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# "The Morphology Distribution Plasma in the Magnetosphere in large Geomagnetic Storms with different Solar Transients and Long-Term Semi-Annual Variations"

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***Abstract***
*The main field of the Earth is subject to a slow variation in time, known as secular variation there are two kinds of transient variation the first includes relatively small and regular daily variation and the second is the disturbances of a more violent nature known as geomagnetic storms. Alexander von Humboldt was the first to discover the dependency of magnetic intensity on latitude and observed the geomagnetic field at various locations at Earth the variation in geomagnetic field is known as geomagnetic storm the magnetosphere is filled with tenuous plasmas.Five plasma domains of different energy characteristics are well identified as the plasma mantle the plasma sheet the cusp region.Basic differences between these solar transients are that the some solar activities arises through corotating flows and some of them with transients disturbances in solar wind streams different Transients* ***(Cane,H.V.1985)[1].*** *The semi-annual variation has been attributed to an interplanetary magnetic field effect as the Earth orbits around the Sun; southward component of interplanetary magnetic field is statistically more likely twice a year, increasing the coupling between the solar wind and magnetosphere. As a result, more storms occur during equinoctial months than during the solstitial months.*

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## I. Introduction

The common characteristics of plasma mantle are that they have magnetosheath-like energy spectra and flow in the anti-solar direction. The magnetosphere has two domains where relatively dense plasmas are located in the first plasmasphere occupies a part of the inner magnetosphere and its location varies with a fraction of local time.The plasmasphere is surrounded by another domain known as plasma sheet.The plasma sheet is a sheet-like distribution (**Barlow,W.H.1848**)[2].Centered on the midplane of the magnetotail called the 'neutral sheet.The plasma particles from inner or central plasma sheet (CPS) contribute significantly in exciting the diffuse auroral luminosity after they are precipitated into the ionosphere by various plasma processes.Plasma particles in the upper and lower boundary layers of the plasma sheet are responsible for background luminosity in the pole-ward half the broad oval band.The cusp regions are the two plasma regions of funnel-like structures in the dayside magnetosphere.The magnetosheath plasma can enter the magnetosphere through itThe events typically occur where the earth's magnetic field is lowest, at the north pole, south pole, and South Atlantic magnetic anomaly. **(Gosling J.T.1993)[3].** Coronal holes are the region of the open field lines and responsible for recurrent geomagnetic storms. Skylab observations show that the coronal holes (CHs), coronal mass ejections (CMEs) and eruptive prominences have causal link with solar activity and energy emitting regions, and they produced large geomagnetic storms. Recently,**(Kahler,S.W.1992)[4]**.A new concept has been developed that coronal mass ejections are the agent driving interplanetary shocks and large geomagnetic storms.

### The Open and Closed Magnetosphere

The open and closed magnetosphere shows the two states of the solar wind plasma 'frozen in magnetic field and the earth's magnetic field.In the closed model, interplanetary magnetic field direction are small and all field lines starting from the Earth and never cross the magnetopause or tail boundaries. In this model the magnetopause is a tangential discontinuity and the normal component of the magnetic field is identically zero. The concept of open magnetosphere model was firstly proposed by.This model indicates that the interplanetary magnetic field may reconnect with the dipole field along the sunlit side magnetopause**.(Russell,C.T.1973)[5]**.The high latitude magnetic field lines, starting from the Earth, would be mingled with the interplanetary magnetic field and could be traced to the Sun.Such a field line may either penetrate the dayside magnetopause or be traced through the geomagnetic tail before finding itself in interplanetary space. Some researchers have been suggested three major sources of open magnetospheric models. First model explains all aspects of energetic solar particle entry in the polar cap when the characteristics of interplanetary particles are accounted for. Second model explains the open magnetosphere that provides a simple explanation of controlling of the magnetospheric current system by the interplanetary magnetic field and an explanation of all phases of the substorm. Third model express the open magnetosphere provides trivial explanation for the plasma pause,These plasma regions are well explained and sketched in **figure 1.** These plasma regions are all together called the plasma mantle.

