Global Warming and Climate Change

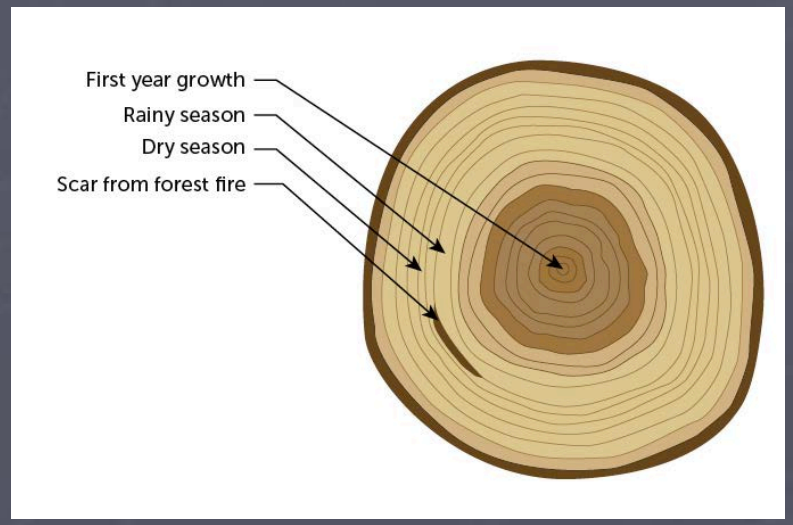
Chapter 10: Climate Change

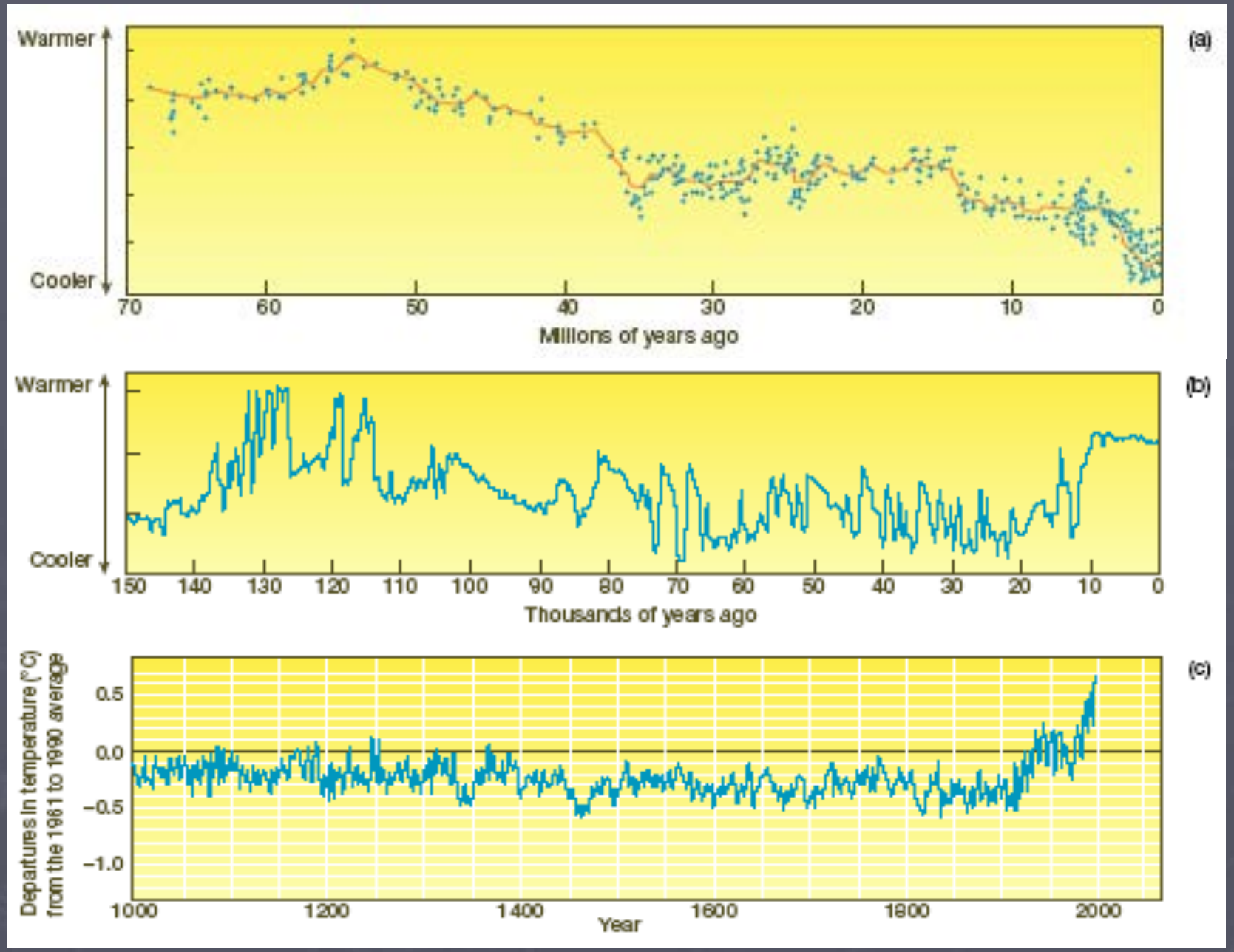
Definitions

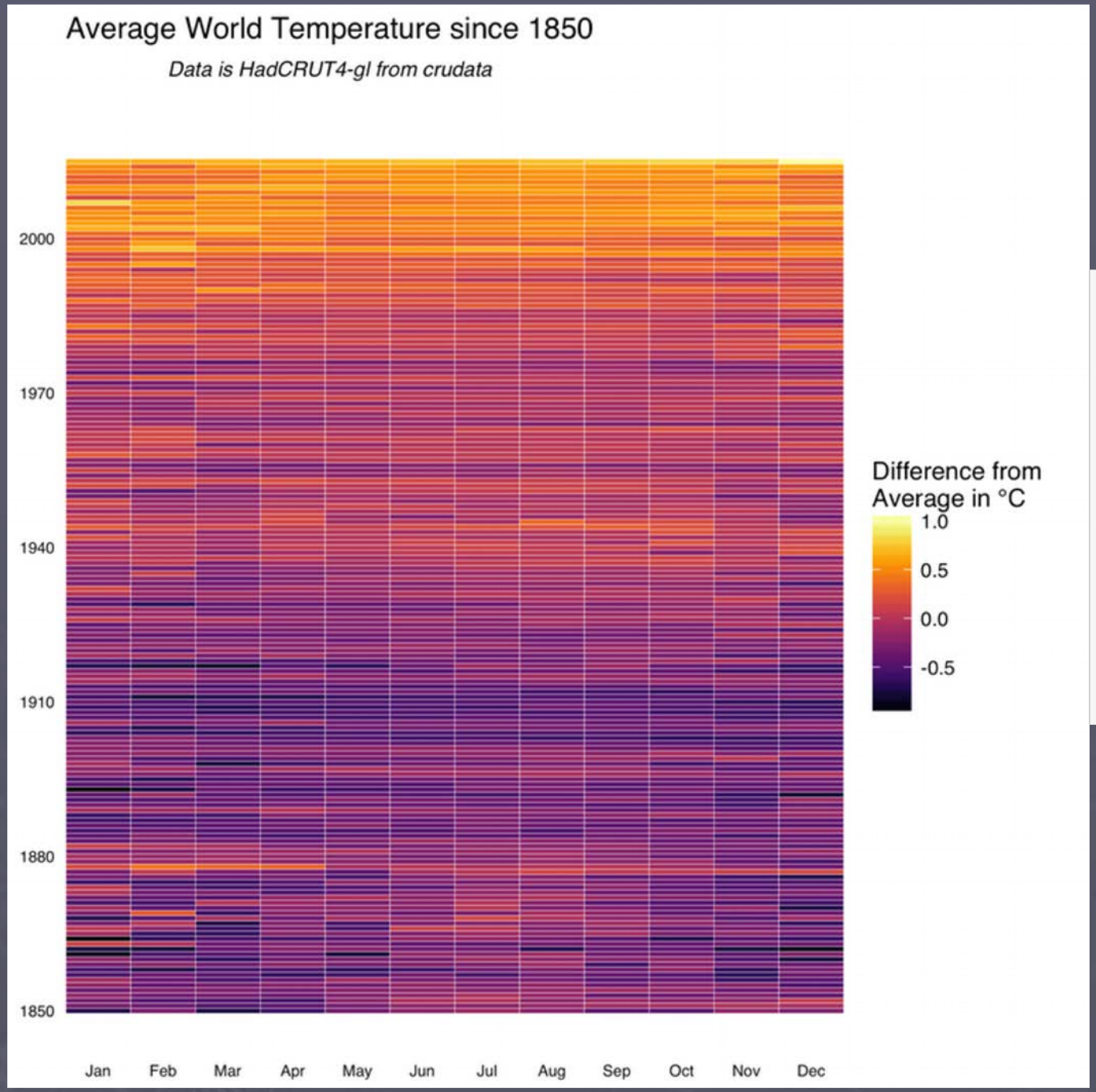
- Climate Change – Natural and anthropogenic process resulting in changes in patterns of wind, temperature, and precipitation
- Global Warming – Long-Term trends in rising averages of global temperatures

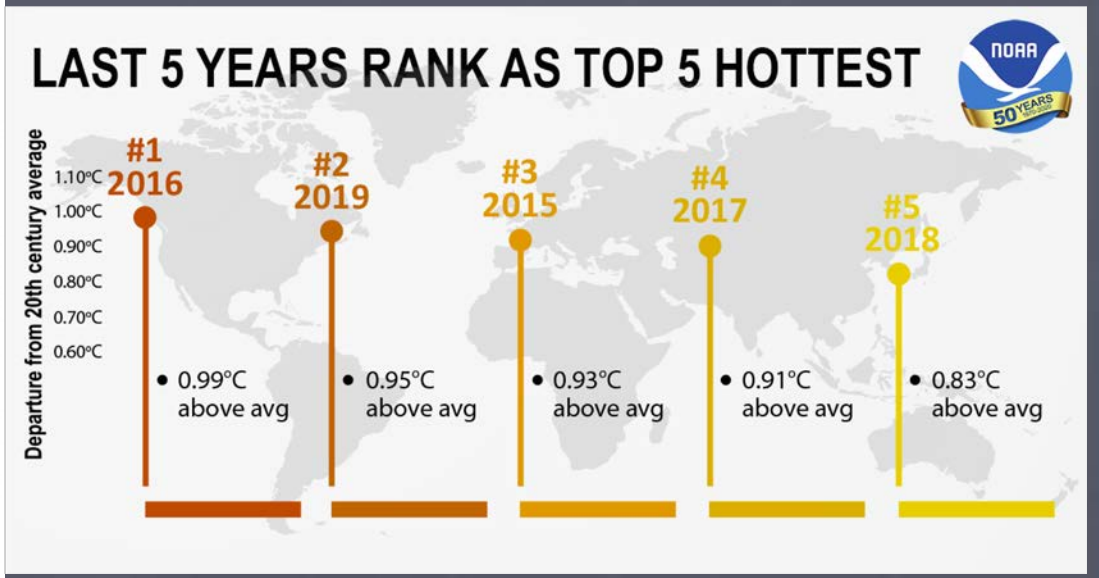
Measuring Climate Change

- Historic
  - Ice Core Samples
    - 800,000 years
  - Dendrochronology (Tree Cores)
    - 11,000 years
    - 100,000s of years (petrified Forests)
  - Historical records of temperature and precipitation
- Present
  - Winds, Surface Temperatures, Ocean Temperatures, Precipitation, Extreme weather events, Biomass, Atmospheric Composition



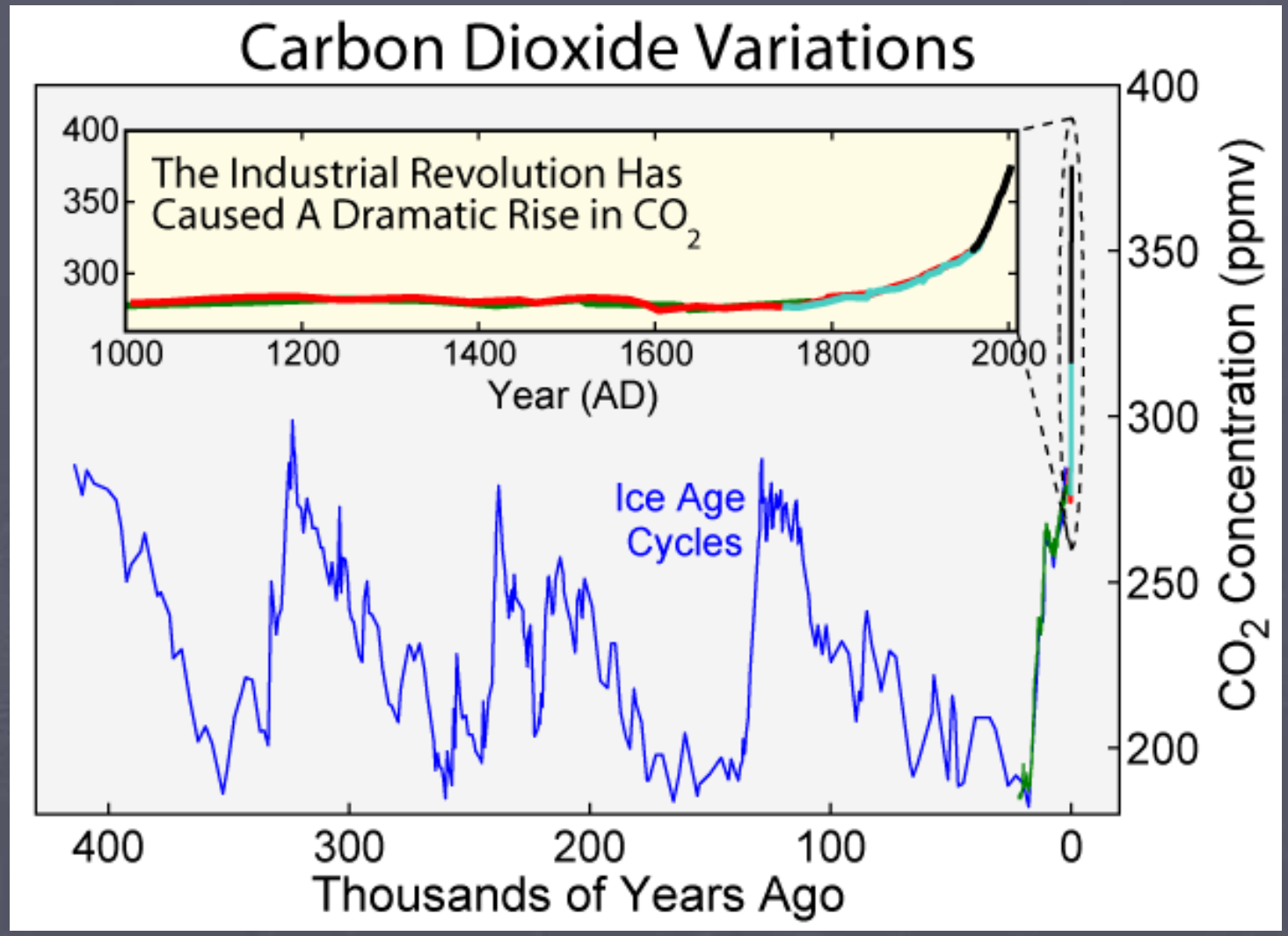

Warmer
Cooler
(a)
70
60
50
40
30
20
10
0
Millions of years ago
Warmer
Cooler
(b)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Thousands of years ago
Departures in temperature (°C) from the 1961 to 1990 average
(c)
0.5
0.0
−0.5
−1.0
1000
1200
1400
1600
1800
2000
Year


