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Global Warming: A half centuryCO$_2$ trend

A graduation project submitted as to complete the requirements of four years course for a B. Sc.(Honor)degree in Physics Science

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الآية

قال تعالي:

قَالَ تَعَالَىٰ: ﴿ وَٱلسَّمَآءِ ذَاتِ ٱلرَّجۡعِ ﴿١١﴾ وَٱلۡأَرۡضِ ذَاتِ ٱلصَّدۡعِ ﴿١٢﴾ ﴾

صدق الله العظيم

سورة الطارق (الايات 11 – 12)

Dedication

To parents (mom and dad)

Acknowledgements

All praises due to Allah.

This project wouldn't be possible without support many people. The first is **Dr. Magdi Elfadil** who helped us by anything without him and his support we couldn't do this project in this form. And we also thanks the ministry of environment depart of weathermen represented in **Dr. Haitham Abdeen**. And all thanks to collage of since physics for appropriate the weather to finish in this project, not forgetting our best friends.

Abstract

The carbon dioxide levels have increased as a consequence the global warming phenomena become apparently a factual matter to be dealt with. The global warming has a negative impact on life on Earth. In this project the carbon dioxide levels over the past 57 years we restudied. The trend of the carbon dioxide showed a remarkable increase; on the other hand, the local rain precipitation has shown irregular variation during those 57 years and the trend showed almost steady level. This study concluded that the human being contribution to the carbon dioxide levels is increasing in recent years; therefore, caution should be raised to terminate the activities lead to increase levels of carbon dioxide.

الملخص

زيادة نسبة غاز ثاني اكسيد الكربون أصبحت معضلة عالمية أدت إلى زيادة في ظاهرة الإحتباس الحراري وهي ظاهره طبيعية ومسألة واقعية يجب التعامل معها.

الإحتباس الحراري له تأثيرات سلبية علي سطح الأرض، في هذا المشروع تمت دراسة الزيادة في نسبة غاز ثاني أكسيد الكربون في فترة مقدارها 57 سنة.

وقد وجد ان هنالك زيادة ملحوظة في نسبة ثاني أكسيد الكربون مع إختلاف كبير في مستوى ترسيب الأمطار محليا، هذه الزيادات العشوائية المضطردة في نسبة ثاني اكسيد الكربون في الآونة الأخيرة مع التقدم الصناعي أصبحت ذات تأثير كبير على ظاهرة الإحتباس الحراري، علية فإنه يجب الحد من والتوقف عن النشاطات التي تؤدي إلى زيادة نسبة ثاني اكسيد الكربون.

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CHAPTER I

Solar Radiation

The Earth's climate is basically determined by an energy balance between the radiant flux emitted by the Sun, the fraction of this flux that is absorbed by the Earth system (with the remainder reflected back into space), and the temperature profile of the Earth from the surface to the stratosphere that determines the rate of radiant heat loss from the Earth to space.

1.1 Variability of solar luminosity

Physical models of the Sun indicate that four billion years ago, the innate solar luminosity was only about70% of what it is today(Rapp, Assessing Climate Change Temperatures Solar Radiation and Heat Balance, 2014). As time progressed, the luminosity increased. Five-hundred million years ago, the solar luminosity was about6% lower than today(Rapp, Assessing Climate Change Temperatures Solar Radiation and Heat Balance, 2014). Since then, it has increased slowly. It is interesting to ask how the Earth has managed to remain a habitable planet with globally distributed liquid water during the past 4 billion years and why it did not turn either into an icy planet. This question is known as the. The early faint Sun "paradox". Some believe that higher levels of greenhouse gases from active volcanism kept the Earth warm despite the much lower solar irradiance.

The rate of change of the fusion process in the Sun is extremely small($10^{-4}\ {W}/{m^2}$) per1,000 years(Rapp, Assessing Climate Change Temperatures Solar Radiation and Heat Balance, 2014). Therefore, the variability potential of the fusion process is completely negligible in regard to timescales relevant to current climate change (tens to hundreds of years). On the other hand, the appearance of the Sun changes over tens to hundreds of years and there is an, 11-year solar cycle with associated small changes in luminosity. Does the solar luminosity vary enough to affect climate over decades and centuries? We have data on solar luminosity over the past 30 years. However, there are some problems aligning the data from several instruments with different calibration procedures, so there is some uncertainty in the results. The data seem to suggest that variability over this 30-year period cannot account for observed changes in climate(Rapp, Assessing Climate Change Temperatures Solar Radiation and Heat Balance, 2014).

