Dünya Meteoroloji Örgütü (WMO) ve Birleşmiş Milletler Çevre Programı (UNEP) tarafından ortaklaşa yürütülen Hükümetlerarası İklim Değişikliği Paneli (IPCC)'nin 1996 yılında hazırladığı 2. Değerlendirme Raporu'nda küresel iklim değişikliğinin tanımı, *"Karşılaştırılabilir bir zaman diliminde gözlenen doğal iklim değişkenlikleri ile küresel atmosferin doğal yapısını doğrudan ya da dolaylı biçimde bozan insan etkinlikleri sonucunda iklimde oluşan değişikliklerin bütünü"* biçiminde yapılmıştır **(IPCC 1996).**

İklim değişimi =f(Jeolojik süreçler, Güneş aktivitesi, Yörünge, Ayresol, Atmosferik değişim)

Jeoloji

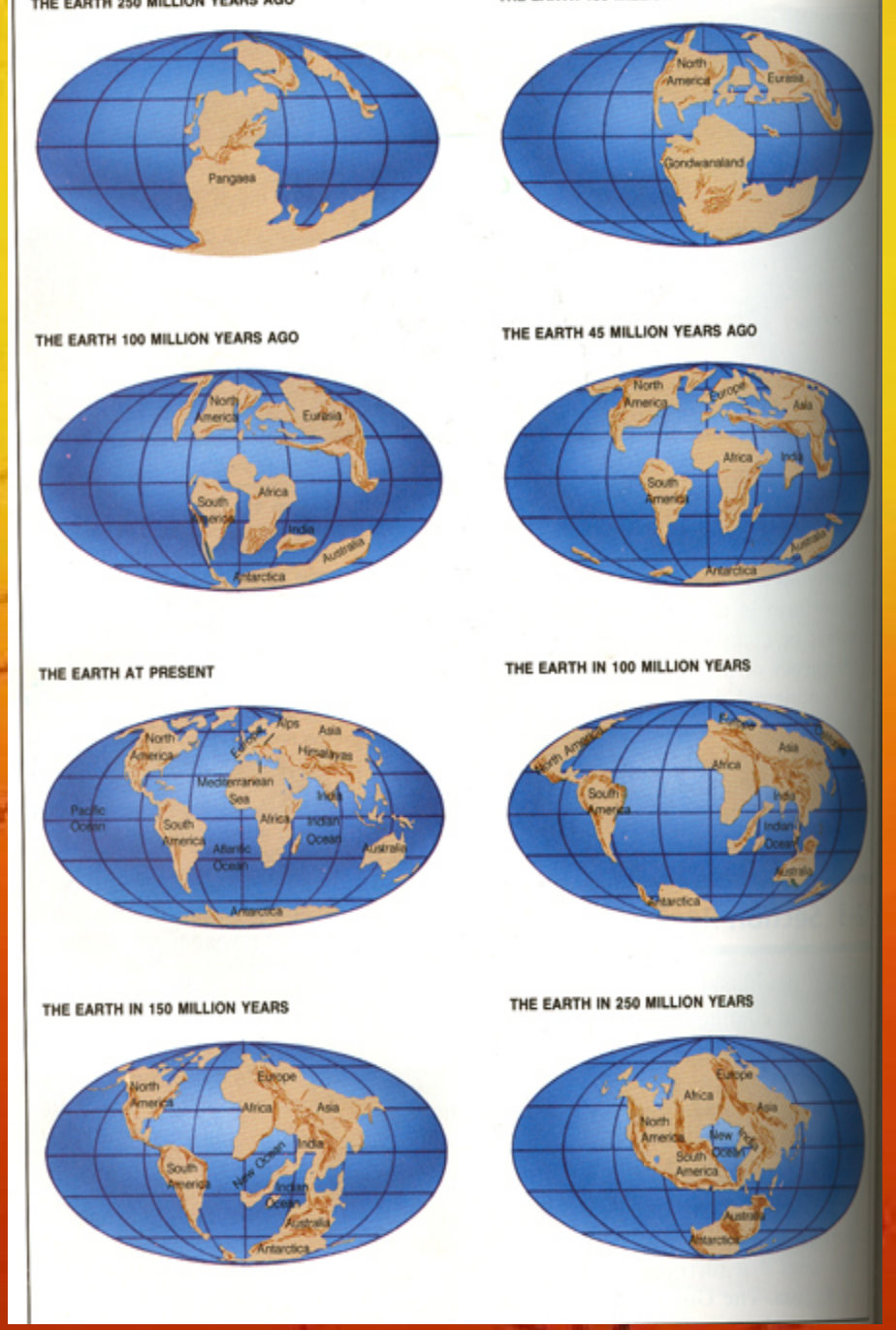
Permian Period
225 million years ago

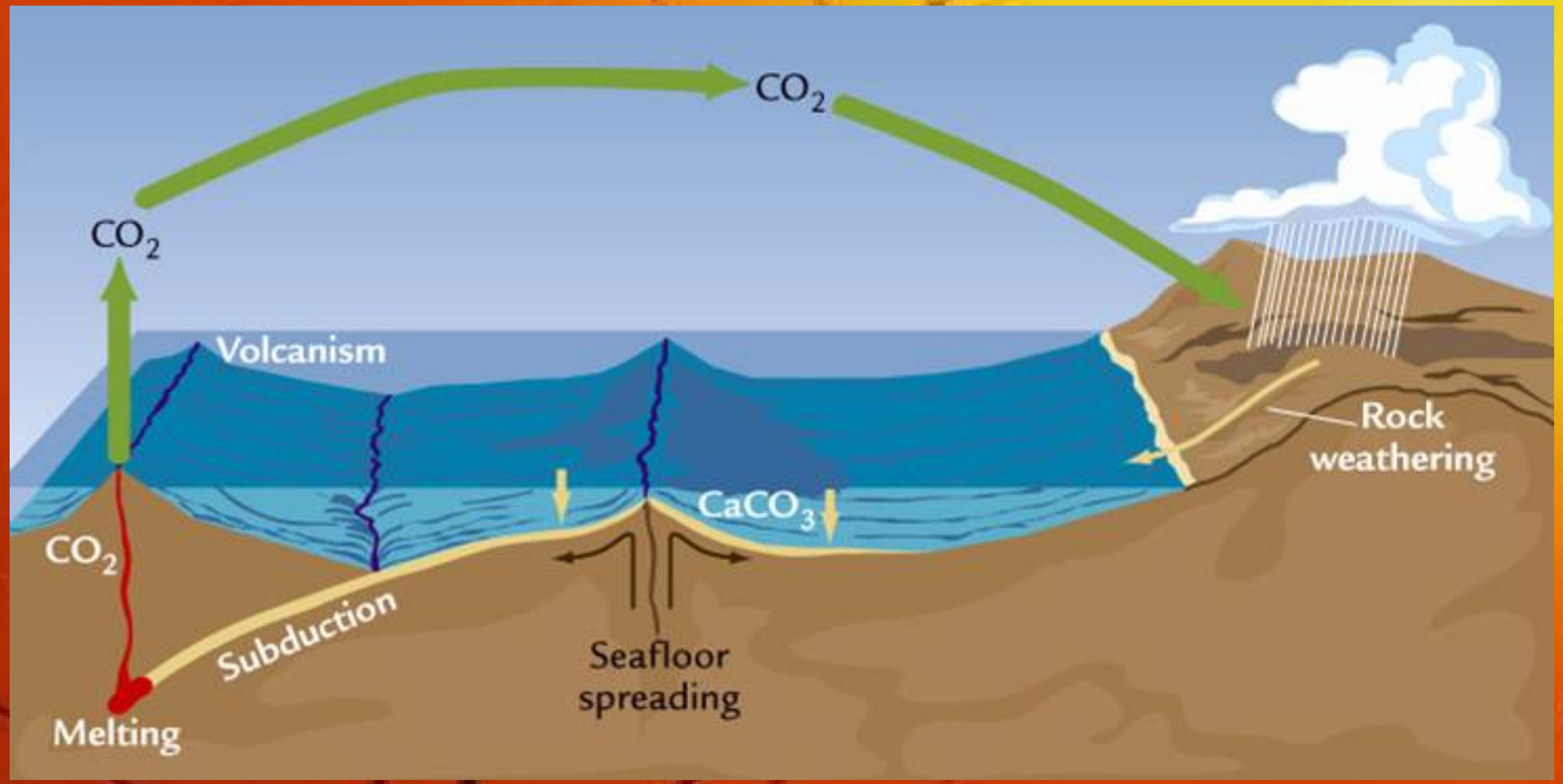
Triassic Period
200 million years ago

Jurassic Period
135 million years ago

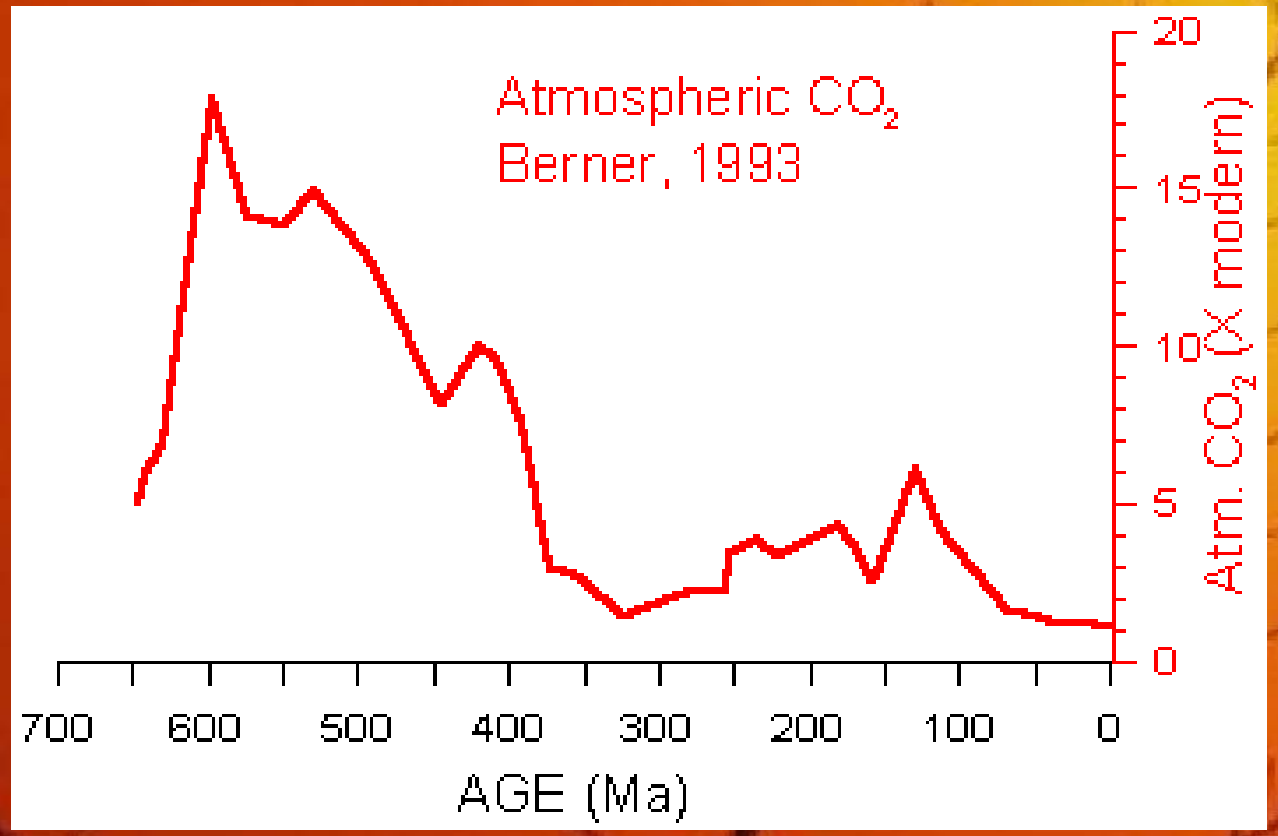
Cretaceous Period
65 million years ago

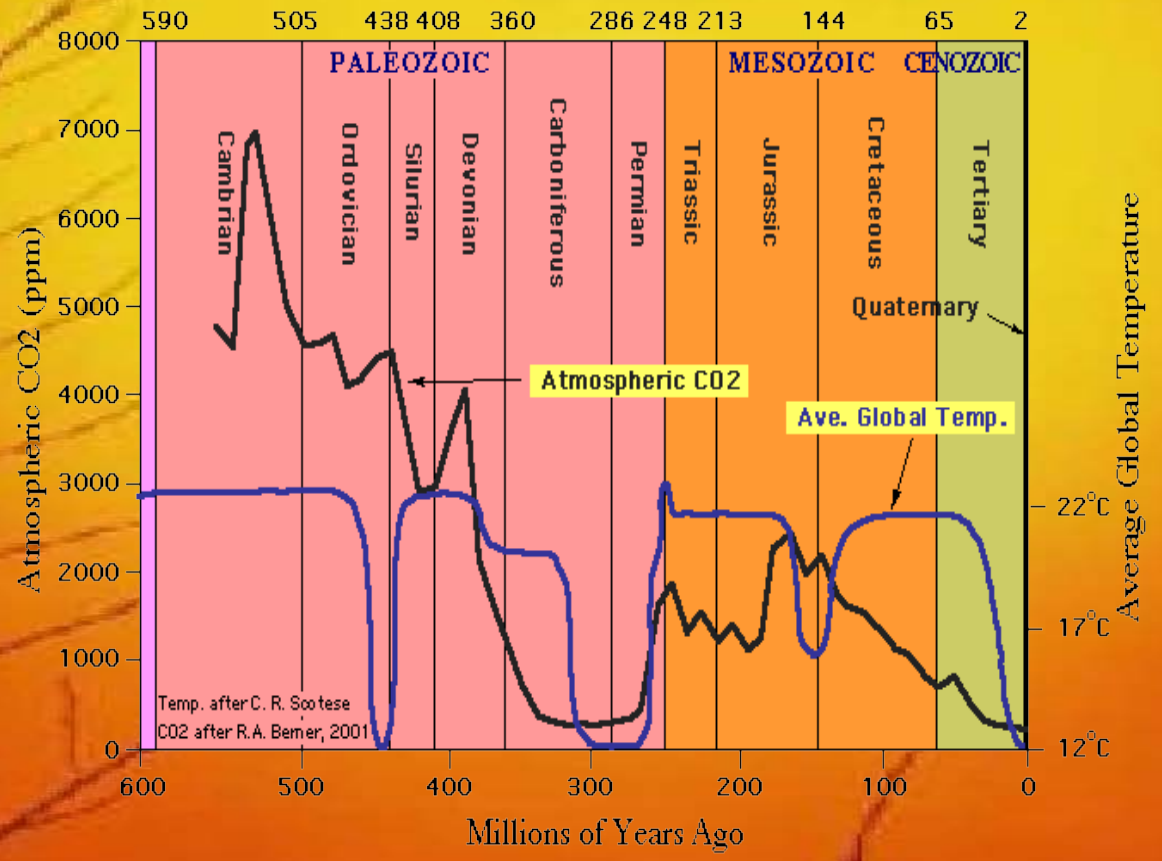
Present Day




CO_2
CO_2
Volcanism
Rock
weathering
$CaCO_3$
CO_2
Subduction
Seafloor
spreading
Melting

Jeolojik süreçler



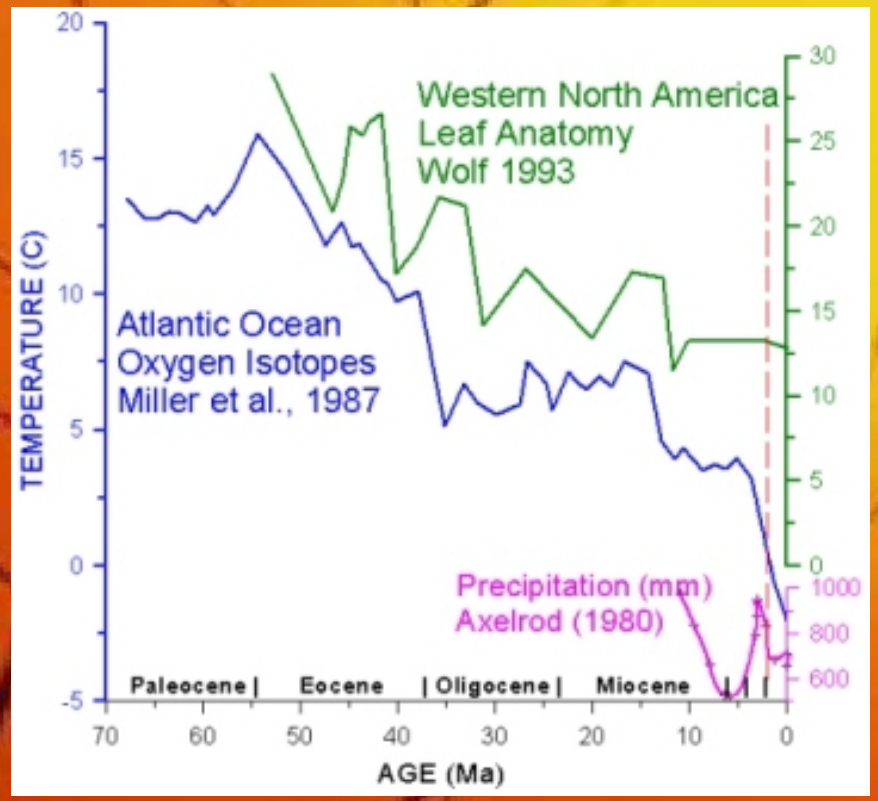


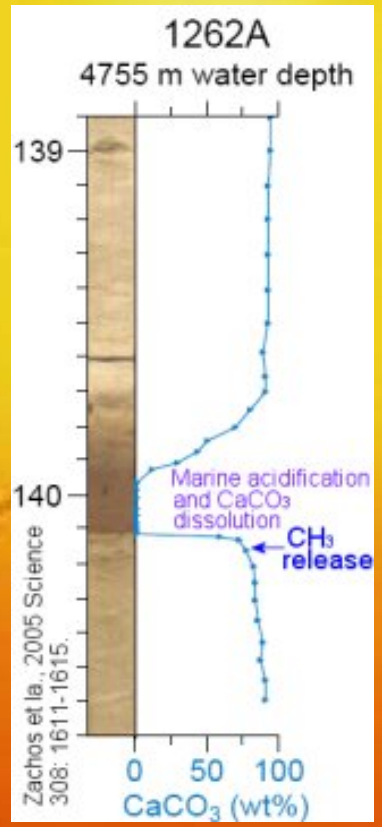
Genel olarak sıcak iklim koşullarının görüldüğü Kretase'de hızlı deniz tabanı yayılması, azalan karbonat birikimi ve artan atmosferik CO_2 belirgindir.(Berner et al. 1983)

Paleosen-Eosen termal maksimumu

8-10 °C sıcak
CO_2 8 x modern (2600 ppmv)

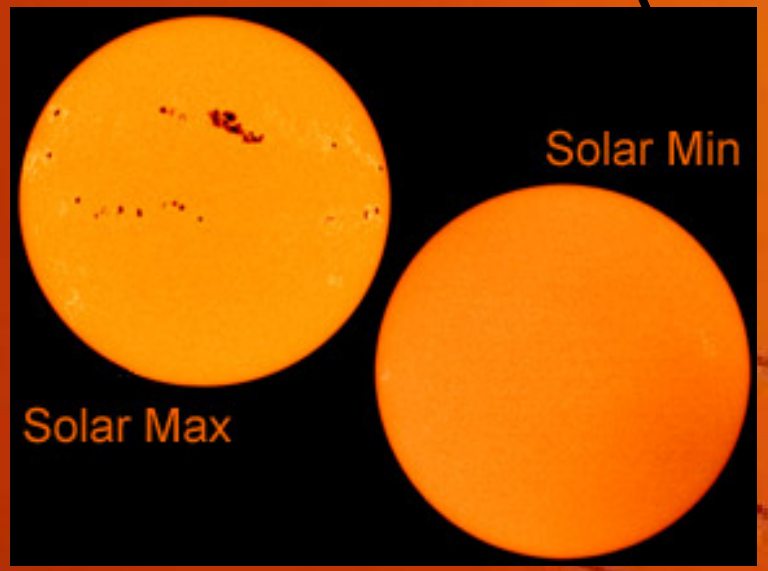
(Zachos et al., 2004)