Average World Temperature since 1850
Data is HadCRUT4-gl from crudata
2000
1970
1940
1910
1880
1850
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Difference from Average in °C
1.0
0.5
0.0
-0.5

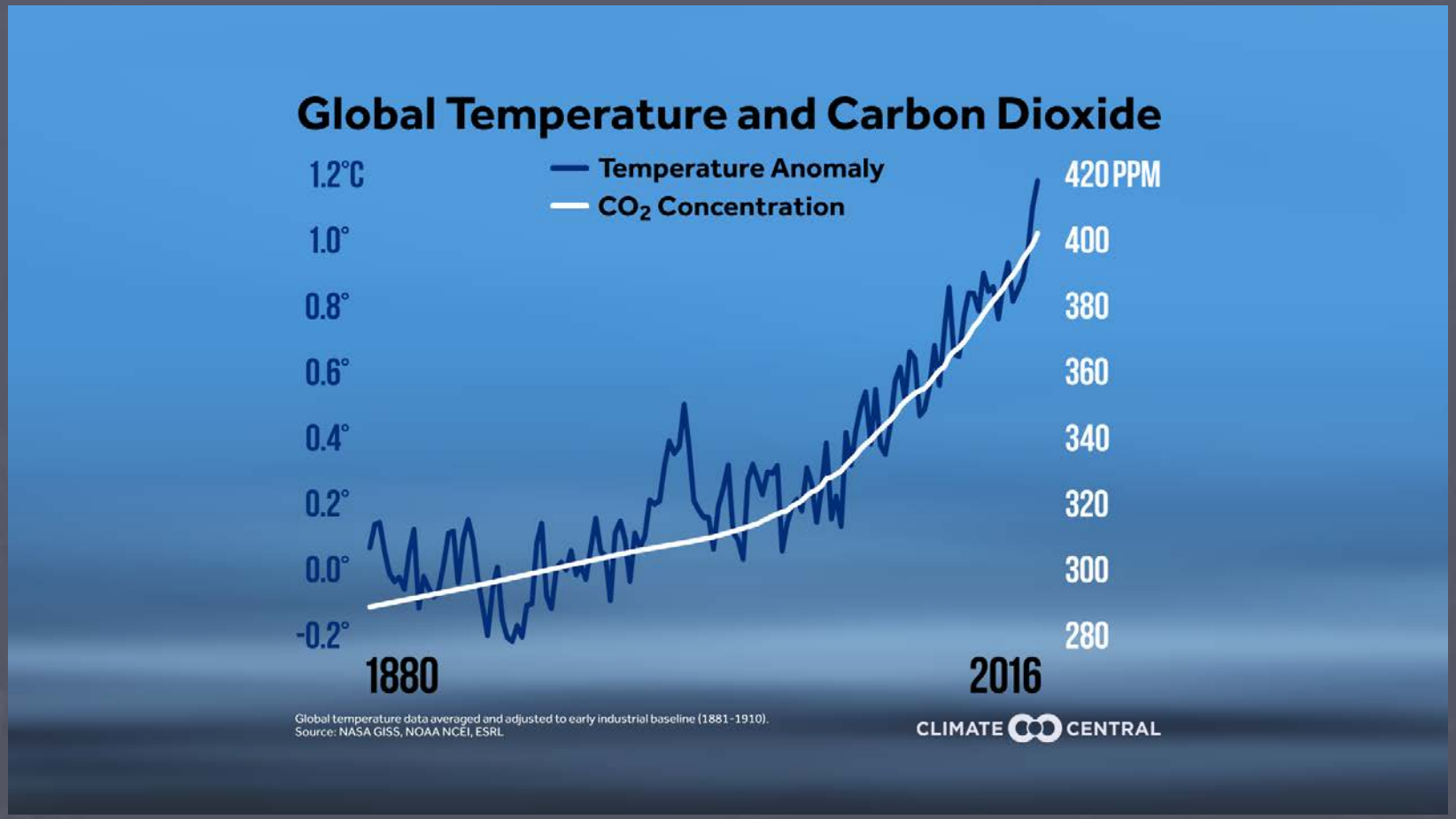

LAST 5 YEARS RANK AS TOP 5 HOTTEST
NOAA
50 YEARS
Departure from 20th century average
1.10°C
1.00°C
0.90°C
0.80°C
0.70°C
0.60°C
#1 2016
• 0.99°C above avg
#2 2019
• 0.95°C above avg
#3 2015
• 0.93°C above avg
#4 2017
• 0.91°C above avg
#5 2018
• 0.83°C above avg

