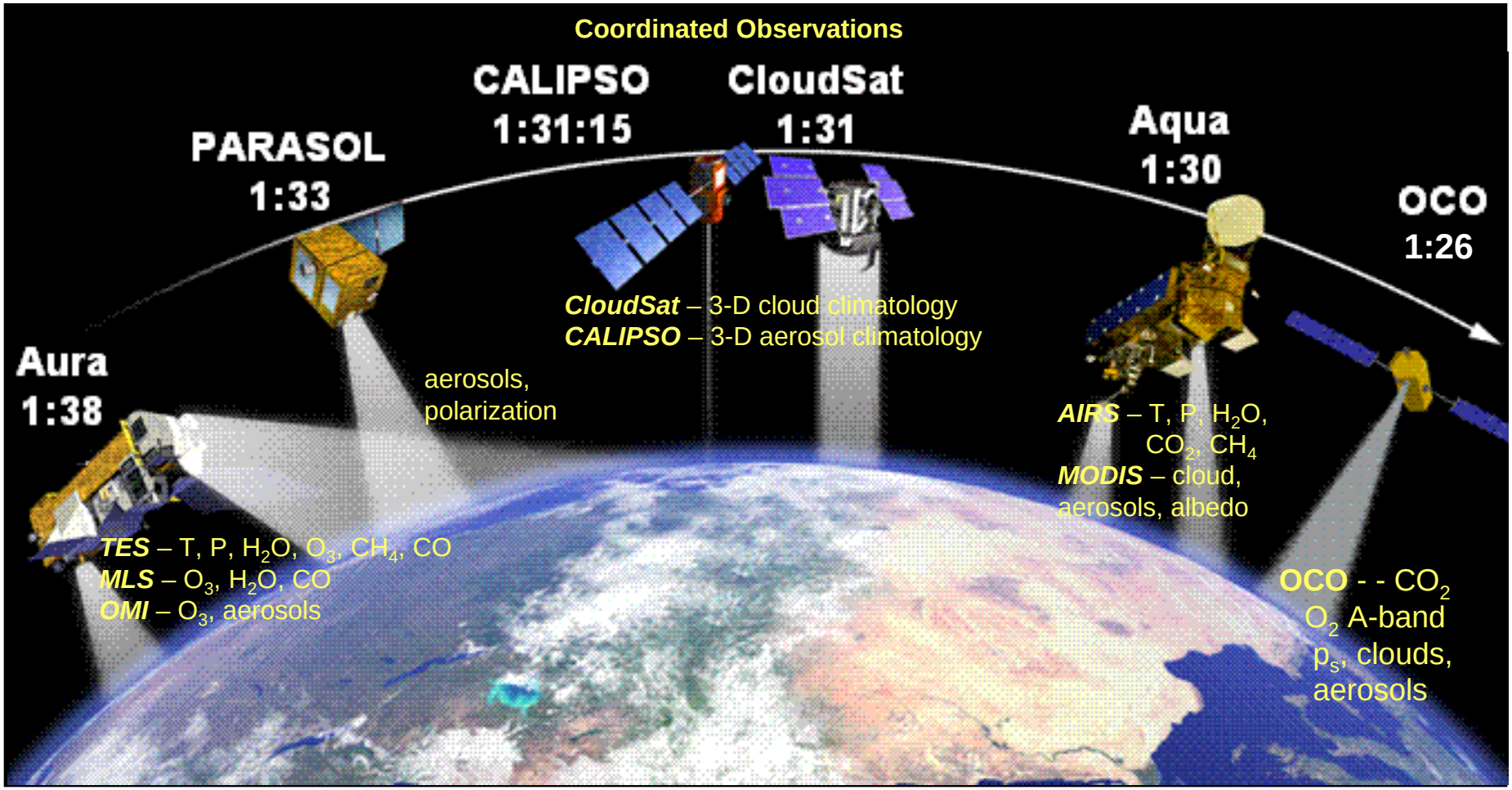


Column CO_2



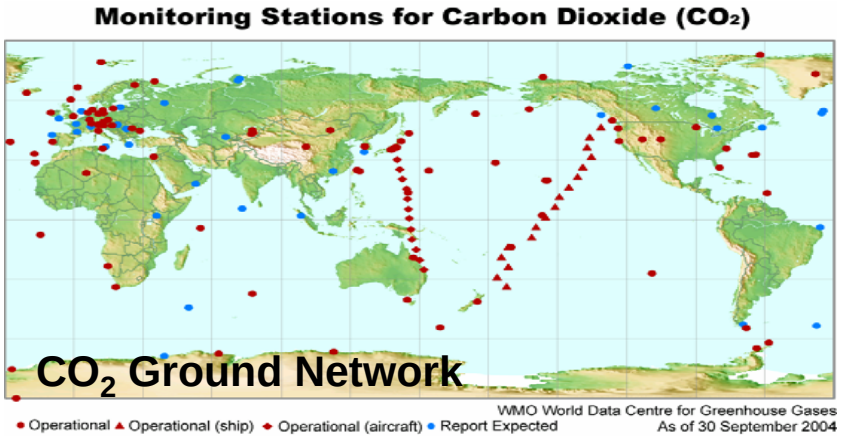
Clouds/Aerosols, H_2O, Temperature

OCO Will Fly in the A-Train



OCO files at the head of the EOS Afternoon Constellation (A-Train)

