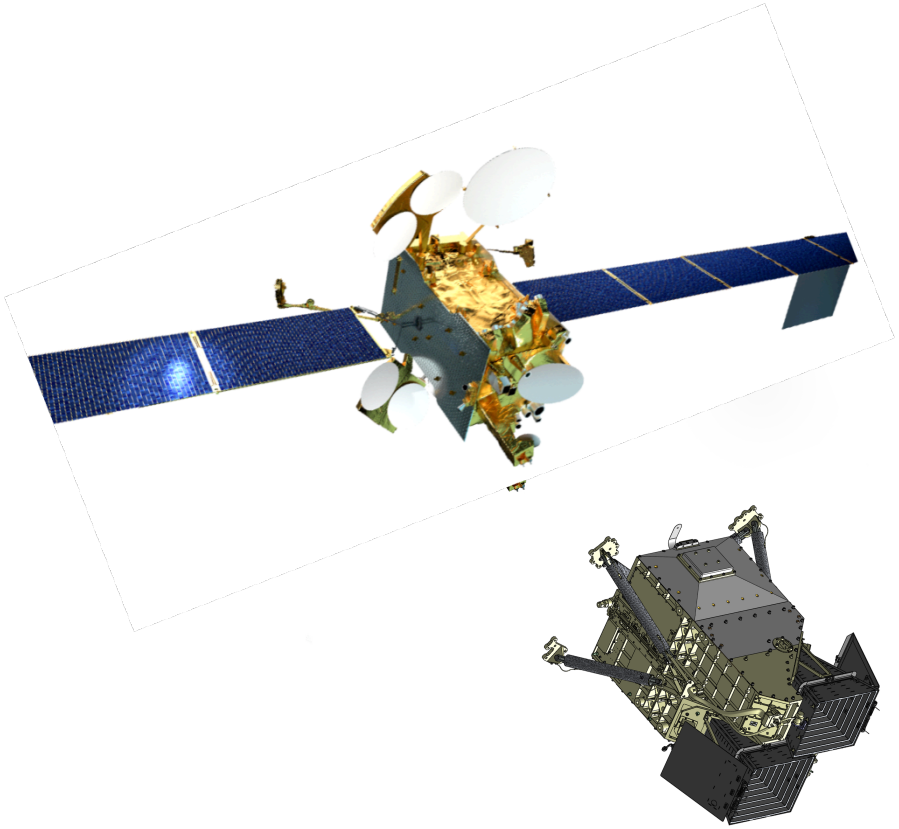
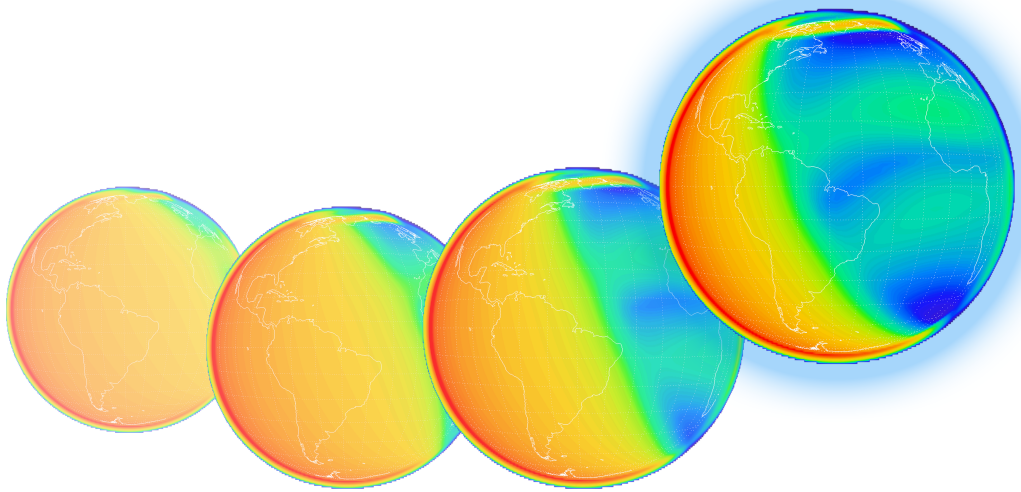


Global-scale Observations of the Limb and Disk (GOLD) – First Light Observations

William McClintock, Richard Eastes and the GOLD Science Team

Laboratory for Atmospheric and Space Physics

University of Colorado



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

Government Solutions

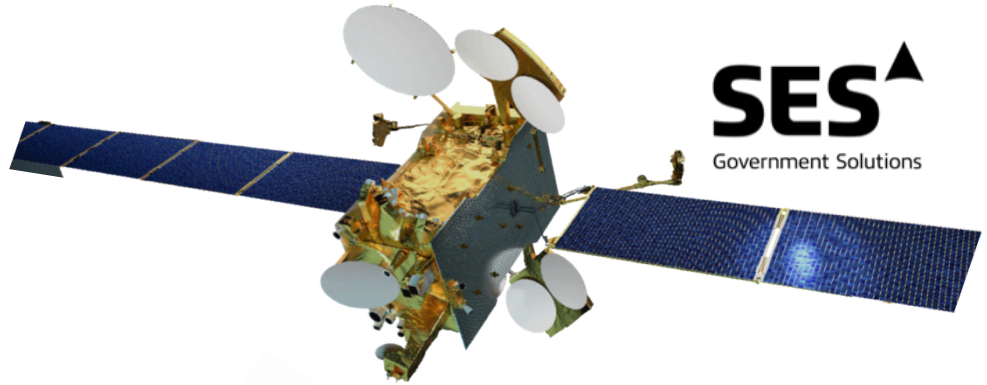
Scientific Motivation

- **GOLD is 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 30-minute cadence
  - Enables the first characterization of the I-T system '**weather**'

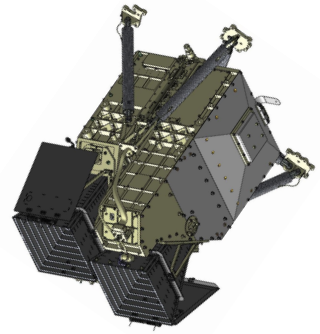
SA11A-06: Global-scale Observations of the Limb and Disk (GOLD): Early Orbit Observations
SA11A-07: Observations and Modeling of Atomic/Molecular Composition in the Thermosphere

GOLD Mission Overview

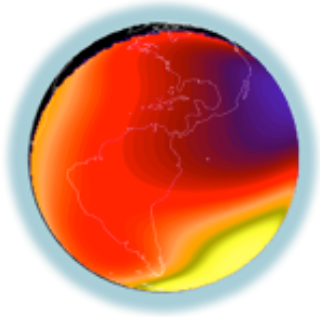
- **Host Mission**
  - SES-14, in geostationary orbit at 47.5˚ west (over mouth of the Amazon River)
- **GOLD Instrument**
  - Two identical, independent imaging spectrographs covering 132-162 nm
- **Measurements**
  - Earth's disk
    - Daytime: Spatial-spectral image cubes of O-135.6 nm and N_2-LBH emission
    - Nighttime: Spatial-spectral image cubes of O-135.6 nm emission
  - Earth's limb
    - Altitude profiles of N_2-LBH emission
    - Stellar occultations



