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Research Article

CLIMATE CHANGE AND GLOBAL WARMING

[*1]Rahul Shrivastava and [2]Subhash Chand Dubey

[1]Department of Physics, Govt. Girls College, Rewa (MP) 486 001, India
[2]Department of Physics, S.G.S. Govt. P.G. College, Sidhi (MP) 486661, India

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ABSTRACT

The Sun is the continuous source of the energy that causes the motion of the atmosphere and thereby controls weather and climate. Any change in the energy from the Sun received at the Earth's surface will therefore affect our climate. The Earth's climate has warmed over the last century. It is very likely that the primary cause of this global warming is the emission of greenhouse gases due to a range of human activities and the resulting increase in the concentrations of greenhouse gases in the atmosphere. Climate models indicate that the global warming and other climate changes will continue and accelerate through the coming century if emissions of greenhouse gases continue to increase. There are two well-known causes that affect the global warming and other climate changes. One of them is solar variation (mainly TSI) and other is increase in greenhouse gases (mainly increases of carbon dioxide, Co2 after industrial revolution). 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 activities follow the approximately 11-year solar activity cycle. We have analysed long-term correlative behaviour of total solar irradiance (TSI), sunspot number (SSN), global surface temperature (GSTemp) and emission greenhouses gases (mainly Co2) during 1900 onwards. It is social need to awareness of maintain emission of greenhouse gases in present time; otherwise our future is very dangerous. Adverse impacts of climate change and challenges in near future along with perspective roll of above activities on recent climate change have also been discussed.

INTRODUCTION

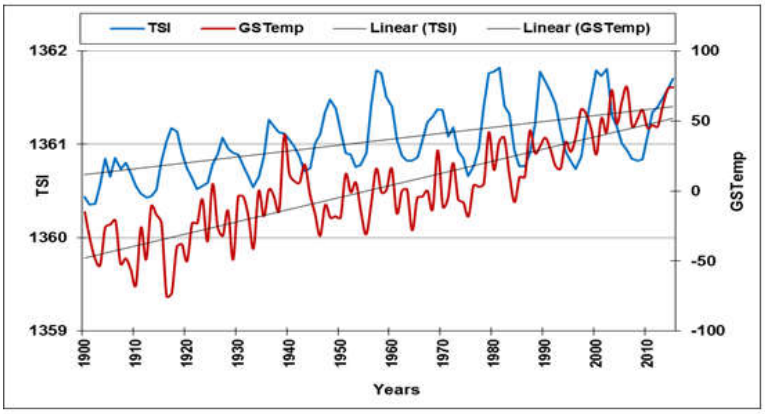
There are two well-known source for climate change and global warming, one is Earth itself and other the Sun. The Earth's climate system constantly adjusts so as to maintain a balance between the energy that reaches it from the Sun and the energy that goes from Earth back to space. An increase in the 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 (IPCC, 2007) report estimates that over the 20th century, the mean global surface temperature increased by 0.7°C.

Corresponding author: Rahul Shrivastava,
Department of Physics, Govt. Girls College, Rewa (MP) 486 001, India.

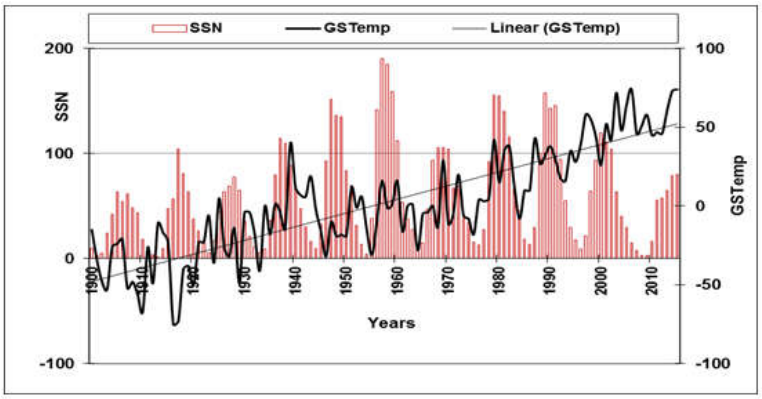
Herschel (Herschel, 1801) was the first to speculate that the Sun's variations may play a role in the variability of the Earth's climate. The role of solar variability in climate estimates of the solar influence on the global mean surface temperature. The most obvious impact of the Sun is its influence on the Earth's radiation budget through variations in TSI.

