Ministry of Higher Education and Scientific Research
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The effects of ionospheric disturbance's on GNSS signals during solar cycle 24

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Outline

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Introduction

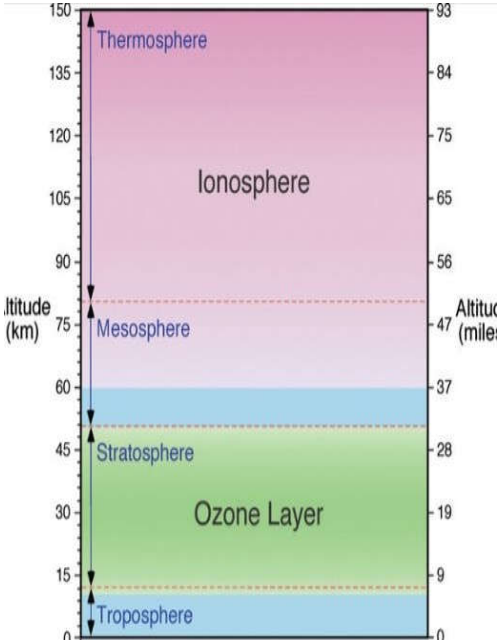
Radio Wave play significant role in varies modern technological systems, Terrestrial and Space based telecommunication, Ground and space based navigation systems(GNSS) and Remote sensing Radars.

Radio wave propagation is closely related to ionospheric conditions in most applications and the ionosphere is impacted by space weather.

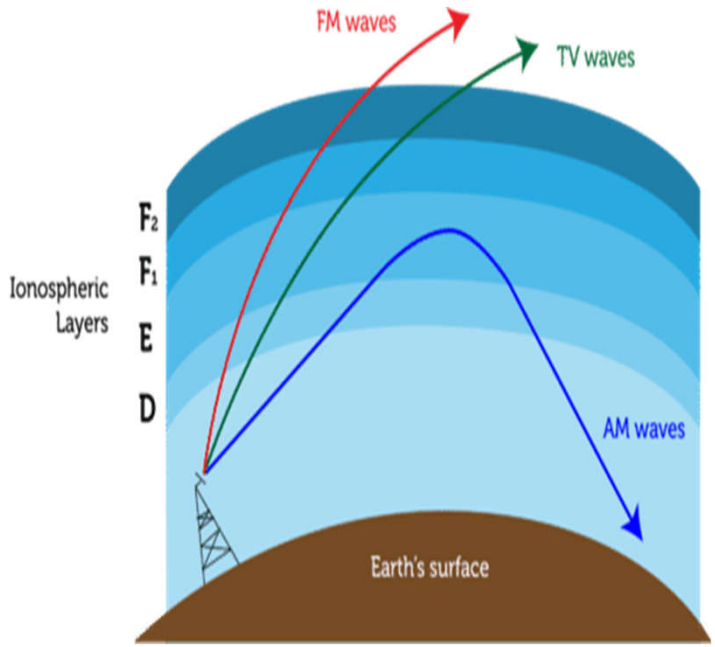
Space weather refers to changes in the space environment near Earth such Solar Flares, CME(Control Mass Ejection), and Solar Winds.

It is due to changes in the near-Earth space environment, which are caused by varying conditions on the Sun and its atmosphere.

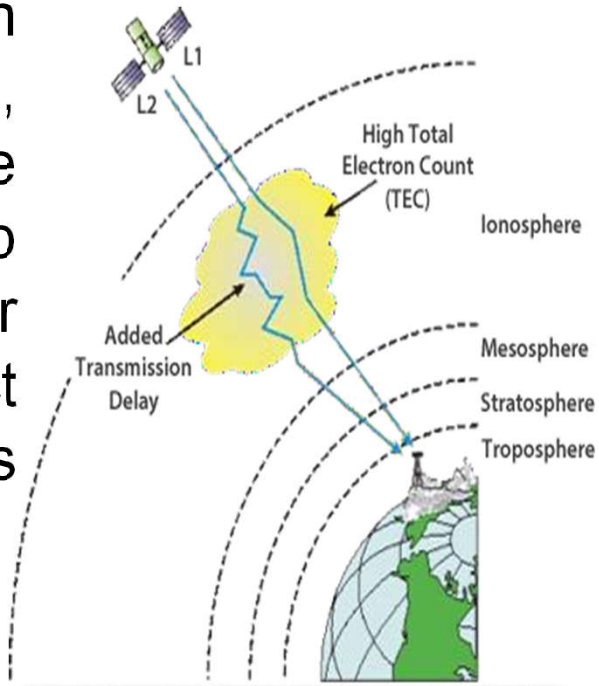
The ionosphere exists between about 90 and 1000 km above the earth's surface. This ionize layer consists of many Layers of high densities of electrons are given special names called the D, E, and F layers. The height and density of these layers vary with time of the day, time of the year, sun-spot cycle and latitude, and these conditions in turn, decide which layers control the communications at various distances on various wavelengths.