SES Government Solutions

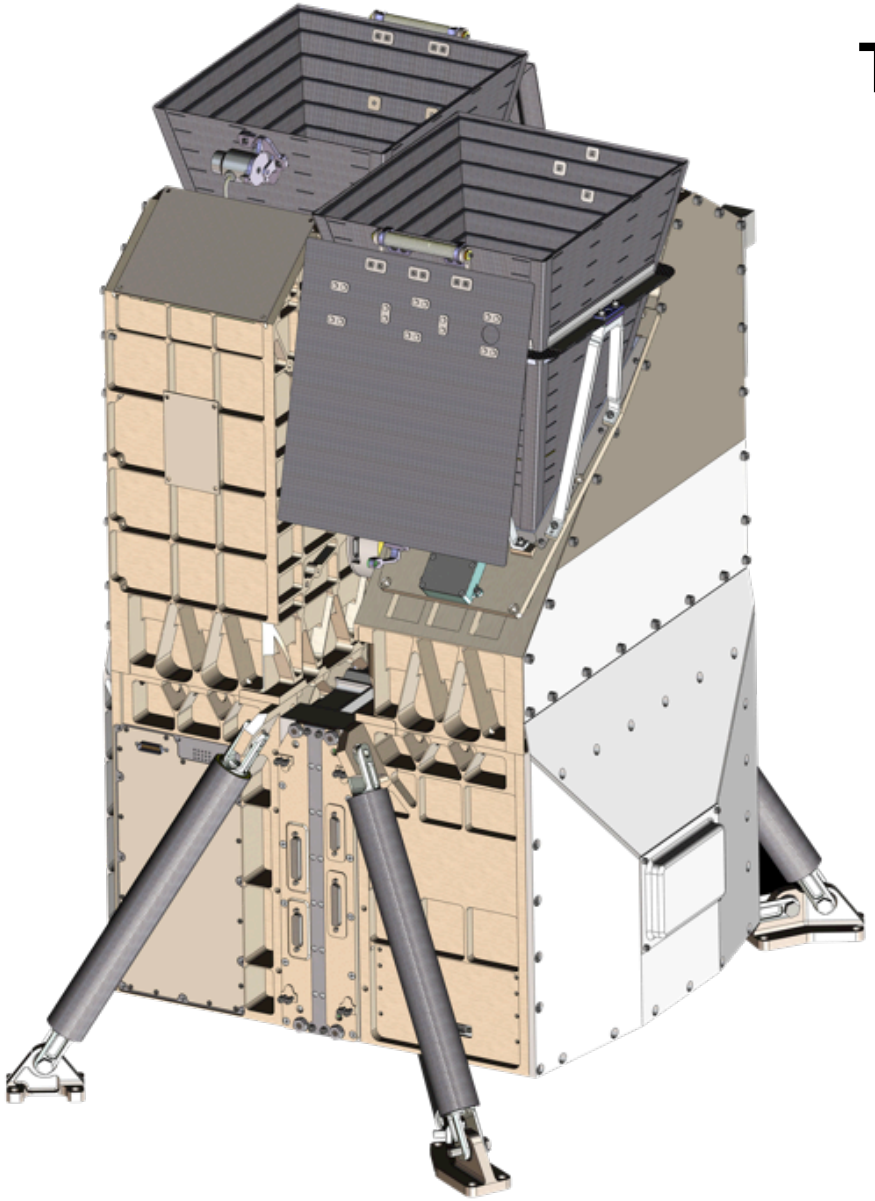


LASP
Laboratory for Atmospheric and Space Physics
University of Colorado Boulder



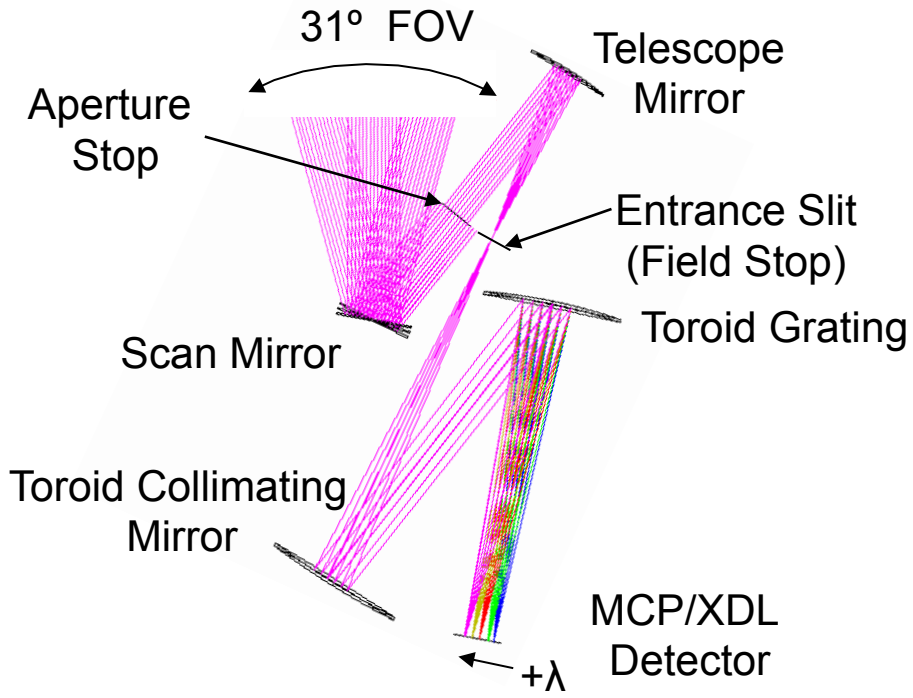
UCF

GOLD Configuration Enables Simultaneous Measurements of Composition and Temperature



Two imaging spectrometers independently image the limb and disk, and a single processor packaged in one housing

