CHAPTER I

INTRODUCTION

Space weather

Definition of Space weather:

conditions on the Sun and in the solar wind, magnetosphere, ionosphere and thermosphere that can influence the performance and reliability of space-borne and ground-based technological systems and can endanger human life or health. Space weather although describes disturbances that occur in near-Earth space, which can disrupt modern technologies. It is a natural hazard to which human civilization has become vulnerable, through our use.

(1-1) **Magnetosphere**

Is the area of space around the earth in which the charged particles are controlled by the earth magnetic field near the surface of the earth the magnetic field lines resemble those of a magnetic dipole, farther away from the surface, the field lines are significantly distorted by electric currents flowing in plasma (e.g. in ionosphere or solar wind) (Ratcliffe, 1972).

(1-2) Ionosphere

The ionosphere contains only a small fraction of the Earth's atmosphere (less than 1 % of the mass of the atmosphere). However, this layer is extremely important for modern telecommunication systems since it influences the passage of radio waves.

At low latitudes the largest electron densities are found in peaks on either side of the magnetic equator, which is called the equatorial anomaly.

The electric fields transport plasma and are caused by a polarizing effect of thermospheric winds.

The ionosphere varies because for the following two reasons:

• Two varying sources of ionization (aurora, Sun)

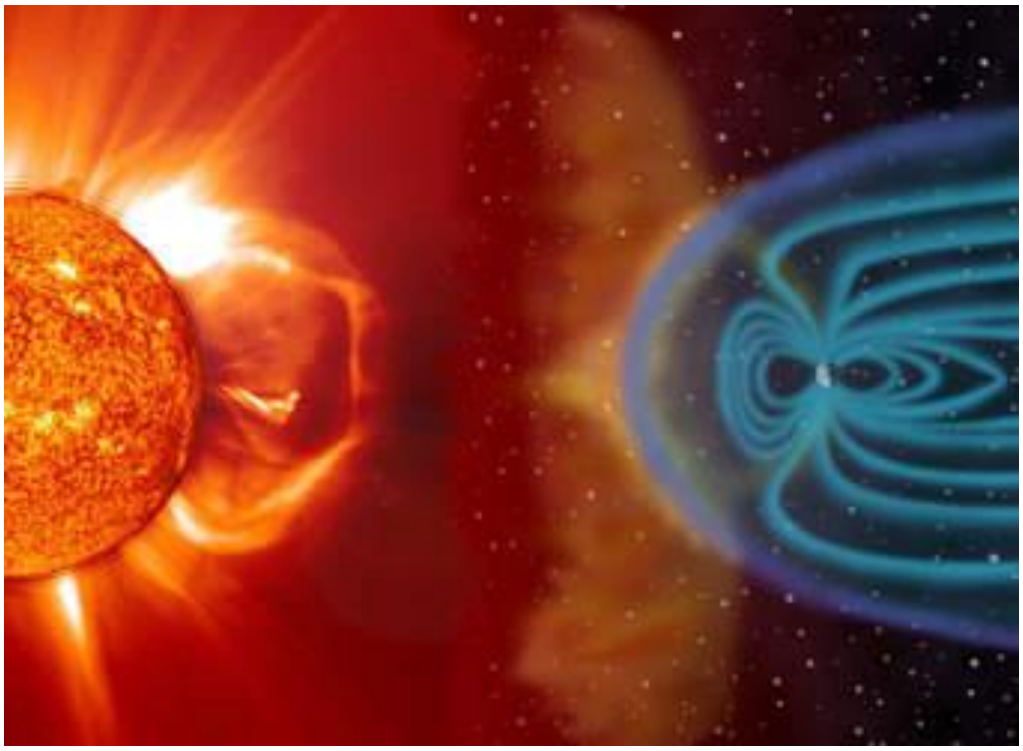
• Changes in the neutral part of the thermosphere, which responds to solar EUV radiation.

Thus the ionospheric variation mainly occurs at a 24 hours period (daytime-nighttime) and over the 11 year cycle of solar activity (HANSLMEIER, 2006)

(1-3) Solar winds

Charged particles are always flowing from the sun toward the earth, creating what is called the solar wind. During solar flares, the stream of charged particles that flows towards the earth significantly adds to the existing ambient solar wind. These charged particles are mostly made up of hydrogen ions, helium ions, and electrons The solar wind travels towards the earth at a speed of 500-1000 kilometers (300-600 miles) per second, taking 2-3 days to reach the earth's own magnetic field . The solar wind also has a magnetic field associated with it. It is the orientation of the solar wind's magnetic field that determines whether or not a geomagnetic storm will occur. It should be noted that the orientation of the vertical component solar wind's magnetic field can be either northward or southward. The earth's magnetic field is oriented from south to north and tends to prevent the solar wind from entering the earth's magnetosphere. However, if the magnetic field of the solar wind is oriented from north to south (opposite to the earth's magnetic field) then the field lines of the solar wind and the magnetosphere "reconnect" .allowing the solar wind to enter the

earth's magnetosphere, giving a possibility of a geomagnetic storm. (Manitoba-Hydro,1996)



