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The Solar-Terrestrial Links and Energy Transfer Mechanism in Recurrent and Non-recurrent Geomagnetic activities And Impacts of Solar Plasma on Earth's

S.C.Chaturvedi[1] Achyut Pandey[2] Brijesh Singh Chauhan[3] S.kumar Singh[4]
1. Department of physics Govt. Lahiri P.G.College Chirimiri Distt.Koriya (C.G.)
2. Department of Physics, Govt.T.R.S.College Rewa Distt.Rewa (M.P)
3. Department of Physics Govt. College Majhauli Distt.Sidhi (M.P.)
4. Department of Physics Govt. Model Science College Rewa Distt.Rewa (M.P.)

Abstract
Geomagnetic storms are the most dramatic manifestation of solar-terrestrial coupling.They involve the injection of large amounts of energy from the solar wind into the earth's magnetosphere, ionosphere and thermosphere. There are number of solar sources, two types of solar wind streams and different interplanetary parameters that are responsible for geomagnetic storms have been investigated by many researcher. Recurrent storms occur most frequently in the declining phase of the solar cycle. Non-recurrent geomagnetic storms occur most frequently near solar maximum. The low-energy ions that replace them contribute little current, and so the strength of the ring current decreases with time. This is the recovery phase of the storm. Many storm recoveries occur in at least two stages. The first stage occurs due to rapid loss of oxygen ions, and the second from the slower loss of protons. only two are well known for our climate change and global warming, one is Earth itself and other the Sun.

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I. Introduction

The basic components that influence the Earth's climatic system can occur externally (from extraterrestrial systems) and internally (from ocean, atmosphere and land systems). The external change may involve a variation in the Sun's output.Internal variations in the Earth's climatic system may be caused by changes in the concentrations of atmospheric gases, mountain building, volcanic activity.Sun, oceans, atmosphere, cryosphere, land surface and biosphere. The Sun is the main source of the Earth's weather and climate.Solar Terrestrial Links.They involve the injection of large amounts of energy from the solar wind into the earth's magnetosphere, ionosphere and thermosphere geomagnetic storms and auroral display. Geomagnetic storms also have major effects on technical systems in space.The major perturbations in ionospheric conditions that affect communications and performance of satellites in geosynchronous orbit. Thus major magnetic storms are the events of significant scientific and natural interest.Energy Transfer Mechanism.

Geomagnetic hazards

Geomagnetic storms are large scale disturbances on the earth's magnetosphere and decreases horizontal component (H) of earth's magnetic field. The solar wind pressure on the magnetosphere will increase or decrease depending on the solar activities. Solar wind pressure changes modify the electric currents in the ionosphere. The solar wind also carries with it the magnetic field of the Sun. This field will have either a north or south orientation. Either the solar wind has energetic bursts, contracting and expanding the magnetosphere, or the solar wind takes a southward polarization. The southward field causes magnetic reconnection of the dayside magnetopause, rapidly injecting magnetic and particle energy into the earth's magnetosphere. During a geomagnetic storm the ionosphere's F_2 layer will become unstable, fragment, and may even disappear. In the northern and southern pole regions of the Earth aurora will be observable in the sky. The telegraph lines in the past were affected by geomagnetic storms as well. Earth's magnetic field is used by geologists to determine rock structures. For the most part, these geodetic surveyors are searching for oil, gas, or mineral deposits. They can accomplish this only when earth's field is quiet, so that true magnetic signatures can be detected. Other surveyors prefer to work during geomagnetic storms, when the variations to earth's normal subsurface electric currents help them to see subsurface oil or mineral structures. When magnetic fields move about in the vicinity of a conductor such as a wire, an electric current is induced into the conductor. Power companies transmit alternating current to their customers via long transmission lines. The nearly direct currents induced in these lines from geomagnetic storms are harmful to electrical transmission equiptment, especially to the transformers, it overheats their coils and causes their performance; it also tends to trip various protective devices. Rapidly fluctuating geomagnetic fields can induce currents into pipelines. During these times, several problems can arise for pipeline engineers. Figure1. Shows the formation of the bow shock front. In this figure bow shocks are formed on frontal surface of the magnetosphere, Flow meters in the pipeline can transmit erroneous flow information, and the corrosion rate of the pipeline is dramatically increased.

