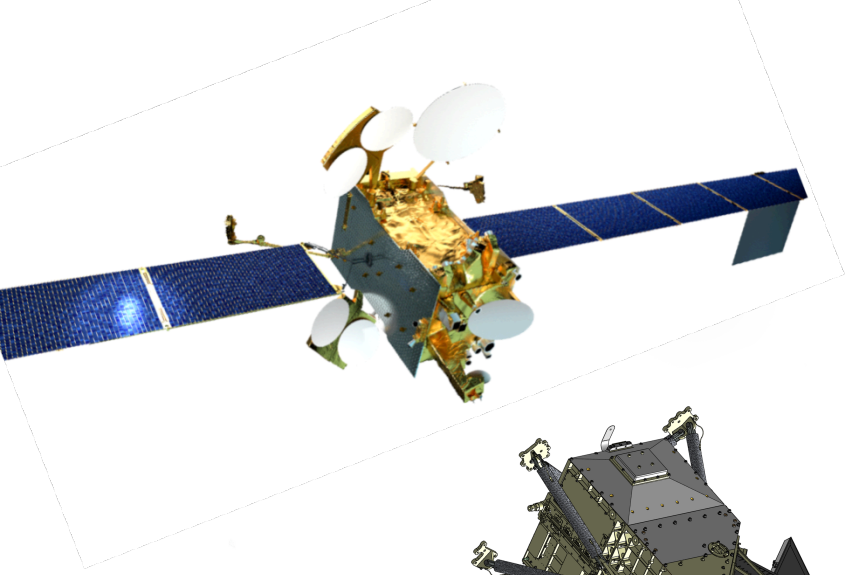
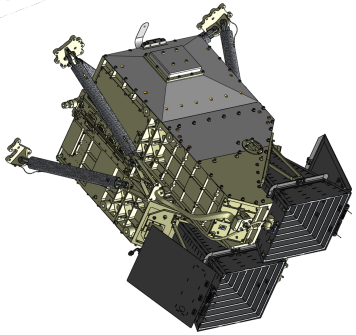


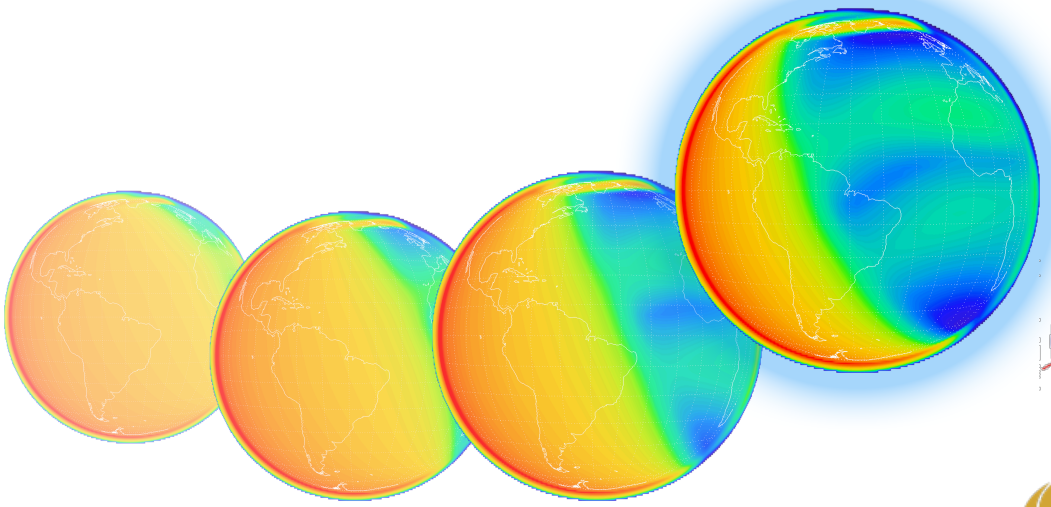


Global-scale Observations of the Limb and Disk (GOLD) Mission – Ultraviolet Imaging of Earth's Space Environment from Geostationary Orbit

