Supporting Information for "Red Line Diffuse-Like Aurora Driven by Time Domain Structures Associated with Braking Magnetotail Flow Bursts"

Yangyang Shen[1], Jun Liang[2], Anton Artemyev[1,3], Vassilis Angelopoulos[1],

Qianli Ma[4,5], Larry Lyons[4], Jiang Liu[1], Yukitoshi Nishimura[5], Xiao-Jia

Zhang[6], Ivan Vasko[6], Donald L Hampton[7]

[1]Department of Earth, Planetary, and Space Sciences, University of California, Los Angeles, CA, USA

[2]Department of Physics and Astronomy, University of Calgary, Calgary, AB, Canada

[3]Space Research Institute of Russian Academy of Sciences, Russia, Moscow

[4]Department of Atmospheric and Oceanic Sciences, University of California, Los Angeles, CA, USA

[5]Center for Space Physics, Boston University, Boston, MA, USA

[6]William B. Hanson Center for Space Sciences, University of Texas at Dallas, Richardson, TX, USA

[7]Geophysical Institute, University of Alaska Fairbanks at Fairbanks, Fairbanks, AK, USA

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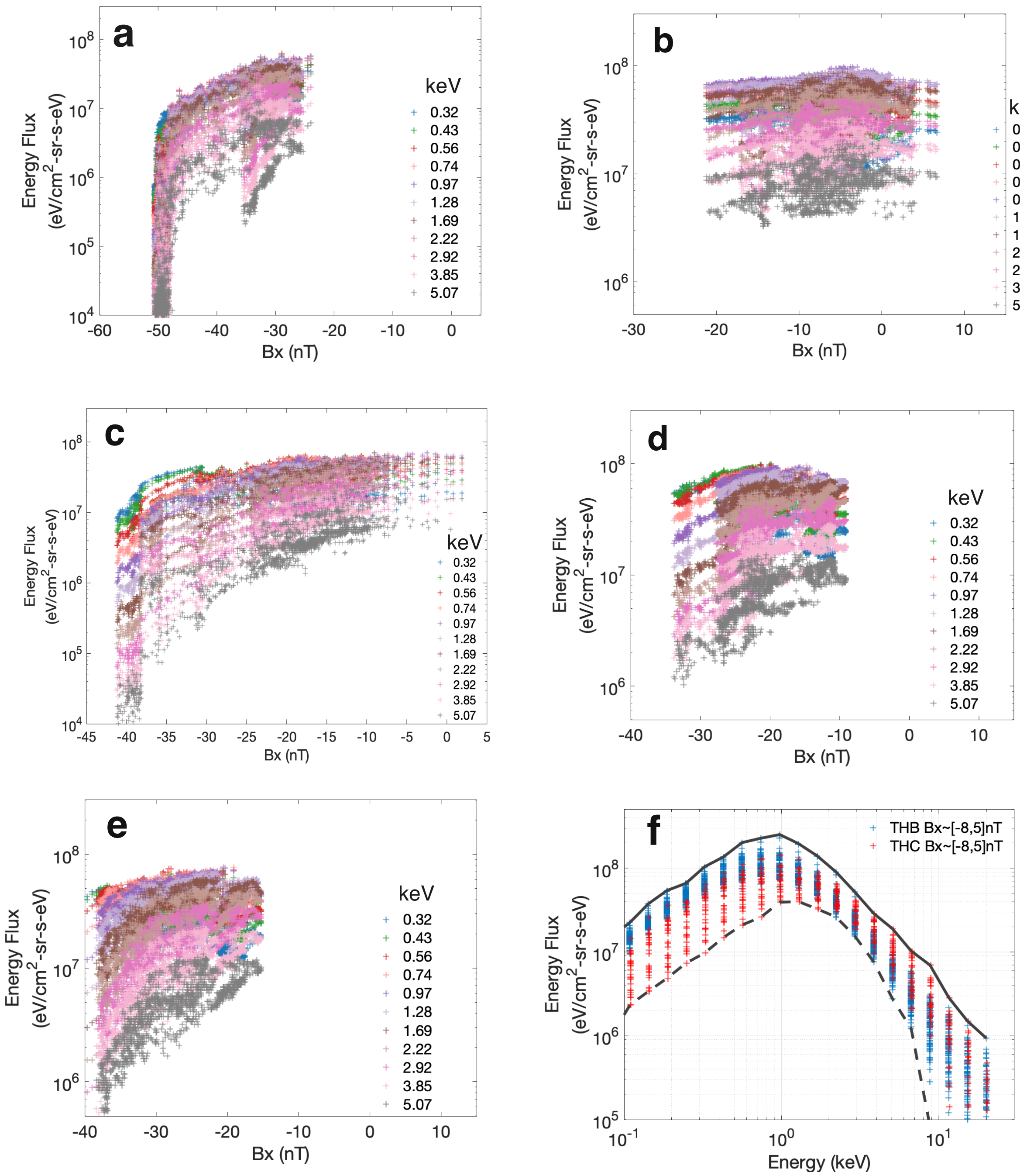
Introduction