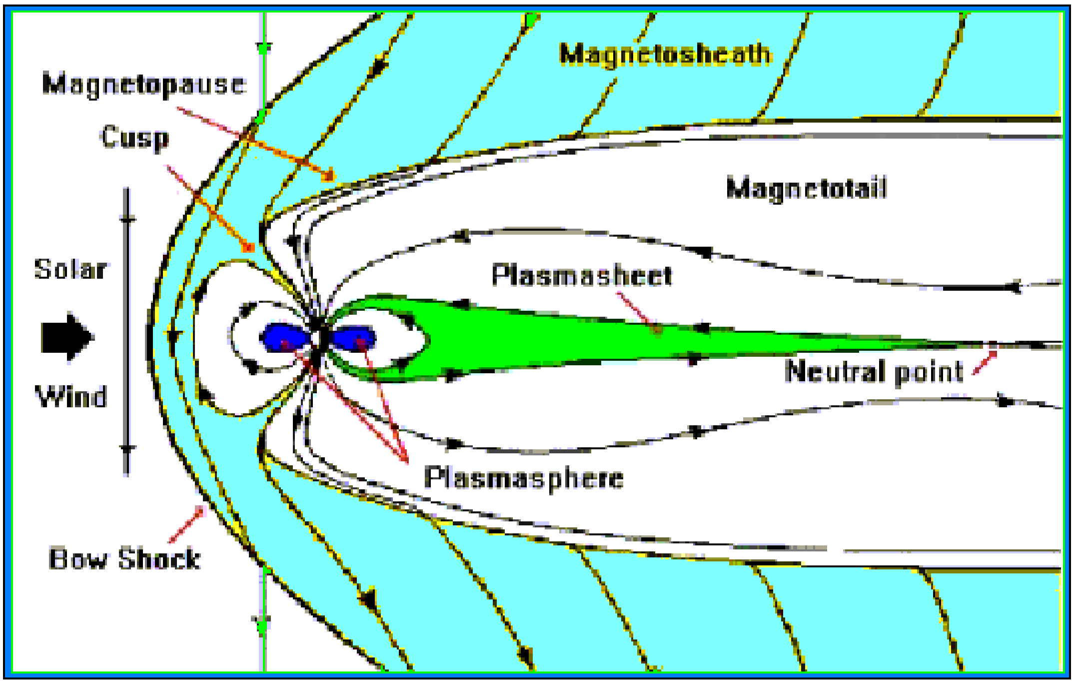


**Figure 1.** Shows the formation of the magnetosphere and its different regions such as bow shock, magnetopause, magnetosheath, magnetotail, cusp, plasma sheet, plasmasphere and neutral point.

We can use the open model of magnetosphere to estimate the length of the tail, as field lines are swept tailward in the solar wind; their ionospheric foot-prints are swept across the polar cap from near noon to midnight.(**Bartels,J.1940)**[6] .Flow speed, time duration and foot of a field line cross the polar cap, can be measured from the ground. Those tail field lines that have disconnected from the Earth will retain tail geometry several thousand $R_E$ beyond the Earth.

**Magnetospheric Dynamics**

The magnetospheric dynamics is principally concerned with magnetic reconnection between solar wind and earth's magnetic field. The solar wind and interplanetary magnetic field have intimate control over the shape and dynamics of the earth's magnetosphere as well as the level of geomagnetic activity **(Kivelson,M.G.1995)**[7].Dungey postulated the mechanism of magnetic reconnection between geomagnetic and interplanetary magnetic field in 1961. The magnetic flux is transported from the dayside of magnetosphere to the night side. This magnetic flux builds up in the tail until reconnection occurs there too and returns the magnetic flux to the magnetosphere. When the IMF is directed predominantly southward, then the magnetic field driven by the solar wind flow against the front of the magnetosphere will be approximately antiparallel to the geomagnetic field on the other side of the magnetopause. The solar wind flow will pull the solar wind portion of the field line antisunwards, or, to pull it another way, the plasma on the flux tube will sense an electric field $E = U_{sw} \times B_{sw}$, where $U_{sw}$ is the flow velocity of solar wind and $B_{sw}$ is the magnetic field of solar wind. In a steady state,**(Agrawal,S.P.1976)**[8]. The electric field must be sensed all along these now open flux tubes, as field lines are equipotentials. At the ionospheric end of the field line, this electric field, which is directed from down toward dusk, derives flow from noon towards midnight. The variation of the north-south component of IMF provides an opportunity to enter solar wind energy that is transferred into magnetosphere and others have described the relationship of $B_y$ component of the IMF to the configuration of the auroral oval, polar cap arcs and ionosphere convection pattern in both hemispheres of the Earth. The interplanetary magnetic field has a long southward component ($B_s \geq 10$ nT), the amount of transferred energy from solar wind to the magnetosphere becomes very large. On the other hand, the transferred energy becomes very small when the IMF directed primarily northward.Suggested that the polarity of the IMF at the Earth can be predicted from the observed polarity of the field near the solar flare.