*As of 2019

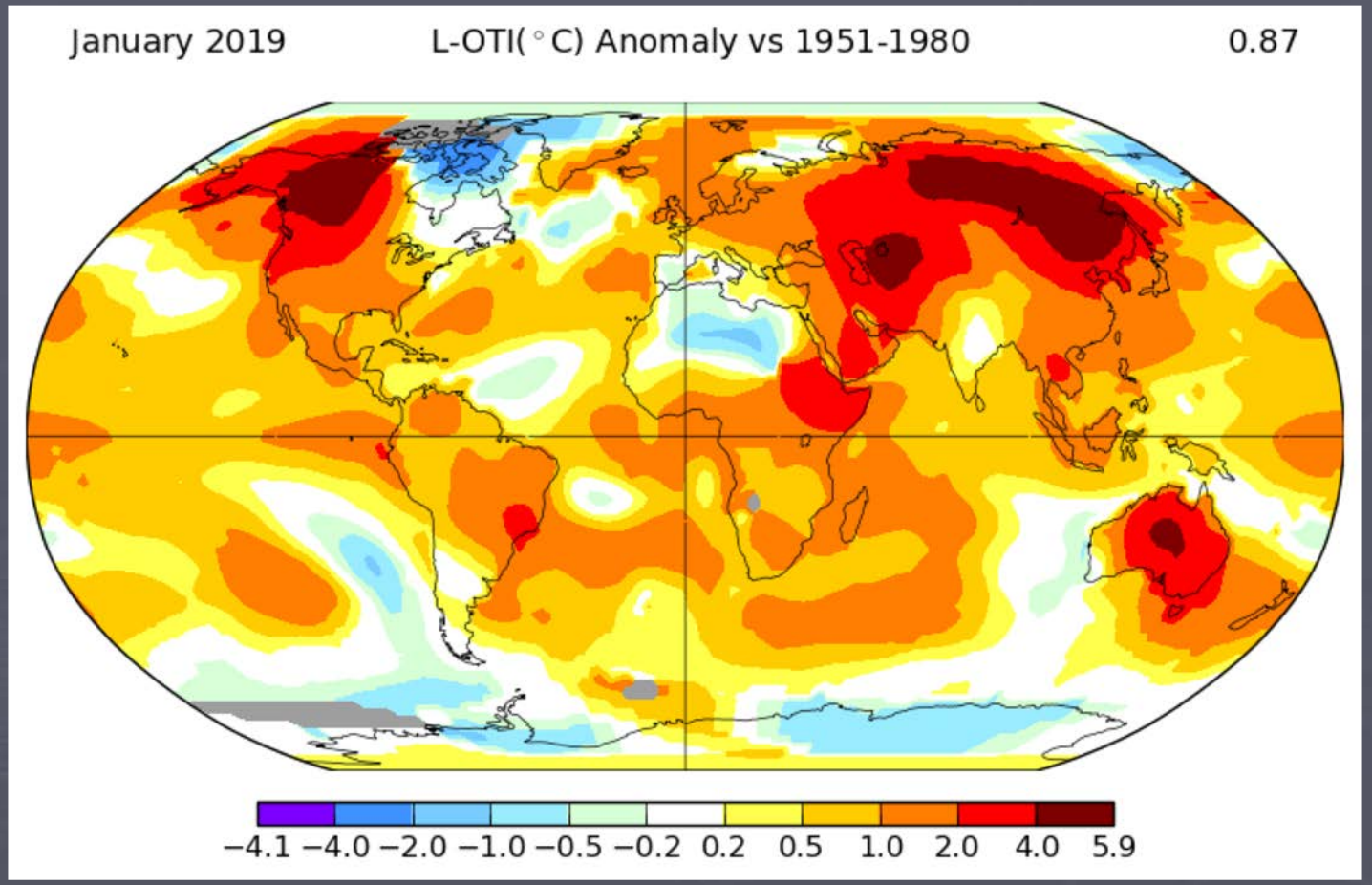
Measuring CO2



CO2 Linkage to temperature increase



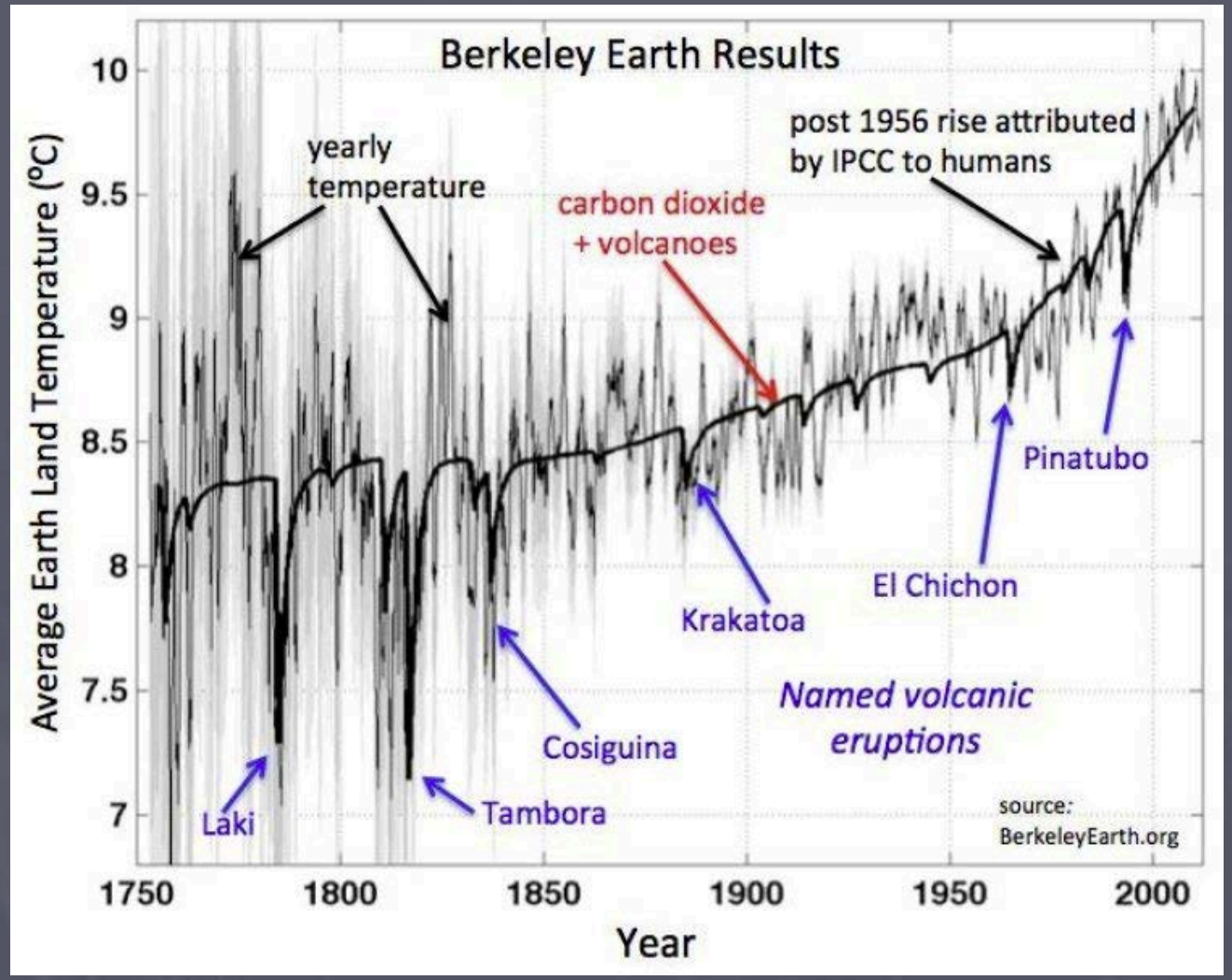
Temperature Change not Uniform



Natural Causes of Climate Changes

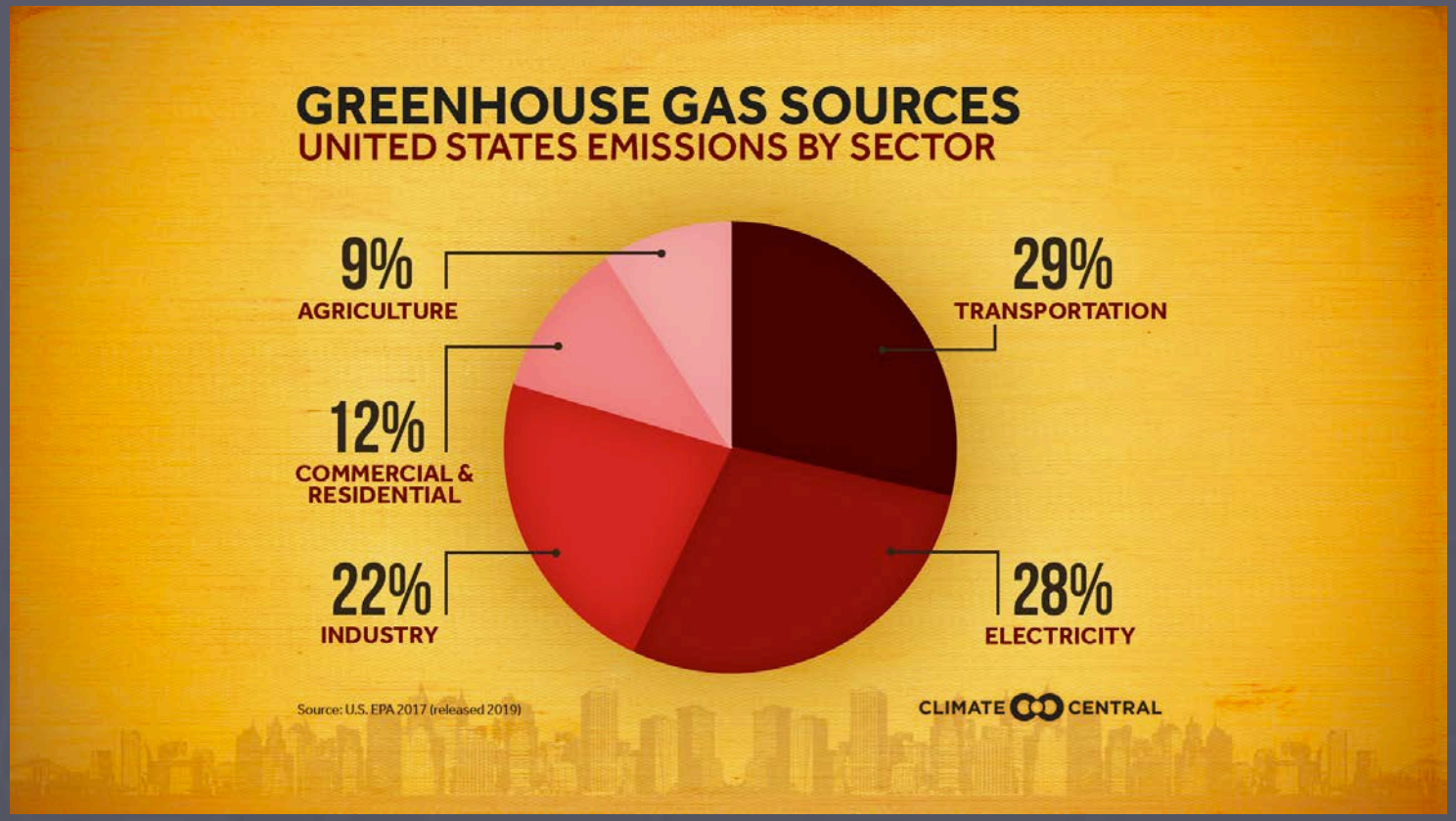
- Volcanic Activity
- Meteorite Activity
- Milankovitch Cycles
- Changes in Sun’s Behavior
- Natural Greenhouse Gas Emission

Volcanic Activity

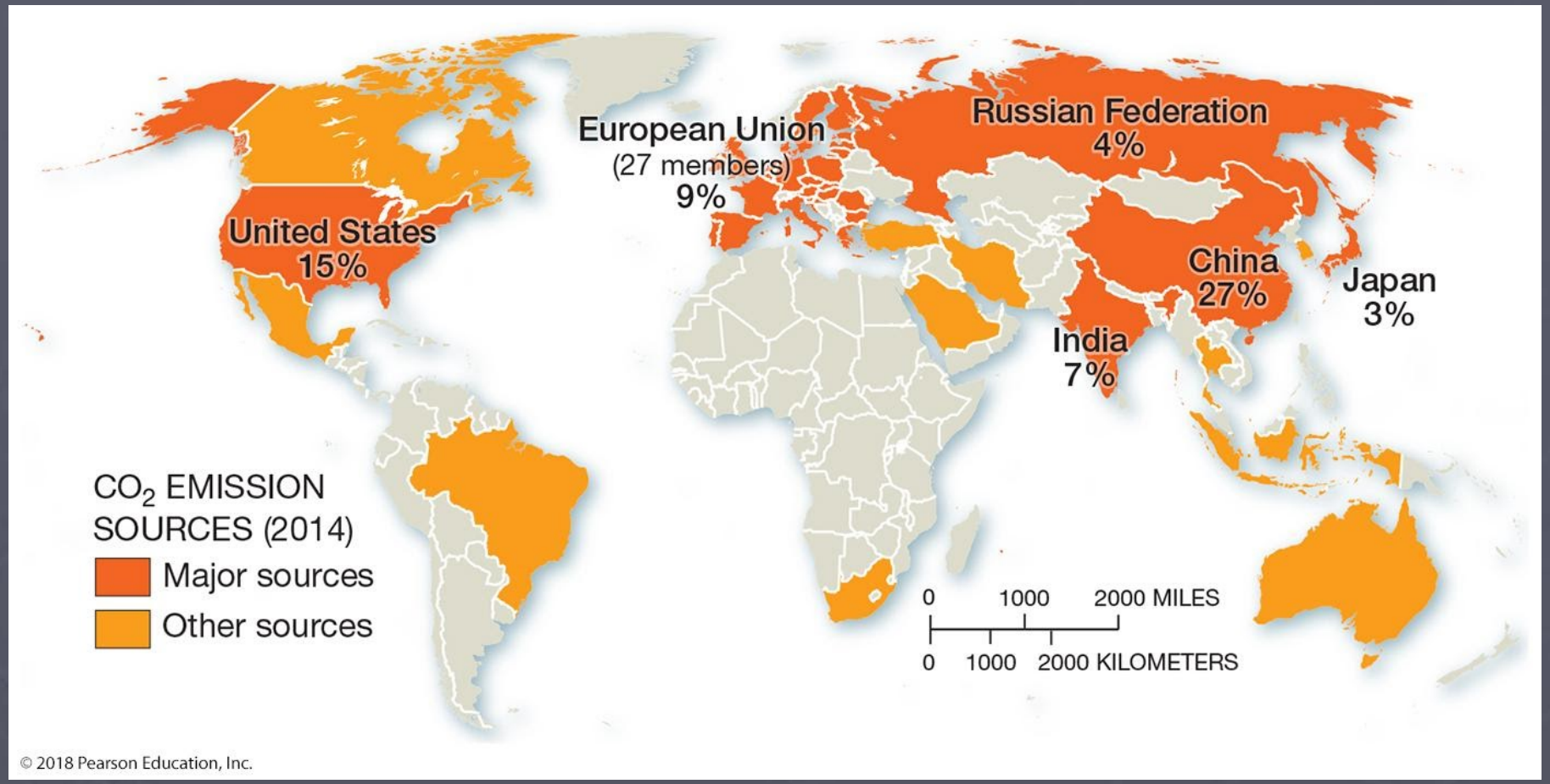


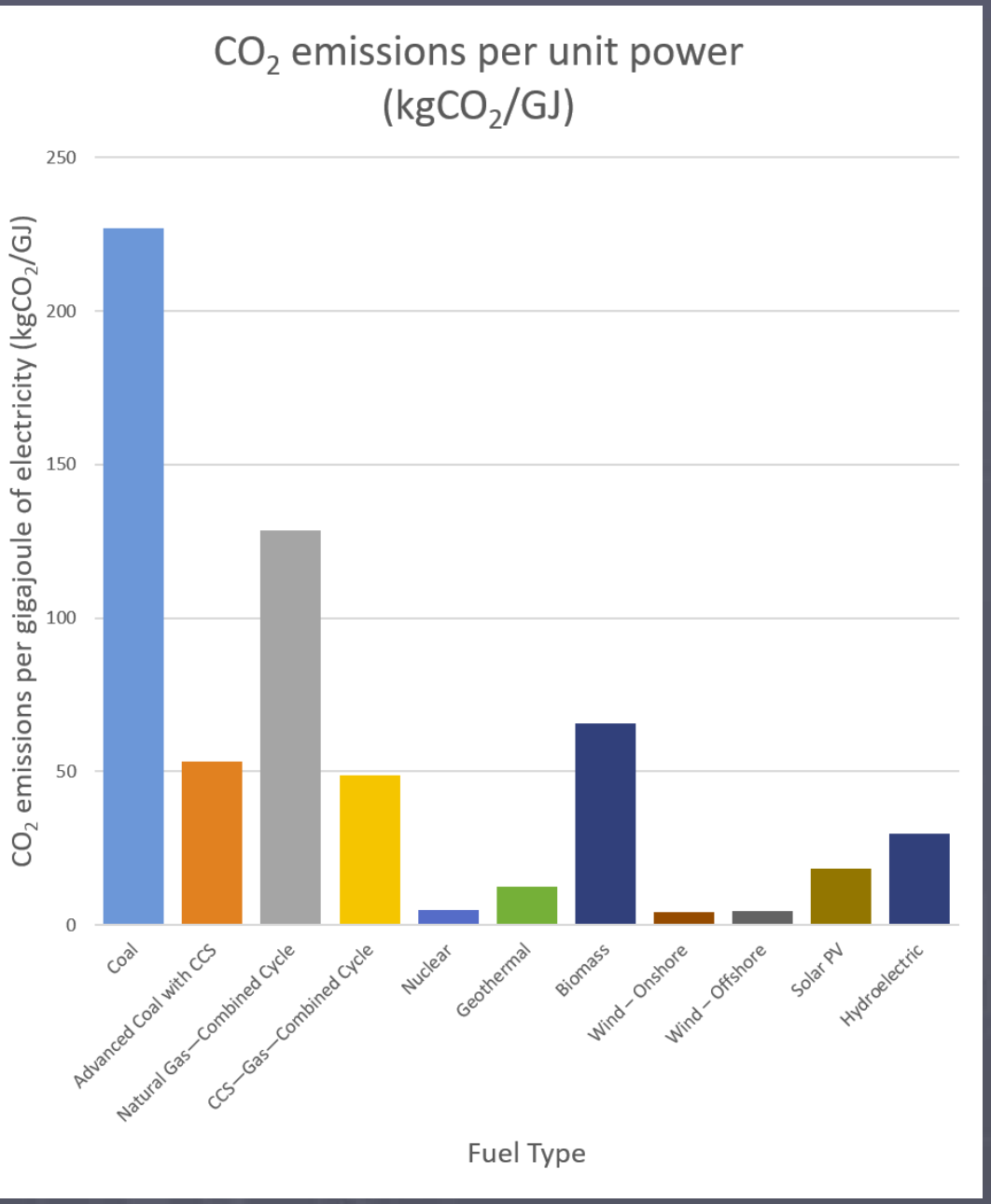
Anthropogenic Causes of Climate Change

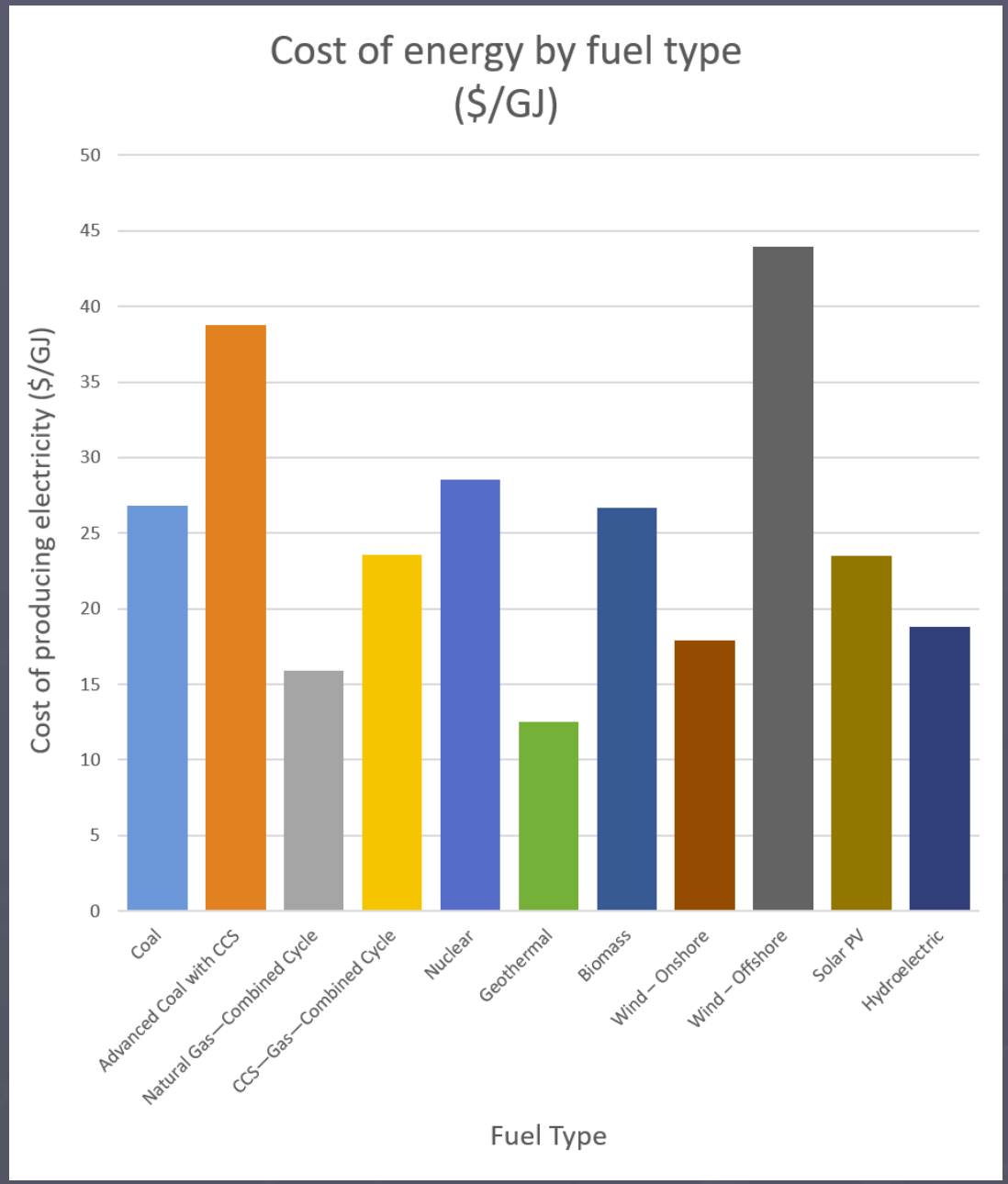
- Carbon Emissions
  - Energy
  - Transportation
  - Heavy Industry
  - Agriculture
  - Buildings
- Deforestation