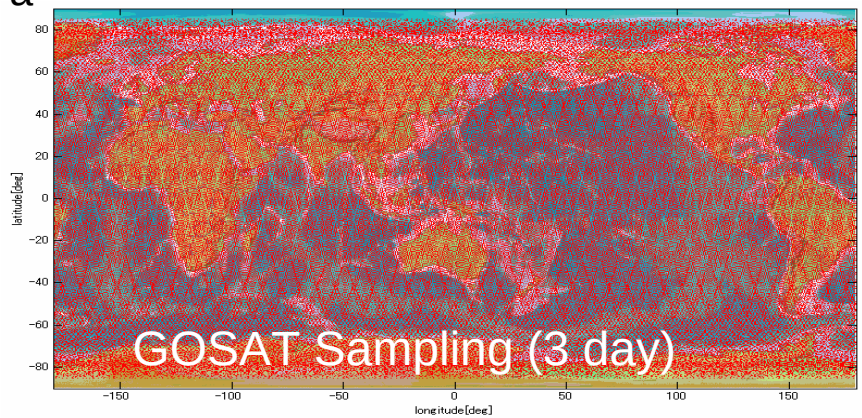
OCO and GOSAT Will Dramatically Improve the Density and Coverage of CO_2 Data



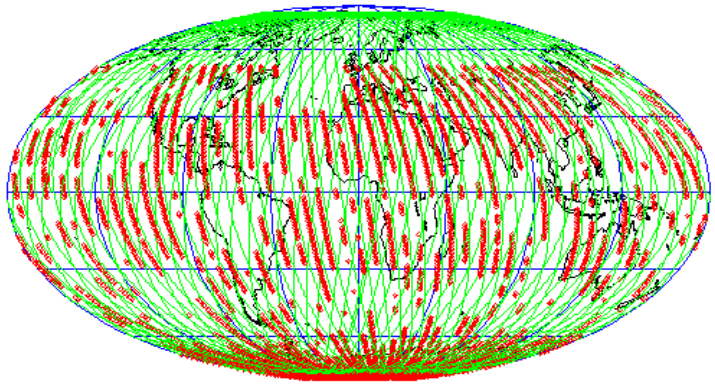
Space-based CO_2 column measurements complement surface measurement network.

- GOSAT collects over 100,000 soundings every 3 days
- OCO collects 7 to 14 million soundings every 16 days

Each red dot is a measurement



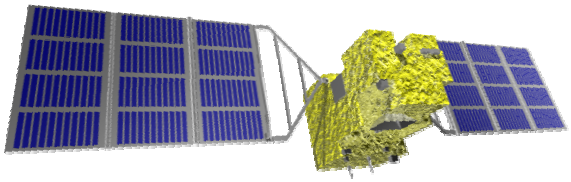
OCO (3-Days)



Clouds-free samples shown in red

Chevallier et al. 2006

OCO vs GOSAT:
Same Objective, Different Methods



	GOSAT	OCO
Gases Measured	CO_2, CH_4, O_2, O_3, H_2O	CO_2, O_2
Instruments	SWIR/TIR FTS, CAI	Grating Spectrometer
Total Mass	1750 kg	440 kg
Power	4400 Watts	887 Watts
Orbit Altitude	666 km	705 km
Local Time	13:00±0:15	13:26±0:1.8
Revisit Time	3 Days	16 Days
Launch Vehicle	H-IIA	Taurus 3110
Launch Date	August 2008	September 2008
Nominal Mission Life	5 Years	2 Years

Racing to Launch!

Which mission will be the "FIRST" dedicated Greenhouse Gas Measurement mission?

