SEC-2 Climate change: Basic Concepts

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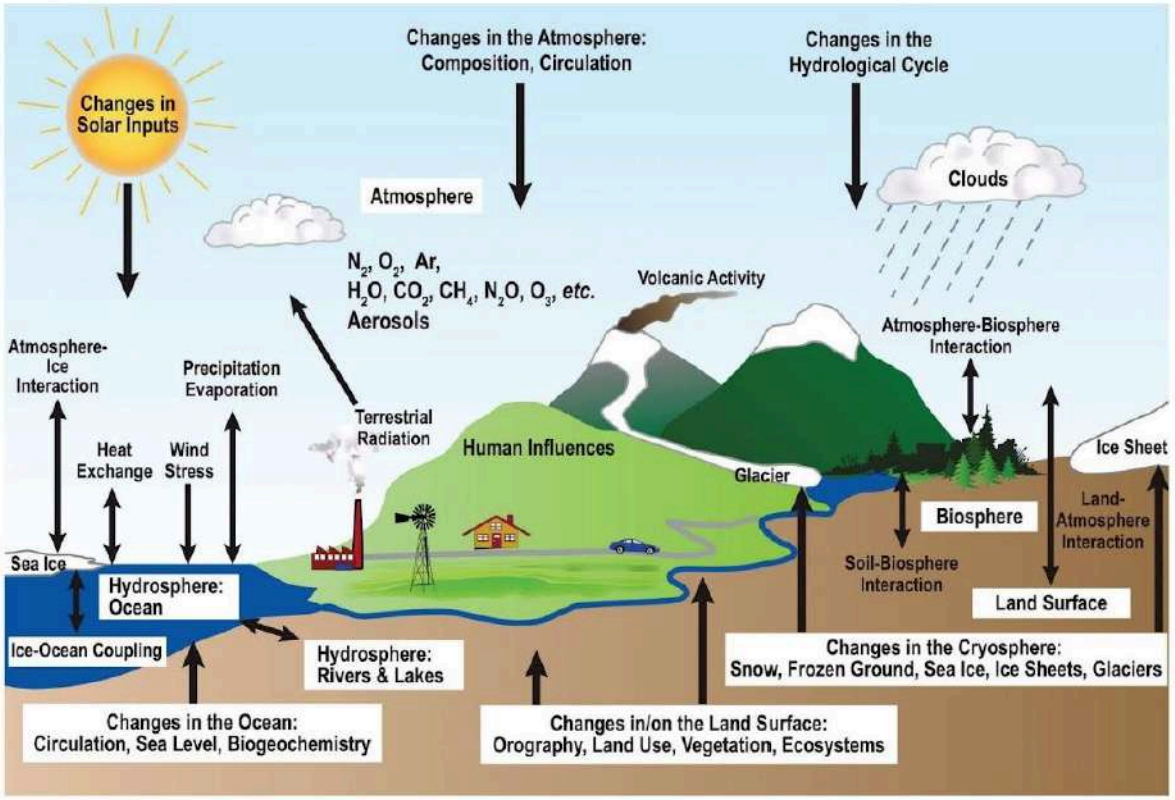


Figure 13.1 A schematic of processes driving variability and change in the climate system.

Source: IPCC (2007). Reproduced by permission of the IPCC (ch. 1, Historical overview of climate change science, Report of WG1 1, IPCC, P. 104, FAQ 1.2, fig. 1).

Climate change is a very natural phenomena and the earth's climate has witnessed changes in its climatic characteristics throughout the geological periods. Different parts of the world have undergone drastic changes in climate and the factors (**Climate forcing**) are many. The **drifting continents** are the major driving force that forced the climatic change of different parts of the world along with some other natural factors. These are **periodic variations of solar output**, volcanic eruptions, **earth eccentricity**, **obliquity** and precession or **wobble**, volcanic eruptions etc created climate changes on a regular basis. The glacial and interglacial period on the Earth surface of 10,000 years interval are subject to these earth events.

