CLIMATE CHANGE, GREENHOUSE GASES, & OZONE DEPLETING SUBSTANCE

Speaker:

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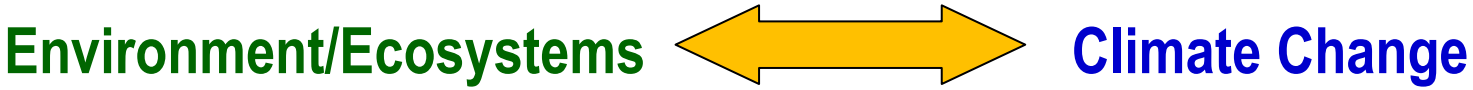
CPD Technical Staff
EMB MIMAROPA

Key Messages

- Learn the basic concepts of climate change
- Understand the relationship between climate change and the environment and ecosystems



- Understand the linkages between climate change and development

Climate and Weather

Is there any difference?

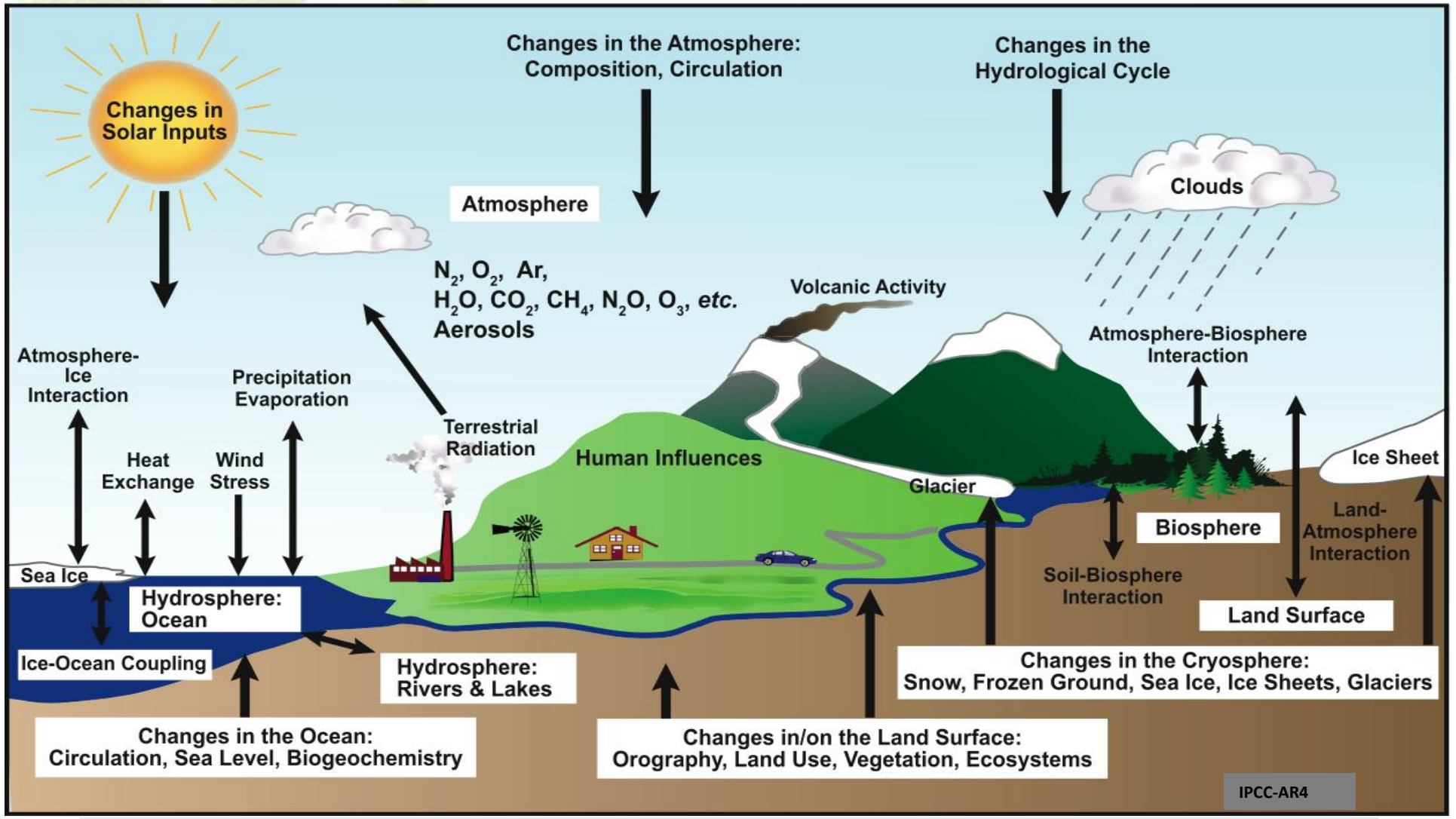
Climate

- **Long-term** average weather pattern in one place.
- Influenced by slow changes in the ocean, the land, the orbit of the Earth about the sun, and the energy output of the sun.
- Fundamentally controlled by the balance of energy of the Earth and its atmosphere.

Weather

- **Conditions at one particular time and place,** including temperature and rainfall
- Can change very rapidly from day to day, and from year to year.
- Changes involve shifts in temperatures, precipitation, winds, and clouds.

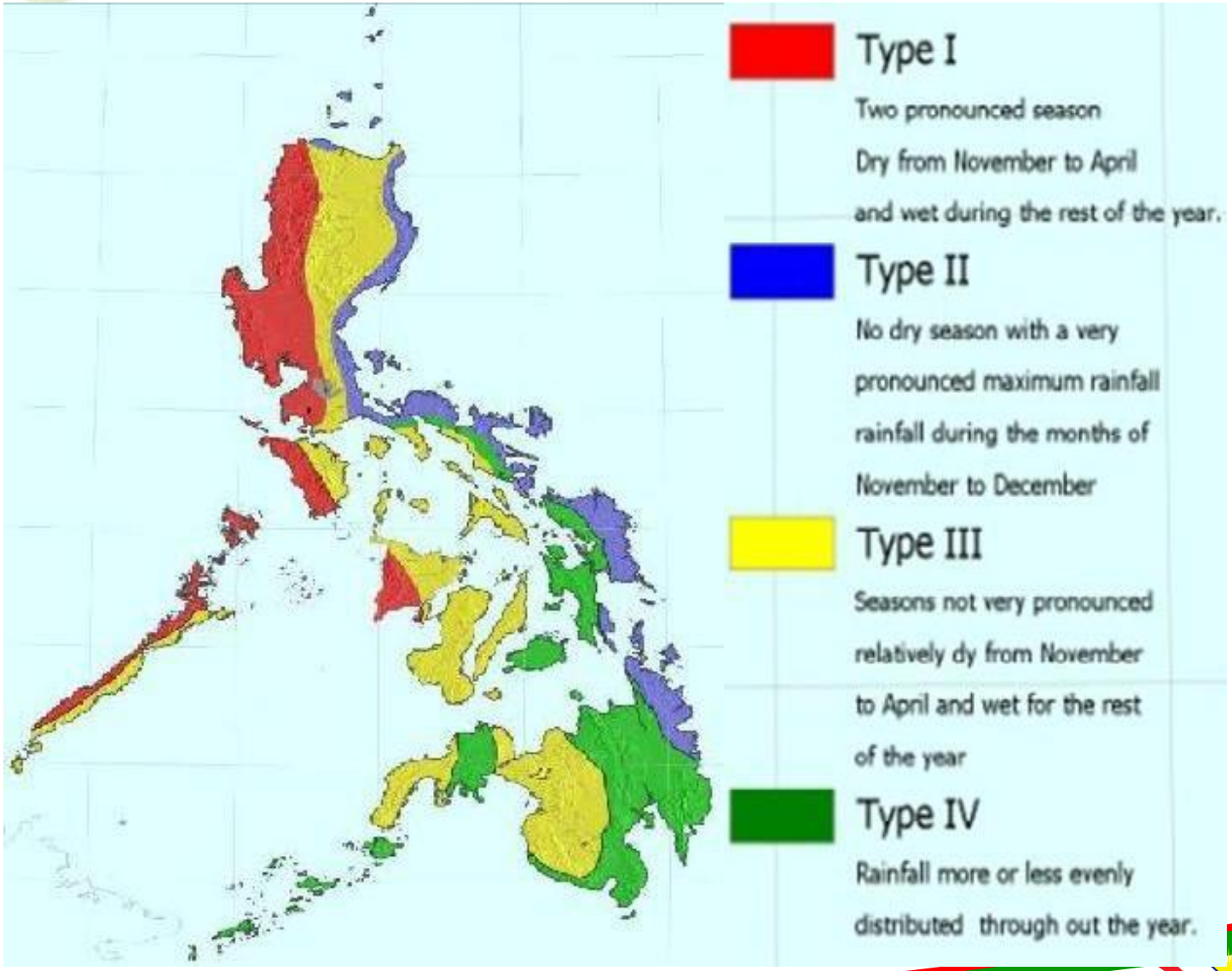
What is the climate system?



The Earth's climate system is created by complex interactions between the Sun, our atmosphere, oceans, land, ice and biosphere which in turn are affected by an area's latitude, elevation, terrain, and distance from coasts, mountains and lakes.

Four Climate Types of the Philippines

based on Modified Coronas Classification System

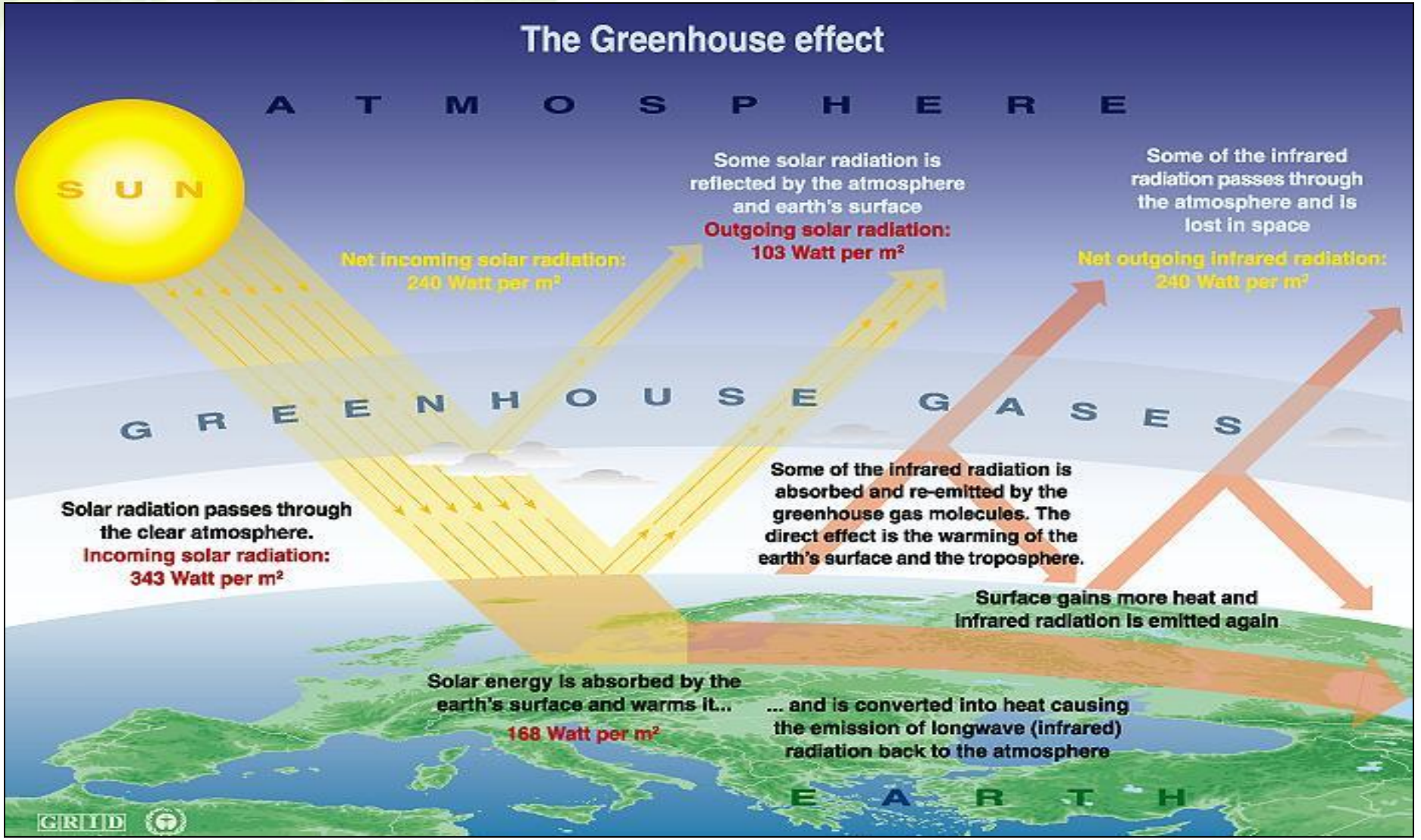


Source: PAGASA

To be able to understand climate change is to understand first the concept of ***greenhouse effect***.

