

Early results and ionospheric observations from LITES on the ISS

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Acknowledgements

LITES is integrated and flown on the International Space Station as part of the Space Test Program – Houston 5 payload under the direction of the DoD Space Test Program (STP).

Funding for the refurbishment of the LITES sensor was provided to the University of Massachusetts Lowell by the Office of Naval Research and the National Science Foundation.

Research at the U.S. Naval Research Laboratory was supported by the Chief of Naval Research as part of the NRL Basic Research Program. Integration and testing support for LITES was provided by STP.



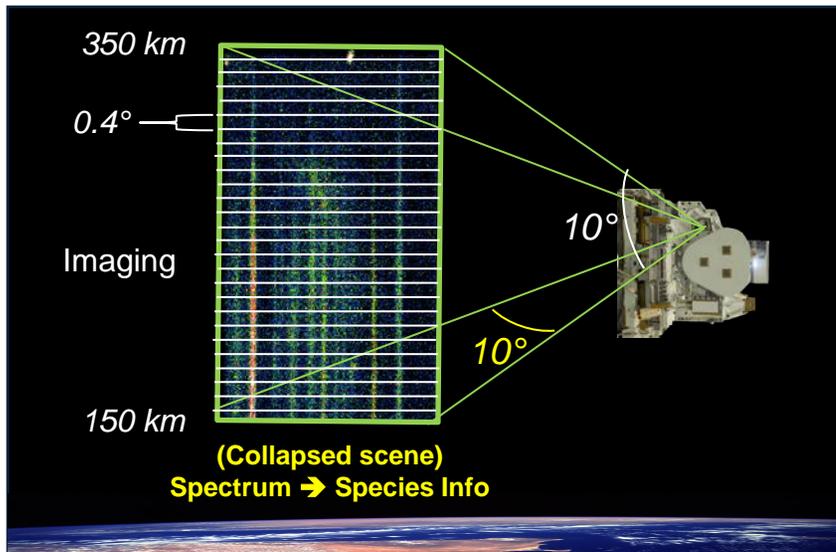
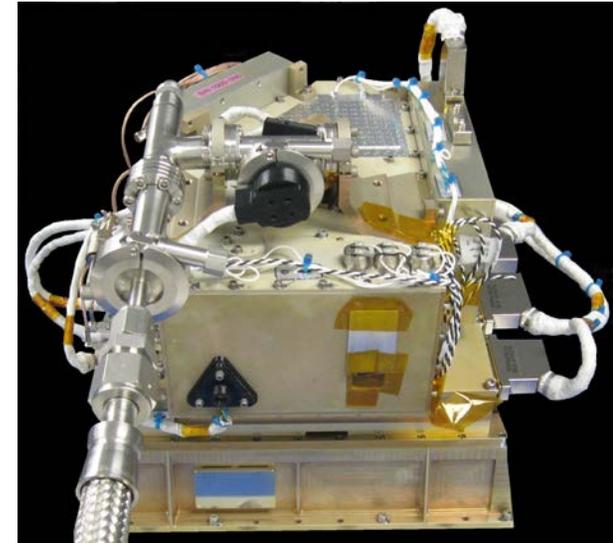
Description

LITES is an imaging spectrograph that measures:

- UV airglow from 60-140 nm (~1.0 nm resolution)
- $10^\circ \times 10^\circ$ field of view, (0.4° degree resolution)
- 2D image: spectrum vs vertical (altitude) profile images with no moving parts

LITES is flying with GROUP-C (coming up next!) on the ISS as part of the STP-H5 payload:

- 3-second cadence
- Telemetry: 300 kbits/s



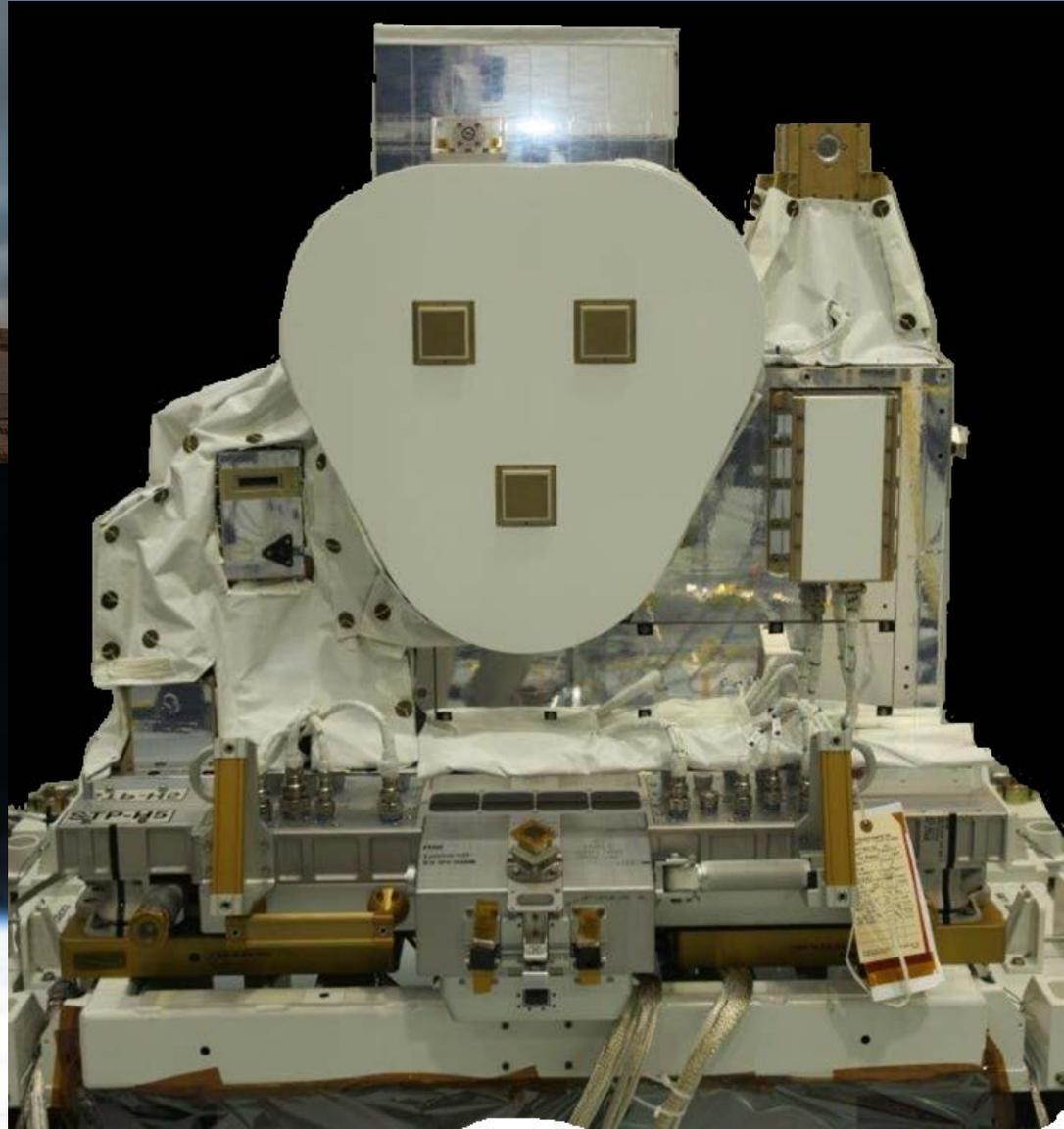
LITES persistently images altitude profiles of the ionosphere and thermosphere with high-sensitivity, without moving parts.

