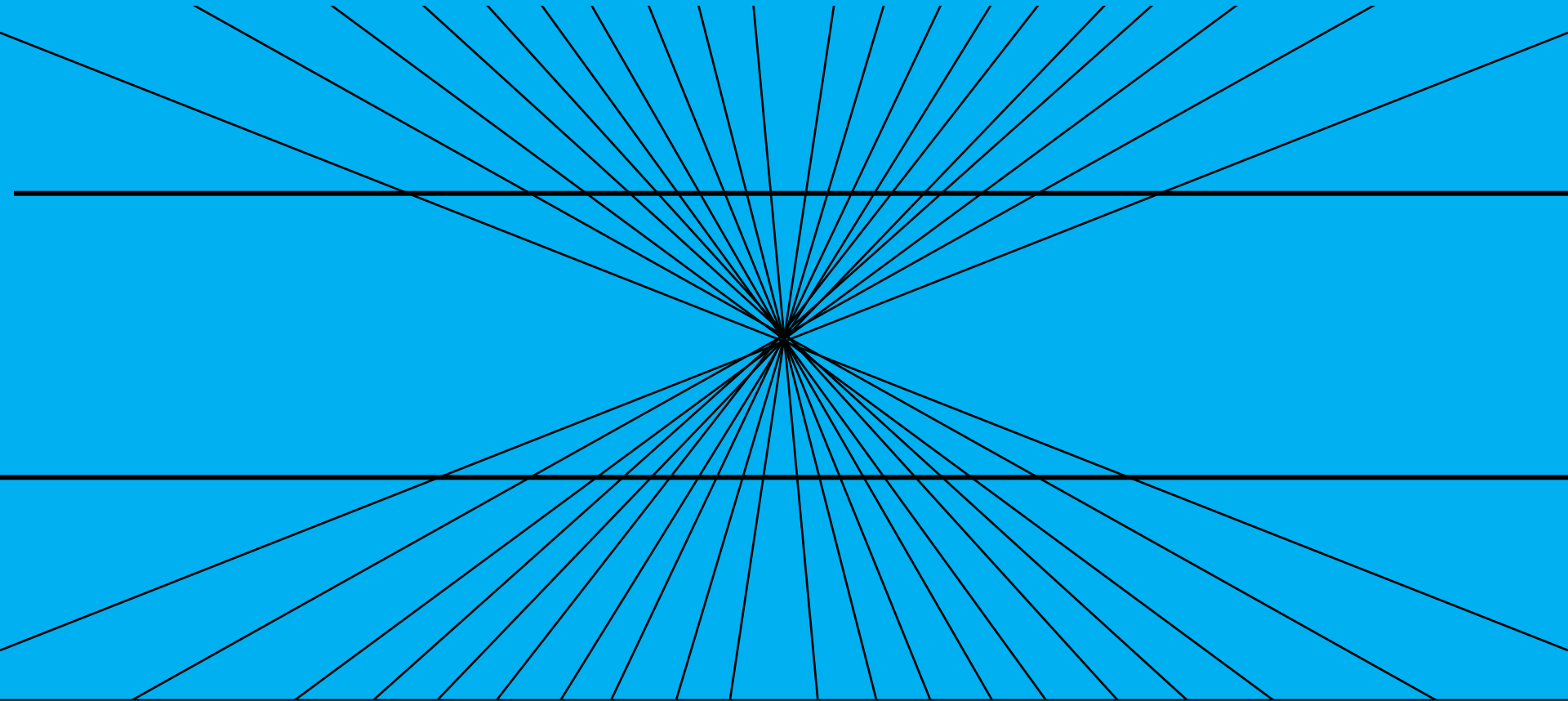


Current understanding of global climate change and of its possible impacts on agriculture



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Outline

1. Scientific understanding of climate change
 - The greenhouse effect
 - Climate Change
 - Driving forces
 - Pressures
 - State
 - Impacts
 - Responses
2. Attributing climate change and climate scepticism

What do we mean by climate system?

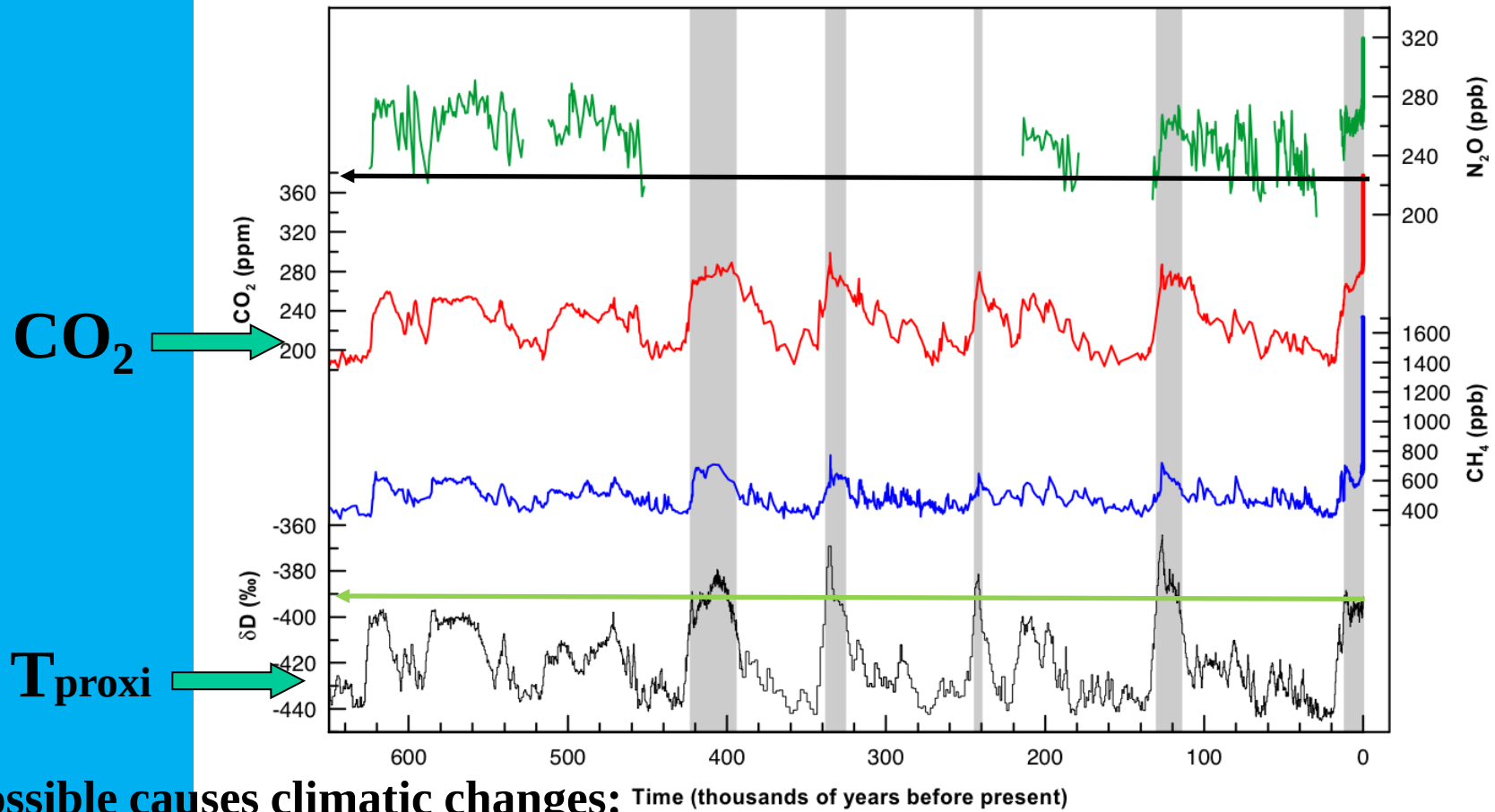
- Atmosphere
- Hydrosphere
- Cryosphere
- Geosphere
- Biosphere

What have been the main causes of climate changes in the last million years?

