Initial Description of the Local Ionospheric Response to Geomagnetic Storms

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Abstract: Geomagnetic storms are planet-wide disturbances of the Earth's magnetic field, closely related with solar activity events. In this work, we describe the response of our local ionosphere (as per foF2-critical frequency, TEC-total electron content) to geomagnetic activity (ap index) for year 2015. We found that for Equinox and Summer, the ionospheric parameters suffer a depletion from the quiet reference, indicating a more active recombination process due to the presence of fresh molecular mass. For winter conditions the ionospheric parameters increase over the quiet mean, corresponding with a prevalence of atomic elements, resulting in a less predominant recombination process. These results agree with previously published studies of mid to mid-low ionosphere.

Keywords: *ionosphere; ionospheric storm; geomagnetic storm; solar activity*

Author Contributions

Solar activity is the main source for disturbances of the geomagnetic field, which results in perturbations of the ionosphere, a layer of the earth's atmosphere with a high concentration of ions and free electrons. These disturbances are known to disturb technological system (*i.e.,* navigation and communication systems, power lines, generators, and transformers, satellites, etc.), in various degrees, depending on the intensity of the ionospheric storm, geomagnetic location of the system, and technological awareness.

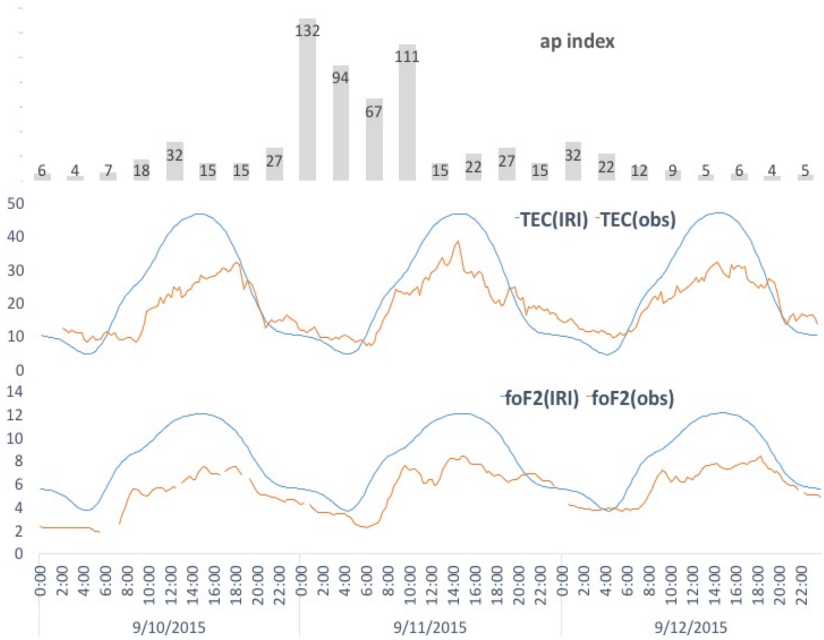

Figure 1: Equinox event showing a depletion of TEC and foF2 values (negative phase). Quiet values in blue, disturbed in brown.

In this work, we study the response of the ionosphere to disturbed events for south Florida, year 2015. The quiet ionospheric values were generated from the International Reference Ionosphere (IRI), while the foF2 disturbed values are from the sounder at the Eglin Air Force Base (EAFB), and the TEC disturbed values and geomagnetic ap-index from the National Geophysical Datacenter. Six events with ap ≥ 100 (units of 2 nT) were identified. Due to space restrictions, only two examples are offered, exposing the opposite seasonal ionospheric responses. For example, Figure 1 shows the level of geomagnetic activity (ap-index, upper panel), quiet (blue) and disturbed (brown) TEC (expressed in 10^{16} e^{-}/m^2, mid panel), and foF2 (expressed in MHz, lower panel) for the period of September 10-12, 2015 (Equinox). Notice that the time scale at the bottom of the figure is common for all panels. In this figure it is easily observed that both parameters, TEC and foF2, show a consistent trend to lower values respect to the quiet conditions, a so-called negative phase. All Equinox/Summer events display the same behavior, in full agreement with previous results (*i.e.,* Araujo-Pradere *et al.,* 2006, 2002a) for equinox and summer conditions, with the exception of the abnormal ionospheric behavior during the past solar minimum (Araujo-Pradere, *et al.*, 2011), but including the normal variability (Araujo-Pradere, *et al.*, 2004).

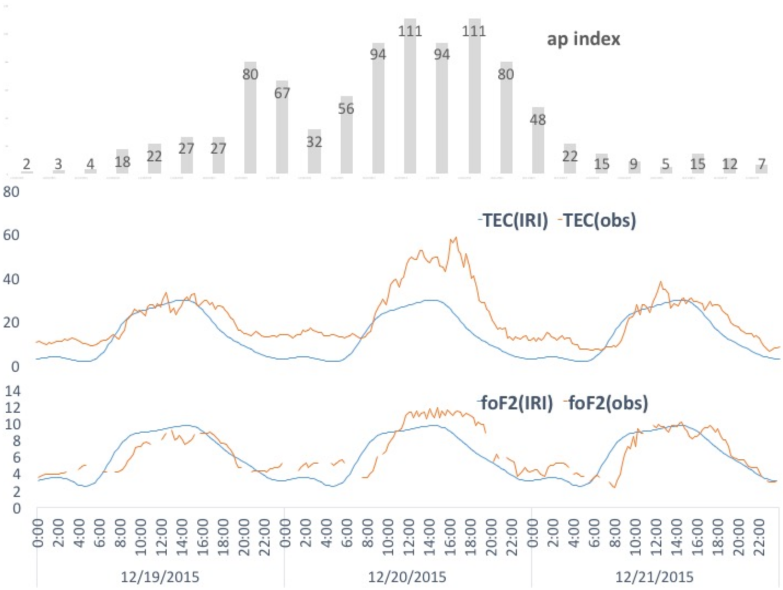

Figure 2: Winter event showing an increment of TEC and foF2 values (positive phase). Quiet values in blue, disturbed in brown.

A different picture is shown in Figure 2. Here, TEC and foF2 disturbed values are higher than the quiet reference, commonly identified as a "positive phase". This seasonal difference is explained by the fundamental summer-to-winter circulation, which transports the molecular rich gas to mid and low latitudes in the summer hemisphere over a day or two following the storm. In the winter hemisphere, poleward winds restrict the equatorward movement of the composition bulge. Consequently, the altered environment in summer depletes the F region midlatitude ionosphere to produce a negative phase, while in winter midlatitude a decrease in molecular species, associated with downwelling, persists and produces the positive storm (Araujo-Pradere *et al.,* 2002b).

Conflicts of Interest

The authors declare no conflict of interest.

References and Notes

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