# Climate Change & Kyoto Protocol

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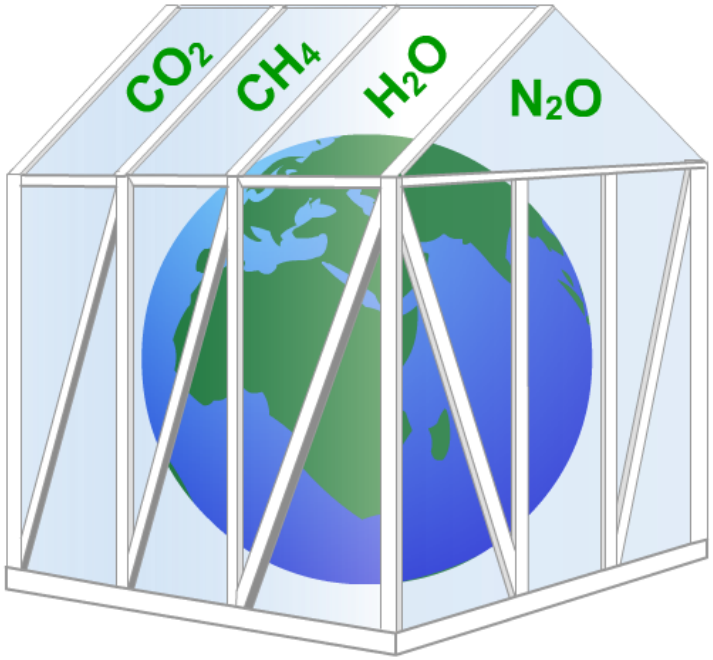
# Concepts

- Climate = long-term atmospheric conditions
- Weather = short-term atmospheric conditions
- Both climate and weather are dynamic – they change with time
- One of the greatest threats caused by air pollution is global warming.
- Human activities are releasing greenhouse gases (GHG) into the atmosphere
- Climate change is a global issue.
- Global warming is caused by a build-up of greenhouses gases, which leads to an increase in the Earth's temperature.

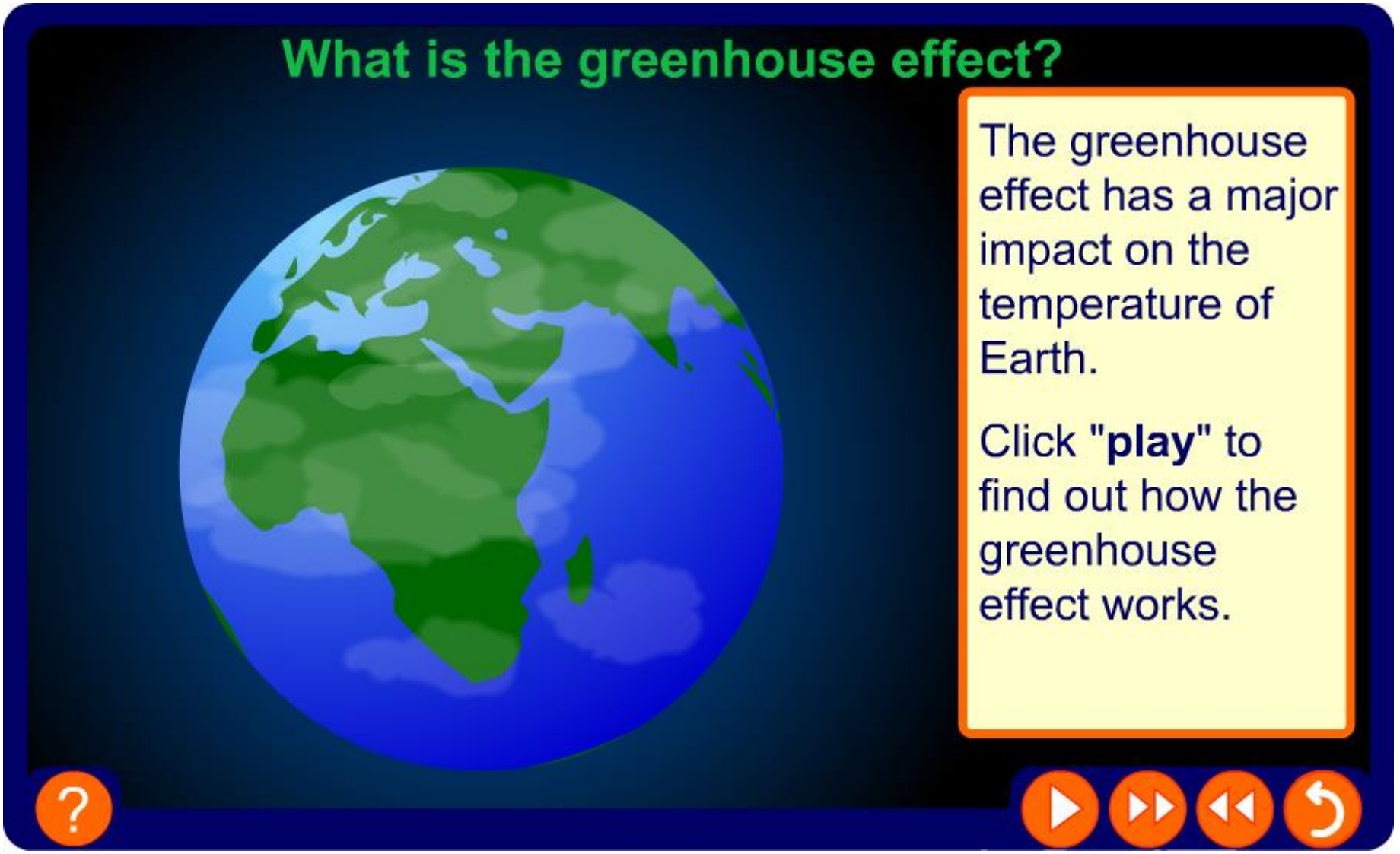
# Greenhouse gas (GHGs)

- A **greenhouse gas** is an atmospheric gas that absorbs infrared light.

