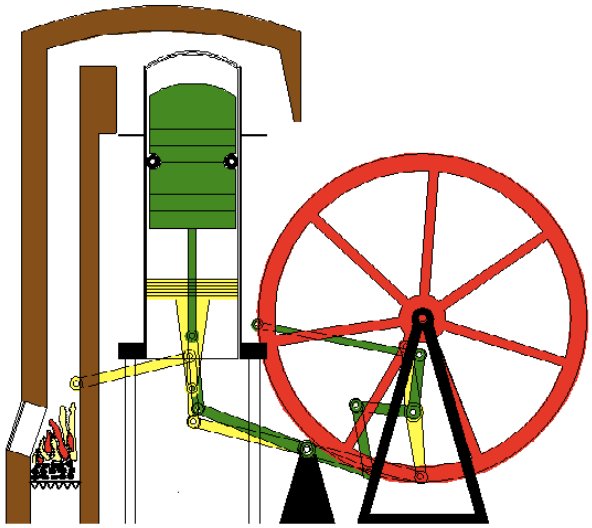
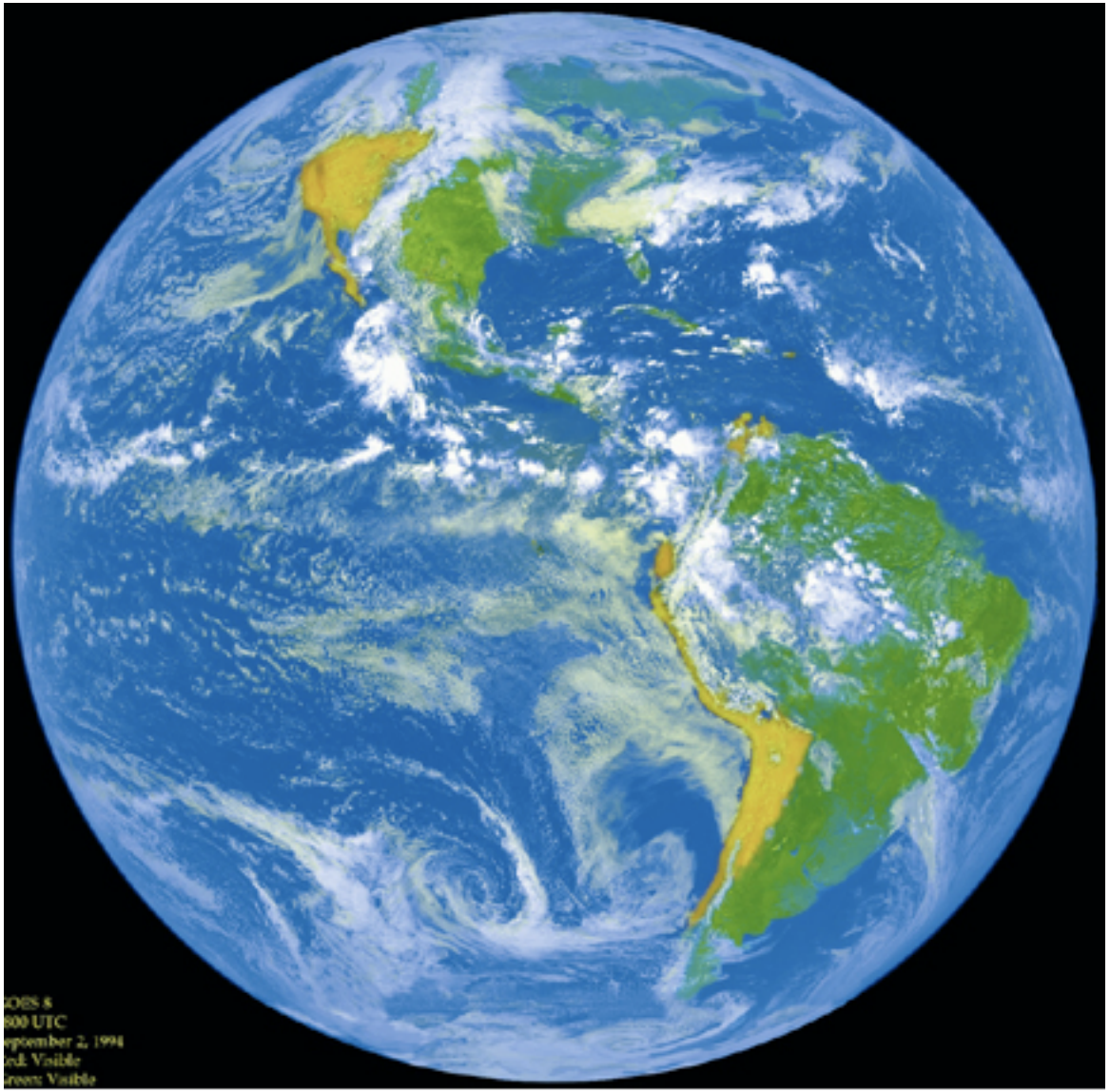
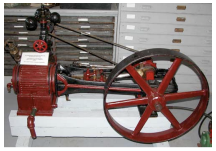
# THE ENGINE AND THE ATMOSPHERE