The solar impact

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 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



Figures 1. Shows the variation of TSI and global surface temperature, during 1900 onwards



Figures 2. Shows the variation of SSN and global surface temperature, during 1880 onwards

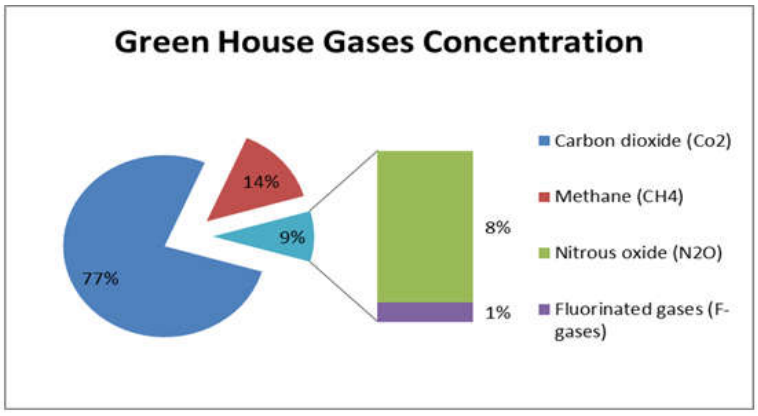
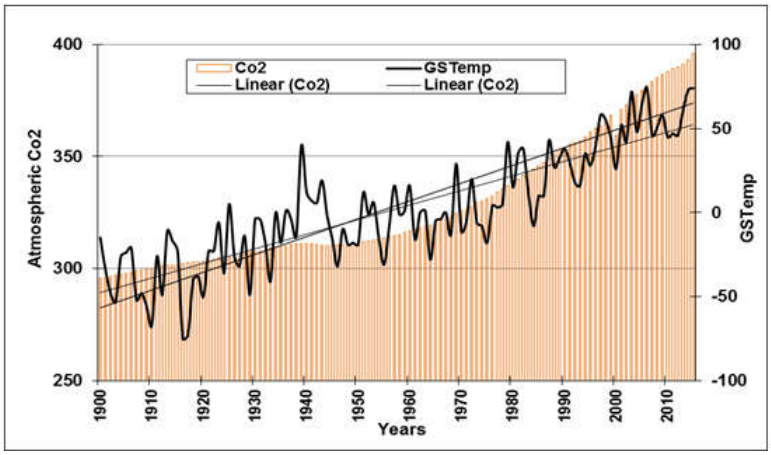


Figure 3. Represents the recently concentration of greenhouse gases (GHGs) in the atmosphere



Figures 4. Shows the variation of Co_2 and global surface temperature, during 1880 onwards

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 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. The Solar activities follow over an 11-year cycle. Eddy (Eddy, 1976) 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 (Lockwood and Fröhlich, 2008) 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.

Total solar irradiance (TSI) variation

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 (Lockwood and Fröhlich, 2008). The historical reconstruction of TSI absolute value is described by Kopp and Lean (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 historical reconstruction of TSI and their association with 11-year sunspot cycle from 1700 onwards shows 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. The associations of TSI with global surface temperature (GSTemp) from 1900 onwards are shown in Figure 1. From the plot, centurial variation trends of TSI and GSTemp both show increasing trends.