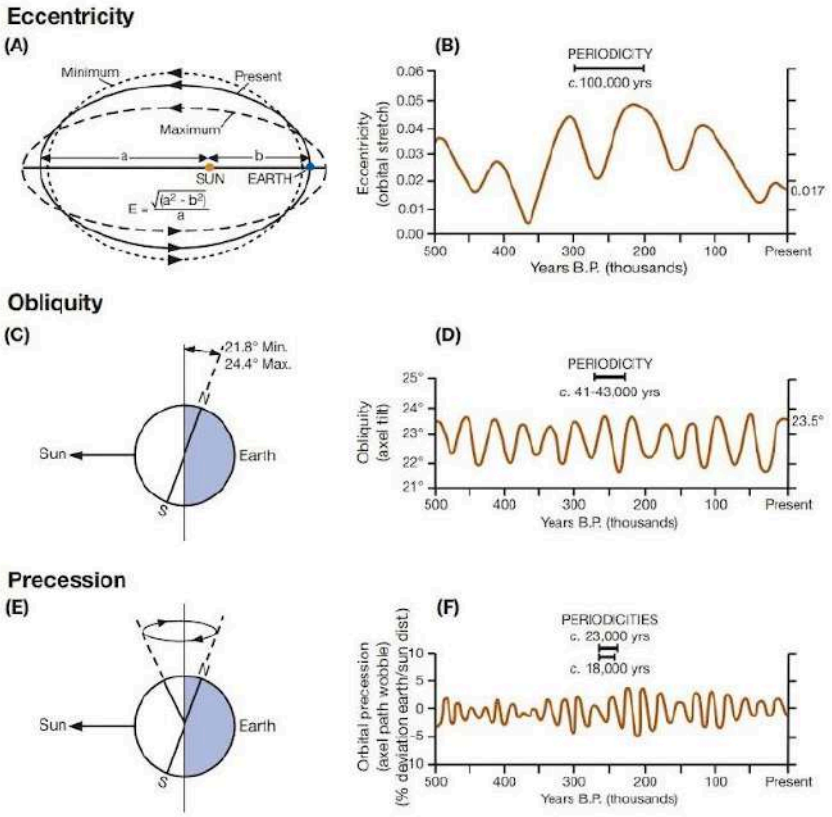


Figure 13.3 Summary of astronomical (orbital) effects on solar irradiance and their relevant timescales over the past 500,000 years. A and B: Eccentricity or orbital stretch; C and D: Obliquity or axial tilt; E and F: Precession or axial path wobble.

Sources: Partly after Broecker and Van Donk 1970, and Henderson-Sellers and McGuffie 1984. B, D and F: from *Review of Geophysics and Space Physics* 8 (1970). Reproduced by kind permission of the American Geophysical Union.

Element	Index range	Present value	Average periodicity
Obliquity of Ecliptic (′) (Tilt of axis of rotation) Effects equal in both hemispheres, effect intensifies poleward (for caloric seasons)	22–24.5°	23.4°	41 ka
Low ′ / High ′ Weak seasonality, steep poleward radiation gradient / Strong seasonality, more summer radiation at poles, weaker radiation gradient			
Precession of Equinox (v) (Wobble of axis of rotation) Changing earth–sun distance alters seasonal cycle structure; complex effect, modulated by eccentricity of orbit	0.05 to –0.05	0.0164	19, 23 ka
Eccentricity of Orbit (e) Gives 0.02% variation in annual incoming radiation; modifies amplitude of precession cycle changing seasonal duration and intensity; effects opposite in each hemisphere; greatest in low latitudes	0.005 to 0.0607	0.0167	410, 95 ka

But in this **modern populus human world** there are some signs of climatic variability in different parts of the world with different magnitudes which are putting considerable impacts on the pattern of agriculture and settlement and the life and economy of people. The records from the recent past warn human society for climatic change in different parts of human habitations making people vulnerable and forcing them towards danger. S**evere climatic hazards in the form of heal wave, flood, drought, cyclones, inundation and flooding due to oceanic surge, desertification, global warming, drying of water bodies, acid rain, ocean acidification, shortening of mountain glaciers and ice sheets in polar region,** all are signs of global climate change. The immediate result is the changing scenario of food production resulting in famine and hunger with severe malnutrition, livelihood changes and economic losses causing poverty, environmental forced migration and climate refugee, extinction of species due to ecosystem modification.

Instrument records started 100- 150 years ago and the data earlier than this was collected from **tree rings** (one to half yearly cycle), **ice cores** (long column of ice), **peat bogs** and **ocean sediments** (100- 1000 year resolution).

