Climate Change Workshop

Introduction to Climate Science

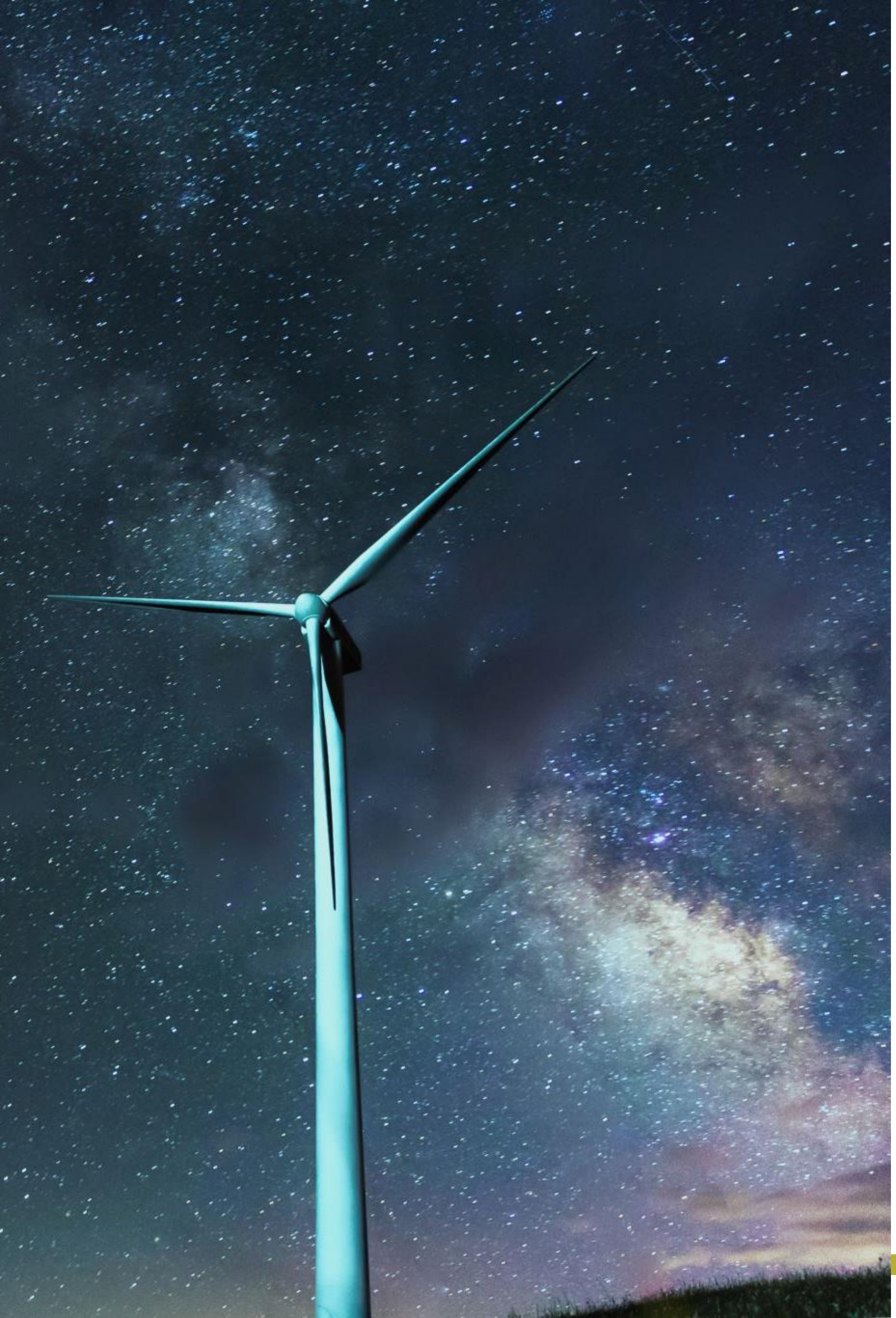
Calgary / November 27 & 28, 2019

FIRST NATIONS
LAND MANAGEMENT
RESOURCE CENTRE

Workshop Learning Objectives:

- Discuss the fundamentals of climate science, the predicted scope and severity of the climate emergency
- Introduce the International context of climate change and the intersection of climate change and indigenous rights
- Explore the importance of the law-making authority of the Framework Agreement in setting out climate-informed plans, laws and targets
- Hear the success stories from other FA signatory communities in responding to the climate emergency

Parking Lot!



Understanding the Basics of Climate Science and Earth's Climate System

"Scientific evidence for warming of the climate system is unequivocal."

- Intergovernmental Panel on Climate Change

- Definitions & Basics of Earth Climate System
- Overview of Greenhouse Effect and GHG's
- Temperature Records and Climate Models
- Observations and Impacts of Climate Change
- International & Canadian Context
- Intersection of Climate Change and Indigenous Peoples

Definitions: Weather vs Climate

Weather refers to what conditions we experience outside locally and on a day-to-day basis.

"It's snowing outside my house today. So much for global warming!"

Climate refers to trends in weather patterns over long time scales and at regional, national and global scales. Climate refers to the statistical properties of weather over time (ranging from months to decades or more), and includes average conditions and the range of variability, as well as the frequency of extreme events.

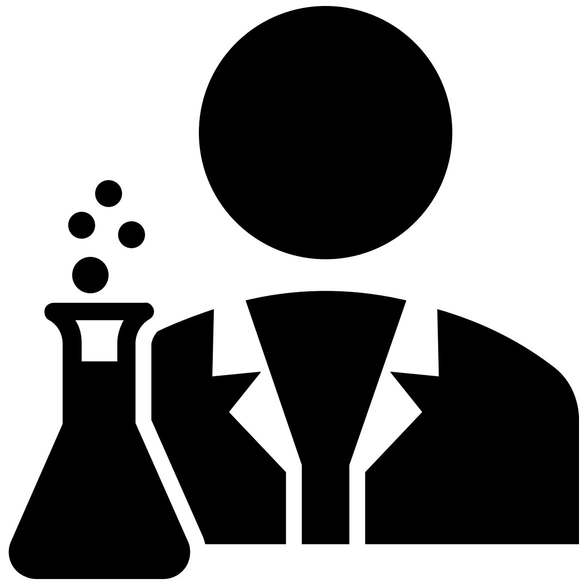
"Even though it's snowing outside my house today, I've noticed a trend in our Territory that we're getting less snow every winter and the snow appears later in the season."

Global Mean Temperature is a statistical expression of the average Global temperature. Climate statistics are usually calculated based on thirty-year intervals.

Definitions: Global Warming vs. Climate Change

Global Warming refers to the long-term heating of the Earth's climate system observed by scientists since the pre-industrial period (ca. 1850) due to human activities, primarily the burning of fossil fuels.

Climate Change refers to long-term changes in the average weather patterns in local, regional and global settings. Climate change can be caused by natural processes but since the industrial revolution and the burning of fossil fuels, human activities are accelerating climate change.

