Spectral structures of high-energy electrons as observed by the Science and Technology Satellite-I (STSAT-1) of Korea

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Abstract

The Science and Technology Satellite-I (STSAT-1) was launched in September 2003 as the first Korean satellite dedicated to astronomy and space science. The satellite was placed at a Sun-synchronous orbit whose altitude was about 680 km and local time was at 10:45 and 22:45 hours. The Far-Ultraviolet Imaging Spectrograph (FIMS: also known as the Spectroscopy of Plasma Evolution from Astrophysical Radiation, SPEAR) is the main payload of the satellite. In addition, secondary payloads such as Electro-Static Analyzer (ESA), Solid State Telescope (SST), and Scientific Magnetometer (SM) regularly conducted in-situ observations in northern high-latitude regions. In this study we analyze notable spatial/spectral sub-structures present in electron energy spectrograms as observed by the onboard ESA (0.1 keV ~ 20 keV) and SST (170 keV ~ 360 keV).

Science and Technology Satellite-I (STSAT-1) of Korea

- Manufacturer: Satellite Research Center (SaTReC) of Korea Advanced Institute of Science and Technology (KAIST)
- A micro-satellite launched on 27 September 2003
- Orbit: Low-Earth Orbit (altitude~680 km)
- Local time: 22:45 (Sun-synchronous)
- Instruments: Electro-Static Analyzer, Solid-State Telescope, Langmuir Probe, and flux-gate magnetometers

References

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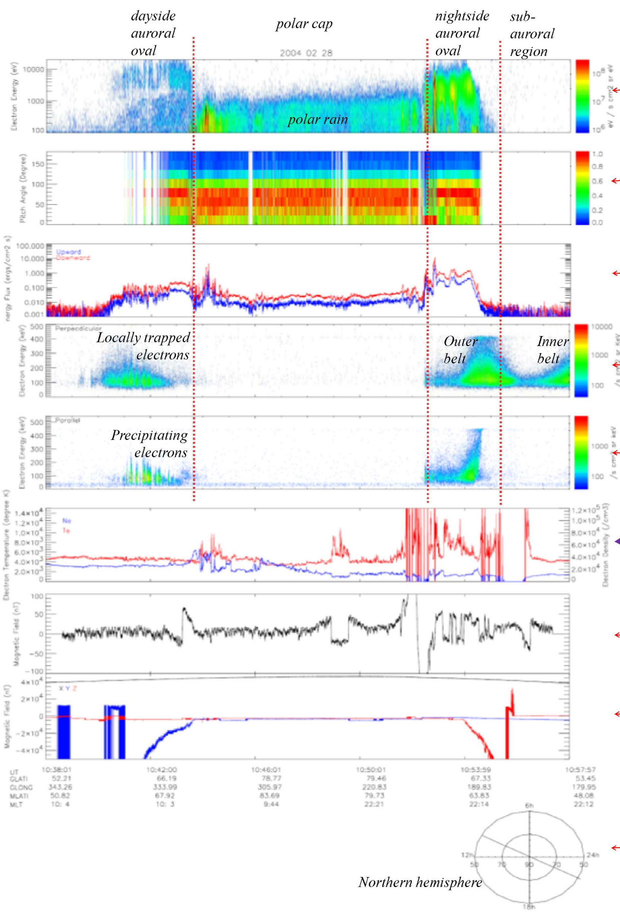


Energy spectrogram of auroral electrons (ESA)

pitch angle distribution of auroral electrons (ESA)

Integrated energy flux of auroral electrons (ESA)

Energy spectrogram of sub-MeV perpendicular electrons (SST)

Energy spectrogram of sub-MeV parallel/ electrons (SST)

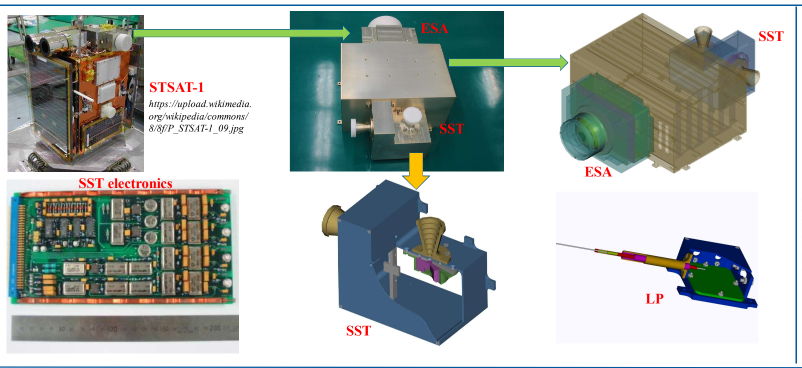
Density and temperature of cold background electrons (LP)