Figure(1-1) show the solar winds

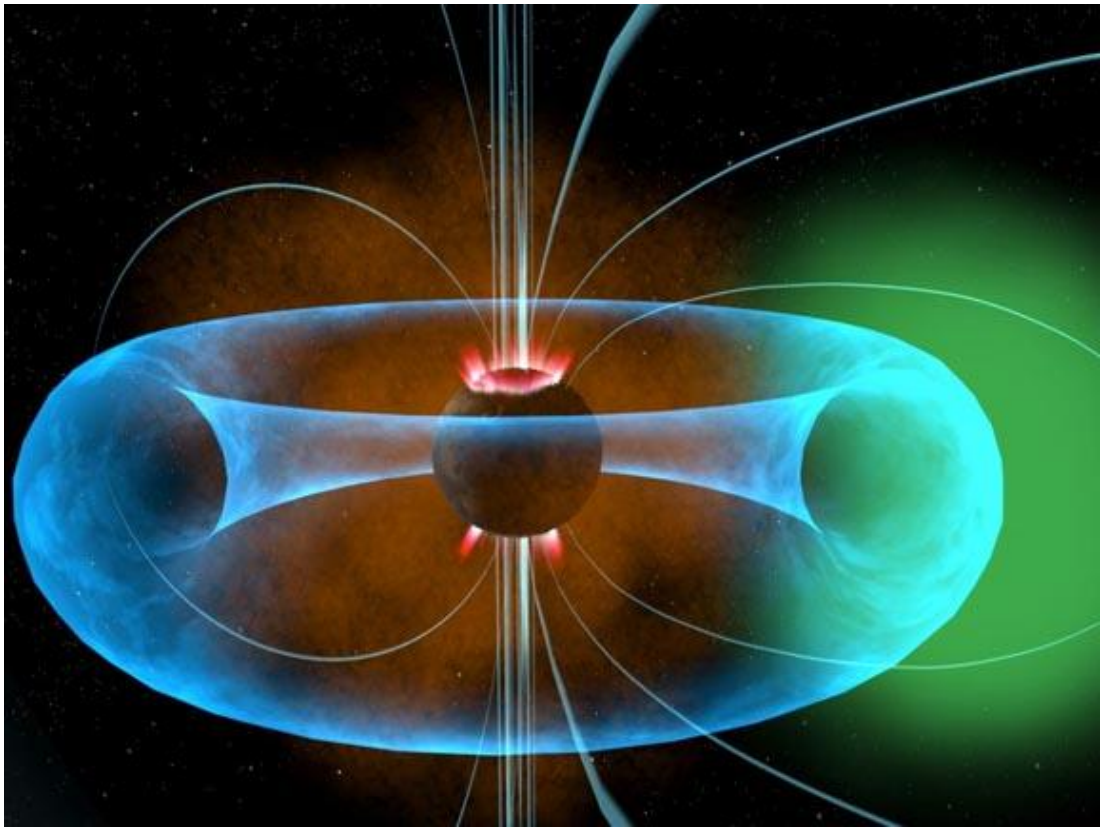
(1-4) Ring current

The terrestrial ring current is an electric current flowing torridlywestward around the Earth, with variable density at geocentric distances between; 2*RE* and; 9*RE*. Changes in this current are responsible for global decreases in the Earth's surface magnetic field, which are known as geomagnetic storms.

The main carriers of the storm ring current are positive ions, with energies from , 1 KeV to a few hundred KeV, which are trapped by the geomagnetic field and undergo an azimuthal drift, it's oppositely directed for ions and electrons, electron's move eastward and most ions (with energies above a relatively low threshold) move

westward. This drift constitutes a net charge transport of the current associated with the charge transport is the ring current.

The ring current is formed by the injection of ions originating in, the solar wind and the terrestrial ionosphere (Daglis, 1999).



Figure(1-2) show the flow of the ring current

(1-5) Aurora:

There are many shapes and features of aurorae. They generally start at 100 km above the surface and extend upward along the magnetic field for hundreds of km. Auroral arcs can nearly stand still and then suddenly move (dancing, Turning). After midnight one often sees a patchy appearance of aurora, and the patches blink on and off every 10 s or so. Most of auroras are greenish yellow and sometimes the tall rays turn red at their top and along their lower edge. On rare occasions sunlight hits on the top creating a faint blue color.