This Supporting Information includes Figure (S1) illustrating the variability of parallel electron energy fluxes (0°–22.5° in pitch angle) near the loss cone. These fluxes are closely related to the magnetic field B_x parameter, reflecting the spacecraft's proximity to the true magnetic equator. The observed flux variability primarily results from changing magnetic field configurations during bursty bulk flows (see Figure 1 in the main text). For accurate calculations of precipitating electron distributions corresponding to ground-based red-line diffuse auroral observations, it is necessary to use realistic equatorial fluxes measured when $|B_x|$ is near its minimum at the equator.

Figure 1a in the main text shows that THEMIS-B and THEMIS-C were near the equator, while the other three spacecraft were farther away. Here Figure S1 demonstrates that electron energy fluxes measured by all spacecraft increase as B_x decreases. However, unlike the fluxes from THEMIS-B and THEMIS-C (panels b and c), which plateau, those from THEMIS-A (panel a), THEMIS-D (panel d), and THEMIS-E (panel e) do not. Based on this dependence on B_x, we select equatorial flux data solely from THEMIS-B and THEMIS-C during intervals when B_x is near its minimum, i.e., within -8 to 5 nT. The fast survey (peer) electron energy flux data were collected during the time intervals of 10:20–11:40 UT, whereas the burst mode (peeb) electron fluxes were measured during 10:53–11:22 UT. Because burst mode data provide better angular coverage thus more reliable parallel flux measurements, we use burst mode data to obtain realistic electron fluxes. In calculating precipitating electron distributions, we keep THEMIS-measured local energy distribution unchanged but proportionally adjust the maximum flux level to the maximum and minimum equatorial fluxes according to panel f of Figure S1. The flux-adjusted energy distributions are used to drive the TREx-ATM model runs.

We have included one figure (Figure S2) that displays four characteristic ASI auroral images from Fort Yukon, showcasing discrete and diffuse auroras observed at 10:49:30, 10:59:18, 11:09:48, and 11:13:45 UT. These images are projected to an altitude of 110 km and presented in AACGM latitude and longitude coordinates, with the scanning path of the Poker Flat meridian spectrograph marked by a blue line. Note that the three time intervals of discrete auroras identified in the main text based on ASI imagery are 10:59:09–10:59:45 UT, 11:02:10–11:05:33 UT, and 11:08:30–11:11:54 UT.



a
b
c
d
e
f
Energy Flux (eV/cm^2-sr-s-eV)
Bx (nT)
keV
0.32
0.43
0.56
0.74
0.97
1.28
1.69
2.22
2.92
3.85
5.07
THB Bx~[-8,5]nT
THC Bx~[-8,5]nT
Energy (keV)

Figure S1. (a)THEMIS-A peer (reduced mode) parallel (0°–22.5° in pitch angle) electron energy fluxes versus B_x. (b-e) Same as (a) but for THEMIS-B, C, D and E, respectively. (f) THEMIS-B and THEMIS-C peeb parallel electron energy fluxes versus energy. Electron fluxes are included only when B_x is in the range of [-8, 5] nT, indicating near-equatorial measurements. The maximum and minimum flux levels are marked by the gray solid and dahsed lines.

