Climate Science Literacy

Why and For Whom?

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What is Climate Science Literacy

Climate science Literacy is an understanding of the climate's influence on you and society and your influence on climate

A climate-literate person:

- Understands the essential principles of Earth's climate system,
- Knows how to assess scientifically credible information about climate,
- Communicates about climate and climate change in a meaningful way, and
- Is able to make informed and responsible decisions with regard to actions that may affect climate.

What is Climate ?

- Climate is defined as an area's long-term weather patterns. The simplest way to describe climate is to look at average temperature and precipitation over time. Other useful elements for describing climate include the type and the timing of precipitation, amount of sunshine, average wind speeds and directions, number of days above freezing, weather extremes, and local geography.

Timeline: How the world discovered Global Warming

300 BC - Theophrastus, a student of Greek philosopher Aristotle, documents that human activity can affect climate. He observes that drainage of marshes cools an area around Thessaly and that clearing of forests near Philippi warms the climate.

17th century - Flemish scientist Jan Baptista van Helmont discovers that carbon dioxide is given off by burning charcoal.

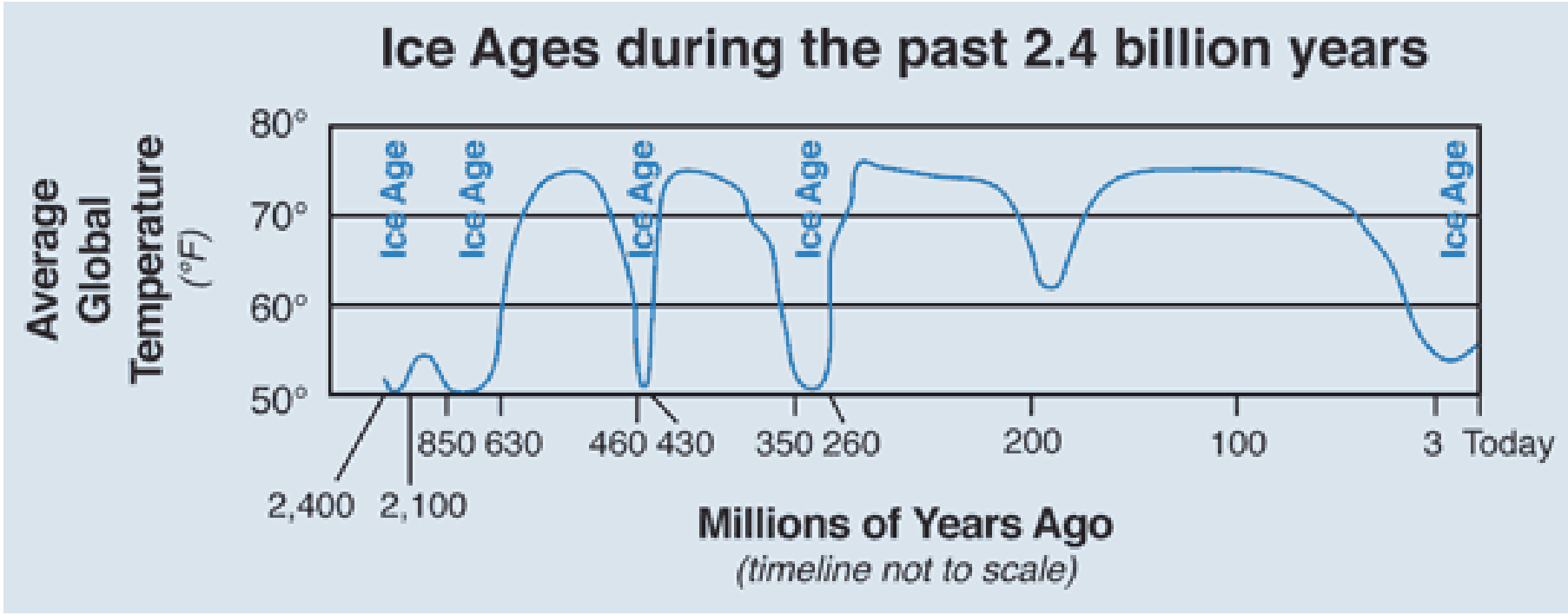
18th century - The Industrial Revolution starts, bringing rising use of fossil fuels.

1820s - French mathematician Jean-Baptiste Joseph Fourier suggests something in the atmosphere is keeping the world warmer than it would otherwise be, a hint at the greenhouse effect.

1860s - Irish scientist John Tyndall shows that molecules of gases such as water vapour and carbon dioxide trap heat. He wrote that changes "could have produced all the mutations of climate which the researches of geologists reveal."

1896 - Swedish chemist Svante Arrhenius becomes the first to quantify carbon dioxide's role in keeping the planet warm. He later concluded that burning of coal could cause a "noticeable increase" in carbon levels over centuries.

1950s - U.S. scientist Charles Keeling sets up stations to measure carbon dioxide concentrations in the atmosphere at the South Pole and at Mauna Loa, Hawaii. The measurements have shown a steady rise.


Ice Ages during the past 2.4 billion years
Average Global Temperature (°F)
80°
70°
60°
50°
Ice Age
Ice Age
Ice Age
Ice Age
Ice Age
850 630
460 430
350 260
200
100
3 Today
2,400
2,100
Millions of Years Ago
(timeline not to scale)

Climate is a Master Factor

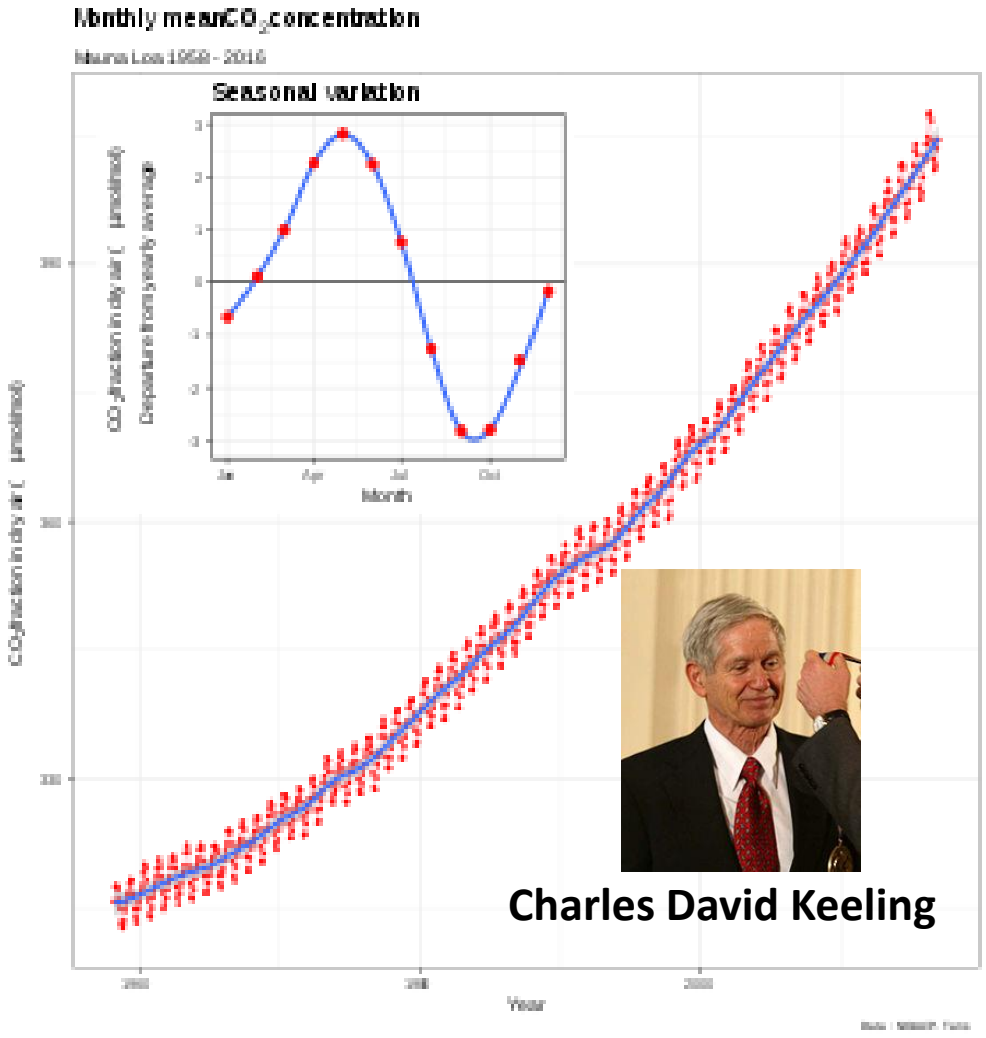
Hawaii's Mauna Loa Observatory: Fifty Years of Monitoring the Atmosphere

- Hawaii's Mauna Loa Observatory (MLO) is one of the world's leading scientific stations for monitoring the atmosphere. For more than fifty years, beginning with atmospheric chemist Charles Keeling's readings of carbon dioxide levels in the atmosphere, MLO has provided climate scientists a continuous record of the atmosphere's increasing concentration of carbon dioxide—and sparked the international debate over global warming. *Hawai'i's Mauna Loa Observatory* tells the story of the men and women who made these and many other measurements near the summit of the world's largest mountain.