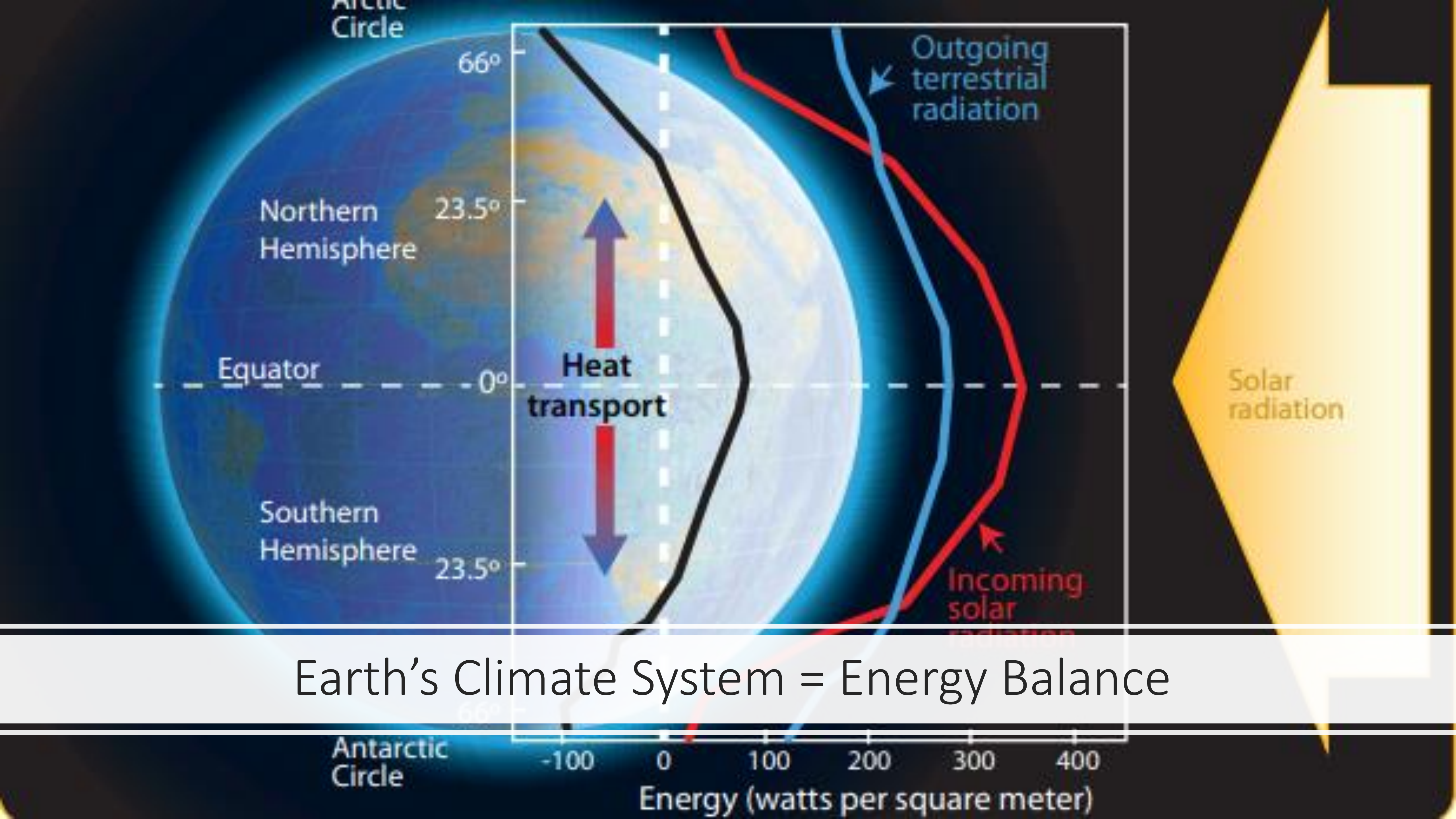


Definitions: Science

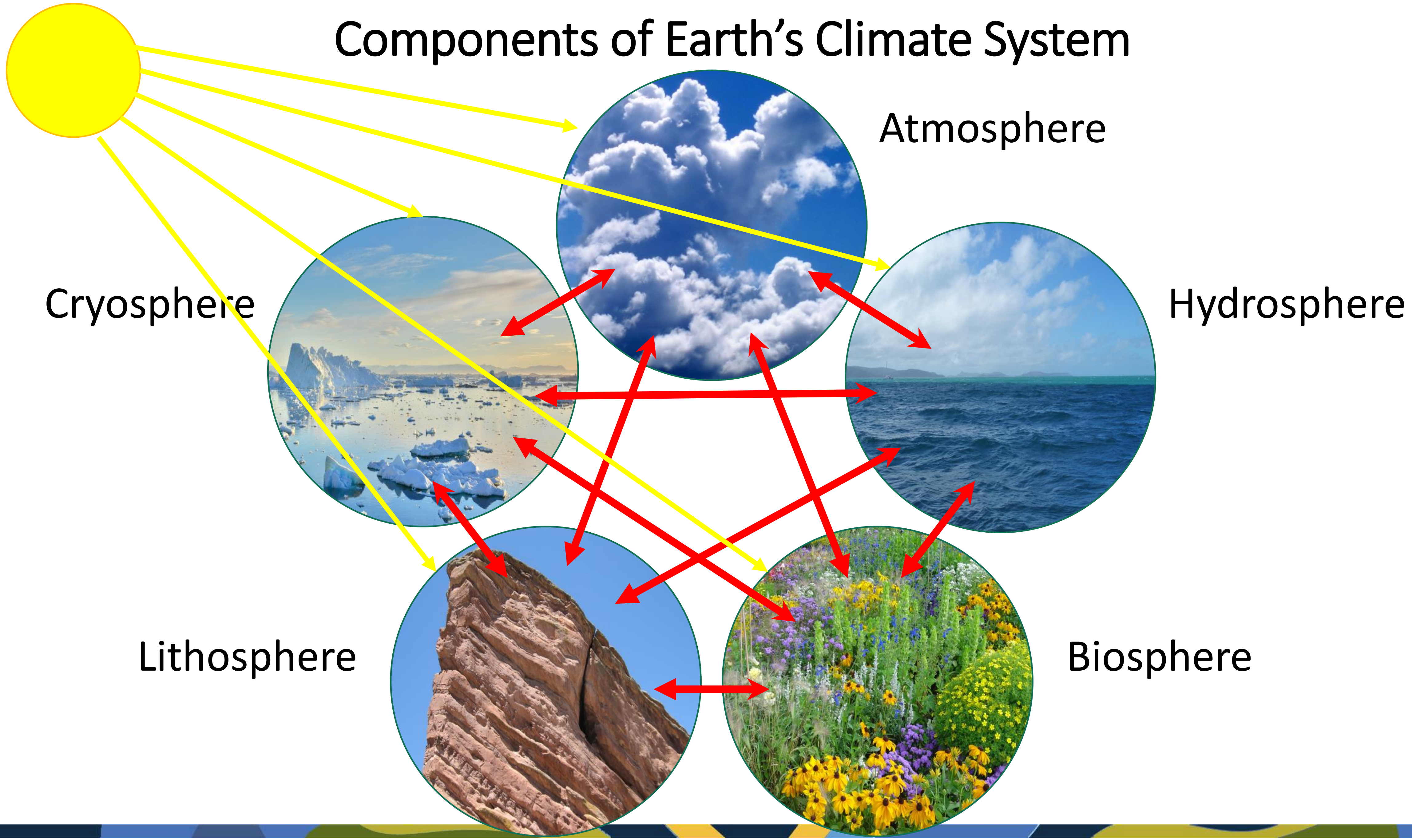
Science provides an explanation of the natural world that can be repeatedly tested and verified in accordance with accepted protocols of observation, measurement and evaluation of results.

An Introduction to Earth's Climate System

Earth’s Climate System = Energy Balance



Components of Earth’s Climate System



Climate Change is a natural phenomenon…

The four main influences of change (i.e. climate forcing agents) in Earth’s climate are:

1) changes in Earth’s orbit around the Sun
2) variations in the output of energy from the Sun
3) fluctuations in the upwelling of deep cold ocean water
4) changes in **atmospheric composition**.

…but human activity is accelerating it

Our Atmosphere

- Nitrogen (78%)
- Oxygen (21%)
- Argon
- Others (ozone, water vapour, GHG’s, etc.)

Greenhouse Gases

Carbon Dioxide

77%

Tens of thousands of years

Methane

15%

10-12 years

Nitrous Oxide

7%

100+ years

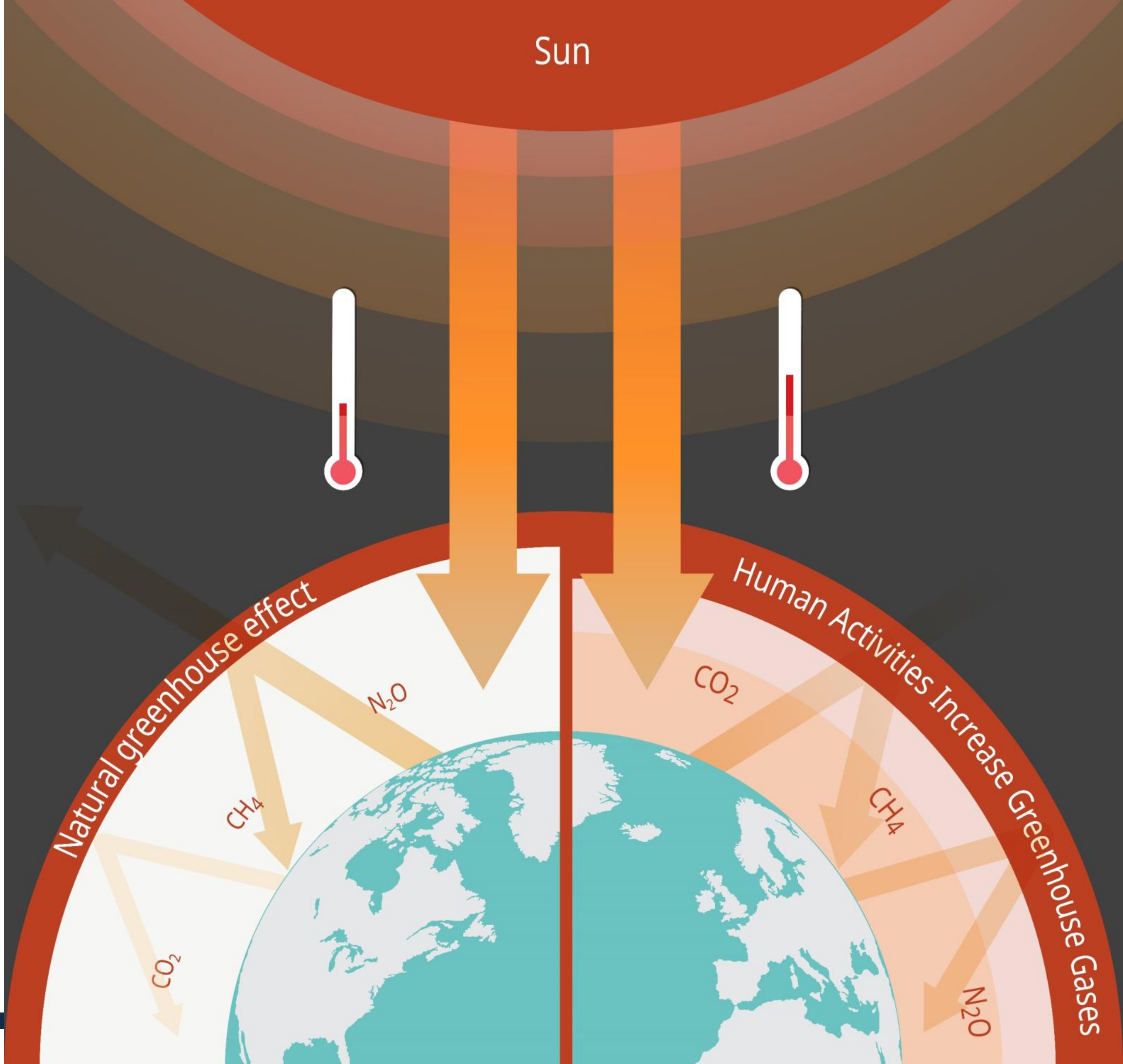
(Water vapor)

These gases absorb and emit radiant thermal energy (heat) at different rates, they remain in the atmosphere for different amounts of time, and are emitted by human activities at different rates.

The “Greenhouse Effect”

is a function of Earth’s atmosphere whereby **greenhouse gases (GHG)** such as carbon dioxide retain heat from the Sun on Earth; historically this has made the planet habitable for life. Natural factors that contribute to atmospheric composition and the concentration of greenhouse gases include volcanic activities and forest fires.

However, over the last 200 years, human activity has resulted in an increased concentration of greenhouse gases in the atmosphere, causing an intensification of the greenhouse effect, which results in **accelerated global warming**.

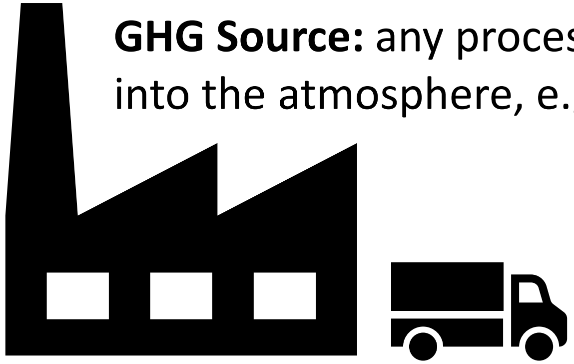


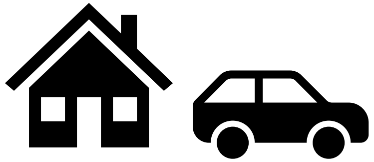

The Greenhouse Effect
Atmosphere
climate.nasa.gov

Tula like’s the greenhouse effect

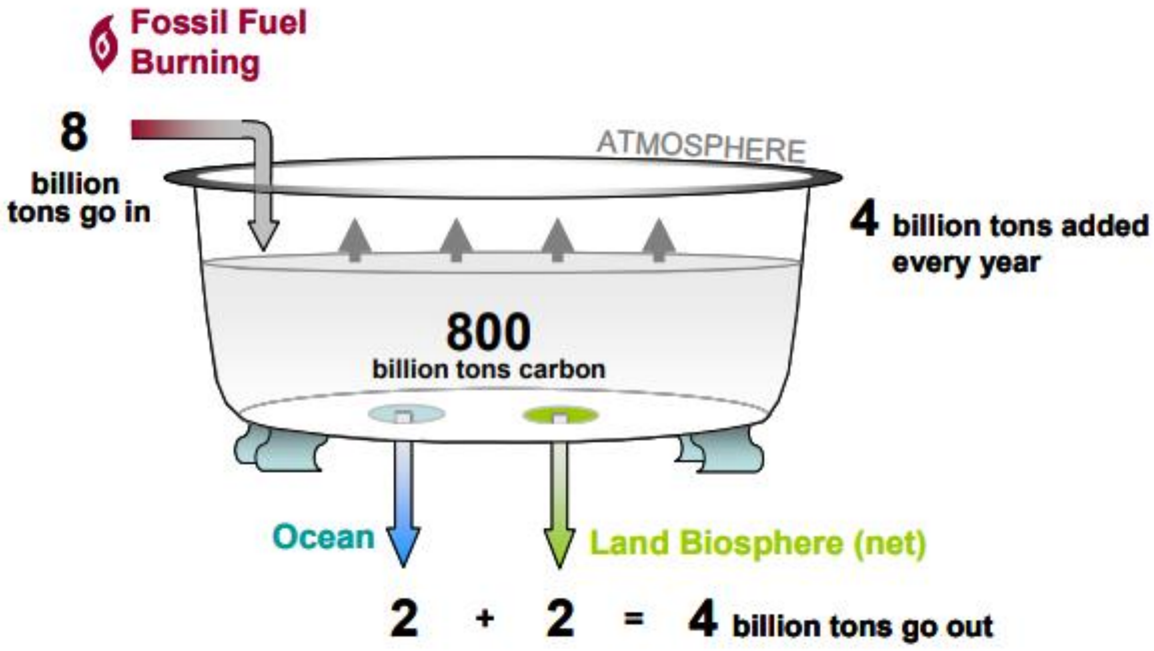
GHG Sources and Sinks

GHG Source: any process or activity, natural or human, that releases a greenhouse gas into the atmosphere, e.g. volcanoes, forest fires, fossil-fuel combustion.