In addition, a number of models have been developed to estimate solar luminosity over the past few centuries. Some models indicate that variability of luminosity was small over the past few hundred years, while others indicate that variability of luminosity was sufficient to impact the climate. There is no definitive answer to this question, but it seems unlikely that changes in solar luminosity had a major effect on climate over the past several centuries(Rapp, Assessing Climate Change Temperatures Solar Radiation and Heat Balance, 2014).

1.2 Variations in reflected solar flux

While variations in solar luminosity over decades and centuries are probably small, variations in the fraction of incident solar flux that is reflected by the Earth into space (the albedo") can be significant. The energy flux absorbed by the Earth system is (1-albedo) times the solar flux impinging on the Earth. Since the solar flux impinging on equatorial and lower mid-latitude regions is the major solar input to the Earth, it is the albedo in these regions that is of the greatest importance. The albedo depends primarily on the area and location of landmasses, the amount and location of glaciations on Earth, and the distribution and thickness of clouds(Rapp, Assessing Climate Change Temperatures Solar Radiation and Heat Balance, 2014).

In general, water has a low albedo, land has a higher albedo, and snow and ice have very high albedos. Fresh snow and ice have albedos as high as 0.9(depended on the reflection) while dirty snow and ice and sea ice might have albedos as low as 0.3 to 0.4(Rapp, Assessing Climate Change Temperatures Solar Radiation and Heat Balance, 2014). Land encompasses a wide range of albedos from 0.15 to 0.45 with an overall average of roughly 0.25. Oceans (which presently cover 70% of the Earth) have an average albedo of less than. 0.1when the Sun is not at a large zenith angle (Rapp, Assessing Climate Change Temperatures Solar Radiation and Heat Balance, 2014). Clouds determine the fraction of incident solar flux that reaches the surface. Thick clouds have an albedo of 0.6 to 0.9 and thin clouds have an albedo of 0.3 to 0.5. An estimate of the average solar flux over the Earth and the absorption and reflection by the atmosphere and surface for the period 2000-2010 is given in **Figure 1.2.** In this model, 22% of the incident solar flux is absorbed by the atmosphere, 48.5% is absorbed at the surface (predominantly by oceans), and 28.7% is reflected back into space. However, other assessments suggest that the albedo of the Earth varies around 31%(Rapp, Assessing Climate Change Temperatures Solar Radiation and Heat Balance, 2014).

The net albedo of the Earth depends on a global average of all land and ocean areas, but clouds add significantly to the global average albedo(Rapp, Assessing Climate Change Temperatures Solar Radiation and Heat Balance, 2014).

Since the general acceptance of the continental drift theory, it has been widely surmised that changing continental geometries likely contributed to long-term climate change. However, it is not exactly clear how this occurred(Rapp, Assessing Climate Change Temperatures Solar Radiation and Heat Balance, 2014).

"Continents are important to climate for three main reasons: They are a platform upon which polar glaciers can form; They are the primary sites of the silicate weathering reaction that governs atmospheric CO2, and the amount of weathering is strongly affected by the continental configuration; They affect the geometry of ocean basins, and hence the ability of oceans to transport heat from one latitude to another"(Rapp, Assessing Climate Change Temperatures,Solar Radiation and Heat Balance, 2014)

