Introduction to Climate Change

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What is Climate?

- Climate VS Weather
  - Weather consists of the short-term (minutes to months) changes in the atmosphere. Most people think of weather in terms of temperature, humidity, precipitation, cloudiness, brightness, visibility, wind, and atmospheric pressure, as in high and low pressure.
  - Climate is the description of the long-term pattern of weather in a particular area. It is an average weather for a particular region and time period, usually taken over 30-years. It's really an average pattern of weather for a particular region.

Source: NASA (2017)

What is Climate Change?

- UNFCCC (1994)
- "Climate change" means a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

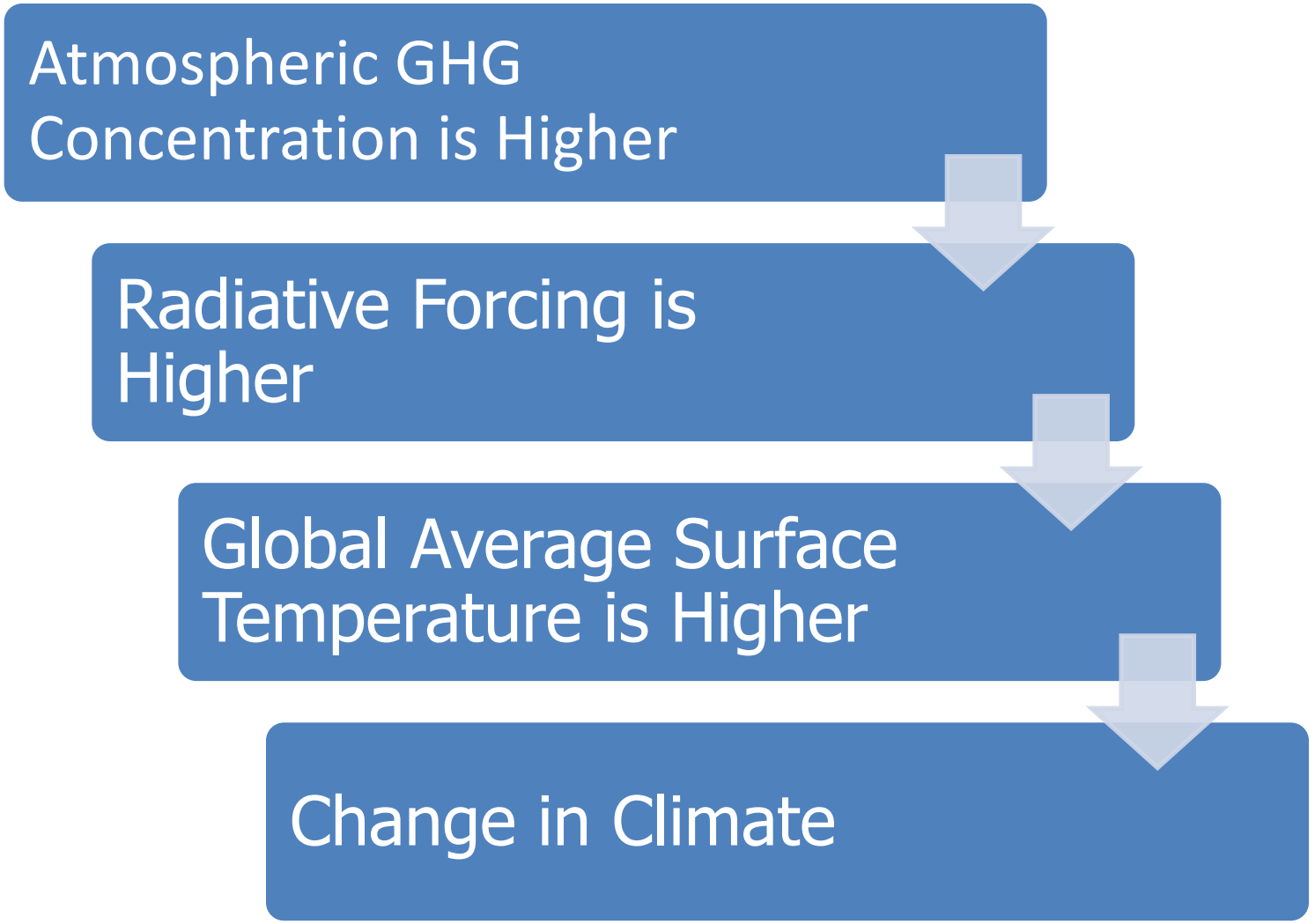
United Nations Framework Convention on Climate Change

What is Climate Change? (2)

- IPCC AR4 (2007)
- A change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity.

IPCC
INTERGOVERNMENTAL PANEL ON climate change

What is Changing in Climate Change?

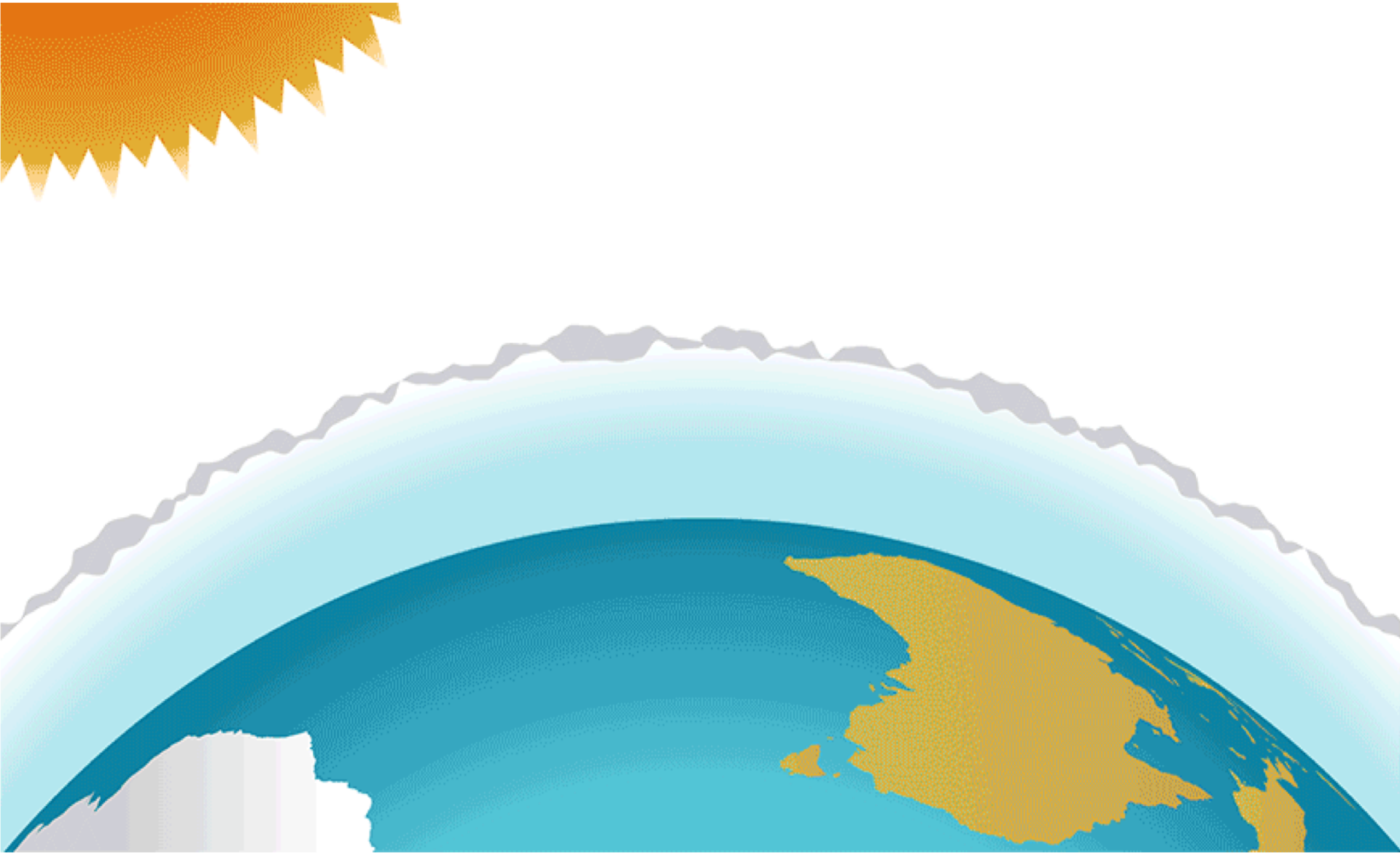


Greenhouse Effect

- Greenhouse Effect is vital to every life on Earth

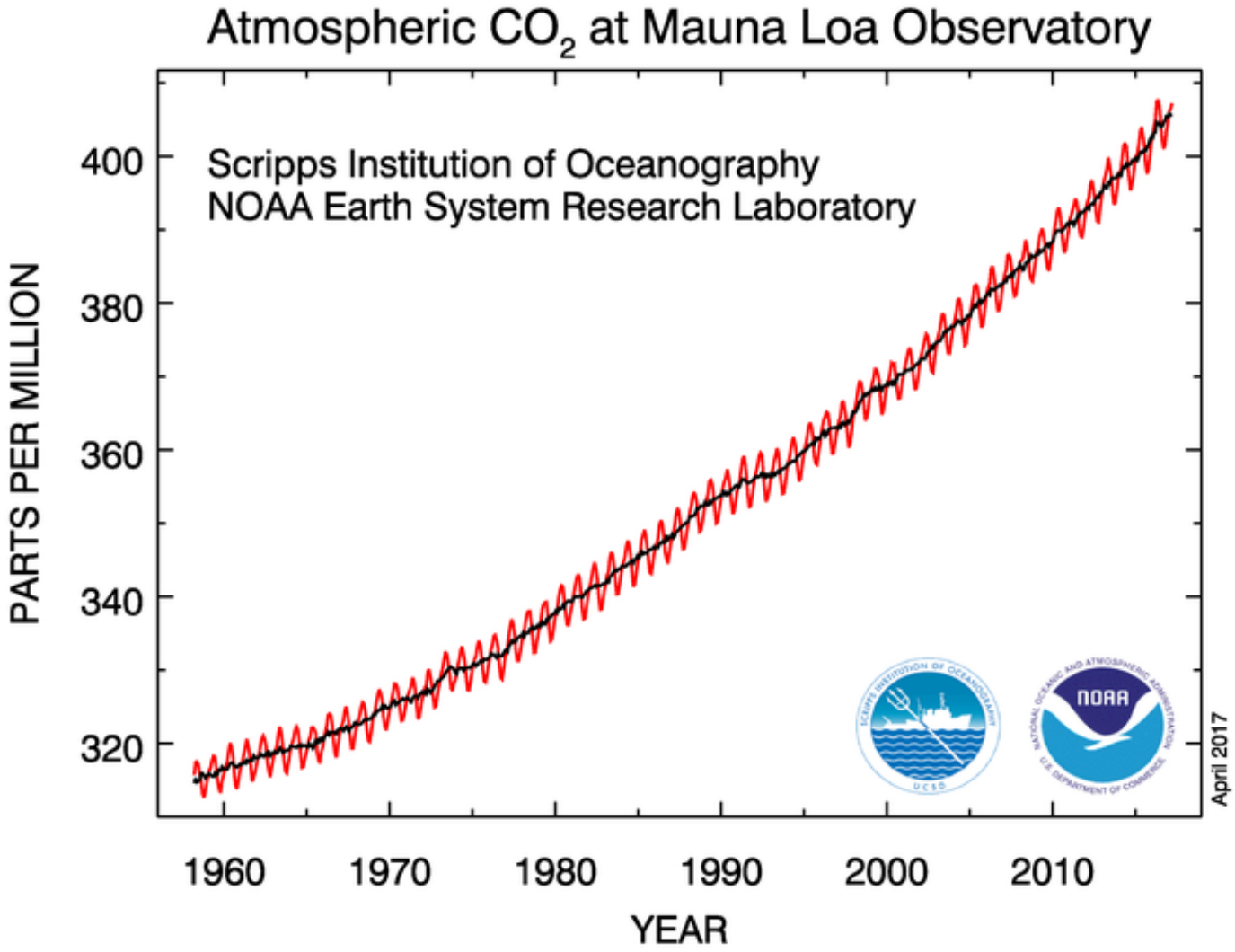
- The Sun powers Earth's climate, radiating energy in the visible or near-visible (e.g., ultraviolet) wavelength. Because the Earth is much colder than the Sun, it radiates back the incoming energy at much longer wavelengths, primarily in the infrared. Much of this thermal radiation emitted by the land and ocean is absorbed by the atmosphere, including clouds, and reradiated back to Earth. (IPCC)

- If there was no Greenhouse Effect, average surface temperature would be -18ºC instead of +15ºC (NASA)



Source: Commonwealth of Australia (2013)