- **Carbon Dioxide** - fossil fuel burning, land clearing/burning.
- **Methane** - Breakdown of organic material by anaerobic bacteria.
- **Nitrous Oxide** - Biomass burning, automobile exhaust.
- **Ozone** – automobile exhaust
- **Chlorofluorocarbons** - Refrigerants, cleaning solvents, propellants.



# The greenhouse effect



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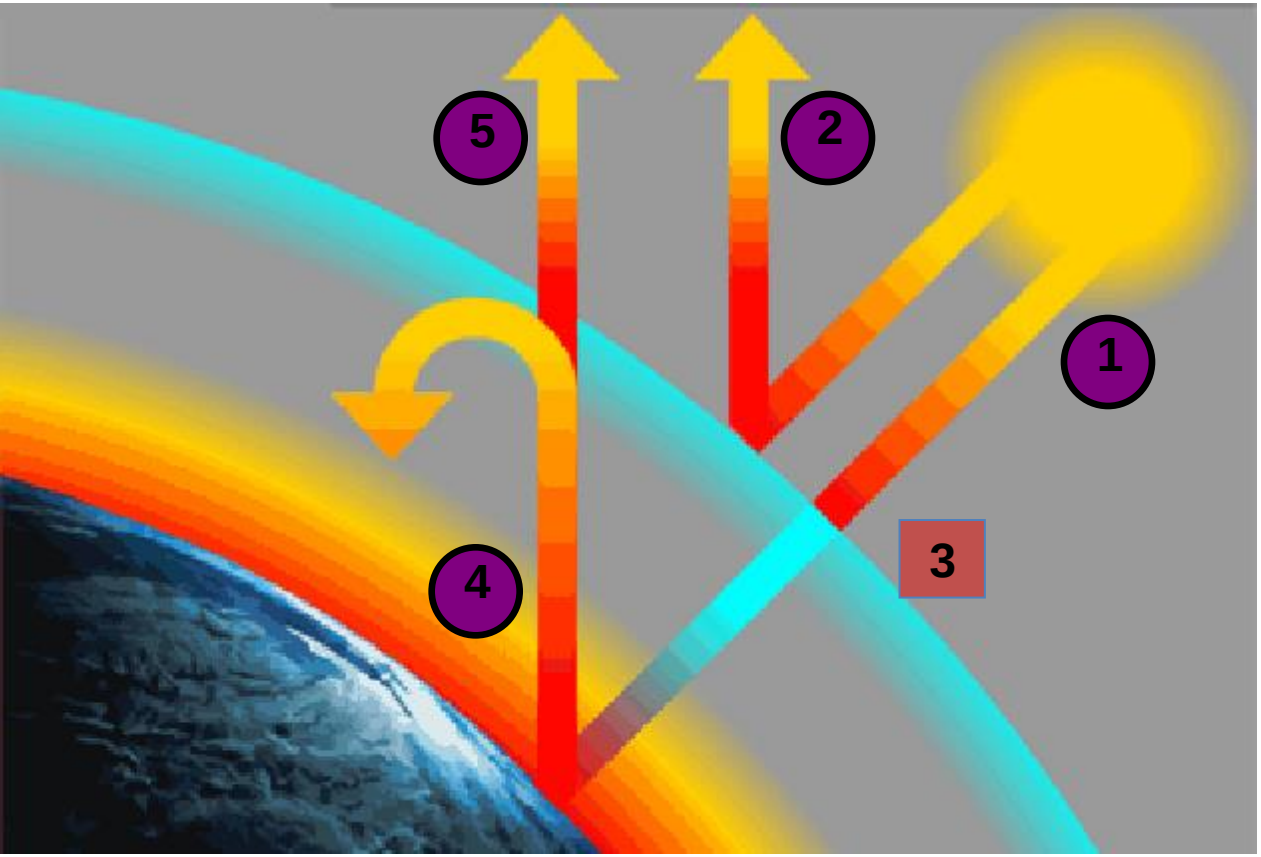