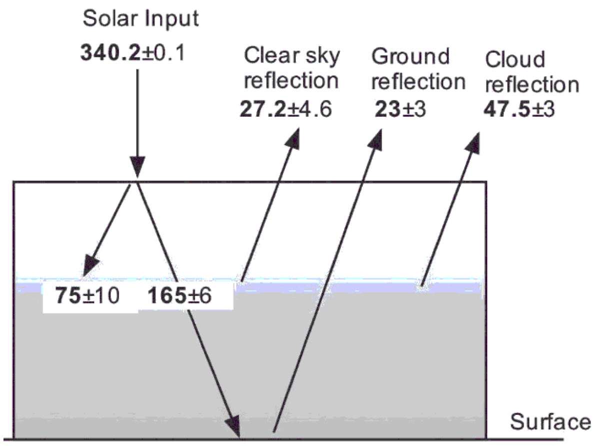


Figure1.1. Solar power input to the Earth ($W/_{m^2}$) for the decade 2000-2010(Rapp, Assessing Climate Change Temperatures Solar Radiation and Heat Balance, 2014).

CHAPTER II

What is a global warming?

2.2The Earth's natural greenhouse

The temperature of the Earth is controlled by the balance between the input from energy of the sun and the loss of this back into space. Certain atmospheric gases are critical to this temperature balance and are known as greenhouse gases. The energy received from the sun is in the form of short-wave radiation, i.e. in the visible spectrum and ultraviolet radiation. On average, about one-third of this solar radiation that hits the Earth is reflected back to space. Of the remainder, some is absorbed by the atmosphere, but most is absorbed by the land and oceans. The Earth's surface becomes warm and as a result emits long-wave 'infrared' radiation. The greenhouse gases trap and re-emit some of this long-wave radiation, and warm the atmosphere. Naturally occurring greenhouse gases include water vapor, carbon dioxide, ozone, methane, and nitrous oxide, and together they create a natural greenhouse or blanket effect, warming the Earth by 35°C(Mark Maslin, 2004).

Another way to understand the Earth's natural 'greenhouse' is by comparing it to its two nearest neighbors'. A planet's climate is decided by several factors: its mass, its distance from the sun, and of course the composition of its atmosphere and in particular the amount of greenhouse gases. For example, the planet Mars is very small, and therefore its gravity is too small to retain a dense atmosphere; its atmosphere is about a hundred times thinner than Earth's and consists mainly of carbon dioxide(Mark Maslin, 2004). Mars's average surface temperature is about −50°C(Mark Maslin, 2004), so what little carbon dioxide exists is frozen in the ground. In comparison, Venus has almost the same mass as the Earth but a much denser atmosphere, which is composed of 96% carbon dioxide(Mark Maslin, 2004). This high percentage of carbon dioxide produces intense global warming and so Venus has a surface temperature of over + 460°C(Mark Maslin, 2004).

The Earth's atmosphere is composed of 78% nitrogen, 21% oxygen, and 1% other gases(Mark Maslin, 2004). It is these other gases that we are interested in, as they include the so-called greenhouse gases. The two most important greenhouse gases are carbon dioxide and water vapor. Currently, carbon dioxide accounts for just 0.03–0.04%(Mark Maslin, 2004) of the atmosphere, while water vapor varies from 0 to 2%(Mark Maslin, 2004). Without the natural greenhouse effect that these two gases produce, the Earth's average temperature would be roughly −20°C(Mark Maslin, 2004). The comparison with the climates on Mars and Venus is very stark because of the different thicknesses of their atmospheres and the relative amounts of greenhouse gases. However, because the amount of carbon dioxide and water vapor can vary on Earth, we know that this natural greenhouse effect has produced a climate system which is naturally unstable and rather unpredictable in comparison to those of Mars and Venus.

2.3The enhanced greenhouse effect

The debate surrounding the global warming hypothesis is whether the additional greenhouse gases being added to the atmosphere will enhance the natural greenhouse effect. Global warming skeptics argue that though levels of carbon dioxide in the atmosphere are rising, this will not cause global warming, as either the effects are too small or there are other natural feedbacks which will counter major warming. Even if one takes the view of the majority of scientists and accepts that burning fossil fuels will cause warming, there is a different debate over exactly how much temperatures will increase. Then there is the discussion about whether global climate will respond in a linear manner to the extra greenhouse gases or whether there is a climate threshold waiting for us (Mark Maslin, 2004).

