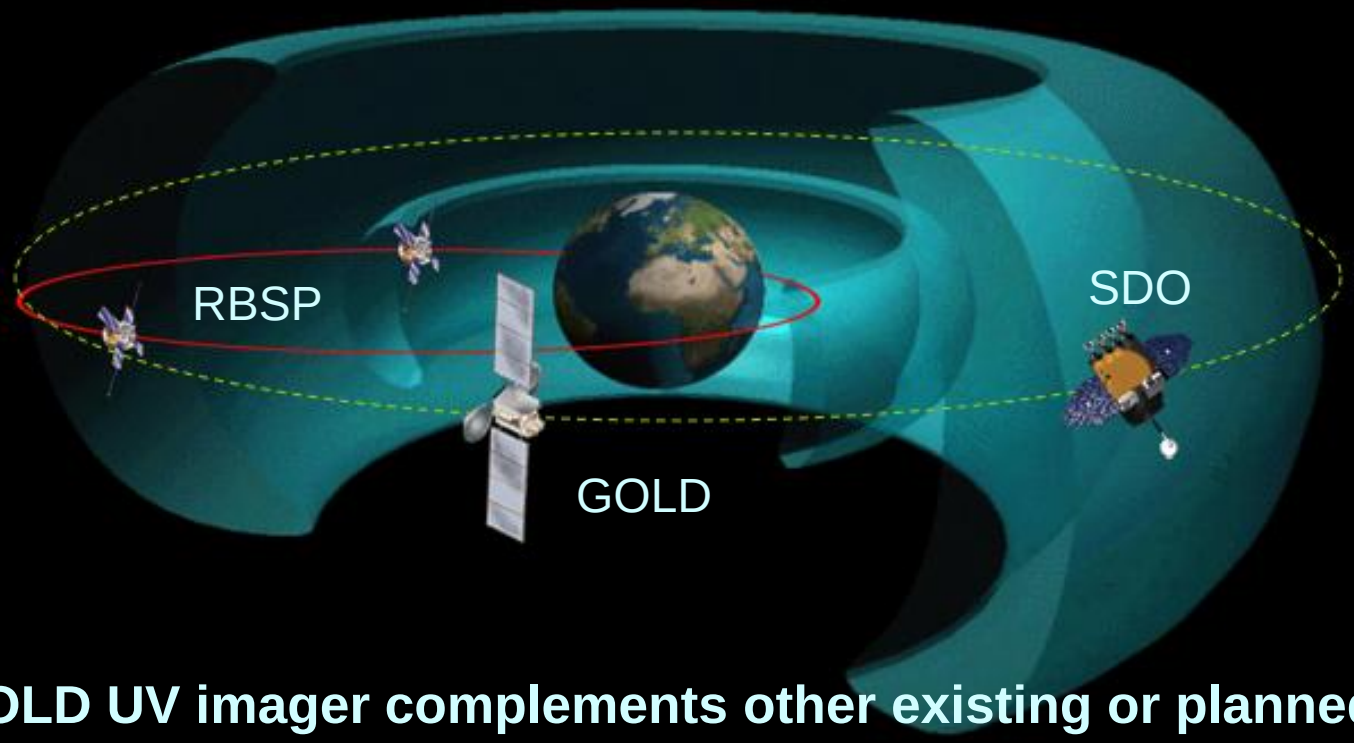
GOLD

Global-scale Observations of the Limb and Disk

R. Eastes, W. McClintock, M. Lankton, A. Aksnes, D. Anderson, L. Andersson, A. Burns*, S. Budzien, M. Codrescu R. Daniell, K. Dymond, S. England, F. Eparvier, J. Harvey, T. Immel, A. Krywonos, J. Lumpe, A. Richmond, D. Rusch, O. Siegmund, S. Solomon, D. Strickland and T. Woods

