What are the consequences of our pollution ?

A major consequence: acid rain

ACID RAIN

* **Involves deposition of aqueous acids, acidic gases and acidic salts**

- Acid deposition has 2 parts: wet and dry
- Wet deposition refers to acidic rain, fog & snow
- Dry deposition refers to acidic gases and particles
- Half of the acidity in the atmosphere falls back to earth through dry deposition

* **Acid rain is a regional air pollution problem**

- Canada, & North Western USA are worst affected
- Average pH of rainfall recorded in Toronto in Feb. 1979 is 3.5. In 1989 fog in Los Angles had a pH as low as 2.2. Most acidic rain fall in US in Wheeling West Virginia is 1.4.
- Precipitation of clean atmosphere may have 5.6 pH.

What are the origins of ACID RAINS ?

Human activities are at the origin of important quantities of polluting items that are thrown out in the atmosphere which contibutes to acid rain .

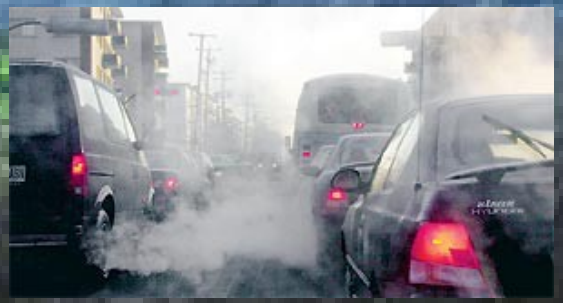
Combustion of fossil fuels like Coal, Firewood etc which produces air pollutants like sulphur dioxide and nitrogen dioxide.

Gases which are at the origin of acid rains are :

Sulphur dioxyde

Carbon dioxyde

Nitrogen oxide




Acid rains appear when :
Sulphur dioxyde
Nitrogen oxide
Release sulphuric acid and nitric acid !
They move up into the air and are released as acid rains

Gas phase chemistry

In the gas phase sulfur dioxide is oxidized by reaction with the hydroxyl radical via an intermolecular reaction:

$$SO_2 + OH\cdot \rightarrow HOSO_2\cdot$$

which is followed by:

$$HOSO_2\cdot + O_2 \rightarrow HO_2\cdot + SO_3$$

In the presence of water, sulfur trioxide(SO_3) is converted rapidly to sulfuric acid:

$$SO_3\,(g) + H_2O\,(l) \rightarrow H_2SO_4\,(l)$$

Nitrogen dioxide reacts with OH to for

$$NO_2 + OH\cdot \rightarrow HNO_3$$

What are the consequences of acid rains on the environnement ?

On top of the disastrous consequences on our health, the different components of our environment can be affected by acid rains :

- ***water***
- ***ground***
- ***materials***
- ***plants***

Consequences on water and the wildlife of lakes

The water looks more transparent because plankton has disappeared

Fish can't breathe properly, different species disappear

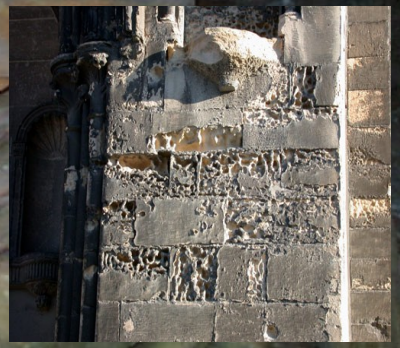
Consequences on materials

The acid effect of acid rains prompts :

The corrosion of metal items →

The erosion of railways →

Stone disintegration into dust →



Unfortunately monuments are not spared by pollution !!

IMPACTS OF ACID RAIN:

a) Acidification of soils:

- Acid rain increases acidity of soil, lakes, streams etc.
- Lower pH can mobilize or leach out important minerals and release heavy metals in $Al3^{+}$, Cd, Pb etc. beyond safe limits
- This affects the land & aquatic flora & fauna especially fish
- Thousands of lakes across the world have died i.e. they have lost all the fish population and much of other organisms

b) Phyto toxicity:

- Directly from excessive concentration of acid and acid forming gases particularly SO_2 & NO_2
- Indirectly from $Al3^{+}$ liberated from soil
- Acid rain, acid fog and acid vapors damage the surfaces of leaves and needles, reduce a tree's ability to withstand cold & inhibit plant germination and reproduction.
- Tree Vitality and regenerative capability are reduced

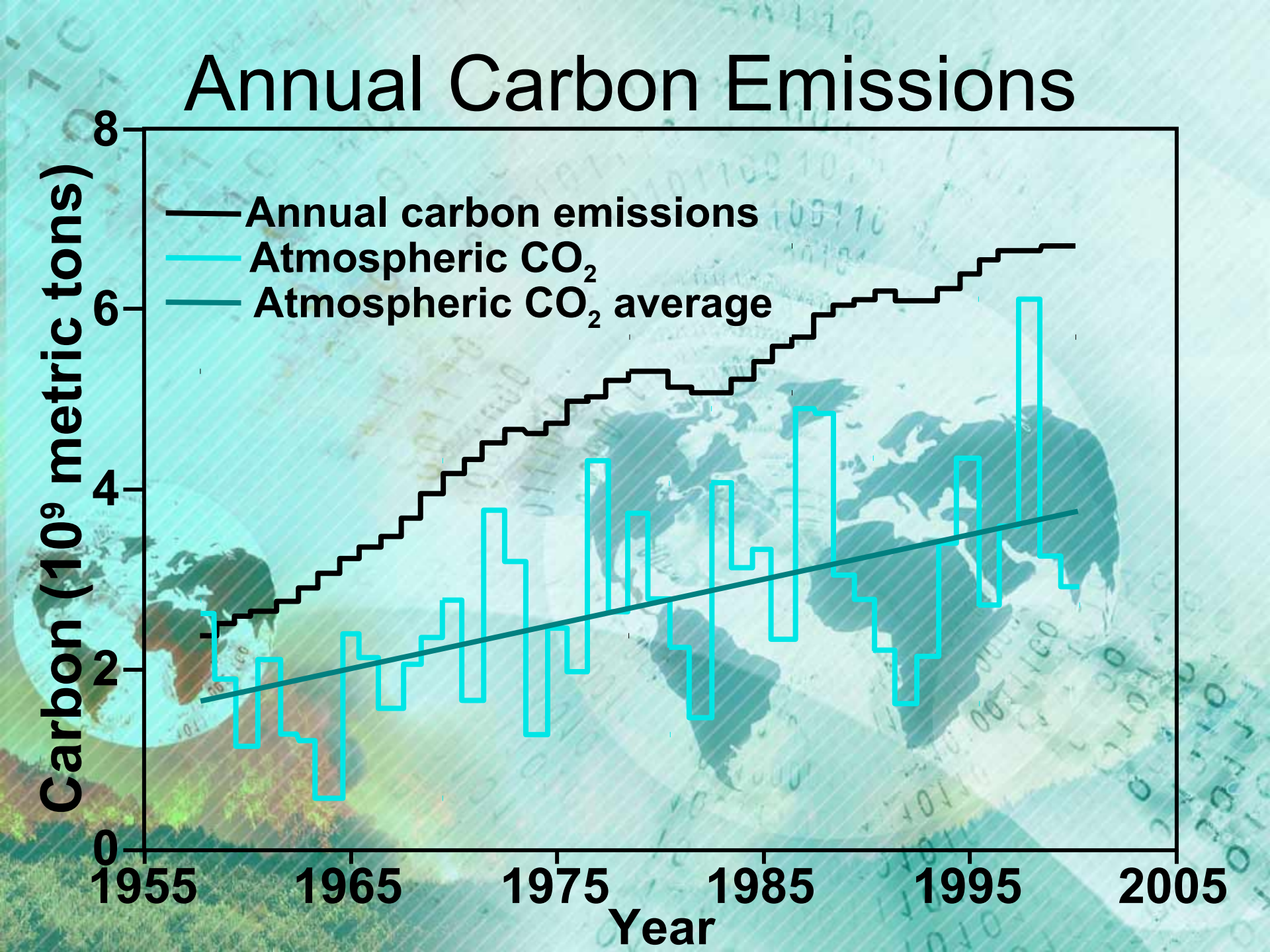
GLOBAL WARMING

Impacts, Solutions, Actions

Introduction

- Is the world really getting warmer?
- What are greenhouse gases and greenhouse effect?
- What are the actions of mankind to blame for earth's temperature increase?
- What are the Impact of an increase in atmospheric CO_2 on greenhouse effect ?
- What can/should be done about these issues?

