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Study on Carbon Dioxide, Methane, Sulfur Dioxide, Temperature, Ozone and Rainfall Variations in Hawaiian Island (19^0 34' Latitude, 155^0 30' Longitude)

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Abstract

The Hawaii observatory is located at 19^0 34' latitude, 155^0 30' longitude and 4207 sq m area. The island of Hawaii is built from fine separate shield volcanoes that erupted somewhat sequentially one overlapping the other. Moderate to strong trade winds carry as and vog from Kilauea volcano around the southern tip of the island. Ninety-nine percent of the gas molecules emitted during a volcanic eruptions are water vapor (H_2O), carbon dioxide (Co_2), and sulfur dioxide (So_2). The remaining one percent is comprised of small amounts of hydrogen sulfide, carbon monoxide, hydrogen chloride, hydrogen fluoride, and other minor gas species. The most critical factors that determine how much vog impacts any area are wind direction and speed. Where and how bad the vog is ultimately depends on several additional factors including air temperature, humidity, and rainfall emitted from Kīlauea Volcano. The Co_2 atmosphere concentration measured at Mauna Lao observatory (MLO). Hawaii have been used by advocates of anthropological global warming (AGW) as a bell weather of climate. Carbon dioxide concentrations in units of parts per million (PPM) have been measured daily and monthly have been averages reported since 1958. We have analyzed Co_2 data from 1958 to 2014, So_2 data from 1979 to 1997, CH_4 data from 1992 to 2001, rainfall data from 1920 to 2012, temperature data from 1955 to 2015 and ozone data from 1958 to 2014. Here We have analyzed and interpret to draw the line graphs and bar graphs in the following parameters ozone, carbon dioxide, methane, temperature and rainfall. We find the following parameters i) Co_2 gradually increased from 1958 to 2014 ii) CH_4 gradually increased from 1992 to 2001 iii) The So_2 gradually increased and decreased from 1979 to 1997 iv) Mauna loa Temperature increased from 1955 to 2015 and Opihihale Temperature increased from 1965 to 2010 v) Rainfall increased and decreased from 1920 to 2012 vi) Ozone increased and decreased from 1958 to 2014.

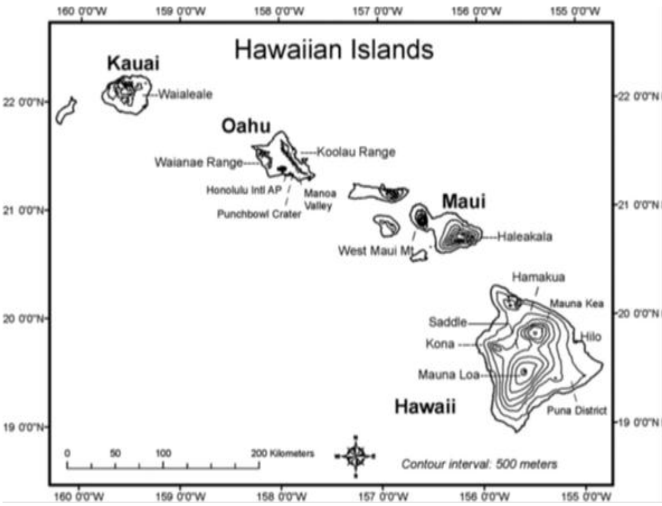
***Keywords*:** volcano eruption, Kilauea, Carbon dioxide, Ozone, Temperature, So_2, CH_4, Rainfall and climate change.

INTRODUCTION

The largest island of Hawaiian is located in the U.S. state of Hawaii. It is the largest and the southeastern-most of the Hawaiian islands, a chain of volcanic islands in the North Pacific Ocean. With an area of 4,028 square miles (10,430 km^2), The Hawaii observatory is located at 19^0 34' latitude, 155^0 30' longitude and 4207 sq m area. It is larger than all of the other islands in the archipelago combined and is the largest island in the United States. The island of Hawaii is the third largest island in Polynesia, behind the two main islands of New Zealand. The island is often referred to as the **Island of Hawaii** the **Big Island**, or **Hawaiʻi Island** to distinguish between the island and the state. Administratively, the whole island is encompassed by Hawaii_County. As of the 2010 Census, the population was 1,85,079.

The county seat and largest city is Hilo. The island of Hawaii lies over or just north of the Hawaiian hot spot and is composed of five volcanoes and one active seamount: Kohala, Hualalai, Mauna Loa, Kilauea, Mauna Kea and Loihi. Of these, only Mauna Loa, Kilauea and Loihi are considered active, while Haulalai is dormant with its most recent eruption ending around 1800–1801. The island has 428 km of coastline and is so large relative to the other Hawaiian islands that it is known locally and abroad as the big Island.

Well-developed black and green sand beaches signify the reworking by waves and currents of recent lavas. These beaches are relatively limited along the rough volcanic coastline, and white calcareous sands are restricted because of poor coral reef development due to recent volcanic activity. There is lush vegetation in the NE, where the annual rainfall is 1,500-4,000 mm.



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KILAUEA VOLCANO–HAWAII

The Kilauea volcano system, called Hot Spot, has been active for 300,000–600,000 years, with no known prolonged periods of quiescence. Hot Spot means that magma penetrates the plate and rises up to the surface, leaving a string of volcanoes. The Hot Spot is merely an anomalous concentration of heat that is transferred constantly from the Earth's interior to the surface. Beginning in 1983, a series of short-lived lava fountains built the massive cinder and spatter cone named Pu'u 'O'o vent. This eruption of Kilauea is the most voluminous outpouring of lava in the volcano's east rift zone in the past five centuries. Kilauea emits more than 700,000 tons of CO_2 each year. The observations since 1958 that established the systematic increase of atmospheric CO_2 **(Keeling et al., 1976)** were carried out at the NOAA Observatory on Mauna Loa (altitude 3397ma.s.l. (above sea level), Big Island, Hawaii. It has been argued **(Ryan, 2001)** that this is an excellent location to make atmospheric measurements because of the isolation from localized anthropogenic and continental sources and sinks. The well-mixed atmosphere at this isolated high elevation observatory has very small variations in CO_2 concentrations, and the observations have been widely taken as representative of global average values **(IPCC, 2007).**

We recognize that temperature trends are often obtained utilizing spatial averages of results from multiple stations, rather than one station. For example, Jones and Moberg (2003) utilized 5159 stations to map global values of surface temperature trends. In another example, trends for averaged stations in the Hawaiian Islands have been given by **Giambelluca et al. (2008).** Annual mean maximum temperatures (Tmax), minimum temperatures (Tmin), and diurnal temperature ranges (DTR), for 1977–2006, based on hourly Mauna Loa Observatory, Hawaii data (NOAA, 2009) have been given for "all months" during the year, summer (June, July, August) and winter (December, January, February).

As discussed above, we have found that there is an overall annual warming trend of temperatures dT /dt = 0.021±0.011_C yr-1 at this observatory for the same period. This is very close to the Hawaii regional sea surface temperature (SST) trend d (SST)/dt = 0.018 ±0.006 _C yr-1 for the period 1977–2006, the average "preferred" value of the IPCC (2007) for the period 1980–2005 of dT /dt = 0.018±0.005 _C y-1 and our inferred CO_2 trend analysis value of dT /dt = 0.019 [0.012 to 0.029] _C yr-1.

Since the 1980's, more frequent light precipitation and less frequent moderate and heavy precipitation have been observed in Hawaii **(chu et al., 2010; Timm et al., 2011).** Using observed temperature across the Island of Oahu, Safeeq (2010) reported a 0.43 and 0.29 ^{0}C per decade increase in minimum and maximum air temperature, respectively, during 1947-2007. At a longer (1905-2006) time scale, **Giambelluca and Luke (2007)** reported an increasing trend in the mean annual temperature between 0.12 and 0.23 ^{0}C per decode across the Hawaiian Island. Although the magnitude of change is temporal and spatial, the anticipated impact on the hydrology of mountainous Hawaiian watersheds cannot be disregarded.

Elevated Co_2 emissions and changes in temperature and precipitation affected the stream flow as well as the ET of the study area. Effects of increased temperature alone on stream flow and ET were small compared with what was reported by other climate change studies **(Fu et al., 2007; Ficklin et al., 2009; Liu and Cui, 2010).** Absolute change in ET and stream flow with a 5% change in precipitation was higher than that due to a 6.4 ^{0} C increase in temperature alone.

