

MESOSCALE CONVECTION STRUCTURES ASSOCIATED WITH POLAR CAP PATCHES AND THEIR MAGNETOSPHERE COUNTERPART

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INTRODUCTION

- During a southward Interplanetary Magnetic Field (IMF) high-latitude plasma convection is typically viewed as a two-cell pattern (Dungey, 1961), but recent studies show that there are mesoscale flows embedded in the polar cap associated with patches (Nishimura et al., 2014).
- Ionospheric mesoscale flows and airglow patches are associated with Magnetosphere-Ionosphere coupling on open field lines through both localized Field-Aligned Currents (FACs) (Zou et al., 2016) and enhanced localized precipitation (Zou et al., 2017).
- What remains unclear is how mesoscale flows correspond to open fields under southward IMF, and what role these structures play in plasma transport and daynight reconnection coupling across the open-field line region in the magnetosphere.

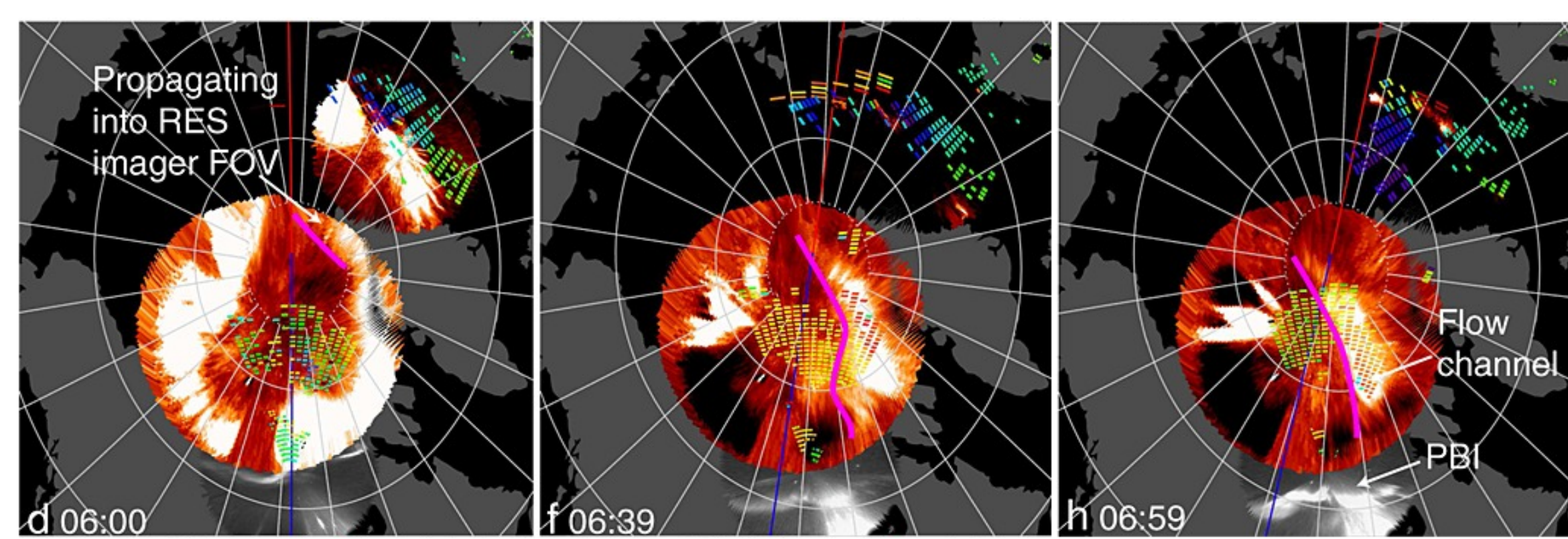


Figure 2: Nishimura et al. (2014).

