Multi-scale ionosphere responses to the May 2017 magnetic storm over the Asian sector

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1 Abstract

Ionospheric storms primarily occur as a consequence of a sudden input of solar wind energy into MIT system. We investigate multi-scale ionosphere responses to the May, 2017 geomagnetic storm over the Asian sector by using multi-instrumental observations. Results show that:

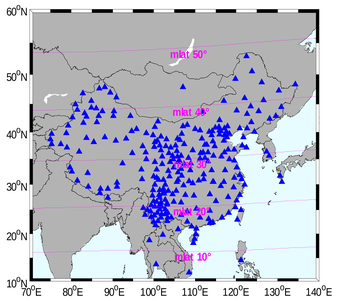
(1) Two ionospheric positive storm periods were observed. The first dayside one was initiated by the IMF Bz southward turning, while the second nightside one was disrupted by the PPEF due to the nighttime IMF Bz southward turning.

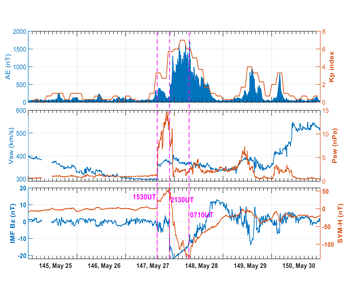
(2) A negative storm occurred during 0000-1200UT on May 30 nearly two days after the main phase, which was due to decrease of O/N2 ratio.

(3) A band-like TEC enhancement, also referred as plasma blob, was observed aligning in the northwest-southeast direction and propagated slowly southwestward during 1500-2000UT (near midnight) on May 28 during the recovery phase. Ne measurements from Swarm satellites confirmed the density enhancement. Similarities of the observed plasma blob characteristics with nighttime TID are consistent with the TID-blob theory.

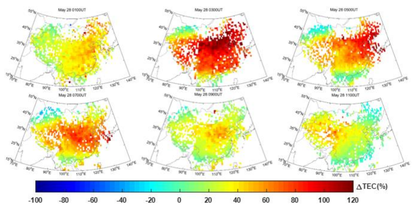
2 Data and Methodology

- GNSS TEC datasets: ground-based GNSS receivers provided by the CMONOC and IGS network
- To detect wave-like features in TEC, such as TID, the background TEC variations are removed by using the cubic polynomial fitting.
- Electron density profiles (EDP) obtained from the COSMIC RO and FY-3C GNOS missions
- In-situ Ne measurements from the Swarm B, and DMSP satellites
- O/N2 ratio in the thermosphere provided by the TIMED/GUVI
- Interplanetary and geomagnetic conditions of May 25-30: This geomagnetic storm was caused by a CME released on May 23. The minimum SYM-H reached -150 nT

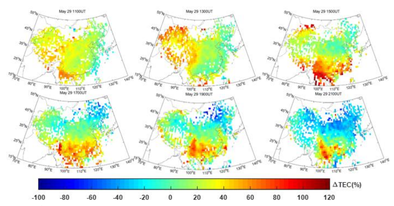




3 Regional positive and negative ionospheric storms

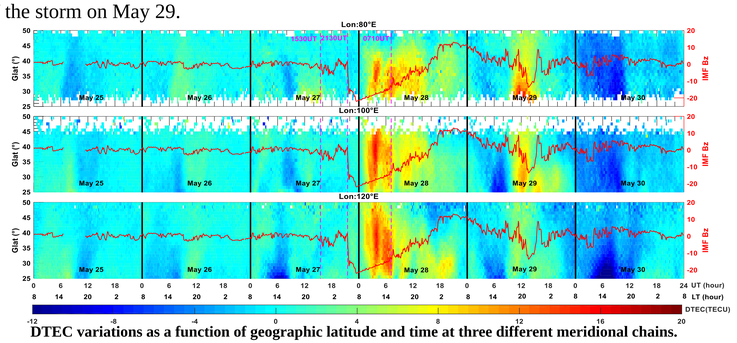


2D △TEC(%) maps during 0100-1100UT (0900-1900LT) on May 28.



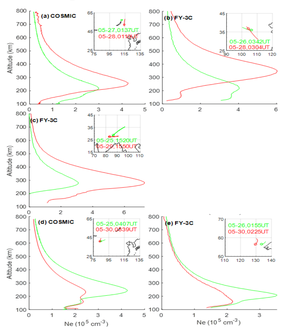
2D △TEC(%) maps during 1100-2100UT (1900-0500LT) on May 29, 2017.