Keeling Curve

Keeling worked at the Scripps Institution for 43 years during which time he published many influential papers. Roger Revelle, the Director of Scripps Institution of Oceanography, based at La Jolla, California, persuaded

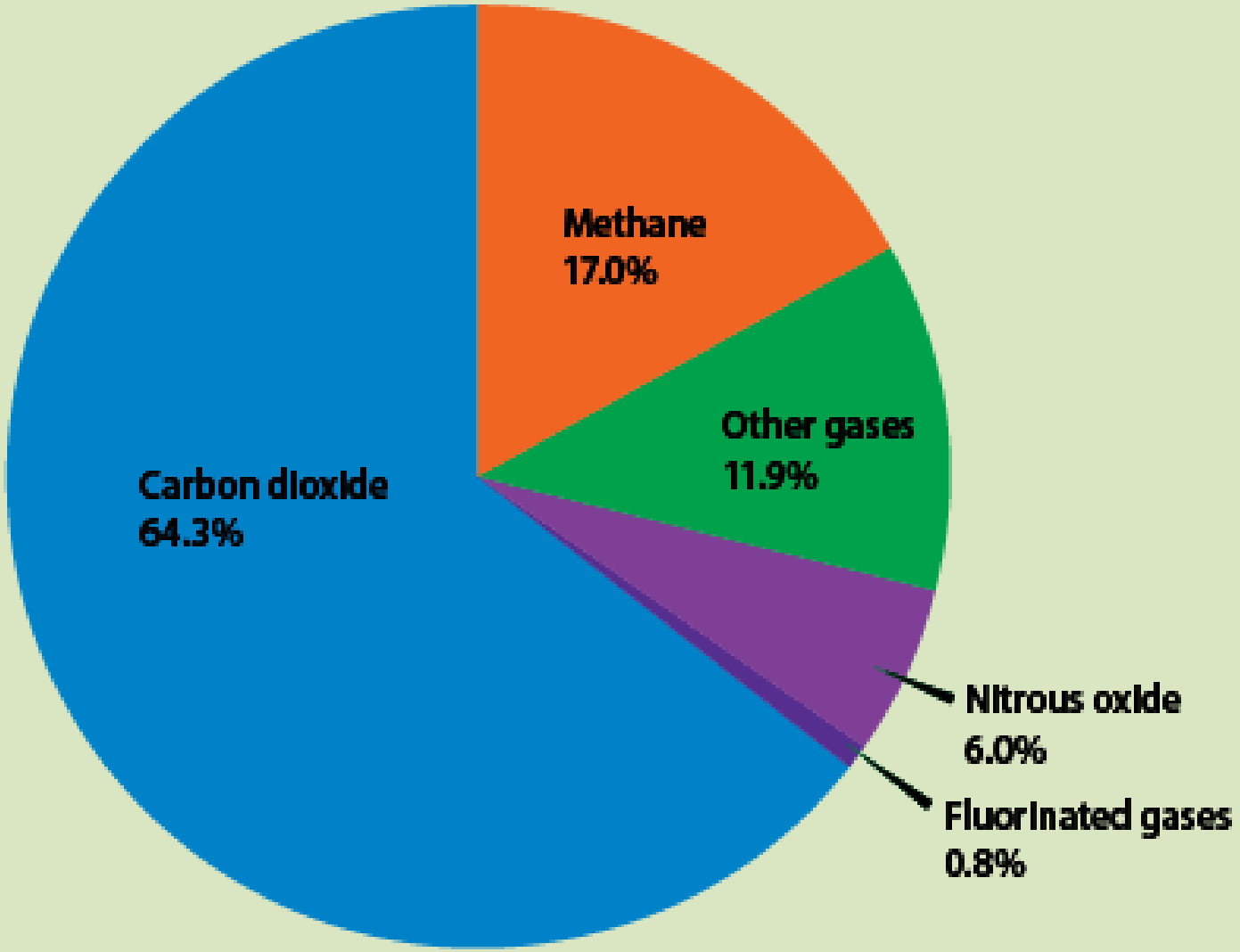
Dr. Keeling to continue his work there. Revelle was also one of the founders of the International Geophysical Year (IGY) in 1957–58 and Keeling received IGY funding to establish a base on Mauna Loa in Hawaii, two miles (3,000 m) above sea level.



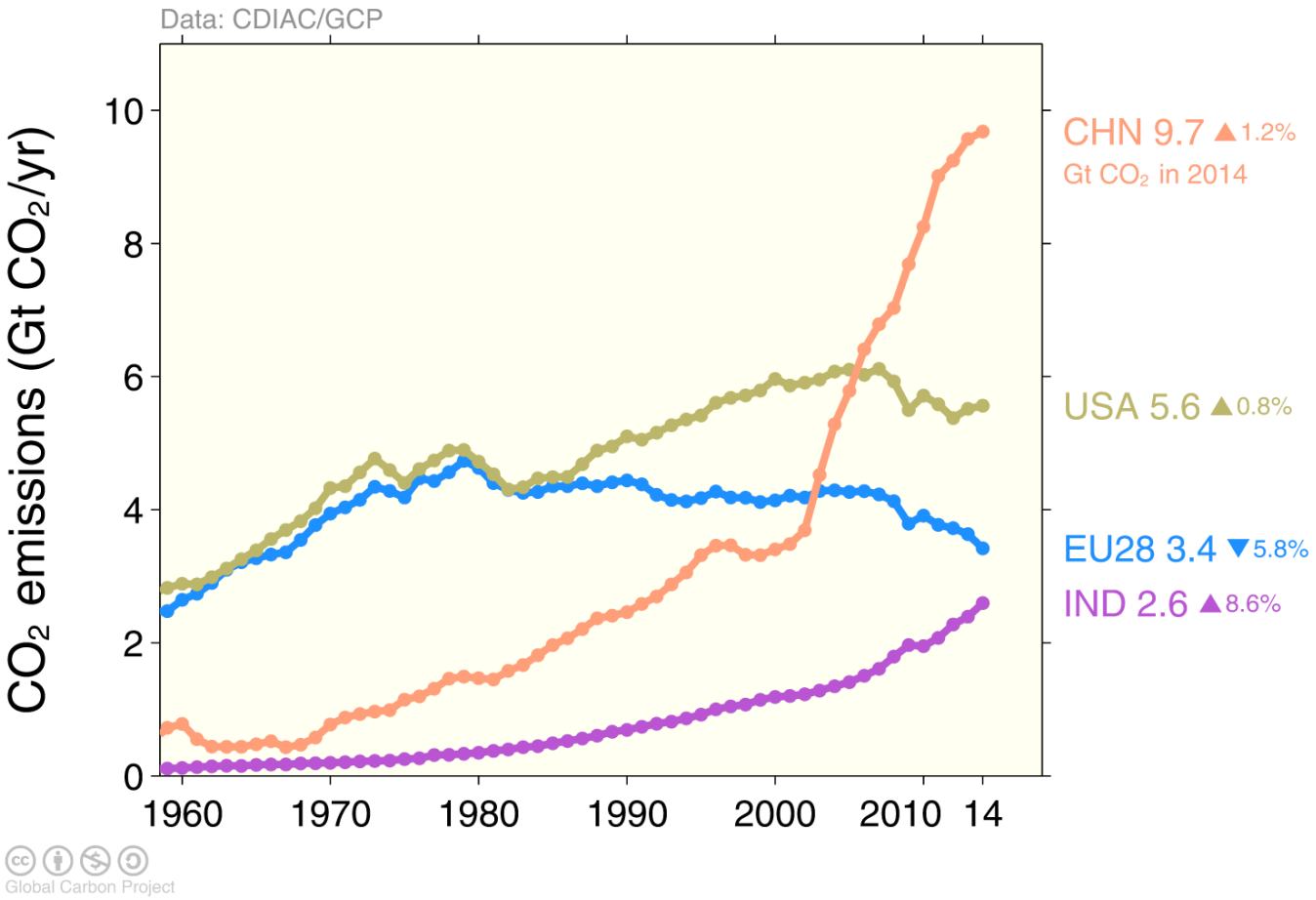
What is Climate Change?