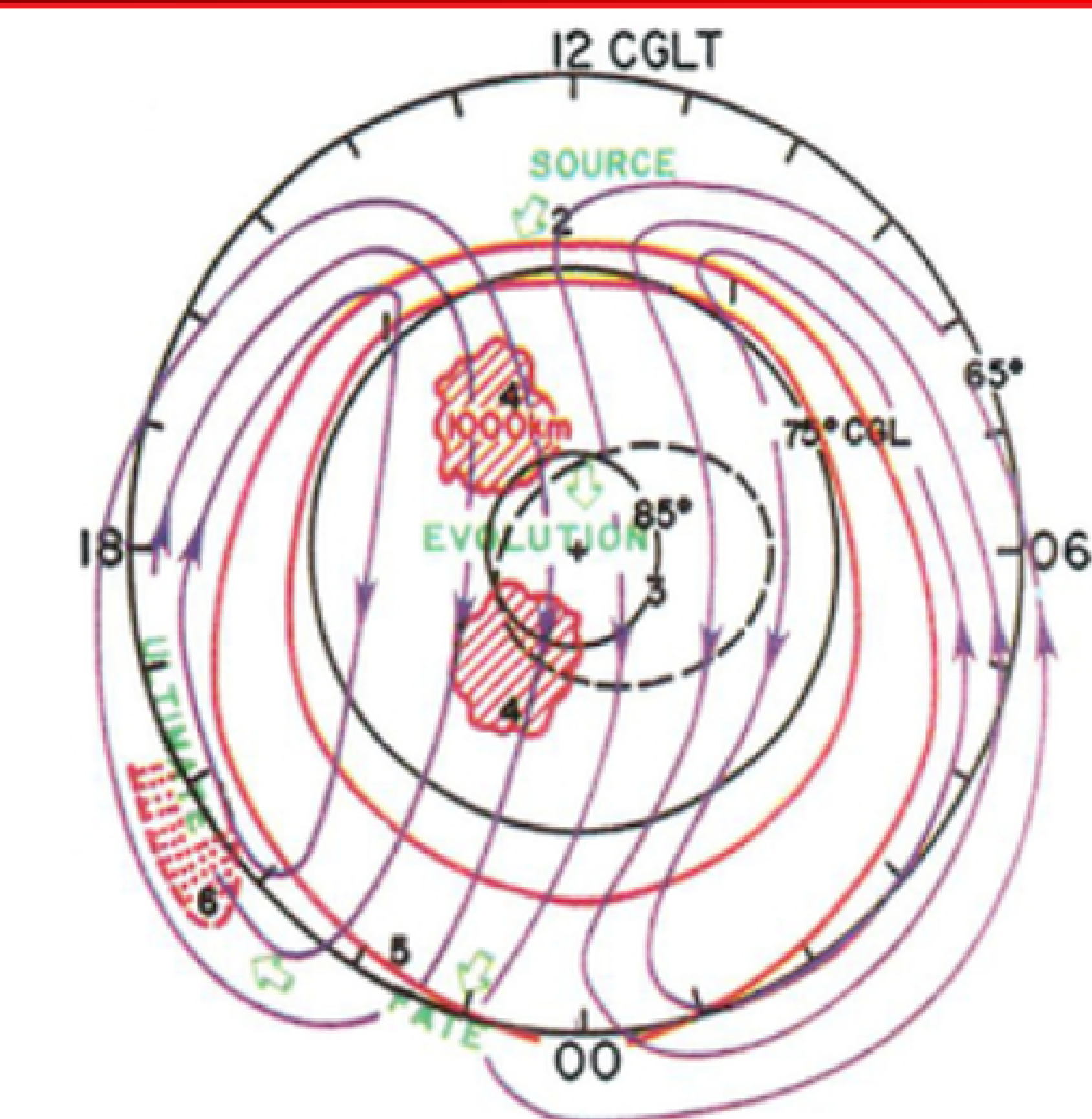


Figure 1: Carlson (2012).

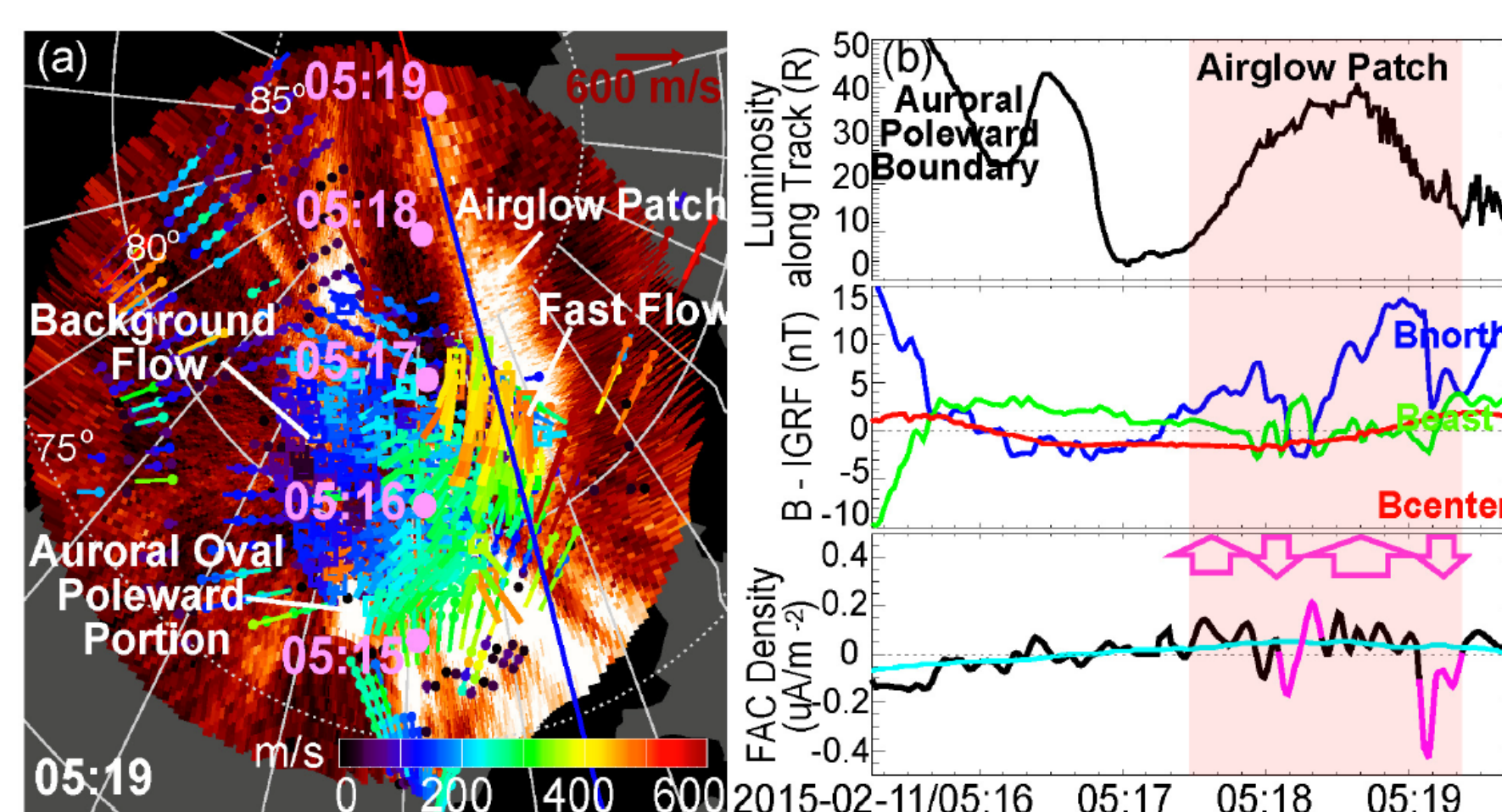


Figure 3: Zou et al. (2016).

DATA AND METHODOLOGY

- Open field-line measurements are taken using the Cluster spacecraft, which are four satellites each containing 11 identical instruments in order to obtain 3D multi-point measurements of parameters such as electric field, and ion/electron flux.
- Airglow patches are found using the Optical Mesosphere Thermosphere Imager at Resolute Bay.
- In this work, conjunctions are periods in which one or more Cluster satellite footprints pass through an airglow patch in the Resolute Bay imager field of view.
- So far this work has found 14 conjunctions between 2005 and 2008.

