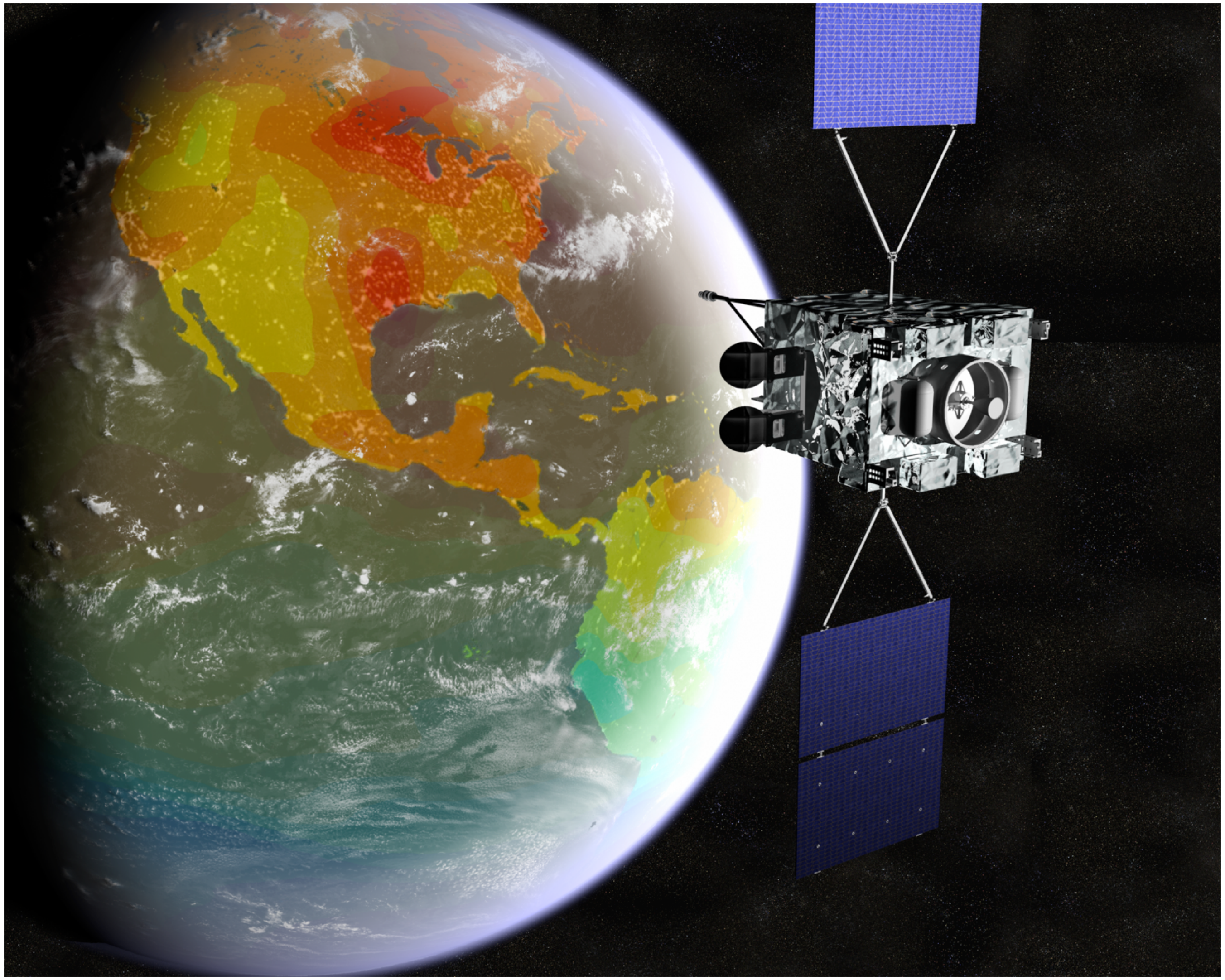
Geostationary Carbon Cycle Observatory



GeoCarb Mission: Overview

The GeoCarb Mission is designed to collect observations of the column averaged concentrations of carbon dioxide (CO_2), methane (CH_4), and carbon monoxide (CO), and solar induced fluorescence (SIF) from geostationary orbit (GEO) at a spatial resolution of 5-10 km over the Americas between 50º North and 50º South Latitudes using a SES communication satellite in orbit over the Americas.

