Discovery of the Major Mechanism of Global Warming and Climate Change

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Abstract — Statistical analysis of the number of destructive earthquakes versus global temperature and greenhouse gases revealed very significant correlations. This is a strong indication that the frequent occurrence of major earthquakes had increased earth's obliquity and induced both global warming and emission of greenhouse gases (GHG) in recent years. It is further shown by a simple model developed here that seismic-induced oceanic pressure could enhance the obliquity leading to increased solar radiative flux on earth. The possible increase in the planetary obliquity was substantiated by the solar radiation model SOLRAD, which simulated an associated increase of absorbed solar radiation. The model also revealed a net poleward gain of solar radiative flux with enhanced obliquity which could be the cause of the observed polar amplification of global warming and climate change. Multiple regression analysis also showed that the sudden obliquity change since 1995 played a major role in the temperature rise and GHG increase, and coincided with the 10 warmest years on record. Climate simulations conducted with the EdGCM also showed that enhanced obliquity causes increased solar radiative flux, increased air and ocean temperature, and decline of ocean ice cover. The enhanced obliquity and absorbed solar radiation could have accelerated the melting of ice sheets and glaciers, exposure and degradation of permafrost regions, increased CO_2 respiration fluxes from soil, and forest fires during summer. This study confirmed in several ways that earthquake-pressured obliquity change, and not greenhouse effect, is the major mechanism governing global warming and climate change presently occurring on earth.

Keywords — earthquakes, enhanced obliquity, global warming, total solar radiation

1 Introduction

Many natural disasters presently occurring on earth are climate-related. Few people realize that earthquakes have something to do with climate change and the global warming problem. Rising greenhouse gases (GHG) especially carbon dioxide (CO_2) concentrations due to anthropogenic sources had been blamed as the major factor triggering the global warming problem and associated climate changes. However, the anthropogenic input of CO_2 is a mere 3% of the global load as compared to the 97% input of natural sources emanating from the permafrost regions, oceans and the continents **[**15**]**. In addition**,** the observed increase of CO_2 concentrations from anthropogenic and natural sources cannot explain the increasing number of destructive earthquakes and volcanic eruptions presently occurring in many regions on earth. Recent studies also found that global warming could be the cause of the increasing CO_2 concentrations due to increasing respiration flux of surface soils as temperature rises [2]. A long data set of temperature and CO_2 concentrations based on air bubble analyses of ice cores also showed a big lag in time between the two factors, with CO_2 rise following the increasing trend in temperature [4]. Some climate models showed that natural forcing due to volcanic activity and solar radiation do not account for the observed warming on the planet [17]. Using a Global Climate Model, it was pointed out that the observed warming during the last part of the 20th century could not be explained by natural sources alone and that the combined influence of anthropogenic greenhouse gases and natural sources including volcanics, solar radiation, and sulfate aerosols could explain the observed warming. However, the possible change of the earth's tilt on its axis (i.e. obliquity), as a natural cause of global warming was neglected in the global climate simulations. A major part of the problem can be traced from the accepted 41,000-year periodicity of the obliquity as previously established under the Milankovitch astronomical theory of climate change. The computed cyclical change of obliquity is thus too long and climate models do not assume short-term annual variability and generally consider a constant obliquity.

It is a long-established fact that the near-constant tilt or obliquity of the earth causes the seasons to change leading to short-term seasonal variability of the climate. The obliquity of the planet earth had been estimated in the early 20th century by Milankovitch to vary from 22.1-24.5° for every 41,000 years and that the present trend is a declining phase from the average tilt of 23.44°. However, more accurate astrophysical modeling conducted in [7] suggested that the earth's obliquity could range from 19-28.4° from the ecliptic. It has been pointed out that the moon, sun and the planets of the solar system can affect the obliquity of the earth and therefore regulate the global climate by constraining the

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present value within the average tilt of 23.4°. It is possible however, that the obliquity of the planet earth can change in a short-term as a result of the dynamic variation of oceanic pressure within the planet itself. The Chandler wobble, which puzzled scientists for a century, proves that the planetary tilt can change almost every year (i.e. once every 1.2 years) due to physical changes in the oceans. NASA (2000) has confirmed that changes in the earth's obliquity due to the Chandler wobble is largely due to the changing pressure and salinity distribution at the bottom of the oceans [12]. It is therefore possible that earthquake-induced tsunamis and the associated strong pressure and force in the ocean bottom could also alter the average tilt of the earth. A major earthquake like the December 2004 temblor off western Sumatra, Indonesia could impart a very strong pressure in the bottom of the ocean triggering a series of destructive tsunami waves [20]. The strong oceanic pressure and force due to the great earthquake could increase the planetary tilt as shown in this paper.

1.1 Objectives

The main objective of this study is to determine the impact of forced axial tilting of the earth on the global warming problem and associated climate change, and the possible cause of the enhanced obliquity. A new simplified model of the enhanced obliquity is presented in this paper. A simple measurement technique is also proposed and was used to determine the possibility of enhanced planetary obliquity. In the absence of annual measurements of planetary obliquity, available observations of major earthquakes are used to determine the change in the earth's obliquity. Time-series analysis of the data is then performed using multiple regression technique.

The impact of the enhanced obliquity on the global climate was also analyzed using the EdGCM global climate model. The model results and available observations on surface temperature are compared to determine if the assumed natural forcing could indeed be the cause of the global warming and abrupt climate change problem presently occurring on earth.

2 METHODOLOGY

2.1 Statistical Analysis

In the absence of a clear record of annual planetary obliquity, this study found that the number of destructive earthquakes (e.g. earthquake count) could be used for time-series analysis. Statistical analyses such as linear correlation and multiple regression were used on the various climate parameters including global temperature, CO_2 and GHG concentrations, earthquake count and estimated obliquity, and total solar irradiance. These were obtained from the National Climate Data Center (NCDC) of the National Oceanic and Atmospheric Administration (NOAA) and from the public domain [9], [10]. Strength of relationships between the various climate parameters was deduced from the resulting correlation coefficients and standard errors. In addition, the contributions (i.e. attribution) of the major climate forcing factors on global warming were also determined from the multiple regression analysis made.

2.2 Global Climate Modeling

The educational Global Climate Model (EdGCM) simulates global processes on a coarse horizontal resolution of 8° x 10° x 9 vertical layers in the atmosphere. However, the use of EdGCM in simulating climate change due to planetary-scale changes on earth (i.e. increased planetary obliquity) and solar changes can help elucidate the major mechanism of challenging problems like the present global climate change. The large-scale climate determines the environment for microscale (1 km or less) and mesoscale (from several kilometers to several hundred kilometers) processes that govern weather and local climate [8]. Hence, even the EdGCM could be used to understand the impact of important physico-chemical processes on earth or basic mechanisms that are external in nature. For instance, changes in solar irradiance or the increase of destructive earthquakes and the concomitant tilting of the earth on its axis (i.e. variable obliquity) could now be simulated. The axial tilting of the earth as a result of the great Sumatra earthquake that triggered the Asian Tsunami in 2004, and the great Chile earthquake of February 2010 had been documented by the National Aeronautic and Space Administration (NASA). In addition, changes in the solar constant (luminosity) had also been observed using open solar magnetic field [25]. Slight changes in the solar output had also been detected by NASA using estimations of the solar meridional circulation and the associated magnitude of its velocity. The potential change in the obliquity is re-evaluated in this study while documented changes in the solar output were retained.

The present study considers the possible cause and effect of enhanced planetary tilt (i.e. increased obliquity) on the global climate. Using an accurate astrophysical model, [7] was able to show that with the influence of other external forces in the solar system (sun, moon and the planets), the earth's obliquity varies from 19-28.4 degrees. The average value used by global climate models at present is about 23.44° and is normally assumed constant throughout the simulation. This value however, can be varied in the climate model EdGCM.