CASE STUDIES

Case 1: 2008-02-04

- At approximately 0:10 Universal Time (UT) the IMF B_z turns northward and B_y turns positive.
- The observed patch is moving antisunward.
- Open field-line measurements of the electric field are reasonably enhanced, particularly in the y-component which indicates an anti-sunward plasma motion. Over time/space this enhancement decays, possibly in response to the northward turning of the IMF B_z .
- All three spacecraft show an enhanced electron flux parallel, perpendicular, and anti-parallel to the magnetic field.

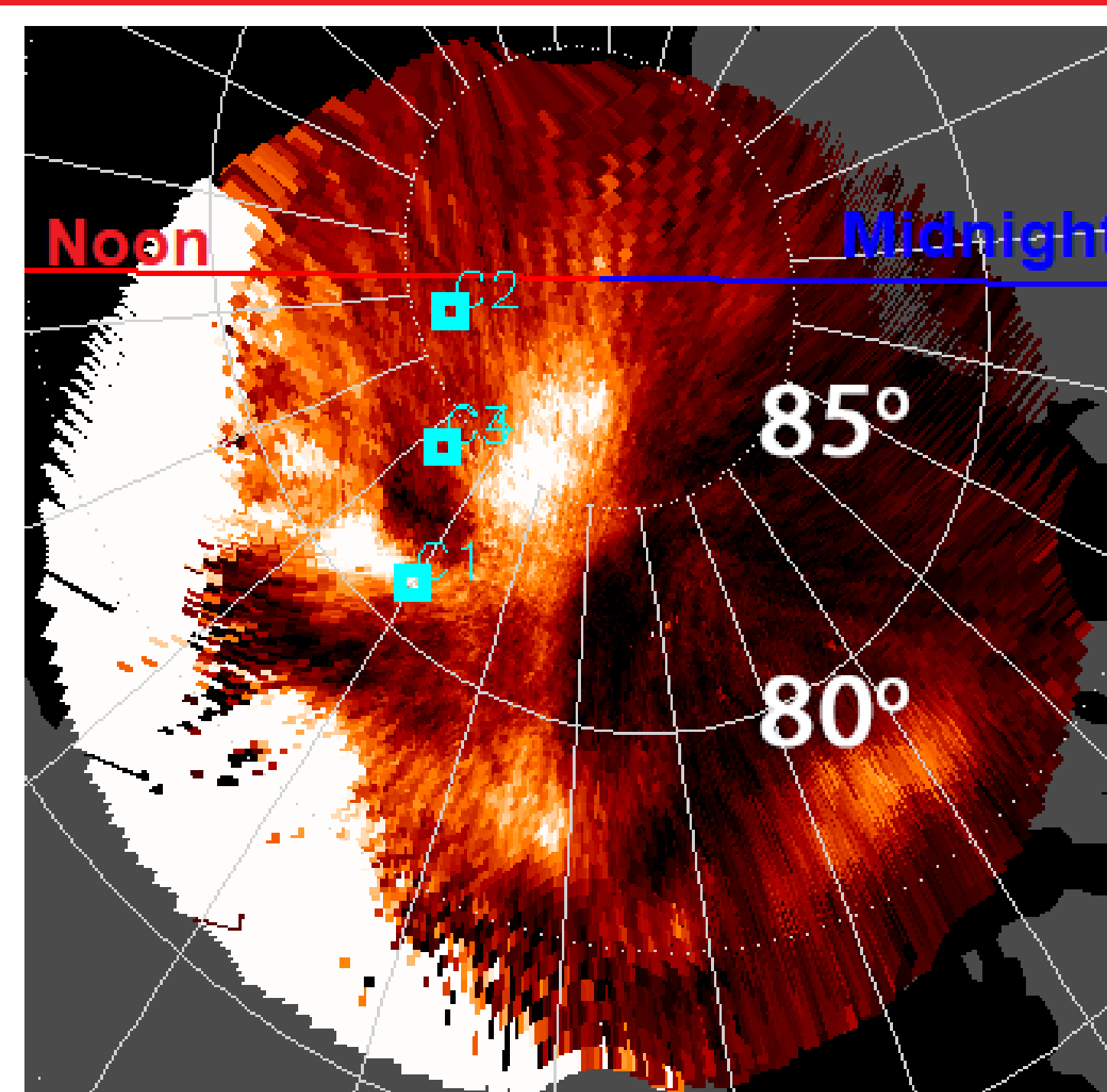


Figure 4: Background subtracted red-line emissions at 1:20 UT. The blue squares indicate the spacecraft footprints.