The Goal of the GeoCarb Mission *is to provide observations and demonstrate methods to realize a transformational advance in our scientific understanding of the global carbon cycle.*

Science Hypotheses

Baseline Mission

Threshold Mission

1. The ratio of CO_2 fossil source to biotic sink for CONUS is ~4:1
2. Variation in productivity controls spatial patterns of terrestrial sinks
3. Amazonian ecosystems are a large (~0.5-1.0 GtC/y) net sink for CO_2
4. Larger cities emit less CO_2 emission per capita than smaller ones
5. Amazonian ecosystems are a large (~50-100 MtC) net source for CH_4
6. The CONUS methane emissions are a factor of 1.6 ± 0.3 larger than in EDGAR and EPA databases

GeoCarb aims to fundamentally shift our understanding of how the carbon cycle behaves on regional scales.

GeoCarb is an international effort!

NASA

LOCKHEED MARTIN

SES GOVERNMENT SOLUTIONS

AEM
AGENCIA ESPACIAL MEXICANA

JPL

Goddard SPACE FLIGHT CENTER

Ames Research Center

CIRA

Environment and Climate Change Canada

LSCE

UNIVERSIDAD NACIONAL AUTONOMA DE MEXICO
POR MI RAZA HABLARA EL ESPIRITU

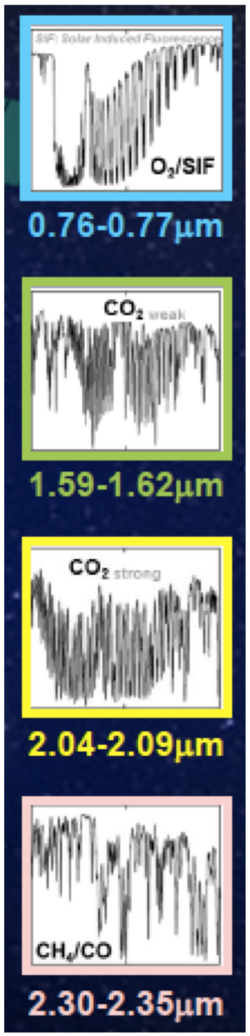
Colorado State University

VELUT ARBOR ÆVO

POSTERA CRESCAM LAUDE
THE UNIVERSITY OF MELBOURNE

THE UNIVERSITY OF EDINBURGH

GeoCarb Bands & Level 1 Requirements



Solar Induced Fluorescence (SIF), O_2, Clouds, Aerosol

CO_2

CO_2, H_2O, Clouds, Aerosol

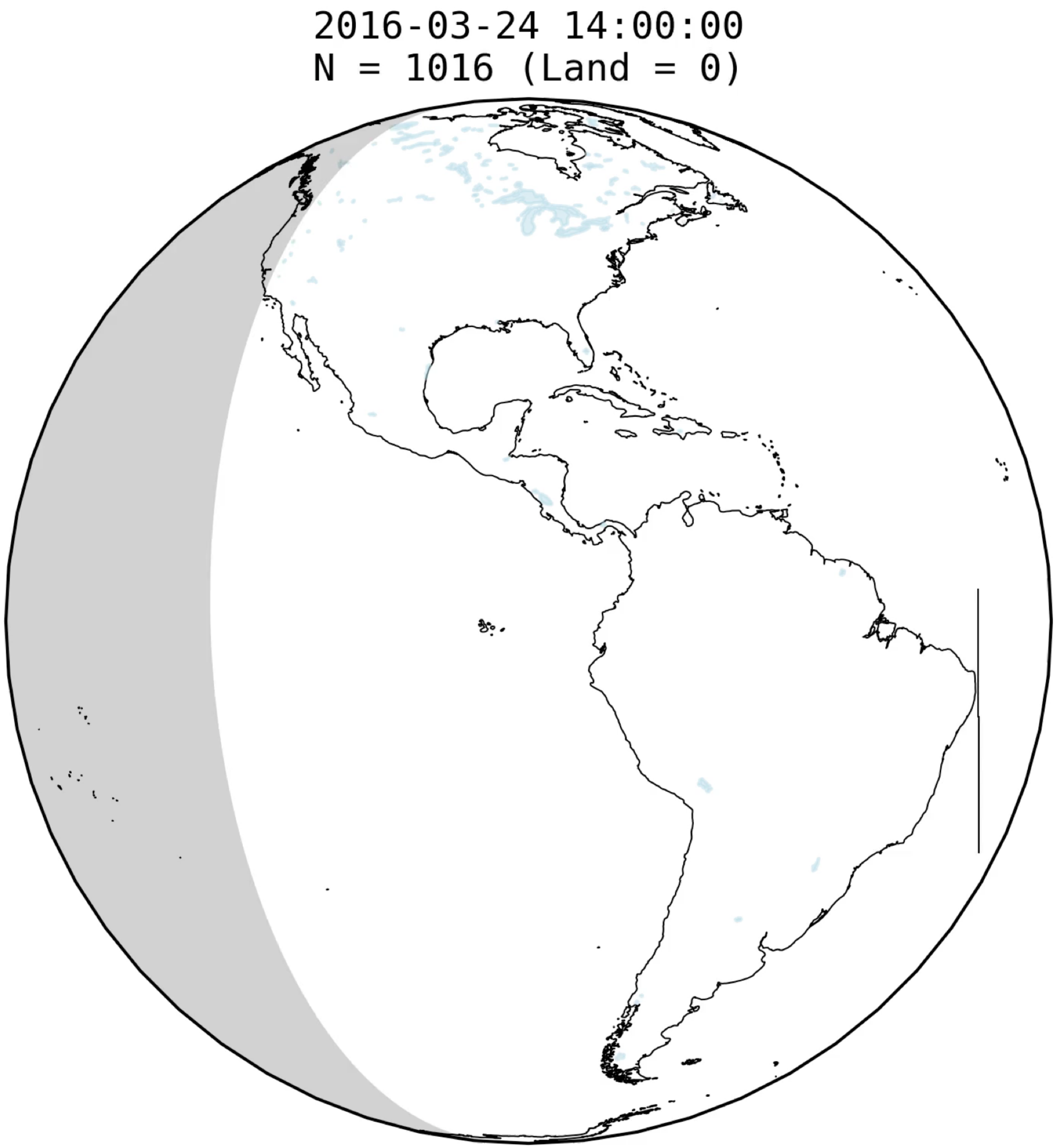
CH_4, CO, H_2O, HDO

<u>Multi-Sounding Precision*</u>

- **CO_2 : 0.3% (1.2 ppm)**
- **CH_4 : 0.6% (10 ppb)**
- **CO : 10% or 12 ppb, *whichever is greater***
- **SIF : 0.75 W m^{-2} μm^{-1} sr^{-1}**

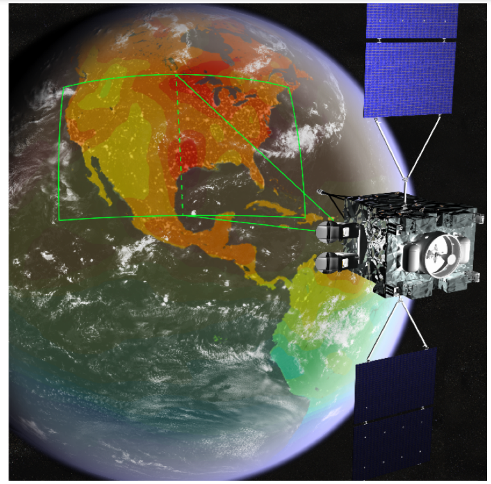
* *Evaluated over at least 100 cloud-free soundings*