- A change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.

Major Greenhouse Gases from People's Activities



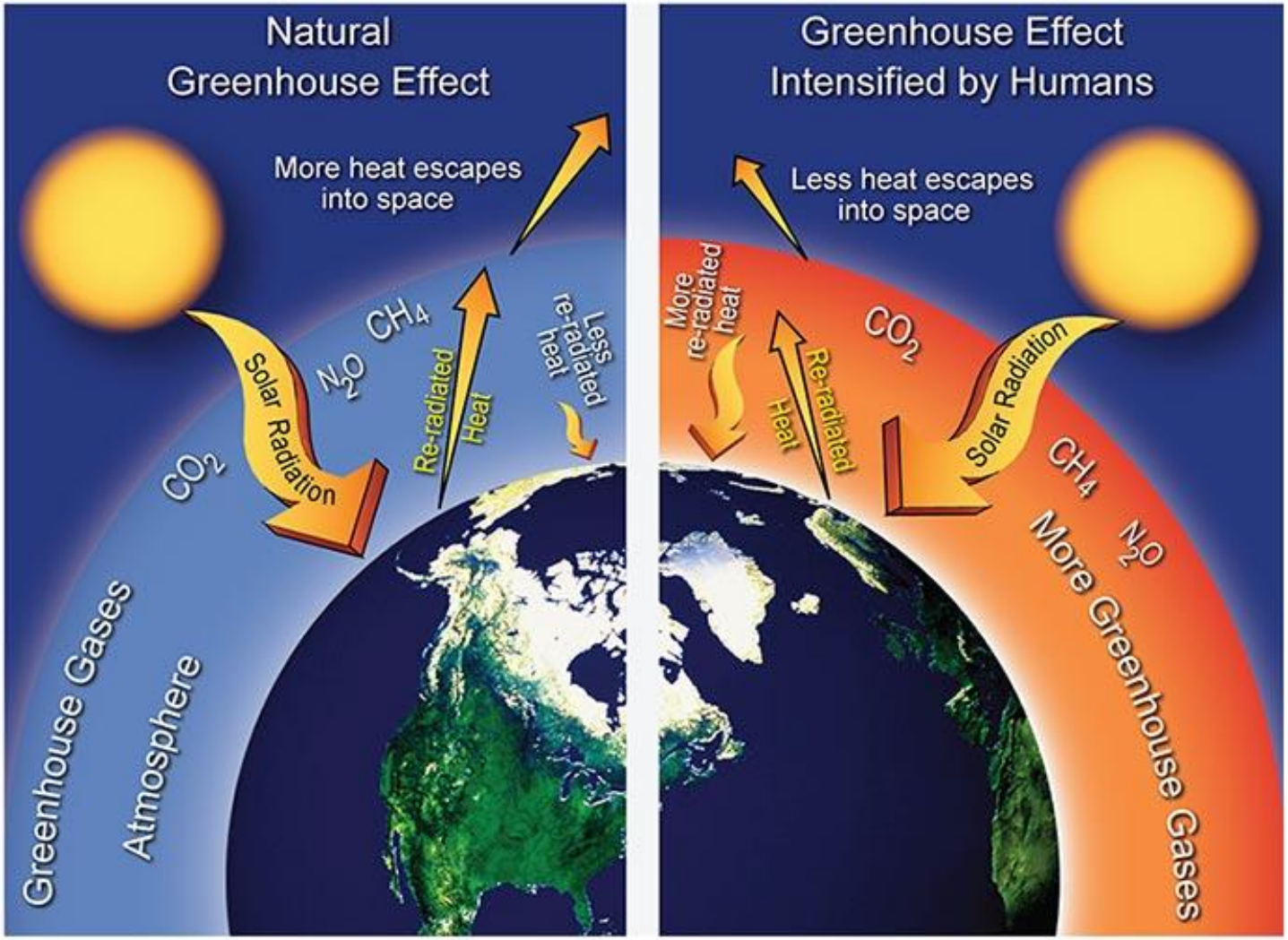
CO2 Emission



Global Carbon Dioxide Emissions 1850 to 2011 (Mt CO_2)

- 1850 198 MtCO2
- 1890 1304 MtCO2
- 1930 3855 MtCO2
- 1970 14531 MtCO2
- 2011 32274 MtCO2

Human Influence on the Greenhouse Effect



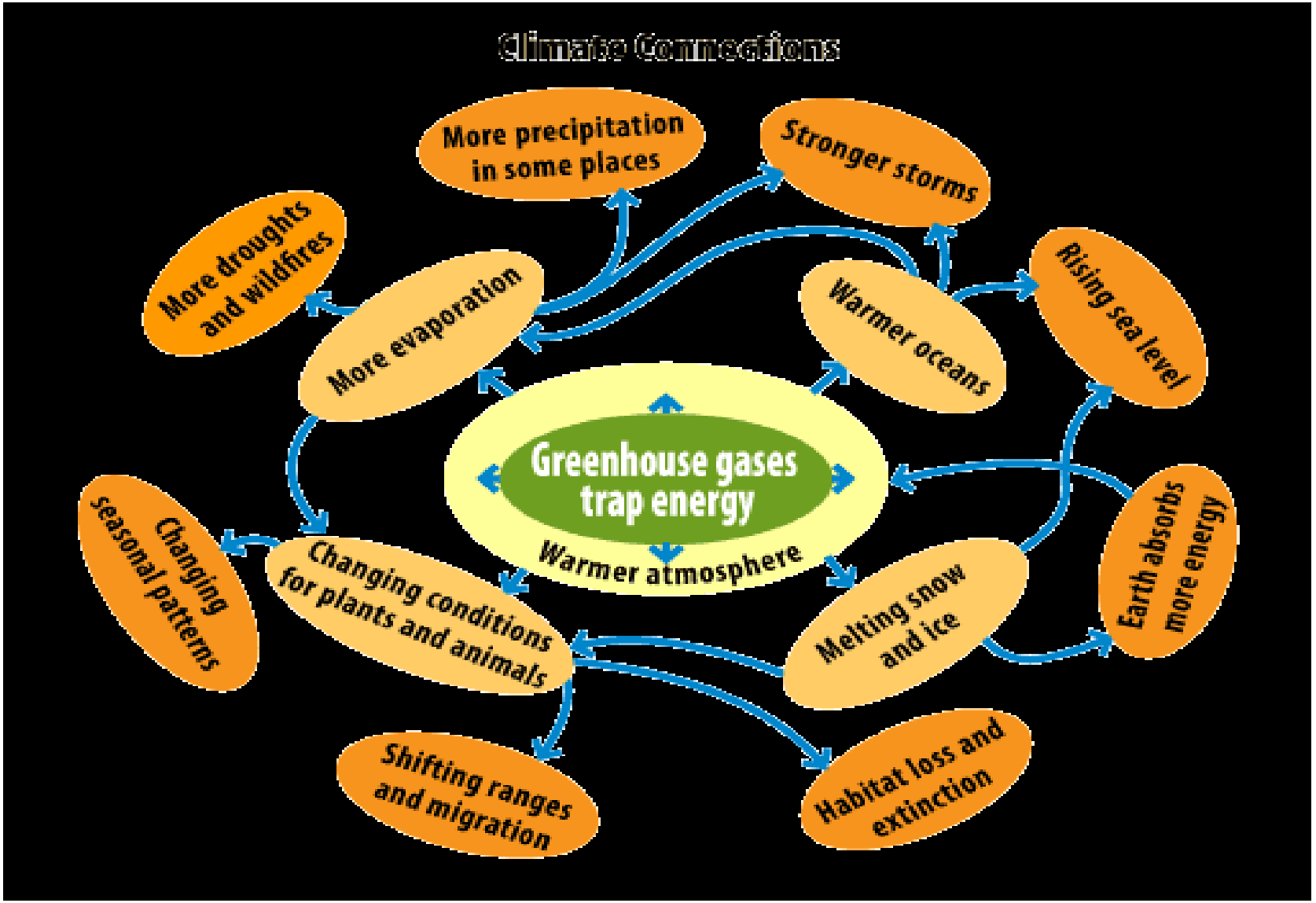
- Understanding the impacts of climate change Global emissions of carbon dioxide, a major greenhouse gas (GHG) and driver of climate change, increased from 22.4 billion metric tons in 1990 to 35.8 billion in 2013, a rise of 60 percent.