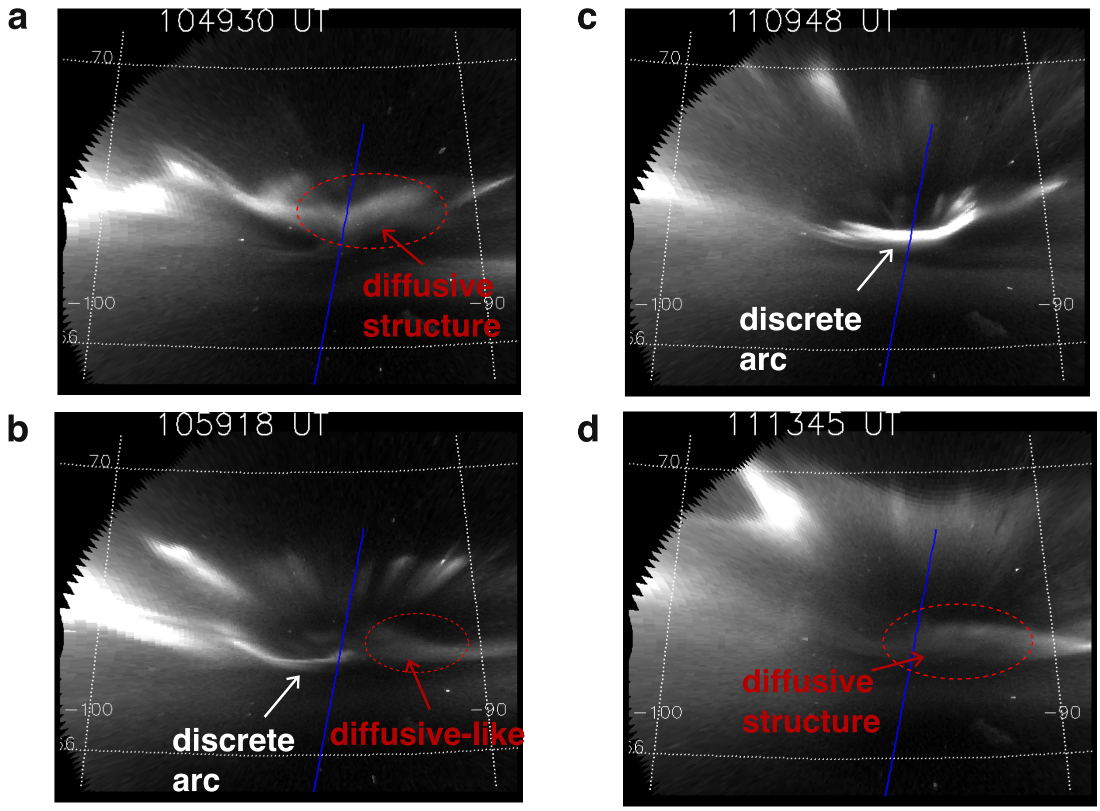


Figure S2. Examples of white-light ASI images captured at Fort Yukon near the PFMSP meridian, following the format of Figure 4j in the main text: (a) Diffuse structures overlaying discrete auroras, observed at 10:49:30 UT. (b) Discrete aurora beside fading diffuse-like auroras, observed at 10:59:18 UT. (c) Discrete auroral arc, observed at 11:09:48 UT. (d) Diffuse aurora to the east of PFMSP, observed at 11:13:45 UT.