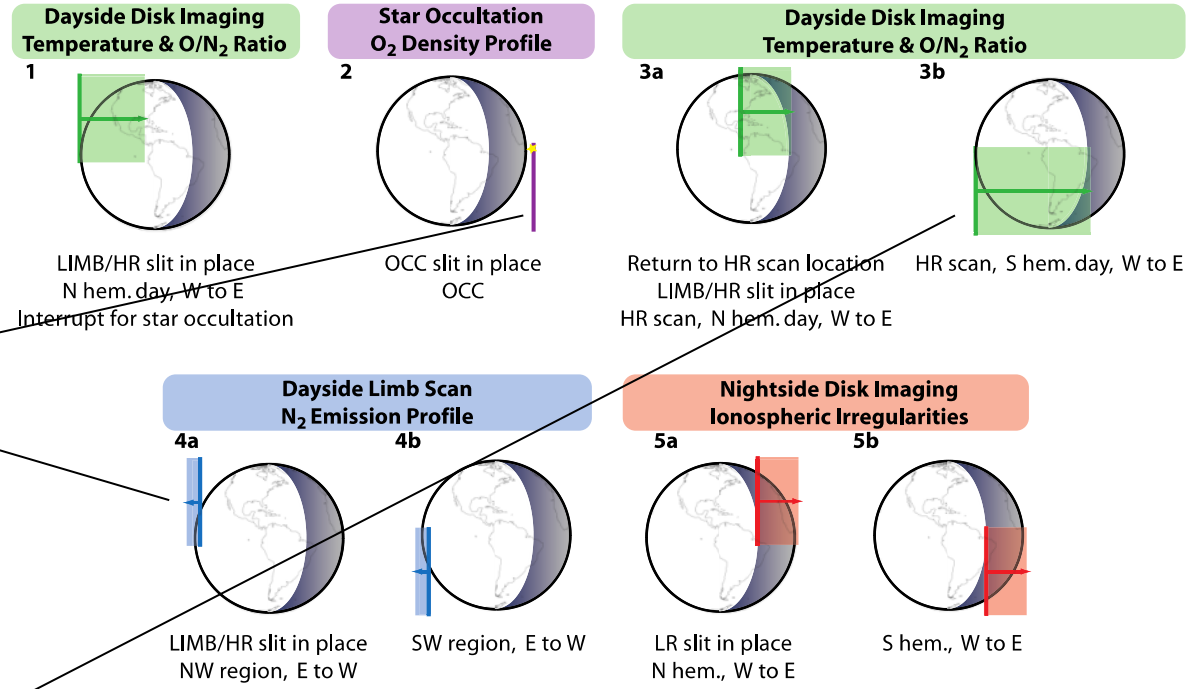
Single Channel Optical Design



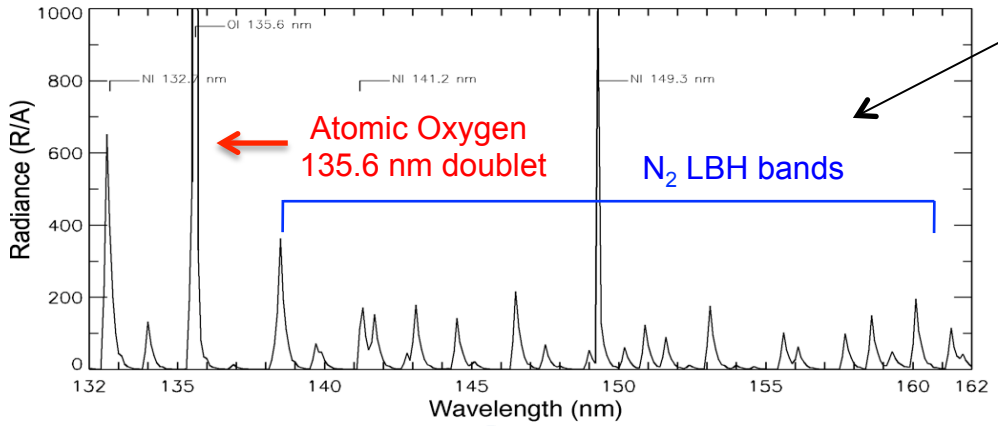
GOLD Uses Whiskbroom Imaging to Build Spatial-Spectral Image Cubes

Technique

- Telescope equipped with a scan mirror images the T-I system onto the slit of an imaging spectrograph.
- The limiting resolution is ~ 50 km.
- Measurements include stellar occultations and altitude profiles on the limb

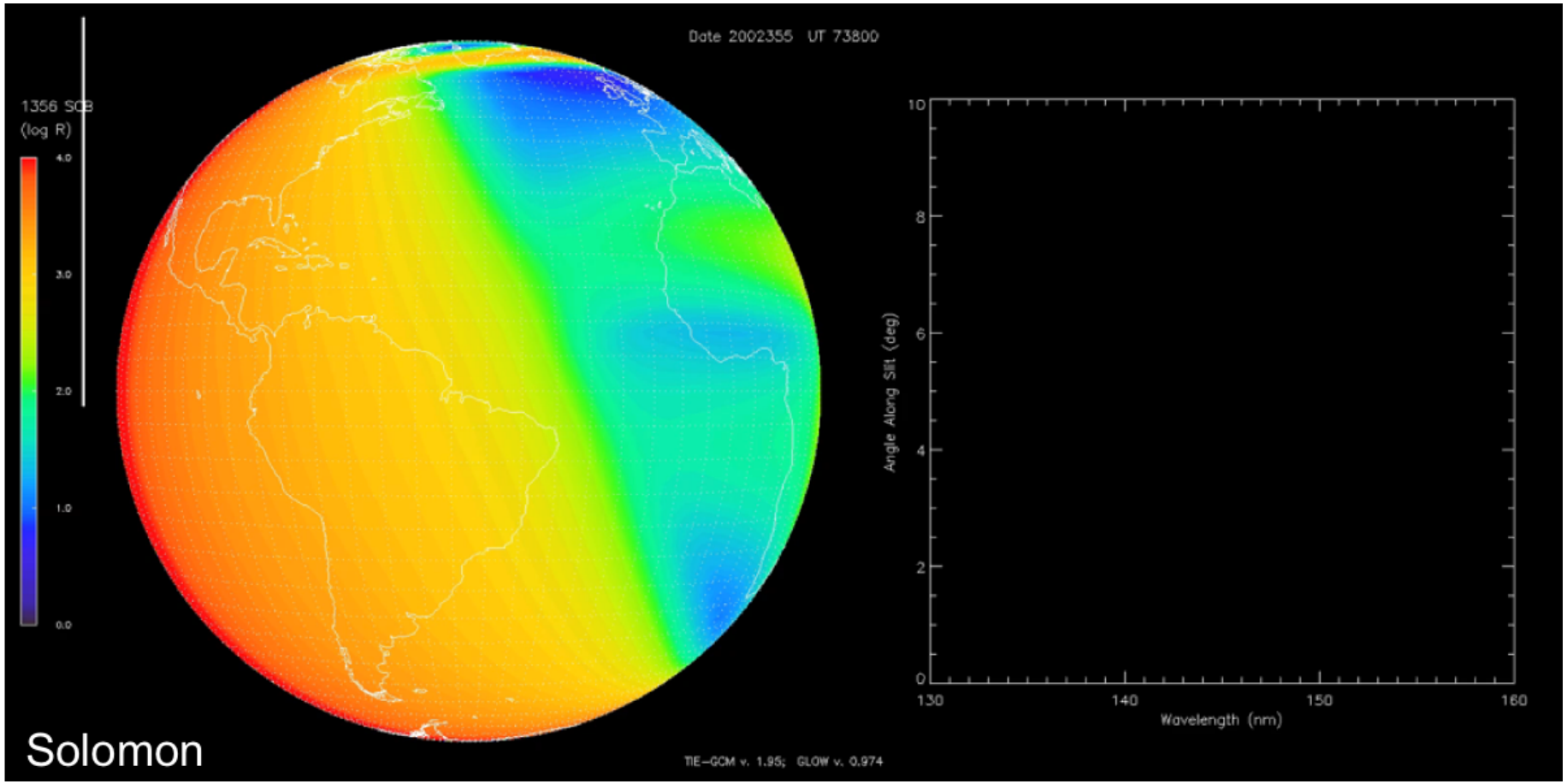


Daytime Far-Ultraviolet Spectrum



The spectrograph records spectra as a function of slit height at each point on the disk.

