Remote Sensing of the Tropical Arcs with LITES Observations from the ISS

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The limb-imaging Ionospheric and Thermospheric Extreme-ultraviolet Spectrograph (LITES) has been collecting EUV and FUV altitude emission profiles since early 2017 from the International Space Station (ISS). LITES observes the limb in the altitude range ~150 to 350 km from 60 to 140 nm both daytime and nighttime. Nighttime measurements of 91.1 and 135.6 nm can emit trace the O² and electron density. The 400-km altitude orbit of the ISS provides an ideal vantage point for remotely sensing the ionosphere and features such as the tropical arcs. LITES observations are complementary to the other ionospheric missions, such as GOLD and ICON.

LITES on the ISS

- The LITES instrument is an imaging spectrograph aboard the ISS
- Observes one-dimensional, vertical (altitude) profiles of FUV/EUV airglow from Earth’s limb with 10nm FWHM
- 60-140 nm wavelength coverage
- Observes both daytime and nighttime
- 3 second imaging cadence, corresponding to better than 25 km in-track resolution

STP-HS, with LITES, during installation on the ISS (February 2017).

Nighttime Ionosphere

Both OI 91Å and 135Å emission features can be used to trace the F-region ionospheric density under nighttime conditions. LITES remotely senses both of these features from the ISS at ~400 km altitude. These emission lines arise from radiative recombination of O² ions and electrons.

\[ O^+ + e^- \rightarrow O^2 (5S) + h\nu_{1356} \]
\[ O^+ + e^- \rightarrow O^2 (3P) + h\nu_{911} \]
- O² is the dominant ion in the nighttime F-region
- The plasma is quasi-neutral (i.e., ions ≈ electrons)
- The OI 91Å and 135Å emission is optically thin

LITES 91Å and 135Å at Night

(Above) Nighttime brightness of 91Å (left) and 135Å (right) measured by LITES integrated over two orbits from 4 April 2017, and summed over all altitudes. Nighttime data were chosen to have solar zenith angle (SZA) < 90°.

Summary

LITES observes nighttime OI emission brightness from the ISS, which can be used as a proxy for the electron density in the ionosphere. Enhancements in brightness at low magnetic latitudes show the tropical arcs, with varying intensity over different days.

Global Observations and Tropical Arcs

The tropical (equatorial) arcs are a well-known feature of the low latitude ionosphere. The eastward electric field at the equator along with Earth’s magnetic field produces an E×B drift causing plasma to flow upwards. The plasma then travels along the magnetic field lines and sinks back down due to gravity (the so-called “fountain effect”). The enhanced density at low latitudes produces an increase in airglow observed as the “tropical arcs.”

LITES observes the upper atmosphere across all longitudes, all local times, and latitudes ±5°. The tropical arcs, and other features, are apparent in the airglow emission. Here we show data from nighttime ISS tracks during the first week of April 2017. For a look at daytime observations, see Stephan et al. Poster SA21A-3154 in this session.

AGU Fall Meeting, December 2018, Washington, DC

This work was supported by NSF 1145166, ONR N00014-13-1-0266 grants, and the University of Massachusetts Lowell. GG is supported in part by the Massachusetts Space Grant Consortium. AWS and SAB are supported in part by Base Program funding provided by the Chief of Naval Research. LITES is part of the STP-HS Payload, integrated and flown under the direction of the DoD Space Test Program (STP).