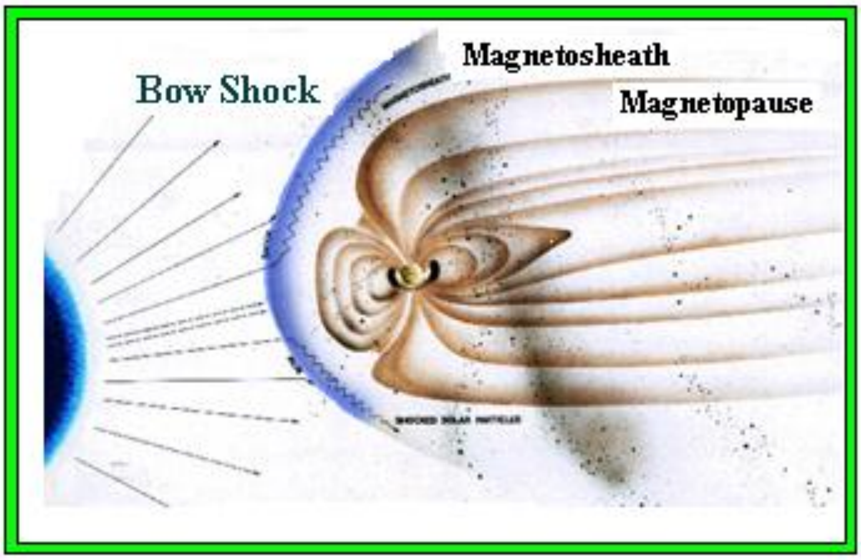
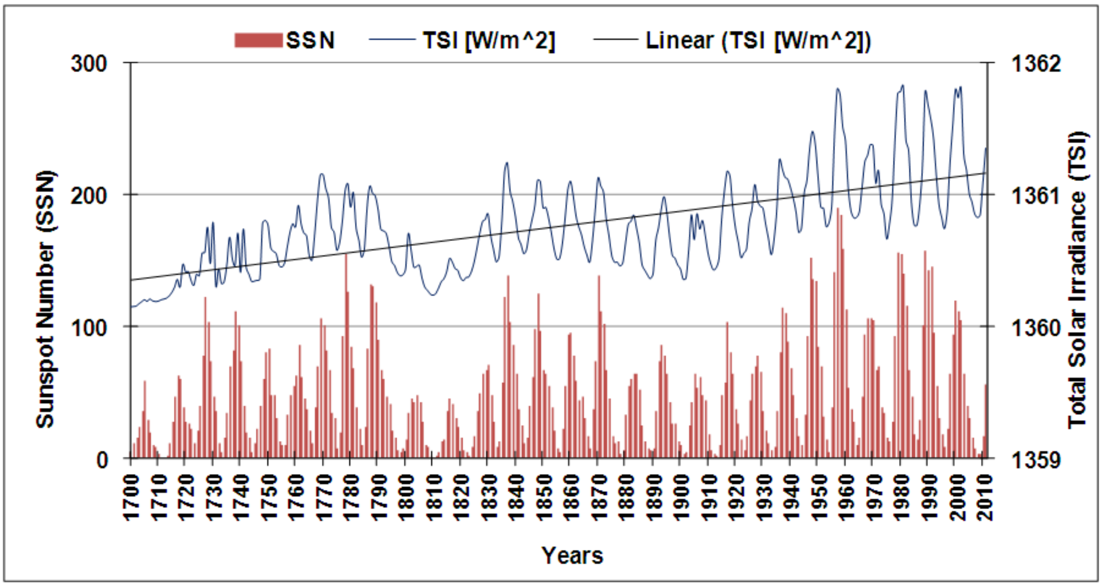