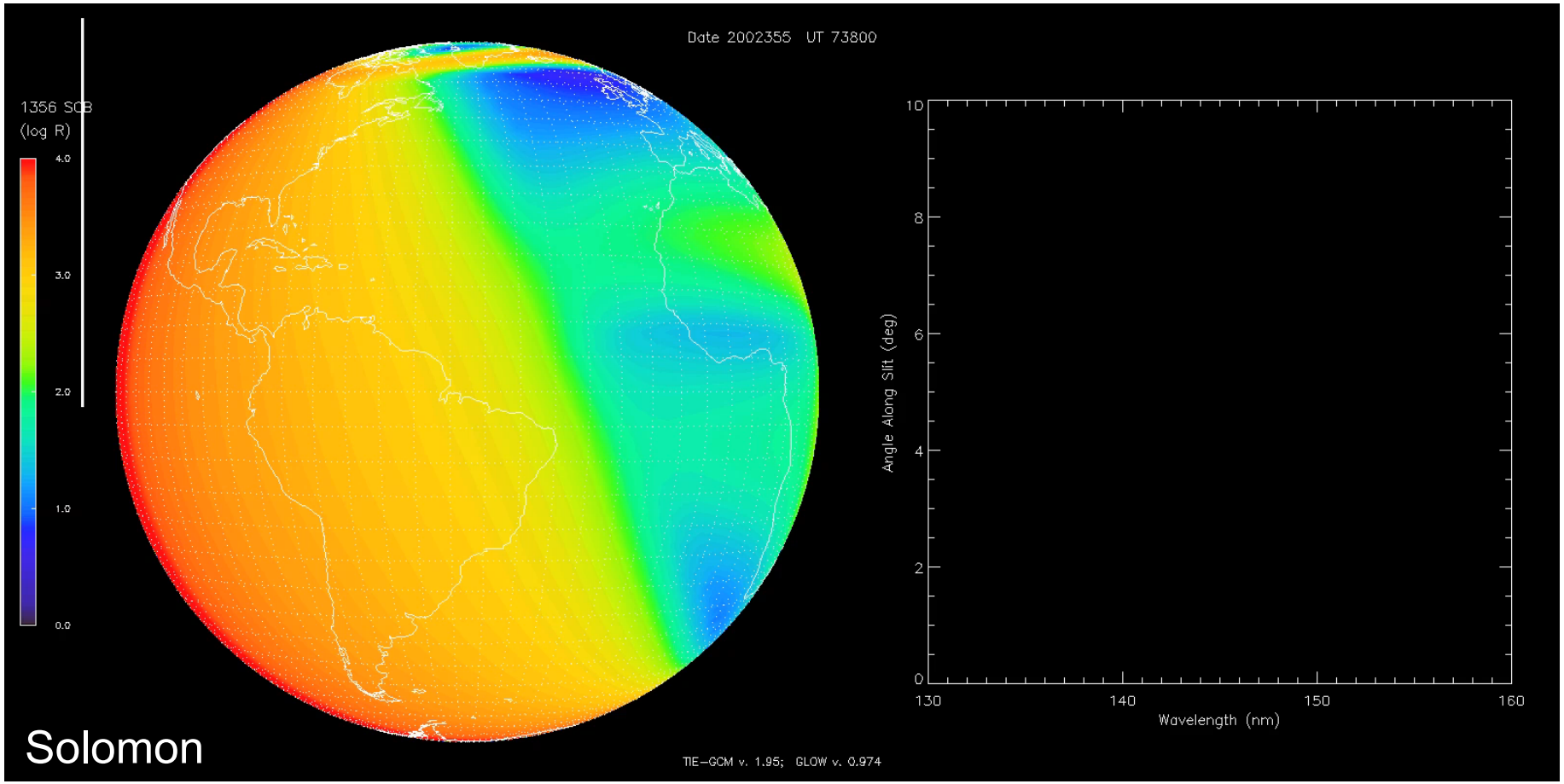
GOLD Disk Imaging Simulation



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

GOLD Disk Imaging Simulation



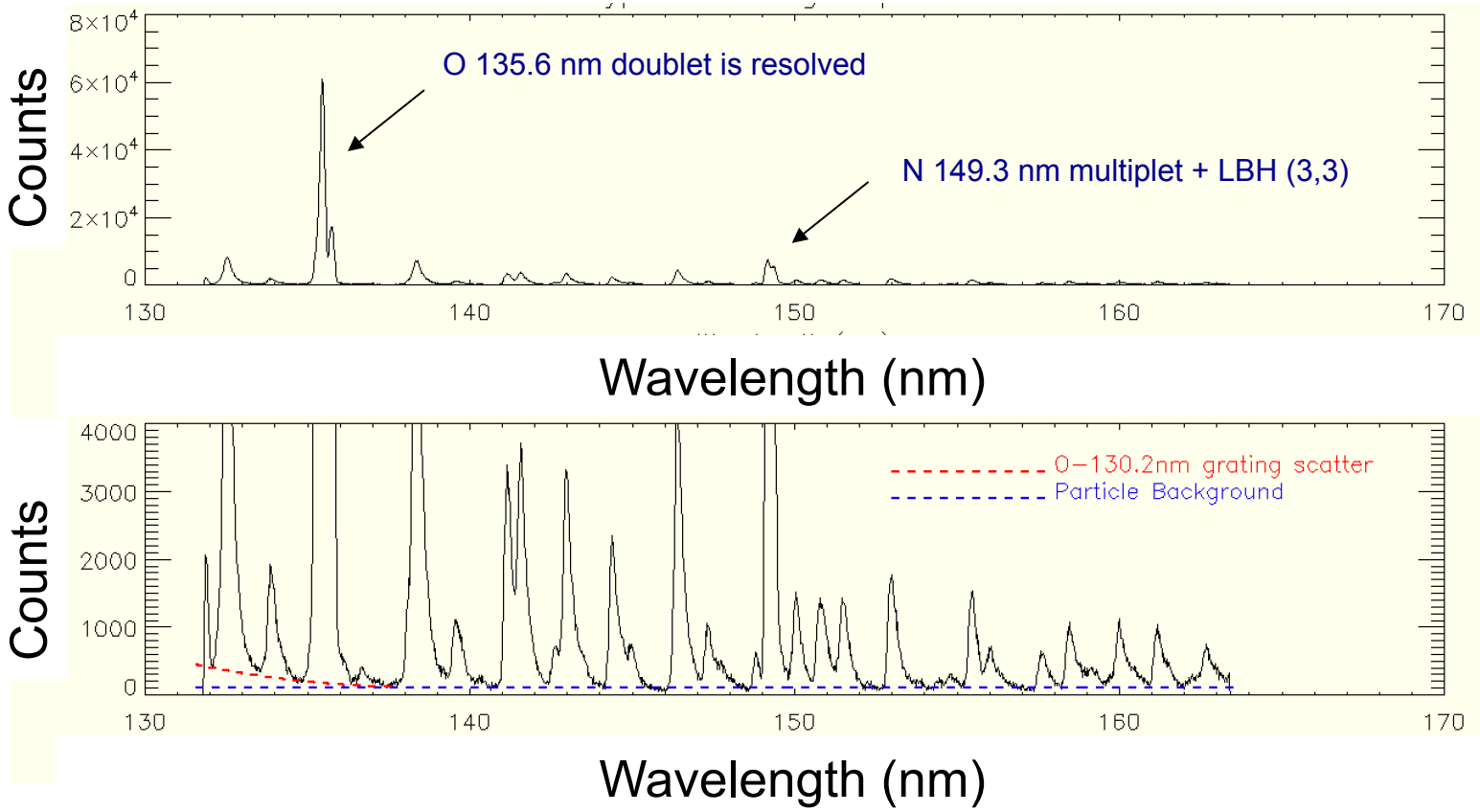
Disk Image **Detector Image**

- 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

Instrument Measurement Performance

- **Flight spectral resolution and wavelength scale are in agreement with design and ground calibration results**
- **Contributions from particle backgrounds and scattered light are small and manageable**