The ionosphere plays a major role in aiding long distance HF (3to 30 MHz) communications as well as in the deteriorating performance of satellite radio systems in the VHF (30 to 300MHz), UHF (300 to 3000 MHz).



The ionized layer has Sudden Ionospheric Disturbance, such as ionospheric scintillation, which can adversely degrade the performance of radio systems operating for communication. It can affect the transmission of radio waves in at least two ways.



Effect of ionospheric refraction. The GPS signal are affected in different ways, depending on whether it is a question of codes or phases.

Firstly, charged particles (electrons) can remove energy from an electromagnetic wave and thus attenuate the signal; in the bad case, the energy of the wave can be absorbed completely. Second, High electron density affects the speed of wave propagation because a wave travelling from one place to another.

Ionospheric Scintillation Phenomenon

Ionospheric scintillations are caused when electromagnetic signals propagate through an irregular ionosphere. The Scintillations May cause strong fluctuations of signal strength(Amplitude) and phase due to diffraction and forward scattering, It occur in all frequency bands.

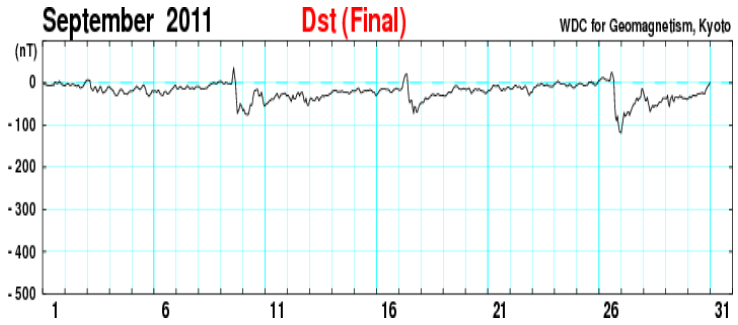
At low latitudes scintillations are mainly caused by plasma instability. Scintillation monitoring is accomplished by monitoring the index S4. The S4 index is increase at lower frequency.

