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Long-term Variation of TSI, Climate Change and Global Warming

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Abstract**—** The Sun is the major source of energy for Earth's ocean, atmosphere, land, and biosphere, averaged over an entire year approximately 342 watts of solar energy fall upon every square meter of Earth. As a comparison, large electric power plants produce about 1 billion watts of power to be exact. The total amount of energy Earth receives from the Sun and then subtract the total amount of energy each reflects and emits back to space, arrive solar energy is called energy budget. Sun's energy enter Earth's atmosphere make it to the surface. The atmosphere reflects some of the incoming Solar energy back to space immediately and absorbs still more energy before it can reach the surface. The remaining solar energy strikes Earth and warms the surface. Presents work deals the long-term variability of total solar irradiance (TSI), climate change and global warming. Climate change is a long-term change in the weather patterns over periods of time that may range from decades to thousands of years. The Earth's magnetosphere and upper atmosphere can be greatly perturbed by variations in the solar variations caused by disturbances on the Sun. The state of near-Earth space environment is governed by the Sun and is very dynamic on all spatial and temporal scales. Mechanisms proposed to explain the climate response on solar variations can be grouped broadly into two categories. The first involves to variations in TSI. The second mechanism category involves energetic particles, including solar energetic particle events (SEPs) and galactic cosmic rays (GCRs). The potential role of solar influences in modulating recent climate has been debated for many decades. Before the satellite period solar luminosity had been scaled from proxy data that exists large uncertainty. Total solar irradiance (TSI) has been monitored continuously from space since 1977. The long-term solar irradiance variations might contribute to global warming over decades or hundreds of years. According to TSI variation trends in recent decades, the Sun has contributed a slight cooling influence but our globe is warmed up continuously. Adverse impact of climate change and global warming in our ecosystems and challenges in near future along-with perspective role of solar irradiance (TSI) in recent climate change have been discussed.

Keywords**—** Total solar irradiance (TSI), SEPs, GCRs, global warming and climate change.

I. INTRODUCTION

The role of Sun in recent global warming and its future influence in the context of man-made climate change has been analyzed. Energy receiving from Sun, in the form of electromagnetic radiation is the fundamental driver of the Earth's climate system. The total solar energy hitting the Earth depend on its distance from the Sun and therefore on the ecliptically, but the distribution of the radiation over the globe depends on the tilt and precession. The amount of energy arriving in summer at high latitudes determines whether the winter growth of the ice cap will recede or wetter the climate will be precipitated in to an ice age. Thus change to seasonal irradiance. The total solar energy hitting the Earth depends on its distance from the Sun. The Sun has an effect on climate bytes radiation and the main energy source of our Planet. Space weather may also in long term effect the Earth climate. Solar ultraviolet, visible and heat radiation are primary factor for Earth's climate. Sunspots have been recorded through several hundreds of year and many scientists observed correlation between the solar magnetic activity, which reflected in the sunspot frequency, and climate parameter at Earth. 70-90 year oscillation in global mean temperature is correlated with corresponding oscillation in solar activity. The role of Sun also had been providing the Earth with energy for billions of years.

There are two well-known source for climate change and global warming, one is Earth itself and other the Sun. The Earth's climate system constantly adjusts so as to maintain a balance between the energy that reaches it from the Sun and the energy that goes from Earth back to space. An increase in the levels of greenhouse gases (GHGs) could lead to greater warming, and have an impact on the world's climate, known as 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. 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. There is an abrupt and drastic cooling in the climate can be possible in near future due to large scale melting of global ice by global warming, and prolonged sunspot minima. IPCC (2007) report estimates that over the 20th century, the mean global surface temperature increased by 0.7°C.

Solar impact on the Earth's climate in the upper atmosphere interacts most directly with the radiation, particles and magnetic fields emitted by the Sun. Solar signals in the stratosphere are relatively large. Ozone is the main gas involved in radiative heating of the stratosphere. Solar-induced variations in ozone can therefore directly affect the radiative balance of the stratosphere with indirect effects on circulation. Solar-induced ozone variations are possible through: (a) changes in solar ultraviolet (UV) spectral solar irradiance, which modifies the ozone production rate through photolysis of molecular oxygen, primarily in the mid-to-upper stratosphere at low latitudes (Haigh, 1994), and (b) changes in