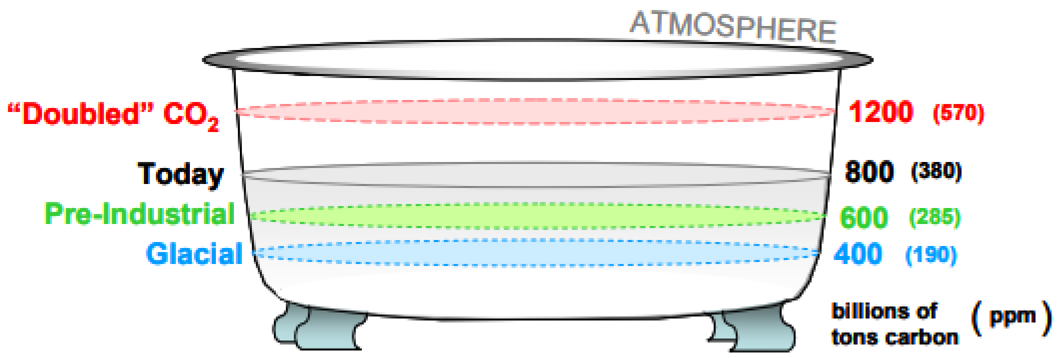




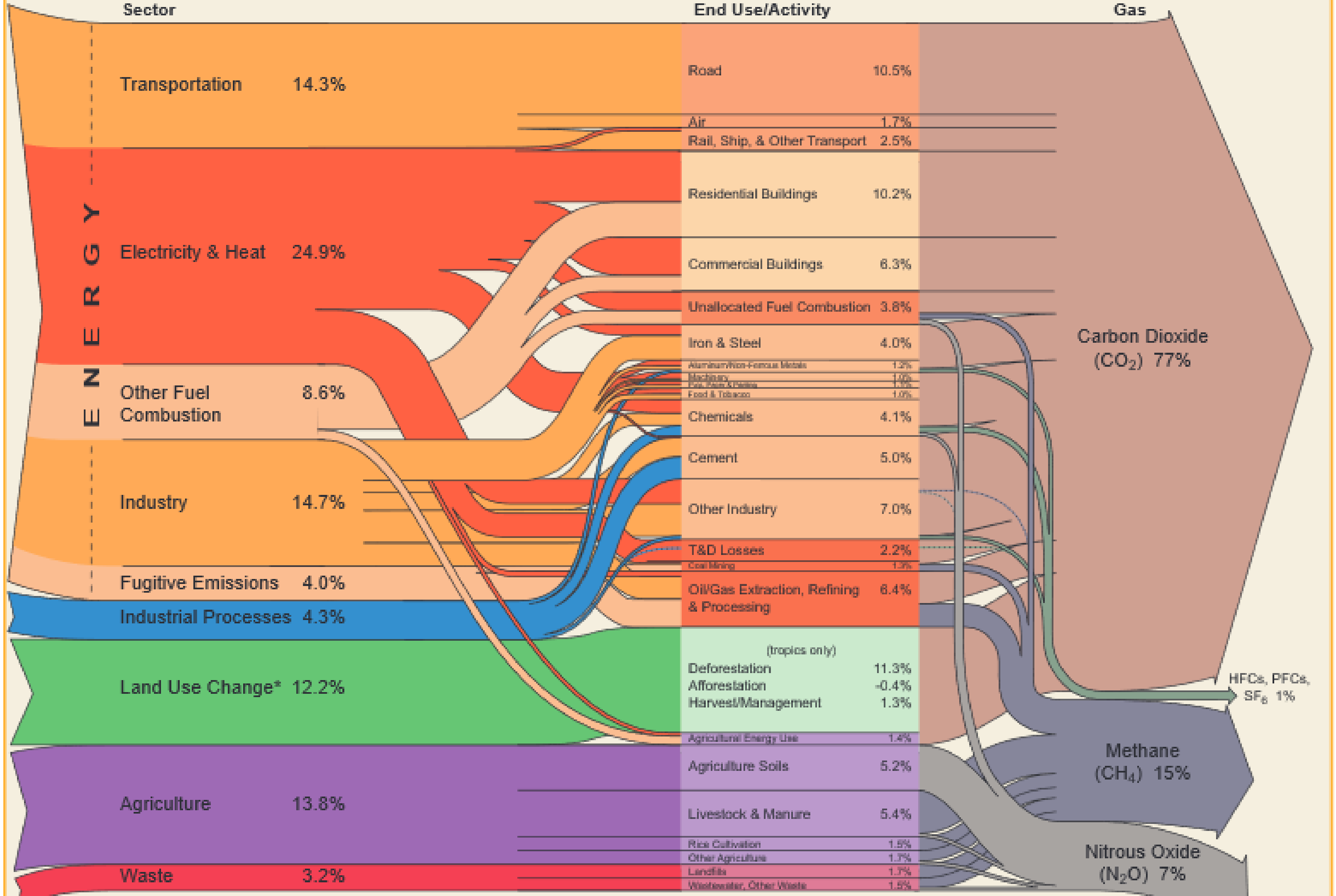
GHG Sink: A reservoir that takes up and stores carbon dioxide and other greenhouse gases. Examples of carbon sinks are forests, grassland ecosystems, oceans, or artificial technologies such as carbon capture and sequestration. Note – sinks can become sources!



Fossil Fuel Burning
8 billion tons go in
ATMOSPHERE
4 billion tons added every year
800 billion tons carbon
Ocean
Land Biosphere (net)
2 + 2 = 4 billion tons go out

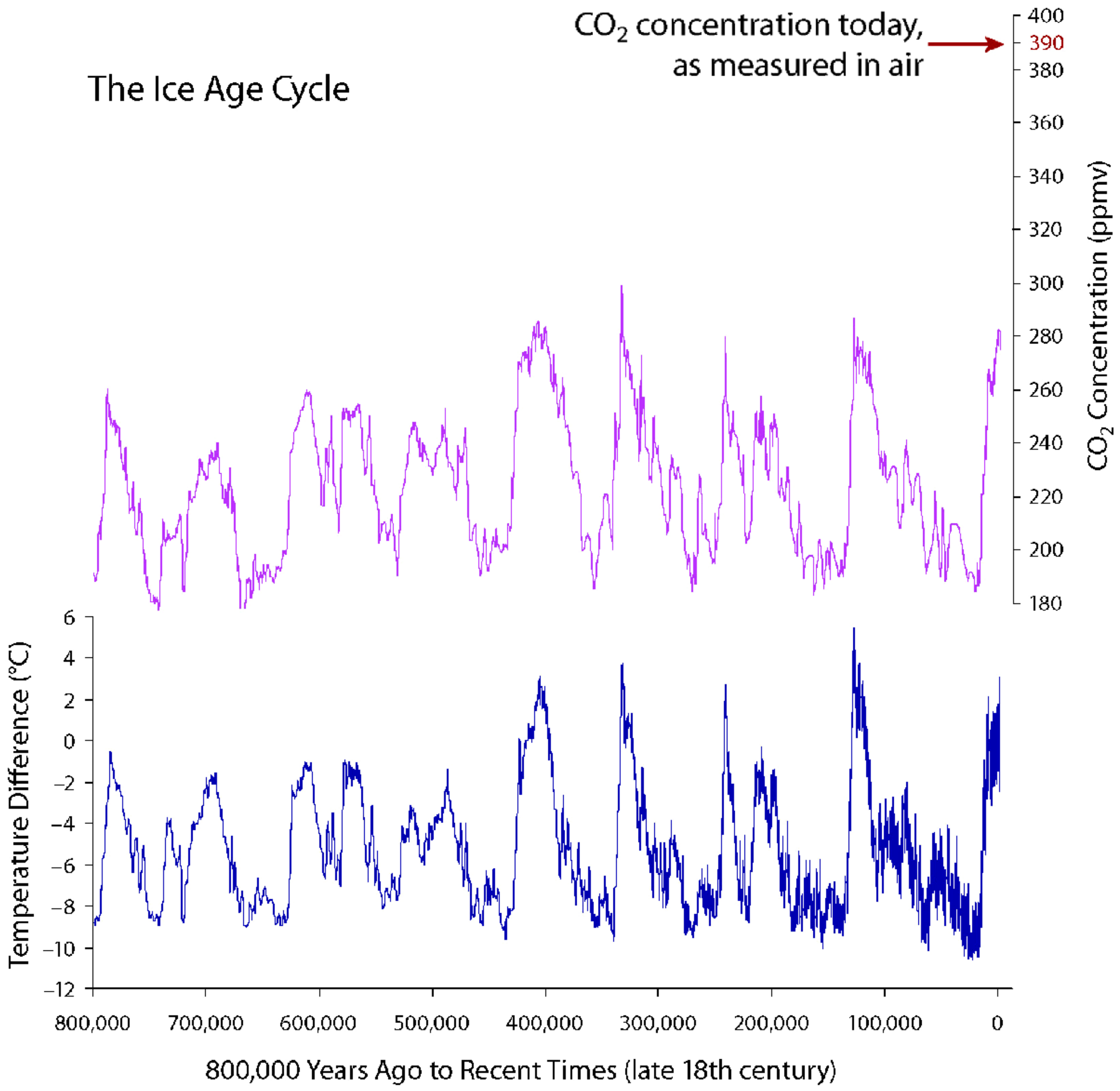


ATMOSPHERE
"Doubled" CO_2
1200 (570)
Today
800 (380)
Pre-Industrial
600 (285)
Glacial
400 (190)
billions of tons carbon (ppm)

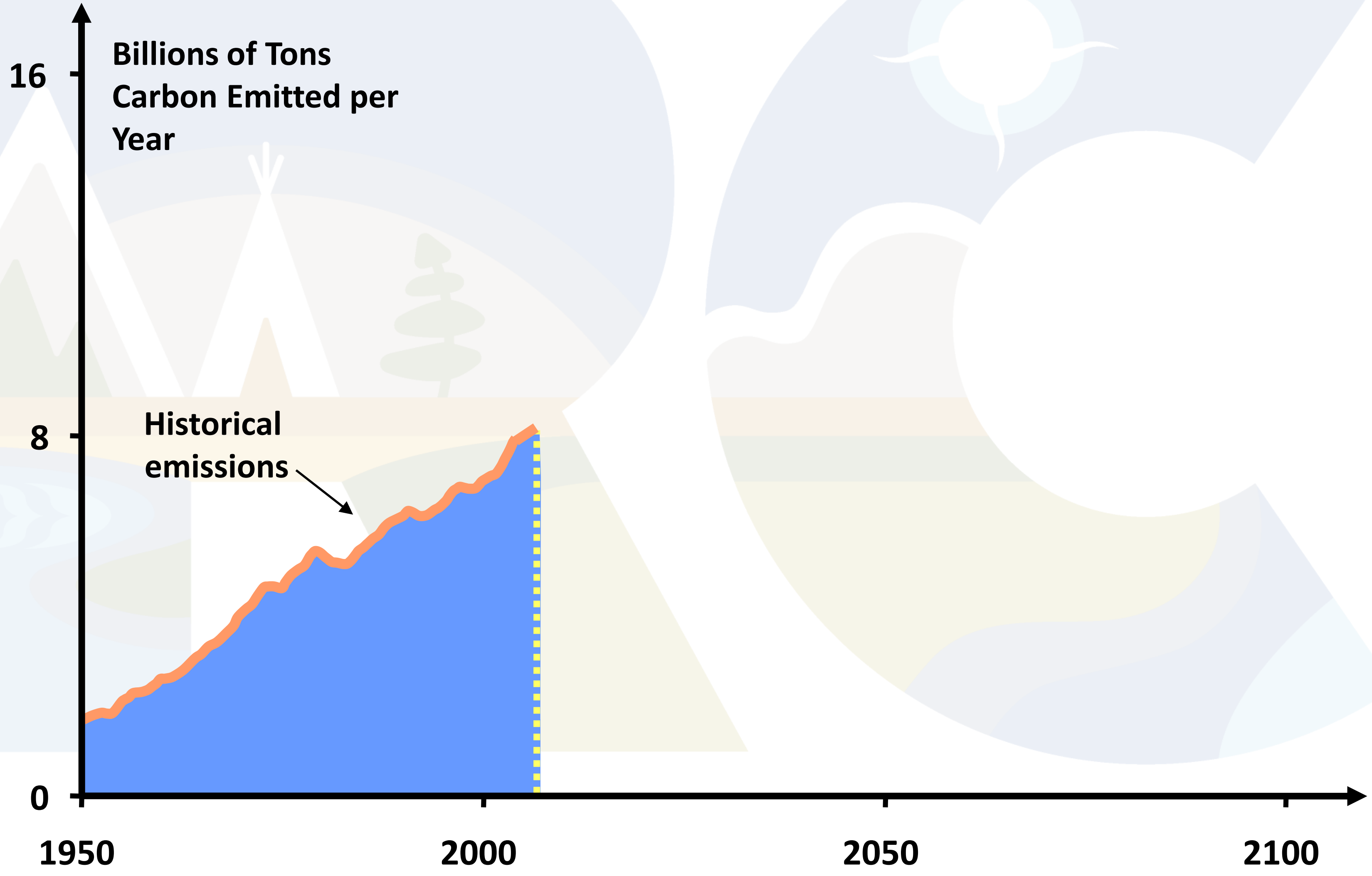


Sources & Notes: All data are for 2005. All calculations are based on CO_2 equivalents, using 100-year global warming potentials from the IPCC (1996), based on a total global estimate of 44,153 $MtCO_2$ equivalent. See Appendix 2 of *Navigating the Numbers: Greenhouse Gas Data & International Climate Policy* (WRI, 2005) for a detailed description of sector and end use/activity definitions, as well as data sources. Dotted lines represent flows of less than 0.1% percent of total GHG emissions.