Volcanoes contribute about 36% to the tropospheric sulfur burden **(Graf et al.,1997).** Volcanic sulfur is not only directly injected into the stratosphere from explosive eruptions, but also from emissions of continuously degassing noneruptive volcanoes and from small eruptive events **(Graf et al. 1998).** Volcanoes substantially contribute to the stratospheric sulfur burden **(e.g., Bluth et al., 1997).** The average input of volcanic sulfur over the last 200 years has been estimated as 1 Tg per year ranging from 0.3-3 Tg per year **(Pyle et al. 1996).** A minimum flux of 0.5-1.0 Tg S for the past 9000 years has been derived from ice core sulfate data. This mean flux, however, is highly variable due to singular explosive events. During periods of little volcanic activity, the background stratospheric load of sulfate is in the order of 0.15 Tg S **(Kent and McCormick 1984)**. In case of cataclysmic volcanic eruptions, this stratospheric sulfate mass can be increased for short periods of time by one to two orders of magnitude.

The historical trends in precipitation and air temperature on Hawaiian Islands have been extensively studied **(Karl et al., 1996; Chu and Chen, 2005; Giambelluca et al., 2008; Timm and Diaz, 2008; Chu et al., 2010). Timm and Diaz (2008)** analyzed the precipitation change over the Hawaiian Islands during the late 21st century using the AR4 A1B emission scenario. From the downscaling of six global circulation models (GCM), **Timm and Diaz (2008)** concluded a 5%-10% reduction of wet season precipitation and 5% increase during the dry season. Using a linear trend analysis of observed air temperature and precipitation at Honolulu airport, Hawaii, **Karl et al. (1996)** reported an increase of the mean air temperature by 2.5^{0}C and 20% decrease in precipitation between 1900 and 1990.

Over the 21st century, the global average surface temperature has increased by approximately 0.6 ^{0} F and is projected to rise by an additional 1.1 to 6.4 ^{0} F **(IPCC, 2007).** Global climate modeling predicts that net precipitation at sea level near the Hawaiian Islands will decrease in winter by about 4-6%, with no significant change during summer **(IPCC AR4, 2007).** The average ambient temperature (at sea level) is projected to increase by about 4.1^{o}F from 2.7 to 6.7^{o}F by 2100 **(IPCC, 2007).** By 2100 the monthly average sea surface temperature in the sea Hawaiian waters may increase from 73 ^{o}F to between 75 ^{o} F and 79^{o}F **(Vecchi and Soden, 2007).** The Sea level rise also is directly implicated in increasing frequency and severity of high wave inundation and accelerate beach erosion **(Fetcher and Marrifield 2009).**

RESULT AND DISCUSSION

The volcanic erupting gases changes Hawaii island in United states are listed and an interpretation is given to show the results of following parameters of i) Carbon dioxide, ii) Ozone, iii) Methane iv) Temperature ,v) Sulfur dioxide and vi) Rainfall.

Interaction between the i) Rain fall and Temperature ii) Methane and Carbon dioxide iii) Rainfall and Carbon dioxide iv) Temperature and Carbon dioxide v) Carbon dioxide and vi) Total ozone.

i) Carbon dioxide

A colorless, odorless, incombustible gas, Co_2, that is formed during respiration, combustion, and organic decomposition, is an essential component in photosynthesis, and is used in food refrigeration, carbonated beverages, inert atmospheres, fire extinguishers, and aerosols. This is also called *carbonic acid gas*. The Carbon dioxide concentration (PPM- Parts Per Million) from 1960 to 2014 is shown in a line graph figure (a).

The Carbon dioxide concentration is the lowest in winter and the highest in summer period respectively. We find that Carbon dioxide concentration increases minimum 0.50 (ppm) level per year**.** The line graph shows the result of Low level Carbon dioxide concentration 316.91 ppm in the year 1960 and the year 1998 Carbon dioxide concentration 316.91 ppm 366.65 and High level Carbon dioxide concentration 398.55 ppm in the year 2014 respectively.

The Carbon dioxide annual growth rate in the year of 1960 (0.54 ppm) gradually increased and Co_2 level decreased very low in the year of 1964 (0.28 ppm) and again Co_2 gradually increased the reach high level in the year of 1977 (2.1 ppm), 1983(2.13 ppm), 1987(2.29 ppm) then Co_2 level decreased very low in the year of 1992(0.48 ppm) again Co_2 gradually increased to reach high level in the year of 1998 (2.93ppm) and 2015 (3.05 ppm).The average of the Carbon dioxide concentration is 350.76 ppm. The Carbon dioxide concentration from 1958 to 2014 gradually increased, the atmospheric Co_2 concentration has increased 315 to 400 parts per million and nowadays increased continuously. The carbon dioxide level increased up to 81.64 ppm from the year 1960 to 2014.

ii) Ozone

The total ozone concentration from the year of 1958 to end year of 2014 is shown in a line graph figure (c). The ozone concentration is the lowest in winter and the highest in summer period respectively. The highest concentration was 273.33 DU at the year of 1974 and the lowest concentration of ozone was 251.68 DU at the year of 1993 respectively. The average of the ozone concentration is 262.DU. we find that after 1993 ozone level decreased up to 251.68 Dobson Unit. The ozone level decreased up to 6.66 DU from the year 1958 to 2014 .

iii) Methane

The Methane variations are shown in a bar graph figure (d). The Methane variations are the lowest in winter and highest in summer period respectively. The Methane level increased in Hawaii island throughout the year from 1992 to 2001. In the year 1992 methane level 1722 ppbv *(*parts per billion by volume) increased inch by inch and it reached the high level 1766 ppbv in the end year of 2001. We find that the average of the Methane level is 1745.63 ppbv. The methane level increased up to 44.51 ppbv from the year 1992 to 2001.

iv) Temperature

The mean temperature variations in Mauna Loa and Opilhihale is shown in a line graph figure (e,f,g). The temperature variations are the lowest in winter and the highest in summer period respectively.

MAUNA LOA: The mean temperature variations in Mauna loa is drawn in a line graph from the year 1957 to 2015.The high level of mean temperature is 48.47^0F at the year of 2007 and the low level of mean temperature of Mauna Loa is 42.2^0F at the year of 1976 respectively. The total average of the mean temperature is 45.34^0F. The temperature level increases up to 1.6^0F from the year 1957 to 2015.

OPIHIHALE

The mean temperature variations in Opilhihale is drawn in a line graph from the year 1965 to 2010. The High level of mean temperature of Opilhihale is 69.8^0F at the year of 1996 and the low level mean temperature is 64^0F at the year of 1966 respectively. The average of the mean temperature is 66.81^0F. The temperature level increases up to 1.1^0F from the year 1965 to 2010

v) Sulfur dioxide

The Sulfur dioxide variation is shown in a line graph figure (s). The Sulfur dioxide variation is lowest in winter and highest in summer period respectively. Sulfur dioxide level increases & decreases Kilauea in Hawaii island throughout the year from 1979 to 1997. The sulfur dioxide high level 401.25 mt/d (Metric Tons Per Day) was recorded in the year of 1987 and the sulfur dioxide low level 93.23 mt/d was recorded in the year of 1997respectively. The average of the sulfur dioxide concentration is 253.18 mt/d. The sulfur dioxide level decreased up to 107.55 mt/d from the year 1965 to 2010.

vi) Rain Fall

The mean rainfall in Hawaii, Lanai, Maui, Kauai, Molokai and Oahu cities from 1920 to 2012 is shown in a line graph figure (h,I,j,k,l and m). The rainfall variation is lowest in winter and highest in summer period respectively. The rain fall particularly increased to the maximum in the year of 1982 in the six stations of Hawaii (2639.7mm), Kauai (3543.2mm), Lanai (935.9mm), Maui (3069.1mm), Molokai (1899.9mm) and Oahu (2513.5mm) respectively.

The Hawaii rainfall level decreased up to 396.7mm from the year 1920 to 2012. The Kauai rainfall level decreased up to 881.2 mm from the year 1920 to 2012. The Lanai rainfall level decreased up to 320.7 mm from the year 1920 to 2012. The Maui rainfall level decreased up to 682.2 mm from the year 1920 to 2012. The Molokai rainfall level decreased up to 248.4 mm from the year 1920 to 2012. The Oahu rainfall level decreased up to 21.87 mm from the year 1920 to 2012. (see in the table - 1).