In the absence of an accurate observation of the change in the earth's angle of tilt, the present climate modeling study uses the computed obliquity from the new theoretical model developed in this study. To get an appreciable impact on the earth's climate, the model assumes that the earth's tilt has been forced to increase from 23.4° to about 28.4°, or an increase of 5° from the average value. This assumes that major earthquakes in the last couple of decades have tilted the earth further than was computed below by our physical model. The modeling study then calculates the impact of increased obliquity of the earth on the global surface air temperature, sea surface temperature, snow cover, precipitation, evaporation and other climate parameters taking into consideration the changes in the radiation absorbed by the planet and the net surface heating on earth.

3.0 EARTHQUAKE-PRESSURED OBLIQUITY CHANGE (EPOCH) MODEL

Pressure is force per unit area acting in all directions. Using the tsunami generation model of [20], a very strong oceanic force and associated oceanic torque or angular momentum can be calculated from the Sumatra submarine quake that generated the Asian Tsunami of December 26, 2004. The strong pressure from the submarine quake generated a horizontal water current motion whose strength was dictated by the earthquake moment magnitude and focal depth, the oceanic buoyancy frequency, and the slope of the ruptured seabed across the fault line (Fig. 1). The new tsunami generation mechanism was corroborated by [23] and [24] and concluded that the great tsunami was largely generated by a strong lateral collision force of the continental slope and the ocean column as shown by independent evidence from seismographs, satellite radar altimeters, and tide gauges in the region. The series of tsunami waves that were generated initially rushed westward and subsequently encircled the globe through the major oceans. This created an imbalance on the existing lunar force of attraction on earth and acted to tilt the earth further that reversed the Milankovitch-predicted decreasing obliquity trend.

3.1 Computed Obliquity Change due to Quake-Induced Oceanic Force

The great Asian earthquake and tsunami of December 2004 occurred during a period of earth's maximum tilt from the sun and towards the moon (i.e. December 26, 2004 was a full moon). Since the earth's radius is very small (1.67%) compared with the earth-moon distance, a balance of forces exists as shown in Fig. 2. The earth and its moon, though spherical in shape, are small dots in the universe but are magnified here to show what happens to the earth's axis with a strong lateral oceanic force and associated oceanic torque produced by a major earthquake.

Using Newton's law of gravitation, the gravitational force exerted by the moon with mass m, on the earth with mass M, separated by a distance r is given by $F_m = G\frac{Mm}{r^2}$. This is equivalent to about **2.0 x 10^{20} N** and was directed towards the moon and away from the sun. The quake-induced tsunami near the equator off Sumatra generated a very strong lateral force and torque that countered the earth's rotation. This oceanic force (per unit mass) is proportional to the current acceleration and was directed westward. The induced oceanic torque (clockwise when viewed from the north pole) thus countered the regular rotation of the earth from west to east, leading to the increased axial tilt or obliquity of the planet (Fig. 2).

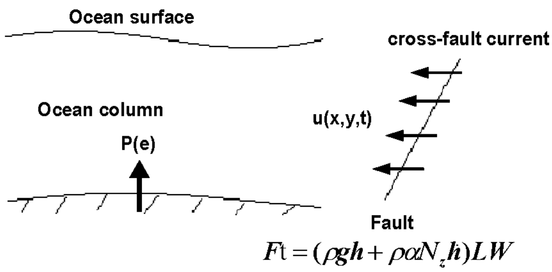

Fig. 1. A strong westward oceanic force proportional to the current acceleration generated by the Sumatra earthquake of December 26, 2004 and triggered the Asian tsunami.

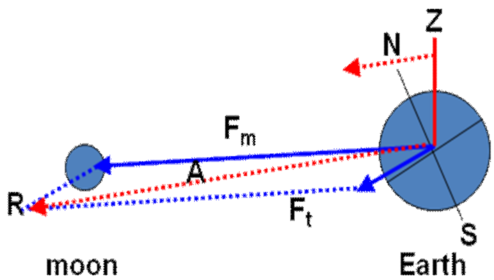

Fig. 2. Balance of forces (not scaled) showing the gravitational pull of the moon on the earth and the total oceanic force that generated the Asian tsunami.

The magnitude of the seismic-induced oceanic force that triggered the tsunami is equivalent to the product of the displaced water mass along the ruptured fault and the total oceanic acceleration. The earthquake-generated oceanic acceleration can be determined from the new current-induced tsunami generation model [20] and is proportional to the slope of the affected seabed. Off the island of Sumatra, the abrupt increase of water depths towards the southwest was responsible for the strong collision force between the continental slope and the oceanic water mass that triggered the tsunami. The seismic-induced total oceanic force is the sum of the hydrostatic force and the earthquake-induced lateral force shown in Fig. 1, namely;

$$F_t = \rho\left[gh + \frac{1}{4}\left(\frac{10^{M_w} g}{\rho(D+h)\upsilon}\right)^{1/3} N_z \Delta h\right] LW \qquad (1)$$

Here, ρ is the ocean water density (kg/m^3), g is gravitational acceleration (m/s^2) , h is the water depth (m) where the faulting occurred, M_w is the moment magnitude of the earthquake, D is the focal depth (m), υ is the kinematic viscosity of seawater (m^2/s), N_z is the ocean buoyancy frequency (s^{-1}), Δh is the slope or difference of water depth (m) on either side of the ruptured fault, L is the length of ruptured fault (m), and W is the width of the fault (m). Using the quake magnitude (M_w = 9.3), focal depth and ocean characteristics, F_t was determined to be about **2.567 x 10^{19} N**. The strong pressure acted in an area of the ocean bottom roughly equal to the length of the ruptured fault times its width (1,200 km x 600 km).

Using the law of cosine in Fig. 2, the resultant force R was estimated to be about **2.134 x 10^{20} N**. The oblique angle opposite of R (=161.45°) is the difference between 180°, the initial obliquity of earth (23.45°), and the 5-degree declination of the moon from the ecliptic. After using the law of sine, the angle A given by;

$$A = \sin^{-1}\left(\frac{F_t \sin(161.45^0)}{R}\right) \qquad (2)$$

was computed to be about **2.193°.** It should be noted that another strong quake with a magnitude of about M_w = 7.1 occurred in the same place about 3 hours later. Assuming that the area affected by the strong pressure at the ocean bottom is about half the previous one (600kmx300km), an additional tilt of the earth's axis of about **0.502°** would result. The strong oceanic force and resulting torque generated a small rotational displacement of Z and consequently of the original N-S axial tilt of the earth, leading to a total increase in the planetary obliquity of about **2.695°.** Hence, the earth's obliquity could have tilted further to about **26.145°** (23.45° + 2.695°) due solely to the great Sumatra earthquake of December 2004. The enhanced obliquity of earth is shown below to have a considerable influence on the global climate due to the associated net gain in the solar radiative flux absorbed by the planet.

It should be noted that the oceanic angular momentum generated by the great earthquake of December 2004 within the ruptured fault amounted to about **4.87 x 10^{27} kg-m^2/s**, which is an order of magnitude (about 37 times) greater than the global atmospheric angular momentum (AAM). This proves that major earthquakes can have a considerable impact on the motion of the predominantly fluid-covered planet and are capable of enhancing the planetary obliquity. As shown further by the estimated time-series of obliquity below, it is possible that major earthquakes could have started to tilt the planet even before the end of the 20th century. The enhanced tilt, which is within the newly simulated earth's obliquity of [7], cannot be easily restored by the gravitational force of distant planets leaving the earth with enhanced obliquity that reversed the Milankovitch-predicted decreasing trend.