Richard Eastes, Bill McClintock, and the GOLD Science Team

Laboratory for Atmospheric and Space Physics

University of Colorado



Laboratory for Atmospheric and Space Physics
University of Colorado **Boulder**

UCF

SES Government Solutions

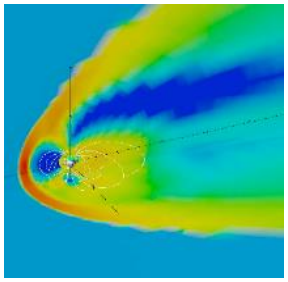
Scientific Motivation

- GOLD represents the next logical step in Ionosphere-Thermosphere studies
  - Decades of research using observations from low earth orbiting (LEO) spacecraft and ground-based facilities
  - Can not separate daily spatial - temporal variability
  - Enabled the characterization of the I-T system 'climate'
- GOLD images the I-T system from geostationary orbit (GEO)
  - NASA Explorers Mission of Opportunity
  - Near-hemispherical measurements of composition (O/N_2) and temperature with 1-hour cadence
  - Enables the first characterization of the I-T system 'weather'

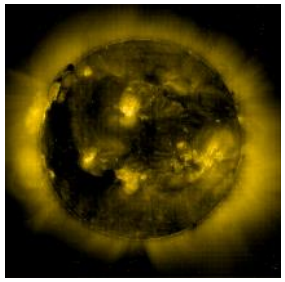
Forcing of the Thermosphere-Ionosphere

Four Scientific Questions Frame the Mission

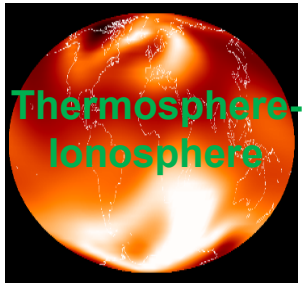
Forcing from Above



Science Question 1 (Q1). ***How do geomagnetic storms alter the temperature and composition structure of the thermosphere?***

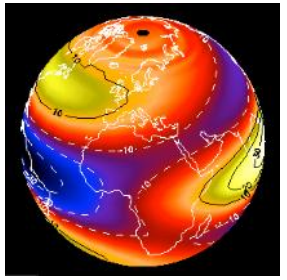


Q2. ***What is the global-scale response of the thermosphere to solar extreme-ultraviolet variability?***



Q4. ***How does the nighttime equatorial ionosphere influence the formation and evolution of equatorial plasma density irregularities?***

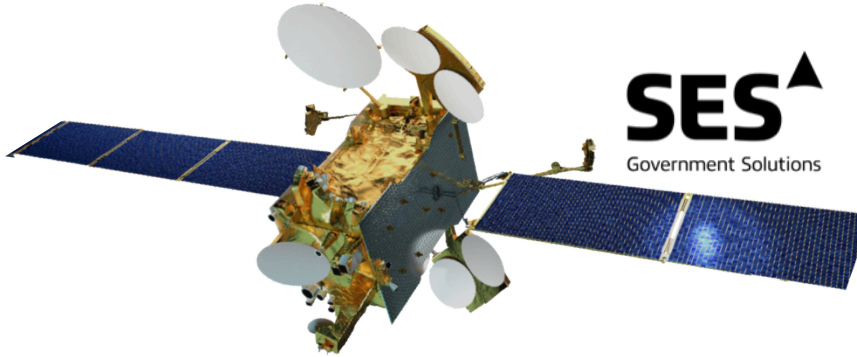
Q3. ***How significant are the effects of atmospheric waves and tides propagating from below on thermospheric temperature structure?***



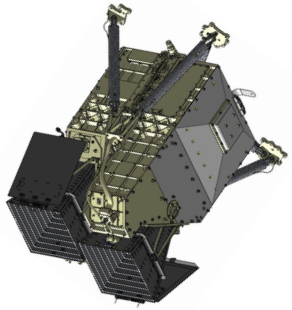
Forcing from Below

GOLD Mission Overview

- **Host Mission**
  - SES-14, in geostationary orbit at 47.5˚ west (over mouth of the Amazon River)
- **GOLD Instrument**
  - Two identical, independent imaging spectrographs
  - Each observes disk and limb at 132-162 nm
- **Science Data**
  - Earth's disk
    - Daytime: images of O/N_2 (density ratio), and temperature
    - Nighttime: images of peak density in ionosphere
  - Earth's limb (edge of Earth)
    - O_2 densities and temperature at top of thermosphere