Objectives

- Demonstrate a compact, high-sensitivity, sensor for the next generation of operational near-Earth space weather remote sensing in the ultraviolet (UV).
- Measure density and composition of the global ionosphere and thermosphere and the evolution of structures within
- (Opportunity with GROUP-C to conduct novel tomographic reconstructions of the nighttime ionosphere, and validate ionospheric products from each sensor using co-located measurements)

STP-H5 (with LITES and GROUP-C)

Launch:	19 February 2017
Payload Installed:	27 February 2017
LITES First Light:	6 March 2017

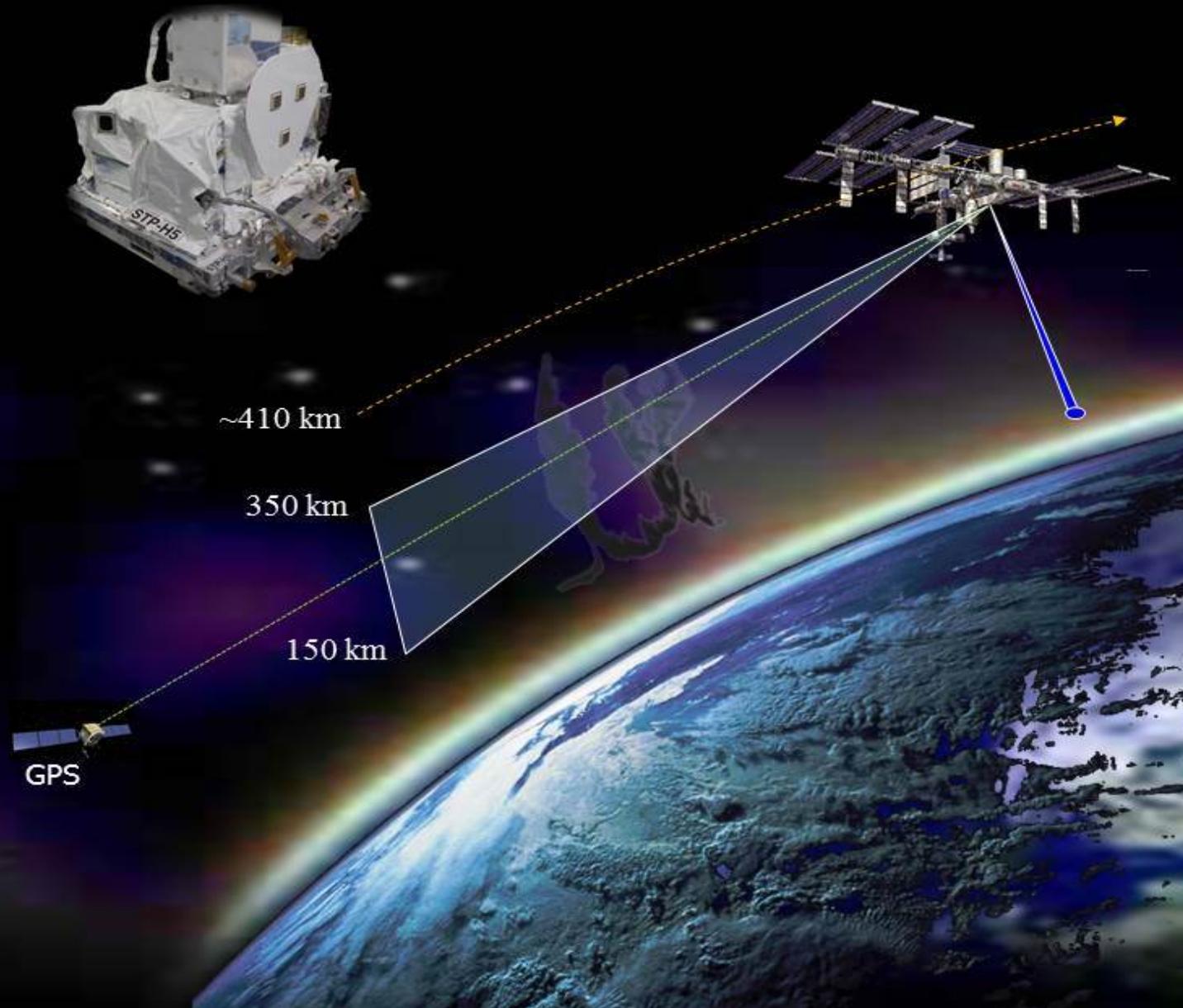


LITES and GROUP-C

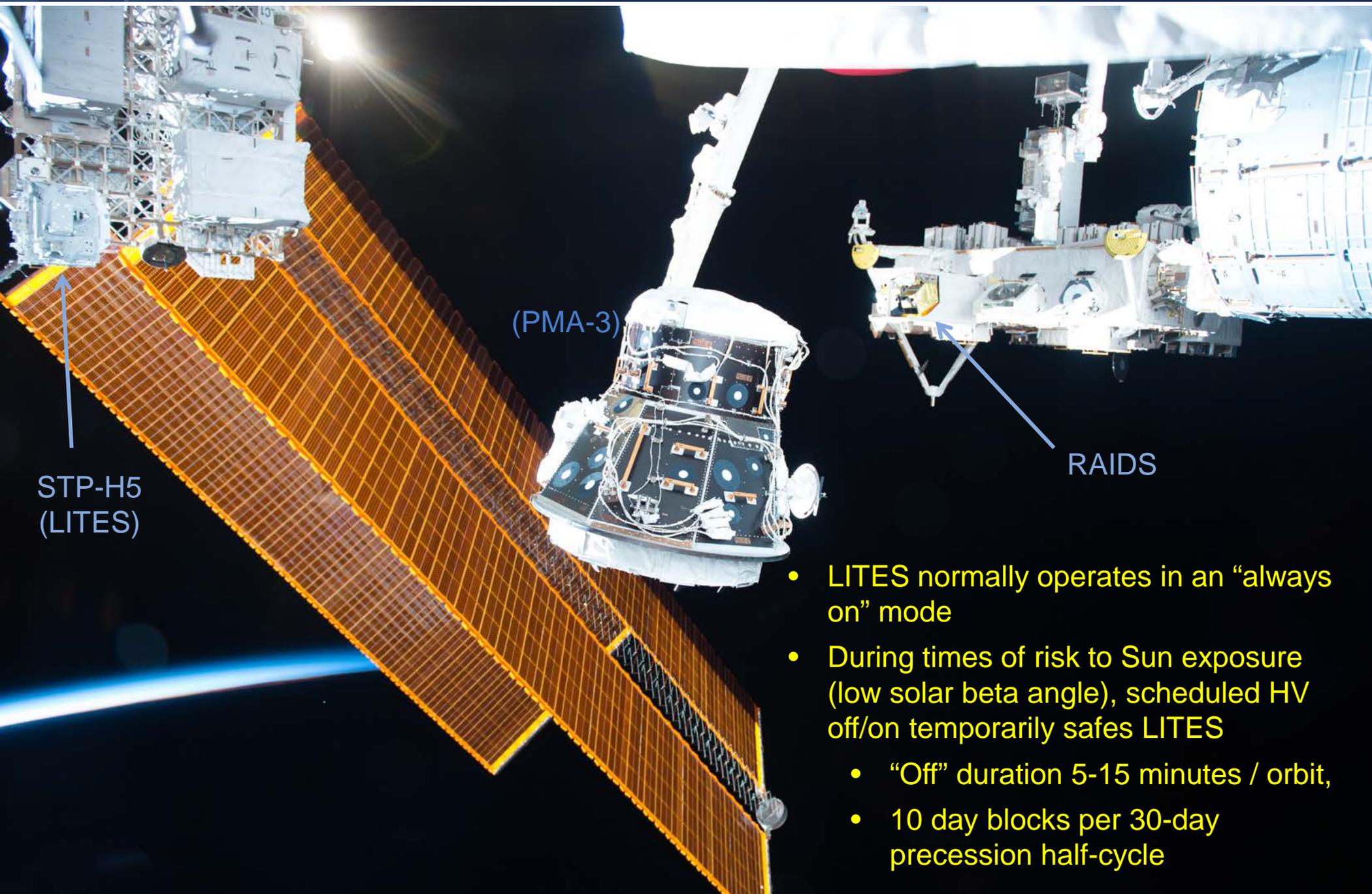
LITES and GROUP-C are positioned to provide ionospheric measurements below 400 km for at least the next two years.