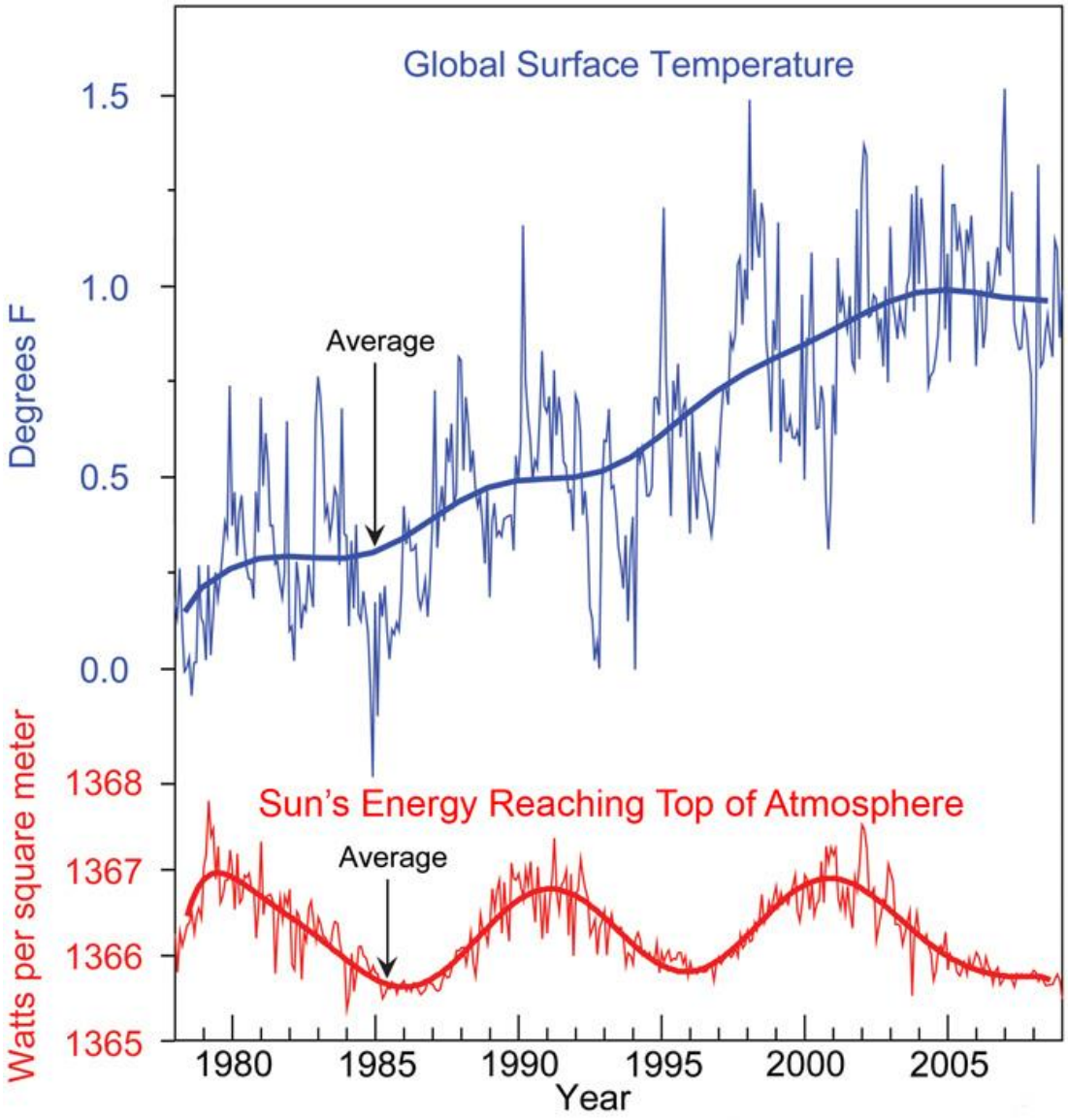
- The increase in CO2 emissions and other greenhouse gases has contributed to a rise of about over 1 degrees Celsius in mean global temperature above preindustrial times.

Climate Change Impact

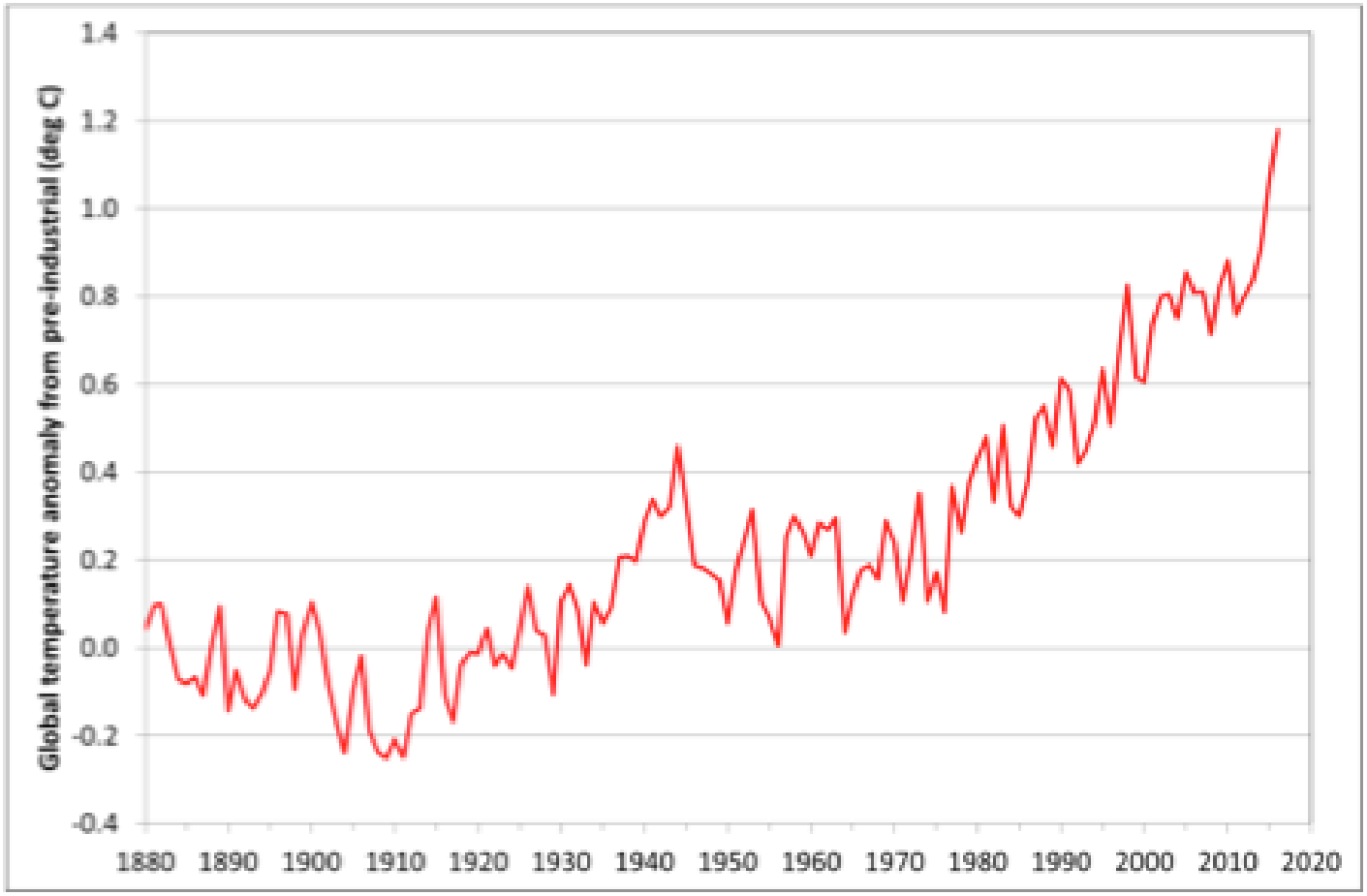
- **Climate change is having mixed — but mostly negative — impacts on ecosystem services, suggest data analysed by a new study.** The research, which brings together the findings of over 100 other studies, found that 59% of reported impacts of climate change on ecosystem services are negative, while just 13% are positive. However, the method of research was shown to strongly influence whether impacts are reported as positive or negative, with expert opinion studies far more negative than other types of study.