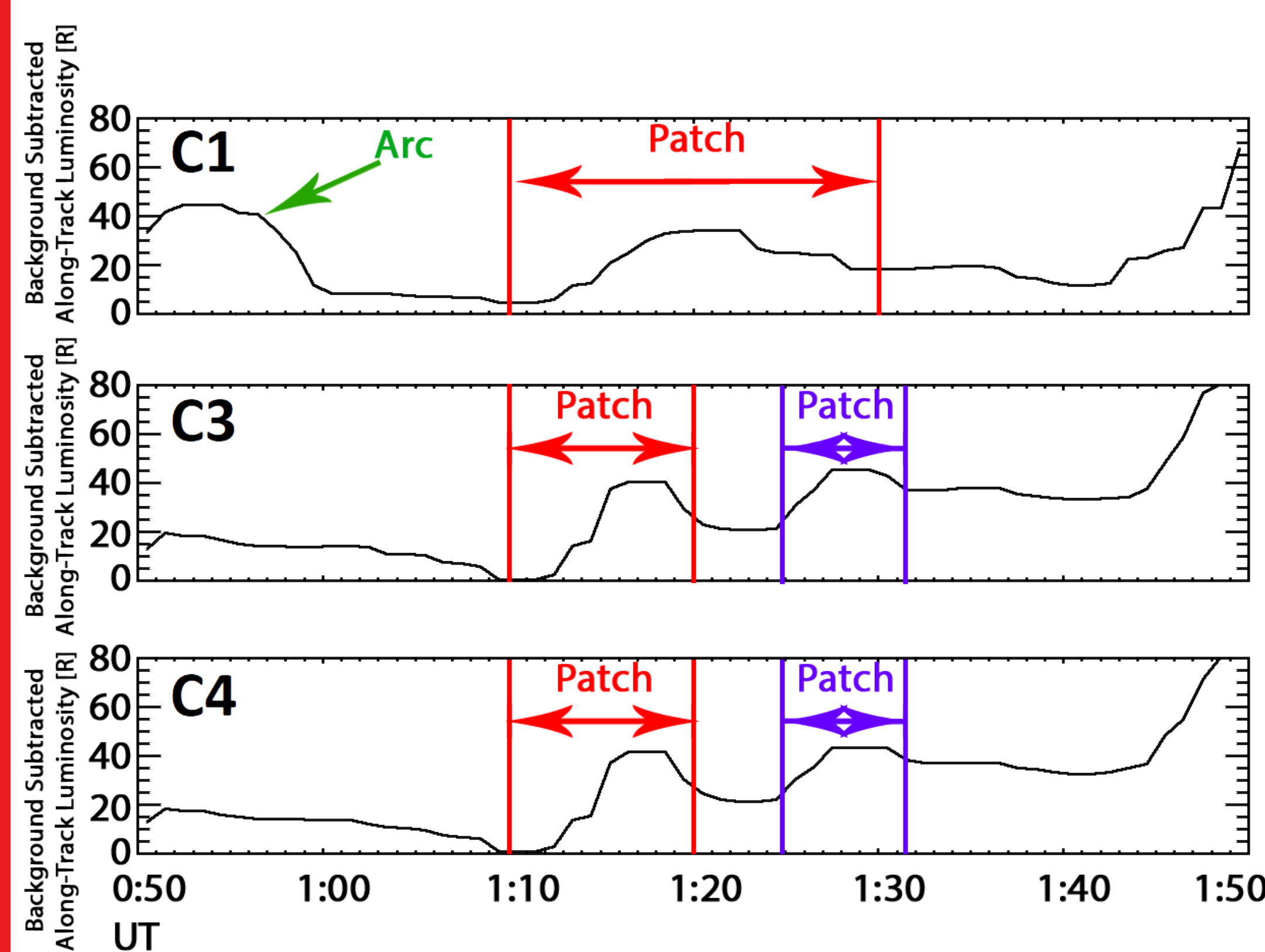


Figure 5: Optical luminosity along the spacecraft trajectory with the background subtracted.

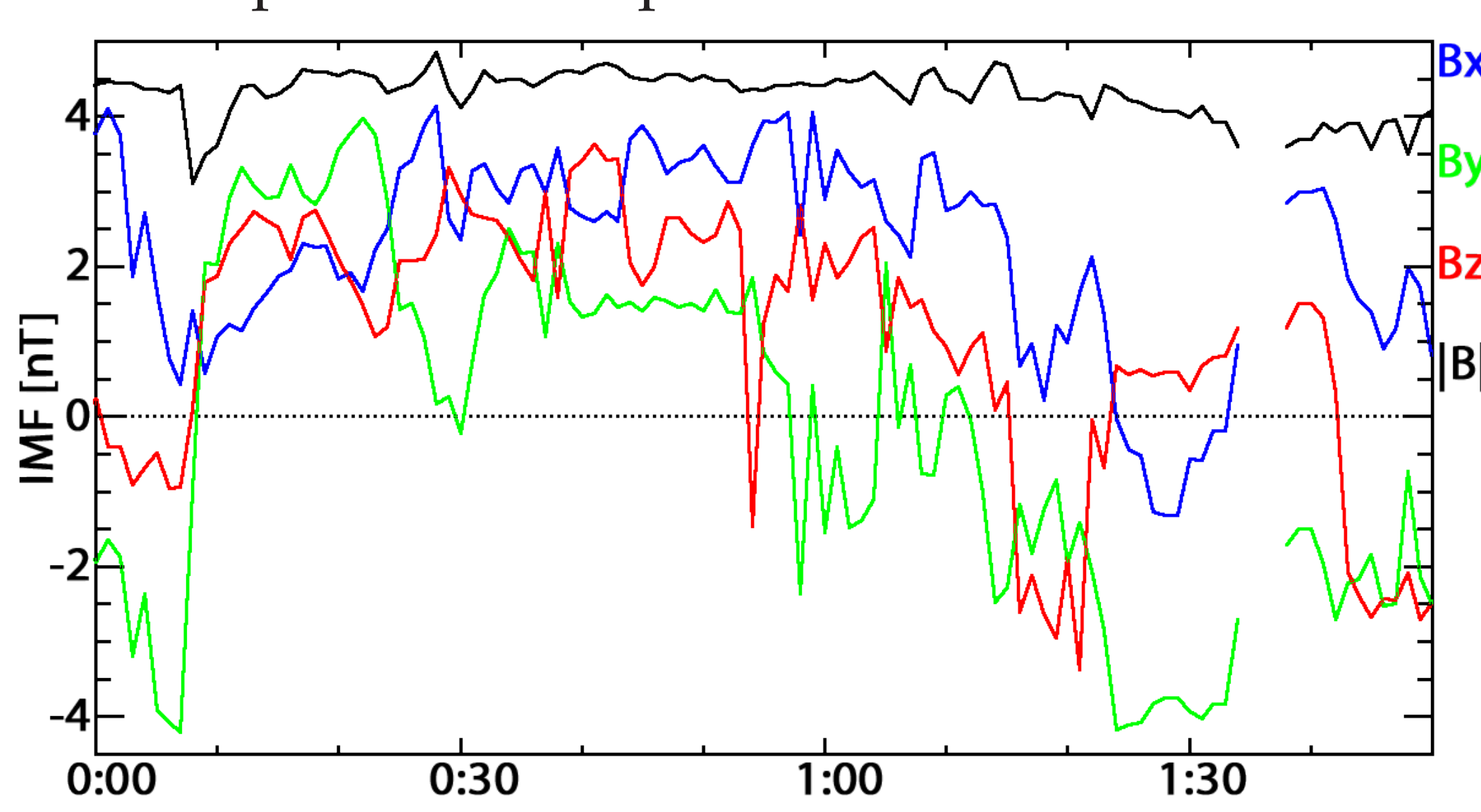


Figure 6: IMF conditions.