- Astronomical and solar activity changes
- Atmospheric chemistry
- Land use and land cover

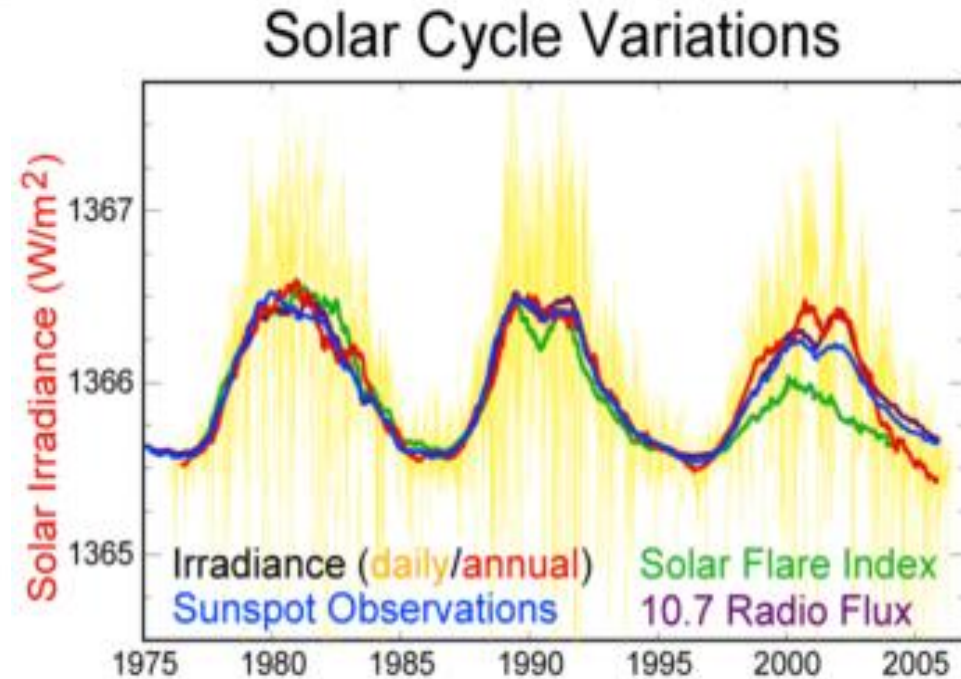
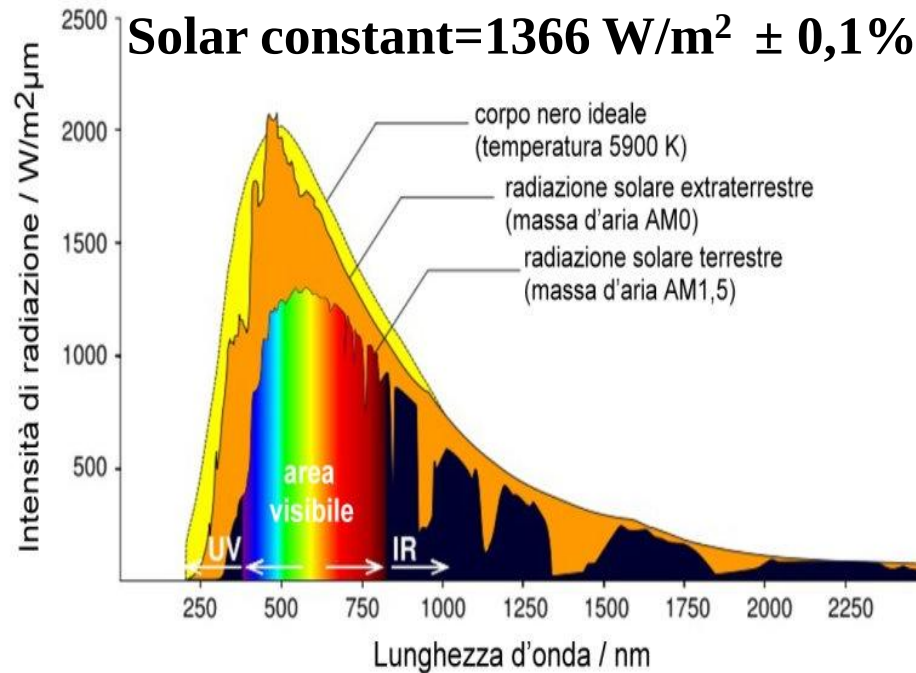
Climate changes in the last 650,000 years

