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Radiative Forcing due to the long lived Green house gases considered for Cape point in South Africa

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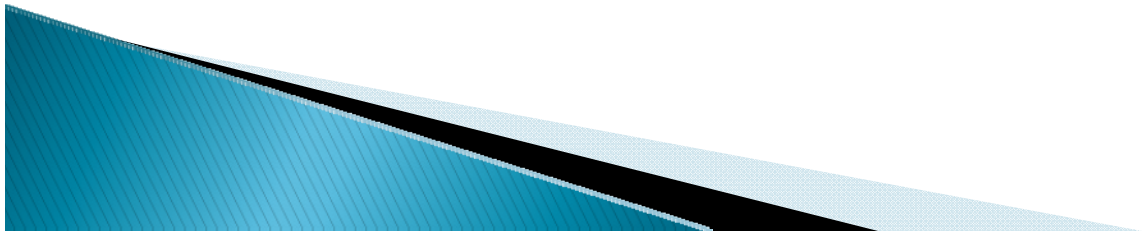
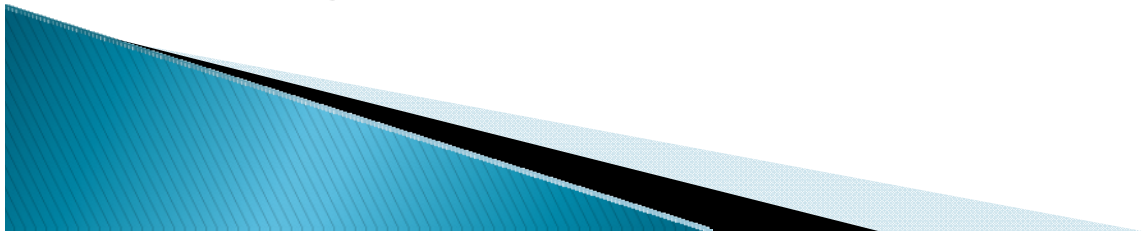
INTRODUCTION

- The Inter-governmental Panel on Climate Change (IPCC) reported that the global average surface temperature of the earth has increased by between 0.6 ± 0.20C over the 20th century, they further predicted that the global average temperature will rise by about 1.4°C- 5.8°C by the year 2100 IPCC(2001).
- The observed warming of 0.6 ± 0.2 °C is modest and, in itself is unlikely to lead to a substantial global impact. The prediction by the year 2100 creates concern on the future global warming. It is obvious that when compared to natural variability over the past 1000 years an additional 1.4-5.8 °C change in the next 90 years would be very significant.



Introduction Contd

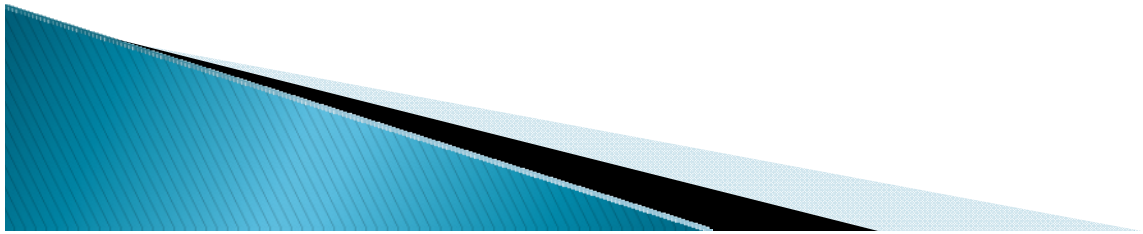
- It seems likely that most of the warming observed to date is associated with human activities releasing greenhouse gases into the atmosphere there by altering the natural green house effect with the atmosphere having excess green house gases.
- When greenhouse gases increase in the atmosphere on account of human activities, the radiative balance of the Earth is altered. The greenhouse gases absorb the longwave radiation emitted by the Earth but are transparent to the radiation coming from the sun. Hence the increase in greenhouse gases causes an increase in the net radiation at the top of the atmosphere thereby warming the earth.



Radiative forcing

- **The change in net radiation at the tropopause caused by changes in greenhouse gas or aerosol concentrations is called radiative forcing.**

- Thus Increased radiative forcing is the change in the rate at which additional energy is made available to the earth-atmosphere system over an "average" square meter of the earths surface due to increased concentration of a greenhouse gas, or group of gases, with reference to the unperturbed time (1750).

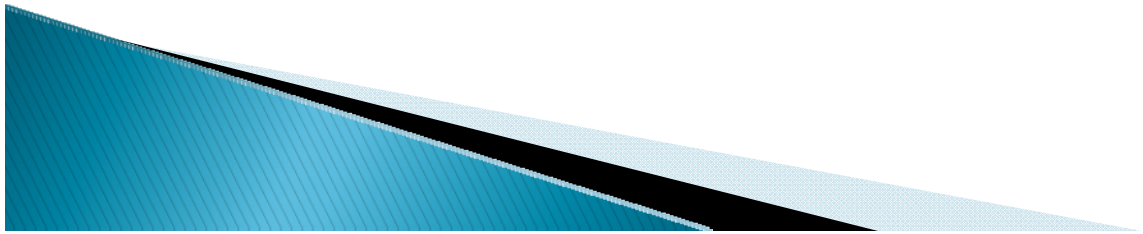


- A positive radiative value indicates warming while negative value cooling effect on the climate. Radiactive forcing is measured in Watts/m^2.