CASE STUDIES [CONTINUED]

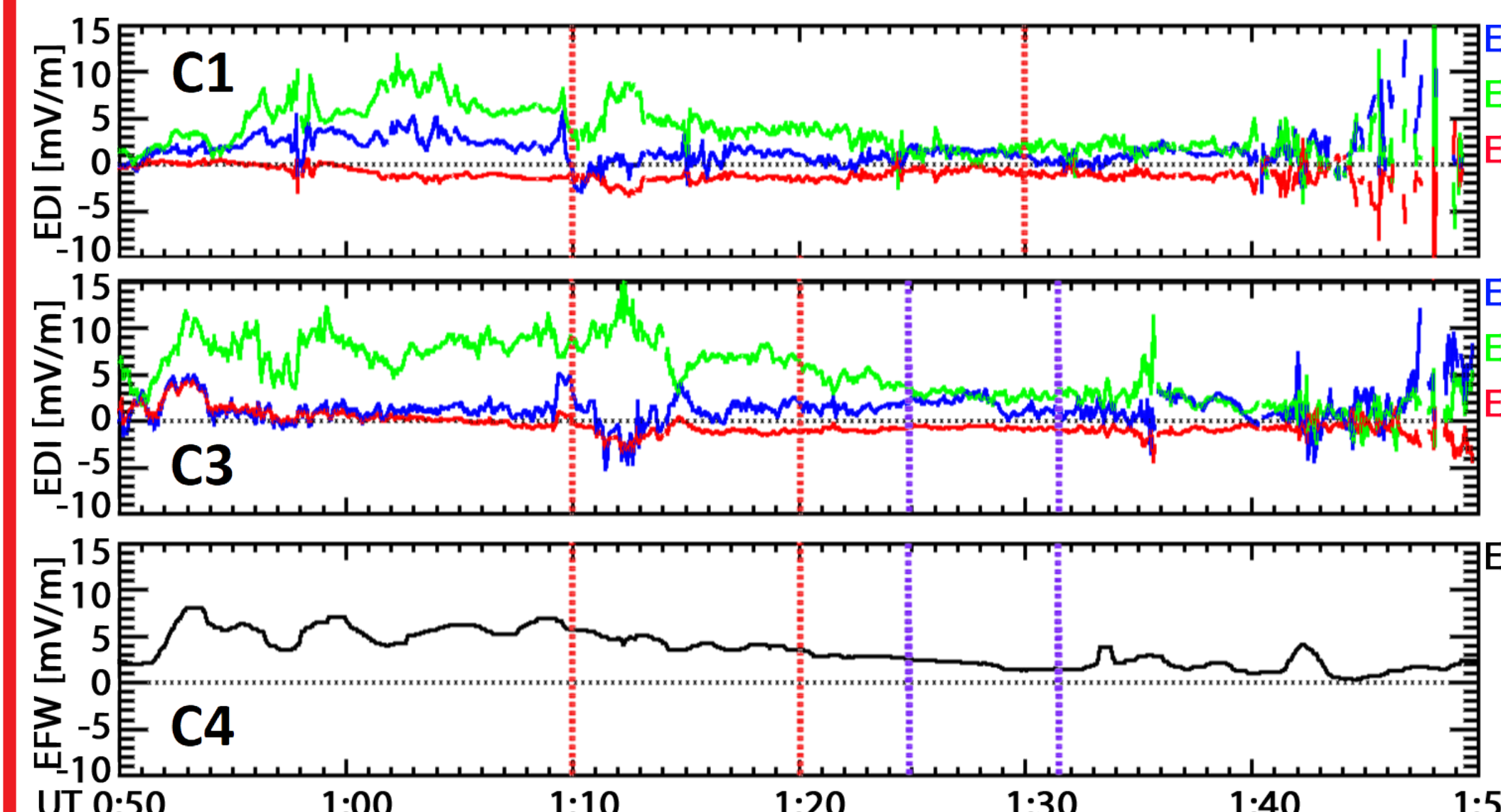


Figure 7: Electric field measurements taken by the Cluster spacecraft.

Case 2: 2007-12-11:

- IMF B_z turns northward near 6:35 UT and IMF B_y is duskward between 7:00 UT and 7:15 UT.
- The patches are moving anti-sunward and downward, but they are essentially stationary as the Cluster footprints travel through them.
- E_x turns positive, indicating a dawnward flow that becomes duskward. E_y is initially negative, indicating an initial sunward flow that is consistent with the northward turning of the IMF.
- An enhanced electron flux is only present at the leading edge of the patch, and is most apparent parallel to the magnetic field. This relatively reduced flux (as compared to case 1) is likely due to the stagnation of this patch.