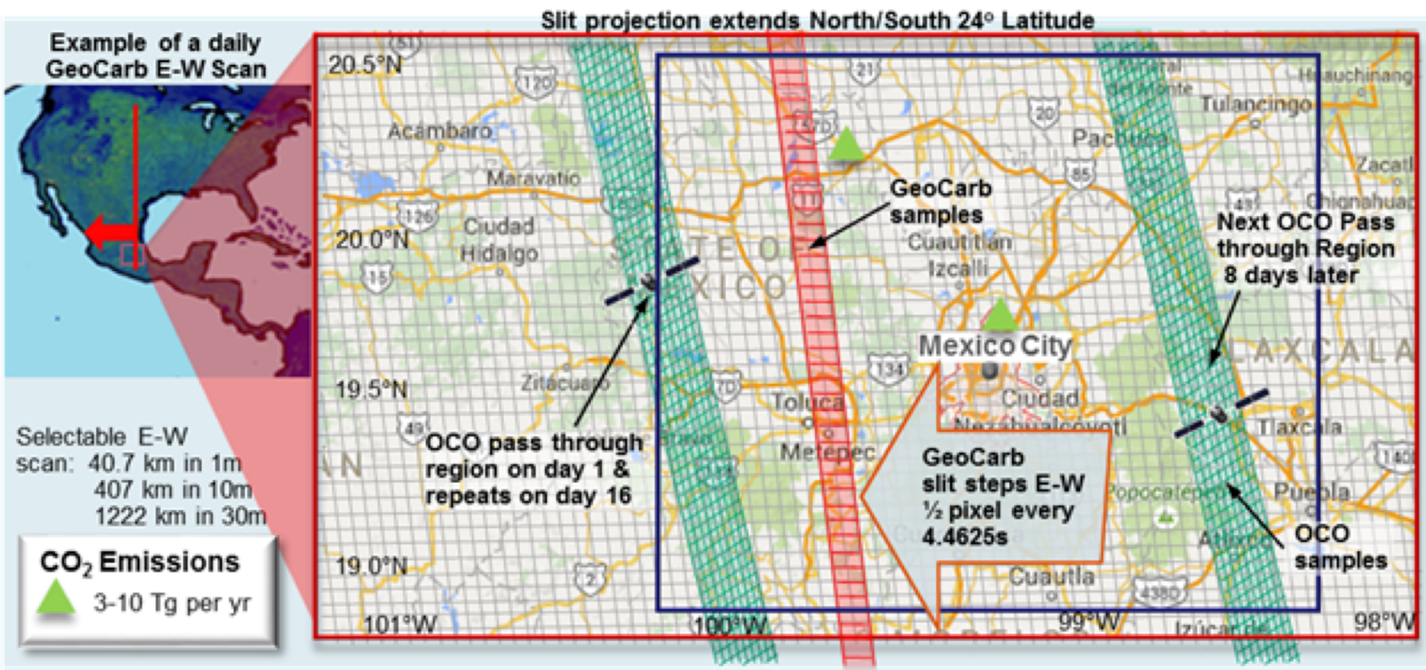
Why Geostationary Orbit?



