Response of equatorial and low latitude ionosphere during the severe G4-class geomagnetic storm of 8th September 2017

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Abstract

Equatorial and low latitude ionospheric response of the 8th September 2017 severe G4-class geomagnetic storm shows a positive storm effect over Asian sector, a complete negative storm effect over African sector and both over American sector during the main phase. A sharp increase in peak total electron content (TEC) is observed over the complete longitudinal chain during the recovery phase. The results show the decisive contribution of prompt penetration electric fields (PPEFs) and disturbance dynamo electric fields (DDEFs), storm time disturbed meridional (equatorward) wind as well as the neutral compositional changes over equatorial and low latitudes.

1. Introduction

The compositions, temperature, circulation and electric fields of the whole thermosphere-ionosphere (T-I) system changes considerably during geomagnetic storms due to the enhanced coupling between the solar wind and the ionosphere. These in turn significantly changes the TEC during the storm period [1]. In low latitude and equatorial regions, the storm-time ionospheric disturbed electric fields can affectively redistribute the ionospheric plasma to create ionospheric storm effects [2, 3].

2. Data

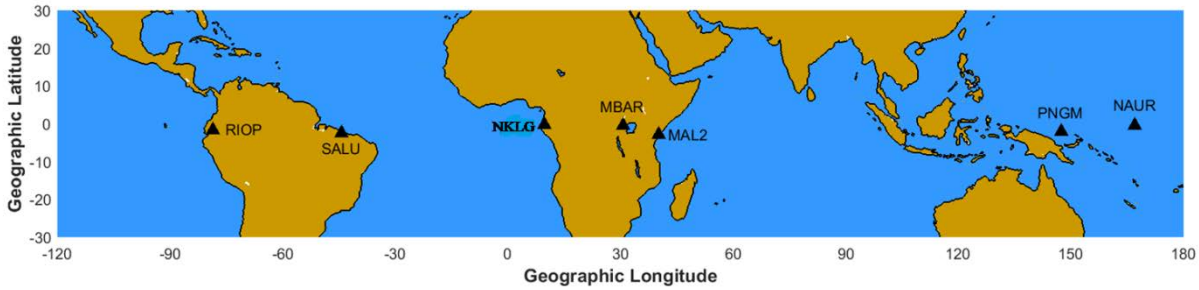

Figure 1. Locations of IGS GPS receivers NAUR, PNGM in Asian sector; MAL2, MBAR, NKLG in African sector and SALU, RIOP in American sector, the data of which is collected from International **Global Navigation Satellite System (GNSS) Service, IGS (geoftp01.ucsd.edu/pub/rinex/2017)**.

3. Results

- During the main phase of the storm on 7th September, the VTEC variation of both the stations shows positive storm effect over Asian sector. Over African sector, a significant negative storm effect in VTEC is observed for all the three stations. Interestingly over the American sector, a negative storm effect is observed for the station SALU and a positive storm effect for the station RIOP.
- After the occurrence of minimum Dst excursion (i.e. after the initiation of the recovery phase) around 1:00 UT on 8th September, sharp increase in VTEC is observed around 2:45-2:50 UT for both the stations over Asian sector. The sharp peak VTEC occurrence over African sector is observed around 15:00-15:30 UT i.e. an almost 12 hours delayed response. Over the American sector, the sharp VTEC occurrence is observed around 15:48 UT for SALU and 18:42 UT for RIOP.

- It is worth mentioning that the storm effect was positive during the recovery phase for all the stations of the entire equatorial longitudinal belt.

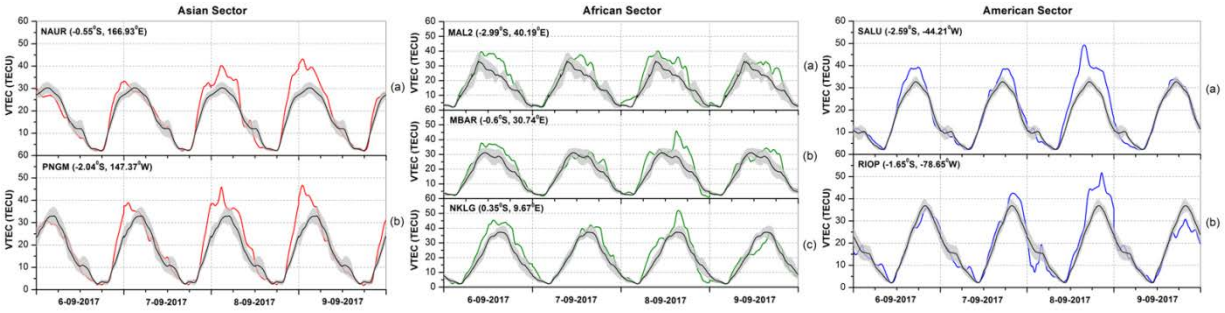

Figure 2. Variation of VTEC along with monthly mean values over Asian sector (left panel), African sector (middle panel) and American sector (right panel), during 6-9 September 2017.

4. Discussion

- During the main phase of the storm, the increase in VTEC over stations of Asian sector is distinctly due to the effect of PPEF [4] and the decrease in VTEC over the African and American sectors is due to a weak efficiency of PPEF during daytime [5].
- The positive storm effect during the recovery phase of the storm can be due to the disturbed equatorward neutral wind which pushes the F2 layer to higher altitudes where the electron densities tend to increase due to the lower recombination rates.
- It can also hinder the formation of equatorial ionization anomaly (EIA), which in turn causes the positive storm effects in the equatorial regions and negative ionospheric storm effects in the crest regions [2,3].

5. Conclusions

The significant outcomes can be concluded as follows:

- During the main phase, a positive storm effect is observed over Asian sector, a complete negative storm effect over African sector and both are observed over American sector.
- A sharp increase in peak TEC is observed over the complete longitudinal chain during the recovery phase.
- The storm effect was positive during the recovery phase for all the stations of the entire equatorial longitudinal belt.
- The results show the decisive contribution of disturbed electric fields (DEFs), storm time disturbed meridional (equatorward) wind as well as the neutral compositional changes over equatorial and low latitudes in the observed ionospheric storm effects.

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