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the precipitation rate of energetic charged particles, which can indirectly modify ozone concentrations through changes in the abundance of trace species that catalytically destroy ozone, primarily at polar latitudes (Randall et al.,2007). In addition, transport-induced changes in ozone can occur (Hood and Soukharev, 2003; Rind et al., 2004; Shindell et al., 2006; Gray et al., 2009) as a consequence of indirect effects on circulation caused by the above two processes. Solar UV radiation directly influence stratospheric temperatures and the dynamical response to this heating extends the solar influence both poleward and downwards to the lower stratosphere and tropopause region. Evidence that this influence can also penetrate into the underlying troposphere is accruing from a number of different sources. One consequence of these solar perturbations is to complicate the detection of human-induced depletion of the protective ozone layer; another may be to perturb the temperature at the Earth's surface, through connections that link the upper and lower parts of the atmosphere.

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 basis of the hypothesis of Svensmark et al. (2009) is that weak solar activity causes a weak solar wind, which in turn increases the number of galactic cosmic rays penetrating the Earth's atmosphere. This increases low level cloud formation and the Earth's albedo. The Earth cools as a consequence.

II. TSI VARIABILITY

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 sunspot cycle and longer timescales (Lockwood and Fröhlich, 2008). Recent research indicates that variability in TSI associated with the 11-year sunspot cycle arises almost entirely from the distribution of sizes of the patches where magnetic field threads through the visible surface of the Sun. Solar variability on time scales of centuries to millennia can be reconstructed using cosmogenic radio nuclides such as ^{10}Be and ^{14}C whose production rate in the atmosphere is modulated by solar activity. In this way, at least the past 10,000 years can be reconstructed (Vonmoos et al., 2006), although the temporal resolution is poorer, signal to noise ratio is lower and the record must be corrected for variations in the geomagnetic field. Recently, Steinhilber[19] derived from ^{10}Be the first TSI record covering almost 10,000 years and calculated the interplanetary magnetic field (IMF) necessary to explain the observed production changes corrected for the geomagnetic dipole effects. They then used the relationship between instrumental IMF and TSI data during sunspot cycle minima to derive an estimate of the TSI record.

TSI has been monitored from 1978 by several satellites, e.g. Nimbus 7, Solar Maximum Mission (SMM), the NASA, Earth Radiation Budget Satellite (ERBS), NOAA9, NOAA 10, Eureca and the UARS (Upper Atmospheric Research Satellite) etc. The historical reconstruction of more recently accepted TSI absolute value is described by Kopp and Lean (2011) based on new calibration and diagnostic measurements by using TIM V.12 data on 19th January 2012, and is updated annually. The basic causes of increase in global temperature can occur from variation in TSI and human made activities (mainly emission of Co_2). The variation of TSI measured by several satellites (composite) and their association with global surface temperature (GSTemp) during 1978 onwards are shown in Figure1. From the plot, it is observed that the TSI varies in a cyclic manner but global surface temperature is increasing continuously during above mentioned periods. Since 1978, the Sun has shown a slight cooling trend but global temperatures have been warmed up continuously. It is indication for a dangerous period and high awareness about global warming is most essential, otherwise we left our Earth as flame of burning for next generation.

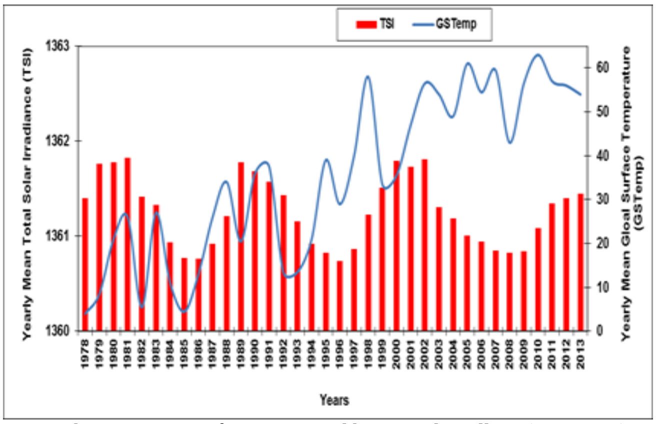

Fig. 1. Shows variation of TSI measured by several satellites (composite) and their association with global surface temperature (GSTemp) during 1978 onwards.