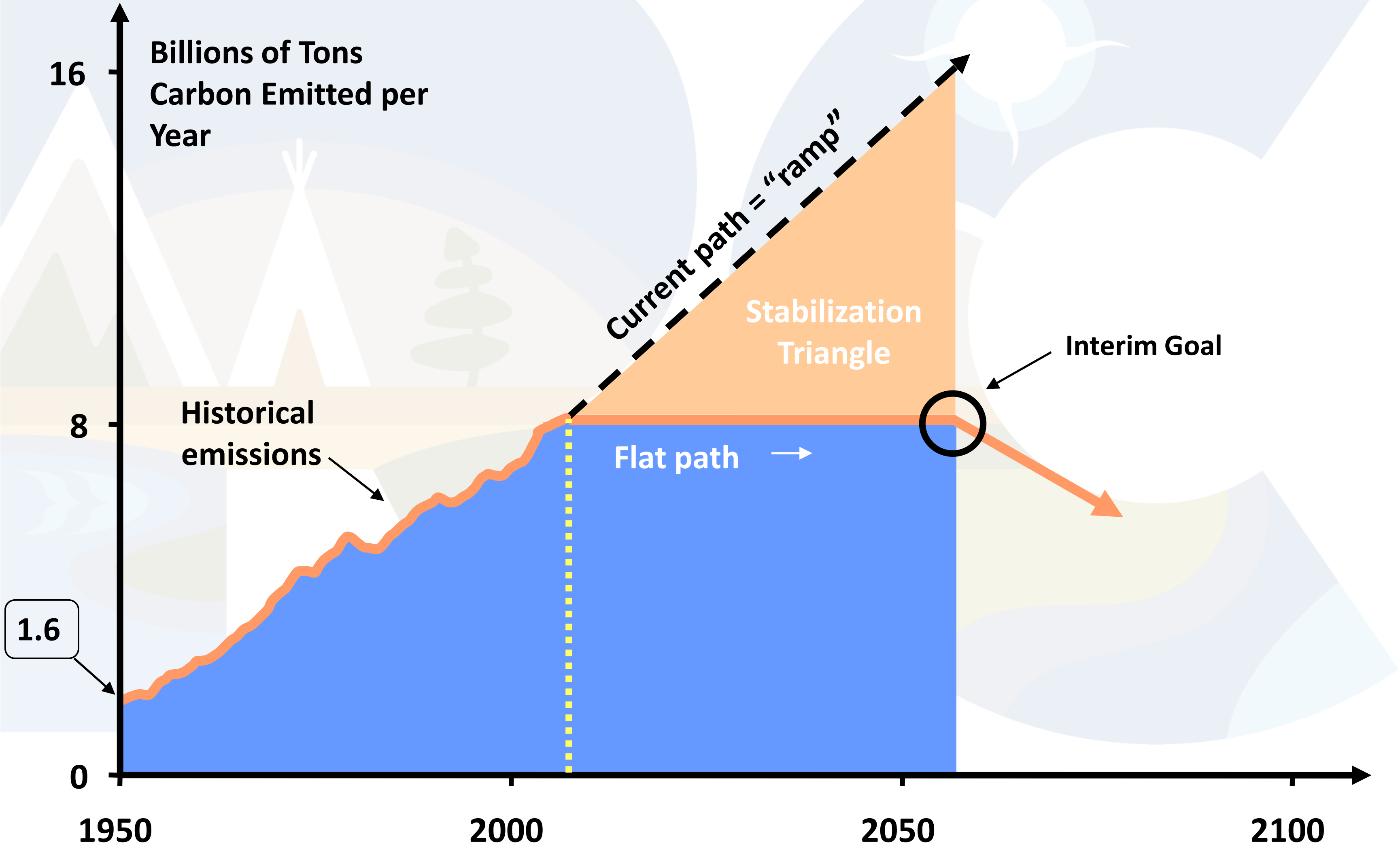
* Land Use Change includes both emissions and absorptions, and is based on analysis that uses revised methodologies compared to previous versions of this chart. These data are subject to significant uncertainties.


The Ice Age Cycle
CO_2 concentration today, as measured in air
400
390
380
360
340
320
300
280
260
240
220
200
180
CO_2 Concentration (ppmv)
6
4
2
0
−2
−4
−6
−8
−10
−12
Temperature Difference (°C)
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
800,000 Years Ago to Recent Times (late 18th century)

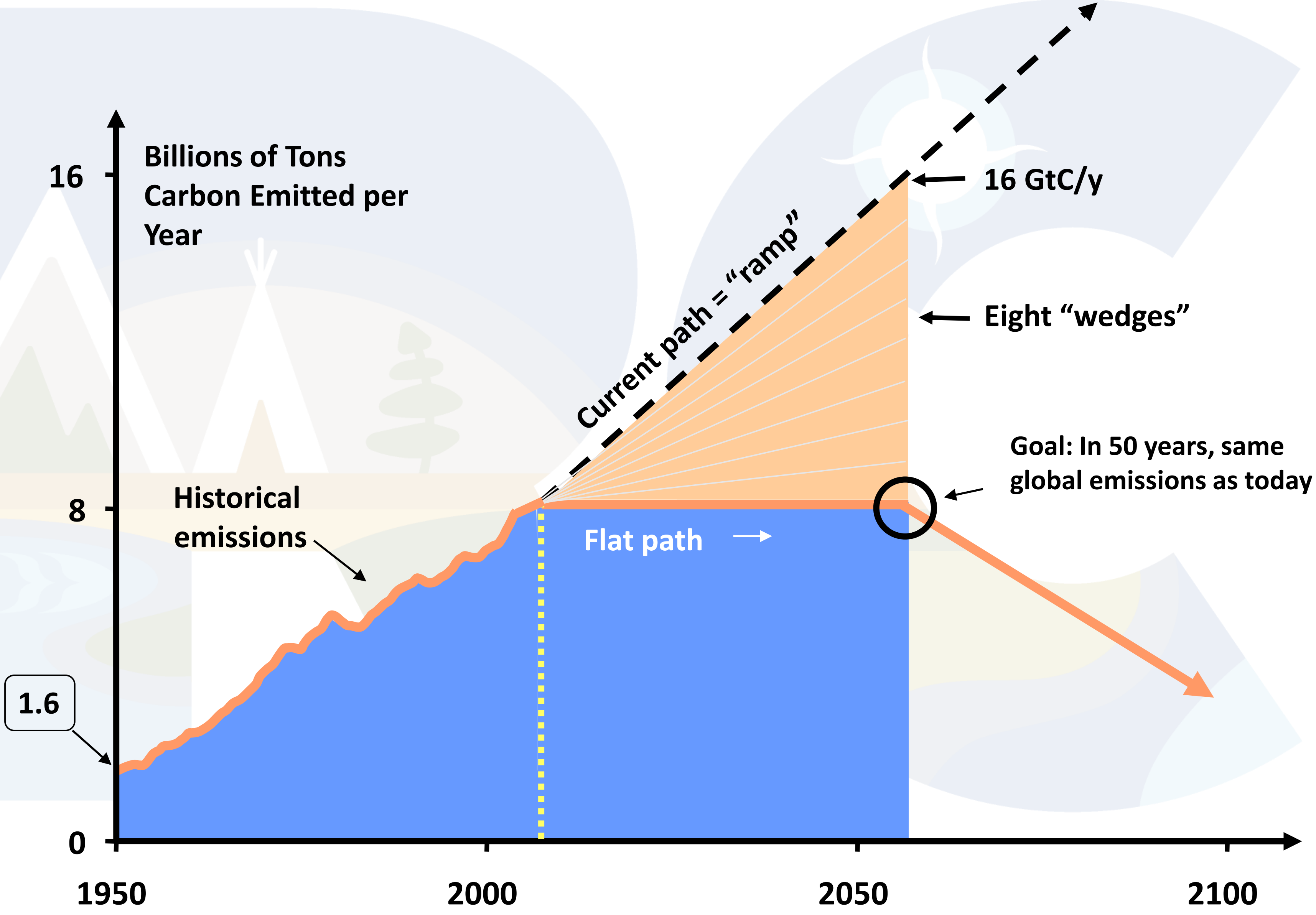
Historical Emissions



The Stabilization Triangle

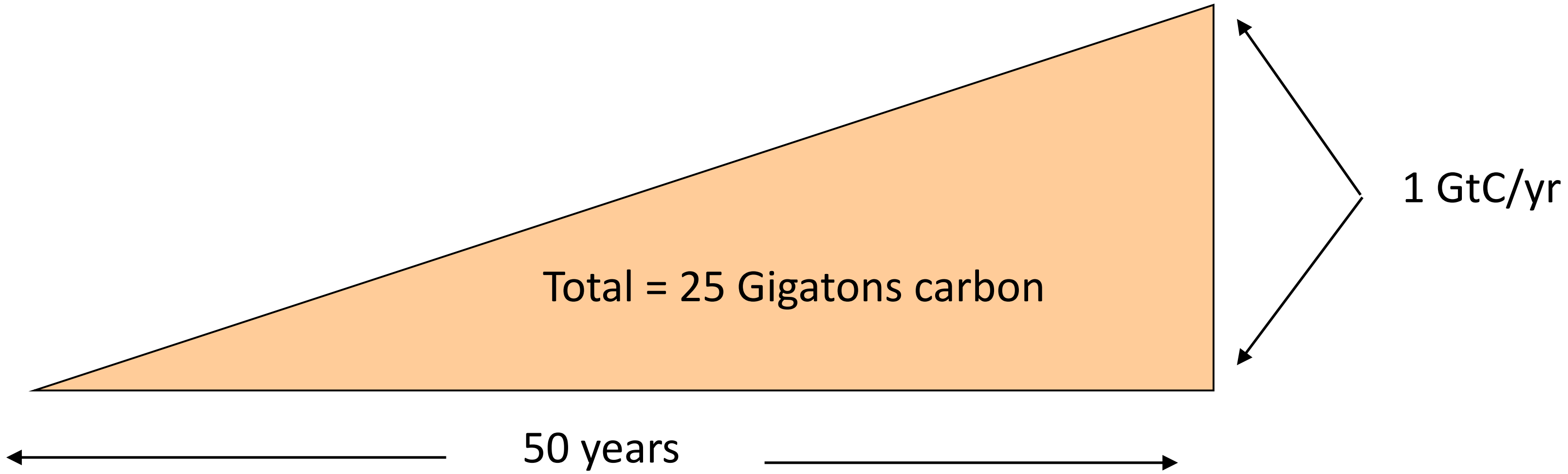


Stabilization Wedges



What is a “Wedge”?

A “wedge” is a strategy to reduce carbon emissions that grows in 50 years from zero to 1.0 GtC/yr. The strategy has already been commercialized at scale somewhere.



Cumulatively, a wedge redirects the flow of 25 GtC in its first 50 years.
This is 2.5 trillion dollars at $100/tC.

A “solution” to the CO_2 problem should provide at least one wedge.

What are some solutions to the C02 problem?

Tula says don’t buy so much stuff!