Table 1: Hawaiian Islands Rainfall

NAME OF THE STATION AND CITY	YEAR	MAXIMUM RAINFALL IN (millimeter)	YEAR	MINIMUM RAINFALL IN (millimeter)
HAWAII	1923	2965	1926	1239.3
	1982	2639.7	1963	1183.8
	1990	2616.1	1983	1904.5
	-------	-------	2010	863.2
KAUAI	1927	3047	1926	1336.5
	1951	2741.5	1952	1766
	1965	2960.6	1982	1240.6
	1982	3543.2	2000	1256.2
LANAI	1937	912.7	1928	205.9
	1951	952.7	1941	214

	1963	1078.2	1953	211
	1967	1182	1984	241.8
	1982	935.9	1998	216
	2004	1085.5	2012	212.3
MAUI	1937	2674.5	1926	1251.8
	1948	2542.6	1953	1061.6
	1982	3069.1	1983	1387.3
	1989	2737.7	2012	964.3
MOLAKAI	1923	1813.9	1926	847.1
	1927	1936.8	1953	611.6
	1965	1962.6	1983	731.4
	1982	1899.9	2012	789.9
	2004	1940.3	--------	---------
OAHU	1927	99.68	1926	38.69
	1965	94.47	1953	36.28
	1982	98.96	1983	36.82
	2004	85.11	2012	39.57

Vii) Rain Fall and Temperature

The Rain fall and temperature variation in Mauna Loa in Hawaii is shown in a line graph figure (n). In Mauna Loa (Hawaii), the low temperature in the years are in 1973 it is 45.1^0F, in 1986 it is 45.7^0F and in 2006 it is 45.7^0F with same coinciding rainfall low level years are in 1973 it is 1457.5 mm, in 1986 it is 2084.4 mm, in 2006 it is 1921.2 mm respectively. Duration these three years the rain fall and temperature reached their very lowest level.

viii) Methane and carbon dioxide

The Methane and carbon dioxide variations in Mauna Loa are shown in a line graph figure (o). This data's taken from 1992 to 2001. Carbon dioxide and Methane level increases and decreases gradually. Methane level gradually increases between the years 1997 to 2000. Carbon dioxide level decreases between the years 1997 to 2000. After the year 2000, Carbon dioxide level increased. Finally we find that the Carbon dioxide level increases up to 16 ppm from the year 1992 to 2001 and methane level increases up to 44.51 ppbv from the year 1992 to 2001 .

ix) Rain fall and carbon dioxide

The Rainfall and carbon dioxide variations shown in a line graph figure (p). This data's taken from 1965 to 2012. The rainfall maximum high years are in 1967 it is 2261.7 mm, in 1982 it is 2639.7 mm, in 1990 it is 2616.1 mm respectively. The rainfall minimum low years are in 1983 it is 1183.8 mm, in 1995 it is 1212 mm, in 2010 it is 863.2 mm. Carbon dioxide level increases up to 73.42 ppm from the year 1965 to 2012 and Rain fall level decreases up to 847.9 mm from the year 1965 to 2012.

x) Temperature and carbon dioxide

The Temperature and carbon dioxide variations are shown in a line graph figure (q). This data is taken from 1960 to 2014. The temperature level maximum years are in 1966 it is 45.4^0F, in 1980 it is 46.7^0F, in 1983 it is 47^0F, in 1986 it is 47.7^0F and in 1995 it is 47.7^0F then the temperature level minimum years are in 1976 it is 42.2^0F, in 1989 it is 44.3^0F and in 2009 it is 44.9^0F. We find that the Carbon dioxide level increases up to 78.08 ppm from the year 1960 to 2014 and temperature level increases up to 1.51^0F from the year 1960 to 2014.

xi) Carbon dioxide and Total ozone

The carbon dioxide and Total ozone variation are shown in a line graph figure (r). This data is taken from 1959 to 2014. The average of the ozone concentration is 262.51 DU. The carbon dioxide level gradually increased from 1959 to 2014 but ozone level increased from 1959 is 350 DU to 1977 up to 350 DU and 270.54 DU. 1979 ozone level suddenly decreased 258. 54 DU and gradually increased in the year 1980 is 269.12 DU. Again in 1981 ozone level suddenly decreased up to 262.15 DU and gradually increased in the year 1994 is 272.25 DU from 1999 up to 2014. We find that the Carbon dioxide level increases up to 81.64 ppm from the year 1959 to 2014 and total ozone level increases up to 3.8 DU from the year 1959 to 2014. (see in the table - 2).

Table 2

YEAR	MAXIMUM OZONE LEVEL IN (Dobson Unit)	YEAR	MINIMUM OZONE LEVEL IN (Dobson Unit)
1962	271.17	1960	258.72
1967	270.46	1966	259.67
1971	271.61	1978	258.54
1974	273.33	1983	254.82
1979	269.12	1993	251.68
1989	272.25	1997	254.85
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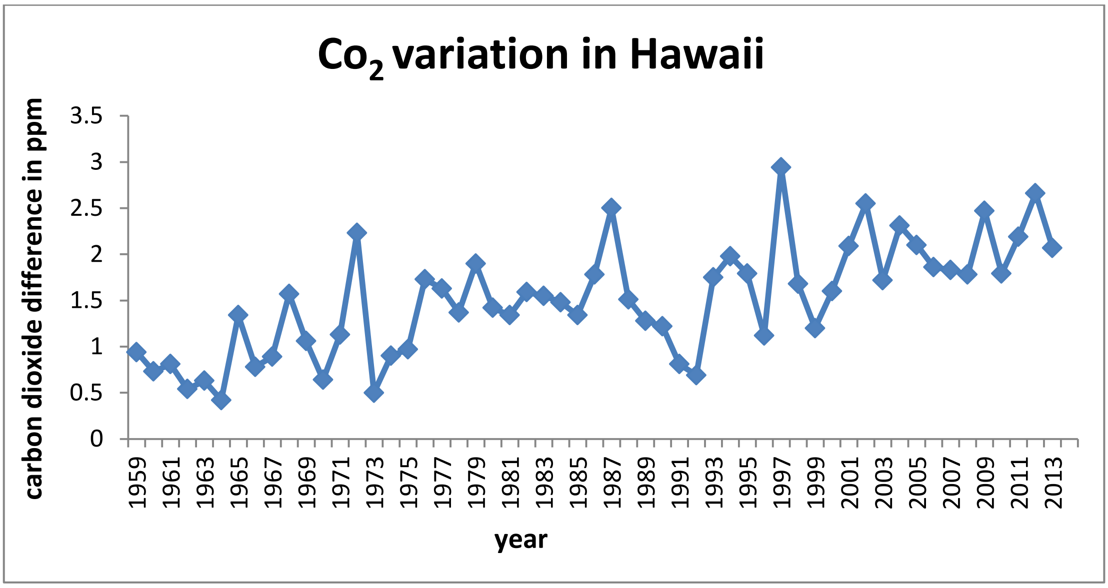

Figure (a): Carbon dioxide variation (ppm) from 1959 to 2014.

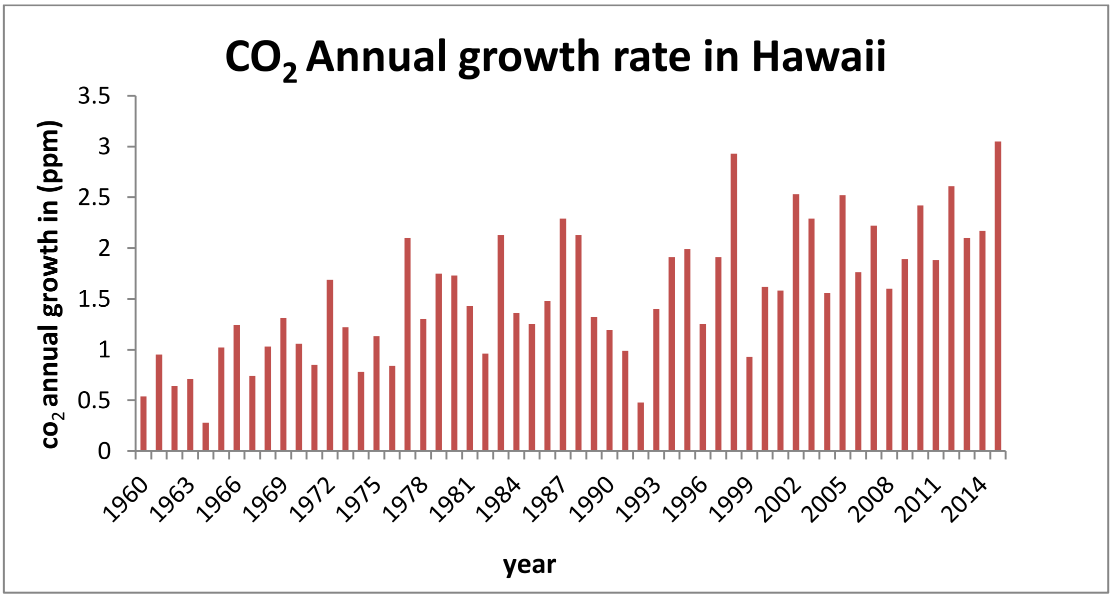

Figure (b): Co_2 Annual Growth rate (ppm) from 1960 to 2015.