# The Planet

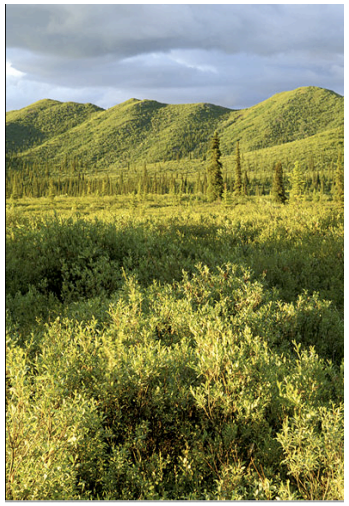


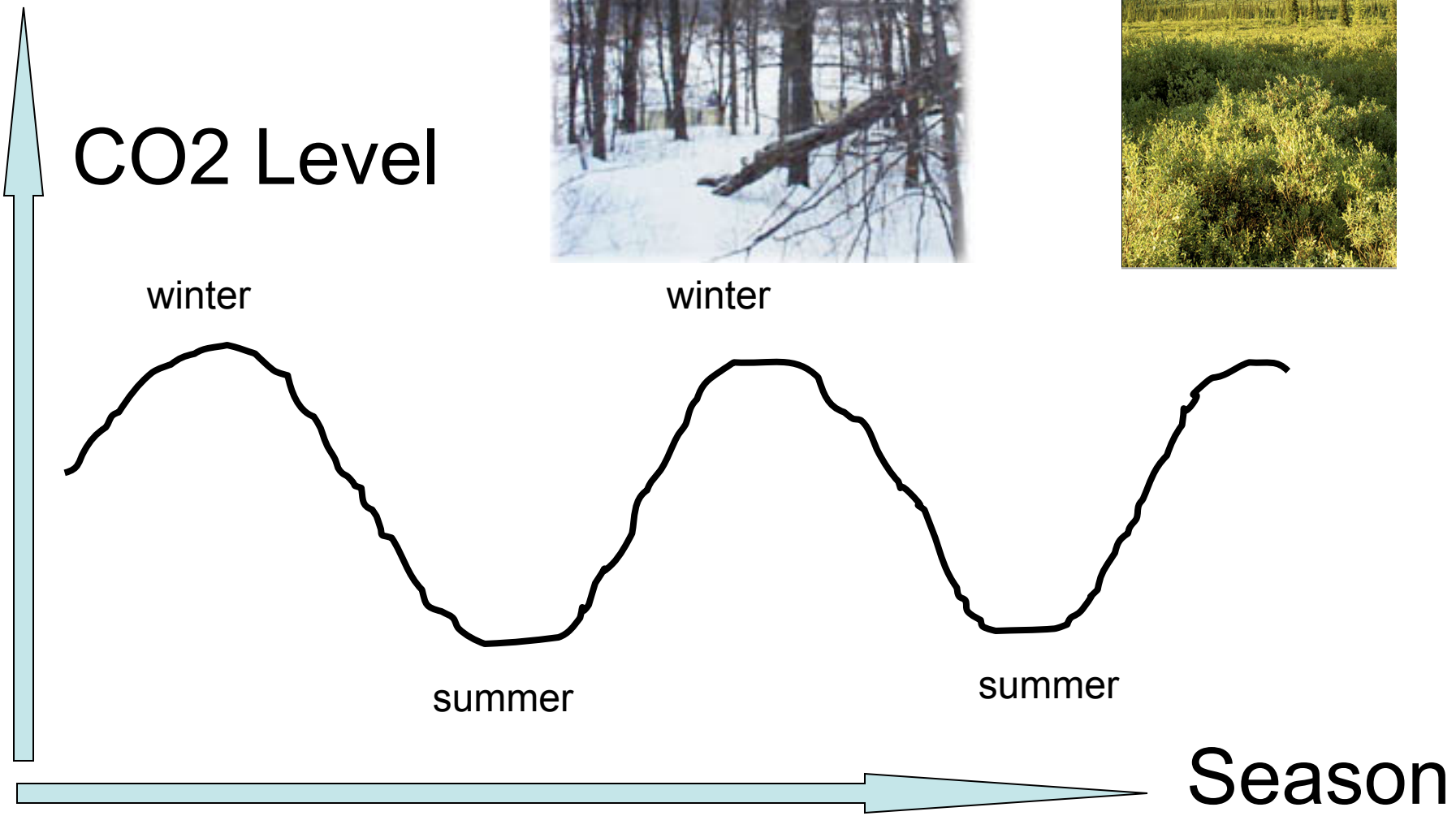
The Engine



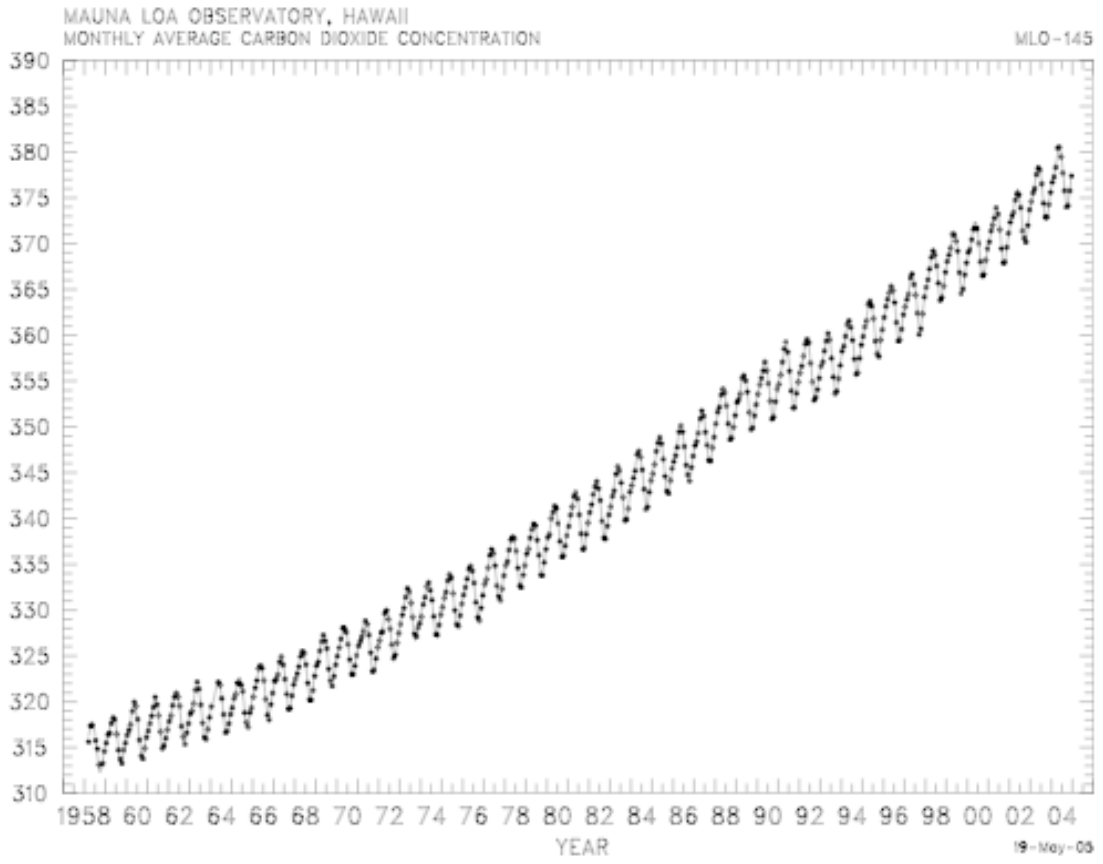
# REGULAR BREATHING

Happy Planet !





# The real planet we live on



GASOLINE OR COAL OR NATURAL GAS ALWAYS PRODUCES CARBON DIOXIDE AND WATER WHEN BURNED IN AIR

Other products too in very small amounts.
What are they?

# Burning hydrocarbon fuels MUST produce carbon dioxide and water

$$2C_8H_{18} + 25O_2 = 16CO_2 + 18H_2O$$

(2)Fuel +(25) Oxygen= (16) Carbon- + (18)Water
dioxide

PLUS ENERGY : 22 MILLION JOULES
PER POUND OF FUEL

(One teaspoon of fuel has the same energy
As a brick traveling at a speed of 2000 mph)

# Thus , 1 gallon of gasoline produces 18 lbs of carbon dioxide

RULE OF THUMB: 1 MILE~ 1 POUND OF $CO_2$.

It stays in the atmosphere for about 100years.