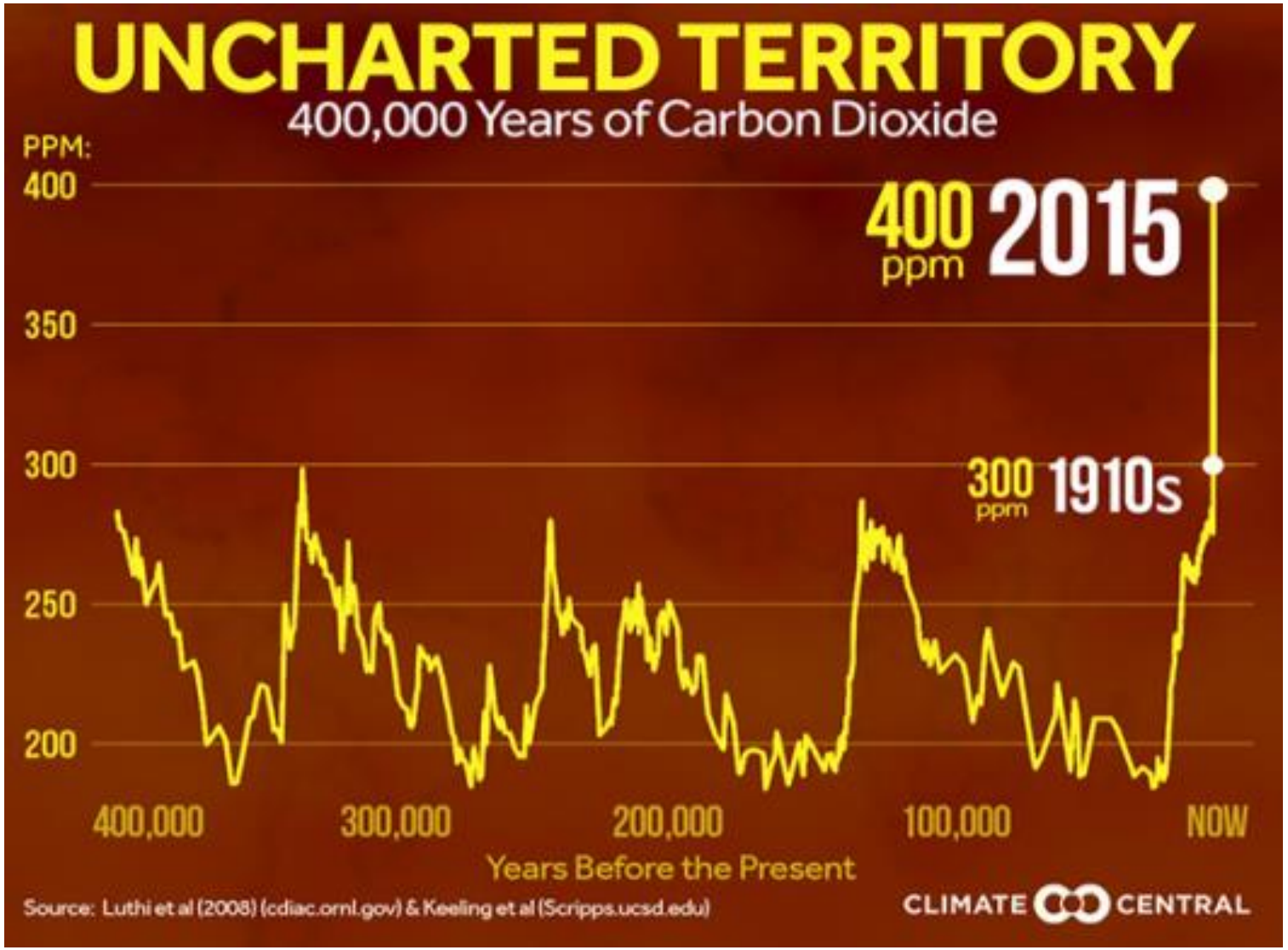
Atmospheric CO_2 Concentration



March 2017	407.18 ppm
March 2016	404.83 ppm
Updated April 2017	

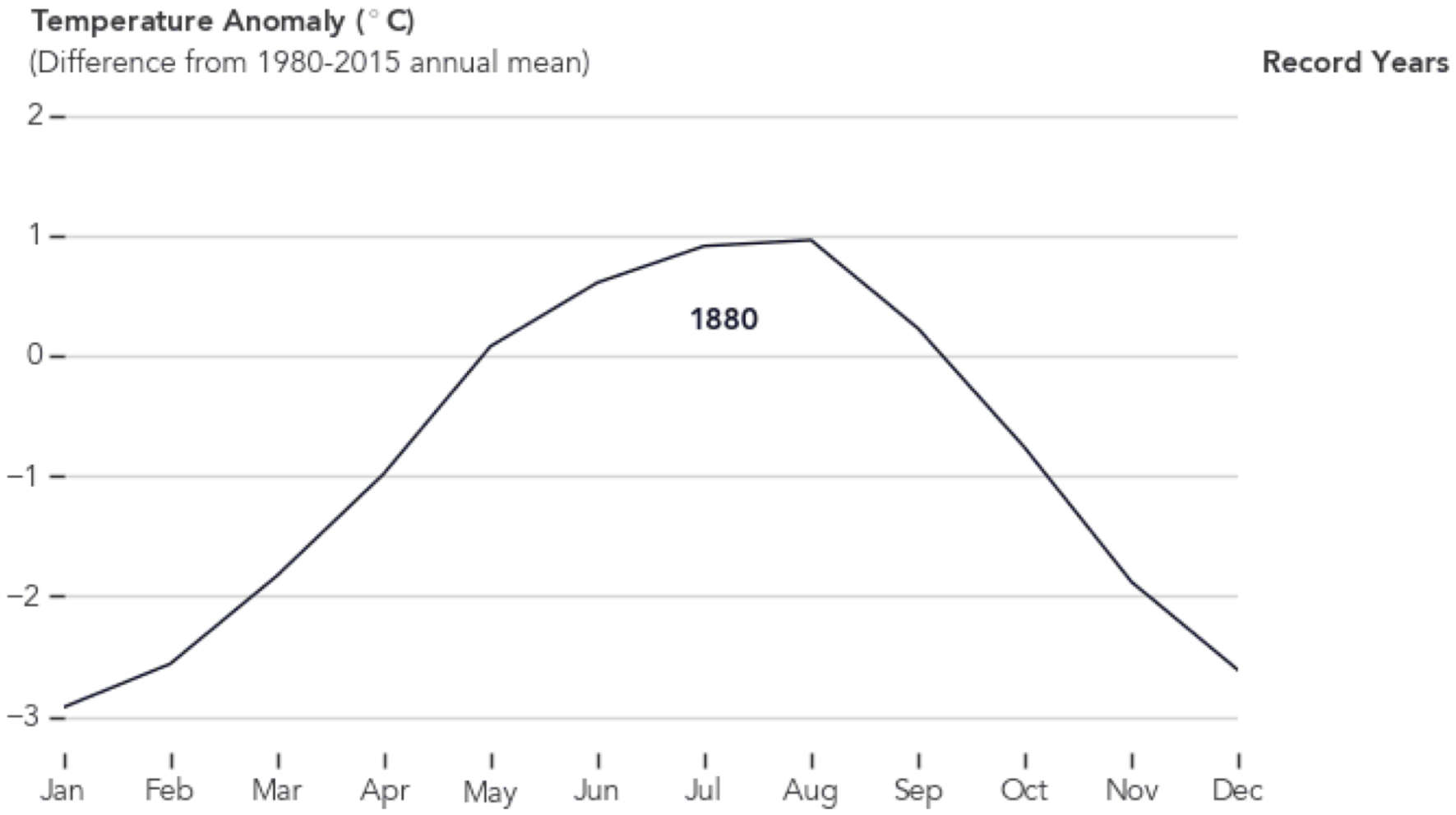
Source: US National Oceanic and Atmospheric Administration (2017)

Atmospheric CO_2 Concentration (2)



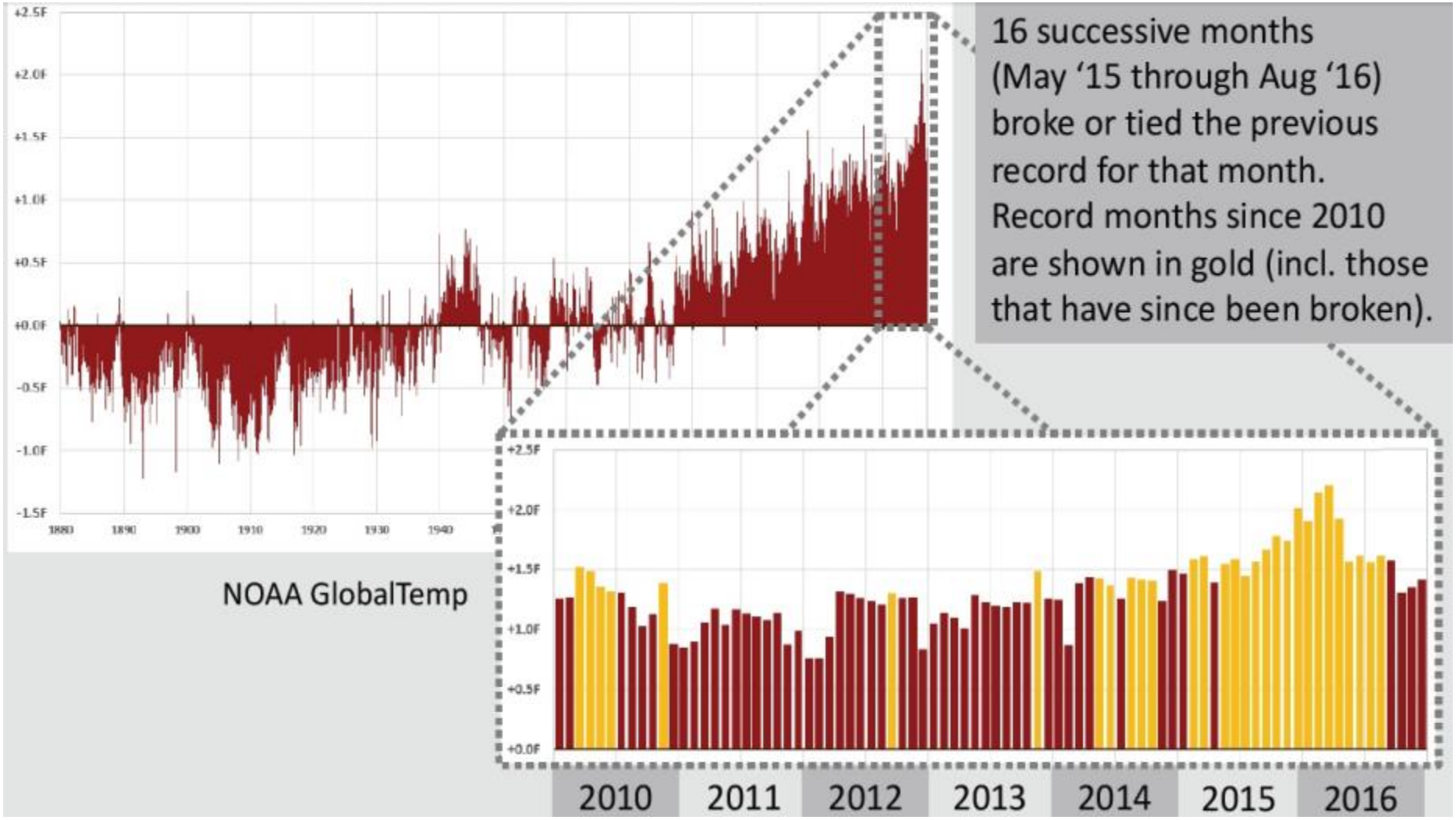
Source: Climate Central (2015)

Change in Global Surface Temperature



Source: US National Oceanic and Atmospheric Administration (2017)

Change in Global Surface Temperature (2)



Source: US National Oceanic and Atmospheric Administration (2017)

Causes of Climate Change

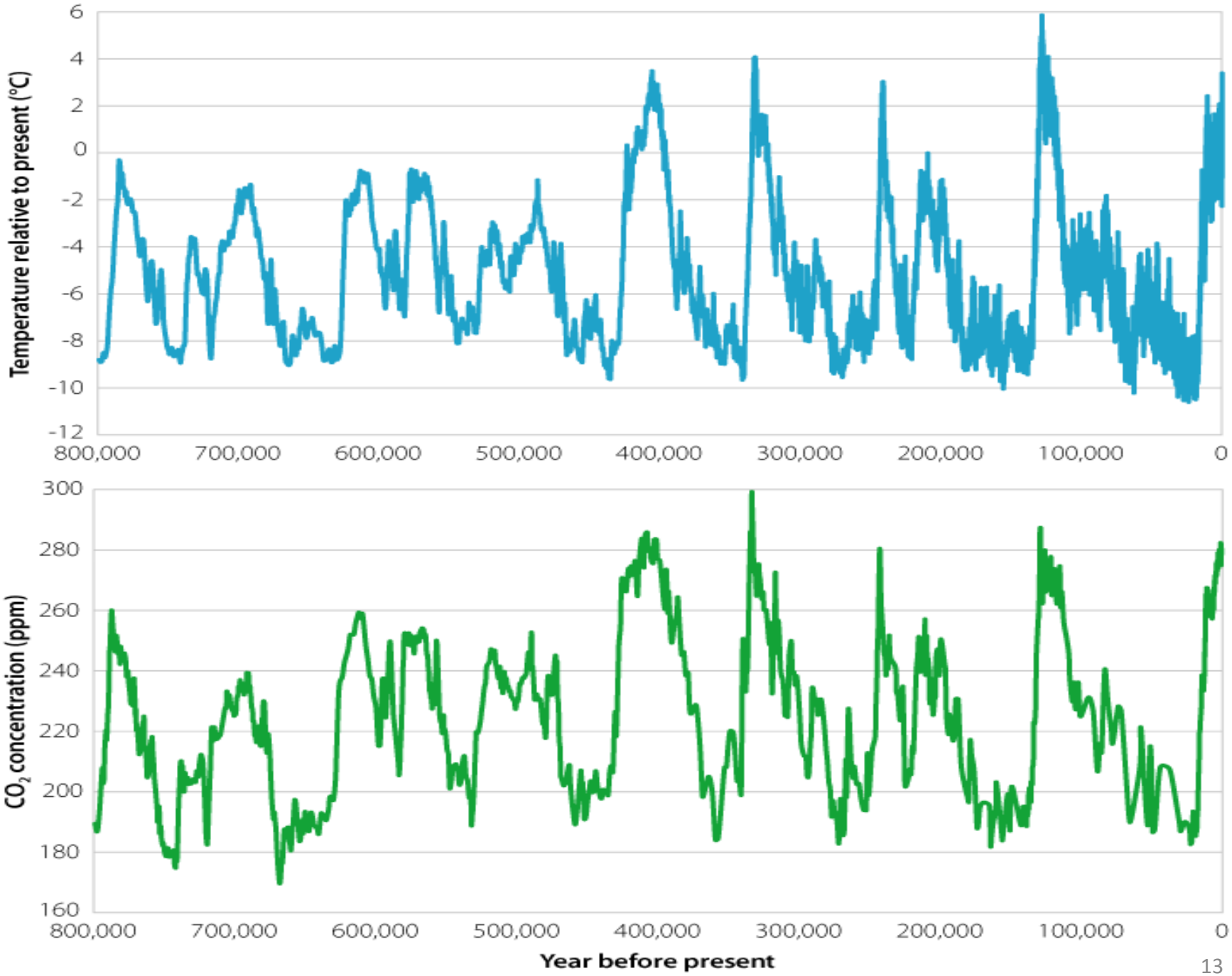
Greenhouse Gases: CO_2, CH_4, N_2O, SF_6, NF_3, PFCs, HFCs, H_2O

<u>Natural Sources</u>

- Solar influences
- Earth's Orbit
- Earth's Natural Cycle
- Volcanic Eruption
- Wildfire
- Plant and Animal Respiration
- Plant and Animal Decomposition