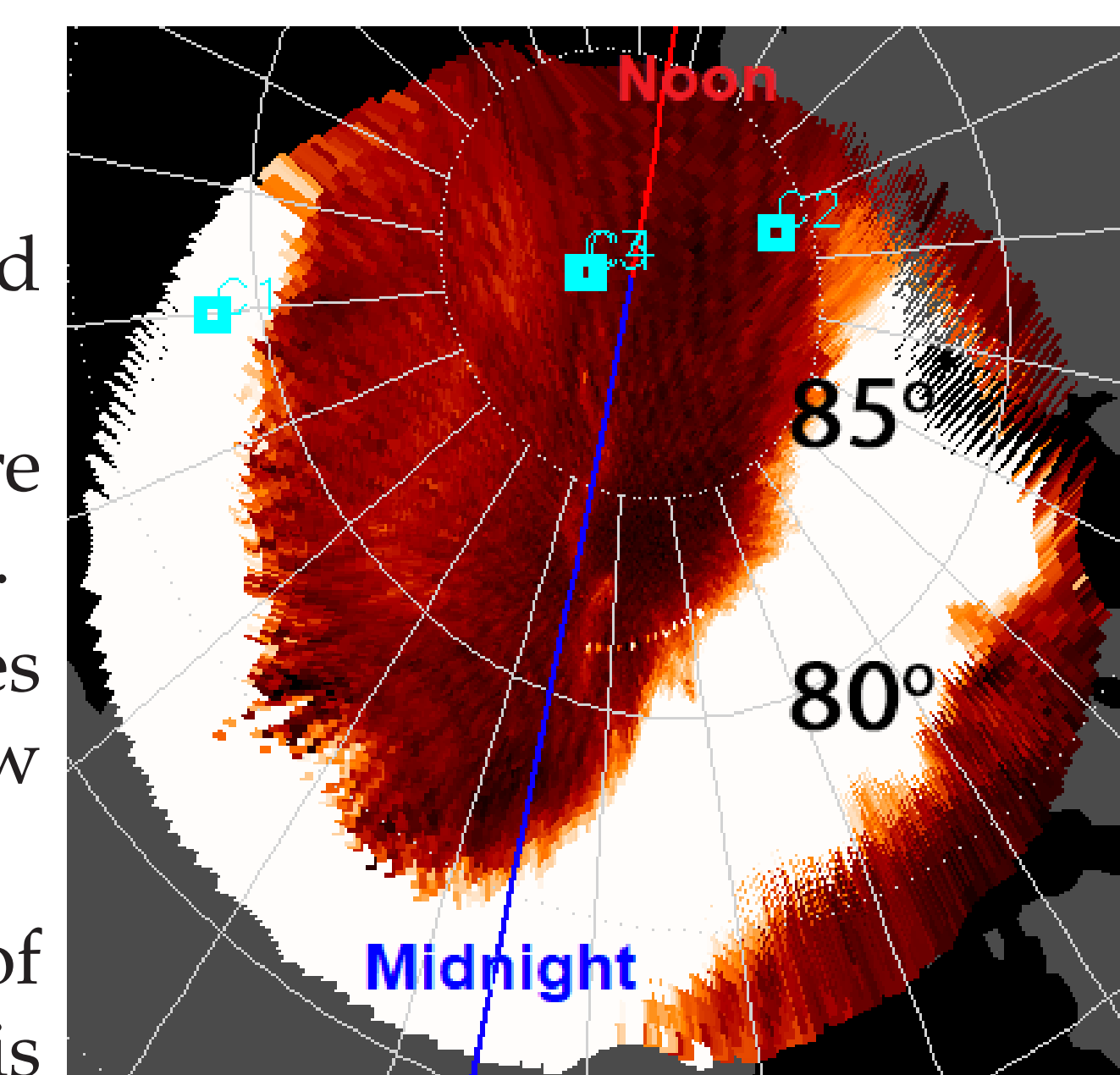


Figure 9: The same as Figure 4, but at 7:50 UT on 2007-12-11.

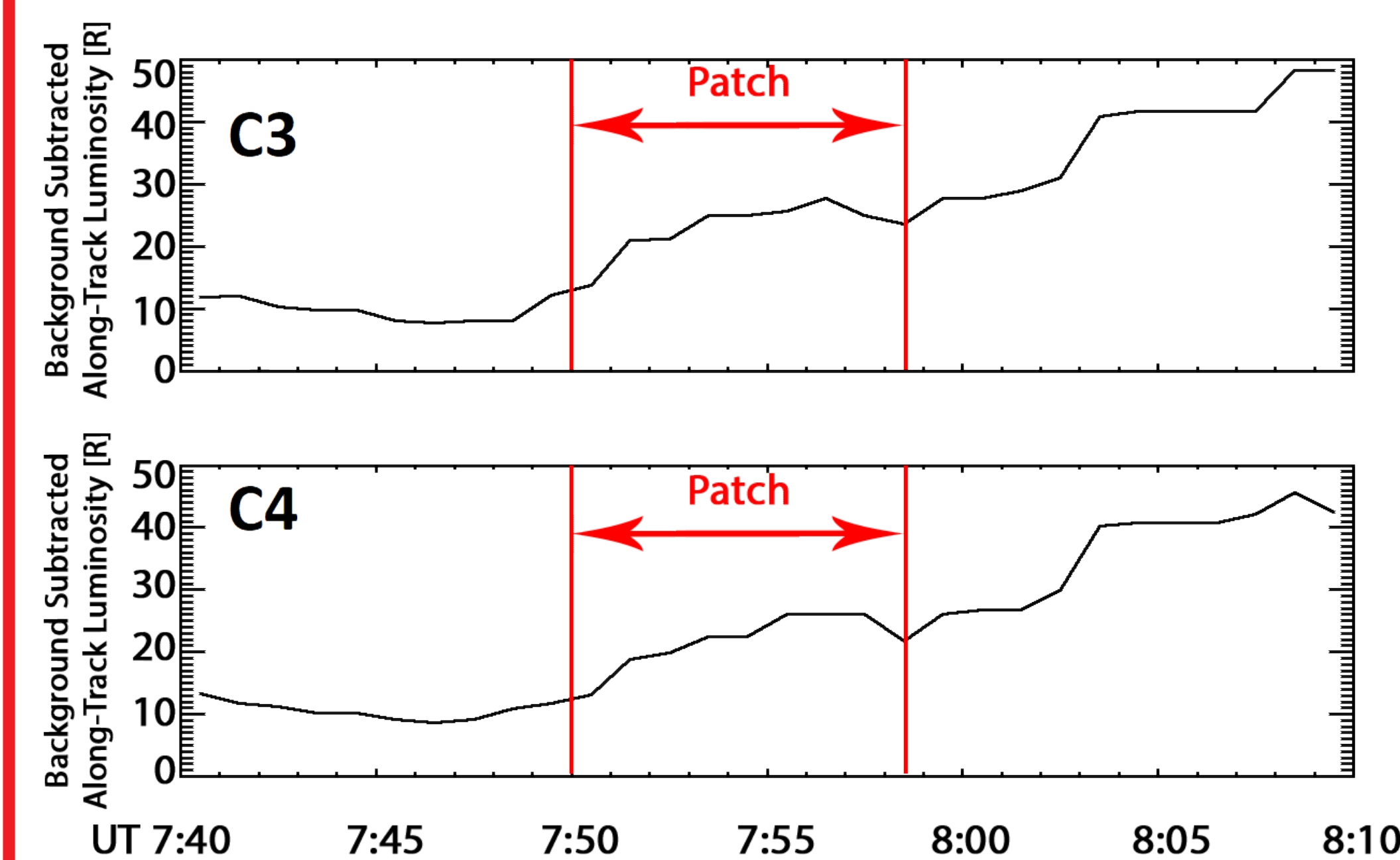


Figure 10: Optical luminosity along the spacecraft trajectory with the background subtracted.

