Introduction to Climate Science

Youba Sokona, IPCC Vice-Chair &
Edvin Aldrian, WGIII Vice-Chair
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INTERGOVERNMENTAL PANEL ON climate change
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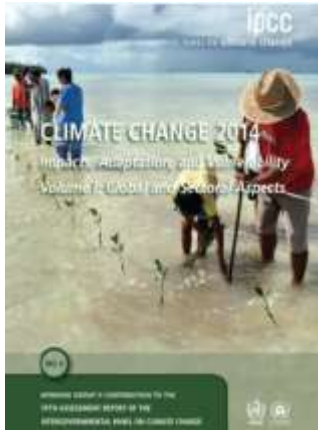
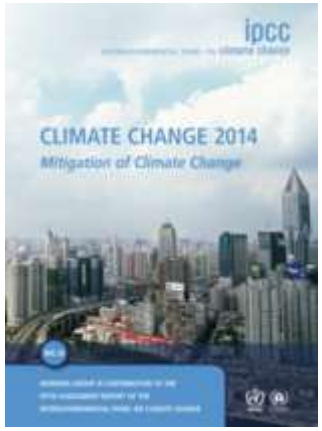
Climate Change is Broad Issue

- Majority of the sciences and engineering disciplines are involved.
- Social sciences are interested.
- Business/Industry has a stake in.
- Involves citizens, politicians, public policy experts, and advocates.
- **Every sector of the economy is affected**.
- All aspects of our lives touched: environment, jobs, health, politics, national security, arts, religion, etc.

What is happening in the climate system?



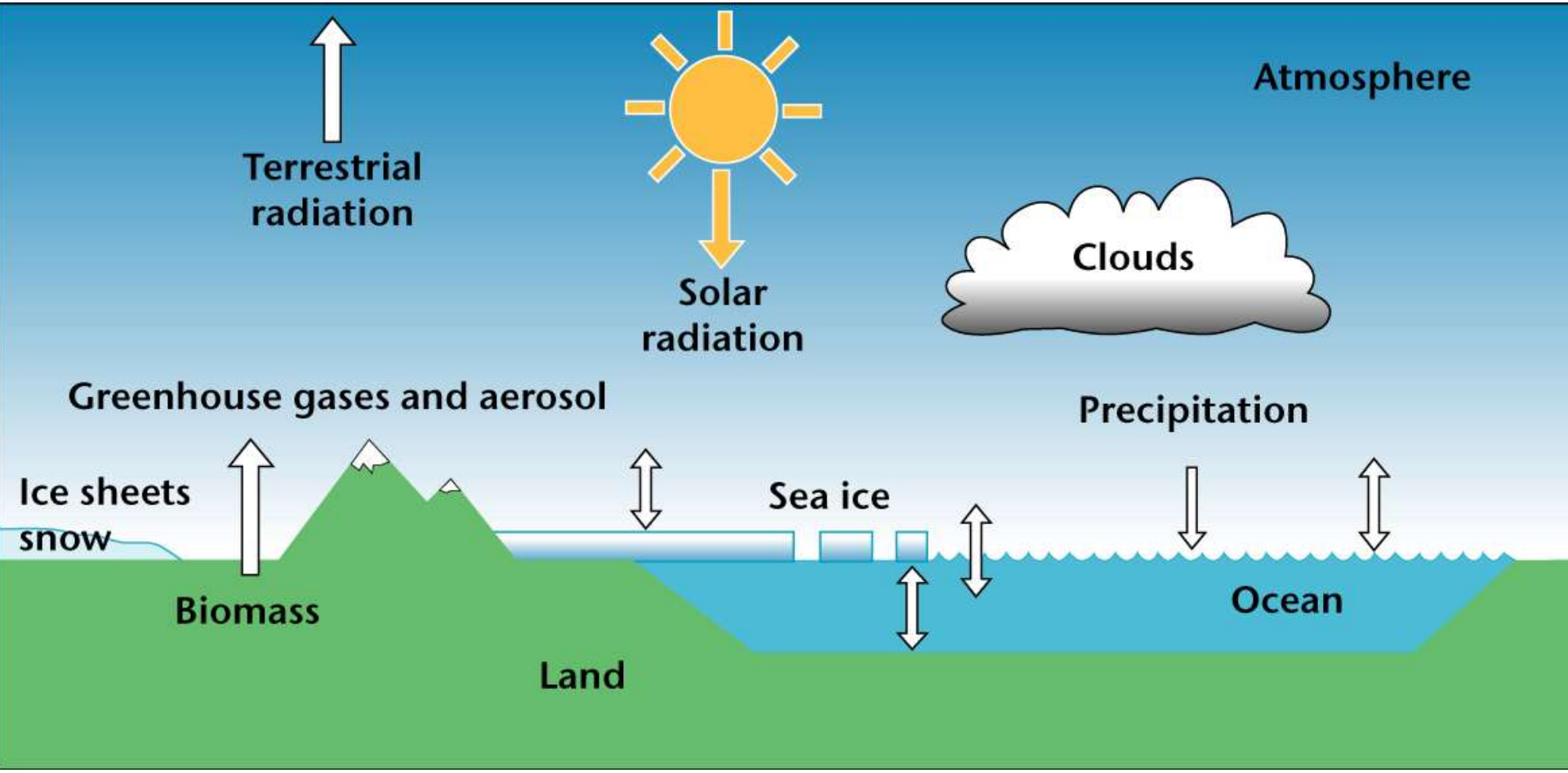
What are the risks?



What can be done?

Climate system

Main components: the atmosphere, hydrosphere [liquid water components], cryosphere [frozen water components], lithosphere [land surface] and biosphere [living things]) and the interactions between them



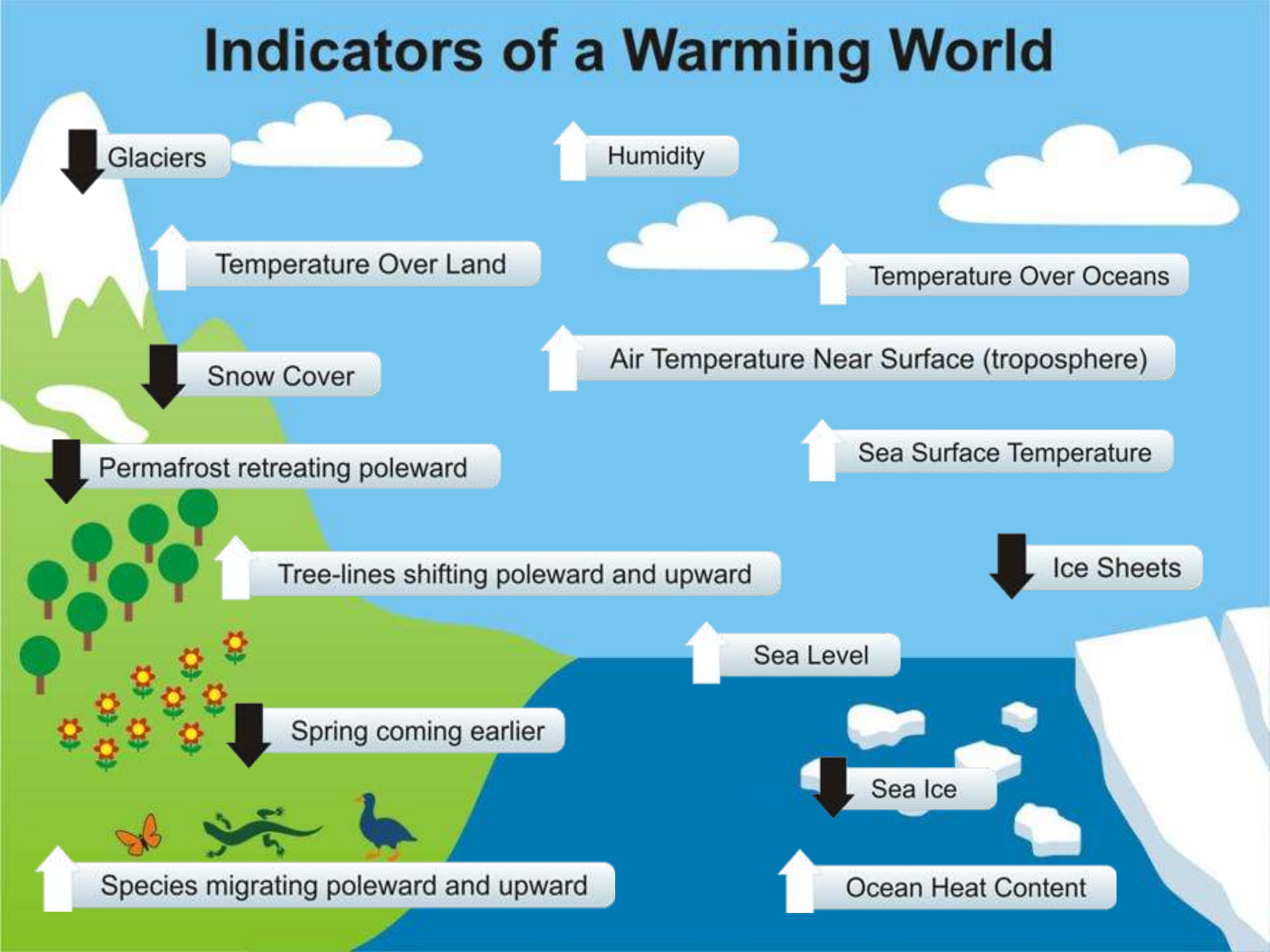
THE COMPOSITION OF AIR IS CHANGING RAPIDLY due to human activities:

→ more GHG (CO_2, CH_4, NO_x...)
→ more aerosol (air pollution)

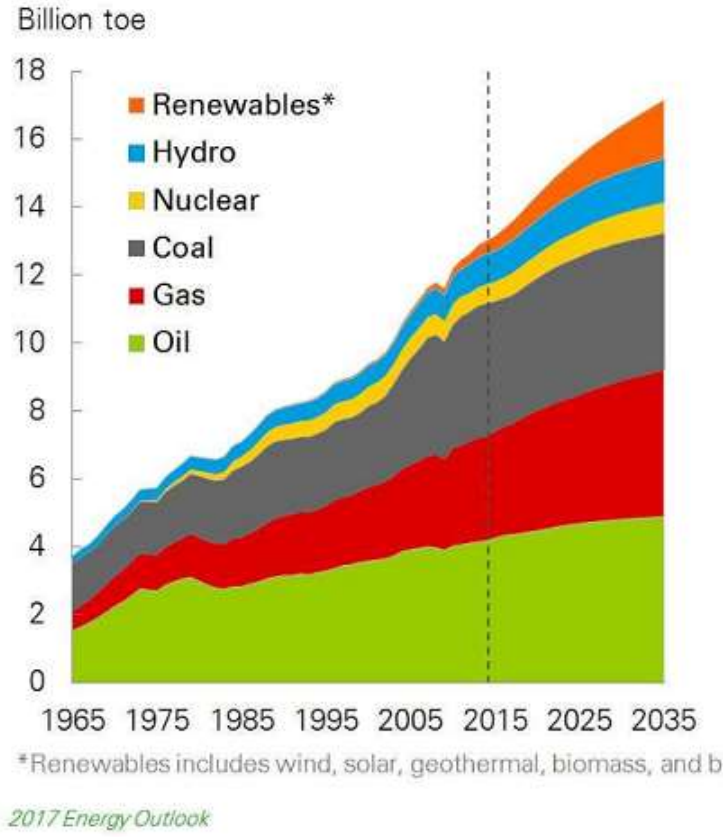
Human activities induced LAND USE CHANGES

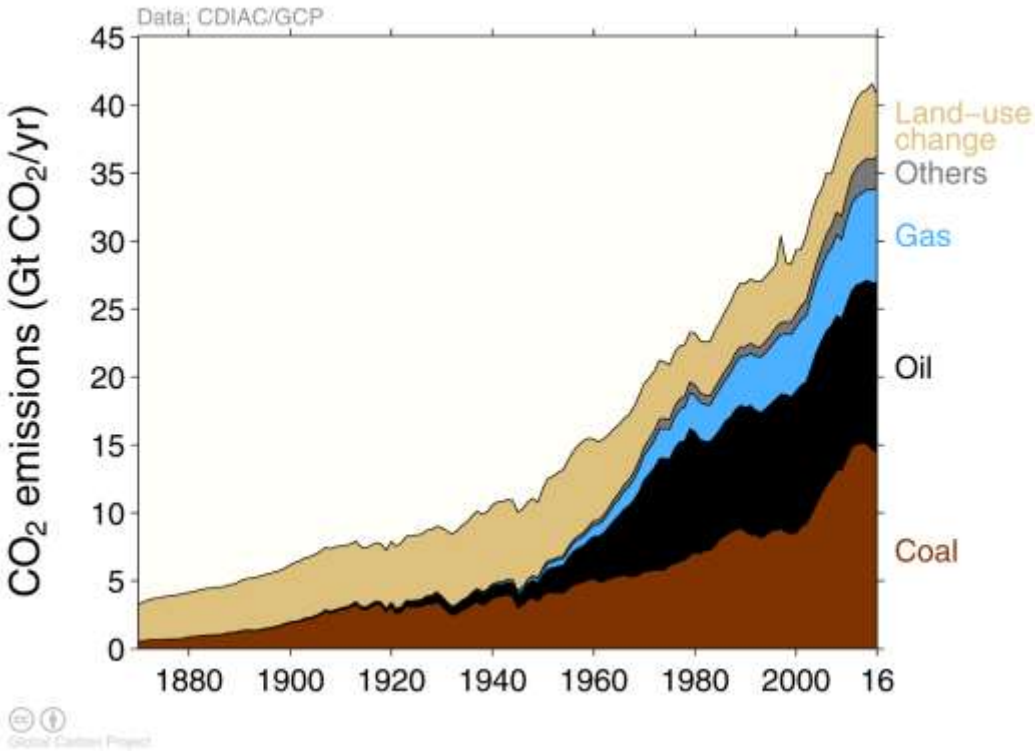
→ deforestation changed CO_2 balance, more GHG (CO_2)
→ changes in albedo, water balance etc.