When major earthquakes and tsunami of similar magnitudes occur in the future, the planetary obliquity may be enhanced further depending on the position of the moon and the location of the quake on earth until the maximum tilt is reached. This is based on the assumption that the moon, the sun and the planets of the solar system remain in their relative distances with respect to the earth, and no foreign body in orbit comes in between the earth and the sun. A foreign body in orbit may lead to inconceivable obliquity and chaotic motion of the earth and the moon with tremendous devastating consequences due to great changes in the atmospheric dynamics and the oceanic tides on earth.

3.2 Measuring the Obliquity from the Declination of the Sun

Due to the obliquity of the earth on its axis and the rotation of the planet around the sun, the declination angle varies seasonally. If the earth were not tilted on its axis (i.e. obliquity = 0°), the declination would be 0°. The earth is initially tilted by about 23.45°, and the declination angle of the sun originally spans about 46.9° in the horizon throughout the year.

To determine if the earth's obliquity has been enhanced, a simple measurement technique can be undertaken. An observer can use a magnetic compass and a straight rod for the simple experiment which can be done before sunset or at sunrise. By fixing the rod vertically upwards and measuring the angle that the shadow of the rod makes on the compass (make sure that the compass arrow points towards the north), one can determine the value of the enhanced obliquity of the planet. The obliquity and declination angle should attain a maximum negative value of about -23.45° on December 21 as the maximum declination of the sun during the winter solstice is about -23.45°. However, this may no longer be the case due to the enhanced obliquity of the earth. The enhanced obliquity is found by subtracting 90° before sunset (or 270° at sunrise) from the observed angle in the compass. If the resulting angle is about -23.45° during the winter solstice, this implies that the earth has not been tilted further. However, if the resulting angle is less than -23.45°, this proves that the earth has tilted further.

During the summer solstice (June 21), the declination angle of the sun should be about +23.45°. The same experiment with the compass and the rod can be repeated before sunset and then subtract 90° from the observed angle. If the resulting angle is greater than 23.45°, this implies that the earth's obliquity has indeed increased.

Using a magnetic compass, the simple experiment was conducted before sunset during the period 14-17 December 2010 (at Latitude 14.6°N) and the observed angle was about 62.5° giving an obliquity of about -27.5°. Similar experiment was also conducted at sunrise during the winter solstice of December 21, 2010. The observed angle was about 297.5° degrees resulting to an obliquity angle of about -27.5° (e.g. 270°-297.5°). Due to the curvature of the earth, the actual obliquity could be slightly smaller since measurement was done when the sun is slightly above the horizon (i.e. the horizon was partly covered with clouds during sunrise and sunset). Such an obliquity change may have a profound effect on flight navigation due to the apparent shifting of the earth's magnetic poles.

The change in the obliquity could be oscillatory in nature as the earth spins on its axis and that temporal changes can occur throughout the year as the earth orbits the sun. The maximum change could have occurred after the great 2004 earthquake and tsunami in the Indian Ocean and the obliquity is no longer on a gradual declining phase but oscillating about the obliquity change after the event. The Milankovitch-trend of obliquity is thus reversed.

3.3 Enhanced Obliquity and its Impact on the Global Solar Radiation

The previous theoretical computation and physical experiment shows that strong forces due to major earthquakes, and not greenhouse effect, could be the major physical mechanism of the present global warming and abrupt climate change presently occurring on earth. A shown above, the obliquity of the earth could be enhanced during the occurrence of major earthquakes and tsunamis. This could affect the earth's climate in several ways including increased radiative flux received by the earth and associated surface heating and accelerated release of greenhouse gases.

SOLRAD (version 1.2) which was written by [19] is a simplified solar radiation model that is based on clear sky conditions and therefore does not take into account the dynamics of cloud formation and other complex atmospheric processes. The solar position calculations in this Excel/VBA application are a translation of NOAA's solar position calculator [19]. Solar radiation calculations were based on the models of [1], [3], and [21]. For simplicity, only the results of the Bird and Hulstrom model are presented here and discussed. The potential change in the global solar radiation due to enhanced obliquity was computed using this model. The computed solar radiative flux from an obliquity value of 23.4° was subtracted from computed radiative flux for the case of an enhanced obliquity of 28.4°. The computed values for each latitude circles are shown in Fig. 3. It can be seen that the monthly change is all negative at the equator, whereas positive and negative changes representing gain and losses in radiative fluxes occur at higher latitudes. At latitude 30-45°N, the reduction of solar radiation due to enhanced obliquity ranges from -60W/m^2 to -80W/m^2 from November to February which could easily explain the occurrence of (early and late) extreme winters nowadays. Above the Arctic circle (and also at the Antarctic circle), the gain in radiative flux is so high that the loss is so small in comparison. This could be the real cause of the accelerated melting of polar ice sheets and exposure of permafrost in recent years. When the daily radiative fluxes are averaged over a year, global warming becomes more evident. The computed latitudinal variation of the annual global solar radiation (left) and net changes of the solar radiative flux with enhanced obliquities (right) on a horizontal surface on earth are shown in Fig. 4.

If the earth's obliquity was enhanced further to 26.145° from the Sumatra earthquake of December 2004, it is estimated that a net annual gain of about 3.56 W/m^2 for the solar radiative flux would result under clear sky conditions. Assuming that the total cloud cover is about 56%, this would result to about 1.56 W/m^2 gain in the total radiative flux absorbed by the earth. A net increase of **5.58 W/m^2** or **2.8 W/m^2** (with 50% cloud cover), is estimated by SOLRAD when the earth's obliquity is about **27.67°**. It should be noted that the estimated solar radiative flux here is equivalent to the infrared radiative (IR) climate forcing being attributed to greenhouse gases (GHG's). The enhanced obliquity and associated changes of solar radiative flux on earth could therefore be the real cause of accelerated melting of polar ice caps and glaciers in recent years and not greenhouse effect, since the earth's poles now experience more direct radiation from the blazing sun. It should be noted that infrared radiation reflected by the earth and trapped by greenhouse gases is quite small in terms of energy magnitude as compared to the energy of total solar radiation and may not be able to melt a kilometer thick of ice sheet in the Antarctic.

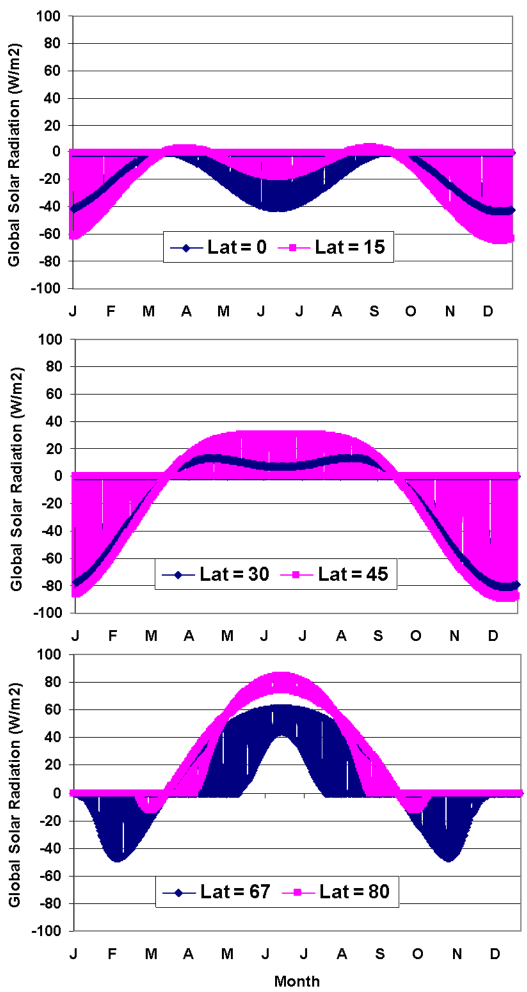

Fig. 3. Change in the monthly radiative flux (W/m^2) received by the earth due to enhanced obliquity. The altered solar radiation absorbed by the planet could be the real cause of the present global warming and climate change.

