GLOBAL WARMING & CLIMATE CHANGE

Presented by Dr. Kaustubh A. Bondre

CONCEPTS

- Global warming refers to gradual rise in atmospheric & ground surface air temperatures and consequent changes in global radiation balance caused mainly by anthropogenic processes, leading to climatic changes at different levels (local, regional & global).

- Radiative forcing, as defined by IPCC, refers to the effects which greenhouse gases have in altering the energy balance of the earth–atmosphere system.

EVIDENCES FOR GWCC

- Temperature records
- Melting of mountain & continental glaciers
- Warming of ocean water & rise in sea-level
- Thawing of permafrost areas
- Upward shifting of snow-lines of tropical & sub-tropical mountains
- Spreading of tropical diseases towards temperate & polar regions

CONTINUED..

- Changes in weather & patterns of precipitation
- Decrease in antarctic penguin population by 40%
- Poleward shift of jet streams

OZONE LAYER

- The thinning of stratospheric ozone layer allows more UV solar radiation to reach the Earth surface and thereby, increases the temperature of the Earth surface

- The creation and destruction of ozone gas is a gradual and continuous natural process

OZONE FORMATION

- Formation of ozone is due to collision of 3 oxygen atoms through the process of photomechanical reaction triggered by sunlight
- Most of the stratospheric ozone is formed over the tropical areas from where some ozone is transported by the atmospheric circulation to the polar areas up in the atmosphere
- Ozone is transformed into oxygen by photochemical processes and by collision of ozone with monoatomic oxygen

OZONE HALO

- Contrary to ozone depletion, ozone halo refers to concentration of excess ozone around a low ozone zone above a specific location

THE CFC gases

- Chlorofluorocarbons are neither toxic nor flammable at ground level
- In stratosphere, they become potent destroyer of the ozone layer through a set of chemical reactions

Air-conditioners

Refrigerators

USES

Spray-cans

Styrofoams

Industrial solvents

MECHANISMS OF DEPLETION

NATURAL PROCESSES	ANTHROPOGENIC
Conversion of nitrogen to nitrous oxides by solar activity	Chlorine hypothesis
UV radiation splits Ozone to O_2 & single oxygen molecule	Sulphate hypothesis
Atmospheric circulation redistributes the ozone molecules	Nitrogen oxides hypothesis
	Polar stratospheric clouds hypothesis

Impact on human beings

- Skin cancers, especially among the whites
- Reduction in immunity to various diseases
- Suppress the mental development of humans
- Negative impact on respiratory system
- Impact on food security- crops, vegetation & fishes

Major sources of ghg emissions

- Electric power stations based on fossil fuels
- Factories that consume energy
- Transport sector that burns fossils majorly
- Deforestation & burning of the firewood

Carbon dioxide emissions

- The pre-industrial level of atmospheric CO_2 was fixed at 280-290ppm (1860 A.D.)
- The relative contribution of developing countries in carbon emissions outpaced industrialised ones by 1986
- Total emissions based on per capita basis are still dominated by the developed nations