1) Solar radiation

2) Reflected back to space

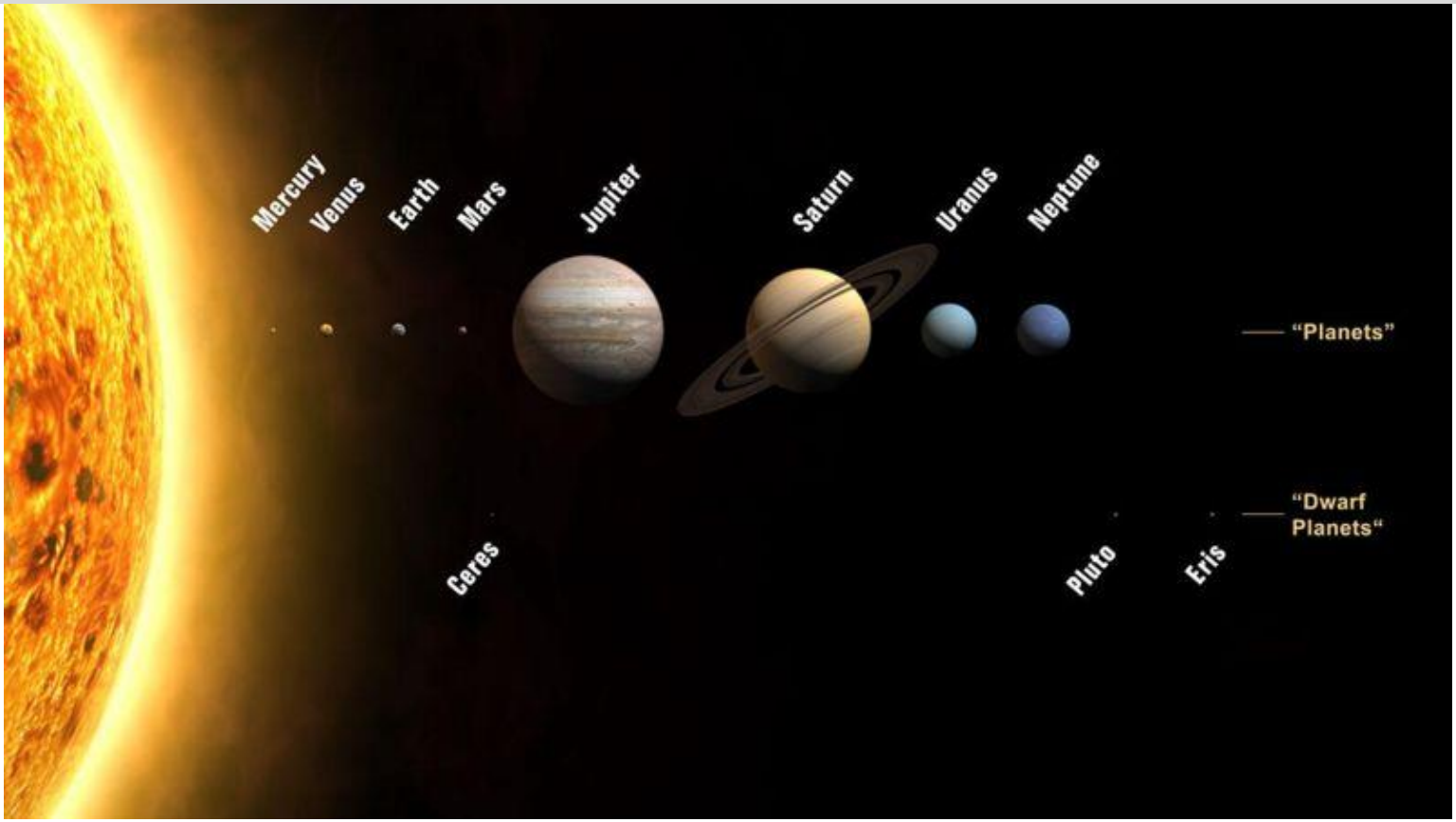
3) Absorbed by atmosphere

4) Infra-red radiations emitted from Earth

5) Some of the IR passes through the atmosphere

**The effect is increasing temperatures on Earth**

# How hot can the greenhouse effect get?




- The planet Venus is further from the Sun than Mercury but has an higher average temperature. Its surface can reach up to 482°C, which is hot enough to melt lead! Venus' atmosphere is mostly made up of carbon dioxide, which traps so much of the solar radiation that the planet becomes extremely hot, which makes it impossible for life to survive.

# Global warming

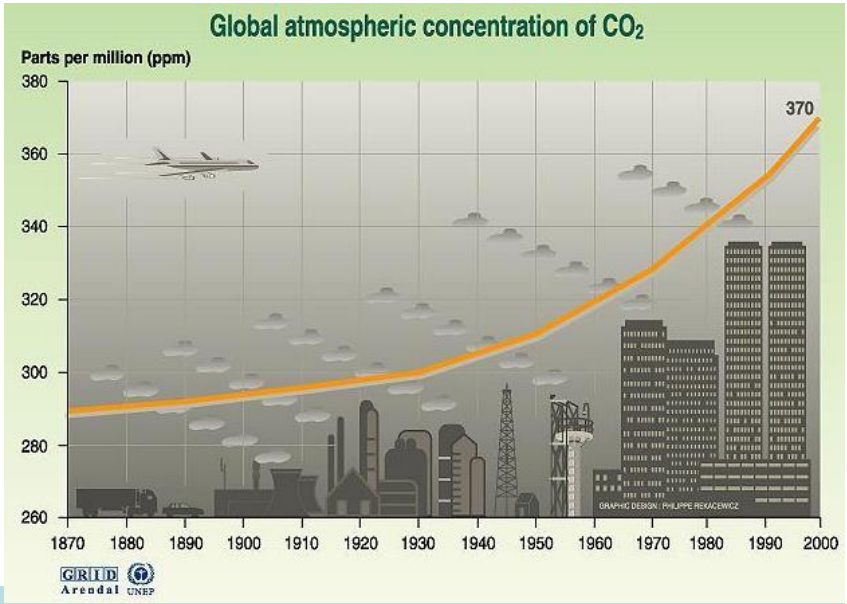
- The term “global warming” is often used in connection with climate change, but what does it mean?

- Global warming refers to the increase in the Earth’s temperature due to the greenhouse effect, which can cause changes in climate.

- However, the term “global warming” is being used now to refer to the warming predicted to occur as a result of increased emissions of greenhouse gases and other human activities. This enhanced greenhouse effect may lead to significant climate change.