Glacial-Interglacial Ice Core Data

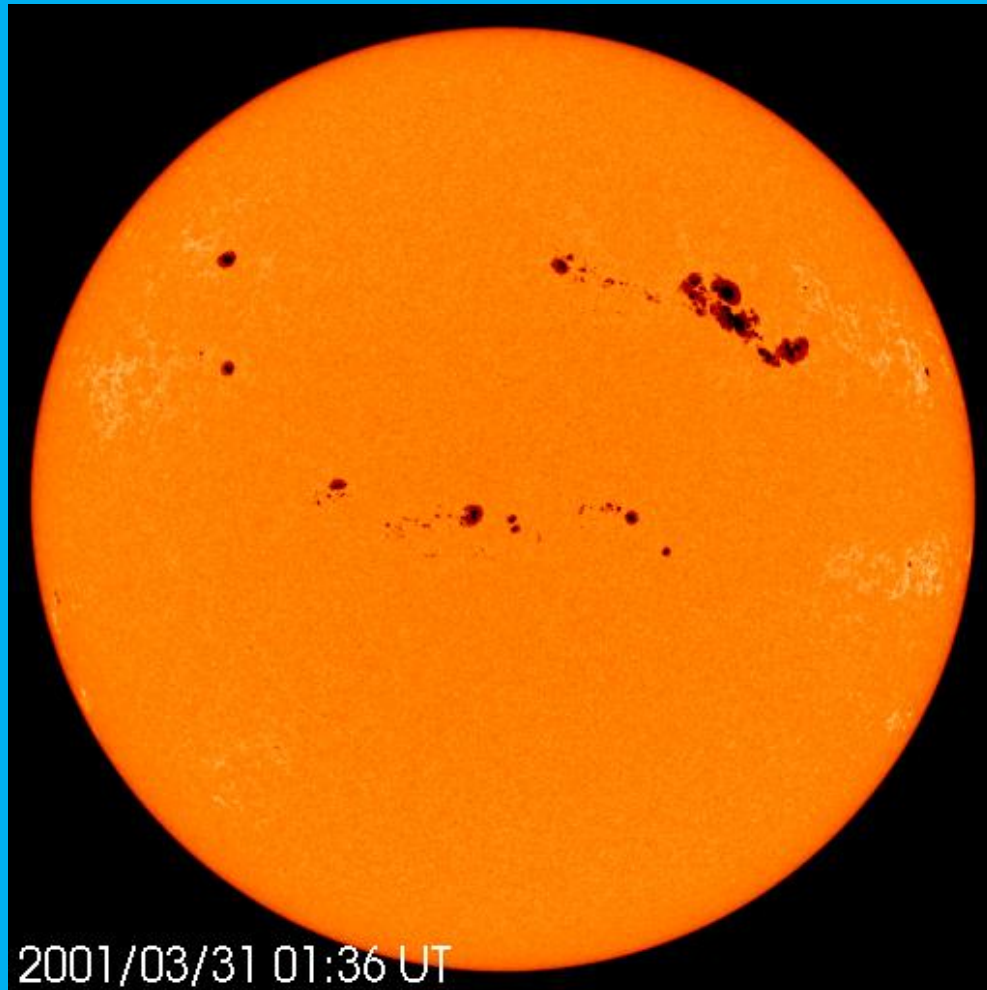


- changes in the Earth's orbit around the Sun known as Milankovitch cycles,
- changes in atmospheric composition
- changes in solar output