800 MILLION VEHICLES IN THE WORLD
BURN 2 GALLONS EACH PER DAY

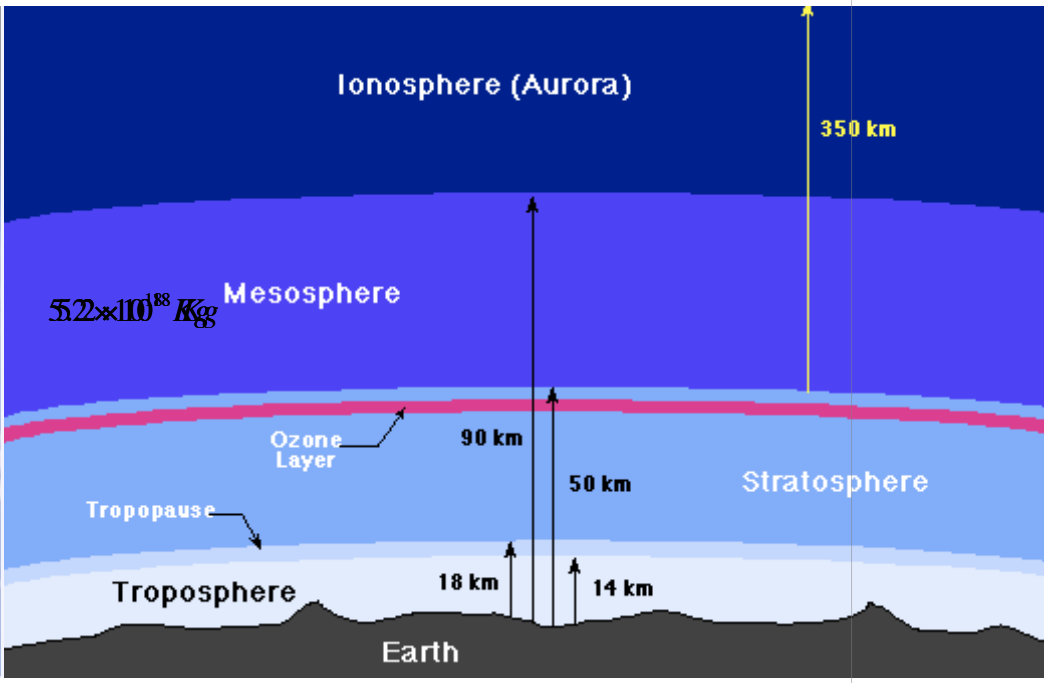
That is about 5 billion tons
(5,000,000,000,000 Kg) of carbon
dioxide per year into the atmosphere!!

# Our Atmosphere is very Thin

# The Atmosphere

- The atmosphere of the earth is mainly Nitrogen (78%) and Oxygen (21%) by volume.
- Carbon dioxide (a green house gas) is only around 0.038%.

# Mass of the Atmosphere is 5.2 thousand trillion tons

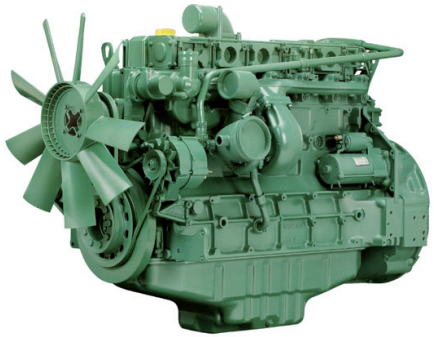



$$F = ma$$

$$m_a = p_0 A / g = p_0 4\pi R^2 / g$$

The vehicles added 5 billion tons of carbon dioxide per year.

The mass of the atmosphere is 5.2 thousand trillion tons



$$\frac{mass\ of\ co_2\ entering\ atmosphere}{mass\ of\ atmosphere}$$

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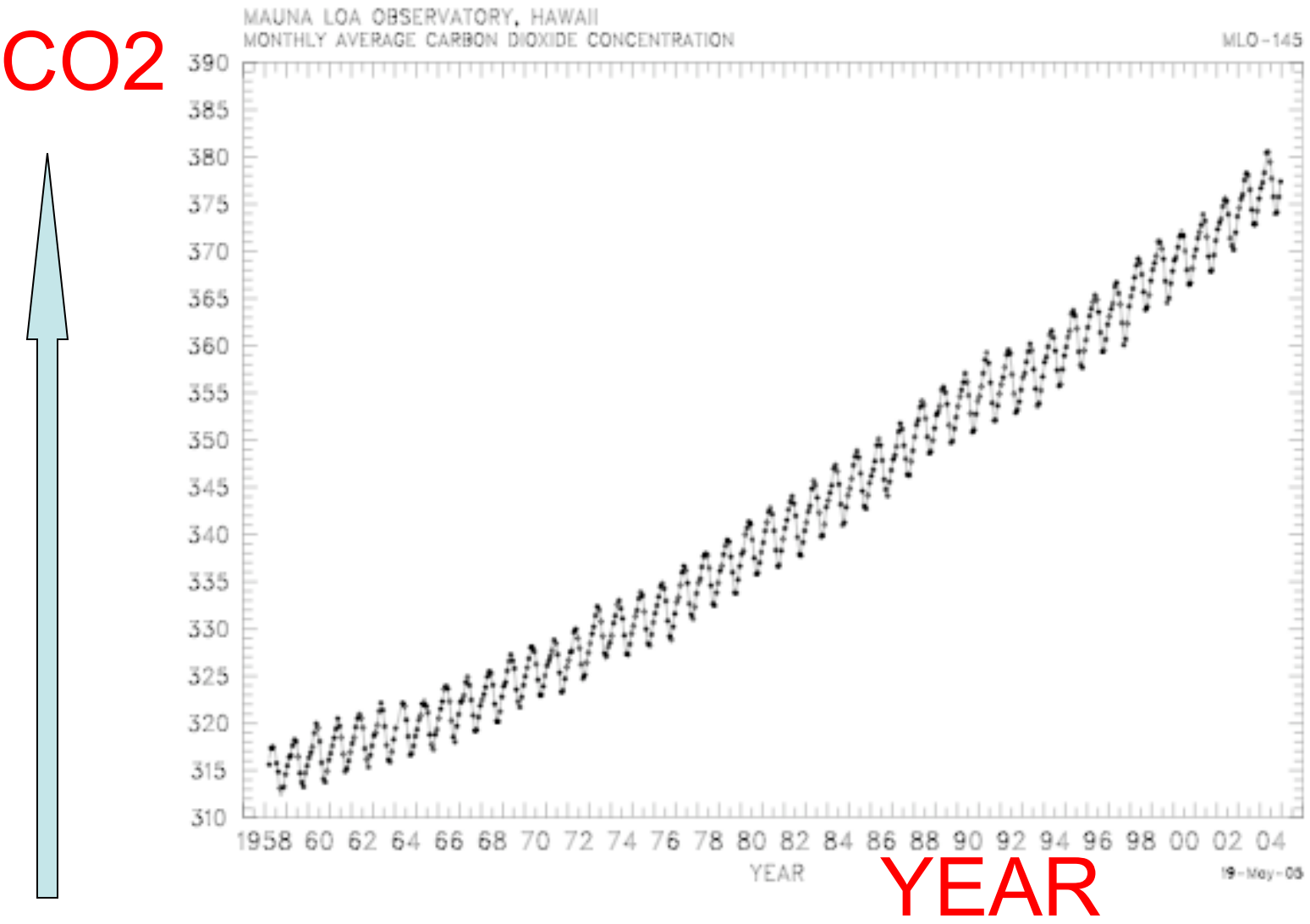
$$= \frac{5 \times 10^{12}}{5.2 \times 10^{18}} \approx 10^{-6}$$

i.e. one part of Carbon Dioxide per million parts of atmospheric mass per year.