Past, present and future Climate

How do scientists estimate the global mean temperature (GMT) of the Earth’s distant past?

How do scientists calculate the current GMT of the Earth?

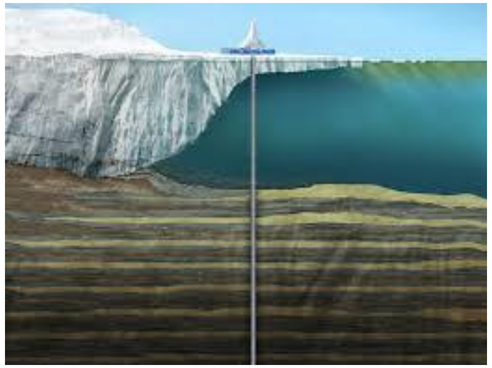
How do scientists estimate the GMT of Earth’s future?

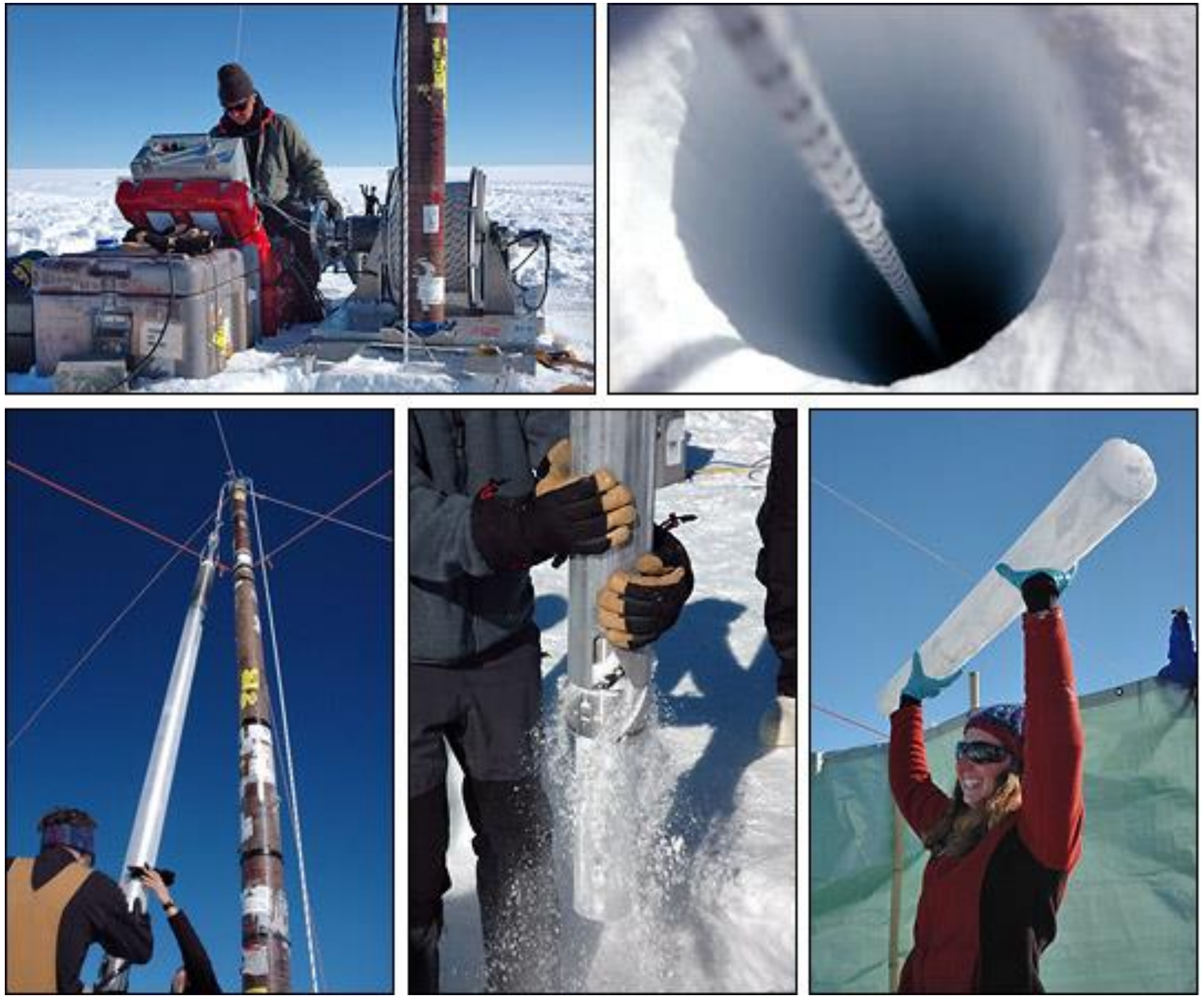
Paleoclimatology: The Study of Earth’s Ancient Climate History & Evolution

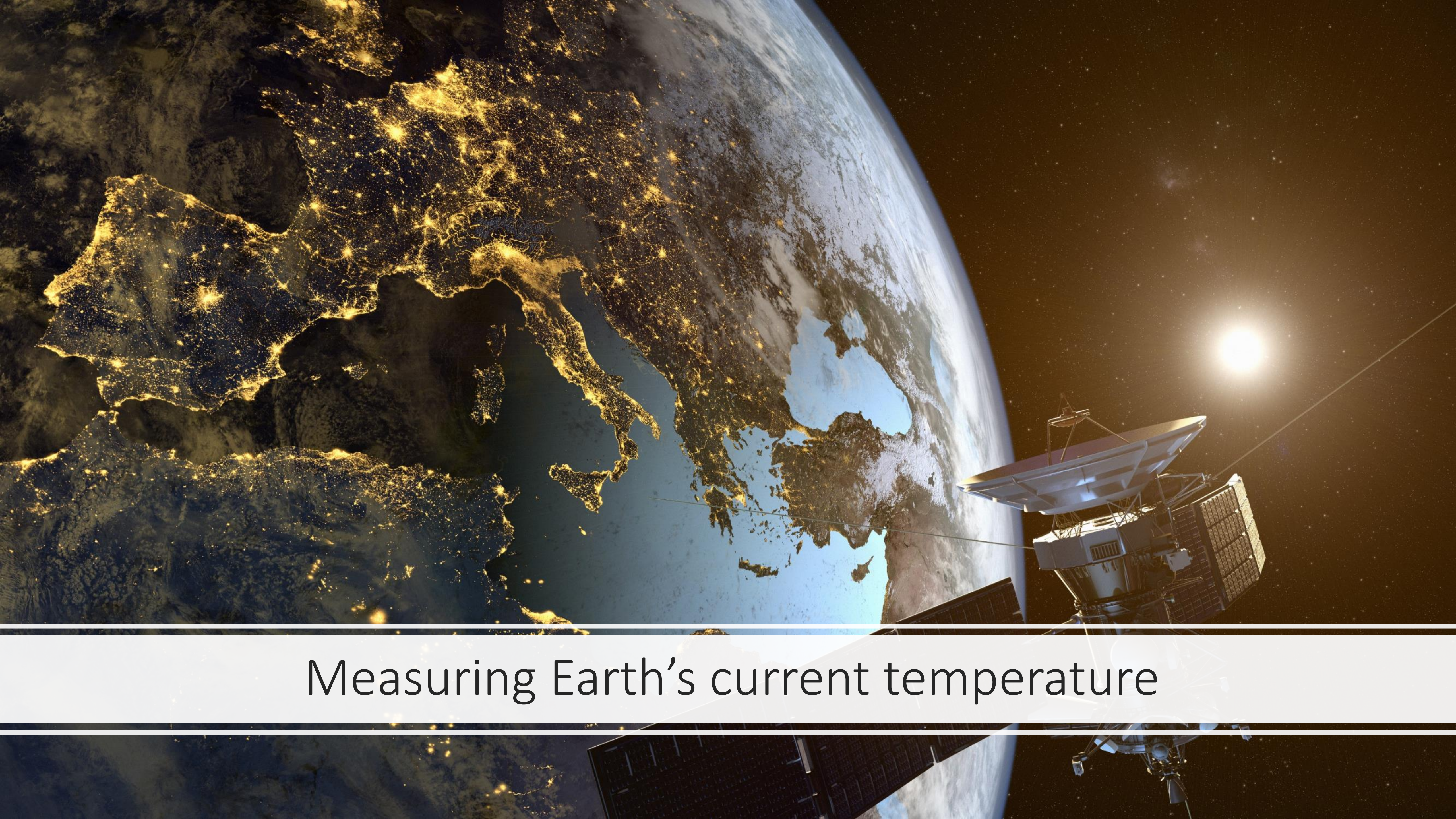
Paleoclimatology – the study of past climates

Earth’s Natural Archives!

- Arctic and Antarctic Ice Core samples
- Deep Sea and Lake sediment samples
- Tree rings and fossil pollen
- Coral Reefs



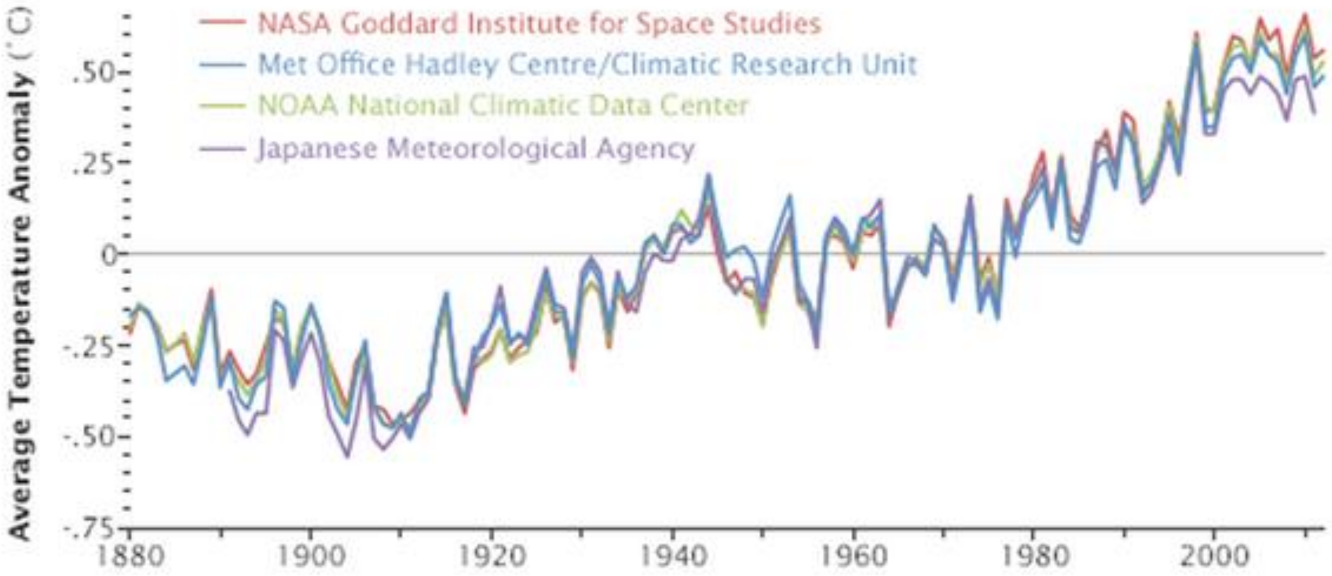




Measuring Earth’s current temperature

Measuring Earth’s current temperature

- Scientists combine temperature measurements from land, sea and air across the globe. These are collected from weather stations, boats, buoys, and satellites placed all over the globe
- Temperatures recorded at each location are compared to a 30-year average and anomalies reported
- 4 primary global datasets
- GMT represents a global average!