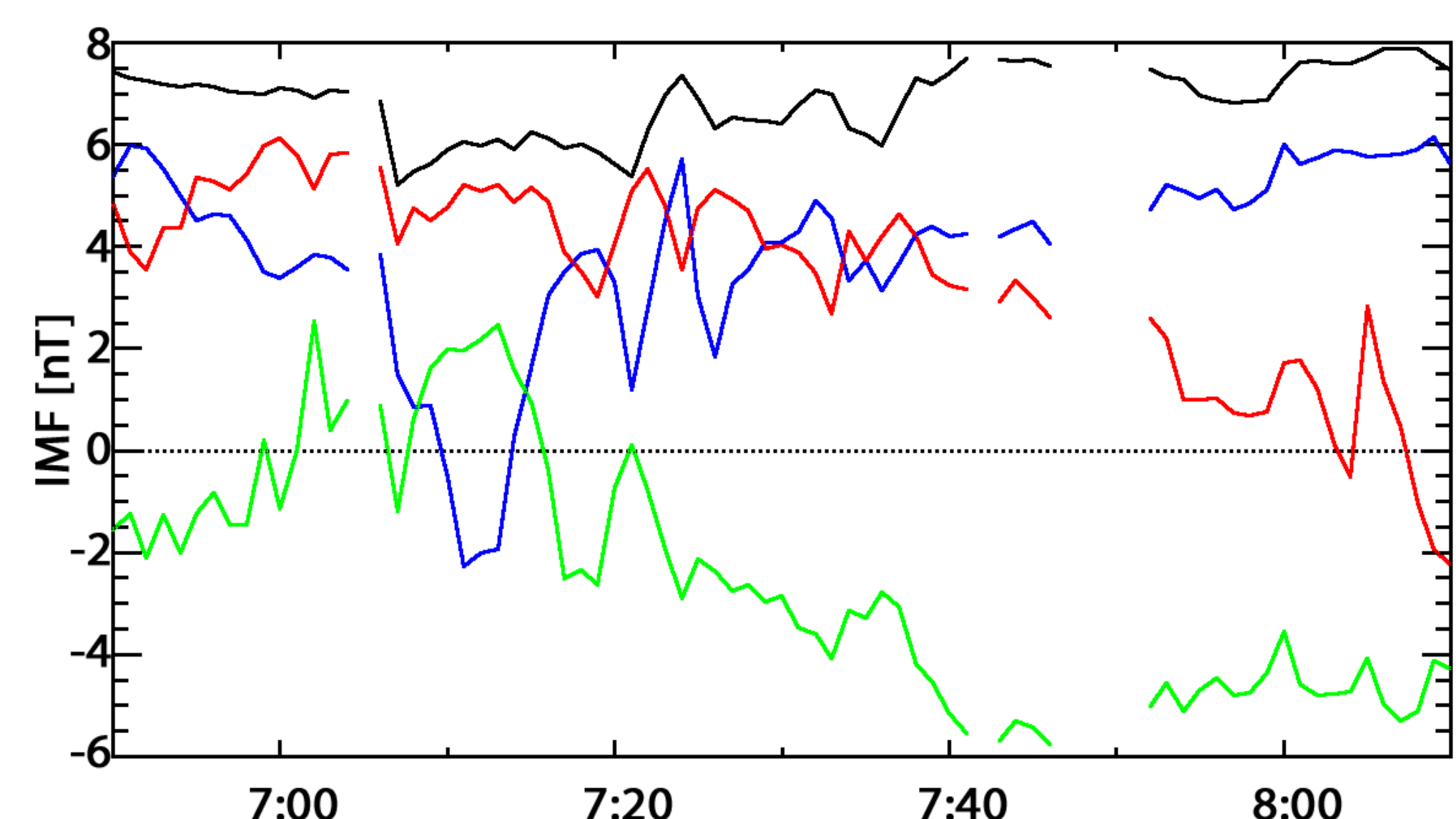


Figure 11: IMF conditions.