Global CO2 Emissions

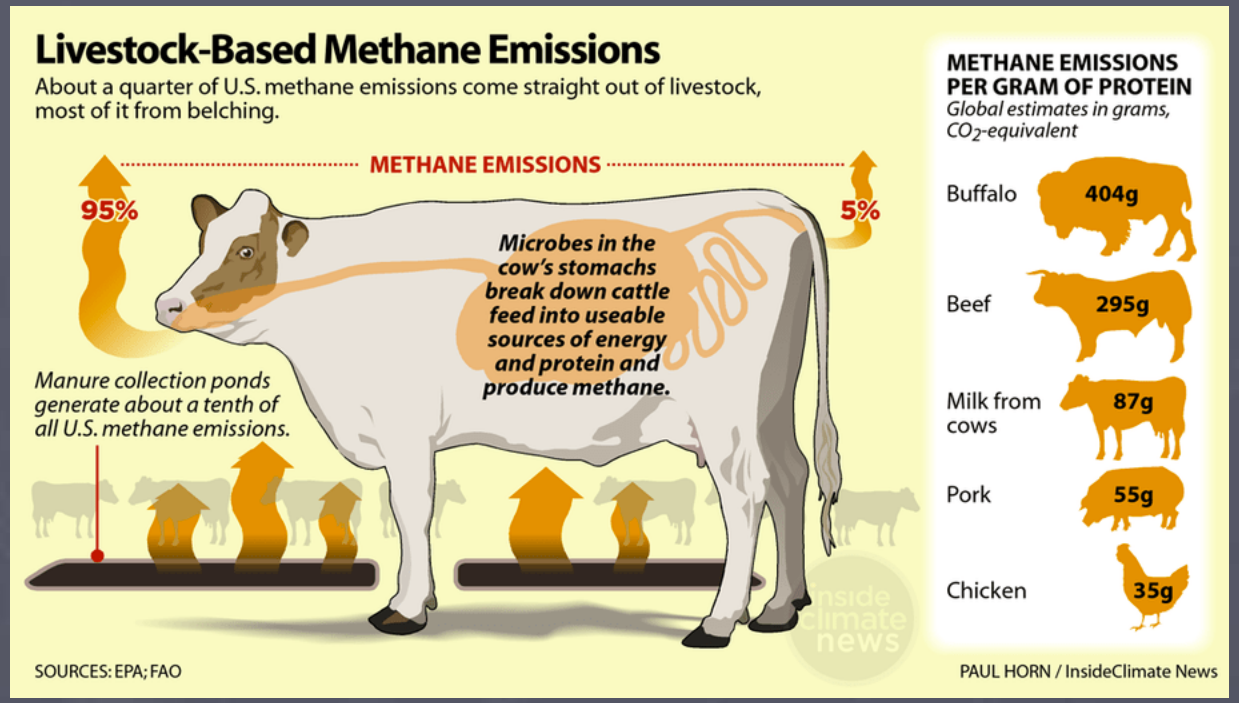


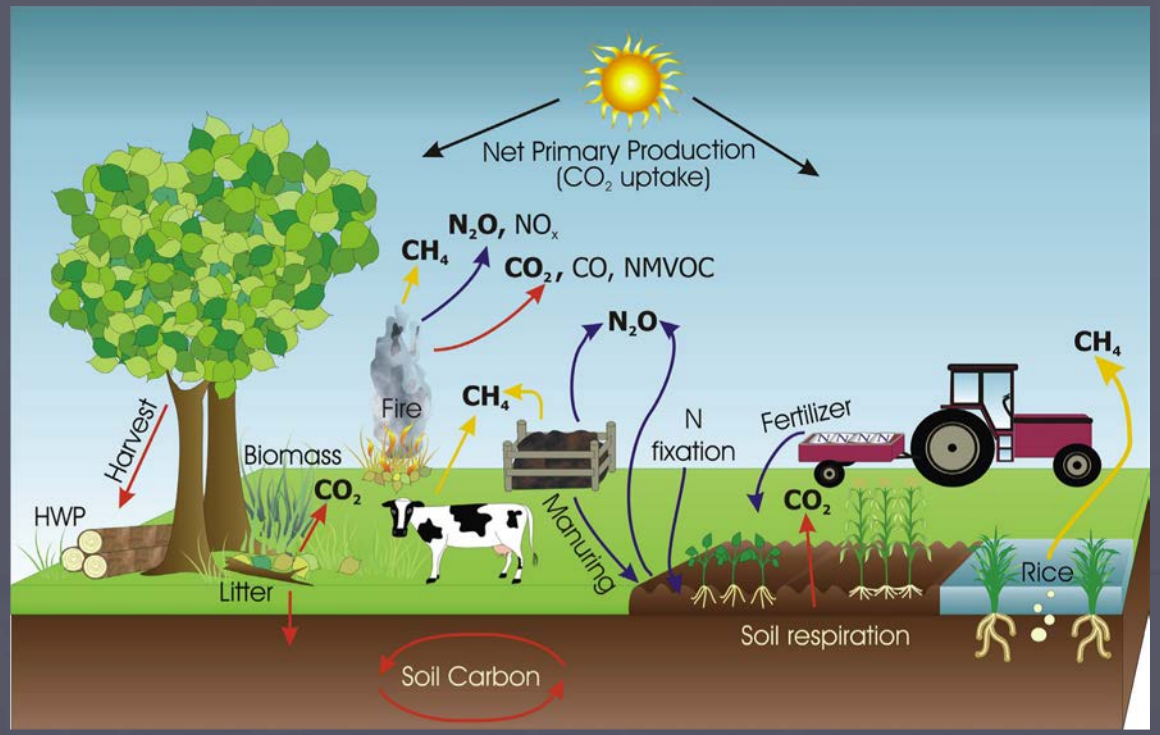




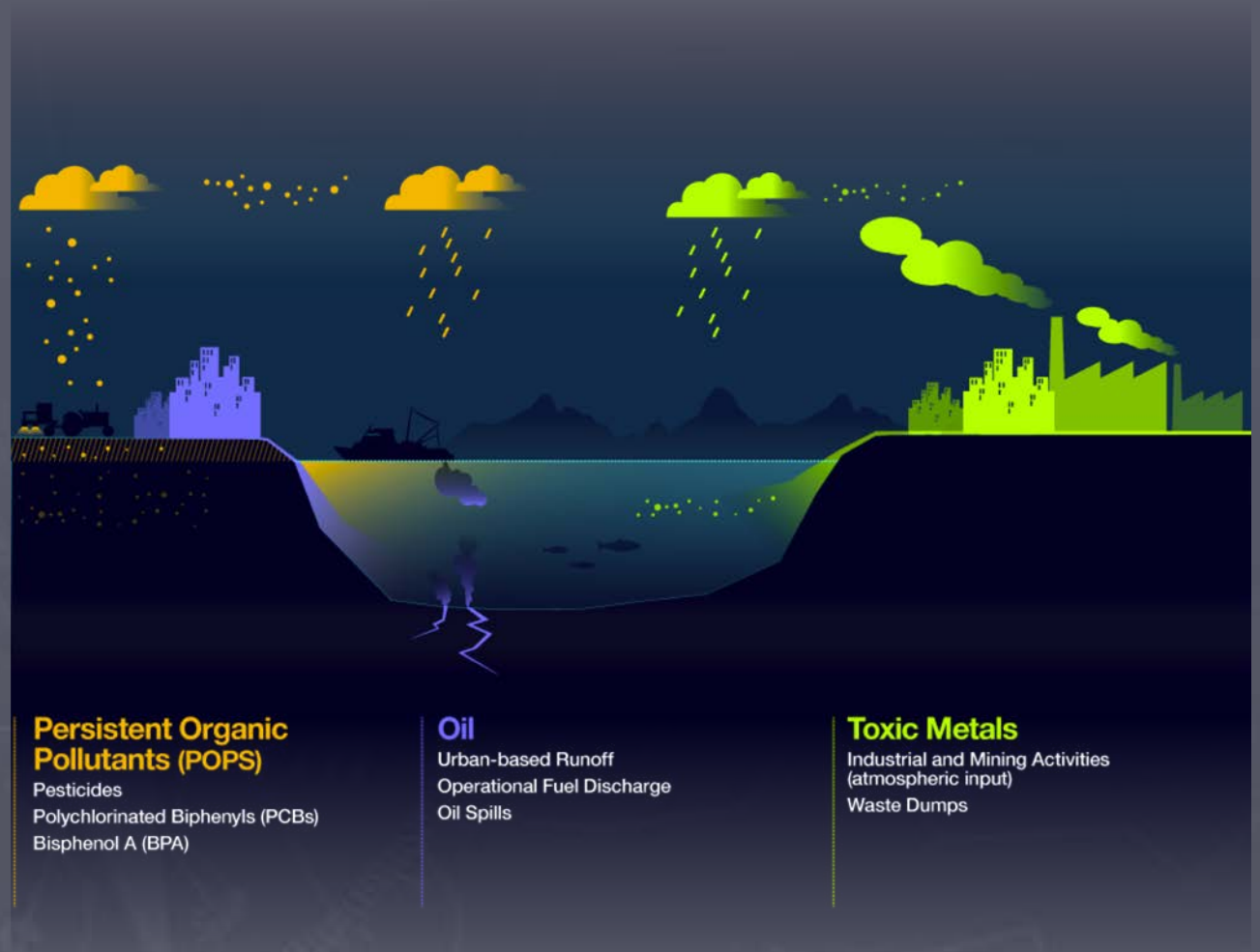
Source: IPCC and US Energy Information Administration