# Evidence for Climate Change

- 20th Century was the hottest in the past 1000 years
- Global temp has risen 0.6°C (1.1°F) since 1861
- 16 warmest years on record since 1980, 10 warmest since 1990
- Glaciers and sea ice are melting
- Sea level has risen 100-200 cm over 20th Century



# Projecting Future Changes in Earth's Climate

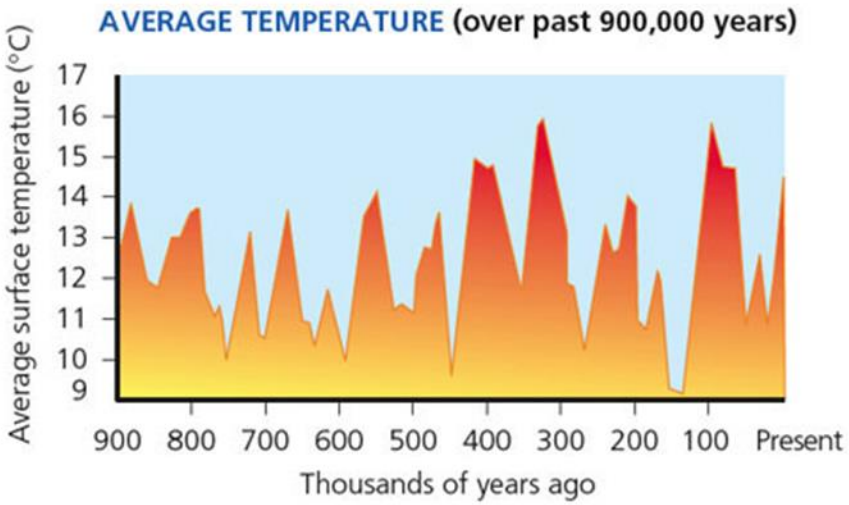
- We can't do real experiments on the whole earth's climate, so how do we predict future climate change?

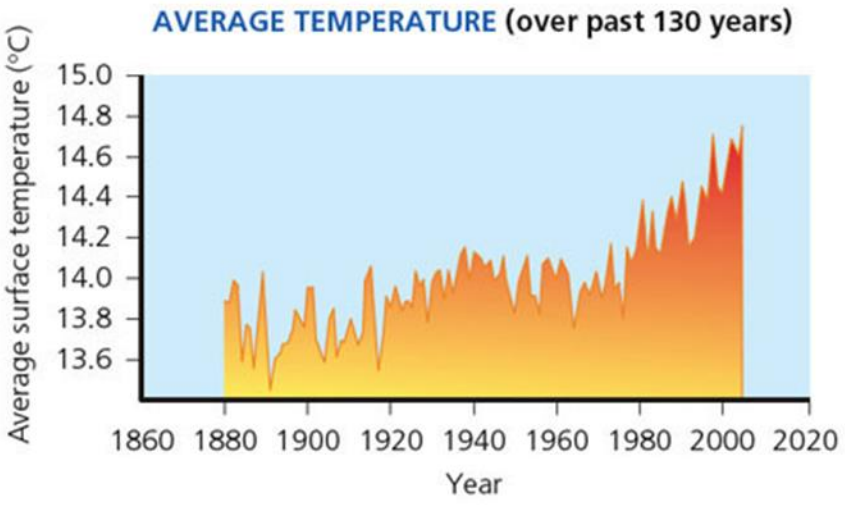
  - Scale up from small experiments
  - Computer models (GCMs)
  - Learn from the past

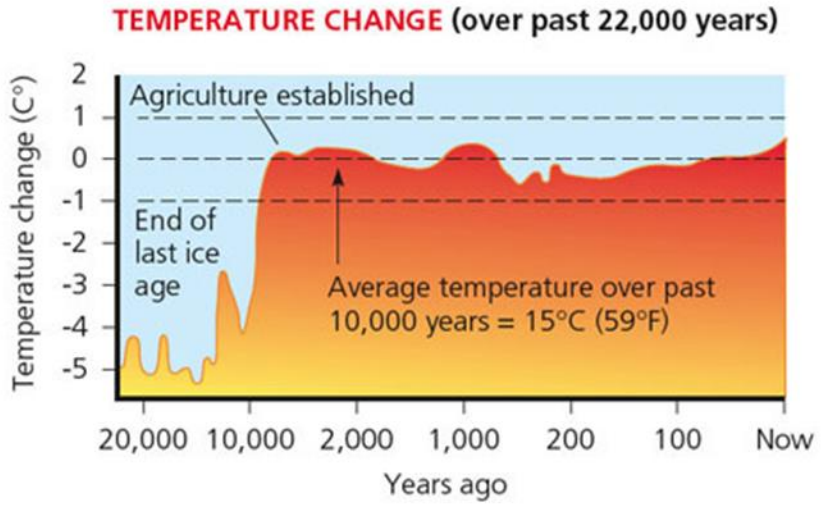
Scientists analyze tiny air bubbles trapped in ice cores learn about past:

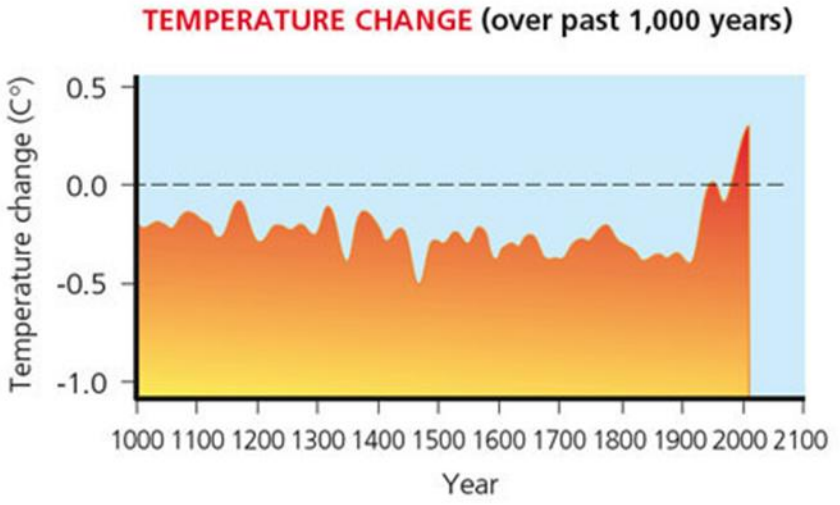
- troposphere composition.
- temperature trends.
- greenhouse gas concentrations.
- solar, snowfall, and forest fire activity.