SES Government Solutions



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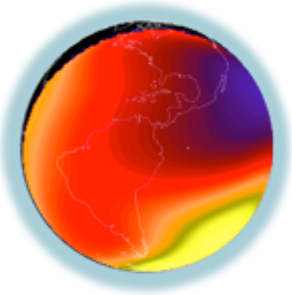

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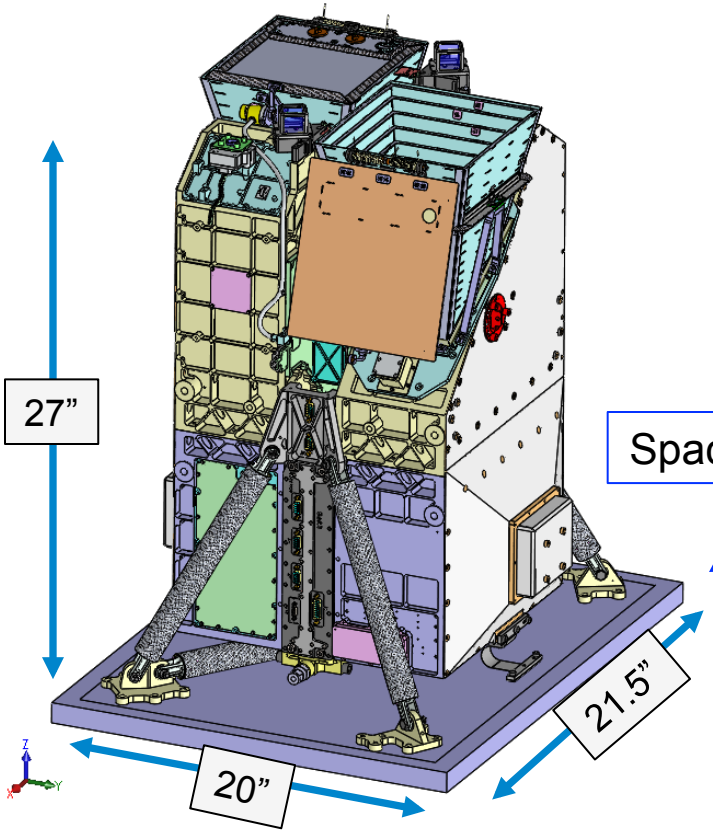
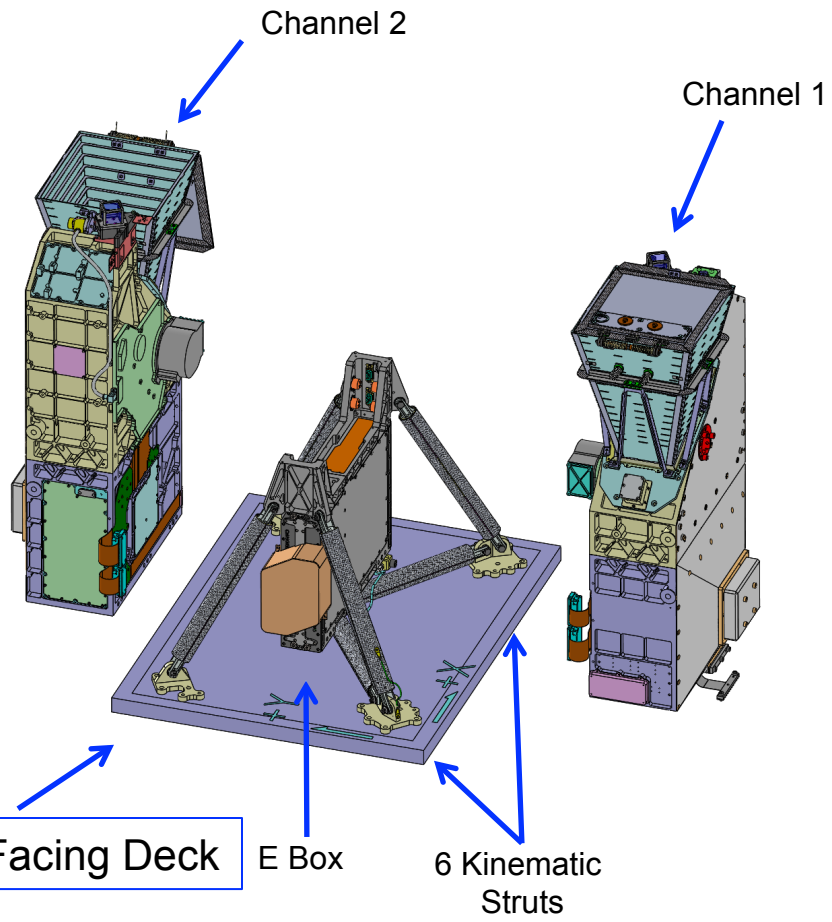
GOLD Mission Imager