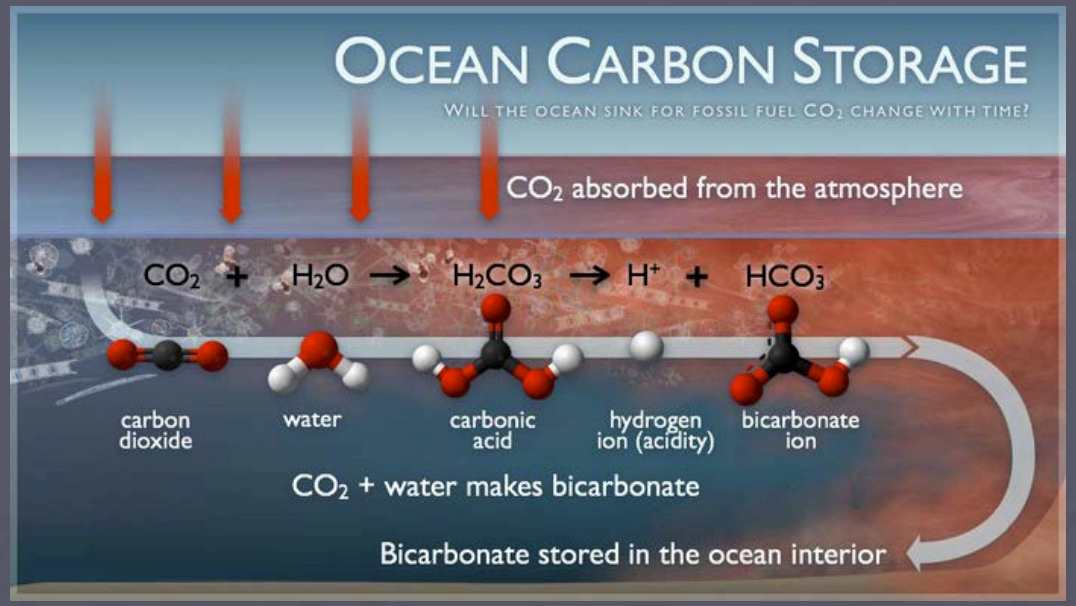
Agriculture and Climate Change



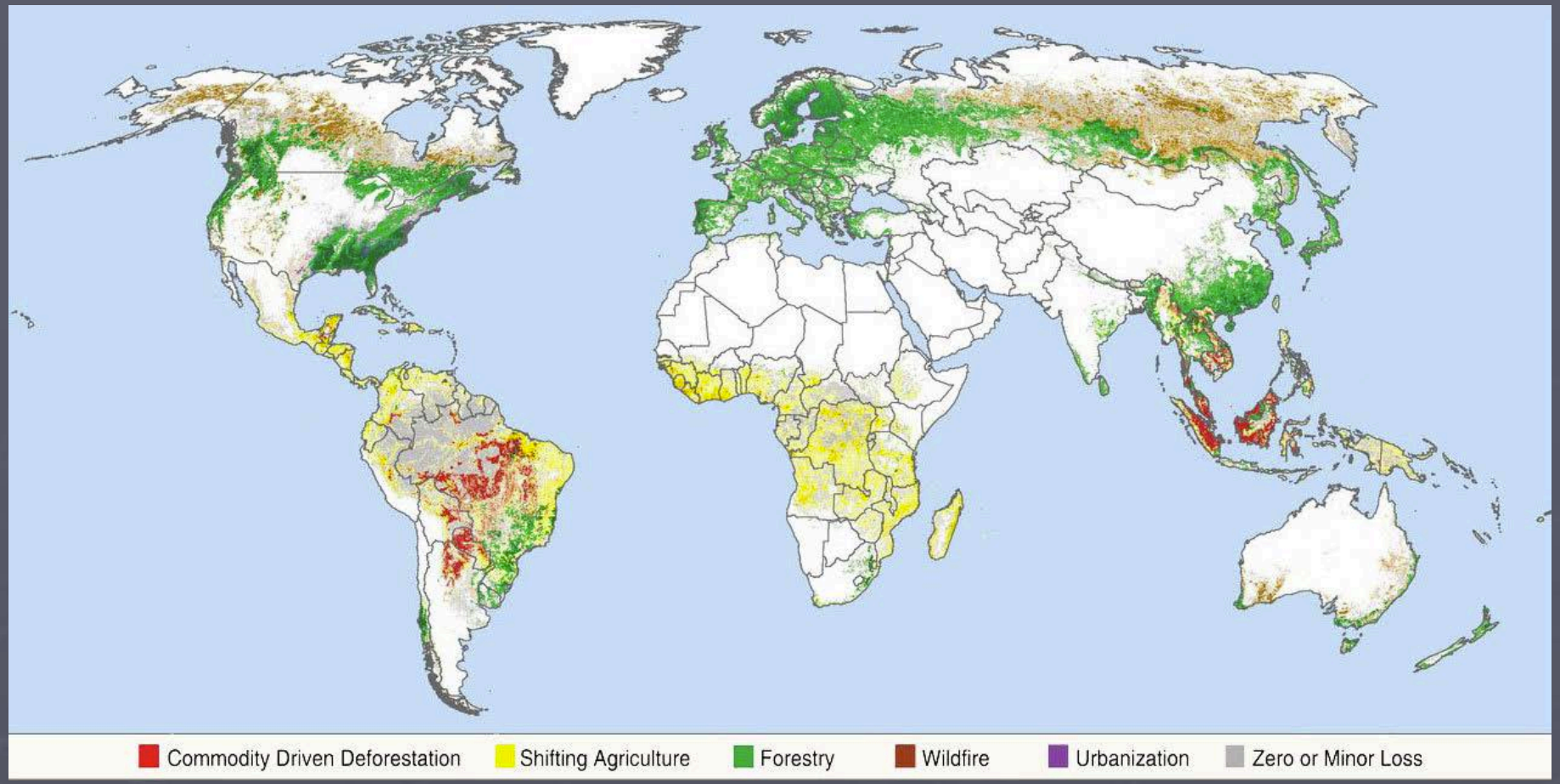


Ocean Dead Zones





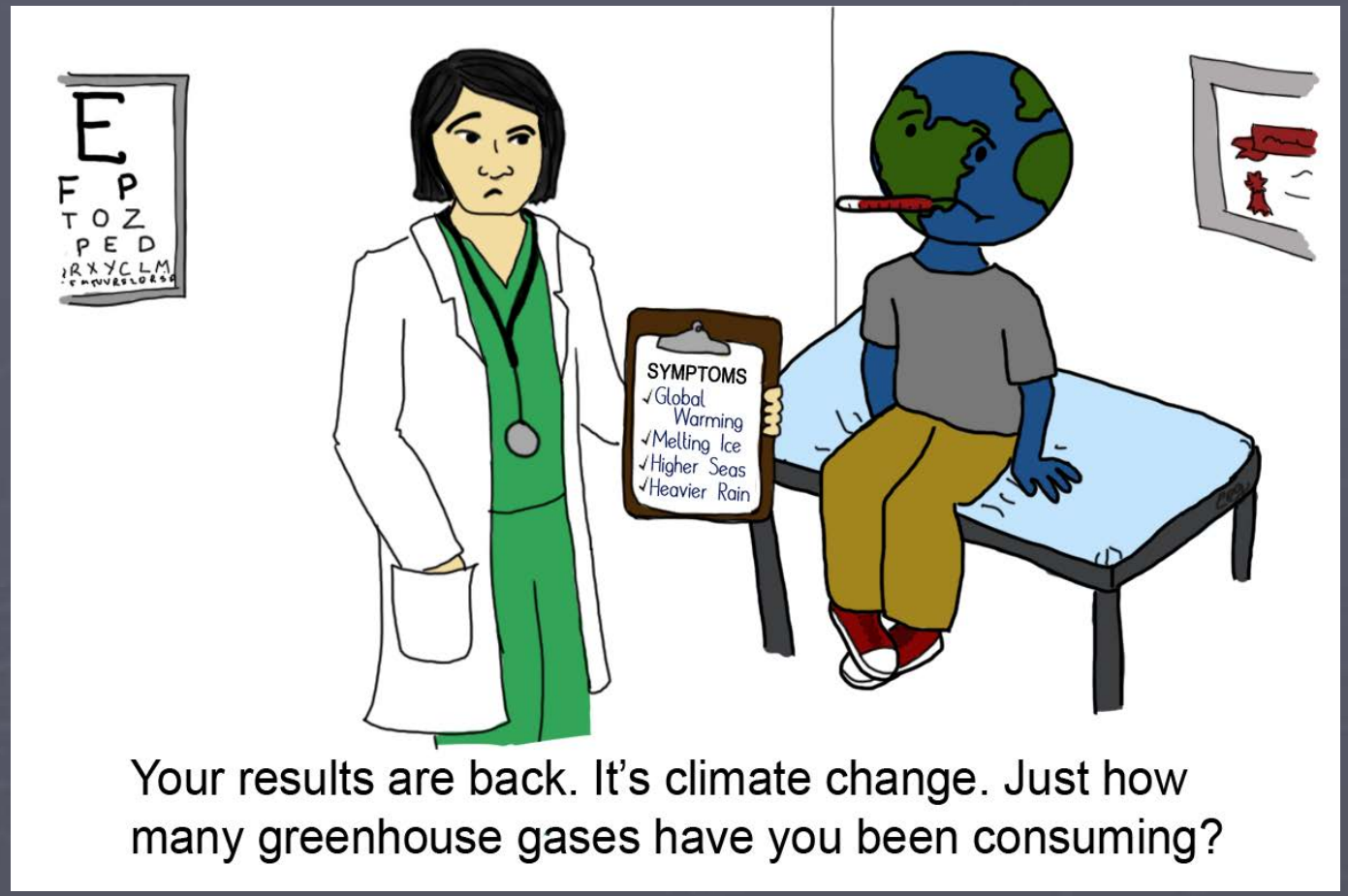
Deforestation



Deforestation by sector (2001-2015)

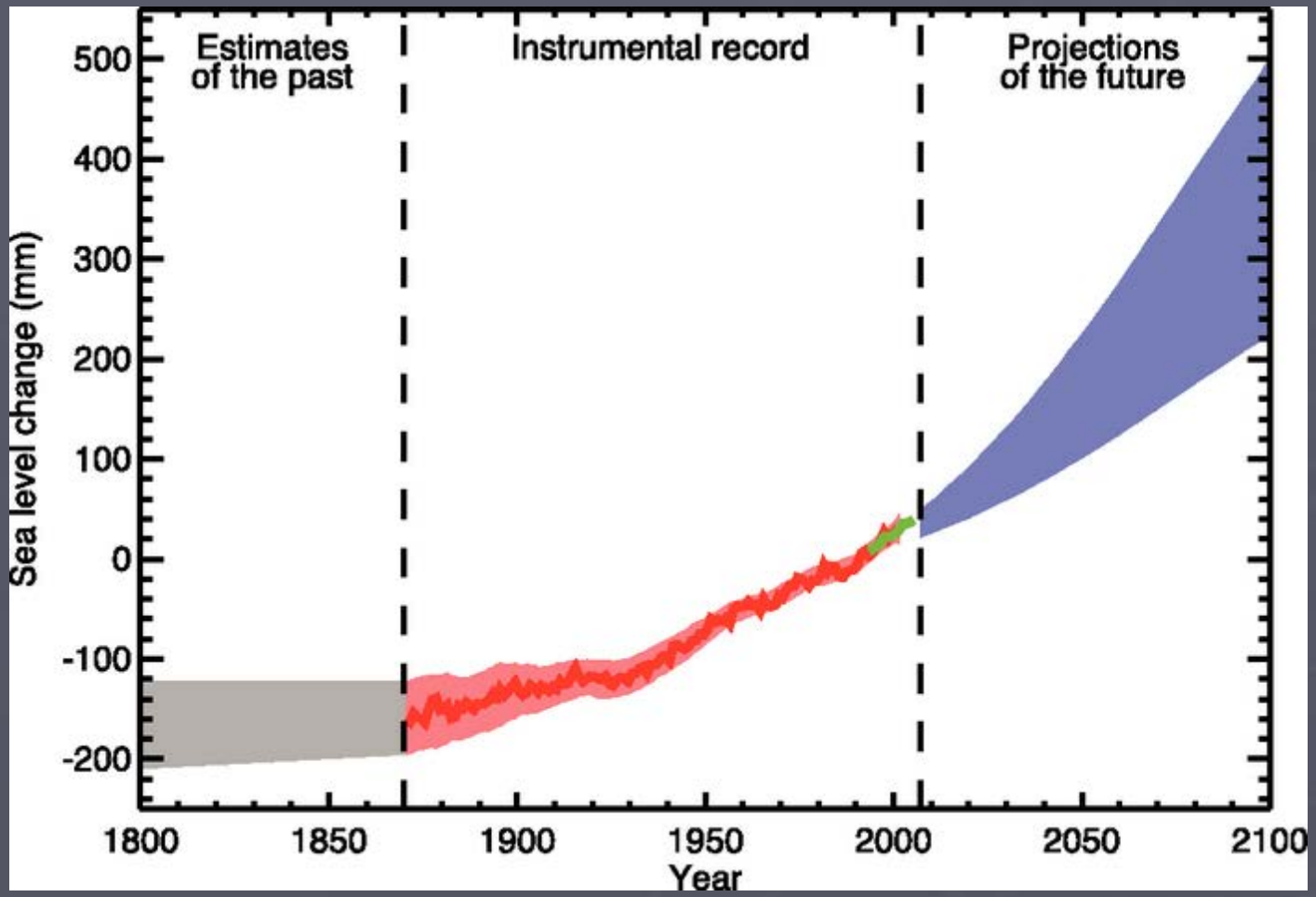
Earth Engine Partners: Global Forest Change

Symptoms of Climate Change



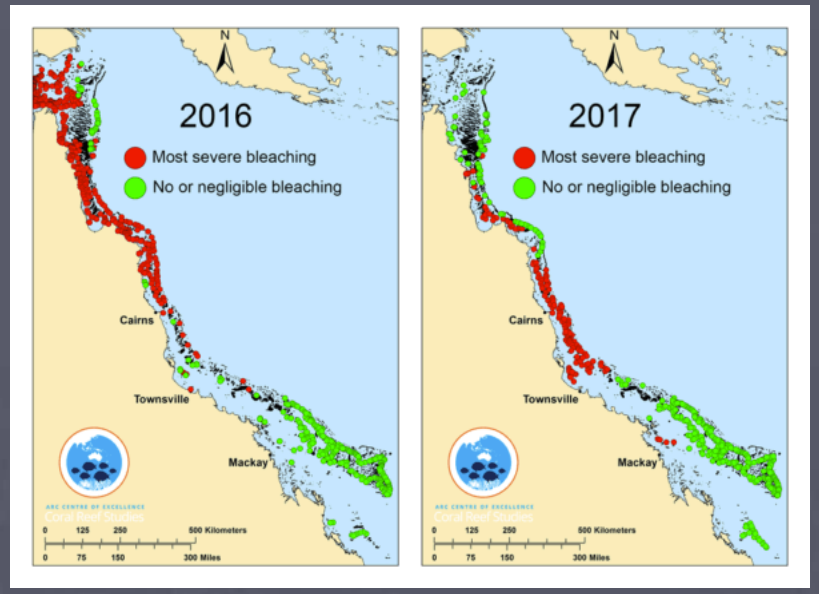
Effects of Climate Change on Sea Level

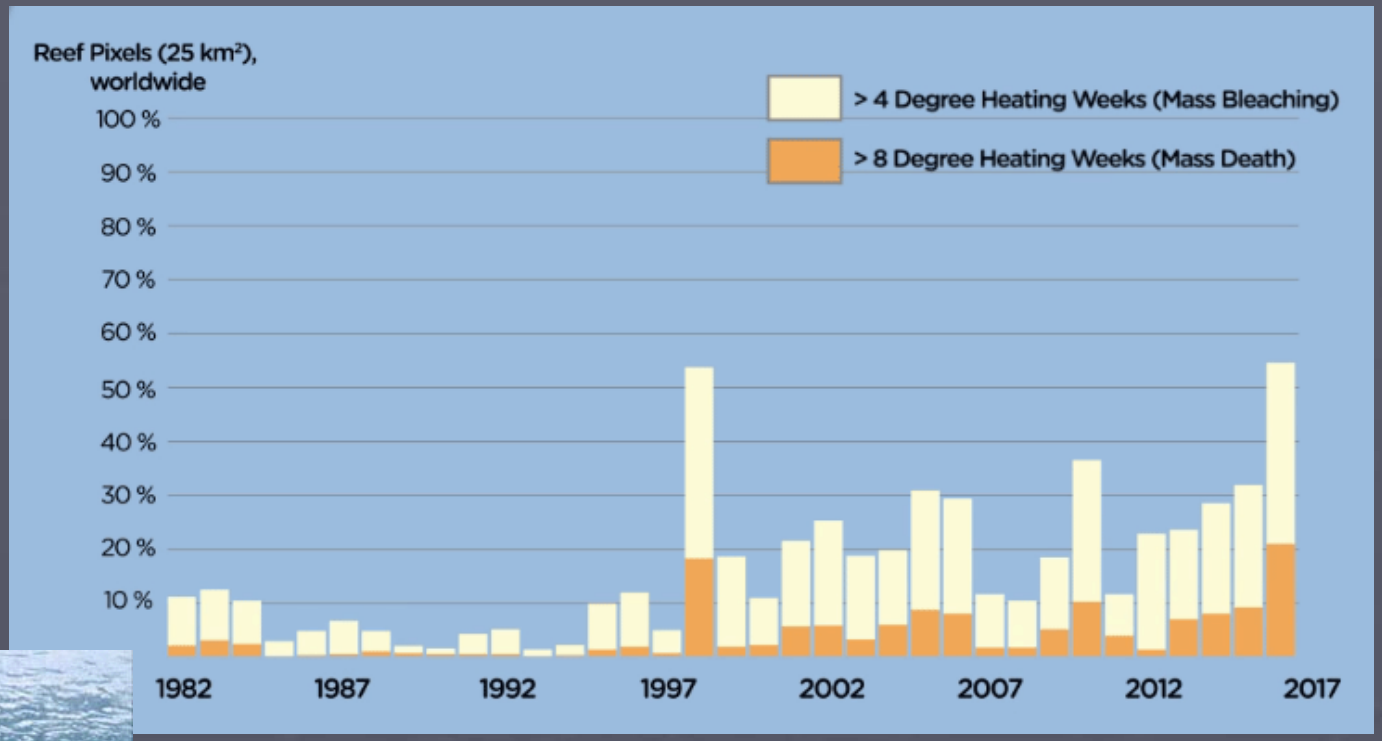
- Sea levels have been steadily rising at a rate of 0.04 to 0.1 inches per year since 1900
- Since 1992, new methods of satellite altimetry indicate a rate of rise of 0.12 inches per year