# Past Climate Changes

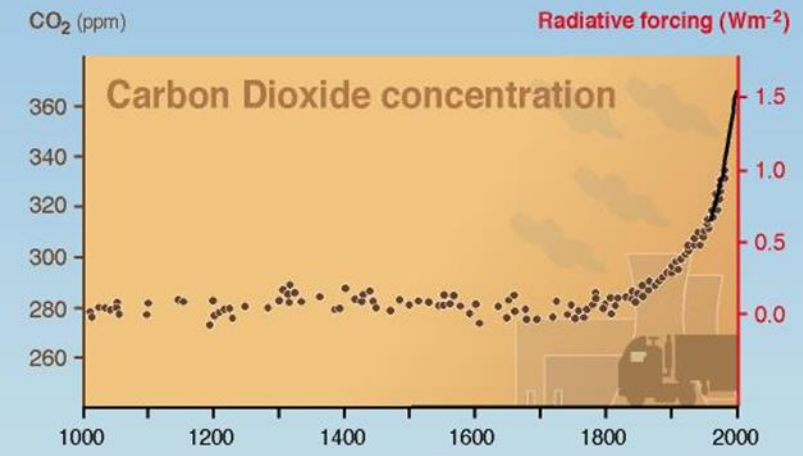


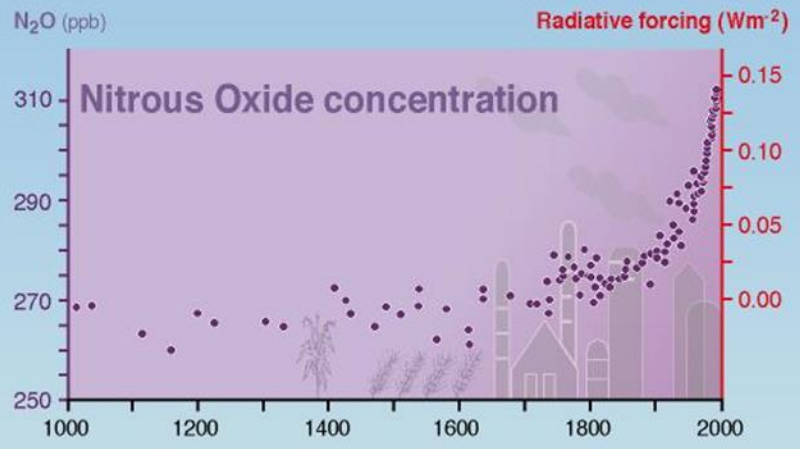



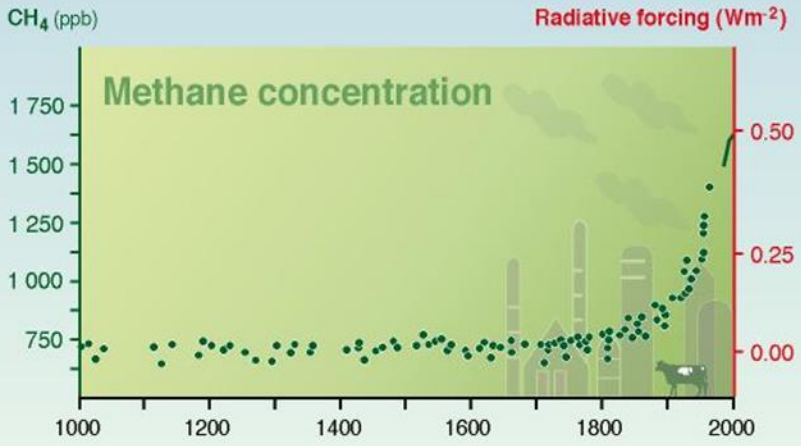



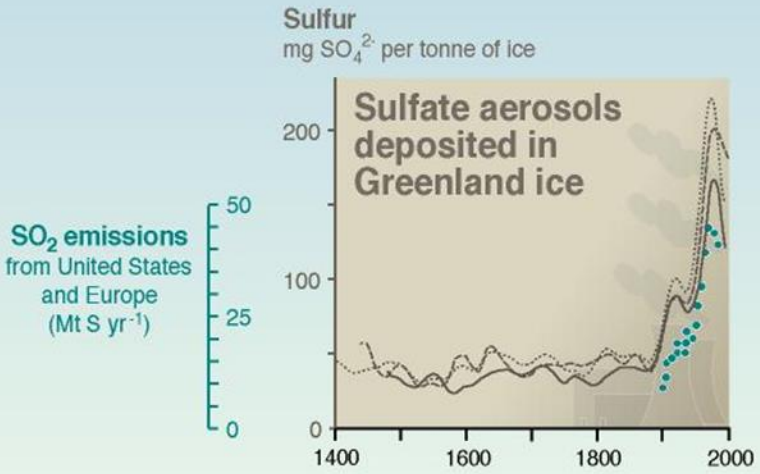



# GHGs are increasing!



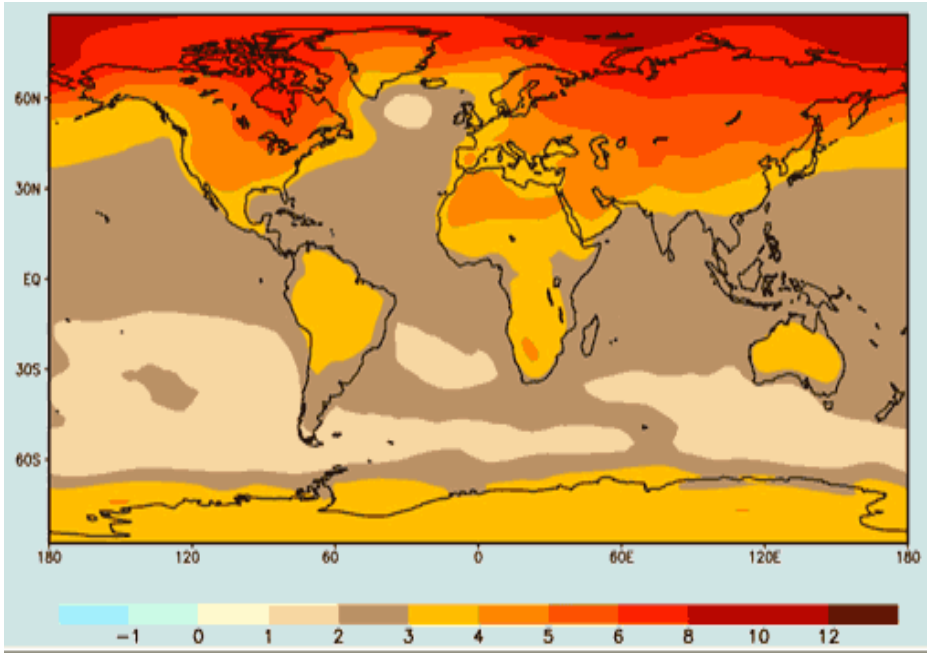



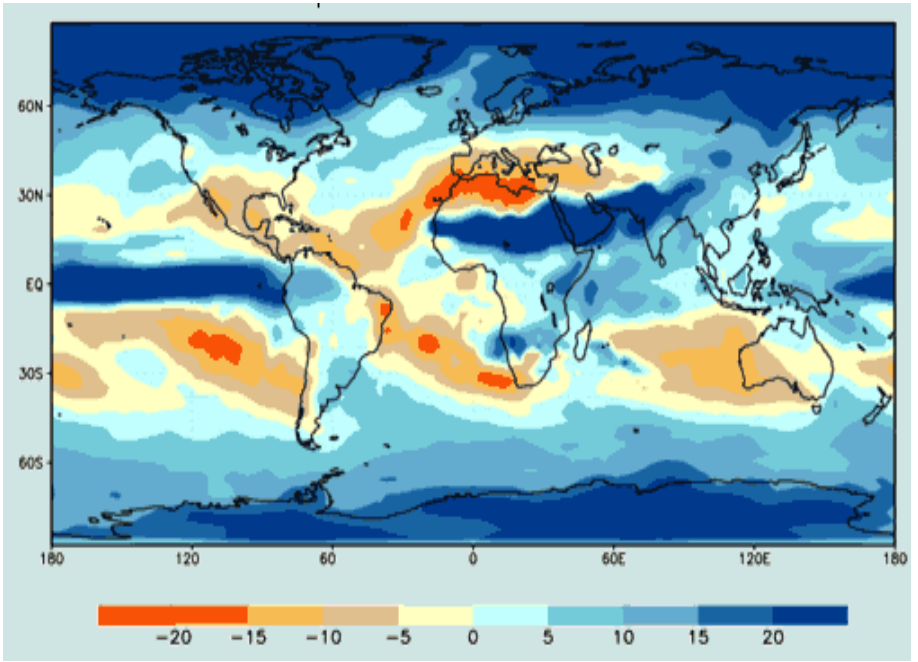



# Trends for 2100

**TEMPERATURE**




**PRECIPITATION**




**5 degrees** = What separates us from the last glacial era (-15 000 BC)

Models' forecasts : **+1.4** to **+5.8 degrees** by 2100.

# United Nations Framework Convention on Climate Change (UNFCCC)

- A global legal instrument (international agreement) to protect the climate system and stabilize GHG emissions
- The ultimate objective of the Convention is **"to achieve stabilization of atmospheric concentrations of greenhouse gases at levels that would prevent dangerous anthropogenic interference with the climate system**...
- Adopted in 1992, entered into force in 1994
- Status of participation: 189 Parties
- Contains 2 annexes:
  - Annex 1: countries with obligations to take measures to mitigate the effects of climate change
  - Annex 2: countries with obligations to provide financing to developing countries for their obligations under UNFCCC

# UNFCCC Principles

- Convention's principles of "equity" and "common but differentiated responsibilities" respond to the fact that, although climate change is a global issue and must be tackled as such, industrialized countries have historically contributed the most to the problem and have also more resources to address it. Developing countries are more vulnerable to its adverse effects and their technological, economic and institutional capacity to respond is generally lower.