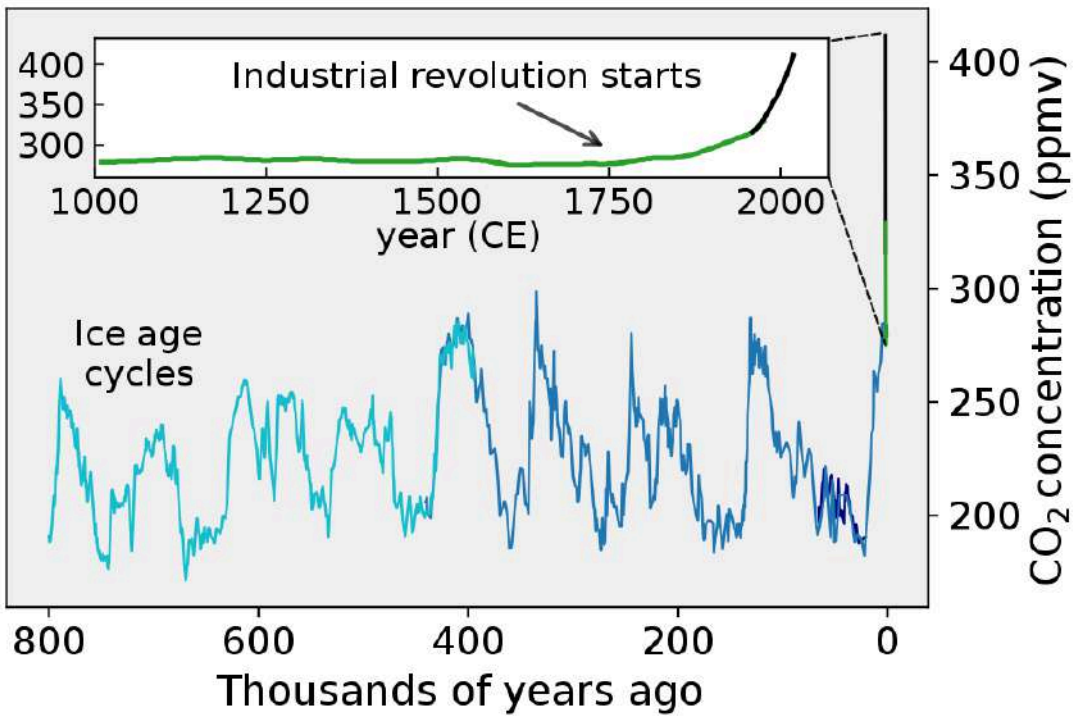
Increasing **concentration of carbon dioxide** in the atmosphere in the last 200 years creates an **enhanced greenhouse effect (climate feedbacks)** in the atmosphere, which in turn forces the global average atmospheric temperature to rise (positive climate feedbacks). **Positive feedback of CO2** and other greenhouse gases on global warming put positive impacts on the **positive water vapour feedback,** Even melting of snow and ice and permafrost zones further lead to **lowering of its albedo**, thereby causing more warming and positive climate feedback by **increasing methane from melting permafrost region.**

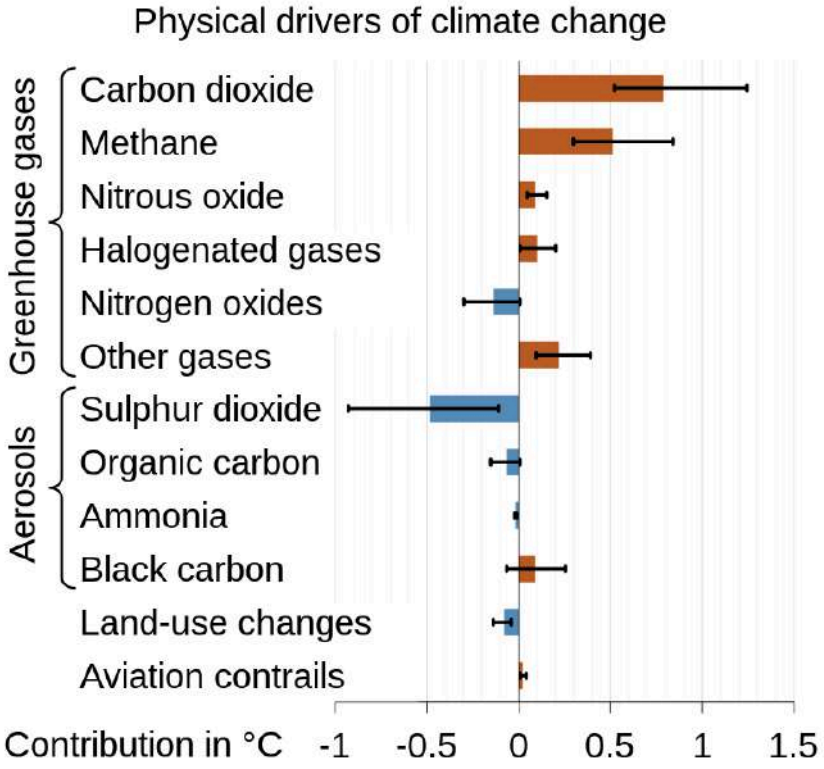
Along with global warming **global dimming** is also observed in some places where the amount of aerosols and dust particles has increased in the atmosphere.

