IJST EXPLORE International Journal of Science and Technology
CENTRE OF PROFESSIONAL RESEARCH PUBLICATIONS
ISSN 2049-7318

International Journal of Science and Technology Volume 3 No. 3, March, 2014

Variational Trends in the Concentration of Greenhouse Gases and its Impacts on the Global Climate

Audu Moses Owoicho, Bernadette Isikwue
Department of Physics, Federal University of Agriculture Makurdi, Benue State, Nigeria.

ABSTRACT

This work investigated the trends, concentrations and impacts of some greenhouse gases on the global climate with temperature as an index. Over the years, a lot of awareness has been created worldwide on the dangers of emitting greenhouse gases into the atmosphere. Hence, there is need to ascertain if people have adhered strictly to these warnings. The data used for these analyses are the global average abundances of the major well-mixed, long-lived greenhouse gas, global annual mean Earth surface temperatures anomalies and the annual global land, ocean and global (land-ocean) temperature anomalies for ten (10) warmest years on record. The data were obtained from the National Oceanic and Atmospheric Administration (NOAA) and National Aeronautic Space Administration (NASA). The periods under consideration are 1978-2010 and 1880-2012. The result of the observations and analyses generally revealed that the concentrations of greenhouse gases are still on the increase especially since the industrial revolution and this has caused a corresponding increase in the global temperature. This increase in the global temperature has contributed immensely to the global warming and other attendant climatic problems.

Keywords: *Climate change, greenhouse gases, temperature anomaly, Earth's atmosphere, global warming.*

1. INTRODUCTION

Greenhouse gases in the atmosphere act as blanket as they prevent the escape of infrared radiation. Over a long period of time, because there is a balance between incoming and outgoing radiation, the Earth's temperature remains constant (Nsi, 2007). Recent human activities have led to a significant increase of greenhouse gases in the atmosphere. This is preventing heat from escaping into space and is believed to be responsible for the rise in Earth's surface temperature. This process by which Earth's temperatures are rising is known as global warming. Global warming is caused by natural or human induced activities and has led to the increase in average global temperature of the atmosphere near the Earth's surface.
The impacts associated with the deceptively small change in temperature are evident in all corners of the globe. There is increased flooding and drought, glaciers are melting, spring arriving earlier, oceans are warming and coral reefs are dying, desert encroachment, deforestation, more turbulent weather, and many more – attributed to the global warming are being witnessed across the globe.

Burning of fossil fuels – coal, natural gas and petroleum, deforestation and burning of grasses, anaerobic bacteria in wet places such as swamps and wetland where oxygen is scarce, and manufacture chemicals such as nitrogen fertilizers are some of the sources of greenhouse gases.

Records of global average surface temperature are usually presented as anomalies rather than as absolute temperatures. The term temperature anomaly is a departure from a reference value or long-term average. A positive anomaly indicates that the observed temperature was warmer than the reference value, while a negative anomaly indicates that the observed temperature was cooler than the reference value (Crouch, 2012). Temperature anomalies are useful for deriving average surface temperatures because they tend to be highly correlated over large distances of the order of 1000 km (Hansen, 2012). In other words, anomalies are representative of temperatures over large areas and distances. By comparison, absolute temperatures vary markedly over even short distances.

A lot of researches have been carried out about greenhouse gases and global warming. Chenge (2007), in her work on the importance of forests to global warming, pointed out that tropical deforestation is the source of large amount of annual human-induced emission of heat trapping gases to the atmosphere. Forests act as CO_2 sinks by absorbing and holding immense amount of CO_2 that mitigate global warming.

The Intergovernmental Panel on Climate Change (IPCC, 2007) reviewed that the increases in the abundance of atmospheric greenhouse gases since the industrial revolution are largely the result of human activity and are largely responsible for the observed increases in global temperature.

According to Audu (2008), in his work on the effects of some greenhouse gases on the global climate, noted that the concentrations of greenhouse gases have increased and this has caused a corresponding increase in the global temperature.
Working on the Global trends of measured surface air temperature, Hansen and Lebedeff (1987) noted that global mean

annual surface temperatures have increased between 0.3 and 0.6ºC during the last 150 years.
Tominaga (1992), in his work on Chlorofluorocarbons in the Atmosphere: Trends and Vertical profiles, noted that Chlorofluorocarbons with extremely long atmospheric lifetimes are responsible for both stratospheric ozone depletion and global warming as they accumulate in the atmosphere.

