Geostationary Carbon Cycle Observatory
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

1. The ratio of CO₂ 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 CO₂
4. Larger cities emit less CO₂ emission per capita than smaller ones
5. Amazonian ecosystems are a large (~50-100 MtC) net source for CH₄
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!
GeoCarb Bands & Level 1 Requirements

Solar Induced Fluorescence (SIF), O₂, Clouds, Aerosol

CO₂

CO₂, H₂O, Clouds, Aerosol

CH₄, CO, H₂O, HDO

Multi-Sounding Precision*

- CO₂: 0.3% (1.2 ppm)
- CH₄: 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?

2016-03-24 14:00:00
N = 1016 (Land = 0)
GeoCarb: Two Keys for the Observing Strategy

Geostationary Orbit: *Persistent Observing*
*Staring for SNR*
*Scanning for Coverage*
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

Mean: 0.03
Stddev: 0.73
95%: 1.54

Mean: -0.11
Stddev: 0.69
95%: 1.40

Mean: -0.01
Stddev: 0.83
95%: 1.67
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 – 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.
GeoCarb constrains the temperate North American sink well, but aliases some of the signal into upwind regions, despite daily viewing – we need global coverage for the global budget.
GeoCarb: A key component of a Carbon Observing System

Carbon Monitoring from Earth and from Space: A Global Necessity