Annual Carbon Emissions



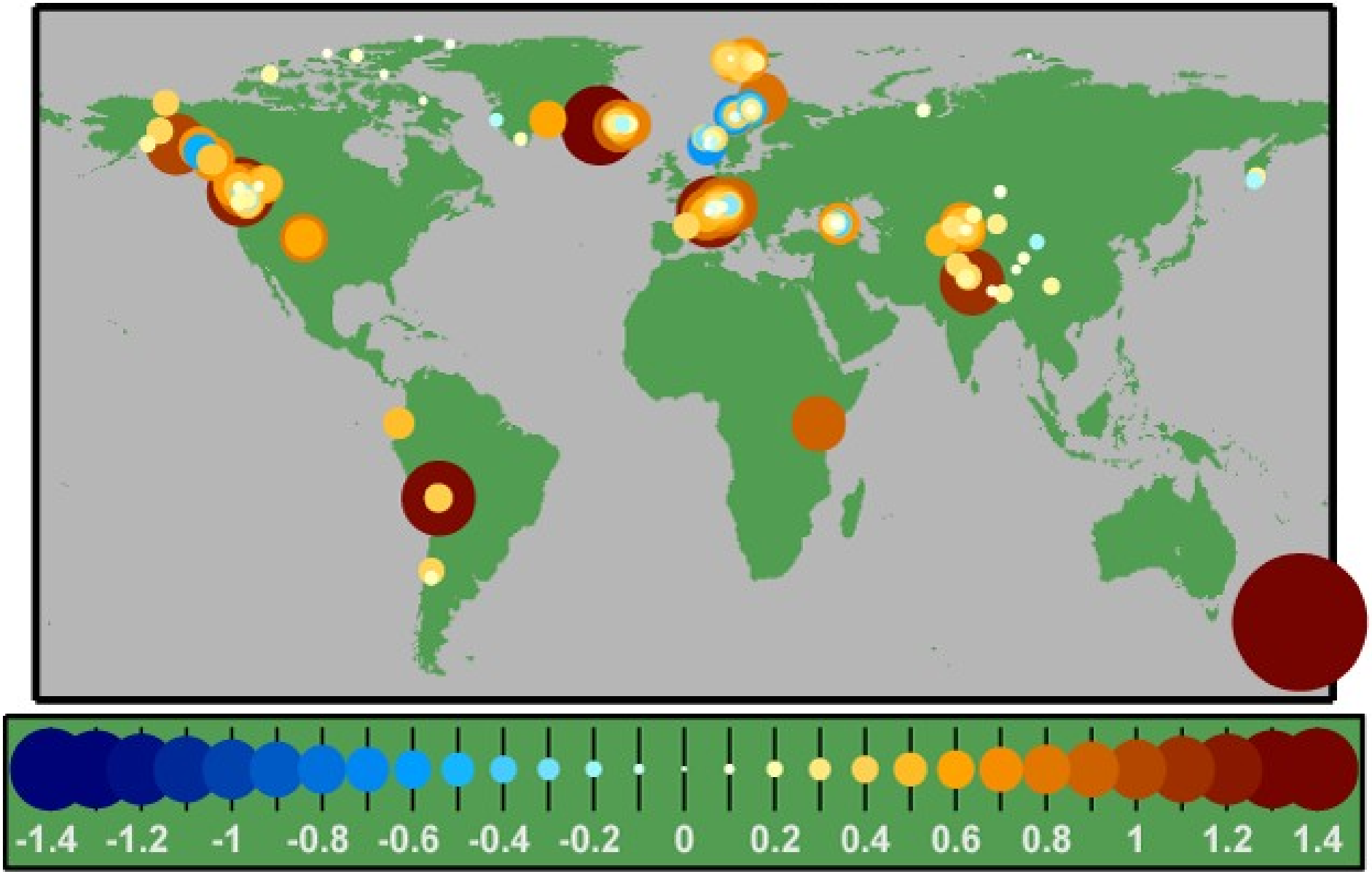
Future Carbon Dioxide Levels

- Increasing CO_2 emissions, especially in China and developing countries
- Likely to double within 150 years:
  - Increased coal usage
  - Increased natural gas usage
  - Decreased petroleum usage (increased cost and decreasing supply)

Observed Parameters

- Highest earth's temperature in last 30 years
- Variations in summer and winter season
- Variations in rain periods
- Unexpected rains, storms
- Melting of snow, rise in ocean level to one feet in last 30 years
- Depletion of glaciers
- Unexpected climate changes