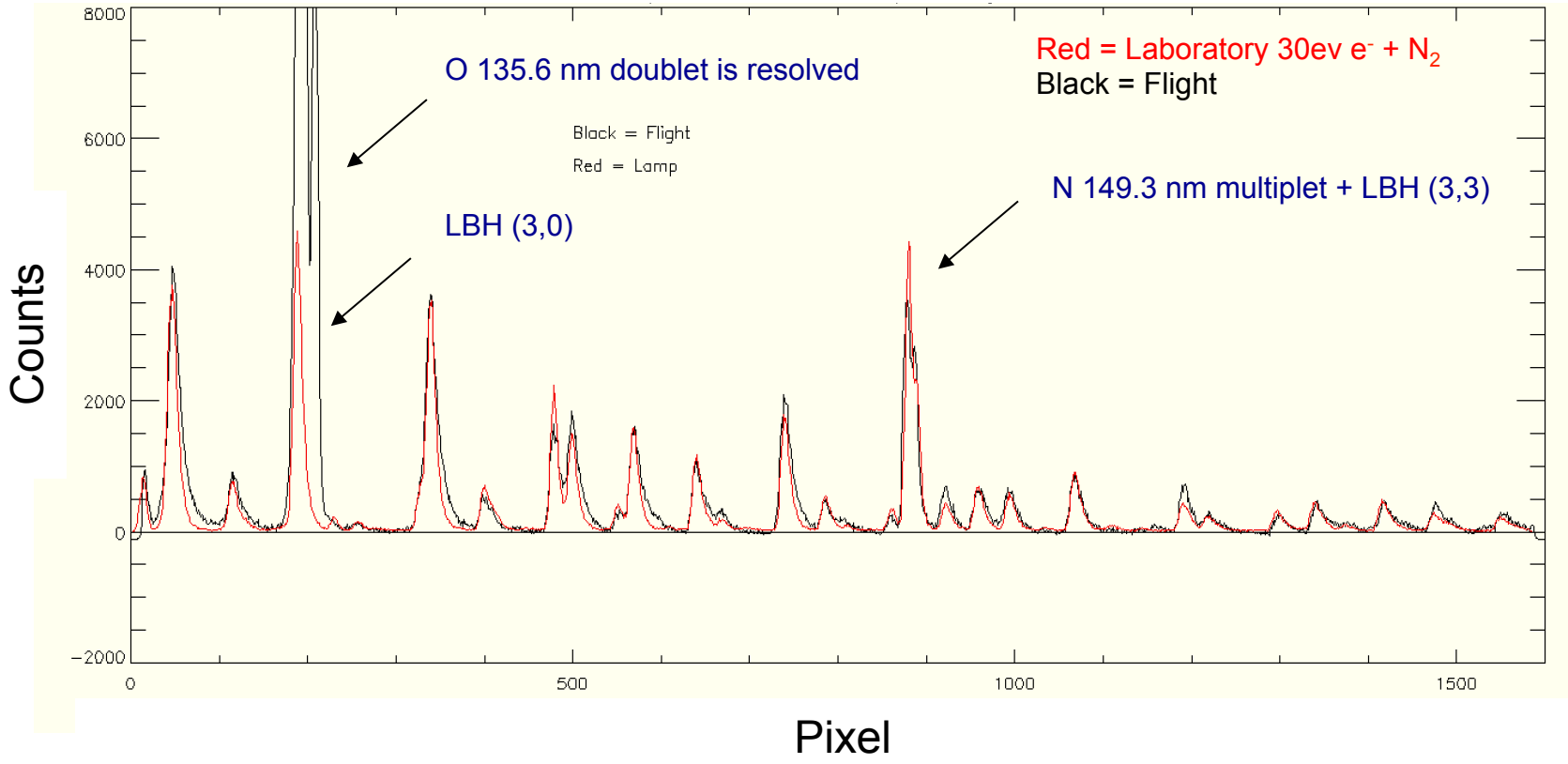
Typical First Light Spectrum



Flight - Laboratory Comparison

Direct comparison with electron lamp spectra acquired during ground calibration shows that the relative band strengths are in good agreement with Franck- Condon factors derived in the laboratory

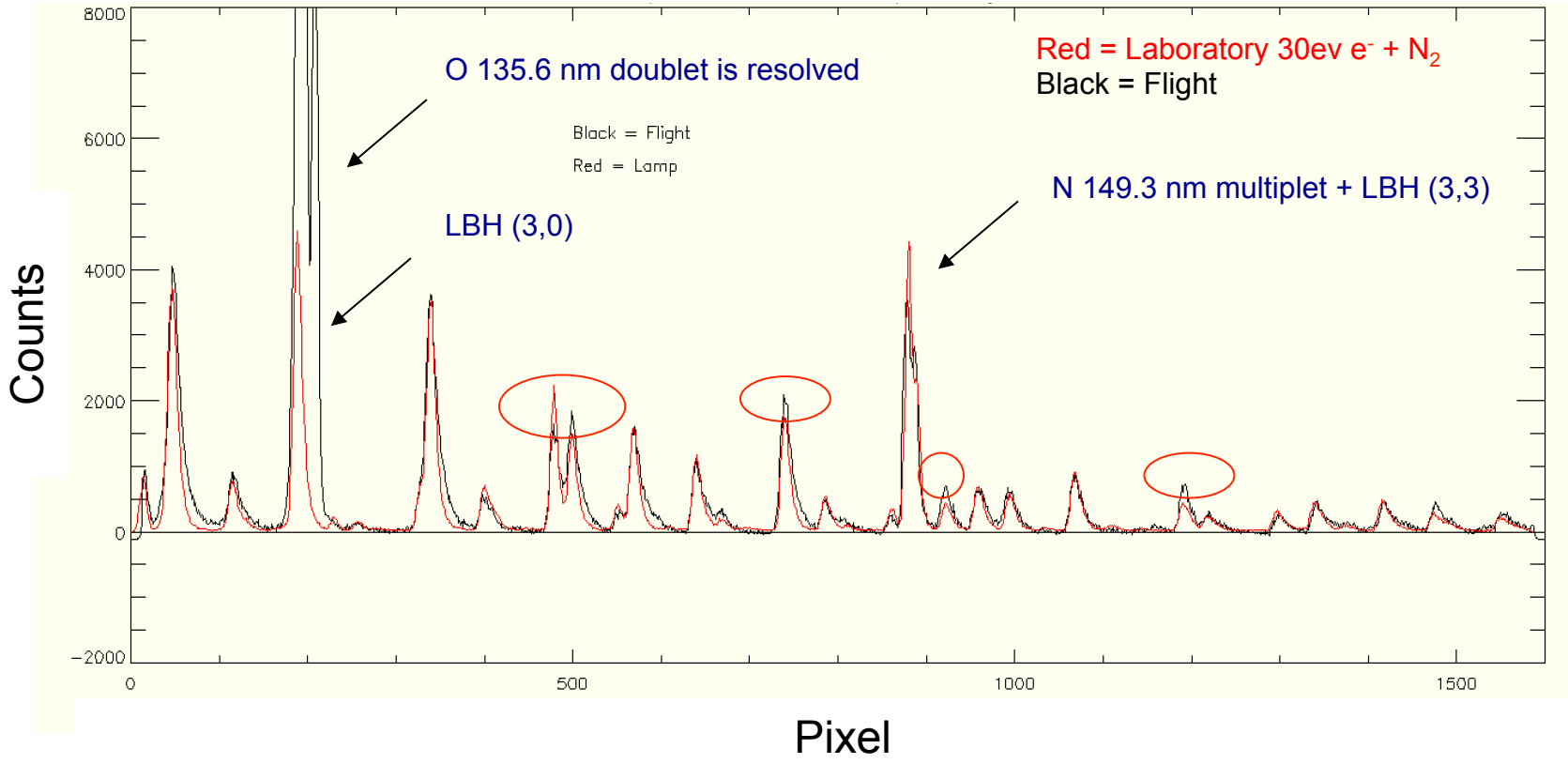
Comparison of Laboratory Electron-Impact Spectrum and Flight Data