Indicators of a Warming World

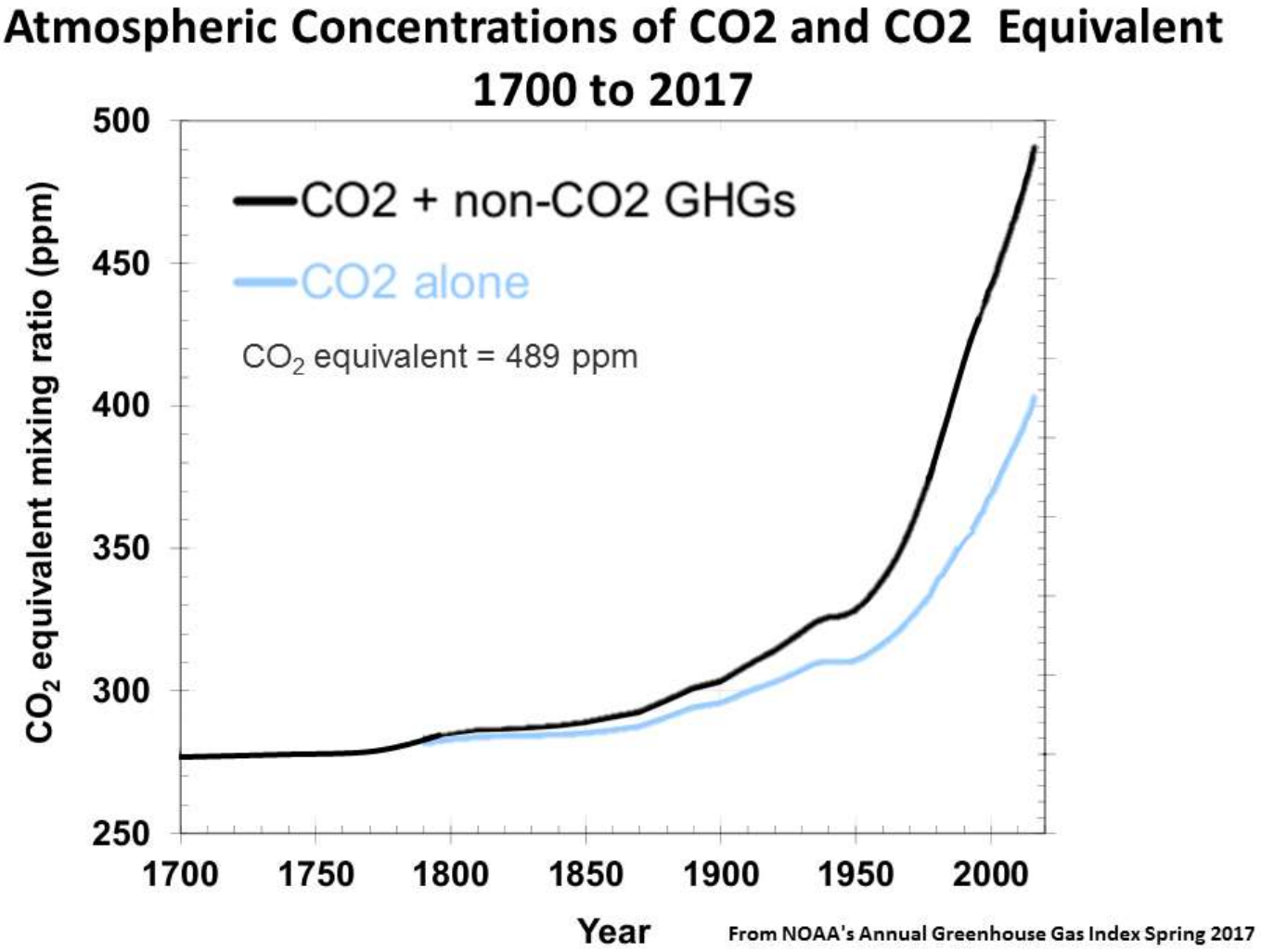


Primary energy consumption and total global emissions are increasing





The atmospheric concentrations of CO_2, methane, and nitrous oxide have increased to levels unprecedented in at least the last 800,000 years.