Mountain Glacier Changes Since 1970

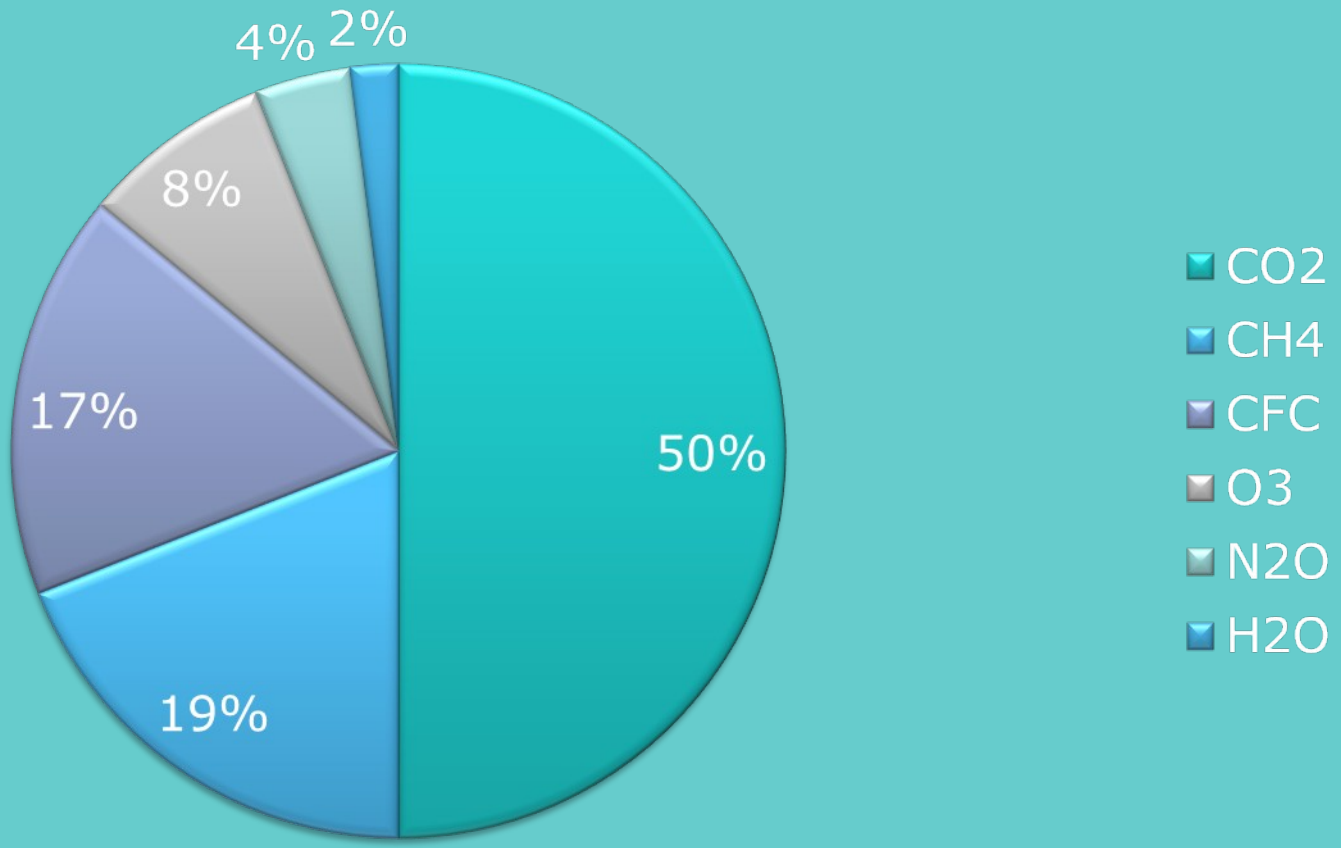


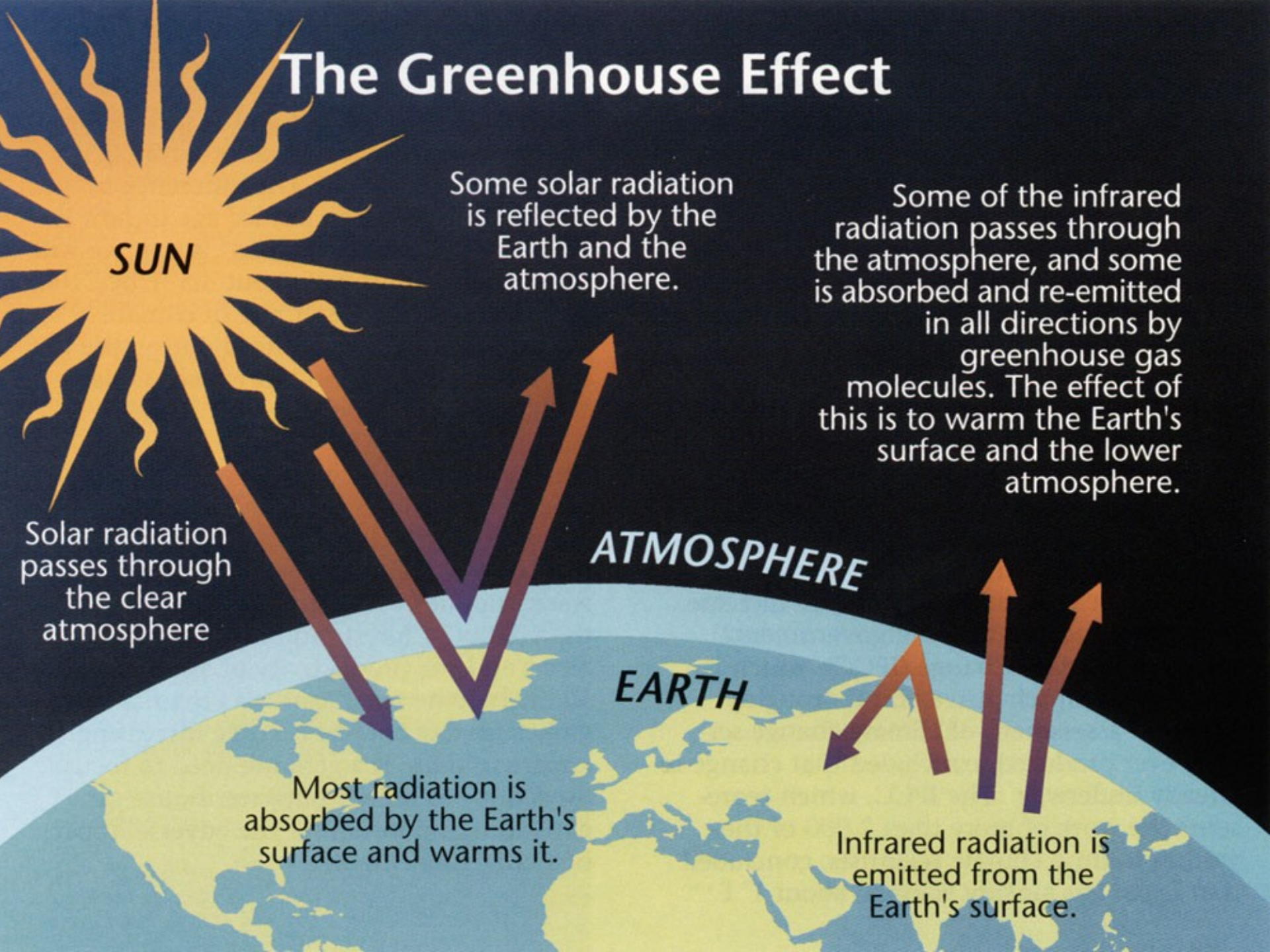
Effective Glacier Thinning (m / yr)

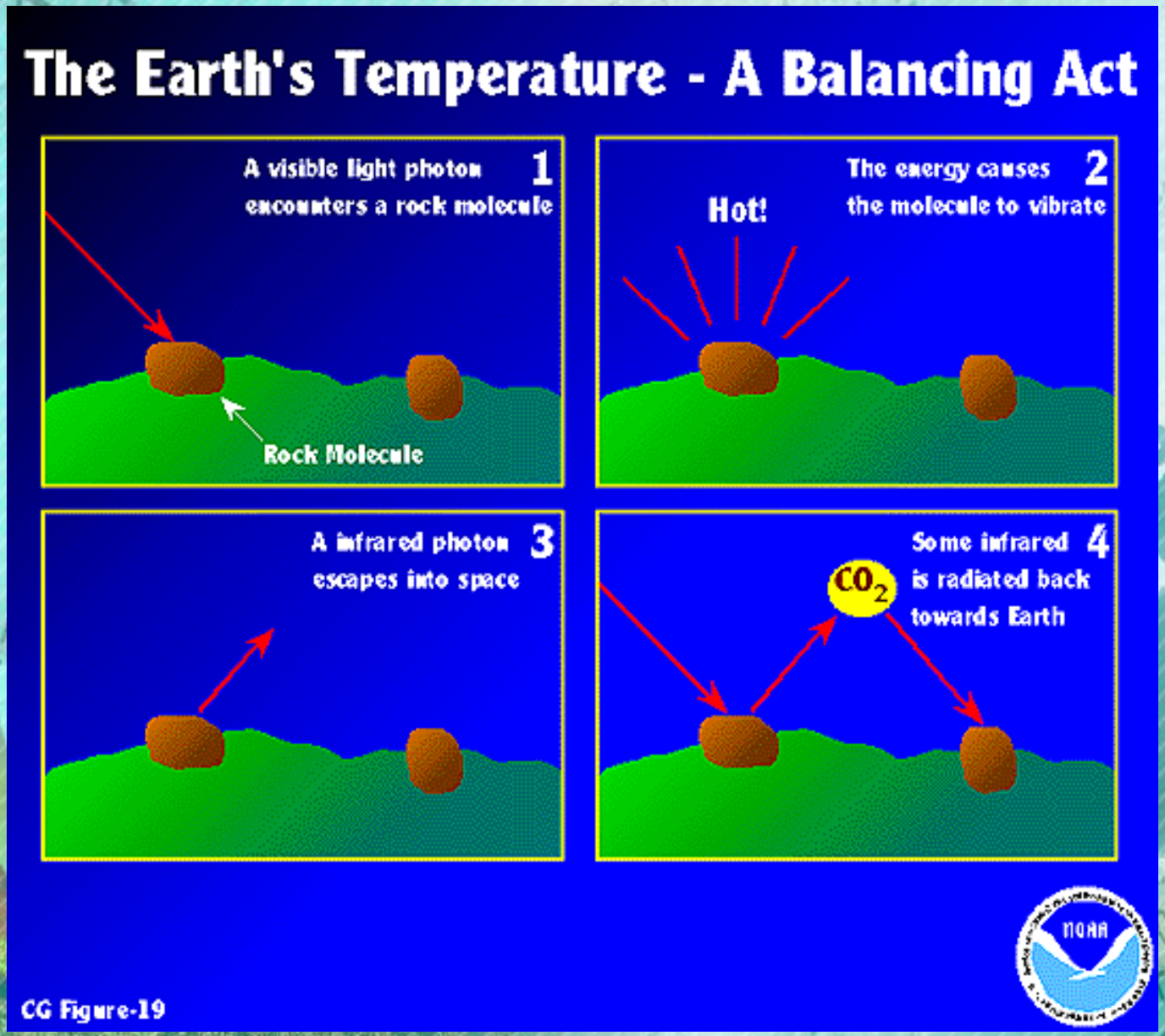
WHAT IS GREENHOUSE EFFECT ?