III. VARIATION OF ATMOSPHERIC 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 amount of Co_2 that can be held in oceans is a function of temperature. 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 change represents a connection between the concentrations of Co_2 in the atmosphere and means global temperature. 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. Co_2 concentrations in the atmosphere have increased from about 280 ppm in pre-industrial times to 387 ppmv at present. The variation of Atmospheric carbon dioxide (in ppmv) collected at Mauna Loa, Hawaii and their association with global surface temperature (GSTemp) during 1978 onwards are plotted in figure 2. The data of global surface temperature (GSTemp) have been taken from National Aeronautics and Space Administration, Goddard Institute for Space Studies. From the plot, it is find that that the rate of concentration of atmospheric Co_2 and global surface temperature both are increasing continuously during above mentioned periods. These increases can reach more than 550 ppmv before the end of the 21^{st} century, if we ignore this problem.

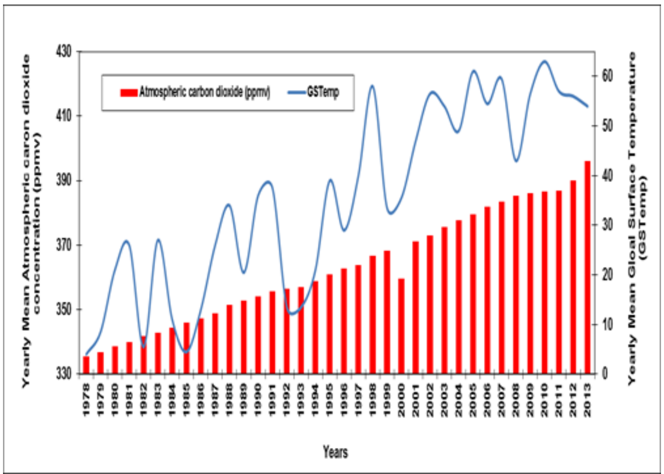

Fig. 2. Shows the variation of Atmospheric carbon dioxide (in ppmv) collected at Mauna Loa, Hawaii and their association with global surface temperature (GSTemp) during 1978 onwards.

The major cause of global warming is the emission of greenhouse gases (GHSs) like carbon dioxide (Co_2), methane, nitrous oxide etc. into the atmosphere. The major source of Co_2 is the power plants. These power plants emit large amounts of Co_2 produced from burning of fossil fuels for the purpose of electricity generation. About twenty percent of carbon dioxide emitted in the atmosphere comes from burning of gasoline in the engines of the vehicles. This is true for most of the developed countries. Buildings, both commercial and residential represent a larger source of global warming pollution than cars and trucks. Building of these structures requires a lot of fuel to be burnt which emits a large amount of carbon dioxide in the atmosphere. Methane is more than 20 times as effectual as Co_2 at entrapping heat in the atmosphere. Methane is obtained from resources such as rice paddies, bovine flatulence, bacteria in bogs and fossil fuel manufacture. When fields are flooded, anaerobic situation build up and the organic matter in the soil decays, releasing methane to the atmosphere. The main sources of nitrous oxide include nylon and nitric acid production, cars with catalytic converters, the use of fertilizers in agriculture and the burning of organic matter. Another cause of global warming is deforestation that is caused by cutting and burning of forests for the purpose of residence and industrialization.

IV. GLOBAL WARMING

Scientists all over the world are making predictions about the ill effects of Global warming and connecting events. The effect of global warming is increasing the average temperature of the Earth. A rise in Earth's temperatures may boost the occurrence and concentration of severe climate events, such as floods, famines, heat waves, tornados, and twisters. Other consequences may comprise of higher or lower agricultural outputs, glacier melting, lesser summer stream flows, genus extinctions and rise in the ranges of disease vectors. As an effect of global warming species like golden toad, harlequin frog of Costa Rica has already become extinct. There are number of species that have a threat of disappearing soon as an effect of global warming. As an effect of global warming various new diseases have emerged lately. The global warming is extending the distribution of mosquitoes due to the increase in humidity levels and their frequent growth in warmer atmosphere. Various diseases due to ebola, hanta and machupo virus are expected due to warmer climates. The marine life is also very sensitive to the increase in temperatures. The effect of global warming will definitely be seen on some species in the water. A survey was made in which the marine life reacted significantly to the changes in water temperatures. It is expected that many species will die off or become extinct due to the increase in the temperatures of the water, whereas various other species, which prefer warmer waters, will increase tremendously. The global warming is expected to cause irreversible changes in the ecosystem and the behavior of animals. Based on the study on past climate shifts and computer simulations, many climate scientists say that lacking of big curbs in greenhouse gas discharges, the 21^{st} century might see temperatures rise of about 3 to 8º C, climate patterns piercingly shift, ice sheets contract and seas rise several feet. With the probable exemption of one more world war, a huge asteroid, or a fatal plague, global warming may be the only most danger to our planet Earth.