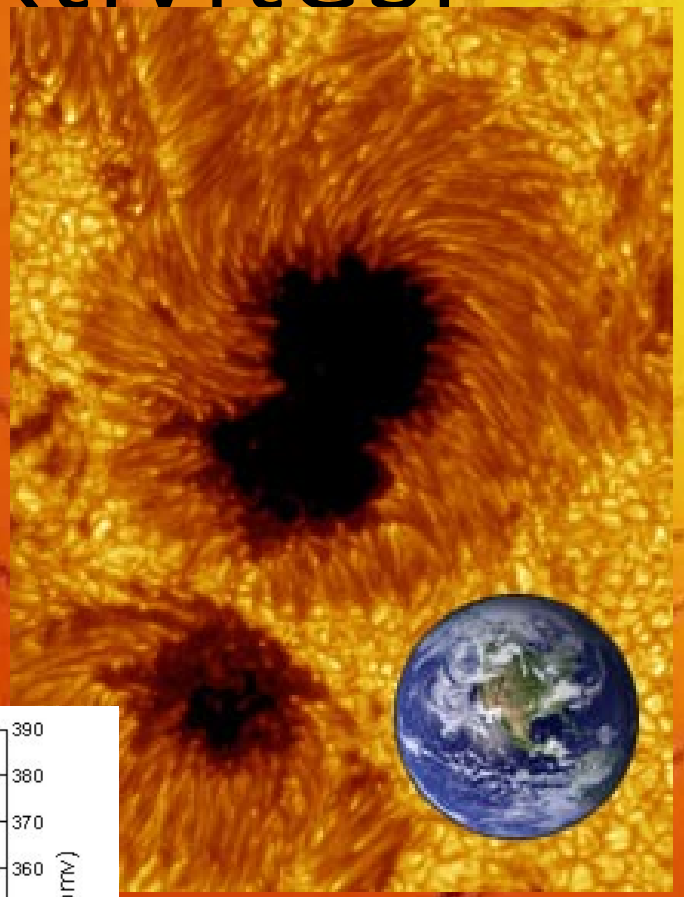


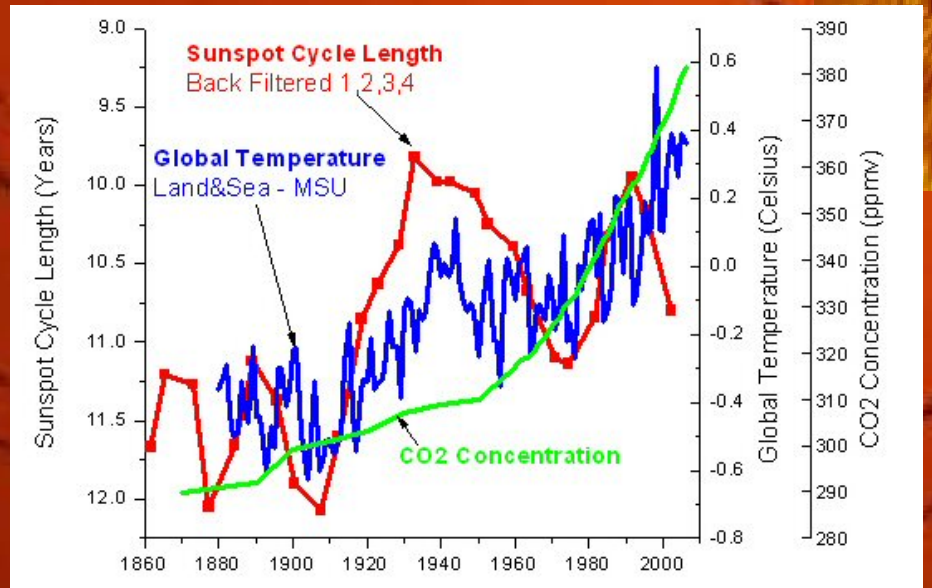


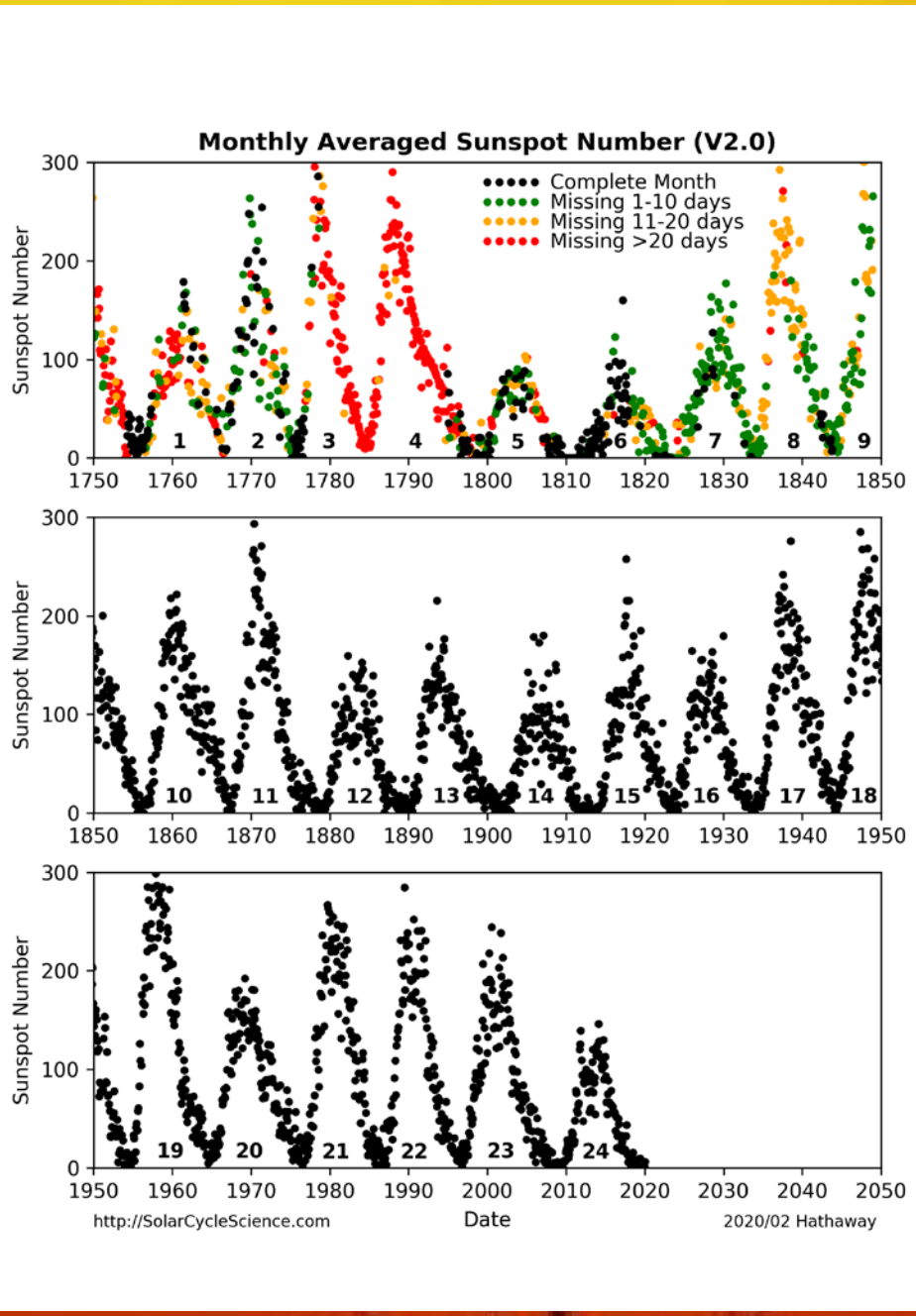
1200 2500 Gt CH_4 derin okyanıs tabanından ayrışıp patlaması. (Dickens et al., 1995, 1997) Hidrotermal olaylarla tetiklenip Kuzey Denizi tabanından ayrılma (Svensen et al., 2004) ption of CH_4 absorblanması sonucunda denizin asidik özellik kazanıp okyanuslardaki karbonatları çözüp atmosfere fazladan 2000 Gt CO_2 atmosfere eklendi..

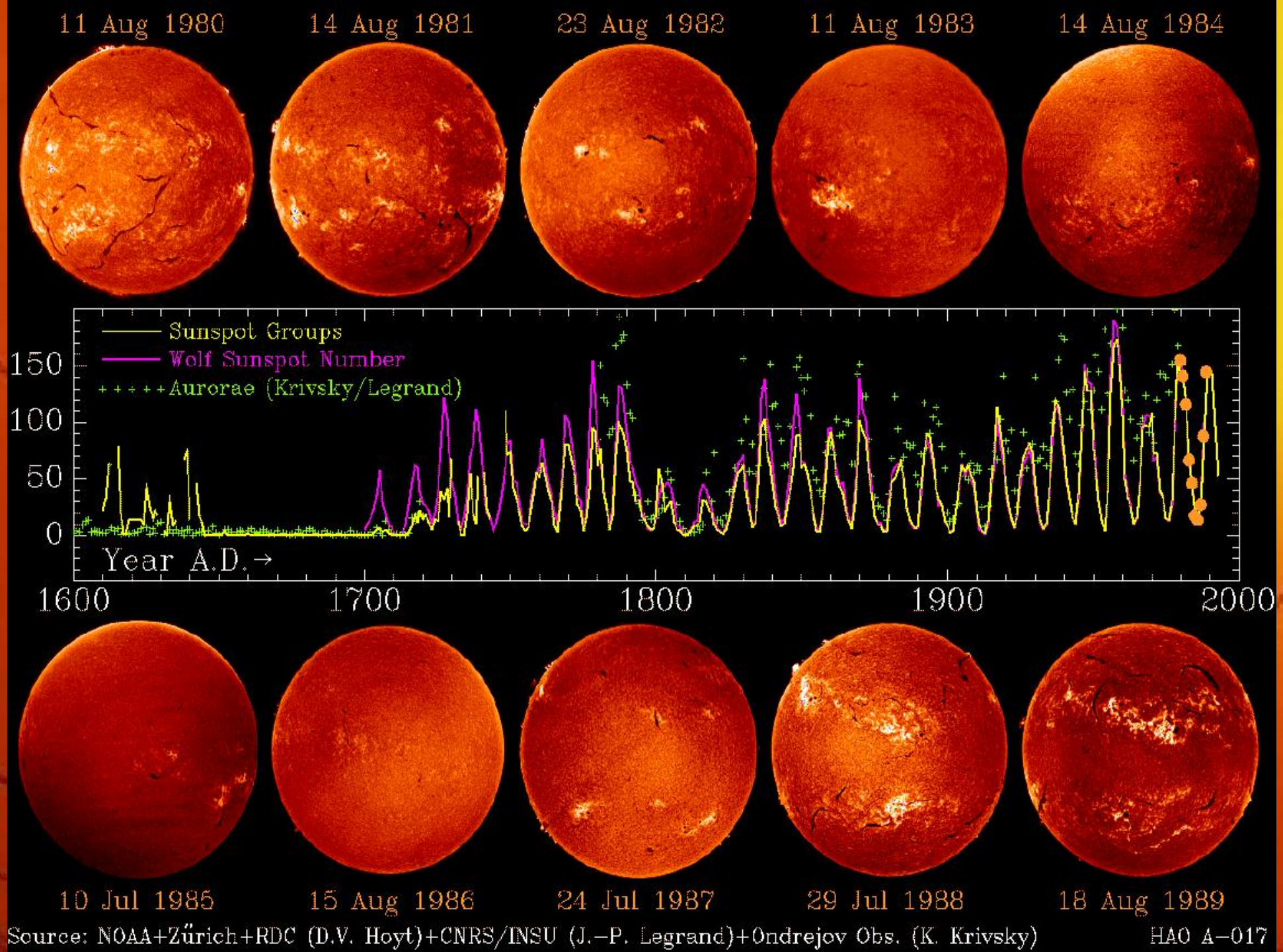
Güneş aktivitesi



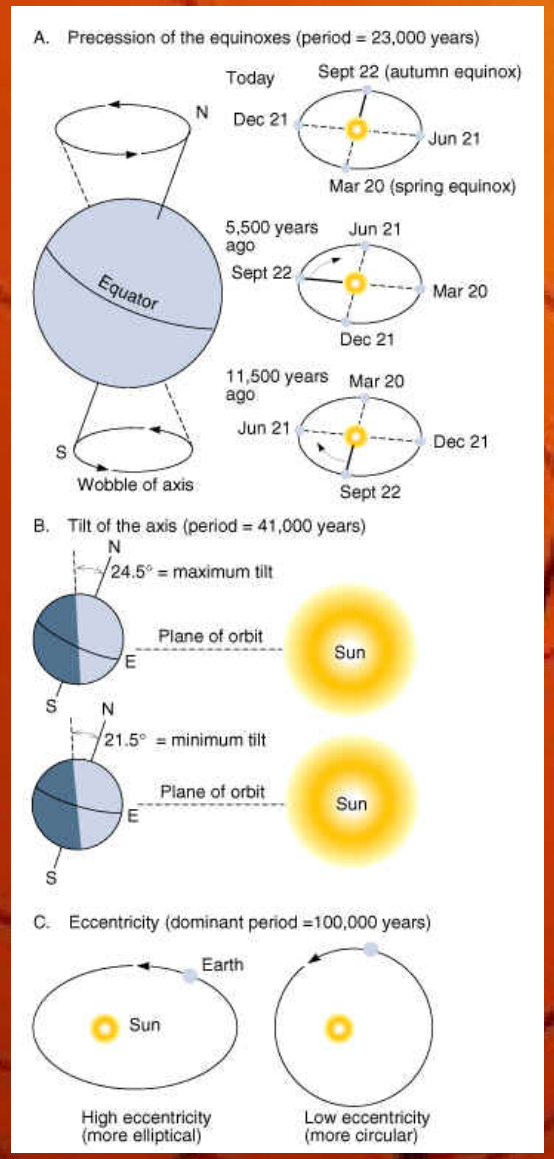


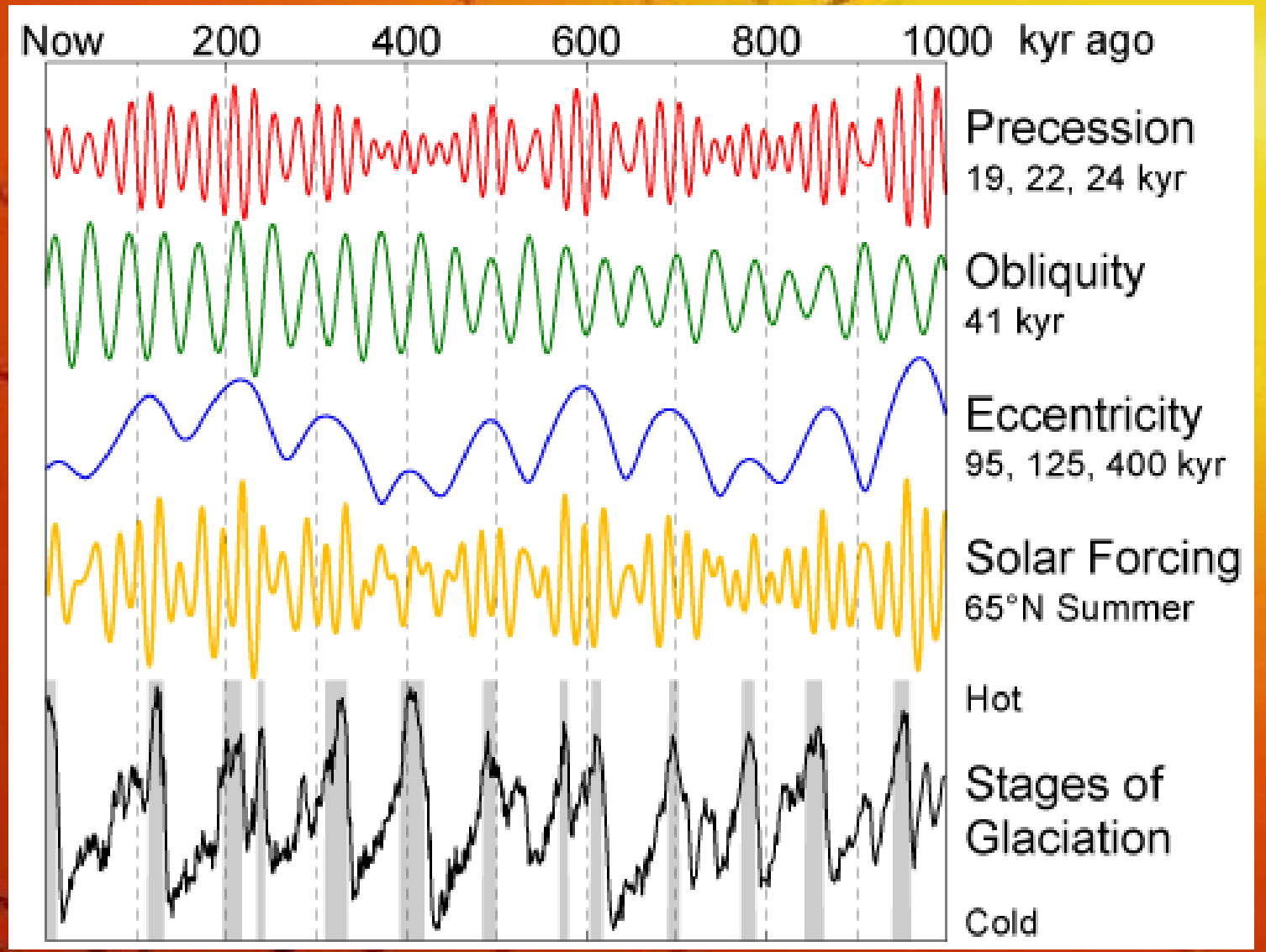




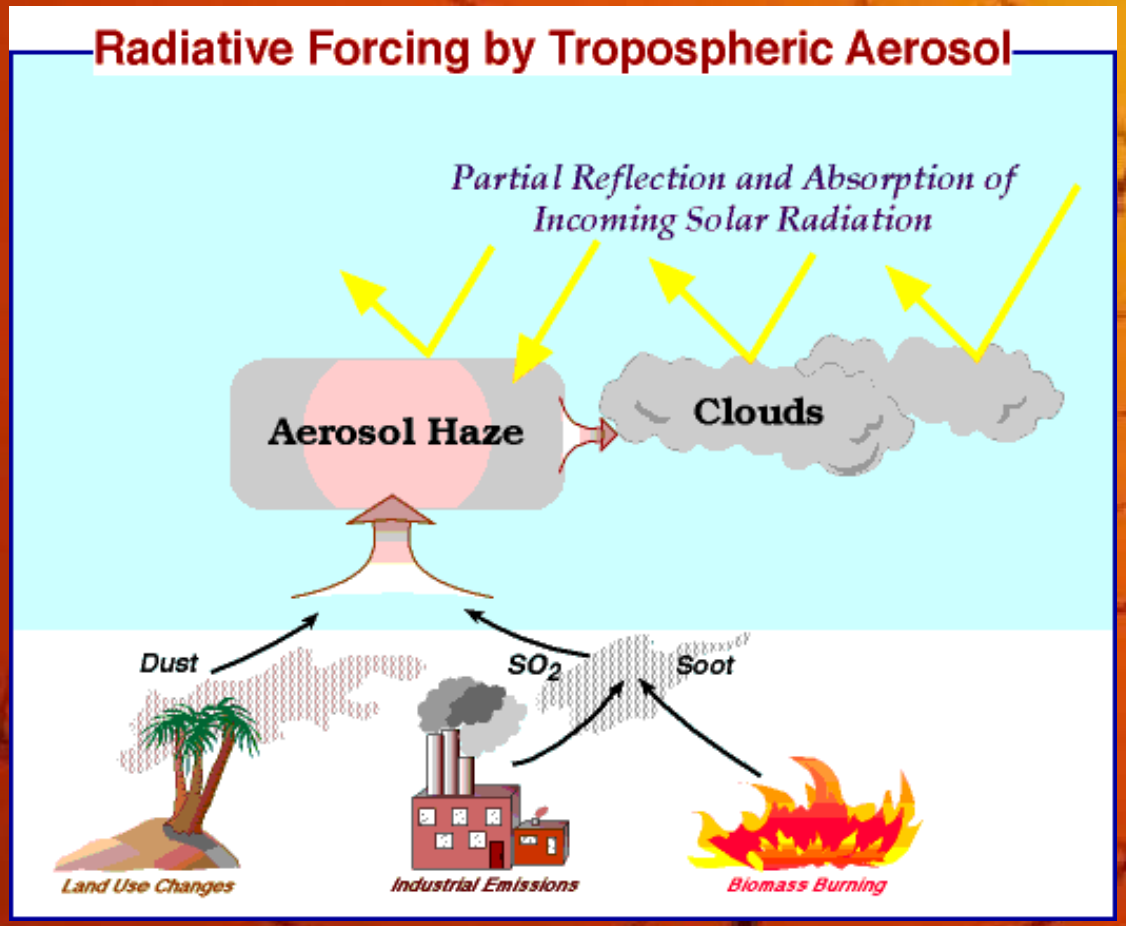

11 Aug 1980
14 Aug 1981
23 Aug 1982
11 Aug 1983
14 Aug 1984
Sunspot Groups
Wolf Sunspot Number
+ + + + + Aurorae (Krivsky/Legrand)
150
100
50
0
Year A.D.→
1600
1700
1800
1900
2000
10 Jul 1985
15 Aug 1986
24 Jul 1987
29 Jul 1988
18 Aug 1989
Source: NOAA+Zürich+RDC (D.V. Hoyt)+CNRS/INSU (J.-P. Legrand)+Ondrejov Obs. (K. Krivsky)
HAO A-017