The different colors depend on the specific atmospheric gas, its electrical state and on the energy of the particle that hits the atmospheric gas.(HANSLMEIER, 2006)

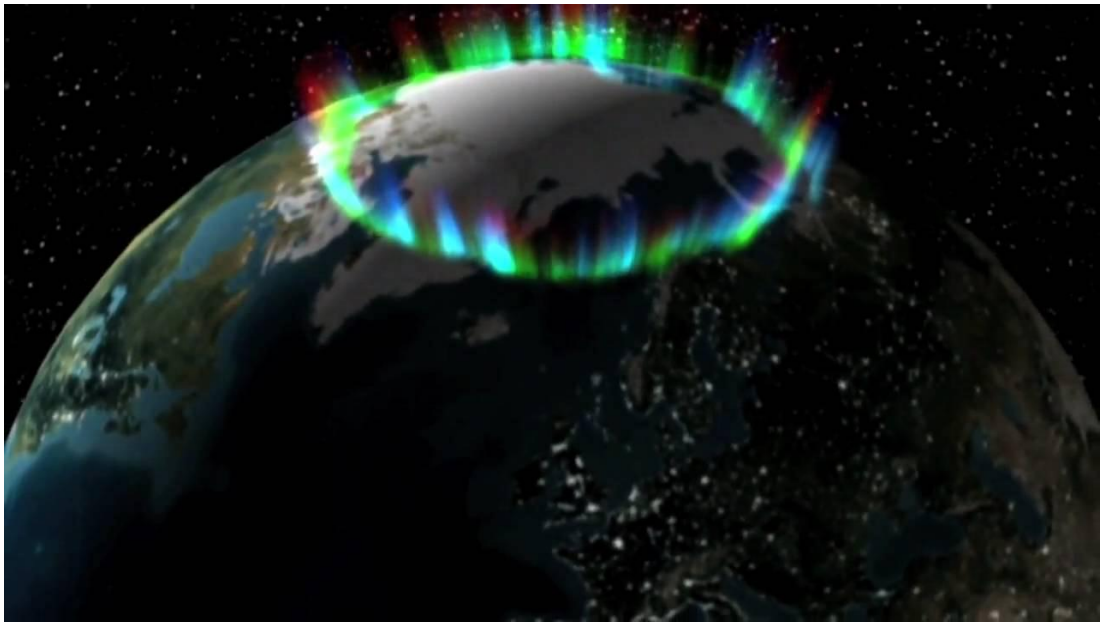


figure (1-3) show the aurora

CHAPTER II

Geomagnetic disturbance

(2-1) Geomagnetic storm:-

A geomagnetic storm is a prolonged depression of the horizontal geomagnetic field component in the mid to low latitudes, in the range of several tens to several hundred nT that lasts from one-half to several days.

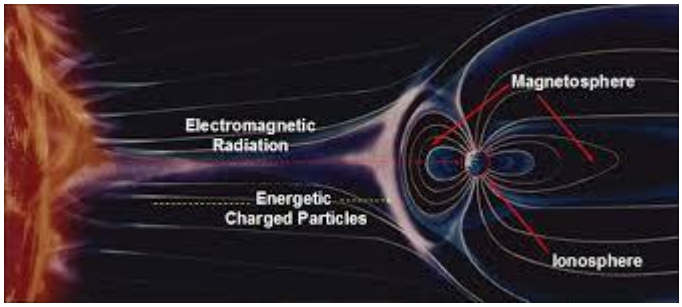


Fig (2-1) Show geomagnetic storm

The geomagnetic storm has three phases:

(2-1-1) Initial phase

In the beginning of the initial phase there is a sudden increase in the magnetic field Intensity which lasts field strength increases from up to $10 - 50\ nT$.

(2-1-2) Main phase:

It's a progressive depression of the field strength It can last anything between an hour and a day, the magnetic field decreases by $\geq 100\ nT$.

(2-1-3) Recovery phase:

It's a period of restoration to the original field strength.

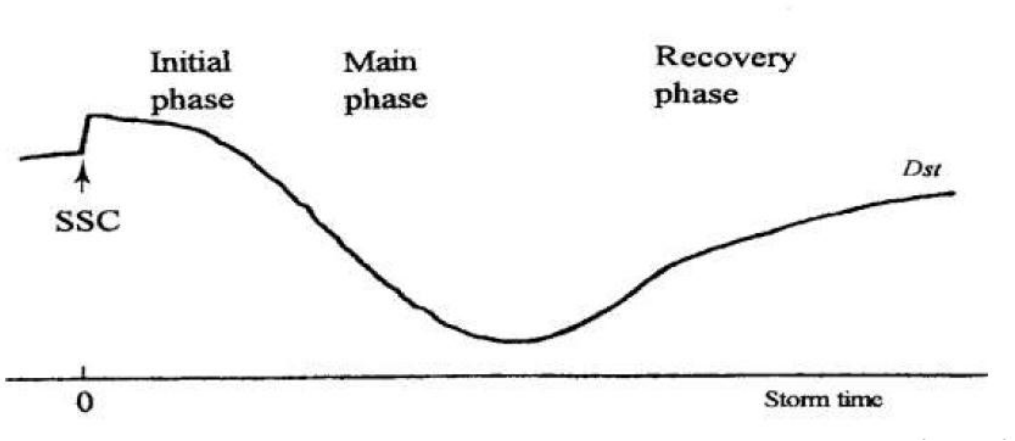


Fig (2-2) Schematic illustration of the DST variation for a typical geomagnetic storm.