Measurements in ISS orbital plane

- UV limb profile imagery (LITES)
- UV nadir photometry (GROUP-C/TIP)
- GPS Radio Occultation (GROUP-C/FOTON)



LITES Operations



STP-H5
(LITES)

(PMA-3)

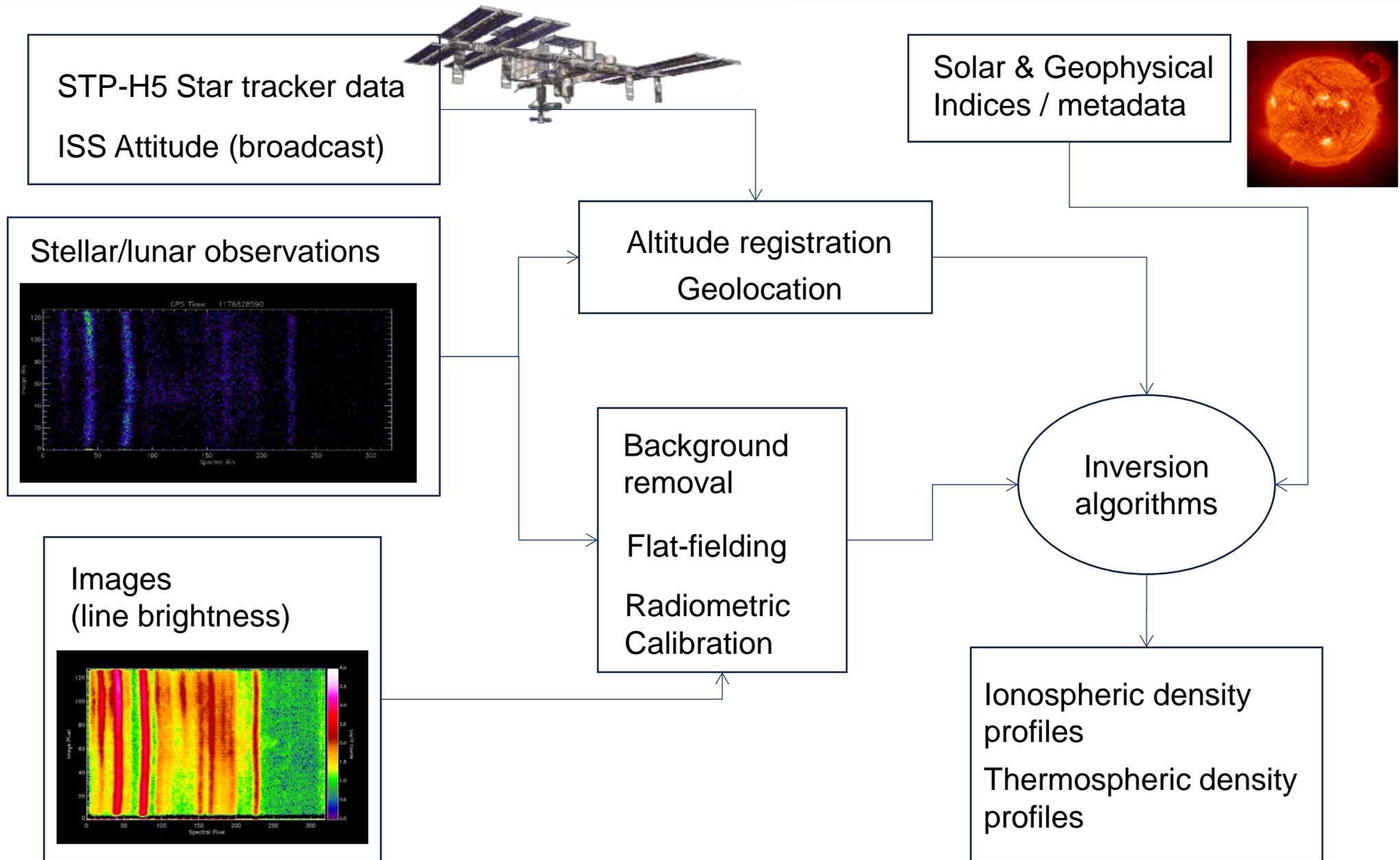
RAIDS

- LITES normally operates in an “always on” mode
- During times of risk to Sun exposure (low solar beta angle), scheduled HV off/on temporarily safes LITES
 - “Off” duration 5-15 minutes / orbit,
 - 10 day blocks per 30-day precession half-cycle

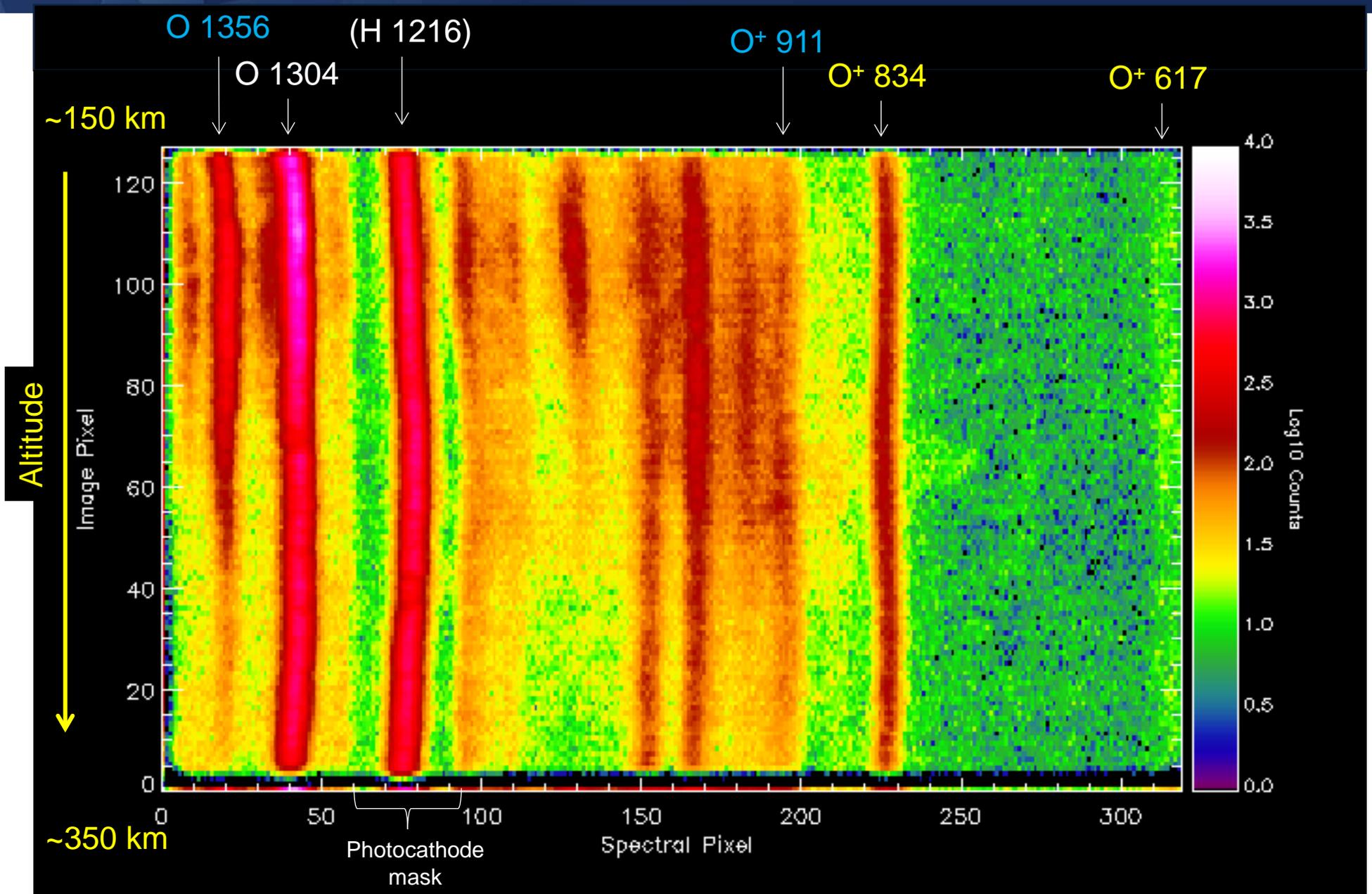
- All experiment data are streamed to NRL POCC in real-time via the TDRSS system, with coverage ~70% of the time
 - Immediate confirmation of commands enables proactive operations
 - Health and Status, and Science data inclusive
 - Potential for near-real-time data processing and evaluation
- Data collected during “loss of signal” (LOS) condition can be retrieved by the experiment teams from Marshall Space Flight Center shortly after return to “acquisition of signal” (AOS)
- NRL currently pulls full data sets for the previous day from Marshall Space Flight Center on a daily basis