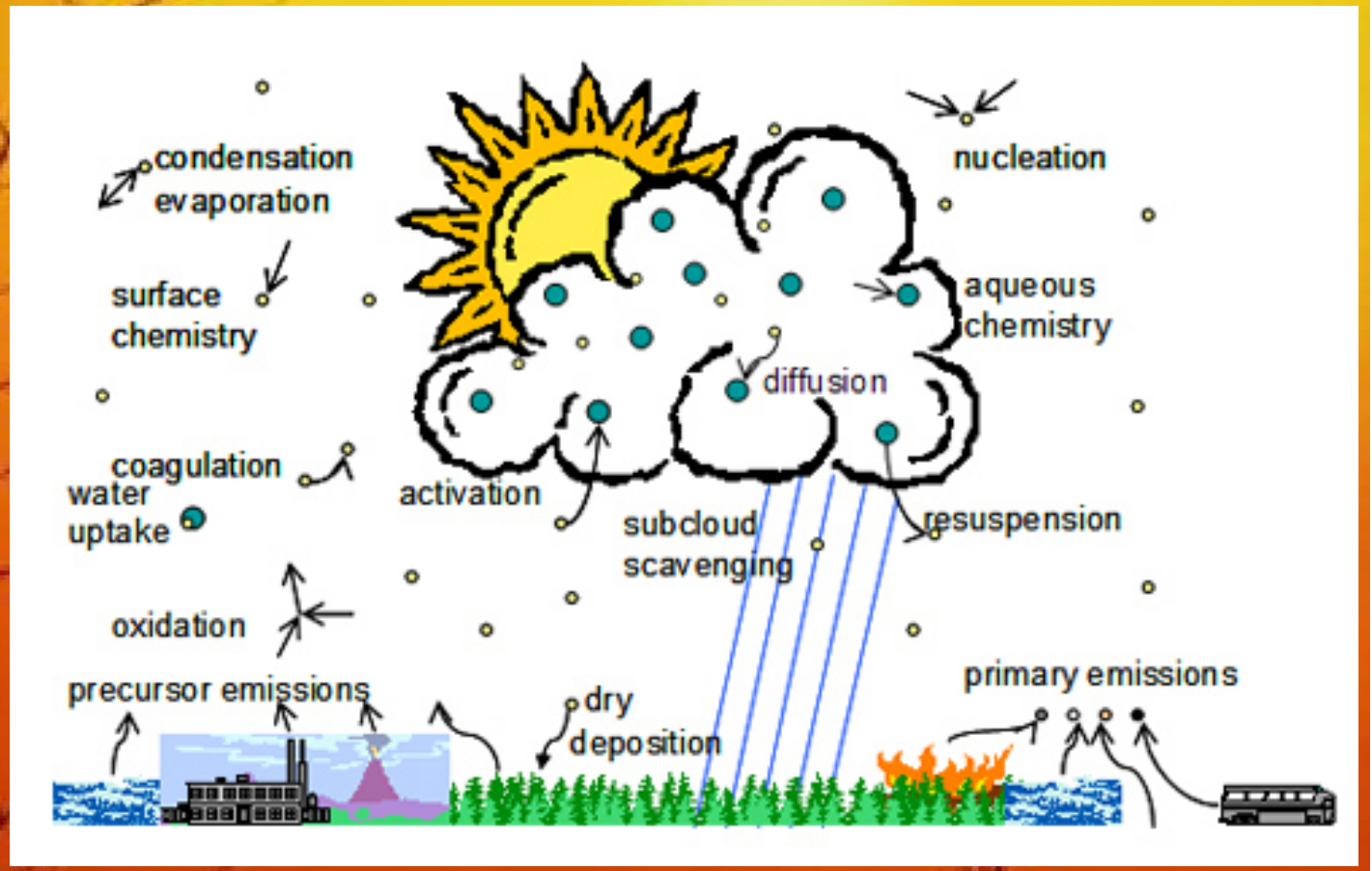
Yörünge

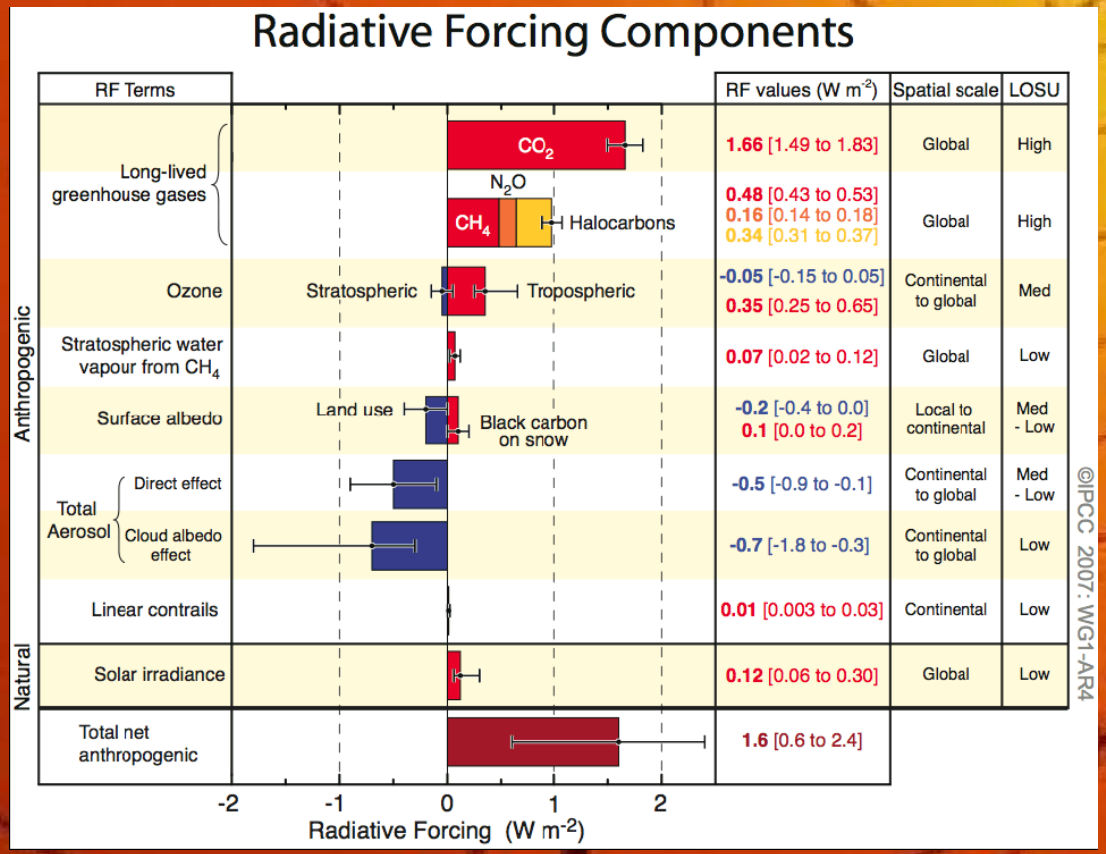

A. Precession of the equinoxes (period = 23,000 years)
Today
Sept 22 (autumn equinox)
N
Dec 21
Jun 21
Mar 20 (spring equinox)
5,500 years ago
Jun 21
Sept 22
Mar 20
Dec 21
Equator
11,500 years ago
Mar 20
Jun 21
Dec 21
Sept 22
S
Wobble of axis
B. Tilt of the axis (period = 41,000 years)
N
24.5° = maximum tilt
Plane of orbit
Sun
E
S
N
21.5° = minimum tilt
Plane of orbit
Sun
E
S
C. Eccentricity (dominant period =100,000 years)
Earth
Sun
High eccentricity (more elliptical)
Low eccentricity (more circular)

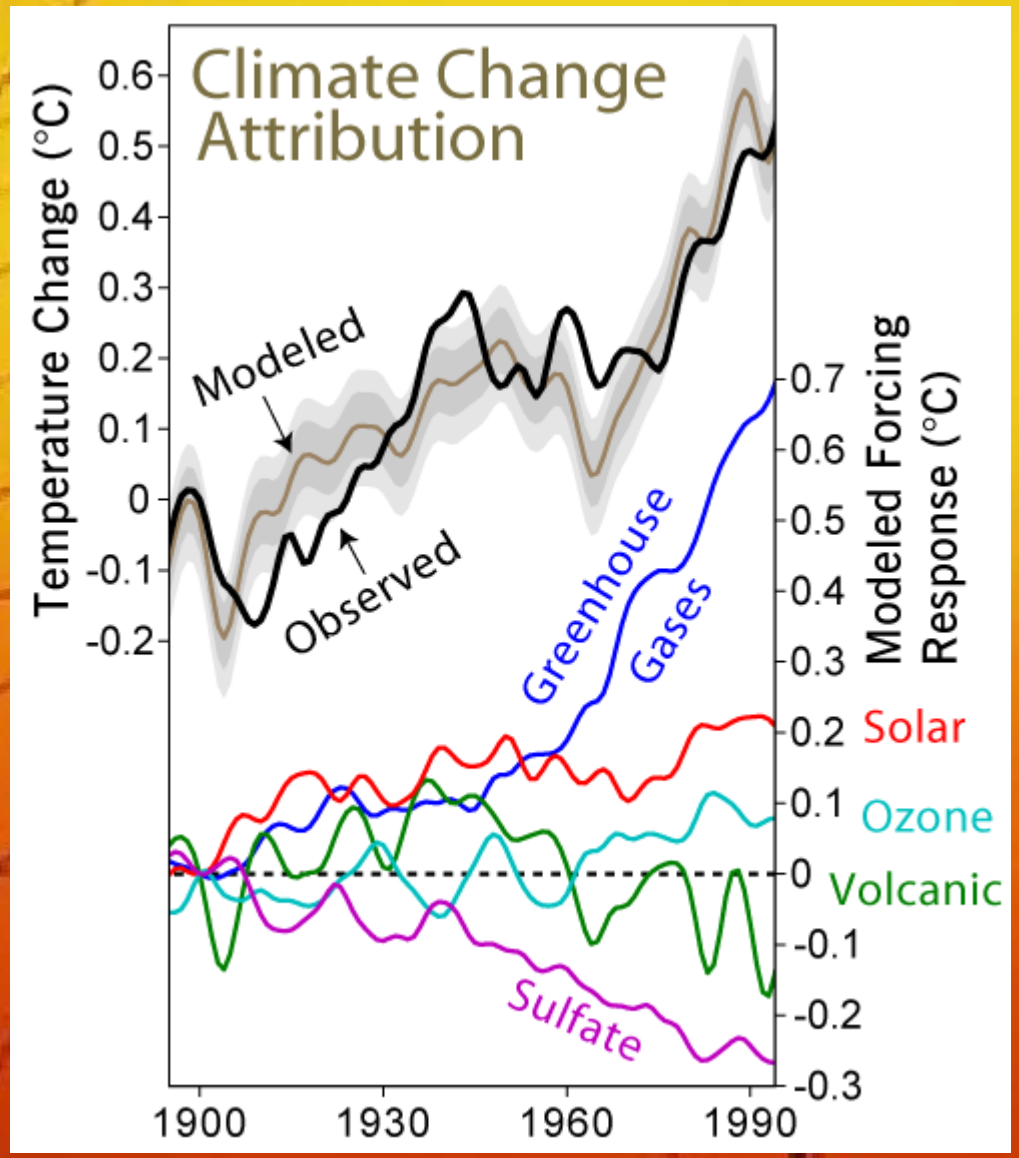

Now
200
400
600
800
1000
kyr ago
Precession
19, 22, 24 kyr
Obliquity
41 kyr
Eccentricity
95, 125, 400 kyr
Solar Forcing
65°N Summer
Hot
Stages of Glaciation
Cold

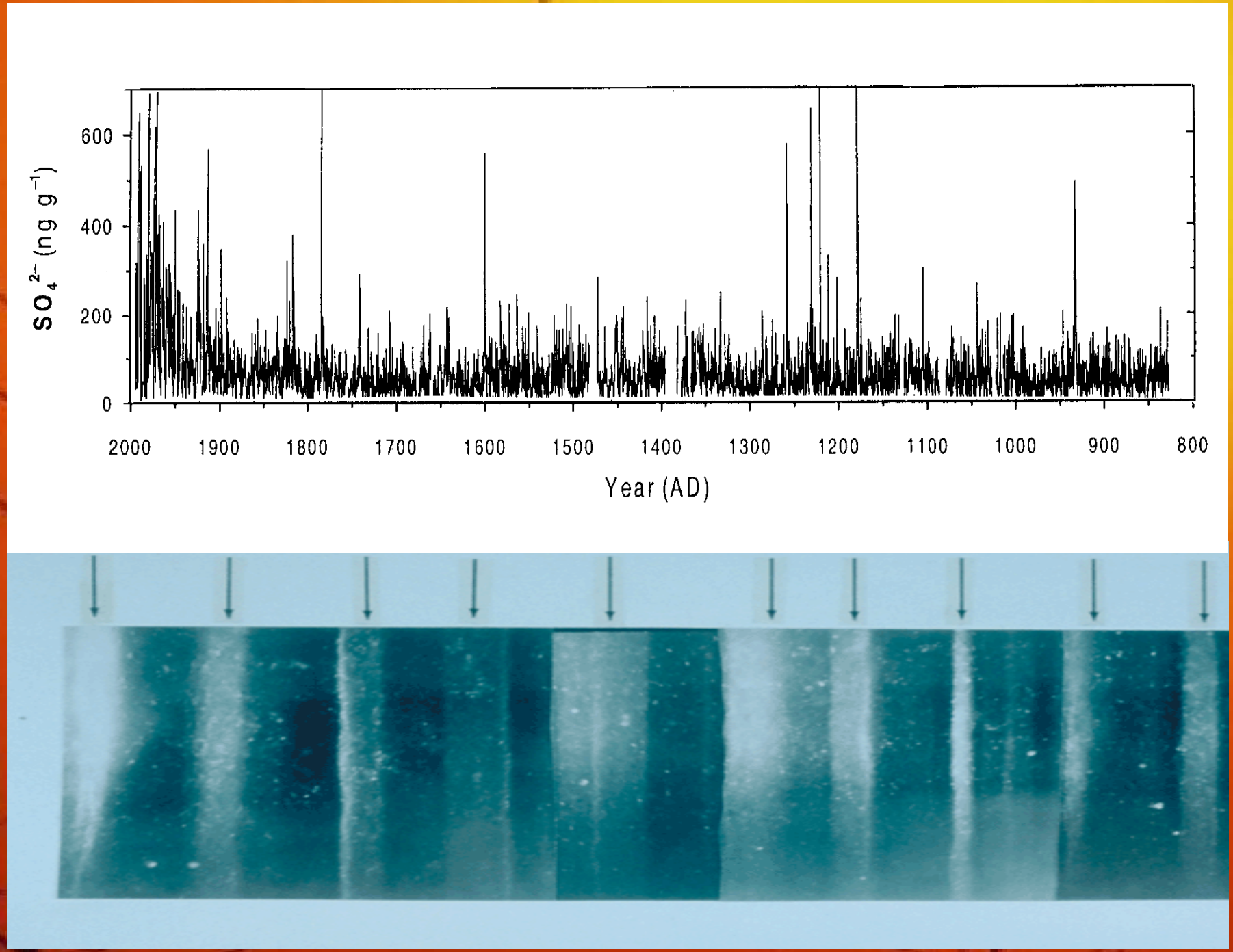
Ayresoller


Radiative Forcing by Tropospheric Aerosol
Partial Reflection and Absorption of Incoming Solar Radiation
Aerosol Haze
Clouds
Dust
SO_2
Soot
Land Use Changes
Industrial Emissions
Biomass Burning

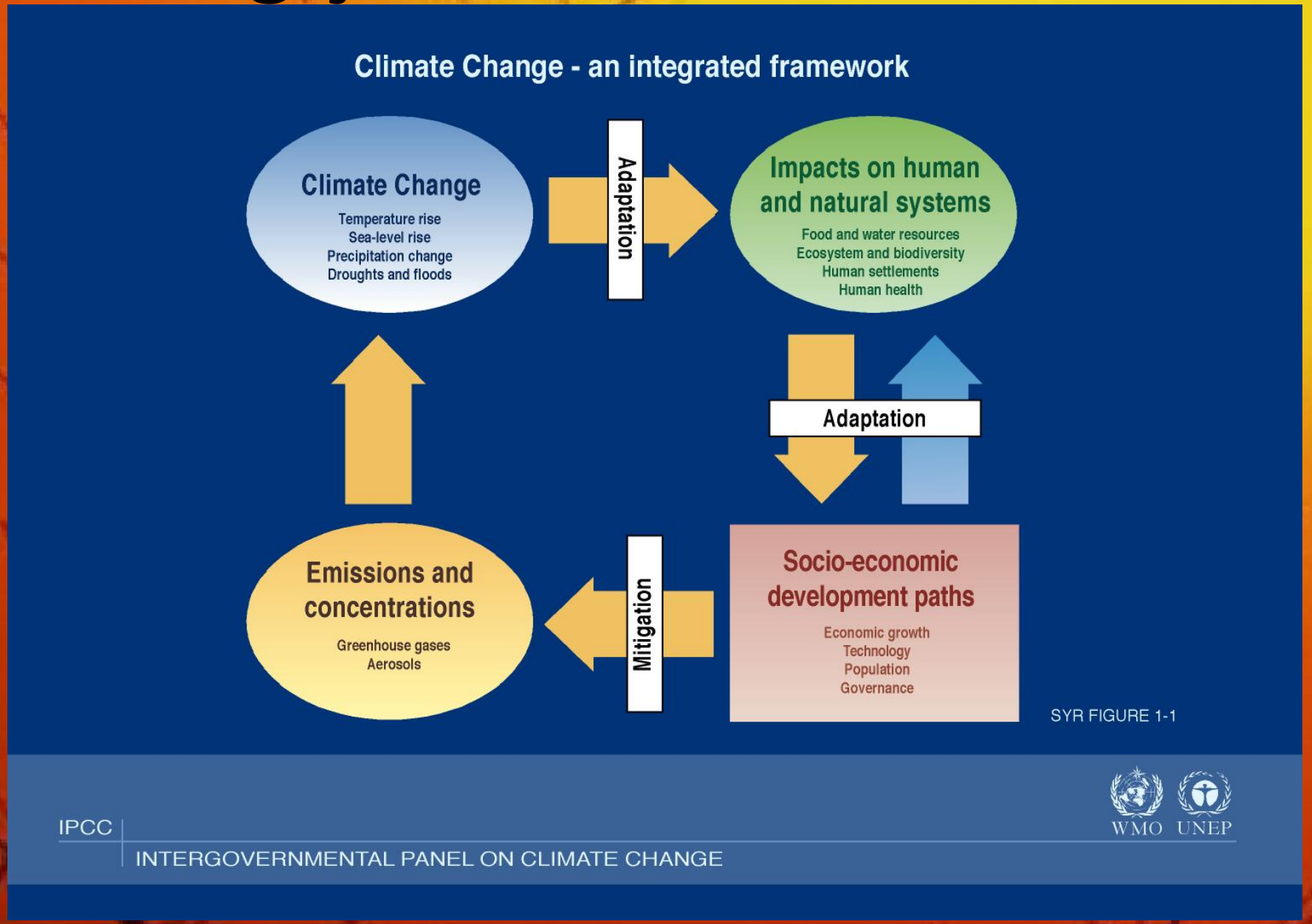

condensation
evaporation
nucleation
surface
chemistry
aqueous
chemistry
diffusion
coagulation
water
uptake
activation
subcloud
scavenging
resuspension
oxidation
precursor emissions
dry
deposition
primary emissions

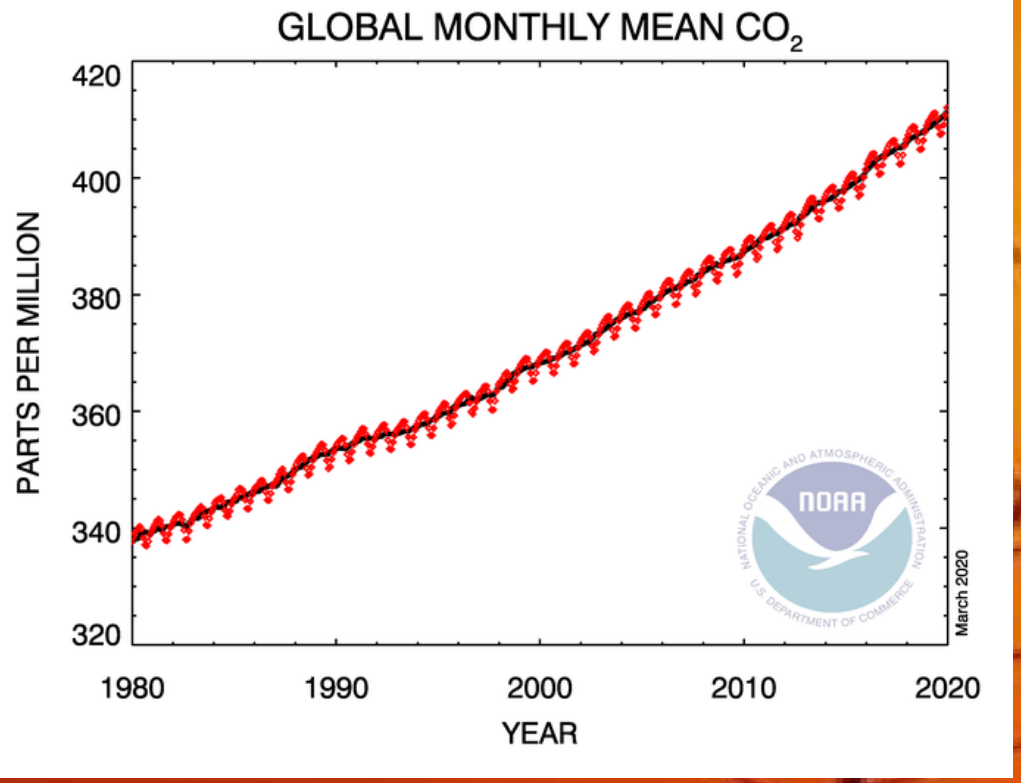

Radiative Forcing Components
RF Terms
RF values (W m-2)
Spatial scale
LOSU
Anthropogenic
Natural
Long-lived greenhouse gases
CO2
N2O
CH4
Halocarbons
1.66 [1.49 to 1.83]
Global
High
0.48 [0.43 to 0.53]
0.16 [0.14 to 0.18]
0.34 [0.31 to 0.37]
Global
High
Ozone
Stratospheric
Tropospheric
-0.05 [-0.15 to 0.05]
0.35 [0.25 to 0.65]
Continental to global
Med
Stratospheric water vapour from CH4
0.07 [0.02 to 0.12]
Global
Low
Surface albedo
Land use
Black carbon on snow
-0.2 [-0.4 to 0.0]
0.1 [0.0 to 0.2]
Local to continental
Med - Low
Total Aerosol
Direct effect
-0.5 [-0.9 to -0.1]
Continental to global
Med - Low
Cloud albedo effect
-0.7 [-1.8 to -0.3]
Continental to global
Low
Linear contrails
0.01 [0.003 to 0.03]
Continental
Low
Solar irradiance
0.12 [0.06 to 0.30]
Global
Low
Total net anthropogenic
1.6 [0.6 to 2.4]
-2
-1
0
1
2
Radiative Forcing (W m-2)
©IPCC 2007: WG1-AR4