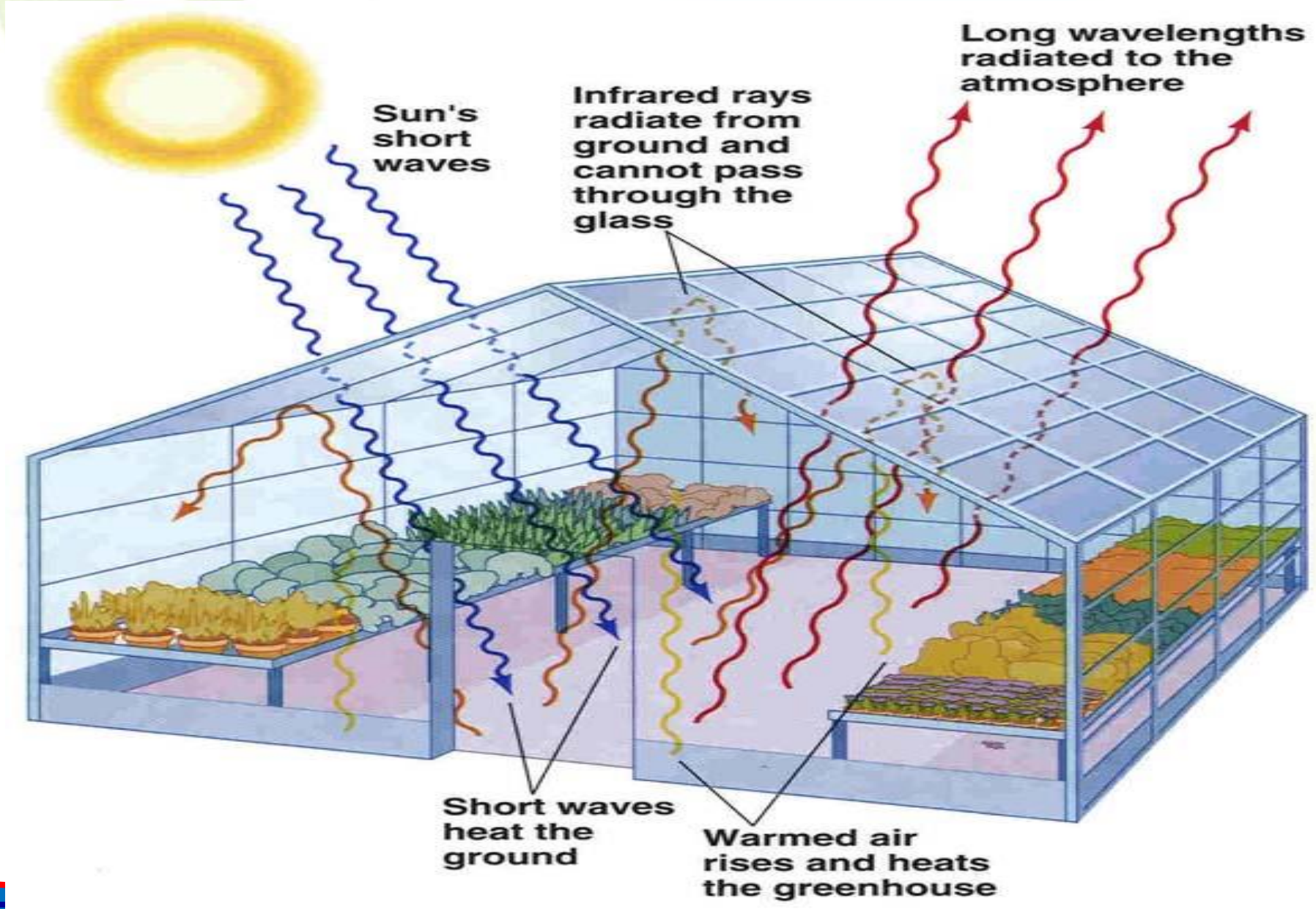
How does the greenhouse effect work?

Most greenhouses look like a small glass house. Greenhouses are used to grow plants, especially in the winter. Greenhouses work by trapping heat from the sun. The glass panels of the greenhouse let in light but keep heat from escaping. This causes the greenhouse to heat up, much like the inside of a car parked in sunlight, and keeps the plants warm enough to live in the cool seasons.



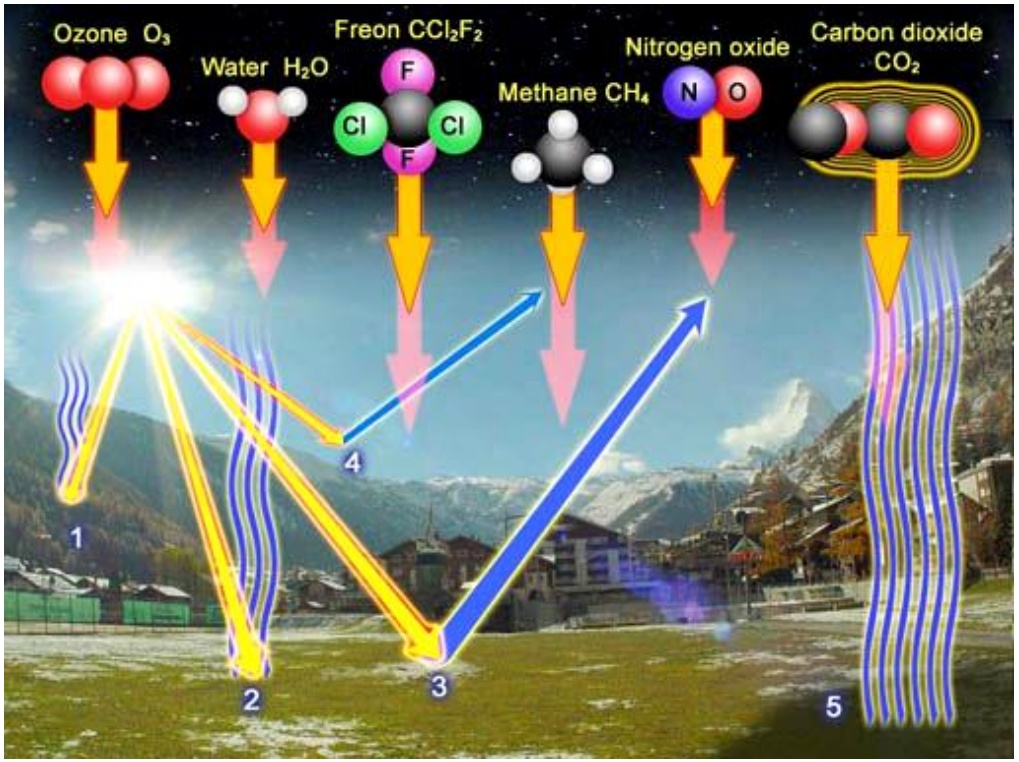
Greenhouse effect refers to rise in global temperature due to the process by which the gases in the atmosphere trap the heat coming from the sun that is re-radiated by the earth's surface and re-emit it downwards. Because of how they warm our world, these gases are referred to as greenhouse gases.

Greenhouse Effect and Global Warming



So what are the greenhouse gases (GHGs)?

- Water vapor
- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Ozone (O_3)



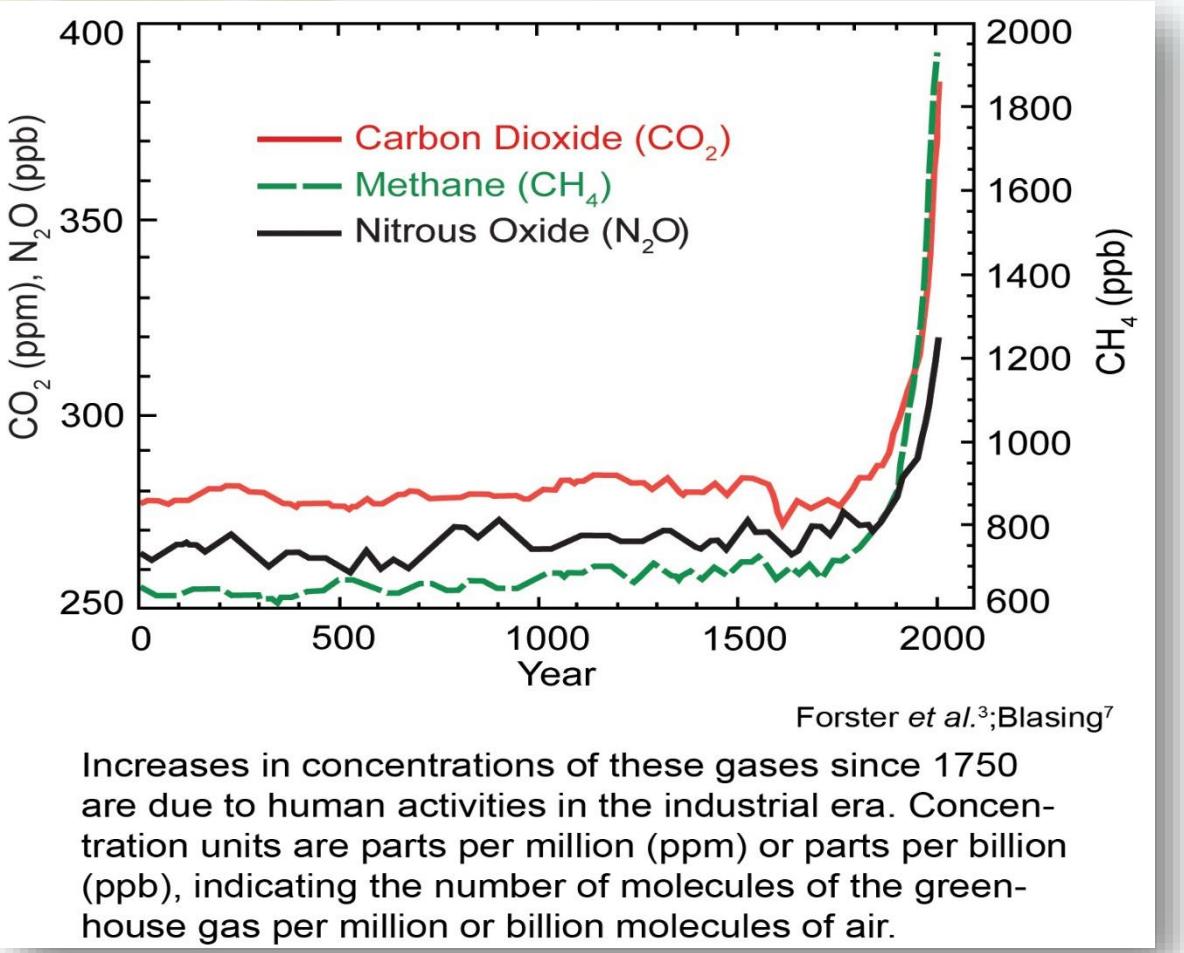
The **GHGs** are produced by **natural processes** such as:

- water cycle
- growth and death of plants and animals
- decaying of wood and other biodegradable materials
- volcanic activities

Importance of greenhouse gases

These are the naturally occurring gases that keep the Earth comfortably warm enough for plants and animals to live in at an average temperature of 15°C. They act as a **natural blanket around the earth**, trapping heat much like a glass roof of a greenhouse.

Without the greenhouse effect, the Earth's average surface temperature would be some 30° C colder or approximately -15° C and possibly not warm enough to sustain life.