Extensive works have been done in this area couple with awareness on the danger and environmental impact of emitting greenhouse gases into the atmosphere over the years. An international environmental treaty, called Kyoto Protocol, linked to the United Nation Framework Convention on Climate Change (UNFCCC) mandated the governments of industrialized nations to take appropriate measures that would control and stabilize global warming by reducing greenhouse gas emissions to a level that would prevent dangerous anthropogenic interference with the climate systems. This was adopted in Kyoto, Japan on December 11, 1997 and entered into force on February 16, 2005. Although, this has been largely contested by opponents (Aizebeokhai, 2009).

Despite all these awarenesses, there is need to ascertain if people have adhered to these warnings. Hence, this study investigates the concentrations and current trend of these gases in the atmosphere so as to determine its impact on the global climate due to the consequent global temperature increase.

2. METHODOLOGY AND DATA SET

The global average abundances of the major well-mixed long-lived greenhouse gases - Carbon dioxide, Methane, Nitrous oxide, CFC-12 and CFC-11, global annual mean Earth surface temperatures anomalies and the annual global land, ocean and global (land-ocean) temperature anomalies for ten (10) warmest years on record data were obtained from the NOAA's National Climatic Data Center (NCDC) and National Aeronautic Space Administration (NASA). The analyses focus on the periods 1978-2010 for greenhouse gases and 1880-2012 for annual global temperature.

The annual global land, ocean and global (land-ocean) temperature anomalies values were anomalies from the 1901–2000 global mean of 13.9°C. The anomalies were computed by subtracting the measured values from 13.9°C which is the reference value (Mahmood *et al*. 2006). Conversely, the global average temperature could be calculated by adding the anomaly to the 1901–2000 mean value (13.9°C).

3. RESULTS

The global annual average concentrations of CO_2 and annual global monthly decadal average concentrations of CO_2 in the Earth's atmosphere are presented in Figures 1 and 2 respectively. Figure 3-5 show the global annual average concentrations of Nitrous oxide, Methane and Chlorofluorocarbons (CFCs) in the Earth's atmosphere. The annual global mean Earth surface temperature anomalies and the annual global land, ocean and global (land-ocean) temperature anomalies for ten (10) warmest years on record are presented in Figures 6 and 7 respectively.