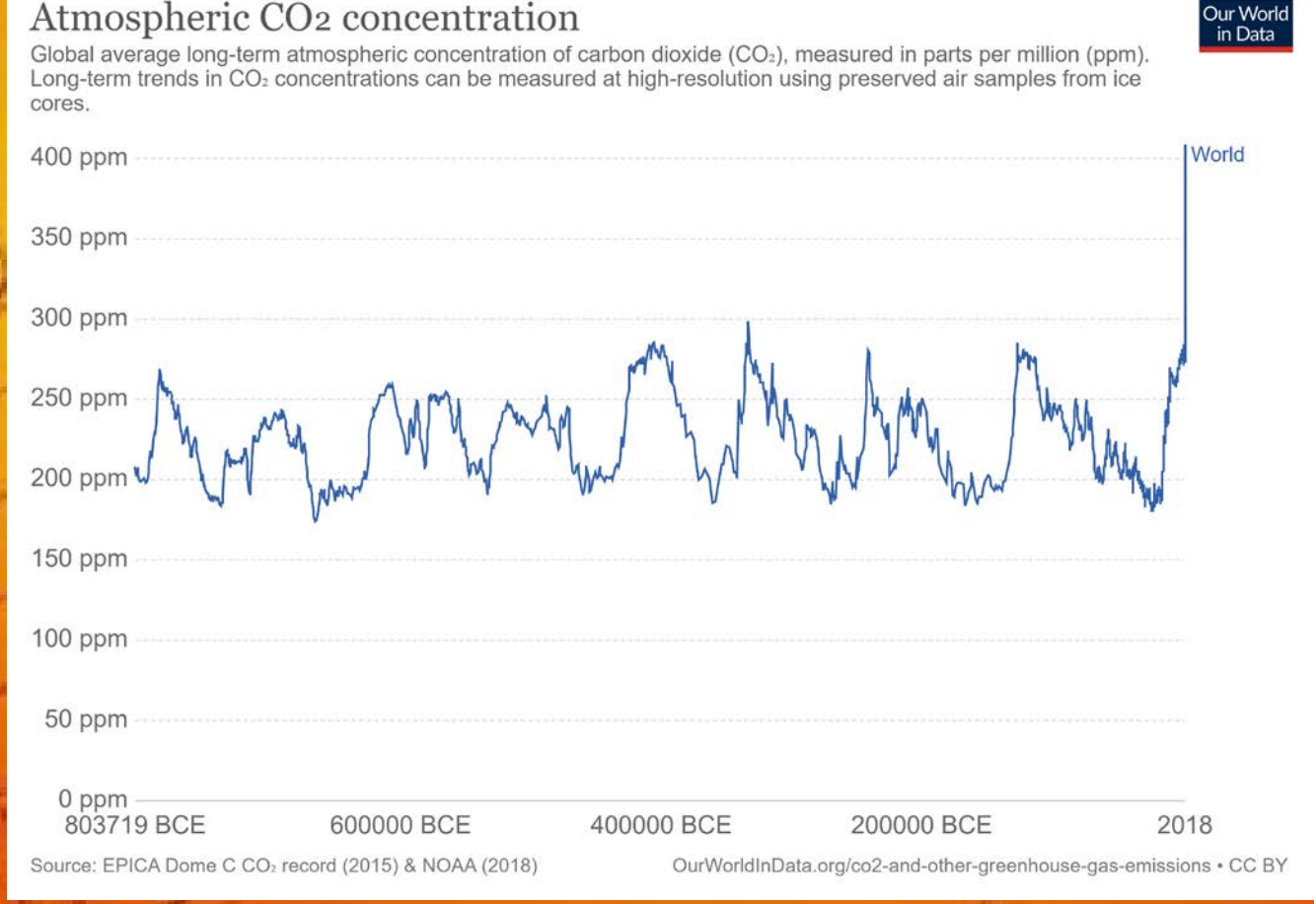

Climate Change Attribution
Temperature Change (°C)
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
Modeled
Observed
Greenhouse Gases
Solar
Ozone
Volcanic
Sulfate
Modeled Forcing Response (°C)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
1900
1930
1960
1990

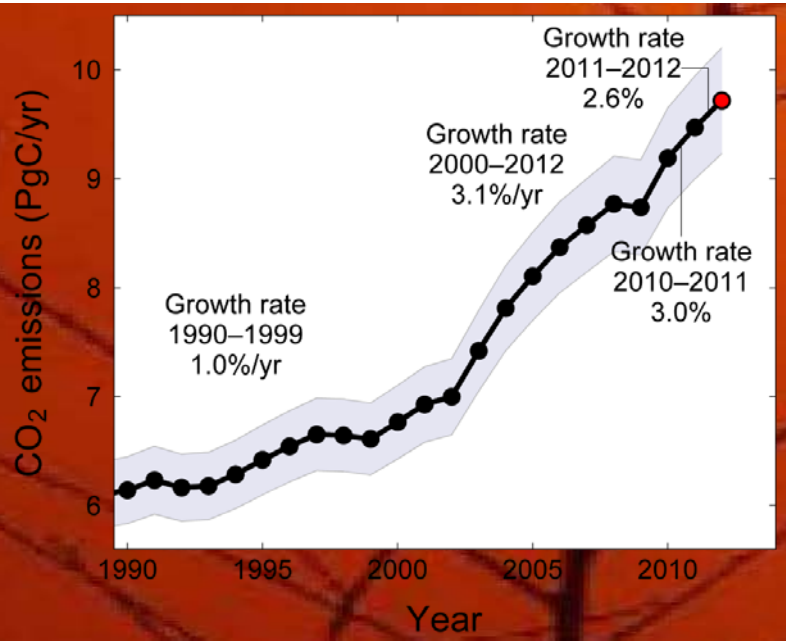

600
400
200
0
SO_4^{2-} (ng g^{-1})
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
Year (AD)

Atmosferik değişim

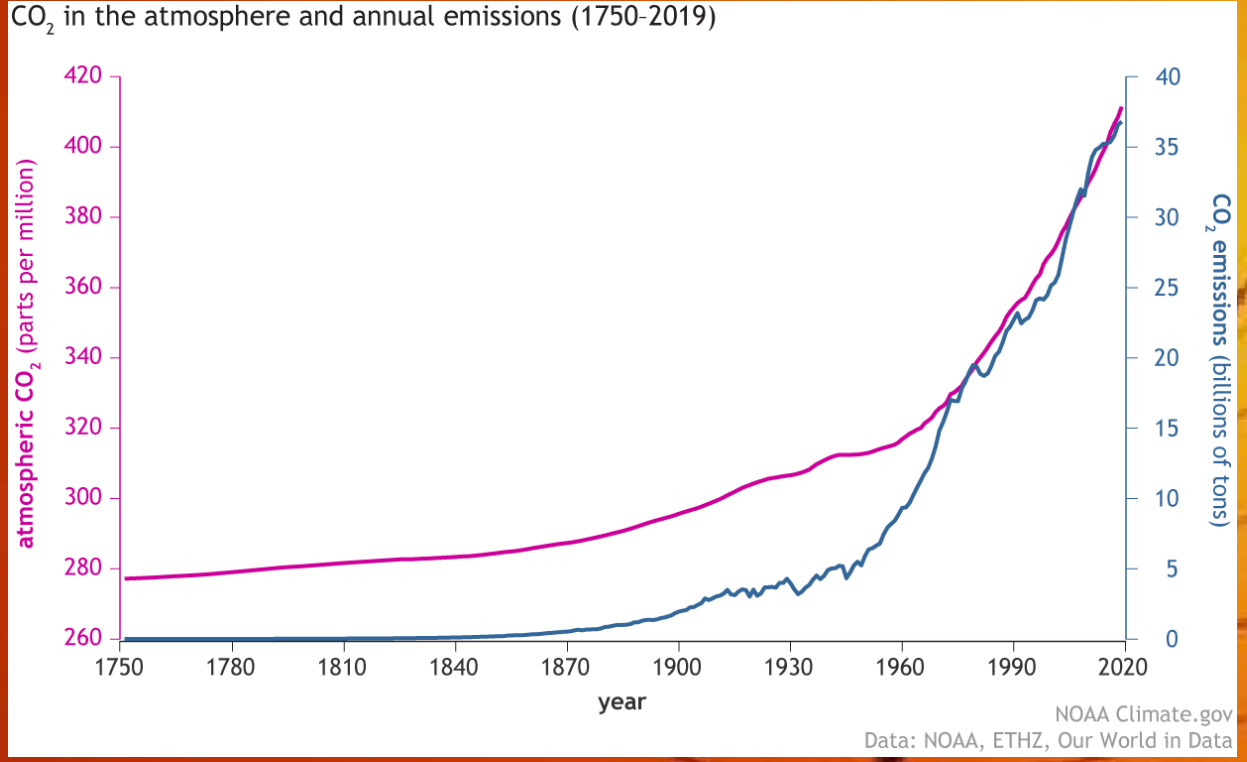


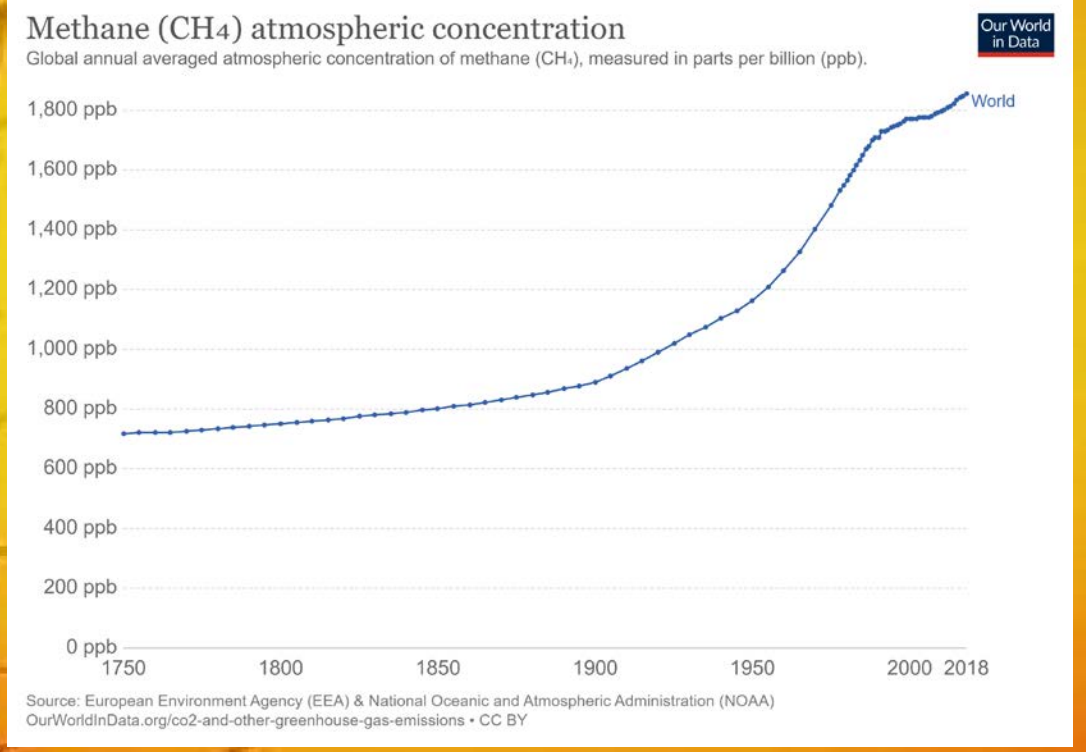


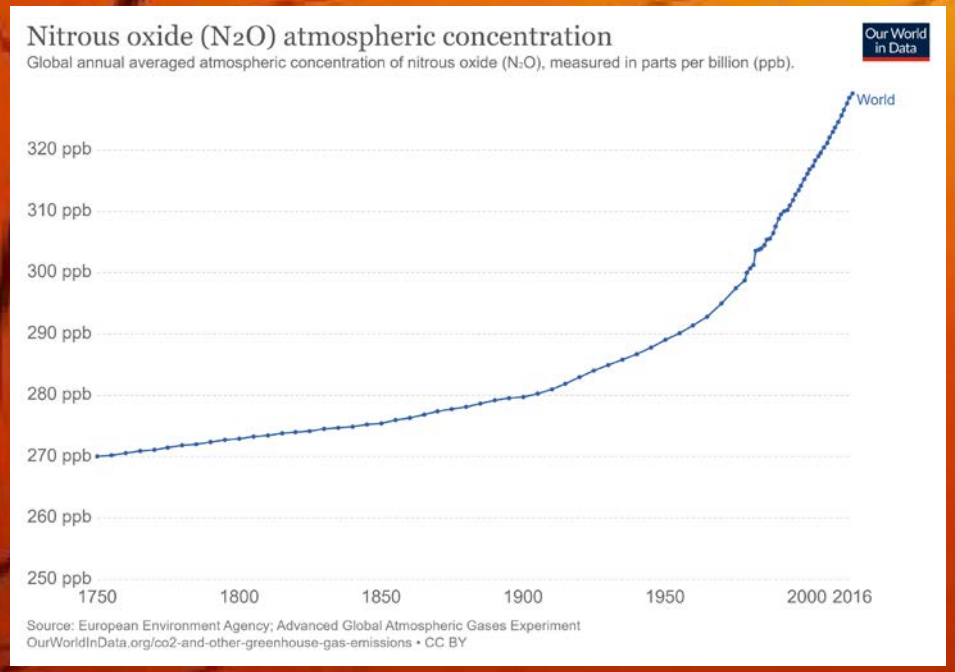




Atmosferik değişim

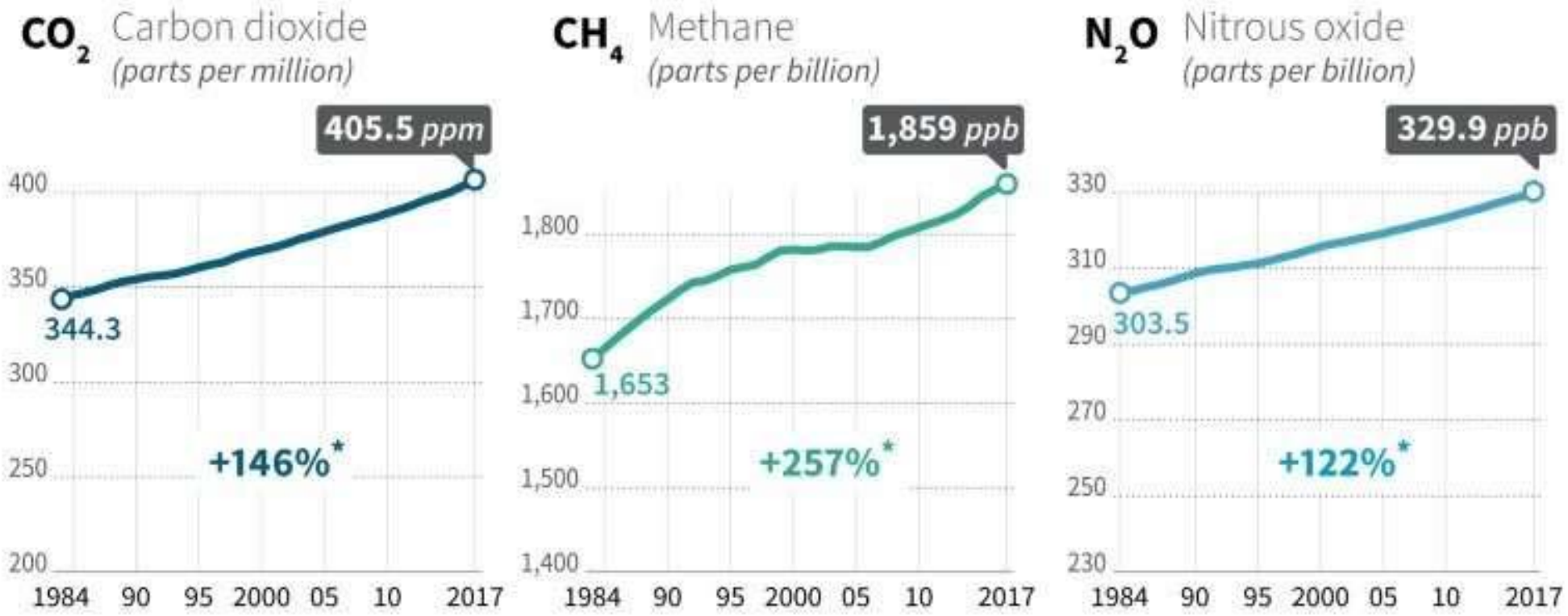

CO_2 in the atmosphere and annual emissions (1750–2019)
atmospheric CO_2 (parts per million)
CO_2 emissions (billions of tons)
420
400
380
360
340
320
300
280
260
40
35
30
25
20
15
10
5
0
1750
1780
1810
1840
1870
1900
1930
1960
1990
2020
year
NOAA Climate.gov
Data: NOAA, ETHZ, Our World in Data


Methane (CH_4) atmospheric concentration
Global annual averaged atmospheric concentration of methane (CH_4), measured in parts per billion (ppb).
Our World in Data
World
1,800 ppb
1,600 ppb
1,400 ppb
1,200 ppb
1,000 ppb
800 ppb
600 ppb
400 ppb
200 ppb
0 ppb
1750
1800
1850
1900
1950
2000
2018
Source: European Environment Agency (EEA) & National Oceanic and Atmospheric Administration (NOAA)
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY


Nitrous oxide (N_2O) atmospheric concentration
Global annual averaged atmospheric concentration of nitrous oxide (N_2O), measured in parts per billion (ppb).
Our World in Data
World
320 ppb
310 ppb
300 ppb
290 ppb
280 ppb
270 ppb
260 ppb
250 ppb
1750
1800
1850
1900
1950
2000
2016
Source: European Environment Agency; Advanced Global Atmospheric Gases Experiment
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY

Record levels of greenhouse gases in 2017

Average concentration in the atmosphere



Share of global warming attributable to greenhouse gases

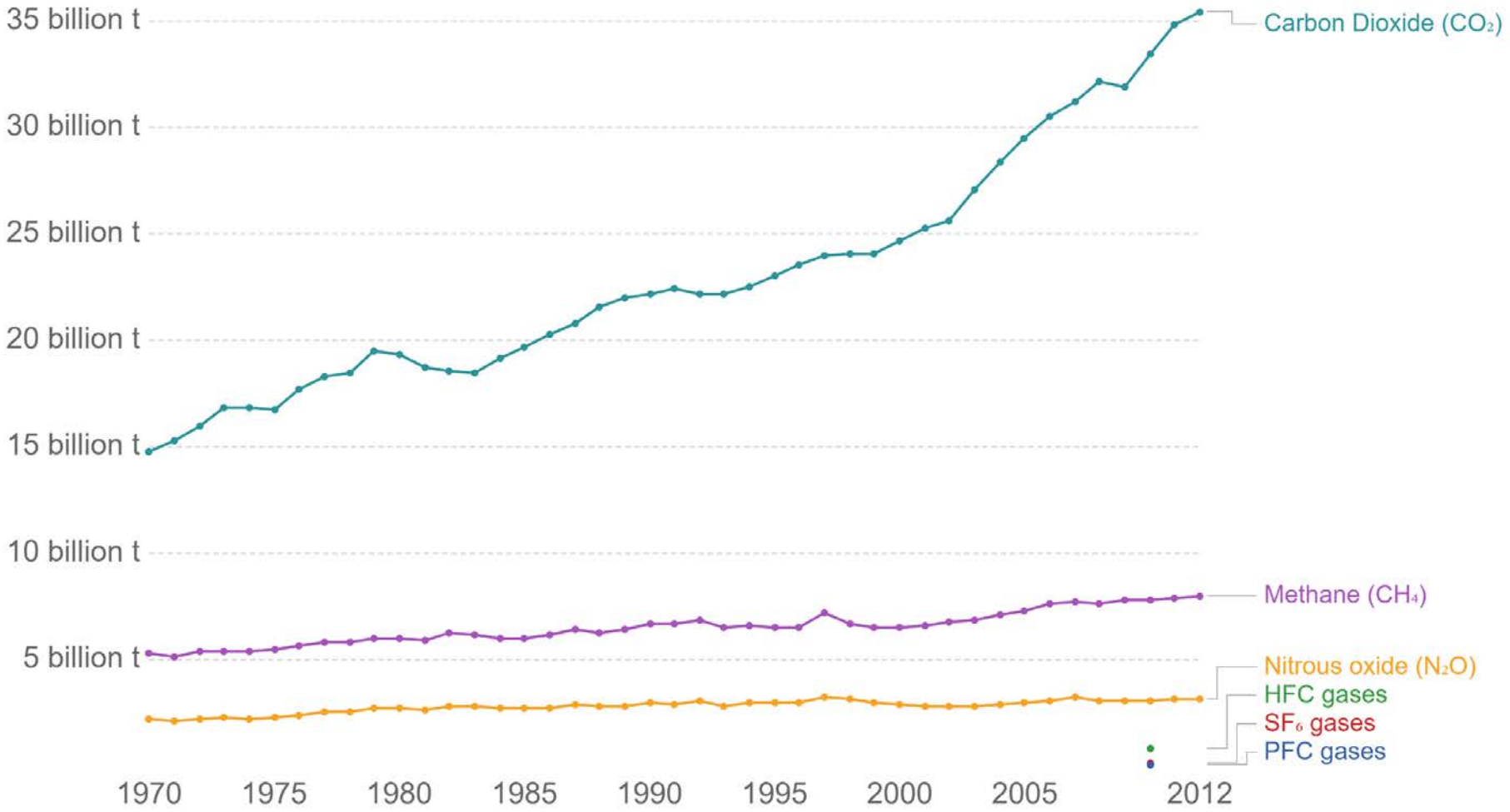
Source: WMO

*Rise in % compared to pre-industrial levels (before 1750)