- The "precautionary principle" responds to the dilemma that although many uncertainties still surround climate change, waiting for full scientific certainty before taking action would be too late to avert its impacts

# Kyoto Protocol – key points

- Adopted at third Conference of Parties (COP) to the UNFCCC in Kyoto in 1997
- Entered into force on February 16th, 2005 after ratification of the Russian Federation
- Until June 2007, 174 countries covering 61.6% of global emissions have ratified the protocol
- Six emissions: CO2, CH4, N2O, PFCs, HFCs, SF6
- Binding emission reduction targets for Annex I countries of 5.2% below 1990 over 2008-2012
- Non-Annex I countries have no binding targets but must report on their actions
- Annex I countries can achieve targets through domestic policies and three market mechanisms
- Non-Annex I countries can participate to facilitate sustainable development

# key points

- 1988 - Intergovernmental Panel on Climate Change (IPCC) established, body of scientists advising UN on climate change
- 1997 - Representatives of 161 nations met in Kyoto, Japan for a UN meeting on climate change
- Kyoto Protocol - agreement reached during meeting to reduce CO2 emissions from 39 developed countries to 5.2% below 1990 levels by 2012.
- 2001 US pulled out of the agreement.
- Russia's recent ratification was enough for the Kyoto Protocol to take effect.

# Kyoto Protocol Mechanisms

- **ET - Emissions Trading**

  AAU (Assigned Amount Units) are exchanged between Annex I countries

- **JI - Joint Implementation**

  Annex I investors receive ERUs (Emission Reduction Units) by investing in a project in another Annex I nation which reduces GHG emissions

- **CDM - Clean Development Mechanism**

  Annex I investors receive CERs (Certified Emission Reductions) by investing in a project in a non-Annex I nation which reduces GHG emissions

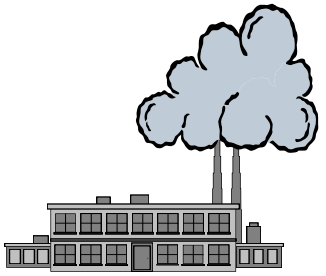
As the emission reductions from CDM projects are certified, unlike those for JI projects, they are termed Certified Emission Reductions (CERs). **one CER is equivalent to one ERU, assigned for a saving in any of the greenhouse gases equivalent in impact to one tonne of carbon dioxide emissions.**

# Tonne Equivalent

- The different GHGs have different potentials to impact on Climate Change, so one ERU is awarded for emission reductions in any of the greenhouse gases equivalent in impact to one tonne of carbon dioxide (CO2) emissions (1 t CO2e).

- For example, methane (CH4) has a global warming potential of 21; this means that one tonne of methane has the same climate change impact as 21 tonnes (t) of CO2, and hence 1 t CH4 = 21 t CO2e. This means that landfill gas projects involving methane emission reductions can be particularly attractive, because they can generate large amounts of ERUs.

# What Annex I countries can do . . . ?

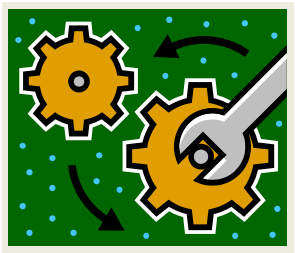


Limitations of CO2 emissions in developed countries (Annex I)

4 options for companies

**1/** Pay expensive **fines.**

**2/** Carry out carbon reduction through **processes improvement**.



**3/** Buy emissions credits on the **$CO_2$ market (ETS).**

**4/** Carry out carbon reduction through technology transfers in **CDM or JI project.**

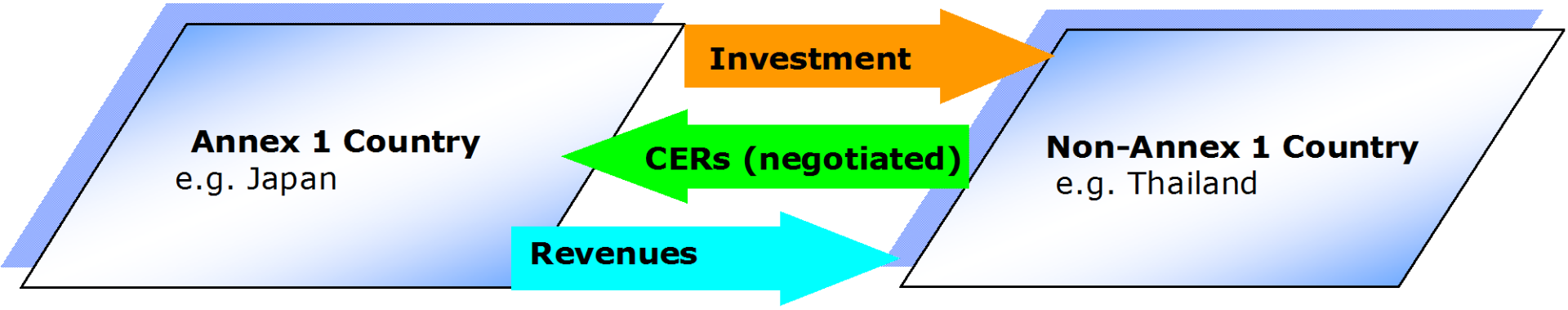
# JI Project example

A UK company might seek to build a hydro power plant in New Zealand, that will displace electricity from the national grid. The project must replace an existing high greenhouse gas emitting source with a lower emitter; i.e. the reduction in emissions must be 'additional' to that occurring under a 'business as usual' scenario. The project would not, for example, generate emission reductions if it replaced a national electricity mix that was mostly composed of hydropower. Each project must have an agreed baseline against which the ERUs are calculated.