- First coined by J-Fourier in 1827 and was investigated by Svante Arhenius
- The greenhouse effect is when the temperature rises because the sun's heat and light is trapped
- The Earth's surface thus receives energy from two sources: the sun & the atmosphere
  - As a result the Earth's surface is ~33°C warmer than it would be without an atmosphere

PERCENTAGE COMPOSITION OF GREEN HOUSE GASES




The Greenhouse Effect
SUN
Some solar radiation is reflected by the Earth and the atmosphere.
Some of the infrared radiation passes through the atmosphere, and some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.
Solar radiation passes through the clear atmosphere
ATMOSPHERE
EARTH
Most radiation is absorbed by the Earth's surface and warms it.
Infrared radiation is emitted from the Earth's surface.



3. **Longer, infrared Wavelengths hit Greenhouse gas Molecules in the atmosphere**

4. **Greenhouse gas Molecules in the Atmosphere emit Infrared radiation Back towards earth**

Greenhouse Gases

Carbon Dioxide (CO_2)

- Source: Fossil fuel burning, deforestation
- Last 30 years increase: **30%**
- Average atmospheric residence time: **500 year**

Methane (CH_4)

- Source: Rice cultivation, cattle & sheep ranching, decay from landfills, mining
- Last 30 years increase: **145%**
- Average atmospheric residence time: **7-10 years**

Nitrous oxide (N_2O)

- Source: Industry and agriculture (fertilizers)
- Last 30 years increase: **15%**
- Average atmospheric residence time: **140-190 years**

Chlorofluorocarbon

- Sources: Air conditioners, refrigerators, evaporation of industrial solvents, production of plastic foam, etc
- Per year increase : 4%
- Average residence time in atmosphere : 10-15 years

Water vapors

- Strongest greenhouse gas
- because it occur in vapor, cloud droplet and ice crystals and transition between phases

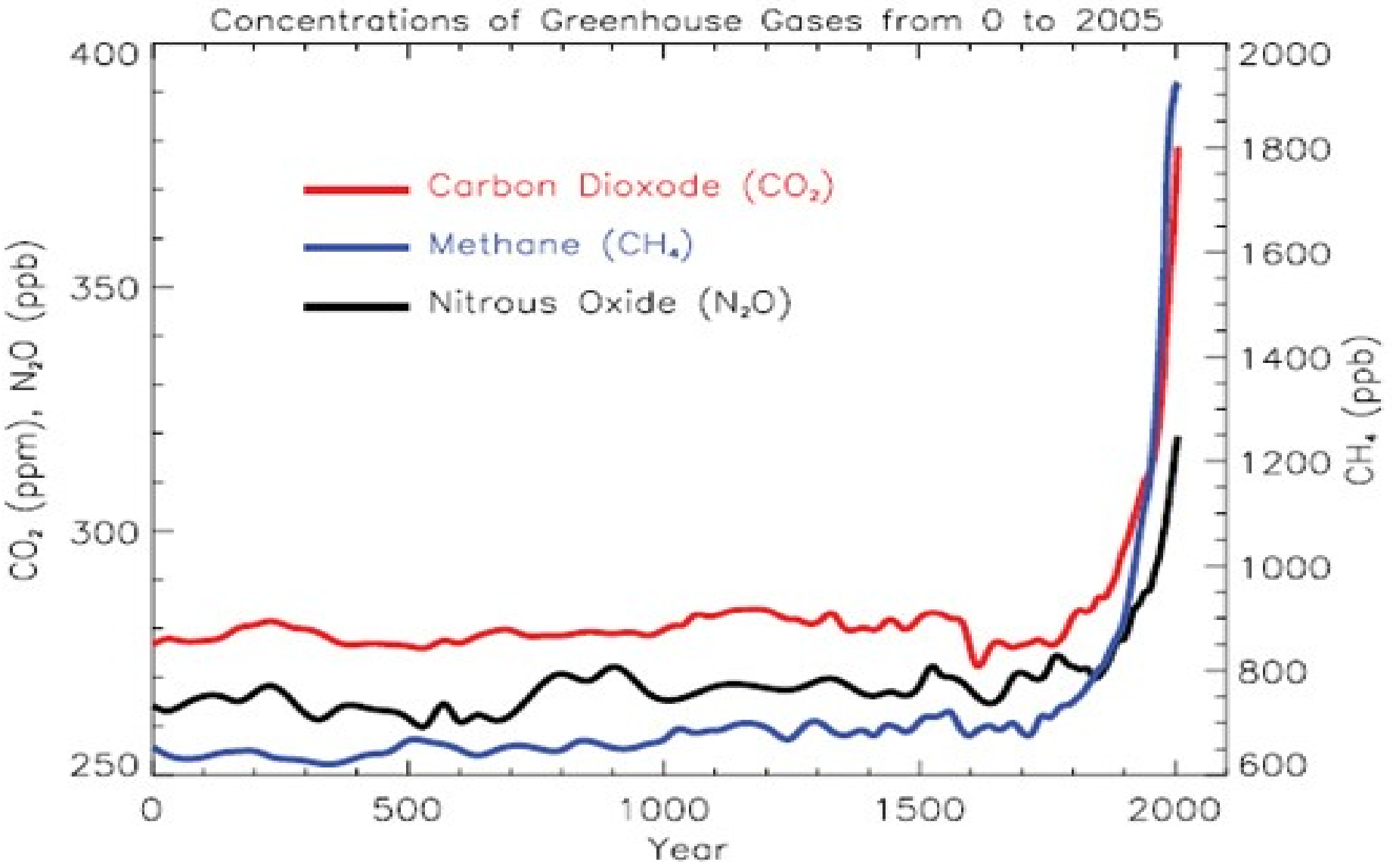
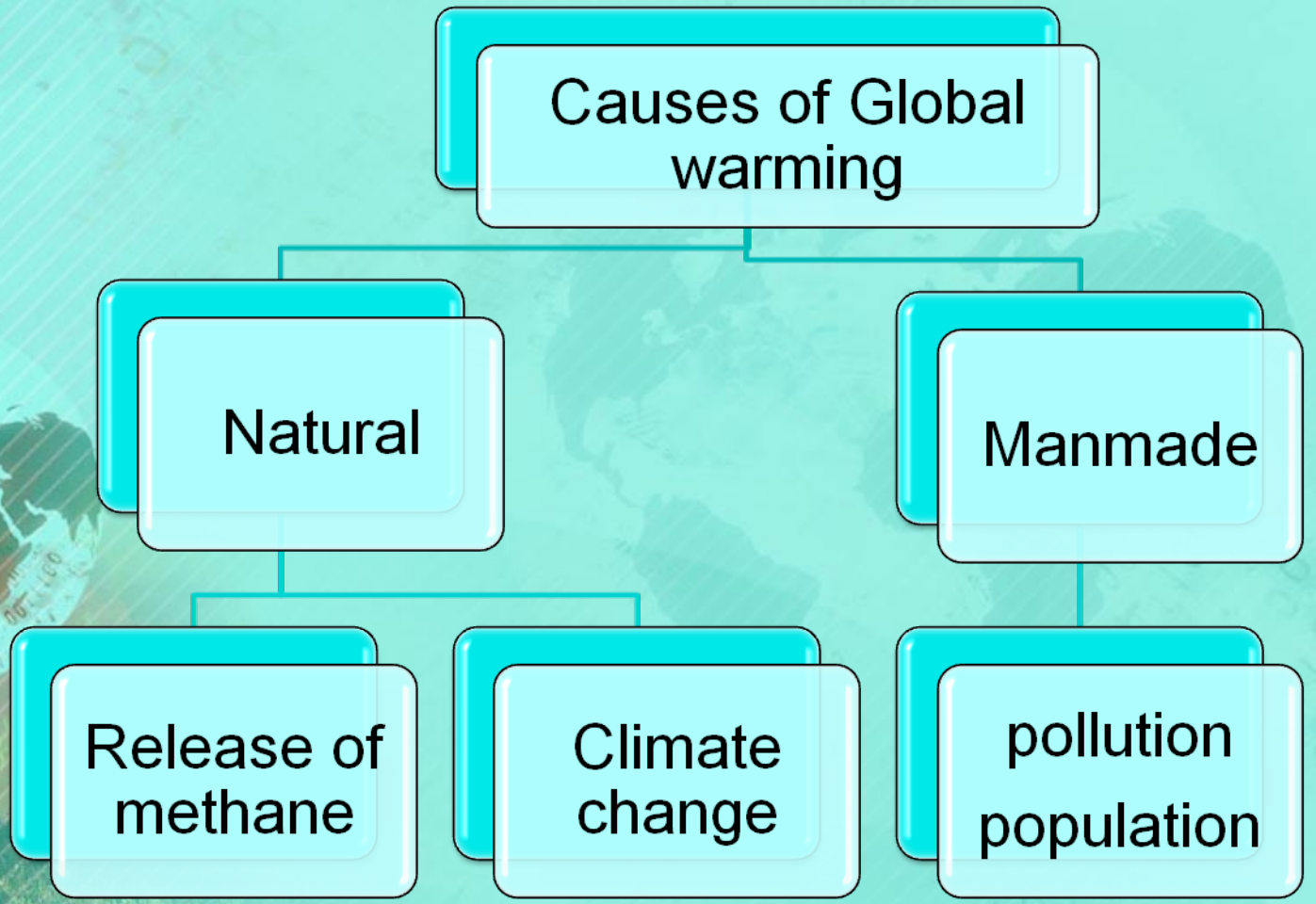