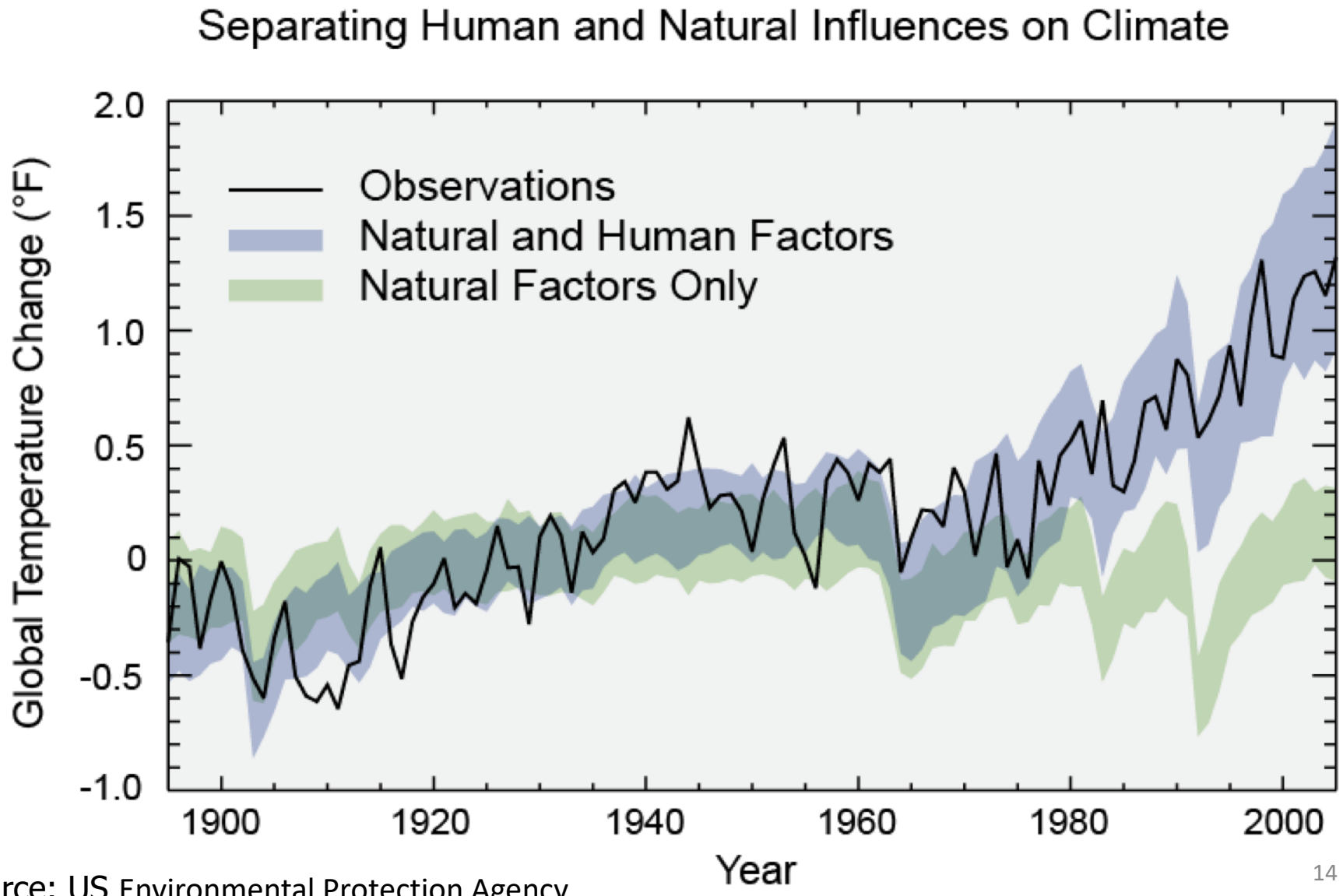
<u>Anthropogenic Sources</u>

- Burning Fossil Fuels
- Agricultural Activities
- Industrial Processes and Product Use (IPPU)
- Waste and Waste Management
- Land Use Change and Forestry



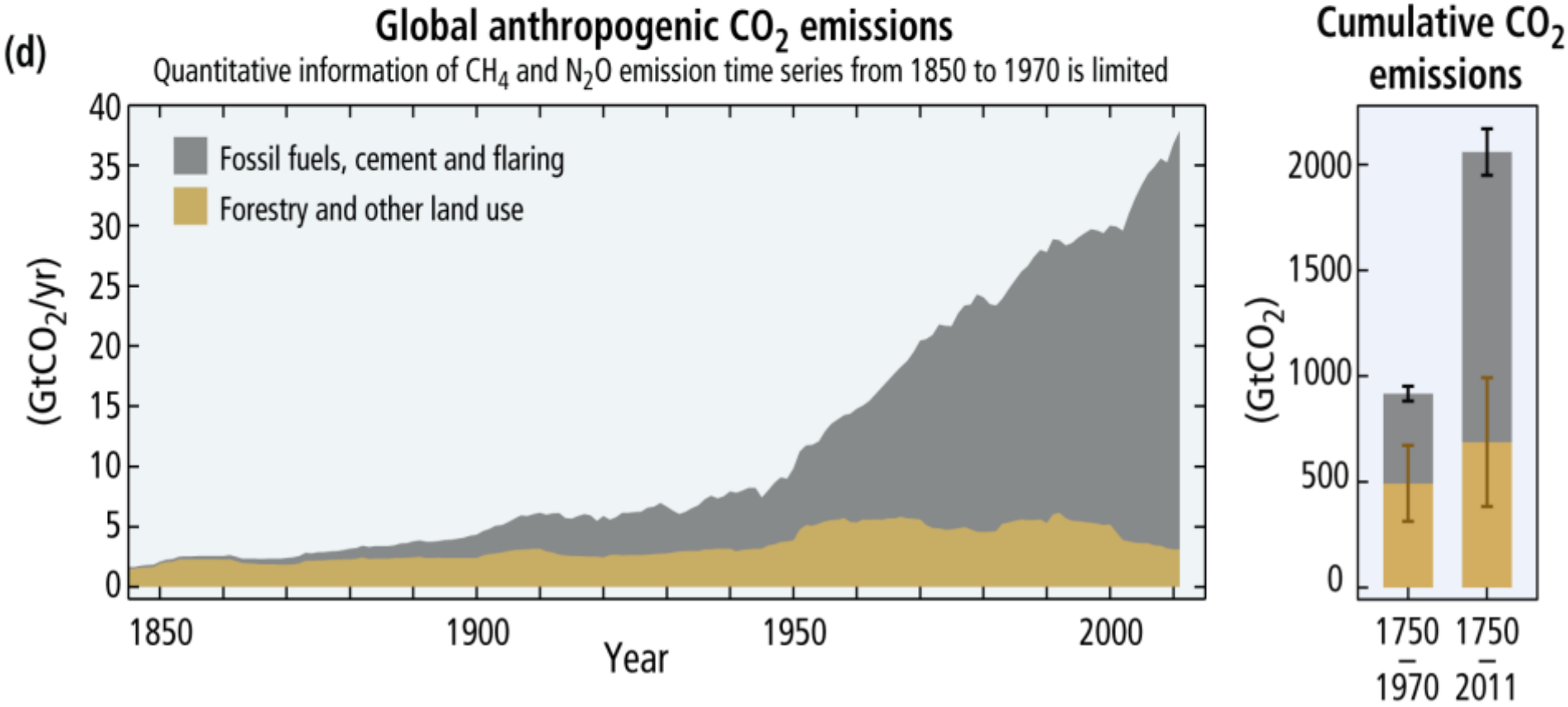
Source: US National Oceanic and Atmospheric Administration (2017)

Human Influences on Climate Change



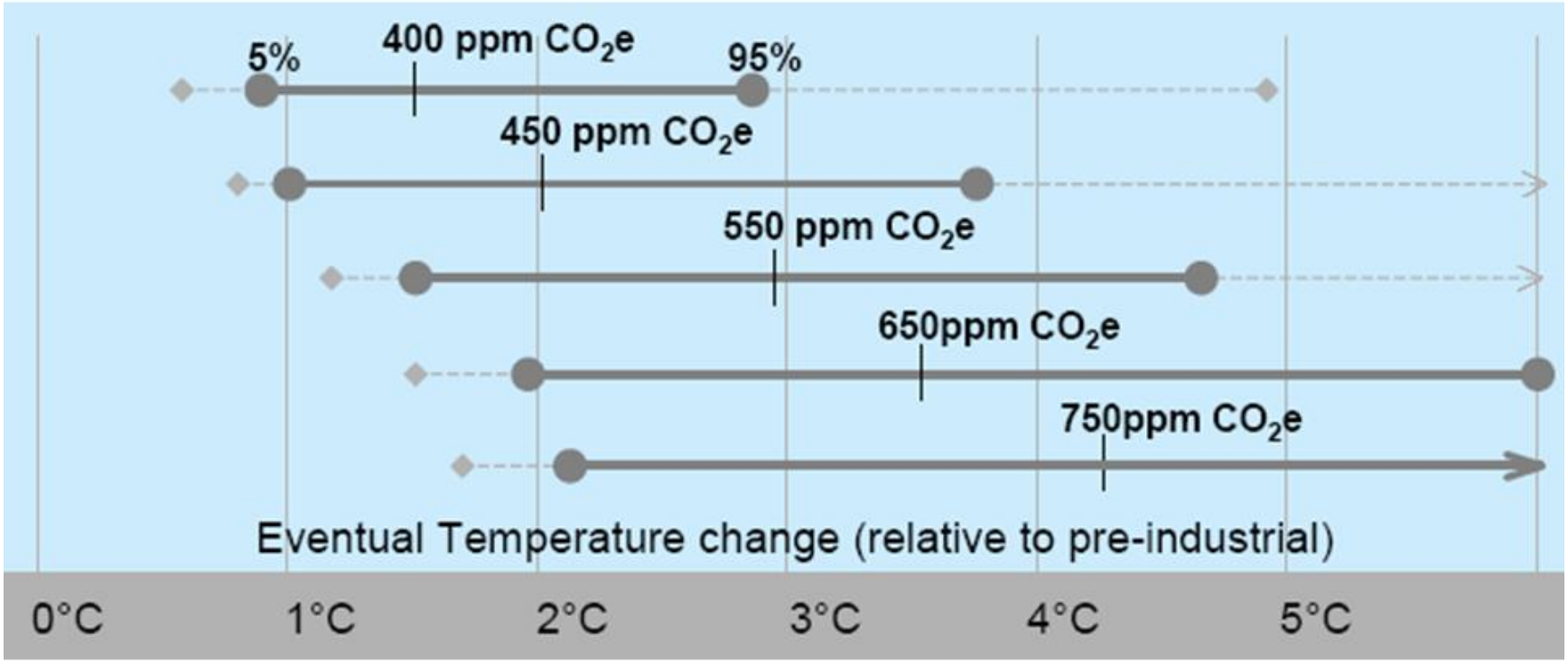
Source: US Environmental Protection Agency

Human Influences on Climate Change (2)



Source: IPCC-AR5 (2013)

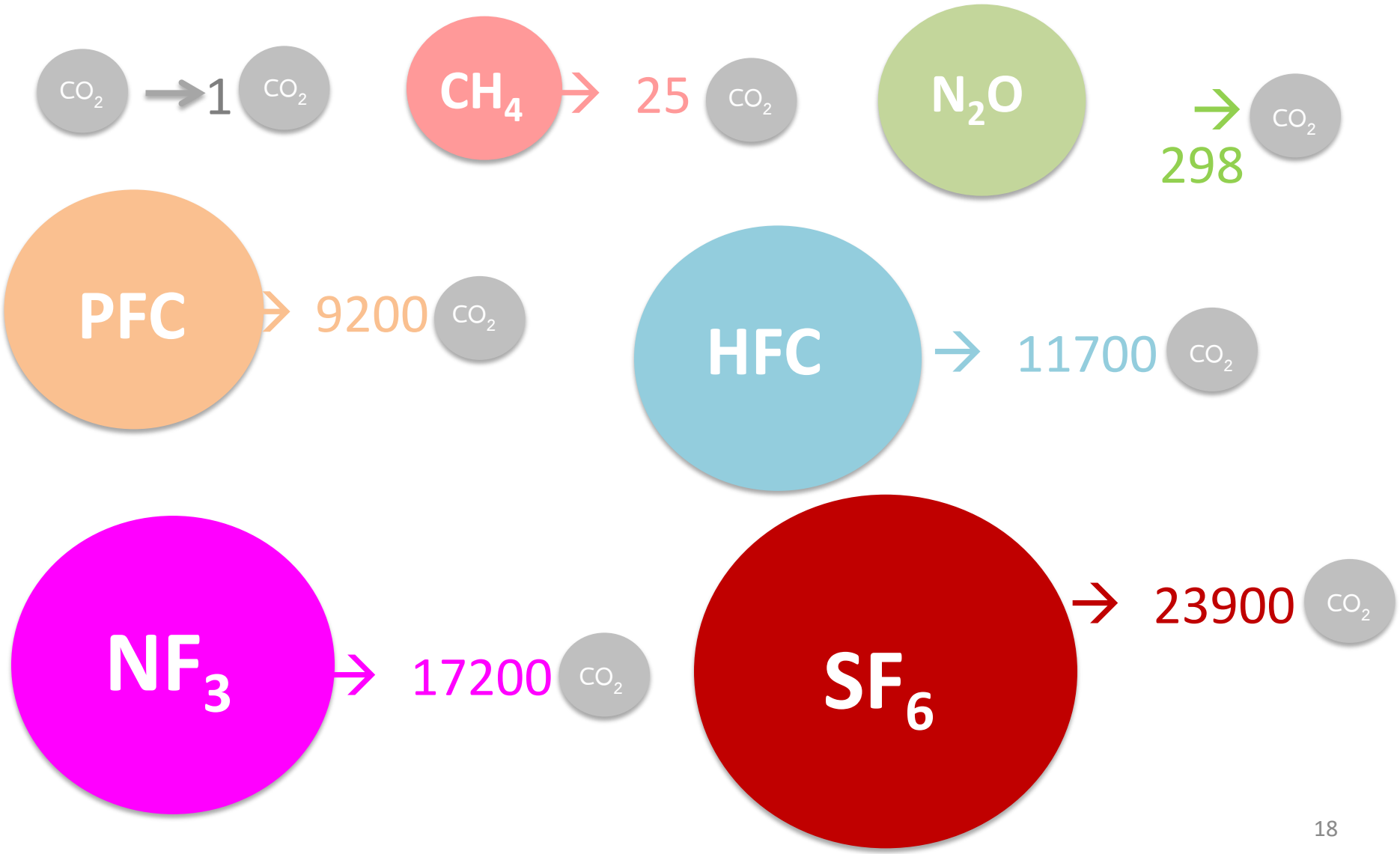
Relationship Between Atmospheric GHG Concentration and Temperature



Source: The Stern Review on the Economics of Climate Change (2007)


Take action for our future
- reduce your CO_2-emissions
This is the size of
ONE TONNE CO_2
Take up the challenge
- reduce every way YOU can.
Now!