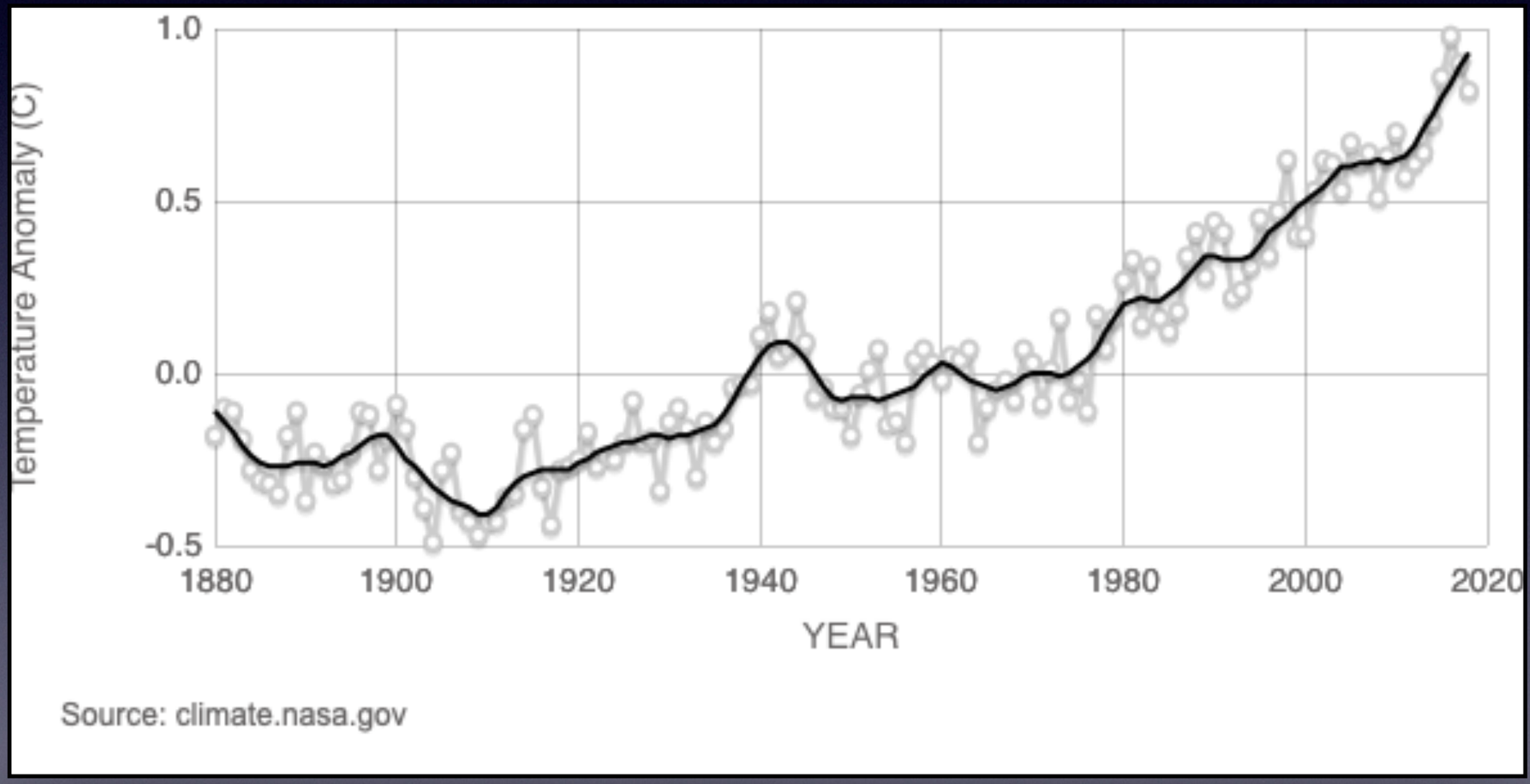
Ipcc

- Created in 1988 by the WMO & the UNEP
- objective of the IPCC is to provide governments at all levels with scientific information
- IPCC reports are also a key input into international climate change negotiations
- The IPCC is an organization of governments that are members of the UN or WMO. The IPCC currently has 195 members.

How ipcc works?

- IPCC scientists volunteer their time to assess the thousands of scientific papers published each year to provide a comprehensive summary
- IPCC identifies the strength of scientific agreement in different areas and indicates where further research is needed
- The IPCC does not conduct its own research
- The assessments are policy-relevant but not policy-prescriptive