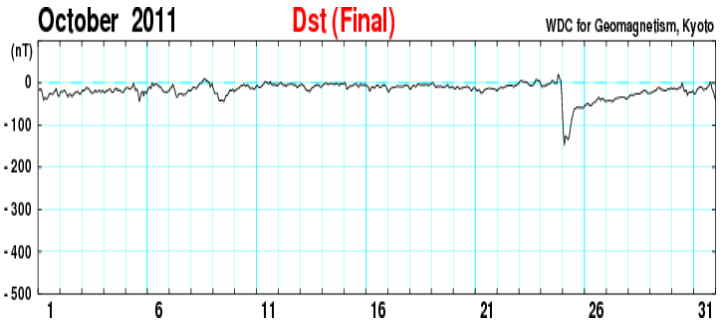
Methodology

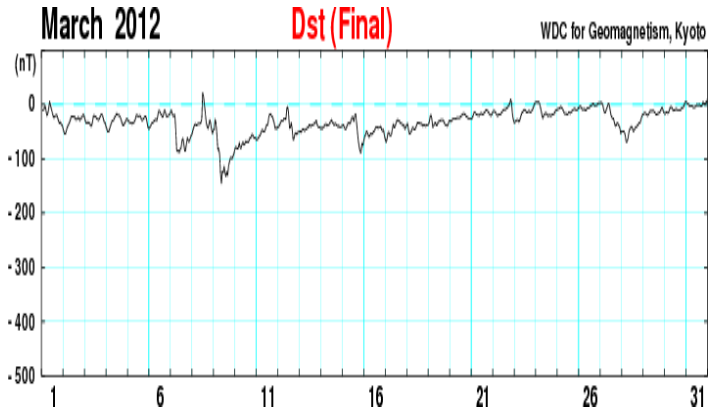
In order to understand more carefully the ionospheric impact on navigation signals we present some results obtained from the Comparison between the Dst, F10.7 and S4 index during the maximum solar event in the 24 solar cycle shown in table 1

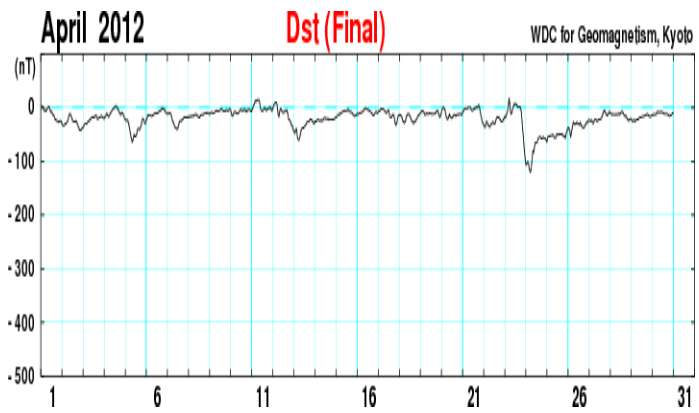
Results and discussions

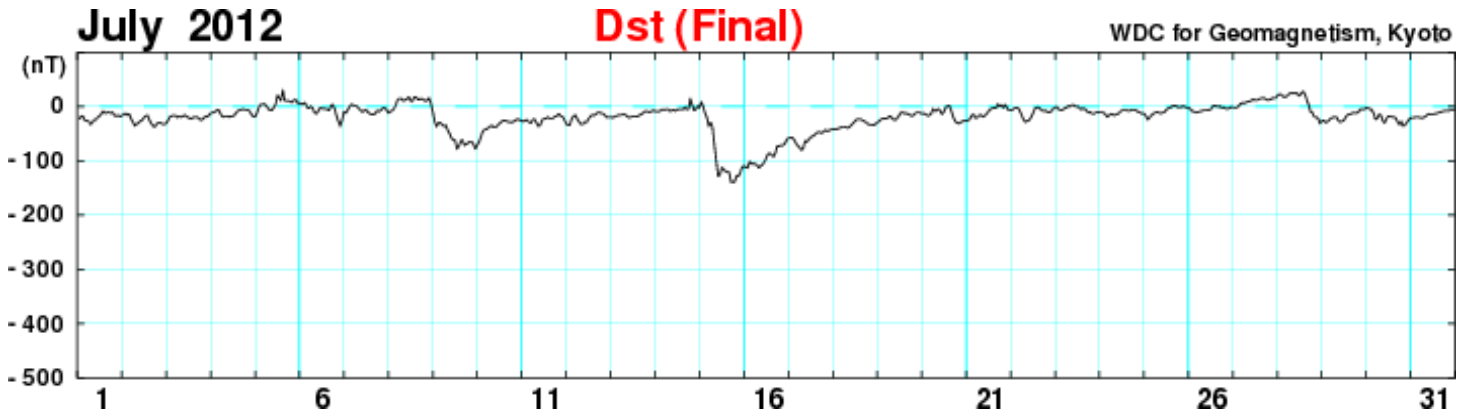
1 disturbance Time storm (Dst)