If the EARTH had no atmosphere, it would be very cold

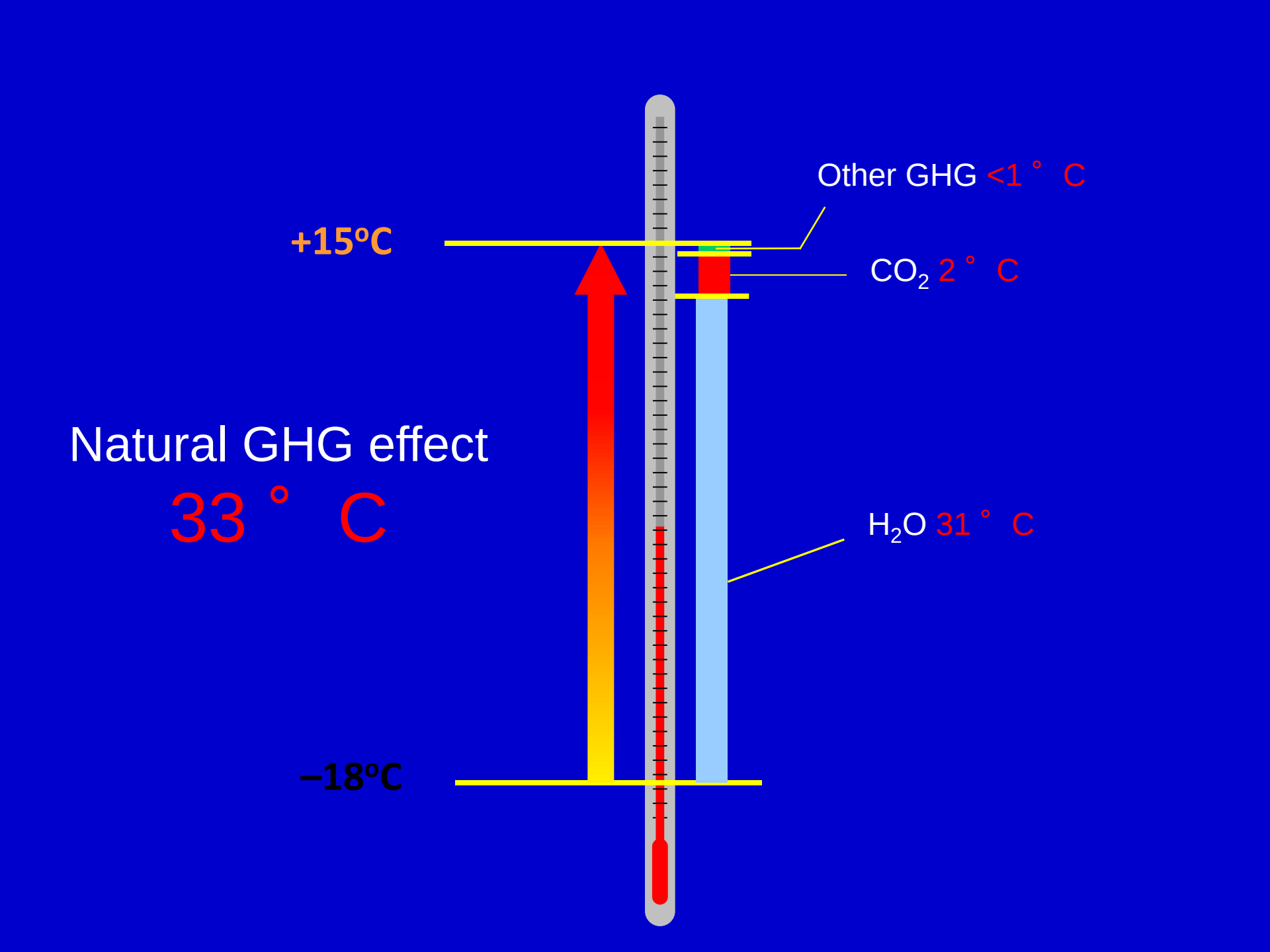
–18°C

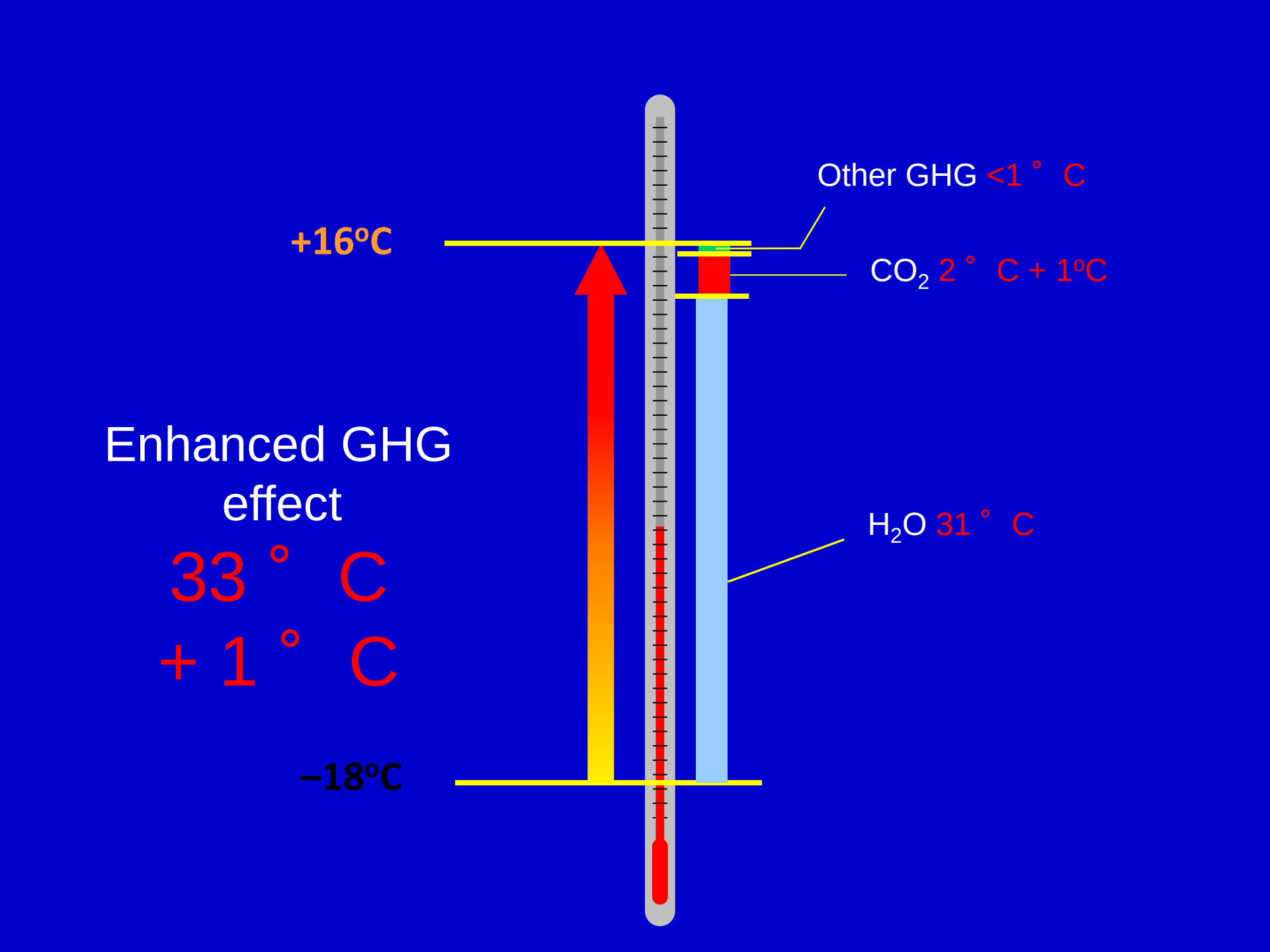
+15°C

+ 33° C

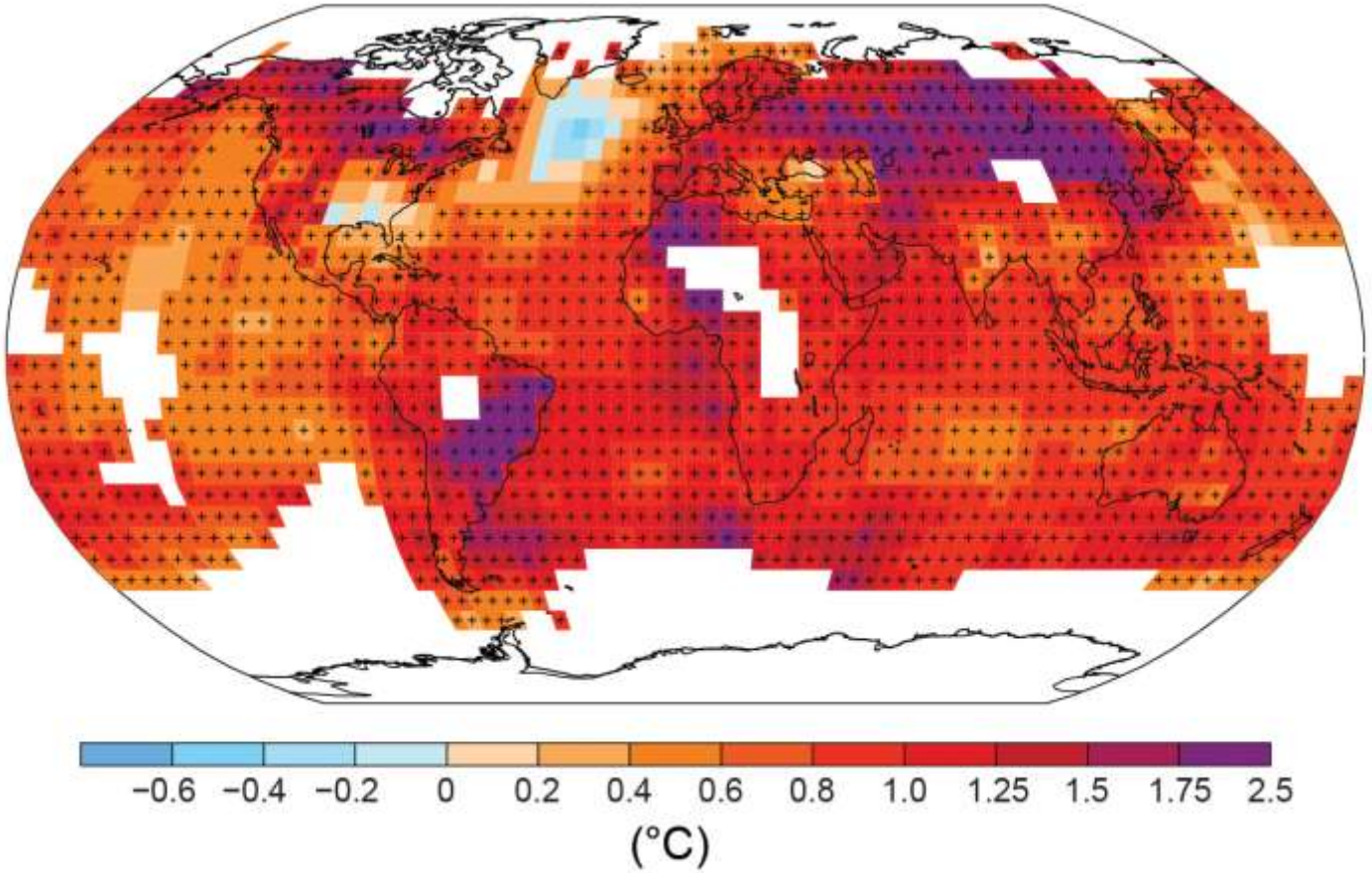
Earth without air

Our planet


Other GHG <1 ° C
+15°C
CO2 2 ° C
Natural GHG effect
33 ° C
H2O 31 ° C
–18°C

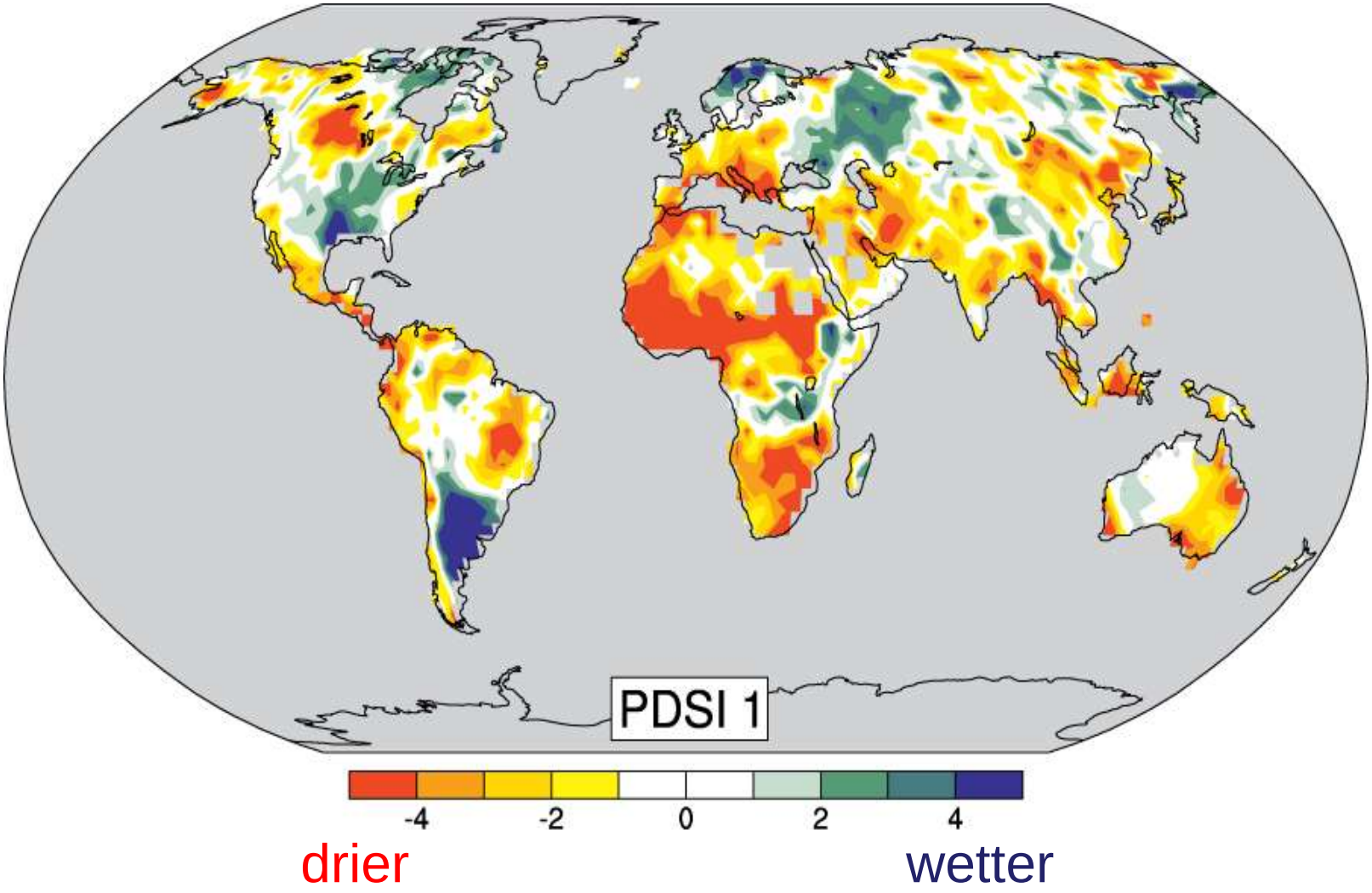

Other GHG <1 ° C
+16ºC
CO2 2 ° C + 1ºC
Enhanced GHG effect
33 ° C
+ 1 ° C
H2O 31 ° C
–18ºC