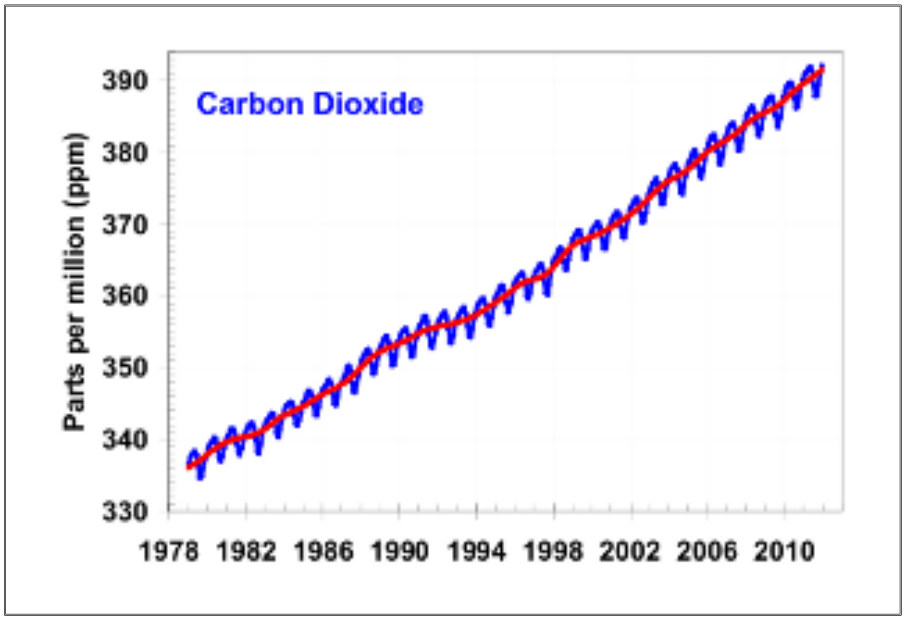

Figure 1: Global annual average concentrations of CO_2 in the Earth's atmosphere

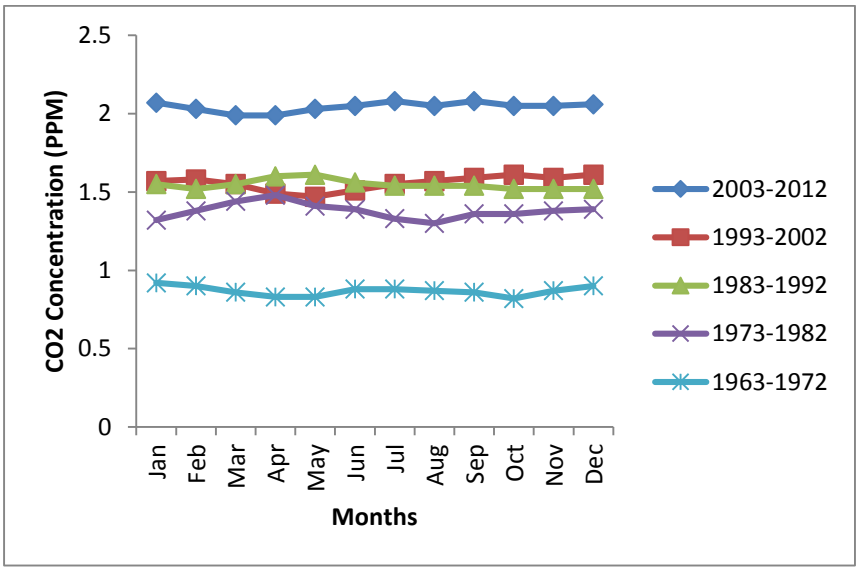

Figure 2: Annual global monthly decadal average concentrations of CO_2

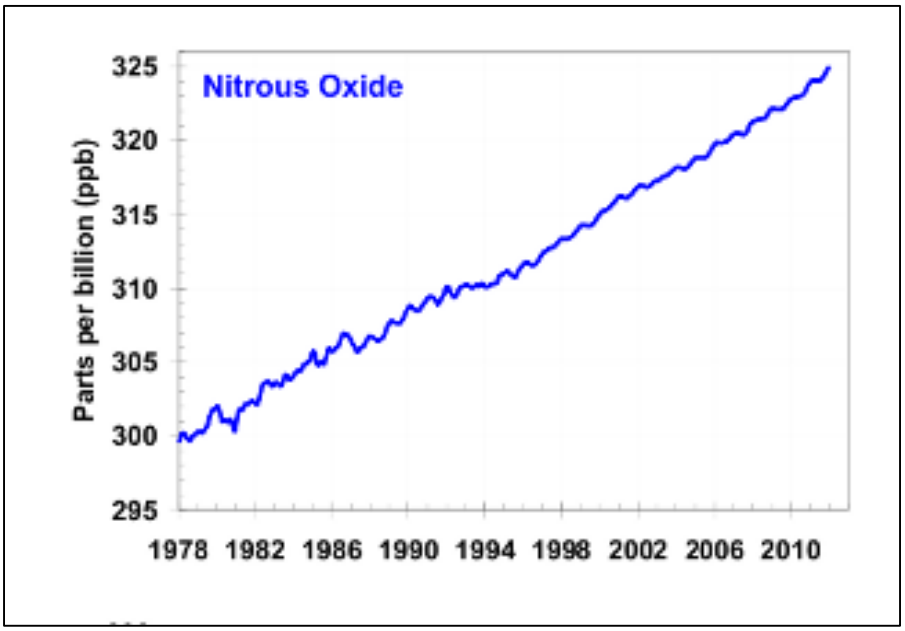

Figure 3: Global annual average concentrations of nitrous Oxide in the Earth's atmosphere