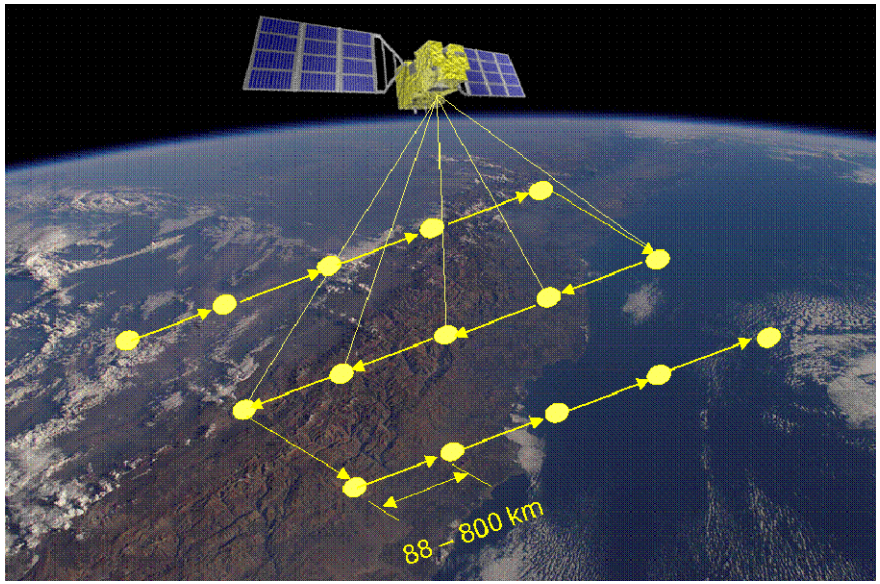
- **GOSAT is currently scheduled for an August 2008 launch**
- **OCO is currently scheduled for a September 2008 launch**

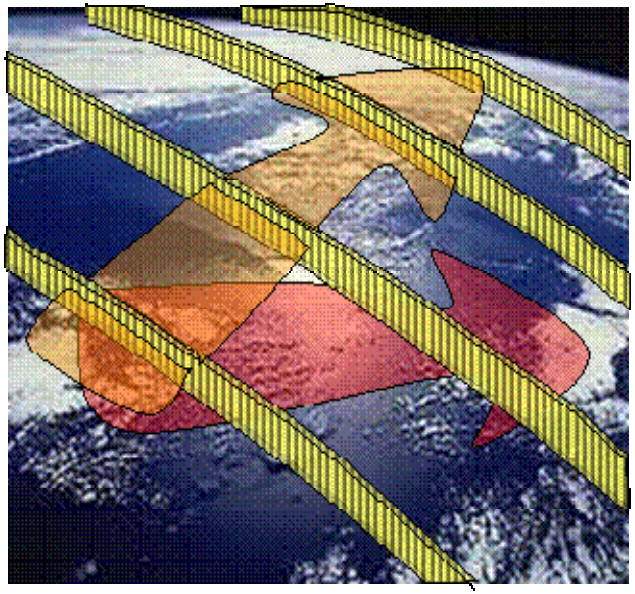
But there are many uncertainties and obstacles on the way to the launch pad…….

The race is on!

Combining OCO and GOSAT Data will Improve the Value of both Missions

- **OCO and GOSAT sample the Earth differently.**
- **Earth Scientists will benefit by combining GOSAT and OCO results.**





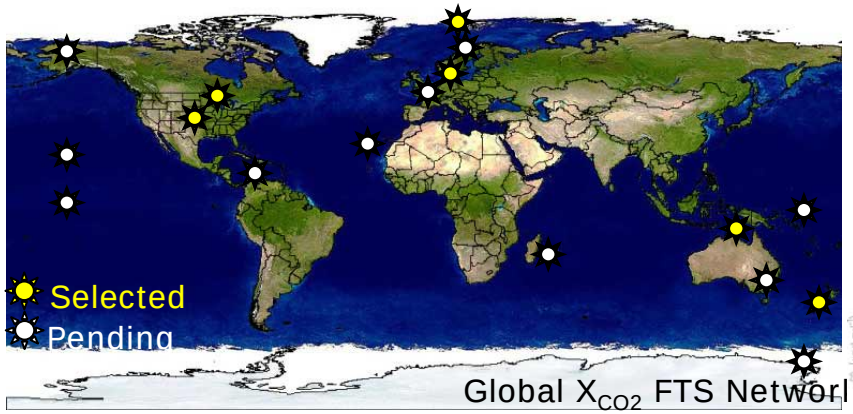
- GOSAT
  - 3-day global repeat cycle resolves synoptic weather patterns
  - Cross-track scanner provides more complete longitude coverage

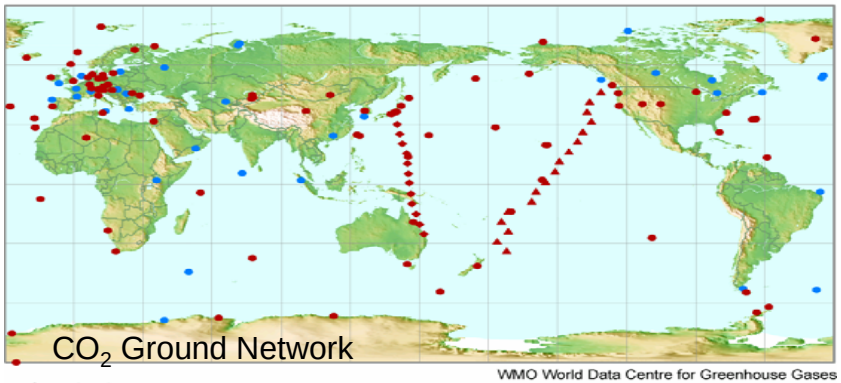
- OCO
  - Small (3 km^2) footprint yields more cloud-free soundings
  - Contiguous measurements capture CO_2 changes on small scales