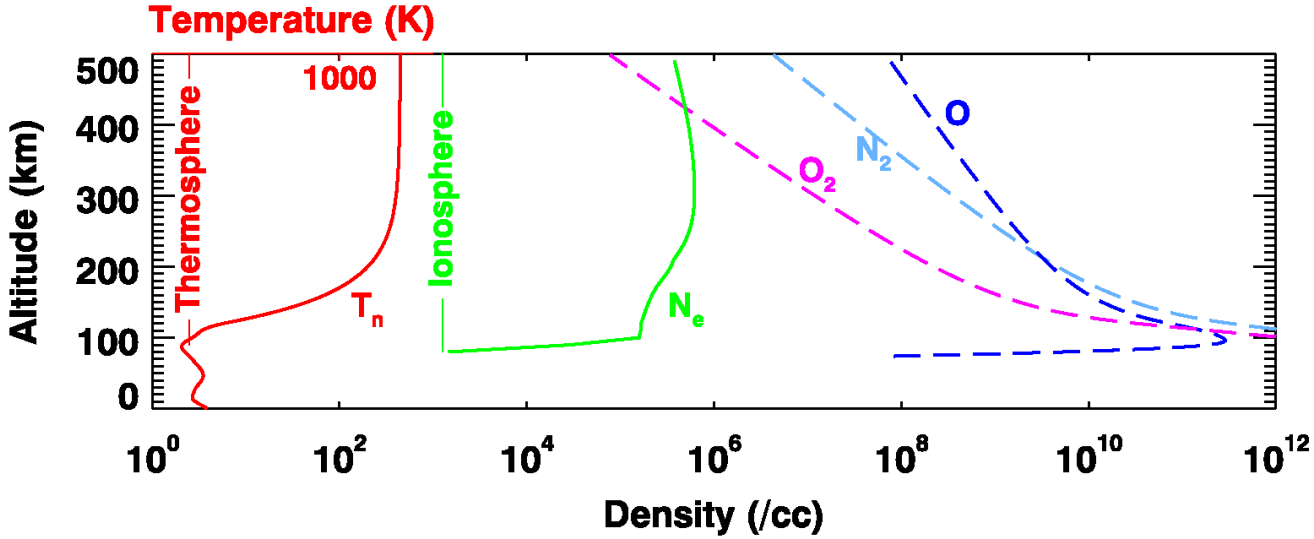
Global UV Imaging is the Frontier in Thermosphere-Ionosphere Science

- 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 complements other existing or planned missions.

The Thermosphere-Ionosphere (TI) System is an Unusual Laboratory



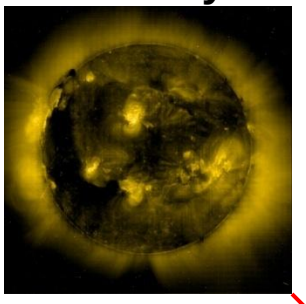
- Weak plasma – even at 300 km there are 1000 neutrals for every ion
- Rare in the solar system – only occurs in the upper atmospheres of the planets and moons
- At some heights and locations the ions drive the neutrals at others the neutrals drive the ions
- Good laboratory for physical and chemical processes
- The dynamics, thermodynamics and electrodynamics of the TI system are dominated by external forcing processes.

The Thermosphere-Ionosphere System

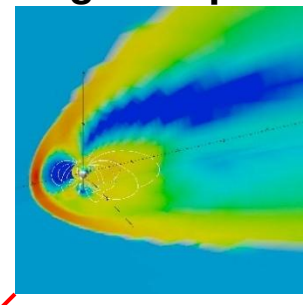
- The thermosphere-ionosphere is controlled by solar and magnetospheric processes, but are the solar high-energy photons more important, or the solar wind - magnetosphere - auroral effects?

- The thermosphere-ionosphere is controlled by atmospheric processes, but are the large-scale tidal dynamics more important, or the turbulent and convective processes?