Global warming

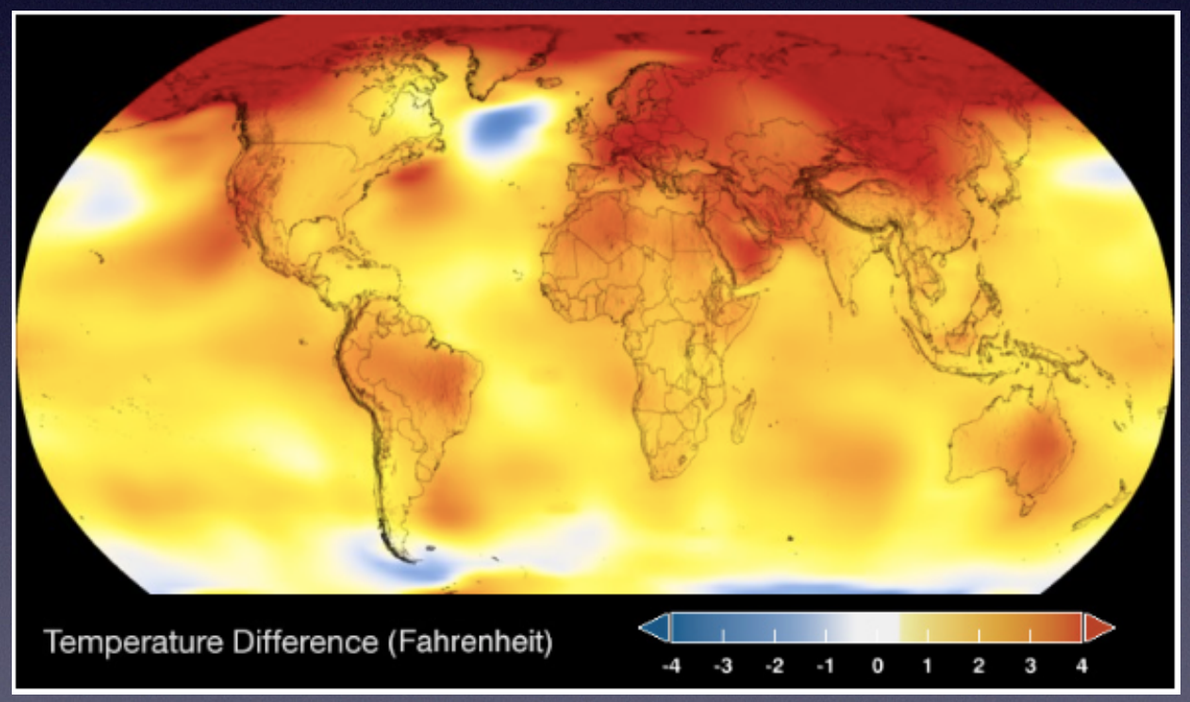


Rising temperatures

- Eighteen of the 19 warmest years all have occurred since 2001, with the exception of 1998

- The year 2016 ranks as the warmest on record

- Latest average annual anomaly for 2018 is $0.8^{0}C$



SEA-LEVEL RISE

- The world's seas have absorbed more than 90% of the heat from the GHGs, but it’s taking a toll
- 2018 set a new record for ocean heating
- Average sea levels have swelled over 8 inches (about 23 cm) since 1880, with about three of those inches gained in the last 25 years.
- Every year, the sea rises another .13 inches (3.2 mm)

