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"The Solar Activities in Climate Change and Major Solar Geomagnetic Activities during Solar Cycle 24"

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Abstract
The solar activities, galactic cosmic rays, interstellar dust and Sun-Earth geometry have strong influence on climate and can increase concentration of greenhouse gases. The world has warmed 0.74°C in the past hundred years due to increases in greenhouse gas concentrations. Global average temperature is forecast to rise 4°C (7.2°F) toward the end of the 21st century. 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.TSI has been monitored from 1978 by on 4th January 2008, a reversed-polarity sunspot (AR10981) appeared, and this signaled the start of SC 24. It was high latitude (30º N) and magnetically reversed. Only a few sunspots were observed in the surface of the Sun throughout 2008. On 2nd November 2008, sunspot 1007 produced the SF of B-class.The temperature variation of Earth's surface and TSI, Sun has shown a slight cooling trend since 1960, over the same period that global temperatures have been warm. According to TSI variation trends in recent decades, the Sun has contributed a slight cooling influence but our globe is warmed up continuously.

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I. Introduction

Only a few sunspots were observed in the surface of the Sun throughout 2008. On 2nd November 2008, sunspot 1007 produced the SF of B-class. On 11th December 2008, sunspot 1009 produced the SF (C1.4). Solar activity remained extremely low throughout 2009. Only in December 2009 the observed monthly sunspots exceeded number 10. Some major solar activities start from year 2010. Solar Cycle 24 has produced 10 major GMSs with three in 2011, five in 2012 and two in 2013**(Alan,H.,1994)[1]**.In the present section, we have analysed these GMSs in brief: resulting in a major power outage for nine hours for the majority of the Quebec region and for parts of the northeastern United States.The Hydro-Quebec grid's geographic location and its 1,000 km transmission lines to the load center made it susceptible to GMSs Central and southern Sweden also experienced power losses when GICs disrupted six 130kV power lines causing them to trip or shut down automatically before preventive measures were possible (NERC, 1990). The loss of the compensators resulted in a system disturbance and severe equipment damage.**(Axford,W.I.1962)[2]**.During 1900 onward is shown in **Figure 1**.The long-term solar irradiance variations might contribute to global warming over decades or hundreds of years. Some of these changes particularly small shifts in the length of the solar activity cycle.

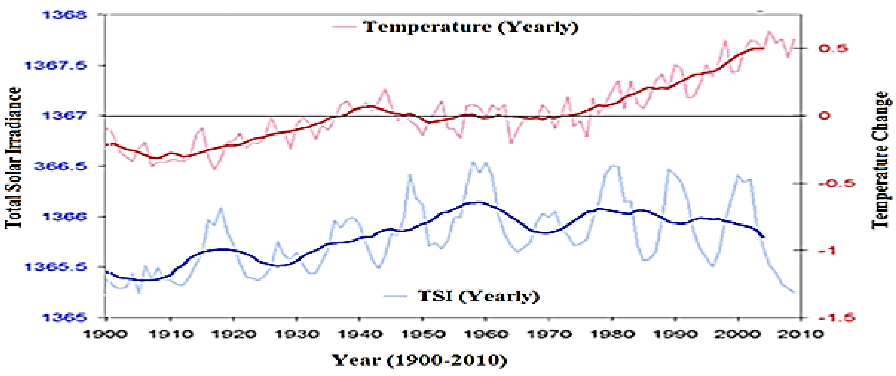

Figure1. Shows the temperature variation of Earth's surface and TSI, during 1900 onward. Dark lines show the average behaviour.

On 5th August 2011,During the GMS, D_{st} index to fall to –113 nT. The total average magnetic field jumps across the shock from 7 to 29 nT, southern component B_z rapidly jumps from -16 to 13nT and solar wind proton density jumps across the shock from 9 to 21 N/cm^3. (**Bame,S.J,1967)[3].** During the event, three halo CMEs and three partial halo CMEs have been observed by the LASCO instrument with a speed of 610, 1315, 1610 km s^{-1} and 338, 1343, 1070 km s^{-1} respectively. On 9th August 2011, sunspot 1263 produced a massive SF (X6.9) produced R3-level radio blackout.

GMS Observed during 26th September 2011

On 22nd September 2011, an SF (X1.4) erupted out of sunspot 1302. A R3-level radio blackout and G4-level GMS were registered. This event is very well known as Bastille Day event. It consists of an interplanetary shock driven by magnetic cloud. While pointing southward it causes a very intense fall in the D_{st} index, reaching its minimum of -103 nT. During this event, two halo CMEs and six partial halo CMEs are observed by the LASCO instrument with a speed of 1915, 971, km s^{-1} and 1936, 557, 788, 641, 309 km s^{-1} respectively.

