CEDAR Satellite Collaboration

A GOLDen Opportunity for CEDAR Science

GOLD (Global-scale Observations of the Limb and Disk) is one of the two missions of opportunity selected by NASA's Small Explorer (SMEX) program in 2008. The far-ultraviolet imager to be constructed for the mission is currently scheduled to launch on a geostationary, communications satellite in 2014.

This imager will fly over the Americas and observe most of the hemisphere throughout the day. Due to its geostationary orbit, GOLD will unambiguously separate local time and longitude differences in the American sector. Consequently, GOLD can provide context for ground-based observations or other space-based observations, such as those from the Neutral-Ion Coupling Explorer (NICE), as well as providing the temperature, density and composition information needed for better understanding the space environment.

While the data may be used to address more questions than those proposed, the GOLD mission is designed to answer key elements of an overarching question: what is the global-scale response of the thermosphere and ionosphere to forcing in the integrated Sun-Earth system? Four key science questions, are addressed as part of this overarching question:

1. How do geomagnetic storms alter the thermosphere-ionosphere, and what is the dependence on the initial state?
2. What is the global-scale response of the thermosphere to solar EUV variability?
3. Do atmospheric waves and tides have a significant effect on the thermospheric temperature structure?
4. Do vertical ion drifts, as manifested in the structure of the equatorial anomaly, affect the occurrence of ionospheric irregularities?

GOLD's ability to provide, for the first time, both global-scale measurements of temperature and composition in the Earth's thermosphere is critical to answering most of these key science questions and to understanding these two major parameters respond to external and internal forcing. GOLD's images will cover the entire disk at a 30 minute cadence. The full, high resolution (~0.1 nm spectral) spectrum (132-162 nm) observed from each pixel (spatial resolution of 25 x 25 km^2 for daytime and 25 x 100 km^2 for nighttime imaging) is sent to the ground through a transponder dedicated to GOLD's data stream. From these data, disk temperatures and composition near 150 km can be obtained during the daytime and peak electron densities in the Appleton anomaly can be obtained at night. Observations of the limb provide exospheric temperatures in the daytime and O_2 density profiles throughout the day. All of these measurements can be performed by the single channel instrument studied during our recently completed Phase A study. One of the most significant benefits of a second channel, which was proposed but included in the selection, is an improved ability to conduct observing campaigns without interrupting the disk imaging. By concentrating the observations of a second channel on a specific location or local time, the temporal resolution and signal-to-noise in that region can be dramatically increased, allowing the observations to address a wider range of questions than originally envisioned. If a second channel is available, we anticipate inviting community input on the operations of that channel.

The CEDAR community's observations and capabilities in integrating ground-based and space-based observations will significantly enhance the understanding achieved from the GOLD mission. Since the GOLD imager will always observe from the same geographic location, it can separate spatial and temporal changes more readily than is possible from low Earth orbit and it will provide observations that are coincident with ground based observations throughout the Americas. Ground-based observations, such as Incoherent Scatter Radar measurements of temperature profiles or optical measurements of neutral winds, will provide information complementary to that from GOLD's observations. This combination of measurements will be even more useful for understanding the coupling of energy and momentum. Conversely, GOLD will be able to provide context and support for studies made from the ground. For example, a study of changing NmF_2 resulting from periodic variations of high latitude forcing can now be complemented by simultaneous observations of neutral temperatures and composition, which can also be put into a wider global context.

Thanks to the efforts of the geophysics community in general, and the CEDAR community in particular, it is clear that combining space and ground-based assets is an effective approach to achieving the system-level understanding necessary for advancing geophysical research and understanding the space environment. For achieving these objectives, data from both NICE, which is in competition to be selected as a stand-alone SMEX mission, and GOLD would be more valuable than data from a single mission.

The GOLD imager will be built by the Laboratory of Atmospheric and Space Physics at the University of Colorado. Data will be available online through the GOLD science data center at the University of Central Florida. More information about the GOLD mission is available at http://fsi.ucf.edu/GOLD/index.htm

~Richard Eastes
University of Central Florida

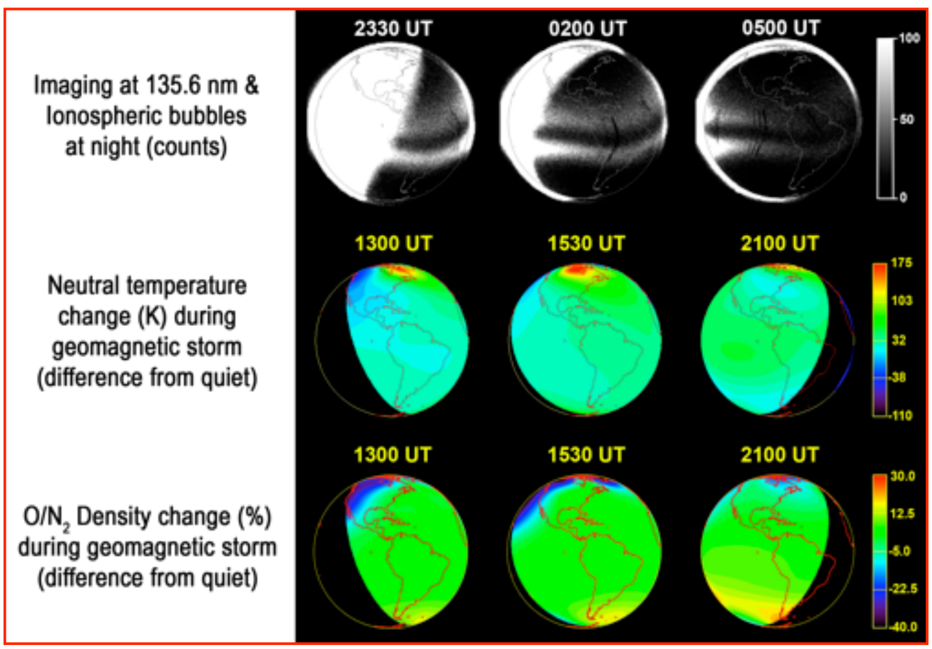

Figure caption: GOLD observes the same geographic locations throughout the day. The pictures above demonstrate potential observations of the nighttime ionosphere (top row) and daytime thermosphere (middle and bottom rows). Actual observations would be available at a higher (30 minute) cadence. Top row: simulation of nightside observations, counts at 135.6 nm, of equatorial ionosphere with "bubbles". This simulation used a 3-D ionosphere and integrated the emissions along the line of sight. Groups of three bubbles - with widths of 25, 50 and 100 km – are introduced just after sunset and allowed to propagate up through the ionosphere. Although the grayscale used saturates on the dayside, both dayside and nightside can be observed simultaneously. Bottom two rows: These pictures are derived from TIEGCM calculations temperature and composition changes from quiet to storm times at ~150 km, approximately the altitude sensed by the GOLD imager. These pictures are at the viewing geometry and approximately the spatial resolution expected from GOLD. Middle row: Neutral temperature change (K) between storm and quiet time. Bottom row: O/N_2 density ratio change (in percent) between storm and quiet time. GOLD observations will be able to distinguish changes of 15 K or 10%.