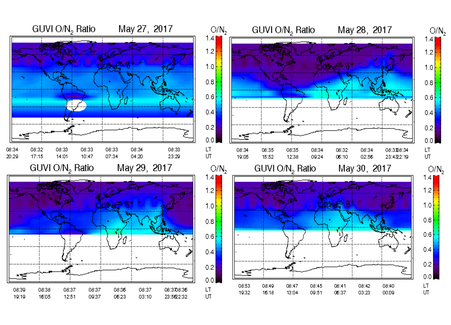
- The first one was observed in the noon-afternoon sector during the storm main phase on May 28, with nearly 120% TEC enhancement.
- The second one was of smaller scale and occurred on the night side during the recovery phase of the storm on May 29.



DTEC variations as a function of geographic latitude and time at three different meridional chains.

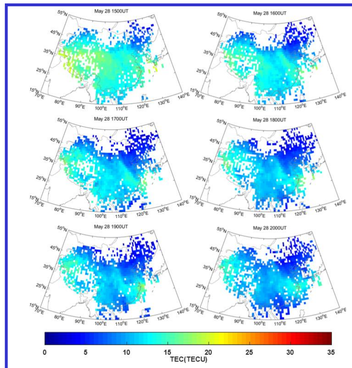
- A negative storm occurred during 0000-1200UT on May 30 nearly two days after the main phase



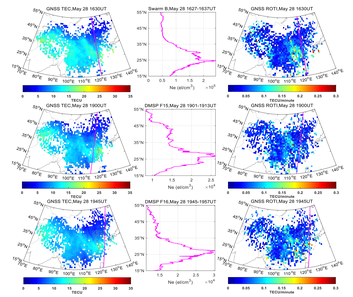


- Considerable increase in NmF2 and hmF2 observed in EDPs suggests that the first positive storm was due to upward lifting of the F layer.
- The first dayside positive storm was initiated by the IMF southward turning, while the second night side one disrupted by the nighttime PPEF due to the IMF Bz southward turning.
- Thermosphere composition change was responsible for the negative storm.

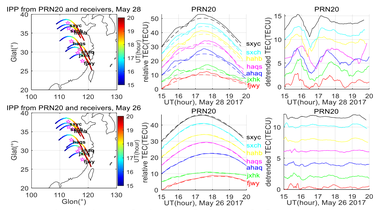
4 Meso-scale TEC enhancement structure observed near midnight sector



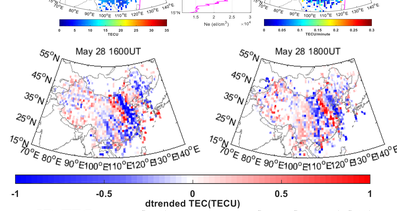
- A band-like TEC structure aligned in the northwest-southeast direction started to appear at ~120° E and 20-40° N at 1500UT during the recovery phase.
- This band-like structure moved slowly to southwestward during 1500-2000UT, and then decayed gradually.
- The drift speed is very slow, close to 90 m/s.



- Ne increased sharply at the locations where the TEC band-like structures are observed.
- The northwest-southeast aligned TEC structure is collocated with enhanced ROTI values.



IPP trajectories, relative and detrended TEC on May 28 (disturbed day) and 26 (quiet day).



2D TEC perturbation maps used to show nighttime on May 28.

- Detrended TEC shows wave-like signatures during the recovery phase, and the amplitude and time durations present clear nighttime TID characteristics.
- When nighttime TID grows, plasma blobs start to appear near the locations of the TID, and extend to southwestward direction driven by the nighttime TID.

5 Conclusion

- The first dayside positive storm was initiated by the IMF Bz southward turning, while the second night side one was disrupted by nighttime PPEF due to the IMF Bz southward turning.
- A negative storm occurred during 0000-1200UT on May 30 nearly two days after the main phase, which was due to decrease of O/N2 ratio.
- Plasma blob was observed aligning in the northwest-southeast direction and propagated slowly southwestward near midnight on May 28 during the recovery phase. Similarities of the plasma blob characteristics with nighttime TID are consistent with the TID-blob theory.