GMS Observed during 25th October 2011

The Sun unleashed eight M-class SFs during October 2011, being the strongest the M3.9 event, followed by an Earth-directed CME, produced by sunspot 1305 on 2nd October 2011. The average interplanetary magnetic field is of the order of 21 nT except at the rare part, where it jumps to around 24 nT. At this rare position of the ejecta, the magnetic field was pointing substantially southward, thus causing the D_{st} to fall up to –137 nT. During the event, three halo CMEs and two partial halo CMEs have been observed by the LASCO instrument with a speed of 593, 1005, 570 km s^{-1} and 441, 270 km s^{-1} respectively.

GMS Observed during 9th March 2012

March 2012, one the most active months of SC 24, ended up with 19 M-class and 3 X-class SFs. Active region 1429 erupted an SF (X1.1) on 5th March 2012 caused an R3 level radio blackout and a G2 level GMS. Active region 1429 erupted a powerful SF (X5.4) with 8 other SF on 7th March 2012, causing a G3 level GMS, R3 level radio blackout and a S3 level solar radiation storm. This event marked the second strongest SF of SC 24 in terms of X-ray SRF. AR1429, rotating toward the other side of the Sun, still generated a SF (M 6.3) on 9th March 2012, a SF (M8.5) one day later and a SF (M7.9) on 13th March 2012. These eruptions causing G2 level GMSs. At this rare position of the ejecta, the magnetic field was pointing substantially southward, **(Barlow, W.H. 1848)[4]** .During the event, three halo CMEs and four partial halo CMEs have been observed by the LASCO instrument. As expected for major storms the B_z-component of IMF, linear speed of CMEs and solar wind speed attain relatively large value of about -14.2 nT, 2684 km s^{-1} and 713km s^{-1} respectively for the storm occurred during 7-13th March 2012. In which the GMS becomes intensified as a result of a combination of two interacting CMEs. The second CMEs compress the first CMEs and as a result, the southward part of the total IMF in the first magnetic cloud becomes more intense.

GMS Observed during 24th April 2012

A prominence eruption producing a CME shot off the east limb of the Sun on 15th April 2012. Such eruptions are associated with SF.The average interplanetary magnetic field is of the order of 10 nT except at the rare part, where it jumps to around 27 nT. At this rare position of the ejecta,**(Berchem J.,1982)[5]** .The magnetic field was pointing substantially southward, thus causing the D_{st} to fall up to –127 nT. During the event, two halo CMEs and four partial halo CMEs have been observed by the LASCO instrument with a speed of 528, 681 km s^{-1} and 443, 521, 433, 547 km s^{-1} respectively.

Long-term Variability of Solar Flare Index (SFI)

The solar flare index (SFI) is of value as a measure of this short-lived activity on the Sun. It represents total energy emitted by the solar flares (SFs). The data of SFI for the SC 21-23 were determined by using the final grouped SFs which are compiled by National Geophysical Data Center (NGDC). (**Cane,H.V.1985)[6] .**It is believed to result from the sudden release of energy stored in the magnetic fields that thread the solar corona in active regions around sunspots involving sudden bursts of particle acceleration, plasma heating, and bulk mass motion.SFI is applicable to study all the probable solar activities which affect our satellite environment and Earth atmosphere. SFI is one of the best indicators of activity variations on the chromosphere. This feature makes the SFI is a suitable full-disk solar index for comparison with similar solar indices which reflect different physical conditions from the different layers of the solar atmosphere.In the present work, (**Chen,J.1998 *J*)[7]**.We have analysed association of Kleczek SFI of solar activity with annual mean SSN for the period 1976 onwards, and are plotted in **Figure 2**. This period covers complete period of past SC's 21, 22 & 23. From this plot, (**Crooker,N. U.1994)[8] .** We have found that the yearly occurred value of SFI varies with 11-year sunspot cycle except at some circumstances. The occurrence of solar transients varies with sunspot cycles. Similarly SFI index of solar activities vary with 11-year SC. The variation of SFI for SC 22 and 23 shows close correspondence with SSN. During decreasing phase of SC 21, it is found that the value of SFI shows the increasing trend. It is also found that, the overall value of SFI is higher during SC 21 and 22 in comparison to SC 23. (**Farrugia,C. J.1996)[9].**This phenomenon is associated with 22-year hale cycle. During SC 21 and 22 northern hemisphere and southern hemisphere of the Sun was most active. After higher value of SFI in 22-year hale cycle, we find the overall value of SFI as small for SC 23.