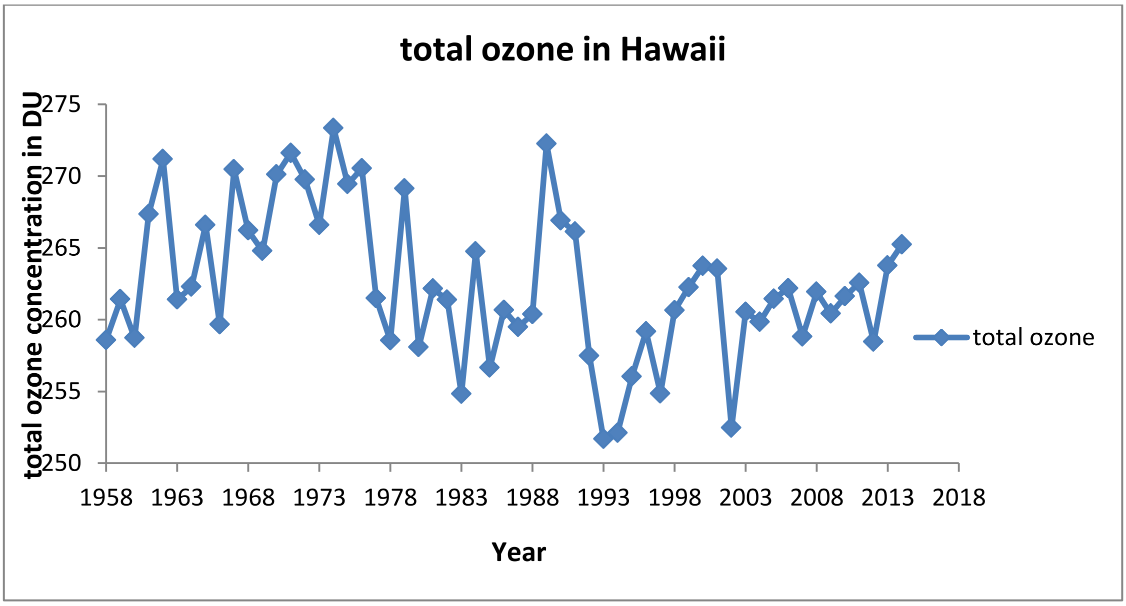

Figure (c): year average of total ozone variation from 1958 to 2014.
1993 after ozone level were decreased.

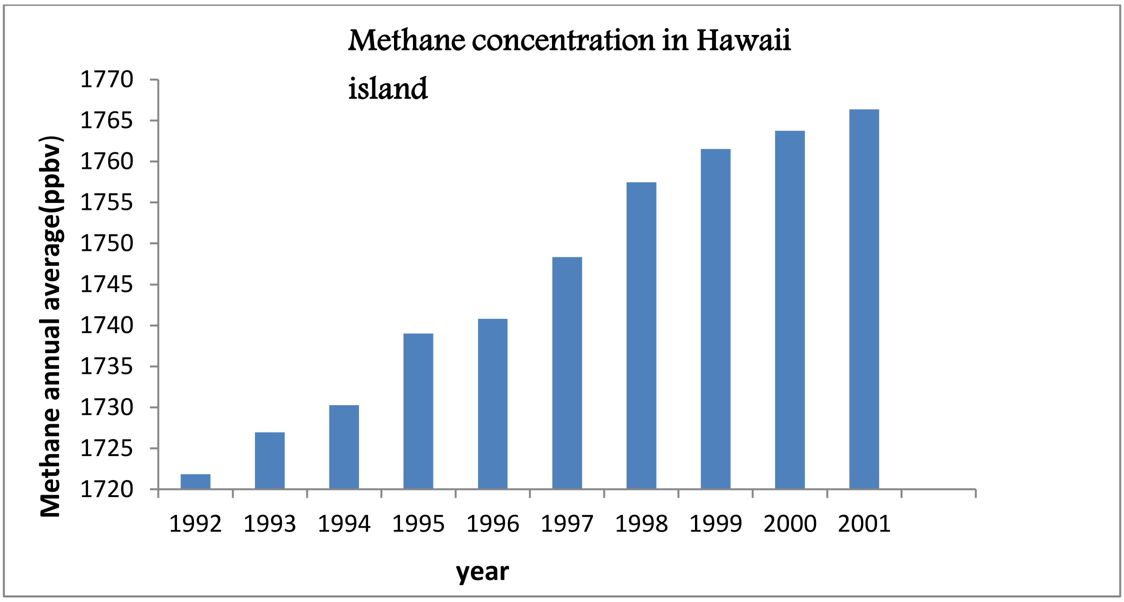

Figure (d): Year average of Methane variation from 1992 to 2001.

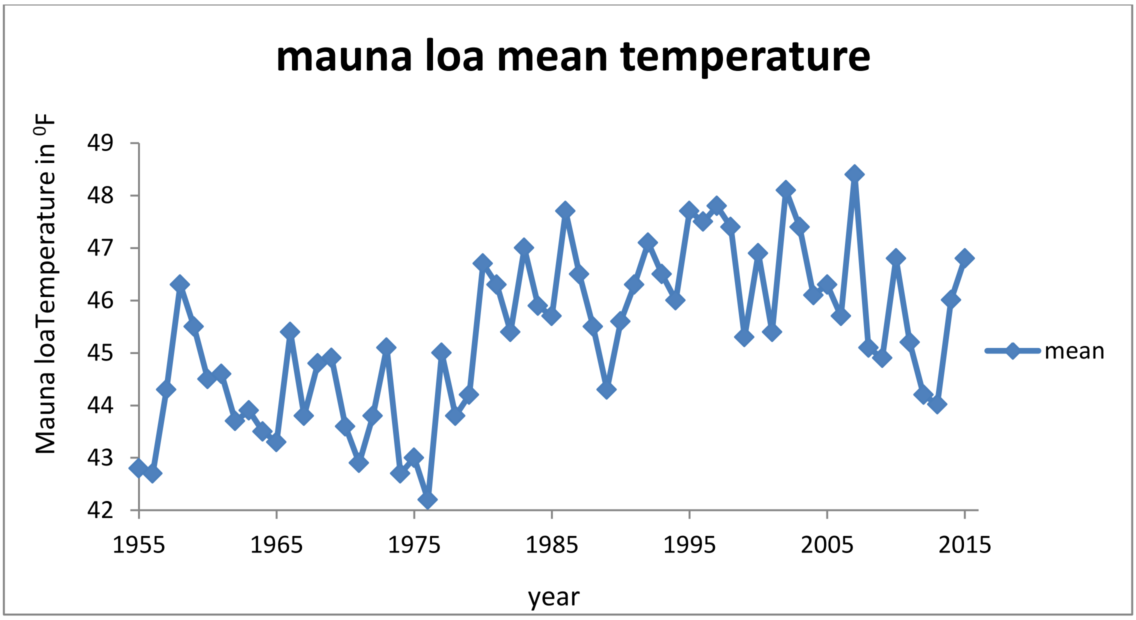

Figure (e): Year mean temperature variation from 1960 to 2014.

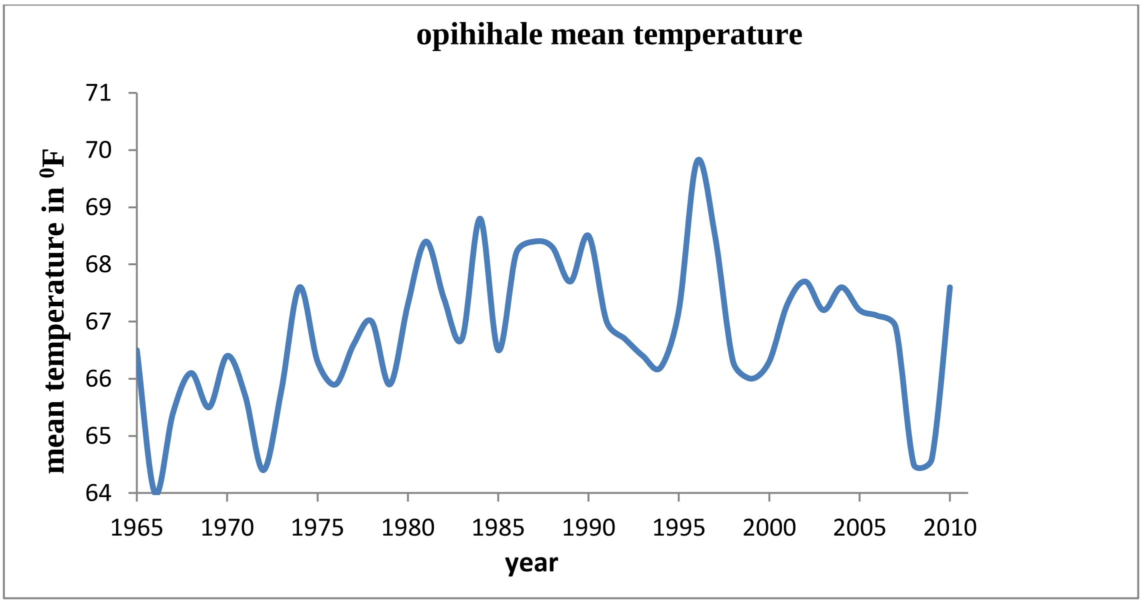

Figure (f): Year mean temperature variation from 1965 to 2010.