The sunspots and climate change

Sunspots are huge magnetic storms that are seen as dark (cooler) areas on the Sun's surface. These spots may be of diameter 37000 km and appear as dark spots within the photosphere, the outermost layer of the Sun. The number of sunspots peaks every 11 years. There is a strong radial magnetic field within a sunspot and the direction of the field reverses in alternate years within the leading sunspots of a group. So the true sunspot cycle is 22 years. 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. There are longer cycles than the 11-year sunspot cycle known as Gleissberg cycle (88-year) with variable amplitudes. The cosmogenic radio nuclides confirm the existence of other longer periodicities (e.g. 208-year DeVries or Suess cycle, 2300-year Hallstatt cycle and others) and also the present relatively high level of solar activity, although there is some controversy (Muscheler et al., 2007; Steinhilber et al., 2008). The Milankovitch theory suggests that normal cyclical variations in three of the Earth's orbital characteristics are probably responsible for some past climatic change. 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. The associations of sunspot number (SSN) with global surface temperature (GSTemp) from 1900 onwards are shown in **Figure 2**. From the plot, centurial variation trends of SSN and GSTemp have not very clear associations.

Greenhouse gases and the Earth's climate

Life on Earth depends on the presence of greenhouse gases (GHGs) in the atmosphere. The main GHGs influenced directly by human activities are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3), and synthetic gases, such as chlorofluorocarbons (CFCs) and hydro fluorocarbons (HFCs). Water vapour is also a major greenhouse gas, but its concentration in the atmosphere is not influenced directly by human activities; rather, it is controlled mainly by the Earth's temperature. **Figure 3** represents the recently concentration of greenhouse gases (GHGs) in the atmosphere. Greenhouse gases influence Earth's climate because they interact with energy flows.

Atmospheric Co_2 and global temperature

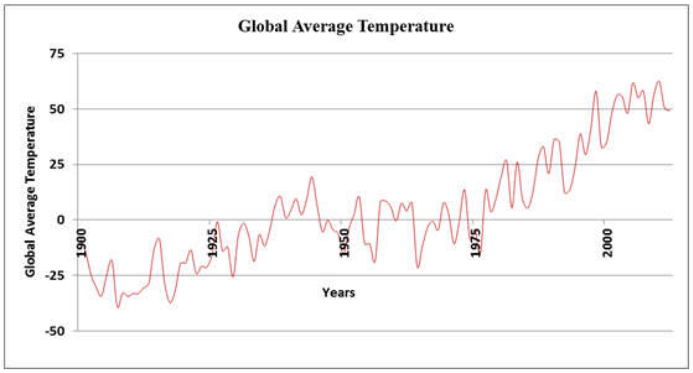
Atmospheric carbon dioxide (Co_2) is an important kind of greenhouse gas which influences global temperature. Its concentration variation could indicate the distribution of human and natural activities in various regions. The increase in Co_2 then amplified the global warming by enhancing the greenhouse effect. The 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.

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 1900 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.

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. The variation of global surface temperature (GSTemp) from 1900 onwards is shown in **Figure 5**. 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 21st 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.



Figures 5. Shows the variation of global average temperature, during 1900 onwards

Climate change: an overview

To aware global warming and climate change, societies must find ways to fundamentally change their patterns of energy use in favour of less carbon-intensive energy generation, transportation, and forest and land use management. A growing number of countries have taken on this challenge, and there are many things individuals too can do. For instance, consumers have more options to purchase electricity generated from renewable sources. Additional measures that would reduce personal emissions of greenhouse gases and also conserve energy include the operation of more energy-efficient vehicles, the use of public transportation when available, and the transition to more energy-efficient household products. Individuals might also improve their household insulation, learn to heat and cool their residences more effectively, and purchase and recycle more environmentally sustainable products. Forecasts of climate extremes can improve awareness and reduce adverse effects. Focusing attention on extreme events also may help countries to develop better means of dealing with the longer-term impacts of global climate change. Conversely, the pressures on the biosphere that drive climate change may cause critical thresholds to be breached, leading to shifts in natural systems that are unforeseen and rapid. Studying historical extremes of climate cannot forewarn on the consequences of such events. Rapid changes in climate during extreme events may be more stressful than slowly developing changes due to the greenhouse effect.

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