Climate Connections



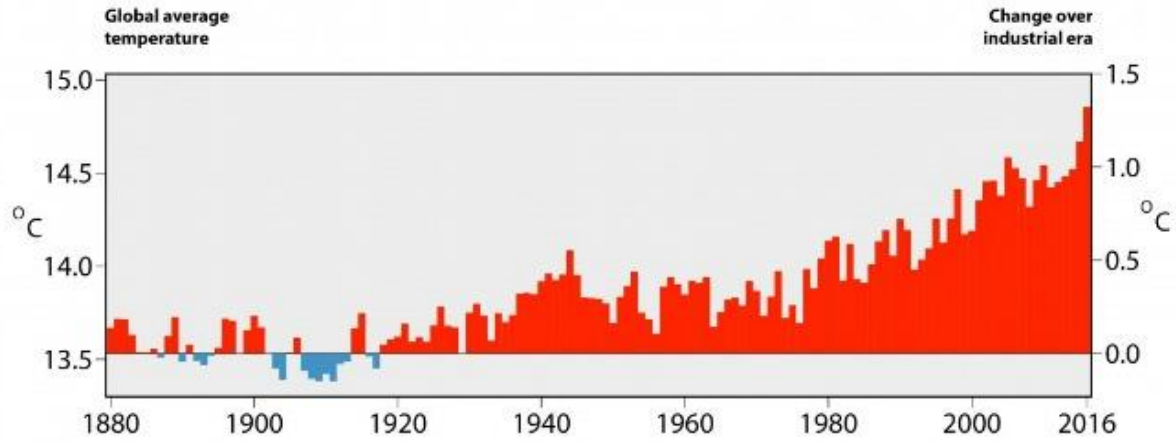

Global Surface Temperature
Degrees F
1.5
1.0
0.5
0.0
Average
Sun's Energy Reaching Top of Atmosphere
Watts per square meter
1368
1367
1366
1365
Average
1980
1985
1990
1995
2000
2005
Year

Global temperatures – change from pre-industrial



Data: NOAA, NASA, UK Met Office/CRU

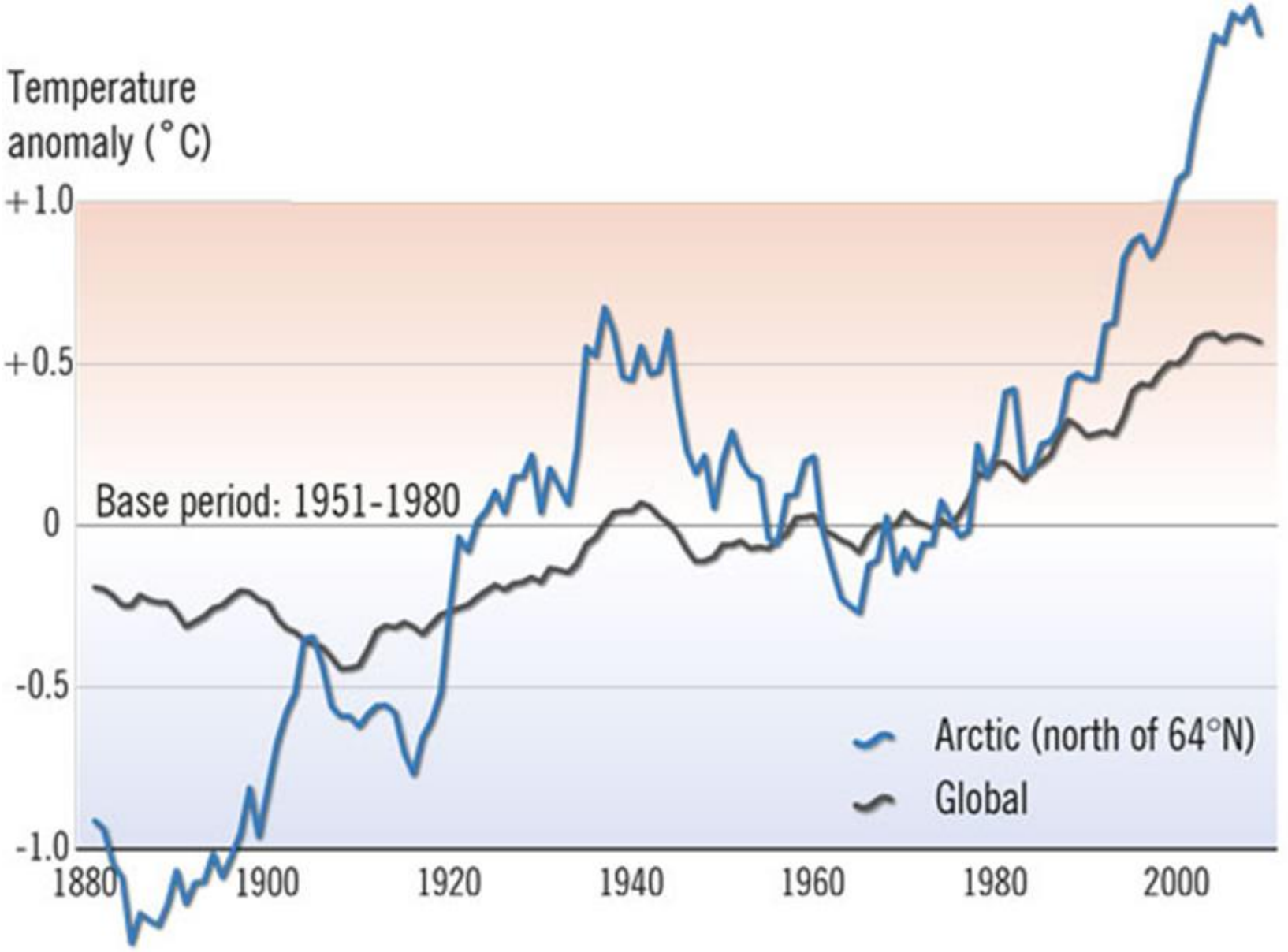
ANNUAL GLOBAL SURFACE AIR TEMPERATURES FROM 1880 TO 2016