Assuming that the obliquity of earth was indeed enhanced by the Sumatra quake to about 26.145° and the present obliquity as estimated by SOLRAD is about 27.67°, this implies that other major earthquakes could be responsible for the additional 1.525° tilt of the earth's axis. With the frequent occurrence of major earthquakes at present, the obliquity of the planet could be very close to the maximum obliquity of 28.4° as predicted by Girkin (2005).

4.0 ANALYSIS OF THE EFFECT OF ENHANCED OBLIQUITY AND SOLAR IRRADIANCE ON GLOBAL WARMING

There is no clear record of annual planetary obliquity during the past century and the last couple of years. The computed obliquity from the old Milankovitch theory shows a gradual decreasing trend of the planetary obliquity from the present mean of about 23.45°.

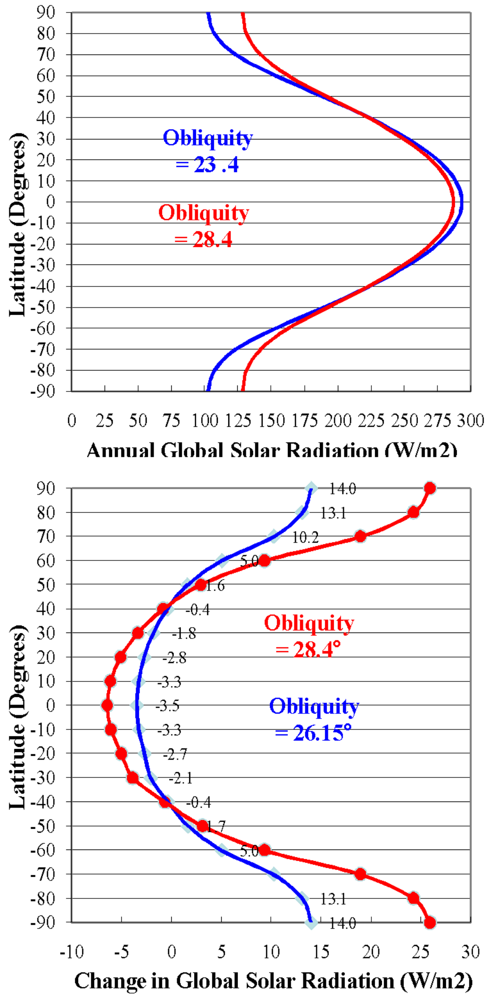

Fig. 4. Computed annual average and latitudinal change of global solar radiation (W/m^2) on a horizontal surface under clear sky. The high radiative flux with enhanced obliquity near the poles causes the observed polar amplification of global warming & climate change.

This study found that the number of destructive earthquakes (e.g. earthquake count) could be used to derive the annual obliquity for time-series analysis. The resulting trend of major earthquake count from the compilation made in the public domain [9], [10] was used to derive the annual variation of the obliquity.

4.1 Estimated Planetary Obliquity from Major Earthquakes

The major earthquakes were counted individually each year from 1901 to 2010 and the resulting annual earthquake count was used to estimate the change in the obliquity. This was done by first taking the difference of the inverse of the earthquake count before and after the observed abrupt increase of major earthquakes (1988 and 2000). The difference (about 0.245) was multiplied by the earthquake count, after which the average tilt of 23° was added. The result was subjected to a moving average of 7 years. It should be noted that some of the estimated obliquities during the last 2 decades are higher than the obliquity computed by the EPOCh model. These were therefore re-adjusted before taking the 7-year running average. The result revealed that the planetary obliquity started to increase after 1990 (Fig. 5). Since 1995, the increased planetary obliquity is apparent from the observed increasing frequency of major earthquakes. Coincidentally, the 11 hottest years recorded since 1900 occurred during the last 16 years (1995-2010). The possible impact of direct solar heating on the earth's surface became very pronounced during these years with the accelerated melting of ice caps in the north and south poles.

Since major earthquakes appeared to have dictated the present change in the obliquity of the planet, the derived data do not show any periodicity. Major earthquakes were just shown by the data to have occurred more frequently before the end of the 20th century. The sudden increase in the number of destructive earthquakes could have tilted further the earth's axis owing to the strong angular momentum and oceanic torques imparted by earthquakes and tsunamis on the predominantly fluid earth, leading to a reversal of the Milankovitch-trend in the planetary obliquity.

4.2 Total Solar Irradiance (TSI)

The data on total solar irradiance used in this study was taken from [25] as compiled by NCDC-NOAA. The date set was derived using open solar magnetic field. In this study, only the recent data set starting from 1900 were used. Since the data set was originally presented every 5 years, simple averaging was implemented in this study to get the yearly TSI data. The new data set is plotted with the original data from [25] shown in red squares in Fig. 6.

The data on total solar irradiance showed a gradual and oscillatory increase of solar radiation from 1901-1994. During this period, there was a gradual increase from about 1365.5 W/m^2 to about 1366.01 W/m^2 in 1993. The solar irradiance suddenly decreased during the years from 1960-1974 but began to increase again thereafter until it reached the maximum value. Since 1995, the irradiance data showed a gradual decrease until the present time with a minimum value that is a bit lower than the minimum in 1973.

A ***solar radiation tide*** appeared from the observed total solar irradiance with pronounced inequality between the two maximum values and the two minimum values. The first peak occurred in 1958 and the second peak appeared in 1988 when global warming was first declared. There appeared a solar periodicity of about 30-35 years from the new TSI data which is not related to the well-known 11-year solar cycle. A third peak, which could be higher than the second, could occur again in the future. It is quite fortunate that the maximum solar irradiance did not coincide with the increase in planetary obliquity. If this happened, the resulting increase of solar radiative flux absorbed by the earth could have been much higher leading to extreme changes in the weather and the climate. As the data showed, when the irradiance began to decrease in 1994, major earthquakes appeared to have increased in number with the associated increase in the planetary obliquity, and dramatic rise of global temperature anomaly.

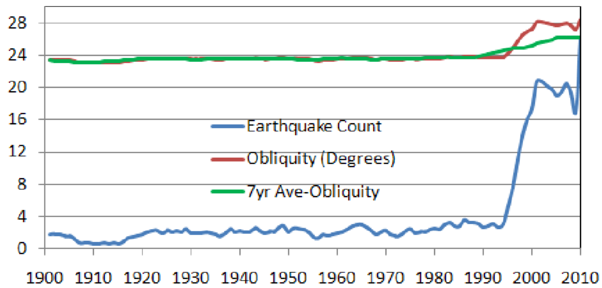

Fig. 5. Observed number of destructive earthquakes since the 20th century ([9],[10]) and estimated obliquity (green line above).

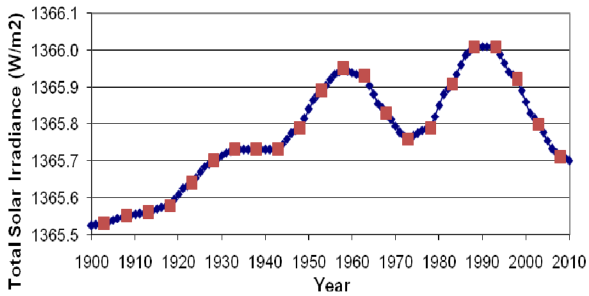

Fig. 6. Total solar irradiance from [25] derived using open solar magnetic field data and averaged annually.