- Projections from the latest generation of climate models (Kattenberg et al., 1995)suggest that global surface air temperature will increase substantially in the future due to the radiative effects of enhanced atmospheric concentrations of greenhouse gases.
- Thus, if the temperature profile and the concentration of the greenhouse gases in the atmosphere are known, Radiative forcing can be calculated accurately. Radiative forcing depends upon how strongly a greenhouse gas absorbs radiation and the atmospheric life time of the gas.

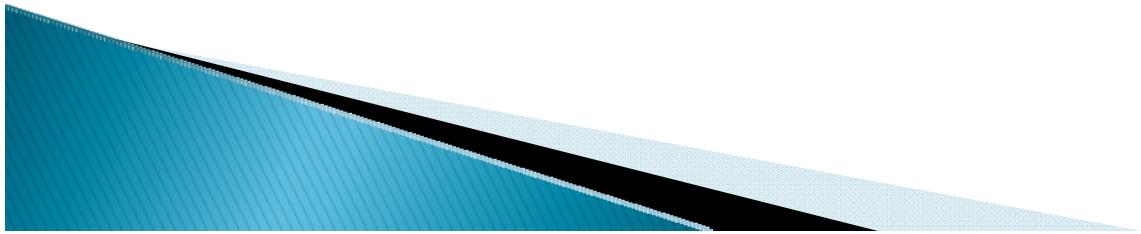
- In light of the long atmospheric lifetime of some of the green house gases namely carbon dioxide, Methane and Nitrous oxide, substantial increases in their emission during the past century, and expected increases in future emissions, the atmospheric concentration of these gases in the year 2100 will almost certainly be substantially greater than that today and the climate will continue to warm.

- South Africa is the 13th largest emitting country of CO_2 the longest living green house gas based on 2007 fossil-fuel CO_2 emissions and the largest emitting country on the continent of Africa. (Carbondioxide Information Analysis Center (CDIAC). Http://cdiac.ornl.gov)



AIM OF THE PRESENT STUDY

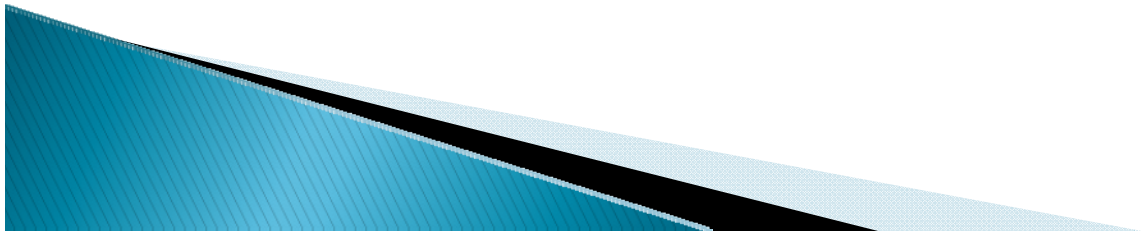
- The radiative forcing is a relatively simple quantity to calculate. Thus By computing the radiative forcings associated with changes in emissions of individual greenhouse gases, we can assess and compare the potential climate effects of different gases and make suggestions to policy decisions makers by suggesting methods of reducing the emission of such gases.



DATA AND METHOD OF ANALYSIS

- The data set used in this analysis were carbondioxide, Methane and Nitrous oxide values emitted from different sources in South Africa for eleven and fourteen years collected from the world data center for green house gases.

- To determine the total radiative forcing of the greenhouse gases, The IPCC *[IPCC 2001]* recommended expressions to convert greenhouse gas changes, relative to 1750, to instantaneous radiative forcing were used.



IPCC Methods

- CO_2 $\Delta F = \alpha \ln\left(C/C_0\right)$
- CH_4 $\Delta F = \beta\left(M^{\frac{1}{2}} - M_0^{\frac{1}{2}}\right) - \left[f(M, N_0) - f(M_0, N_0)\right]$
- NO_2 $\Delta F = \varepsilon\left(N^{\frac{1}{2}} - N_0^{\frac{1}{2}}\right) - \left[f(M_0, N) - f(M_0, N_0)\right]$