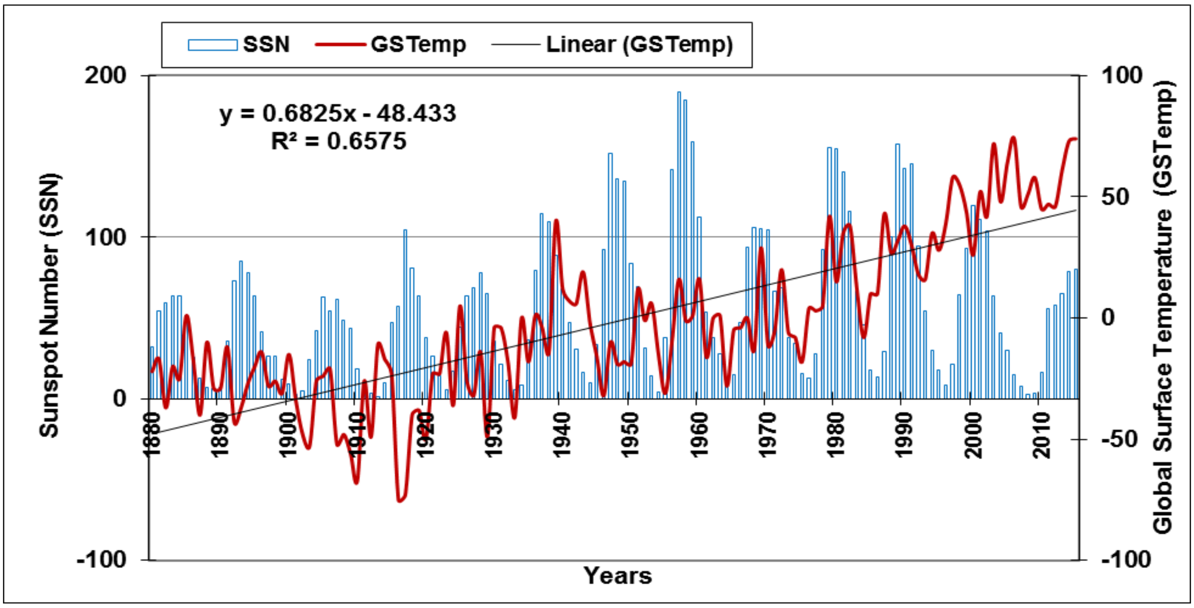
Figure1. Shows the formation of the bow shock front. In this figure bow shocks are formed on frontal surface of the magnetosphere, where the solar wind has its first impact with geomagnetic field. The magnetosheath and magnetopause are also explained in this figure.

The Solar activities follow over an 11-year cycle. provided the first thorough study of long-term (century scale) variations in solar activity and climate. This study indicated a very strong link which he hypothesized could be accounted for by small changes in the solar total irradiance. Subsequently studies of palaeoclimate and historical solar activity inferred by its modulation of ^{14}C in tree rings and ^{10}Be in ice cores provided evidence that long-term minima in solar activity seems to be associated with climate on Earth that is colder than average.The total solar irradiance (TSI) is integrated solar energy flux over the entire spectrum which arrives at the top of the atmosphere at the mean Sun-Earth distance. The TSI observations show variations ranging from a few days up to the 11-year SC and longer timescales The historical reconstruction of TSI absolute value is described by Kopp and based on new calibration and diagnostic measurements by using TIM V.12 data on 19th January 2012, and is updated annually. TSI are known to be linked to Earth climate and temperature. The historical reconstruction of TSI and their association with 11-year sunspot cycle from 1700 onwards are shown in Figure 2.. From the plot, it is find that TSI variation trend follows with SSN within a limit but centurial variation trends of TSI have not shown clear association. Linear variation of TSI for last 311 years shows continuously increasing trend. It is find that decadal TSI variation trend follows with SSN within a limit, except Maunder Minimum period. The centurial variation trends of TSI have not shown clear association. Surface temperatures and solar activity both increased during the past 400 years, with close associations apparent in pre- and post-industrial epochs.However, the inference from correlation studies that Sun-climate relationships can account for a substantial fraction of global warming in the past 150 years is controversial.



Figures2.Shows the long-term variation of TSI and yearly mean SSN, during 1700 onwards. [The data were taken from SOURCE website (http://lasp.colorado. edu/sorce/index.htm)

