Investigating the impact of geomagnetic storm over the ionosphere-thermosphere system of subauroral/midlatitude region using ISR observations and GOCE measurements.

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INTRODUCTION

- Space weather is the effects of the Sun-magnetosphere system on the ionosphere-thermosphere (I-T) system, while space weather events are the phenomena occurring in the system, like geomagnetic storms, and ionospheric perturbations.
- During geomagnetic storm, intense energy and momentum from the solar wind are injected into the I-T system through enhanced electric fields, currents, and particle precipitation, thereby causing significant changes in the system (Foster et al., 2002).
- These significant changes may occur in response to the various chemical, dynamic, and electrodynamic driving processes such as joule heating, ion-drag forcing, penetration electric field, and dynamo electric field.

OBJECTIVES

i. To investigate the storm-time global changes in the upper thermosphere during the 5-7 August, 2011 geomagnetic storm using the zonal neutral wind measurements obtained by GOCE satellite measurements.
ii. To understand the dynamical mechanisms that affect the subauroral/midlatitude I-T system for this particular storm using ionospheric F layer parameters for Millstone Hill station obtained from the Global Ionospheric Radio Observatory (GIRO) database, and Millstone Hill incoherent scatter radar measurements.

OPEN QUESTIONS & METHODOLOGY

a. How does the global perturbation in neutral zonal winds influence the characteristic parameters of the I-T system in the midlatitude/subauroral region?
b. What is the impact of geomagnetic activity's main phase on the I-T system at this latitude?

To achieve the goals and answer the science questions, we investigate a major and very geo-effective geomagnetic storm that occurred on August 5 - 7 2011, at the beginning of the maximum phase of solar cycle 24. The characteristic parameters, such as F layer height parameters was obtain from Global Ionospheric Radio Observatory (GIRO) database, ion temperature, and electron density were obtained from the Millstone Hill Incoherent Scatter Radar, and the interplanetary magnetic field measurement was obtained from the OMNIWeb database website. The F layer height parameters, electron density, and ion temperature were measured for Millstone Hill (42.8°N, 71.5°W). The zonal neutral wind measurements was obtained from the Gravity Field and Steady-State Ocean Circulation Explorer (GOCE) satellite.