(2-2) DsT index

The DsT is indicates the global part of a geomagnetic disturbance as an average of field strengths that remains after the typical quiet-day variation features and a baseline of main-field level are removed from low-latitude (nonequatorial) station data (Campbell W.H., 2003)

(2-3)Sup storm

Defined as a phenomenon that begins with an explosive illumination of the aurora near the midnight region on the night side, that gradually expands both in the longitudinal and latitudinal Directions. The magnetic field intensity $\leq -350nT$, while major storms have $\leq -100nT$.(Tsutomu, 2002),(louise k.harra , keith O.mason, 2004).

(2-4) Geomagnetic pulsation:

The ULF waves (ultra law frequency) incident on Earth's ionosphere is produced by different processes in the Earth's magnetosphere and solar wind.

The ULF waves are usually classified according to their waveforms and periods, waves with quasi-sinusoidal form are called continuous pulsations (Pc), those with irregular waveforms are called pulsations irregular (pi) and on night side (pi2).

CHAPTER III

Geomagnetically induced current (GIC)

(3-1) What's GIC?

GICs are currents in grounded conductors driven by an electric field produced by time varying magnetic fields linked to magnetosphere -ionospheres currents during magnetic storms.

Geomagnetic storms are the root cause of GIC's, which flow into the Grounded neutral points of power systems and it's originated by solar flares from the sun. The GIC's and the corresponding harmonic currents may cause detrimental effects to power systems such as equipment damage (e.g. to transformers, generators, capacitor banks), improper relay operation, and even system shut down.

More frequent and more intense geomagnetic storms occur when sun spots, which are dark areas on the surface of the sun, cause large ejections of charged particles (solar flares) or coronal mass ejections from the sun's outer atmosphere (corona). Charged particles are always flowing from the sun toward the earth, creating what is called the solar wind. During solar flares, the stream of charged particles that flows towards the earth significantly adds to the existing ambient solar wind. These charged particles are mostly made up of hydrogen ions, helium ions, and electrons.

Sun spot activity and thus geomagnetic storms are cyclic, with peaks (intensity and frequency of occurrence) transpiring about every 11 years. The eleven-year cycle is thought to relate to reversal of the main magnetic (dipole) field polarity of the sun. Should a geomagnetic storm occur then there will likely be another one 27 days later

when the solar flare is again in line with the earth (the sun makes a complete rotation on its axis every 27 days).

(3-2) Impact of GIC:

The GIC impact on a system is dependent not only on the magnitude of the magnetic disturbance, but on its orientation, typically the field causing GIC is primarily east west, because the electro jet follows lines of magnetic latitude.

It is now known that a large variation in the magnetic field (B) does not necessarily mean that a large GIC will flow into the power system. Large GIC is caused by a large electric field (E) which is related but not directly proportional to the time derivative of the magnetic field (dB/dt).

(3-2-1) Impact on Transformers:

The main impact of GIC on electrical power systems is through the transmission transformers with grounded neutrals. The DC GIC causes the transformer core to saturate; which has detrimental effects on the transformer operation. The magnetic flux in a transformer core is proportional to the integral of the voltage supplying the transformer. The DC GIC will cause a DC component to this voltage. This DC voltage will cause the transformer core flux to increase as the GIC event continues. The magnetic history of the transformers is important in determining the effect of a given GIC event (molinski, 1996).

(3-2-2) Impact on pipelines:

Pipelines may suffer from problems associated with corrosion due to GIC and the accompanying pipe-to-soil (P/S) voltages.

The telluric currents alter the pipe-to-soil potential to a region.

Where the electrochemical processes of corrosion can proceed, even though the pipelines are provided with an insulating coating, there are always points where the insulation is defective. For this reason, the pipelines are, in addition, equipped with a cathodic protection system which keeps the pipeline at a negative potential of about 1 to 2 volts in relation to the ground (Bochn´ıˇcek, 2005).

(3-2-3) Impact on satellites:

A sup storm will cause expansion of the earth's atmosphere causing drag in Leo satellites orbit then will be disturbed and predictions of satellite position will be degraded.

CHAPTER IV

Data reviewed

In this chapter we shall discus records of GIC as well as previously data of final DsT for the months when blackout occurred.

(4-1) Records of GIC

Below we will show the illustrated. GIC plots taken in 2015.

