Global-scale Observations of the Limb and Disk (GOLD):

A Key Mission For Understanding Thermosphere-Ionosphere Forcing

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Abstract

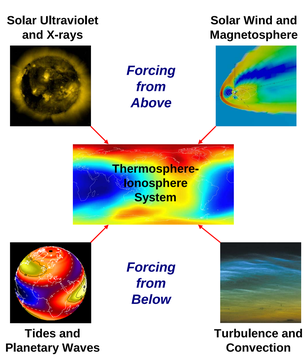
The Global-scale Observations of the Limb and Disk (GOLD) mission will fly an ultraviolet imaging spectrograph on a geostationary satellite to measure the global-scale response of the thermosphere and ionosphere to geomagnetic and solar forcing from above and to tidal forcing from below. GOLD will provide nearly continuous observations of one hemisphere, allowing the temporal and spatial changes associated with these forcing mechanisms to be determined. GOLD will provide the first global-scale observations of temperatures in the lower thermosphere and allow temporal and spatial changes in temperature to be separated uniquely. GOLD also provides more familiar measurements, such as the peak electron densities in the nighttime ionosphere and the daytime atomic oxygen to molecular nitrogen (O/N_2) ratio. These observations will be used, in conjunction with advanced models of the thermosphere and ionosphere, to revolutionize our understanding of the space environment. GOLD has been proposed as a mission of opportunity in response to the Small Explorer (SMEX) and Missions of Opportunity from NASA's Science Mission Directorate. It will leverage observations by NASA's solar (Solar Dynamics Observatory), which is scheduled for flight in 2008-2009 by providing coincident thermosphere-ionosphere information.

GOAL: Understand the global response of the thermosphere and ionosphere to forcing in the integrated Sun-Earth system

METHOD: Far Ultraviolet (FUV) images of the Earth from geostationary orbit to observe global-scale temporal and spatial changes in temperature, composition and density of the thermosphere and ionosphere

RESULT: Definitive answers to critical scientific questions about the effects of solar and atmospheric variability on near Earth space

I. The Thermosphere-Ionosphere System



- The thermosphere-ionosphere is controlled by solar and magnetospheric processes, but are the solar high-energy photons more important, or the solar wind - magnetosphere - auroral effects?
- The thermosphere-ionosphere is controlled by atmospheric processes, but are the large-scale tidal dynamics more important, or the turbulent and convective processes?

The thermosphere-ionosphere is a boundary between regions dominated by plasma and fluid processes

– This transition is common to planetary atmospheres

– Understanding these regions is essential but incomplete

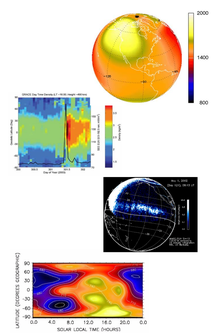
II. GOLD Mission

- GOLD would fly on a commercial communications satellite in geostationary orbit (use of commercial flight increases opportunities for observations from geostationary orbit)
- Requirements for GOLD accommodation included in contract for replacement satellite
- Orbit and operations provide continuous coverage over the Americas
- Flight in 2012 would provide Thermosphere-Ionosphere data necessary for full benefit of other NASA missions, such as the Solar Dynamics Observatory (SDO)

III. Global UV Imaging is a Frontier in Thermosphere-Ionosphere Science

- Ultraviolet imaging on a global scale is the most effective way to advance thermosphere-ionosphere science
- Knowledge of temperature and composition on a global scale gives response of thermosphere-ionosphere system to forcing
- The GOLD UV imager on a geostationary satellite provides the data needed to answer the following key science questions

IV. Four Science Questions Frame the Mission

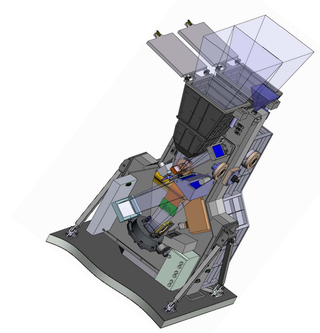


1. What is the global-scale response of the thermosphere and ionosphere to geomagnetic forcing?
2. What is the global-scale response of the thermosphere and ionosphere to changing extreme ultraviolet (EUV) radiation?
3. What are the solar and geospace causes of small-scale ionospheric density irregularities?
4. What are the global-scale tidal amplitude and phase variations?

V. Comprehensive Investigation Provides Answers to the Science Questions

- Integrated approach to studying the thermosphere-ionosphere as a system
- Full-disk temperature and O/N_2 composition measurements in the Earth's thermosphere
  - Provide the picture of the full physical state of the thermosphere-ionosphere system
  - Distinguish roles of forcing mechanisms
- Global-scale observations of the ionosphere at night probe the origin of small-scale irregularities
- Measurements allow separation of temporal and spatial changes

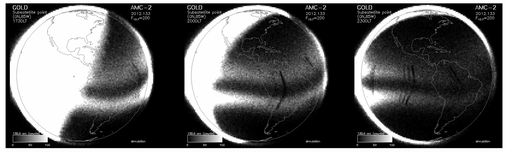
VI. GOLD Configuration Enables Simultaneous Measurements of Composition and Temperature



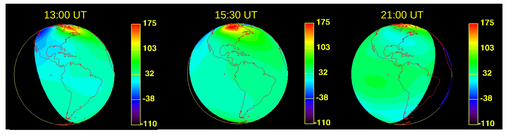
- Two mirror-image instrument channels and a single processor packaged in one housing
- Each channel operates independently in the nominal GOLD observing mode
  - Channel A: full disk maps and limb scans with 30 minute cadence (O/N_2, O and N_2 limb emission)
  - Channel B: sunlit disk maps with 30 minute cadence, interrupted for O_2 occultation measurements (temperature and O_2 limb absorption)
- A single channel can perform all measurements with reduced cadence or reduced O/N_2 spatial resolution

VII. GOLD Observations Provide the Measurements Required to Implement the Science

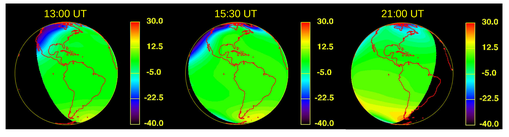
Imaging at 135.6 nm & Ionospheric bubbles at night (counts)



Neutral temperature change (K) during geomagnetic storm (difference from quiet)



O/N_2 Density change (%) during geomagnetic storm (difference from quiet)



VIII. Summary

GOLD provides new capabilities for understanding the thermosphere-ionosphere system.

- GOLD will provide simultaneous observations of O/N_2 density ratio and unprecedented temperature measurements across the daytime disk
- GOLD will allow separation of temporal and spatial changes across the disk
- GOLD will fly on a commercial communications satellite in geostationary orbit
- GOLD mission will use state-of-the-art models and unique observations to critically advance our understanding the Thermosphere-Ionosphere
- GOLD will provide Thermosphere-Ionosphere data essential to obtaining full benefits of NASA missions such as Solar Dynamics Observatory (SDO)