Global Warming Potential: GWP



Human and Climate Change: Verdicts from Scientists

1990: "The unequivocal detection of the enhanced greenhouse effect from observations is not likely for a decade or more."

1995: "The balance of evidence suggests a discernable human influence on global climate."

2001: "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."

2007:"Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations."

2014: "Warming of the climate system is unequivocal, human influence on the climate system is clear, and limiting climate change will require substantial and sustained reductions of greenhouse gas emissions."

Source: Complied by Chalotorn Kansuntisukmongkol (2016)

Activities that Emit GHGs

Electricity used in residential, commercial, and industrial sectors
Transportation that uses fossil-fuel
→ CO_2

Industrial Processes and Product Use
→co_2 and others

Deforestation, Forest Degradation, and Land Use Change

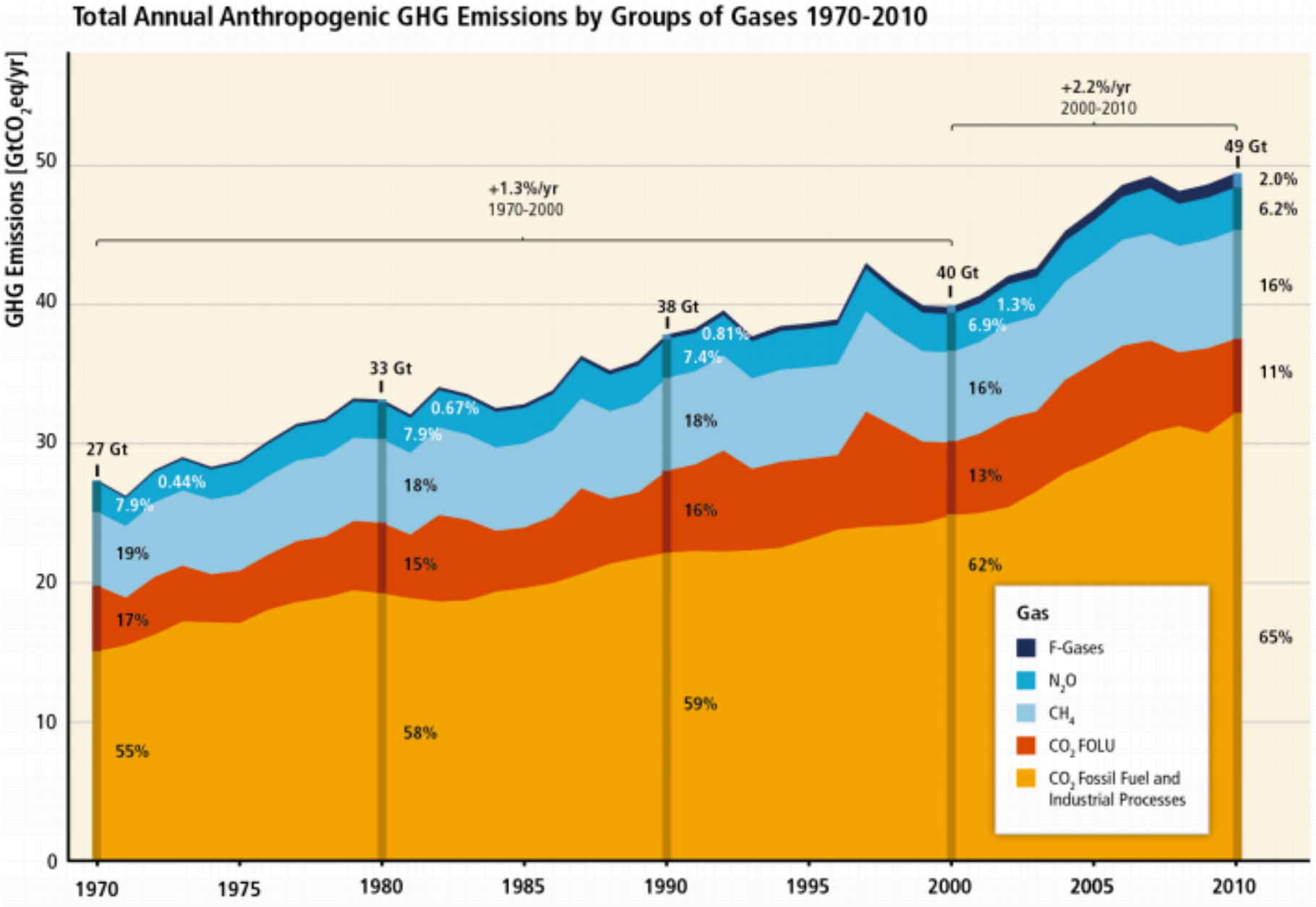
→ CO_2

Waste and Sewage Management

→ CH_4

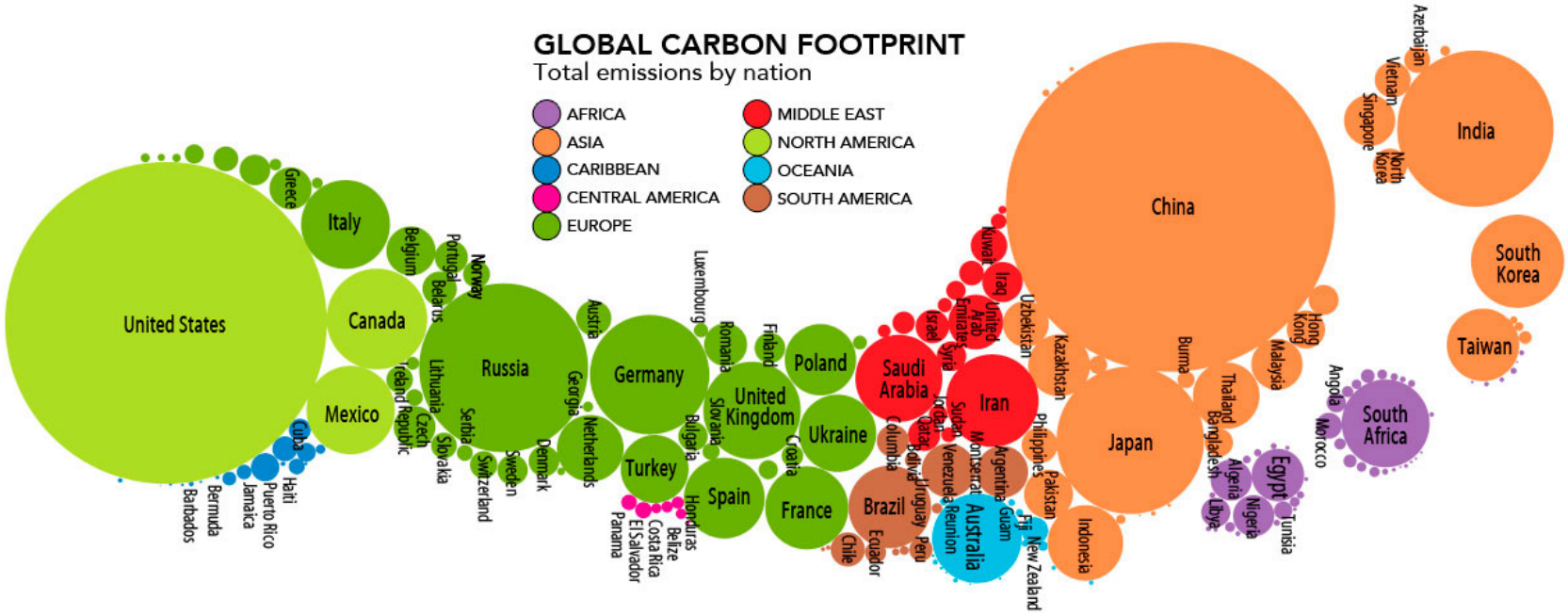
Agricultural Activities and Animal Husbandry

→ $CH_4 + N_2O$



Source: IPCC-AR5 (2013)

Global GHG Emission



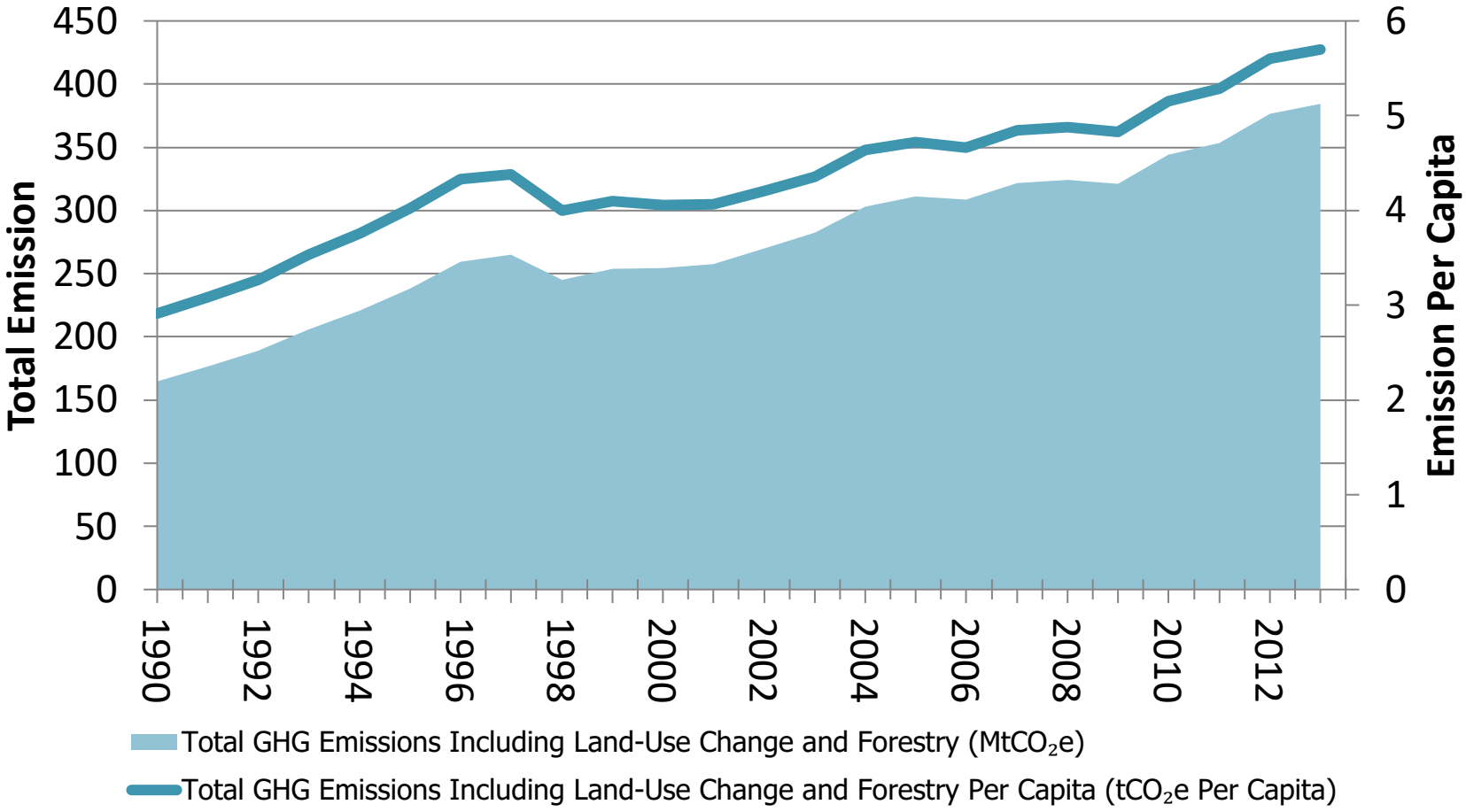
In 2012, Total Emission of the World is 42,790.08 $MtCO_2e$ (World Resource Institute)

Rank	Country	Total GHG Emissions* ($MtCO_2e$)	Total (%)
1	China	10,975.50	24%
2	United States	6,235.10	14%
3	European Union (28)	4,399.15	10%
4	European Union (15)	3,519.99	8%
5	India	3,013.77	7%
6	Russian Federation	2,322.22	5%
23	Thailand	375.70	0.8%

*** Total GHG Emissions in 2012 Excluding LULUCF**

Source: CAIT Climate Data Explorer (2017)

Thailand GHG Emission

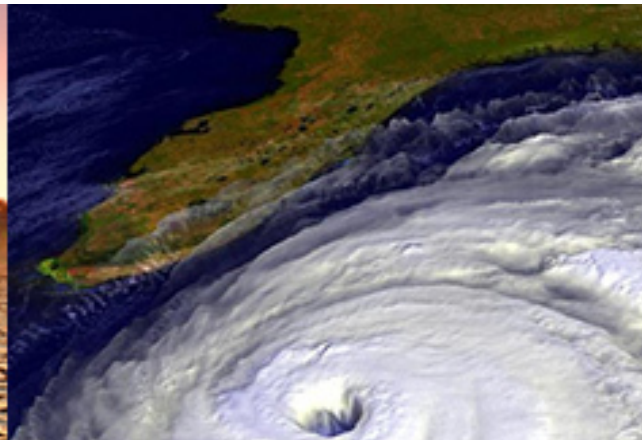


Source: CAIT Climate Data Explorer (2017)

Impacts of Climate change

- Physical Impacts e.g. Change in precipitation, sea temperature, surface temperature, sea level, ocean acidification, ocean currents, and rise in extreme events e.g. more storms, draughts, floods,
- Economic and Social Impacts as consequences of the Physical Impacts