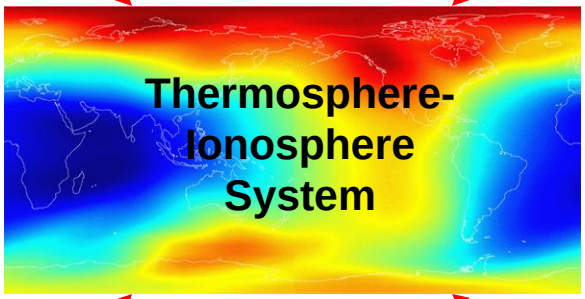
Solar Ultraviolet and X-rays

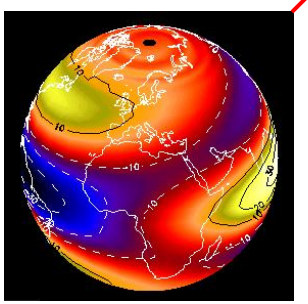


Solar Wind and Magnetosphere



Forcing from Above





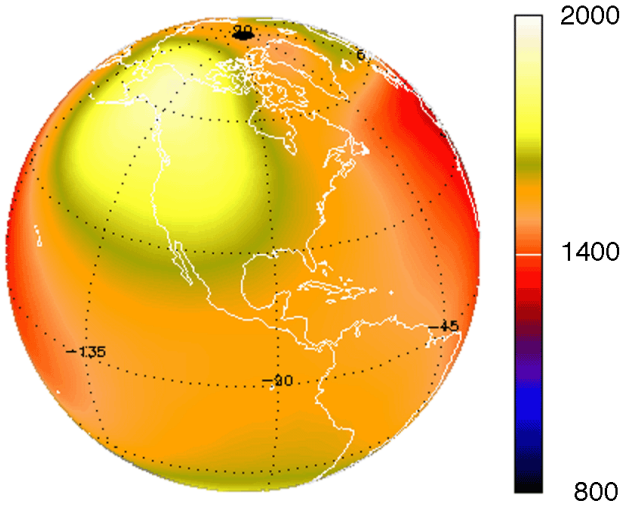
Tides and Planetary Waves

Forcing from Below

Turbulence and Convection

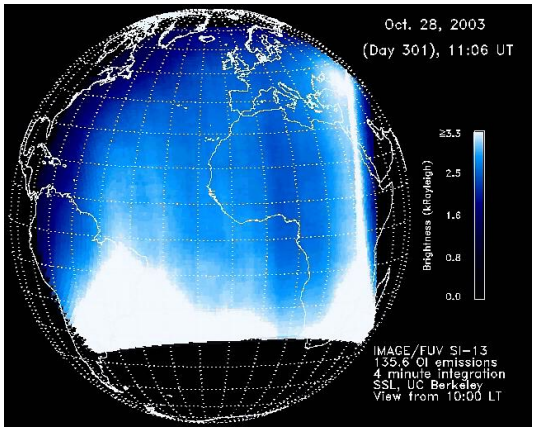
Forcing from Above

- **Geomagnetic and auroral variations**
  - ***Geomagnetic Storms***
  - ***Magnetospheric Substorms***
  - ***Low-latitude electric field processes***
  - ***Local time dependence of response***

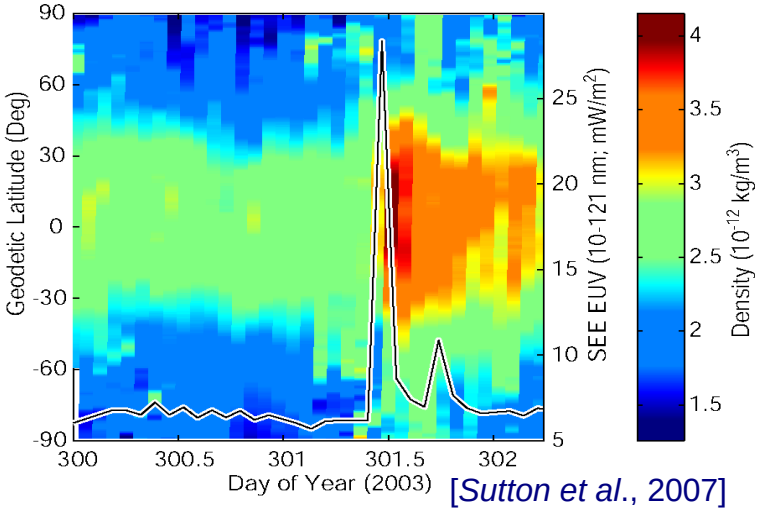


TIE-GCM Simulation of Temperature (K) at 200 km, 29 October, 2003, 2100 UT

- **Solar irradiance variations**
  - ***Solar Cycle*** **(~11 year)**
  - ***Solar Rotation*** **(~27 day)**
  - ***Active Regions*** **(~days)**
  - ***X-ray Flares*** **(~hours)**