Residuals of magnetic field strength (SM)

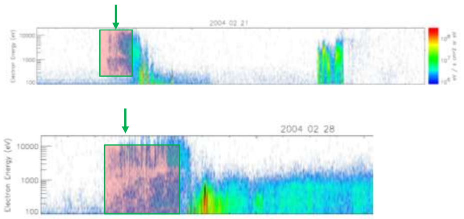
A complete set of magnetic field vector (SM)

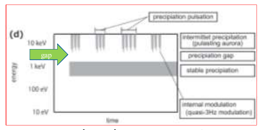
Orbit track of STSAT-1 in MLAT-MLT plane

Results



1. Energy gaps in diffuse auroral (0.1 keV~20 keV) electron spectrograms (~1040 LT)

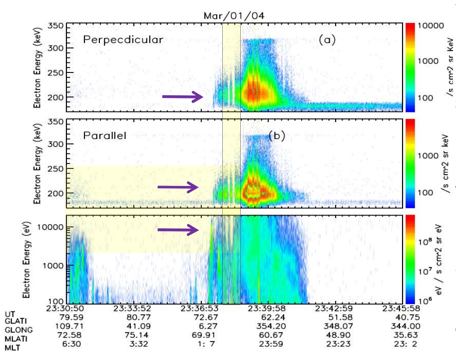




Miyoshi et al. [2015, Figure 4d].

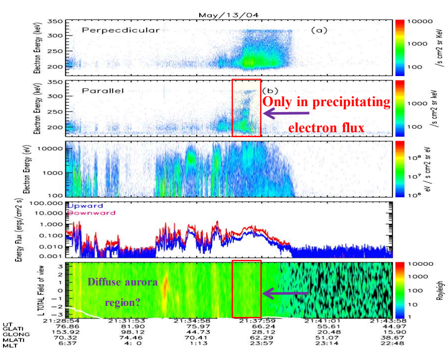
The gaps in the spectrograms remind us of chorus-induced energy gaps suggested by Miyoshi et al. [2015]. However, why doesn't the gap energy always decrease with decreasing latitude (i.e. decreasing L-shell)? Lower L-shell corresponds to higher f_{ce}, and possibly lower electron energy.

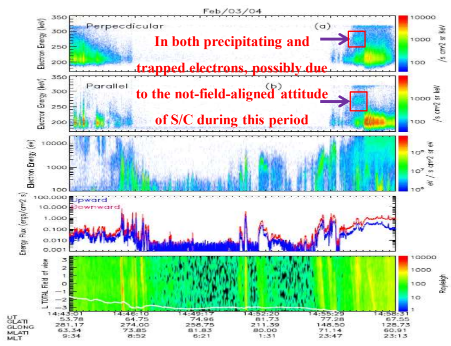
2. Localized depletion of 10 keV~250 keV electron flux (~2240 LT, auroral oval)



1. Around 23:38 UT on 01 March 2004
2. Two **black-aurora-like** regions (sharp wedge-shaped regions void of electron flux) were observed by the ESA and the SST, which were outside the plasmapause.
3. Note that the attitude was not field-aligned during this pass, which may have resulted in the quasi-isotropy (parallel flux ~ perpendicular flux).
4. Anyway, the scale sizes of the events seem to be much smaller than those of the attitude variation represented by the B-field.
5. The scale size~10 sec~80 km (comparable to the ~50 km reported by Sakaguchi et al. [2011])
6. There has been no report on the behavior of high-energy (>30 keV) electrons around black aurora.

3. Harmonics in sub-MeV electron spectrograms (~2240 LT, auroral oval)





Such a structure cannot be identified by traditional 'integral-flux' telescopes, but by 'differential-flux' ones such as the STSAT-1/SST.