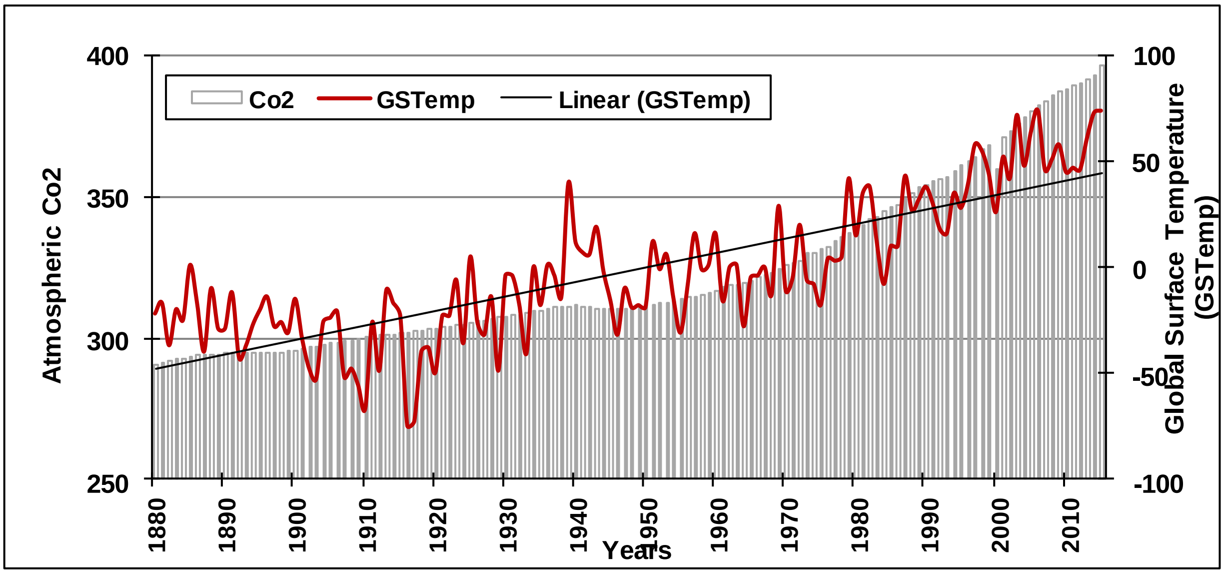
The associations of sunspot number (SSN) with global surface temperature (GSTemp) from 1880 onwards are shown in Figure 3. From the plot, centurial variation trends of SSN and GSTemp have not very clear associations.



Figures3. Shows the variation of SSN and global surface temperature, during 1880 onwards.

The basic components that influence the Earth's climatic system can occur externally (from extraterrestrial systems) and internally (from ocean, atmosphere and land systems).The external change may involve a variation in the Sun's output. Internal variations in the Earth's climatic system may be caused by changes in the concentrations of atmospheric gases, mountain building, volcanic activity, and changes in surface or atmospheric albedo. The basic causes of increase in global temperature can occur from variation in TSI and human made activities (mainly emission of Co_2). Atmospheric carbon dioxide (Co_2) is an important kind of greenhouse gas which influences global temperature. Its concentration variation could indicate the distribution of human and natural activities in various regions. The increase in Co_2 then amplified the global warming by enhancing the greenhouse effect. The long-term climate change represents a connection between the concentrations of Co_2 in the atmosphere and means global temperature. Co_2 concentrations in the atmosphere have increased from about 280 ppm in pre-industrial times to 395 ppm at present. The variation of atmospheric

Co_2 (in ppmv) collected at Mauna Loa, Hawaii and their association with global surface temperature (GSTemp) during 1880 onwards are scatter plotted in Figure 4. From the plot, it is clear that the rate of concentration of atmospheric Co_2 and GSTemp both are increasing continuously during above mentioned periods.



Figures4. Shows the variation of Co_2 and global surface temperature, during 1880 onwards.

Recurrent and Non-recurrent Geomagnetic activities

Geomagnetic storms are classified as recurrent and non-recurrent. Recurrent storms occur every 27 days, corresponding to the Sun's rotation period. They are triggered by the earth's encounters with the southward-oriented magnetic field of the high-pressure regions formed in the interplanetary medium by the interaction of low and high-speed solar wind streams corotating with the Sun. Recurrent storms occur most frequently in the declining phase of the solar cycle. Non-recurrent geomagnetic storms occur most frequently near solar maximum. They are caused by interplanetary disturbances driven by fast coronal mass ejections and typically involve an encounter with both the interplanetary shock wave and the coronal mass ejections (CMEs) that drives it. Sometime another storm take places before the effect of the first storm are wiped out, in that case the geomagnetic field remains disturbed for several days. Feynman and have shown that the sudden and gradual commencement storms are originated from two types of solar wind streams. have shown that near solar activity maximum major geomagnetic storms tend to be preceded by sharp onset or ‘sudden commencement type and are predominately associated with transient disturbances in the solar wind arising from solar activity in magnetically closed regions.