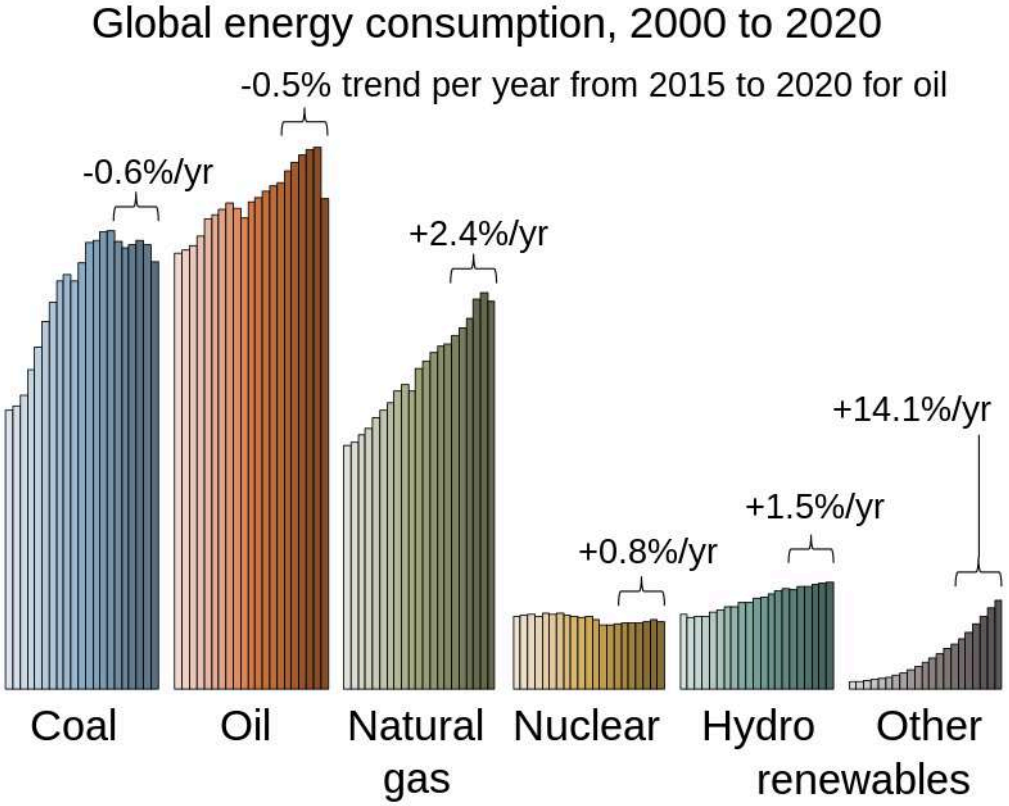
The **climate forcings** are natural as well as human driven. Human driven. Human driven forces are: i. **Increasing fossil fuel burning** and increased concentration of carbon dioxide, ii. **Loss of forest covers**, iii. **Melting of ice sheets** and decreasing albedo, iv. **Concretisation of surface** etc.

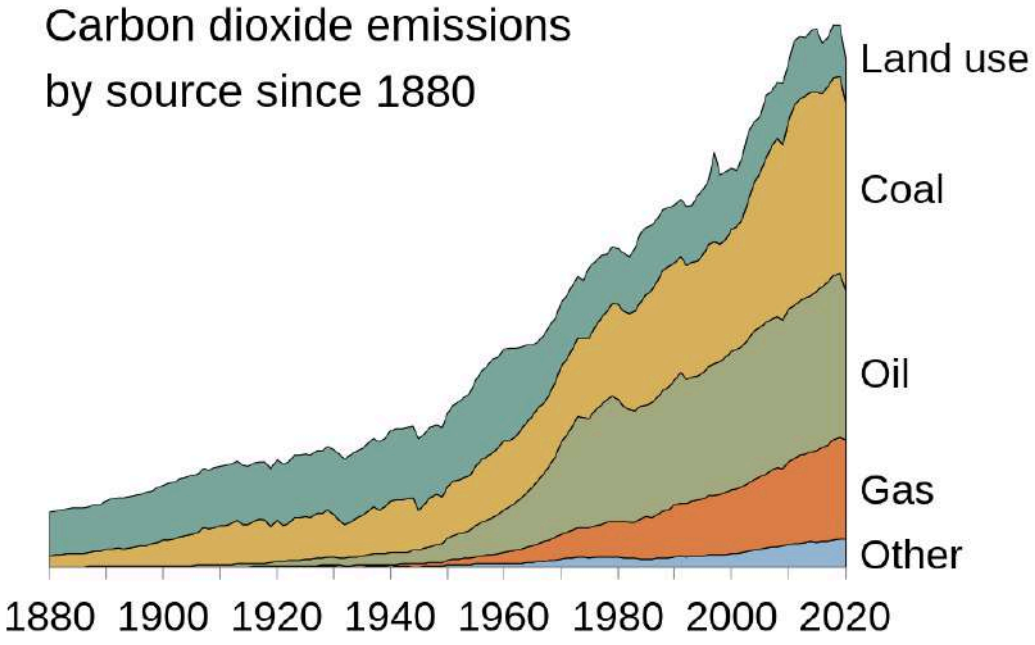
Climate both at global scale, and micro scale are changing and we are now in a position of facing various adverse climatic events. Global climate change is determined by the rise of global average temperature but there is a **wide spatial variation in the temperature changes**. Some areas of the world, especially the Cool temperate region experiences high heatwaves and the oceanic areas in the Equatorial region experience a lowering of average

