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Comparison between 2-D GPS dTEC Data Maps and Digisonde Observations over the South American and Atlantic Regions

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While GNSS-derived absolute total electron content (TEC) measurements contain a wealth of information on the state of the ionosphere, certain ionospheric phenomena are most clearly discernable by examining the detrended TEC data instead. Such phenomena include traveling ionospheric disturbances (TIDs) and equatorial plasma bubbles (EPBs). We have developed a TEC data detrending procedure [Pradipta et al., 2015] that is inherently capable of distinguishing between wavelike fluctuations associated with TIDs and deep depletions associated with EPBs. Subsequent 2-D geospatial latitude/longitude mapping of net detrended TEC (dTEC) values from 200+ stations in South America reveal the spatial structures of EPBs over that region (in close alignment with the geomagnetic meridian), and their drift movement throughout the evening. These 2-D latitude/longitude maps of detrended TEC allow us to gain good spatial awareness on the presence of ionospheric irregularities over the area, but some additional validation from independent measurement data would be useful to confirm the data products.

Here we present the results from our efforts to validate the 2-D dTEC data maps over South America against digisonde observations. We compared the presence of depletions in the dTEC data maps and the observations of equatorial spread-F (ESF) echoes in the digisonde measurements. We used the 2011 data from four digisonde stations in this study: Jicamarca (JI91J), Cachoeira Paulista (CAJ2M), Fortaleza (FZA0M), and Ascension Island (AS00Q). The first three digisondes are located in the mainland Latin America and were used directly for comparison against the GPS-derived 2-D dTEC data maps. However, the Ascension Island digisonde was added to the list to help form an east/west chain of 4 digisondes in the South American/Atlantic region for a combinatoric analysis of day-to-day and east-to-west EPB/ESF occurrence (or no-occurrence) throughout the test year.

Based on our 2011 comparison over Jicamarca: 55.1% fall within the EPB=YES & ESF=YES category, 20.6% fall within the EPB=NO & EPB=NO category, 24.4% fall within the EPB=NO & ESF=YES category, and 0% fall within the EPB=YES & ESF=NO category. Over Cachoeira Paulista: 48.5% fall within the EPB=YES & ESF=YES category, 37.4% fall within the EPB=NO & EPB=NO category, 13.2% fall within the EPB=NO & ESF=YES category, and 0.8% fall within the EPB=YES & ESF=NO category. Over Fortaleza: 68.8% fall within the EPB=YES & ESF=YES category, 10.4% fall within the EPB=NO & EPB=NO category, 20.2% fall within the EPB=NO & ESF=YES category, and 0.6% fall within the EPB=YES & ESF=NO category. From the combinatoric pattern analysis (both day-to-day and east-to-west) of EPB and ESF occurrences, we found that certain combinatoric patterns (e.g. '+++' or '+-+' or '---' from west-to-east) tend to dominate over other permutations. As a notation, here '+' indicates an occurrence & '-' indicates a no-occurrence. However, we found that no single combinatoric pattern attains absolute majority. There might be some implications on the limit of EPB/ESF predictability that can be theoretically achieved.

REFERENCES

Pradipta, R., C. E. Valladares, and P. H. Doherty (2015), An effective TEC data detrending method for the study of equatorial plasma bubbles and traveling ionospheric disturbances, J. Geophys. Res. Space Physics, 120, 11,048-11,055, doi: 10.1002/2015JA021723.