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IMPACTS OF SUNSPOTS ON CLIMATE CHANGE

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ABSTRACT

Sunspots are the coldest part of the Sun, and usually develop in pairs. The magnetic field in sunspots stores energy that is released in solar flares/CMEs. As a result, solar source activities usually occur in a cycle that mimics the 11-year sunspot cycle. The solar energy that drives the weather system, scientists naturally wondered whether they might connect climate changes with solar variations. The Sun is the primary source of our space weather. Storms on the Sun, in the form of solar flares/coronal mass ejections, can launch showers of radiation and powerful magnetic fields into interplanetary space. Space weather comes as short-lived storms which can last minutes to hours to days. The Sun also undergoes cycles in its level of activity that span years to decades, causing longer-term variations in space weather. Finally, the Sun has changed substantially over the multi-billion year history of our solar system, producing long-term "climate change" effects in our space weather.

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INTRODUCATION

The Earth's magnetosphere and upper atmosphere can be greatly perturbed by variations in the solar wind caused by disturbances on the Sun. Changes in the orientation of the interplanetary magnetic field (IMF) and major increases in the velocity and density of solar wind particles striking the magnetosphere resulting geomagnetic storms. Geomagnetic storms are seen at the surface of the Earth as perturbations in the components of the geomagnetic field, caused by electric currents flowing in the magnetosphere and upper atmosphere. Ionospheric and thermospheric storms also result from the redistribution of particles and fields. Global thermospheric storm winds and composition changes are driven by energy injection at high latitudes. Storm effects may penetrate downwards to the lower thermosphere and may even perturb the mesosphere. Many of the ionospheric changes at mid-latitude can be understood as a response to thermospheric perturbations. A typical mid-latitude ionospheric storm has a relatively brief increase (positive phase) in F2 peak electron density (NmF2) and total electron content (TEC), followed by an extended decrease (negative phase), especially in thesummer hemisphere. At low latitudes, the positive phase may be longer and the negative phase absent altogether. However, there are considerable variations in this scenario from storm-to-storm, depending on location, level of solar activity, magnitude of the geomagnetic disturbance, season, local time, time of day of the commencement, and the duration of the storm.

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The Sun and Earth Connection

The Sun is our nearest and dearest star. It is source of energy, which sustains life on earth. It gives steady warmth and light. The Sun affects the near Earth space and terrestrial atmosphere in a variety of ways. There are two kinds of processes by which it can affect the Earth's atmosphere namely, the high energy radiation and galactic particle emission. The formation of the ionosphere, density and plasma temperature are primarily depends on solar energy radiation especially from the extreme ultraviolet (EUV) and X-rays. The high energy radiation from the Sun in the form of EUV rays can destroy extreme conditions of solar activity. The coronal mass ejections (CMEs) are phenomena in which solar plasma material ejected from the corona in the form of charged particles. The more energetic components of these particles can damage the satellite communication as well as can be hazardous to astronauts. Apart from these, energetic particles manifest as aurora in the polar regions. It is now well believed that the solar magnetic field plays a major role in the production of high energy radiation and particles emissions. These strong beliefs follow from the observed enhancement in the high energy radiation and particle emission during solar activity. In this way; the solar magnetic field can be said to influence the earth's weather and climate (e.g. Parker, 1999).

The Sun is the primary driver of space weather. Space weather occurs in the Sun's atmosphere, but may affect Earth's atmosphere. Storms on the Sun, in the form of solar flares and coronal mass ejections (CMEs), can launch showers of radiations and powerful magnetic fields into interplanetary space. Weather on Earth is the set of ever-changing ambient conditions in our atmosphere. Its elements include temperature, air pressure, wind speed and direction, humidity, precipitation, and so on. Space weather is the set of ever-changing ambient conditions in the space within our solar system. Its elements include electromagnetic radiation, the solar wind of charged particles that flows outward from the Sun, and the force of the interplanetary magnetic field (IMF), which spirals outward from our parent star.

The global warming is used to describe the changes of the large scale weather systems on Earth, and especially the surface temperature increase, by increase of atmospheric carbon dioxide (Co_2). The galactic cosmic rays increase the amount of C-14 in the atmospheric Co_2 and consequently, also in vegetation. During the increased solar activity close to solar cycle maximum years, Earth is better shielded from the cosmic rays than during the minimum years, and the amount of C-14 decreases. Thus the C-14 content of, for example, annual rings of old trees may reveal something about the Sun's performance during the last few millennia. Some studies have indicated that there is a connection between long term climate change and Sun's activity (Friis-Christensen and Lassen, 1991; Lassen and Friis-Christensen, 1995). One possible mechanism operating is that during high activity levels the decreased amount of galactic cosmic rays could lead to reduced cloud formation in the atmosphere, and hence to increased temperatures.

The studies of solar-terrestrial impacts are great area of interest because it is concern with space weather environment. Radiation from space storms can endanger astronauts and can damage and destroy satellites, such as those used for cell phone communications. Some electrical power grids have been knocked out of commission by especially powerful solar storms. Such storms can be sources of beauty as well as destruction. The marvelous displays of the aurora are caused by collisions of particles energized by solar storms with gases in Earth's upper atmosphere.

Climate Change

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 which would externally vary the amount of solar radiation received by the Earth's atmosphere and surface. 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.