4.3 Correlation Analysis

A simple correlation analysis was performed using MS Excel for the period (1978-2008) when there was an abrupt increase in global temperature. The results of the simple correlation analysis showed very high correlation coefficients for both global temperature anomaly versus CO_2, and ocean temperature anomaly versus CO_2. However, performing further correlation analysis for temperature anomaly versus earthquake count, and CO_2 concentration versus earthquake count using a logarithmic trend also revealed unexpected results with very high correlation coefficients of about 0.95. This is statistically as significant as the correlation between global or ocean temperature anomaly versus CO_2 concentration. Correlation analysis between Total Solar Irradiance (TSI) and the global temperature anomaly also resulted in significantly high correlations. Earthquake-enhanced obliquity and changes in the solar radiation could therefore be the major mechanisms governing the present global warming and associated climate change on the planet. The high correlation coefficient between global temperature and CO_2 concentrations could mean that temperature rise dictated the increasing CO_2 concentrations.

4.4 Multiple Regression and Attribution of Major Mechanisms

An important statistical test that would show the relative contributions of earthquake count and increased obliquity, total solar irradiance and CO_2 concentration on the global temperature anomaly was performed using multiple regression. The data on earthquake count and estimated obliquity were smoothed by taking the 7-year moving average. All the other data on temperature anomaly and CO_2 concentration were not smoothed since they already represent yearly averaged values from monthly observations.

The multiple regression analysis of the observed data revealed a rather strong positive contribution of earthquake count or obliquity on the observed increase of global temperature and CO_2 concentration. While the correlation analysis above showed a strong correlation between global temperature anomaly and CO_2, the regression analysis showed that the effect of CO_2 concentration on temperature is not very significant when compared to the effect of obliquity and total solar irradiance. In fact, the regression analysis showed that CO_2 changes were largely dictated by obliquity and TSI changes. This shows the possibility that the global warming problem is not dictated by increasing CO_2 concentrations but rather by the enhanced obliquity and absorbed solar radiation. Multiplying the CO_2 anomaly with the global temperature anomaly and subjecting the product to a multiple regression with the TSI anomaly data and the estimated obliquity anomaly revealed a rather good result as shown in Fig. 7. Similar regression analysis of the other greenhouse gases (CH_4, N_2O, CFC-11, CFC-12) against TSI and obliquity showed very significant results with multiple R exceeding 0.90. In fact, the same regression analysis was performed with the proposed GHG index which is the 5th root of the product of the 5 major GHG's, and good results with very high R-values were obtained.

The regression analysis in Fig. 7 revealed that the rise in both global temperature and CO_2 (and GHG) concentrations is primarily dictated by the changes in obliquity and total solar irradiance ($R = 0.97$). The result showed that during the last 16 years (1995-2010), the contribution of enhanced obliquity on the product of global temperature anomaly and CO_2 anomaly is about 99% as compared to the 1% contribution of TSI. This could be attributed to the correct timing in the changes of both the mean obliquity of the earth and the global temperature and GHG rise after 1990. It should be noted that TSI started then to decrease, but the enhanced planetary tilt could not be brought back to its original tilt after that period resulting to a gradual but accelerated warming since the 1990's. The famous 'hockey-stick trend' in the temperature rise and observed increase in GHG concentrations can be easily compared with the sudden increase of earthquake frequency and planetary obliquity after 1990.

The impact of enhanced planetary obliquity on the global temperature and CO_2 concentrations were also analyzed individually. The results of the regression analyses are shown in Fig. 8 below. The regression equations yielded very high values of R^2 (= 0.999) and low standard errors of less than 2% (global temperature) and 5% (CO_2). The individual analysis further showed that the contribution of TSI and obliquity on temperature rise is of similar proportion (i.e. about 50% each) during the last 110 years (1901-2010). However, the regression analysis for CO_2 rise showed that obliquity contributed 98% during this period. Since CO_2 fluxes are also dependent on temperature rise, the result proves that both global warming and the rise in greenhouse gases are directly caused by enhanced planetary obliquity. The individual regression analyses conducted for global temperature and CO_2 concentration (and vice versa) did not show better results with lower R^2 values and higher standard errors. The regression analysis done for global temperature versus CO_2 was also compared with the analysis made for global temperature versus obliquity and TSI in Fig. 9. Undeniably, the R^2 value (0.998) is also very high for global temperature versus CO_2, but the standard error is quite lower for the regression analysis for global temperature versus obliquity and TSI. Thus, the previously accepted theory of anthropogenic global warming and climate change due to CO_2 and other greenhouse gases may not be correct. This is clearly shown by the big difference in the observed global temperature and the results of the regression models (Fig. 9).

While TSI and obliquity contribute (statistically) almost similar proportion to the observed temperature rise during the last century, it should be noted that the magnitude of TSI changes range only from 0.17-0.48 W/m^2, thereby contributing only about 6-17% to the estimated radiative climate forcing of about 2.8 W/m^2. The observed global temperature rise is therefore due largely to enhanced obliquity by contributing over 70% (> 2.0 W/m^2) and hence could be called the major mechanism of global warming and climate change.

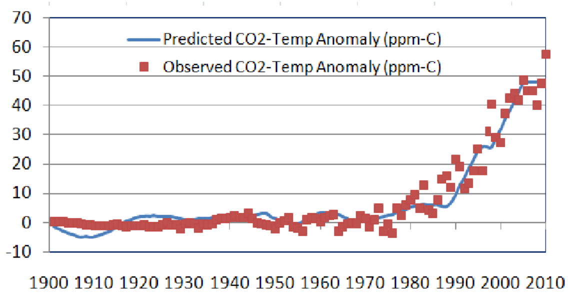

Fig. 7. Multiple regression analysis for combined CO_2-Temperature anomaly versus total solar irradiance and obliquity. The result shows that enhanced obliquity contributes 98% to global warming and GHG rise for the period 1901-2010.

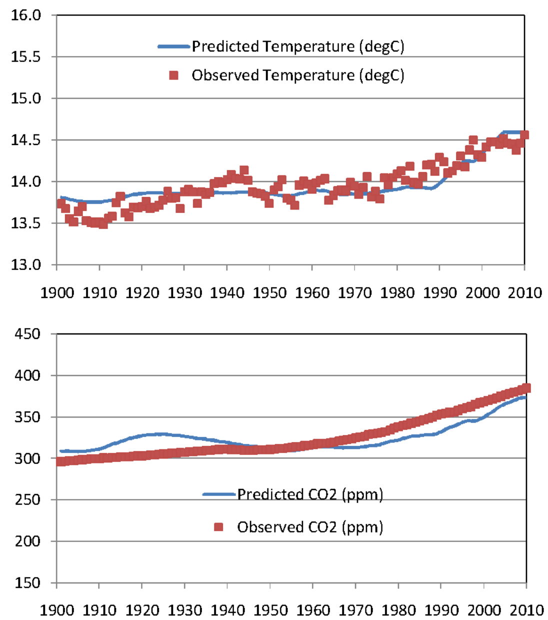

Fig. 8. Individual regression analysis for global temperature (and CO_2) versus obliquity and total solar irradiance. Both analyses yielded very high R^2 (= 0.999) and low standard errors of less than 5%. TSI anomaly was used in the regression analysis for CO_2.

5.0 GLOBAL CLIMATE SIMULATIONS

The improved astronomical model of [7] showed that the maximum axial tilt of the earth could be higher than the Milankovitch-predicted obliquity. A 5-million year simulation that included the gravitational interaction between the earth, moon, sun and the other planets of the solar system showed that the earth's obliquity may vary from 19-28.4° about the ecliptic plane and not 21-25° as initially estimated under the Milankovitch theory.