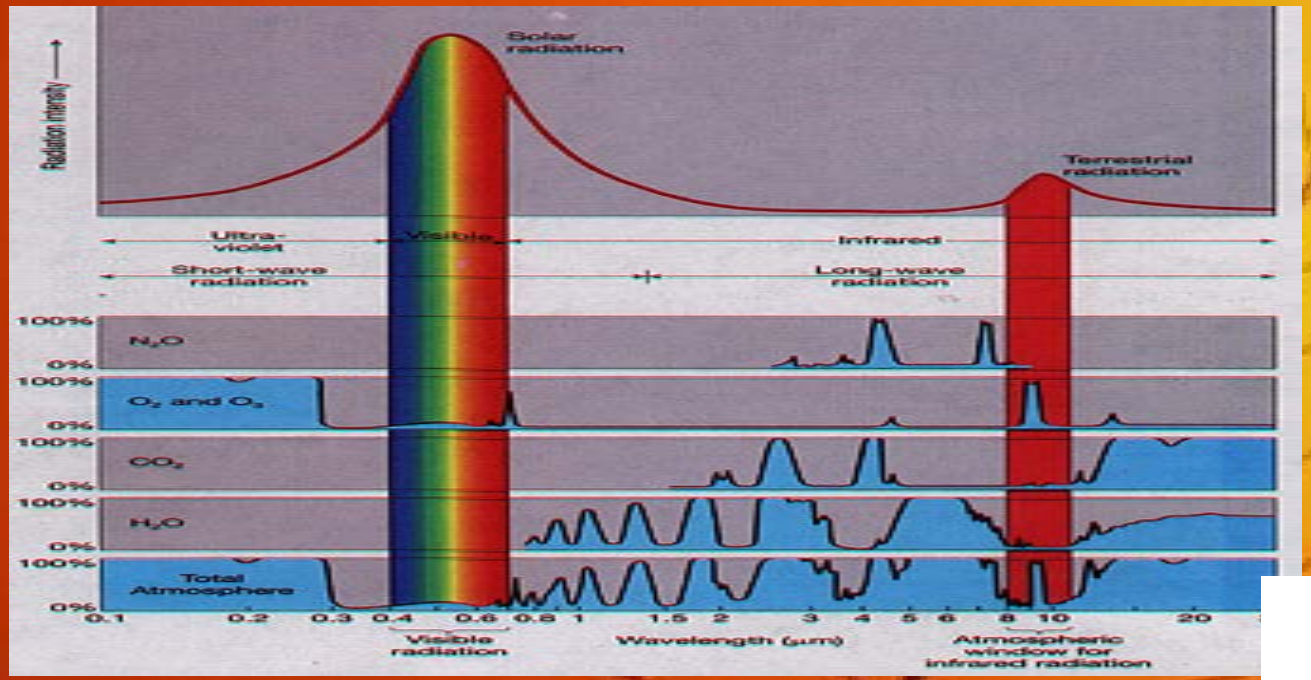
© AFP

Greenhouse gas emissions by gas, World

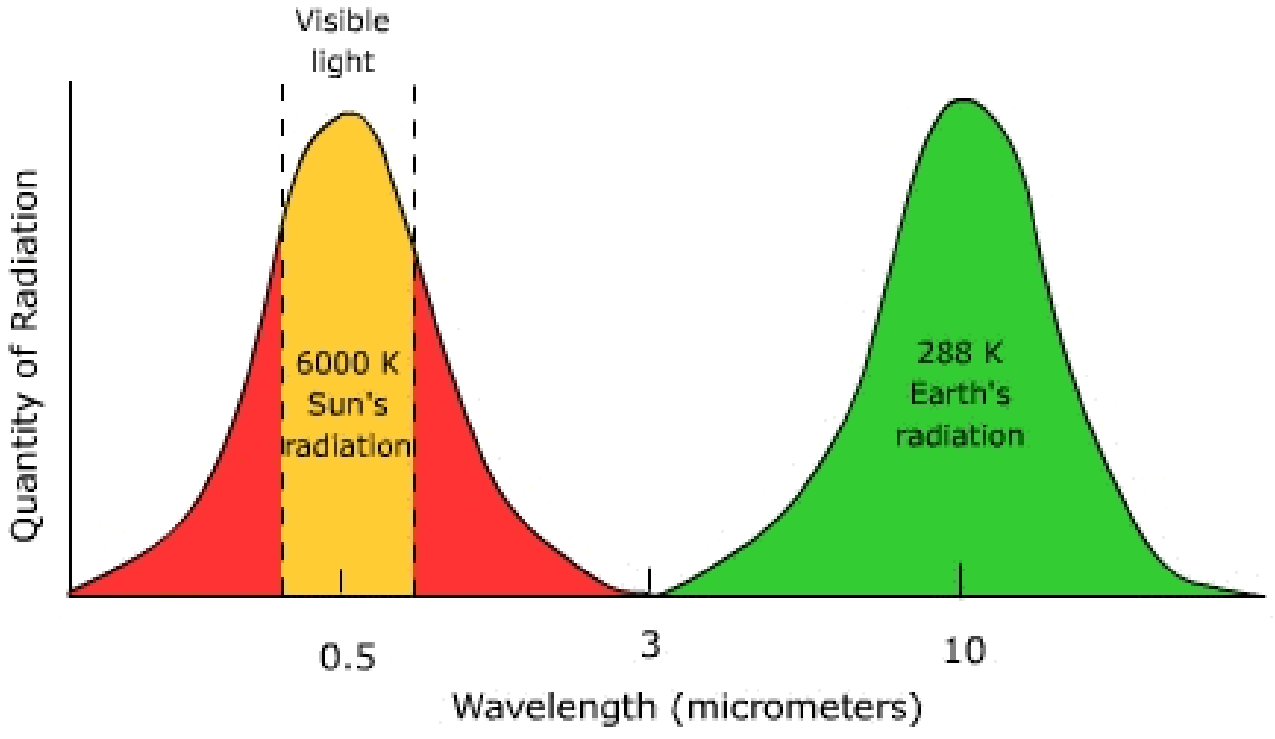
Global greenhouse gas emissions by gas source, measured in tonnes of carbon dioxide equivalents (tCO_2e). Gases are converted to their CO_2e values based on their global warming potential factors. HFC, PFC and SF_6 are collectively known as 'F-gases'.

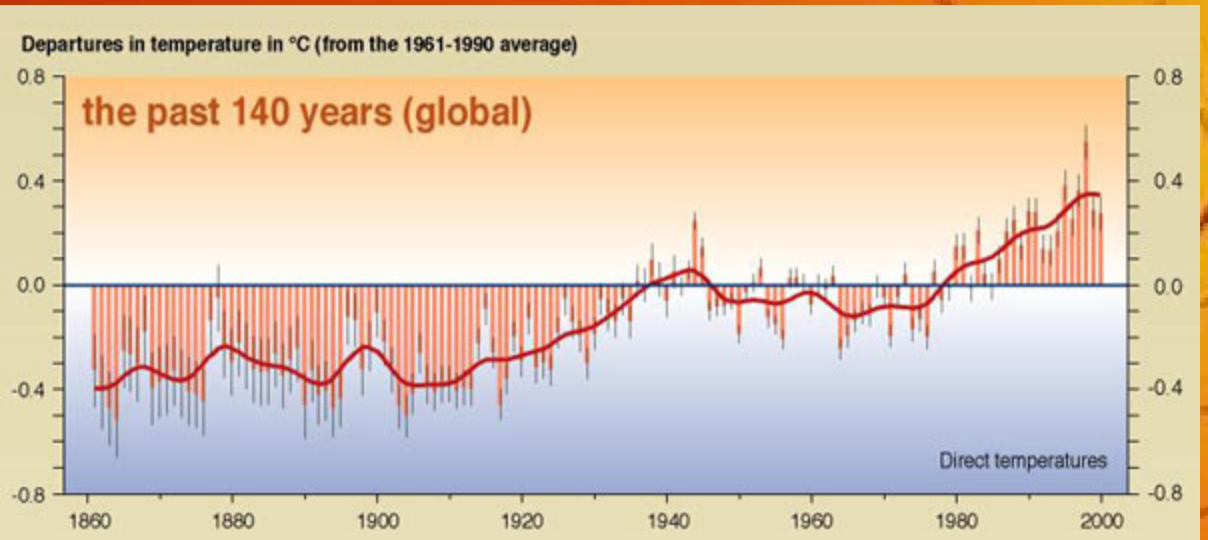


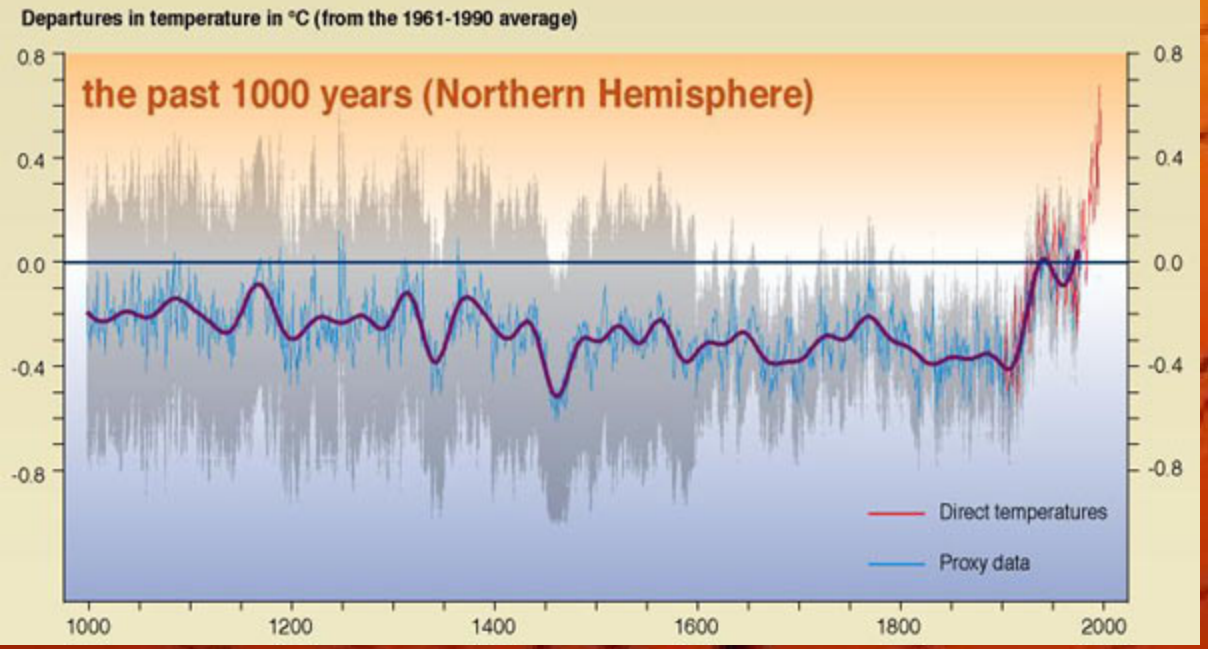
Source: European Commission (JRC); Netherlands Environmental Assessment Agency (PBL); EDGAR
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

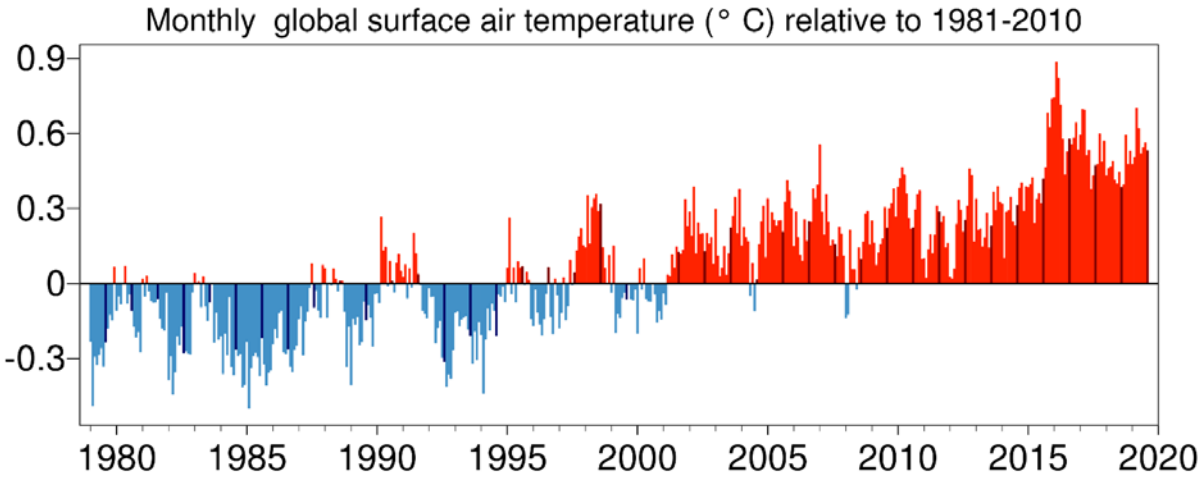


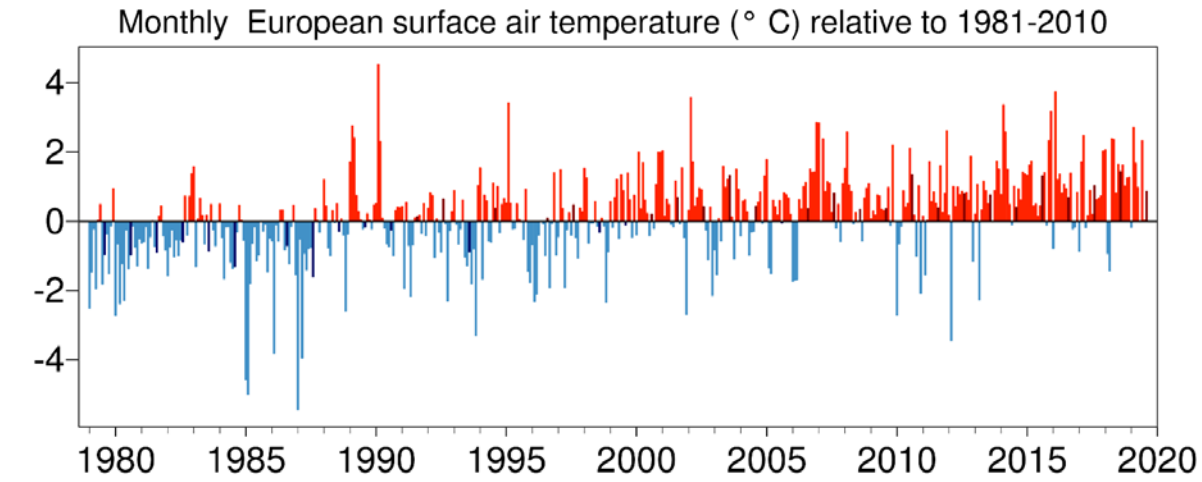
Comparison of Solar and Earth Radiation Spectra