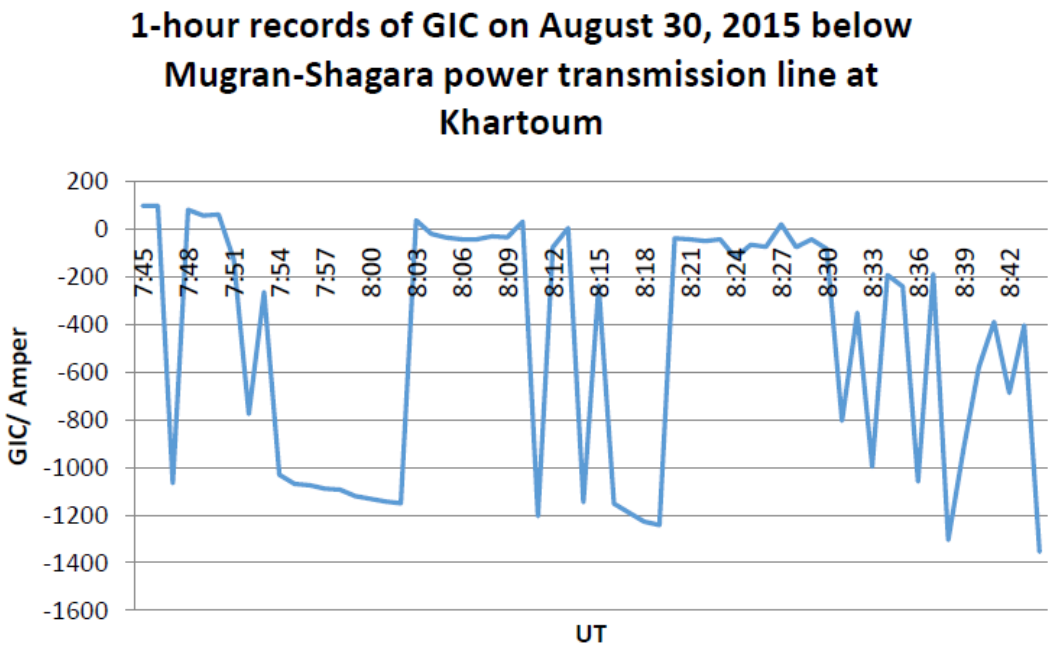


Fig (4-1) shows the amplitude of GIC at 30, august 2015.

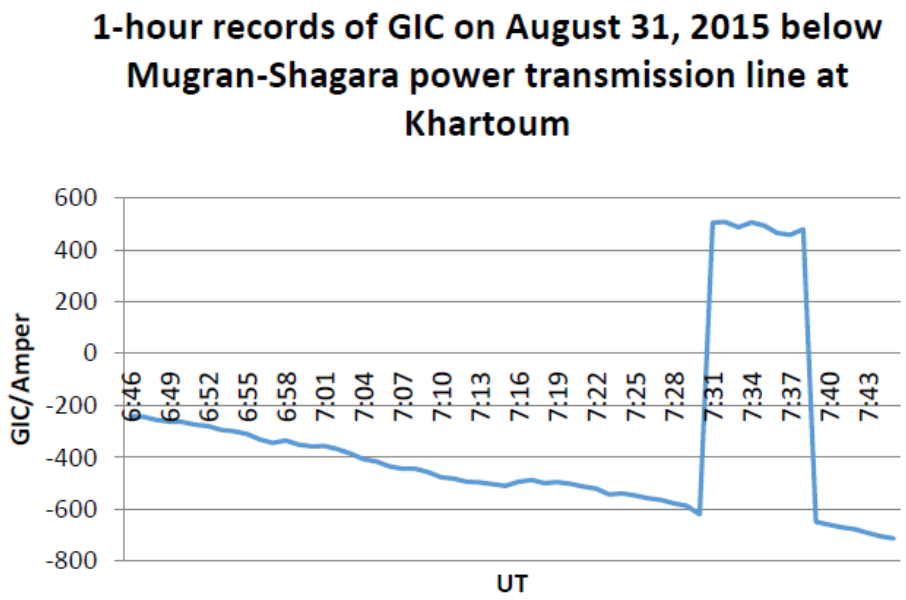


Fig (4-2) shows the amplitude of GIC at 31, August 2015.