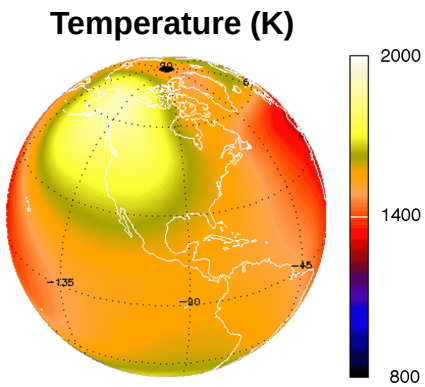


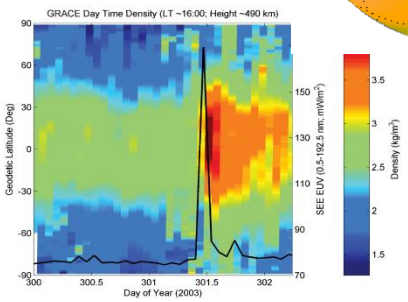
[*Immel et al.*, 2005]

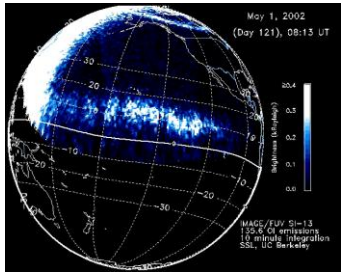


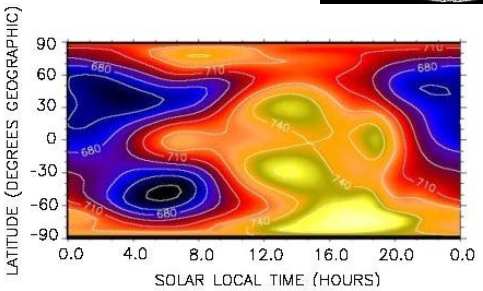
[*Sutton et al.*, 2007]

Key Science Questions Frame the Mission



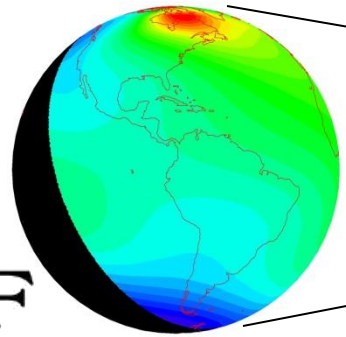


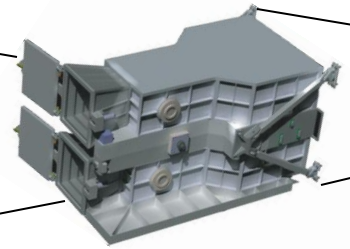


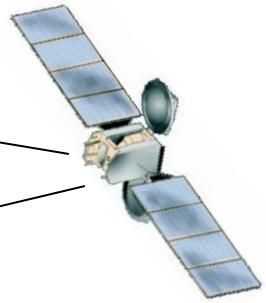


- 1. A) How do geomagnetic storms alter the temperature and composition structure of the thermosphere; B) How does the low-latitude, nighttime ionosphere respond to geomagnetic storms; and C) Is the initial state of the thermosphere-ionosphere system a key determinant of geomagnetic storm effects?
- 2. What is the global-scale response of the thermosphere to solar extreme-ultraviolet variability?
- 3. Do atmospheric waves and tides have a significant effect on thermospheric temperature structure?
- 4. Do vertical ion drifts, as manifested in the structure of the equatorial anomaly, affect the occurrence of ionospheric irregularities?