LITES Data Processing

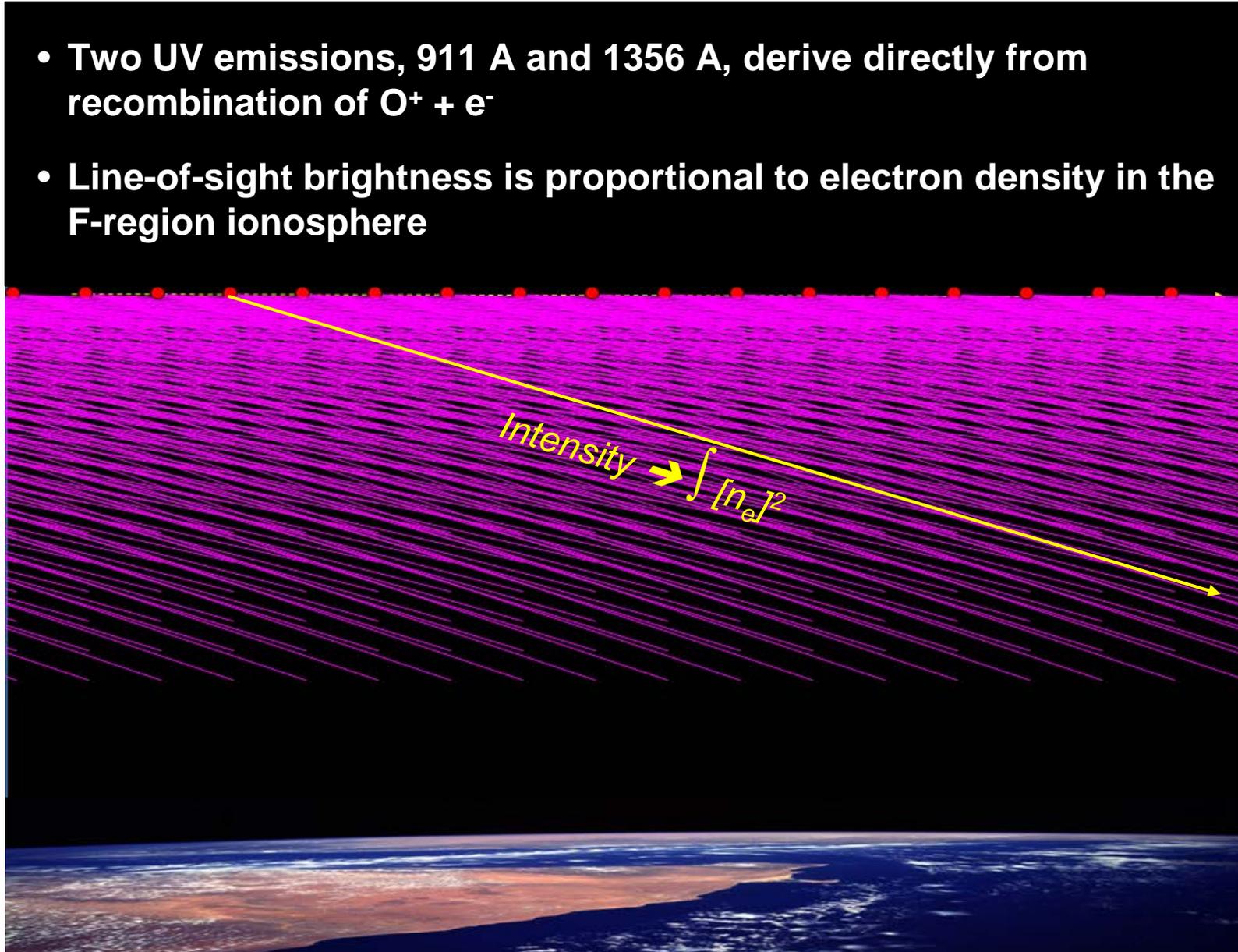


Ionospheric Emission Lines

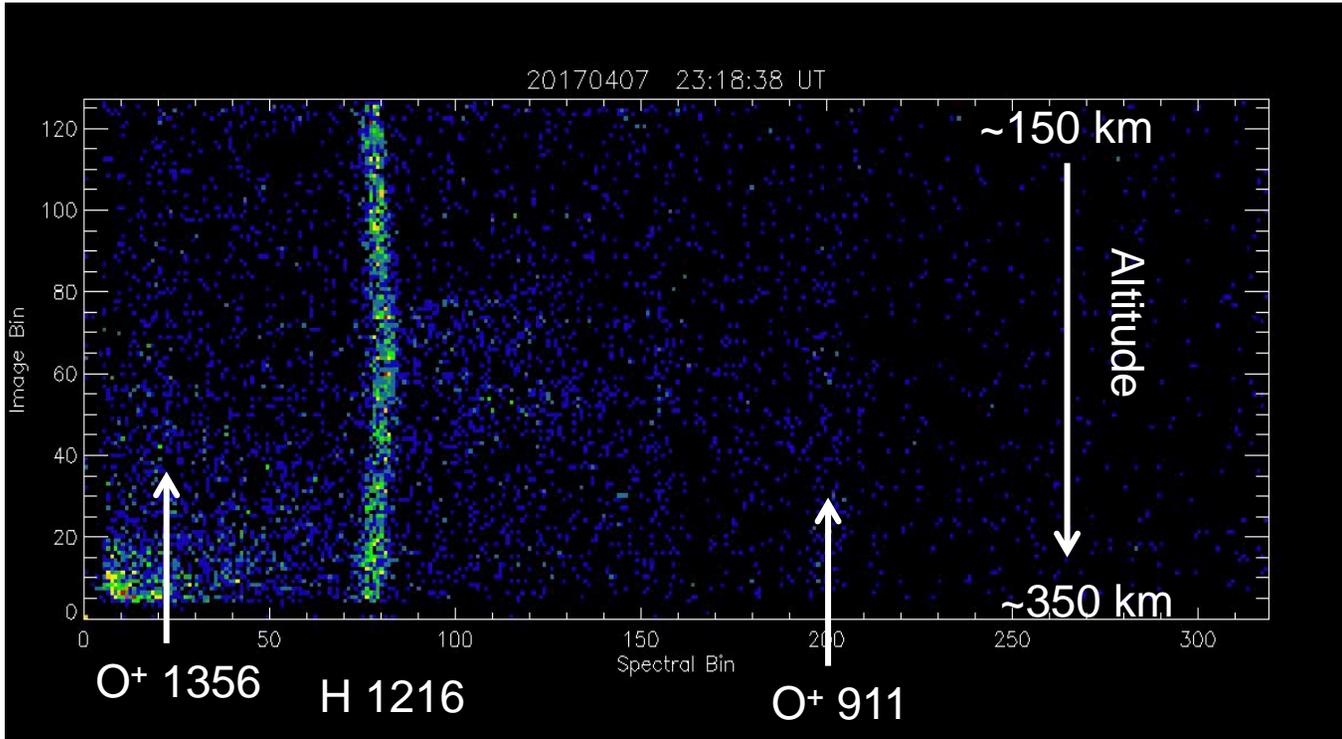


LITES measurement of the nighttime ionosphere

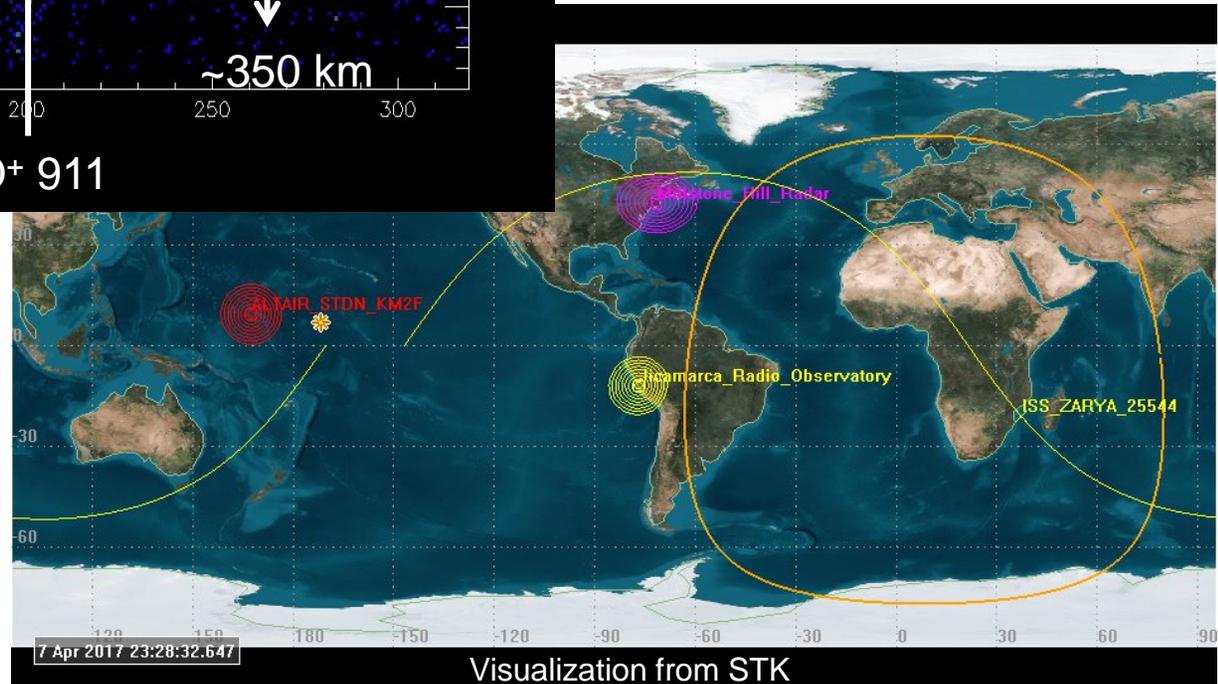
- Two UV emissions, 911 A and 1356 A, derive directly from recombination of $O^+ + e^-$
- Line-of-sight brightness is proportional to electron density in the F-region ionosphere