RESULTS

FIGURE 1

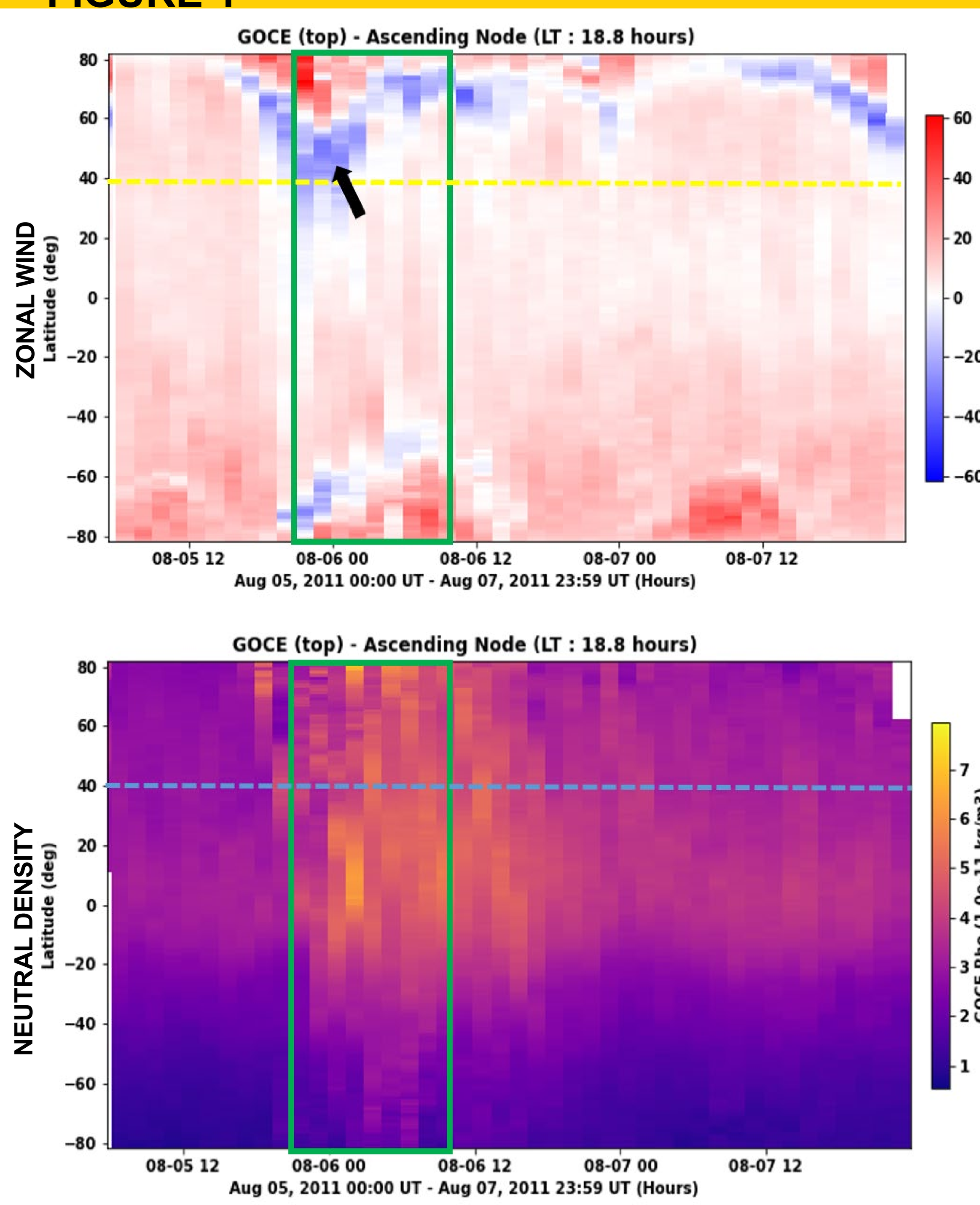


FIGURE 2

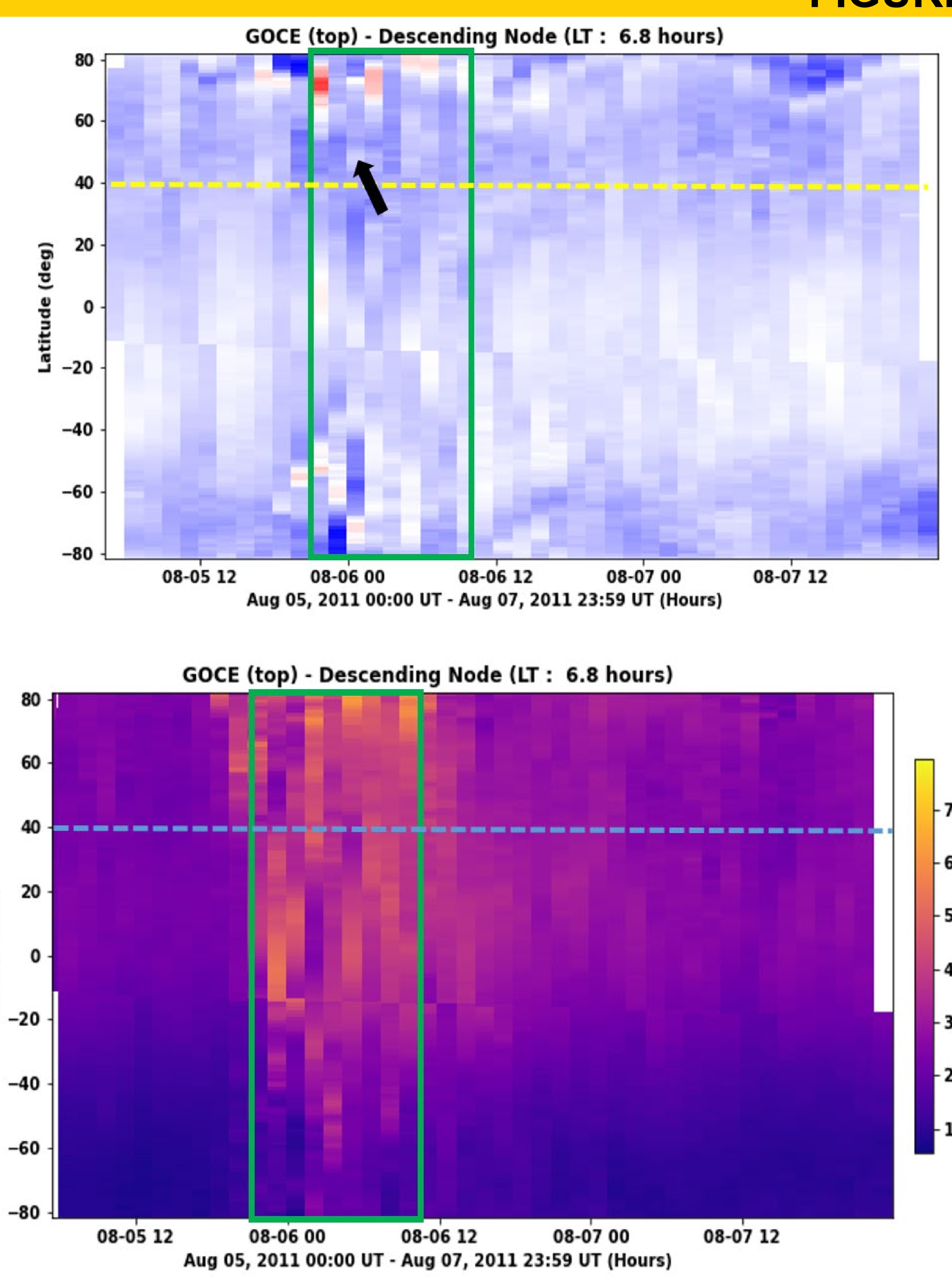