Thermal expansion

Melting glaciers

SEA-LEVEL RISE

Loss of Greenland & Antarctic ice-sheets

Coastal invasion

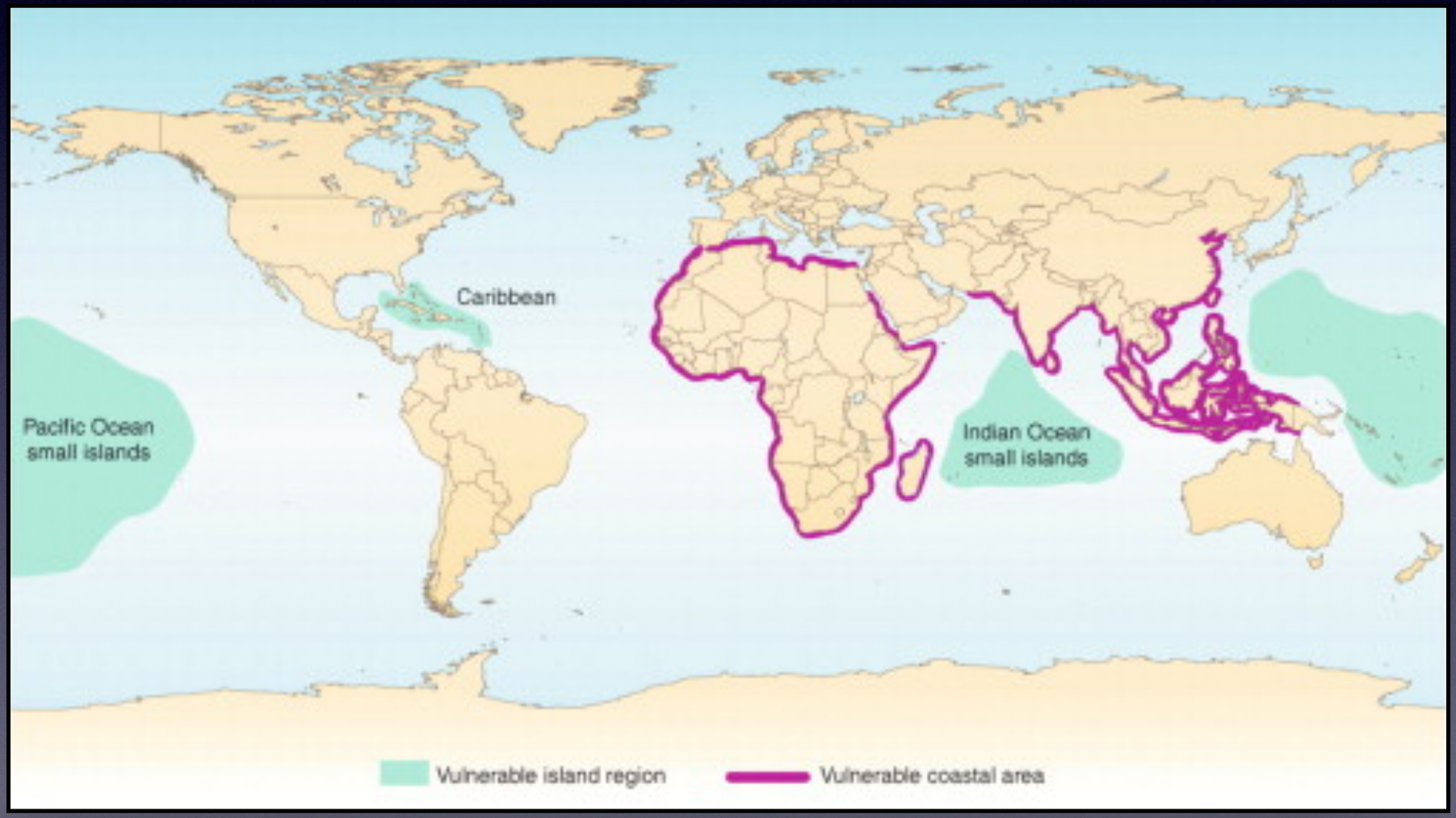
Extreme events

CONSEQUENCES

Climate refugees

Loss of land

Vulnerable coasts



The threat

- Land that is currently home to 300m people will flood at least once a year by 2050, if laissez-faire continues, says the study, published in Nature Communications

- In a worst-case scenario with greater instability of the Antarctic ice sheet, as many as 640 million people could be threatened by 2100, the scientists say

The response

- Mitigation (or source control of sea level)—reducing the magnitude of human-induced climate change & sea-level rise at the global scale, or reducing the magnitude of human-induced subsidence at the local level

- Adaptation (to sea level)—reducing the impacts of sea-level rise via behavioural changes. This includes a range of changes from individual actions to collective coastal management policy, such as upgraded defence systems, warning systems, and land management approaches

CLIMATE CHANGE

It is defined as variations and shift in weather conditions over space and time of different scales & magnitude resulting into change of climate type

Indicators of climate change

CATEGORY	SUB-TYPE
Biological	Floral & faunal indicators
Geological	Terrigeneous, marine & pedogenic indicators
Cryogenic	Glaciation & Peri-glacial evidences
Tectonic	Plate tectonics & sea-level changes
Geomorphological	Morphological features & geo-morphological processes
Historical	Records of floods, droughts & migration

Summary of impact of gwcc

- Perceptible change in atmospheric chemistry
- Change in composition & heat balance of atmos.
- Increase in temp. of earth’s surface & lower atm.
- Increase in the activity of hydrological cycle
- Decline in precipitation & soil moisture content in agricultural regions of the world

- Adverse impact on ecosystems & productivity
- Ocean acidification & change in ocean albedo
- Melting of glaciers & ice-sheets, rise in sea-level & consequent floods in coastal regions
- Probable increase in atmospheric pressure
- May accentuate tropical cyclones by increasing their frequency & intensity
- May change existing patterns of world precipitation

Kyoto protocol

- An international agreement linked to the UNFCCC, which commits its Parties by setting internationally binding emission reduction targets

- The principle of "common but differentiated responsibilities.”

- Adopted in Kyoto, Japan, on 11 Dec 1997 & entered into force-16 Feb 2005

- The detailed rules for the implementation were adopted at COP 7 in Marrakesh, Morocco, in 2001, and are referred to as the "Marrakesh Accords." Its first commitment period started in 2008 and ended in 2012.

THE TARGETS

- The 37 industrialised nations pledged to cut their yearly emissions of carbon, as measured in 6 GHGs, by varying amounts, averaging 5.2%, by 2012 as compared to 1990 (equates to a 29% cut in the values that would have otherwise occurred)

- The two biggest emitters of all – the US & China – churned out more than enough extra GHGs to erase all the reductions made by other countries during the Kyoto period.