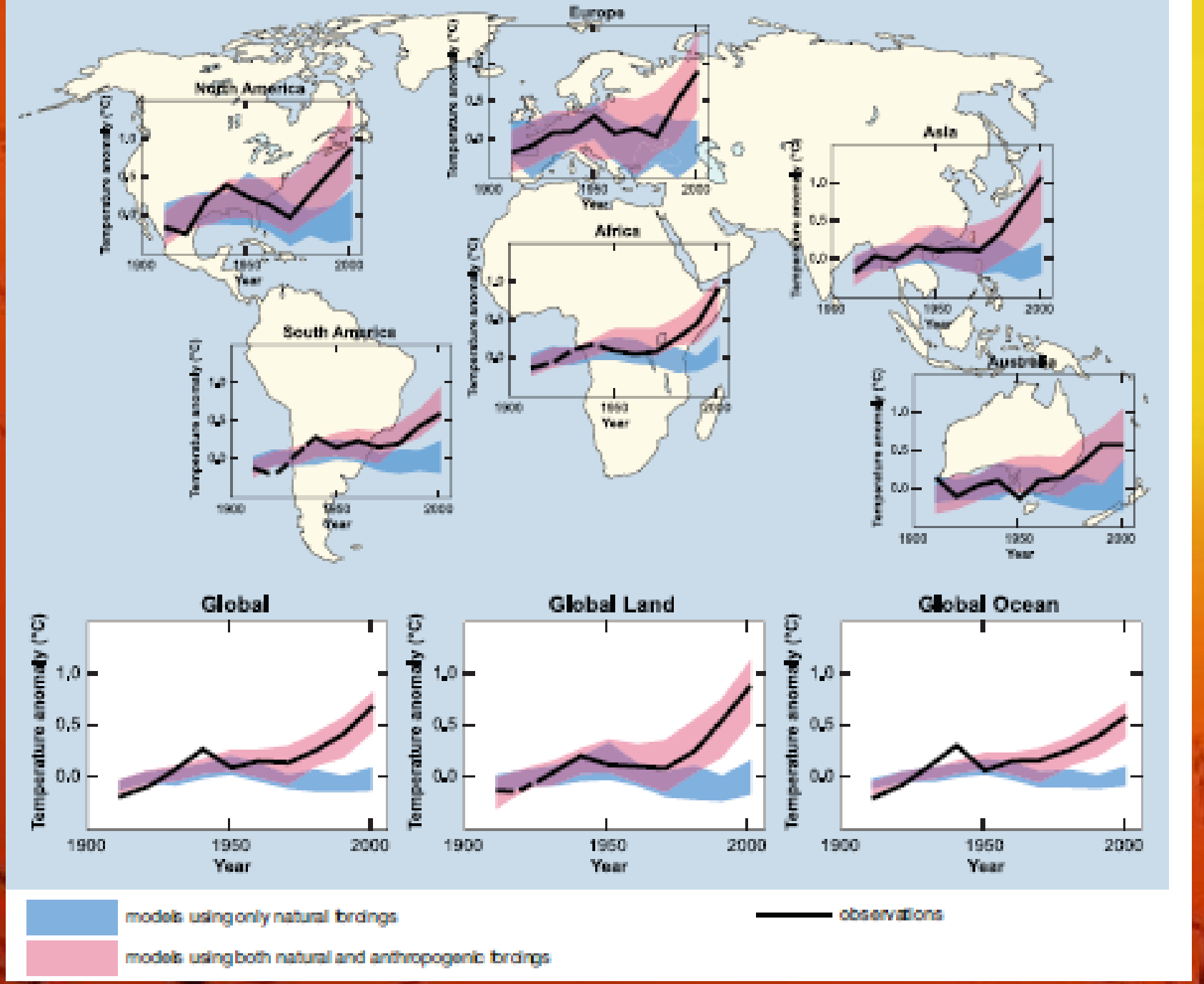


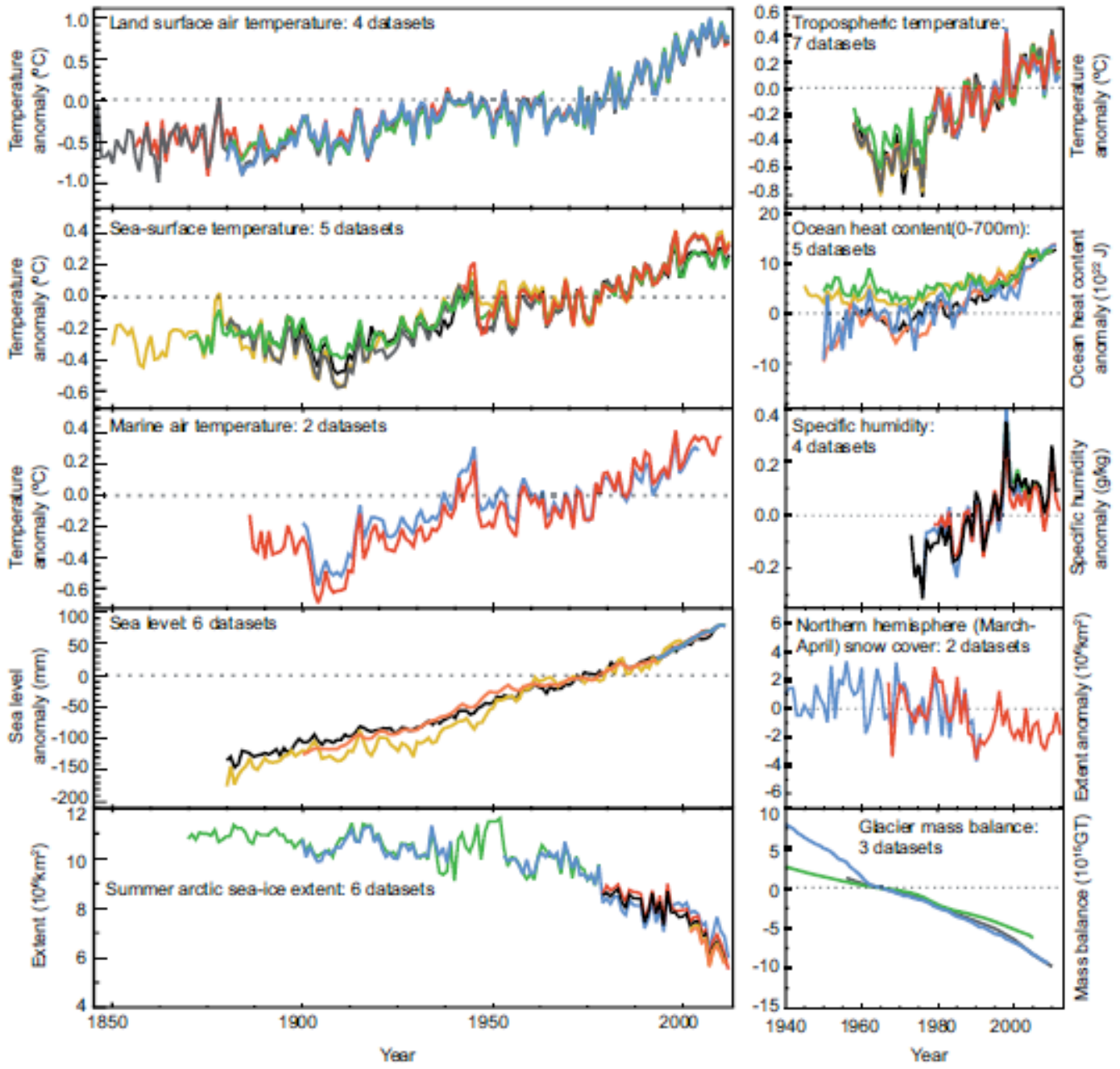


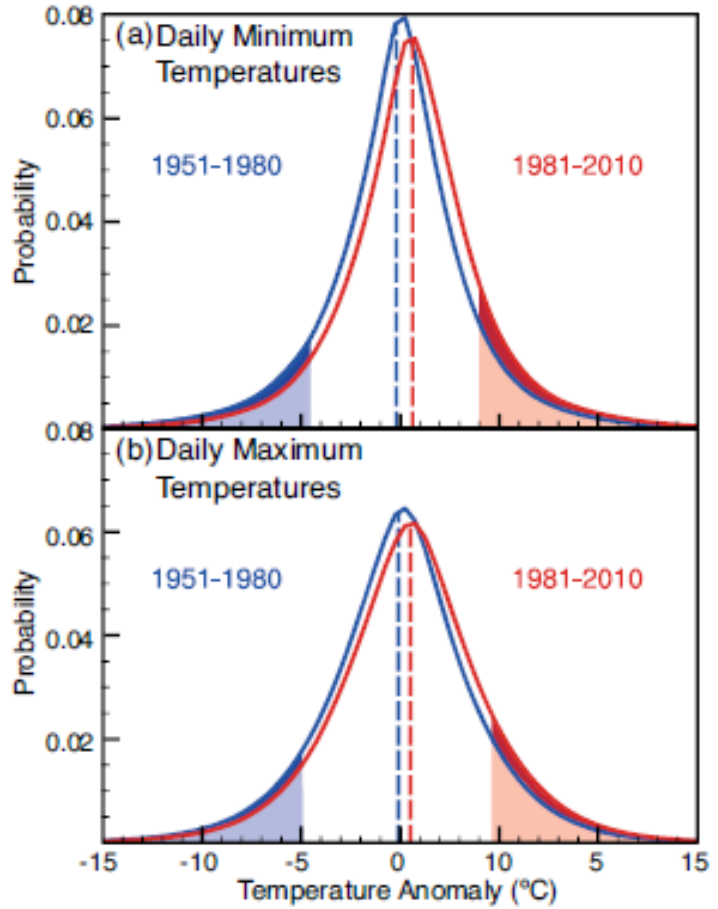


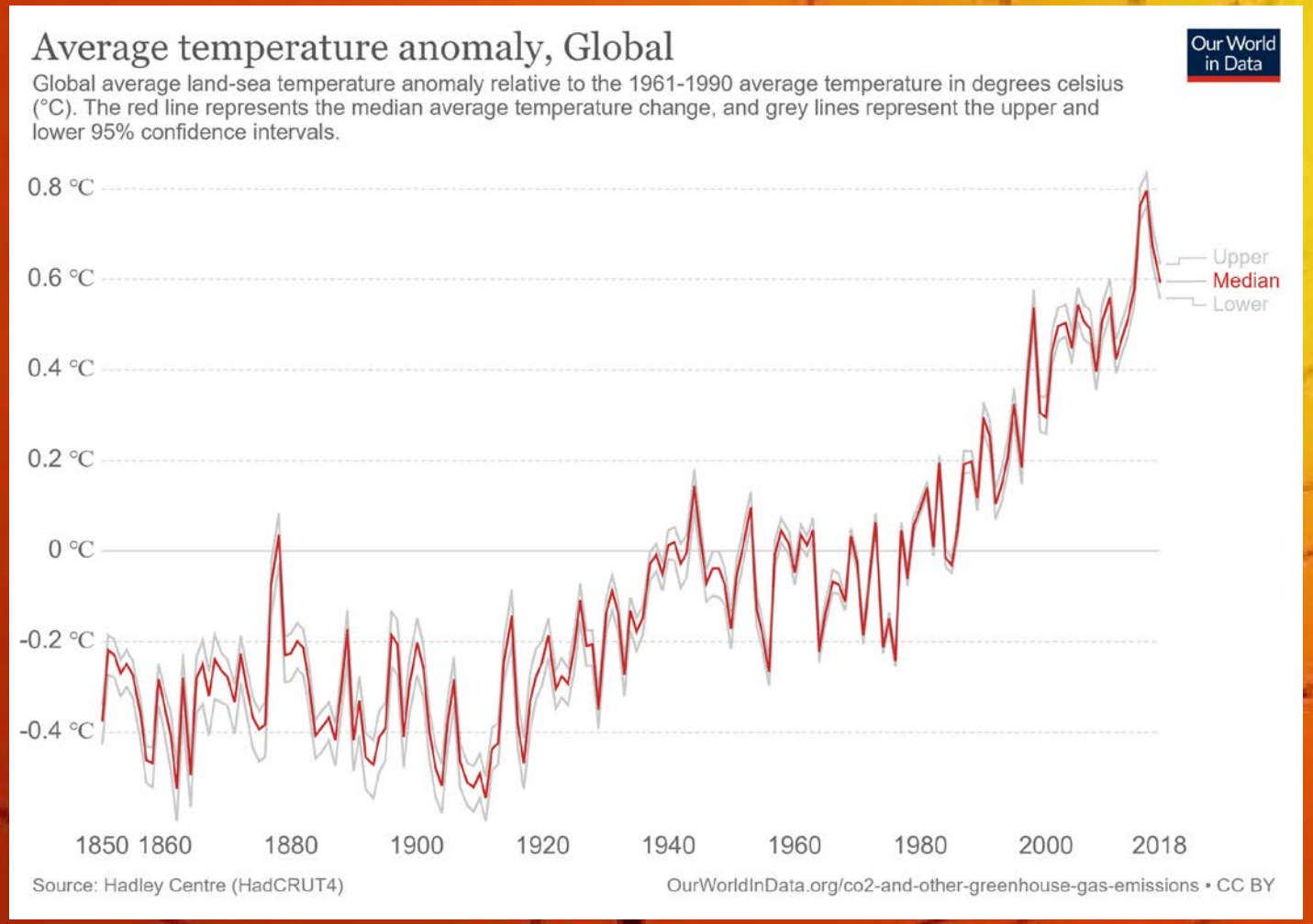


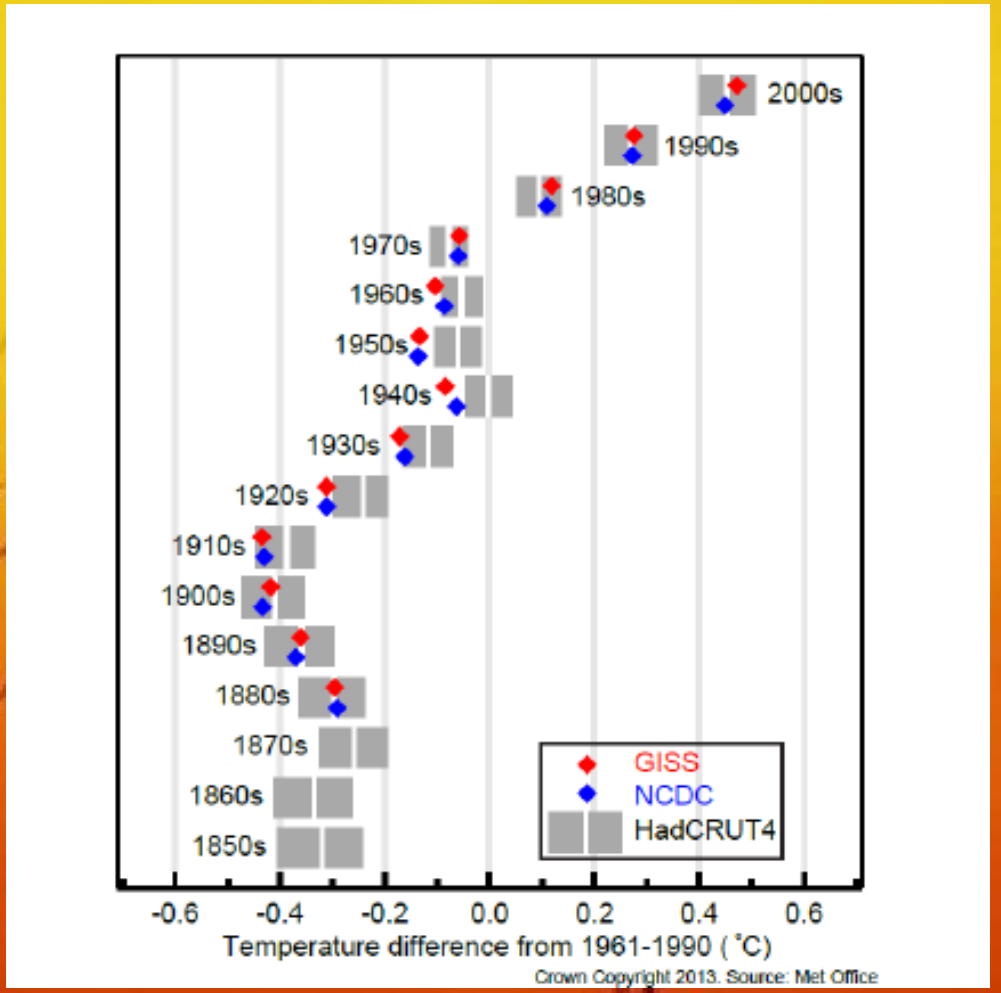
Copernicus
Climate Change Service
ECMWF

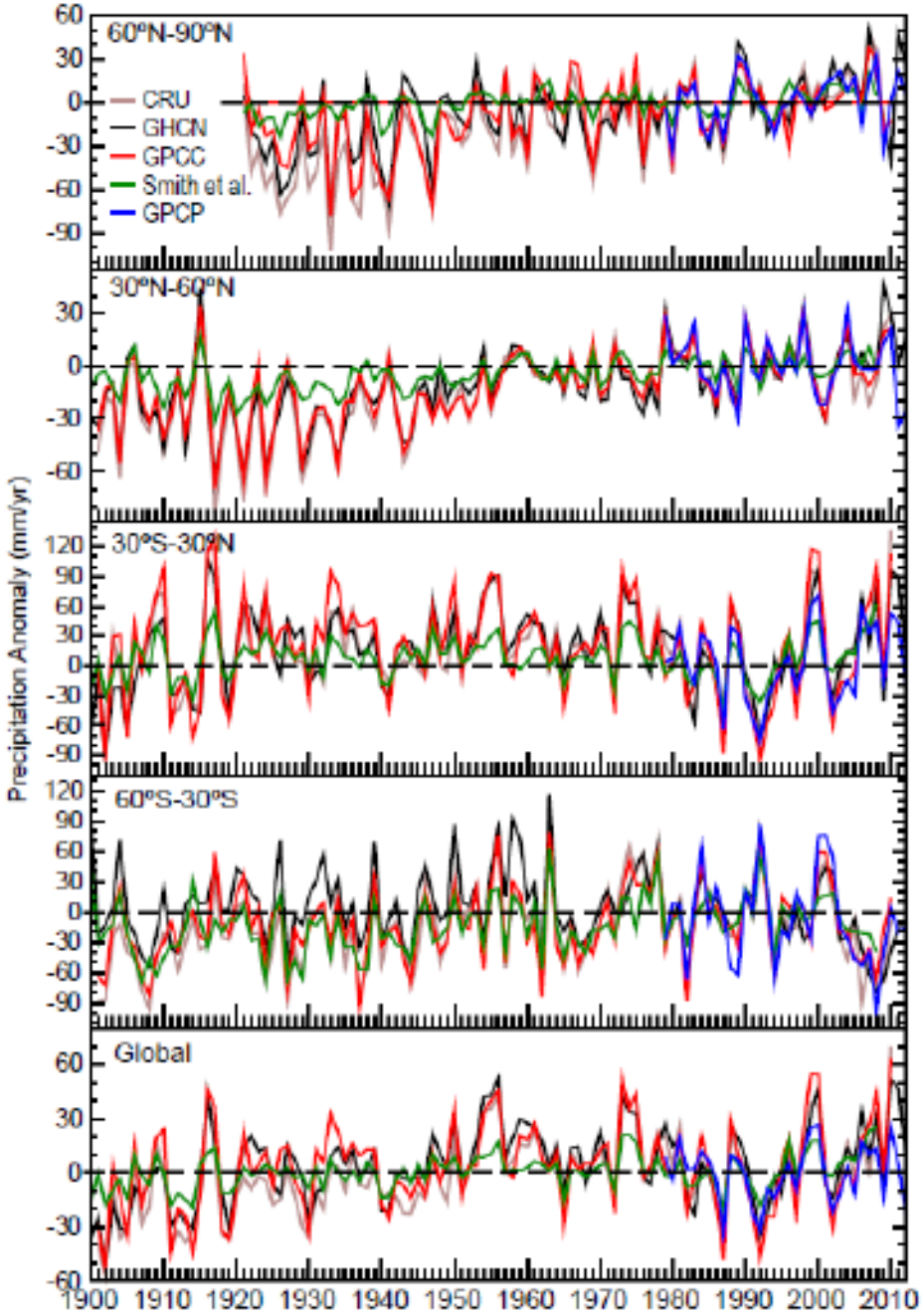

North America
Europe
Asia
Africa
South America
Australia
Temperature anomaly (°C)
Year
1900
1950
2000
Global
Global Land
Global Ocean
models using only natural forcings
models using both natural and anthropogenic forcings
observations


Land surface air temperature: 4 datasets
Temperature anomaly (°C)
Sea-surface temperature: 5 datasets
Marine air temperature: 2 datasets
Sea level 6 datasets
Sea level anomaly (mm)
Summer arctic sea-ice extent: 6 datasets
Extent (10⁶km²)
Year
Tropospheric temperature: 7 datasets
Ocean heat content(0-700m): 5 datasets
Ocean heat content anomaly (10²² J)
Specific humidity: 4 datasets
Specific humidity anomaly (g/kg)
Northern hemisphere (March-April) snow cover: 2 datasets
Extent anomaly (10⁶km²)
Glacier mass balance: 3 datasets
Mass balance (10¹⁵GT)

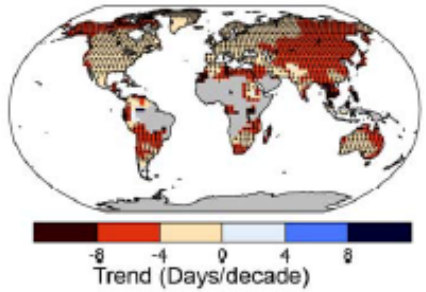

(a) Daily Minimum Temperatures
1951-1980
1981-2010
Probability
(b) Daily Maximum Temperatures
Temperature Anomaly (°C)

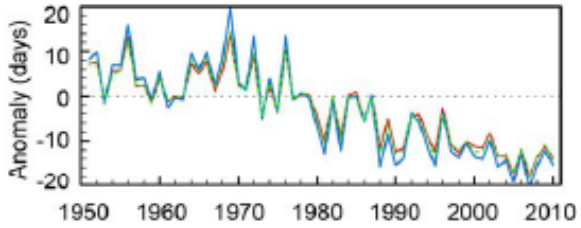

Average temperature anomaly, Global
Our World in Data
Global average land-sea temperature anomaly relative to the 1961-1990 average temperature in degrees celsius (°C). The red line represents the median average temperature change, and grey lines represent the upper and lower 95% confidence intervals.
0.8 °C
0.6 °C
0.4 °C
0.2 °C
0 °C
-0.2 °C
-0.4 °C
Upper
Median
Lower
1850 1860 1880 1900 1920 1940 1960 1980 2000 2018
Source: Hadley Centre (HadCRUT4)
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY


2000s
1990s
1980s
1970s
1960s
1950s
1940s
1930s
1920s
1910s
1900s
1890s
1880s
1870s
1860s
1850s
GISS
NCDC
HadCRUT4
-0.6 -0.4 -0.2 0.0 0.2 0.4 0.6
Temperature difference from 1961-1990 (°C)
Crown Copyright 2013. Source: Met Office

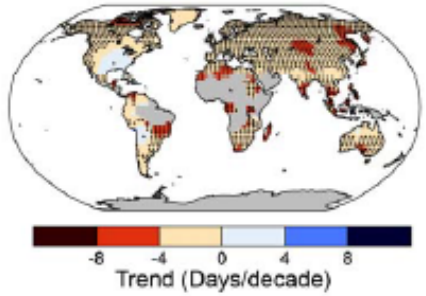

60°N-90°N
CRU
GHCN
GPCC
Smith et al.
GPCP
30°N-60°N
30°S-30°N
60°S-30°S
Global
Precipitation Anomaly (mm/yr)
1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010