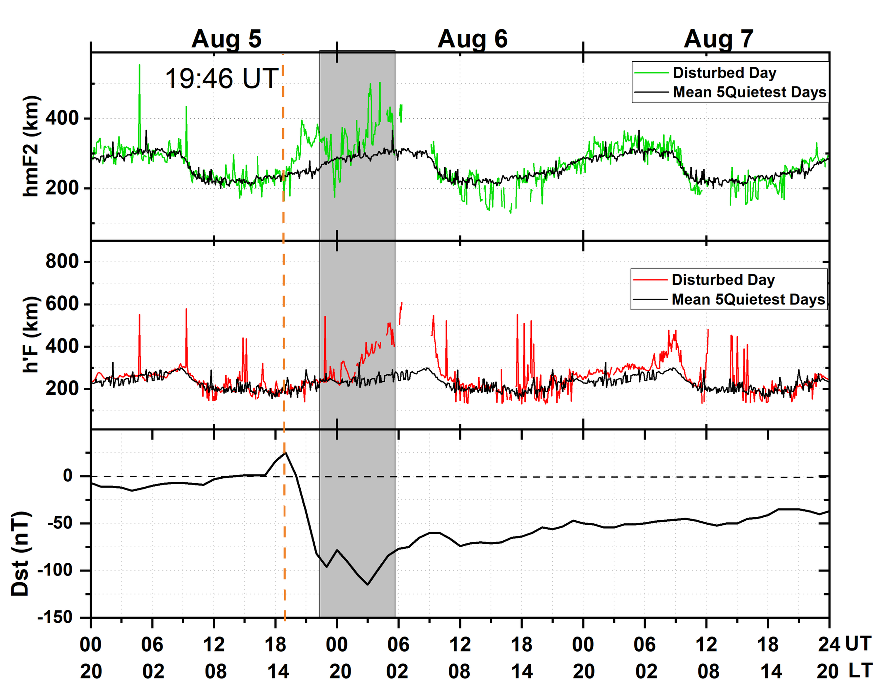
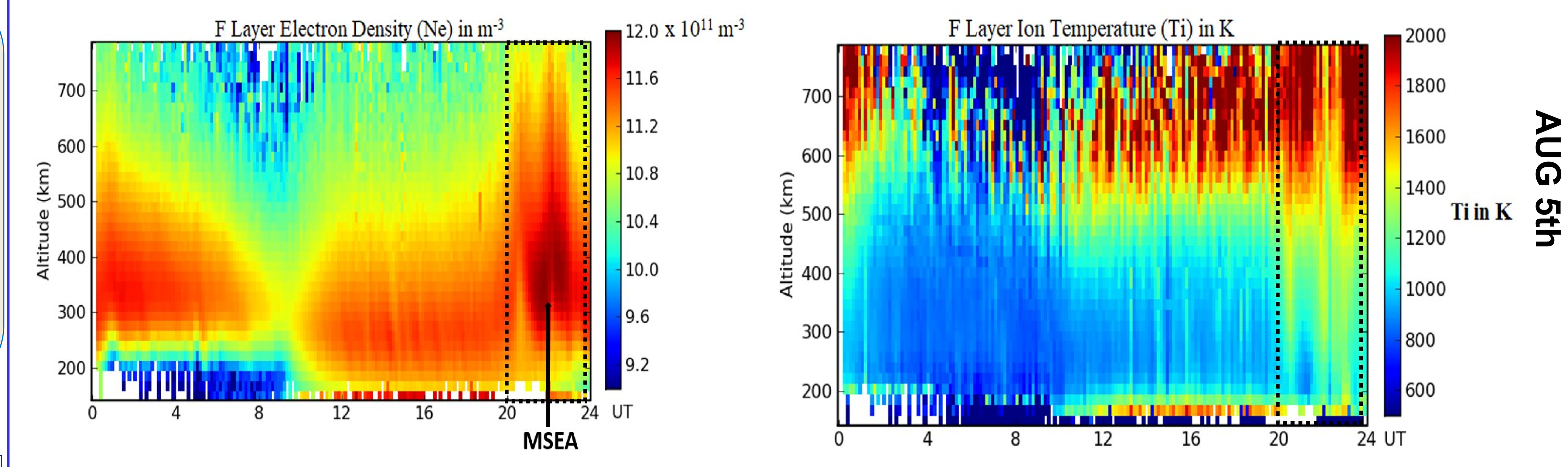