Variations in Solar Output

Sunspots are huge magnetic storms that are seen as dark (cooler) areas on the Sun's surface. The number and size of sunspots show cyclical patterns, reaching a maximum about every 11, 22, 88 and 176 years. The solar activities vary with sunspot cycles. The measurements made with a solar telescope from 1976 to 1980 showed that during this period, as the number and size of sunspots increased, the Sun's surface cooled by about 6° Celsius. Apparently, the sunspots prevented some of the Sun's energy from leaving its surface. However, these findings tend to contradict observations made on longer time's scales. Observations of the Sun during the middle of the Little Ice Age (1650-1750) indicated that very little sunspot activity was occurring on the Sun's surface. The Little Ice Age was a time of a much cooler global climate and some scientists correlate this occurrence with a reduction in solar activity over a period of 88 or 176 years. Measurements have shown that these 88 and 176 year cycles influence the amplitude of the 11 year sunspot cycle. It is hypothesized that during times of low amplitude, like the Maunder Minimum, the Sun's output of radiation is reduced. Observations by astronomers during this period (1645-1715) noticed very little sunspot activity occurring on the Sun.

During periods of maximum sunspot activity, the Sun's magnetic field is strong. When sunspot activity is low, the Sun's magnetic field weakens. The magnetic field of the Sun also reverses every 22 years, during a sunspot minimum. The Milankovitch theory suggests that normal cyclical variations in three of the Earth's orbital characteristics are probably responsible for some past climatic change. The basic idea behind this theory assumes that over time these three cyclic events vary the amount of solar radiation that is received on the Earth's surface.

1. The first cyclical variation, known as eccentricity, controls the shape of the Earth's orbit around the Sun. The orbit gradually changes from being elliptical to being nearly circular and then back to elliptical in a period of about 100,000 years.
2. The second cyclical variation results from the fact that, as the Earth rotates on its polar axis, it wobbles like a spinning top changing the orbital timing of the equinoxes and solstices.
3. The third cyclical variation is related to the changes in the tilt (obliquity) of the Earth's axis of rotation over a 41,000 year period.

Periods of a larger tilt result in greater seasonal climatic variation in the middle and high latitudes. At these times, winters tend to be colder and summers warmer. Colder winters produce less snow because of lower atmospheric temperatures. As a result, less snow and ice accumulates on the ground surface. Moreover, the warmer summers produced by the larger tilt provide additional energy to melt and evaporate the snow that fell and accumulated during the winter months. In conclusion, glaciers in the polar regions should be generally receding, with other contributing factors constant, during this part of the obliquity cycle.

Variations of Atmospheric Co_2

The amount of Co_2 that can be held in oceans is a function of temperature. The Co_2 is released from the oceans when global temperatures become warmer and diffuses into the ocean when temperatures are cooler. Initial changes in global temperature were triggered by changes in received solar radiation by the Earth through the Milankovitch cycles. The increase in Co_2 then amplified the global warming by enhancing the greenhouse effect. The long term climate changes represent a connection between the concentrations of Co_2 in the atmosphere and mean global temperature. The Co_2 is one of the more important gases responsible for the greenhouse effect. Certain atmospheric gases, like carbon dioxide, water vapor and methane, are able to alter the energy balance of the Earth by being able to absorb long wave radiation emitted from the Earth's surface. Without the greenhouse effect, the average global temperature of the Earth would be a cold -18° Celsius rather than the present 15° Celsius.

Human activities like the burning of fossil fuels, conversion of natural prairie to farmland, and deforestation have caused the release of Co_2 into the atmosphere. From the early 1700's, Co_2 has increased from 280 parts per million to 395 parts per million in 2009. The variation of Co_2 concentration is shown in Figure 1. From the plot, exponential growth of Co_2 concentration with period can be observed. The higher concentrations of Co_2 in the atmosphere will enhance the greenhouse effect making the planet warmer. According to computer climate models, if the globe will warm up by 1.5 - 4.5° Celsius then Co_2 concentration can reaches the of 600 parts per million by the year 2050.

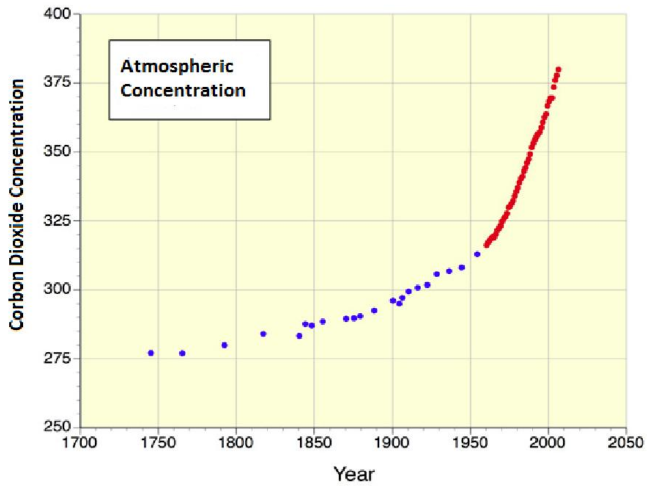

Figure 1. Shows that the variation of Co_2 concentration during 1700 to present. The blue point data of Co2 concentration is taken by Siple station ice core and red points from Mauna Loa

REFERENCES

Echer, E., Gonzalez, W.D., Tsurutani, B.T., Gonzalez, A.L.C., 2008. *J. Geophys. Res*., 113, A05221.

Feldman, U., Landi, E. and Schwadron, N. A., 2005. *Journal of Geophysical Research*, *110, 7109.*

Friis-Christensen, E. and Lassen, K., 1991. *Science,* 254, 698-700.

Lassen, K. and Friis-Christensen, E., 1995. *J. Atmos. Terr. Phys.,* 57, 835-845.

Lane, L.J., Nichols, M.H. and Osborn, H.B., 1994. Time series analyses of global change data*. Environ. Pollut*., 83, 63-68.

Parker, E.N., 1999. Solar Physics: Sunny side of Global Warming", *Nature,* 399.

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