(in volume units it is nearly 0.7 ppmv/yr)

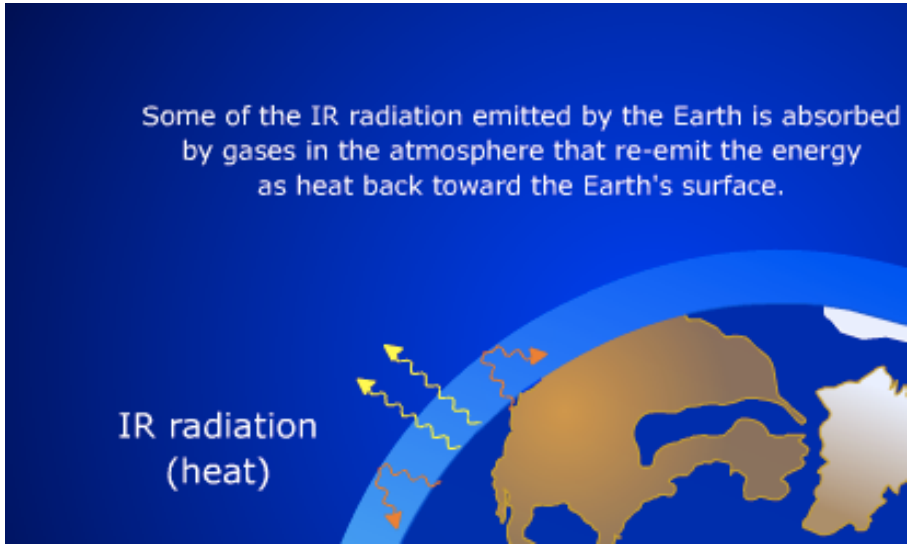
This is for vehicles only (add power plants etc. and it comes to around 2 ppmv/yr)

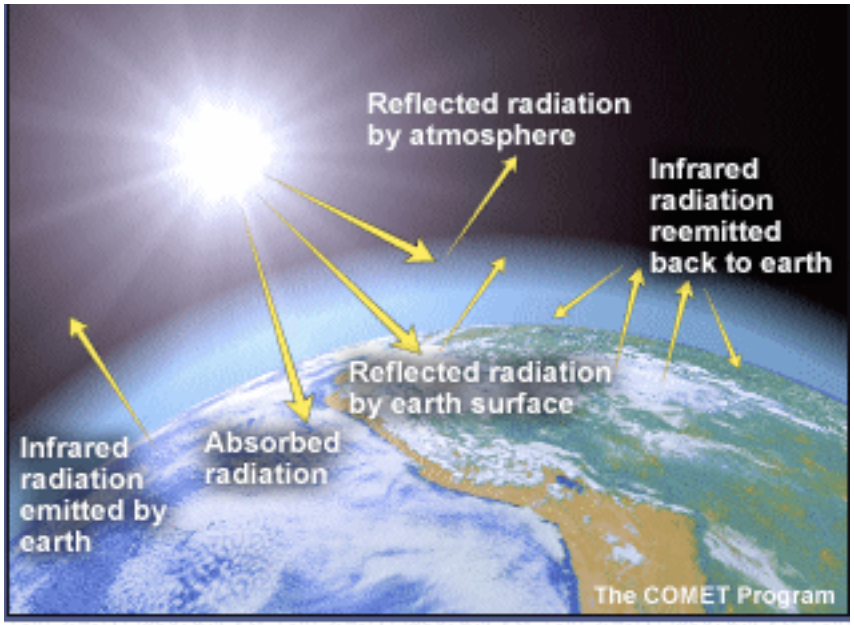
CO2


MAUNA LOA OBSERVATORY, HAWAII
MONTHLY AVERAGE CARBON DIOXIDE CONCENTRATION
MLO-145
390
385
380
375
370
365
360
355
350
345
340
335
330
325
320
315
310
1958 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 00 02 04
YEAR
19-May-05

YEAR

# Greenhouse

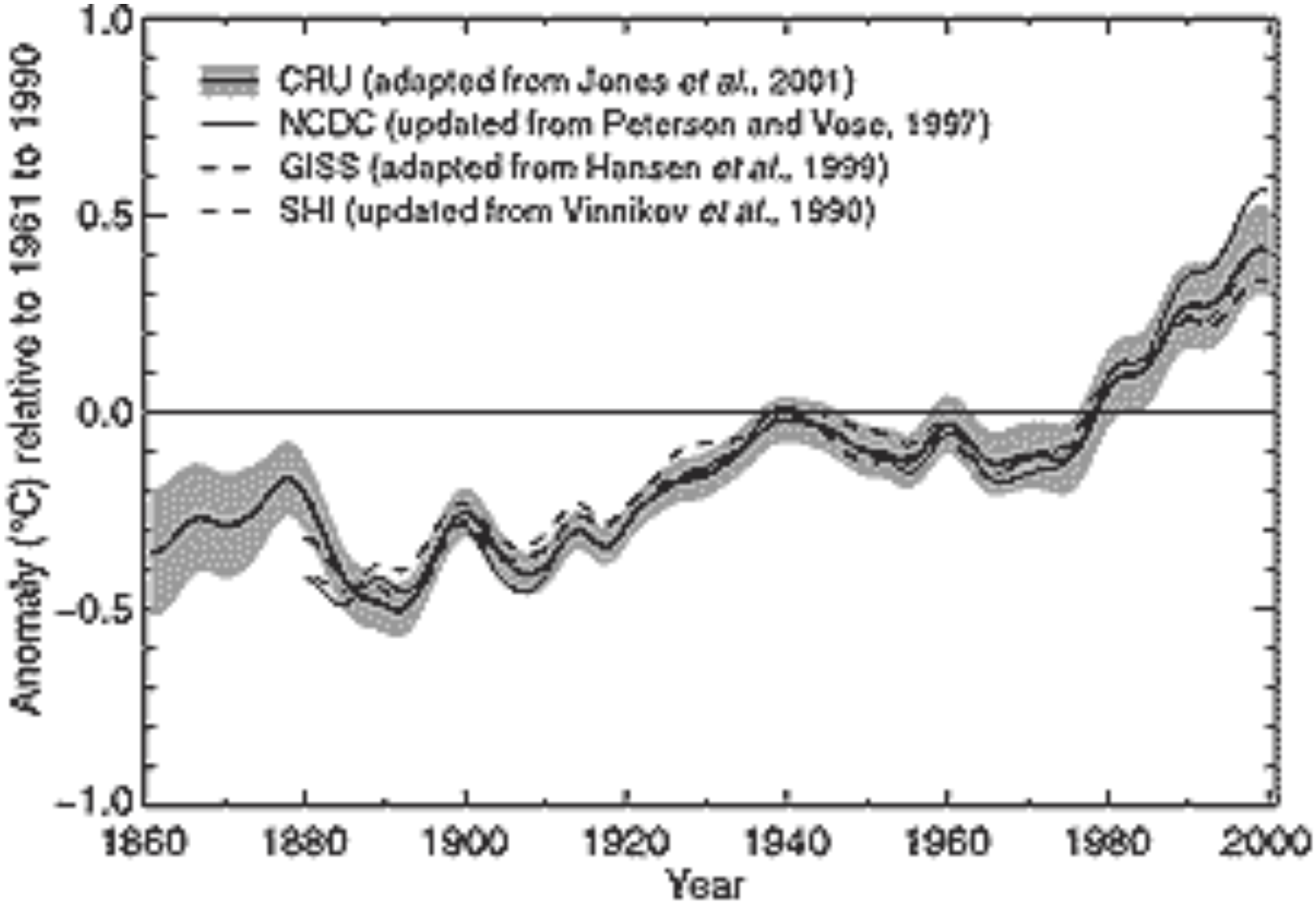

Some of the IR radiation emitted by the Earth is absorbed by gases in the atmosphere that re-emit the energy as heat back toward the Earth's surface.
IR radiation (heat)