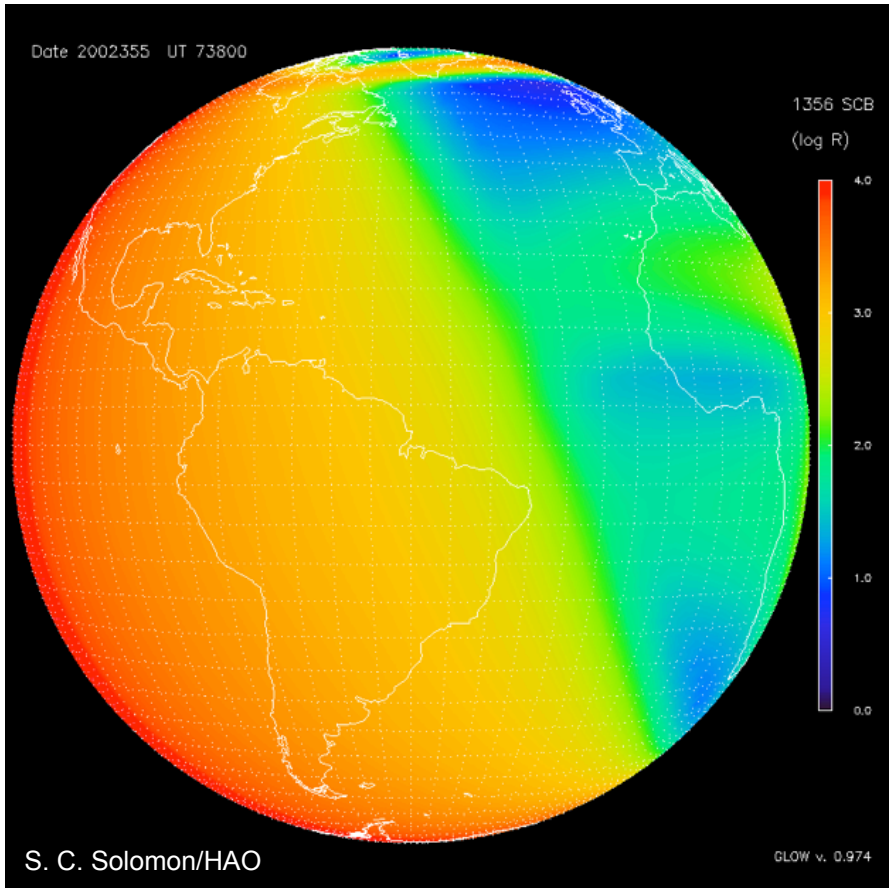
- **Imaging Spectrograph: Two independent, identical channels imaging the limb and disk, and a single processor packaged in one housing**
- **Wavelength range: 132 – 162 nm**
- **Detectors: Microchannel plate, 2-D crossed delay line anode**