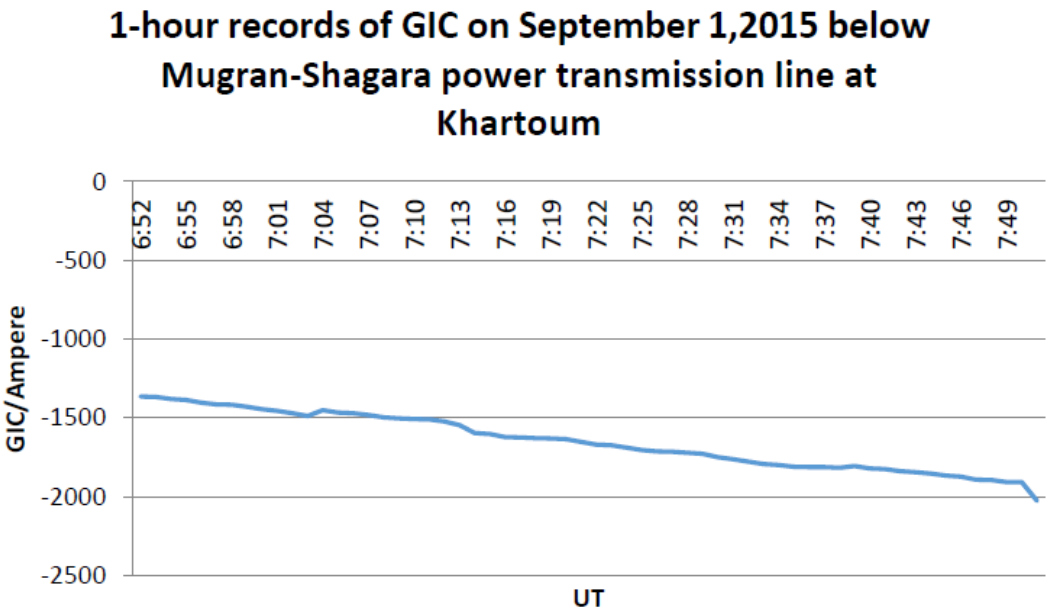


Fig (4-3) shows the amplitude of GIC at 1 September 2015.

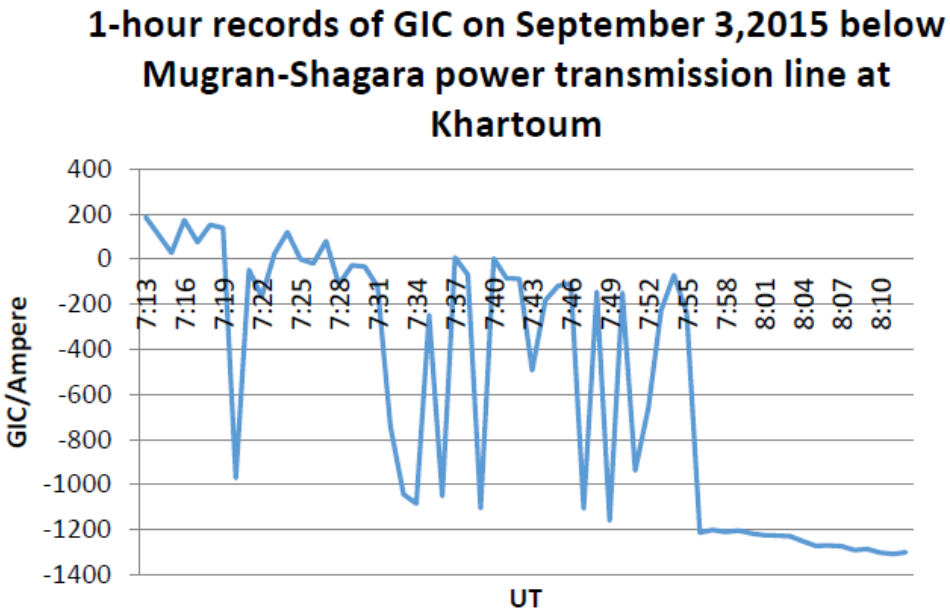


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Fig (4-4) shows the amplitude of GIC at 3 September 2015.

As can be seen from this figures, the amplitude of GIC is (-102.04865 A).

(4-2) Data of final DsT

Figure show Final and Professional DsT for the months when blackout occurred, the red lines show corresponding times of blackouts on Dst scaled disturbed days, while the cyan lines show the corresponding times of blackouts on relatively Dstscaled quiet days.

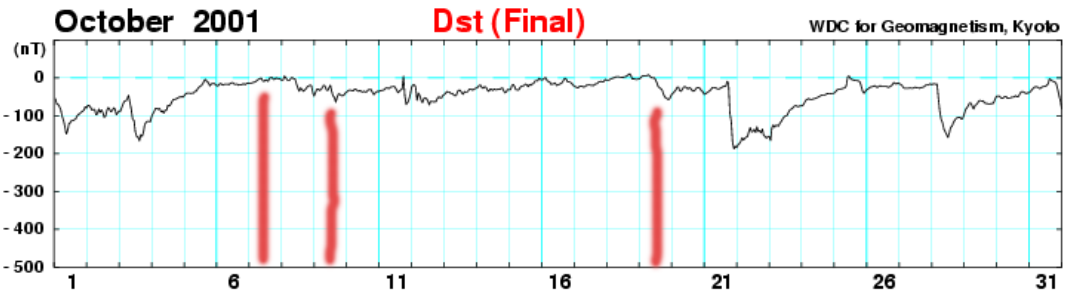


Fig (4-5) show the blackout on DsT scaled

CHAPTER V

Discussion and Conclusion

(5-1) Discussion

From the records of GIC in figures (4-1), (4-2), (4-3) and (4-4) the amplitude of GIC is found -102.04865 A.) Clearly this variation affecting the electric transmission grids

Thus leads to black out.