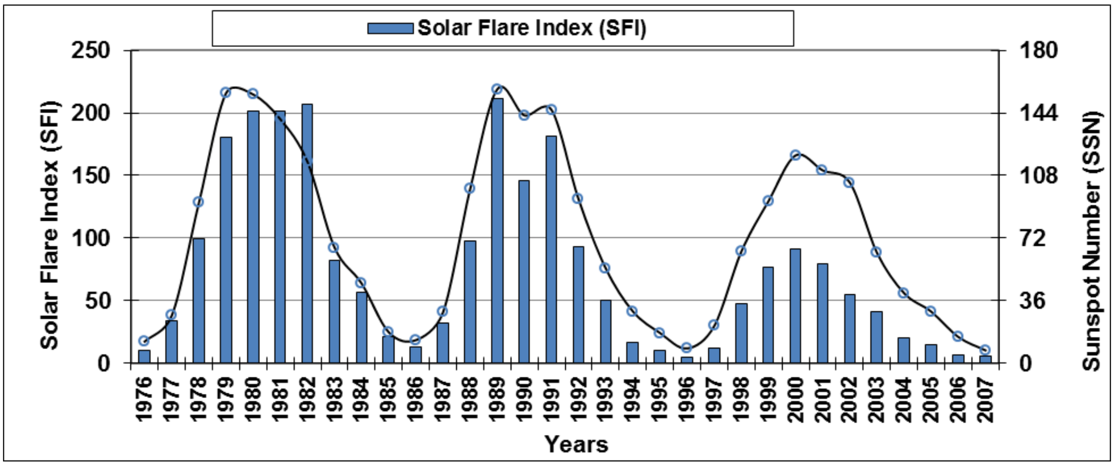

Figure 2 Shows the association of flare index of solar activity (SFI) and their association with 11-year sunspot cycle, observed during the period SC 21-23.

Long-term Variability of Solar Radio Flux (SRF)

The Sun emits radio energy with slowly varying intensity. Solar radio flux (SRF), which originates from atmospheric layers high in the Sun's chromosphere and low in its corona, changes gradually from day to day in response to the number of sunspot groups on the solar disk. SRF from the entire solar disk at a frequency of 2800 MH_z has been recorded routinely by radio telescope near Ottawa since February 1947. Associations of SRF with annual mean SSN for the period 1976 onwards are plotted in **Figure 3** we find that the yearly occurred value of SRF varies with 11-year SC as similar as variation of other solar transients. A difference between the first and second maxima for SC on the one hand and SRF on the other is intriguing. **(Farrugia,C.J.1997)[10].** If the radio emission is associated with SSNs, the relative values of the first and second maximum should be similar, at least qualitatively, for both. However, decimetric frequencies would be from bremsstrahlung and may not follow SSNs. Between the radio emissions themselves, there is no consistency.

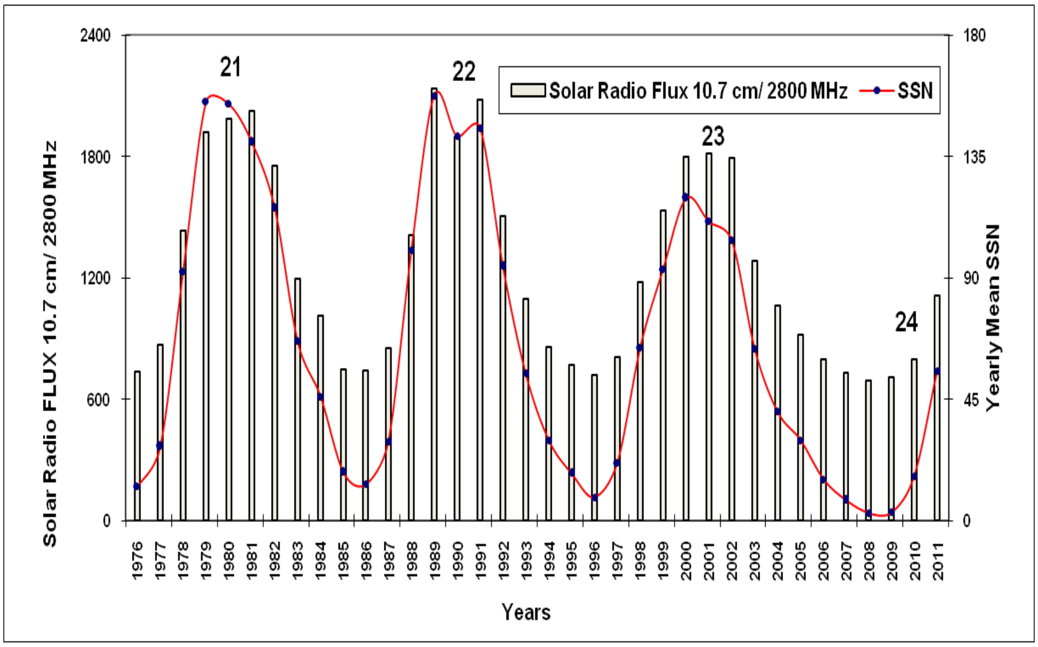

Figure 3. Shows the association of solar radio flux 10.7 cm/2800 MHz and their association with 11-year sunspot cycle, observed during the period 1976-2011.