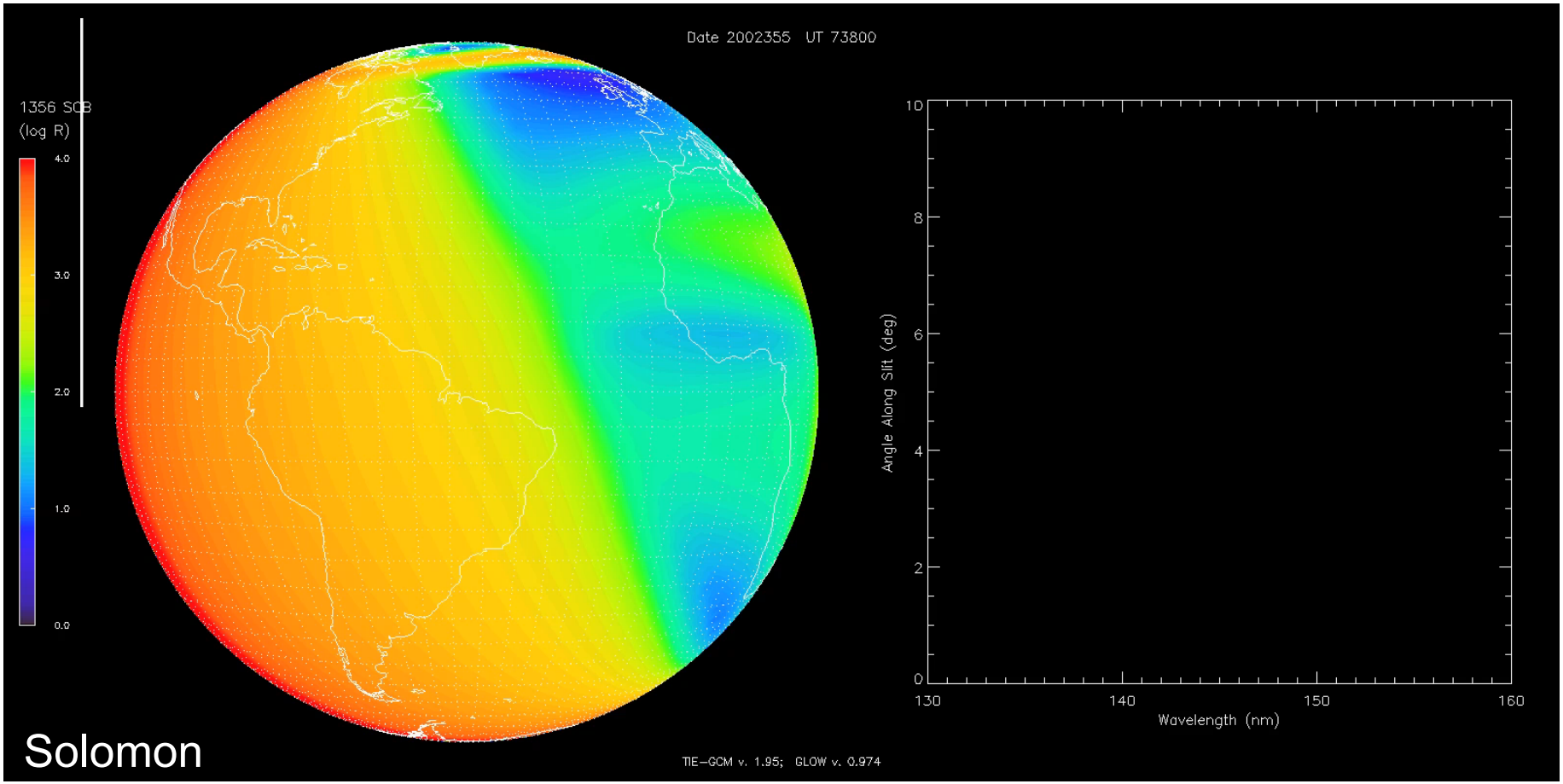
Resources Summary	
Mass	**37.0 kg (measured)**
Power	**60.4 W (CBE, AVG)**
Data	**6 Mbits/second**

GOLD Imaging (1 of 2)



- Simulated GOLD image of oxygen (135.6 nm) emissions
- Simultaneously images N_2 emissions on dayside
- Emissions provide key data for thermosphere and ionosphere

GOLD Imaging (2 of 2)