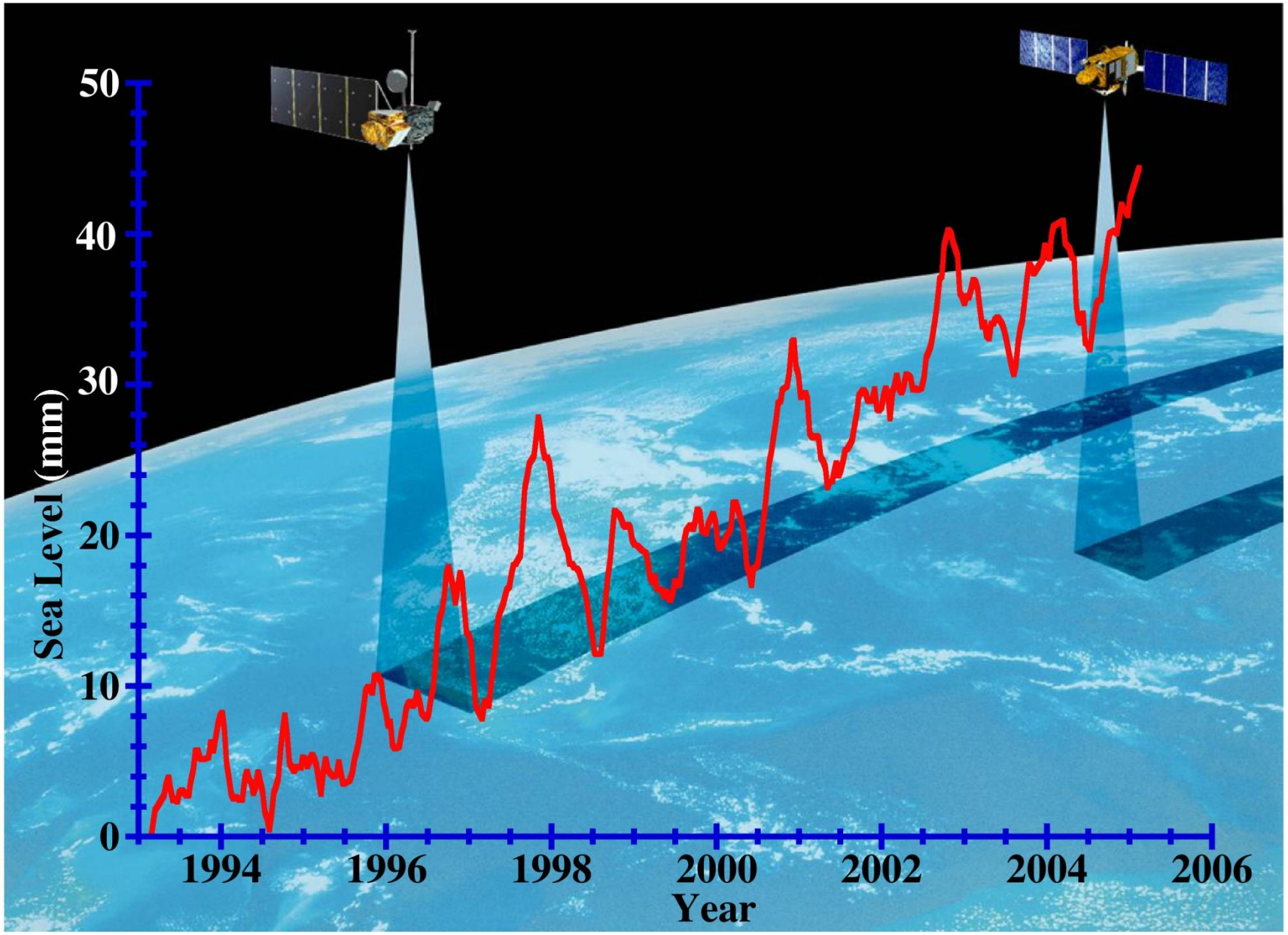
Sources: Copernicus Climate Change Service, ECMWF, for data from 1979;
Met Office Hadley Centre, NASA and NOAA for blended data prior to 1979.

Copernicus
Climate Change Service

Climate Change Catstrophy

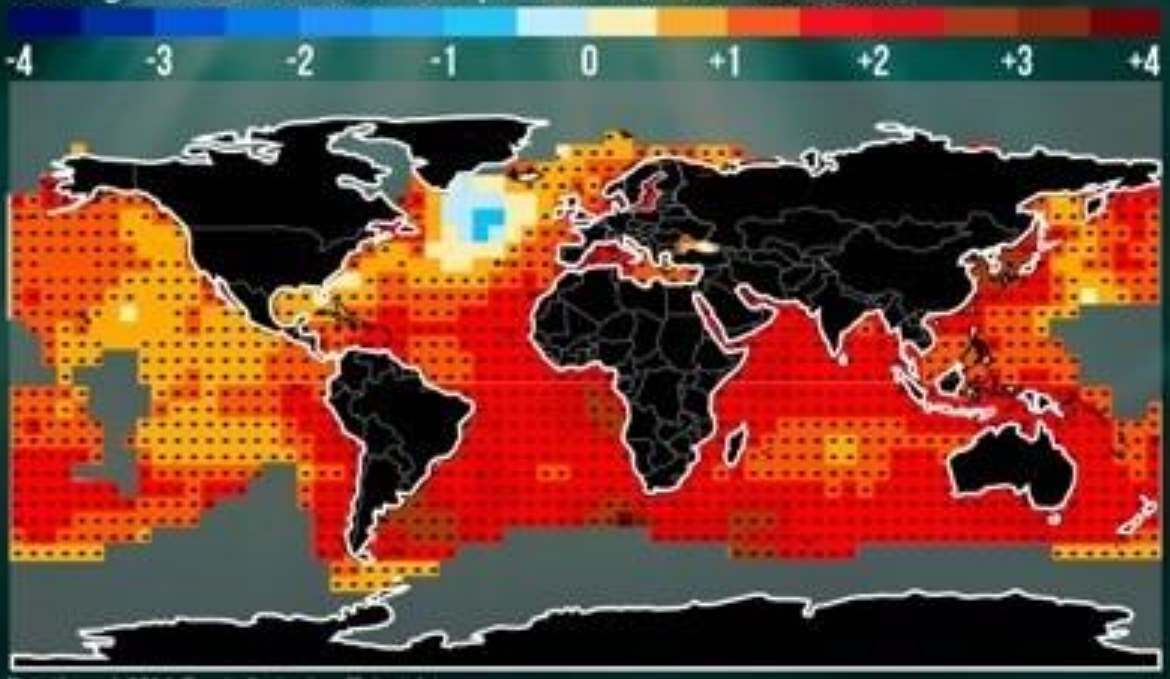

Temperature anomaly (°C)
+1.0
+0.5
0
-0.5
-1.0
Base period: 1951-1980
1880
1900
1920
1940
1960
1980
2000
Arctic (north of 64°N)
Global

Sea-level from satellites: 4 cm rise in last 10 years



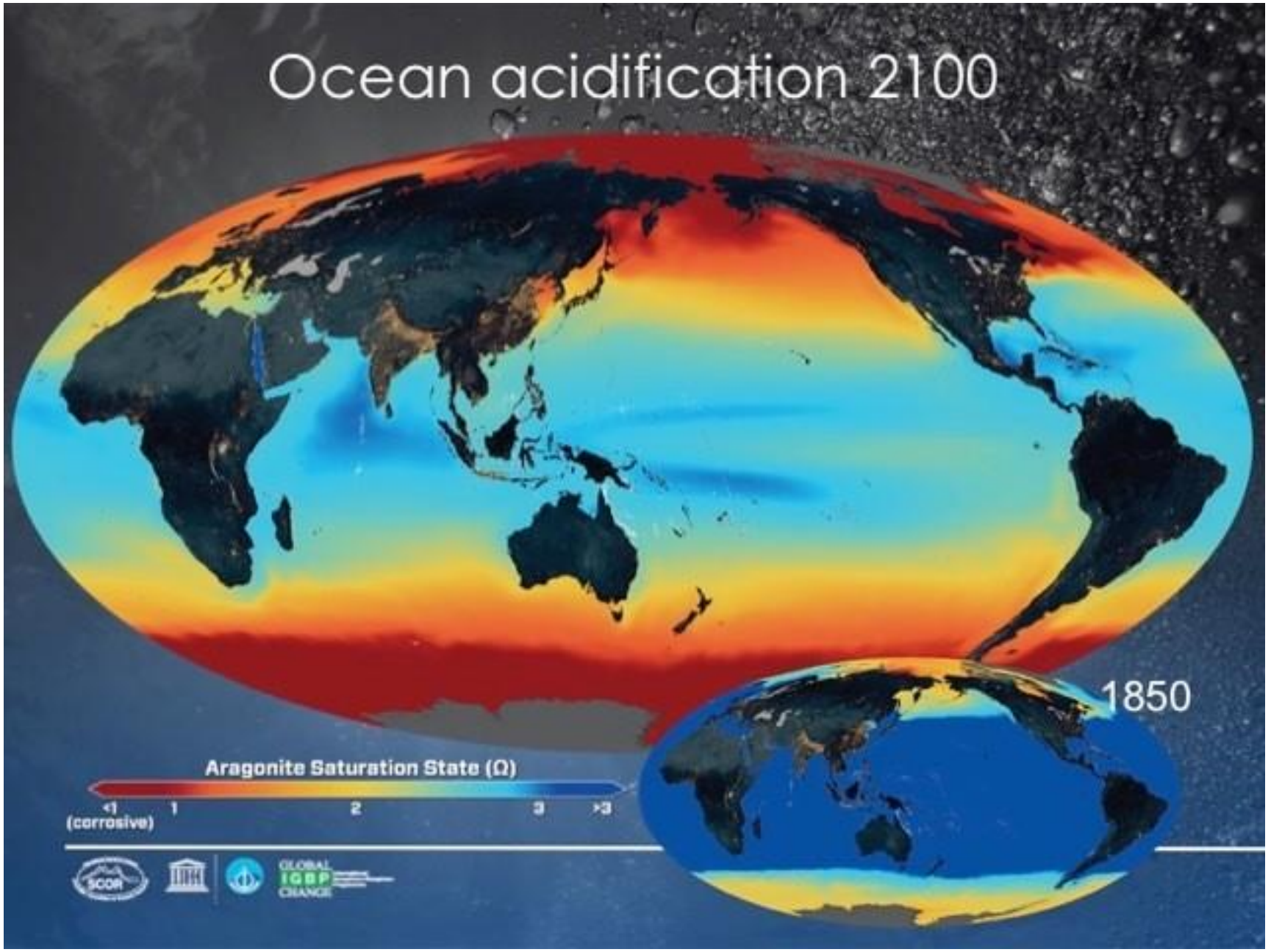
OCEANS HEATING UP

Change in Sea Surface Temperature (°F) Since 1901:



Data through 2014. Gray indicates insufficient data
"+" Indicates statistically significant trend
Source: IPCC, NOAA: Merged Land-Ocean Surface Temp Analysis

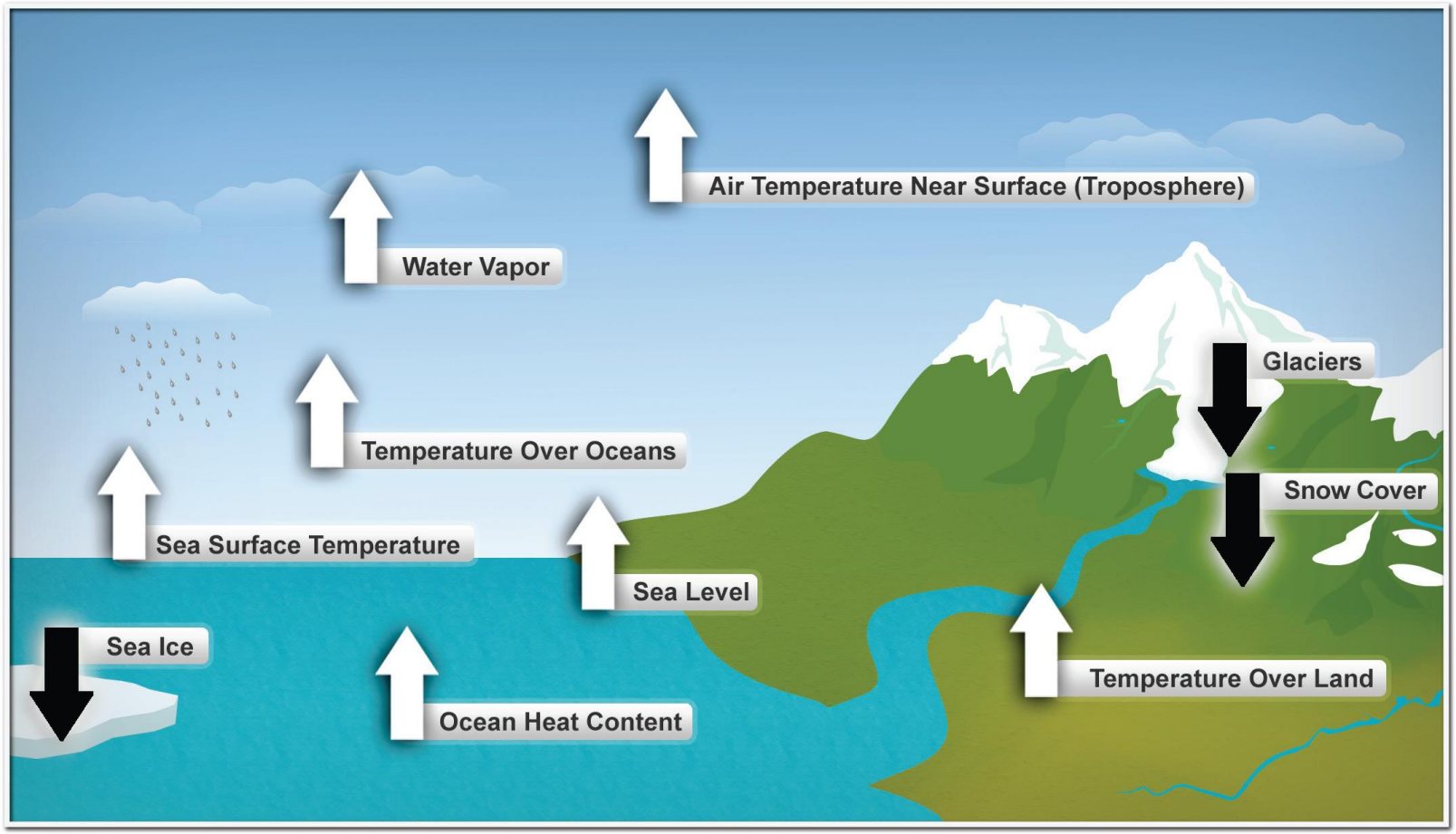
CLIMATE CENTRAL


Ocean acidification 2100
1850
Aragonite Saturation State (Ω)
<1
(corrosive)
1
2
3
>3
SCOR
GLOBAL
IGBP
CHANGE

Coral crisis: Great Barrier Reef

Bleaching is “the worst we’ve ever seen”

Ten Indicators of a Warming World



Summary of Recent Observed Trend of Extreme Events over India

Monsoon Rainfall	
Monsoon Rainfall variability	
Light/Moderate Rainfall	
Heavy/Very Heavy Rainfall	
Long Spell of Rainfall	
Short Spell of Rainfall	
Drought	

How do we know what is scientifically correct?

- Science is an on-going process of making observations and using evidence to test hypotheses. as new ideas are developed and new data are obtained, oftentimes enabled by new technologies, our understanding evolves. The scientific community uses a highly formalized version of peer review to validate research results and our understanding of their significance.

- Peer review does not guarantee that any particular published result is valid, it does provide a high assurance that the work has been carefully vetted for accuracy by informed experts prior to publication. The overwhelming majority of peer-reviewed papers about global climate change acknowledge that human activities are substantially contributing factors.

Global Effort to Stop Climate Change

- 1992 - World leaders agree the U.N. Framework Convention on Climate Change, which sets a non-binding goal of stabilising greenhouse gas emissions by 2000 at 1990 levels, a target not met overall.

- 1995 - The IPCC concludes for the first time that humans are causing global warming, saying: "The balance of evidence suggests a discernible human influence on global climate."

- 1997 - The Kyoto Protocol is agreed in Japan; developed nations agree to cut their greenhouse gas emissions on average by at least 5 percent below 1990 levels by 2008-12. The United States stays out of the deal.

Kyoto Protocol

to the United Nations Framework Convention on Climate Change

negotiated in 1997
open for signature in 1998
came into force February 16, 2005

Kyoto Protocol - Highlights

- The Kyoto Protocol is a agreement under which industrialized countries will reduce their collective emissions of greenhouse gases by 5.2% compared to the year 1990
- Compared to the emissions levels that would be expected by 2010 without the Protocol, this target represents a 29% cut.
- The goal is to lower overall emissions from six greenhouse gases - carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, HFCs, and PFCs - calculated as an average over the five-year period of 2008-12.
- National targets range from 8% reductions for the European Union and some others to 7% for the US, 6% for Japan, 0% for Russia, and permitted increases of 8% for Australia and 10% for Iceland."
- Sinks can be used to offset emission and emission credits can be traded.
- IPPC analyses used in assessments of sources and sinks

The World's Top 3 Emitters Contribute 14 Times the Emissions of the Bottom 100

- The top three greenhouse gas emitters— China, the European Union and the United States— contribute more than half of total global emissions, while the bottom 100 countries only account for 3.5 percent. Collectively, the top 10 emitters account for nearly three-quarters of global emissions. The world can't successfully tackle the climate change challenge without significant action from these countries.(CAIT)

Paris Outcome

Transparency

- Enhanced transparency framework based on existing reporting
- Tracking mitigation, adaptation and support provided and received
- Country performance reports undergo technical review
- Country reports subject to multilateral consideration
- Still to negotiate detailed rules prior to 2020 (top-down)

Review of adequacy – Global Stock Take

- Assess collective progress to inform NDC's every 5 years
- Covers mitigation, adaptation and MoI

Compliance

- Facilitative Compliance mechanism
- Comprised of experts
- Still to negotiate detailed modalities, procedures and rules prior to 2020 (top-down)

Entry into force

- 55 countries and 55% of world emissions

Paris Outcome

Finance

- DC's "shall" provide finance for mitigation and adaptation (top-down)
- Others (DingC's) encouraged
- All sources
- Biennial communication of finance contributions

Technology

- Continuation of the Technology mechanism
- Overarching Technology Framework
- Finance for innovation
- Commitment to international technology cooperation