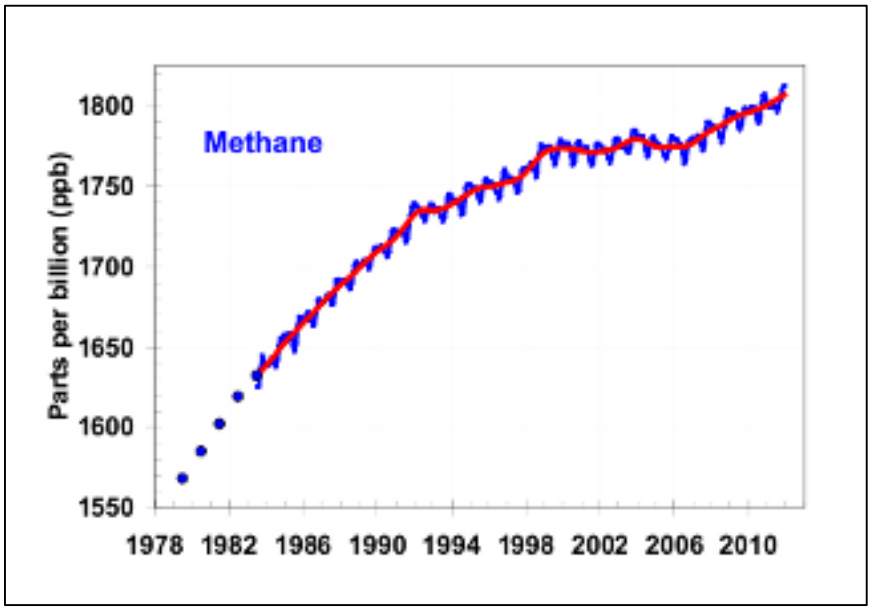

Figure 4: Global annual average concentrations of methane in the Earth's atmosphere