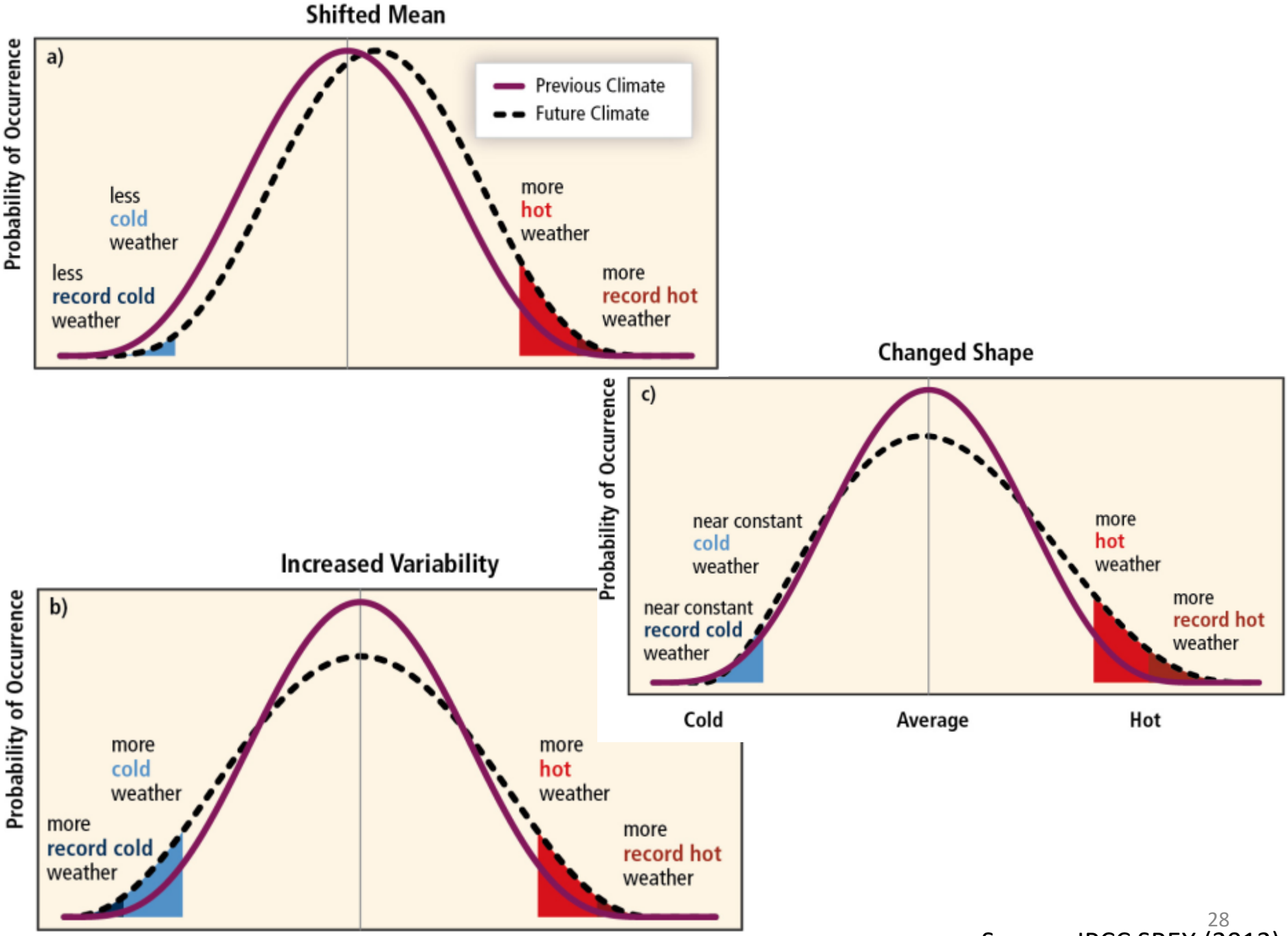




Predicted Temperature Change for Thailand

River Basin	Average Maximum Temperature (°C)				
	1979 – 2003	**2015 – 2039**	Difference (°C)	**2075 – 2099**	Difference (°C)
1. Mekong	29.50	30.33	0.82	32.12	2.61
2. Salween	28.88	29.83	0.95	31.44	2.57
3. Chao Phaya- Tha Chin	29.84	30.72	0.88	32.45	2.61
4. Maeklong	29.15	30.05	0.90	31.88	2.73
5. Bang Pakong	29.91	30.78	0.88	32.64	2.73
6. Group of Basins on the East Coast of the Gulf of Thailand	29.01	29.80	0.79	31.51	2.51
7. Group of Basins on the West Coast of the Gulf of Thailand	29.27	30.15	0.87	31.94	2.67
8. Group of Basins on the Southeastern	28.78	29.51	0.73	31.17	2.39
9. Group of Basins on the Southwestern	28.70	29.48	0.78	31.17	2.47
Country Overall	29.23	30.07	0.85	31.81	2.59

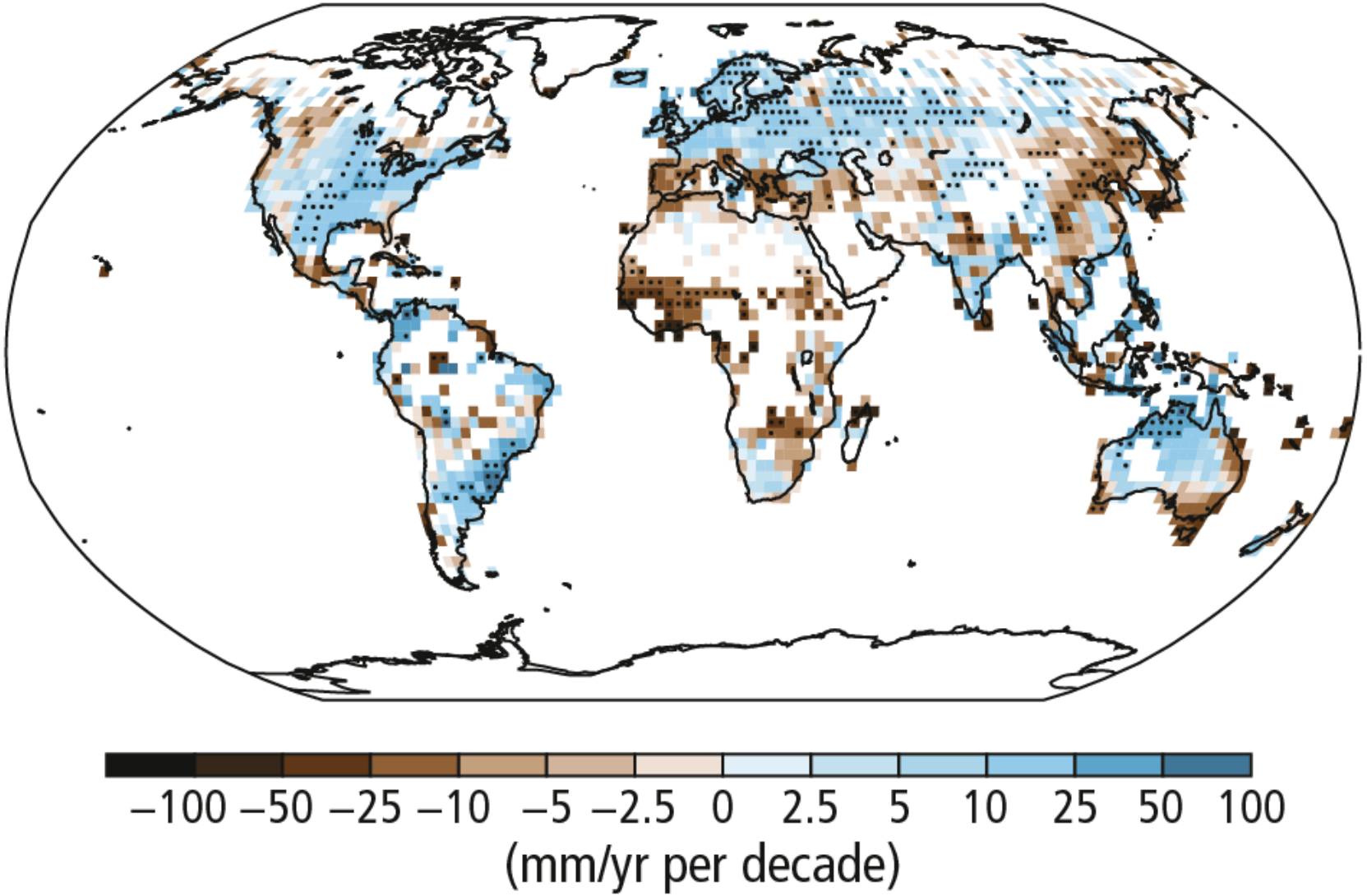
Source: Sucharit Koontanakulvong et. al. (2010)



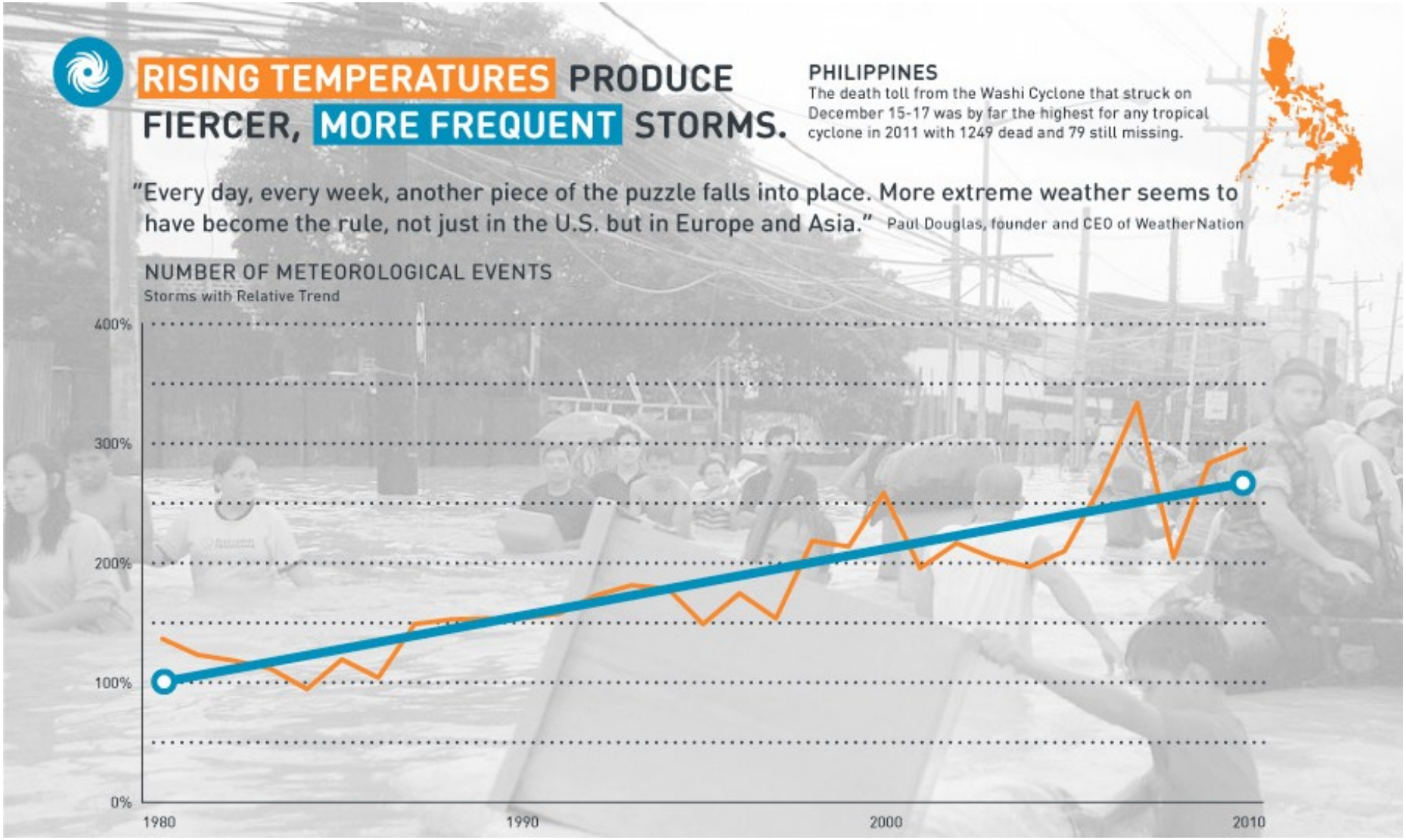
Source: IPCC SREX (2012)

(e)

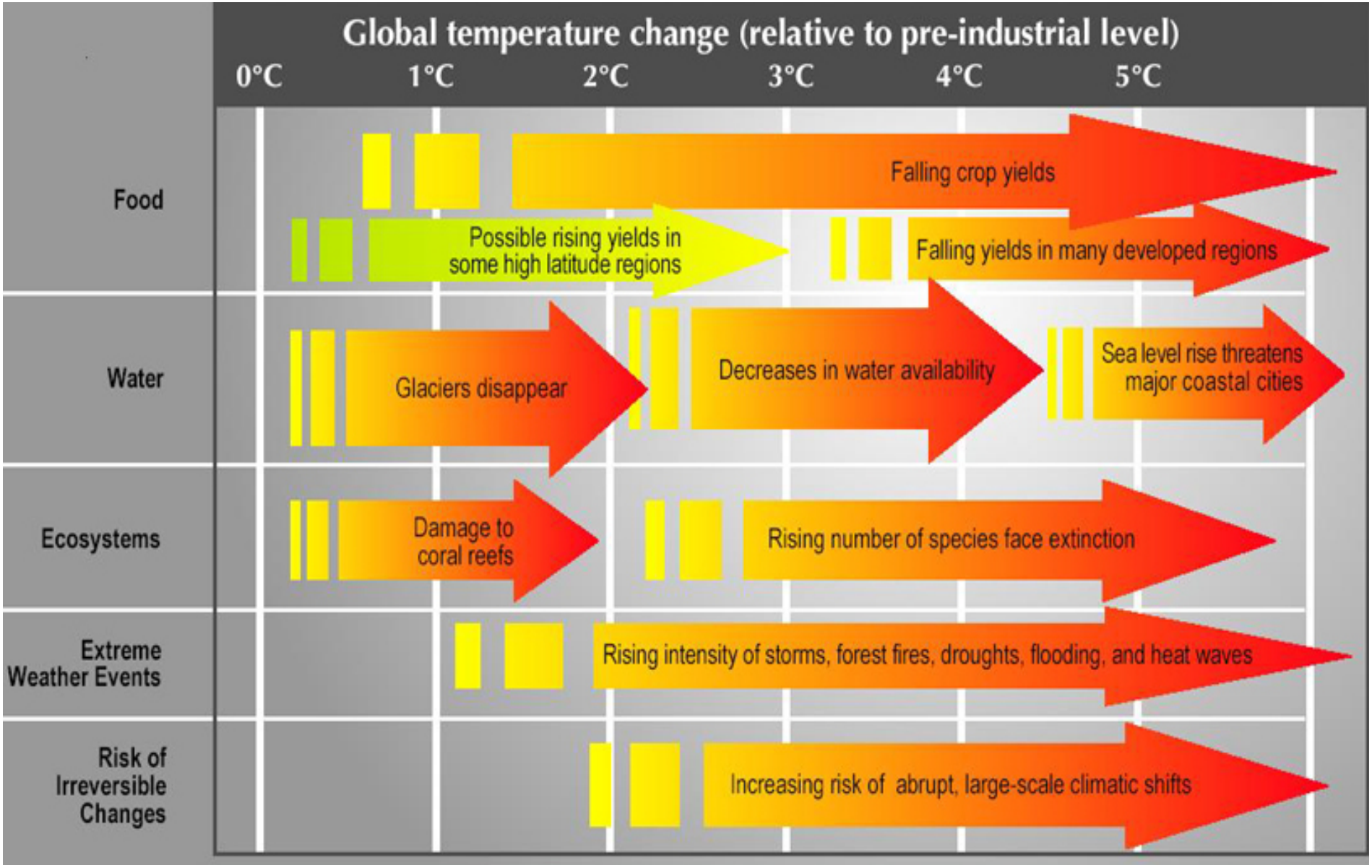
Observed change in annual precipitation over land 1951–2010