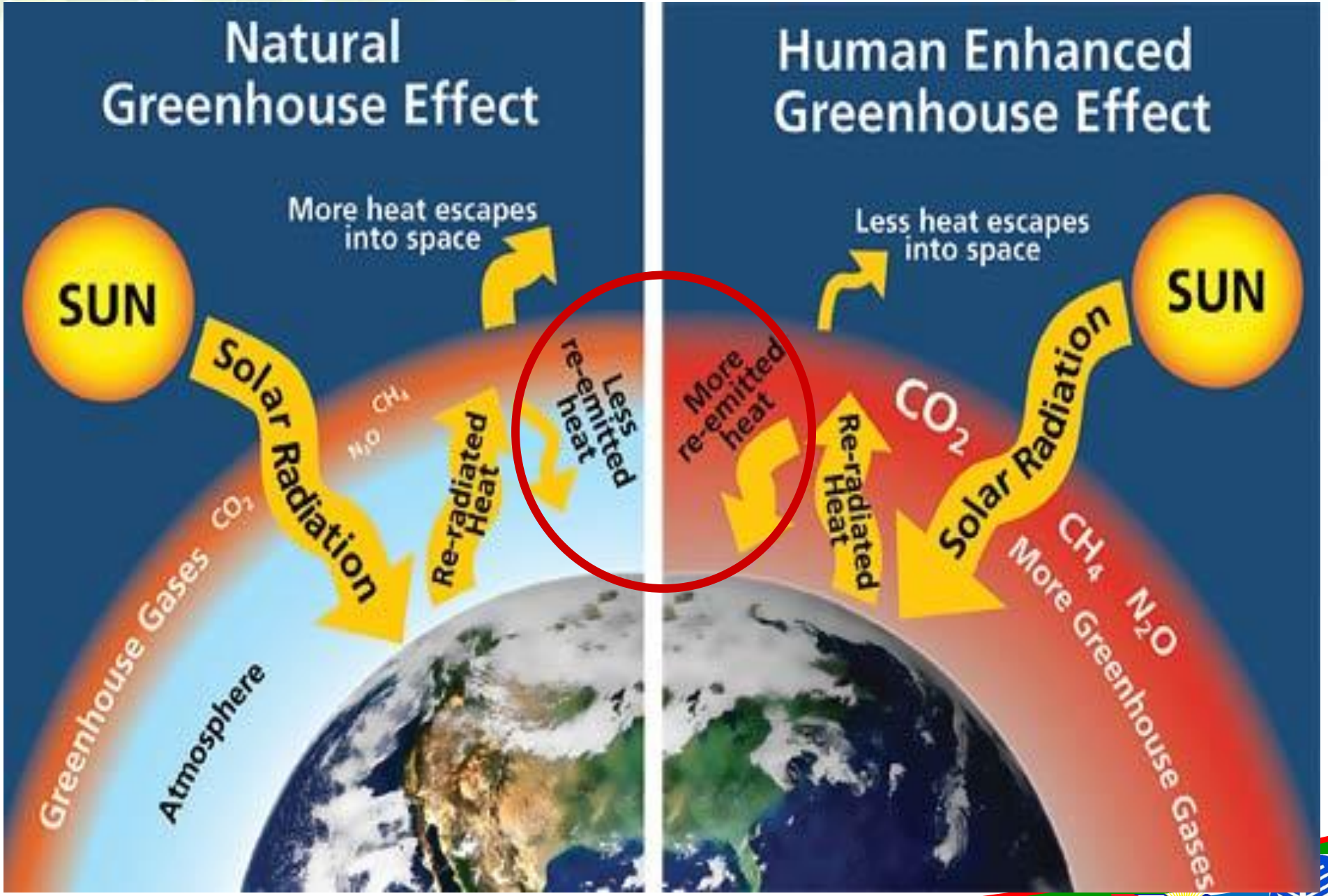
Forster *et al.*[3];Blasing[7]

Increases in concentrations of these gases since 1750 are due 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 molecules of air.

Unfortunately, humans are affecting atmospheric greenhouse gas concentrations by introducing new sources or by interfering with natural processes that destroy or remove GHGs.

How do greenhouse gases influence climate change?

By burning fossil fuels due to industrialization and to sustain our modern lifestyle, the level of GHGs increase rapidly. The higher the concentration of greenhouse gases in the atmosphere, the stronger the greenhouse effect making it into **enhanced greenhouse effect**.


Natural
Greenhouse Effect
More heat escapes
into space
SUN
Solar Radiation
Re-radiated
Heat
Less
re-emitted
heat
Greenhouse Gases
Atmosphere
Human Enhanced
Greenhouse Effect
Less heat escapes
into space
SUN
Solar Radiation
More
re-emitted
heat
Re-radiated
Heat
More Greenhouse Gases

This is what is causing climate change. Climate change, therefore, is caused by both natural events and human (**anthropogenic**) activities. Scientists now agree that most of the global warming today have been caused by human activities.

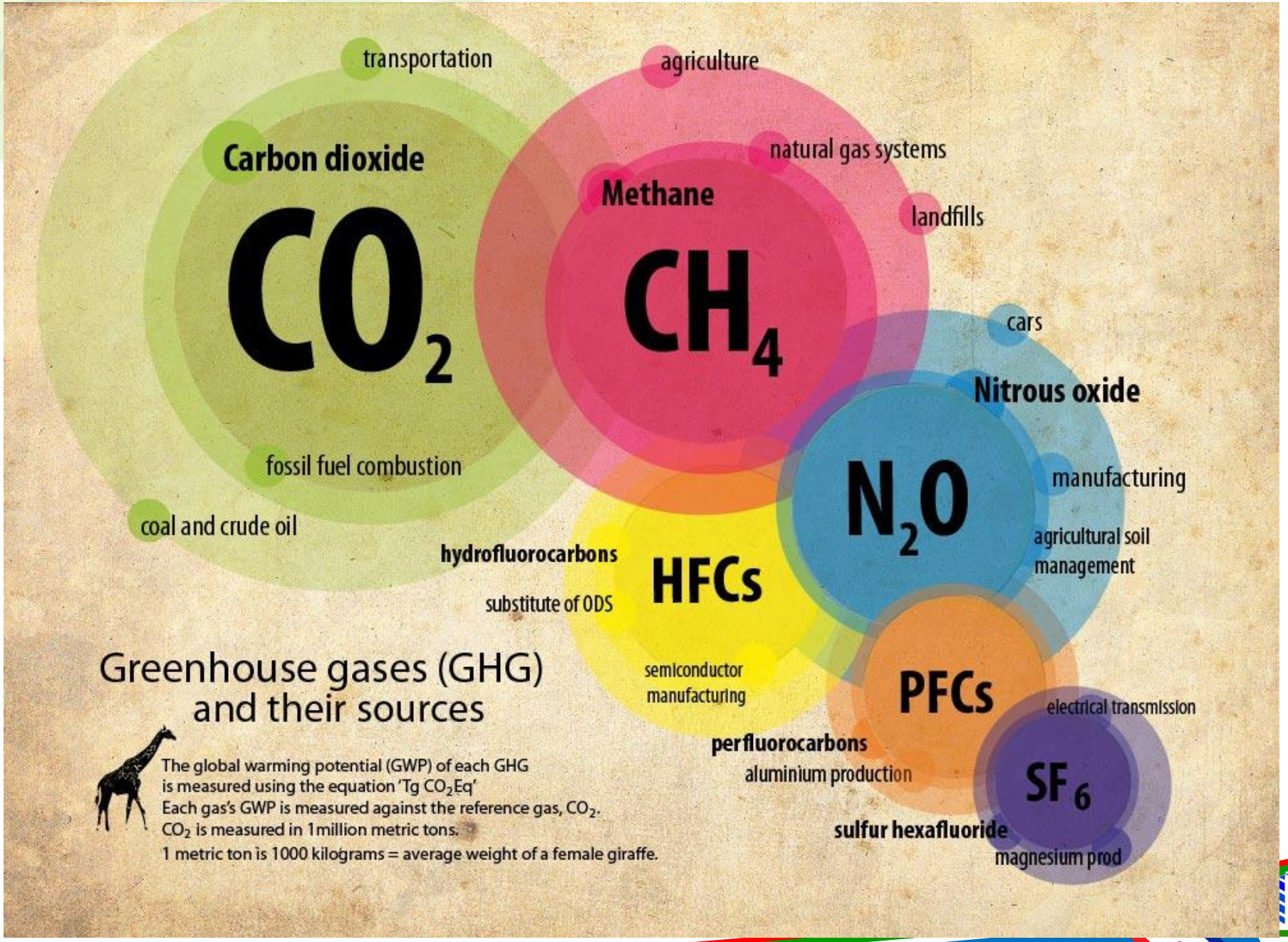
Human (Anthropogenic) Sources of GHGs

Carbon Dioxide (CO_2) – Most prevalent GHG
Methane (CH_4) – Second most common, 21x the potency of CO_2
Nitrous Oxide (N_2O) – 310x the potency of CO_2
Other Gases – HFCs, PFCs, and SF_6 = range 600 – 23900x potency of CO_2

Energy Generation
Industrial Processes

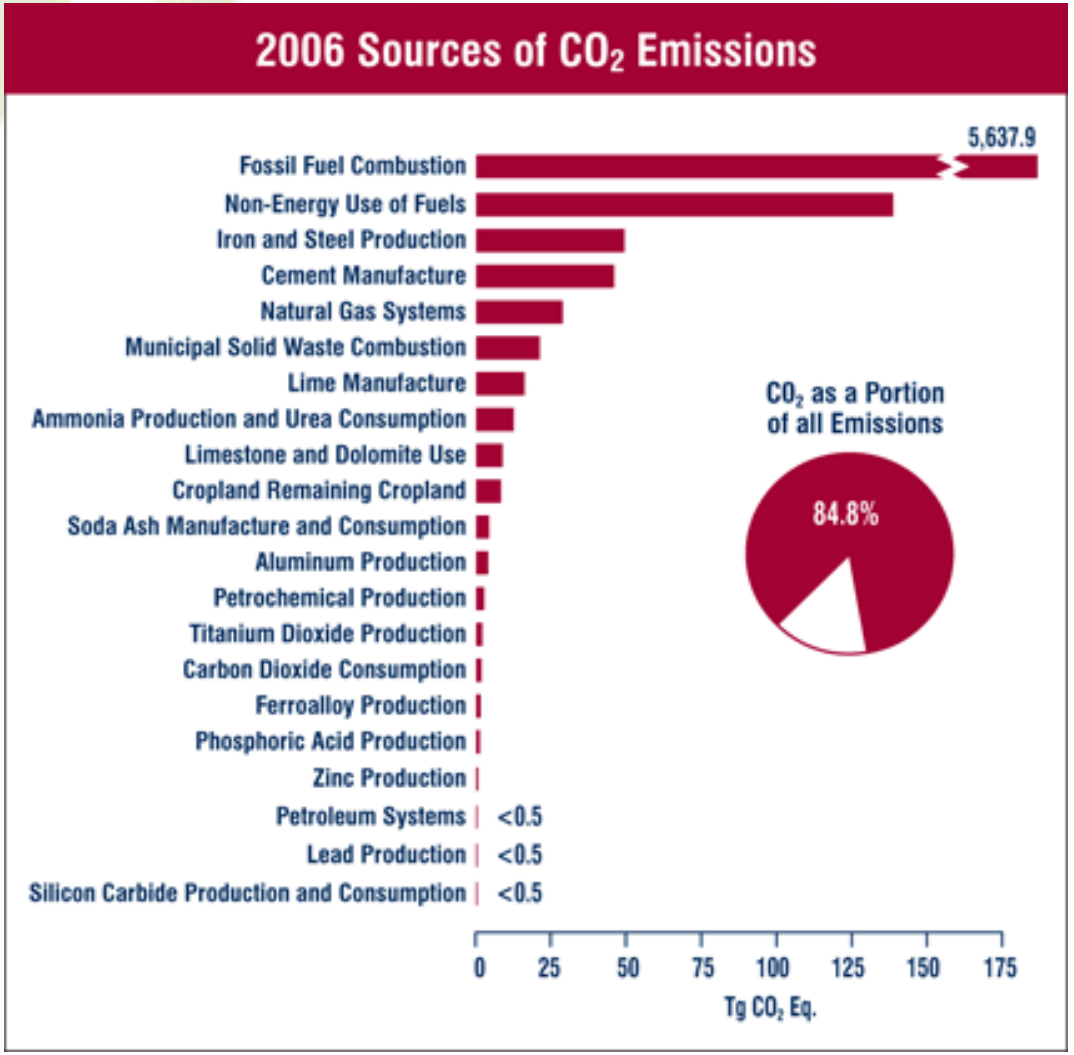
Transportation

Land Use:
Agriculture & Forestry


transportation
agriculture
Carbon dioxide
CO_2
natural gas systems
Methane
CH_4
landfills
cars
Nitrous oxide
N_2O
manufacturing
agricultural soil management
fossil fuel combustion
coal and crude oil
hydrofluorocarbons
substitute of ODS
HFCs
semiconductor manufacturing
PFCs
electrical transmission
perfluorocarbons
aluminium production
SF_6
sulfur hexafluoride
magnesium prod
Greenhouse gases (GHG) and their sources
The global warming potential (GWP) of each GHG is measured using the equation 'Tg CO_2Eq'
Each gas's GWP is measured against the reference gas, CO_2.
CO_2 is measured in 1million metric tons.
1 metric ton is 1000 kilograms = average weight of a female giraffe.