Comprehensive Investigation Provides Answers to the Science Questions

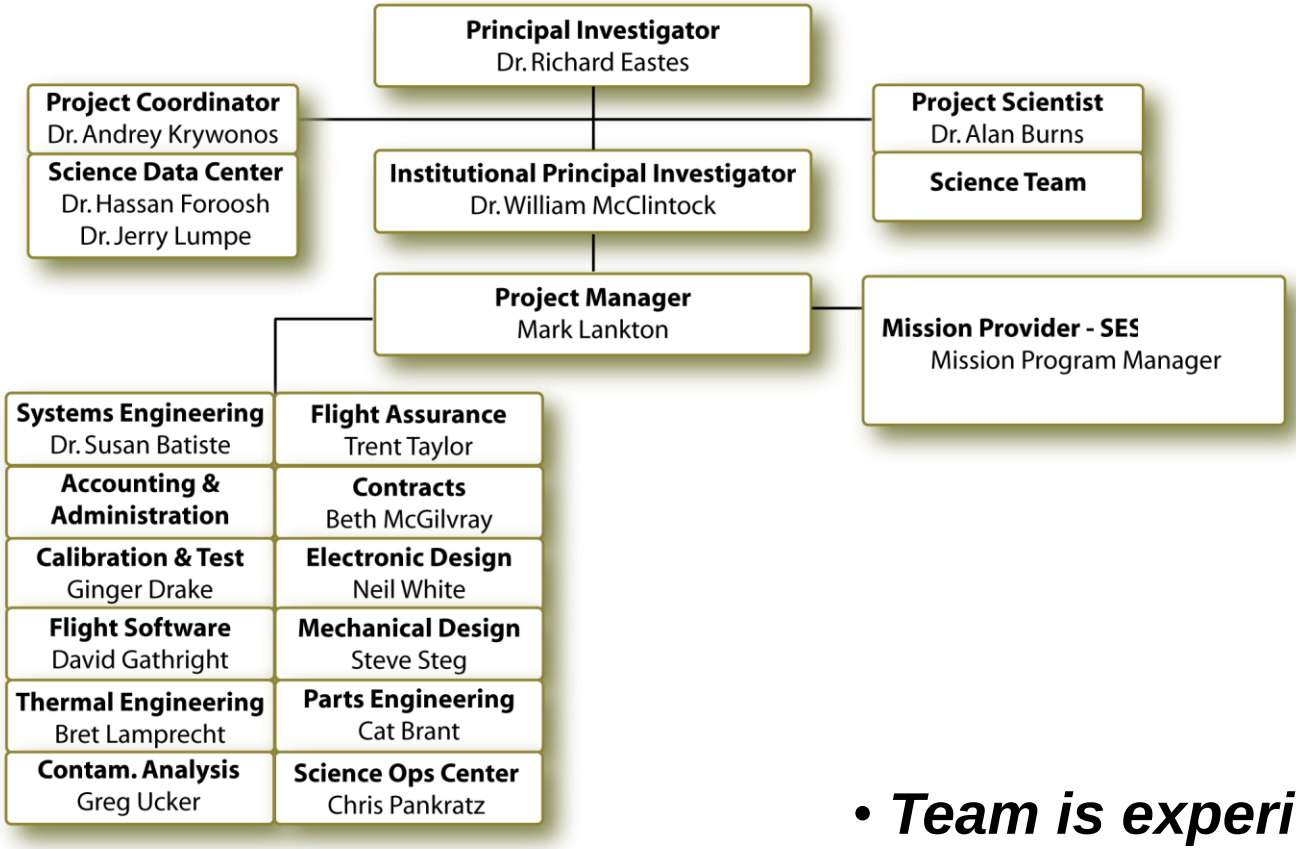






- **Integrated approach to studying the thermosphere-ionosphere as a system**
- **Full-disk temperature and O/N_2 composition measurements in the Earth's thermosphere**
- **Global-scale observations of the ionosphere at night probe the origin of small-scale irregularities**
- **Measurements allow separation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