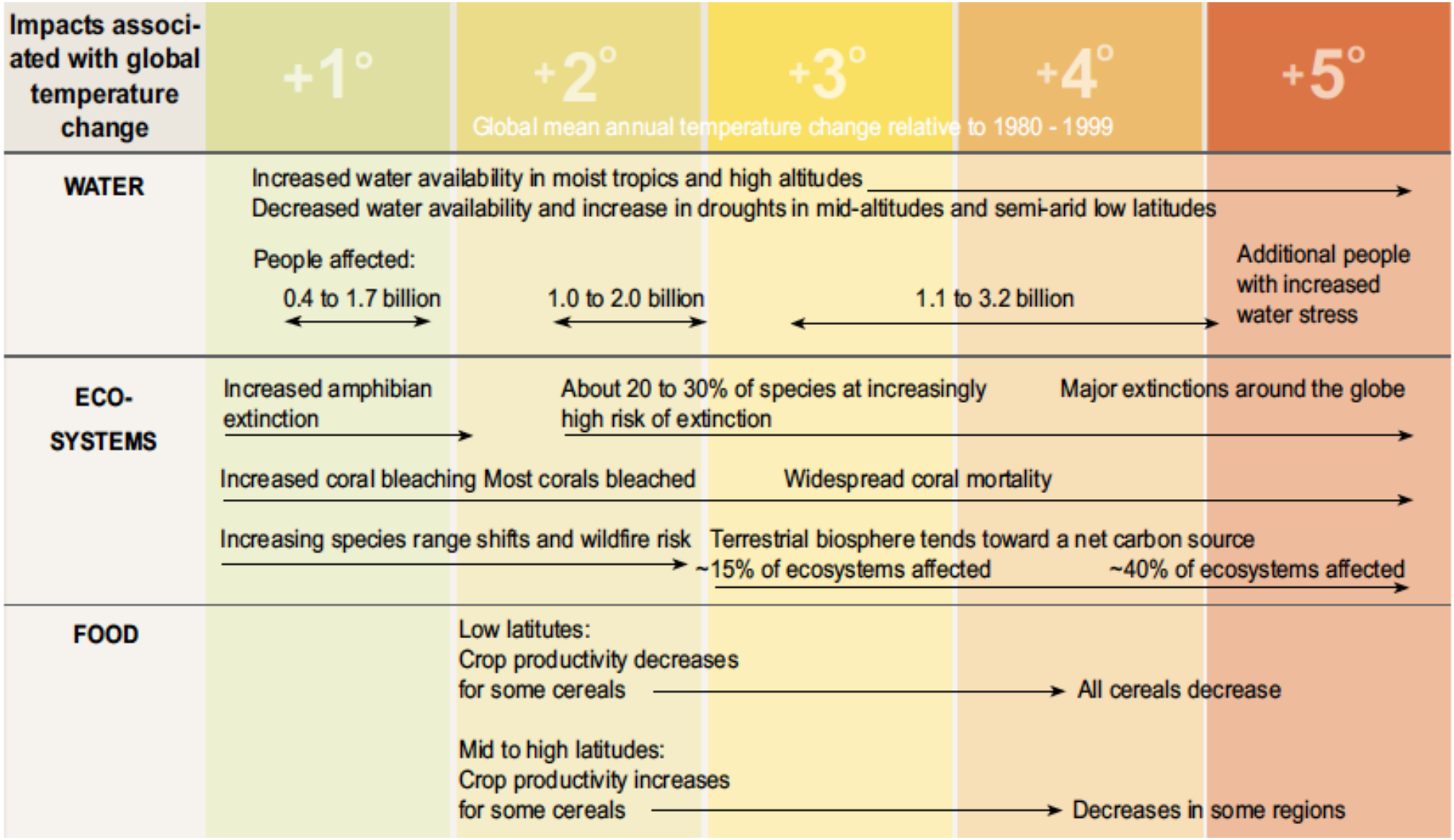
Source: IPCC-AR5 (2013)



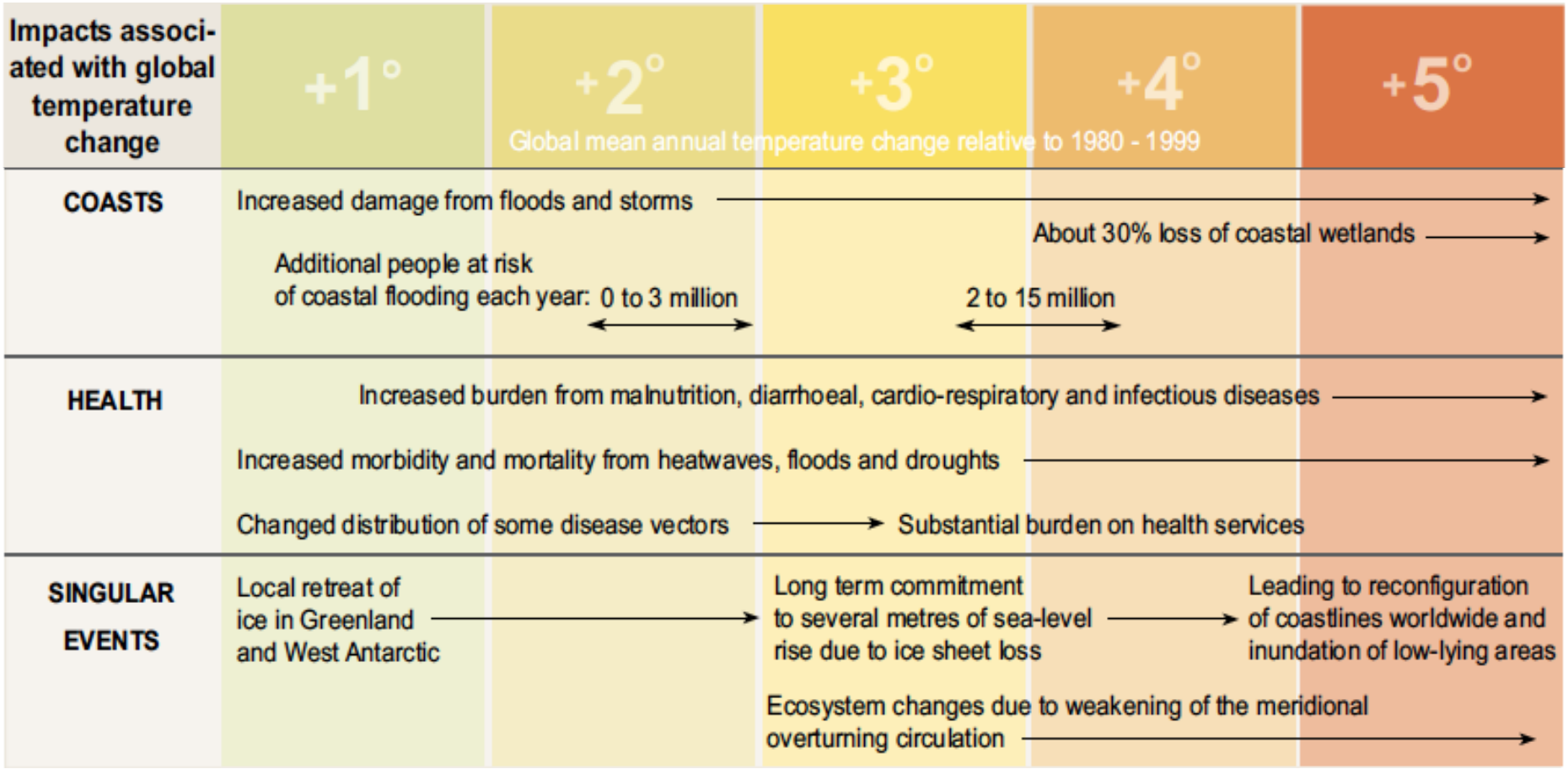
Source: ClimateDots.org (2012)



Source: The Stern Review on the Economics of Climate Change (2007)



Source: Kirby, A. (2008) Climate in Peril, UNEP/GRID-Arendal and SMI Books, pp. 28.



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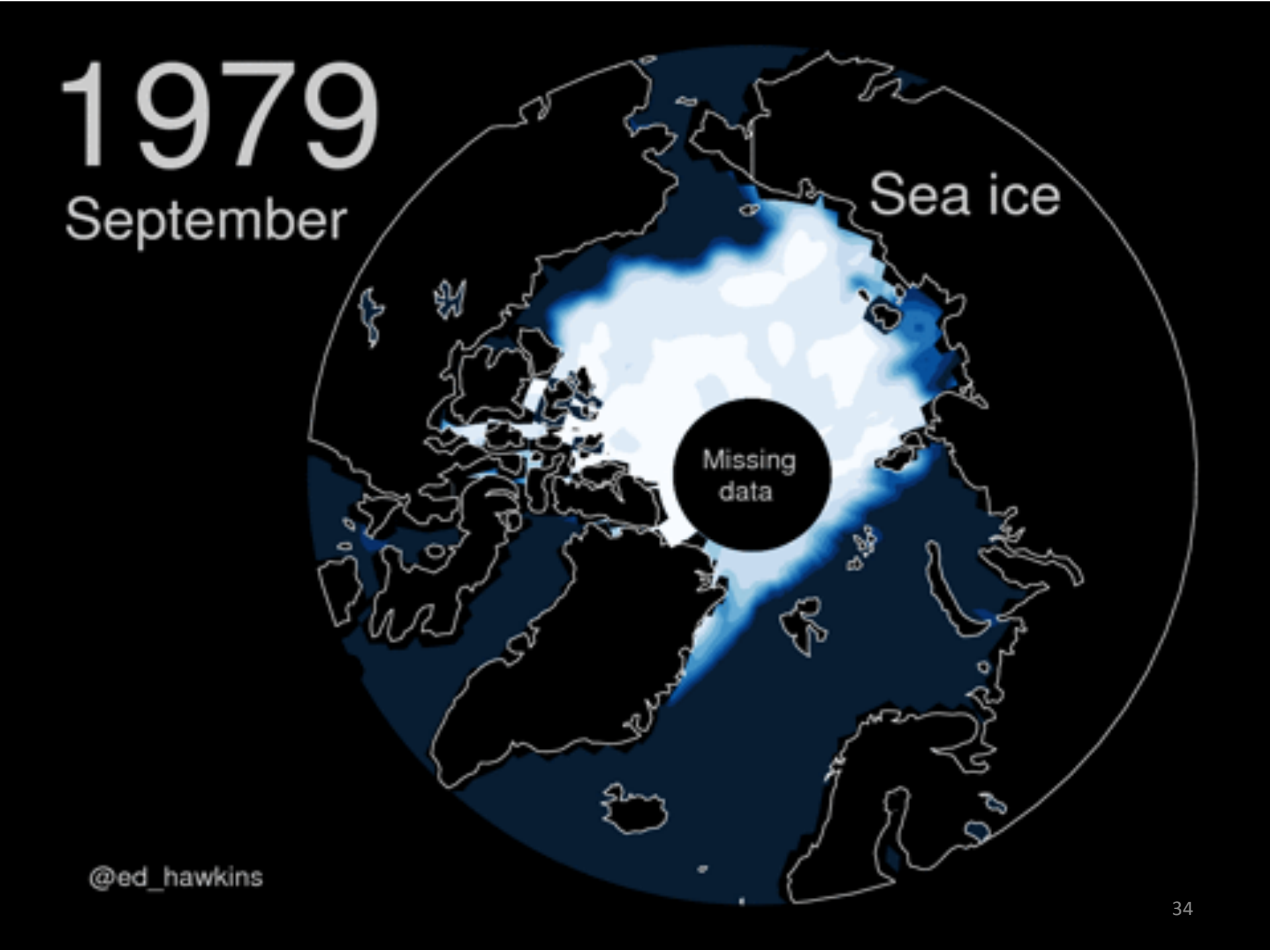
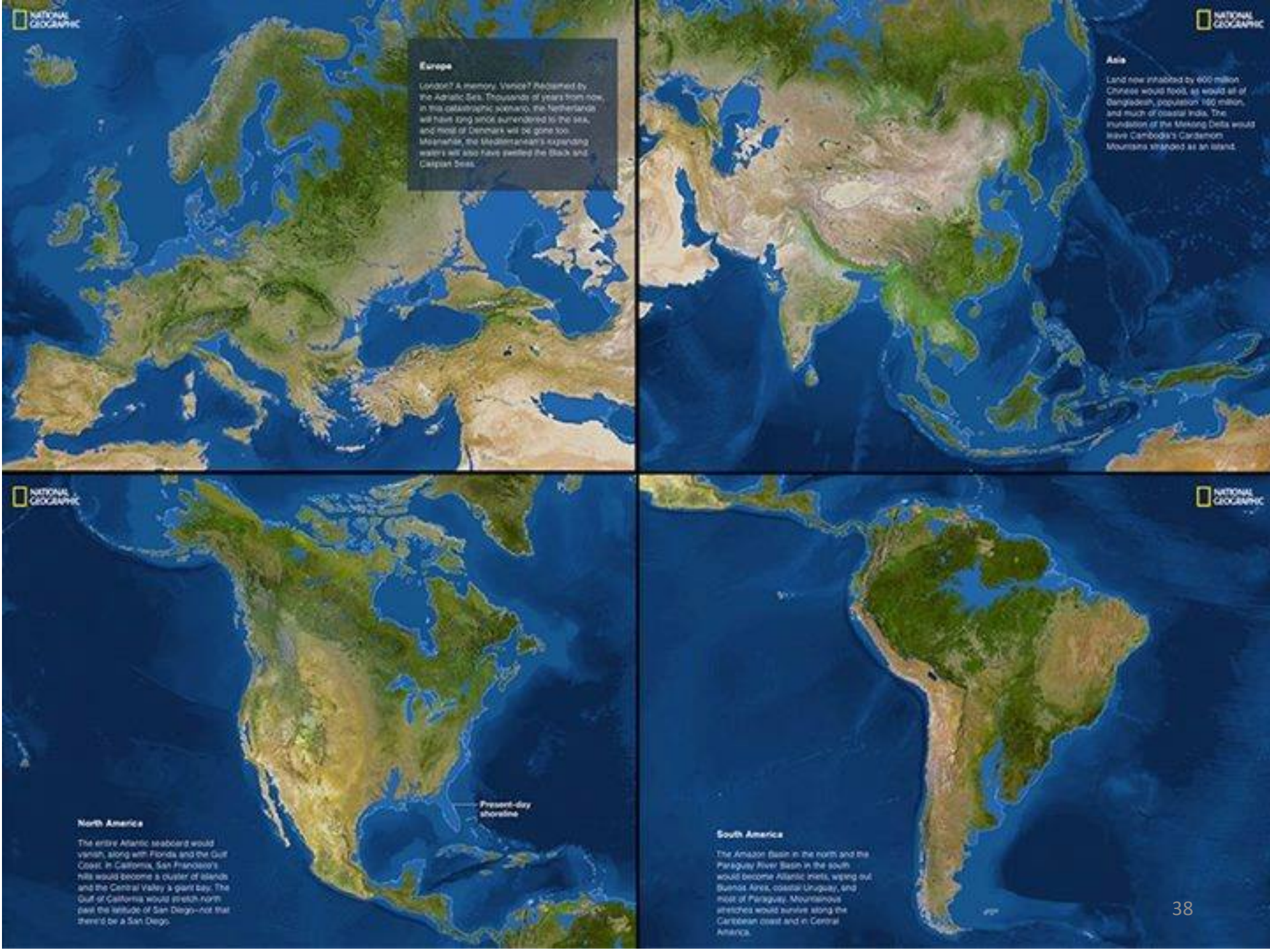

1979
September
Sea ice
Missing data
@ed_hawkins

Upcoming results of climate change

- IPCC report identifies that in the future water and food shortage as well as threats to wild animals will occur because …
  - Species of heat-resistant plant will change..
  - Crops will die => Developing countries become poorer.
- Sea level may increase seven to 23 inches. Only 4 inches increase in sea level could flood islands and many areas in Southeast Asia.