Sources of Greenhouse Gases

Greenhouse Gas	Natural Sources	Human-Induced Sources
Carbon Dioxide (CO_2)	▪ Soils (biological processes) ▪ Ocean	▪ Burning of fossil fuels (coal, oil, gas) for: - power/energy generation - manufacturing - industrial processes - fuel for transportation ▪ Land-use changes, deforestation
Methane (CH_4)	▪ Wetlands ▪ Termites ▪ Ocean	▪ Flooded rice agriculture ▪ Livestock production ▪ Waste management system (landfills, etc.)
Nitrous Oxides	▪ Tropical soils (wet forests) ▪ Ocean	▪ Nitrogen-based fertilizers and chemicals ▪ Acid production processes, other industrial processes ▪ Combustion processes in vehicles
CFCs, HFCs, PFCs, SF_6	▪ None	▪ Coolants ▪ Sealants ▪ Insulations



Fossil fuel combustion is the largest source of carbon dioxide emissions.

Greenhouse Gases (GHGs)

GHG	Lifetime	GWP (CO_2-e)	% Total world emissions
Carbon Dioxide (CO_2)	5-200 years	1	77%
Methane (CH_4)	12 years	28	14%
Nitrous Oxide (N_2O)	114 years	265	8%
Sulfur Hexafluoride (SF_6)	3,200 years	23,900	<1%
Hydrofluorocarbons (HFCs)		140 to 11,700	<1%
Perfluorocarbons (PFCs)		6,500 to 9,200	<1%
Carbon Tetrafluoride (CF_4)	50,000 years		

GWP values and lifetimes from 1995 IPCC SAR

Global Warming Potential (GWP)

Heat-trapping ability of a GHG relative to that of carbon dioxide, it describes the degree of harm to the atmosphere of a unit of a given GHG to an equivalent unit of CO_2 over a given period of time.

Measured in metric tons of CO_2 equivalent (CO_2-e)

1 metric ton = 1.1 short ton

What is Climate Change?

- “A change of climate which is attributed directly or indirectly to **human activity** that alters the composition of the global atmosphere which is in addition to natural climate variability observed over a comparable period of time.” (United Nations Framework Convention on Climate Change (UNFCCC)

- “Any change in climate over time, whether due to natural variability or as a **result of human activity.**” (Intergovernmental Panel on Climate Change (IPCC)

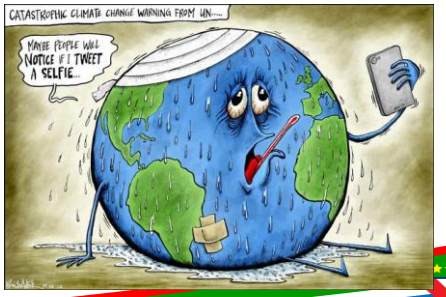
Know the difference . . .

GLOBAL WARMING

The gradual increase in the Earth's average surface temperature due to the increase of greenhouse gas emissions in the atmosphere from anthropogenic sources.

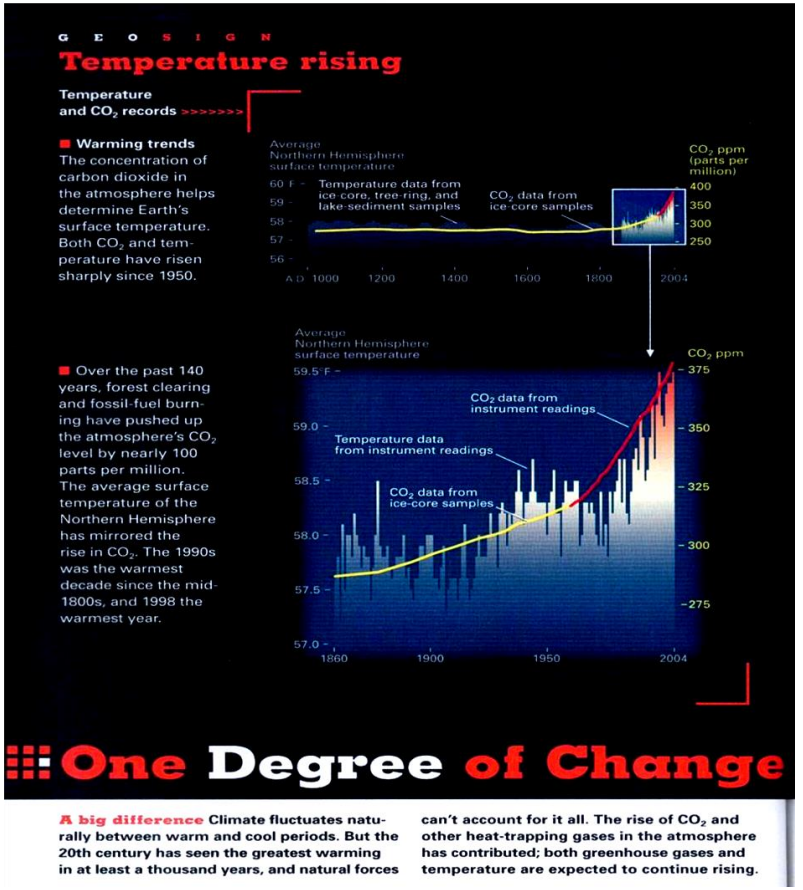
CLIMATE CHANGE

A significant change in the state of climate that persists for an extended period, identified by changes in the mean or variability of its properties including, average temperature and precipitation.



Effects of Climate Change

- Increase in minimum (nighttime) temperatures, maximum (daytime) temperatures, and **increases in the global mean temperature**.
- Increase in **sea surface temperatures, sea level** and changes in evaporation, and thus, changes in rainfall patterns among others.
- **Extreme** changes in weather patterns



What is happening?

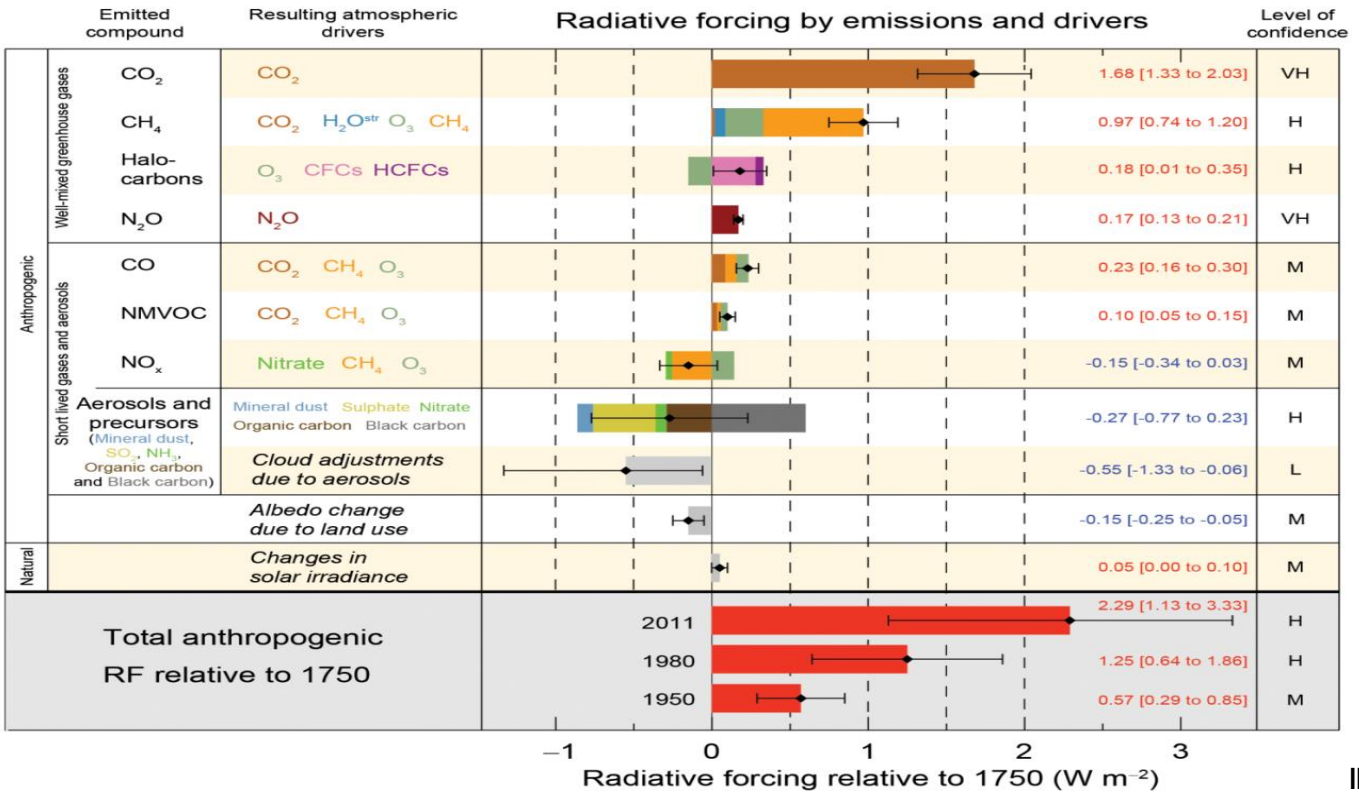
A recent report by the Working Group 1 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC-AR5)), a global group of experts on climate studies had recently been released in September 2013.

"Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millenia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased."

(IPCC-AR5)

Working Group 1 Contribution to the IPCC 5th Assessment Report

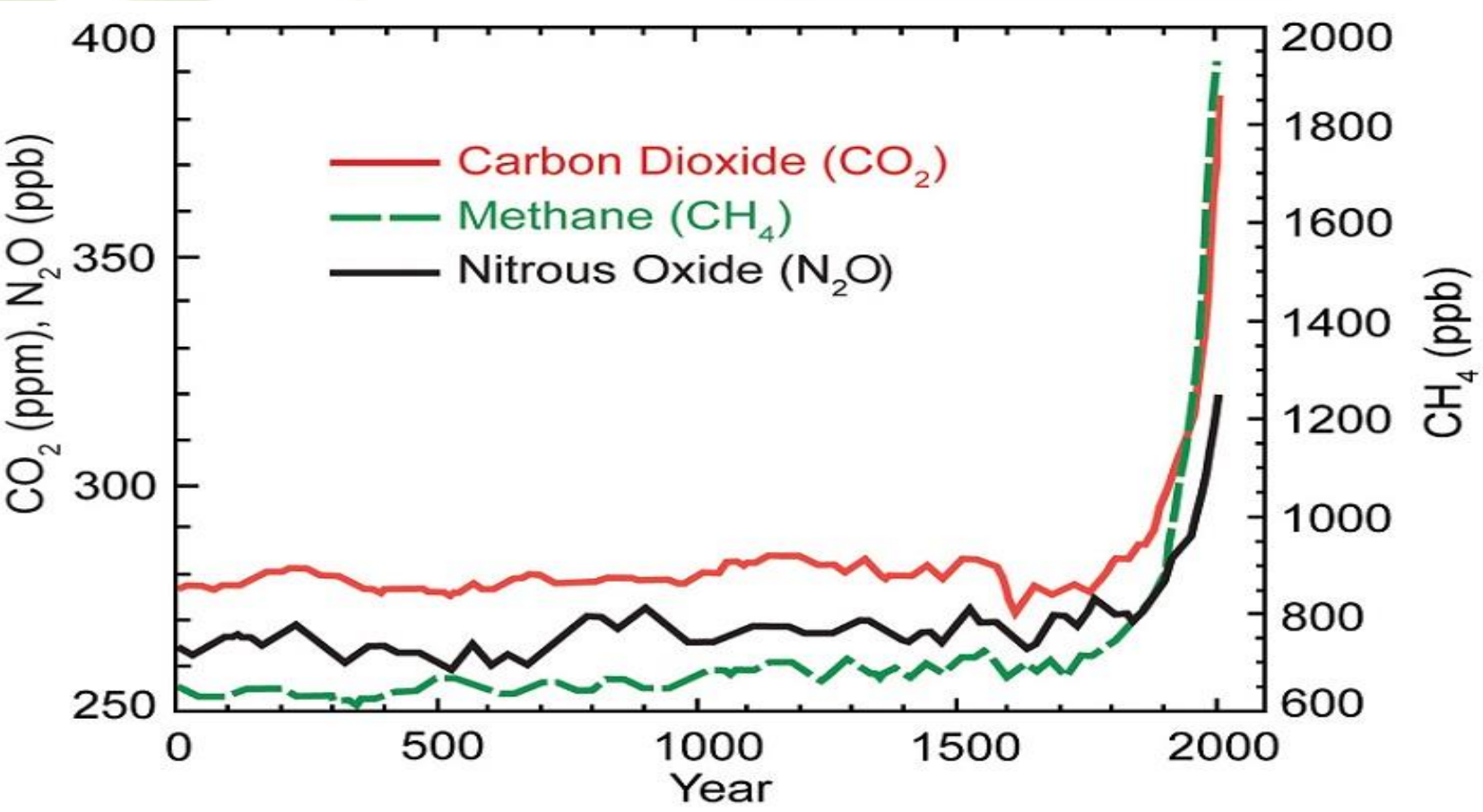
Radiative forcing estimates in 2011 relative to 1750



IPCC AR5 WG1

Human influence on the climate system is clear. This is evident from the **increasing greenhouse gas concentrations** in the atmosphere, positive radiative forcing, observed warming, and understanding of the climate system.

