

Background

Traveling ionospheric disturbances (TID) have been investigated for more than 4 decades, but they remain topics of active research and scientific debate. Present study addresses several important characteristics of TIDs during both disturbed and quiet periods in the geographic region covering middle to equatorial latitudes.

We investigate the hemispheric electrodynamics interconnectivity of the propagating LSTIDs, the LSTID orientation and phase oscillations as they propagate from one source region to the other. Our study also indicates the initialization of the LSTIDs, their duration and whether they survived into the conjugate hemisphere (i.e. whether wave interactions are constructive or destructive).

Method for TID Determination

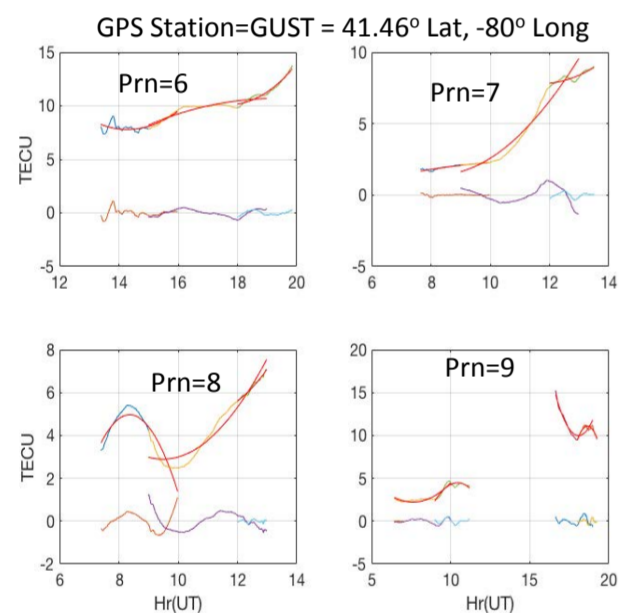


Figure 1. Example of TID analysis procedures for a single GPS station but for different PRN; the orange curve represents a low pass filter fit on the data set, and the curve below represents differential TEC (Δ TEC), obtained by taken the difference between the data set and the low pass filter.

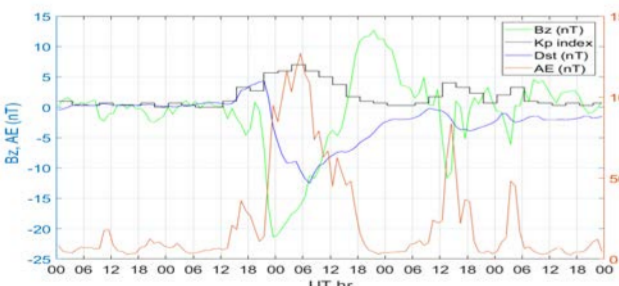


Figure 2. Summary of geomagnetic activity for the Memorial Day weekend geomagnetic storm (May/28/2017) which could be classified as an intense storm. Green, blue, black and red lines represent B_z , Dst , K_p and AE . The storm features southward interplanetary field (B_z) that went below 20 nT for about 4 hr, a minimum Dst of -120 nT at about 0820UT, the K_p index reaching 7 during the main phase of storm, and a strong increase in the AE from \sim 200 to \sim 1300 nT.

Interhemispheric coupling of TIDs during the Memorial Day weekend Storm (May/28/2017)

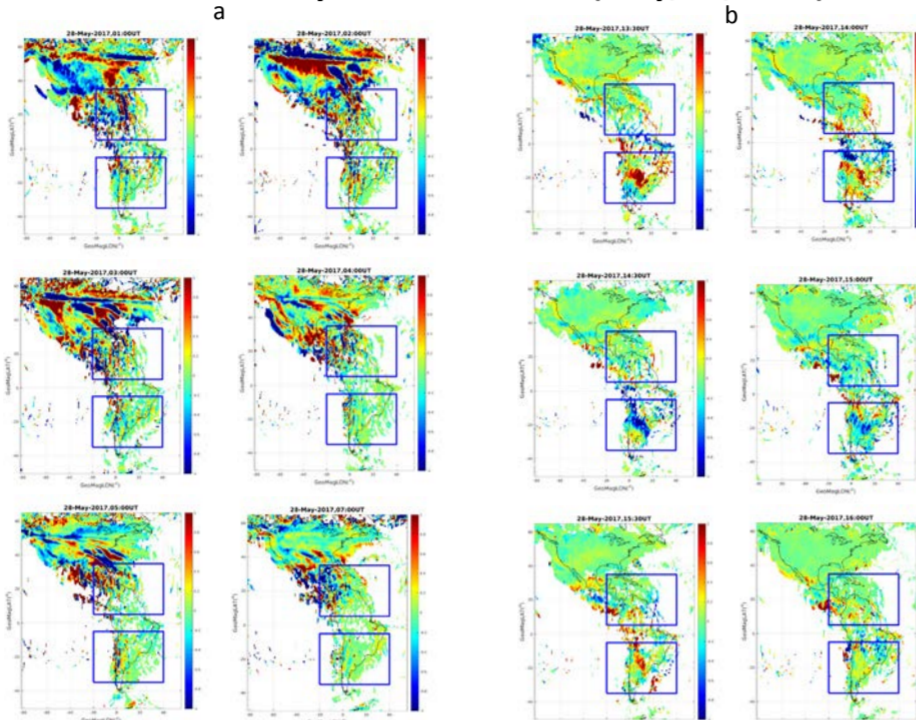


Figure 3(a). Two-dimensional maps (in Geomagnetic coordinate) of TIDs over north and south America at selected times during 00:30 to 07:00 UT (evening) during the main phase of the 2017 Memorial Day weekend geomagnetic storm.