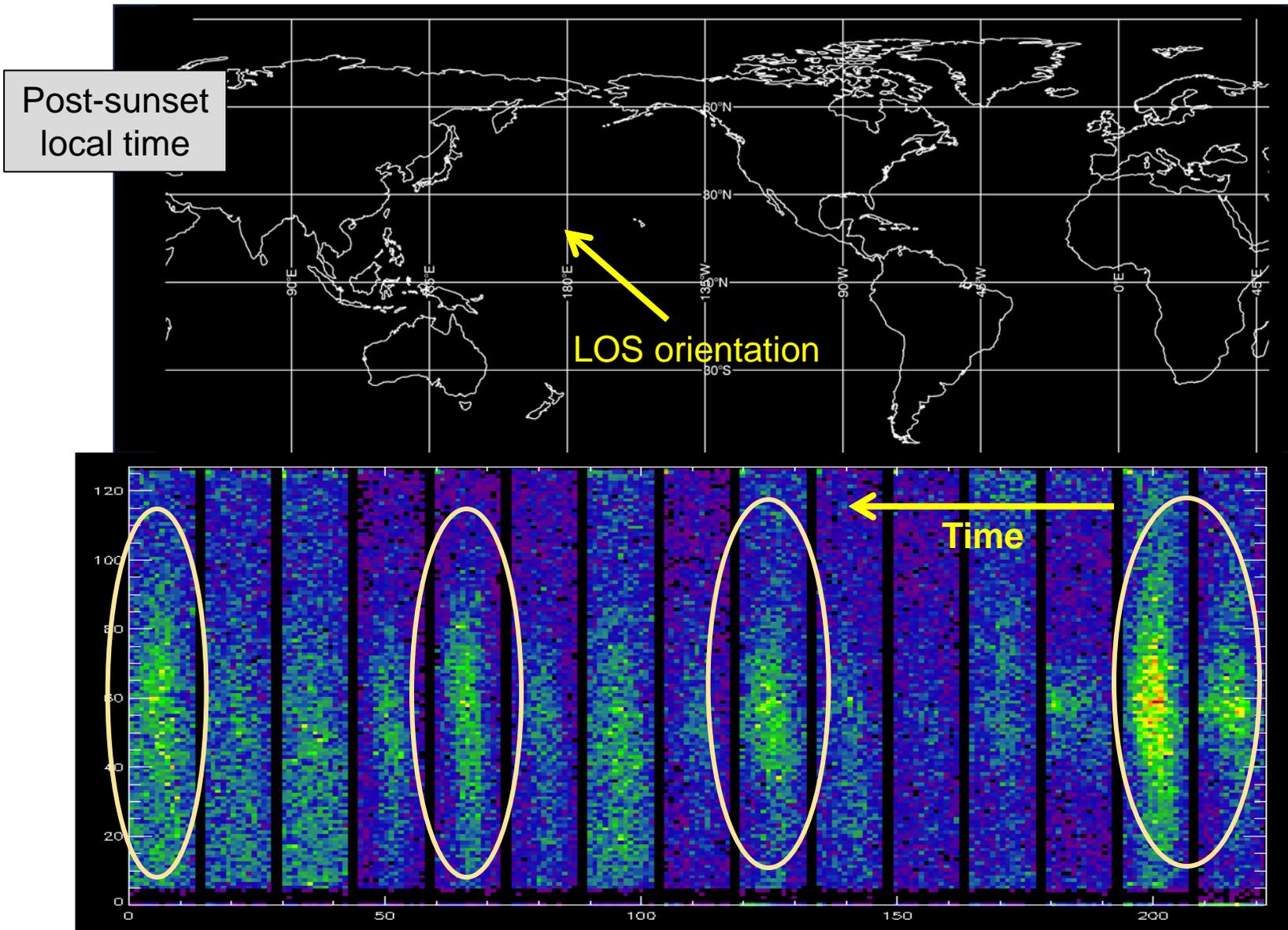
Midnight Ionosphere over Africa



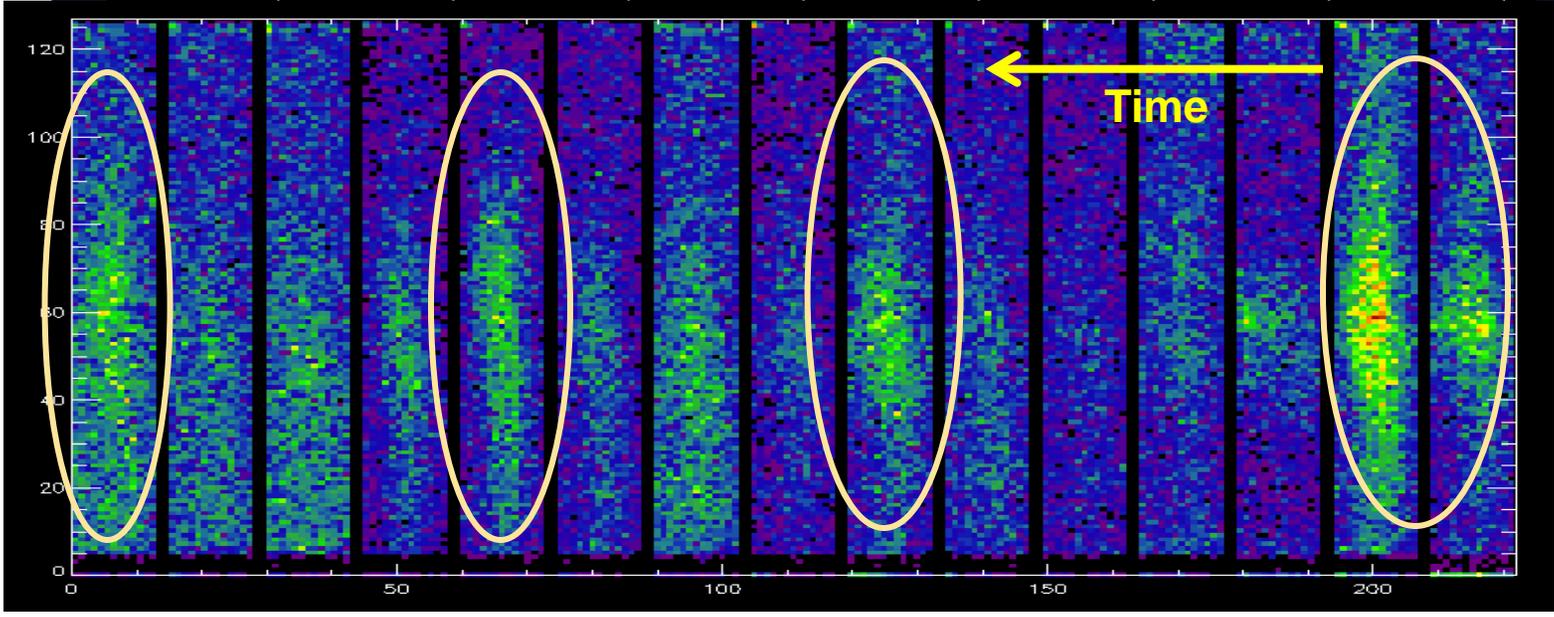