Source: NASA Earth Observatory

Predicting Earth’s future climate: Climate Models

Understanding Climate Models

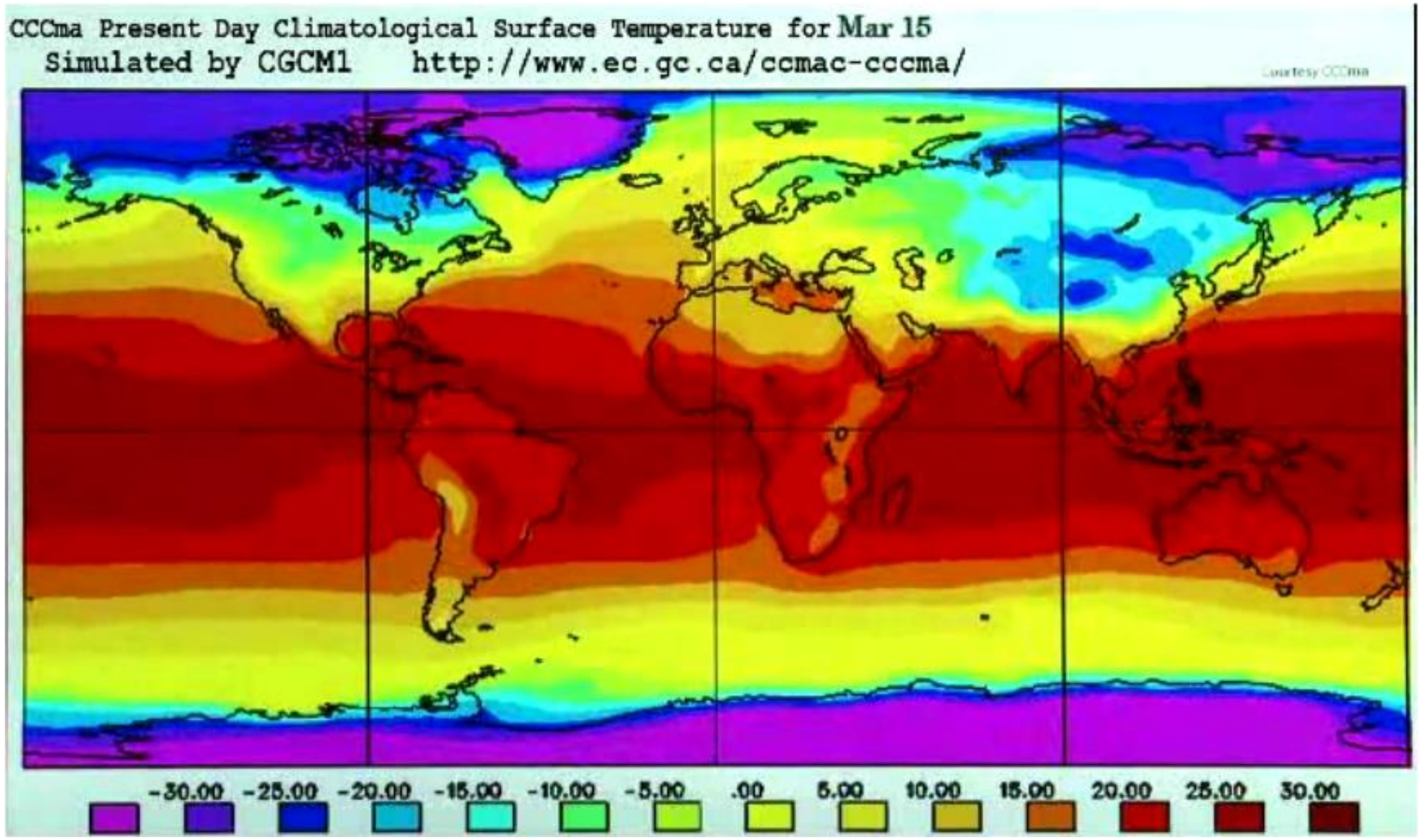
- Extraordinarily complex, utilizing supercomputers
- Climate models aren’t used to predict weather. What’s important is the statistical likelihood of the predicted climate-related events (e.g. overall changes in precipitation patterns, temperature changes, etc.) from the model matching the observed or real climate record
- Climate models are like “virtual Earth’s” – computer models of the Earth’s surface that simulate the different processes (climate components – e.g. atmosphere, hydrosphere, cryosphere, etc.) at work on regional, continental and international scales
- They help us understand potential impacts from a changing climate, e.g. water systems, forests, etc., how we may need to adapt, and what emission reductions scenarios we need to consider
- Used to inform policy at regional, national and international stages

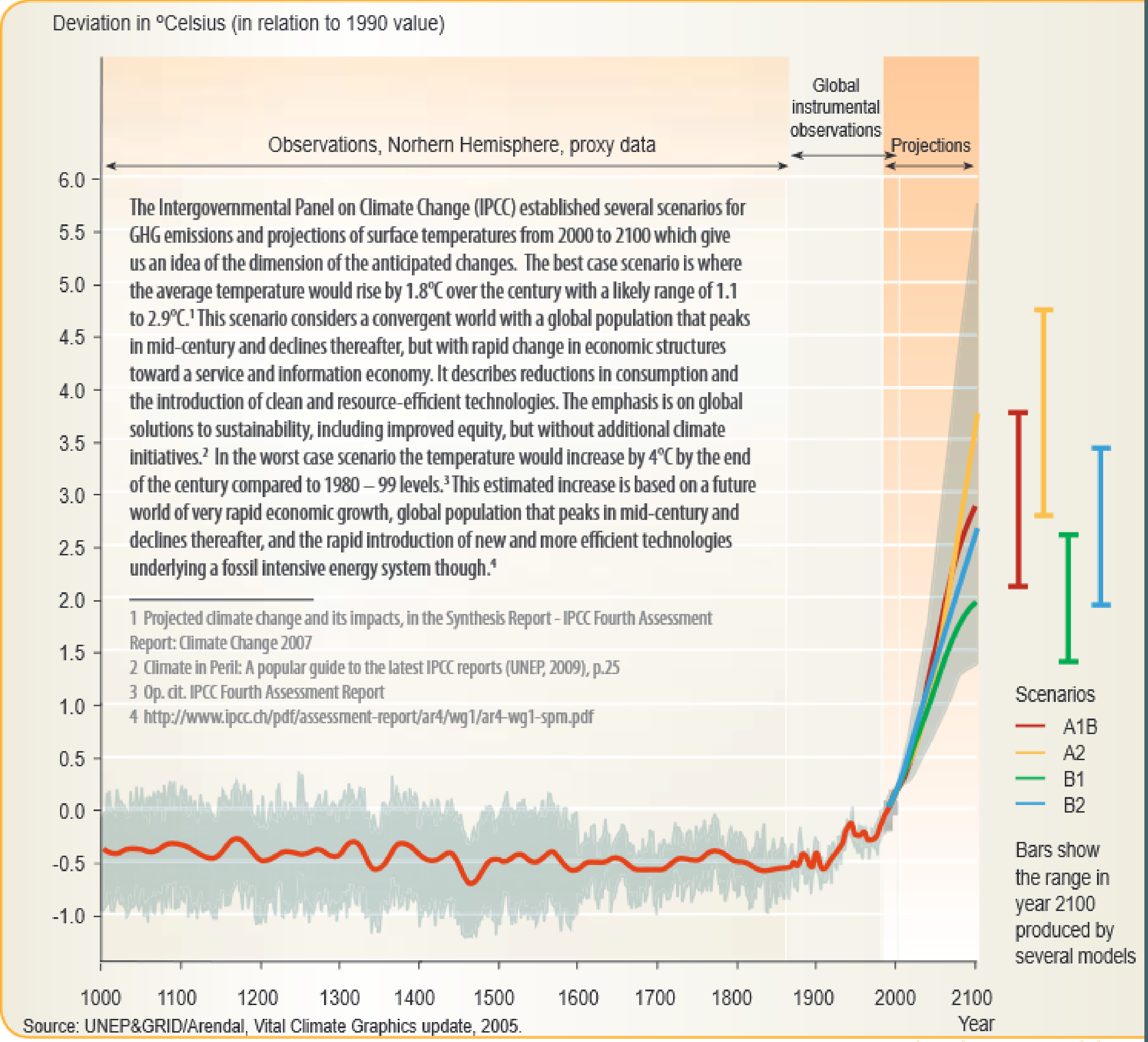
Understanding Climate Models

- Rooted in hard science, based on the laws of thermodynamics that govern the interrelationship and interactions of energy and matter, utilizing mathematical equations to describe these interactions in the atmosphere, land and oceans

- Key climate processes are represented mathematically. A 3 dimensional grid is mapped over the Earth's surface and up into the atmosphere. Mathematical equations are solved for each grid cell – requiring millions of computations

- Climate model predictions about future climate depends on emissions scenarios

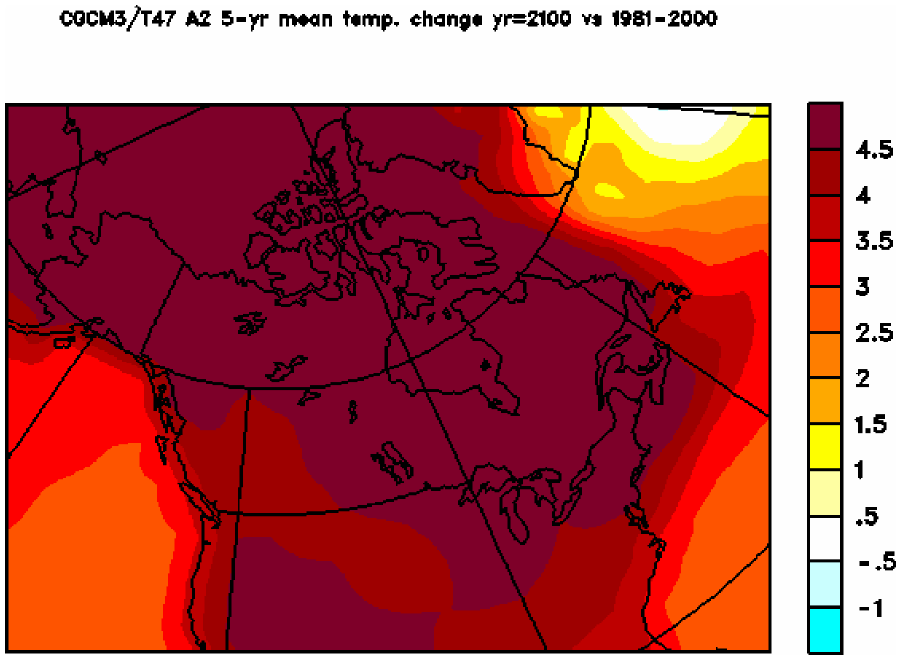




Emission Scenarios

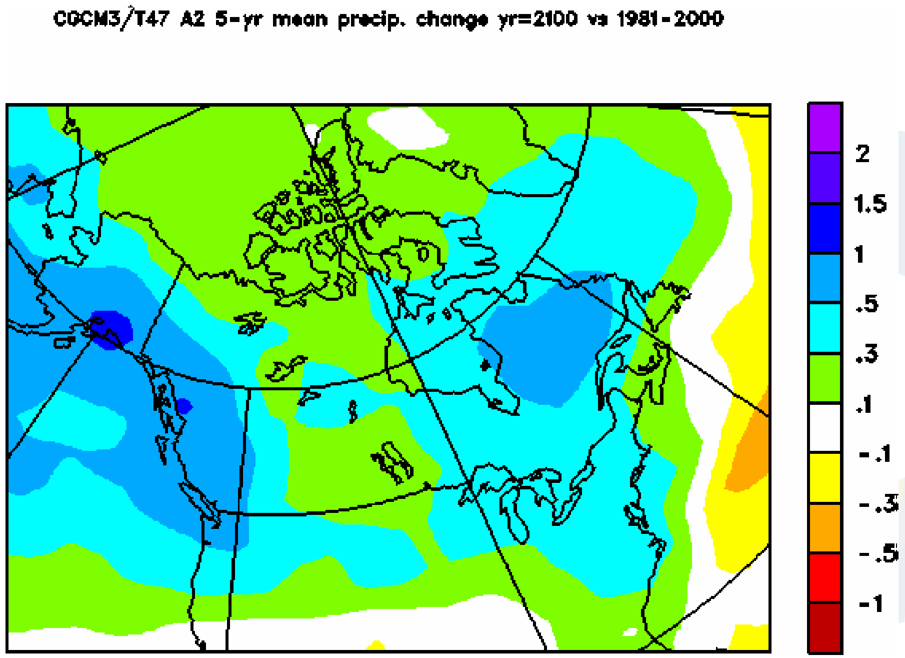
Canadian Centre for Climate Modeling and Analysis (CCCma)