Evidence of Climate Change

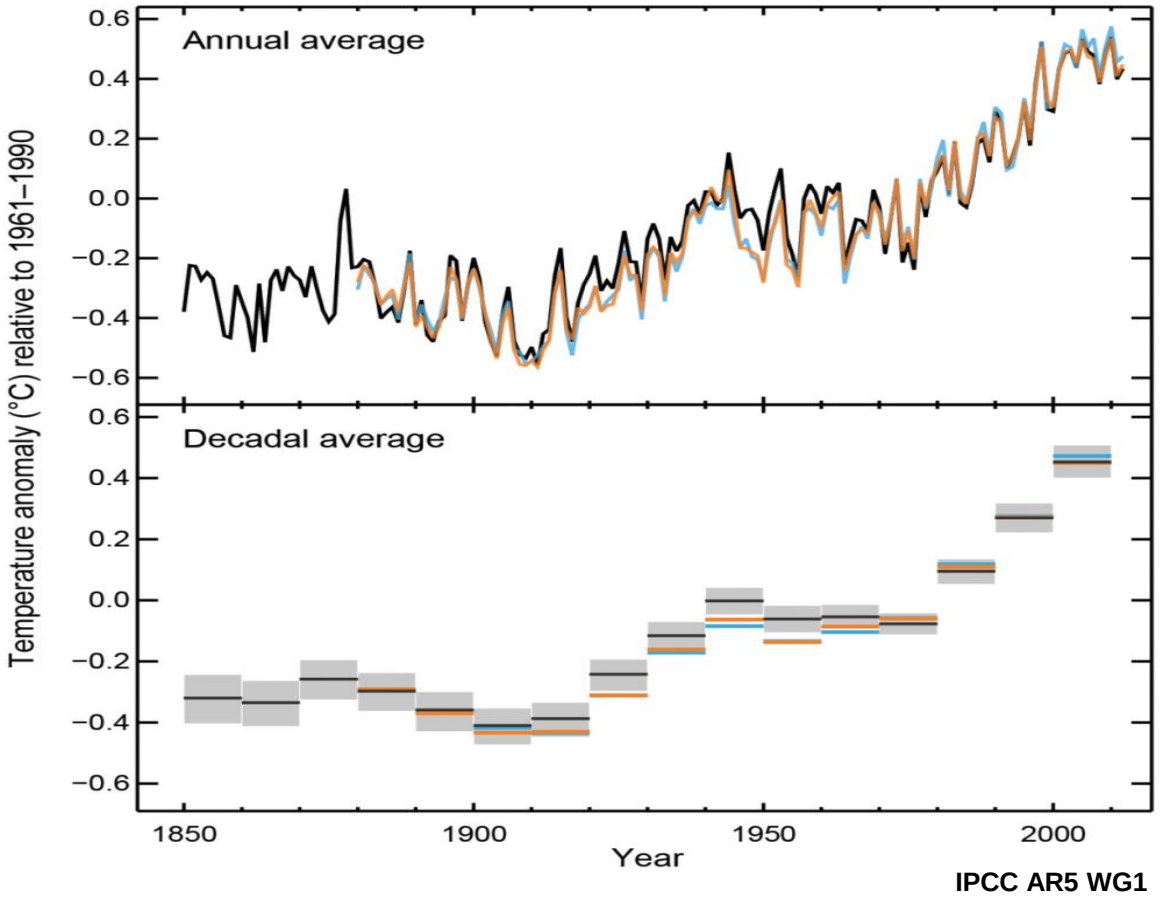


Source: U.S. National Climate Assessment (2014).

This graph shows the increase in greenhouse gas (GHG) concentrations in the atmosphere over the last 2,000 years. Increases in concentrations of these gases since 1750 are due to human activities in the industrial era.

Working Group 1 Contribution to the IPCC 5th Assessment Report

Observed globally averaged combined land and ocean surface temperature anomaly 1850-2012



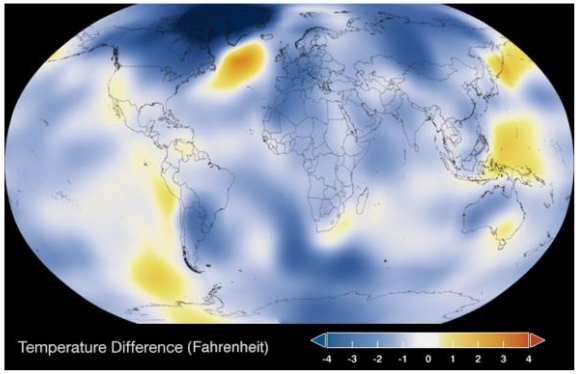
The globally averaged **combined land and ocean surface temperature** data show a **warming of 0.85** [0.65 to 1.08]° C over the period 1880-2012. The total increase between the average of the 1850-1900 period and the 2003-2012 period is 0.78 [0.72 to 0.85]° C.

Evidence of Climate Change

TIME SERIES: 1884 TO 2015

Data source: NASA/GISS
Credit: NASA Scientific Visualization Studio

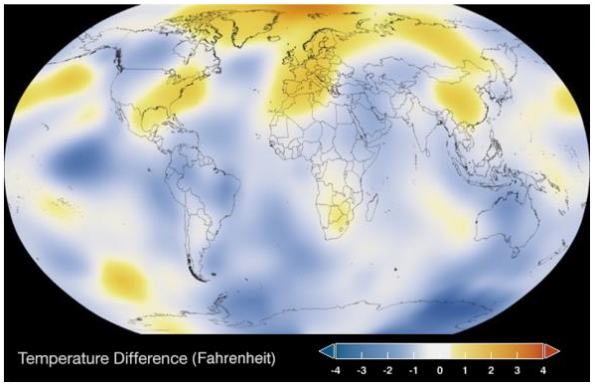
1890



TIME SERIES: 1884 TO 2015

Data source: NASA/GISS
Credit: NASA Scientific Visualization Studio

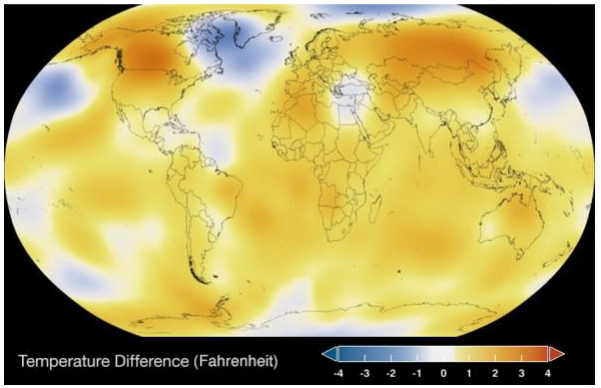
1950



TIME SERIES: 1884 TO 2015

Data source: NASA/GISS
Credit: NASA Scientific Visualization Studio

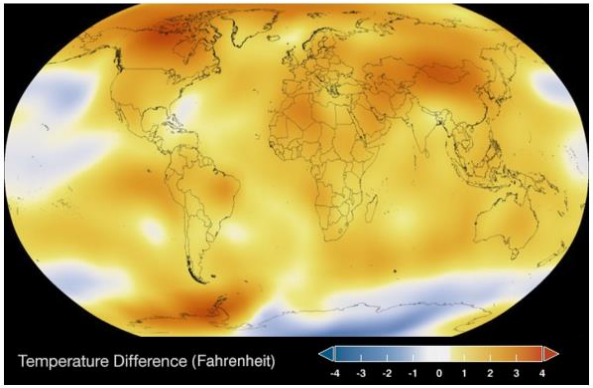
1990



TIME SERIES: 1884 TO 2015

Data source: NASA/GISS
Credit: NASA Scientific Visualization Studio

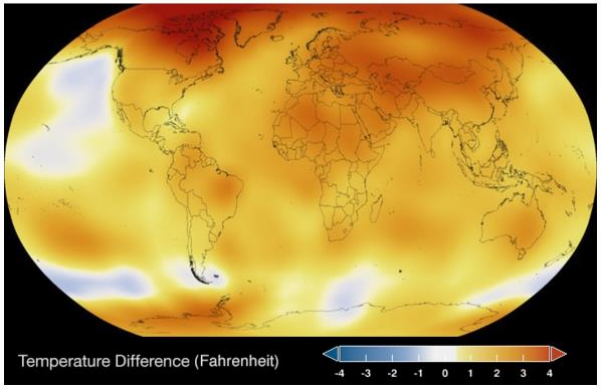
2000



TIME SERIES: 1884 TO 2015

Data source: NASA/GISS
Credit: NASA Scientific Visualization Studio

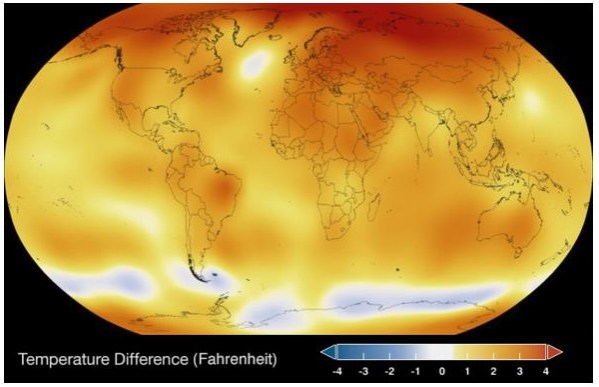
2010



TIME SERIES: 1884 TO 2015

Data source: NASA/GISS
Credit: NASA Scientific Visualization Studio

2015

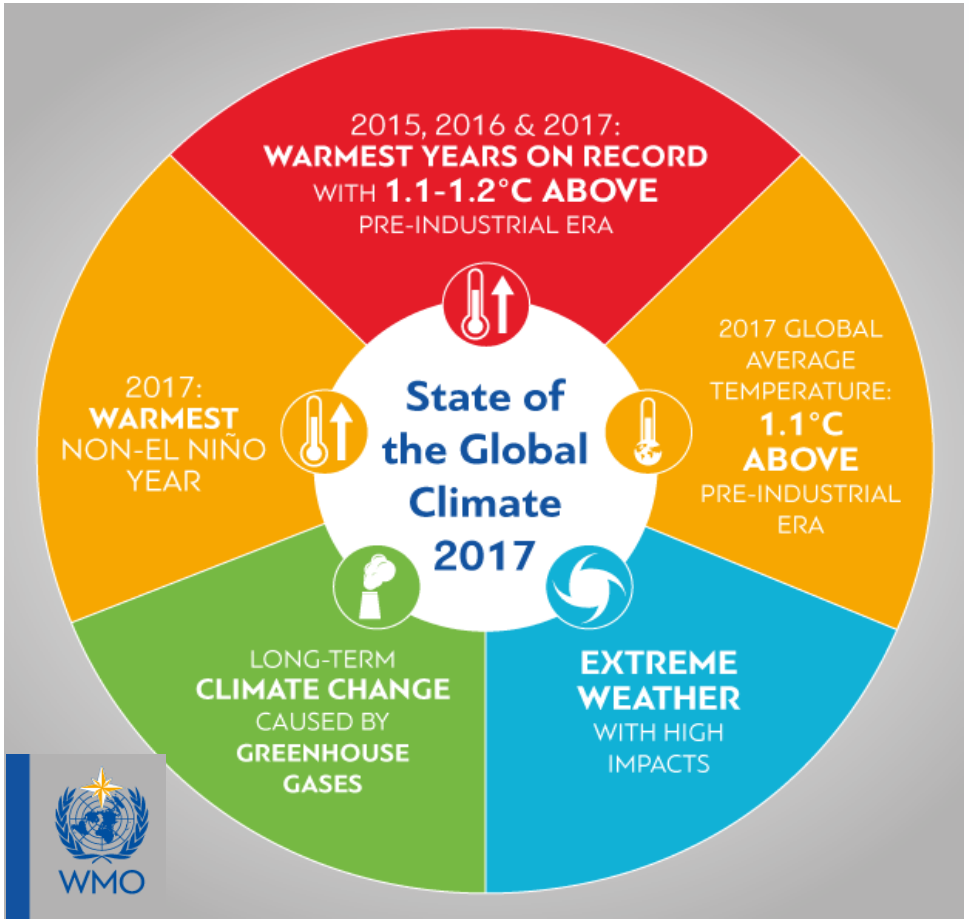


Ten Warmest Years (1880–2017)

RANK: 1880–2017	YEAR	ANOMALY °C	ANOMALY °F
1	2016	0.94	1.69
2	2015	0.90	1.62
3	2017	0.84	1.51
4	2014	0.74	1.33
5	2010	0.70	1.26
6	2013	0.67	1.21
7	2005	0.66	1.19
8	2009	0.64	1.15
9	1998	0.63	1.13
10	2012	0.62	1.12

NOAA National Centers for Environmental Information, State of the Climate: Global Climate Report for Annual 2017, published online January 2018, retrieved on July 23, 2018 from https://www.ncdc.noaa.gov/sotc/global/201713.