Global warming will increase the ocean temperature, cause sea level rise, and will have impact on ocean circulation patterns, ice cover, fresh water run-off, salinity, oxygen levels and water acidity. Sea level is rising around the world. In the last century, sea level rose 5 to 6 inches more than the global average along the Mid-Atlantic and Gulf Coasts, because coastal lands there are subsiding. Due to global warming, higher temperatures are expected to further raise sea level by expanding ocean water, melting mountain glaciers and small ice caps, and causing portions of Greenland and the Antarctic ice sheets to melt. The IPCC (2007) estimates that the global average sea level will rise between 0.6 and 2 feet in the next

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century. As the sea rises, the outer boundary of these wetlands will erode, and new wetlands will form inland as previously dry areas are flooded by the higher water levels. The amount of newly created wetlands, however, could be much smaller than the lost area of wetlands - especially in developed areas protected with bulkheads, dikes, and other structures that keep new wetlands from forming inland. A group of scientists have recently reported on the surprisingly speedy rise in the discharge of carbon and methane release from frozen tundra in Siberia, now starting to melt because of human cause increases in Earth's temperature. The scientists tell us that the tundra is in danger of melting holds an amount of extra global warming pollution that is equivalent to the net amount that is previously in the Earth's atmosphere. This ice would be enough to raise sea level 20 feet worldwide if it broke up and slipped into the sea. The IPCC (2007) suggests that if sea level rise could convert as much as 33% of the world's coastal wetlands to open water by 2080.

REFERENCES

[1] E. Friis-Christensen and K. Lassen, *Science*, vol. 254, pp. 698-700, 1991.

[2] L. J. Gray, S. T. Rumbold, and K. P. Shine, "Stratospheric temperature and radiative forcing response to 11-year solar cycle changes in irradiance and ozone," *Journal of the Atmospheric Sciences*, vol. 66, pp. 2402-2417, 2009.

[3] J. D. Haigh, "The role of stratospheric ozone in modulating the solar radiative forcing of climate," *Nature*, vol. 370, pp. 544-546, 1994.

[4] L. L. Hood and B.E. Soukharev, "Quasi-decadal variability of the tropical lower stratosphere: The role of extratropical wave forcing," *Journal of the Atmospheric Sciences*, vol. 60, pp. 2389-2403, 2003.

[5] IPCC: 2007, Climate Change 2007, The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change eds: Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 663-745.

[6] G. Kopp, and J. L. Lean, "A new, lower value of total solar irradiance: evidence and climate significance," *Geophysical Research Letters Frontier article*, vol. 38, l01706, 2011.

[7] K. Lassen, and E. Friis-Christensen, *Journal of Atmospheric and Solar-Terrestrial Physics*., vol. 57, pp. 835-845, 1995

[8] M. Lockwood, and C. Fröhlich, "Recent oppositely-directed trends in solar climate forcings and the global mean surface air temperature: II. Different reconstructions of the total solar irradiance variation and dependence on response timescale," *Proceeding Roy. Soc.*, Lond, 2008.

[9] C. E. Randall, V. Harvey, C. S. Singleton, S. Bailey, P. Bernath, M. Codrescu, H. Nakajima, and J. M. Russell, Energetic particle precipitation effects on the Southern Hemisphere stratosphere in 1992-2005, *Journal of Geophysical Research*, 112, D08308, 2007.

[10] D. Rind, D. Shindell, J. Perlwitz, J. Lerner, P. Lonergan, J. Lean, and C. McLinden, "The relative importance of solar and anthropogenic forcing of climate change between the maunder minimum and the present," *Journal of Climate*, vol. 17, pp. 906-929, 2004.

[11] D. T. Shindell, G. Faluvegi, R. L. Miller, G. A. Schmidt, J. E. Hansen, and S. Sun, "Solar and anthropogenic forcing of tropical hydrology," *Geophysical Research Letters*, vol. 33, L24706, 2006.

[12] H. Svensmark, T. Bondo, and J. Svensmark, *Geophysical Research Letters*, vol. 36, L15101, 2009.

[13] M. Vonmoos, J. Beer, and R. Muscheler, "Large variations in Holocene solar activity: constraints from Be-10 in the Greenland ice core project ice core," *Journal of Geophysical Research*, 111, A10105, 2006.

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