**Morphology of Geomagnetic Storms**

The first includes relatively small and regular daily variation, and the second is the disturbances of a more violent nature known as geomagnetic storms. Alexander von Humboldt was the first to discover the dependency of magnetic intensity on latitude and observed the geomagnetic field at various locations at Earth. The variation in geomagnetic field is known as geomagnetic storm**. (Allan, D. W.1962)**[9].Geomagnetic storms are major disturbances on the magnetosphere that occur when the interplanetary magnetic field turns southward and remains southward for prolonged period of time. During a geomagnetic storm main phase, charged particles in the near-earth plasma sheet are energized and injected deeper into the inner magnetosphere, producing the storm-time ring current. This phase is characterized by the occurrence of multiple intense substorms, with the attendant auroral and geomagnetic effects. When the interplanetary field turns northward again, the rate of plasma energization and inward transport slows and the various loss processes that remove plasma from the ring current can begin to restore it to its pre-storm state. During geomagnetic disturbances an electromagnetic flux $\approx 10^{11}$-$10^{12}$ W enters in the magnetosphere from the solar wind. According to current concepts, part of the energy flux is stored inside the magnetosphere at the distance of few Earth radii as energetic ions..The ion motion around the geomagnetic dipole is accompanied by a decrease of the H-component of the geomagnetic field.The second part of the energy flux is used in generating 3D current system. The third part of the energy flux is stored in the tail of the magnetosphere as magnetic field energy. It is dissipated in creating 3D current systems and energetic particles, as well as plasmoid during substorm disturbances.Geomagnetic activity indices are well correlated with the solar events and vary with 11-year sunspot cycle. Geomagnetic activity is also modulated by the location of the Earth in its orbit around the Sun.The annual and semiannual variations can easily be seen in geomagnetic indices. The rotation of the Sun about its axis is also important for recurrent geomagnetic activities.

**Secular Change**

The small and erratic secular changes, also known as quiet time variations are apparently caused by motions within earth's interior. The principle source of the quiet time long period geomagnetic field variation is beneath the earth's surface. The studies of rock mechanism as well as geological time survey estimate the geomagnetic field directions over the past $5\times10^8$ years. These measurements have been indicated substantial changes and even reversals in field direction in the past. It has been well known that the total magnetic dipole moment has systematically decreased for more than a century.**(Champbell,W.H.1996a)**[10].The changes in magnetic dipole moments can be expressed by a relation [$M = (15.77 - 0.003951\times t).\ 10^{25}$ Gauss-cm $^{-3}$] where **t** represents time in years reckoned forward or backward from 1900 AD. If this rate of decrease continues, the dipole magnetic moment would become zero at 3991 AD. The geomagnetic secular change in total intensity during only a single decade is noteworthy. The average changes per annum in secular variations are ranging between 100-150nT.The average changes in decade becomes regionally important in semi-annual variation of geomagnetic field.The solar quiet variation (Sq) also known as diurnal variation is an important phenomenon to understand various types of geomagnetic activity. On quiet days magnetospheric and ionospheric currents which are driven by energy input from the solar wind are either very weak or kept at fixed levels, and have a periodicity of one solar day. The Sq have been used to consider the dynamo action of the solar wind in the ionosphere, hence its interpretation requires an understanding of the atmospheric dynamics. The diurnal variation of geomagnetic field is measured through a number of geomagnetic observatories at mid and low latitude. In the Polar Regions there is an additional solar variation due to the current system $S^p{}_q$, show remarkable day-to-day changes of amplitude and phase.**(Bartels,J.1949)**[11].This feature indicates the central position of the current vortices. The current system which is responsible for the $S^p{}_q$ variation consist of an inward field-aligned current from the morning side of the magnetopause to the morning half of the auroral oval and an outward field-aligned current from the afternoon half of the oval to the afternoon side of the magnetopause, together with ionospheric currents across the polar cap.