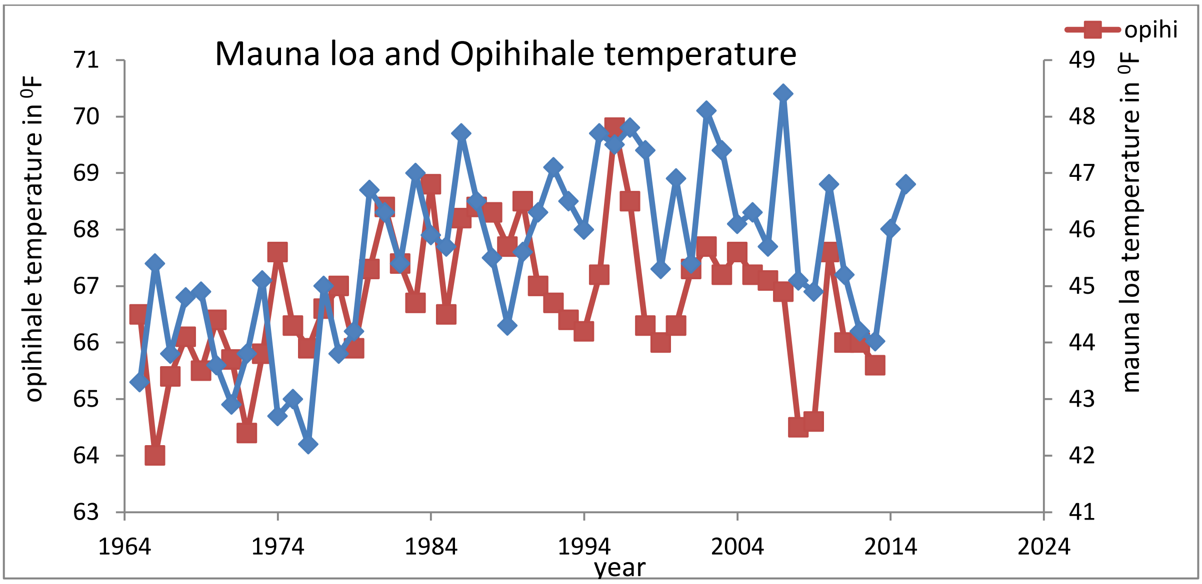

Figure (g): Year mean temperature variation from 1965 to 2015.

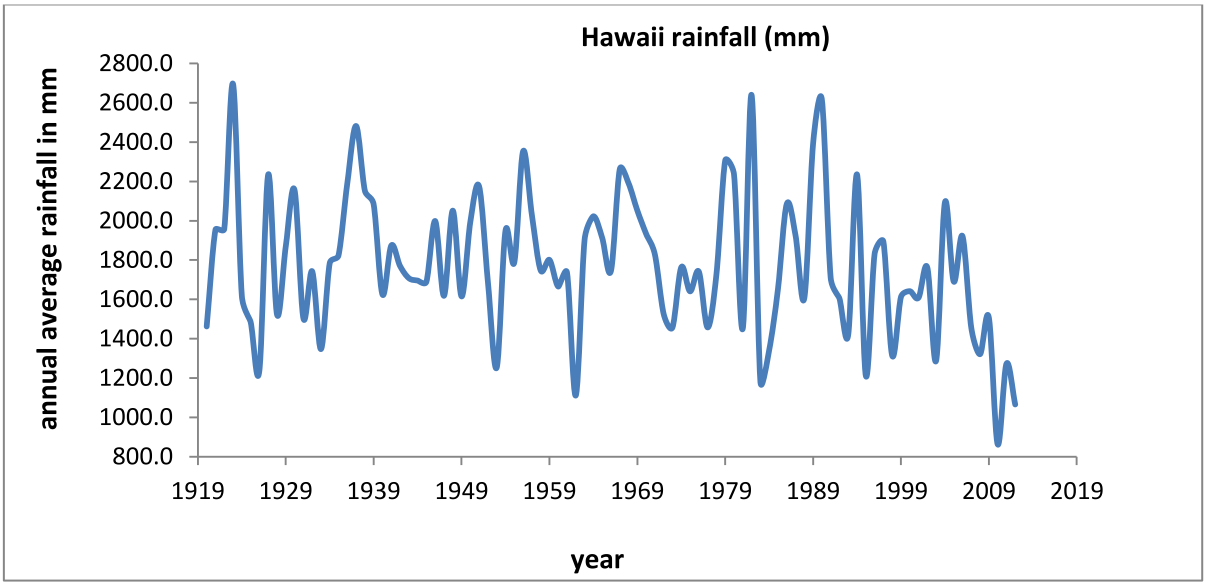

Figure (h): Year annual average Rain fall (Milli meter) from 1920 to 2012.

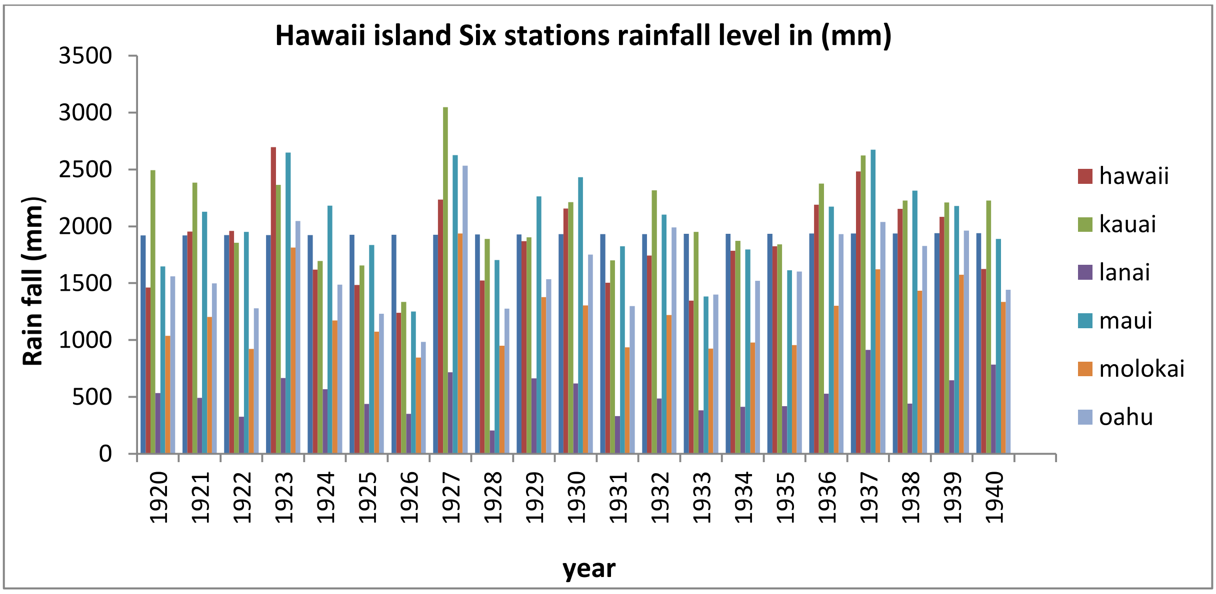

Figure (i): Hawaii, kauai, lanai, maui, Molokai, oahu six cities year annual average Rain fall level in (milli meter) from 1920 to 1940

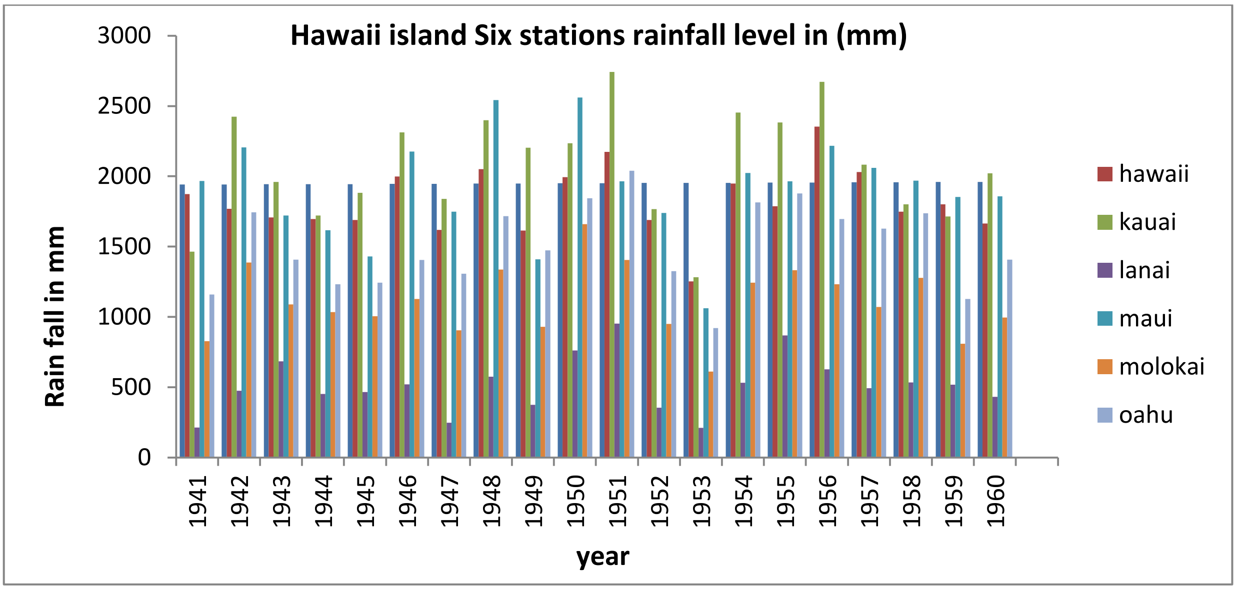

Figure (j): Hawaii, kauai, lanai, maui, Molokai, oahu six cities year annual average Rain fall level in (milli meter) from 1940 to 1960