We observe LSTIDs generated at the north hemisphere map to south hemisphere and propagate in time.

Figure 3(b). Also Two-dimensional maps of TIDs over North America at selected times during 01:30 to 16:00 UT (daytime over south America) on same day, during the recovery phase of the storm. It is possible to observe LSTIDs generated from south hemisphere, propagating to the northeast region and no clear mapping to conjugate hemisphere

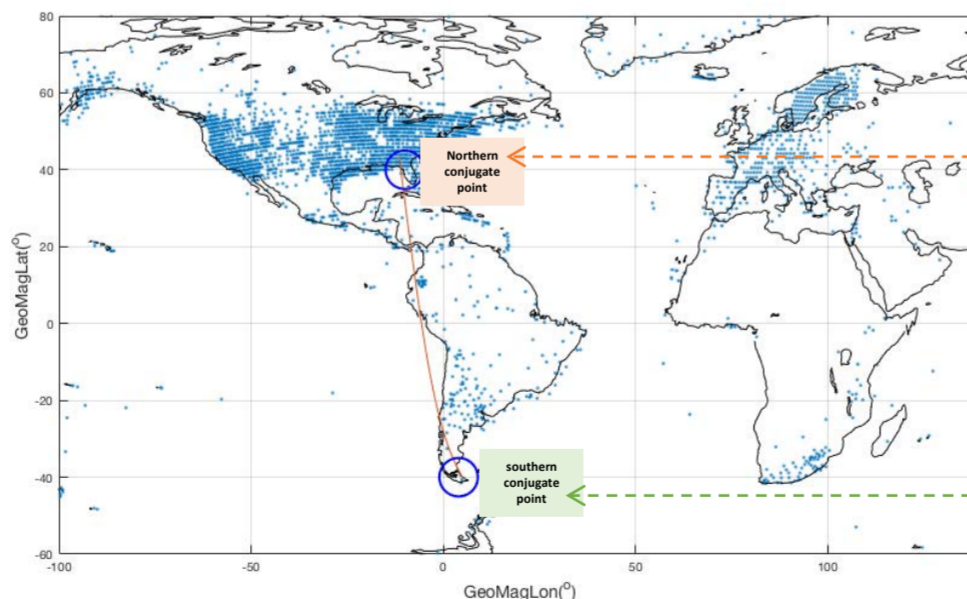


Figure 5. The distribution of GNSS receivers (blue dots) over America, Africa and Europe sectors. The blue circles represents specific conjugate regions focused in this study. The results observed at the conjugate points are shown in Figure 6.

Interhemispheric coupling of TIDs during the quiet day (May/26/2017)