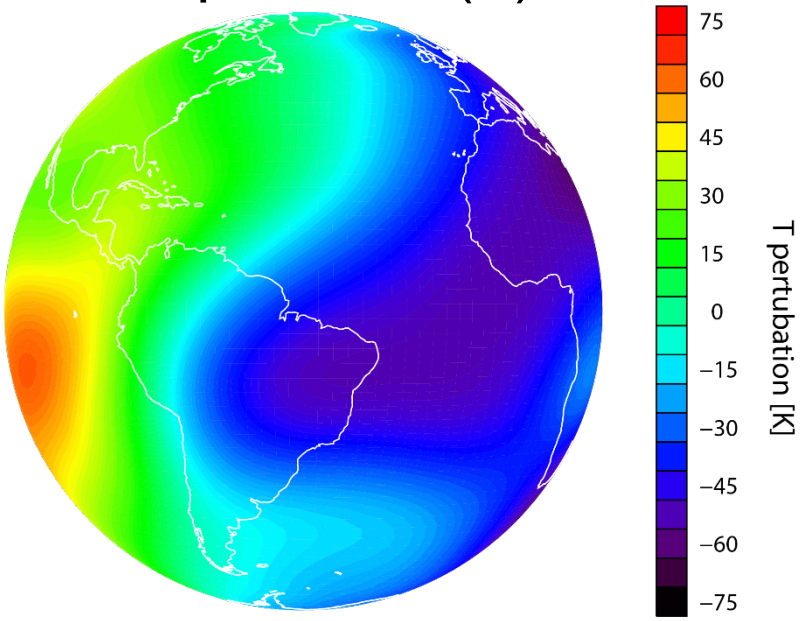


Disk Image **Detector Image**

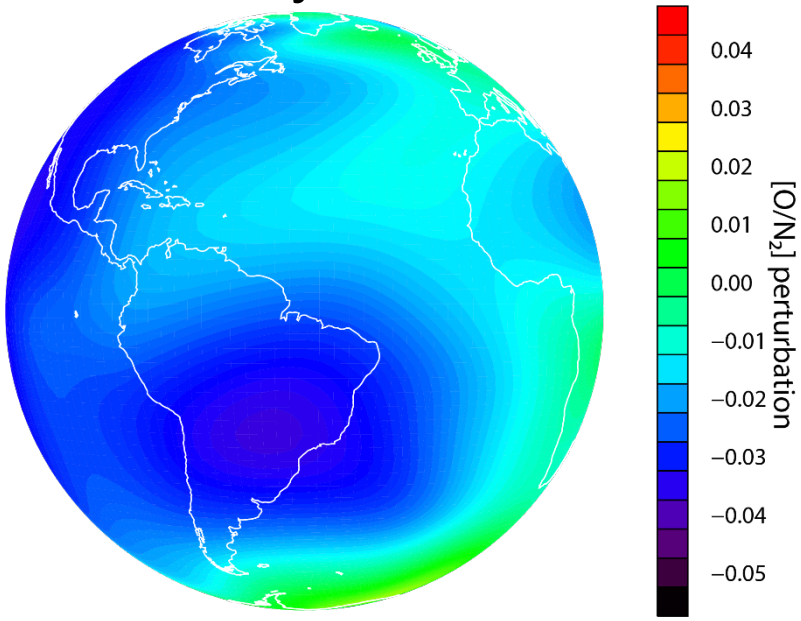
- **Entrance slit of one (of two) channel is shown as white rectangle**
- **Slit step rate and position are commandable, can dwell on selected longitude range**

Modeling Tides to Simulate Observations

Perturbations in Temperature (T)



Perturbations in O/N_2 Density Ratio



- **T and O/N_2 perturbations at ~160 km due to upward propagating tides**
- **Typical temperatures are 625K and O/N_2 ratios are 0.5 near 160 km**
- **Modeled with version 2 of Thermosphere Ionosphere Electrodynamics General Circulation (TIEGCM) model, using to simulate GOLD observations**

(K. Greer, Colorado U., LASP)