Reflected radiation by atmosphere
Infrared radiation reemitted back to earth
Reflected radiation by earth surface
Absorbed radiation
Infrared radiation emitted by earth
The COMET Program

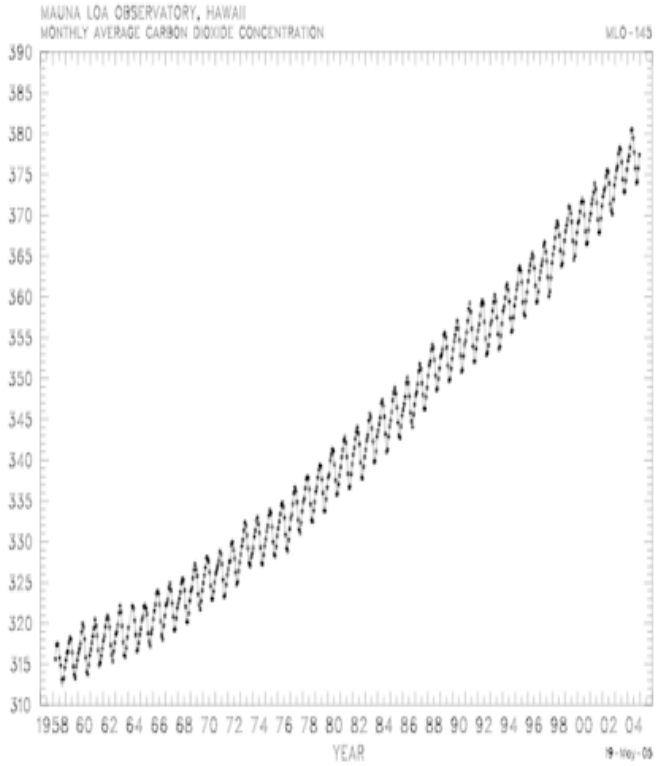
# Artists provide insight too

*Studies of these and other paintings show that cloud cover was greater in the 19th century than it it is today*