GeoCarb: Two Keys for the Observing Strategy

Geostationary Orbit:
Persistent Observing
Staring for SNR
Scanning for Coverage

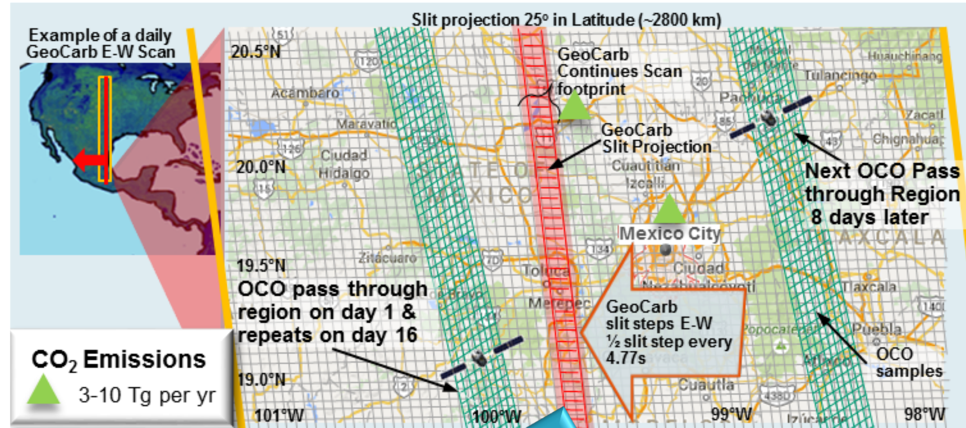


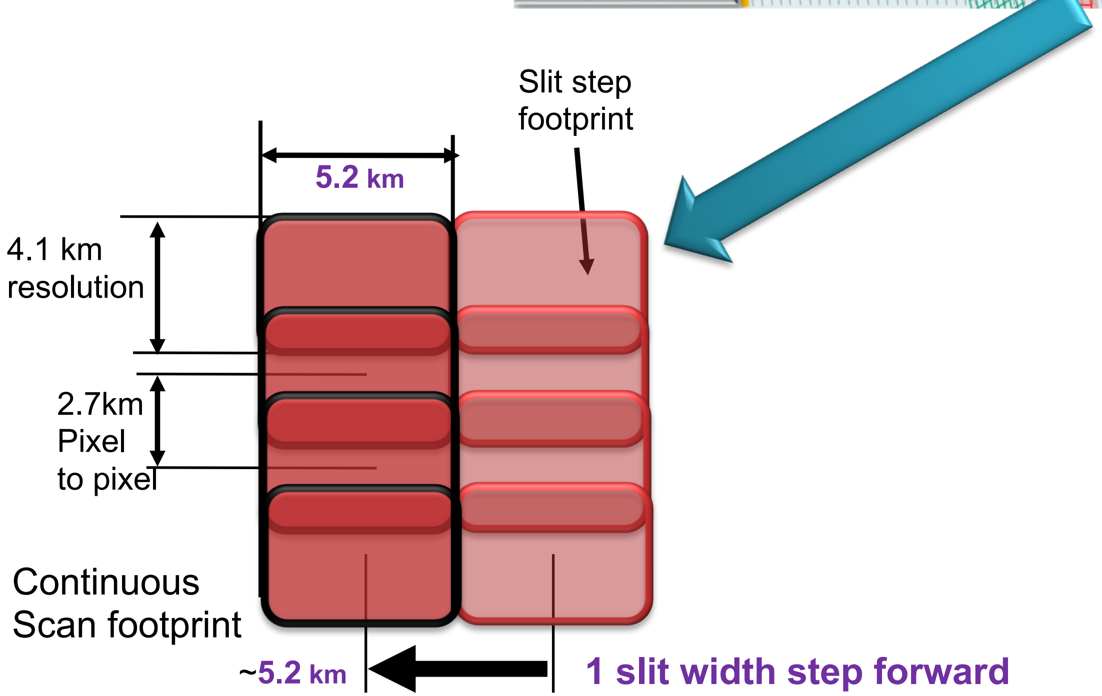


Science Collection Approach: Baseline

Nominal Science Scan

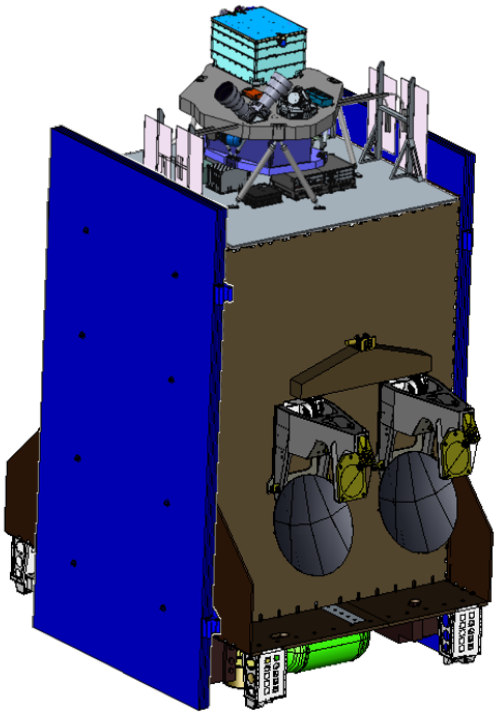
- **E->W slit projection step**
  - E->W step and stare every ~9s