Upcoming results of climate change

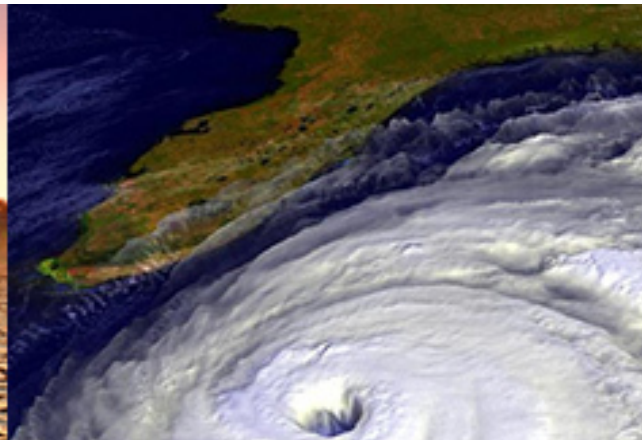
- Millions of people living in areas no more than one foot above sea level may have to migrate. In the US, Florida and Louisiana are at risk from sea level rise as well.
- Glacier melting causes sea level rise and contributes to shortage of fresh water in areas where fresh water source is the glacier.
- Millions of species of animals will be extinct from the loss of their habitat and the change of ecosystem.


NATIONAL GEOGRAPHIC
Europe
London? A memory. Venice? Reclaimed by the Adriatic Sea. Thousands of years from now, in this catastrophic scenario, the Netherlands will have long since surrendered to the sea, and most of Denmark will be gone too. Meanwhile, the Mediterranean's expanding waters will also have swelled the Black and Caspian Seas.
NATIONAL GEOGRAPHIC
Asia
Land now inhabited by 600 million Chinese would flood, as would all of Bangladesh, population 160 million, and much of coastal India. The inundation of the Mekong Delta would leave Cambodia's Cardamom Mountains stranded as an island.
NATIONAL GEOGRAPHIC
Present-day shoreline
North America
The entire Atlantic seaboard would vanish, along with Florida and the Gulf Coast. In California, San Francisco's hills would become a cluster of islands and the Central Valley a giant bay. The Gulf of California would stretch north past the latitude of San Diego—not that there'd be a San Diego.
NATIONAL GEOGRAPHIC
South America
The Amazon Basin in the north and the Paraguay River Basin in the south would become Atlantic inlets, wiping out Buenos Aires, coastal Uruguay, and most of Paraguay. Mountainous stretches would survive along the Caribbean coast and in Central America.

Upcoming results of climate change

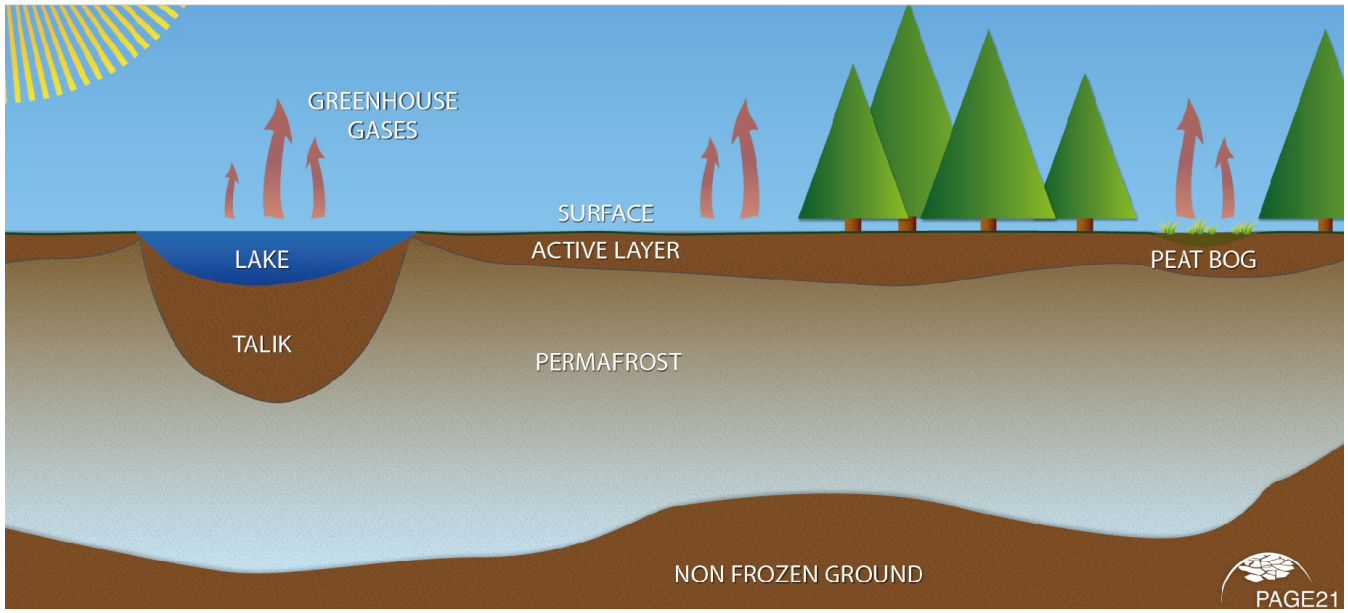
- More intense storms, drought, heat wave, wildfire, and other natural disasters will occur more frequently to the point that they become regular. Desert will expand, causing food shortage in some areas.
- Direction of the flow of ocean currents may change and result in small ice-age in Europe and weather fluctuation in other places.





Upcoming results of climate change

- In the future, when the global warming is in an uncontrollable stage, Positive Feedback Effect will occur. This effect will happen because the higher temperature will melt Permafrost, which is an ice sheet under top soil that has not been melted for centuries, and release captured carbon into the atmosphere, worsening the global warming.

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Climate Change Impact Assessment

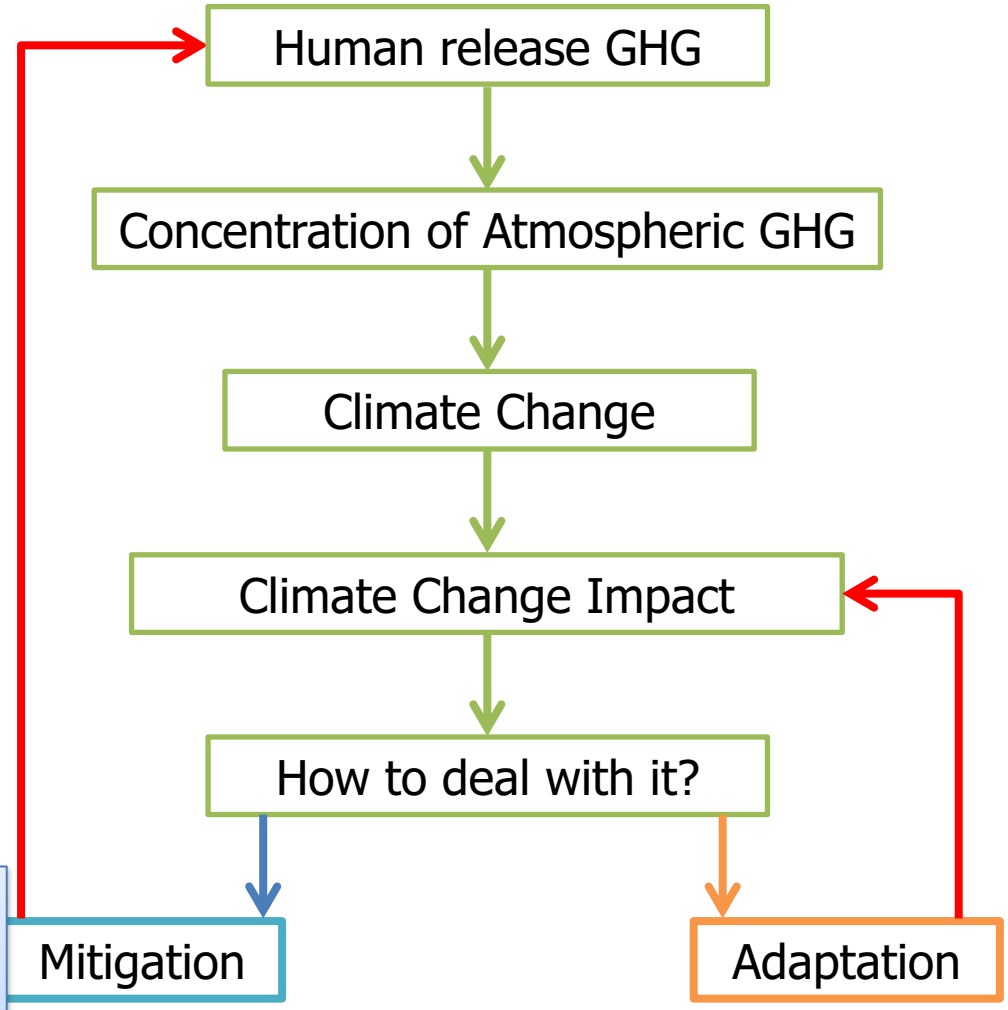
- Predicting the release of GHG from consumption behavior by considering population growth, production, consumption pattern and level of technology.
- Assessing atmospheric GHG concentration.
- Assessing the change of climate that is a result of the atmospheric GHG.
- Assessing the consequences from the change in real sector, such as less production, more disasters, more building damaged, people getting sick, etc.
- Assessing the social and economic impact.

Climate Change Impact Assessment

The Stern Review on the Economics of Climate Change (2007)

- No one can predict certain impacts of climate change. But we can understand the risks of those impacts. Therefore, everyone should consider the reduction of GHG emission as an investment to prevent or reduce the potential losses and damages.
- If the temperature on the earth surface is higher than the period before the industrial revolution about two to three degree Celsius, World GDP will decrease 0-3%. The higher temperature could benefit the rich countries but will severely affected the poor countries.
- If the world does not reduce the GHG emission (Business As Usual: BAU), the loss and damage from climate change could go up to five to 20 percent of the World GDP.
- Stern Review supports a decision that seriously deals with the climate change and the investment must be started as soon as possible to reduce potential damages. In order to maintain the atmospheric CO2 at 500-550 ppm, investment at the value of one percent of GDP is needed within 2050.

Dealing with Climate Change



Mitigation
Is the reduction of GHG and the increase of GHG sequestration

Adaptation
Is about how to change oneself to live with the climate change impact

Climate Change Adaptation

- Vulnerability (ความเปราะบาง) explains the negative situation in which a system or a sector or a social unit is experiencing.
- Risk (ความเสี่ยง) refers to the possibility that the climate change impacts will occur.
- Exposure (การเปิดรับผลกระทบ) refers to physical, climatic, geographical, ecological, economic and social attributes of an area that may be related or interacting with the changing climate.
- Sensitivity (ความอ่อนไหวต่อการรับผลกระทบ) refers to physical attributes of the area concerning sensitivity to climate impact.
- Coping Capacity or Resilience (ความสามารถในการรับมือ) refers to ability of the system, sector or social unit to deal with the climate impacts.

Adaptation and vulnerability to Climate change

Risk = Exposure x Sensitivity

Vulnerability = Risk / Coping Capacity

- A sector or an area is at risk from climate change impact when it has high exposure or high sensitivity to climate change (having direct relationship with or depending on the climate).

- Vulnerability is directly related to the risk but inversely related to the coping capacity of that area.