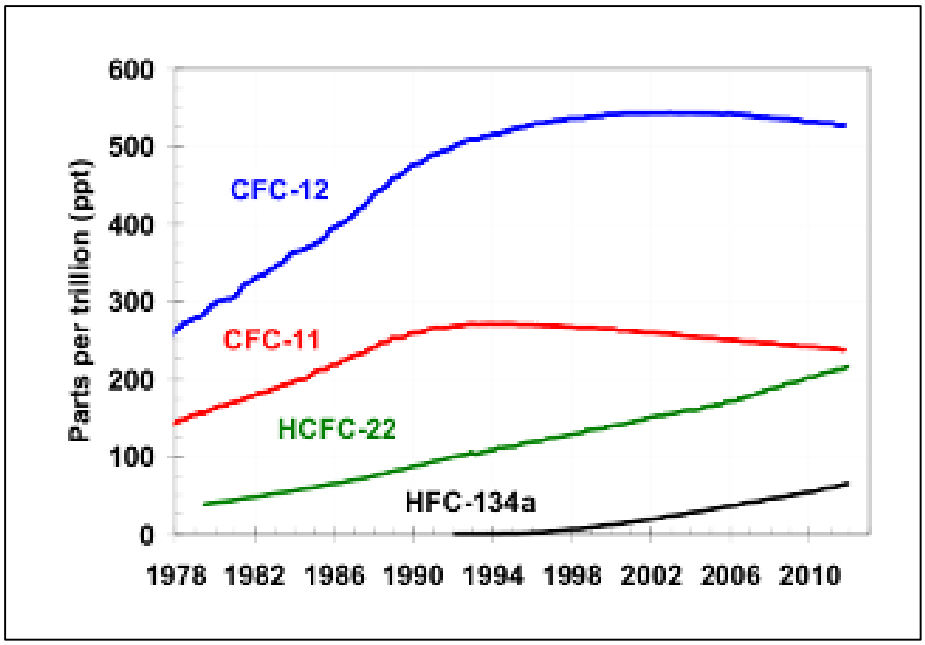

Figure 5: Global annual average concentrations of CFCs in the Earth's atmosphere

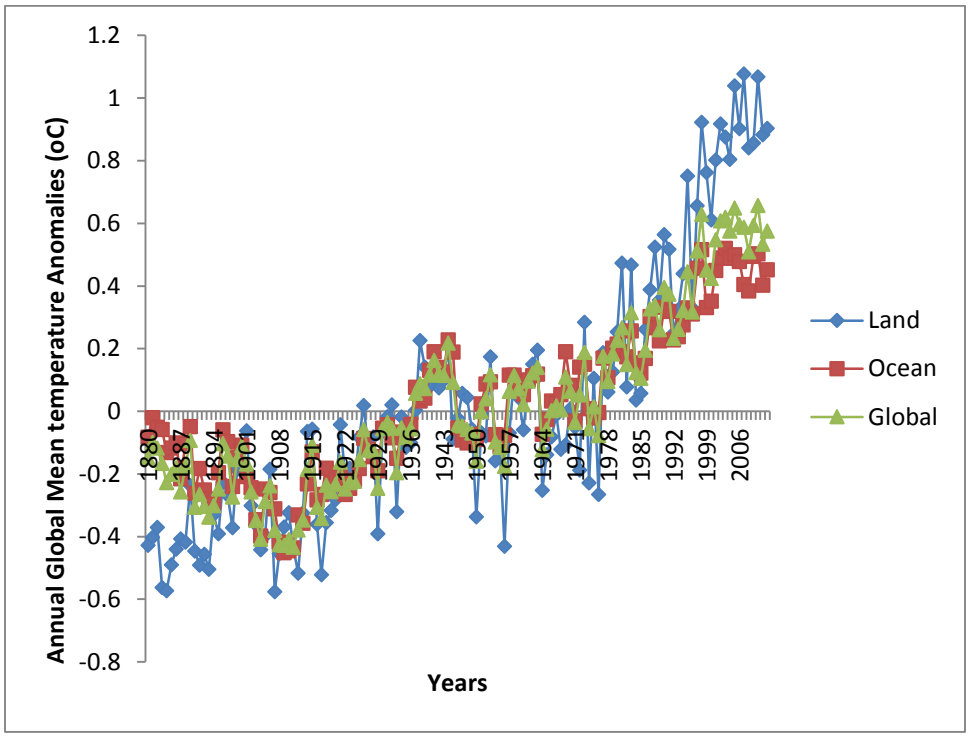

Figure 6: Annual global mean Earth surface temperature anomalies

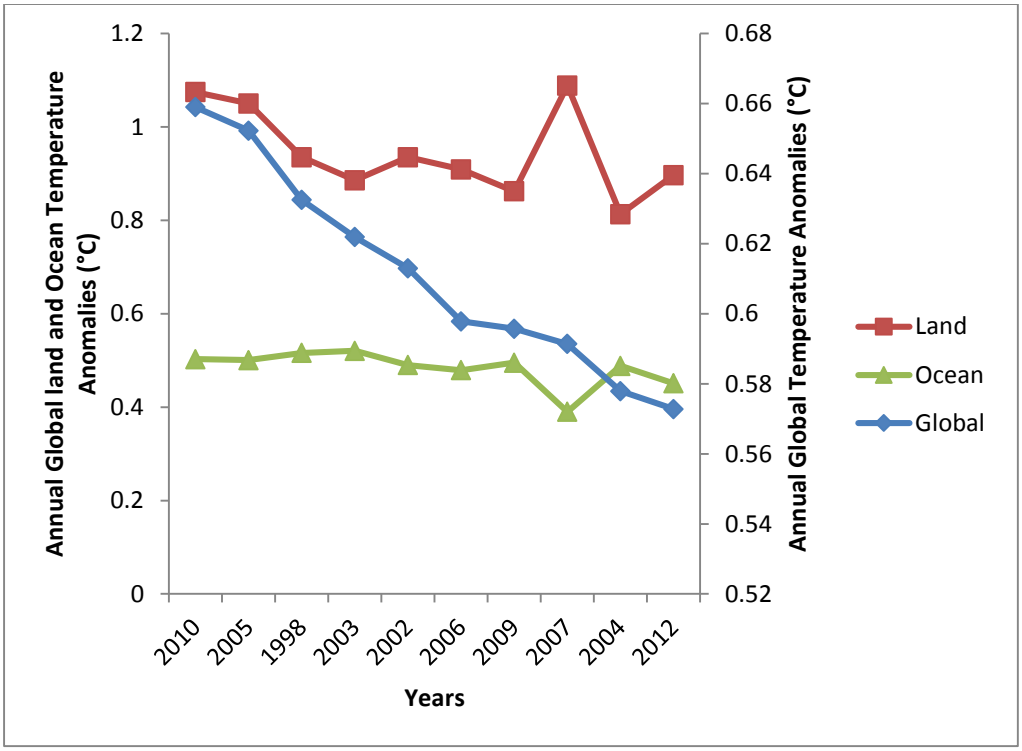

Figure 7: Temperature anomaly for 10 warmest years on record

4. DISCUSSION

It could be observed from Figure 1 that the global annual average concentrations of CO_2 in the Earth's atmosphere are still on the increase. Also, the global monthly decadal average concentrations of CO_2 show that the concentrations of CO_2 increases from 0.82 ppm (1963-1972) to 2.08 ppm (2003-2012). The increase could be due to the continous rise in the concentration of CO_2 in the atmosphere as a result of human activities. This is in line with Chenge (2007), in her work on the importance of forests to global warming, pointed out that tropical deforestation is the source of large amount of annual human-induced emission of heat trapping gases to the atmosphere. Forests act as CO_2 sinks by absorbing and holding immense amount of CO_2 mitigating global warming. If emissions of CO_2 exceed their uptake by "sinks," such as oceans and vegetation, these gases accumulate and their concentrations rise. The concentration of CO_2 in the atmosphere poses a major threat to global warming and climate change because the average lifetime of CO_2 in the atmosphere is 100 to 150 years (James, 2012, Aizebeokhai, 2009).

Figures 3-4 present the global annual concentrations of methane and nitrous oxides respectively in the Earth's atmosphere. It could be observed from the trend that the concentrations of these gases are also on the increase. This increase may be due to the use of fertilizer in farming since nitrous oxide is produced from ammonia fertilizer.

From Figure 5, it could be observed that the global annual average concentration of CFCs in the Earth's atmosphere is decreasing. This may be due to the international agreement to reduce their production, since they are manmade compounds that were not appreciably present in the atmosphere before 1950 (IPCC, 2007).

Generally, the trends of the concentration of the greenhouse gases presented in Figures 1-5 show that there is an increase in the abundance of atmospheric greenhouse gases especially since the industrial revolution. These are largely the result of human activity and are mostly responsible for the observed increases in global temperature (IPCC, 2007, Audu, 2008). Because greenhouse gases and Ozone absorb infrared radiation emitted from the Earth, the Earth is warming due to the increase of these anthropogenic greenhouse gases in the atmosphere (Tominaga, 1992).