Figure 1. Atmospheric concentrations of important long-lived greenhouse gases over the last 2,000 years. Increases since about 1750 are attributed to human activities in the industrial era. Concentration units are parts per million (ppm) or parts per billion (ppb), indicating the number of molecules of the greenhouse gas per million or billion air molecules, respectively, in an atmospheric sample.

IPCC AR4 FAQ

CAUSES OF GLOBAL WARMING



- **Natural causes** are causes that are created by nature.

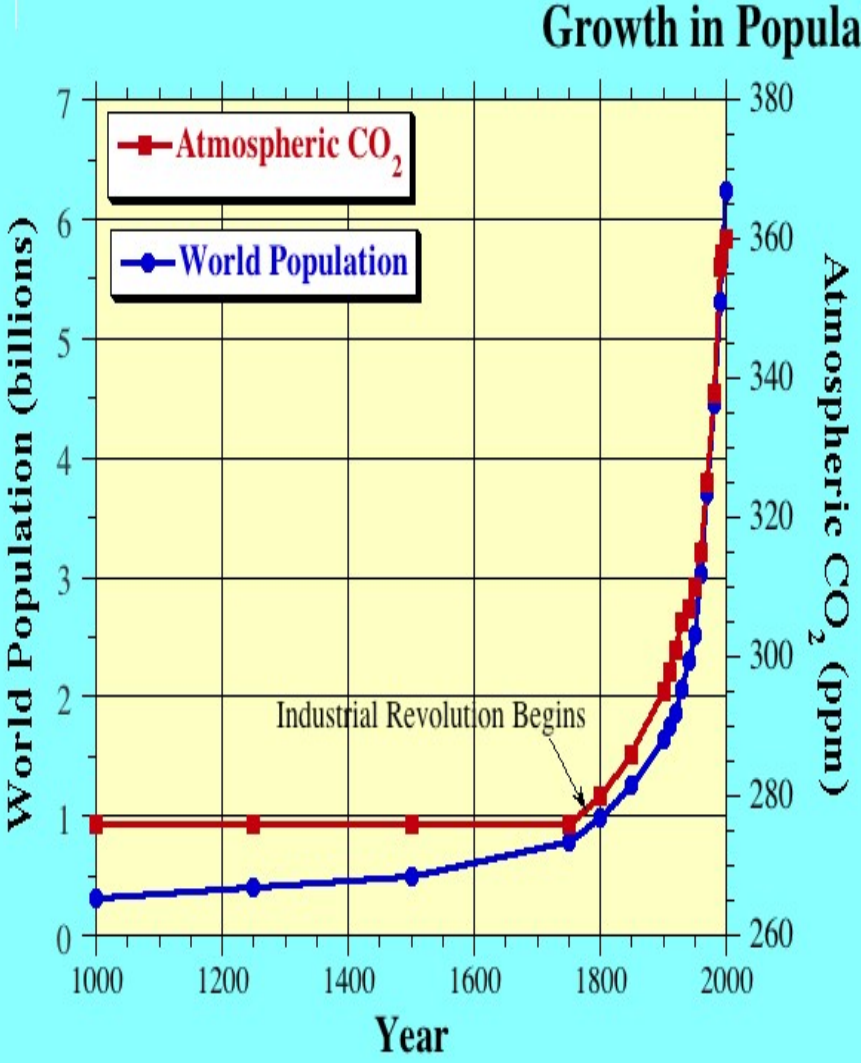
- Release of methane gas from arctic tundra and wetlands.