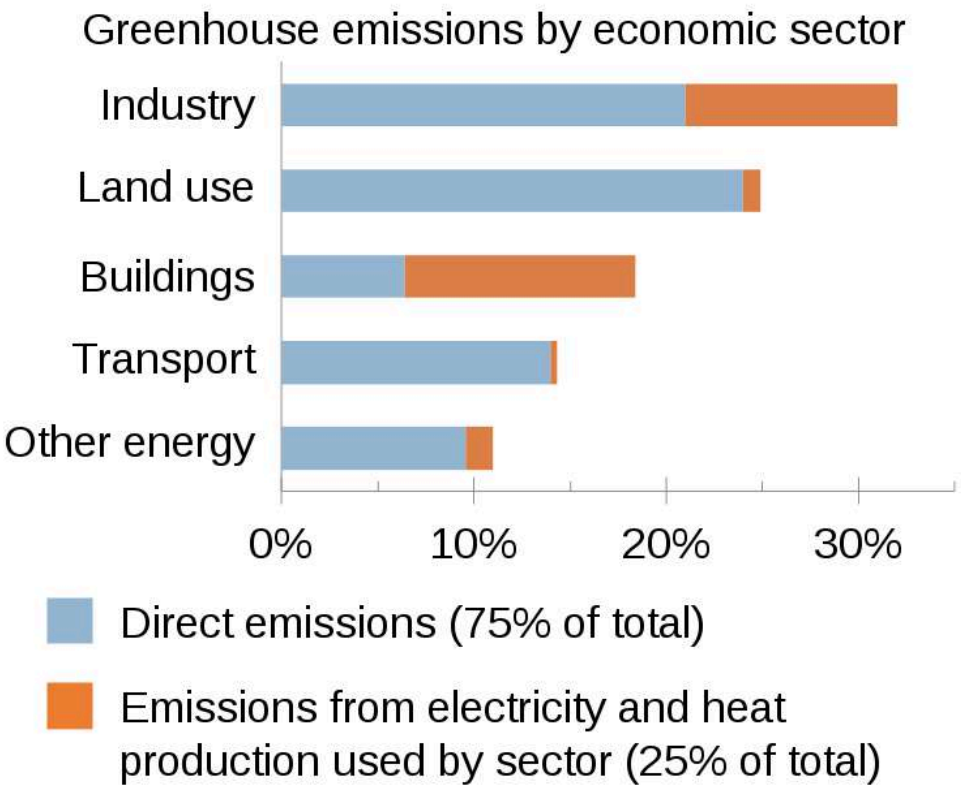
temperature. In a few **areas average temperature is reducing** due to decreasing olar input because of high aerosol concentration in lower atmosphere.