2.4Greenhouse effect

A representation of exchanges of energy between the source (the sun), Earth's surface, the Earth's atmosphere, and the ultimate sink outer space. The ability of the atmosphere to capture and recycle energy emitted by Earth's surface is the defining characteristic of the greenhouse effect.

The greenhouse effect is process by which radiation form a planet's atmosphere warms the planet's atmosphere above what it would be without its atmosphere.

If a planet's atmosphere contains radioactively active gases (i.e. greenhouse gases) the atmosphere will radiate energy in all directions. Part of this radiation is directed towards the surface, warming it. The downward component of this radiation-that is, the strength of the greenhouse effect-will depend on the atmosphere's temperature and on the atmosphere contains.

On Earth, the atmosphere is warmed by absorption of infrared thermal radiation from the underlying surface, absorption of shorter wavelength radiant energy from the sun, and convective heat fluxes from the surface.

Greenhouse gases in the atmosphere radiate energy, some of which is directed to the surface and lower atmosphere. The mechanism that produces this difference between the actual surface temperature and the effective temperature is due to the atmosphere and is known as the greenhouse effect(www.wikipedia.com).

2.5CARBON DIOXIDE

Carbon dioxide is increasing in the atmosphere. Its concentration is now over 380 parts per million (PPM) and rising rapidly (Silver, 2008). At no time in this planet's history has the carbon dioxide level ever been above 300PPM. Today, it is at levels that are unprecedented in recent history, and it is growing at a rate that, if it continues, is likely to have a major impact on global climate.

Each year nature puts about 200 billion tons of carbon dioxide into the atmosphere(Silver, 2008),mostly from decaying plants and spewing from volcanoes. This is 30 times more than what we release into our atmosphere from our cars, power plants, and factories.

However, the hundred billion or so tons of carbon dioxide that we have added to the atmosphere since 1850 (Silver, 2008)are enough to initiate the climate changes that we are beginning to witness around the world. Since we add roughly 7 billion tons each year at current rates, we are continuing to tip the balance.

Nature produces and absorbs carbon dioxide, establishing what is called the *preindustrial level* of about 280PPMin the air. This means that for every million air molecules, 280 of them are carbon dioxide. Today, the global carbon dioxide level, as a result of human activities, is nearly 100PPM (Silver, 2008) higher than the natural level. At current rates, this may reach a level of 560PPM (Silver, 2008) by the end of this century.

Contributions from humans are known as *anthropogenic* greenhouse gases. Carbon dioxide is at the top of the list because of its impact on global warming. Burning fossil fuels primarily for electricity generation, transportation, industrial process eat, and heating buildings contributes carbon dioxide. Cement production stands out as an industry that makes a large contribution to global carbon dioxide levels (Silver, 2008).