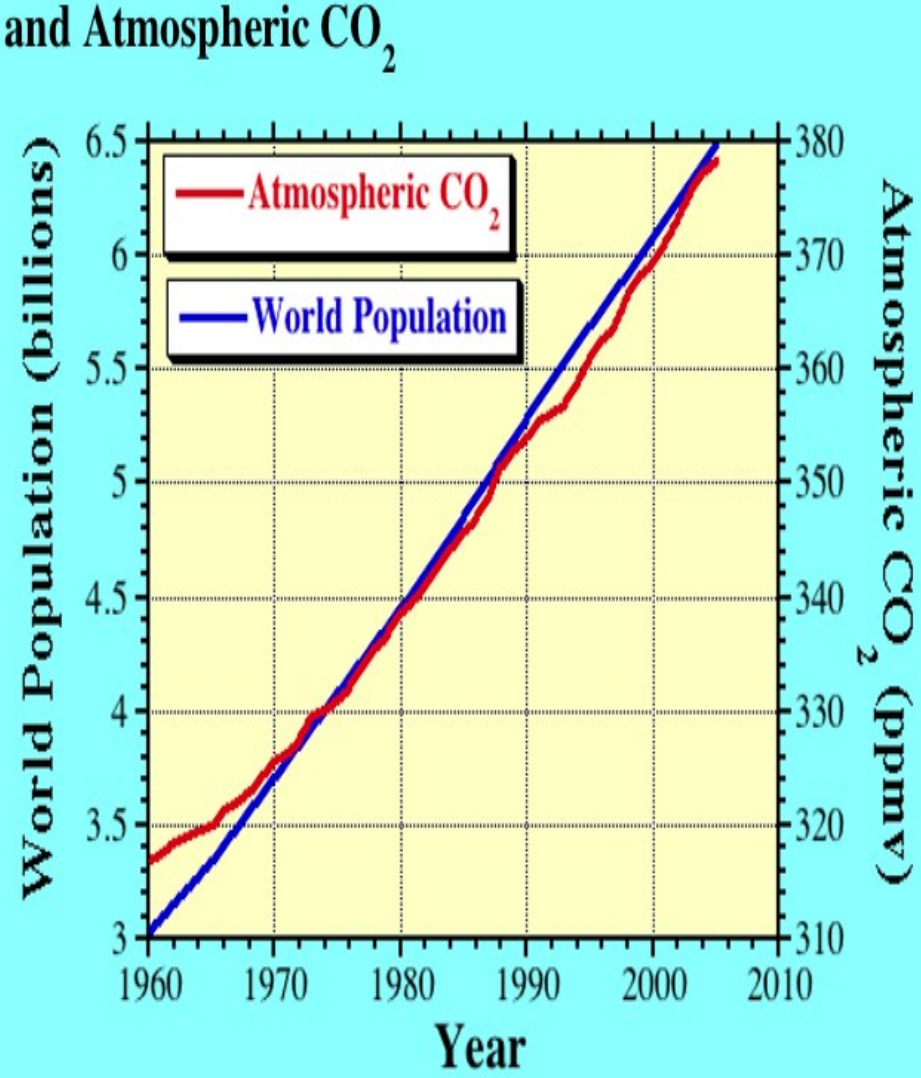
- Methane is a greenhouse gas and a very dangerous gas to our environment.

- Earth goes through a cycle of climate change. This climate change usually lasts about 40,000 years.

- Pollution is one of the biggest manmade problems leading to global warming
- Burning fossil fuels
- Green house gas CO_2
- Mining coal and oil
- Population
- More food, more methane, more burning of fossil fuels
- Transportation

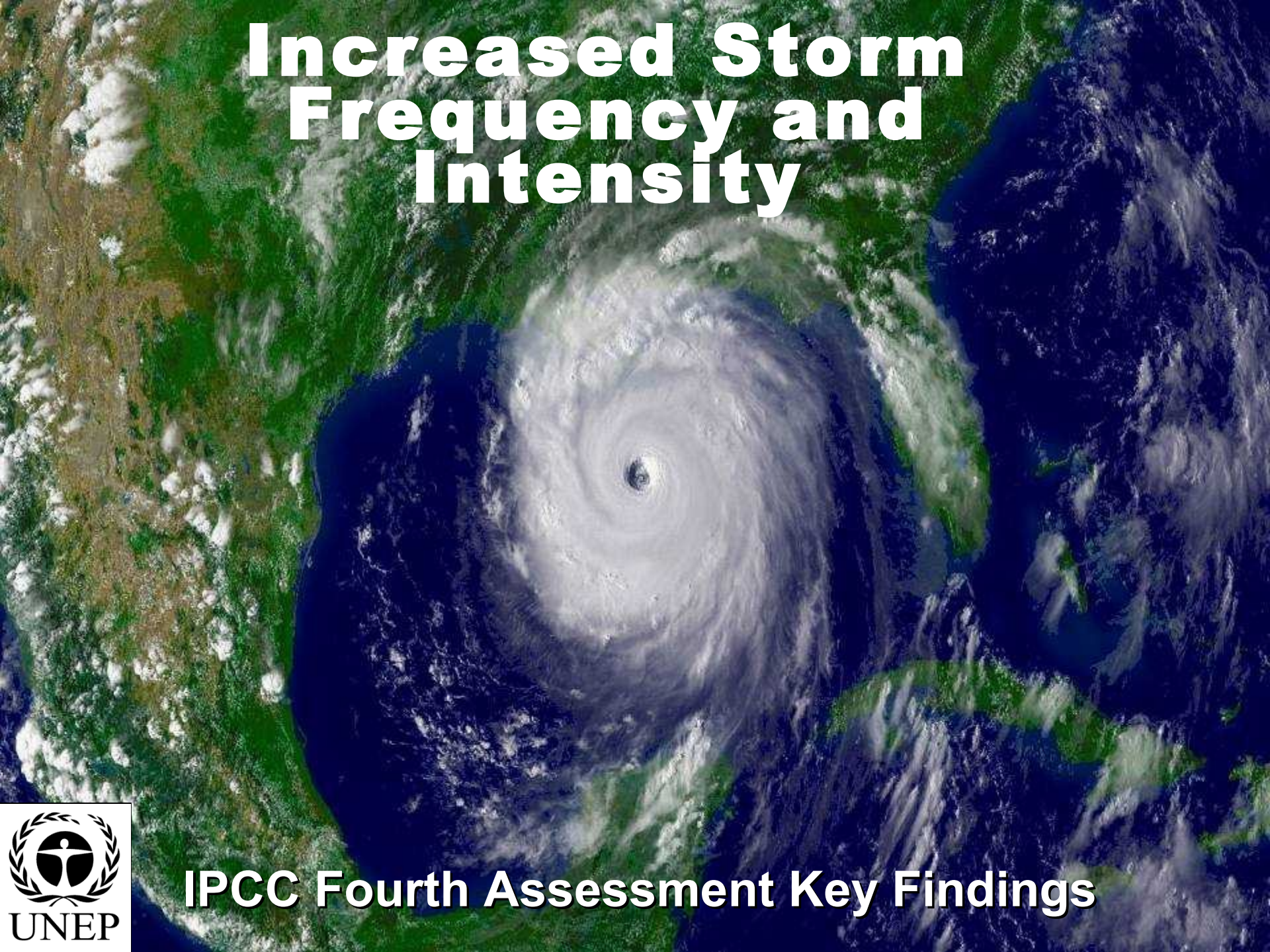
EFFECT OF POPULATION





What's At Risk?

