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DAYTIME MSTIDS OBSERVED AT CONJUGATE GEOMAGNETIC POINTS OF LOW LATITUDE REGION USING TEC PERTURBATION

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ABSTRACT

In this study we focus on the daytime MSTIDs observed in conjugate hemispheres. It is the first time that the geomagnetic conjugate daytime MSTIDs was observed over the South America sector. To observe the MSTID characteristics, we used detrended TEC at Brazilian sector covering the northern and southern hemispheres along the same magnetic meridian. The geographic grid of -30°S to -20°S and -55° W to – 45°W (Figure 1) was selected for this study. The geographical coordinates is later converted to geomagnetic coordinates using the IGRF model. The cross-correlation method between two latitudes and longitudes in time was used to observe the propagation of the MSTID waves. We note the following features: TEC disturbance oscillates in time at a chosen location with periods covering between 15-55 minutes, corresponding cross-correlations maximize sometime during 13-16 UT, the phase oscillations and maxima amplitudes are observed to commonly shift towards equatorward/eastward with time in both hemispheres, these MSTIDs are well defined and last longer in latitude than in longitude, and the mirrored MSTIDs occur around the geomagnetic equator as expected. It is not clear from which hemisphere the MSTIDs are generated as both hemispheres show almost equal wave amplitude. To investigate this hemispheric mapping, the integrated field line conductivity ratio of E and F regions is calculated. We noted that during this period the decrease in E region conductivity results in an increase in this ratio. This shows that the E region conductivity was not short circuited completely hence mapping of E layer electric field to the F region could occur during day time. These results are being compared with SAMI3 model simulations.

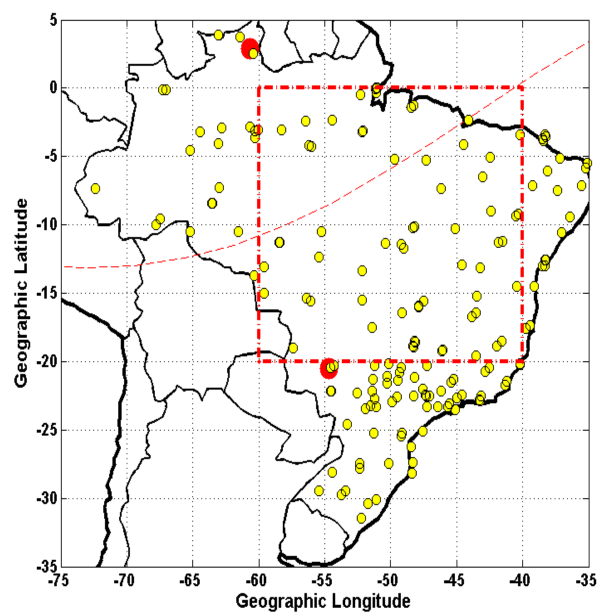

Figure 1: The yellow circles in the thick red dash box show the distribution of the GPS receivers used, the red circles show the station of the ionogram locations and the red dash line shows the magnetic field line.

ESTIMATION OF DELTA TEC AND CORRESPONDING CORRELATION MAPS

TEC disturbance *(ΔTEC)* is derived by subtracting the TEC best fit *(TEC_{fit})* from the TEC mean i.e.:

$$\Delta TEC = \overline{TEC}_i - TEC_{fit}(x,t) \tag{1}$$

where $\overline{TEC_i} = \frac{\sum_{t=1}^{N} TEC_t}{N}$, *i* represents each latitude or longitude for all time and *N* is the total number of *t*. This method of deriving ΔTEC has been earlier employed by Galvan et al. [2011] and Jonah et al., [2016] to identify the tsunamigenic TEC disturbances and TIDs. From these keograms of ΔTEC, cross-correlation maps are generated. The cross-correlation is defined as follows:

$$MSTID_{PROP} = \frac{\Delta TEC(x,t) \times \Delta TEC(x+\Delta x, t+\Delta t)}{(\Delta TEC)^2} \tag{2}$$

Where: *x* is the space (in longitude or latitude) and (Δx, *t)* is change is space with time, and $MSTID_{PROP}$ is the cross-correlation coefficient. These cross-correlation maps enable us to identify the waves, if present, by tracking the space and temporal shift of the maximum cross-correlation region. Equation (2) represents the MSTIDs propagation between two latitudes or two longitudes.

RESULTS

Figures 2 (a) to 2(d) show the MSTIDs oscillation and propagation in the following order: 2(a) shows keogram plot of TEC disturbance in latitude and time, 2(b) show the cross-correlation representing the MSTIDs propagation in latitude and time, 2(c) shows keogram plot of TEC disturbance in longitude and time, 2(d) show the cross-correlation representing the MSTIDs propagation in longitude and time,

From Figures 2(a) to 2(d) below it is possible to note the following: TEC disturbance oscillates in time at a chosen location with periods covering between 15-55 minutes, corresponding cross-correlations maximize sometime during 13-16 UT, the phase oscillations and maxima amplitudes are observed to commonly shift towards equatorward/eastward with time in both hemispheres, these MSTIDs are well defined and last longer in latitude than in longitude, and the mirrored MSTIDs occur around the geomagnetic equator as expected.