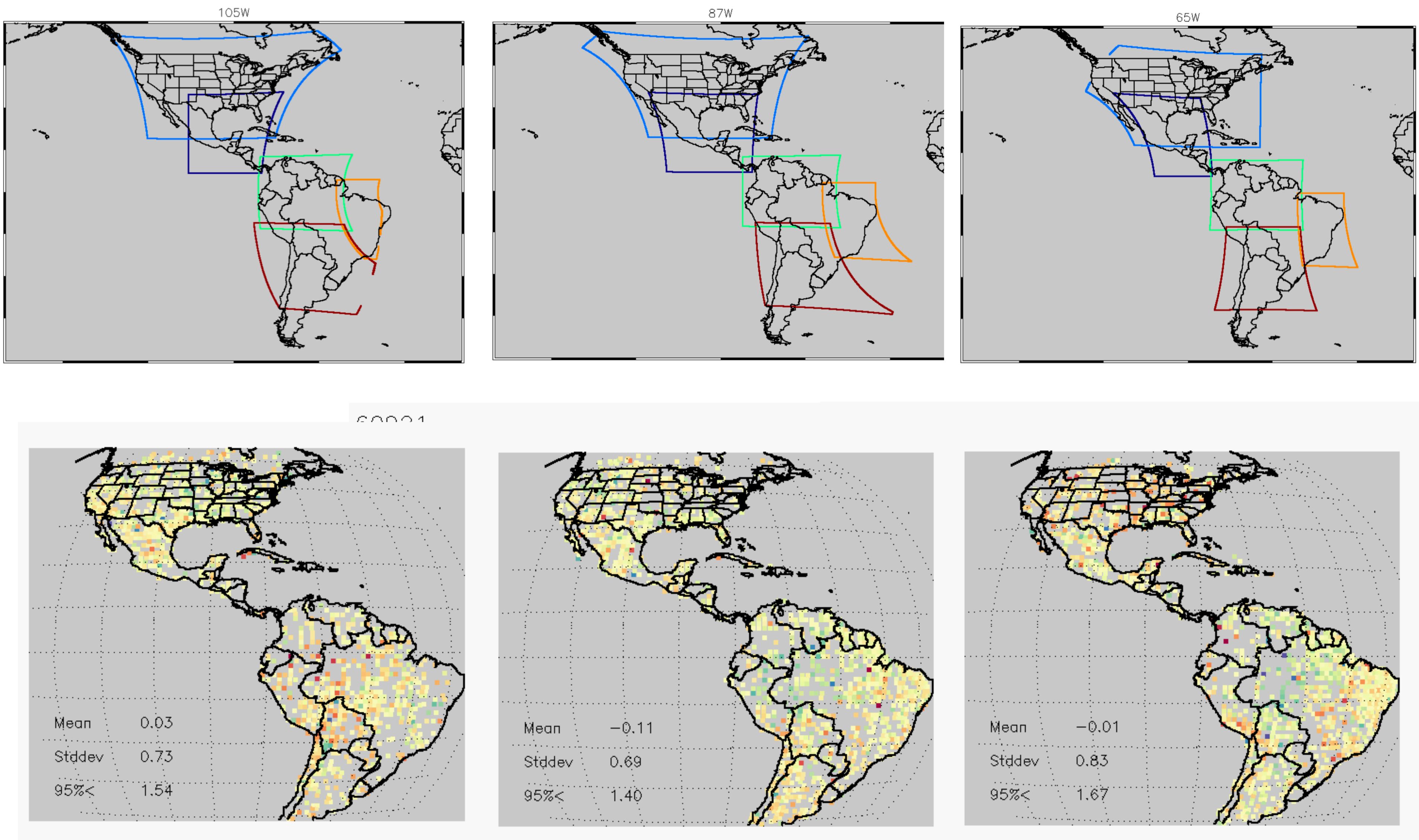
GeoCarb is partnering with the commercial sector to get to space

- Access to a geostationary platform provides persistent views of the western hemisphere
- Commercial spacecraft provides economical access to GEO
- A communications satellite can easily accommodate the mass, telemetry, and power of an Earth looking science mission
- Benefits from existing infrastructure for command/control and mission data delivery