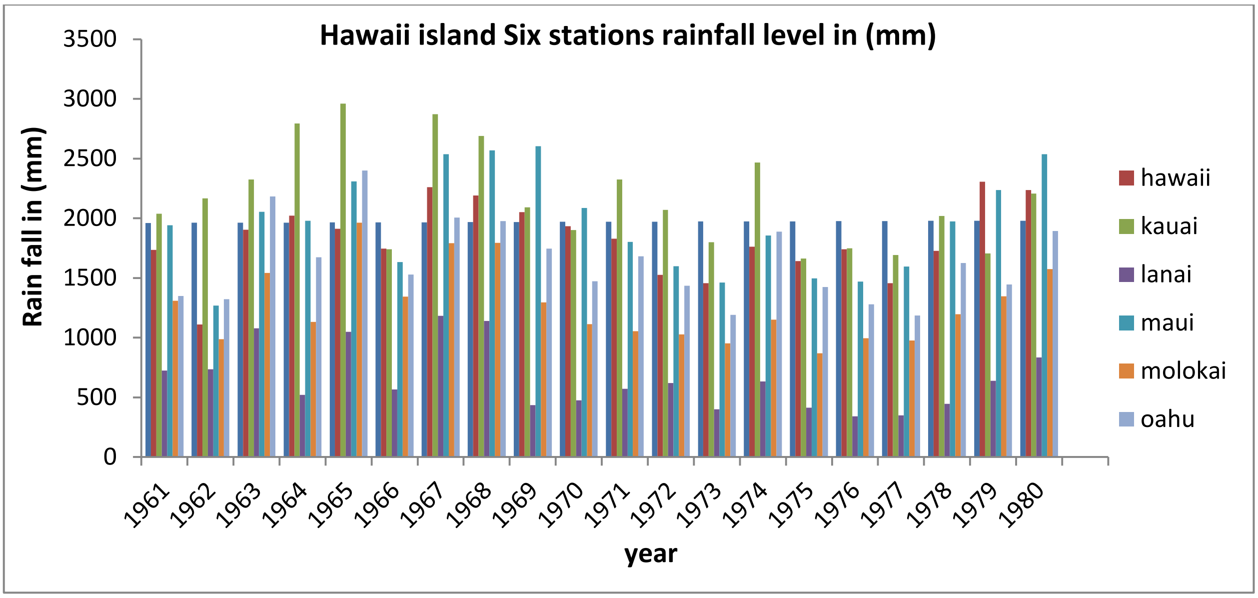

Figure (k): Hawaii, kauai, lanai, maui, Molokai, oahu six cities year annual average Rain fall level in (milli meter) from 1960 to 1980

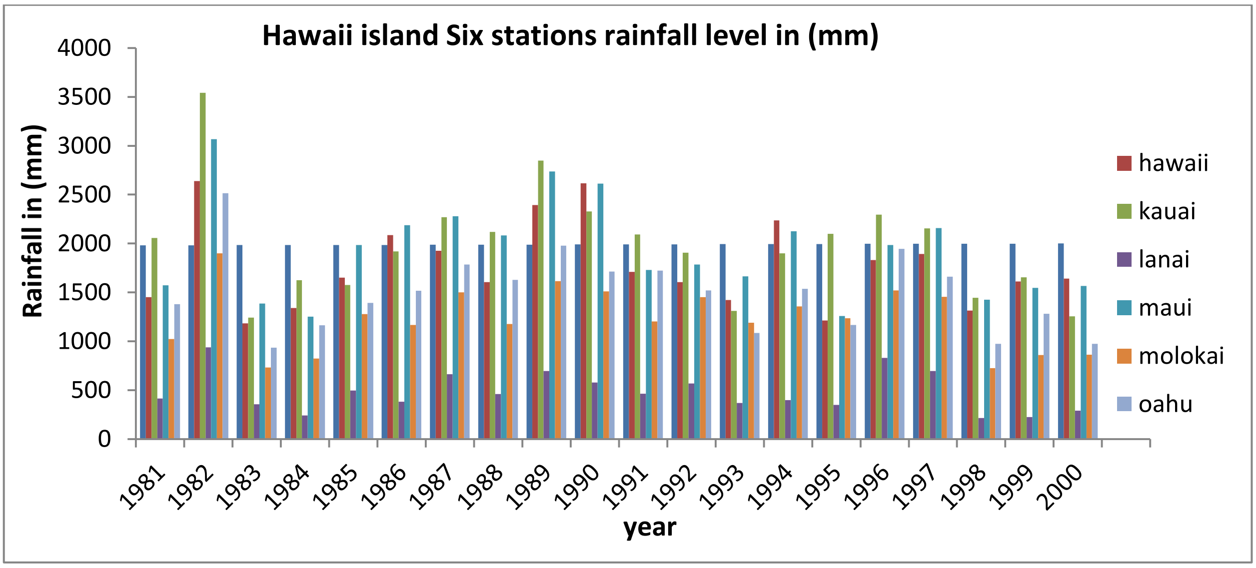

Figure (l): Hawaii, kauai, lanai, maui, Molokai, oahu six cities year annual average Rain fall level in (milli meter) from 1980 to 2000

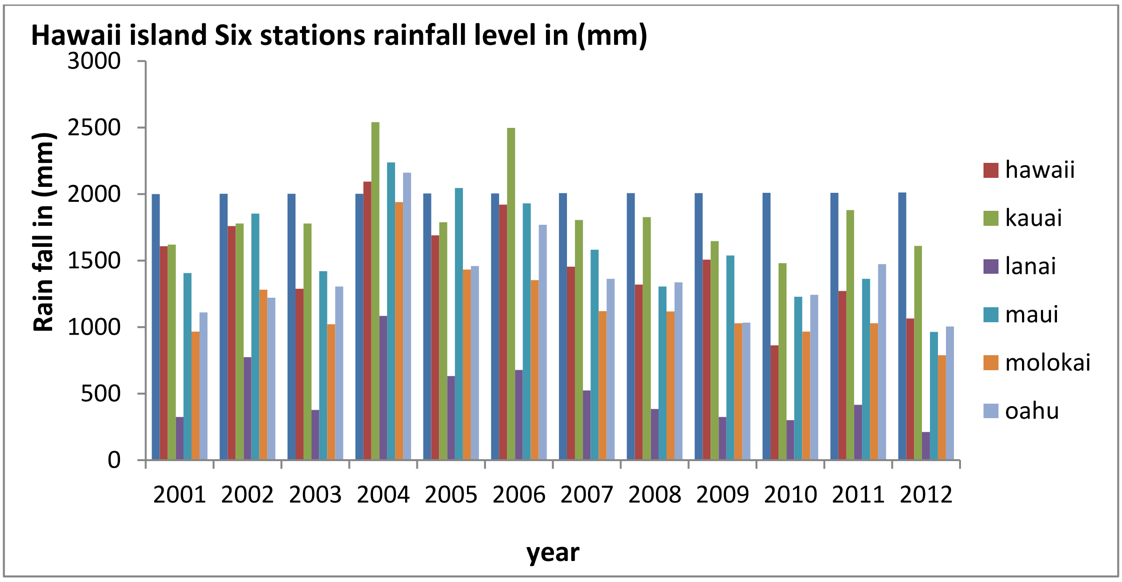

Figure (m): Hawaii, kauai, lanai, maui, Molokai, oahu six cities year annual average Rain fall level in (milli meter) from 2001 to 2012