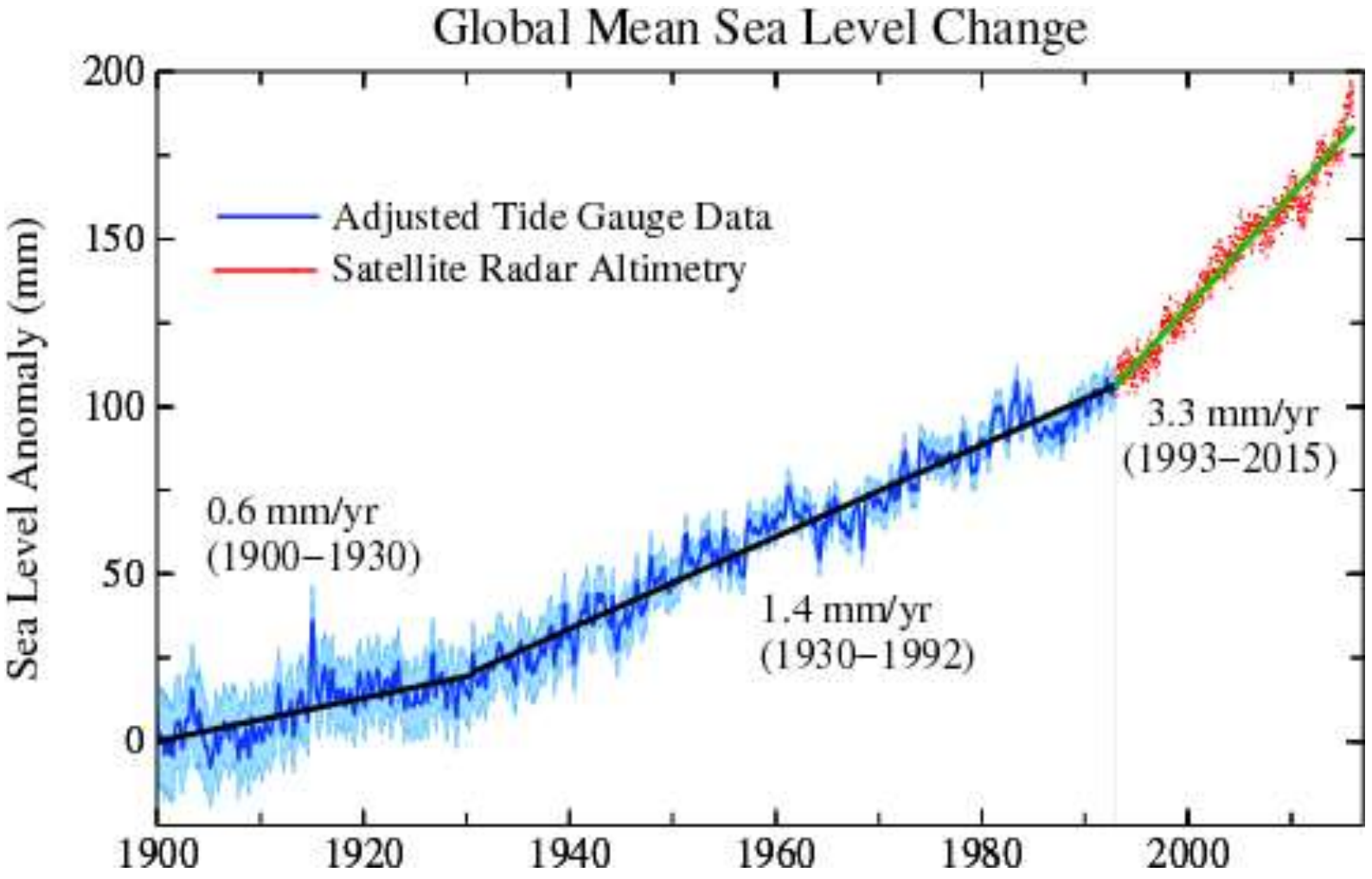
Warming rate K/100 y



- The Earth gets warmer as CO_2 increases in the atmosphere
- The Earth doesn't warm uniformly, the oceans warm slower than the continents and arctic

Changes in water cycle




Global Mean Sea Level Change
Sea Level Anomaly (mm)
200
150
100
50
0
1900
1920
1940
1960
1980
2000
Adjusted Tide Gauge Data
Satellite Radar Altimetry
0.6 mm/yr
(1900–1930)
1.4 mm/yr
(1930–1992)
3.3 mm/yr
(1993–2015)

Global temperature rise

+2°

PROBLEMATIC

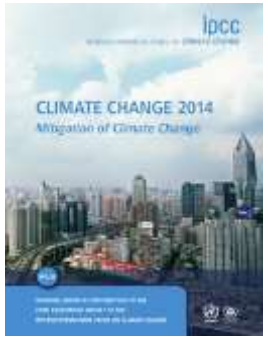
- 1 - 2 billion additional people with water stress
- Impacts on cereal productivity at low latitudes
- Increased coastal flooding and storms
- Greater depth of seasonal permafrost thaw

+4°

DISASTROUS

- A 16 ºC increase in the Arctic
- 1.1 - 3.2 billion additional people with water stress
- Widespread coral mortality; risk of major extinctions around the globe
- Substantial global impact on major crops
- Long-term prospect of sea level rise

2013/2014 Fifth Assessment Report



Key messages

Human influence on the climate system is clear

The more we disrupt our climate, the more we risk severe, pervasive and irreversible impacts

We have the means to limit climate change and build a more prosperous, sustainable future

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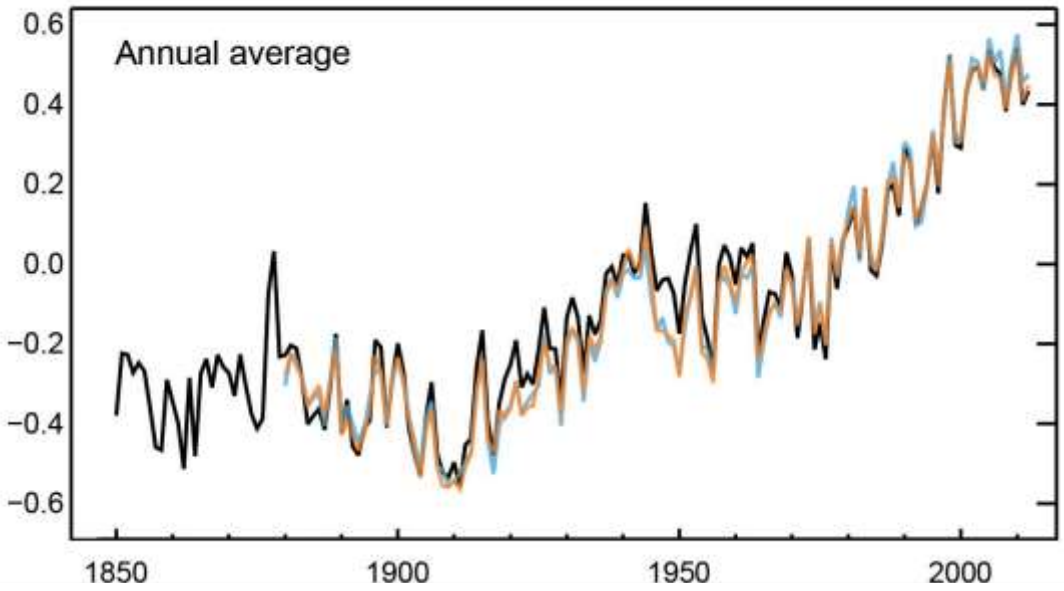
Humans are changing the climate