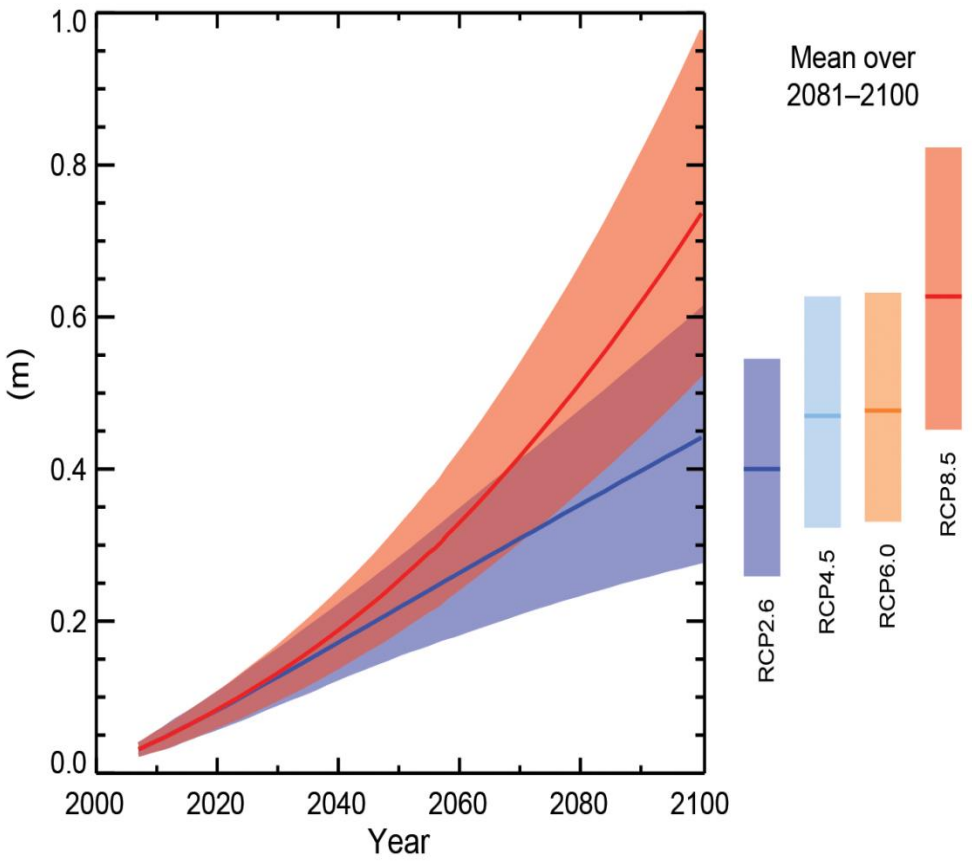
Latest from WMO



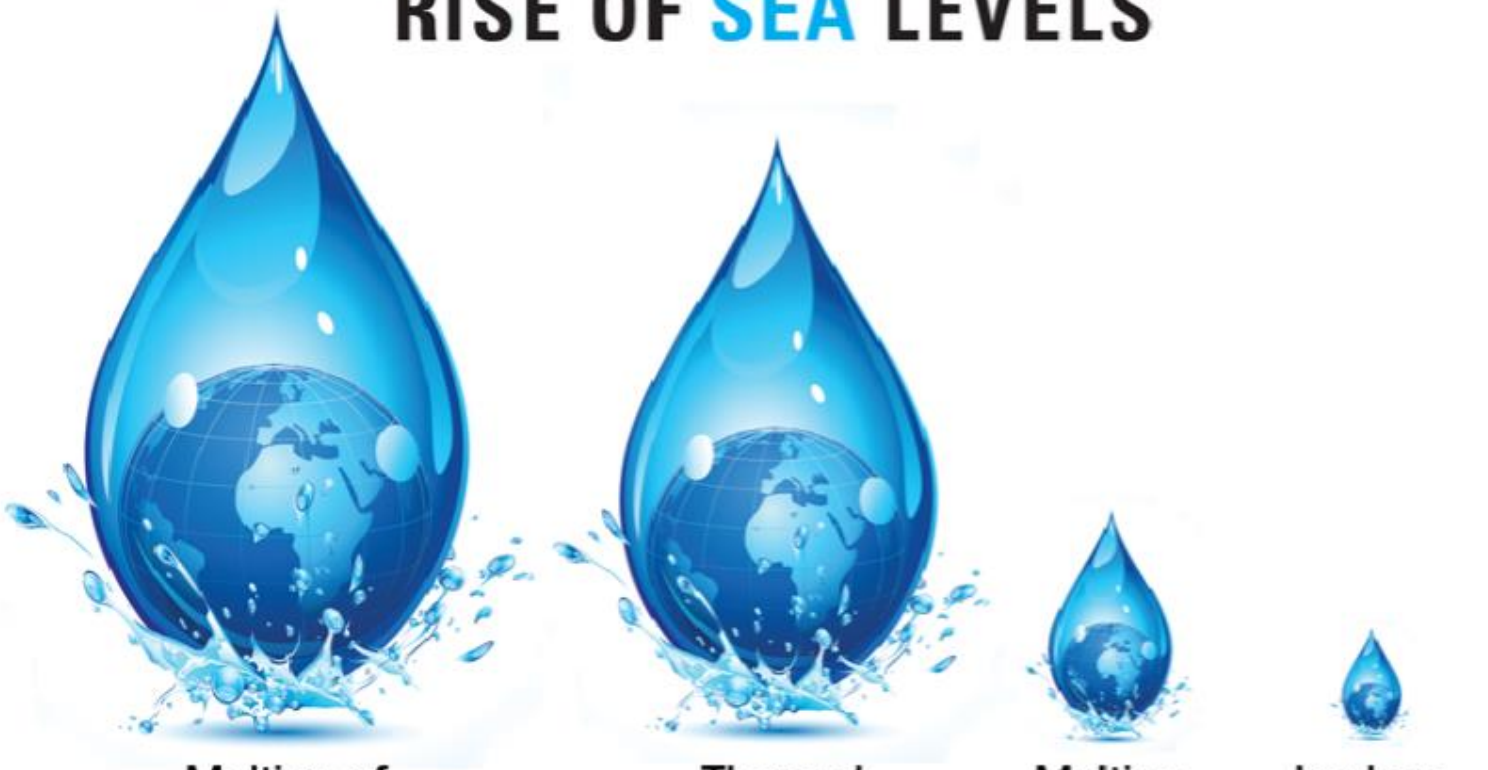
Working Group 1 Contribution to the IPCC 5th Assessment Report

- The rate of **sea level rise** since the mid-19th century has been larger then the mean rate during the previous two millennia. Over the period 1901 to 2010, global mean sea level rose by 0.19 [0.17 to .21] meters.
- Sea level rise will occur mostly as a result of the thermal expansion of warming ocean waters, the influx of freshwater from melting glaciers and ice, and vertical movements of the land itself

Global Mean Sea Level Rise



RISE OF SEA LEVELS



Melting of glaciers **45%**

Thermal expansion **38%**

Melting of Antarctic ice sheet **13%**

Ice loss from Greenland **4%**

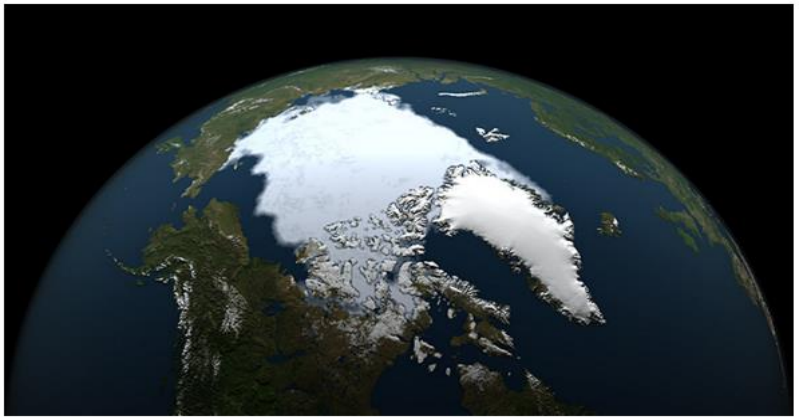
(SOURCE: CHART IS BASED ON THE DATA OBTAINED FROM IPCC)

Evidences of Climate Change: Ice

TIME SERIES: 1979-2015

Data source: Satellite observations.
Credit: NASA Scientific Visualization Studio

1979



TIME SERIES: 1979-2015

Data source: Satellite observations.
Credit: NASA Scientific Visualization Studio

2000

► 1979 2015

TIME SERIES: 1979-2015

Data source: Satellite observations.
Credit: NASA Scientific Visualization Studio

2010

TIME SERIES: 1979-2015

Data source: Satellite observations.
Credit: NASA Scientific Visualization Studio