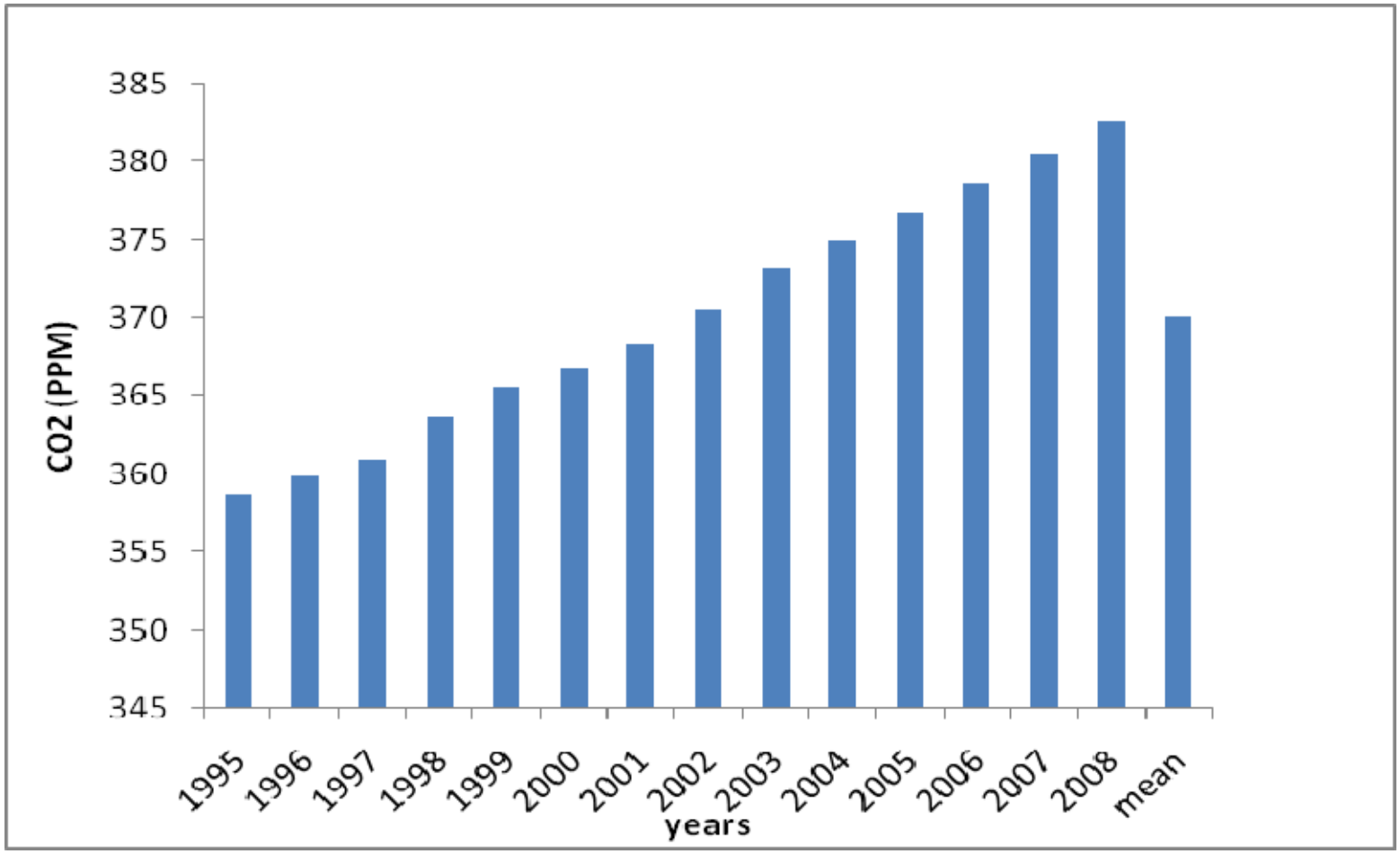
- Where

$$f(M,N) = 0.47\ln\left[1 + 2.01\times10^{-5}(MN)^{0.75} + 5.31\times10^{-15}M(MN)^{1.52}\right]$$

- C_0, M_0,N_0, are the unperturbed 1750 values
- C is CO2 in ppm, M is CH4 in ppb, N is N_2O in ppb
- C_0 =278ppm, M_0 =700ppb, N_0=270ppb
- α =5.35, β = 0.036, ε = 0.12