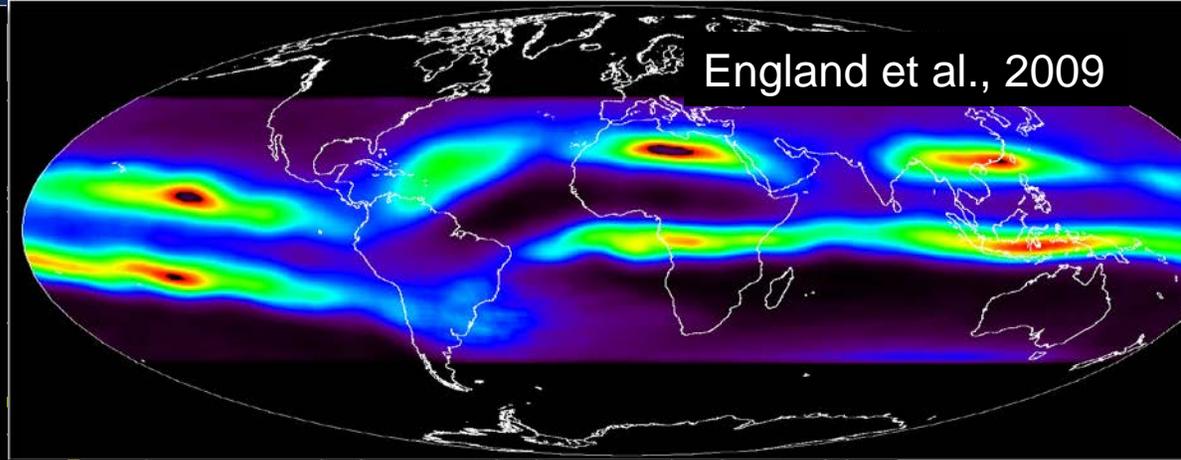
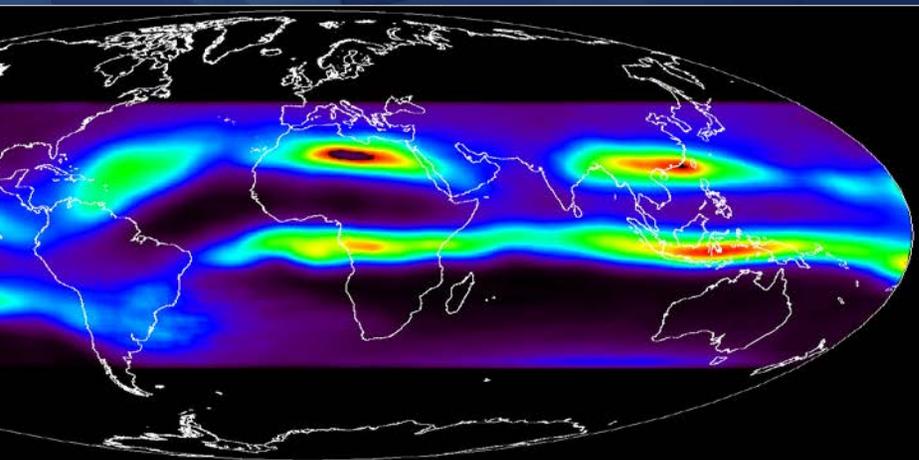
7 April 2017
2318-2330 UT