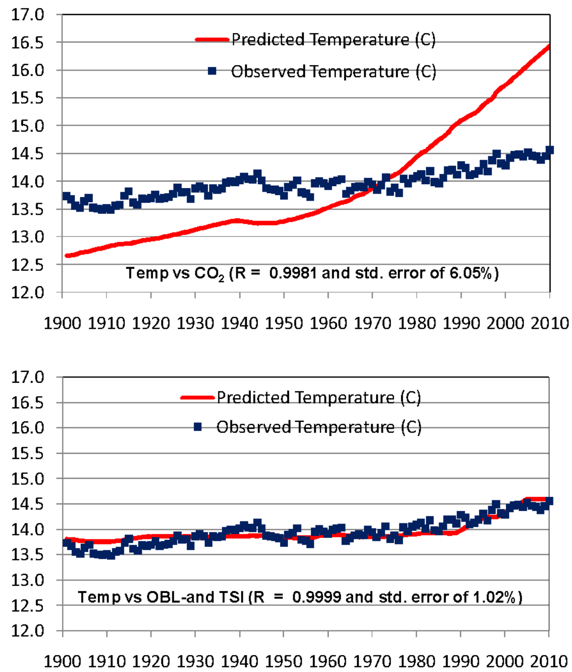

Fig. 9. Regression analysis for global temperature versus CO_2 (up) compared with global temperature versus OBLiquity and TSI (down).

The new planetary model used by Girkin is based on the Hermite Integrator with Individual Time-step Scheme (HITS), a numerically more accurate method as compared with the conventional method used in the early 20th century.

To determine the potential impact of planetary tilting, the concentrations of various greenhouse gases (GHG) had been assumed constant throughout the simulation. Constant GHG concentrations (fixed at 1970 and 1988 values) and even during the pre-industrial era had been assumed in the model simulations. This was done to determine the real impact of the computed enhanced obliquity on the global climate. The results are discussed below.

5.1 Simulated impact of enhanced obliquity

Assuming that the planetary obliquity has been forced to a maximum value of 26.4°, the climate model was run with constant CO_2 and constant solar luminosity. The results of the model show that the global surface air temperature within the period from 1988-2008 would increase from 13.4-14.2°C (Fig. 10).

The global (and ocean) temperature increase during the first 10 years is calculated by the model to be more abrupt with about 0.6°C increase. The estimated warming in the succeeding 10 years is only about 0.18°C. On land, a similar increasing but fluctuating trend is predicted except for a slightly lower magnitude of warming from 9.15-8.37°C or a total of 0.77°C increase for the 20-year period simulated. In addition, the simulated sea surface temperature (SST) has also increased from a global average value of 17.8-18.3°C or about 0.46°C increase (Fig. 11). The steeper rise in the simulated temperatures is due largely to the complementing effect of the greenhouse gases which could not be zeroed during the simulations.

Although fluctuating, the climate model also simulated a general increase in global precipitation and evaporation as shown in Fig. 12. It should be noted that the simulated slight increase is averaged for the whole planet and that higher temperature rise and greater precipitation can occur regionally.

Furthermore, the model simulated a decrease in ocean ice and snow cover as shown in Fig. 13. A decrease of ocean ice cover of about 3% has been simulated by the model for the period of 1988-2008. This is not far from observed reduction of ice sheet in the northern hemisphere (i.e. about 4% decrease in ice cover within the same period). Again, the predicted reduction of ice cover is averaged throughout the whole planet. The general decrease of snow cover due to melting of ice caps (and glaciers) and the associated exposure of organic soil in the polar regions could have facilitated the emission of a vast storage of carbon and methane. In addition, sinking icy water can pump out stored carbon dioxide beneath the cold ocean surface. Thus, the observed poleward increase in GHG concentrations and polar amplification of warming can be explained solely by the forced axial tilting.

The enhanced planetary obliquity and its profound effect on the reduced ice cover can now explain the global warming problem, with the poles warming at a faster rate than other regions on earth. Global temperature anomaly record from NCDC shows a 0.5°C increase during the period simulated. While the simulated increase of 0.7°C is slightly higher, this is largely due to overestimated effect of CO_2 (via feedback on water vapor increase). The simulated albedo anomaly shown in Fig. 14 cannot explain such abrupt warming during the period of 1988-2008. The simulated higher temperature (as compared to the observed global temperature rise) could only be explained by the forced axial tilt of the planet and the concomitant increase in the absorbed solar radiative flux.

It was further shown by the EdGCM model results that even if CO_2 is fixed at pre-industrial values, the absorbed global radiation and net heating of the planet increases due to axial tilting alone. The model simulated an increase of the net global radiation absorbed by the planet and net heating at ground surface of about 22% and 18% respectively, due solely to planetary tilting within just a 10-year period. The model result showed an increase in the solar radiative forcing of about 1.1 W/m^2 even if CO_2 concentration did not increase from pre-industrial value. It should be noted that the observed radiative forcing within a period of about 30 years (1975-2005) is about 0.6-1.7 W/m^2 and the modeled radiative forcing is just within the range of observed values. This should somehow increase the air temperature at the surface resulting to higher global evaporation and precipitation.

5.2 Simulated Albedo

The global variability of albedo is affected primarily by cloud distribution, amount and thickness. Assuming that the earth's axis has been tilted to 26.4°, the model showed that the global value of the planetary albedo decreases with time as shown in Fig. 14. This can cause a slight increase in the surface air temperature. The unsuccessful reproduction of the observed increase of albedo from 1999 onwards could be due to the underestimated feedback from low clouds (and water vapor) rising up and increasing in thickness. Whereas observations show that low clouds have decreased in recent years, high clouds have increased to a large extent, leading to both increase in albedo and increased trapping of infrared radiation by clouds [18]. The parameterization of this process poses a difficult problem in global climate modeling. Observations show that the distribution and thickness of clouds can change very rapidly and this has to be simulated correctly to reproduce successfully the observed changes in various atmospheric parameters.

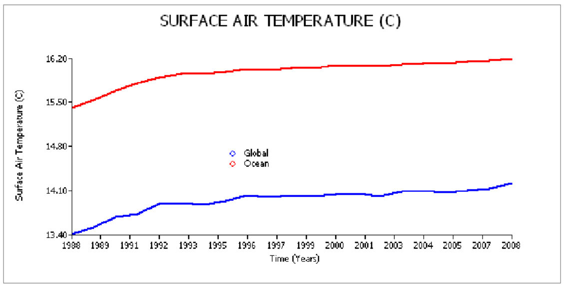

Fig. 10. Simulated increase in surface air temperature (C) with an obliquity of 26.4°.

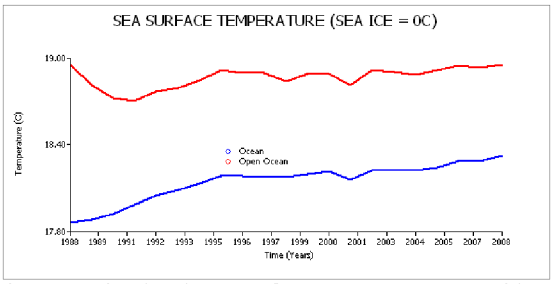

Fig. 11. Simulated sea surface temperature (C) with an obliquity of 26.4°.

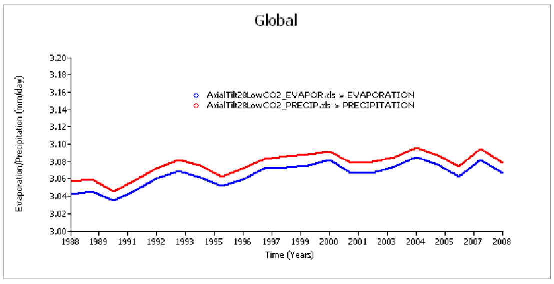

Fig. 12. Simulated precipitation in mm/day (red) and evaporation in mm/day (blue) with an obliquity of 26.4°.