- Worldwide, emissions soared by nearly 40% from 1990 to 2009

KYOTO LIST OF GHG

- Carbon dioxide (CO2)
- Methane (CH4)
- Nitrous oxide (N2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF6)

DOHA AMENDMENT TO KYOTO PROTOCOL

- New commitments for Annex I Parties to the Protocol who agreed to take on commitments in a second commitment period from 1 Jan 2013 to 31 Dec 2020
- Revised list of GHGs to be reported on by Parties in 2nd commitment period
- Amendments to several articles of the Protocol which specifically referenced issues pertaining to the 1st commitment period & which needed to be updated for the 2nd commitment period
- The composition of Parties in the second commitment period is different from the first

International emissions trading

Joint Implementation

Kyoto mechanisms

Clean Development mechanism

Theories of climate change

- Outside or extra-terrestrial changes
- Inside or terrestrial changes
- Anthropogenic sources

Solar irradiance theory

- Solar radiative forcing- a significant factor
- Fluctuations in energy radiated by photosphere
- Can be long-term or short-term (periodic) change
- Expansion & contraction of the core of the Sun (contraction leads to more radiation)

Sunspot theory

- It is related to variation in solar irradiance
- 11 year cycle has been accepted
- Increase sunspot activity (more sunspots) causes warming of the earth's surface & vice-versa
- Sunspots are darker & cooler areas in the photosphere of the sun
- Perfect correlation has not been yet substantiated

Atmospheric dust hypothesis

- The SPM present in the atmosphere reduces the amount of solar radiant energy reaching the earth's surface
- Processes are scattering, reflection & absorption
- Violent powerful volcanic eruptions reduce the temperature; but may heat the stratosphere

Carbon dioxide theory

- Related to change in relative composition of the atmosphere, in terms of CO_2
- Greenhouse effect refers to progressive warming up of the earth's surface due to blanketing effect of man-made carbon dioxide in the atmosphere
- Icehouse phase refers to lowering of earth's temperature leading to beginning of glacial period

Continental drift & pole- wandering

- Results into a change in relative position of continents & origin of mountains of varying heights

- Clustering of continental masses around the poles causes glaciation and vice-versa

- Glaciation of high mountains located away from the poles cannot be explained on this basis

Tectonism & topographic controls

- High mountains control temp. & upper air circulation patterns
- Ice ages have been correlated with active tectonism and mountain building
- High relief tends to augment erosional and weathering processes which in turn affect atmospheric carbon dioxide
- The weathering of rocks has been correlated with climatic cooling