# GLOBAL SURFACE TEMPERATURE CHANGE

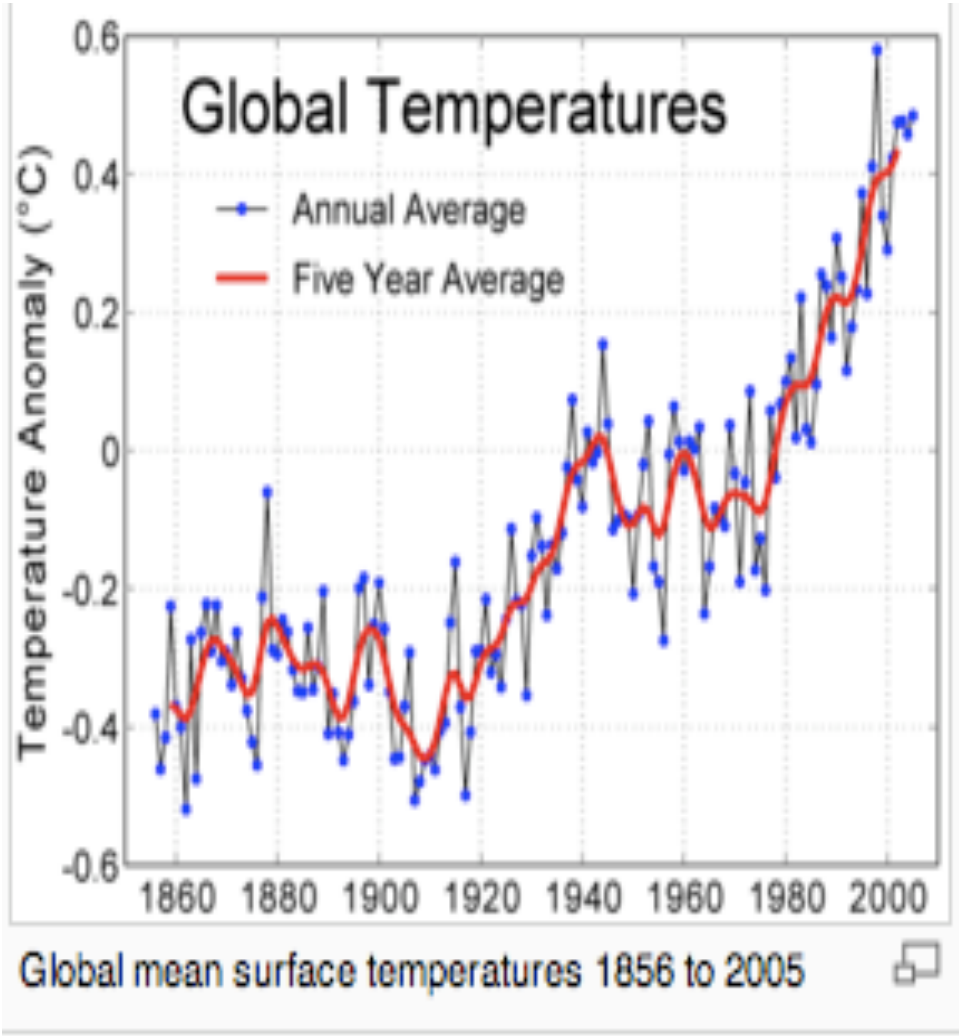


*Carbon dioxide*




*Easy to understand*

*temperature*




*Much harder to understand*

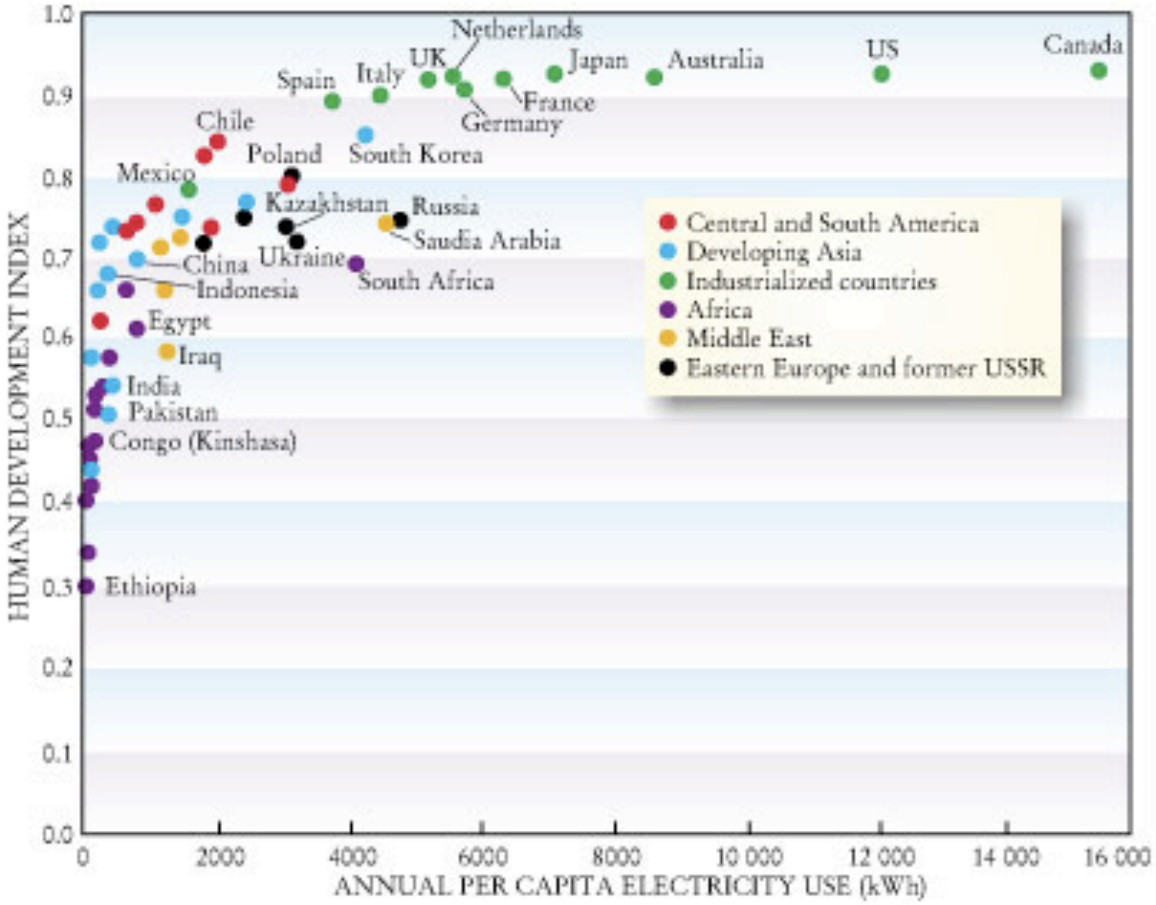
**Snow and Ice on Kilimanjaro**


# Kilimanjaro

# floods….

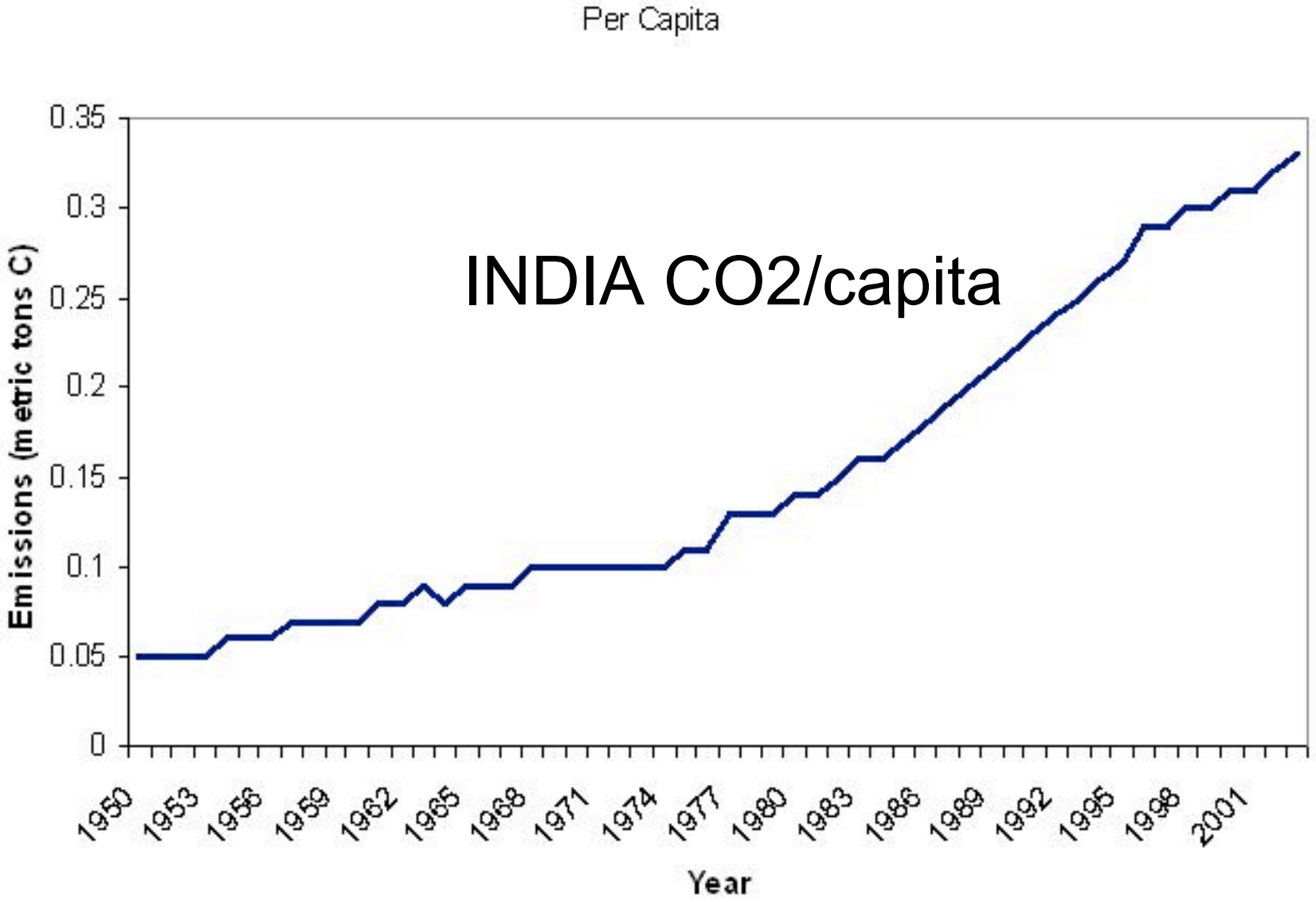
# ……and famine

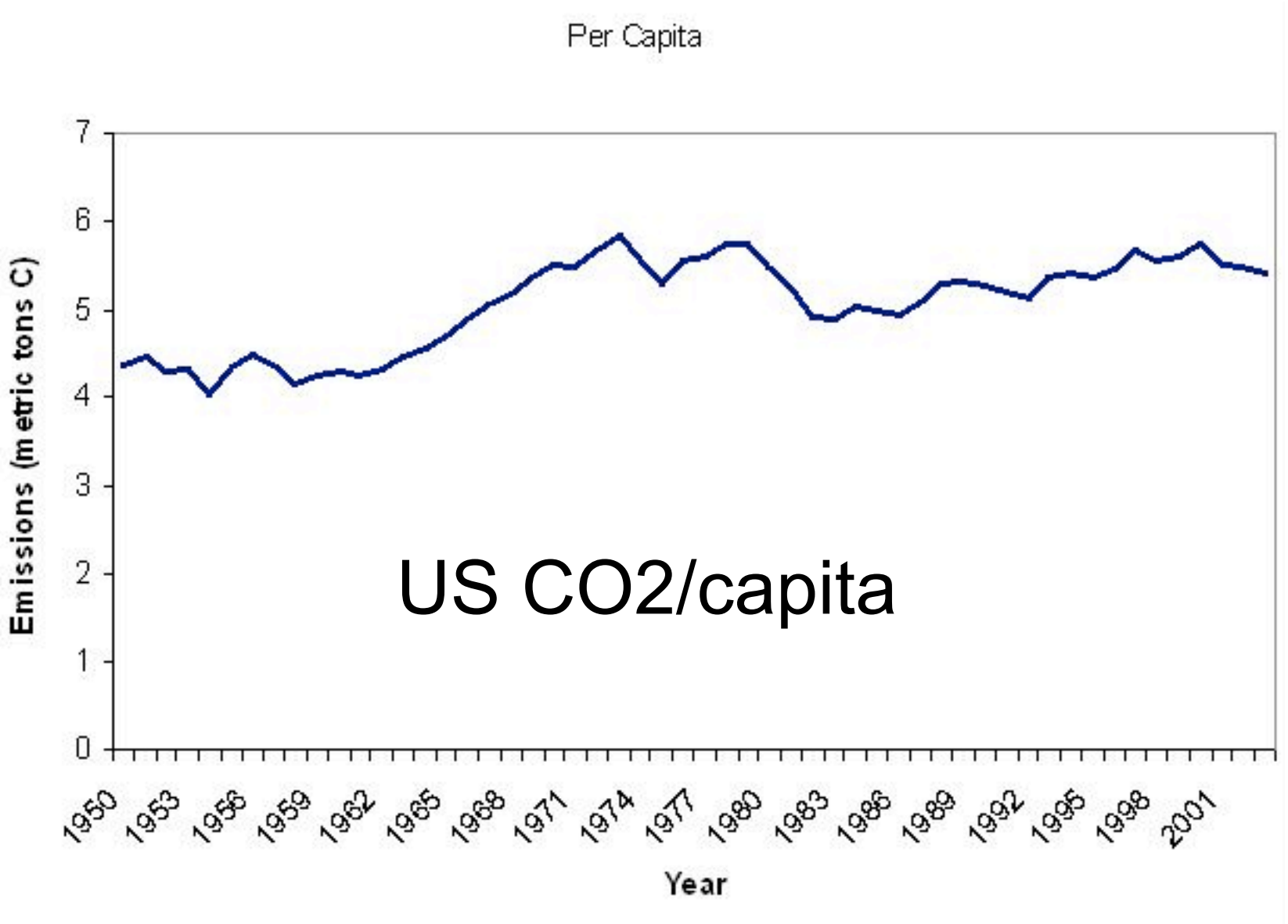