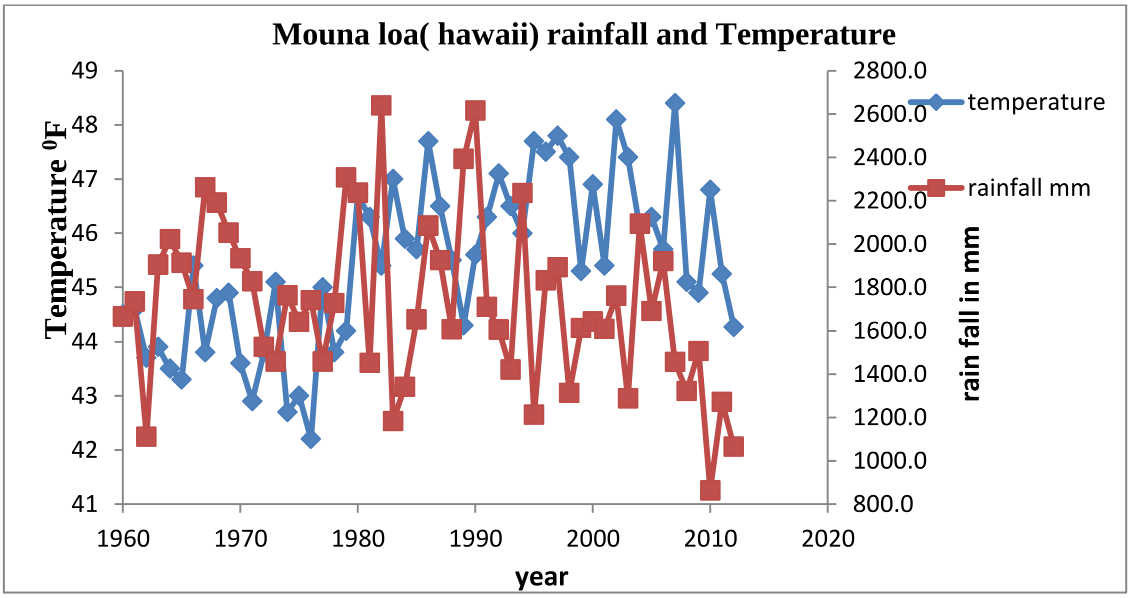

Figure (n): year annual average Rain fall (mm) and temperature(^{0}F) from 1960 to 2012.

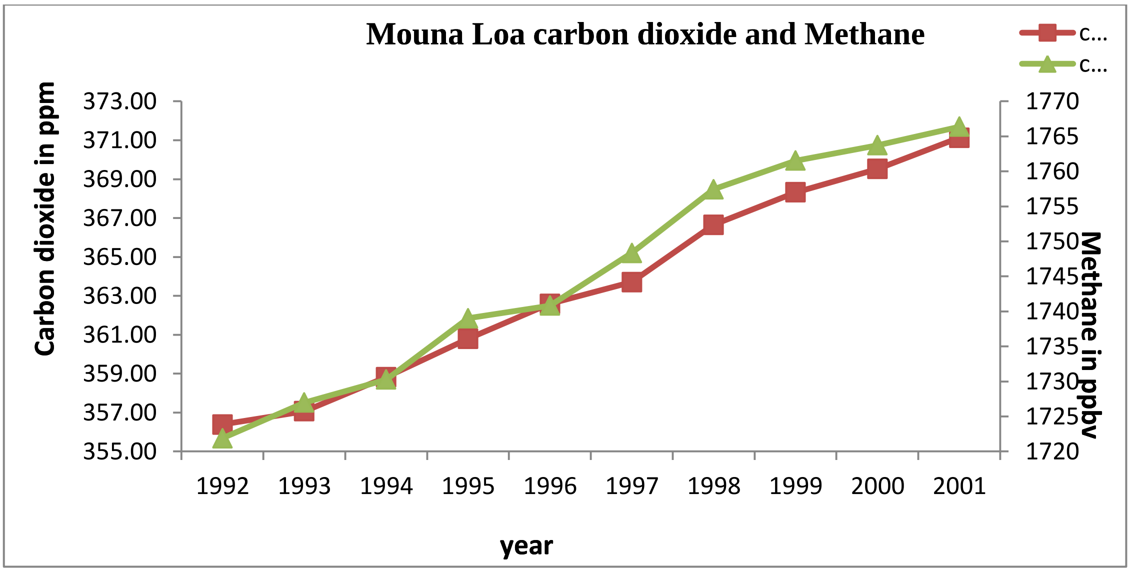

Figure (o): Hawaii Methane and carbon dioxide from 1992 to 2001

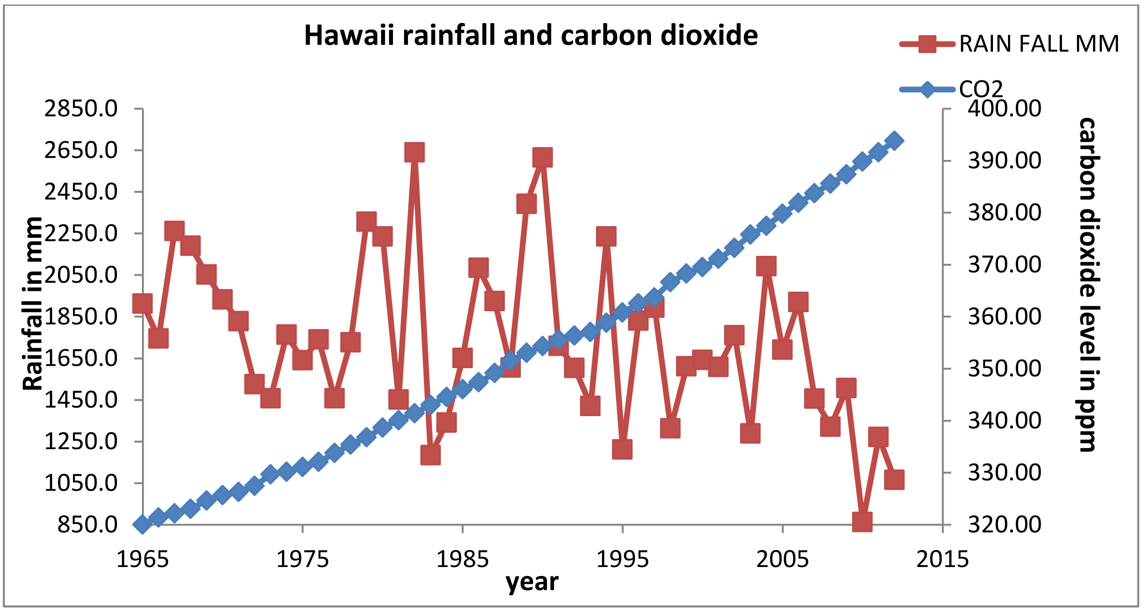

Figure (p): year annual average Rain fall and carbon dioxide from 1965 to 2012.

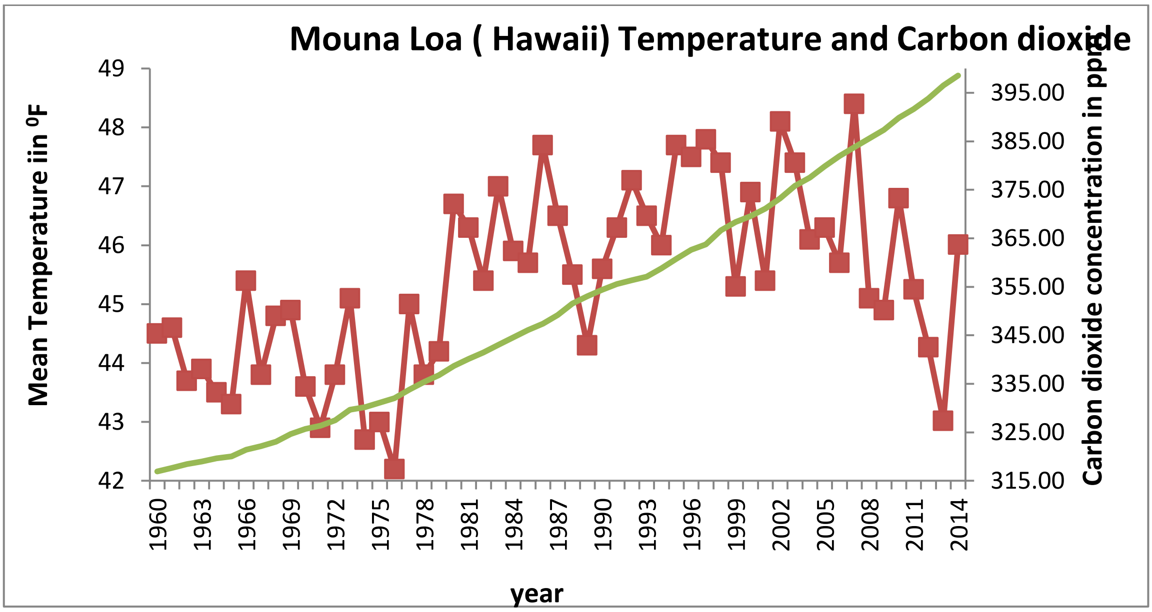

Figure (q): Year annual average Temperature and carbon dioxide from 1960 to 2014.