Data Products versus Science Requirements

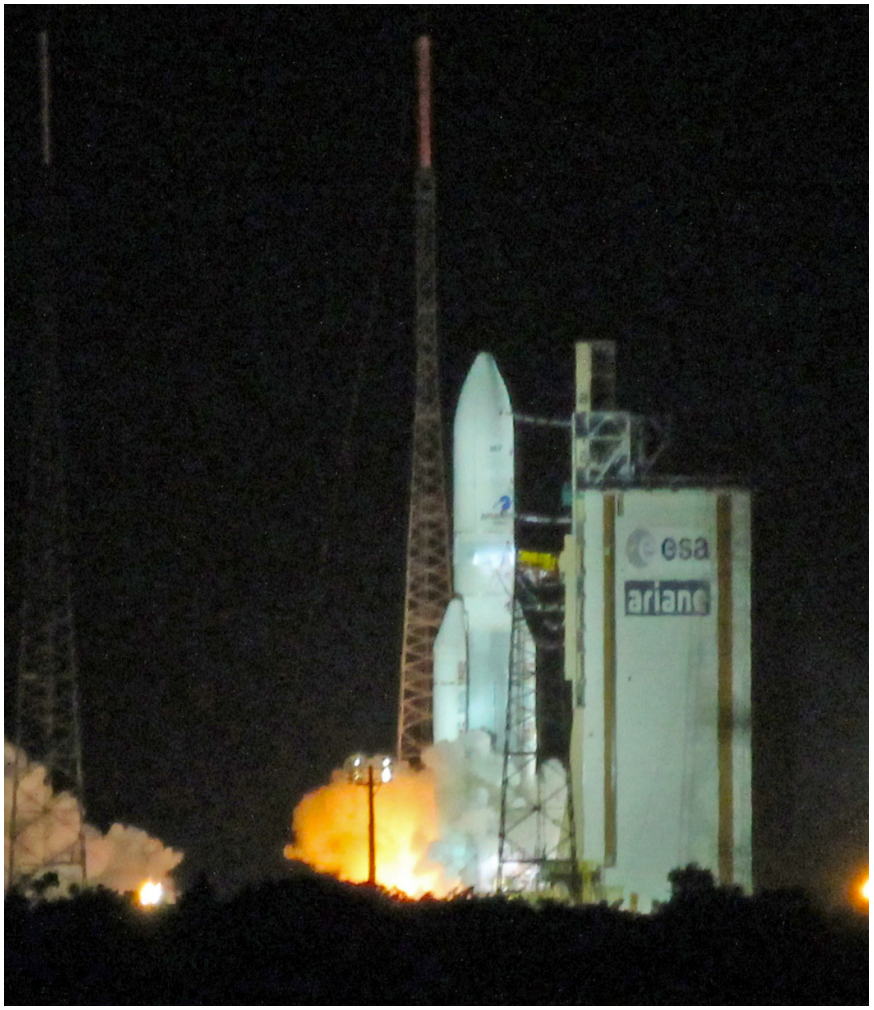
Data Product	Notes/Constraints	Requirement	Realized*
Images of Temperature	60 min Cadence 250 x 250 km^2 Resolution	Precision – 55 K	27 K
Images of O/N_2 Radiance Ratio	30 min Cadence 250 x 250 km^2 Resolution	Precision – 10 %	6.5 %
Exospheric Temperature	100 km Vertical Resolution on Limb	Precision – 40 K	22 K
O_2 Column Density	at 160 km	Precision – 10 %	2 %
		Vertical Resolution – 10 km	5.5 km
Nmax F2	220 x 220 km^2 Resolution	Precision – 10 %	5.7 %

*Realized values from retrievals using simulated data

GOLD Status

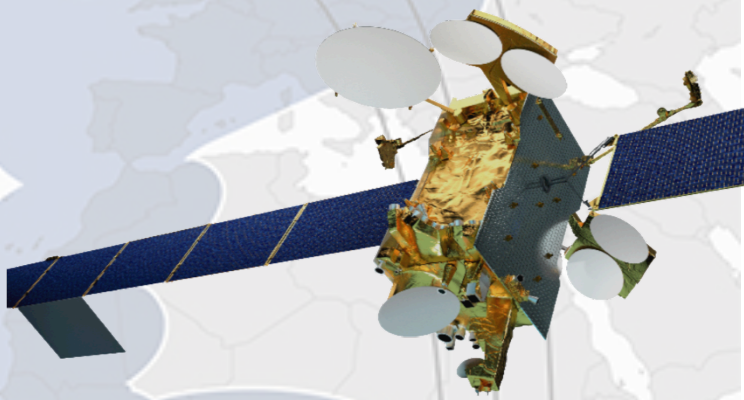
- **Launched on SES-14 - Jan 25, 2018**
  - Ariane 5 rocket from French Guiana
- **Transfer to GEO in progress**
  - Instrument commissioning scheduled for Sep 2018
- **Operations begin October 2018**

GOLD Launch (Jan 25th, 2018)



