Imaging the Boundary Between Earth and Space – A Preview of Space Weather Data from the Global-scale Observations of the Limb and Disk (GOLD) Mission

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**The View from Geostationary Orbit**

**GOLD will make unprecedented images of neutral temperature and composition in the upper atmosphere’s**

**GOLD images the disk and limb from geostationary orbit**

**Full disk images at 30-minute cadence**
Weather in the Thermosphere-Ionosphere

**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**
Simulated GOLD image of oxygen (135.6 nm) emissions

Simultaneously images N₂ emissions on dayside

Emissions provide key data for bubbles, satellite drag, and electron densities

Provides data to advance predictions of assimilation models and of geomagnetic storm effects
GOLD simultaneously images key parameters - temperature and composition (O/N\textsubscript{2}) - in lower thermosphere on the dayside disk.
How do geomagnetic storms impact Earth’s space environment?

Modeled changes in upper atmosphere during storm

**GOLD will discover how the upper atmosphere acts as a weather system**
Forcing from Below During Typhoon

T (K) at ~110 km

WACCM Calculation of Gravity Waves at High Resolution
(0.25° Spatial by 0.1 Scale Height)

From: Hanli Liu at NCAR/HAO
With and Without Lower Atmosphere:

Typical iono-thermosphere model:
- Driven by Solar EUV and Geomagnetic Storms.
- Global maps show little fine structure

Ionosphere-thermosphere model coupled to the lower atmosphere:
Global maps show structure relevant to
- GPS accuracy and availability
- HF Comm.

The temperature structure from a stand-alone thermosphere ionosphere plasmasphere model (e.g., CTIPe) is similar to the MSIS empirical model. The Whole Atmosphere Model (WAM) drives variability from the chaotic lower atmosphere which introduces a whole spectrum of variability.
GOLD Mission Instrument

- Imaging Spectrograph: Two independent, identical channels imaging the limb and disk, and a single processor packaged in one housing
- Wavelength range: 132 – 160 nm
- Detectors: Microchannel plate, 2-D crossed delay line anode

<table>
<thead>
<tr>
<th>Instrument Summary</th>
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<tbody>
<tr>
<td><strong>Mass</strong></td>
<td>33 kg (CBE)</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>51 W (CBE, AVG)</td>
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<tr>
<td><strong>Size</strong></td>
<td>51 × 55 × 69 cm³</td>
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Instrument sensitivity is a factor of ~2 better than at CSR due to updated design.
GOLD’s Observing Scenario and Data Products

- Full disk images and limb scans with 30 minute cadence
  - Dayside data products: Disk Temperature, Disk O/N₂, OI and N₂ emission brightness, $T_{EXO}$, $Q_{EUV}$
  - Nightside products: Disk OI brightness, crest locations, $N_{max}$

- Occultation measurements
  - Dayside and nightside products: O₂ density profile
Proven Measurement Techniques

Daytime Far-Ultraviolet Spectrum

- Temperature obtained on disk from rotational shape of N$_2$ LBH bands
- O/N$_2$ composition measured using ratio of 135.6 doublet to LBH bands
- Temperature on limb determined by slope of emission altitude profile
- O$^+$ at night observed using 135.6 recombination emission
- O$_2$ profile on limb from stellar occultations
GOLD Mission Space Segment

• Host Mission
  - Managed by SES
  - Host Accommodation will be on SES-14
    • GEO commercial communications satellite at 47.5°W, owned and operated by SES
    • Host satellite is a Eurostar 3000 built by Airbus Defence & Space
• GOLD Mission Instrument
  - Hosted Payload is an ultraviolet imager developed by UCF/LASP
    - 6 Mbit/s data down-link
• Data processing at UCF
• Launches in 2017 for a two-year mission
• Unprecedented, simultaneous imaging of composition and temperature
• Able to separate changes in time from changes in location
• Capability for continuous, real time data availability is inherent to the mission
• Provides context for ground-based and LEO measurements
• Coincident with ground based and LEO missions, ICON
• Mission confirmed on March 5
• Spacecraft accommodation contract has been signed