The DsT date we previously mentioned in figure (4-5) show us in high level of DsT corresponding times of blackouts.

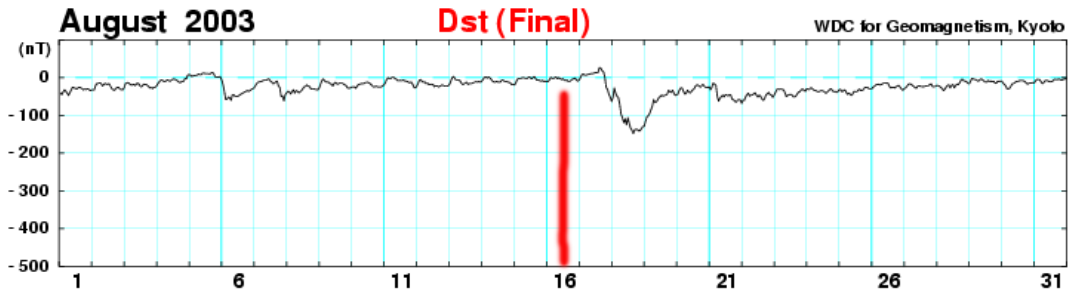
(5-2) Conclusion

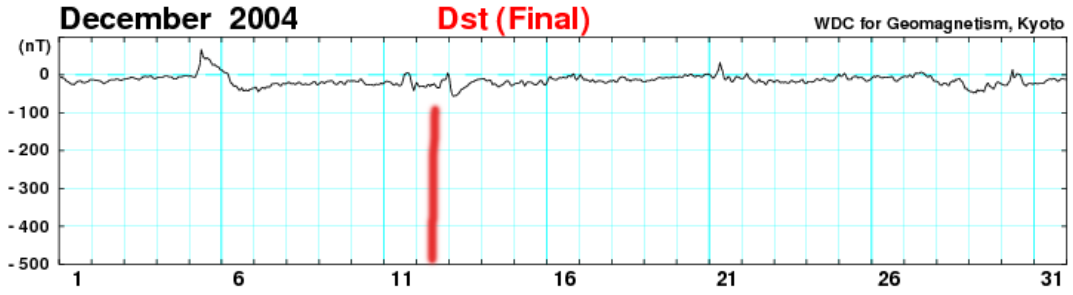
In this research we reviewed the records of black out (high level of (DsT) as a consequence of space disturbances and measurements of the geomagnetically induced current (GIC) carried out within the same region.

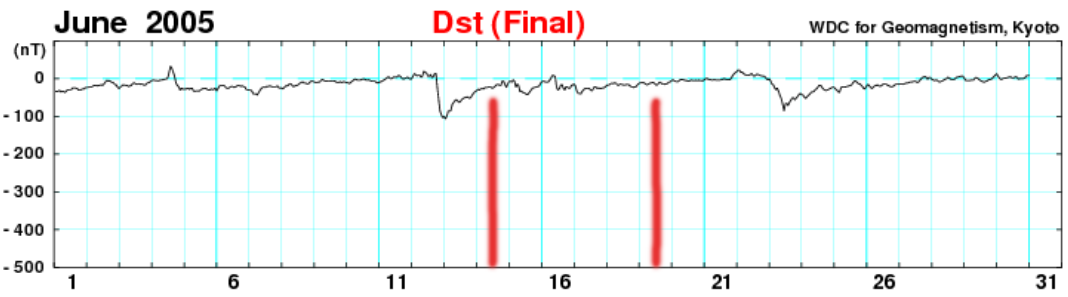
Clearly the space disturbance affect on power grid so thatwe recommend the national power grid to consider the geomagnetic disturbance as a big problem that affect on power transmission and take the GIC as a serious factor leads to black out.