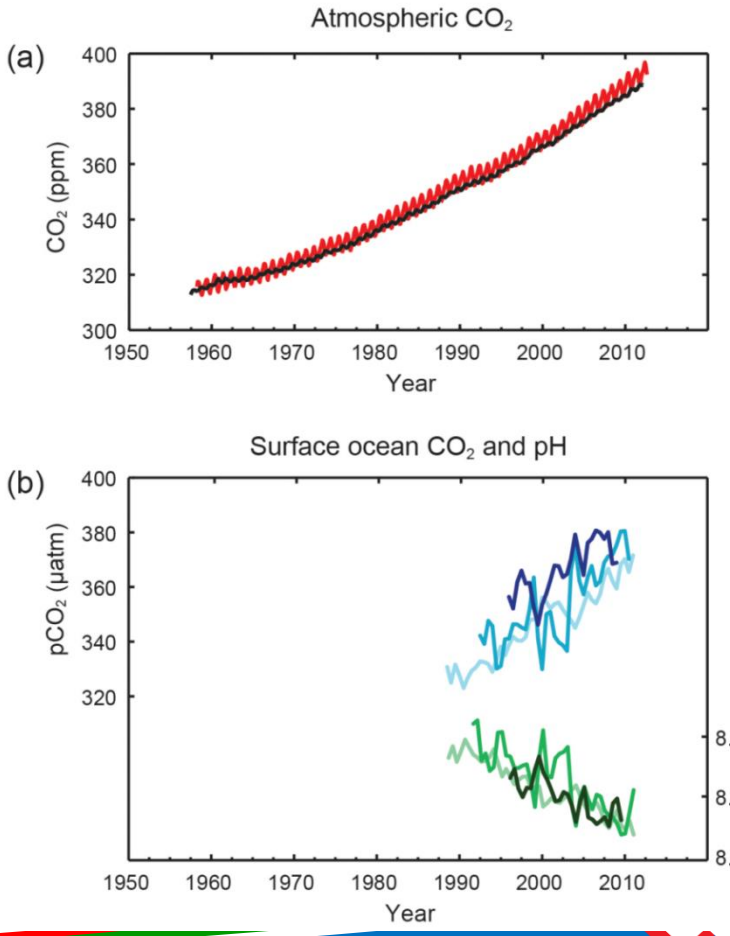
2015

Working Group 1 Contribution to the IPCC 5th Assessment Report

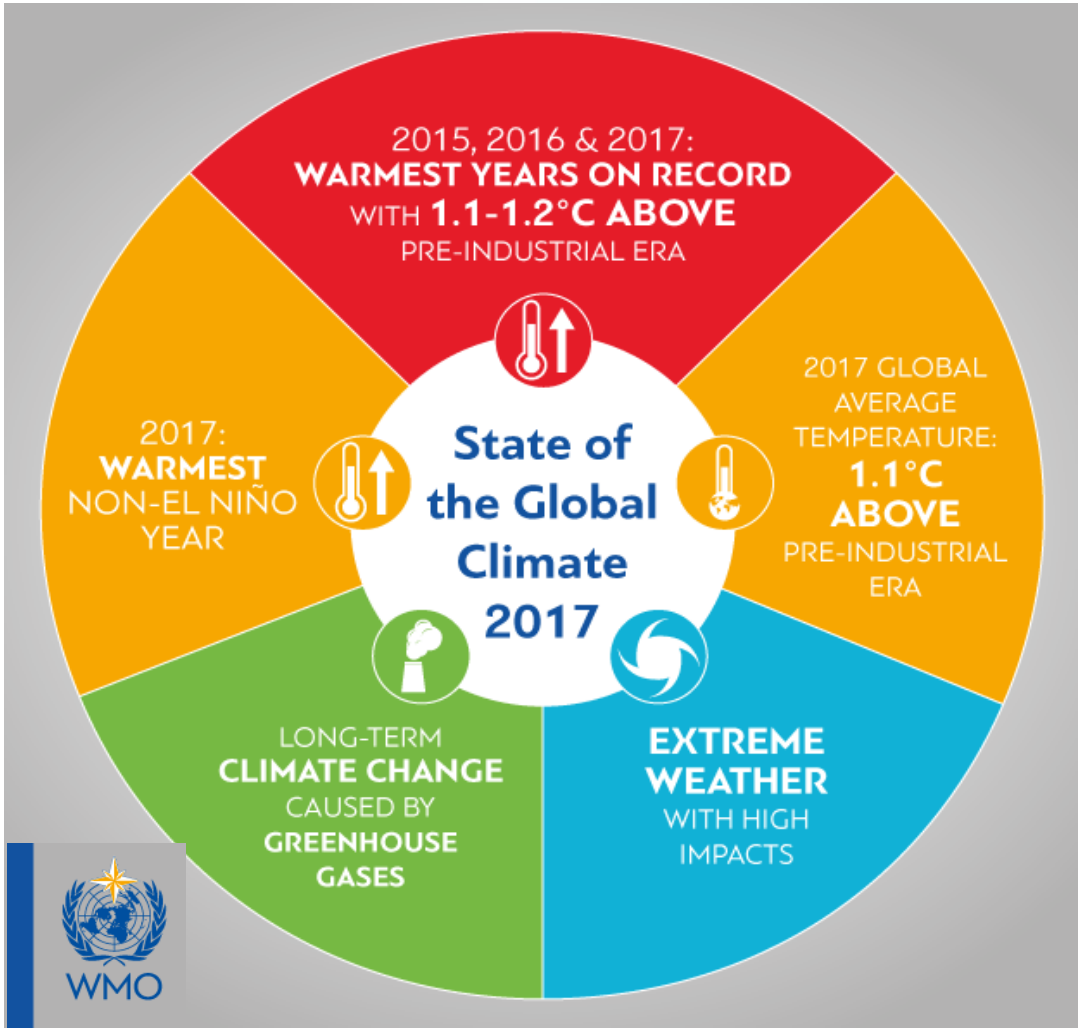
Multiple observed indicators of a changing global carbon cycle

The atmospheric concentrations of CO_2, CH_4 and N_2O have increased to levels unprecedented in at the last 800,000 years.

CO_2 concentrations have increased by 40% since the pre-industrial times. **The ocean has absorbed 30% of the emitted anthropogenic CO2, causing ocean acidification.**



Latest from WMO



The starting point

for WWF's analysis was
the strong scientific consensus that
any human-induced warming
greater than two degrees Celsius
above pre-industrial levels
would have a dangerous
and highly damaging impact
on both human societies
and their economies
and the global environment
as a whole.

2°C

Peak 475 ppm

Climate Change Impacts

Changes in temperature, weather patterns and sea level rise

Coastal/Marine Ecosystem

- Coastal erosion
- Storm surges
- Coastal flooding
- Saltwater intrusion
- Coral bleaching
- Ocean acidification

Agriculture

- Added heat stress, shifting monsoons, drier soils, water shortages/ irrigation demands
- Decreased rice/crop production
- Impact on livestock production
- Occurrence of weed infestation & diseases

Human Health

- Increase in vector-borne diseases
- Increase in cardio-vascular illnesses
- Increase in upper respiratory illnesses
- Occurrence of infectious diseases

Water Resources

- Impact on hydrological cycle, changing evaporation, precipitation and runoff patterns which could affect water resources (freshwater quantity and quality)
- Impact on power generation

Forests/ Biodiversity

- Shift in feeding point and disruption in flight patterns for migratory birds.
- Extinction of some mountain plants and animals
- Changes in species distribution, composition
- Invasion of weeds and alien species
- Loss and migration of plant and animal species

Industry and Energy

- Changes in energy supply and demand
- Impact on energy infrastructure
- Impact on industries such as wine, tourism, livestock, fishing, insurance, holiday resorts, mining, and others

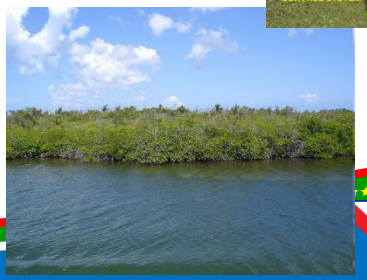
What can we do?

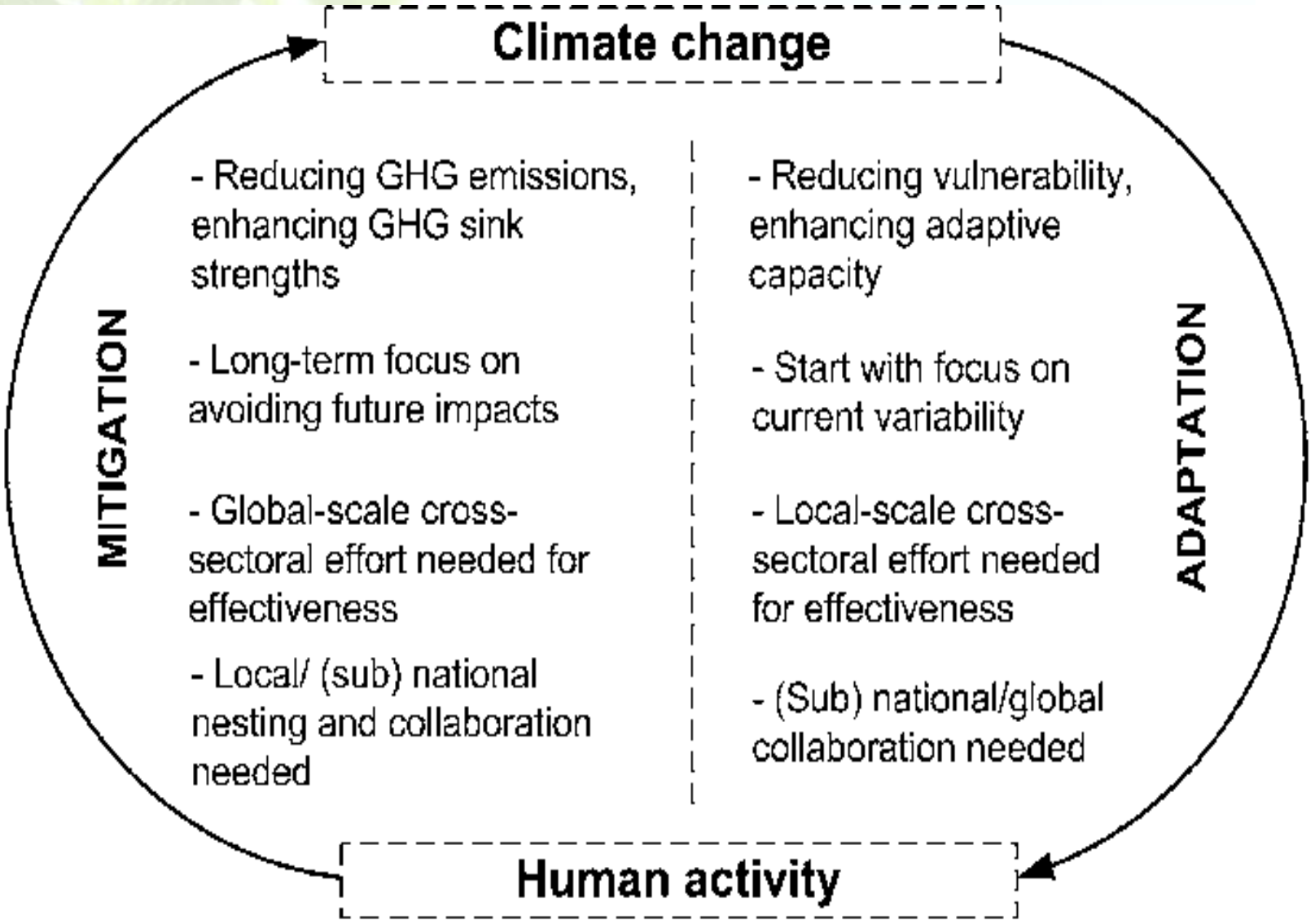
- Limit the cause of climate change through measures that could slow down the build up of atmospheric GHGs concentrations by reducing current and future emissions and by increasing GHG sinks (**Mitigation**)

  Reduce, minimize, avoid or stop GHG emissions

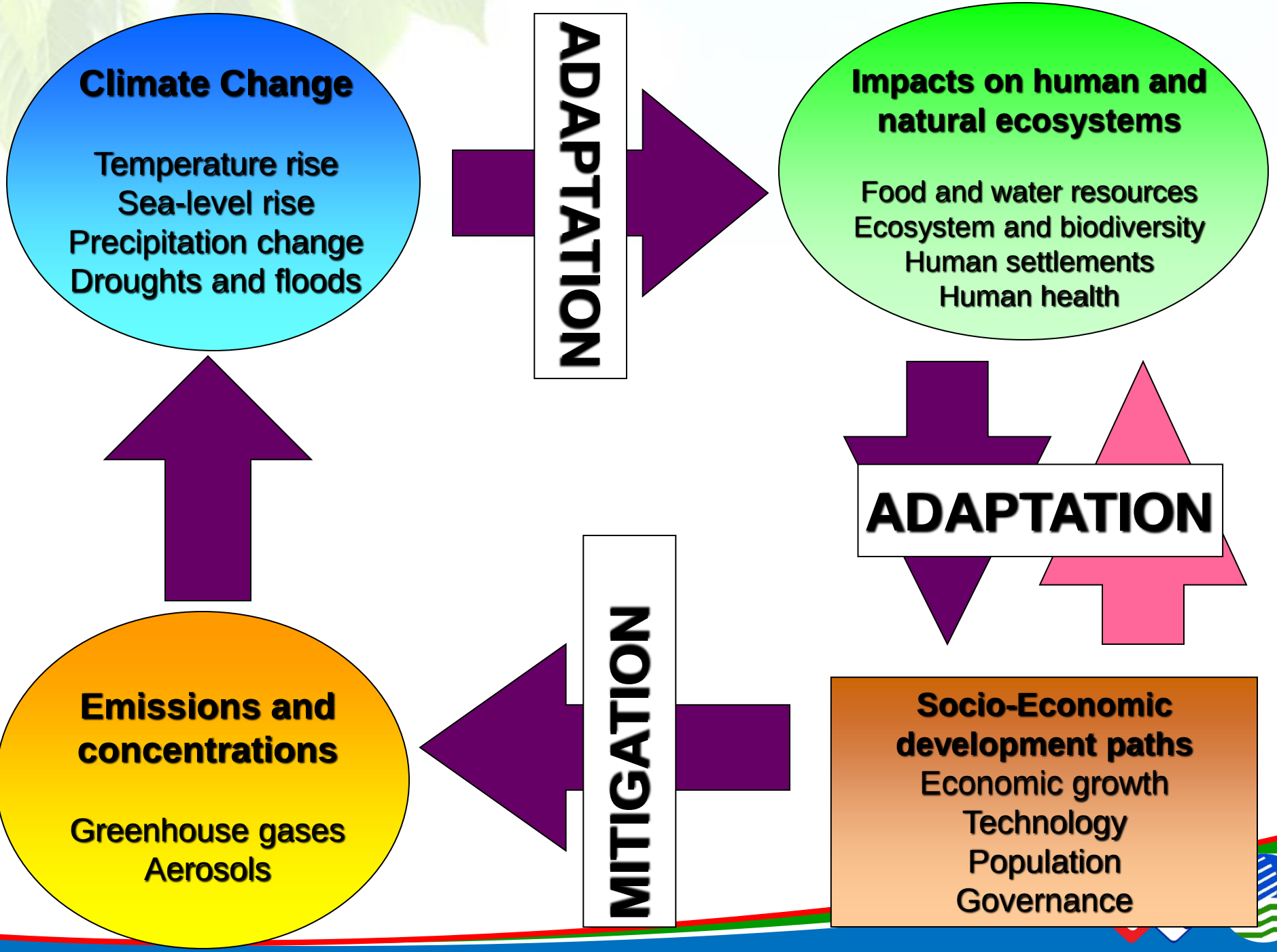
- Adjustment in natural or ***human systems*** in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (**Adaptation**)

  Increase the resilience and coping capacity of the sector with the current and future changes