Case Study: Miami

Coral Bleaching

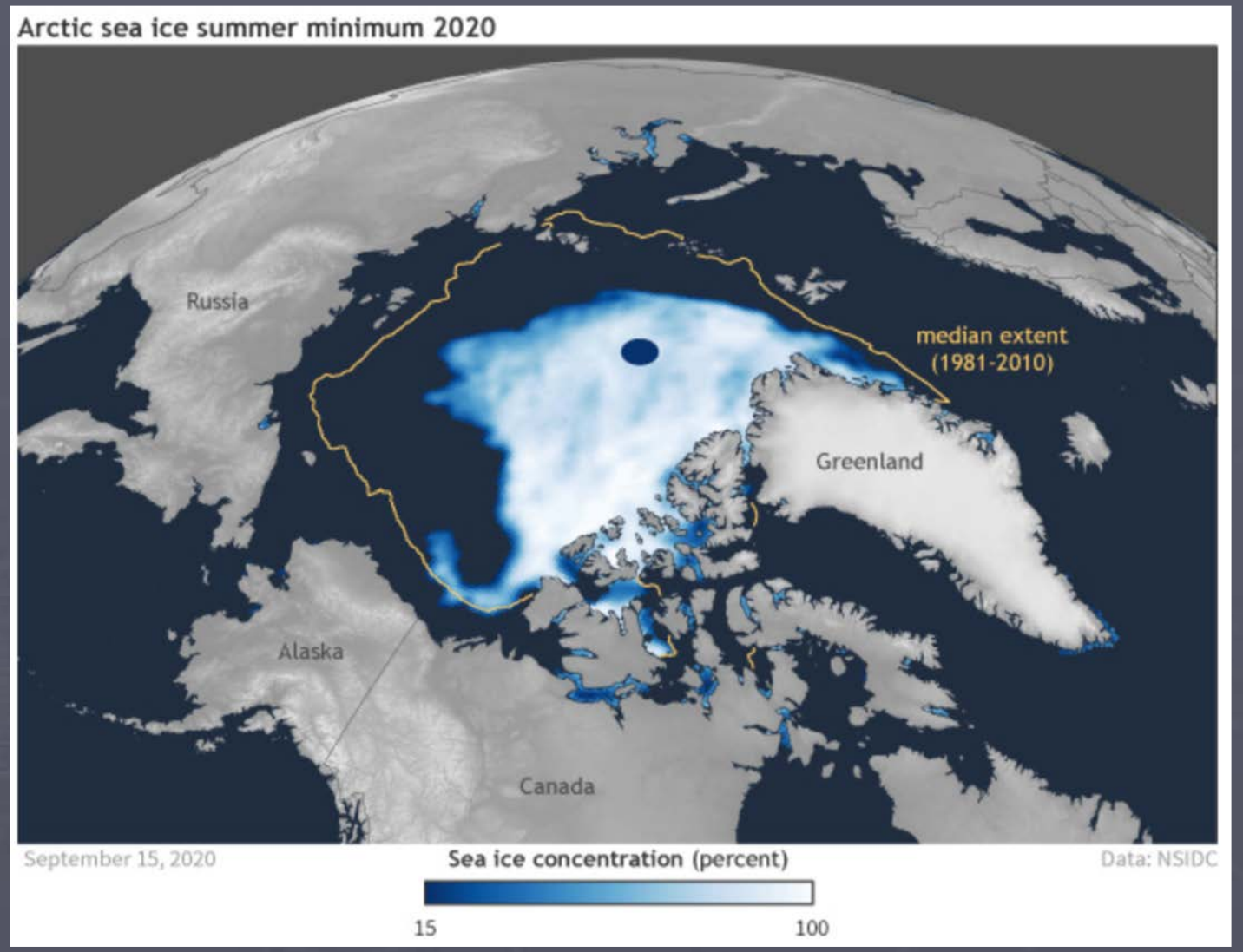




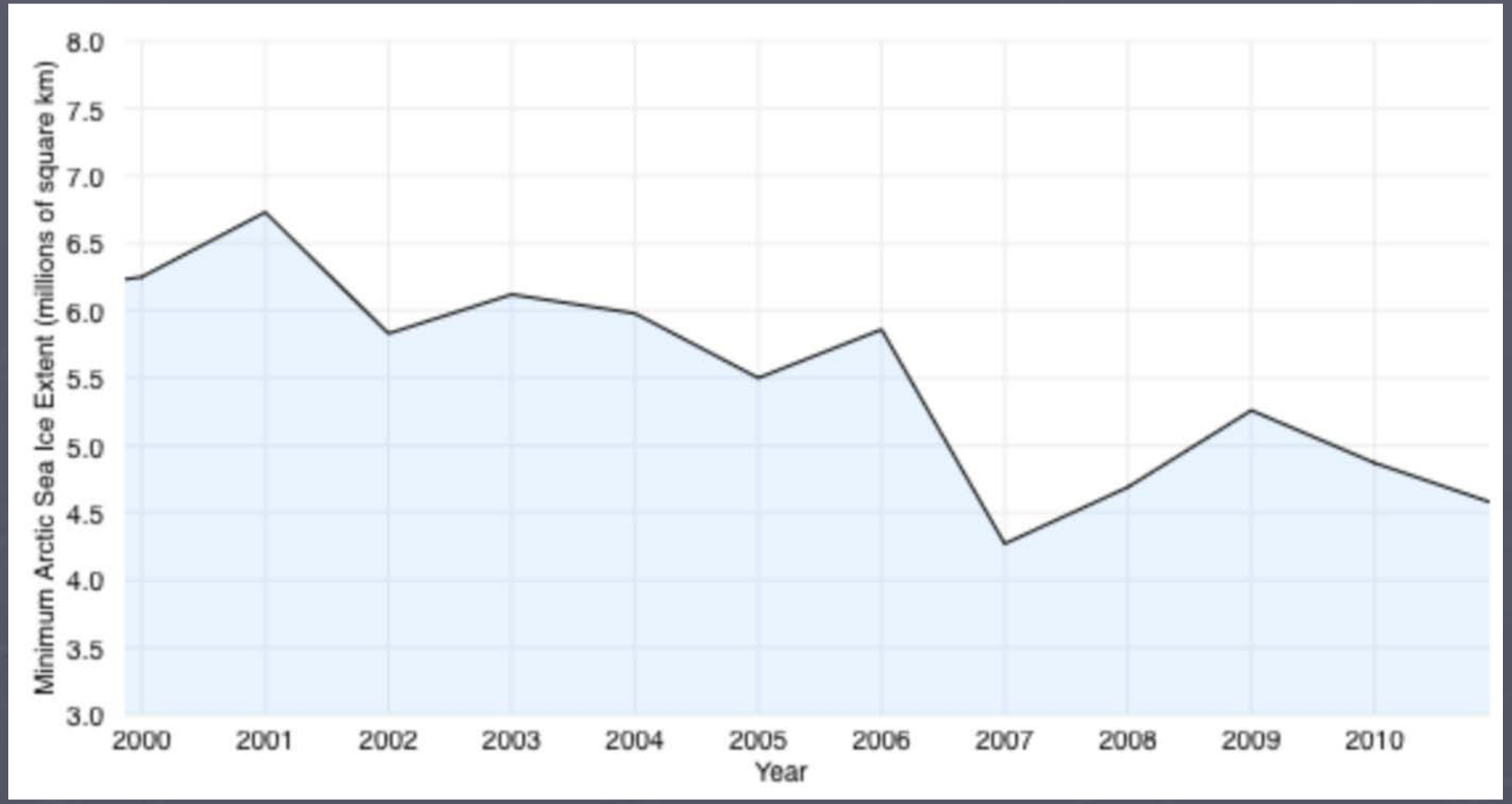
Permafrost Melting

Methane Releases

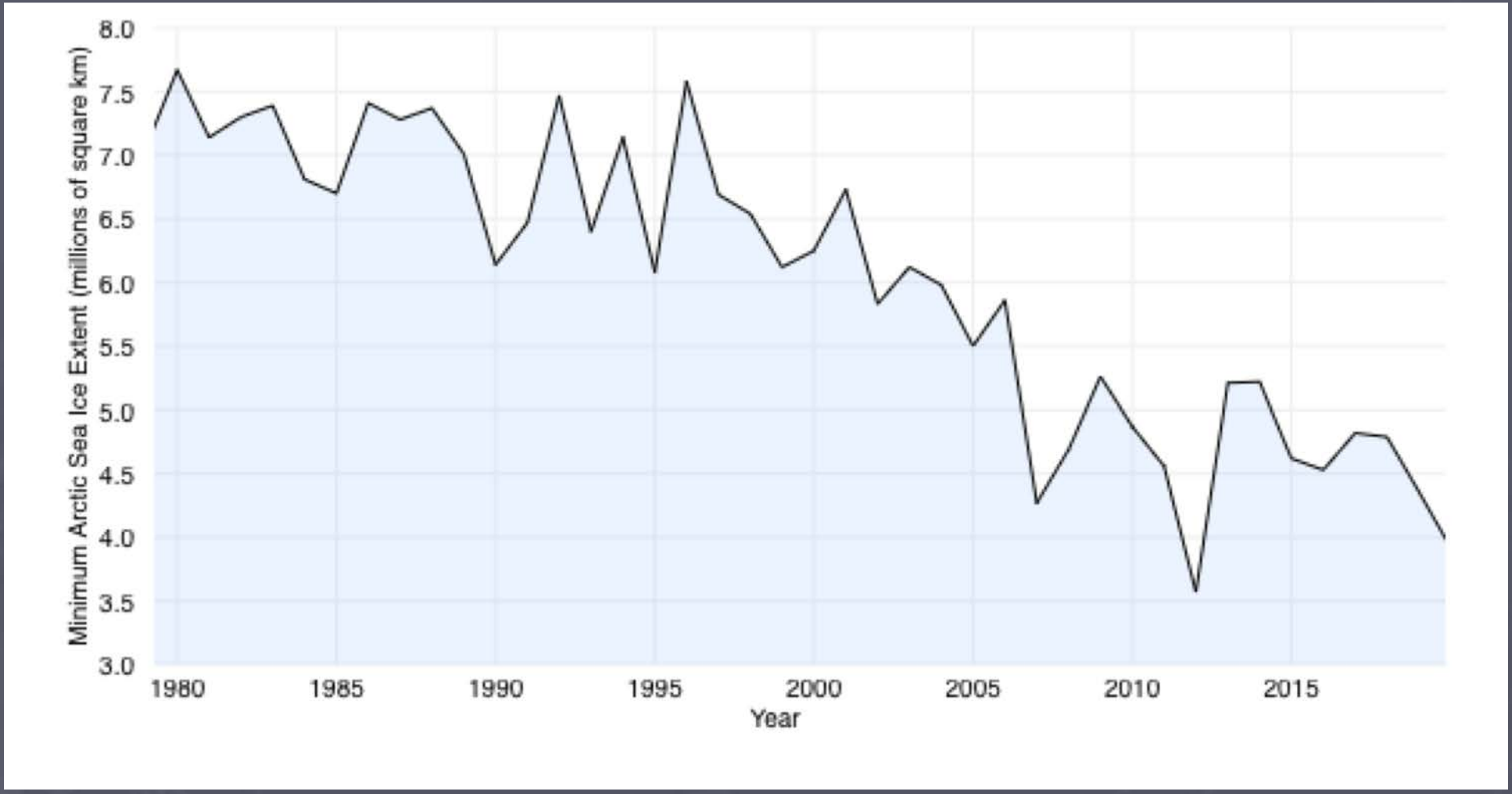
Arctic Sea Ice Decline



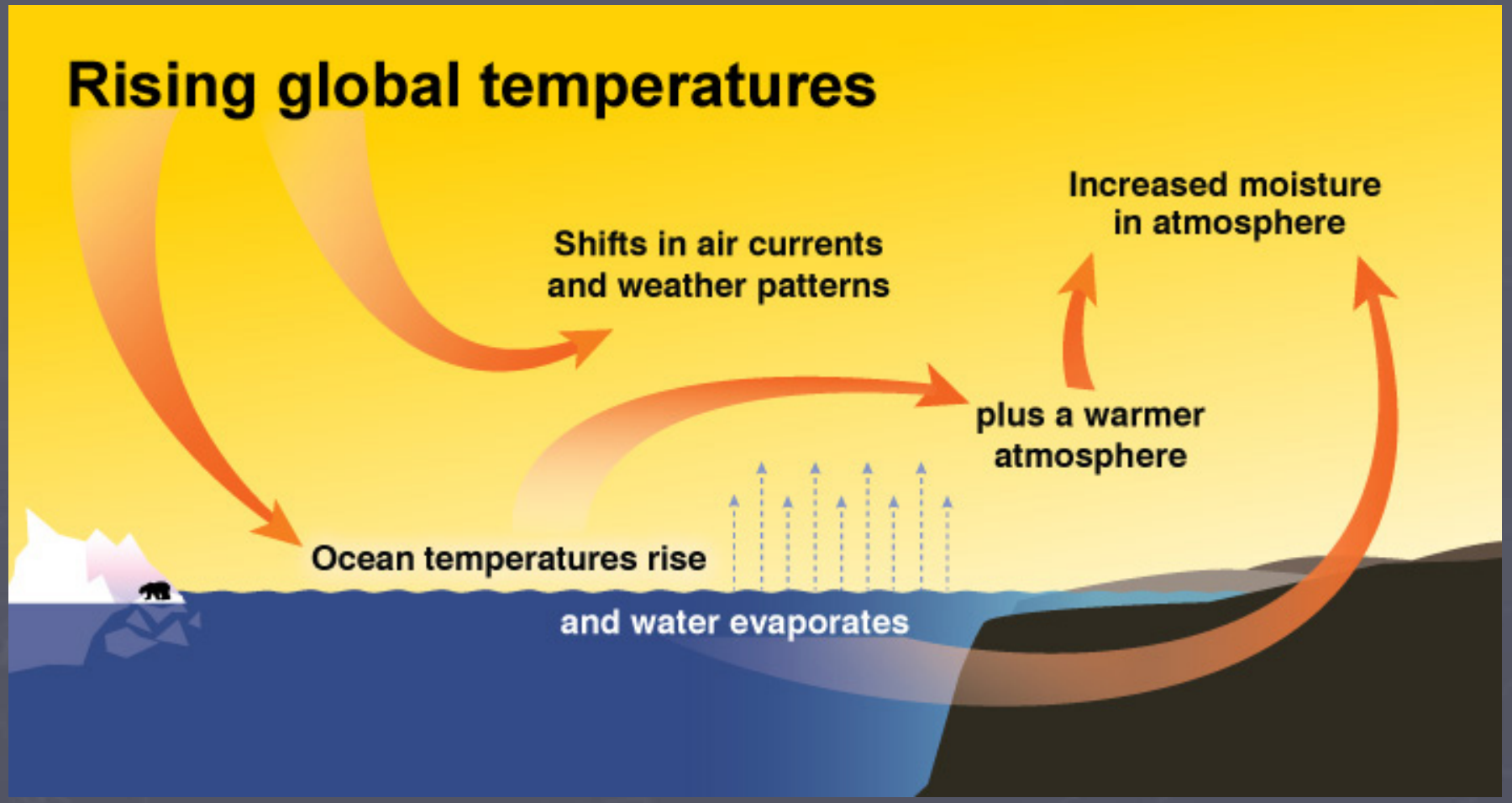
Sea Ice Decline since 2000



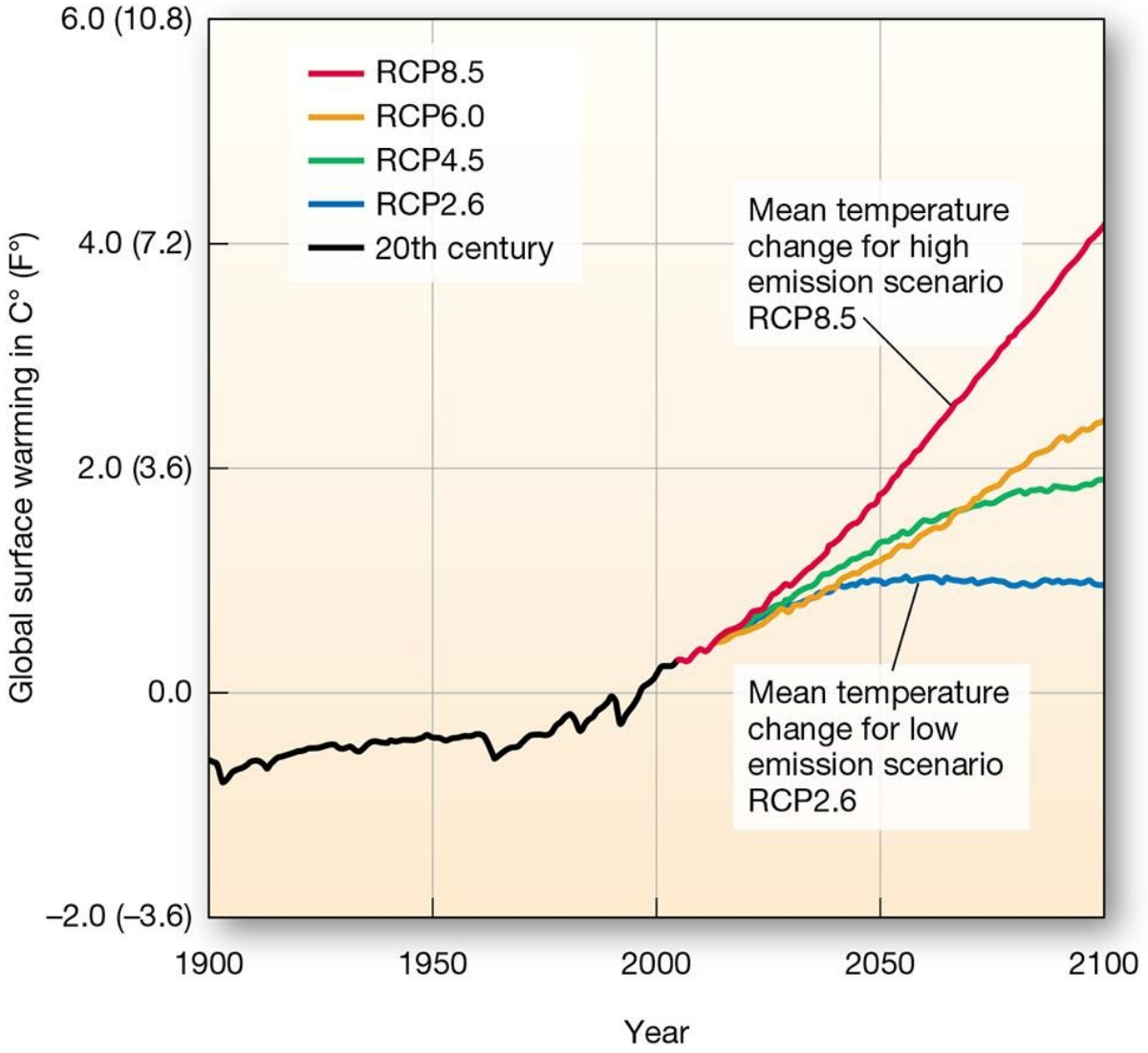
Sea Ice Decline since 1980