View Zenith Angles from Different Slots

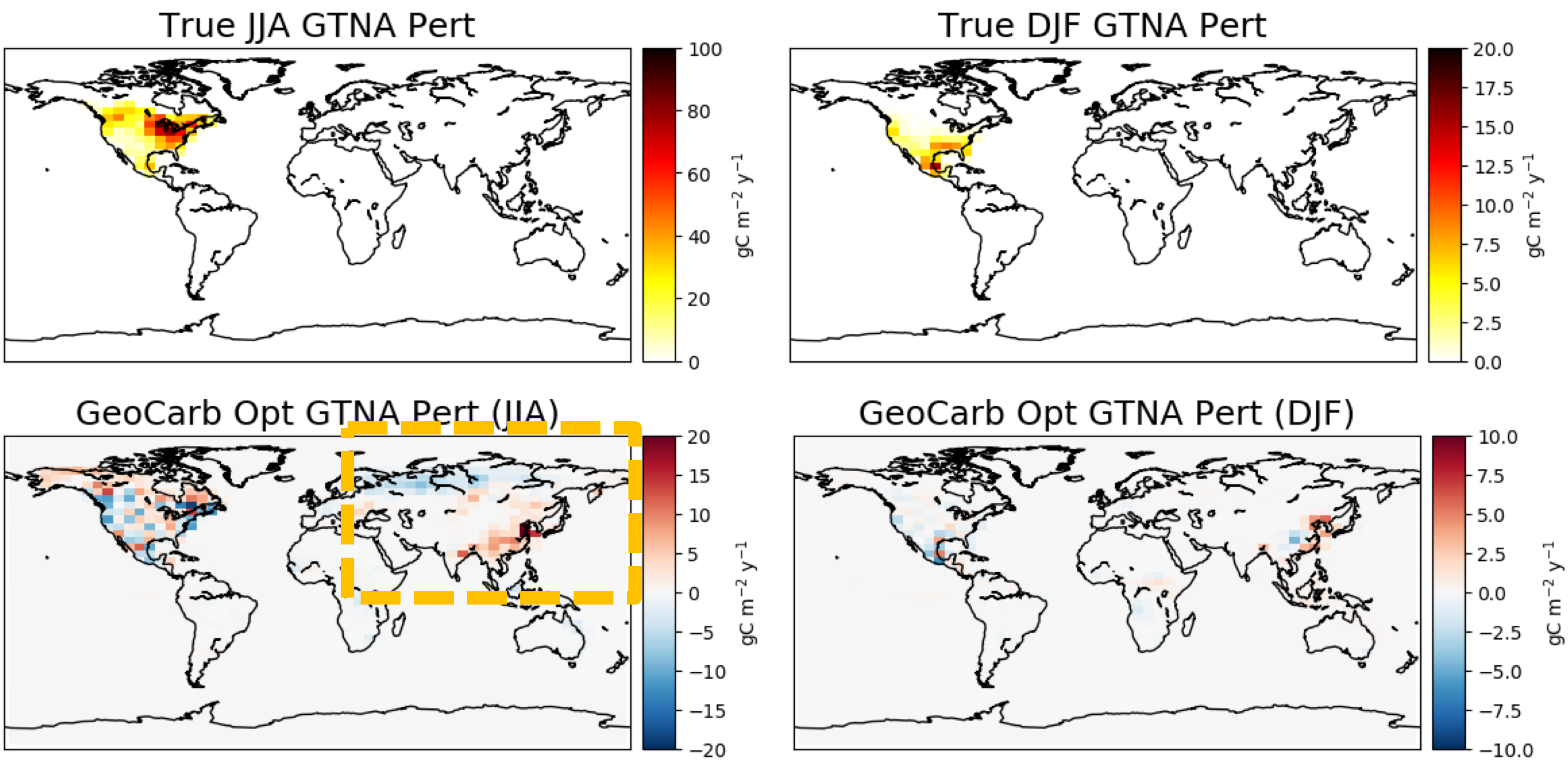
105W | 87W | 65W



We Need International Collaboration for Success!