It is extremely likely that we are the dominant cause of warming since the mid-20th century

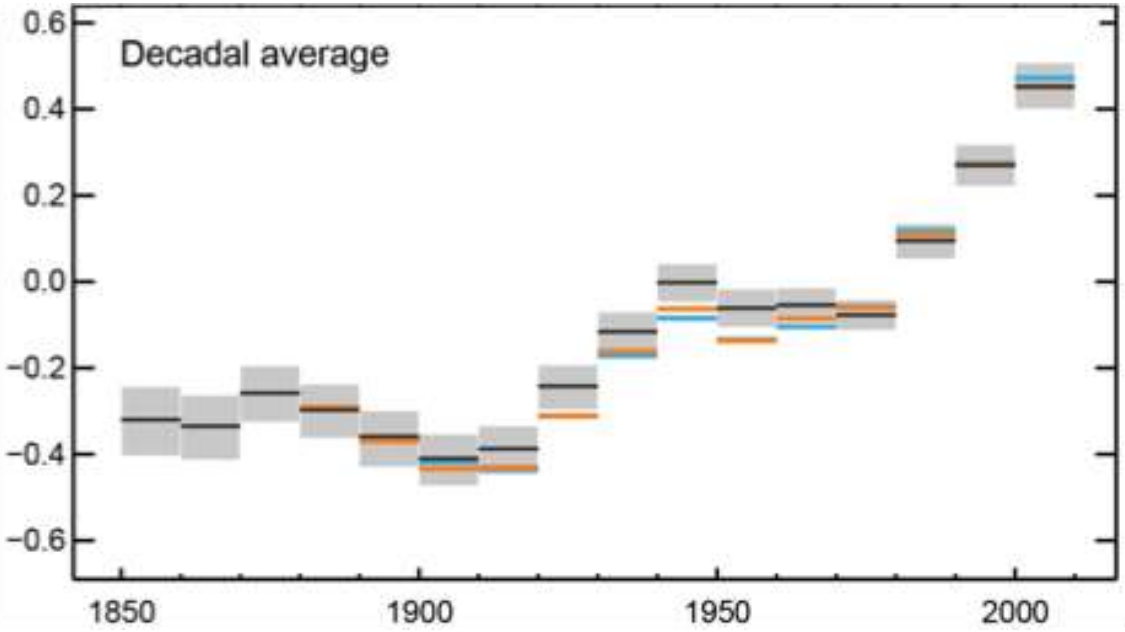


Globally averaged combined land and ocean surface temperatures

AR5 WGI SPM

Temperatures continue to rise

Each of the past 3 decades has been successively warmer than the preceding decades since 1850



Globally averaged combined land and ocean surface temperatures

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Some of the changes in extreme weather and climate events observed since about 1950 have been linked to human influence

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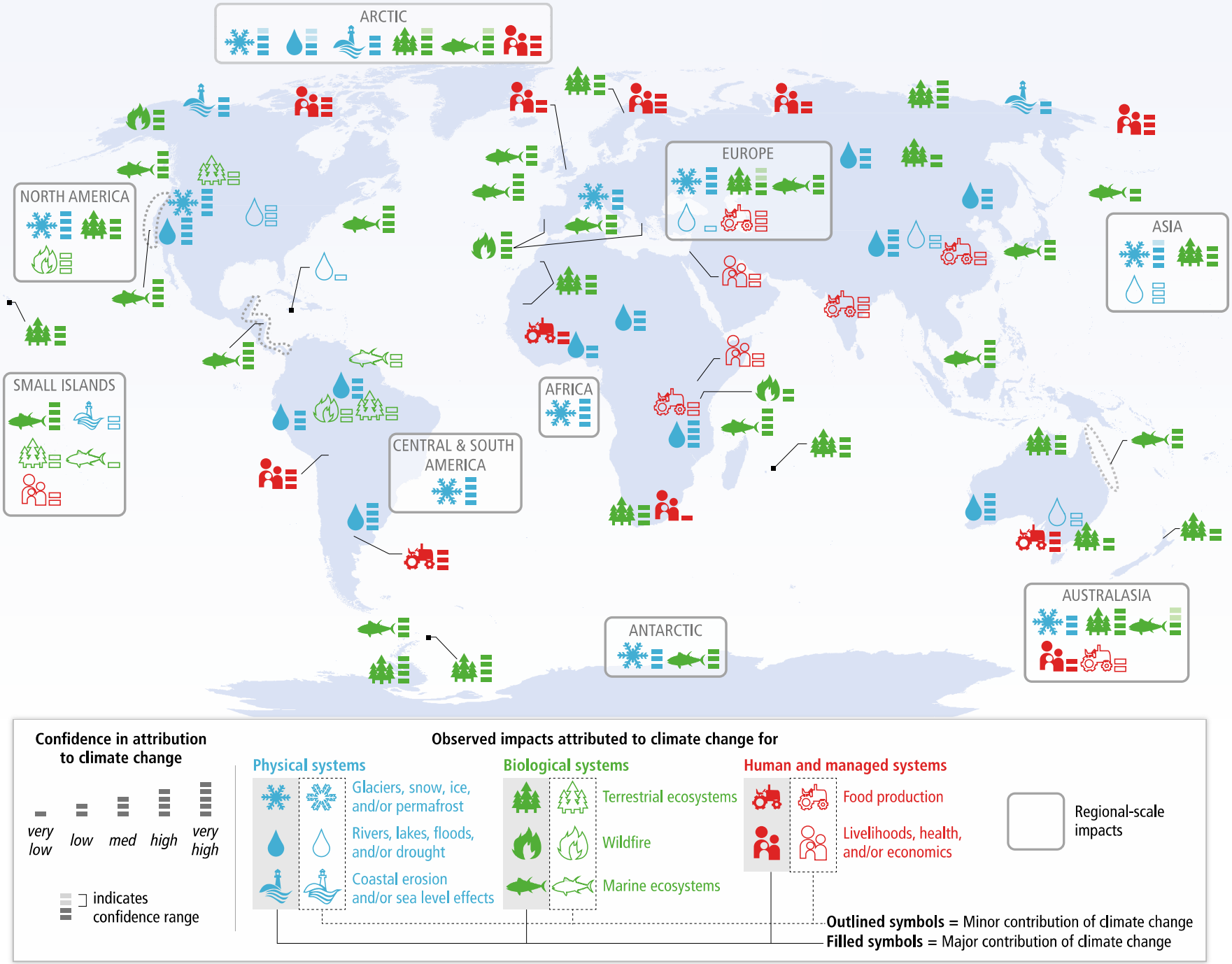
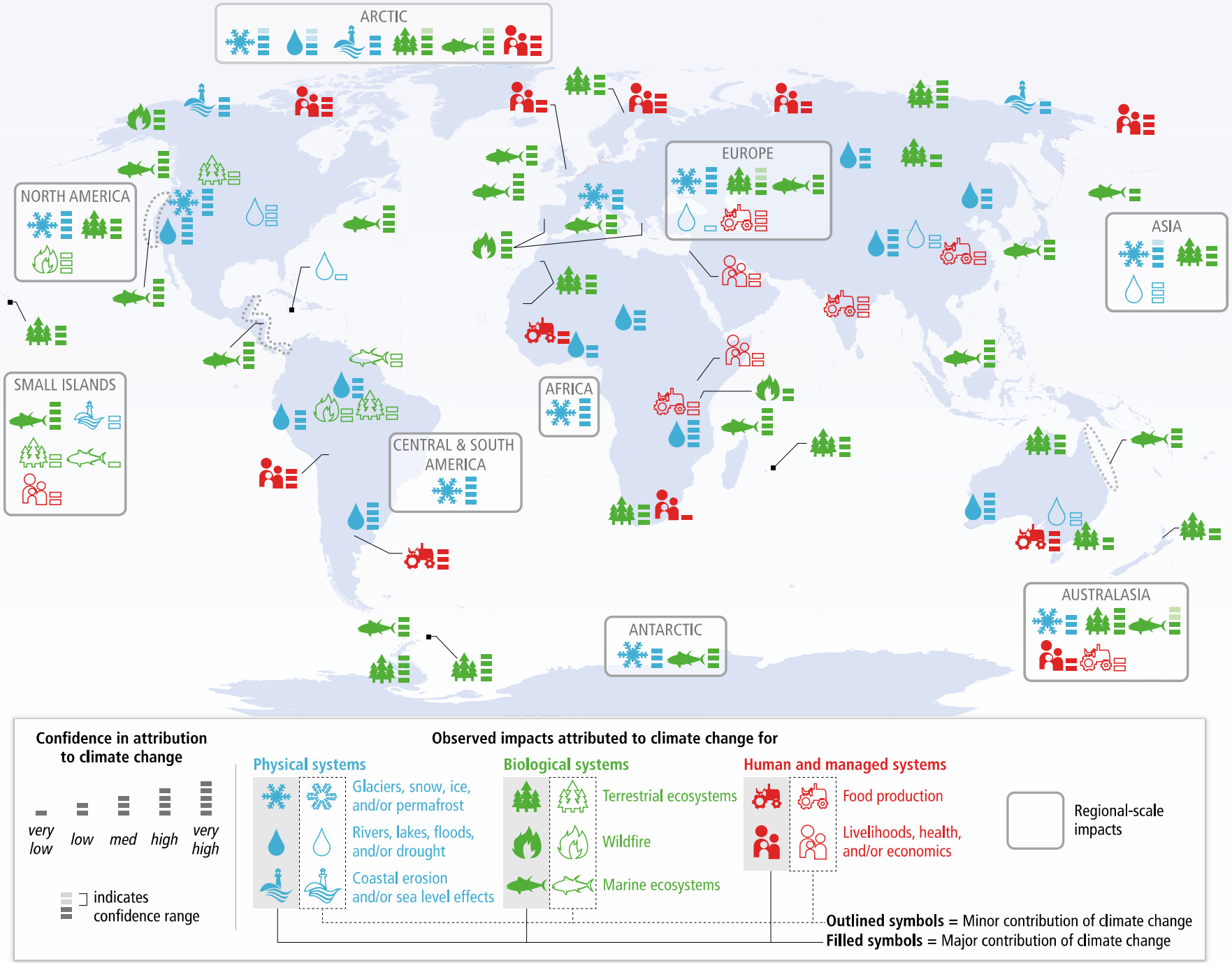
Impacts are already underway