Aurora and Auroral Substorm

The aurora is also known as the northern and southern lights. From the ground, aurora can usually be seen where the northern and southern auroral ovals are on the Earth. Sometimes, when the Sun is active, the northern auroral oval expands and the aurora can be seen much farther south. The aurora is formed when charged particles interact with the earth’s upper atmosphere, and the injection of these particles is due to interaction with the solar wind. The aurora depends both, on the plasma streaming away from the Sun and on the earth’s magnetic field. During night time near the auroral oval, homogeneous arcs of fairly low intensity (1-10 kR) elongated approximately in the east-west direction. After some time, the aurora starts to move equatorward, increase in intensity, and may develop ray structure and takes the form of less regular bands. Then suddenly, the whole sky explodes, and the aurora spread over the entire sky. Simultaneously, the aurora moves rapidly, with change in form and intensity, at time increasing to several hundred kilorayleight, and the individual structures in the aurora may slow apparent speed in an easterly or westerly direction of several tens of kilometers per second. After a few minutes, the aurora becomes weaker and rather diffuse. These four-sense active periods is known an auroral substorm.Morphology of formation of the magnetosphere, during storm time and its different regions alongwith reconnection techinique are dispayed in Figure 5.

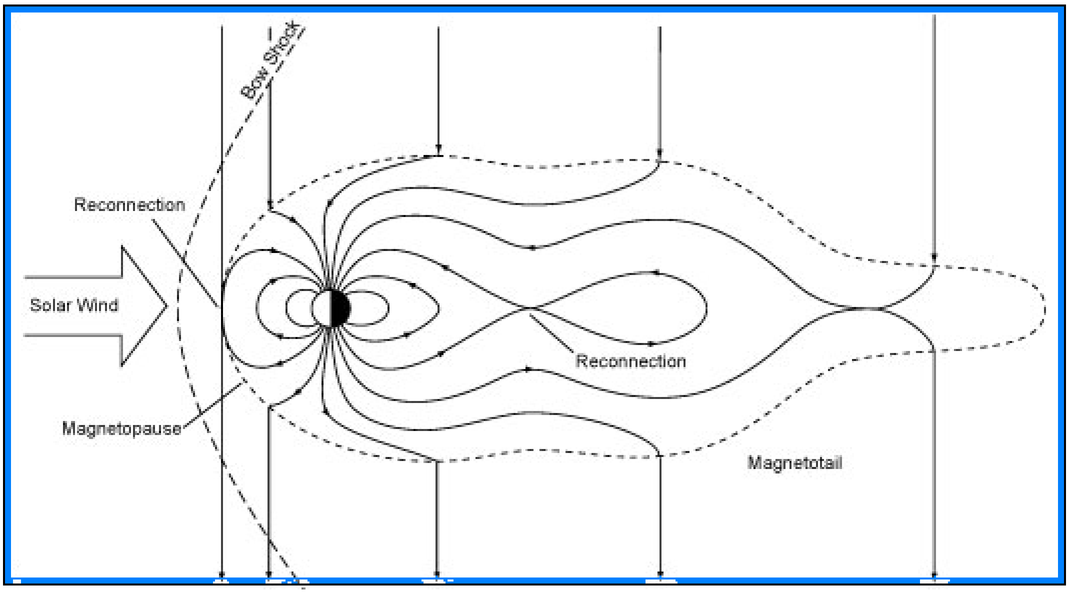


Figure5. Shows the formation of the magnetosphere, during storm time. The different regions and process occur on magnetosphere alongwith reconnection techinique are displayed in the figure.

Space weather phenomena are highly concerned with geomagnetic activities. Energetic particles thrown out from the Sun interact with the geomagnetic field producing magnetic disturbances and increased ionization in the ionosphere. The high energy particles affect satellites causing dis-operation or damage the satellite. Radio waves used for satellite communications or GPS navigation are affected by the increased ionization with disruption of the communication or navigation systems. The magnetic disturbances directly affect operations that use the magnetic field, such as magnetic surveys, directional drilling, or compass use. Magnetic disturbances also induce electric currents in long conductors such as power lines and pipelines causing power system. Geomagnetic disturbances can have a serious effect on power systems. Currents induced in power lines flow to ground through substation transformers. In this section, we described most common geomagnetic hazards in brief.