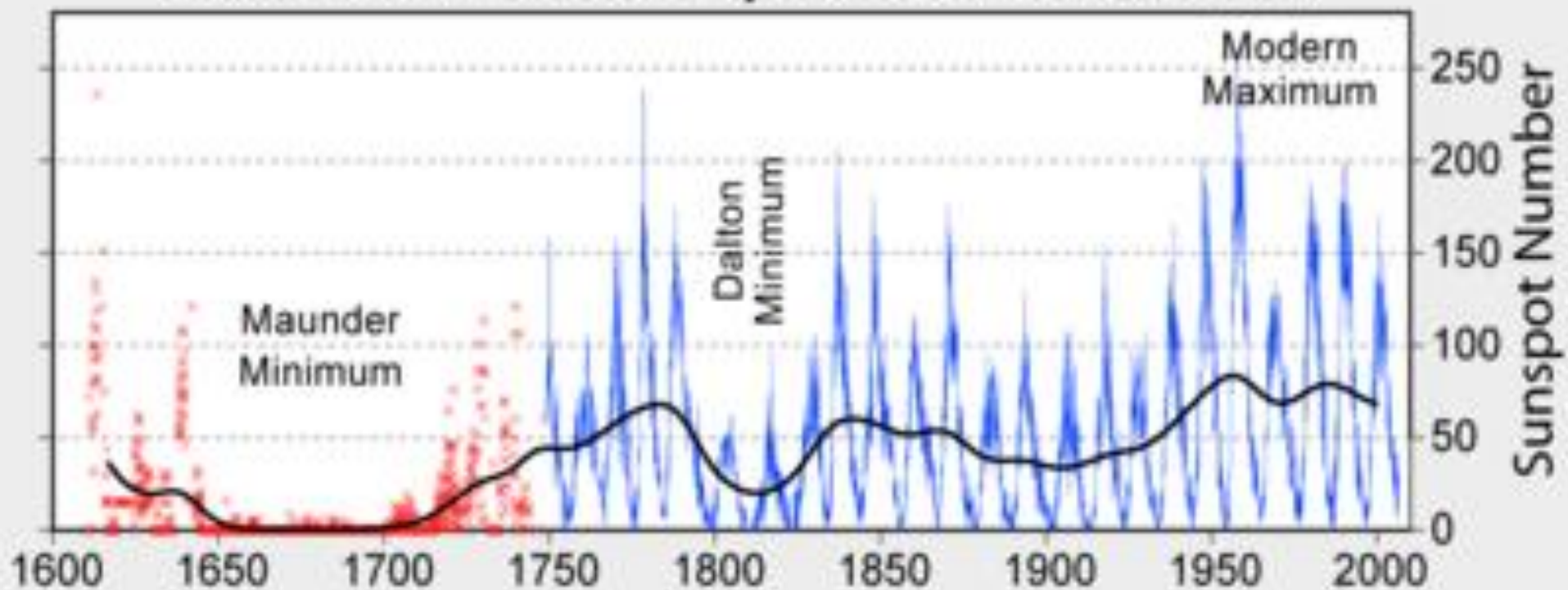
THE SOLAR RADIATION



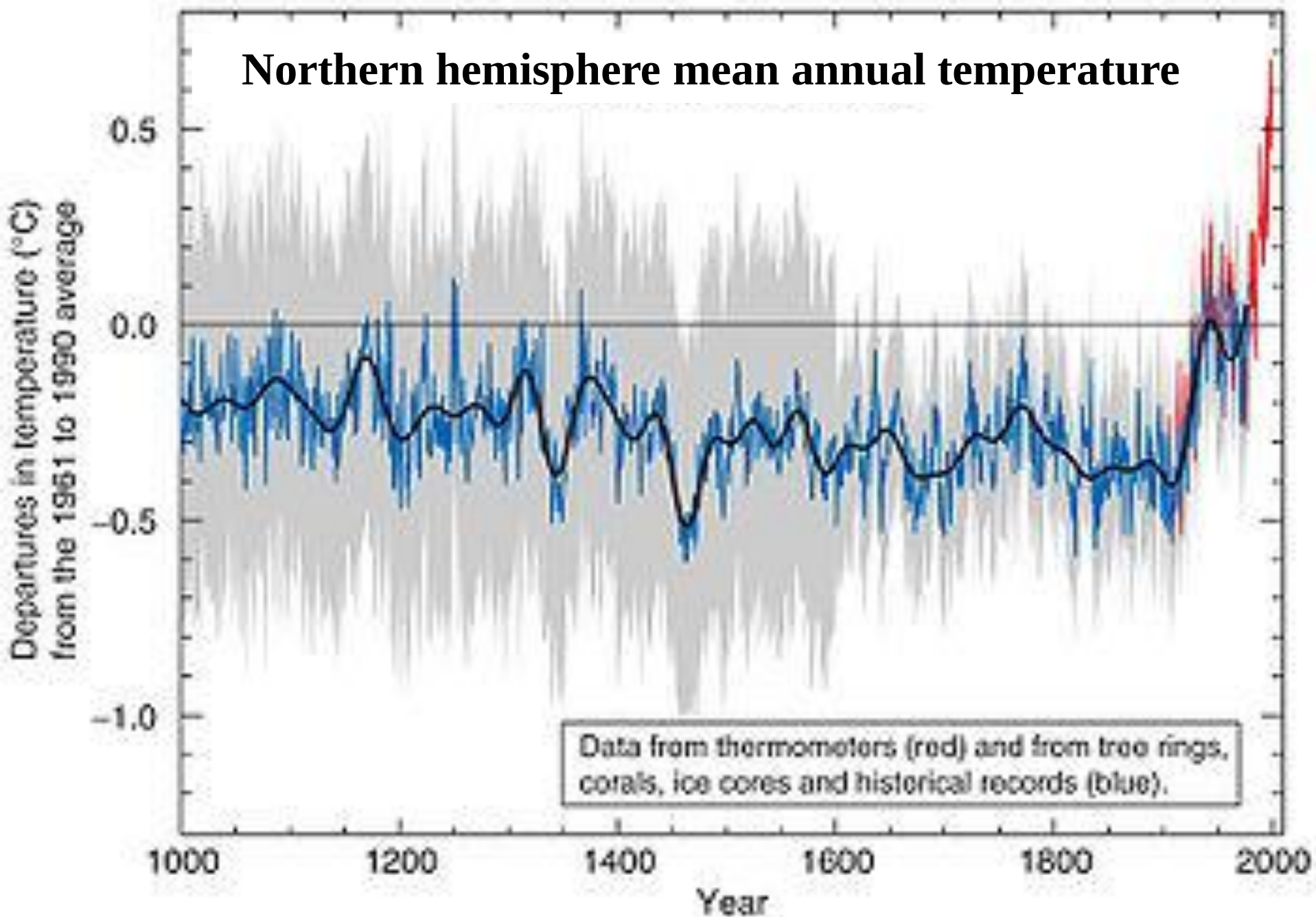
Sunspots



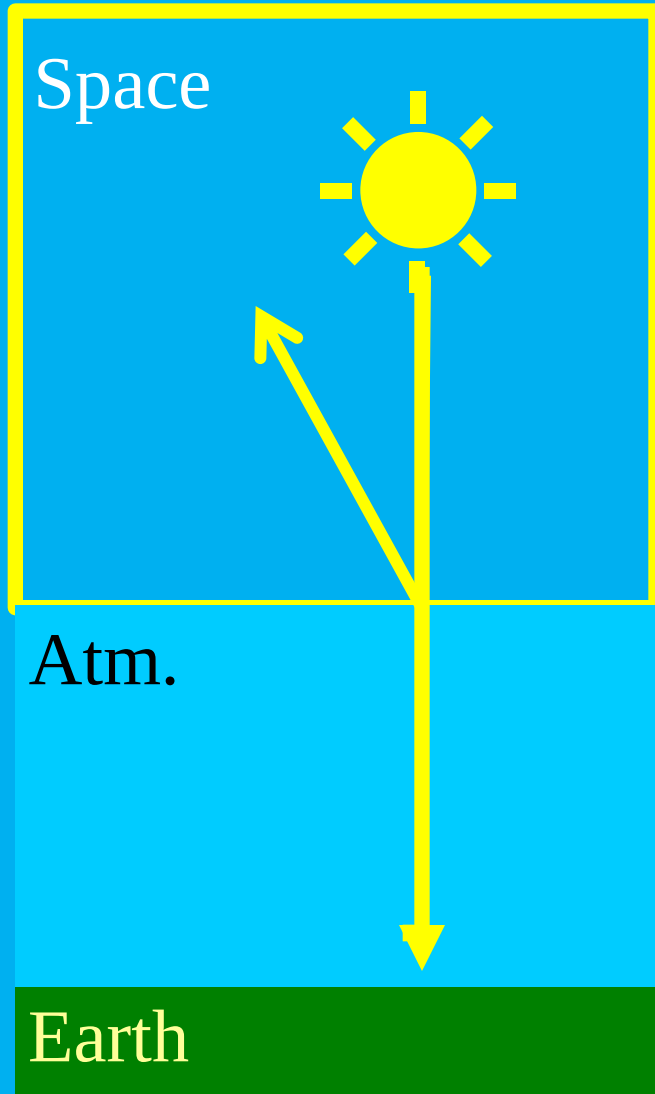
400 Years of Sunspot Observations



Northern hemisphere mean annual temperature



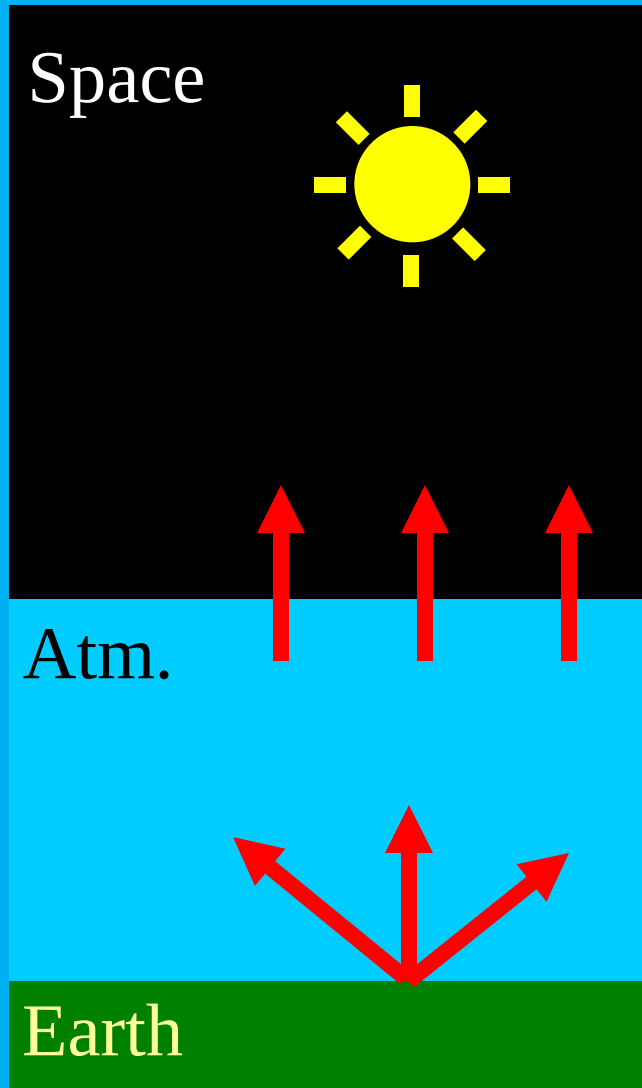
The Greenhouse Effect



Solar radiation (Visible and infrared radiation)

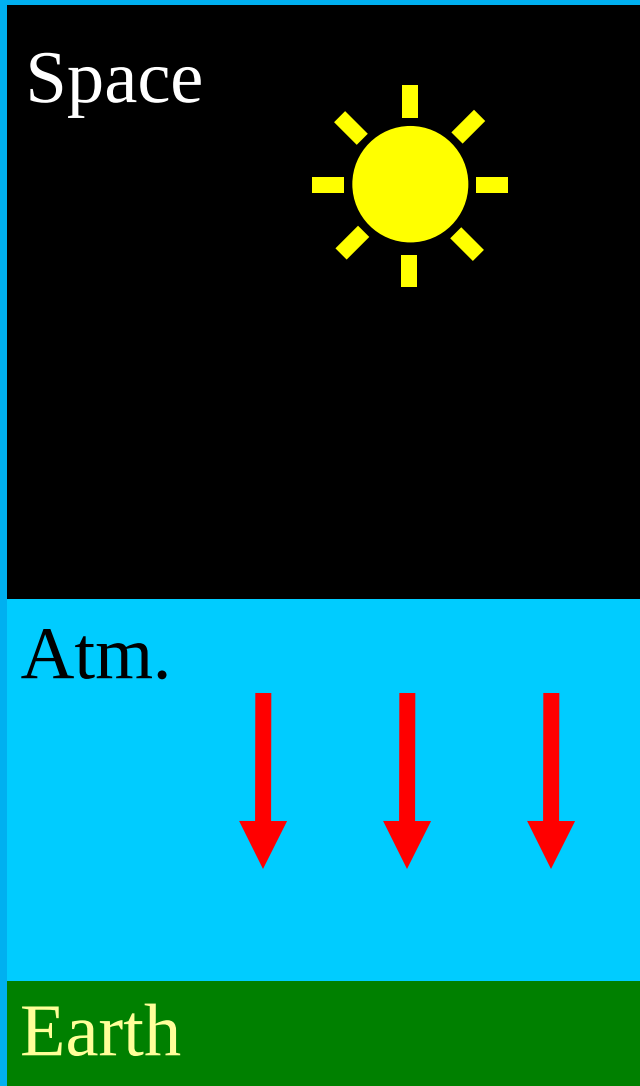
- 50% reflected back to space
- 50% reaches Earth