- Tropics to the poles
- On all continents and in the ocean
- Affecting rich and poor countries (but the poor are more vulnerable everywhere)





ARCTIC
NORTH AMERICA
EUROPE
ASIA
SMALL ISLANDS
AFRICA
CENTRAL & SOUTH AMERICA
ANTARCTIC
AUSTRALASIA
Confidence in attribution to climate change
very low
low
med
high
very high
indicates confidence range
Observed impacts attributed to climate change for
Physical systems
Glaciers, snow, ice, and/or permafrost
Rivers, lakes, floods, and/or drought
Coastal erosion and/or sea level effects
Biological systems
Terrestrial ecosystems
Wildfire
Marine ecosystems
Human and managed systems
Food production
Livelihoods, health, and/or economics
Regional-scale impacts
Outlined symbols = Minor contribution of climate change
Filled symbols = Major contribution of climate change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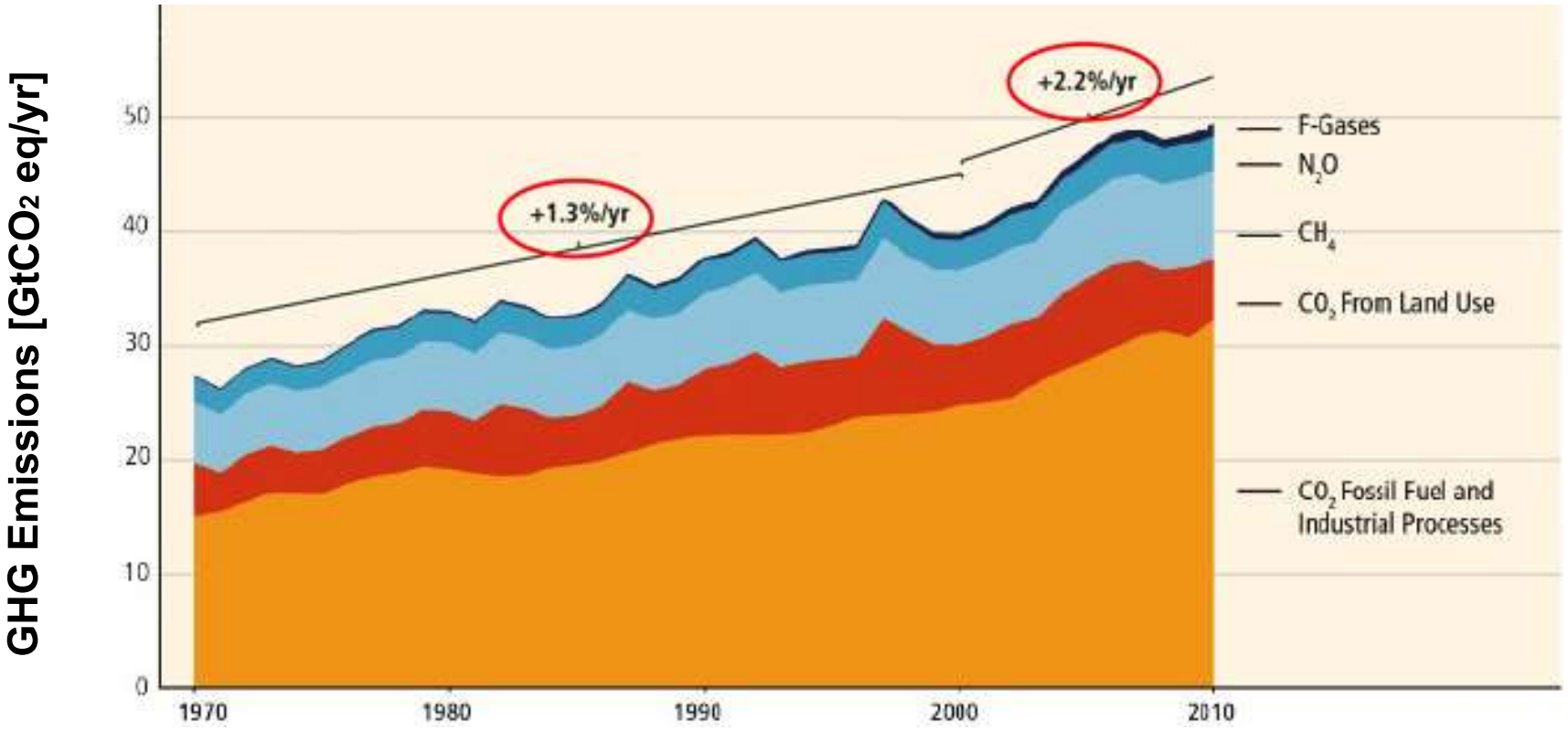
GHG emissions growth between 2000 and 2010 has been larger than in the previous three decades



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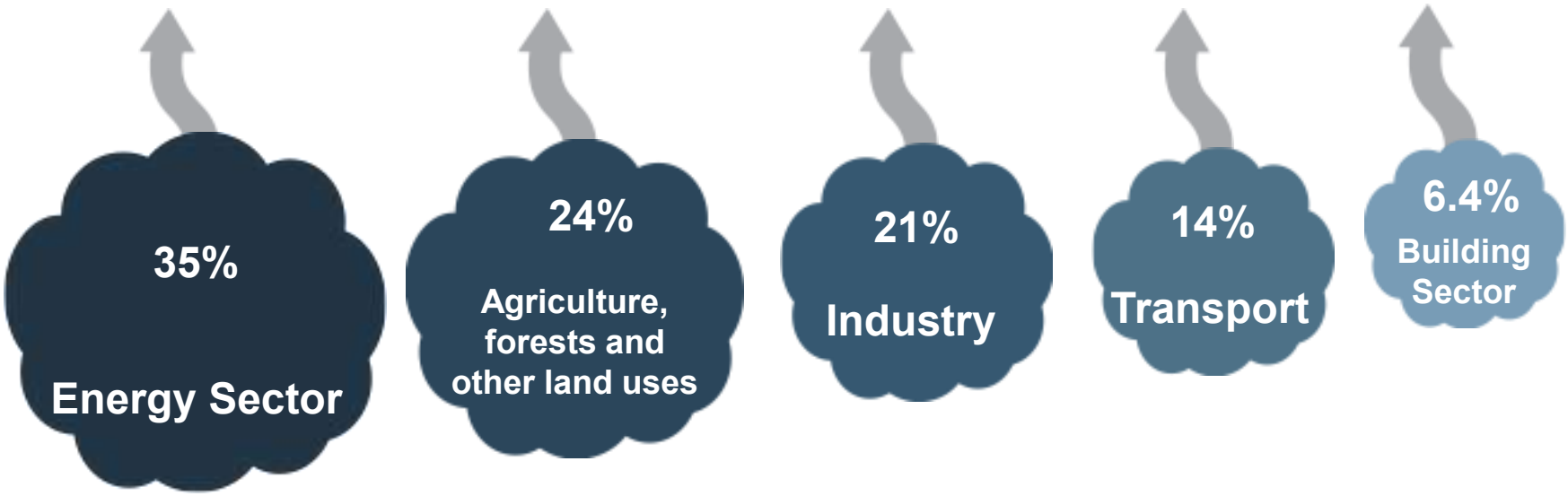
Sources of emissions