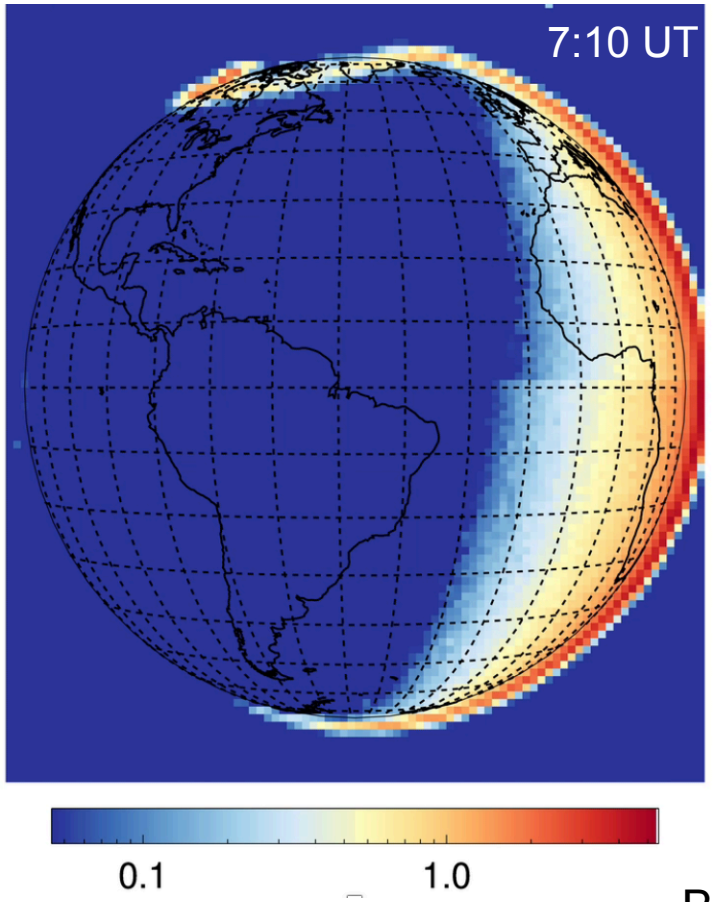
Flight - Laboratory Comparison

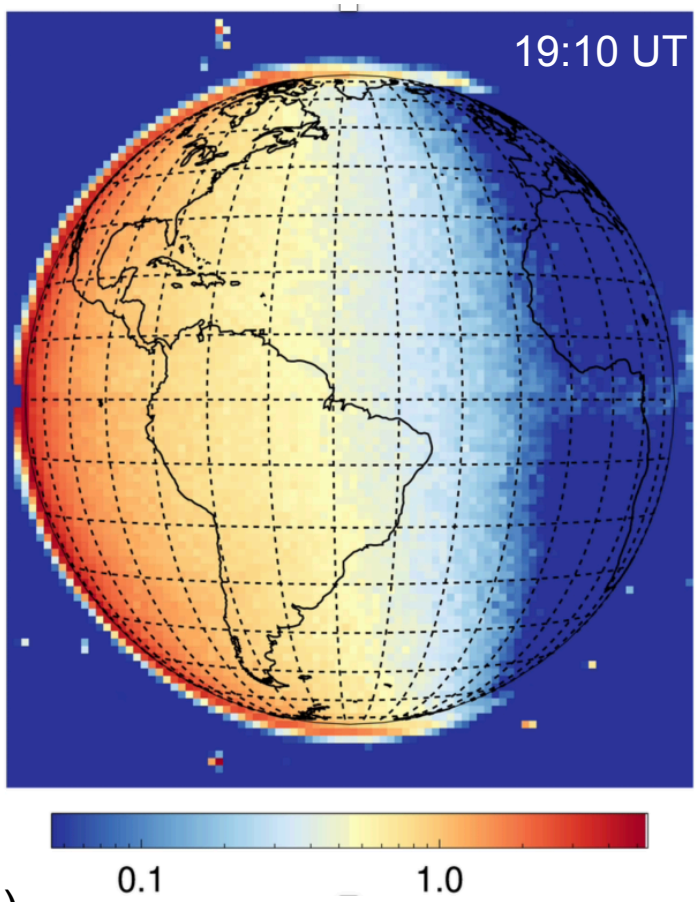
Direct comparison with electron lamp spectra acquired during ground calibration shows that the relative band strengths are in good but not perfect agreement with Franck- Condon factors derived in the laboratory

Comparison of Laboratory Electron-Impact Spectrum and Flight Data



Images of 135.6 nm Radiance, Day 282





Brightness (kR)

30-minute disk images

Morning

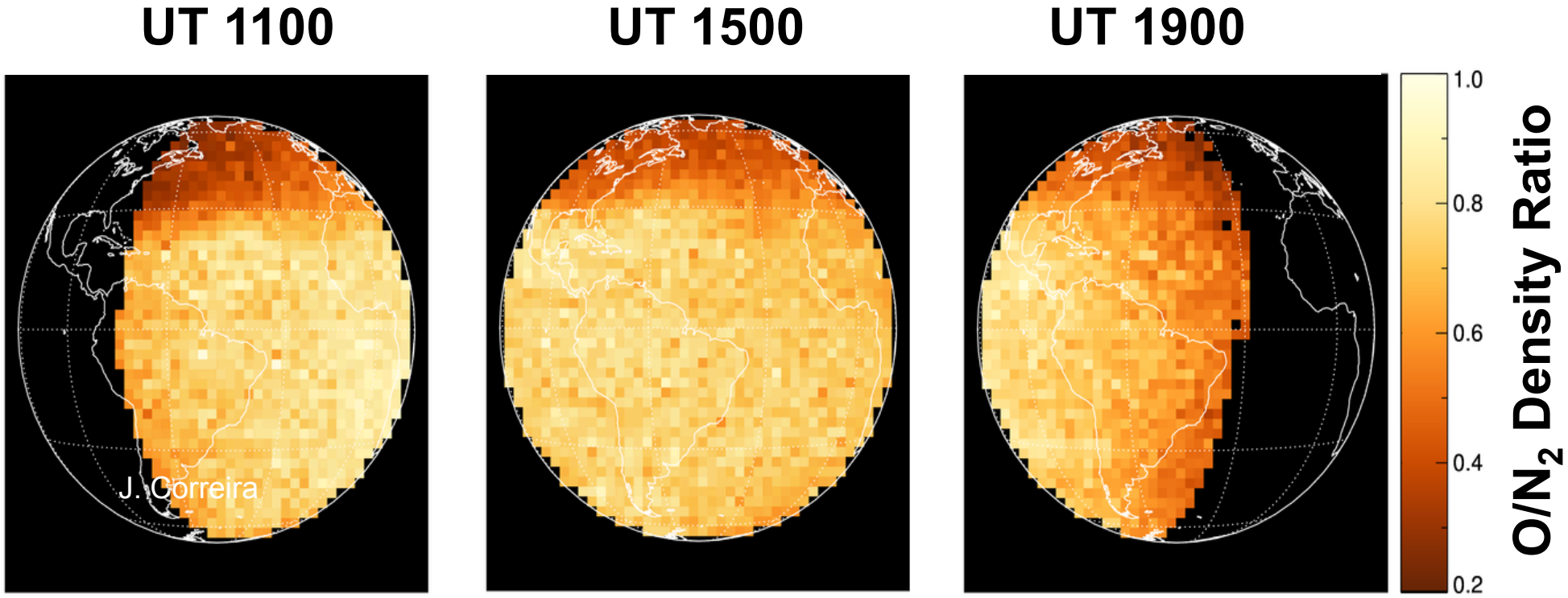
- Aurora is visible above North America

Afternoon

- Numerous stars in the galactic plane appear around the disk
- Equatorial arcs are visible in the nominal disk scan

O/N_2 Density Ratio

Day 254 (Sept 11) of 2018



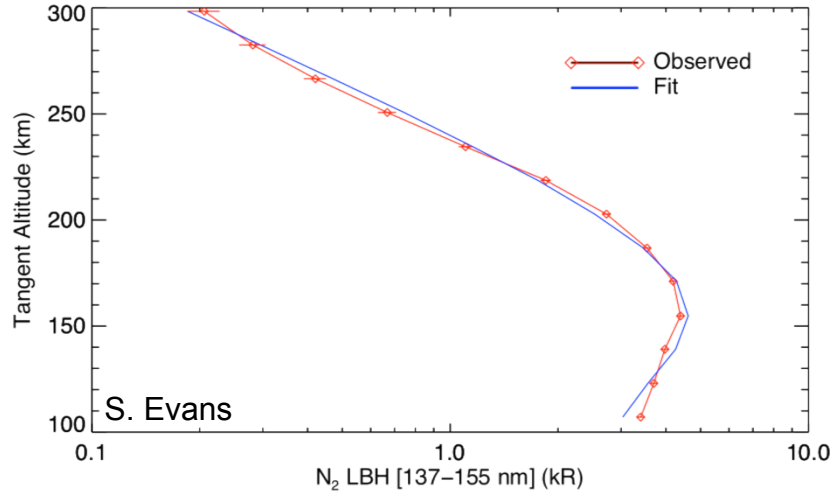
- Geomagnetic storm (Kp > 5) began at ~3 UT
- Images of O/N_2 indicate a change in the density ratio with longitude at high latitudes