# HUMAN DEVELOPMENT INDEX VS. ENERGY USE



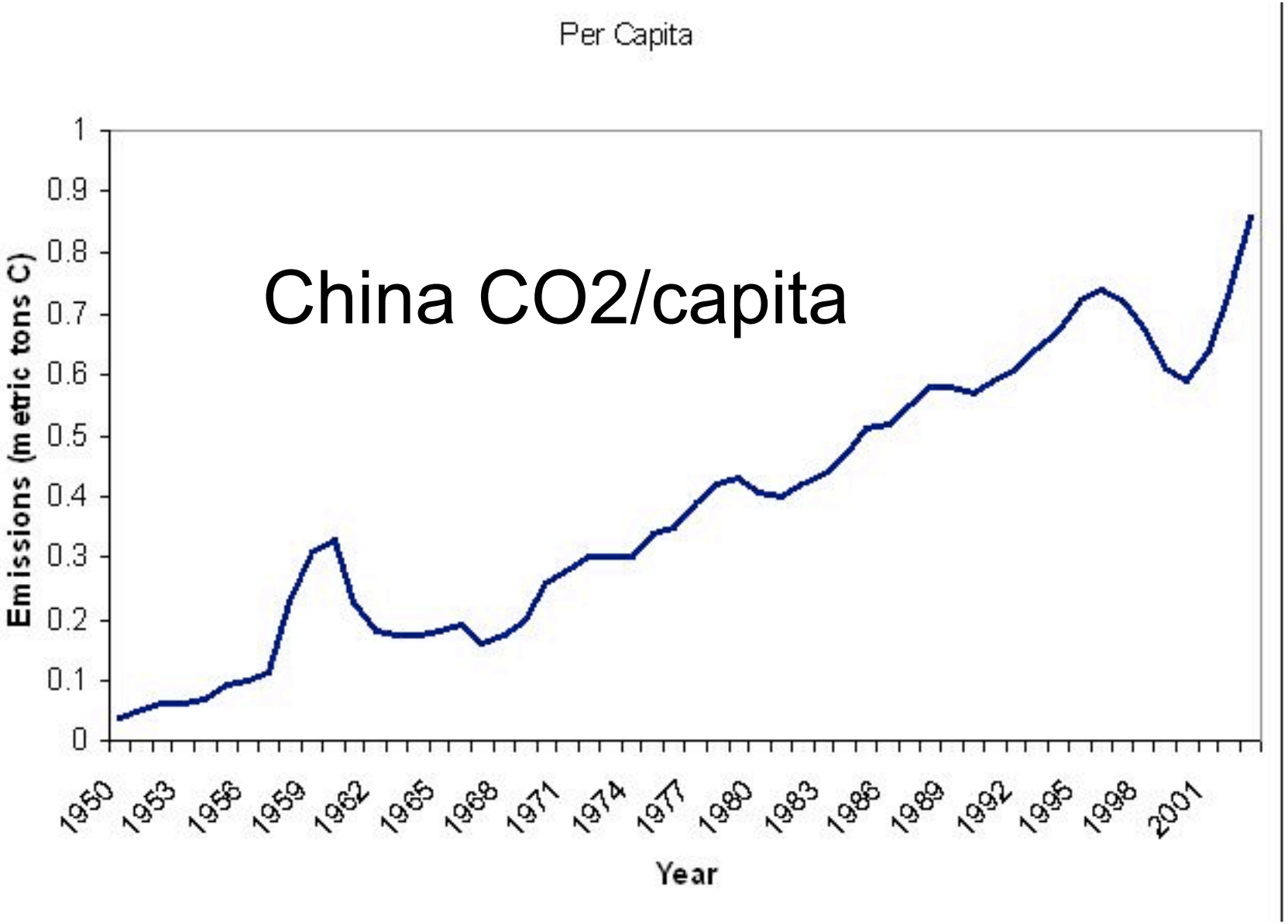

Human Development Index, a measure of basic human well-being used by the United Nations, reaches a plateau a about 4000 kilowatt hours of annual electricity use per capita. Sixty nations were analyzed, representing 90% of Earth's population. (Adapted from ref. 3.)