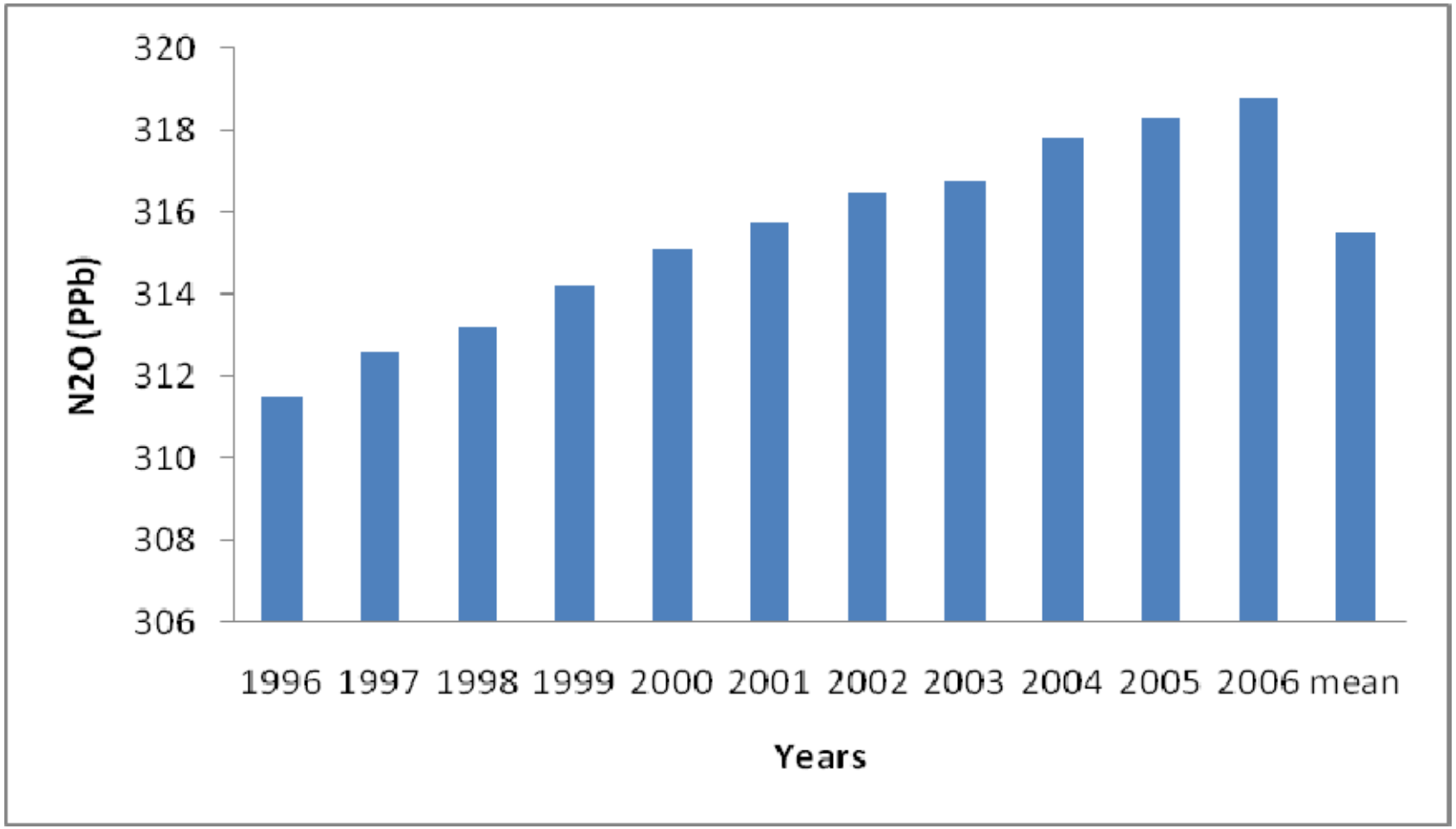
RESULTS

FIG. 1



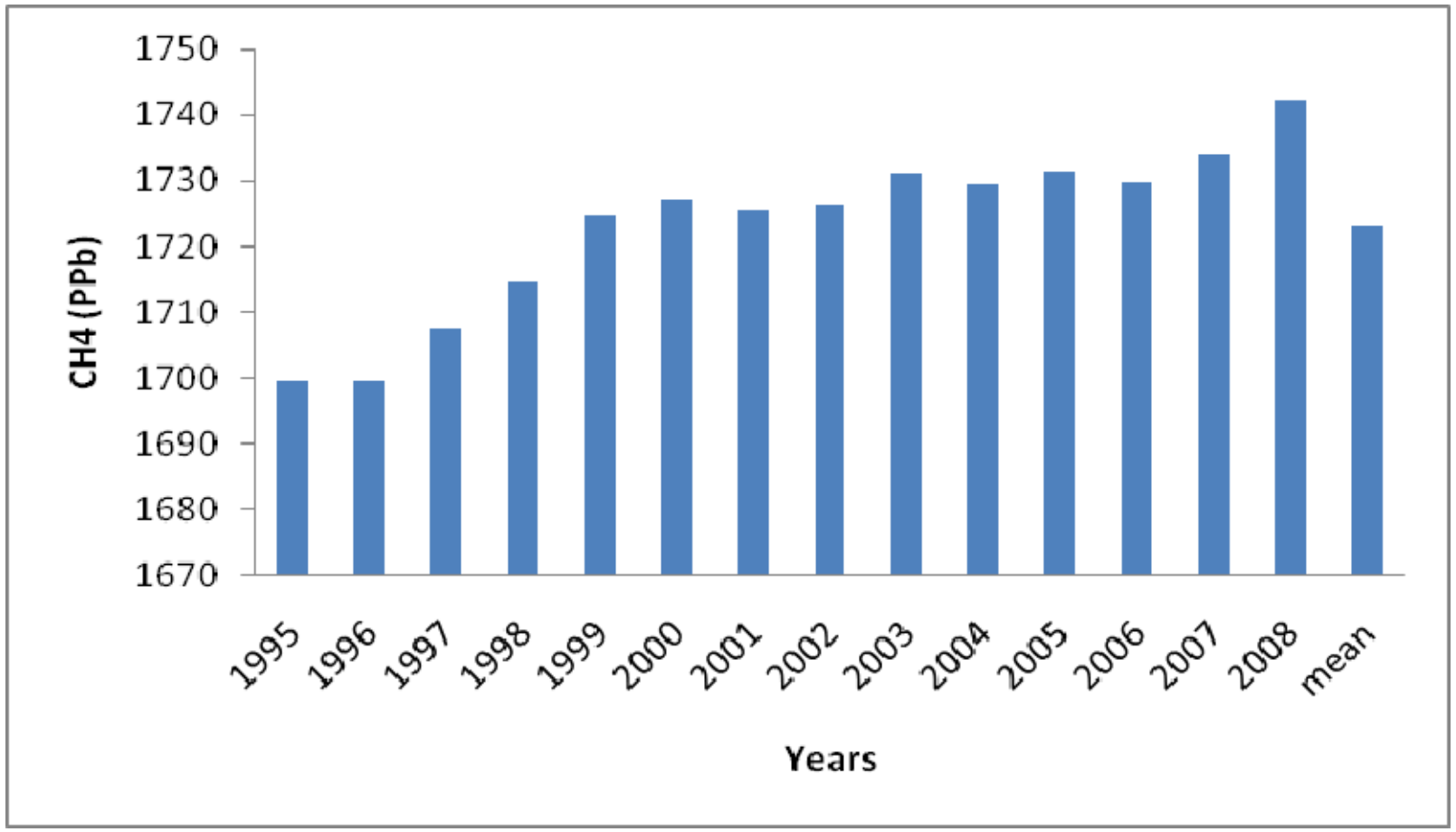
RESULTS

FIG.2

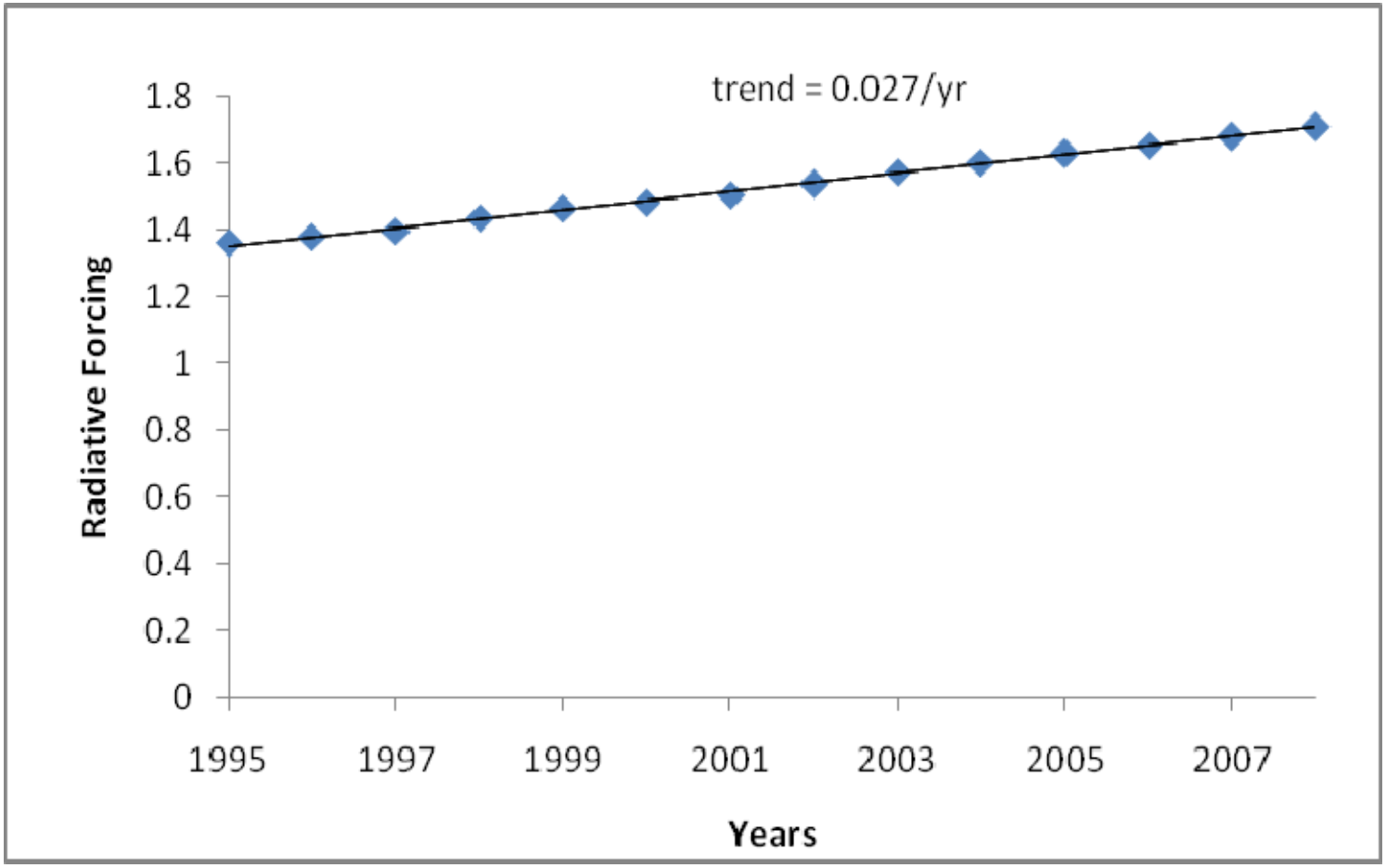