Energy production remains the primary driver of GHG emissions



2010 GHG emissions

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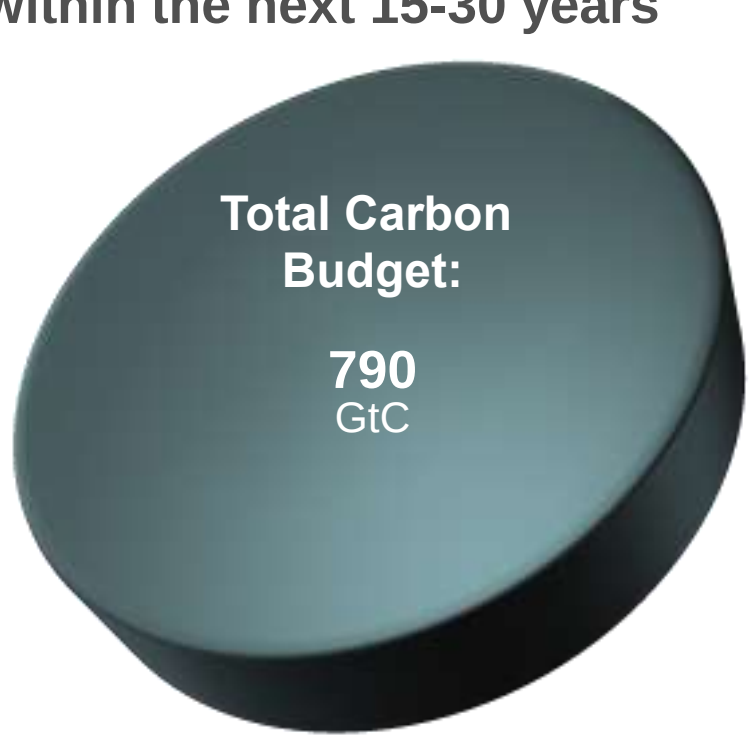
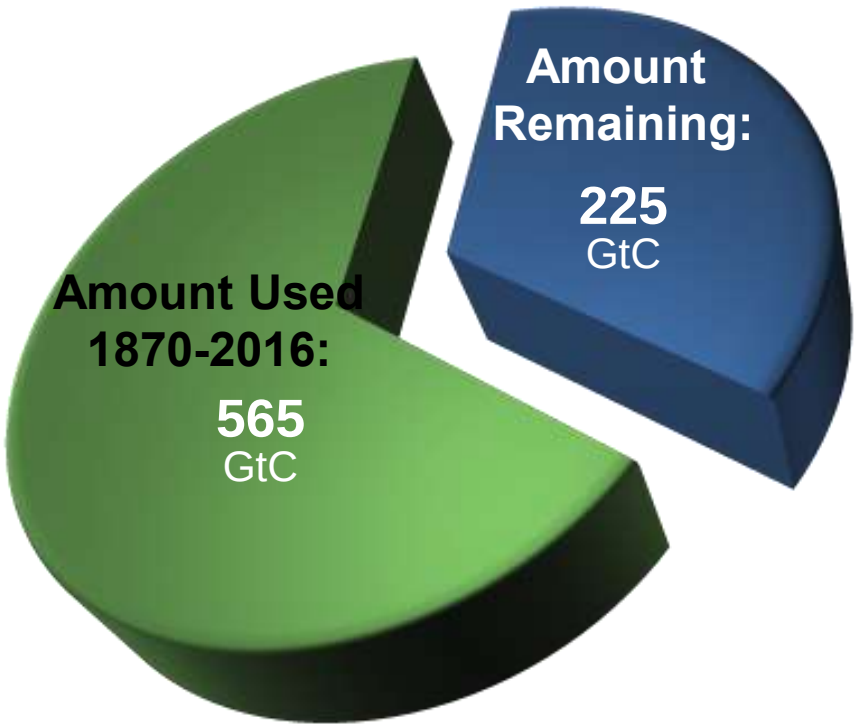
The window for action is rapidly closing

72% of our carbon budget compatible with a 2° C goal already used and continued emissions at current levels will exhaust the budget within the next 15-30 years

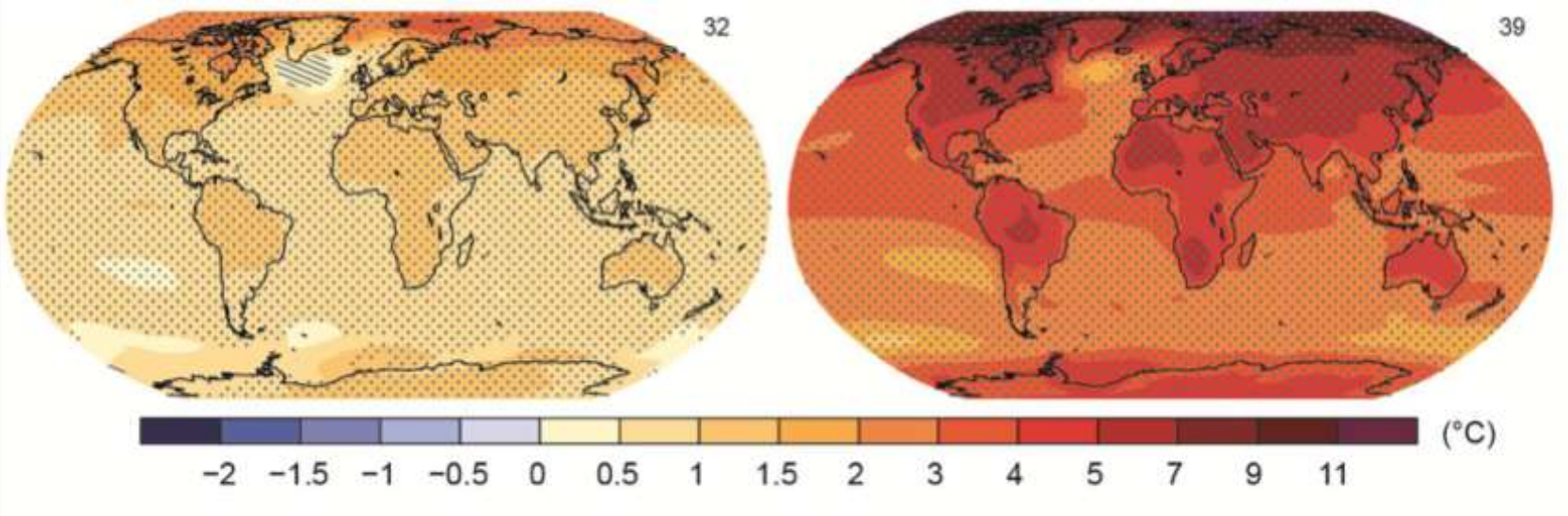




The Choices We Make Will Create Different Outcomes

With substantial mitigation

Without additional



Change in average surface temperature (1986–2005 to 2081–2100)

AR5 WGI SPM

Facing the dangers from climate change…

…there are only three options:

Mitigation, meaning measures to reduce the pace & magnitude of the changes in global climate being caused by human activities.

Adaptation, meaning measures to reduce the adverse impacts on human well-being resulting from the changes in climate that do occur.

Suffering the adverse impacts that are not avoided by either mitigation or adaptation.