The Greenhouse Effect



Incoming energy from sun is converted to thermal radiation and in part returned to space

The Greenhouse Effect



**and in part absorbed by
greenhouse gases and re
emitted towards the earth
surface.**

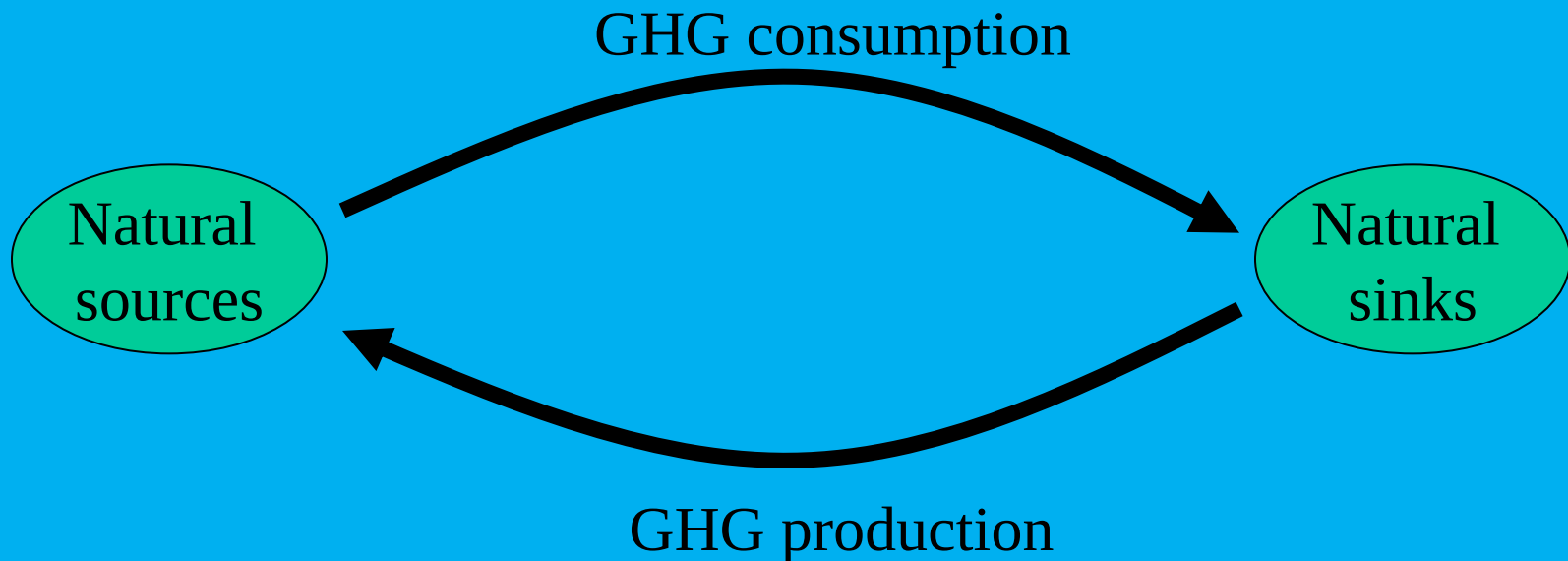
The Greenhouse Effect

- The greenhouse effect is natural
- Most greenhouse gases are natural
- Without the greenhouse effect average temperatures would be 30 degrees less and life may not have been possible on Earth

So what's the problem ???!!!??

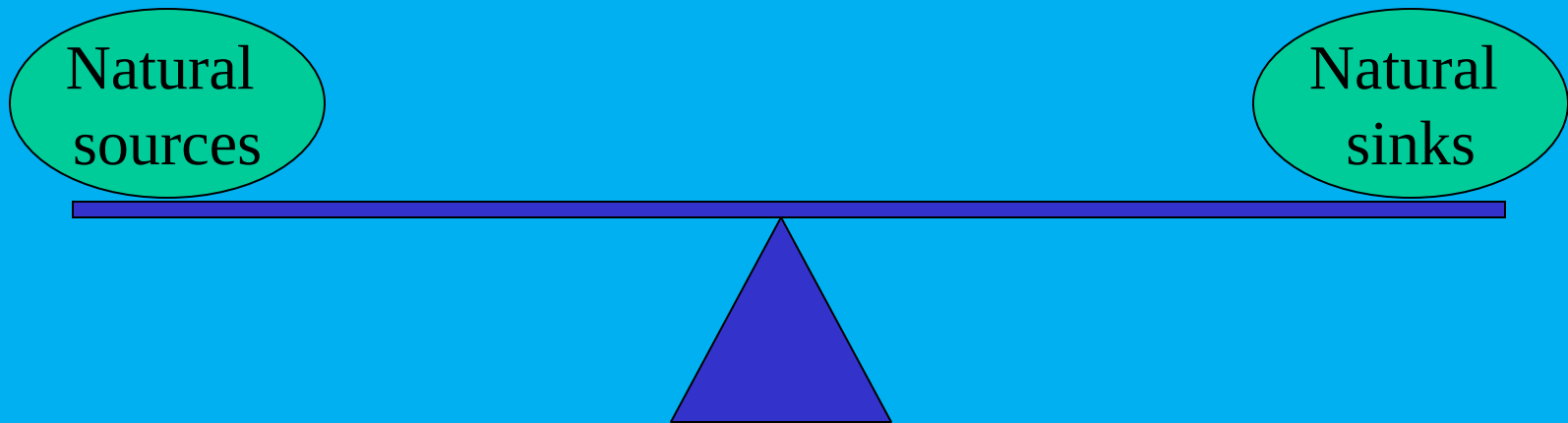
The Greenhouse Effect

- Up until the **industrial revolution** the atmosphere was in equilibrium between natural sources and sinks of greenhouse gases