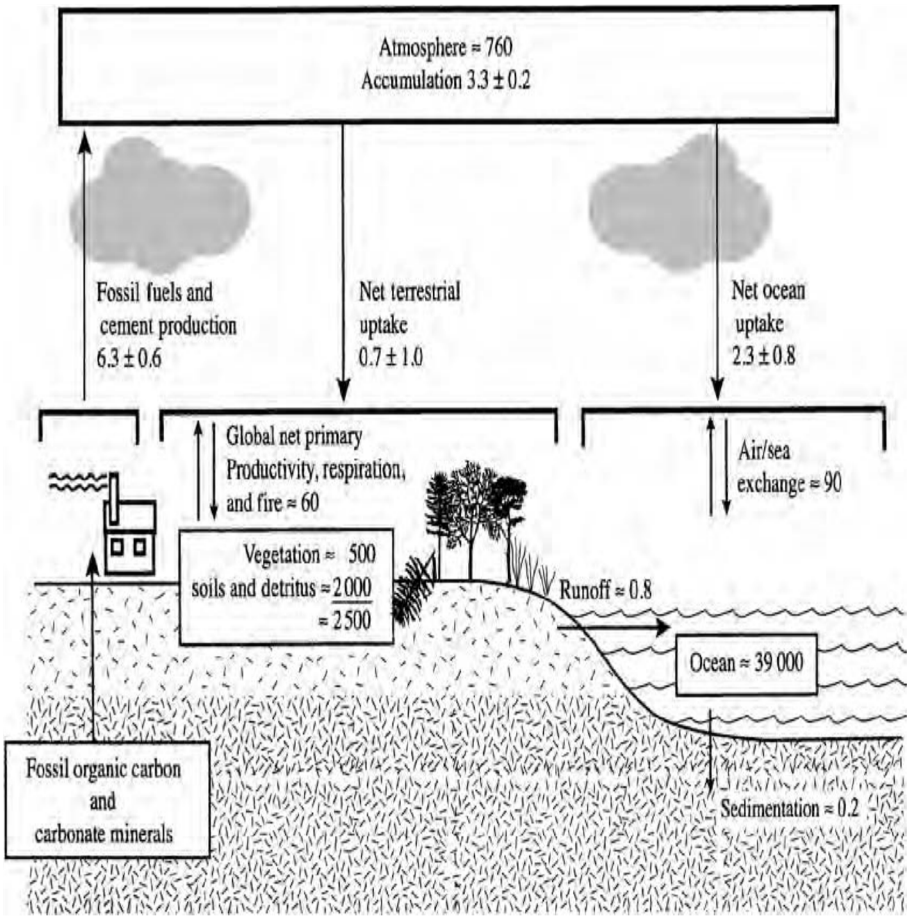
2.6Carbon dioxide and the carbon cycle

Carbon dioxide provides the dominant means through which carbon is transferred in nature between numbers of natural carbon reservoirs – a processes known as the carbon cycle. We contribute to this cycle every time we breathe. Using the oxygen we take in from the atmosphere, carbon from our food is burnt and turned into carbon dioxide that we then exhale; in this way we are provided with the energy we need to maintain our life. Animals contribute to atmospheric carbon dioxide in the same way, so do fires, rotting wood and decomposition of organic material in the soil and elsewhere. To offset these processes of respiration where by carbon is turned into carbon dioxide, there are processes involving photosynthesis in plants and trees which work the opposite way; in the presence of light, they take in carbon dioxide, use the carbon for growth and return the oxygen back to the atmosphere. Both respiration and photosynthesis also occur in the ocean.

Figure 2.1 is a simple diagram of the way carbon cycles between the various reservoirs – the atmosphere, the oceans (including the ocean biota), the soil and the land biota (biota is a word that covers all living things–plants, trees, animals and soon–on land and in the ocean, which **Figure 2.1** The global carbon cycle, showing the carbon stocks in reservoirs (in Gt) and carbon flows (in Gt $year^{-1}$) relevant to the anthropogenic perturbation as annual averages over the decade from 1989 to 1998. Net ocean uptake of the anthropogenic perturbation equals the net air/sea input plus run-off minus sediment. The units are thousand millions of tones or rigatonis (Gt).

Make up a whole known as the biosphere). The diagram shows that the movements of carbon (in the form of carbon dioxide) into and out of the atmosphere are quite large; about one-fifth of the total amount in the atmosphere is cycled in and out each year, part with the land biota and part through physical and chemical processes across the ocean surface. The land and ocean reservoirs are much larger than the amount in the atmosphere; small l changes in these larger reservoirs could therefore have a large effect on the atmospheric concentration; the release of just two per cent of the carbon stored in the oceans would double the amount of atmospheric carbon dioxide.

It is important to realize that on the timescales with which we are concerned anthropogenic carbon emitted into the atmosphere as carbon dioxide is not destroyed but redistributed among the various carbon reservoirs. Carbon dioxide is therefore different from other greenhouse gases that are destroyed by chemical action in the atmosphere. The carbon reservoirs exchange carbon between themselves on a wide range of timescales determined by their respective turnover times – which range from less than a year to decades (for exchange with the top layers of the ocean and the land biosphere) to millennia (for exchange with the deep ocean or long-lived soil pools). These timescales are generally much longer than the average time a particular carbon dioxide molecule spends in the atmosphere, which is only about four years. The large range of turnover times means that the time taken for a perturbation in the atmospheric carbon dioxide concentration to relax back to an equilibrium cannot be described by a single time constant. Although a lifetime of about a hundred years is often quoted for atmospheric carbon dioxide so as to provide some guide, use of a single lifetime can be very misleading.