Earth's orbital eccentricity

Obliquity of earth's axis

Astronomical theories

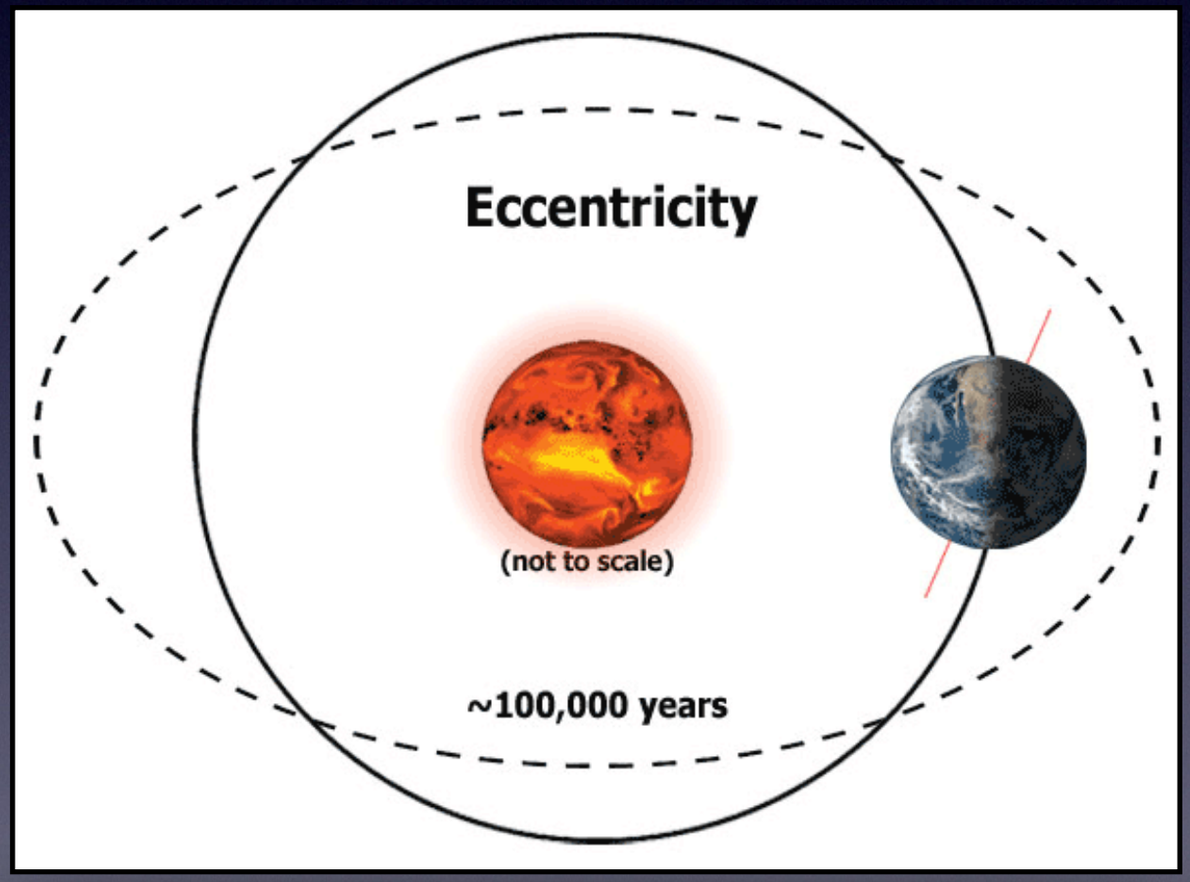
Precession of equinoxes

Earth’s orbital eccentricity

- Refers to the deviation of its elliptical orbital path from true circular path

- A cyclical process: Milutin Milankovitch cycle of 95000 years

- Temporal variations in eccentricity influence the amount of solar radiation to be received on earth’s surface