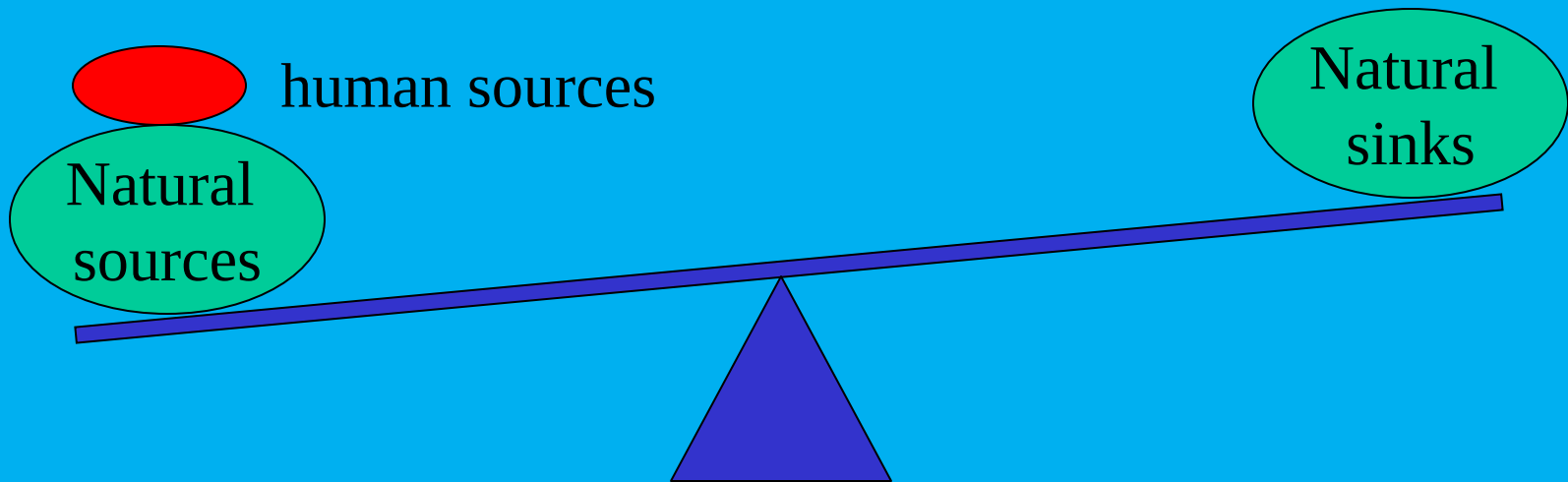
The Greenhouse Effect

- Balanced system
- relatively **stable concentrations** of greenhouse gases in the atmosphere

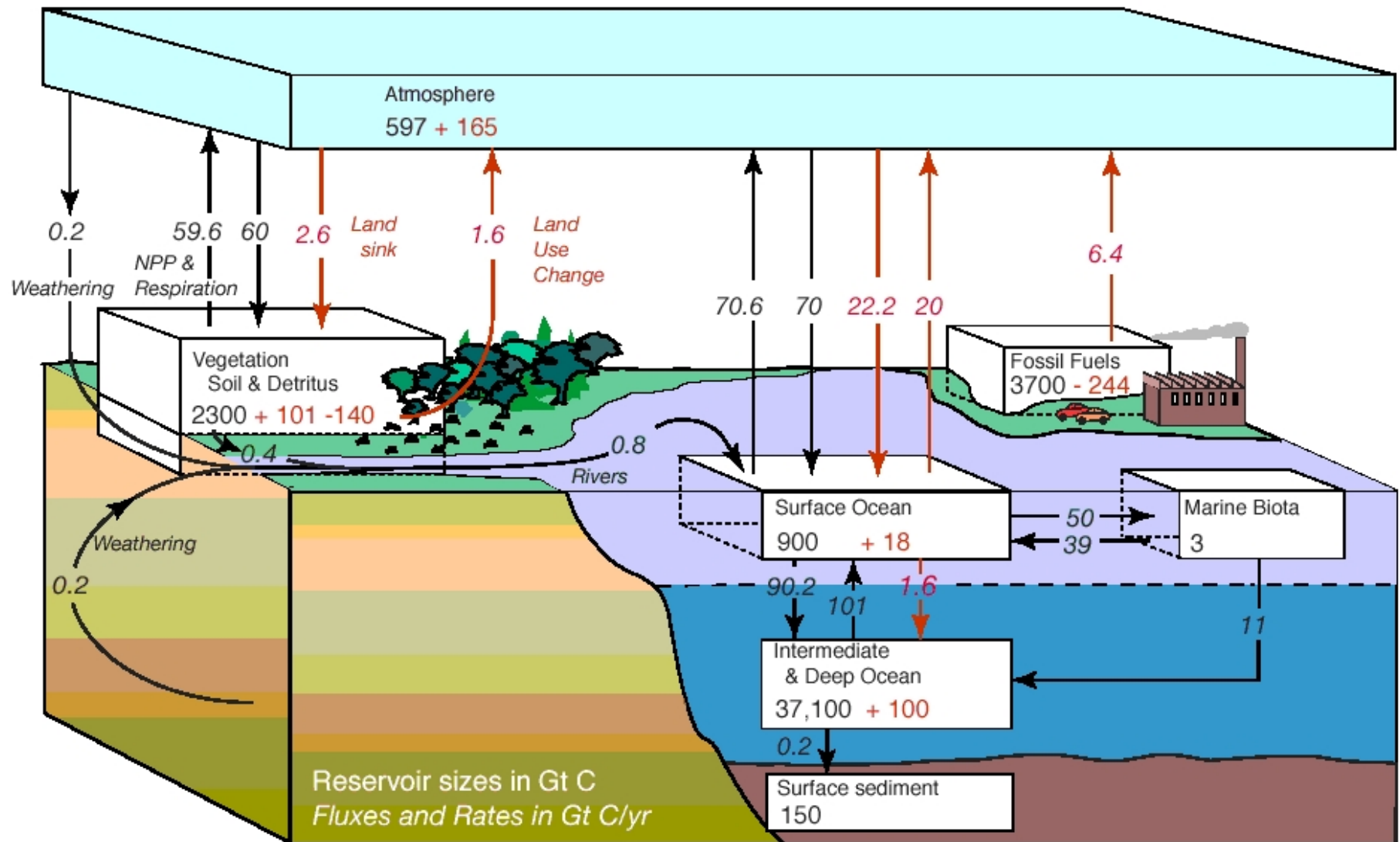


The Greenhouse Effect

- However this system is no longer in equilibrium because of additional sources from man.
- Referred to as **“Enhanced” Greenhouse Effect**



