Electron Density Changes During Geomagnetic Storms

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The July 2017 Monthly Feature titled "When the K Index Goes Up" discussed the common belief that major geomagnetic storms totally disrupt the higher bands. It was pointed out that enhancements in the F2 region electron density can occur during major geomagnetic storms, and several unusual QSOs in the 2017 CQ WPX CW contest were reviewed. Additionally, a technical paper was reviewed that showed an electron density increase over the Millstone Hill (MA) observatory during an April 2004 geomagnetic storm.

Right after this Monthly Feature was posted to my web site, I became aware of another technical paper about electron density changes during geomagnetic storms (Note 1). This paper took a global view of the changes in electron density, and discussed pre-storm enhancement effects, negative ionospheric storm effects and positive ionospheric storm effects. The purpose of this Monthly Feature is to give a quick summary of the authors' results. This will be done in tabular format.

Pre-Storm Enhancements

Region Affected	When	Cause of Enhancements
High latitudes	Several hours before storm onset, most pronounced during equinoxes	Not well understood – could be due to changes in solar wind densities, could be linked to coronal source structure

Negative Ionospheric Storm Effects

Region affected	When	Cause of Depletions
High latitudes	At storm onset under the auroral zone, several hours later equatorward of the auroral oval	Decrease in O/N_2 ratios
Middle and low latitudes	Several hours to days after storm onset	Decreased O/N_2 ratios transported to lower latitudes via either storm-induced equatorward surge of thermospheric circulations or seasonal differential heating

Positive Ionospheric Storm Effects

Region Affected	When	Cause of Enhancements
High latitudes	Several hours prior to storm onset (until O/N_2 depletion takes over) in the summer hemisphere and equinoxes that have favorable solar wind and magnetosphere-coupling angles	Low-energy electron precipitation increasing photo-ionization rates
Middle latitudes	Up to a day after storm onset	Strong daytime eastward prompt penetration electric fields (lifts equatorial ionization into the mid latitudes) and stronger than normal persisting equatorward winds (reduces downward diffusion of increased mid latitude ionization)
Low latitudes	For up to 3 days after storm onset, mainly during the equinoxes	Collision of storm-induced stronger-than-normal equatorward winds from opposite hemispheres

The authors also point out that in conditions of both positive and negative storm processes occurring simultaneously, the negative storm processes tend to dominate.

Although this is a quick summary, it should be apparent that this is more proof that there can be positive storm enhancements during geomagnetic storms. For more details, please reference the article in Note 1.

So always keep an ear open during geomagnetic storms. If you're in the right place at the right time, you may be pleasantly surprised.

Note 1 – Vickal V. Kumar and Murray L. Parkinson; *A global scale picture of ionospheric peak electron density changes during geomagnetic storms*; **AGU Space Weather**; April 2017