FIGUER(2.1) The global carbon cycle, showing the carbon stocks in reservoirs (in Gt) and carbon flows (in Gt year$-^{1}$) relevant to the anthropogenic perturbation as annual averages over the decade from 1989 to 1998. Net ocean uptake of the anthropogenic perturbation equals the net air/sea input plus run-off minus sediment. The units are thousand millions of tones or gigatonnes (Gt)(Sir Houghton, 2004).

Before human activities became a significant disturbance, and over periods short compared with geological timescales, the exchanges between the reservoirs were remarkably(Sir Houghton, 2004).

2.7A Brief History of Climate Change

Period	Time Period	Characteristics
Instrumental record (direct measurements)	Past 150 years	On the warm side of the historical range and increasing
Little ice age	600–150 years ago	Coldest in thousands of years, possibly caused by volcanic activity and reduced solar activity
Medieval warming	1050–750 years ago	Warm—close to modern-day levels—drought in North America
Interglacial warm period	11,000 years ago	Warm—ice sheets retreated
Younger Drays period	13,000–11,700 years ago	Cold followed by abrupt warming
Ice ages	Four events between about 1million and 115,000 years ago	Ice sheets covered much of Canada and northern Scandinavia—advanced and retreated four times
Interglacial warm period	3 million years ago	Much warmer climate with reduced global ice cover and higher sea levels

Table(2.I) from (Silver, 2008).

CHAPTER III

3.1 Methodology

We had examined the trend of CO_2 as a contributor to greenhouse effect. Moreover, we also had selected rain precipitation as an atmospheric weather parameter. Both time series data were examined for their trend in time by showing variations of each of them in the span of 57 years.

The data were obtained from the ministry of environment, meteorology department in Sudan and we checked the relationship between the rainfall precipitation as a minor weather variable in the past 57 years as independent variable (data are shown in the appendix). Finally, the level of CO_2 variation in the time span of 57 years was checked for its trend.

CHAPTER IV

Results, discussion and conclusion

4.1 Results

F**igure (4.1)**here, shows on the upper panel the local rain precipitation time series; while in the same figure and in the lower panel it shows the carbon dioxide level time series and the increasing trend is obvious in this lower panel.