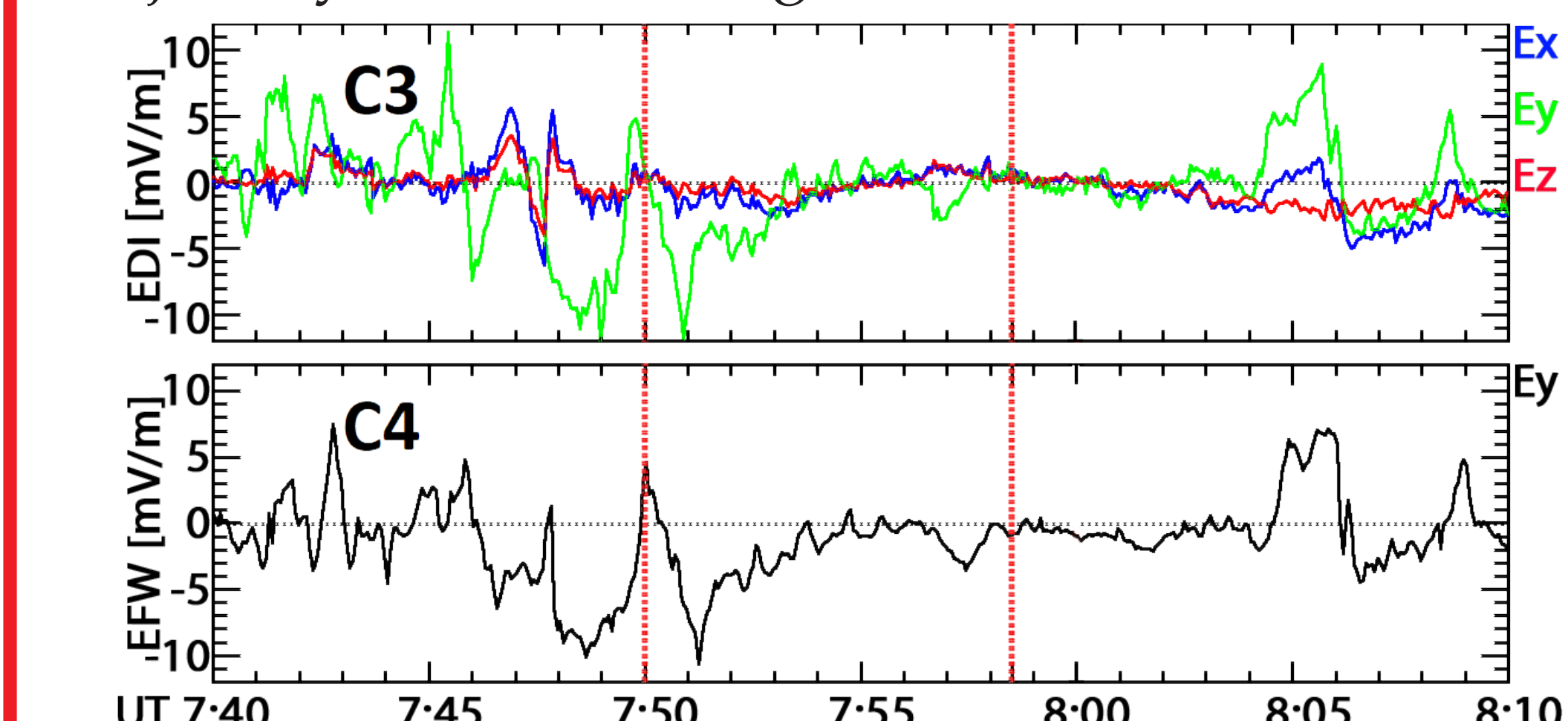


Figure 12: Electric field measurements taken by the Cluster spacecraft.

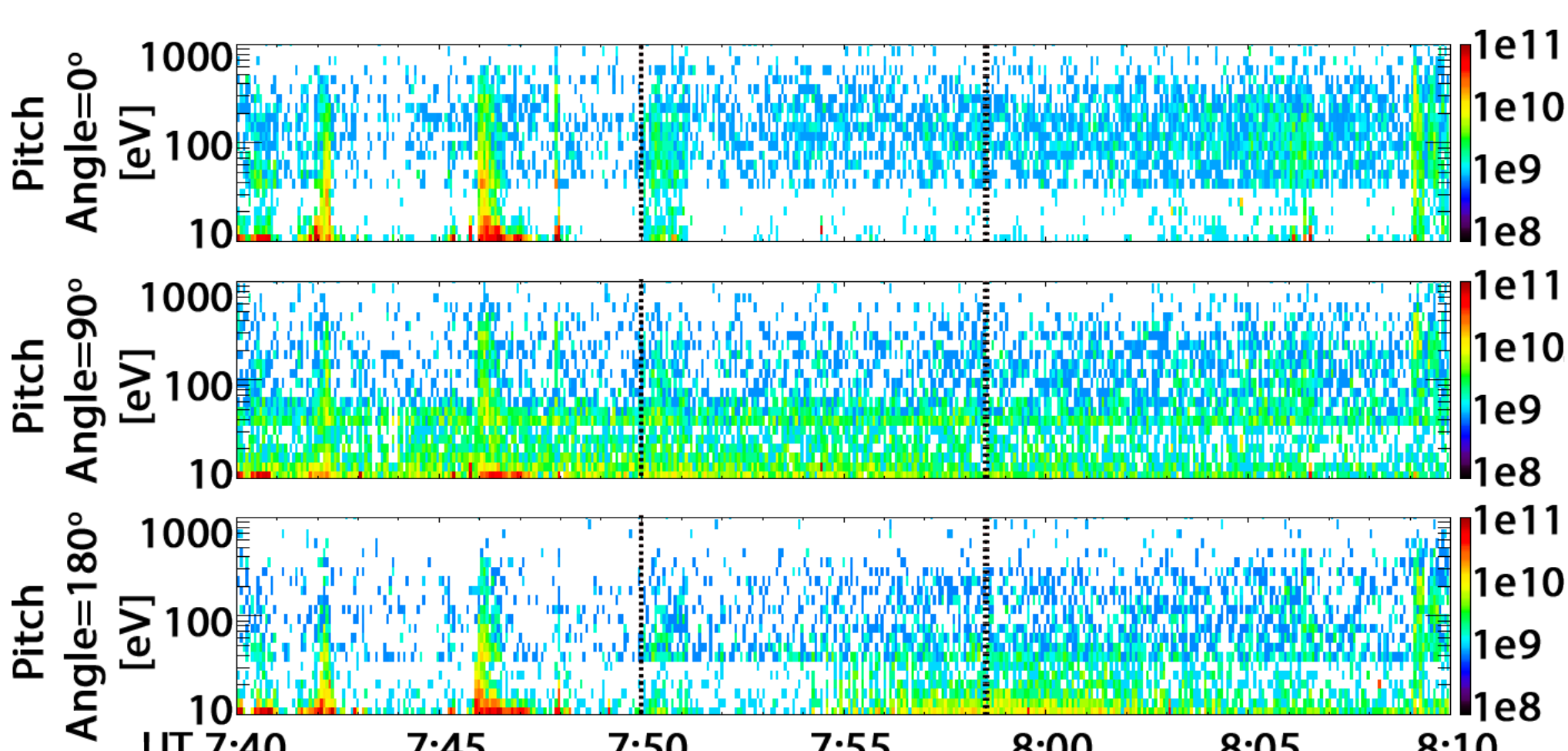


Figure 13: Cluster 4 electron flux measurements.

CONCLUSIONS

- The goal of this work is to characterize lobe measurements corresponding with ionospheric mesoscale structures collocated with patches.
- This work shows that ionospheric patches are collocated with electric field changes in the lobe and an enhanced electron flux.
- These findings further emphasize the connection airglow patches have to enhancements in dayside magnetospheric reconnection and the enhanced propagation of open flux tubes.

References:

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