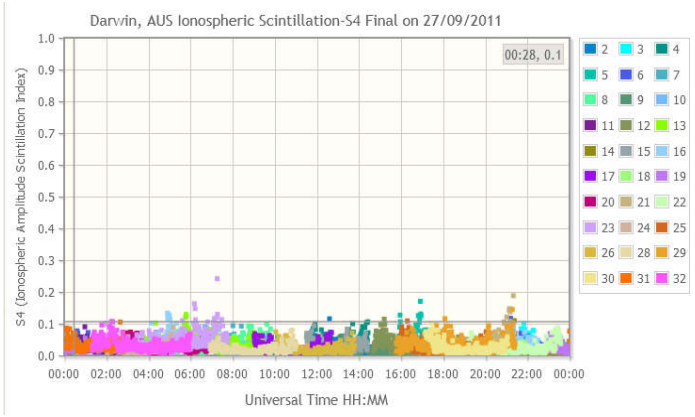


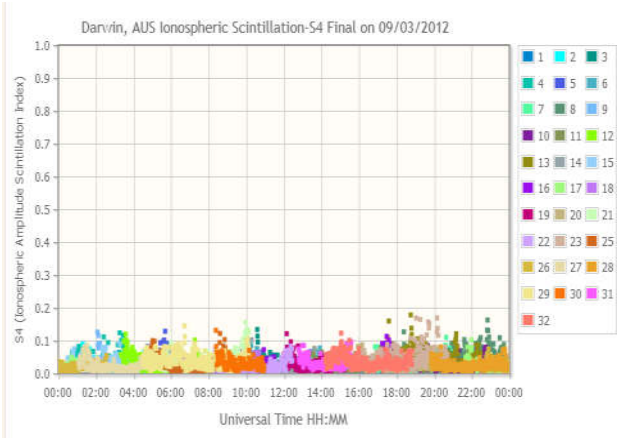

March 2012
Dst (Final)
WDC for Geomagnetism, Kyoto
(nT)
0
-100
-200
-300
-400
-500
1
6
11
16
21
26
31

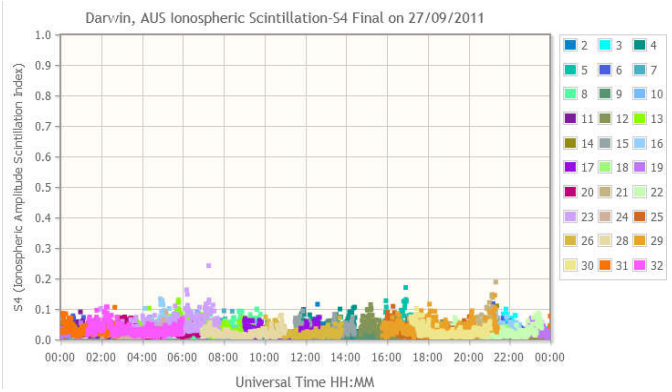

April 2012
Dst (Final)
WDC for Geomagnetism, Kyoto
(nT)
0
-100
-200
-300
-400
-500
1
6
11
16
21
26
31

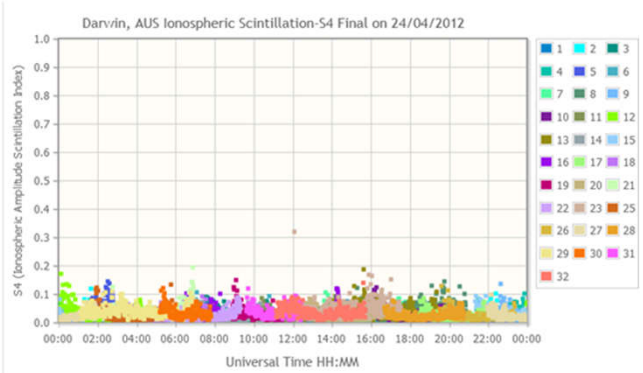

July 2012
Dst (Final)
WDC for Geomagnetism, Kyoto
(nT)
0
-100
-200
-300
-400
-500
1
6
11
16
21
26
31