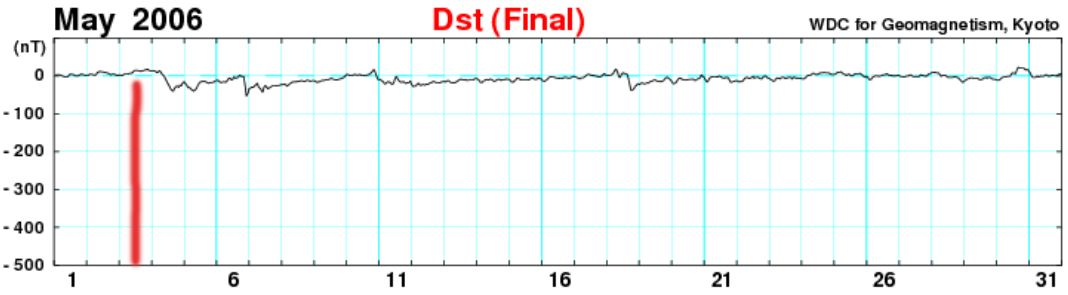
Appendices:

Figures show Final and Professional DsT for the Months when blackout occurred, the red lines show corresponding times of blackouts on DsT scaled disturbed days, while the cyan lines show the corresponding times of blackouts on relatively Dstscaled quiet days.






June 2005
Dst (Final)
WDC for Geomagnetism, Kyoto
(nT)
0
- 100
- 200
- 300
- 400
- 500
1
6
11
16
21
26
31


May 2006
Dst (Final)
WDC for Geomagnetism, Kyoto
(nT)
0
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- 300
- 400
- 500
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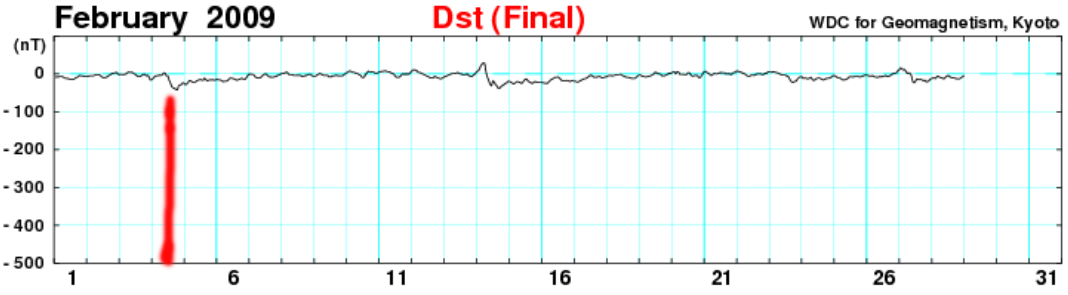
February 2009
Dst (Final)
WDC for Geomagnetism, Kyoto
(nT)
0
- 100
- 200
- 300
- 400
- 500
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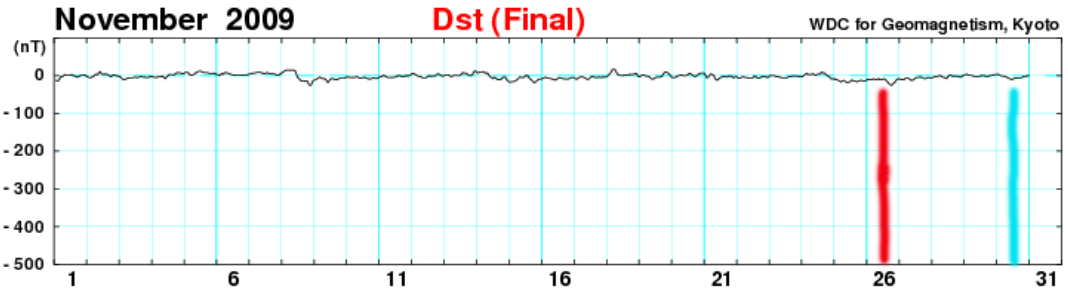
November 2009
Dst (Final)
WDC for Geomagnetism, Kyoto
(nT)
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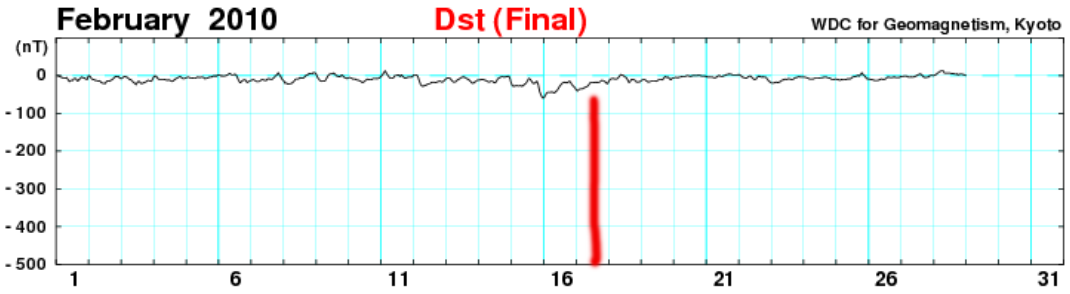
February 2010
Dst (Final)
WDC for Geomagnetism, Kyoto
(nT)
0
- 100
- 200
- 300
- 400
- 500
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