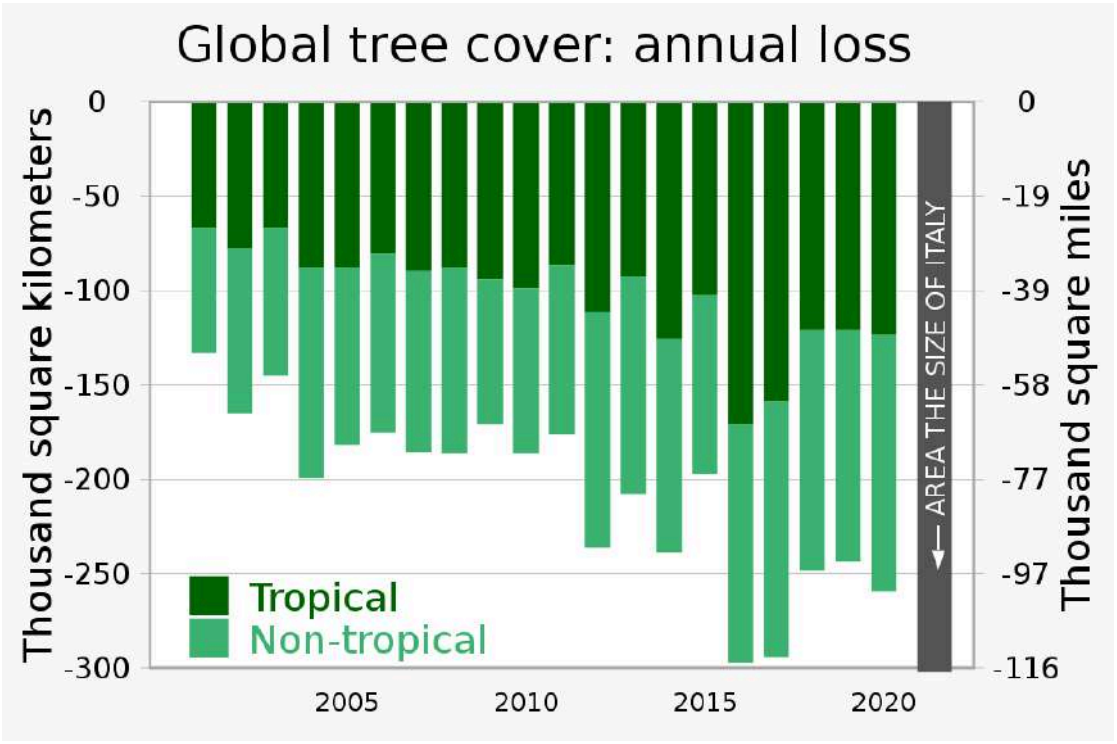


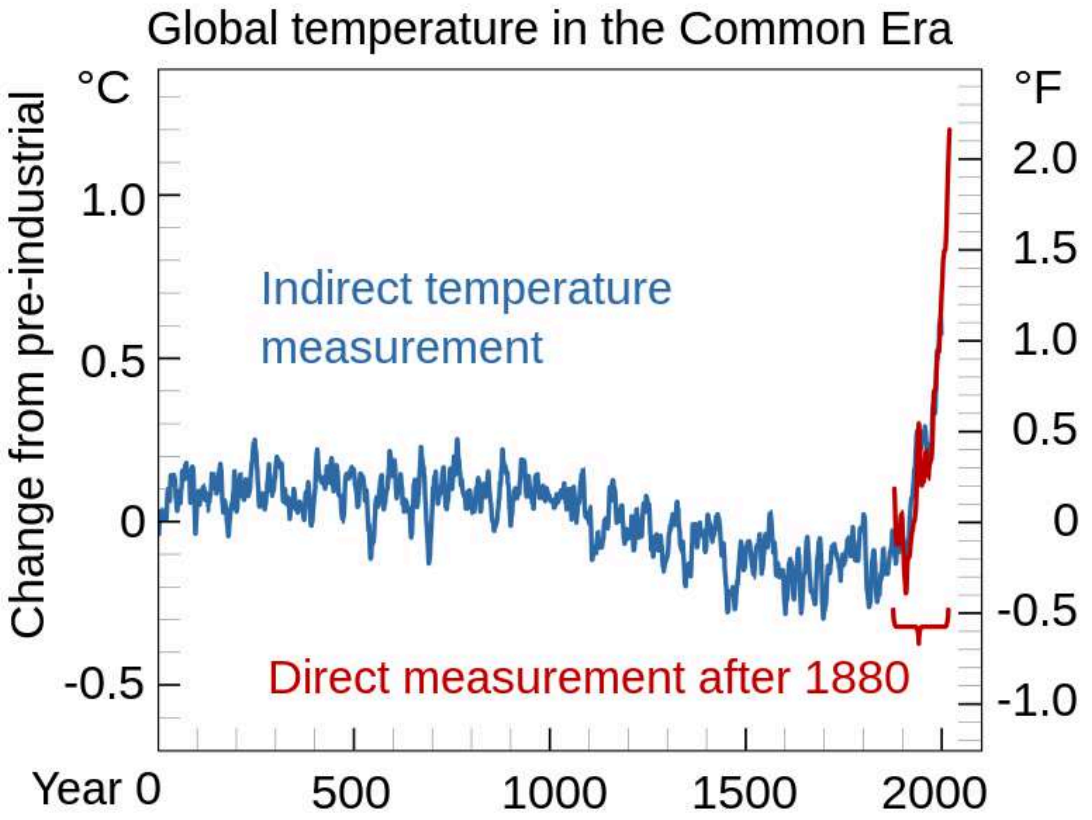


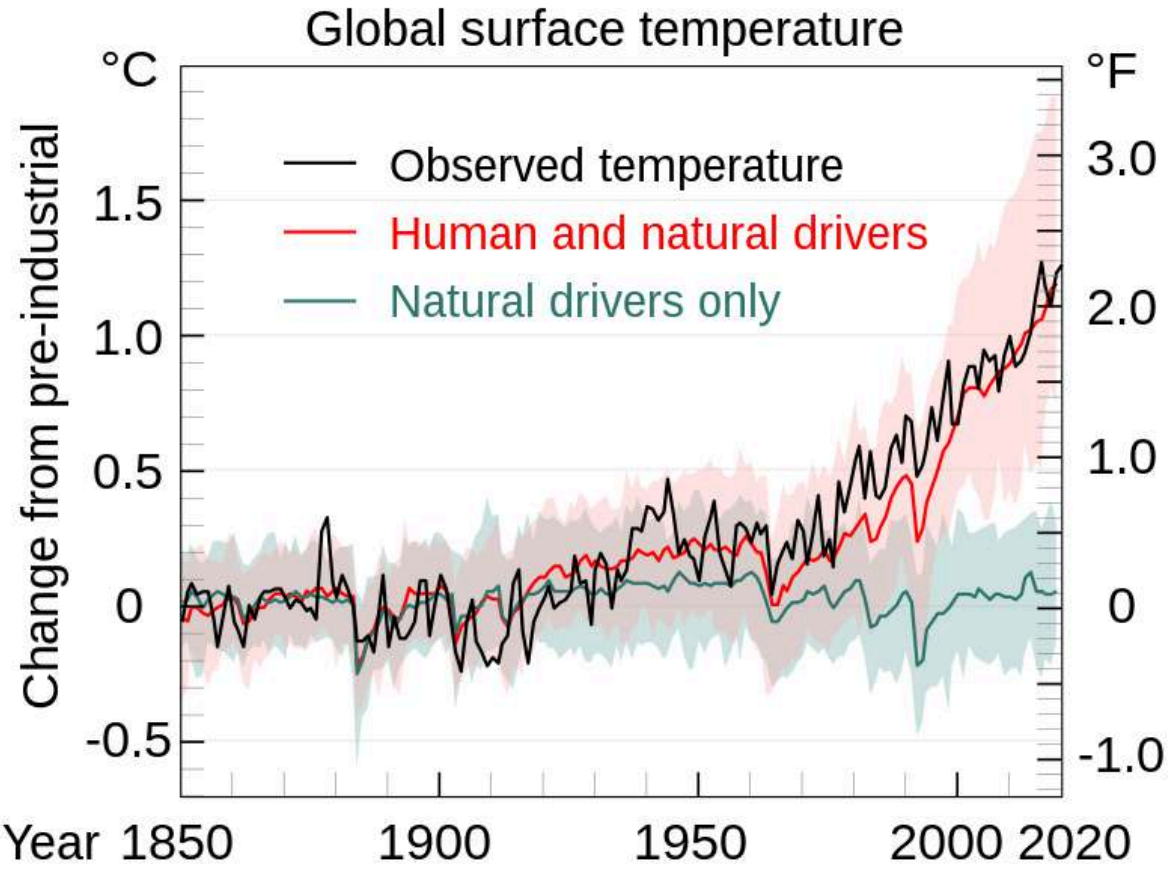

Global energy consumption, 2000 to 2020
-0.5% trend per year from 2015 to 2020 for oil
-0.6%/yr
+2.4%/yr