Increased Storm Frequency and Intensity



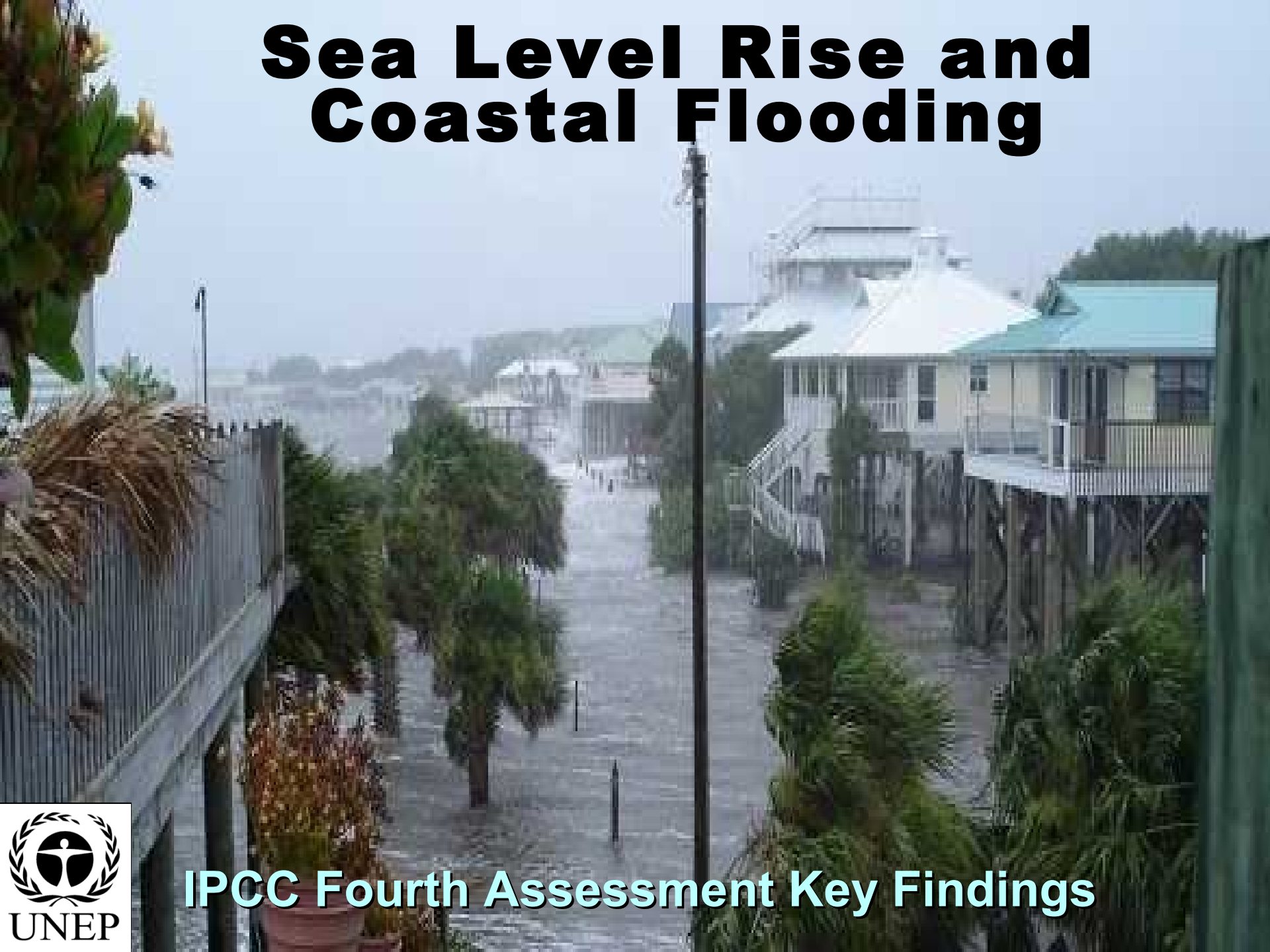
IPCC Fourth Assessment Key Findings

UNEP

Spread of Disease

- After warming the Nordic countries, diseases carried by insects migrate north, bringing plague and disease with them. Scientists believe that in some countries due to global warming, malaria has not been completely exterminated.

Sea Level Rise and Coastal Flooding



IPCC Fourth Assessment Key Findings

UNEP

Increasing temperatures and changing landscapes of the Arctic circle

- 1> Will endanger several species. Only those who adapt will survive

- 2> Increased temperature could lead to extinction of up to one million species. And we can not exist without diversity of species on Earth


Increasing Risk of
Catastrophic Fires

Melting Ice: Unbalanced Global Ecosystem

- 1>Desalination due to melting of polar ice caps.

  2>Leading to change in current patterns and further erratic change in climate leading to loss of indigenous species

- 1> Droughts will be the largest in Africa

- 2> There is 90% chance that 3 billion people worldwide having to choose between family moved to areas with milder climatic conditions or starvation due to climate change in the next 100 years

Increased Drought

Economic Toll

Global Warming impacts will cost 20 times more than reducing our emissions *now*.*

* 2007 Report by British Treasury Secretary Nicholas Stern

OZONE LAYER

DEPLETION OF OZONE LAYER

Initially the atmosphere was devoid of oxygen. Photosynthetic activities of the blue green algae added oxygen in the atmosphere and only after that the evolution of complex multicellular organisms took place.

- Ozone occurs in the form of a layer in the concentration of 10 ppm in stratosphere between 16 to 40 Kms. At the ground surface the conc. is very low just around 0.05 ppm.
- Ozone in stratosphere accounts for the 90% of total ozone present in atmosphere.
- Ozone layer at stratosphere has a very protective role to play. It acts as a protector filter that absorbs Sun's damaging UV radiations in wavelengths between 220 and 330 nm.
- Ozone is formed from oxygen molecular in stratosphere through radiation absorption at 242 nm.
- Ozone gets destroyed through radiation absorption at < 325 nm.
- A total of about 350,000 tonnes of ozone is formed and destroyed everyday.
- Average thickness of ozone layer in stratosphere is estimated to be around 300 dobson units. It varies marginally with latitude/season. Ozone layer thickness is comparatively is lower in polar regions due to cold conditions and other parameters

Causes of Ozone layer depletion:

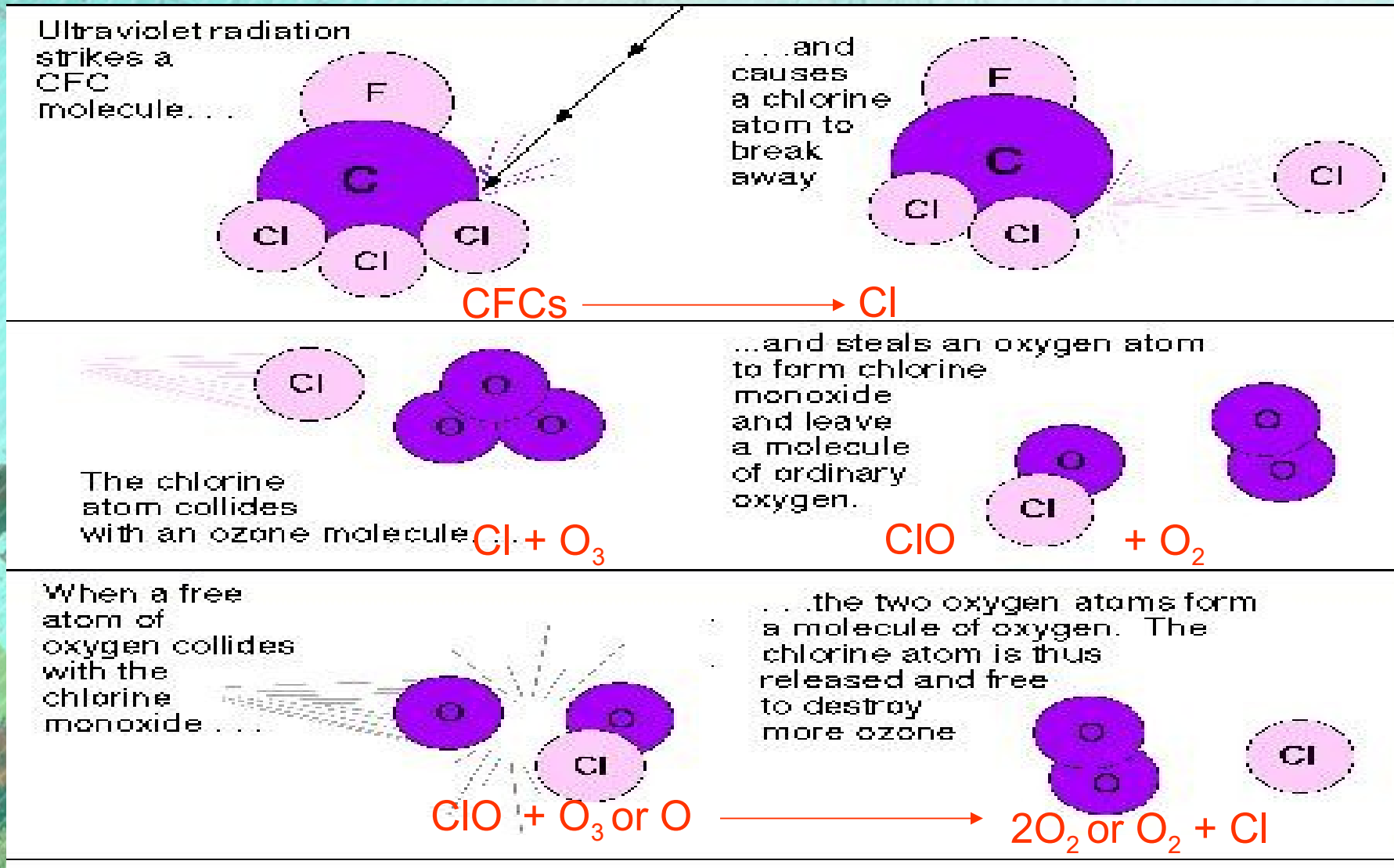
1. Chlorofluorocarbons (CFCs) and halons (entirely man made) with wide application in air conditioning refrigeration, aerosols, foam blowing and modern fire fighting are the main culprits responsible for the destruction of ozone in the stratosphere.