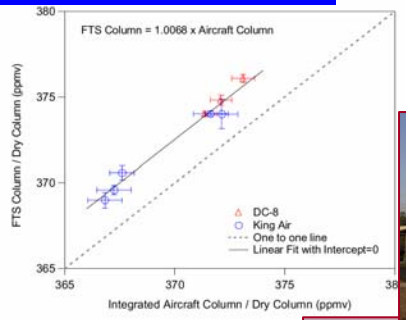
Space-based X_{CO2} Validation Strategy Ensures Accuracy and Early Acceptance

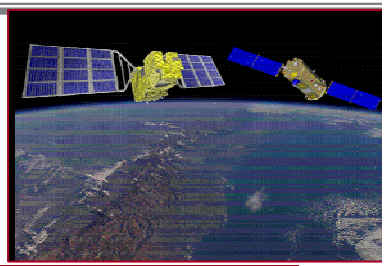
A common validation approach will speed acceptance of OCO and GOSAT data by the Science Community

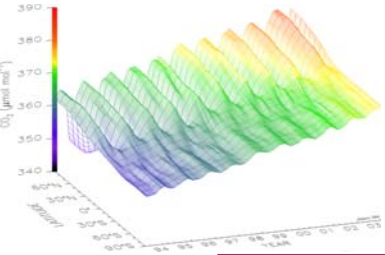
- The space-based measurements must be validated against the surface CO_2 standard

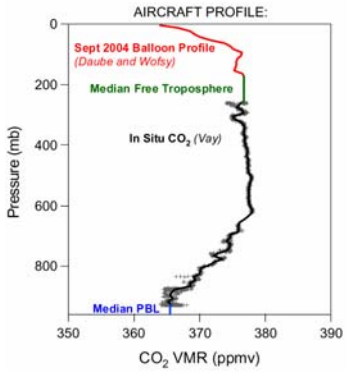




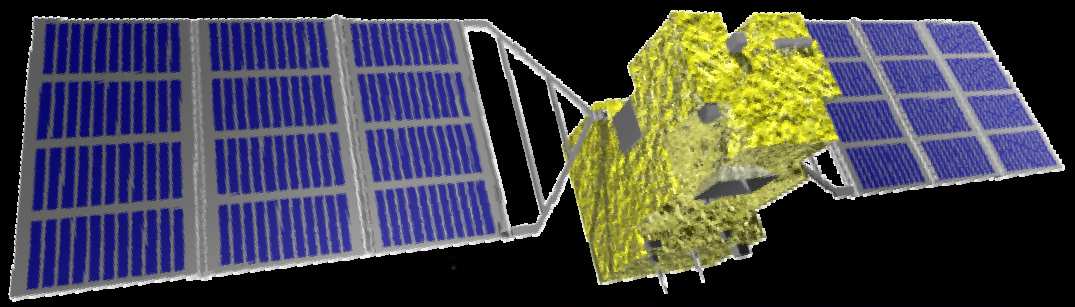


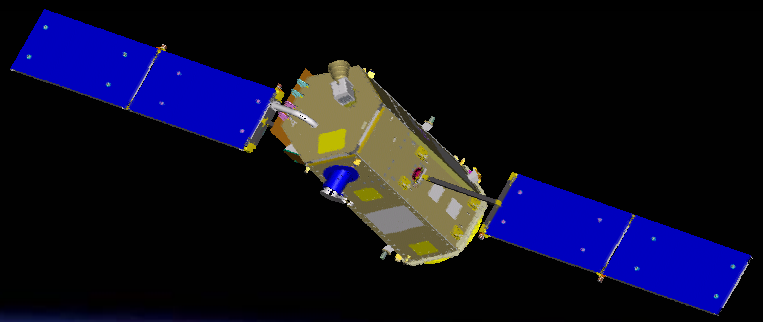






CO_2 is the principal man-made driver of climate change





Accurate forecasting of future climate requires an improved understanding of the global carbon cycle and its interaction with the Earth System

OCO and GOSAT will make the first space-based measurements of CO_2 with the accuracy needed to quantify sources and sinks of this important greenhouse gas.

Continuing Cooperation between the OCO and GOSAT teams will improve the value of both missions to the science community.