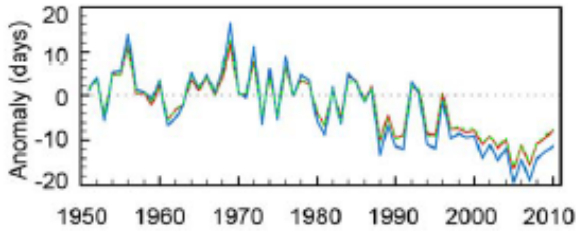
(a) Cold Nights



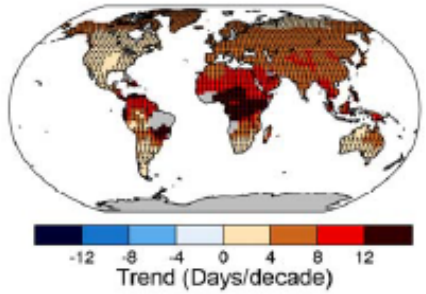


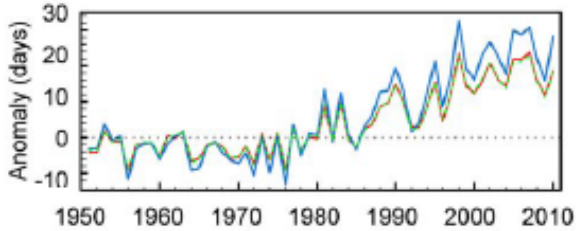
(b) Cold Days



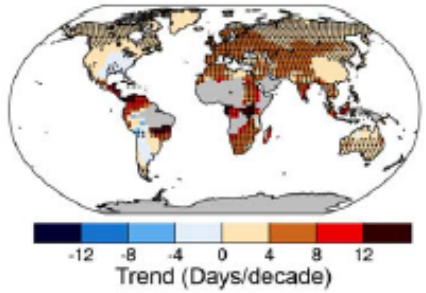


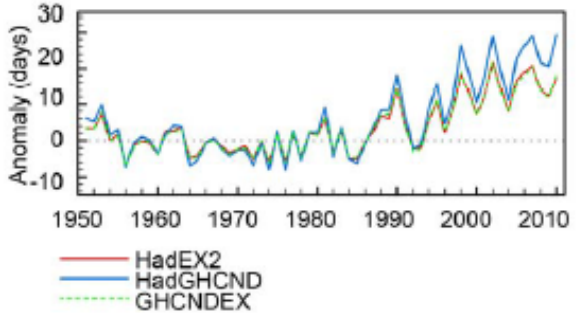
(c) Warm Nights





(d) Warm Days

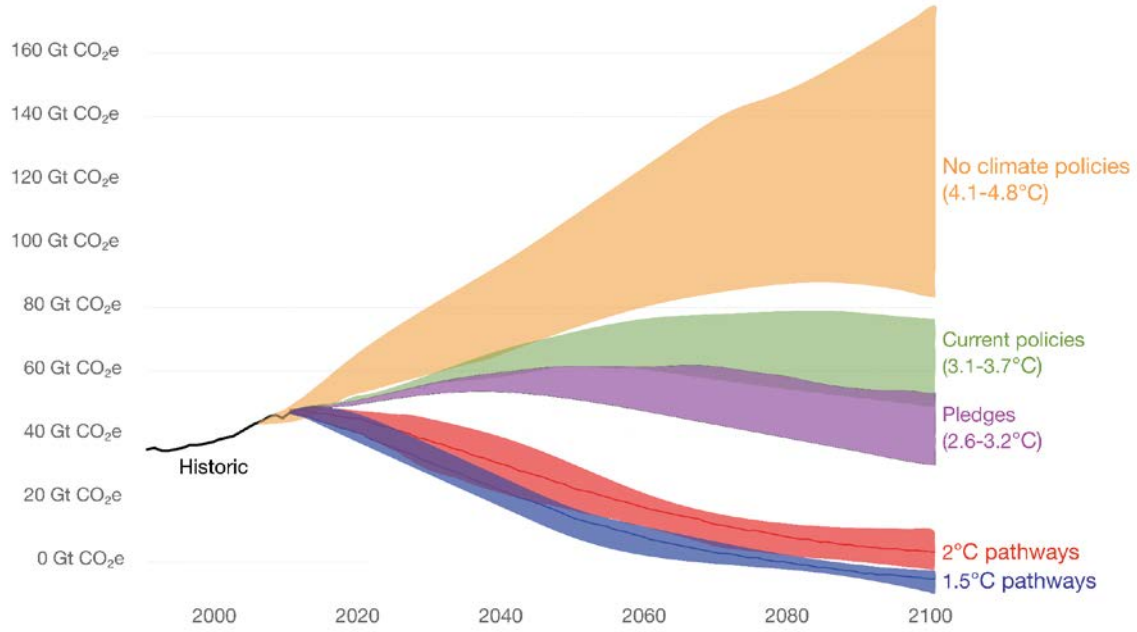




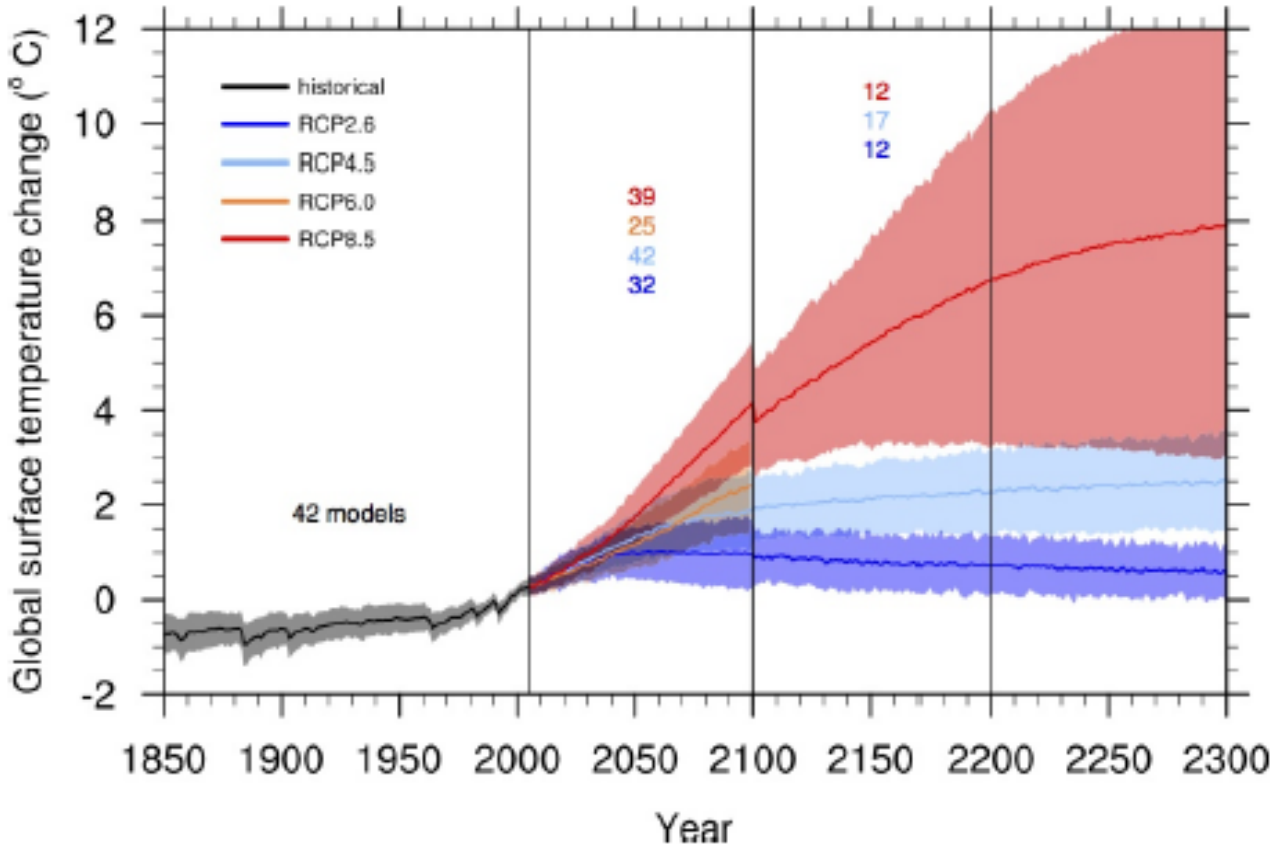
Global greenhouse gas emissions scenarios

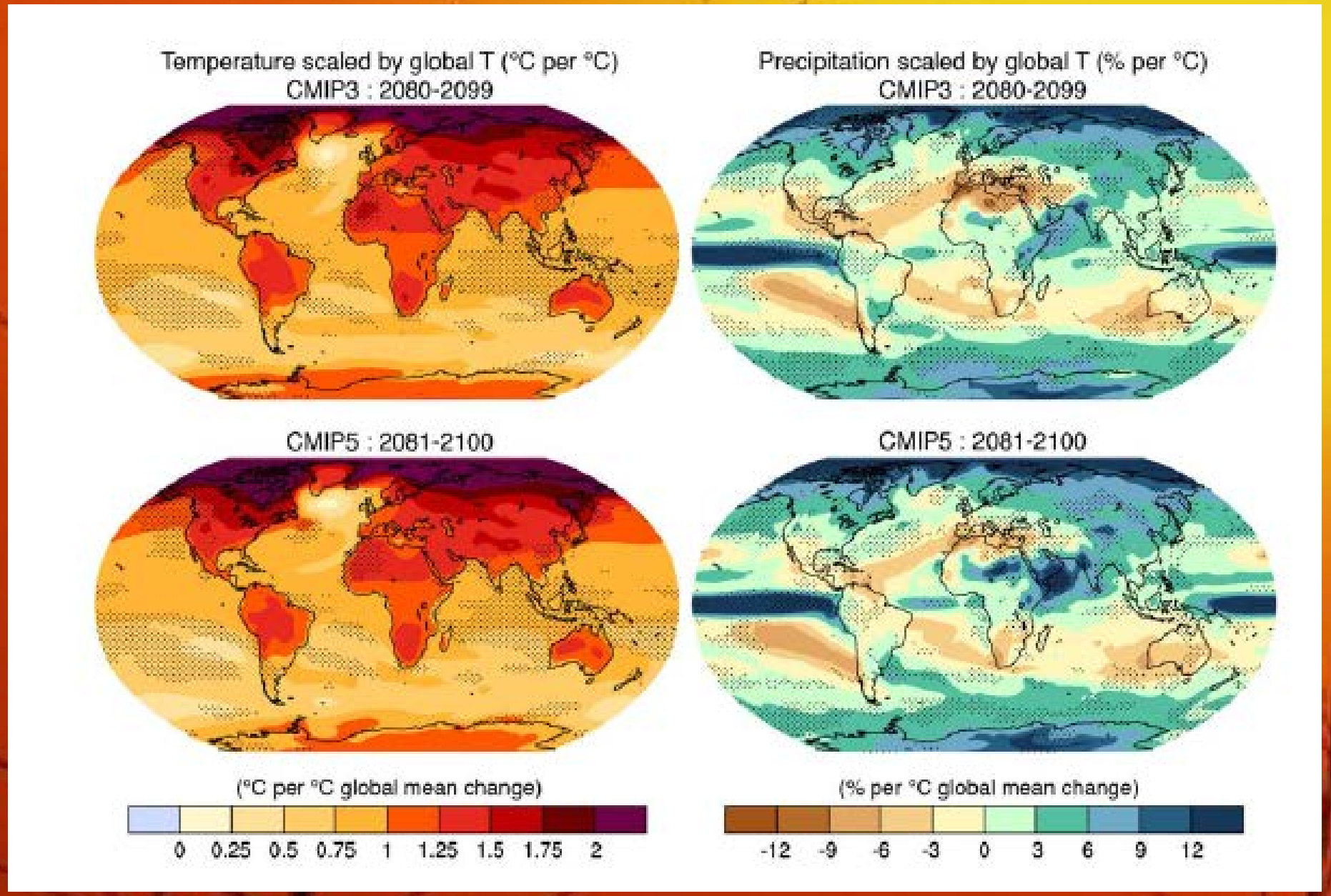
Our World in Data

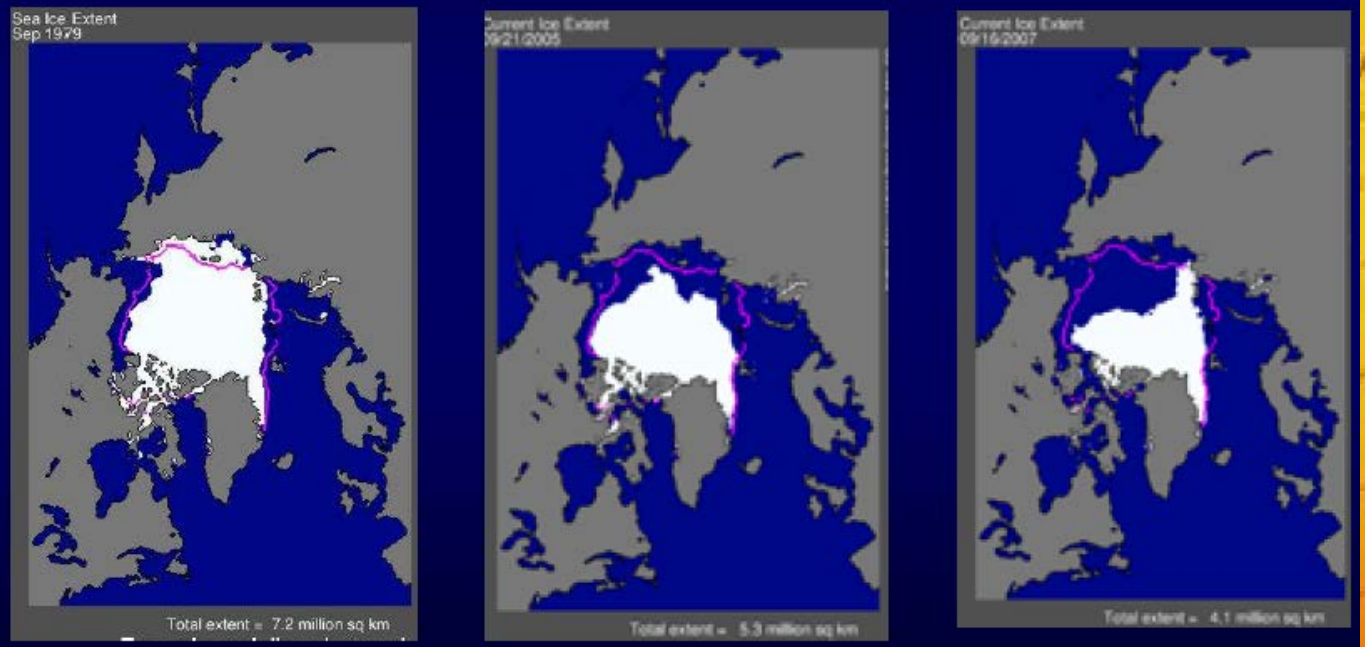
Potential future emissions pathways of global greenhouse gas emissions (measured in gigatonnes of carbon dioxide equivalents) in the case of no climate policies, current implemented policies, national pledges within the Paris Agreement, and 2°C and 1.5°C consistent pathways. High, median and low pathways represent ranges for a given scenario. Temperature figures represent the estimated average global temperature increase from pre-industrial, by 2100.

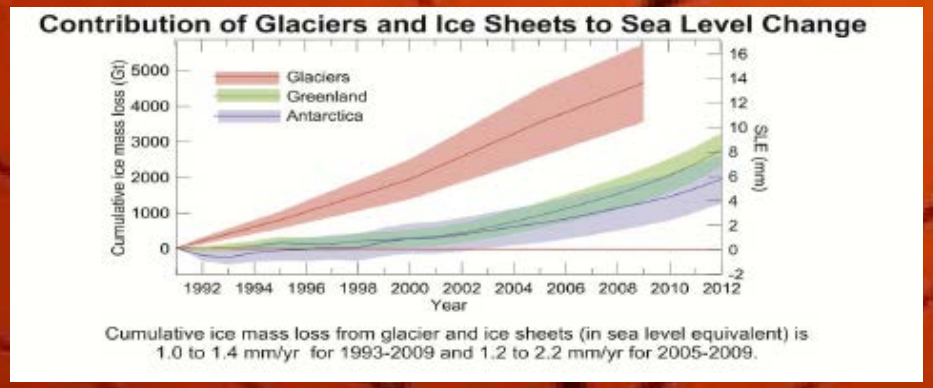


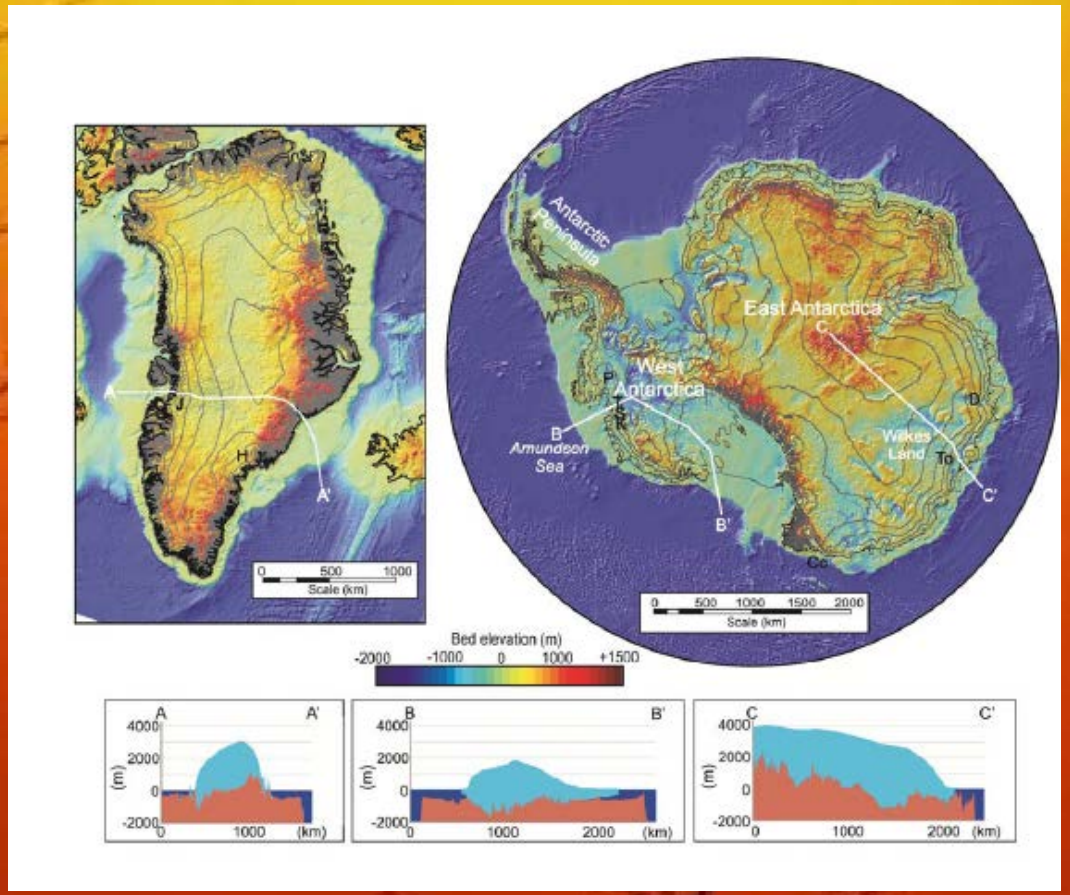
Based on data from the Climate Action Tracker (CAT).
The data visualization is available at OurWorldInData.org. There you find research and more visualizations on this topic.

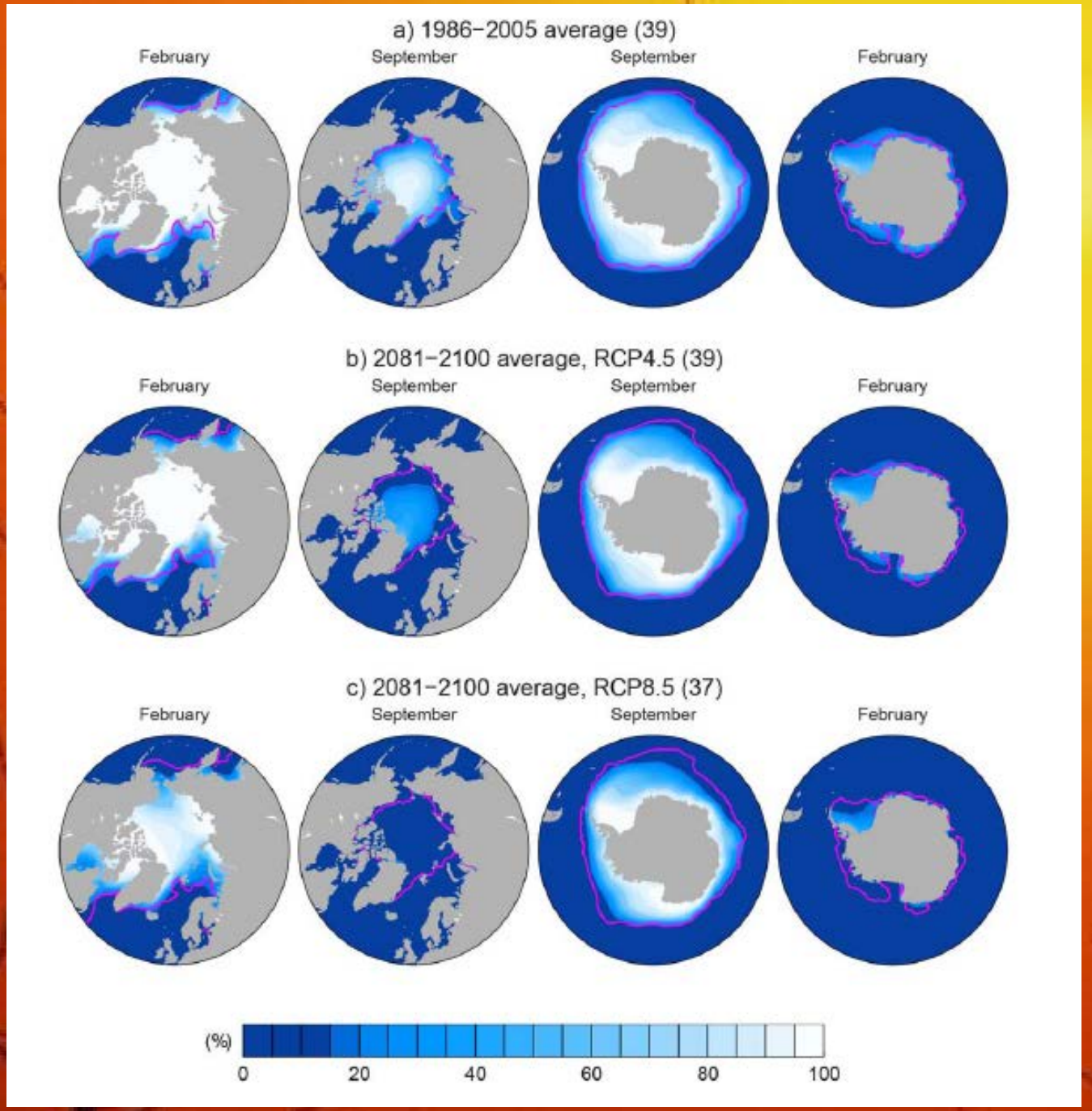


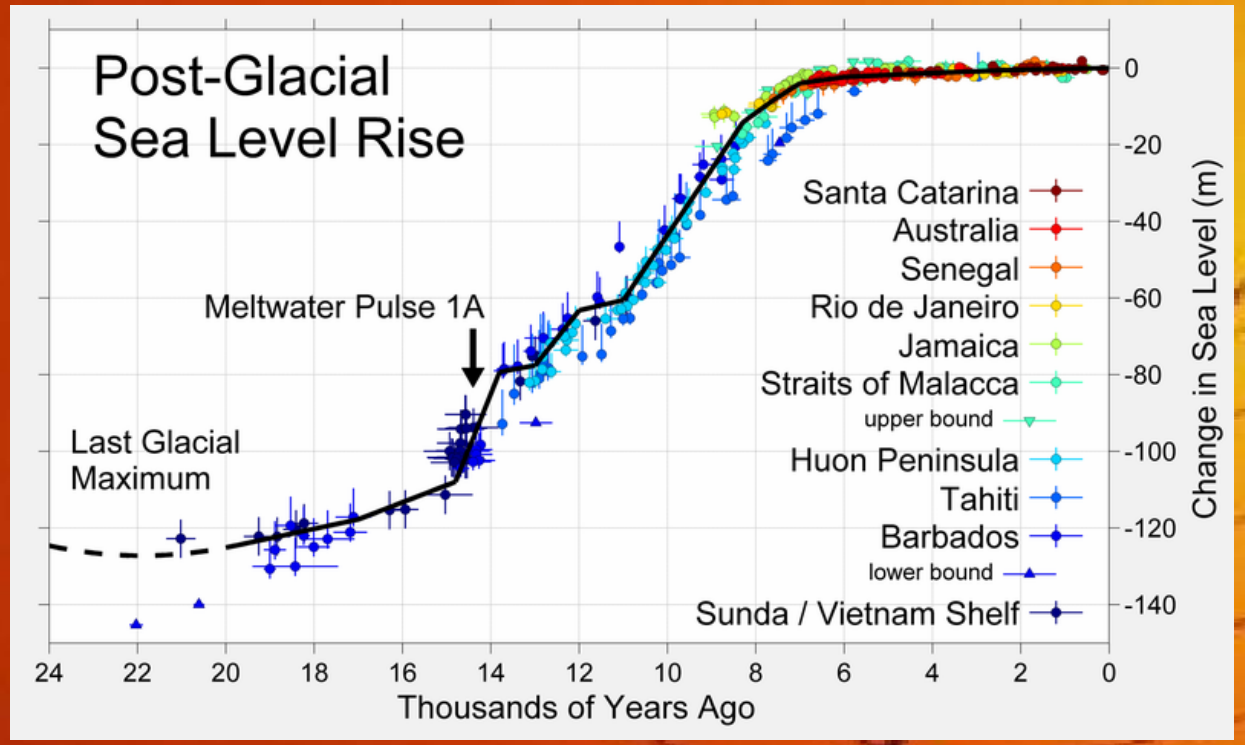

Temperature scaled by global T (°C per °C)
CMIP3 : 2080-2099
Precipitation scaled by global T (% per °C)
CMIP3 : 2080-2099
CMIP5 : 2081-2100
CMIP5 : 2081-2100
(°C per °C global mean change)
0 0.25 0.5 0.75 1 1.25 1.5 1.75 2
(% per °C global mean change)
-12 -9 -6 -3 0 3 6 9 12