The carbon cycle



Climate change indicators

DPSIR Framework

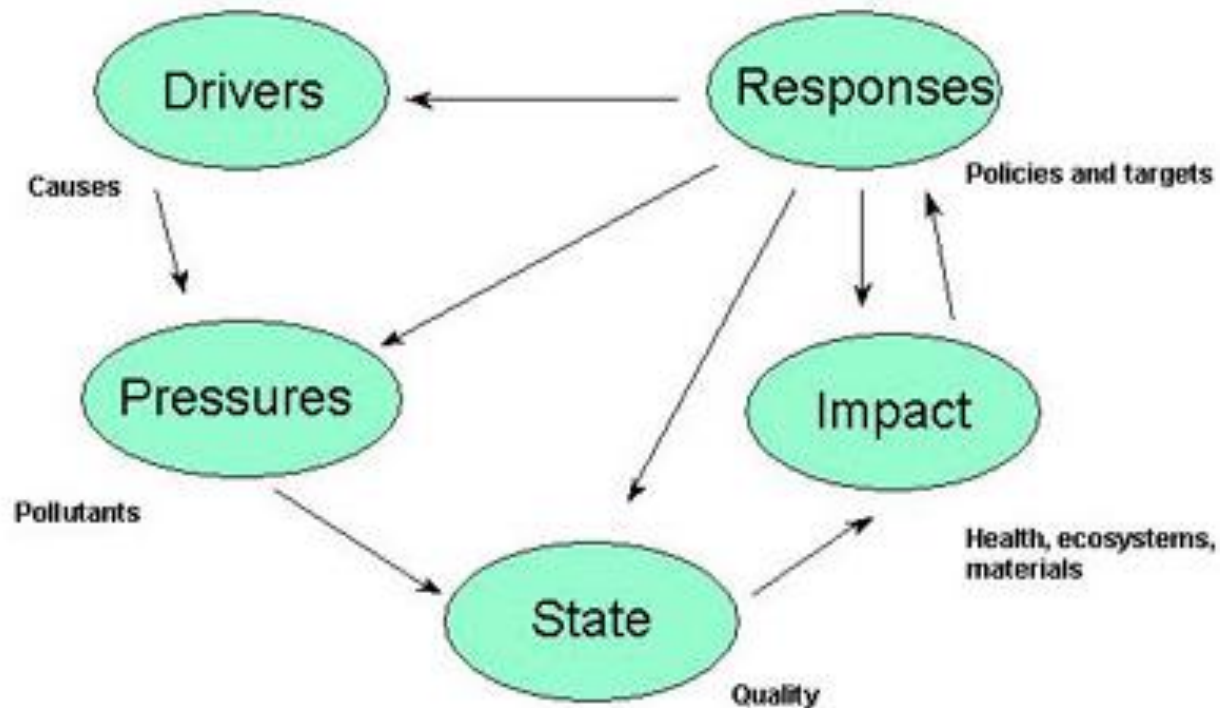


Figure 1. The DPSIR assessment framework

DRIVERS

Economic sectors human activities

- During the past 3 centuries human population has increased tenfold to 6000 million and fourfold in the 20th century
- Cattle population increased to 1400 million (one cow/family); by a factor of 4 during the past century
- Urbanisation grew more than tenfold in the past century; almost half of the people live in cities and megacities
- Industrial output increased 40 times during the past century; energy use 16 times
- Almost 50 % of the land surface has been transformed by human action

PRESSURES

Pollutants emissions and wastes resulting from human activities

- **GHGs emissions increased from pre-industrial era increasing atmospheric concentrations about 27%**
- **The release of SO₂ (160 Tg/year) by coal and oil burning is at least twice the sum of all natural emissions; over land the increase has been 7 fold, causing acid rain, health effects, poor visibility, and climate changes due to sulfate aerosols**
- **Releases of NO to the atmosphere from fossil fuel and biomass burning is larger than its natural inputs, causing high surface ozone levels over extensive regions of the globe**

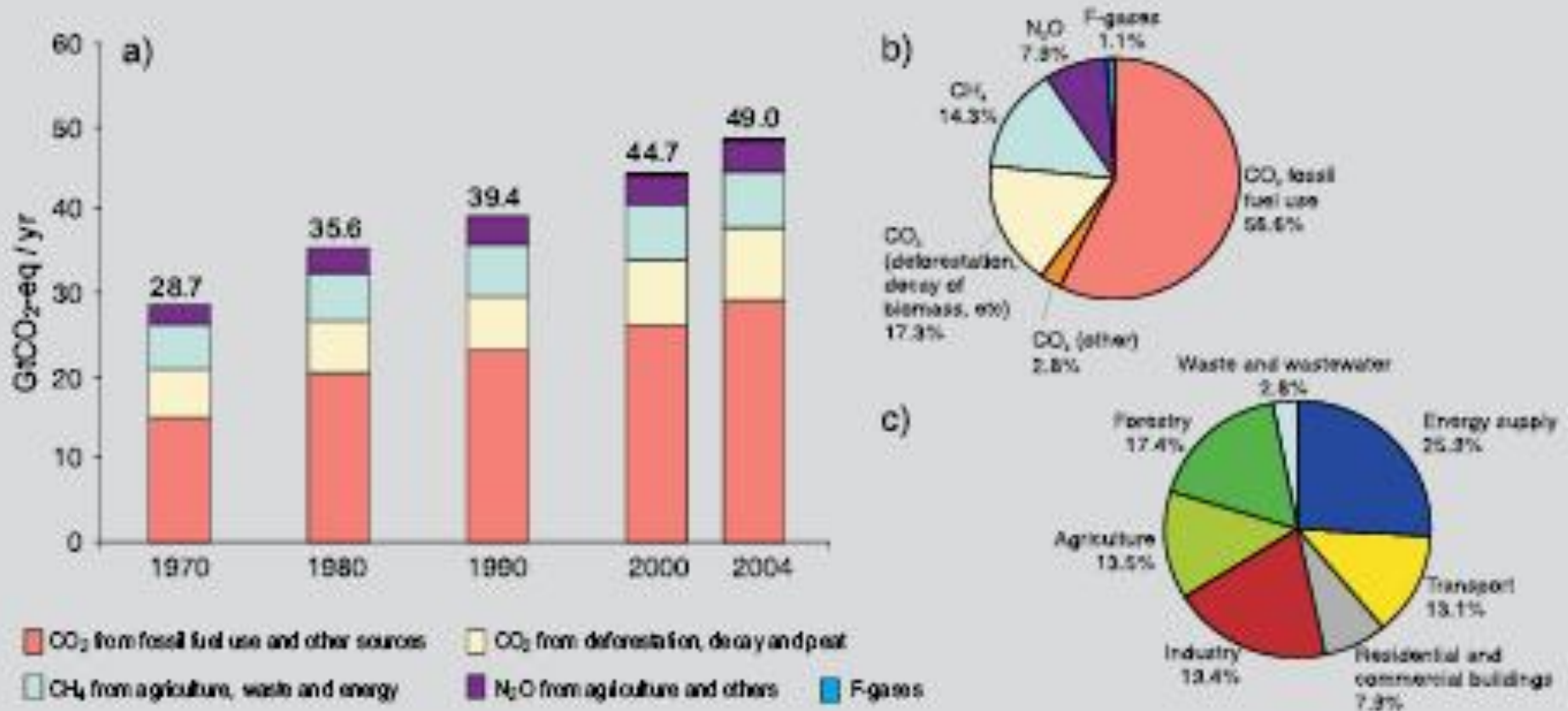
PRESSURES

Emission and absorption of carbon from 1750 to 2000

	GtC	%
Fossil fuels combustion emissions	244	64
Land Use Change (including deforestation)	140	36
TOTAL emissions	384	100
Vegetation uptake (60 ppm)	101	26
Oceans uptake (72 ppm)	118	31
Anthropogenic carbon in the atmosphere (100 ppm)	165	43
TOTAL	384	100

PRESSURES

Long lived GHG's emissions resulting from human activities



(a) Global annual emissions of anthropogenic GHGs from 1970 to 2004.

(b) (b) Share of different anthropogenic GHGs in total emissions in 2004 .

(c) (c) Share of different sectors in total anthropogenic GHG emissions in 2004
(Forestry includes deforestation).