Natural Effects: Warmer Temperatures

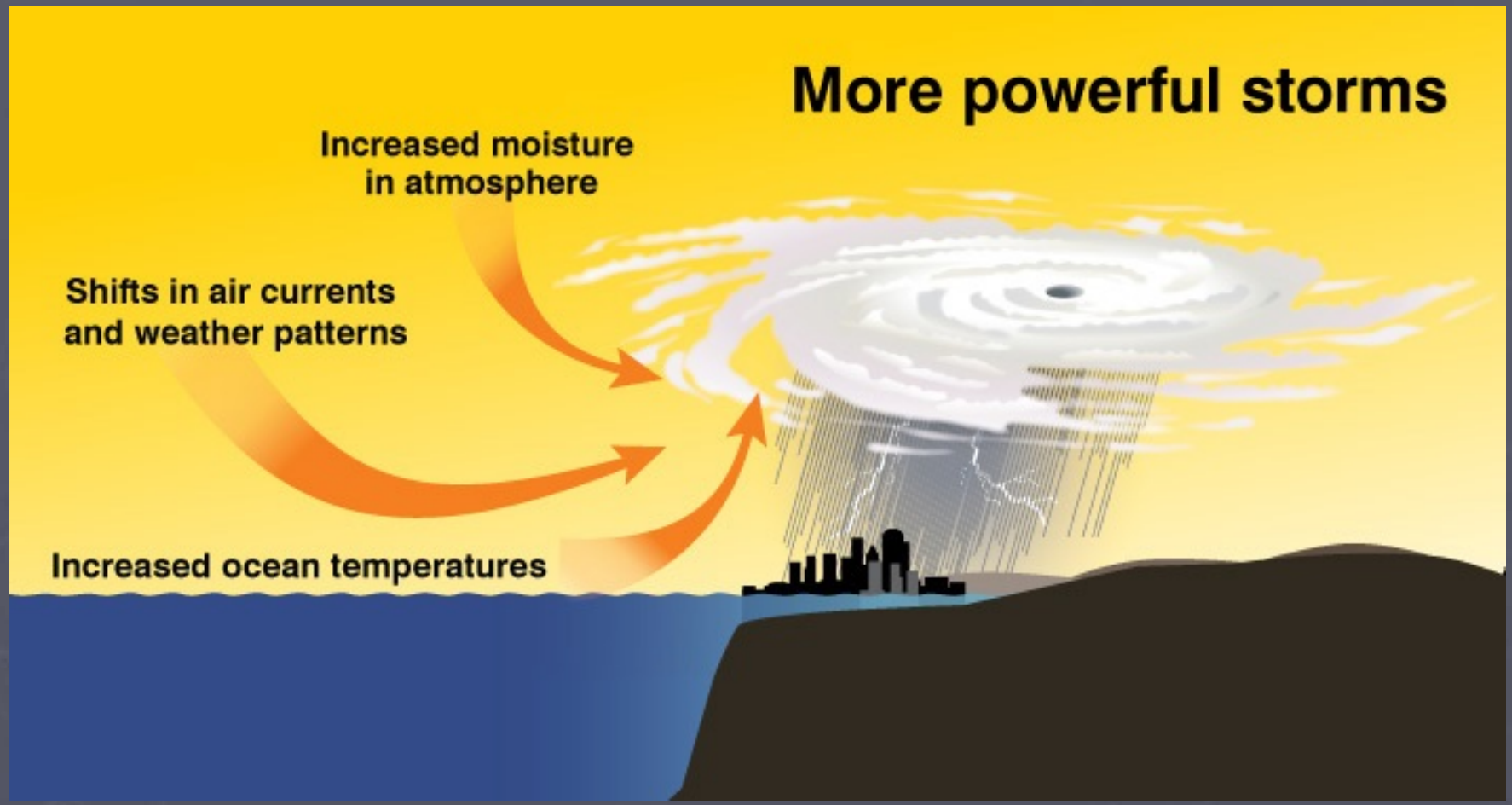


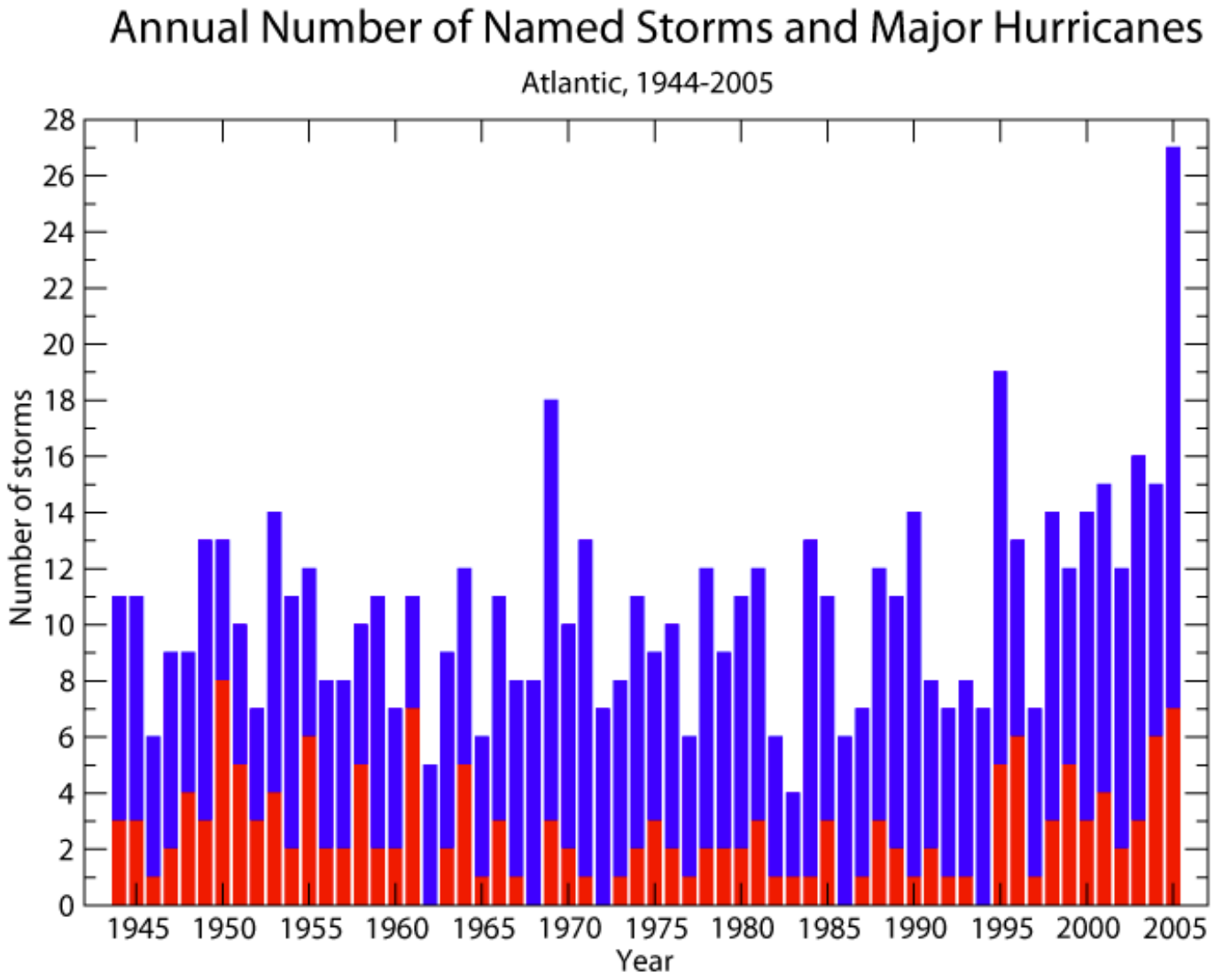
Modeling Warmer Temperatures



(a) Models suggest that the smallest amount of warming corresponds to the lowest CO_2 emissions scenario (RCP2.6). Warming is greatest under the RCP8.5 scenario, with the highest CO_2 emissions and strongest positive radiative forcing of temperature.