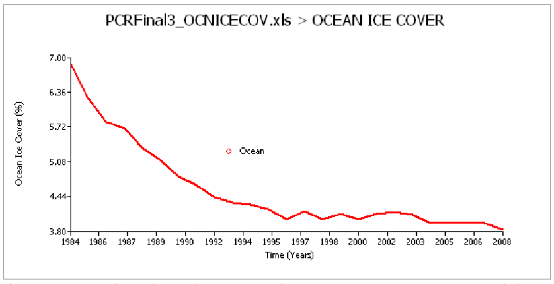

Fig. 13. Simulated ocean ice cover (percent) with an obliquity of 26.4°.

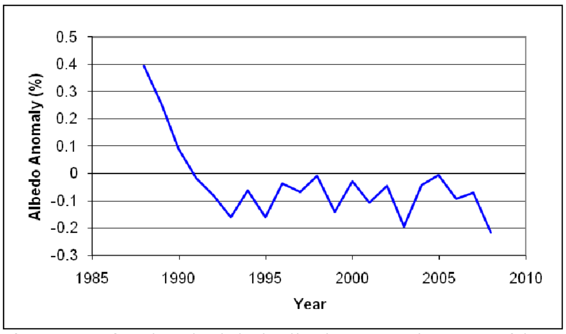

Fig. 14. Simulated global albedo anomaly (%) with an obliquity of 26.4°.

5.3 Comparison of Observed and Simulated Global Temperature

Assuming that the planetary obliquity has been enhanced to a value of about 26.4°, EdGCM was run and the model result revealed a close approximation of the observed global temperature anomaly (Fig. 15). Only the short period from 1988-2008 was simulated since obliquity change started to occur only from the 1990's when major earthquakes increased in frequency of occurrence. The UAH data set (satellite-derived) was taken from the University of Alabama in Huntsville [14]. They represent global temperature anomalies in the lower troposphere and are therefore slightly lower than the NCDC temperature anomalies obtained from surface stations on land and over the oceans.

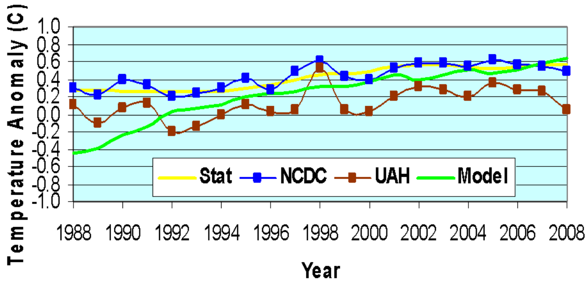

Fig. 15. Observed and predicted global temperature anomaly (C). The green line is averaged from the EdGCM model results with constant CO_2 values (1988 & 1978). The model results are departure from a mean global temperature of 13.9°C.

From 1992 onwards, the model result showed very close agreement between the observed and simulated global temperature anomaly. This corresponds to the period when earthquake count (and planetary obliquity) started to increase abruptly. The small discrepancy between the observed and simulated values before this period could be attributed to the additional GHG impact as the EdGCM model could not be run without the GHG forcing (e.g. zero GHG did not work). In addition, the obliquity value in the model cannot be varied annually and was increased immediately from the start of simulation. The slightly steeper increase in the simulated global temperature could also be attributed to the slightly higher obliquity assumed in the model as compared to the actual value. This necessitates a more detailed study on the annual variability of the obliquity and the results be used in a global climate model.

5.4 Complicating Effect of Clouds

The effect of clouds is two-fold. As more clouds developed at the surface, reflection of short-wave radiation from the sun occurs resulting to a relative cooling at the ground surface due to increased albedo. However, recent observations by the International Satellite Cloud Climatology Project (ISCCP) and Big Bear Solar Observatory (BBSO) show that the albedo had increased significantly by the end of the 20th century during which the global warming problem has become conspicuous [11]. The dramatic change of albedo from 1999-2004 could be attributed to the increase in water vapor concentration and cloud thickness in the atmosphere. The main mechanism that explains the contrasting phenomena is shown by [5] that warming of the earth's surface causes low clouds to rise. This warming is shown in this study to be due largely to the enhanced obliquity and small changes in the solar output. According to [5], when low clouds rise up, reflection of infrared radiation back to the earth increases which heats up the lower atmosphere while albedo increases. Warming of the earth's surface itself due to increased solar radiative flux from planetary tilting and increased solar irradiance could have started the increasing amount of high clouds and water vapor concentration in the atmosphere. This differs from [27] which concluded that global warming from increasing absorbed solar radiation was due to decreasing cloud amount.

5.5 Rise in Greenhouse Gases and Global Warming

Increasing number of measurements and better estimates point to the fact that the rise in global temperature and increasing concentrations of greenhouse gases particularly CO_2 and methane in recent decades occur almost simultaneously. Because of the forced planetary tilting, increased CO_2, methane and other GHG's in the atmosphere could have been due to natural emission during the occurrence of seismic disturbances. In addition, the observed CO_2 rise is most likely enhanced by the release of carbon dioxide from exposed soil and degradation of organic matter in land and suppressed dissolution of CO_2 in the oceans due to increased insolation and net heating. Additionally, there is an associated increase in occurrence of forest fires during summer leading to higher CO_2 concentrations in the atmosphere. Theoretical and model calculations had shown that the net radiation absorbed by the planet and net heating at ground surface both increased due to planetary tilt. The increasing CO_2 concentration in Mauna Loa, Hawaii over the last couple of years could be a strong manifestation of the major contribution of natural emission from seismic disturbances in the total carbon content of the atmosphere. It should be noted that the Hawaiian Islands are made up of volcanoes that could emit substantial amount of GHG's from underwater vents.

Observations of inorganic carbon in the oceans also show that over the years, carbon has increased in the ocean column, with a higher rate of increase in the surface than in deeper waters. In surface layers, the carbon increase (converted to pCO2) is also larger than the observed atmospheric increase [22]. This might be an indication that the increase of CO_2 in both ocean and atmosphere system, could have been triggered by increased planetary tilting through increased radiation and heating of oceans and continents. When the net absorbed radiation and surface heating increases due to planetary tilt, release of CO_2 trapped under ocean ice could be triggered by natural pumping by sinking melted ice water. CO_2 emission could also be enhanced through decreased solubility as sea surface temperature (SST) increases. The anthropogenic impact in this respect should not be disregarded as more and more thermal effluents are discharged in coastal oceans that could trigger the degradation of dumped organic wastes and release of carbon, methane and sulfur compounds when heated waters are dispersed by currents and tidal action.

It should be noted, that as the net radiation absorbed by the planet increases as a result of the forced axial tilting, the release of carbon from soils throughout the globe also increases. The rise in CO_2 concentrations in the atmosphere could therefore be largely natural. Recent estimates of soil respiration in [2] showed that as much as 98 Pg Carbon is stored in soils (flux integrated over the earth's land surface) and that it increased by $0.1 PgCyr^{-1}$ between 1989 and 2008. The study found that the air temperature anomaly (deviation from 1961–1990 mean) is significantly and positively correlated with changes in soil respiration. In addition, it was estimated that the carbon released in the northern (Arctic) regions rose by about 7 percent; in temperate regions by about 2 percent; and in tropical regions by about 3 percent. This geographic distribution pattern also implies that the northern regions are presently receiving much higher solar radiation during summer due to the forced axial tilting of the planet.