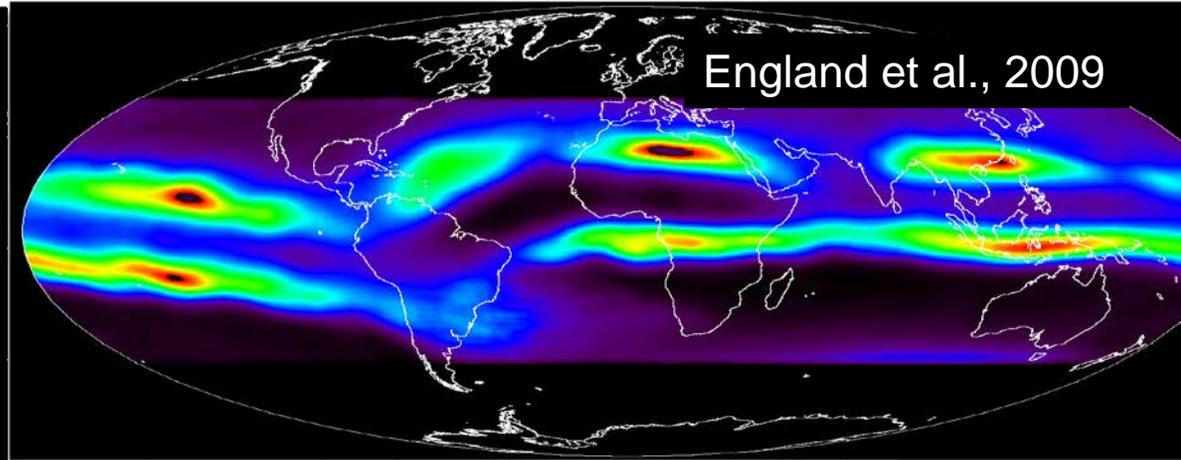
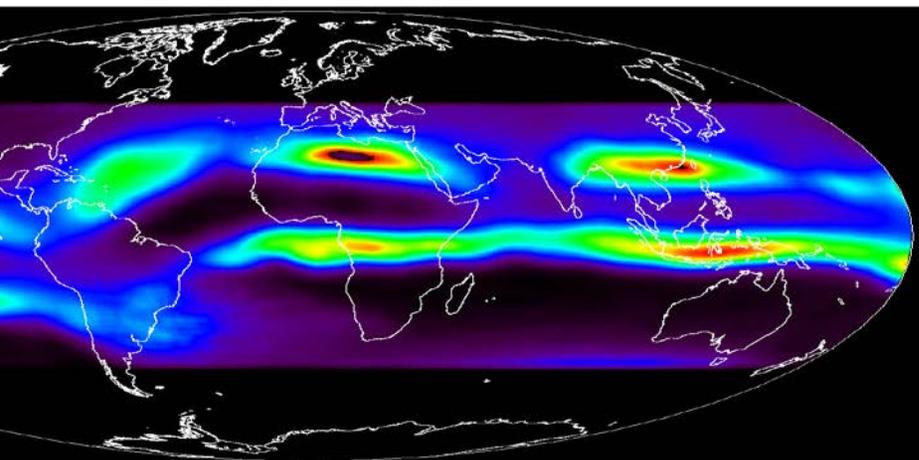
Ionospheric pattern: 1 April 2017



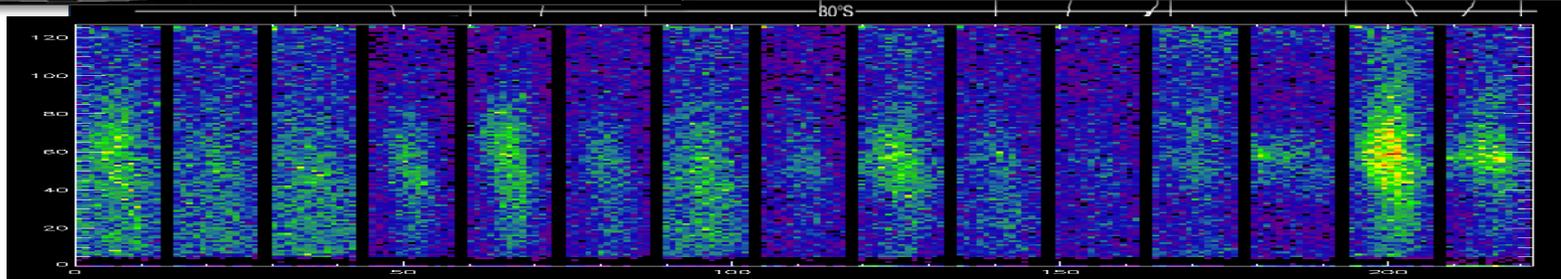
Ionospheric pattern: 1 April 2017



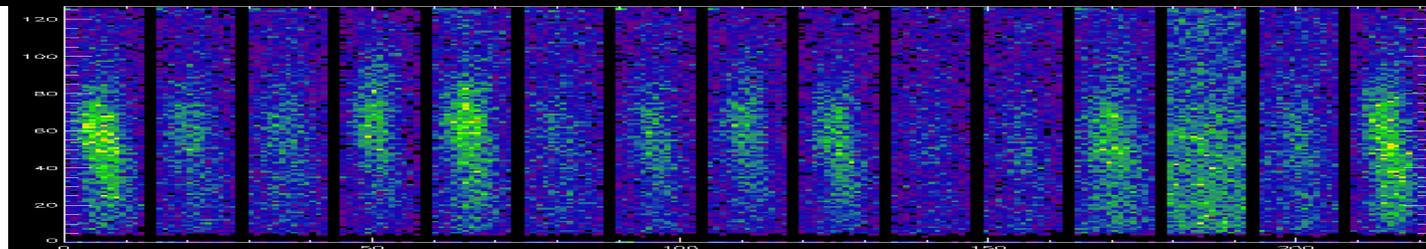
Ionospheric patterns: 1-3 April 2017



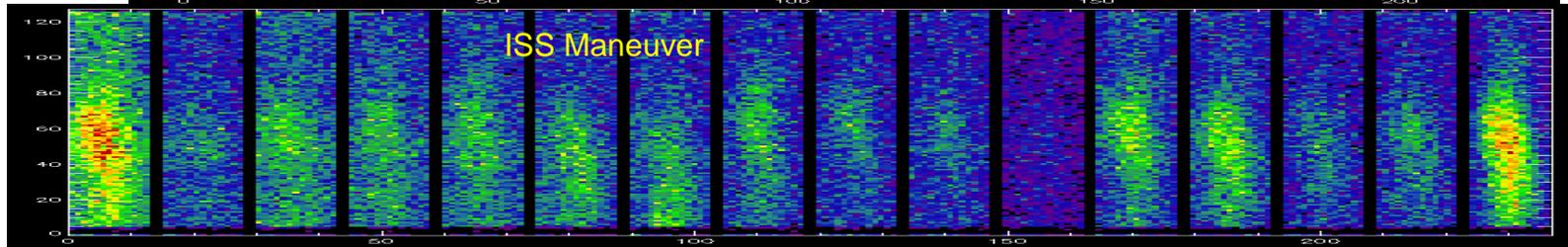
1 April



2 April

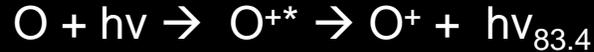


3 April

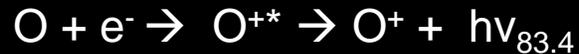
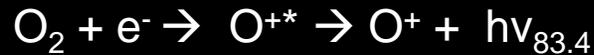