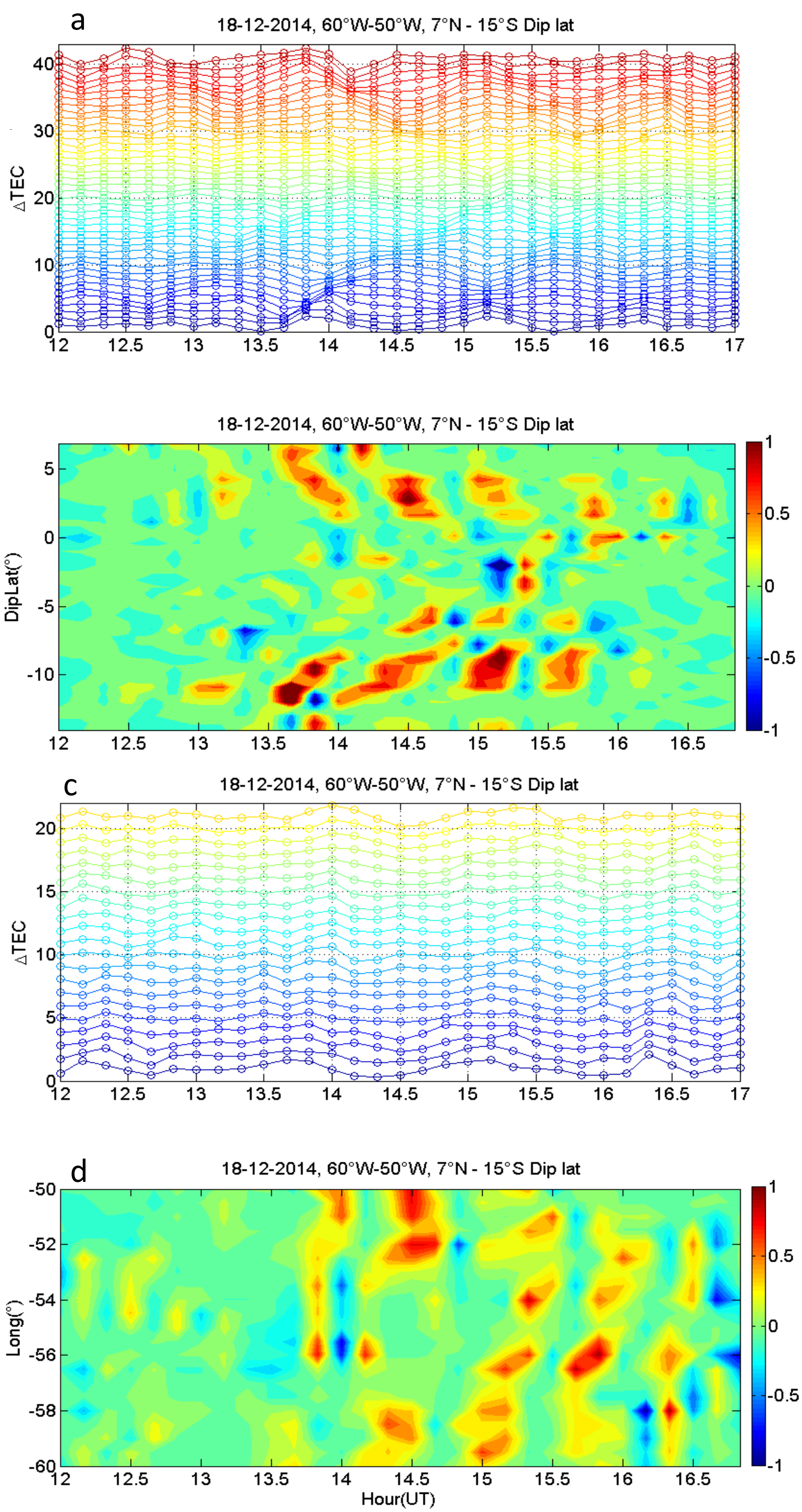

Figure 2: The first and third panels represent the TEC disturbance. Each line represents latitude and longitude respectively. The second and fourth panels represent MSTID propagation derived from the cross-correlation coefficients in latitude and longitude respectively.

CONCLUSIONS

- Observation of daytime MSTIDs at conjugate hemispheres for the first time over the South America region.
- Investigations show that F region magnetic field aligned integrated conductivity has more influence than E region conductivity during the mapping periods.
- GW induced electric field in ionosphere could map from one hemisphere to the other causing the mirrored MSTIDs in both hemispheres.

REFERENCES

Otsuka, Y., T. Ogawa, A. Saito, T. Tsugawa, S. Fukao, S. Miyazaki, (2002), A new technique for mapping of total electron content using GPS network in Japan. *Journal of Earth Planets Space*, v. p. 54, 63–70.

Galvan, D. A., A. Komjathy, M. P. Hickey, and A. J. Mannucci (2011), The 2009 Samoa and 2010 Chile tsunamis as observed in the ionosphere using GPS total electron content, *J. Geophys. Res.*, vol. 116, A06318, doi:10.1029/ 2010JA016204.

Jonah, O. F. Kherani, E. A. de Paula, E. R. (2016), observation of TEC perturbation associated with medium scale travelling ionospheric disturbance and possible seeding mechanism of atmospheric gravity wave at the brazilian sector, *J. Geophys. Res, (submitted)*

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