Management Plan is in Place

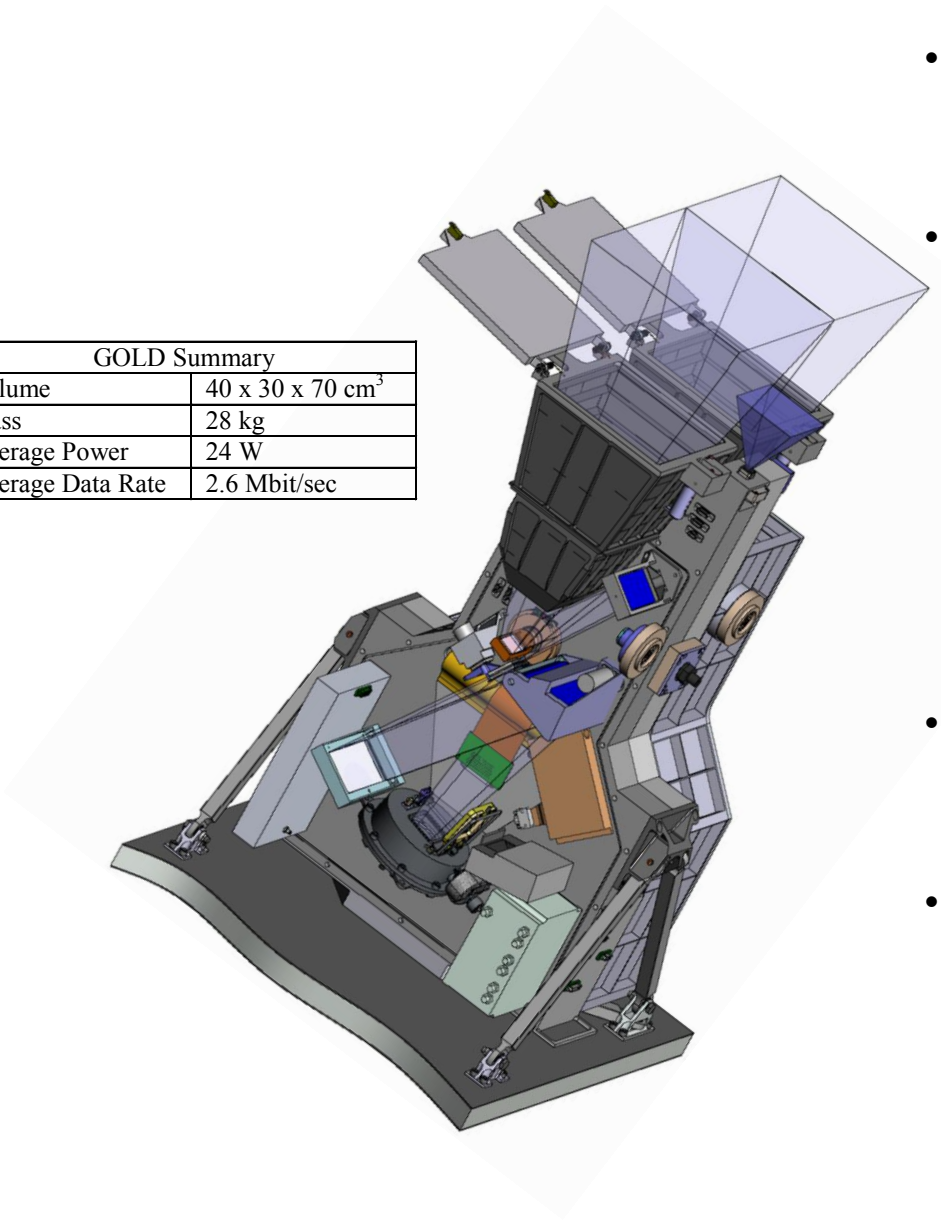


Design Heritage From LASP Flight UV Instruments

- Galileo UVS & EUV
- UARS SOLSTICE
- Cassini UVIS
- TIMED SEE
- SORCE SOLSTICE
- MESSENGER MASCS
- AIM CIPS
- SDO EVE

- ***Team is experienced***
- ***Partners are committed***
- ***Instrument has heritage***
- ***Cost is controlled***
- ***Schedule matches science goals***