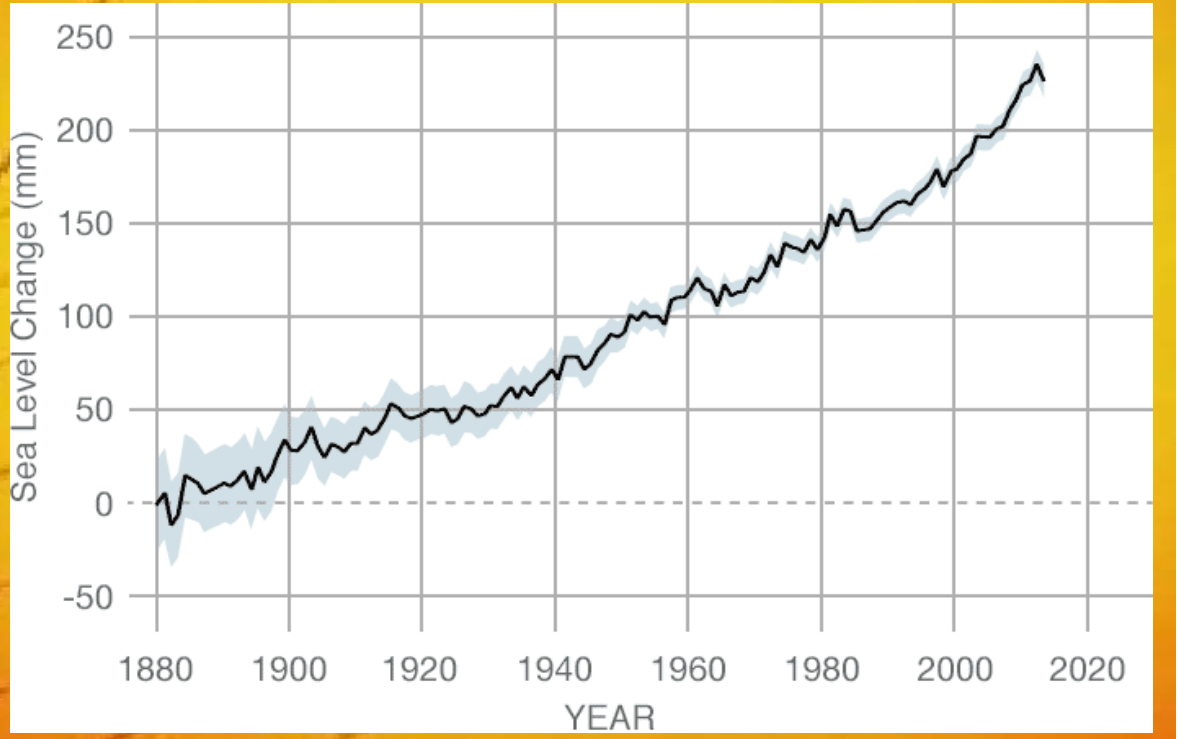

September 1979
September 2005
September 2007
Sea Ice Extent
Sep 1979
Total extent = 7.2 million sq km
Current Ice Extent
09/21/2005
Current Ice Extent
09/16/2007

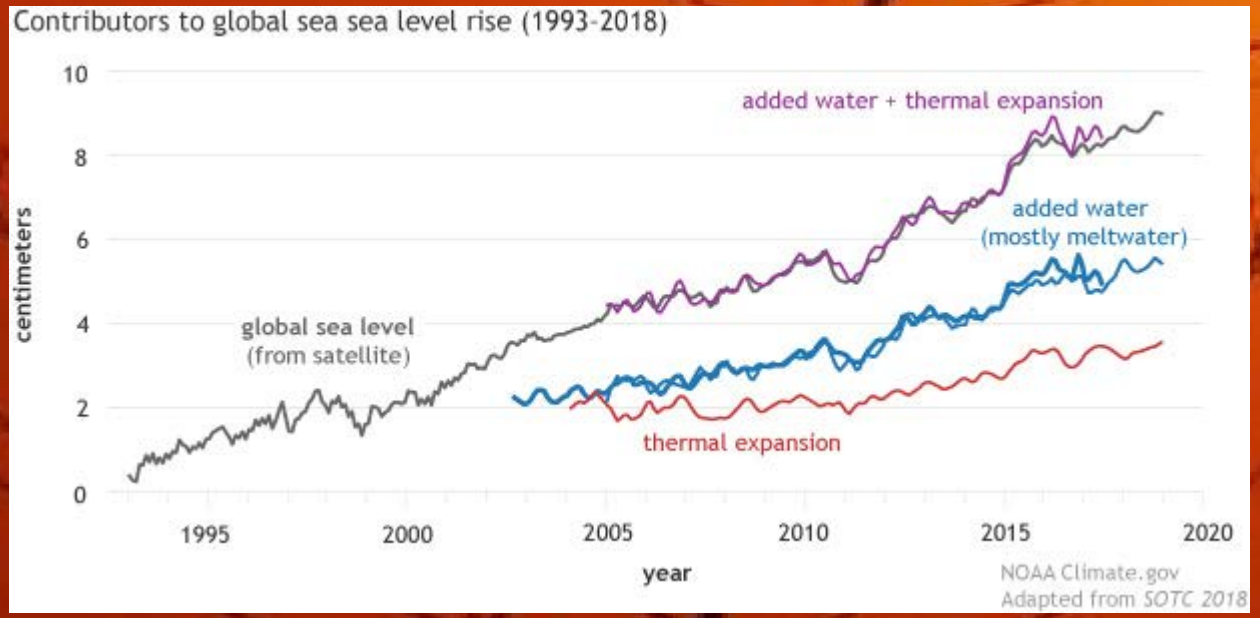

Contribution of Glaciers and Ice Sheets to Sea Level Change
Glaciers
Greenland
Antarctica
Cumulative ice mass loss (Gt)
SLE (mm)
Year
Cumulative ice mass loss from glacier and ice sheets (in sea level equivalent) is
1.0 to 1.4 mm/yr for 1993-2009 and 1.2 to 2.2 mm/yr for 2005-2009.

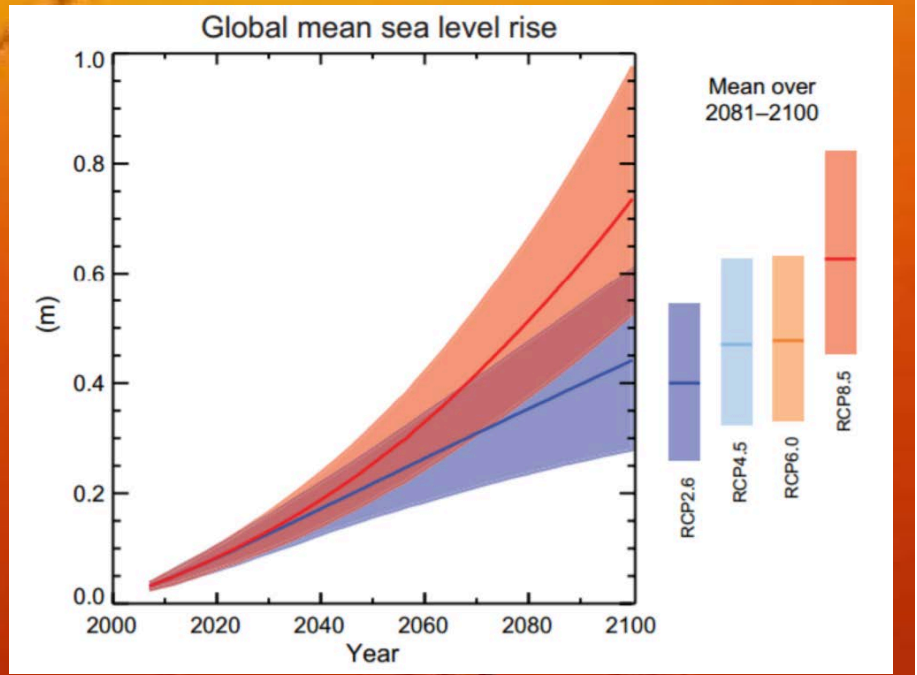

Antarctic Peninsula
East Antarctica
West Antarctica
Amundsen Sea
Wilkes Land
Scale (km)
Bed elevation (m)
-2000
-1000
0
1000
+1500
(m)
(km)


a) 1986–2005 average (39)
February
September
September
February
b) 2081–2100 average, RCP4.5 (39)
February
September
September
February
c) 2081–2100 average, RCP8.5 (37)
February
September
September
February
(%)
0
20
40
60
80
100


Post-Glacial
Sea Level Rise
Meltwater Pulse 1A
Last Glacial
Maximum
Santa Catarina
Australia
Senegal
Rio de Janeiro
Jamaica
Straits of Malacca
upper bound
Huon Peninsula
Tahiti
Barbados
lower bound
Sunda / Vietnam Shelf
Change in Sea Level (m)
Thousands of Years Ago


Sea Level Change (mm)
YEAR


Contributors to global sea sea level rise (1993-2018)
added water + thermal expansion
added water
(mostly meltwater)
global sea level
(from satellite)
thermal expansion
centimeters
year
NOAA Climate.gov
Adapted from SOTC 2018


Global mean sea level rise
Mean over
2081–2100
(m)
Year
RCP2.6
RCP4.5
RCP6.0
RCP8.5

Potential impact of sea-level rise on Bangladesh

Today
Total population: 112 Million
Total land area: 134,000 km^2

1.5 m - Impact
Total population affected: 17 Million (15%)
Total land area affected: 22,000 km^2 (16%)

GRID Arendal UNEP

Source : UNEP/GRID Geneva; University of Dacca; JRO Munich; The World Bank; World Resources Institute, Washington D.C.

Potential impact of sea level rise: Nile Delta

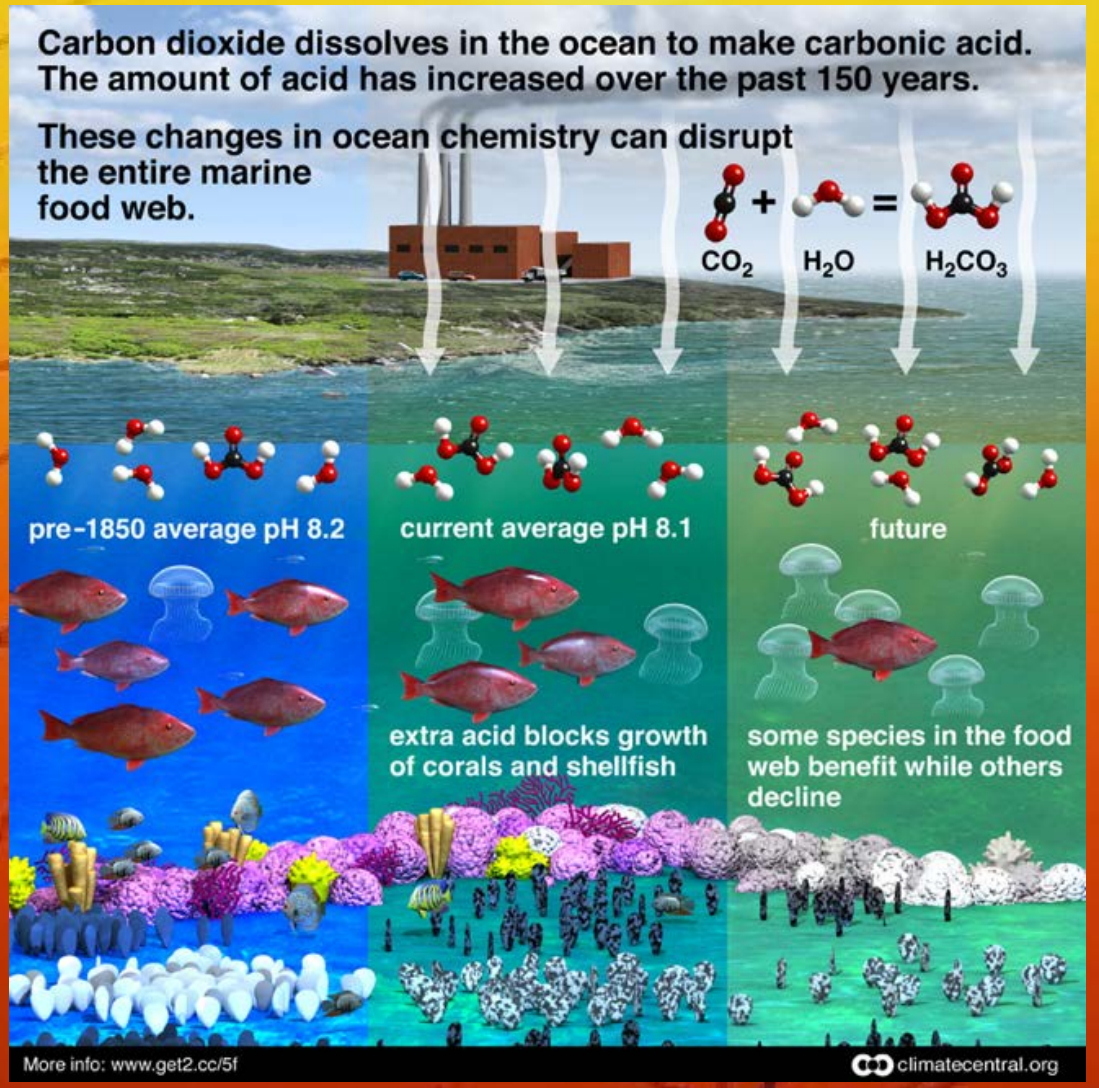
Population: 3 800 000
Cropland (Km^2): 1 800

Population: 6 100 000
Cropland (Km^2): 4 500

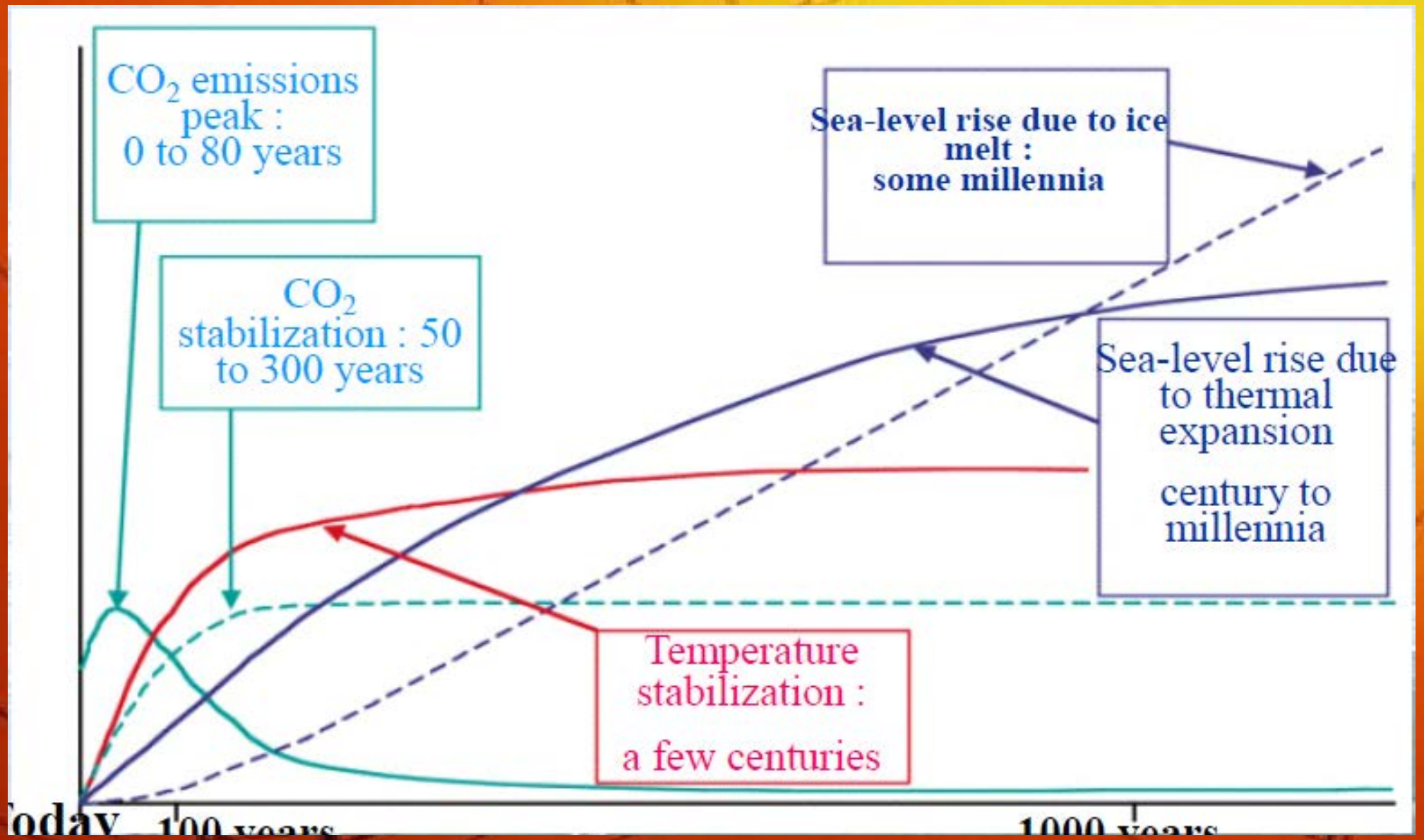
GRID Arendal UNEP IUCC

0 50 km

Sources: Otto Simonett, UNEP/GRID Geneva; Prof. G. Sestini, Florence; Remote Sensing Center, Cairo; DIERCKE Weltwirtschaftsatlas.


Carbon dioxide dissolves in the ocean to make carbonic acid.
The amount of acid has increased over the past 150 years.
These changes in ocean chemistry can disrupt the entire marine food web.
CO_2 + H_2O = H_2CO_3
pre-1850 average pH 8.2
current average pH 8.1
future
extra acid blocks growth of corals and shellfish
some species in the food web benefit while others decline
More info: www.get2.cc/5f
climatecentral.org


Sea Level Rise &
Population Impact
Projected Sea Level Rise by 2100
(Feet)
6.6'
7.8 million
3.9'
4.7 million
1.6'
1.8 million
0.7'
1.3 million
Highest Projection
Intermediate-High Projection
Intermediate-Low Projection
Lowest Projection
Today's Population Living Below
Projected High-Tide Line
CLIMATE CENTRAL
Source: National Oceanic and Atmospheric Administration and Climate Central
Population numbers are based on 2010 U.S. Census data for the contiguous U.S..


CO_2 emissions peak : 0 to 80 years
CO_2 stabilization : 50 to 300 years
Sea-level rise due to ice melt : some millennia
Sea-level rise due to thermal expansion
century to millennia
Temperature stabilization :
a few centuries
Today
100 years
1000 years