Figure 6 presents the global annual mean Earth surface temperature. It could be observed that the global annual mean Earth surface temperatures is increasing despite the warning on the danger of emitting greenhouse gases into the atmosphere that causes global warming which mitigate the effects of climate change. This agreed with the 2012 annual report from NOAA's National Climatic Data Center that the Earth has experienced annual temperatures above the long-term average since 1976. The rate of warming is 0.06°C (0.11°F) per decade since 1880 and a more rapid 0.16°C (0.28°F) per decade since 1970. Global temperatures have warmed significantly since 1880. As greenhouse gas emissions from energy production, industry and vehicles have increased, temperatures have climbed, most notably since the late 1970s (Hansen and Lebedeff, 1987, Aizebeokhai, 2009).

Figure 7 presents the annual global temperature anomalies of the 10 warmest years on record for land, ocean and the globe (land and ocean combined). Analyses from the availably meteorology station reviewed that the decade between 2000 and 2009 are the hottest since modern records began more than a century ago. It could be observed that the trend of the annual global land temperature anomaly is diagrammatically opposite to that of ocean. The years 2007 and 2004 have the highest (1.09°C) and lowest (0.81°C) temperature anomalies for land. The values of the temperature anomalies for ocean are 0.52°C (highest) and 0.39°C (lowest) and they occurred in 2010 and 2007 respectively. For the annual global temperature anomaly, the year 2010 appeared to be the warmest while 2012 is the coolest with the values 0.66°C and 0.57°C respectively. According to the International Panel on Climate Change (IPCC, 2013), the averaged temperatures over all land and ocean surfaces showed that temperatures warmed roughly 1.53 °F (0.85°C) from 1880 to 2012.

A particular trend is observed from Figures 1-7. An increase in the emission of greenhouse gases into the atmosphere leads to an increase in the average global Earth's surface temperature, hence a change in global climate. In this 21st century, observation show that our climate has changed and its effects are felt worldwide.

5. CONCLUSION

The foregoing results have shown that increase in greenhouse gas concentrations in the Earth's atmosphere lead to corresponding increase in the Earth's surface temperature and its impacts are experienced worldwide.

6. RECOMMENDATION

It is hereby recommended that:

- The use of fossil fuels should be reduced by depending more on non-conventional renewable energy such as wind, solar, nuclear and bio-gas energies.
- The Earth existing forest could be preserved and more trees should be planted.
- The concentrations of greenhouse gases should be monitor so as to avert their ugly consequences in human lives.
- There should be strict adherence to any report and warning given by climate observatory center.

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