Science Data Downlink

GOLD Ground Station,
Woodbine, MD

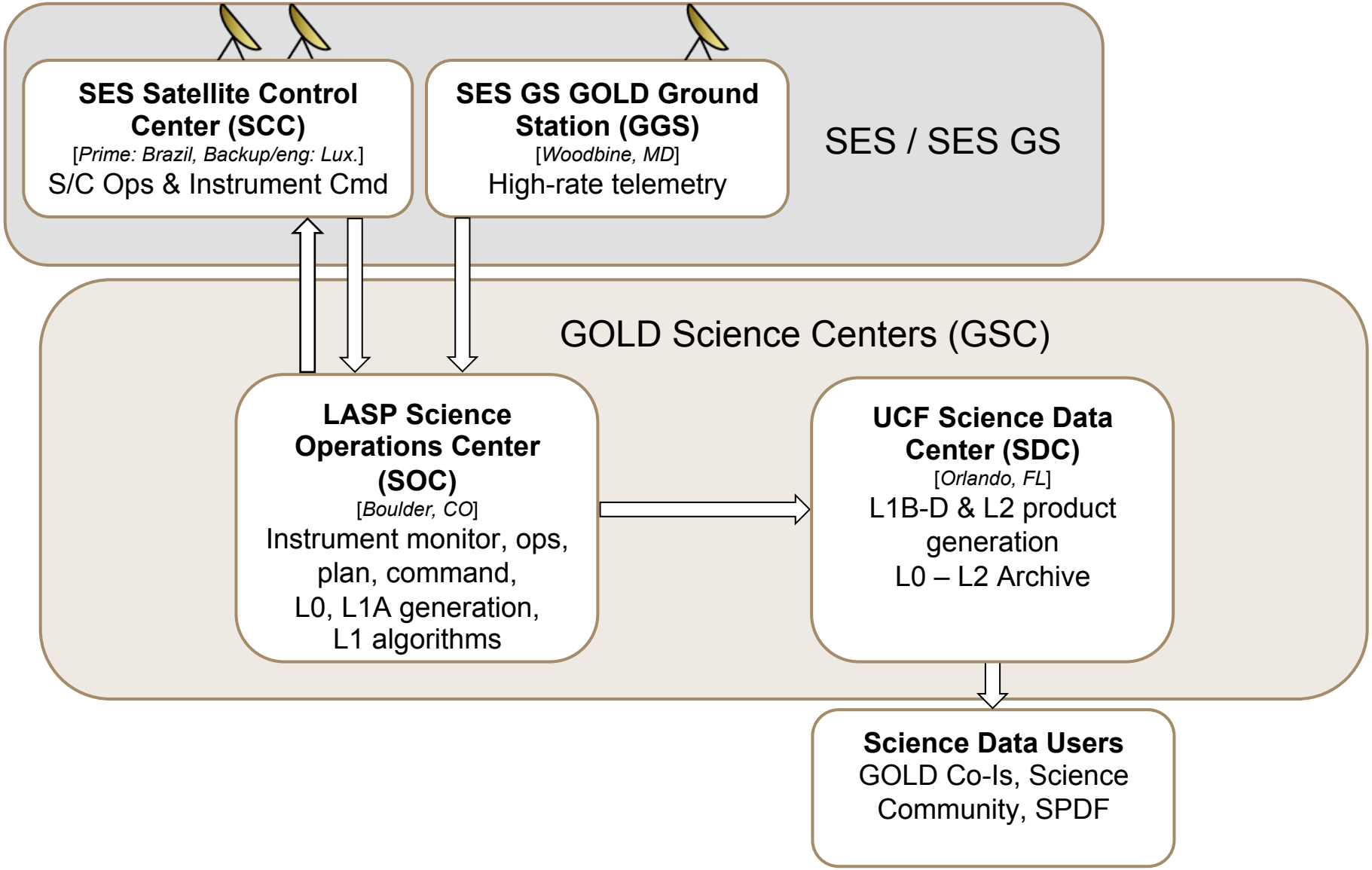


SES-14/GOLD Subsatellite Point

- Geostationary orbit, satellite stays over same location
- Each event that occurs in the detectors is sent to the ground
- Data transmitted to GOLD ground station in real-time (24/7)
- Data is only stored on the ground

GOLD Ground Segment

Ground segment architecture enables near real-time imaging



Major milestones for Phase E

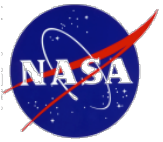
- + 0 months - beginning of Phase E on October 10, at completion of commissioning
- + 3 months - data validation completed
- + 3 months - first data release to public
  - GOLD web site http://gold.cs.ucf.edu
- + 6 months − first data delivery to SPDF

GOLD Mission Summary

- GOLD will image space environment response to forcing from above and below
- Simultaneous disk images of thermospheric composition and temperature
- Can separate changes in time from changes in location
- Provides context for ground-based and LEO observations
- Now transferring to geostationary orbit
- Two year mission projected to begin 10 October 2018

- More details in the poster session

- X4.272: GOLD Science Implementation



Thank You