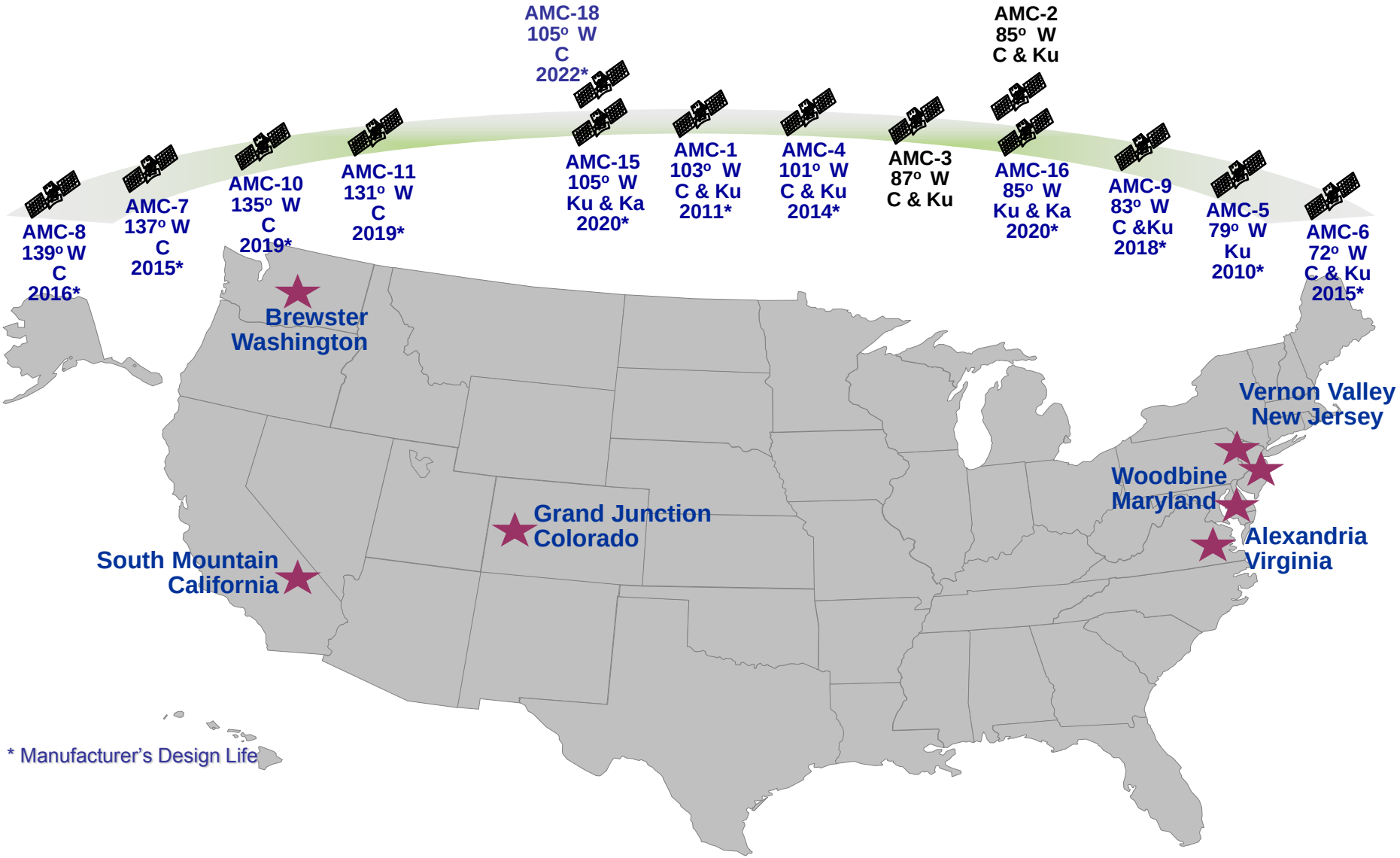
GOLD Configuration Enables Simultaneous Measurements of Composition and Temperature



GOLD Summary	
Volume	40 x 30 x 70 cm^3
Mass	28 kg
Average Power	24 W
Average Data Rate	2.6 Mbit/sec

- **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**
- **LASP's planetary exploration experience provides the foundation for GOLD's implementation**
  - **Cassini: Ultraviolet Imaging Spectrograph**
  - **Messenger: Mercury Atmospheric and Surface Composition Spectrometer**

SES - North American Fleet



* Manufacturer's Design Life

Why GOLD?

Global UV Imaging is the frontier in thermosphere-ionosphere research.

GOLD provides breakthrough imaging of the thermosphere-ionosphere system.

- **GOLD will analyze the global effects of geomagnetic storms using unprecedented temperature measurements with sophisticated models.**
- **GOLD will evaluate the thermosphere-ionosphere response to solar EUV and X-rays, in conjunction with the EUV Variability Experiment (EVE).**
- **GOLD will explore ionospheric bubbles, and their connection to the low-latitude electric fields.**
- **GOLD will study the variability of global atmospheric tides and other waves from the unique perspective of geostationary orbit.**
- **GOLD and NICE will complement each other to improve the science of both.**