Capacity Building

- Adopted at CMA 1 the Paris Committee on Capacity Building or other institiutional arrangement
- International capacity building cooperation
- Enhanced EE and public awareness
- Communication of capacity building action

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KEY OUTCOMES

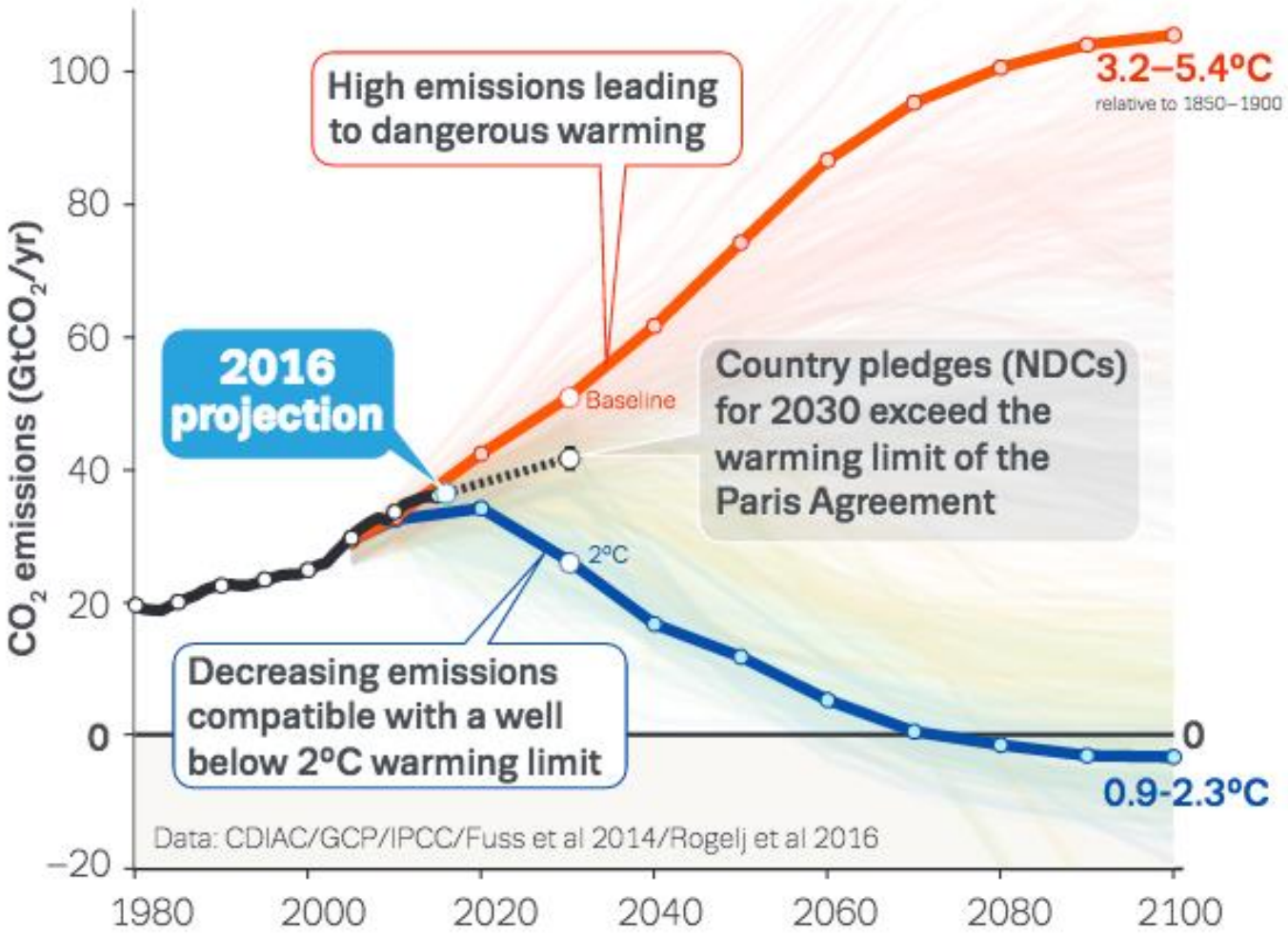
- COP 21 in Paris is universally regarded as a seminal point in the development of the international climate change regime under the UNFCCC, concluding as it did with the **Paris Agreement** (PA).

- The PA is **a comprehensive framework** which will guide international efforts to limit GHG emissions and to meet all the associated challenges posed by climate change.

- PA does not provide much of the detail necessary for its implementation. This **detail will instead be negotiated by Parties over the next five years** - through Ad Hoc Working Group on the Paris Agreement (APA).

- SA played a central and constructive role in its capacity as Chair of the Group of 77 and China, member of the AGN, BASIC, as well as in its national capacity.

Global CO2 emissions since 1980 (solid black) and country pledges under the Paris Agreement (dashed) compared to a high emissions scenario (orange) and a scenario compatible with limiting warming to 2C above pre-industrial levels (blue).)



Source: Le Quéré, C. et al. (2016) based on Rogelj et al, (2016)

Uncle Sam is wrong,

India is aggressively working t to fight climate change

A majority of right-wing American politicians are climate change deniers, consider global warming to be a hoax and blame emerging countries like India and China on the rising level of CO2 emission in the world.

World is planning to reduce dependency on fossil fuels . But an executive order of President Donald Trump reverses Barack Obama's policies, that were powering the country's emerging renewable industry , and lifted restrictions on the coal industry to create more mining jobs.

A few days ago, Republican politician Rick Santorum again passed the blame on to India and China for the increasing level of CO2 emission. This is far from fact.

Indian government runs one of the largest renewable capacity expansion programmes in the world. According to the Climate Change Performance Index released this year, India's per capita emissions are still relatively low, but emissions are rapidly increasing. 25 percent of the growing energy supply is covered by renewables, but there still is room for improvements.

Climate Science Literacy is a part of Science Literacy.

- *"Science, mathematics, and technology have a profound impact on our individual lives and our culture. They play a role in almost all human endeavors, and they affect how we relate to one another and the world around us. . . . Science Literacy enables us to make sense of real-world phenomena, informs our personal and social decisions, and serves as a foundation for a lifetime of learning."*

- From the american association for the advancement of Science, atlas of Science Literacy, Volume 2, Project 2061.

- People who are climate science literate know that climate science can inform our decisions that improve quality of life. They have a basic understanding of the climate system, including the natural and human-caused factors that affect it.
- Climate science literate individuals understand how climate observations and records as well as computer modeling contribute to scientific knowledge about climate. They are aware of the fundamental relationship between climate and human life and the many ways in which climate has always played a role in human health. They have the ability to assess the validity of scientific arguments about climate and to use that information to support their decisions.

Why does Climate Science Literacy Matter?

• During the 20th century, Earth's globally averaged surface temperature rose by approximately 1.08°F (0.6°c). Additional warming of more than 0.25°F (0.14°c) has been measured since 2000. Though the total increase may seem small, it likely represents an extraordinarily rapid rate of change compared to changes in the previous 10,000 years.

• Over the 21st century, climate scientists expect Earth's temperature to continue increasing, very likely more than it did during the 20th century. Two anticipated results are rising global sea level and increasing frequency and intensity of heat waves, droughts, and floods. These changes will affect almost every aspect of human society, including economic prosperity, human and environmental health, and national security.

• Scientific observations and climate model results indicate that human activities are now the primary cause of most of the ongoing increase in Earth's globally averaged surface temperature.

Climate Science Literacy is an Ongoing Process.

No single person is expected to understand every detail about all of the fundamental climate science literacy concepts. Full comprehension of these interconnected concepts will require a systems-thinking approach, meaning the ability to understand complex interconnections among all of the components of the climate system. Moreover, as climate science progresses and as efforts to educate the people about climate's influence on them and their influence on the climate system mature, public understanding will continue to grow.

Climate is an ideal interdisciplinary theme for lifelong learning about the scientific process and the ways in which humans affect and are affected by the Earth's systems. This rich topic can be approached at many levels, from comparing the daily weather with long term records to exploring abstract representations of climate in computer models to examining how climate change impacts human and ecosystem health.

Learners of all ages can use data from their own experiments, data collected by satellites and other observation systems, or records from a range of physical, chemical, biological, geographical, social, economic, and historical sources to explore the impacts of climate and potential adaptation and mitigation strategies.


Thank You !