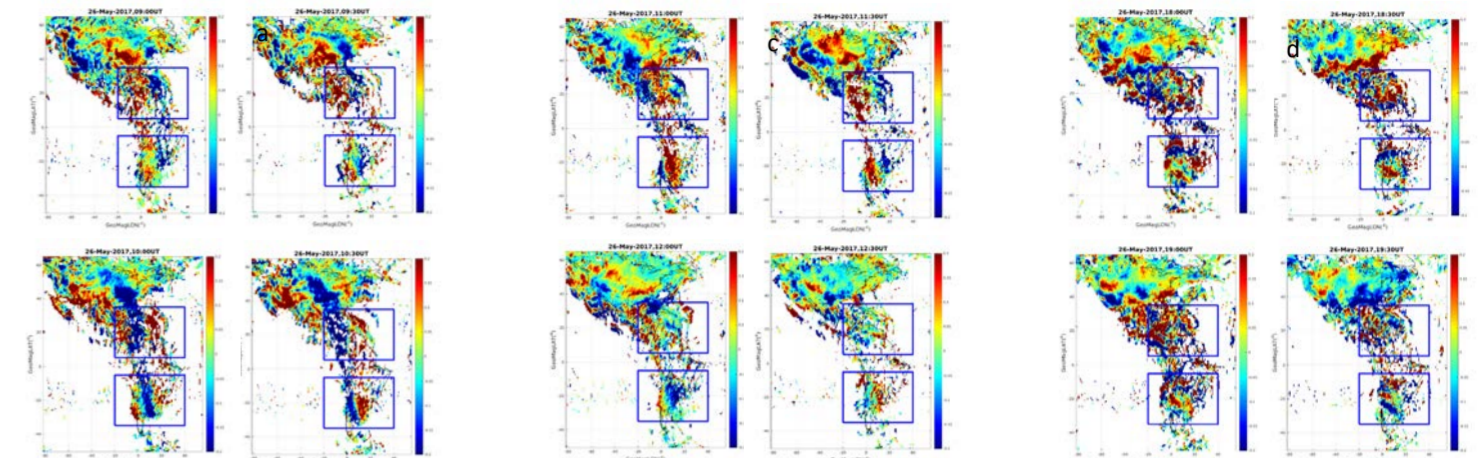


Figure 4(a). Two-dimensional maps (in Geomagnetic coordinate) of TIDs over north and south America at selected times during 09:00 to 10:30 UT (Nighttime) during the a quiet day.

We observe LSTIDs generated from either north or south hemisphere and propagate in time to the southwest in both hemisphere.

Figure 4(b). TIDs observed over north and south America at selected times during 11:00 to 12:30 UT (daytime) during the same quiet day.

We observe LSTIDs generated from either north or south hemisphere and propagate in time in the northeast direction in the south hemisphere and southwest direction in the north hemisphere.

Figure 4(c). TIDs observed over north and south America at selected times during 18:00 to 19:30 UT (evening time) during the same quiet day.

We observe LSTIDs generated from either north or south hemisphere and propagate in time in the southwest direction in the south hemisphere and northeast direction in the north hemisphere. TID seem to be generated by different localized forcing.

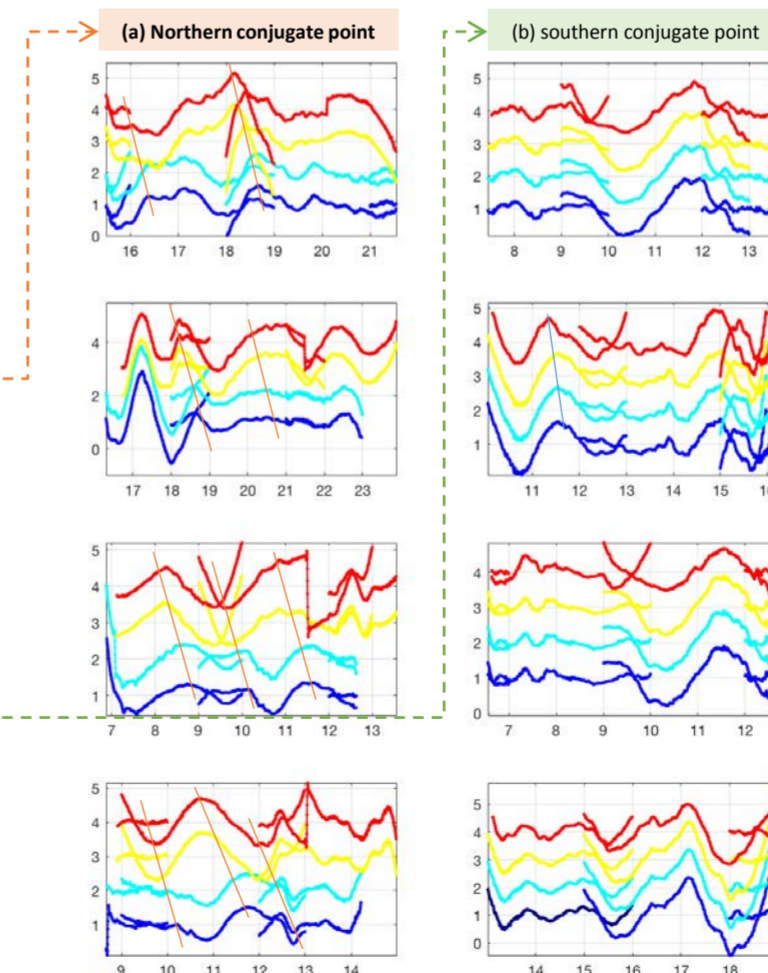


Figure 6. Observation of AGW signature in the northern and southern conjugate points.

Figure 6(a) Observations from 4 different GPS receiver stations and different PRN. (a) Each panel represents TIDs obtained from 4 receiver station of different PRN for the **north** conjugate point.

Figure 6(b). Each panel represents TIDs obtained from 4 receiver station of different PRN for the **south** conjugate point.

Besides the TIDs from both conjugate area, it is possible to also observe stronger signatures of gravity wave from the north hemisphere station than from the southern hemisphere counterpart. This implies that the conjugacy of TID observed are possibly generated by gravity wave source from the northern hemisphere. More investigation of this nature will be carried out to established this point.

Conclusion

- ✓ TIDs generated in one hemisphere are observed at conjugate hemisphere.
- ✓ The direction of TIDs propagation rotate/ changes with time within multiple events.
- ✓ Observed TIDs are mostly generated by gravity wave from the northern hemisphere and form conjugacy with the southern hemisphere.