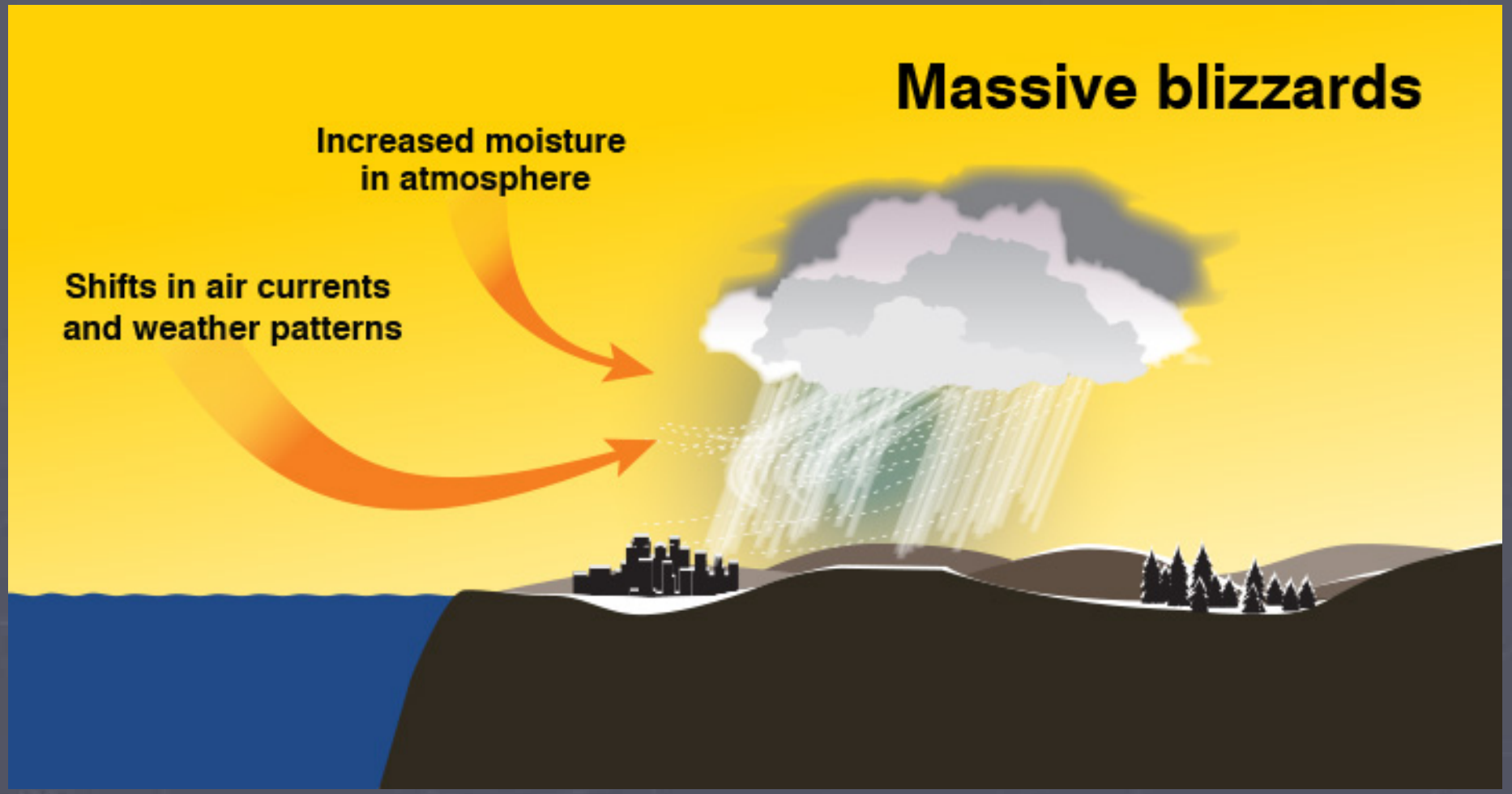
Natural Effects: More Powerful Storms

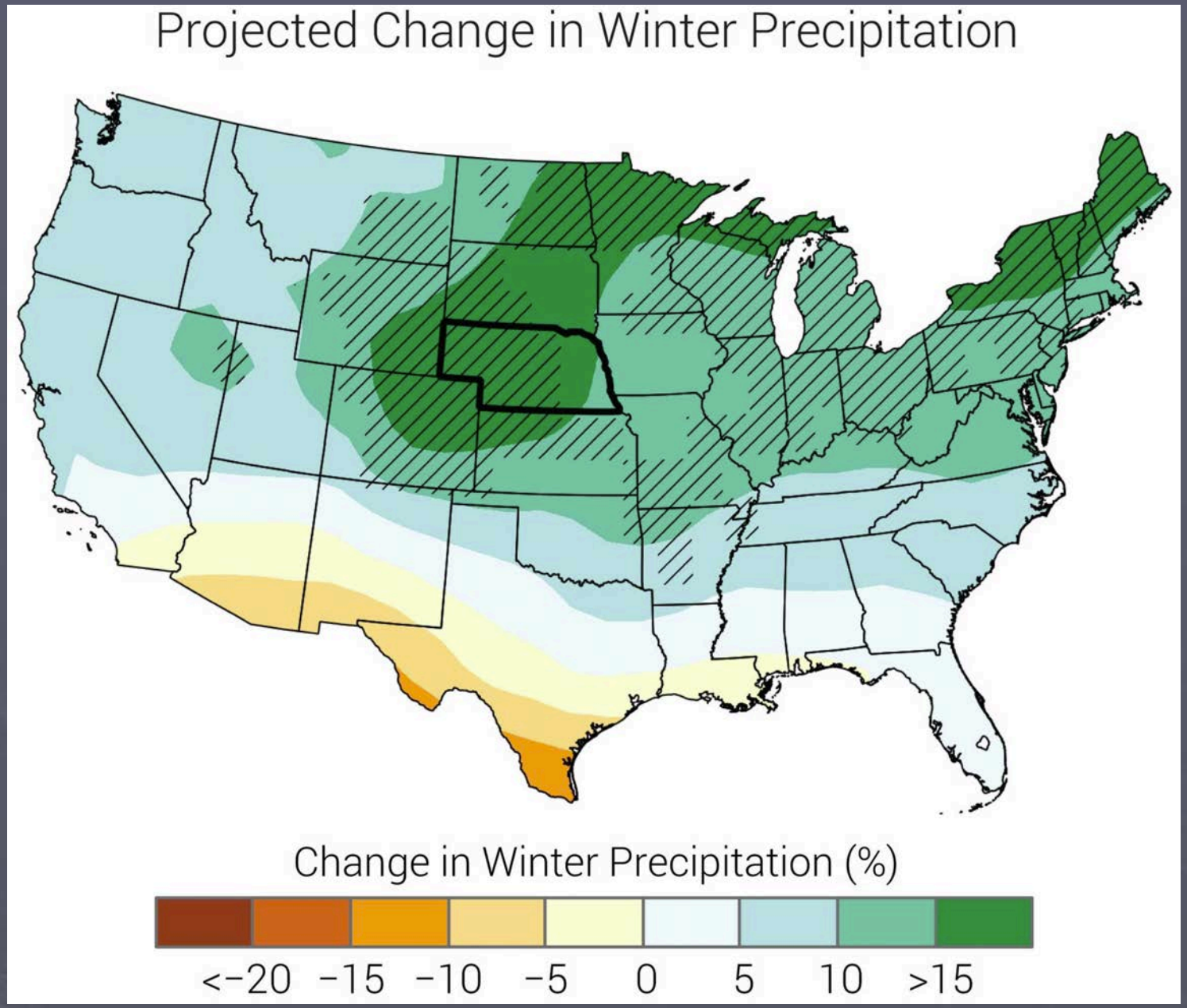



Annual Number of Named Storms and Major Hurricanes
Atlantic, 1944-2005
Number of storms
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

Source: NOAA

Natural Effects: More Blizzards

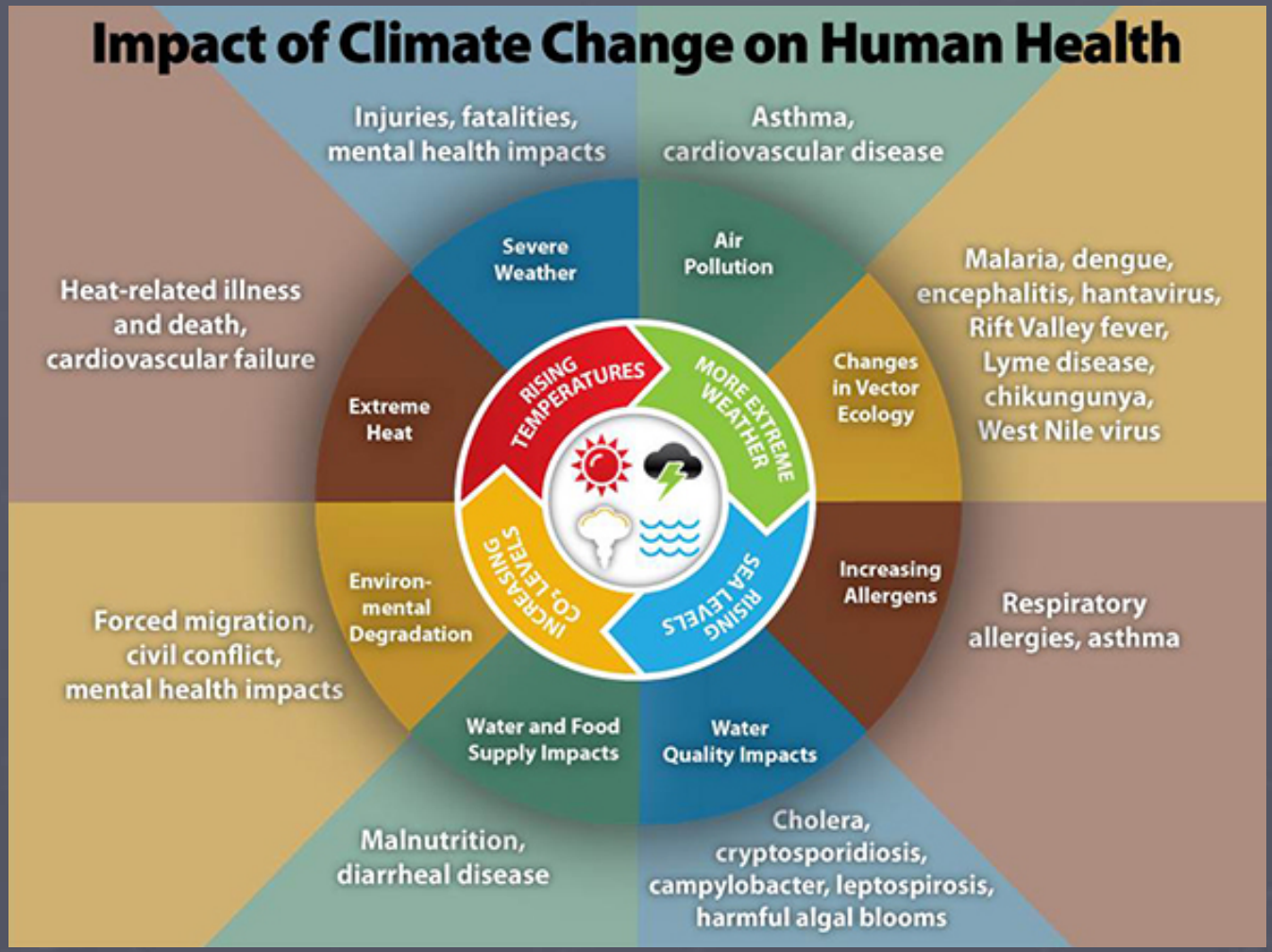




Source: University of Nebraska Lincoln

Human Effects: Health

- Humans are able to adapt to their environment fairly well, but changes in the climate can have many adverse effects on us directly and indirectly



IPCC Projections

Virtually certain (99–100% probability of occurrence)

Cold days and nights will be warmer and less frequent over most land areas.

Hot days and nights will be warmer and more frequent over most land areas.

The extent of permafrost will decline.

Ocean acidification will increase as the atmosphere accumulates CO_2.

Global mean sea level will rise and continue to do so for many centuries.

IPCC Projections

Extremely likely (90–100% probability of occurrence)

Arctic sea ice cover will continue to shrink and thin; Northern Hemisphere spring snow cover will decrease.

The frequency of warm spells and heat waves will increase.

The frequency of heavy precipitation events will increase.

The ocean's conveyer-belt circulation will weaken.

Extreme high sea-level events will increase, as will ocean wave heights of midlatitude storms

Discussion

- What are necessary short term and long-term fixes to address the issues of climate change?
- How are different entities responsible (corporations, organizations, governments, individuals)