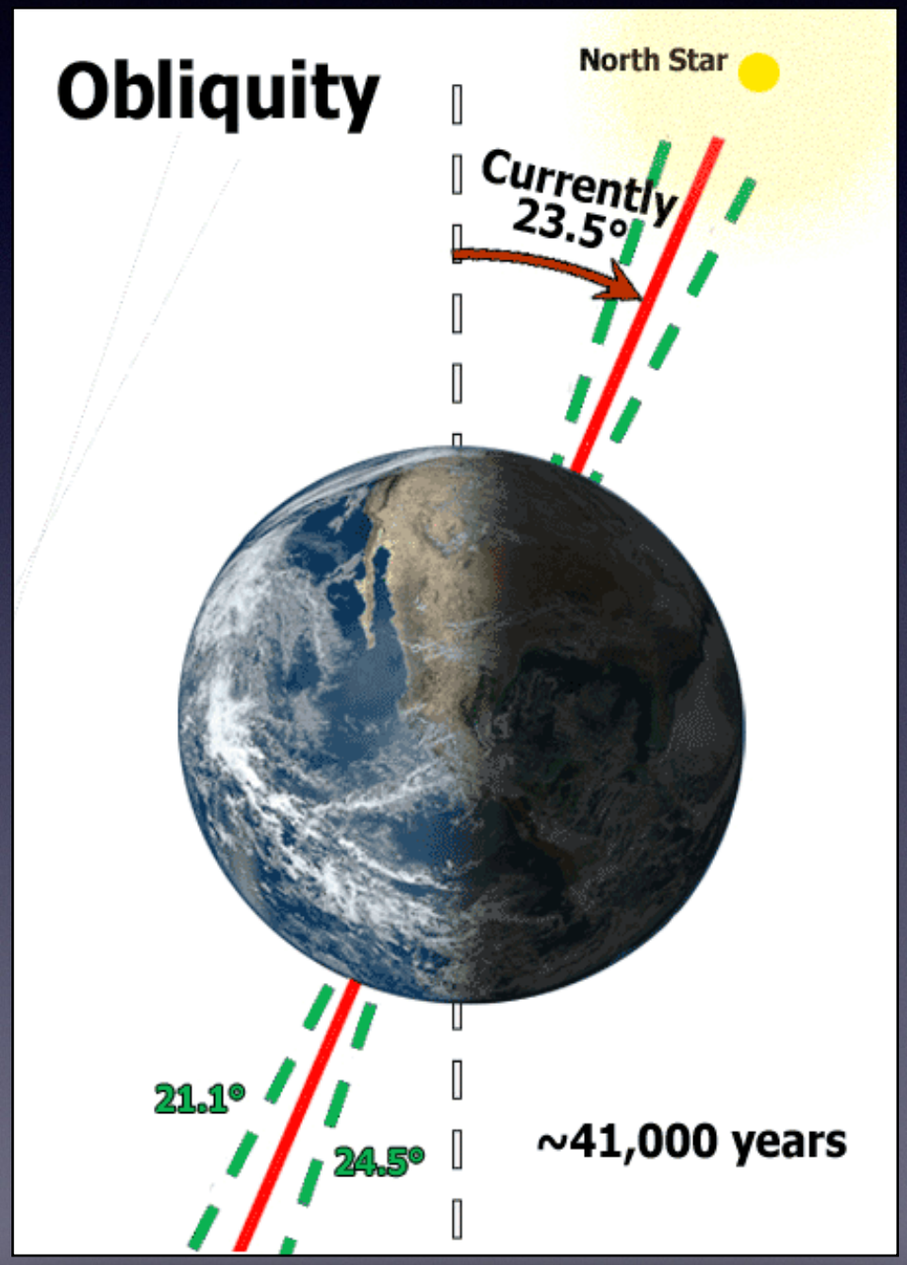
Obliquity of earth’s axis

- It refers to the angle of the Earth rotational axis in relation to the plane in which the Earth revolves around the Sun

- It varies temporally between 22° and 24° 27’

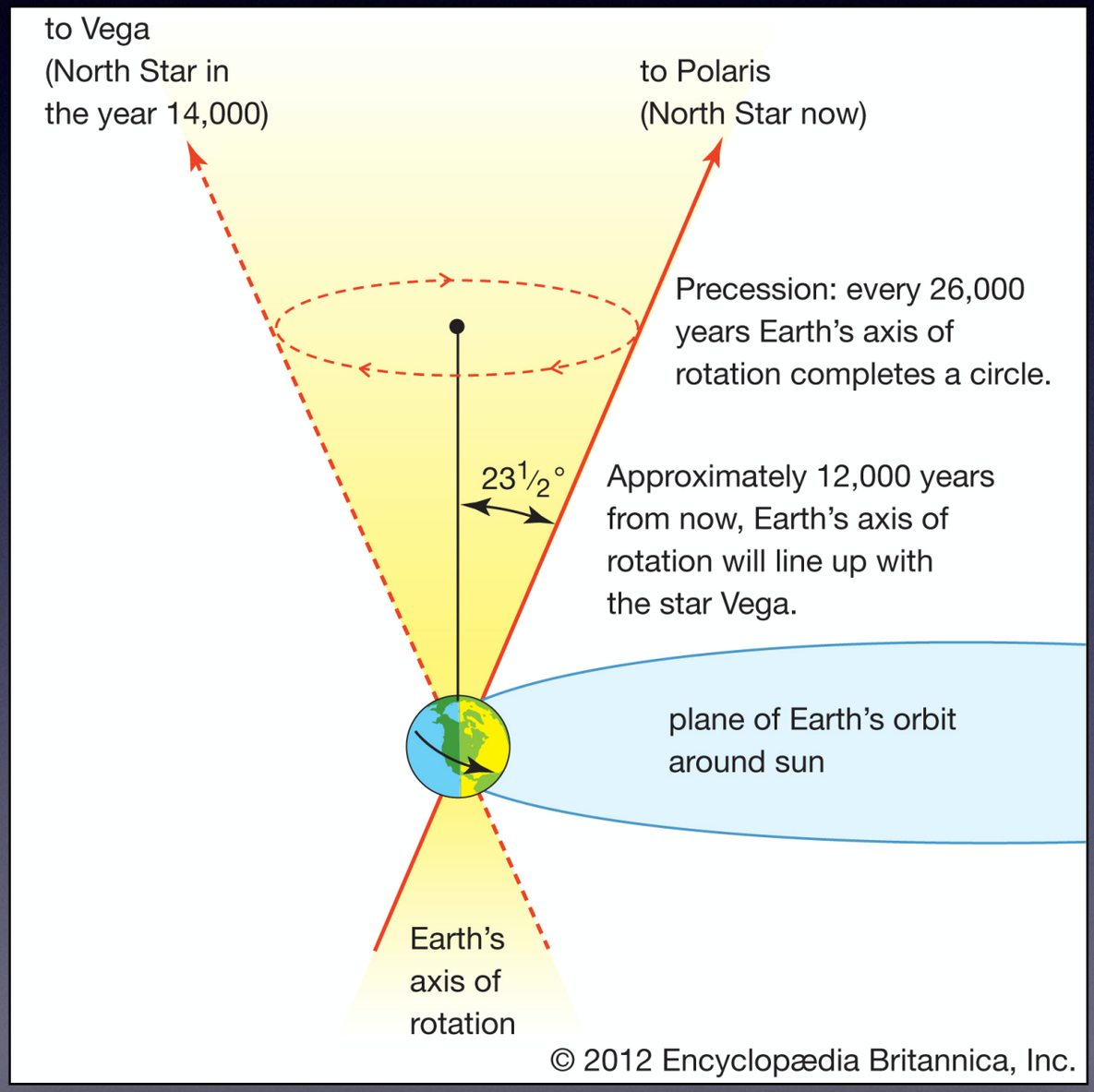
- It controls the latitudinal distribution of solar radiant energy and the intensity and duration of different seasons