From A Pasternack LLNL Rep. No. UCLR-ID 140773 (Oct. 2000)


Per Capita
INDIA CO2/capita
Emissions (metric tons C)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1950
1953
1956
1959
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
Year




Carbon dioxide Information Center cdiac.ornl.gov

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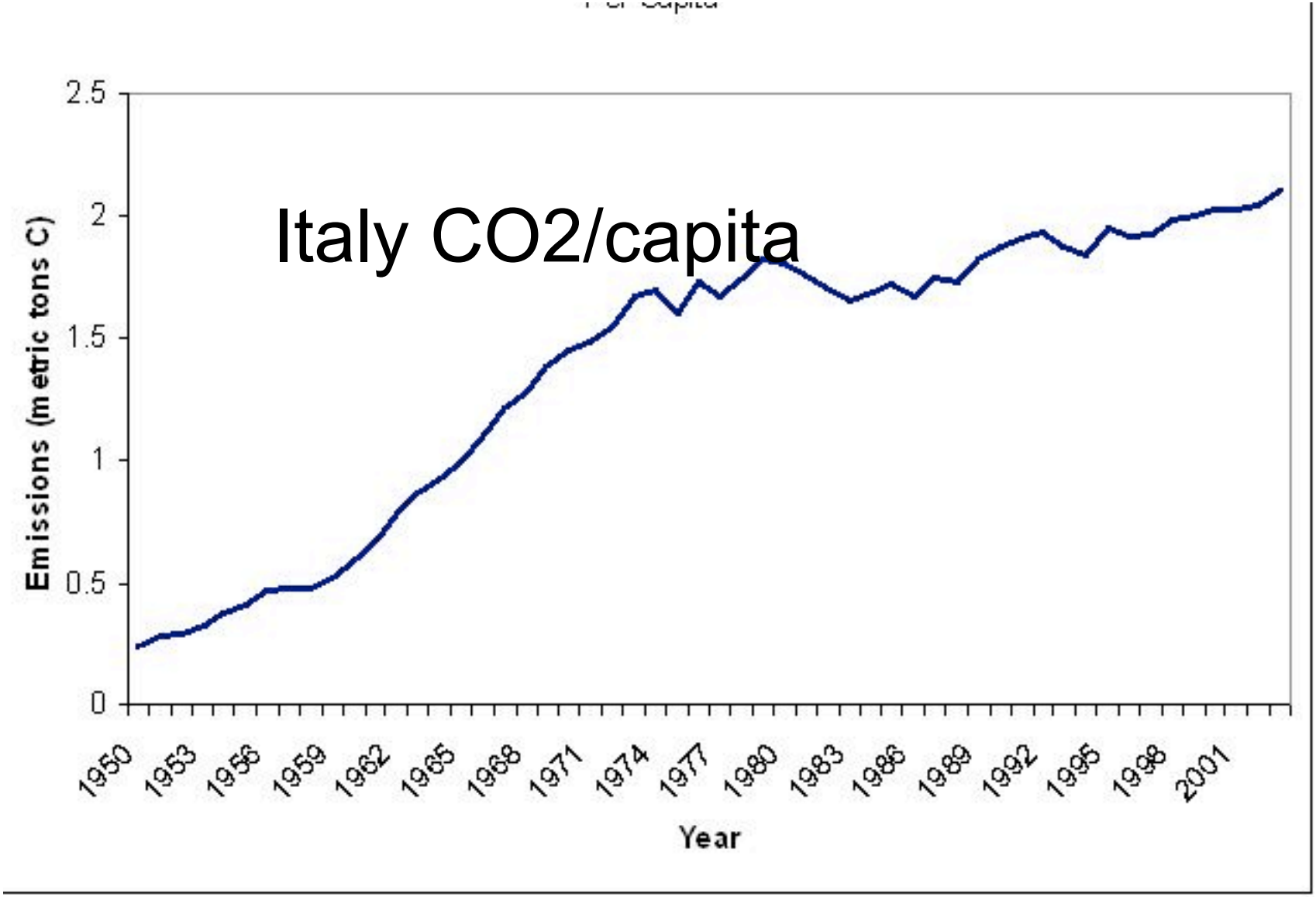


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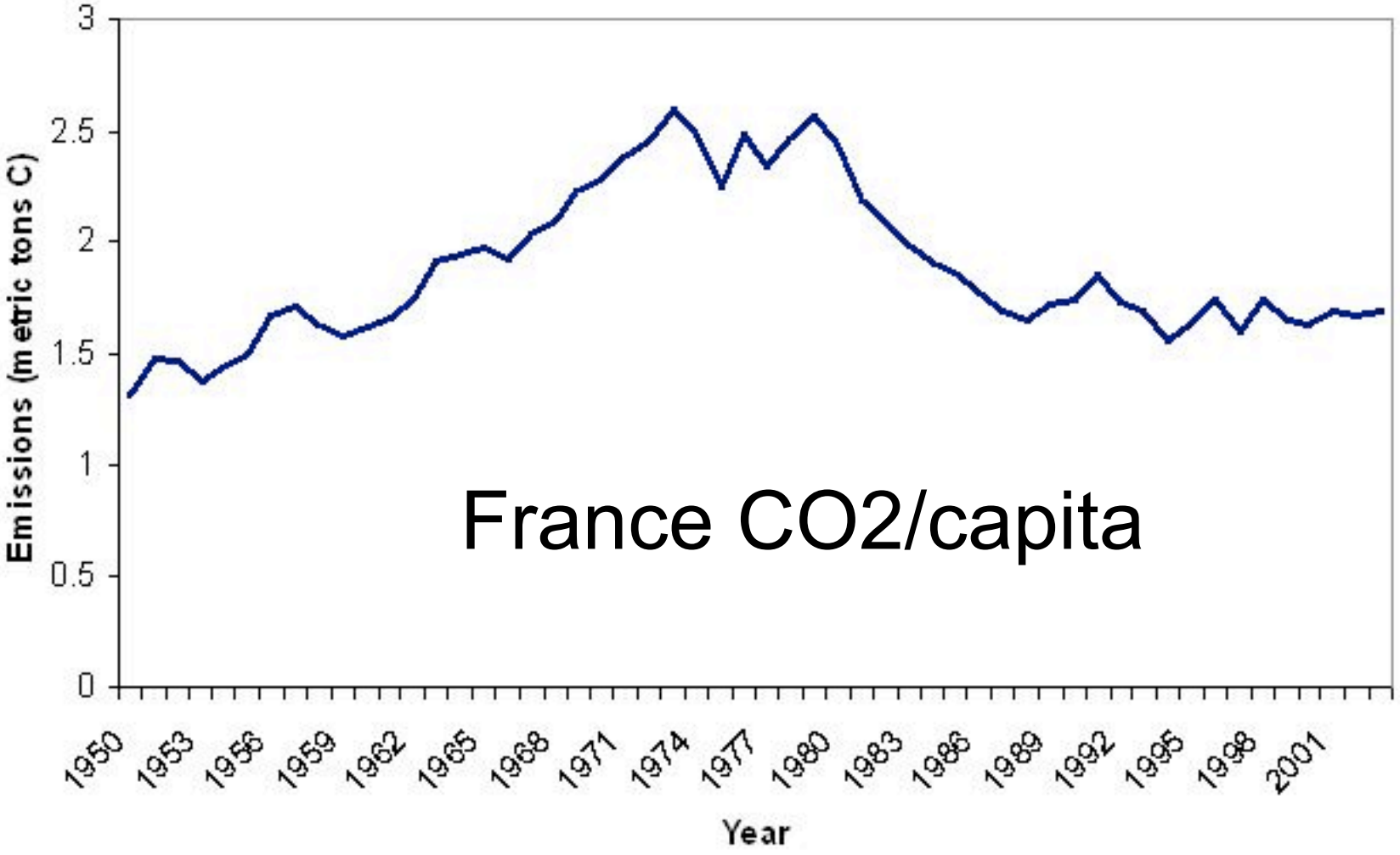


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$CO_2$ and global warming are due to:

Population increase (demography, geography,economics,sociology,psychology,history….)

Increase in standard of living (development,sociology,economics,business,engineering ,government…… )

The amount of carbon we use to produce the energy(engineering, chemistry,physics,materials science…….)

The energy usage per unit of GDP (business, economics,engineering,operations research……..)