Adaptation and vulnerability to Climate change

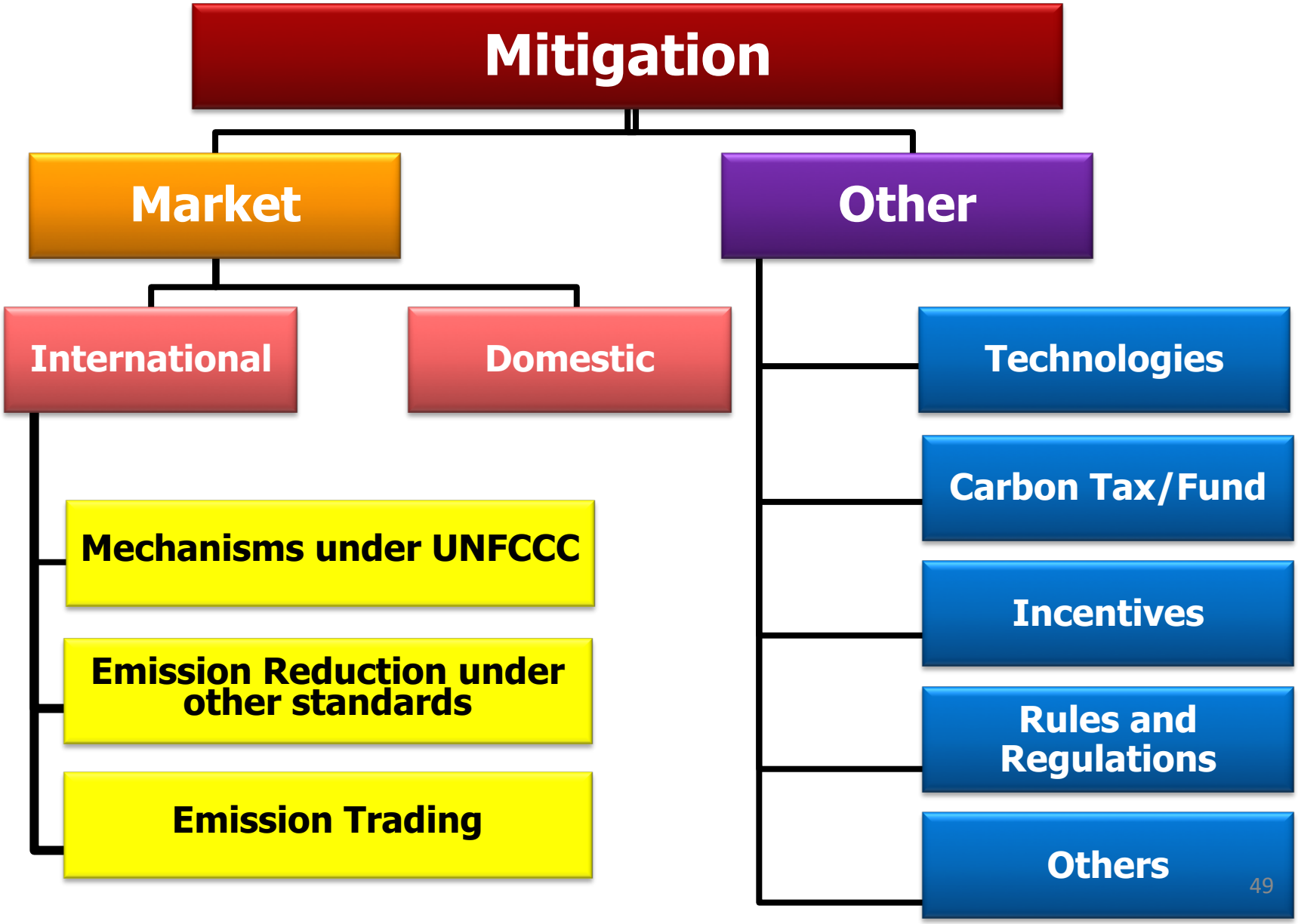
- Goal of adaptation is to reduce vulnerability to climate change by …
  - Reducing exposure, for example, moving people out of a repeatedly flooded area, or from an area with potential risk of costal degradation.
  - Reducing sensitivity to the climate impacts, for example, building dam or dikes to prevent erosion of river bank.
  - Increasing coping capacity, for example, teaching people about potential risk of climate impacts and how to deal with them.

Vulnerability to Climate Change in each sectors in Thailand

Sectors	Sub-sectors
Vulnerability of natural resources and ecosystem	- Geohazard and coastal degradation - Coastal and marine ecosystem - Terrestrial forest and its ecosystem - Wetland and fresh water ecosystem - Hydrology, surface and underground water resources
Vulnerability of economic sectors	- Agriculture and commercial crops - Livestocks - Industries, businesses, services, and tourism - Transportation and logistics
Vulnerability of society and human security	- Health and Sanitation - Cities, settlements, and infrastructure - Human security issues related to society and community

Source: Thailand Research Fund (2011)

Mitigation: Reducing Emission and Increasing Sequestration of GHG



International Cooperation for Tackling Climate Change Issues

Sustainable Development Goals (SDGs)

SDGs Goal13

SDGs has 17 goals
Climate change is #13

13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries

13.2 Integrate climate change measures into national policies, strategies and planning

13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning

13.a Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible

13.b Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities

United Nations Framework Convention on Climate Change (UNFCCC)

- Open for signature in 1992, entered into force in 1994
- Annually hold "The UN Climate Change Conference" to serve as the formal meeting of the UNFCCC Parties (Conference of the Parties, COP) to assess progress in dealing with climate change

- UNFCCC objective:

[Stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, **to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.]**

Principles of UNFCCC

Common But Differentiated Responsibilities (CBDR) and Respective Capabilities → **Climate Change is a common problem for mankind but share of responsibilities should not be the same**

Communications → **Parties should submit GHG report (called National Communication)**

Precautionary → **Lack of full scientific certainty should not be used as a reason for postponing such measure**

UNFCC and Kyoto Protocol

United Nations Framework Convention on Climate Change (UNFCCC) entry into force in 1994

Annex I Parties
(developed country)
41 countries

Non-Annex I Parties
(developing country)
155 countries

Kyoto Protocol
(Legally binding protocol)
Entry into force in 2005

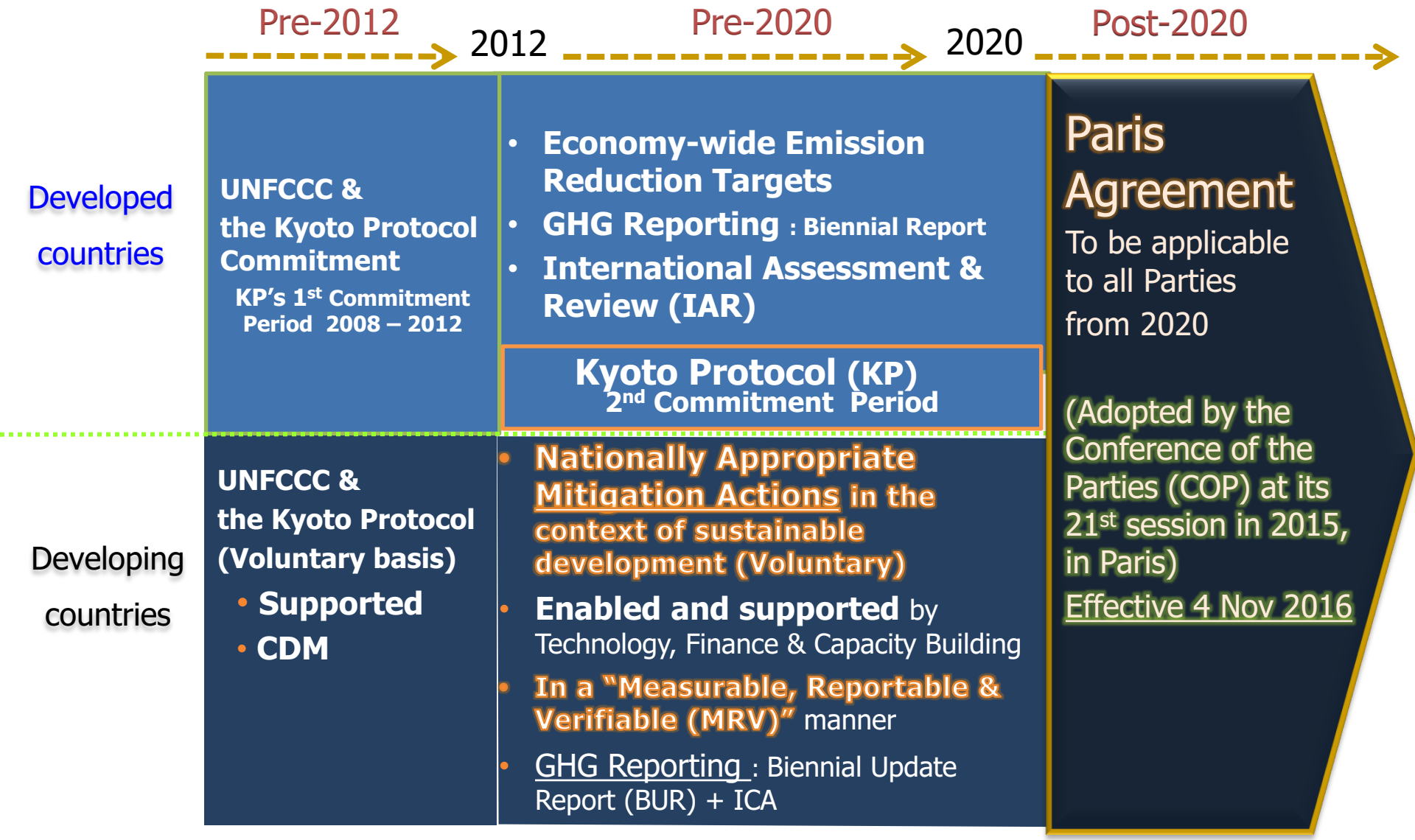
Annex I Parties
With binding targets : reduce GHG 5% of 1990 by 2012
in first commitment period

Non-Annex I Parties
Without binding targets

Kyoto Protocol

- Open for signature in 1997, entered into force in 2005
- Quantified Emission Limitation or Reduction Commitment for Developed countries (Annex B of the Protocol)
- Creating "Flexibility Mechanisms" as tools for assisting Annex B countries to reduce GHG and for encouraging developing countries to participate in mitigation activities
  - Joint Implementation (Article 6)
  - Emissions Trading (Article 17)
  - **Clean Development Mechanism (Article 12)**

A New Agreement under the UNFCCC



Paris Agreement

- **Aims to strengthen the global response to the threat of climate change**, in the context of sustainable development and efforts to eradicate poverty, **including by:**

(a) **Holding the increase in the global average temperature to well below 2°C** above pre-industrial levels and to **pursue efforts** to **limit the temperature increase to 1.5 °C** above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;

(b) **Increasing the ability to adapt to the adverse impacts of climate change** and **foster climate resilience** and **low greenhouse gas emissions development**, in a manner that does not threaten food production;

(c) **Making finance flows consistent with a pathway towards low GHG emissions and climate resilient development**.

Pre-2020

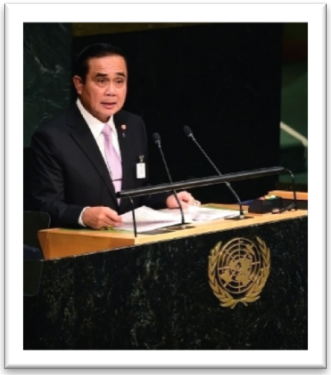
❖ Nationally Appropriate Mitigation Action (NAMAs)

"Thailand will endeavor, on a voluntary basis, **to reduce its GHG emissions** in the range of **7 to 20 percent below the Business as Usual (BAU) in energy and transportation sectors in 2020**, subject to the level of international support provided […]"

Coverage: RE | EE | Bio-fuels | Transport

Post-2020

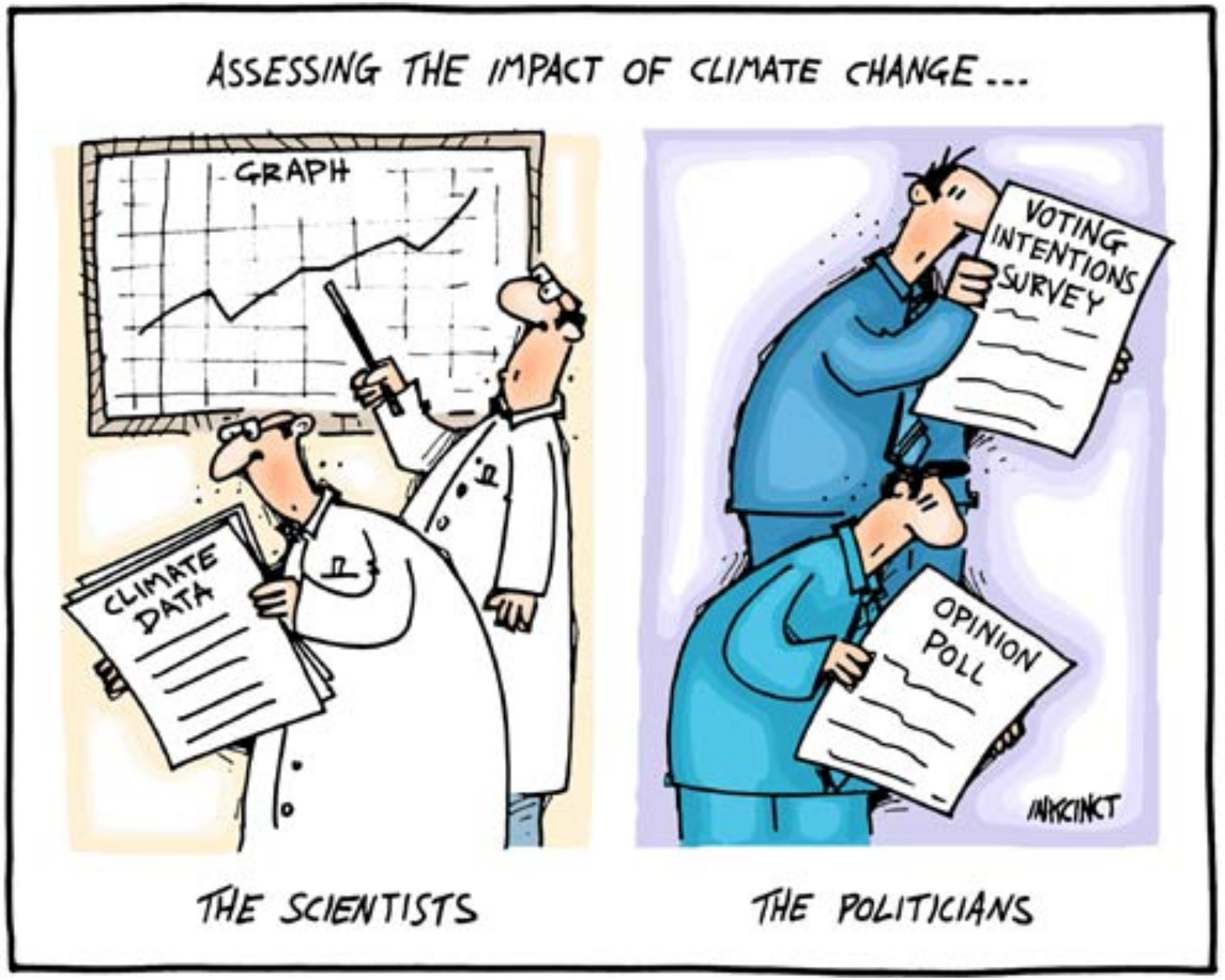
❖ Intended Nationally Determined Contributions (INDC)



"**Thailand intends to reduce its greenhouse gas emissions by 20 percent from the projected business-as-usual (BAU) level by 2030.** The level of contribution could increase up to 25 percent, subject to adequate and enhanced [support] through a balanced and ambitious global agreement […]"

Coverage: Economy-wide

Inclusion of LULUCF will be decided later



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