+14.1%/yr
+1.5%/yr
+0.8%/yr
Coal
Oil
Natural gas
Nuclear
Hydro
Other renewables

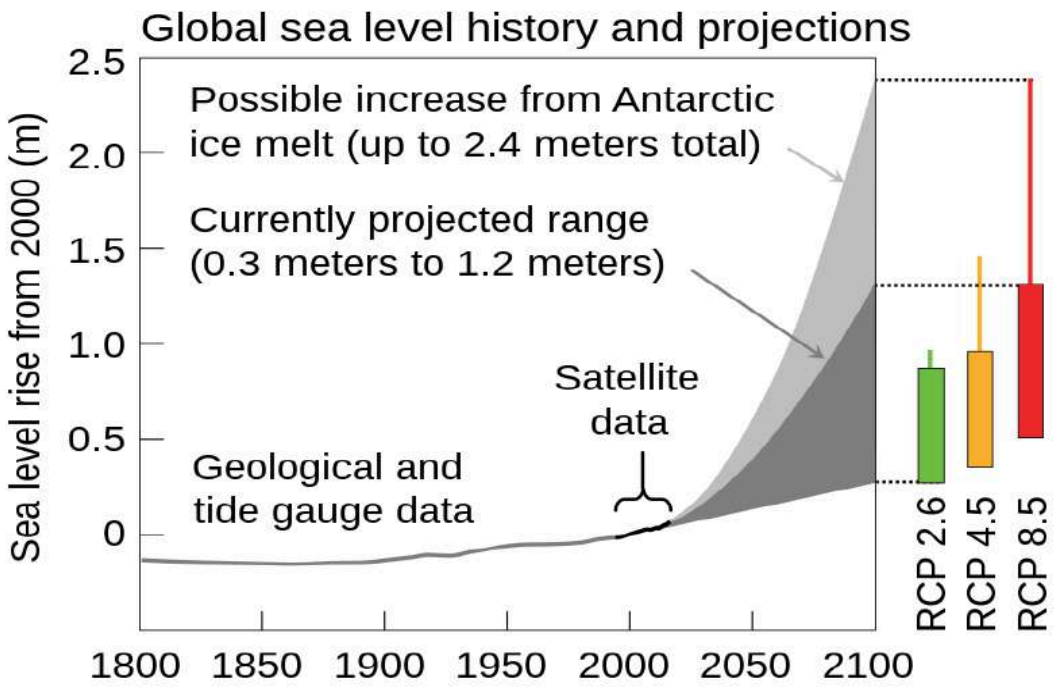

Carbon dioxide emissions by source since 1880
Land use
Coal
Oil
Gas
Other
1880
1900
1920
1940
1960
1980
2000
2020