FIGURE 3



MORE RESULTS & DISCUSSION

FIGURE 4



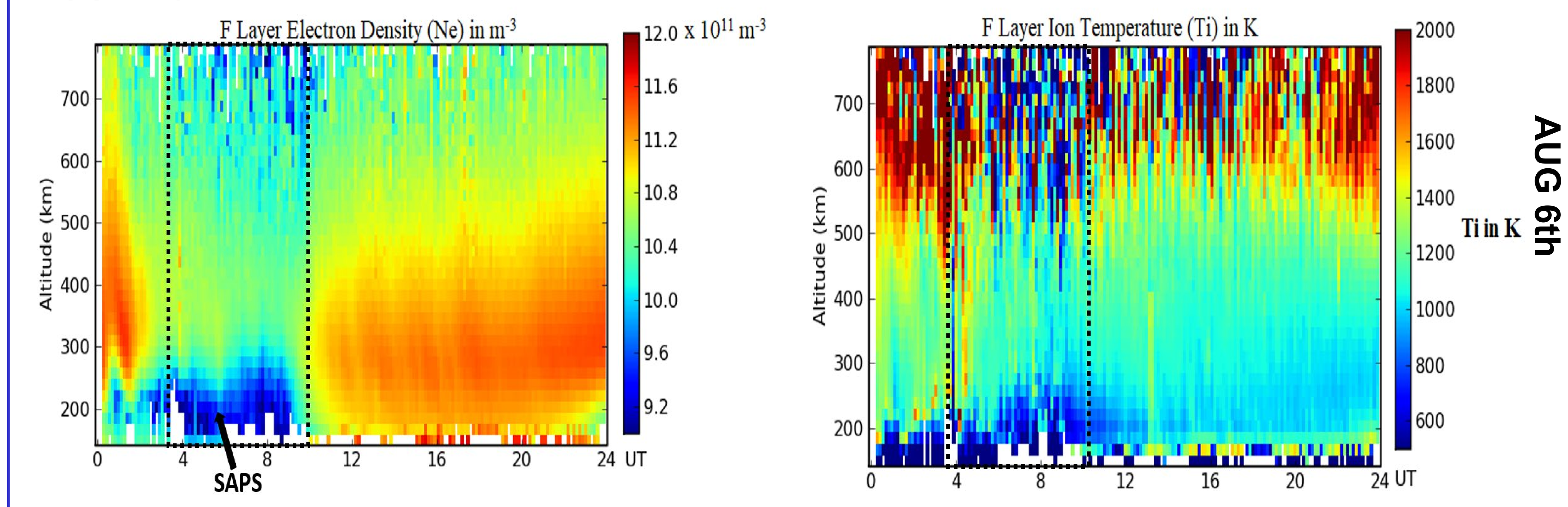
Midlatitude Summer Evening Anomaly (MSEA) is observed:

- Intense electron density increase around 300-400 km
- With associated acceleration of ion velocity (40-80 m/s)