RESULTS

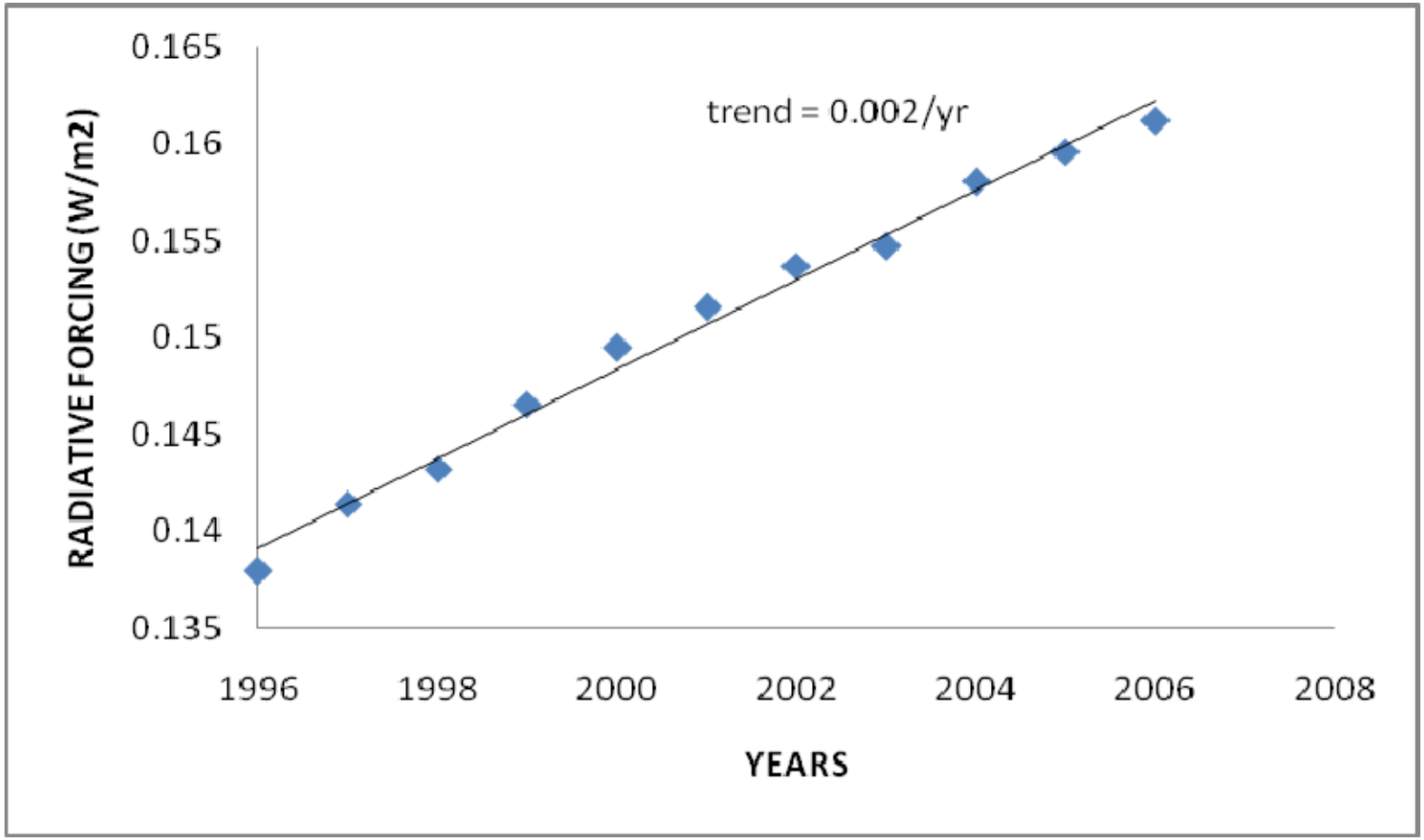
FIG. 3



RESULTS
FIG. 4 CO2 Radiative forcing/YEAR

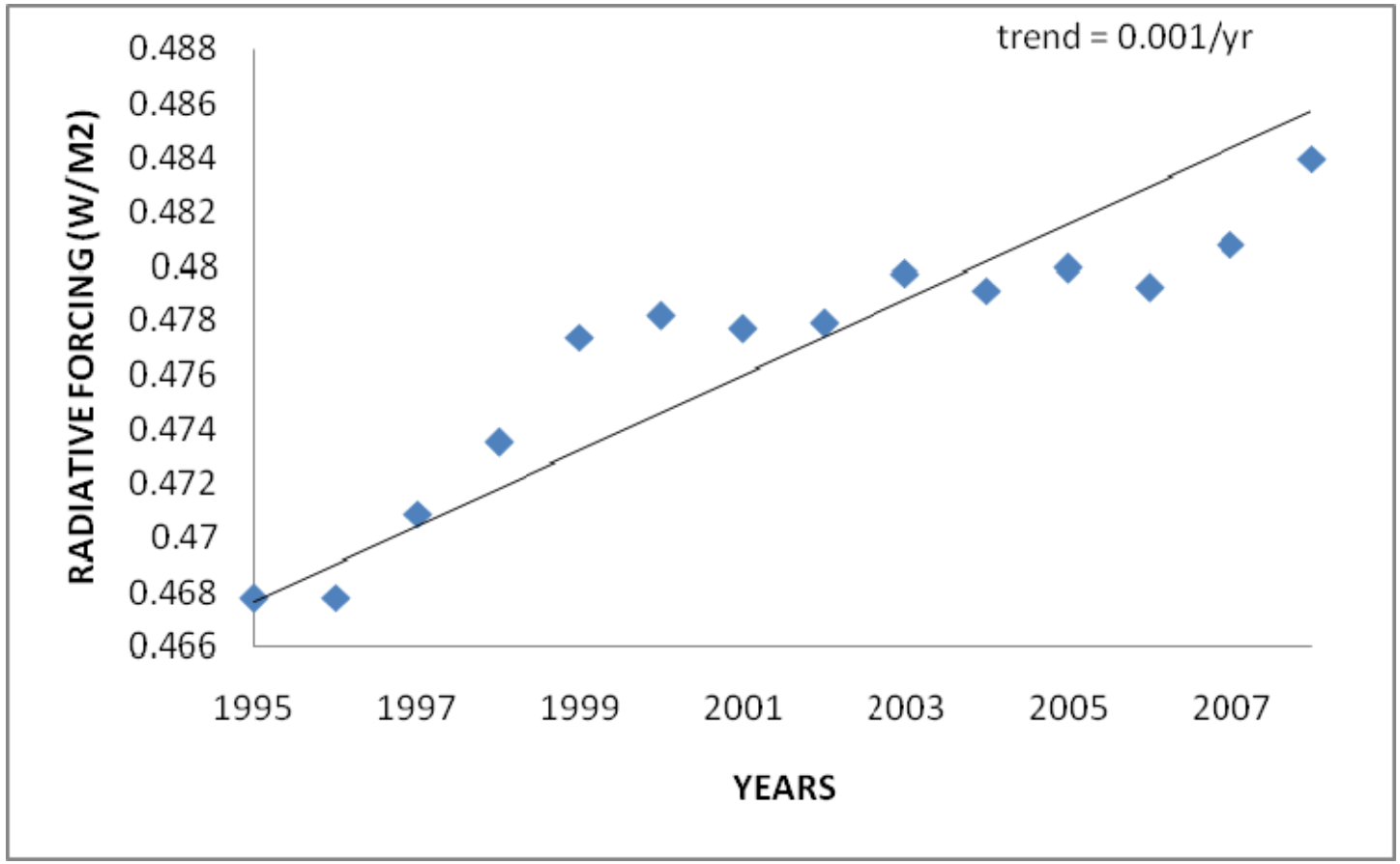


RESULTS
FIG.5 N_2O Radiative forcing/YEAR



RESULTS

FIG.6 CH4 Radiative forcing/YEAR



Discussions

- Fig. 1 displays the Variation of CO_2 with respect to years. The average value of CO_2 over the fourteen year period is found to be 370ppm this is a 33% increase from it's 1750 value.