SA21A-3169: Global-scale Observations of the Limb and Disk (GOLD): Overview of O/N_2 and QEUV Science Data Products

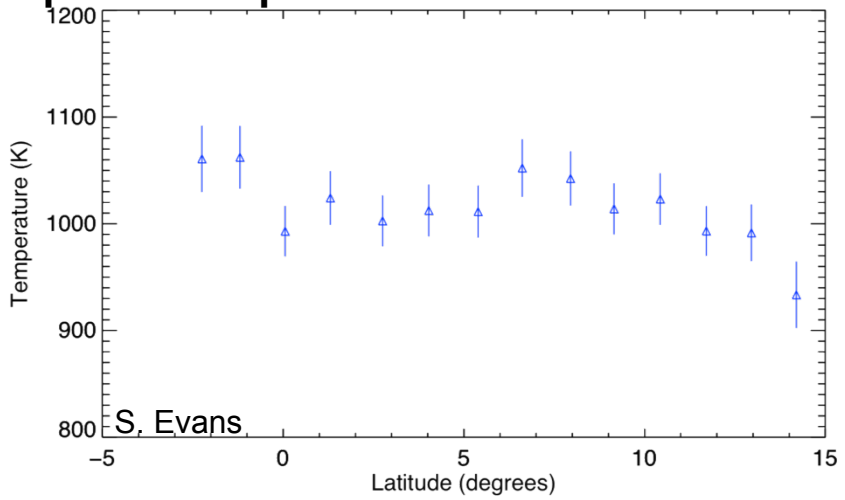
Limb Scans for Exospheric Temperature

Limb scans are used to derive exospheric temperature Texo near the equator

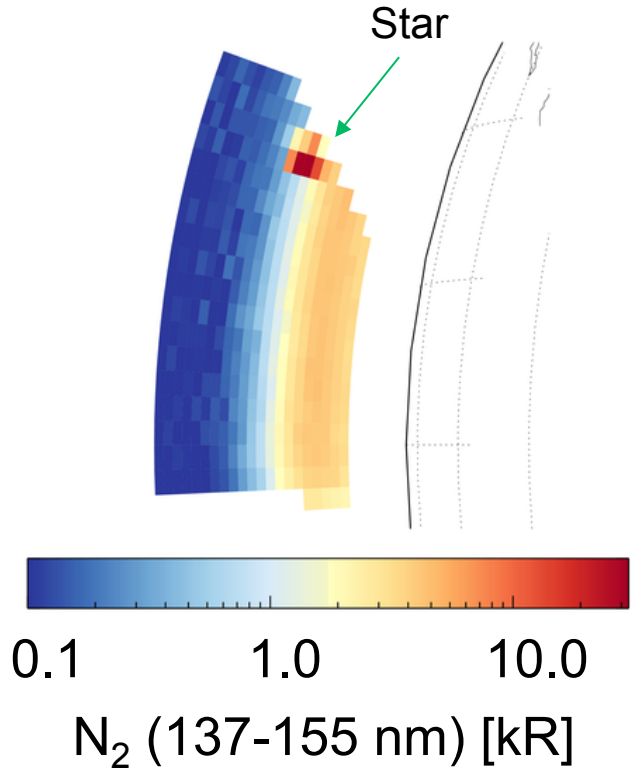
Fit to N_2 emission the profile at 2.75 N latitude



Exospheric temperature is derived from each profile



Day 254 20:07 UT limb scan



SA21A-3171: Global-scale Observations of the Limb and Disk (GOLD): Overview of Daytime Exospheric Temperature Science Data Product

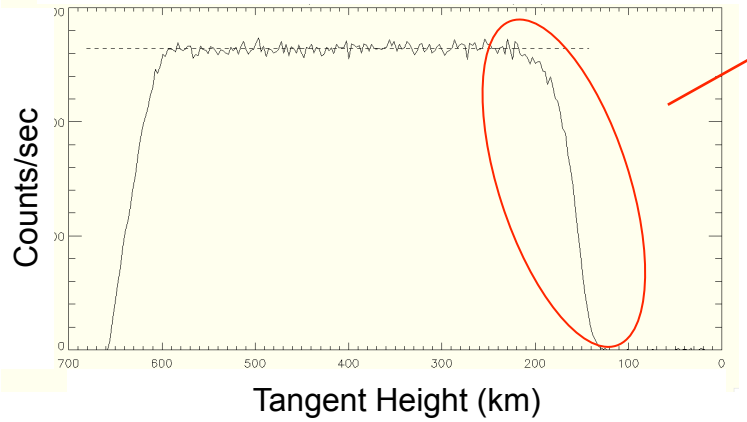
Stellar Occultations for O_2 Density

Stellar occultations provide O_2 column densities on the limb

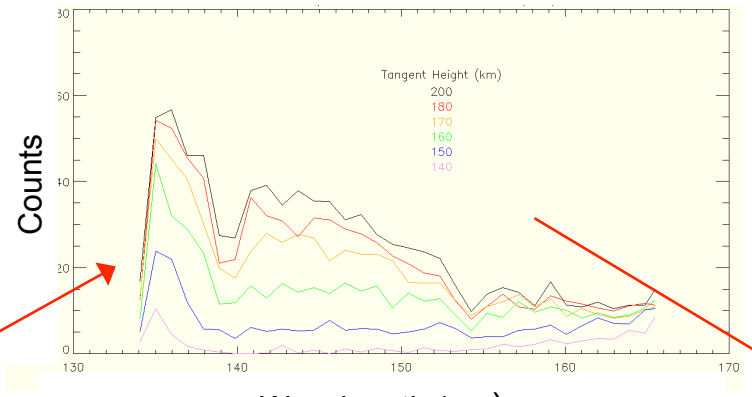
GOLD uses a 1˚ wide slit for occultations

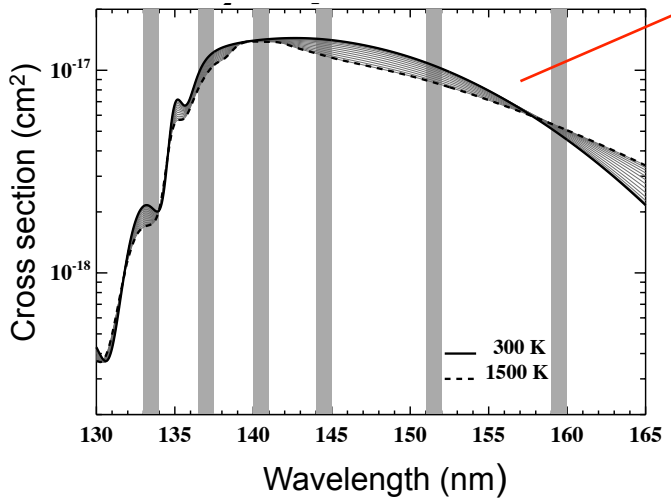
- Subtends ~ 725 km altitude at the limb
- Slit center is placed at ~ 250 km tangent altitude for the latitude of the star
- Timing is such that the star completely traverses the slit during the occultation (~ 240 sec)
- Measurable absorption occurs for 140 - 220 km