During MSEA event:

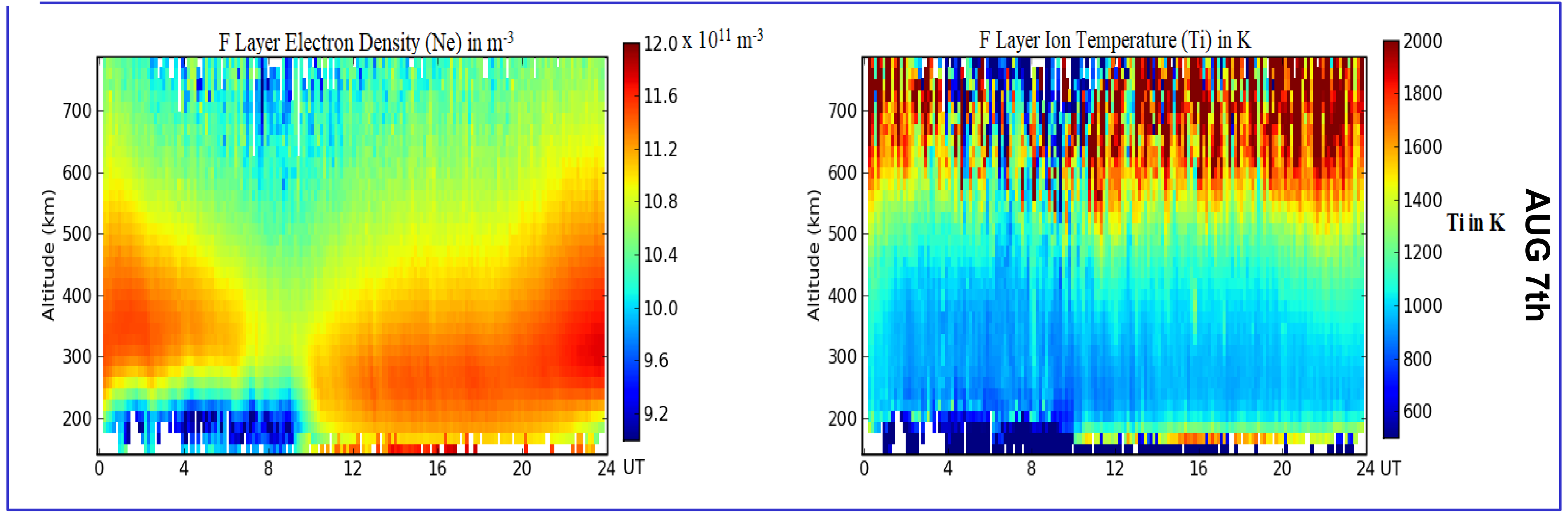
- Peak height of F2 layer had strong increase in Ti
- Associated acceleration of ion velocity was maximum (80-100 m/s)

FIGURE 5



During main phase, the bottom F layer had strong depletion in Ne, which is a signature of Sub-Auroral Polarization Stream (SAPS).
The low plasma density associated with SAPS implies a low ion-neutral collision frequency.
There was evidence of MSEA during the local evening.

FIGURE 6



CONCLUSIONS & FUTURE WORK

- We observe that at the bottom F region, there was day-to-day depletion in Ne at post-midnight local time, which is a signature of SAPS.
- We find that the storm onset had intense MSEA, and during the time period, the top-peak of the F layer experienced severe increase in Ti.
- We also find that the global neutral wind at the subauroral location encountered extreme perturbation in the westward direction.
- Finally, we observe that there is altitudinal and time-dependency of the plasma characteristics on SAPS.
- In the near future, we plan to compare the CEDAR Madrigal database measurements with the Global Ionosphere-Thermosphere Model (GITM)

Acknowledgement & Data Availability Statement

The authors would like to appreciate the PI (Phil Erickson) of the Millstone Hill ISR data for making this data publicly available. The Dst Index data is from the OMNI Web Data Explorer system through the website (https://omniweb.gsfc.nasa.gov/form/omni_min.html). The F layer height parameters are available from the Global Ionospheric Radio Observatory (GIRO) website (https://giro.uml.edu/didbase/scaled.php). The electron density and ion temperature data are available from the CEDAR Madrigal database website (http://cedar.openmadrigal.org/). GOCE data are available on the website (https://doi.org/10.5270/esa-l8g67jw).

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