Long-term Variability of Solar Energetic Particles (SEPs)

The solar energetic particle (SEP) events are the energetic outbursts as a result of acceleration and heating of solar plasma during SFs and CMEs. SEP events associated with SFs are called impulsive where as those associated with CMEs are gradual. SEP events occur when high-energy protons are ejected from the Sun's surface during fast solar eruptions and causes geomagnetic and ionospheric disturbances on large scale. These effects are similar to auroral events, the difference being that electrons and not protons are involved. These events typically occur at the north pole, south pole, and South Atlantic magnetic anomaly, where the Earth's magnetic field is lowest. (**Feynman, J. and 1994)**[11] **.**The more severe SEP events can cause widespread disruption to electrical grids and the propagation of electromagnetic signals. Occurrence of SEP events are varies with 11-year sunspot cycle. In the present section, we investigate the association of SEP events on long-term basis. An association of occurrence of SEP events (E ≥10 MeV) with 11-year sunspot cycle is plotted in **Figure 4**. We haven't shows very significant associations between the yearly occurrences of SEP events with 11-year sunspot cycle except solar cycle 22. SEP events are an important cause to produce geomagnetic and ionospheric disturbances on large scale. The more severe SEP events can cause widespread disruption to electrical grids

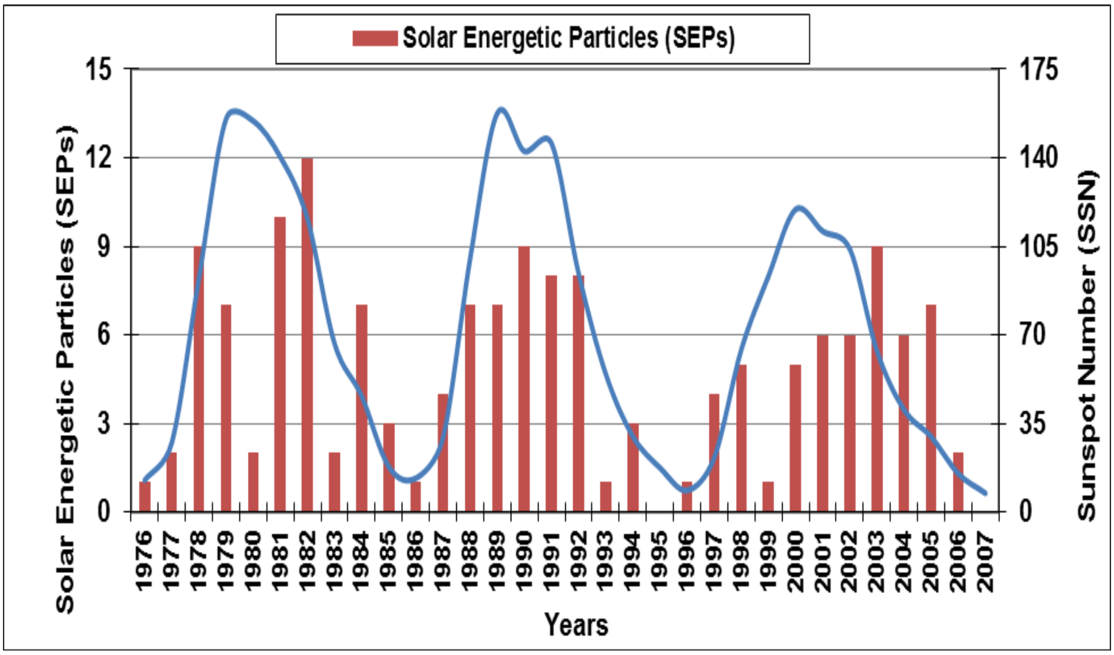

Figure 4. Shows the association of SEP Events (E ≥10 MeV) and their association with 11-year sunspot cycle, observed during the period SC 21-23.

II. Conclution

The unavailability of new equipment to replace the La Grande network's damaged equipment prevented power restoration to the transmission network. The power delay was also due to the damaged equipment and load transfers at the distribution network level. While work was being conducted to bring power back to the Hydro-Quebec grid, the New Brunswick and Ontario power systems helped provide emergency assistance to Quebec. As power was restored to Hydro-Quebec,(**Kahler,S. W.1992)**[12]**.**It received assistance from New England and New York systems as well as the Alcan and McLaren systems based in Quebec. The voluntary reduction of power use by industrial customers during the incident also helped Quebec to meet its power demands. After nine hours, 83% of full power was restored but one million customers were still without electrical power (NERC,1990). Since the incident, the Canadian government has set up protective measures at the Hydro-Quebec site, such as transmission line series capacitors,

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