– Temperature Change Projections: http://climate-modelling.canada.ca/climatemodelgraphics/cgcm3-t47/animation_sresa2_st_pcan.shtml



Year: 2100

– Precipitation Change Projections: http://climate-modelling.canada.ca/climatemodelgraphics/cgcm3-t47/animation_sresa2_pcp_pcan.shtml



“Hind-Casting”

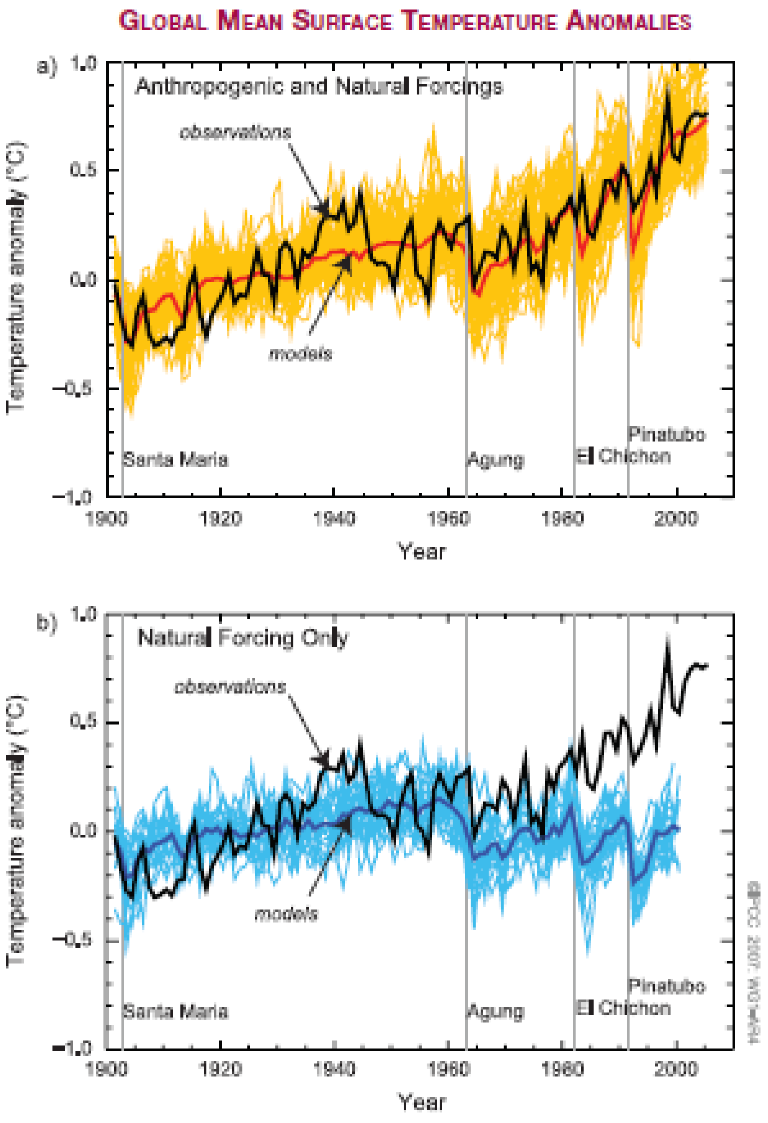
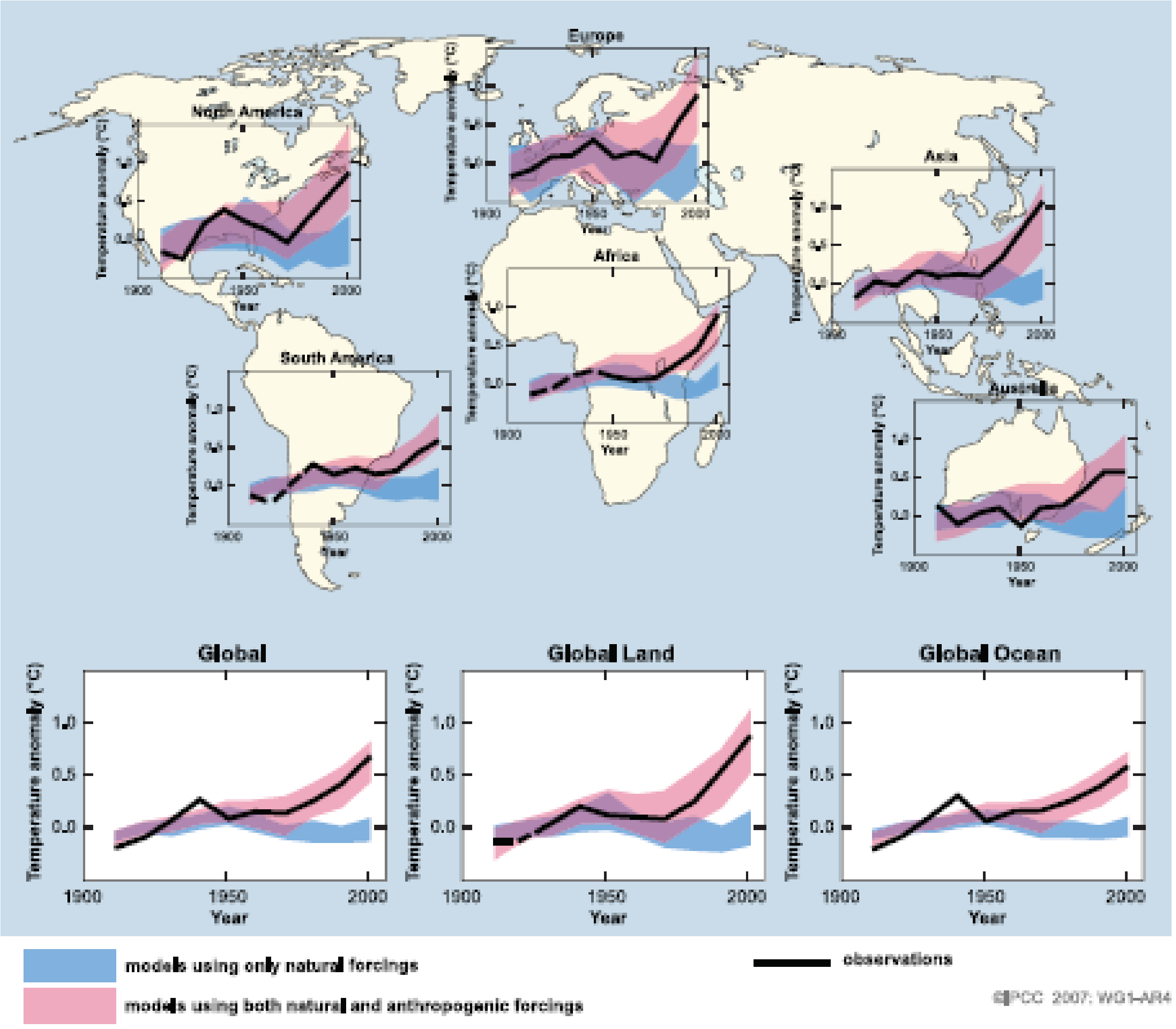
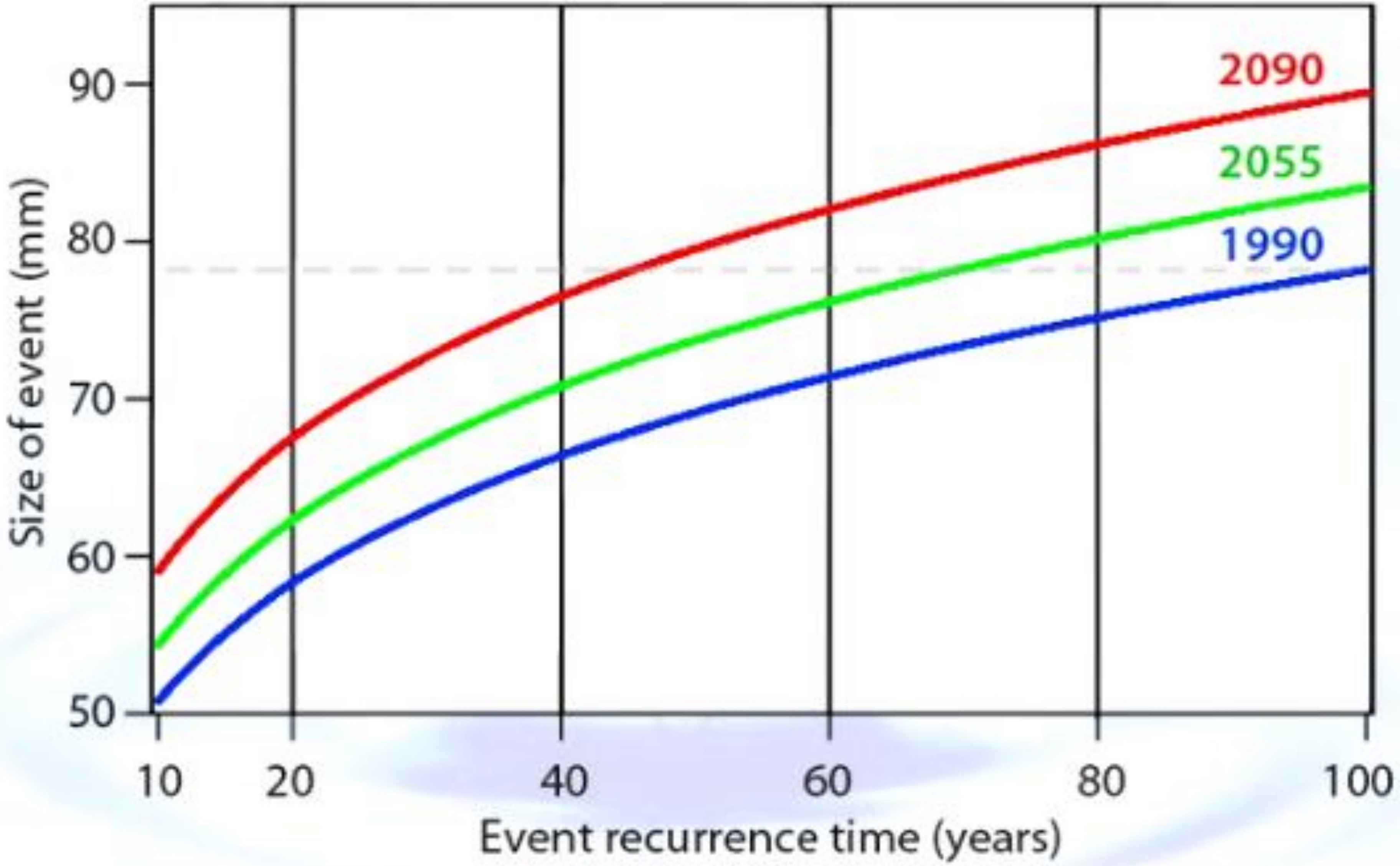


Figure TS.23. *(a) Global mean surface temperature anomalies relative to the period 1901 to 1950, as observed (black line) and as obtained from simulations with both anthropogenic and natural forcings. The thick red curve shows the multi-model ensemble mean and the thin yellow curves show the individual simulations. Vertical grey lines indicate the timing of major volcanic events. (b) As in (a), except that the simulated global mean temperature anomalies are for natural forcings only. The thick blue curve shows the multi-model ensemble mean and the thin lighter blue curves show individual simulations. Each simulation was sampled so that coverage corresponds to that of the observations. {Figure 9.5}*


Europe
North America
Asia
Africa
South America
Australia
Temperature anomaly (°C)
Year
1900
1950
2000
Global
Global Land
Global Ocean
1.0
0.5
0.0
models using only natural forcings
models using both natural and anthropogenic forcings
observations
©IPCC 2007: WG1-AR4

24-hour Precipitation Extremes
North America (25N-65N)