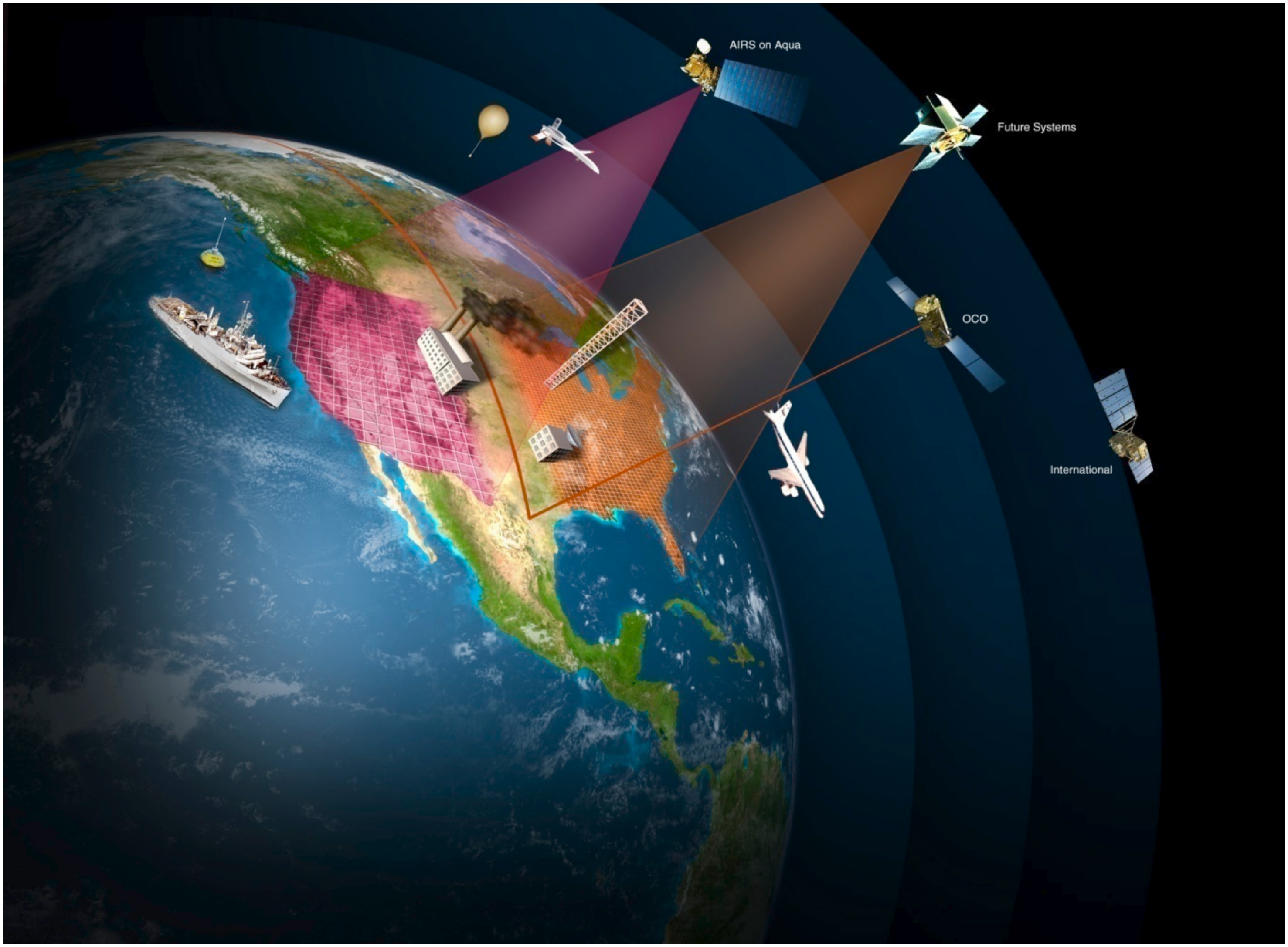
- **GeoCarb algorithms are adapted from OCO-2 algorithms (with the addition of a 2.3um band), which were trained on GOSAT L1b data**
- **We would love to train our algorithms on GOSAT-2 L1b data!**
- **During operations, we will compare our data directly with underflights of all GHG observing satellites for cross-validation of radiances and retrieved species (heritage between OCO-2 and GOSAT) – daily opportunities!**
- **Most importantly: GeoCarb observes over land in the western hemisphere between 50S and 50N latitudes – <u>we NEED polar orbiters to close the global carbon budget and EXPECT synergy from using both data sets simultaneously to estimate surface fluxes of CO2/CH4</u>**

Regional Viewing Can Induce Flux Errors



GeoCarb constrains the temperate North American sink well, but aliases some of the signal into upwind regions, despite daily viewing – we need <u>global coverage</u> for the <u>global budget</u>

GeoCarb: A key component of a Carbon Observing System



Carbon Monitoring from Earth and from Space: A Global Necessity