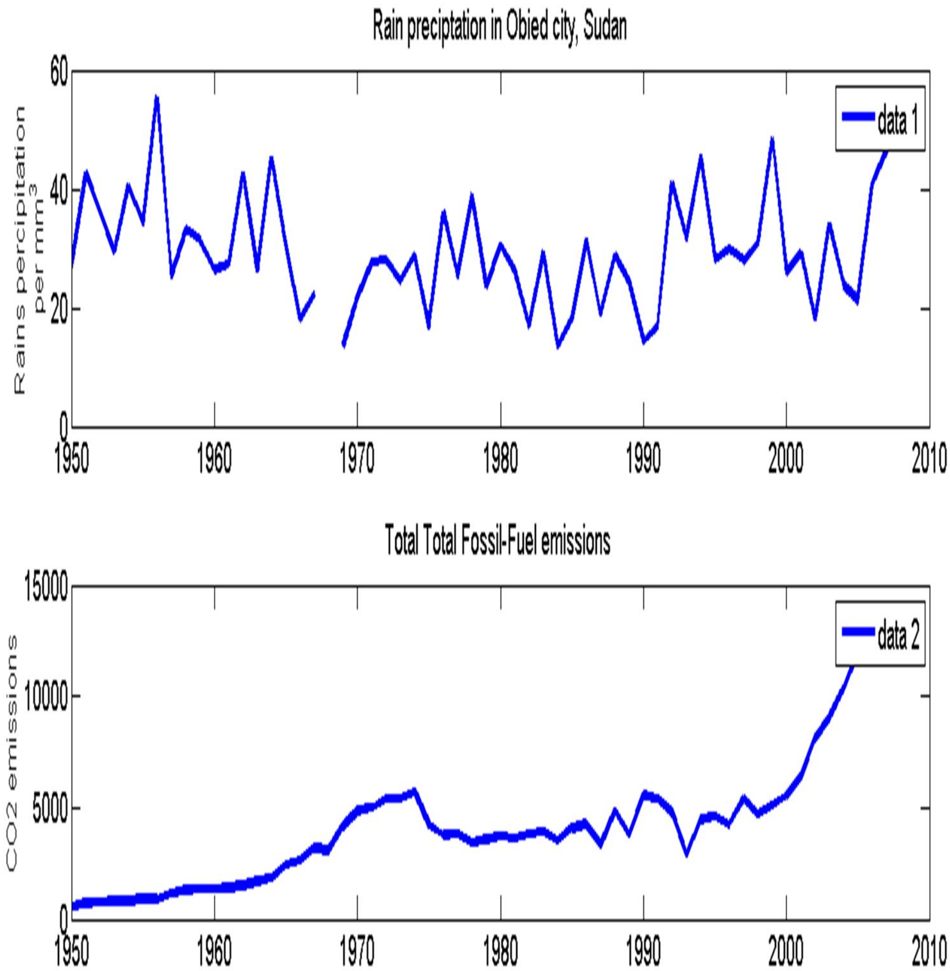


Figure (4.1) In data 1 is rate of CO_2(global) is trend is increasing, and data 2 is rate of Rain fall precipitation is trend steady.

4.2 Discussion

It is known that the climate change may occur as a result of several factors, but global warming is an outstanding factor. Rain precipitation is one of weather parameters, in order to assess the whole weather change many collective parameters should be taken altogether under investigation. Among the greenhouse effect gases is the carbon dioxide, so it is important to monitor the level of carbon dioxide during last couple of decades. Our investigation (as in figure 4.1) showed that the level of carbon dioxide is increasing, but on the other hand the only weather parameter, i.e. the rain precipitation showed no significant trend.

4.3 Conclusion

Global warming is an important issue to be investigated, because of its impact on human being life. We conclude that CO_2 level is in increase annually. Therefore efforts should be extended forward to mitigate the increase in CO_2 level.

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the data from the ministry of environment - depart of meteorology in SUDAN (1950-2007).

Watts, R. G. (2007). *Giobal warming and the future.* Colorado: Tulane univercity.

www.wikipedia.com.

Appendix:

The data from the ministry of environment - depart of weather men in SUDAN (1950-2007).

Data of rain fall precipitation and emissions ofCO_2.

Years	Rain fall precipitation	Emissions of CO_2
1950	27.02	150
1951	42.72	197
1952	36.02	207
1953	29.49	227
1954	40.52	223
1955	34.1	253
1956	55.38	245
1957	25.27	315
1958	33.02	352
1959	31.24	373
1960	26.47	371
1961	27.23	378
1962	42.65	405
1963	26.32	458
1964	45.36	507

Years	Rain fall precipitation	Emissions of CO_2
1965	29.91	662
1966	18.12	721
1967	22.28	869
1968		847
1969	13.68	1141
1970	21.78	1324
1971	27.72	1359
1972	28.07	1467
1973	24.46	1480
1974	28.9	1550
1975	16.8	1156
1976	36.05	1024
1977	25.3	1038
1978	39.02	938
1979	23.7	974
1980	30.41	1022
1981	26.06	993
1982	16.86	1044

Years	Rain fall precipitation	Emissions of CO_2
1983	29.32	1066
1984	13.48	956
1985	18.27	1111
1986	31.3	1159
1987	18.86	914
1988	28.83	1322
1989	24.34	1025
1990	14.22	1516
1991	17.03	1469
1992	41.05	1297
1993	31.55	793
1994	45.39	1212
1995	28.14	1255
1996	29.95	1164
1997	27.85	1478
1998	30.88	1281

Years	Rain fall precipitation	Emissions of CO_2
1999	48.46	1389
2000	26.03	1509
2001	29.09	1737
2002	18	2214
2003	33.9	2474
2004	23.8	2830
2005	21.2	3271
2006	40.9	3186
2007	46.5	3457