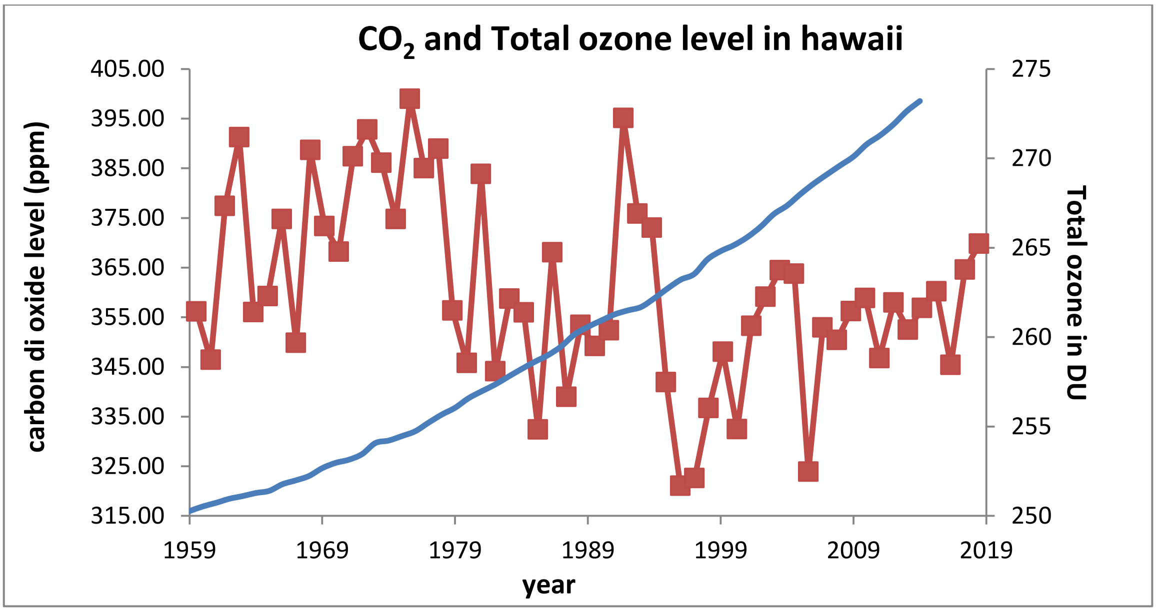

Figure (r): Year annual average carbon dioxide and Total ozone from 1959 to 2014.

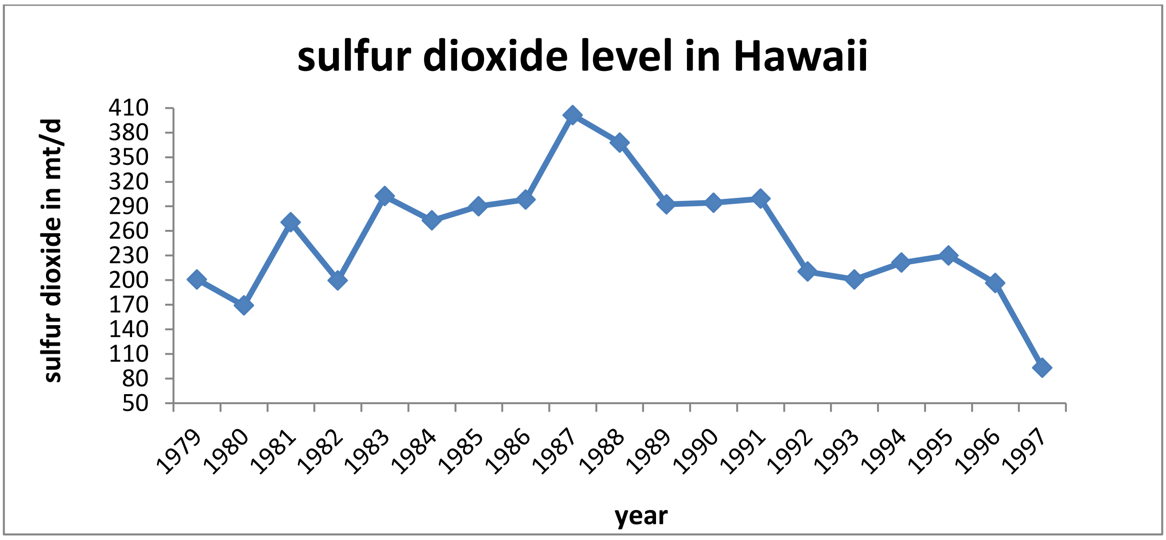

Figure (s): year annual average sulfur dioxide from 1979 to 1997.

SUMMARY AND CONCLUSION

We have analyzed various volcanic gases like carbon dioxide, methane, Nitrous oxide and ozone. Also we have studied the relationship between carbon dioxide and Temperature, carbon dioxide and methane, Rain Fall and Temperature, Rain fall and carbon dioxide, carbon dioxide and Total ozone. We have studied and analyzed at Mauna Loa Observatory (Hawaii) the measured Carbon dioxide concentrations gradually increased up to 81.64 ppm in the period from 1960 to 2014 and the Methane concentrations is gradually increased up to 44.51 ppbv in the period from 1992 to 2001.

Another major volcanic gas of Sulfur dioxide concentration is gradually increased up to 200.47 mt/d in the period from 1979 to 1987 and gradually decreased up to 308.02 mt/d in the period from 1987 to 1997.Then Sulfur dioxide concentration is gradually decreased up to 107.55 mt/d in the period from 1979 to 1997.

Total Ozone concentration is gradually increased up to 6.66 DU in the period from 1958 to 2014. Comparing the two variations of carbon dioxide and ozone level, carbon dioxide continuously increased till 2014 and at the same time ozone level after 1984 slowly decreased.

Comparing the temperature variation between two cities of Mauna loa and Opilhihale in Hawaii island, first Mauna Loa Temperature variations is gradually increased up to 1.6 ^{0}F in the period from 1957 to 2015 second Opilhihale Temperature variations is gradually increased up to 1.1^{0} F in the period from 1965 to 2010.

In Hawaiian island's six stations rainfall variations are gradually decreased. Mauna loa rainfall variation is gradually decreased up to 396.7 mm in the period from 1920 to 2012. Kauai rainfall variation is gradually decreased up to 881.2 mm in the period from 1920 to 2012. Lanai rainfall variation is gradually decreased up to 320.7 mm in the period from 1920 to 2012. Maui rainfall variation is gradually decreased up to 682.2 mm in the period from 1920 to 2012. Molokai rainfall variation is gradually decreased up to 248.4 mm in the period from 1920 to 2012. Oahu rainfall variation is gradually decreased up to 21.87 mm in the period from 1920 to 2012.

Global warming is evident in Hawaii. surface temperature is rising , rainfall and steam flow has decreased. Rain intensity has increased, sea level and sea surface have increased, and the ocean is acidifying. Scientists anticipate growing impacts to Hawaii's under resources and forests, coastal communities and marine ecology. It is time to consider adaption and mitigation strategies. There is a significant need for sustained and enhanced climate monitoring and assessment activities. There is a compelling requirement for focused research to produce models of future climate changes and impacts. Carbon dioxide, methane and nitrous oxide levels are higher than they have been in 800,000 years. Carbon dioxide concentrations are 40% higher than preindustrial times. Fresh water supply especially on atolls will decline.

Increased coastal flooding and erosion due to sea level rise will damage infrastructure, agriculture, tourism, endangered species, habitat and coral reefs. Short term sea level changes such as high tides and storm surge will compound the effects of climate induced sea level rise. As the ocean absorbs more Co_2 from the atmosphere it will become increasingly acidic threading both near shore and open ocean ecosystems. Warmer oceans will lead to increased coral bleaching. Changes in marine ecosystems will alter fish distribution and ultimately decrease fish populations. Native plants and animals will be exposed to greater environmental stressors.

In Mauna Loa all annual maximum concentrations in the seasonal cycle were recorded in the month of May, whereas the minimum concentrations shifted between September and October. The analysis is carried out for the Northern Hemisphere warm season May to October when photosynthesis exceeds respiration and for the preceding Northern Hemisphere cold season November to April when heterotrophic respiration dominates the CO_2 flux to the atmosphere.

In Our study, we find that August and September are the warmest months of the year of Hawaii. August tends to be the warmest on Kauai, the northernmost island of the State, and September the warmest on Hawaii, the southernmost island.

Due to Carbon dioxide and other volcanic gas changes, in Hawaii island annual rainfall decreased and annual temperature increased. We studied and found that volcanic gases of carbon dioxide and sulfur dioxide change the climate of Hawaii island.

Temperatures at sea level generally range from highs of 85-90 °F during the summer months and low 79-83 °F during the winter months. The surface waters of the open ocean around Hawaii range from 77 °F between late February and early April, to a maximum of 83 °F in late September or early October. Rainfall low from 1462.3 mm to1000mm in November to April. Global mean temperature is projected to increase by at least 2.7° F by the end of the century for intermediate to high future emissions scenarios also referred to as representative concentration pathways.

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