A UK company will be able to use the credits towards its emission reductions target under the EU Emission Trading Scheme (if it has such a target), or it could choose to sell the credits, either now (as a futures option or contract) or once they have been verified

# How CDM works?

- Annex I country invests in GHG reduction project in non-Annex I country
- Annex I country receives CERs
- Non-Annex I country receives revenues from CERs

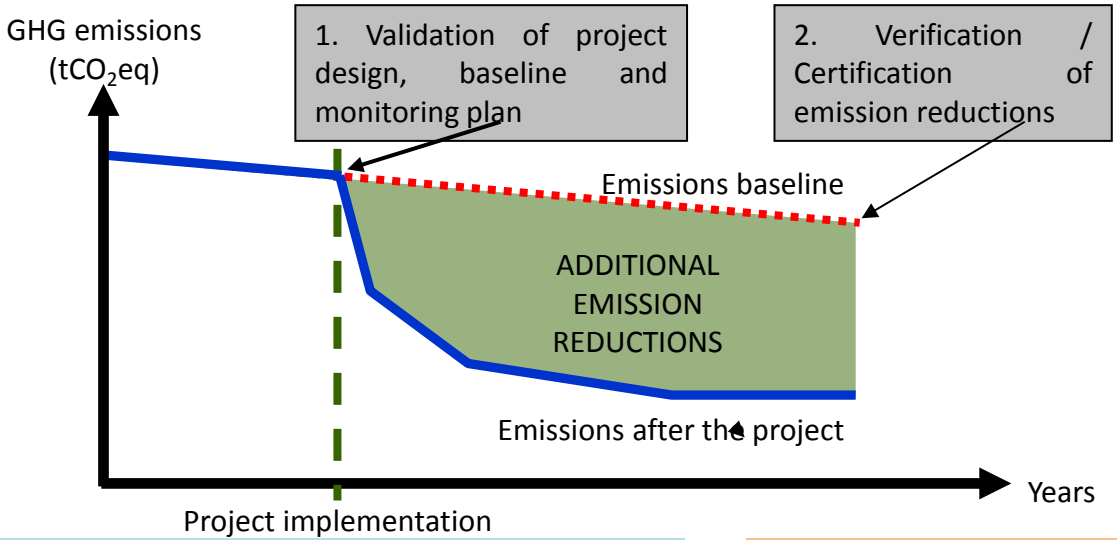


# CDM Project example

An example of a CDM project would be the use of biomass to displace the use of diesel for electricity generation in the sugar production process in a developing country. To be eligible, a CDM project must replace a planned or existing high greenhouse gas emitting source with a lower emitter, and the reduction in emissions must be 'additional' to that which would occur under a 'business as usual' scenario. Each project will have an agreed baseline against which credits are calculated. Each project will also need to demonstrate its contribution to sustainable development in the host country, as determined by the host country Government.

# CDM Eligibility

- Will the project reduce emission types under the Kyoto Protocol?
  CO2, CH4, N2O, HFCs, PFCs, SF6
- Does the country meet sustainable development requirements of the host country?
  - **Economy, e.g. creation of employment**
  - **Ecology, e.g. reduction of air pollution**
  - **Social, e.g. improved availability of public services**
- Are emission reductions additional?



# CDM Eligibility

- Does the project fall into one of the seven project type categories?
  - End-use energy efficiency
  - Supply-side energy efficiency
  - Renewable energy
  - Fuel switching
  - Methane reduction
  - Industrial processes
  - Sequestration and sinks
- Does the project result in significant negative environmental impacts?
  - If “yes”, then environmental impact assessment (EIA) required
  - Covers non-GHG impacts
  - Significant impacts may disqualify project for CDM
  - EIA brings additional costs to the company

# The opportunities for reducing energy usage and lowering environmental impact

- Managing energy more efficiently  performing energy assessment/audits, utilizing energy management training, and implementations programs
- Upgrading existing equipment < shifting to more energy-efficient processes (e.g. from wet to dry)
- Utilizing biomass fuels
- Utilizing waste fuels
- Replacing high-carbon fuels by low-carbon fuels (e.g. shifting from coal to natural gas)

**Example 4.12:** Say, a proposed CDM project involves use of ethanol to substitute 10% gasoline in a fleet of 1000 private cars. Assume that on average cars consume 0.1 litre of gasoline per km and the average annual travel is 10,000 km. Substitution of gasoline by ethanol does not result in any change in fuel use efficiency; therefore, the reduction in gasoline is equal to the amount of ethanol used in the cars.

The baseline for example 4.12 can be estimated as shown below.

| | |
|---|---|
| Fuel consumption of a car per km (A) | = 0.1 litre gasoline (0.074 kg) |
| Average annual distance traveled per car (B) | = 10,000 km |
| Number of cars covered in the project (C) | = 1000 |
| Emission factor of gasoline(kgC/ tonne) (D) | = 847 (IPCC default for gasoline) |
| Emission baseline (tonne $CO_2$) (E = AxBxCxDx44/12) | = (0.074x10,000x1000x0.847)x 44/12 = 2298.2 |
| Project emission (tonne $CO_2$) | = 0.9x2298.2 = 2068.4* |

**: In project case 10% of gasoline consumption is replaced by ethanol, which is produced from organic sources and has zero GHG emissions. Therefore, only 90% of baseline gasoline used in baseline results in emissions during project case.*