**Long-Term Variability**

The coronal mass ejections (CMEs) arises due to high solar activity and associated with transient disturbances arising from solar activity in magnetically closed regions, and mainly produces interplanetary disturbances that causes large non-recurrent geomagnetic storms at the Earth, whereas, coronal holes are associated with corotating flows in solar wind streams, arising from magnetically open regions and could produce interplanetary disturbances that causes recurrent geomagnetic disturbances.**(Champbell,W.H.1996b)**[12] .Both solar activities (CMEs and Chs) can produce interplanetary shocks that are responsible for geomagnetic disturbances. Some time it is seen that a large geomagnetic storm may be caused by more than one solar activity. So it is a difficult job to assess real causes of geomagnetic disturbances. Therefore, we have shown the semi-annual variations of selected large geomagnetic storm events occurring during interval (1986-2002), which are plotted in **Figure 1.** This plot indicates that in the first half annual part (January-July),

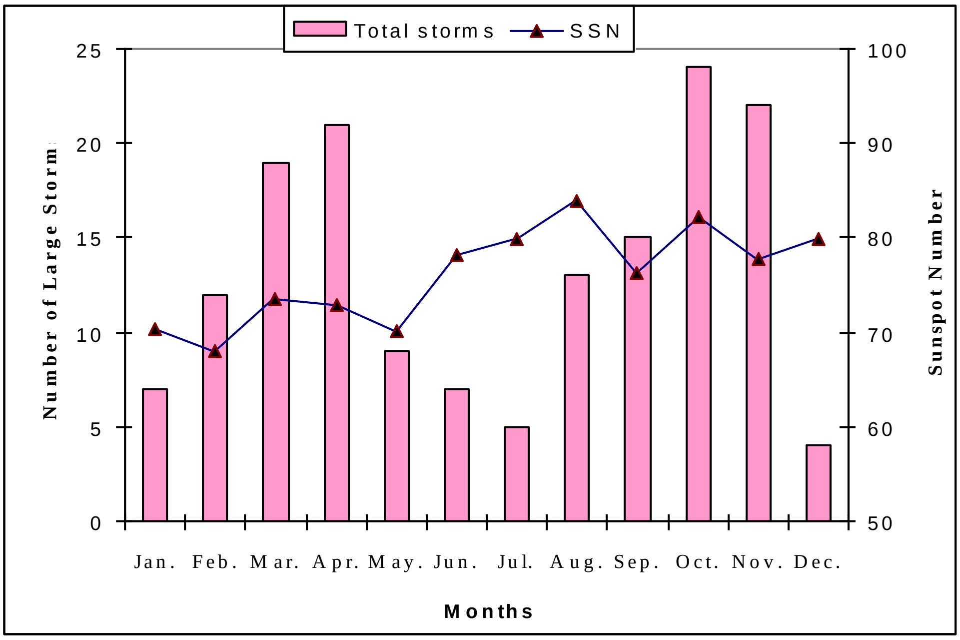


**Figure 1.**Depicts monthly variations of large geomagnetic storms and their association with sunspot number that is observed during 1986-2002.

In the present work, we have investigated solar causes, type of solar wind streams and interplanetary shocks of selected 158 large geomagnetic storms,The maximum value of solar wind speed (SWV), interplanetary magnetic field (IMF B) and southward component (IMF $B_z$), The importance of studying geomagnetic storms is basically two fold. One refers to their academic aspect of being considered a central part of geophysics. (**Hundhausen,A.J.and Burkepile J.T.1994)**[13]**.** The magnetosheath plasma enters the magnetosphere in the form of a wedge and this perpendicular region is known as cleft.The cusp plasma is generally observed in the closed, rather than open field line regions. The energetic electrons in the cusp region have a pancake-like, pitch-angle distribution peaking at 90°. The solar electrons do not penetrate into the cusp region.

## II. Conclusions

A geomagnetic storm is a global disturbance of the earth's magnetic field and usually occurs in response to abnormal conditions in the interplanetary magnetic field and solar wind.The geomagnetic storm is a sequence of varying magnetospheric disturbances and varying conditions in interplanetary space, which are caused by coronal magnetic storms. During the geomagnetic storm, physically and geometrically disturbed geomagnetic fields D around the Earth have been studied by a number of researchers.Geomagnetic storm can be classified into many alternative ways on the basis of their distribution in space, intensity, development in time and frequency of occurrence**.(Paredes M.B.1992)**[14].The geomagnetic storms have long been classified into two standard types, known as sudden gradual commencement storms depending upon different solar source activities. The Van Allen belts which are the trapped regions of charge particles inside the magnetosphere can be classified as inner and outer belts. From these observations,**.** We find that severe geomagnetic storms are mostly caused by coronal mass ejections, transient disturbances in solar wind streams and fast interplanetary shocks and verified the latest paradigm of CMEs, solar wind streams and interplanetary shocks as discussed by scientific community. Studies of severe geomagnetic storms are widely applicable in the field of space weather phenomena, satellite communications,Nvigation and power systems. We cannot stop these harmful geomagnetic storm events any way but protect to our scientific systems or us by forecasting of them.

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