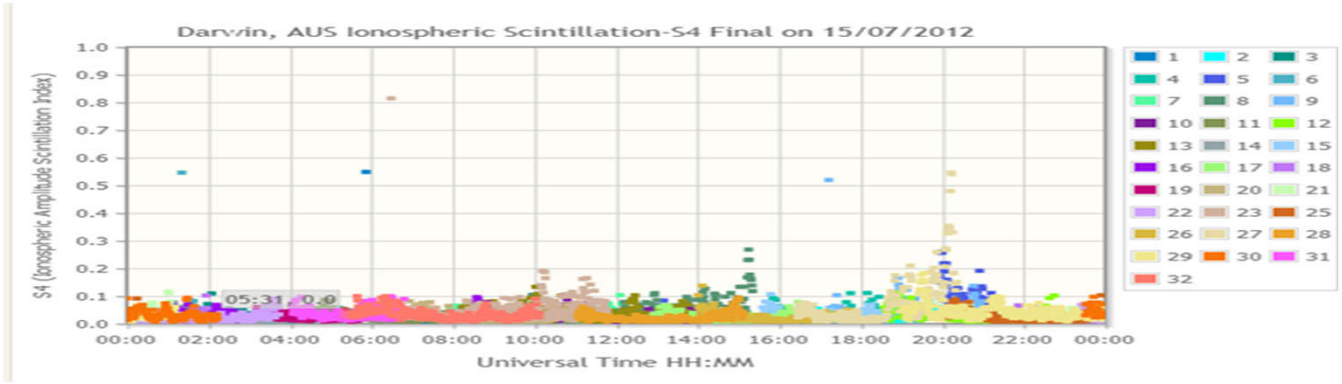
2 ionospheric scintillation index (S4)



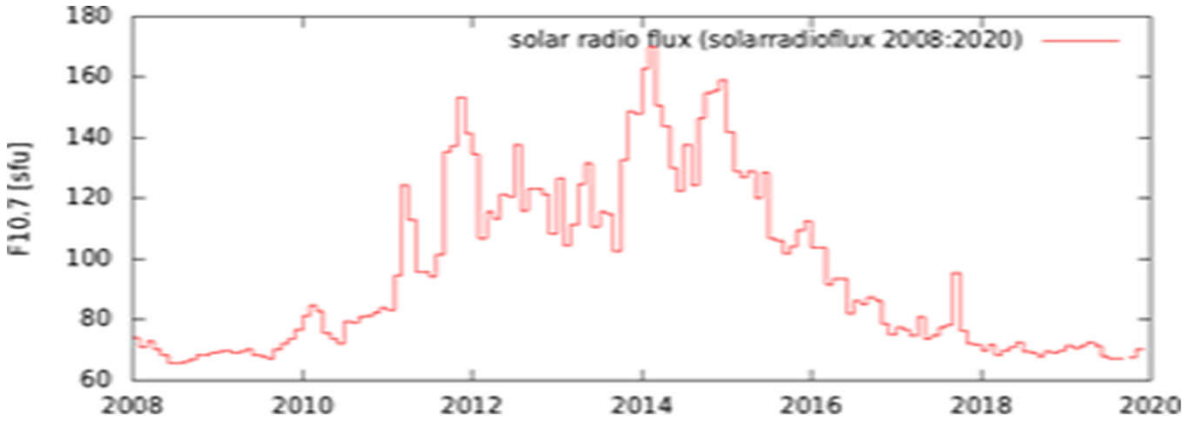








3 solar radio flux F10.7



Discussions

The results presented that Disturbance Storm Time (Dst) in state increasing and reach up to -

500 nT and Solar Radio Flux (F10.7cm) showed high values during Maximum Solar Cycle 24 So, that this enhance the Ionospheric Scintillation (S4), hence certain days were taken throughout the time of peak solar activity, in order to know the effects of solar activity on the global navigation satellites systems(GNSS), and this was clarified by reading the results of the indexes,

which led to Ionospheric Scintillation occurrence resulted from interactions of plasma was come from the Sun during the period of solar activity with the density of electrons and protons in the Ionosphere layer, which increases the density of the Ionosphere layer and thus leads to instability in the Ionosphere layer, and may be causes the delay of radio signals or lose it.

Conclusions

The results we obtained showed that during the period of solar activity, the ionosphere is affected and caused disturbances that lead to distortion in the propagation and path of radio signals and cause errors in the amplitude and phase of the signals received from the navigation satellites.

We recommend that in the future work to use real time GPS data and analysis according to the space data in order to get more accurate results.

We can use Internet of Thangs Technology(IOT) and long Rang(LORA) Technology to monitoring the ionosphere.

References

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Thank you for Listening