Measurement approach

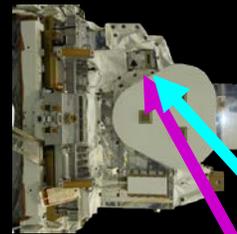
OII 83.4 nm emission is produced in the lower thermosphere primarily through solar photoionization of atomic O:



Secondary sources:



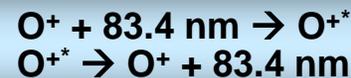
Solar 83.4 nm



83.4 nm

61.7 nm

Ionosphere
(200 - 500 km)



Lower thermosphere
(150-200 km)



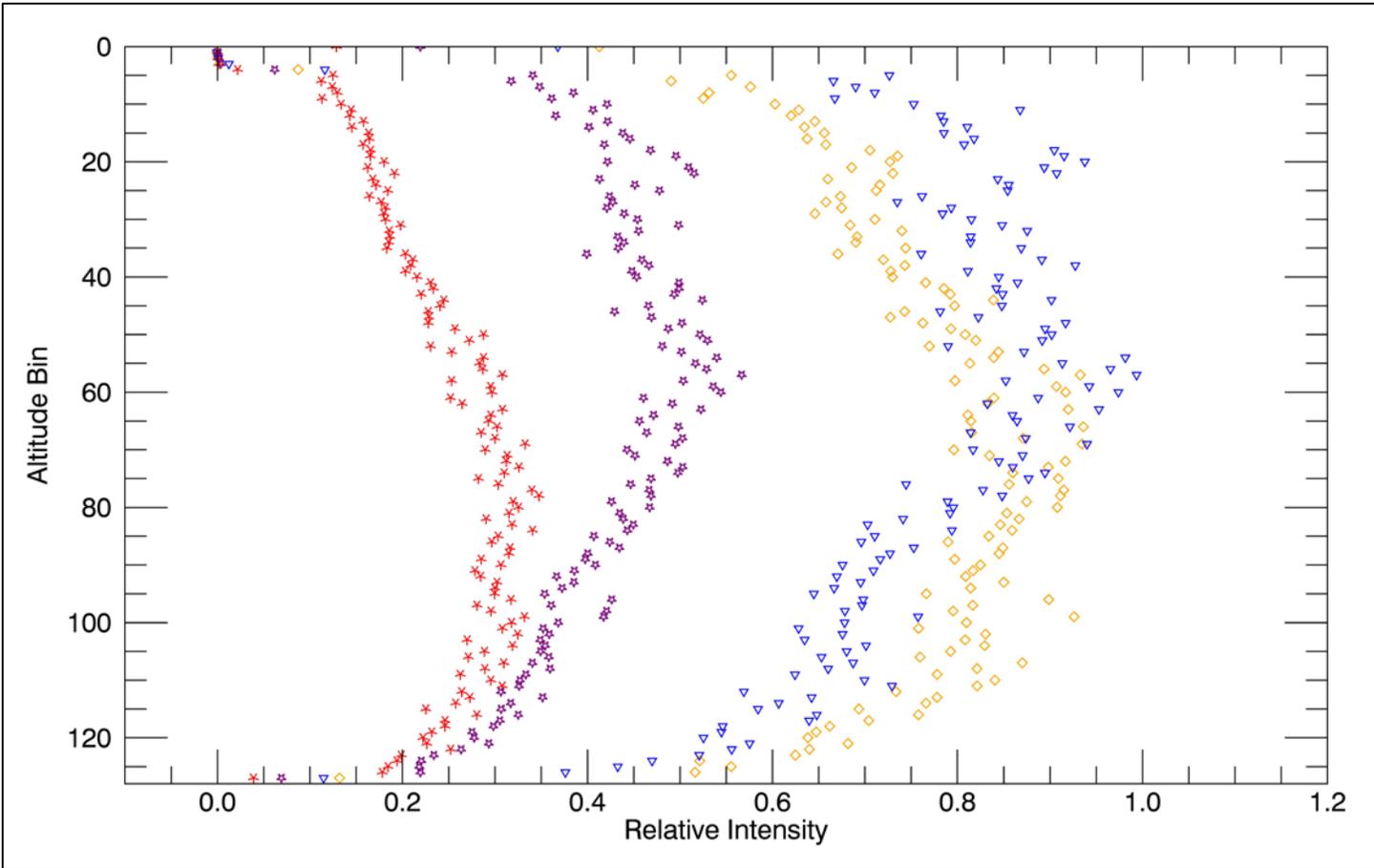
Resonant scattering of 83.4 nm photons by ionospheric O^+ results in a measured altitude profile driven by a combination of:

1. O^+ ion density
2. Initial source of photons in the lower thermosphere (also observed by O^+ 61.7 nm)

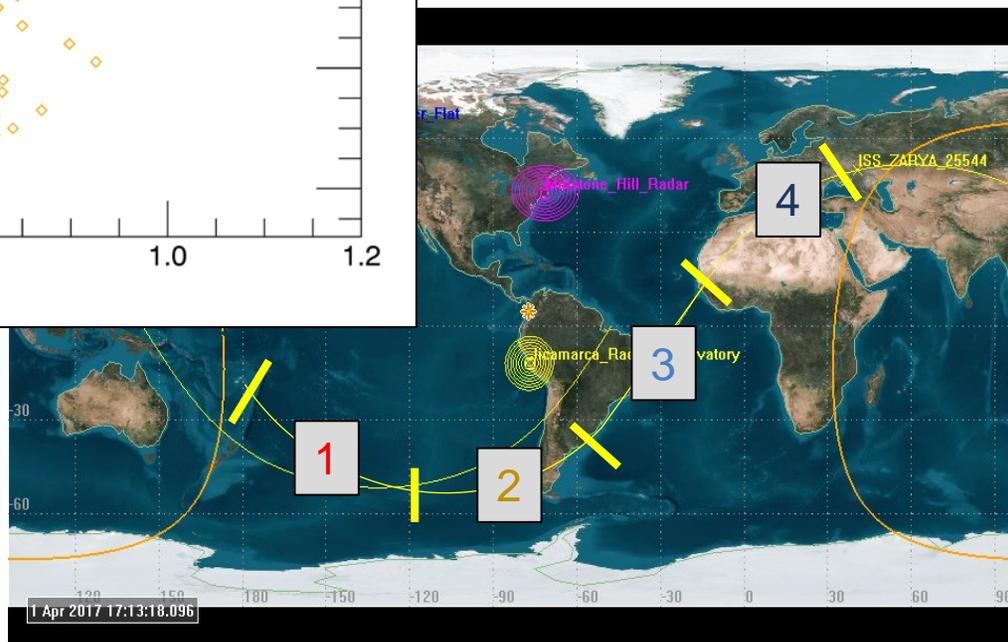
We derive the ionospheric profile by inversion of 83.4 nm limb profiles



Daytime Ionosphere reflected in Oil 83.4 nm



1 April 2017
1616-1714 UT



- LITES sees evidence for the longitudinal wave-4 pattern in the nighttime low-latitude ionosphere with variability in time. Changes can be compared to other TEC measurements to separate uplift from density changes.
- LITES data can be used to characterize the *comprehensive daytime ionosphere and thermosphere system* to improve ionospheric specification and forecasting.
- LITES pairs with GROUP-C as an ionospheric observatory with an uniquely persistent view of the low-altitude ionosphere, below 400 km, and provides complementary data to conduct tomographic inversions of the ionosphere in the ISS orbital plane
- LITES/STP-H5 mission will operate for at least 2 years (through Feb 2019), with low data latency that open the door for possible inclusion in assimilative ionospheric models.

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