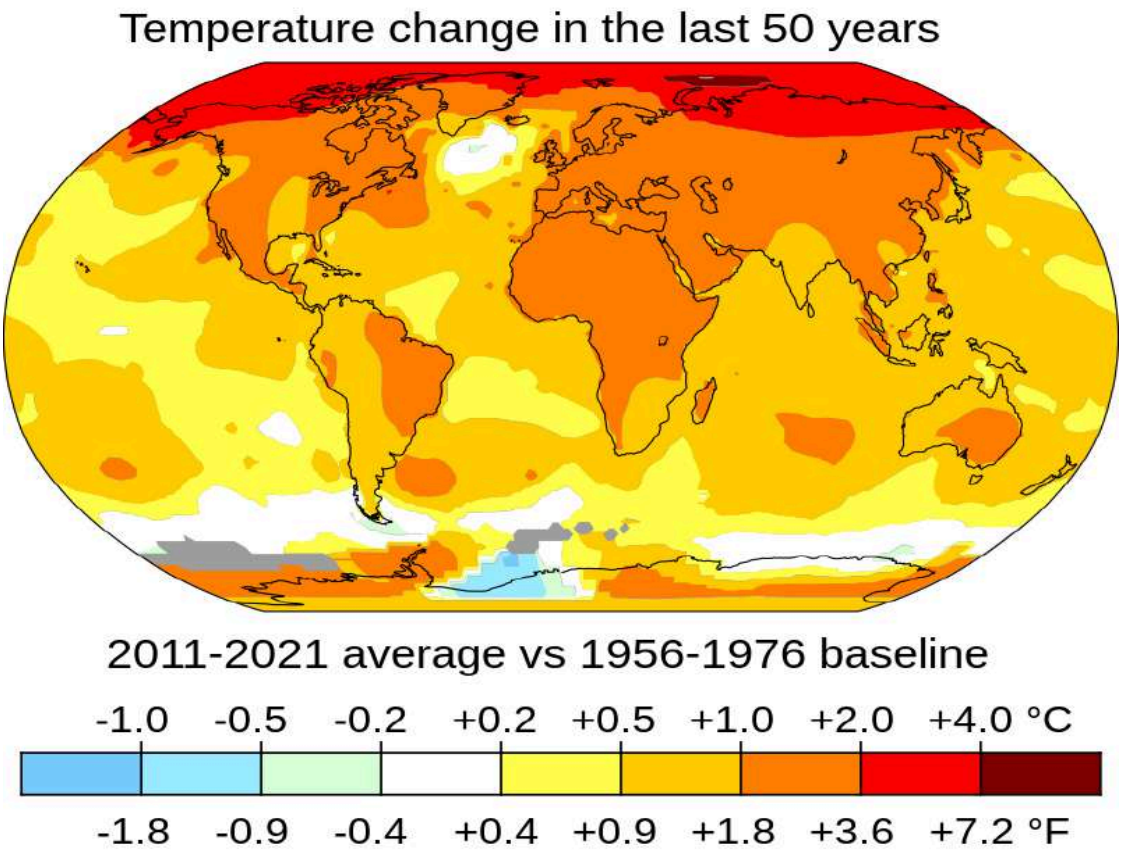

Greenhouse emissions by economic sector
Industry
Land use
Buildings
Transport
Other energy
0%
10%
20%
30%
Direct emissions (75% of total)
Emissions from electricity and heat production used by sector (25% of total)


Global tree cover: annual loss
Thousand square kilometers
0
-50
-100
-150
-200
-250
-300
Thousand square miles
0
-19
-39
-58
-77
-97
-116
AREA THE SIZE OF ITALY
Tropical
Non-tropical
2005
2010
2015
2020


Global temperature in the Common Era
°C
°F
Change from pre-industrial
1.0
0.5
0
-0.5
2.0
1.5
1.0
0.5
0
-0.5
-1.0
Indirect temperature measurement
Direct measurement after 1880
Year 0
500
1000
1500
2000


Global surface temperature
°C
°F
Change from pre-industrial
1.5
1.0
0.5
0
-0.5
3.0
2.0
1.0
0
-1.0
Observed temperature
Human and natural drivers
Natural drivers only
Year 1850
1900
1950
2000
2020


Global sea level history and projections
Sea level rise from 2000 (m)
2.5
2.0
1.5
1.0
0.5
0
Possible increase from Antarctic ice melt (up to 2.4 meters total)
Currently projected range (0.3 meters to 1.2 meters)
Satellite data
Geological and tide gauge data
RCP 2.6
RCP 4.5
RCP 8.5
1800
1850
1900
1950
2000
2050
2100


Temperature change in the last 50 years
2011-2021 average vs 1956-1976 baseline
-1.0 -0.5 -0.2 +0.2 +0.5 +1.0 +2.0 +4.0 °C
-1.8 -0.9 -0.4 +0.4 +0.9 +1.8 +3.6 +7.2 °F