Occultation Profile: HD212571

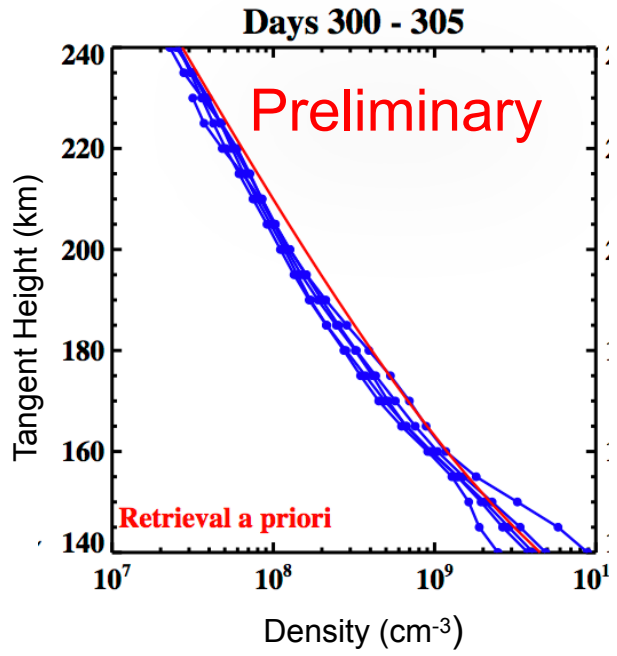


Occultation Spectra: HD212571





Occultation profiles, observed as a function of wavelength, provide tata to determine O_2 column density



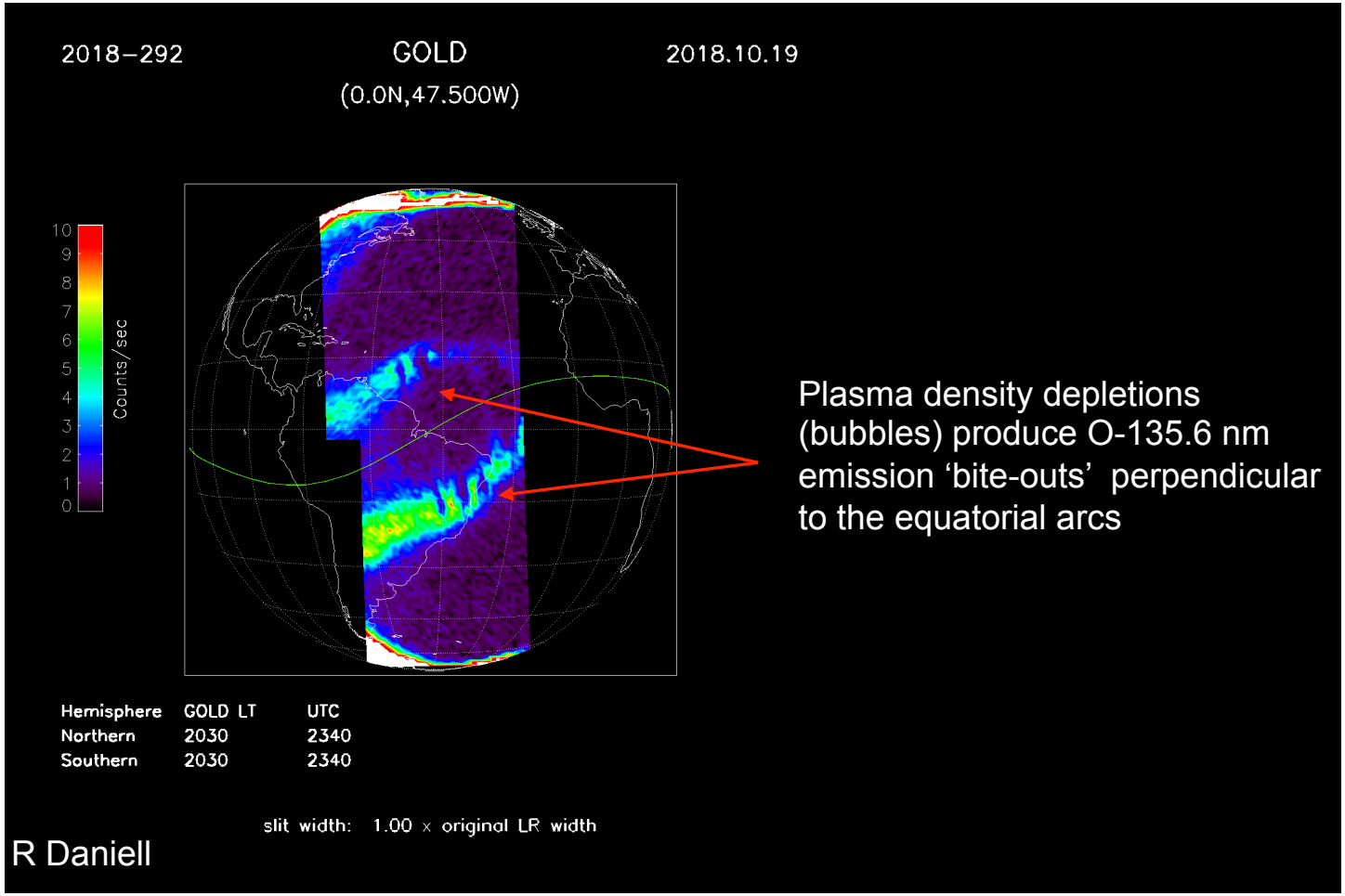
SA21A-3170: Initial Measurements of Thermospheric O_2 Density Profiles from GOLD

Dedicated Nighttime Scans Map the Equatorial Arcs and Image Bubbles

Observing sequence begins at 17:00 hrs SLT

- Until 20:00 hrs SLT, nightside images are constructed from two 15-minute scans of the southern and northern hemispheres acquired sequentially by a single channel
- After 20:00 hrs SLT the two hemispheres are scanned together using two channels to provide 15-minute cadence
- Current scan range covers 40˚ longitude starting ~ 5˚ East of the terminator

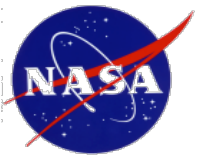
Composite 30-minute image taken between 19:30 and 20:00 hrs SLT and covering 40˚ in longitude



Summary

- **GOLD began science operations began in mid October 2018**
- **Instrument flight performance is nominal and consistent with ground test and calibration measurements**
- **Routine observations include:**
  - **Dayside disk scans (03:00 – 20:00 LT)**
  - **Nightside disk scans (17:00 – 21:00 LT)**
  - **Limb scans (03:00 – 20:00 LT)**
  - **Stellar Occultations (03:00 – 20:00 LT)**
- **More details here and in other sessions**

- SA11A-06: Global-scale Observations of the Limb and Disk (GOLD): Early Orbit Observations
- SA11A-07: Observations and Modeling of Atomic/Molecular Composition in the Thermosphere
- SA 13B-2769: Heat Flow from the Upper to the Lower Thermosphere
- SA21A-3169: Global-scale Observations of the Limb and Disk (GOLD): Overview of ON2 and QEUV Science Data Products
- SA21A-3170: Initial Measurements of Thermospheric O_2 Density Profiles from GOLD
- SA21A-3171: Global-scale Observations of the Limb and Disk (GOLD): Overview of Daytime Exospheric Temperature Science Data Product
- SA21A-3172: Global-scale Observations of the Limb and Disk (GOLD): Overview of Daytime Neutral Temperature Science Data Product
- SA21A-3175: Inference of thermospheric temperature profiles from GOLD disk images and applications for tracking Traveling Atmospheric Disturbances
- ED31A-01: Revolutionizing our understanding of the space environment: A data visualization tool for the NASA GOLD Mission



Thank You