2. In addition, oxides of nitrogen released from the exhausts of large fleet supersonic aircrafts are also responsible for increasing the rate of ozone destruction.

3. CFCs and halons have a long residential period in atmosphere. $CFCl_2$ has a residential time between 60 and 110 years whereas CF_2Cl_2 has 'Residence time between 55 and 400 years.

4. They remain inactive in the troposphere (0-15 Kms) and it takes about 20-40 years for these chemicals to travel to reach stratosphere.

Depletion of Ozone layer…Chemistry



Polar Ozone hole & Ozone depleting substances:

1. Depletion of ozone layer has been found to be much more acute in polar region particularly Antartic (South pole) than in other parts of the earth.

Why ozone depletion at poles:

- Due to prolonged cold climate, drop of temperature to –90°C during winter and formation of stratospheric clouds.

<u>Air turbulence</u>

- Absence of N_2O (Nitrous oxide) in these areas. Under normal conditions N_2O destroys chlorine monoxides and checks ozone depletion.

- In Polar regions, N_2O at sub zero temperature freezes into the ice droplets or clouds thus leaving ClO free to act on ozone molecules.

-ClO in turn accumulates and continues destroying ozone.

Concentration of ozone depleting substances:

- Chlorine in 25 years increased from 0.6 to 2.7 ppb in 1987 & by 2075 the conc. may triple.

- Bromine 1 ppb in 1987, may be 10 ppb by 2075.

Ozone Depletion Levels:

* 1-2% depletion over all the areas of the globe.
* 1.7 – 3% depletion between 30-60^{o}N latitude during 1969 – 86 (2.3 to 6.2% in winters)
* 5% depletion beyond 60^{o}S latitude.
* 5-20% more UV radiations may be received by the earth due to ozone depletion by 2030.

Consequences of Stratospheric Ozone depletion:

Stratospheric ozone layer is the key life support system.

- Absorbs UV radiations very strongly in 220-320 nm wavelength.
- Depletion of ozone will result in increase in the percentage incidence of UV radiations (290-320 nm). It will have profound affect on the DNA which is the genetic material. DNA disorders leads to mutation and genetic defects.
- Promotes skin cancer (squamous cell carcinoma and malignant melanoma), cataracts and depresses immune system. 1% drop in ozone can lead to 4-6% raise in number of skin cancer cases (5 fold increases in Australia during the last 50 years).
- Increased inflow of UV radiations will lower the sea productivity. It will adversely affect the marine flora and fauna.
- Adverse Impact on agricultural crops and natural vegetation

MONTREAL PROTOCOL (1987) ON SUBSTANCES THAT DEPLETE THE OZONE LAYER

Signed by 35 developed and developing countries.

- Limitations were put forward on use of CFCs and halons and their phasing out schedule was chalked out.
- Proposes freezing CFCs production by 1989 and halons by 1992.
- Protocol proposes the freezing of production of ozone depleting substances at 1986 level and called for 20% reduction by 1994 & ultimately to 50% (of 1986 level) by year 1998.
- Later on these targets were further stringent to phase out these chemicals much earlier in an international meet held in London in 1990.
- As per these London amendments of Montreal protocol, it has been decided to reduce production of these chemicals to 50% of 1986 level by 1995, 15% of this level by 1997 and their complete phase out by 2000 AD.
- Protocol granted 10 years grace period to developing countries during which consumption can increase upto 0.3 Kg per capita.
- UK allowed to expand consumption upto 0.5 Kg per capita during the then 5 year plan
- Allowing import from non signatory countries for one year.
- Allowing trade upto mid 1990s.
- Protocol assume upto 2% ozone depletion by 2075.
- According to US environmental protection agency (EPA), even after implementation of Montreal Protocol, the total conc. of chlorine may increase three folds by 2075.

- 45% of it from the controlled use of CFCs.
- 40% from the compounds not covered by the protocol (methyl chloroform & carbon tetrachloride)
- 15% by the non-participatory countries.

Strategies for protecting the stratospheric ozone layer:

If all known technical control of measures are used, emissions of CFCs & halons can be reduced by 90%.

Banning of CFCs :

Banning of CFC propellants in Canada, Norway, Sweden & USA.
Banning land disposal of chlorinated solvents (incineration as disposal and recovery & recycling of the solvents as alternatives)
Prohibition of venting of refrigerants.

So how can each of us can prevent global warming, acid rain, ozone layer depletion now?

STEPS TAKEN BY GOVERNMENT:

- The government made a law called **The Clean Air Act** so there is less air pollution
- Making many companies change their products
- These products have a label on them telling people what this product can do to the environment and many people
- Making car companies change some of the things inside of the cars

STEPS WHICH WE CAN TAKE:

- Reuse your shopping bag
- Plant a tree
- Buy fresh foods instead of frozen
- Start a carpool with your co-workers or classmates
- Keep your car tuned up
- Protect forest worldwide
- Fly less

Reduce our consumption of fossil fuels

Because greenhouse gas emissions are tied very closely to our energy consumption, using less fossil fuel based energy puts fewer greenhouse gases into the atmosphere.

This will help slow global warming.

Producing more and more electricity thanks to wind or water power

Use fewer and fewer power stations

We can make some simple substitutions

Replacing just 1 incandescent light bulb with 1 compact florescent bulb saves about 150 pounds of carbon dioxide per year!

Source: http://www.energystar.gov

Building vehicles that :

- use less petrol or energy
- and are equipped with catalytic converters

Not driving as fast on motorways, with a maximum speed of 110 Km/h instead of 130 Km/h

Small changes really add up

Replace your old refrigerator with a new Energy Star:
Annual savings:
$90; 700 pounds CO_2

Set your thermostat down a few degrees in the winter
Annual savings:
$135; 1400 pounds CO_2

Drive JUST 10 fewer miles per week
Annual savings:
$80; 520 pounds CO_2

Wash clothes in cold water only
Annual savings:
$70; 500 pounds CO_2

Reduce your garbage by 10% through greater recycling or reduced packaging
Annual savings:
1200 pounds CO_2

Caulk and weather-strip around doors and windows
Annual savings:
$80; 650 pounds CO_2

* These are mid-range estimates from published sources; your savings may vary.

Our take-home message…

Each of us must take steps to protect our Earth's climate.