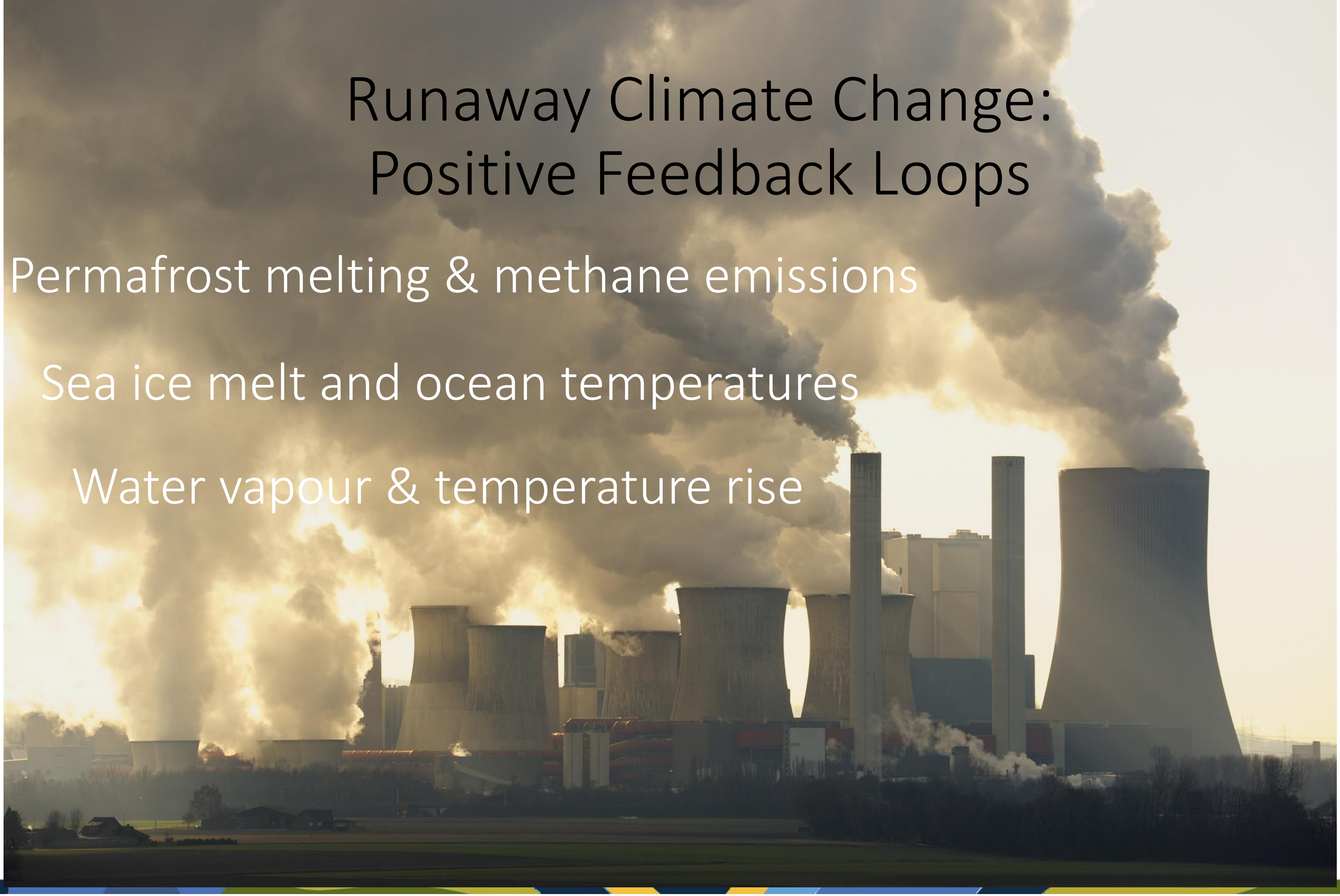
Courtesy V. Kharin, CCCma

Runaway Climate Change: Positive Feedback Loops

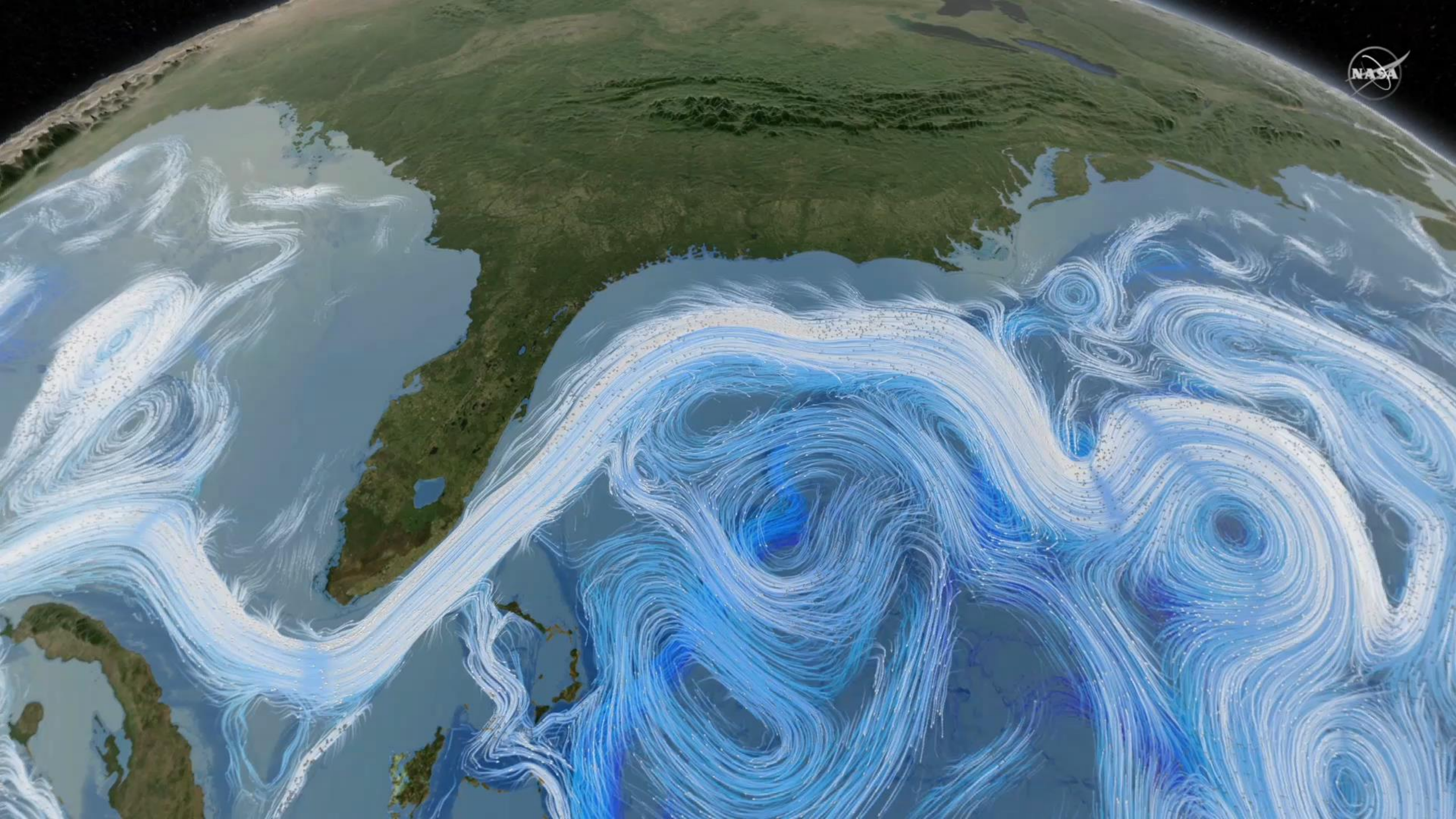
Permafrost melting & methane emissions

Sea ice melt and ocean temperatures

Water vapour & temperature rise



Runaway Tula



So what?

Observable Changes

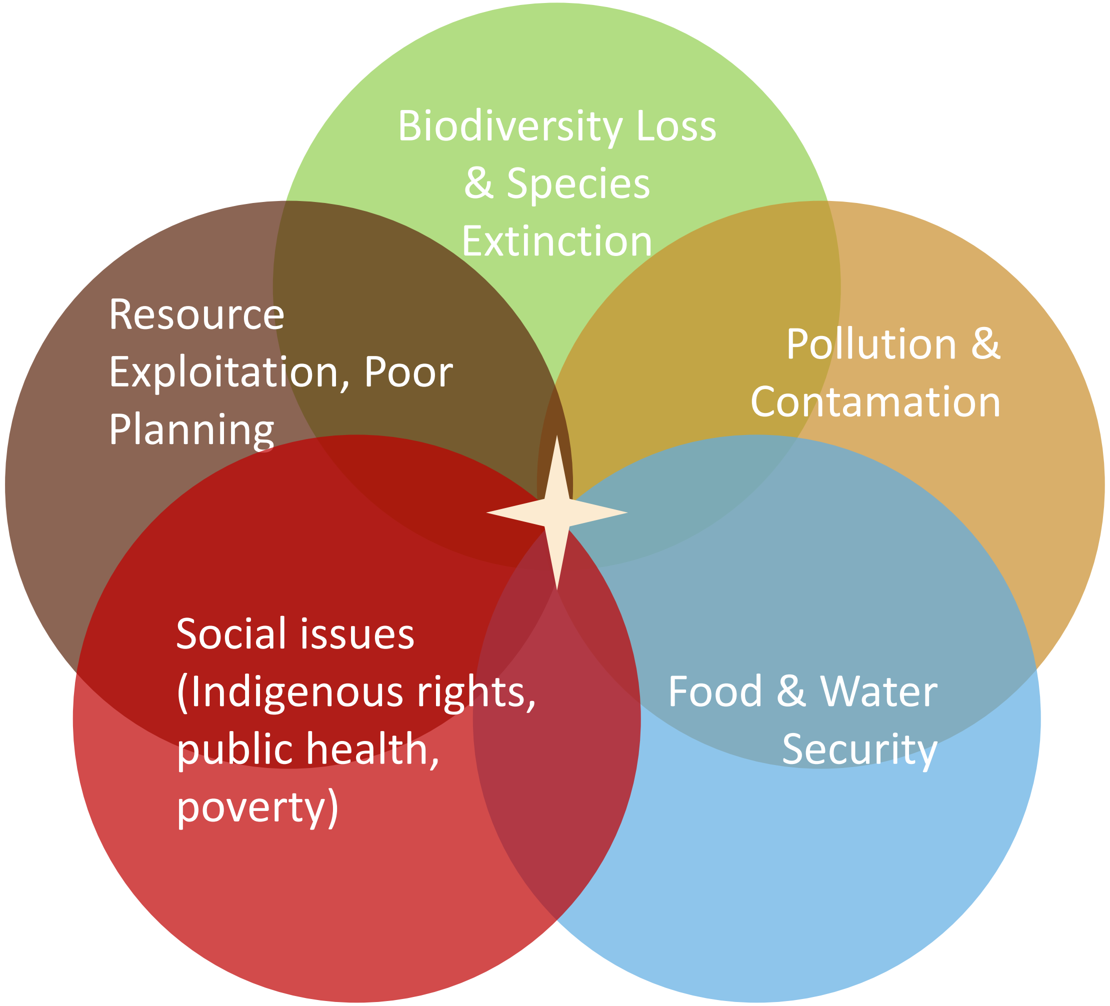
Predicted impacts

Indicators of Climate – what's changing?

- TEMPERATURE
- PRECIPITATION
- FROST-FREE DAYS AND GROWING SEASON
- DROUGHTS AND HEAT WAVES
- HURRICANES AND OTHER EXTREME WEATHER
- SEA LEVEL RISE
- ICE FREE ARCTIC AND GLACIAL RETREAT
- OCEAN ACIDIFICATION
- ECOLOGICAL SHIFTS AND SPECIES AT RISK
- FOOD & WATER SECURITY

Climate Change is not the only challenge we're facing…

Climate Change is a "**Threat Multiplier**"



…but it **exacerbates** nearly every existing Environmental, Social and Economic issue

Breakout session

“Community experiences with climate change”