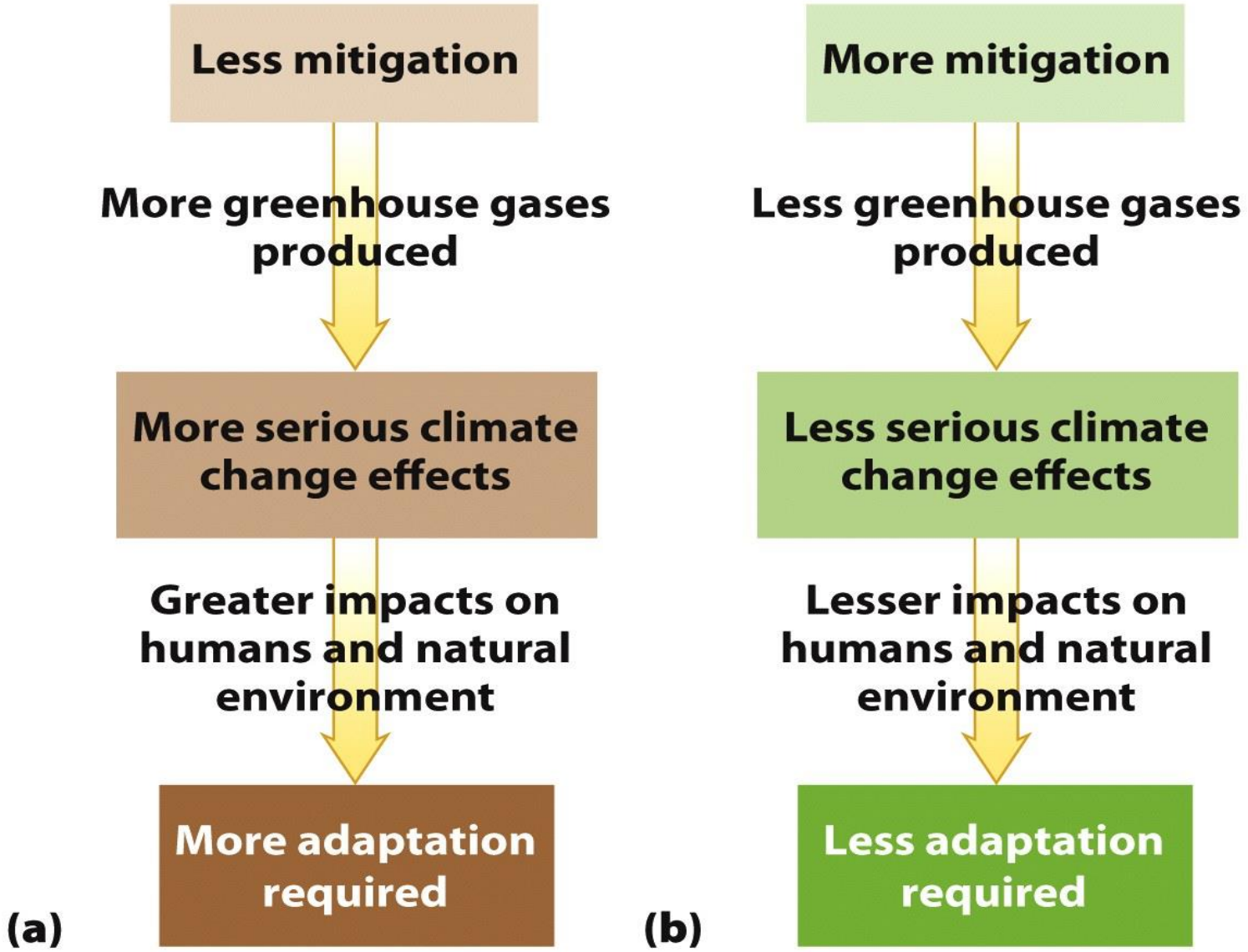




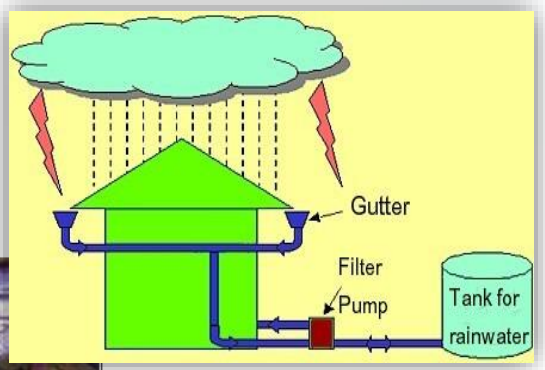
https://www.researchgate.net/figure/Climate-change-mitigation-and-adaptation-as-distinct-interventions-in-the-two-way_fig1_264126585

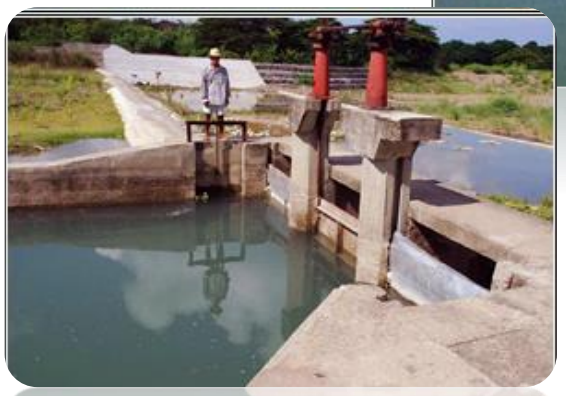

Climate Change
Temperature rise
Sea-level rise
Precipitation change
Droughts and floods
ADAPTATION
Impacts on human and natural ecosystems
Food and water resources
Ecosystem and biodiversity
Human settlements
Human health
ADAPTATION
Socio-Economic development paths
Economic growth
Technology
Population
Governance
MITIGATION
Emissions and concentrations
Greenhouse gases
Aerosols

Which is better?



Adaptation Measures





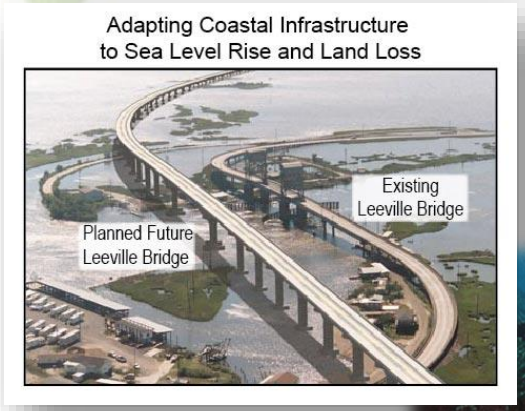
Water Sector

- Expanded rainwater harvesting
- water storage and conservation techniques
- water re-use desalination;
- water-use and irrigation efficiency

Agriculture

- adjustment of planting dates
- development of crop varieties
- crop relocation
- improved land management, e.g. erosion control and soil protection through tree planting

Coastal Areas



- Relocate residents living along low lying areas
- Set up marine reserve networks to replenish coral/fish larvae
- Mangrove reforestation to serve as buffer for strong waves and storm surge

Health Sector

- Sanitary practices
- Preventive care(e.g., vaccines)
- Information and awareness
- Health surveillance and monitoring

Energy Sector

- Strengthening of overhead transmission and distribution infrastructure
- Energy efficiency
- Use of renewable sources
- Reduced dependence on single sources of energy

Early Warning Systems

Awareness and Information Dissemination as Adaptation Strategies to Climate Change

- Promote awareness on climate change in your office, school, community, or in your home
- Update yourself on the latest information on climate change
- Be prepared for disasters

Mitigation measures/strategies

Energy Supply

Improved supply and distribution efficiency; fuel switching from coal to gas, nuclear power, renewable heat and power (hydropower, solar, wind, geothermal and bioenergy); combined heat and power; early applications of Carbon Dioxide Capture (e.g. storage of removed CO2 from natural gas)

Transport

More fuel efficient vehicles; hybrid vehicles; cleaner diesel vehicles; biofuels; modal shift from road transport to rail and public transport systems; non-motorised transport (cycling, walking); land use and transport planning

Buildings

Efficient lighting and daylighting; more efficient electrical appliances and heating and cooling devices; improved cook stoves, improved insulation; passive and active solar design for heating and cooling; alternative refrigeration fluids, recovery and recycling of fluorinated gases.

Mitigation measures/strategies

Forestry Sector

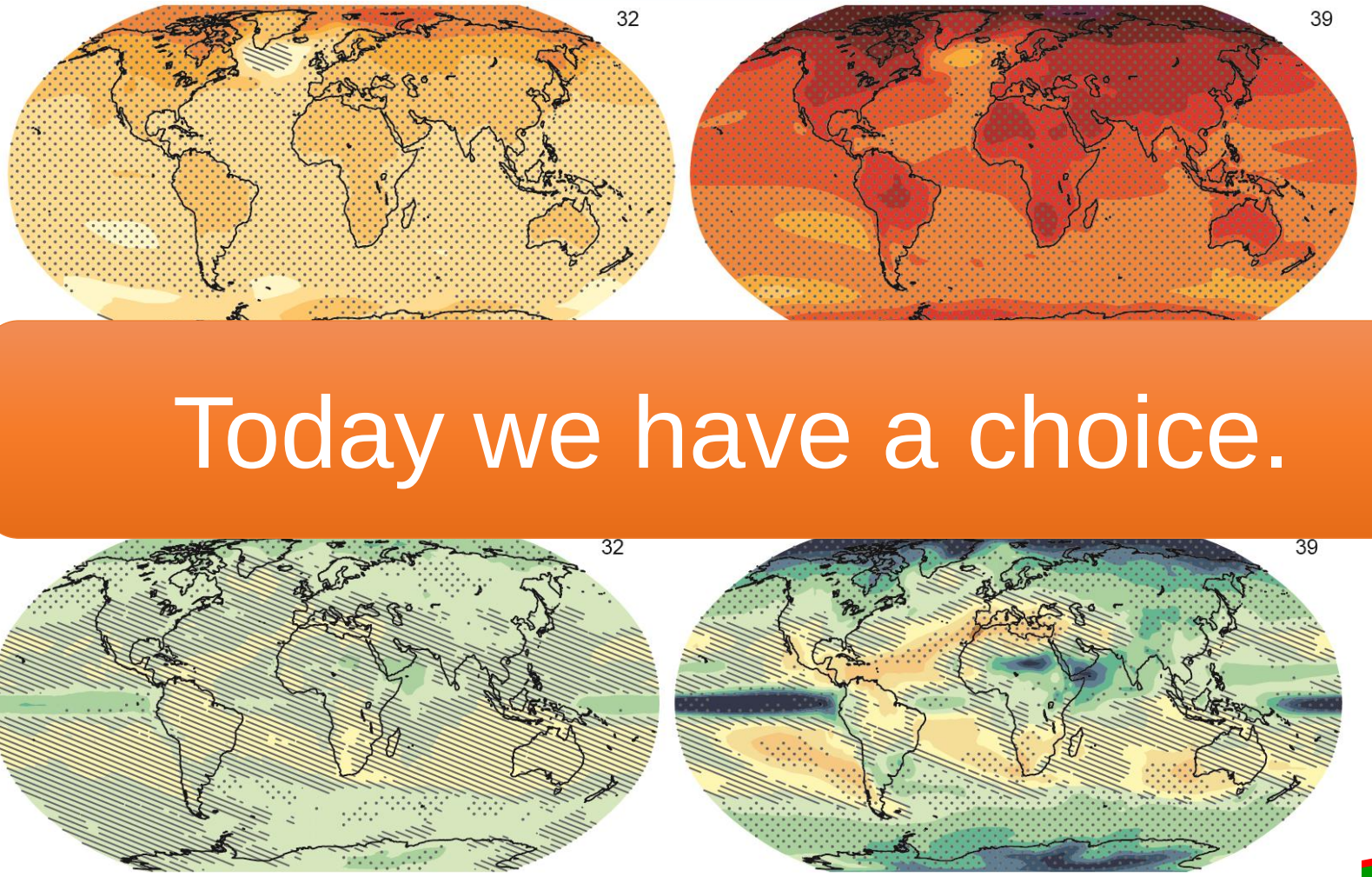
- Reforestation
- Afforestation
- Forest management
- Reduced deforestation
- Use of forestry products for bioenergy to replace fossil fuel use

Climate change is a core development issue

- Driver: Climate change is **caused by fossil fuel use to power development** as well as land conversion for production and development
- Outcomes: Impacts of climate change **jeopardize the inputs to development** and people's ability to benefit from and sustain development gains
- Solutions: Climate change **solutions** will be achieved **through low-carbon and climate-resilient development**

2°C world

4.5°C world



Today we have a choice.

IPCC 2013, Fig. SPM.8

Thank You!

Speaker:

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EMB MIMAROPA