In addition, as the enhanced planetary tilt is a major factor of heating of the polar ice caps and thawing of permafrost during summer when the sun's rays strike the ground directly, subsequent exposure of carbon-rich soil could facilitate the emission of carbon dioxide. Even with a constant solar output, this warmer condition near the poles during summer can also trigger the emission of vast reservoir of carbon and methane naturally contained by the permafrost. [26] estimated that the stored carbon in permafrost regions is about twice as much as the present global CO_2 content of the atmosphere. Degradation of the permafrost during warm summers and exposure of the organic soil beneath has been found to be a major contributor of atmospheric GHG's as CO_2 and methane dominate the exposed soil. Carbon pools alone had been estimated to be about 1024Pg for the first 3 meters of soil column of which yedoma and deltaic deposits account for over 63%. Increased net heating from direct solar radiation normally occurs intensely at and beneath the soil surface.

6.0 CONCLUSION/RECOMMENDATION

The present study showed in several ways that the present global warming problem including GHG rise is due mainly to enhanced planetary obliquity and changes in the total solar irradiance. First, the enhanced obliquity is confirmed primarily by the analysis of the perturbed lunar force of attraction during the great Sumatra quake and tsunami of December 2004. It was shown by the EPOCh model developed here, how the obliquity could be enhanced by a strong oceanic pressure during the occurrence of major earthquakes and tsunamis.

Second, the solar radiation model SOLRAD also showed that the net gain in solar radiative flux on earth is due mainly to enhanced obliquity. This simplified model clearly showed that the enhanced planetary tilt was the cause of the poleward amplification of climate change due to the poleward increase of net solar radiative flux received by the planet. Third, statistical analysis of observed major earthquake count and estimated obliquity, total solar irradiance, global temperature, and greenhouse gases also showed that the major factor contributing to both global warming and GHG rise is enhanced planetary obliquity.

Major earthquakes and associated forces and applied torques within the earth-ocean interface proved to be the major cause of enhanced planetary tilt as shown by the sudden obliquity change since the 1990's when the frequency of occurrence of major earthquakes started to increase. Fourth, a physical experiment revealed that the obliquity of the earth has indeed increased by noting the changes in the solar positions (with respect to the rotating earth) during sunrise and before sunset. The model-predicted increase in the planetary tilt, which is within the newly computed obliquity by Girkin (2005), is also shown by SOLRAD to be the cause of the observed net gain in the solar radiative flux of about **2.8 W/m^2** which has been wrongly attributed to greenhouse gases. Fifth, global climate simulations using EdGCM also showed that enhanced planetary obliquity could indeed lead to increased atmospheric and sea surface temperatures, increased evaporation and precipitation, and decline of snow and ocean ice cover in agreement with global observations. Using constant GHG concentrations, the simulated increase in the global temperature was shown to agree well with observations from the NCDC. Finally, the observed polar amplification of climate change is a strong manifestation that seismic-enhanced obliquity through oceanic pressure forces and the concomitant increase of absorbed solar radiation by higher latitudes, is the real cause of the global warming problem and GHG rise presently occurring on earth. As major earthquakes occur in the future, the obliquity could reach the maximum value of 28.4° which would further increase the net radiative flux on earth resulting to more decline of polar ice mass, more forest fires and GHG emission during the summer, and a considerable impact on the weather and climate on earth.

The climate simulations also showed that when CO_2 concentration is increased at present day values and held constant throughout the simulation, the surface temperature, evaporation and precipitation all increased. The climate model appears to yield results that show *preconditioned* global warming due solely to CO_2 and GHG increases since decreasing the CO_2 concentration to pre-industrial values resulted to unrealistic cooling and decreasing evaporation and precipitation. It is therefore recommended that the atmospheric chemistry module on GHG's be temporarily removed from existing Global Climate Models and the models are run with variable obliquity.

The model results using the EdGCM also showed realistic increases of surface air and sea surface temperatures (SST), evaporation and precipitation, while snow cover was shown to decrease as the obliquity is increased to about 28°. It was further shown by the climate model that even if CO_2 and other gases are fixed at 1978 or 1988 values, the absorbed global radiation and net heating of the planet increases due to axial tilting alone. Even if CO_2 is fixed at pre-industrial values, the global radiation and heating of the planet was simulated to increase due to enhanced obliquity. The model simulated an increase of the net global radiation absorbed by the planet and net heating at ground surface of about 22% and 18% respectively, due to enhanced obliquity of only 26.4° within just a 10-year period. It is postulated that increased seismic disturbances in recent years could have caused the emission of stored GHG's under the earth and the oceans. The net increase in the total radiation and surface heating received by the planet particularly at high latitudes due to increased axial tilt could have caused the emission of additional GHG's including CO_2 and methane in permafrost regions as the ice caps started to melt in previous years. Furthermore, the poleward gain in solar radiation and increase of SST could suppress CO_2 dissolution in the oceans allowing more CO_2 to be further released. In addition, the heated soils in tropical and temperate zones could cause CO_2 emission via increased soil respiration fluxes.

A better understanding of the physico-chemical processes involved in the interaction of net radiative forcing, emission of CO_2 from heated soil and degraded permafrost, and increase in water vapor should be studied. This should result in concrete mathematical terms that can be used by climate models to explain the increasing CO_2 concentrations in the atmosphere. While the sensitivity of climate to the concentration of CO_2 could be much less than previously estimated [16], the anthropogenic contribution of CO_2 in the global climate can only be estimated accurately when the natural emission is determined correctly. It is also recommended that a better relationship between the surface heating of coastal ocean and cleared mangrove forests and the release of CO_2 therein be derived and used by global climate models. Mangrove areas are quite substantial and when combined with deforestation of upland areas, may have a substantial effect on the global climate as well.

It is further recommended that more observational studies be conducted to determine the change in the obliquity as the tilting of the earth spinning on its axis may be oscillatory in nature. More studies should also be conducted to determine the relationship between GHG emission and seismic disturbance and surface heating and the results be used by global climate models. This can help elucidate the potential contribution of natural and anthropogenic factors in the global climate and obtain more realistic predictions of climate change on regional and global scales. More studies should be conducted to better understand the feedback mechanism of GHG's on the water vapor content of the atmosphere (through increased radiation absorbed by the planet), as overestimation may result to unreasonable abrupt warming due to GHG alone as shown by the EdGCM simulations conducted in this study.

6.1 Impacts of Altered Solar Radiation on Regional Climate

The enhanced warming of higher latitudes due to enhanced obliquity and changes in solar radiation could enhance sub-tropical warming due to net transport of heat in low latitudes via a reversed Hadley circulation. More model simulations and observations in the atmosphere should be conducted to validate this possibility. The estimated polar amplification of solar radiative flux due to enhanced obliquity may result to:

1. Reversal and intensification of the Zonal Geostrophic Wind due to altered temperature gradient and pressure distribution from the North Pole to low latitudes.
2. Weakening and reversal of the Trade Winds in the South Pacific due to reversal of the temperature gradient from South Pole to low latitudes during Southern Hemisphere summer possibly leading to El Niño followed by La Niña episodes.
3. Intensification and expansion of the Hadley Circulation possibly leading to increased westerly flow and increased atmospheric angular momentum.

This study showed that the enhanced planetary obliquity and associated changes in the solar radiative flux received by the earth started to occur from 1994 onwards and this could have initiated the extreme El Niño Southern Oscillation (ENSO) event of 1997-1998 and the La Niña event in the succeeding years. The previous 3-5 year periodicity of ENSO is clearly manifested here after the observed increase of major earthquakes in the mid-1990's. The possible start of the tilting of the earth and reversal of the Milankovitch trend in obliquity must also have dictated the increase in precipitation brought about by the La Nina episodes that followed. More studies are needed to confirm this hypothesis.

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