- Cycle of 41000 years: Milankovitch



Precession of equinoxes

- Refers to regular change in time when the earth is at given distance from the sun
- Orbital Variation theory or Milankovitch theory
- Climatic precession (26kyrs) controls the difference in the length of seasons & has an opposite effect on each hemisphere



Global warming of 1.5^{0}c

- In Oct 2018 the IPCC issued a special report on the impacts of global warming of 1.5°C
- Unlike the previous estimates focused on 2°C rise, this report shows that many of the adverse impacts of climate change will come at the 1.5°C mark
- Coral reefs would decline by 70-90 percent with global warming of 1.5°C, whereas virtually all (> 99 percent) would be lost with 2^{o}C
- Limiting global warming to 1.5°C would require “rapid and far-reaching” transitions in land, energy, industry, buildings, transport, and cities
- Global net human-caused emissions of CO_2 would need to fall by about 45% from 2010 levels by 2030, reaching ‘net zero’ around 2050. This means that any remaining emissions would need to be balanced by removing CO_2 from the air

Paris agreement

- Brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so
- Keeping a global temperature rise this century well below 2^0C above pre-industrial levels & to pursue efforts to limit the temperature increase even further to 1.5^0C
- Aims to strengthen the ability of countries to deal with the impacts of climate change
- Entered into force on 4 Nov 2016, 30 days after the date on which at least 55 Parties to the Convention accounting in total for at least an estimated 55 % of the total global GHG emissions have deposited their instruments of ratification, acceptance, approval or accession with the Depositary

NDC

- Requires all Parties to put forward their best efforts through nationally determined contributions (NDCs)

- Requirements that all Parties report regularly on their emissions and on their implementation efforts

- A global stocktake every 5 years to assess the collective progress towards achieving the purpose of the Agreement

KEY-TERMS IN PARIS DEAL

KEY-TERM	MEANING
Carbon neutrality	a balance between emitting carbon and absorbing carbon from the atmosphere in carbon sinks
Carbon offsetting	to offset emissions made in one sector by reducing them somewhere else (EU's ETS, clean tech, etc.)
Loss & Damage	averting, minimising & addressing L & D associated with GWCC, and the role of SD in reducing the risk of L & D
Global stocktake	to take place in 2023 and every 5 years thereafter, will assess collective progress toward achieving the purpose

Kyoto vs. paris

KYOTO PROTOCOL	PARIS AGREEMENT
Legally binding targets	Nationally determined contributions
Penalties for non-compliance	No such clause
For developed nations only	For all nations irrespective of status
Weak oversight mechanism	Monitoring, reporting, and reassessing
Aimed, not included	Next round of targets every 5yrs

Cop 25: Madrid

- Australia controversy: Katoomba fire & coal mining; Aus not keen on targets
- Climate grief: Most ‘disappointed’ with the progress in setting roadmap
- Disconnect: Those inside & those outside the venue (The ‘Youth’ factor)
- Chile retained the Presidency, while Spain organised (Leadership matters)
- Need to raise ambition: State & Non-State actors (Climate Ambition Alliance)
- The blue COP: focus needs to shift on oceans & impact on coastlines
- Differing interpretations of the word “ambition”: developed vs developing

unep: emission gap report

- The stretch 1.5^{0}C goal of the Paris Agreement is “slipping out of reach”
- Even if existing climate pledges – countries’ Nationally Determined Contributions, or NDCs – are met, emissions in 2030 will be 38% higher than required to meet that target

The need to bridge the gap between
greenhouse gas targets set in 2015 in Paris and
scientific advice that says
much deeper cuts are needed.