- Fig.2 displays the variation of N_2O with respect to years. The average value for N_2O over the eleven year period is found to be 315.47ppb this is about 16.8% increase from it's1750 value

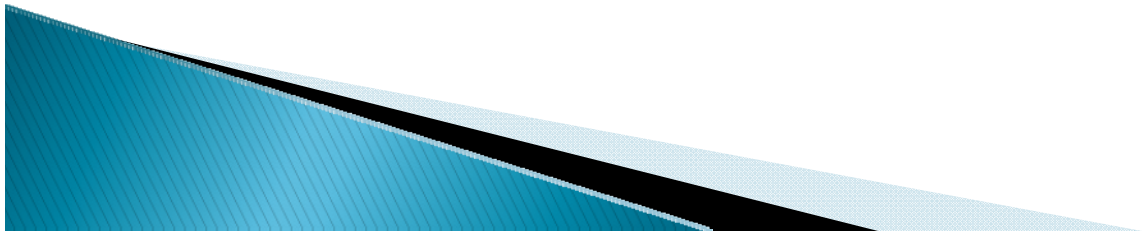
- Fig.3 displays the variation of CH4 with respect to years. The average value for CH4 over the fourteen year period is found to be 1723.12ppb which is about 146% increase from the 1750 value

Discussions CONTD

- These increases in the green house gases should indeed create a lot of concern. By the next 99 years if this trend continues.

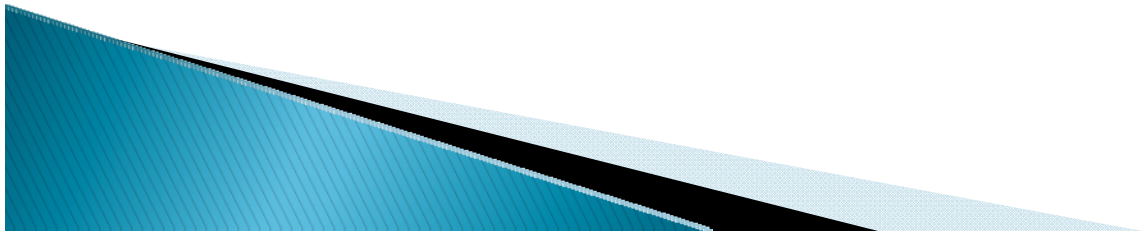
- A simple view shows that since pre-industrial times, the amount of carbon dioxide in the atmosphere has increased from 278ppm to 370ppm and resulted in a radiative forcing change of approximatly1.53W/m^2

- The amount of methane has increased from 700ppb (in pre industrial time) to 1723ppb at present and resulted in radiative forcing of approximately 0.48W/m^2



Discussions CONTD

- The amount of N_2O has increased from 270ppb (in pre industrial time) to 315.47ppb at present and resulted in radiative forcing of approximately 0.151W/m^2
- It is worth noting that the forcing by CO2 is about 3times more than that by methane and 10 times higher than that by N2O
- Hence , it can be inferred that Carbon dioxide is more important than methane or N2O as regards its impact on global warming .
- Thus attempts to significantly reduce global warming should include a reduction of carbon dioxide emissions from human activities. With the present trend in the next CO2 must have increased to 4.1w/m2, as such a reduction in emission should be sought



Ways to reduce greenhouse gases in South Africa

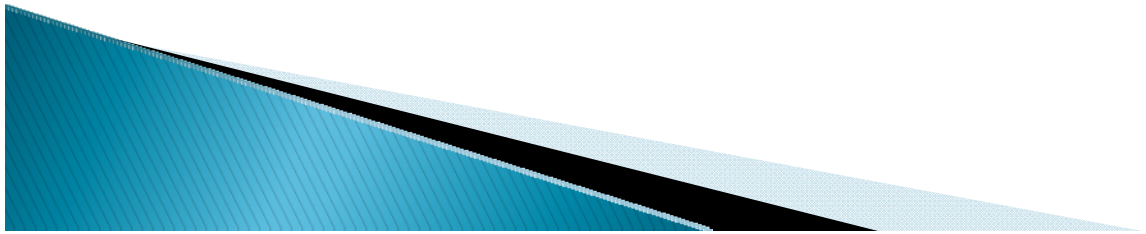
- Tree planting
- Biomass sources of energy -- fuelwood, alcohol fermented from sugar, combustible oils extracted from soybeans, and methane gas emitted by waste dumps -- can help cut greenhouse gas emissions.

- Natural gas releases less carbon dioxide per unit of energy than coal or oil. Hence, switching to natural gas is a quick way to cut emissions.

- Nuclear energy produces virtually no greenhouse gases, but public concern over safety, transport and disposal of radioactive wastes

Ways of Reduction contd

- New technologies have become available for "capturing" the carbon dioxide emitted by fossil-fuel power plants before it reaches the atmosphere. The carbon dioxide is then stored underground in empty oil or gas reservoirs, unused coal beds, or in the deep ocean.



SUMMARY

- The average value of CO_2 over the fourteen year is on is a 33% increase from it's 1750 value. And has produced a n average radiactive forcing of 1.53W/m^2
- The average value of N_2O over the eleven year period is on a 16.8% increase from it's1750 value and produced forcing of abot 0.151W/m^2
- The average value of CH4 over the fourteen year period is on a146% increase from the 1750 value and has produced a radiative forcing of about 0.48W/m^2
- The forcing by CO2 is about 3times more than that by methane and 10 times higher than that by N2O