Geomagnetic Storm Affect to us and our Climate

During large geomagnetic storms, very low earth's magnetic field and harmful radiations received from the Sun hazards to us and our climate. Earth's atmosphere and magnetosphere allow adequate protection for us on the ground, but astronauts in space are subjected to potentially lethal dosages of radiation. The penetration of high-energy particles into living cells, measured as radiation dose, leads to chromosome damage and, potentially, cancer. Large doses can be fatal immediately. Solar protons with energies greater than 30 MeV are particularly hazard. Solar proton events can also produce elevated radiation aboard aircraft flying at high altitudes. The Sun is the heat engine that drives the circulation of our atmosphere. It has long been assumed to be a constant source of energy and output can vary with 11-year solar cycle. Atmospheric scientists observed that this variation is significant and that it can modify climate over time. Plant growth has been shown to vary with the 11-year sunspot and 22-year magnetic cycles of the Sun, as evidenced in tree-ring records. During proton events, many more energetic particles reach the earth's middle atmosphere. They cause molecular ionization, creating chemicals that destroy atmospheric ozone and allow increased amounts of harmful solar ultraviolet radiation to reach the earth's surface. There is a growing evidence that the changes in the geomagnetic field affect biological systems. Recent studies indicate that physically stressed human biological systems may respond to fluctuations in the geomagnetic field. Possibly the most closely studied of the variable Sun's biological effects has been the degradation of homing pigeons navigational abilities during geomagnetic storms. Pigeons and other migratory animals, such as dolphins and whales, have internal biological compasses composed of the mineral magnetite wrapped in bundles of nerve cells. While this probably is not their primary method of navigation, there have been many pigeon race smashes.

Geomagnetic Storm Disrupt Many Systems

Geomagnetic storms and increased solar ultraviolet emission heat earth's upper atmosphere, causing it to expand. The heated air rises, and the density at the orbit of satellites upto 1000 km increases significantly.

This results increased drag on satellites in space, causing them to slow and change orbit slightly. Low Earth orbit satellites are routinely boosted to higher orbits, they slowly fall, and eventually burn up in earth's atmosphere. Another problem for satellite operators is differential charging. During geomagnetic storms, the number and energy of electrons and ions increase. When a satellite travels through this energized environment, the charged particles striking the spacecraft cause different portions of the spacecraft to be differentially charged. Eventually, electrical discharges can arc across spacecraft components, harming and possibly disabling them. Bulk charging occurs when energetic particles, This discharge is potentially hazardous to the satellite's electronic systems. Many communication systems utilize the ionosphere to reflect radio signals over long distances. Ionospheric storms can affect radio communication at all latitudes. Some radio frequencies are absorbed and others are reflected,

II. Conclusion

Over the course of a year, the angle of rotation results in equatorial areas receiving more solar energy than those near the poles. As a result, the tropical oceans and land masses absorb a great deal more heat than the other regions of Earth. The atmosphere and oceans act together to redistribute this heat. As the equatorial waters warm air near the ocean surface, it expands rises and drifts towards the poles; cooler denser air from the subtropics and the poles moves toward the equator to take its place. This continual redistribution of heat is modified by the planet's west to east rotation and the coriolis force associated with the planet's spherical shape, giving rise to the high jet streams and the prevailing westerly trade winds. The winds, in turn, along with Earth's rotation,drive large ocean currents such as the Gulf Stream in the North Atlantic,the Humboldt Current in the South Pacific, and the North and South Equatorial Currents.Ocean currents redistribute warmers waters away from the tropics towards the poles.The ocean and atmosphere exchange heat and water, carbon dioxide and other gases.By its mass and high heat capacity, the ocean moderates climate change from season to season and year to year. These complex, changing atmospheric and oceanic patterns help determine Earth's weather and climate.The Earth's climate has always been changing. The climate variations prior to the industrial era may thus be strongly influenced by variations in solar activity.The Sun is the source of the energy that causes the motion of the atmosphere and thereby controls weather and climate. Solar activity variations have traditionally been associated with the sunspot number although it is well known that solar activity may not be described by a single number.

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