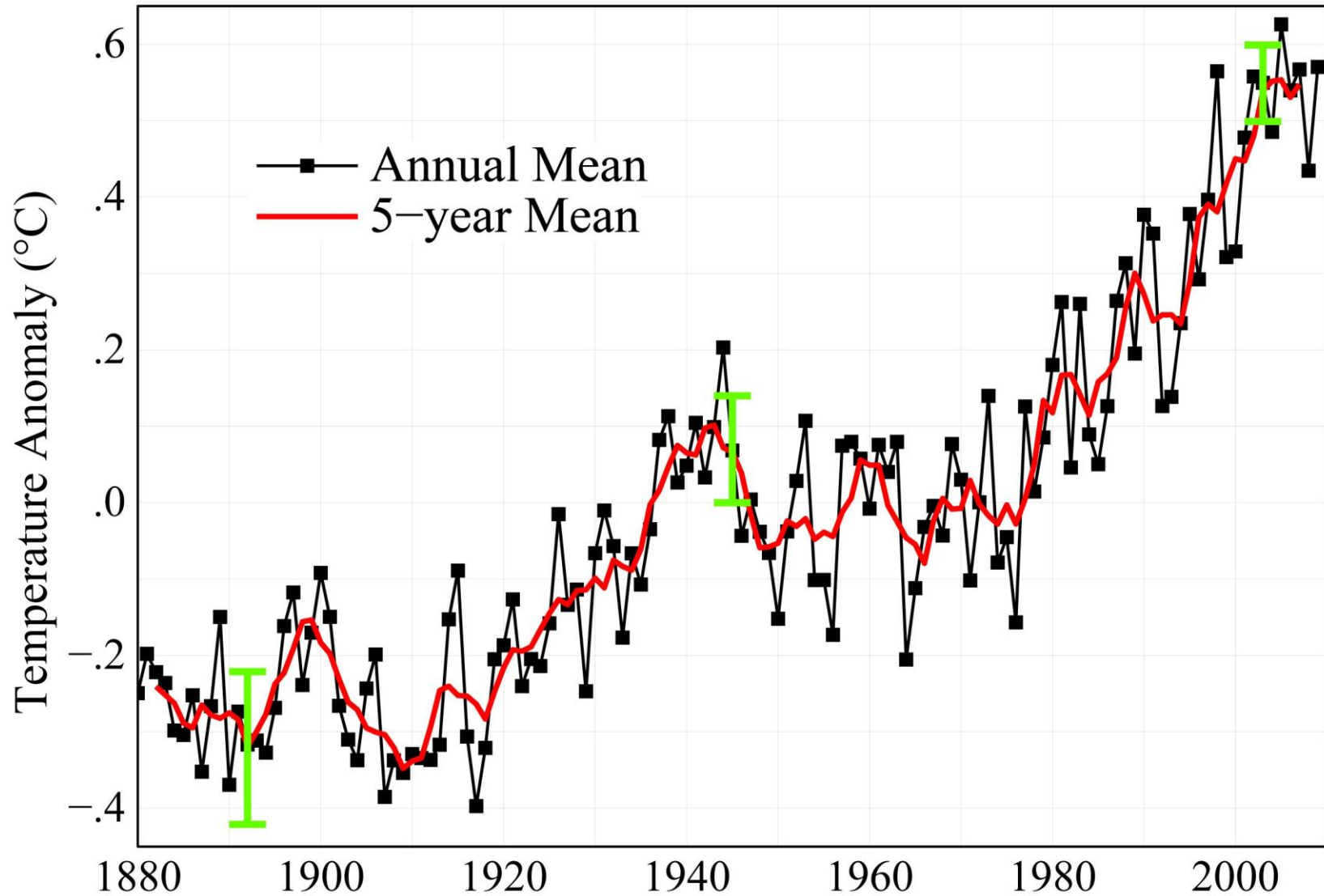
STATE

As a result of pressures, the 'state' of the environment is affected in terms of its physical, chemical ,biological properties

- **Temperature trends**
- **Atmospheric concentration of GHG**

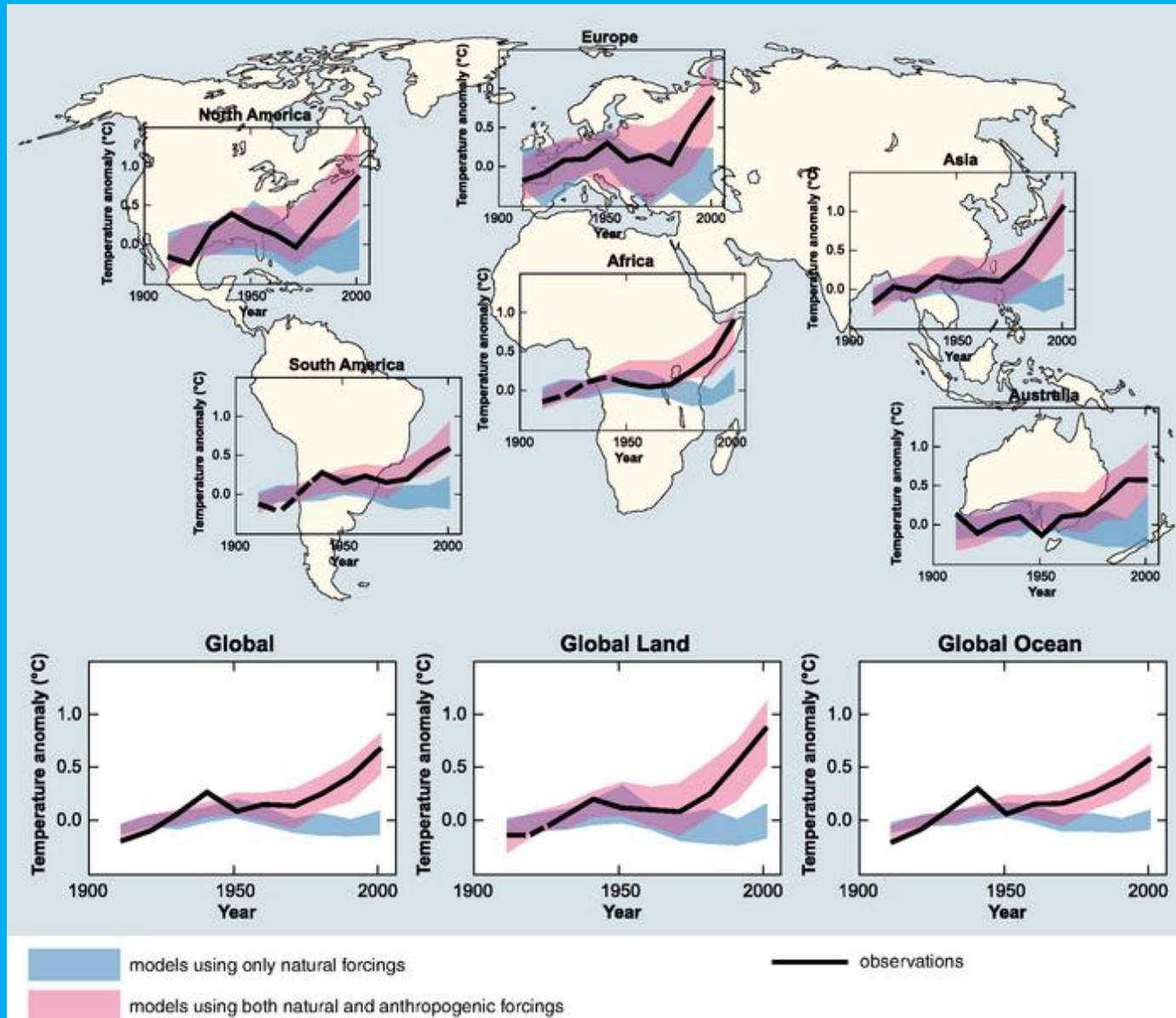
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Global Land–Ocean Temperature Index



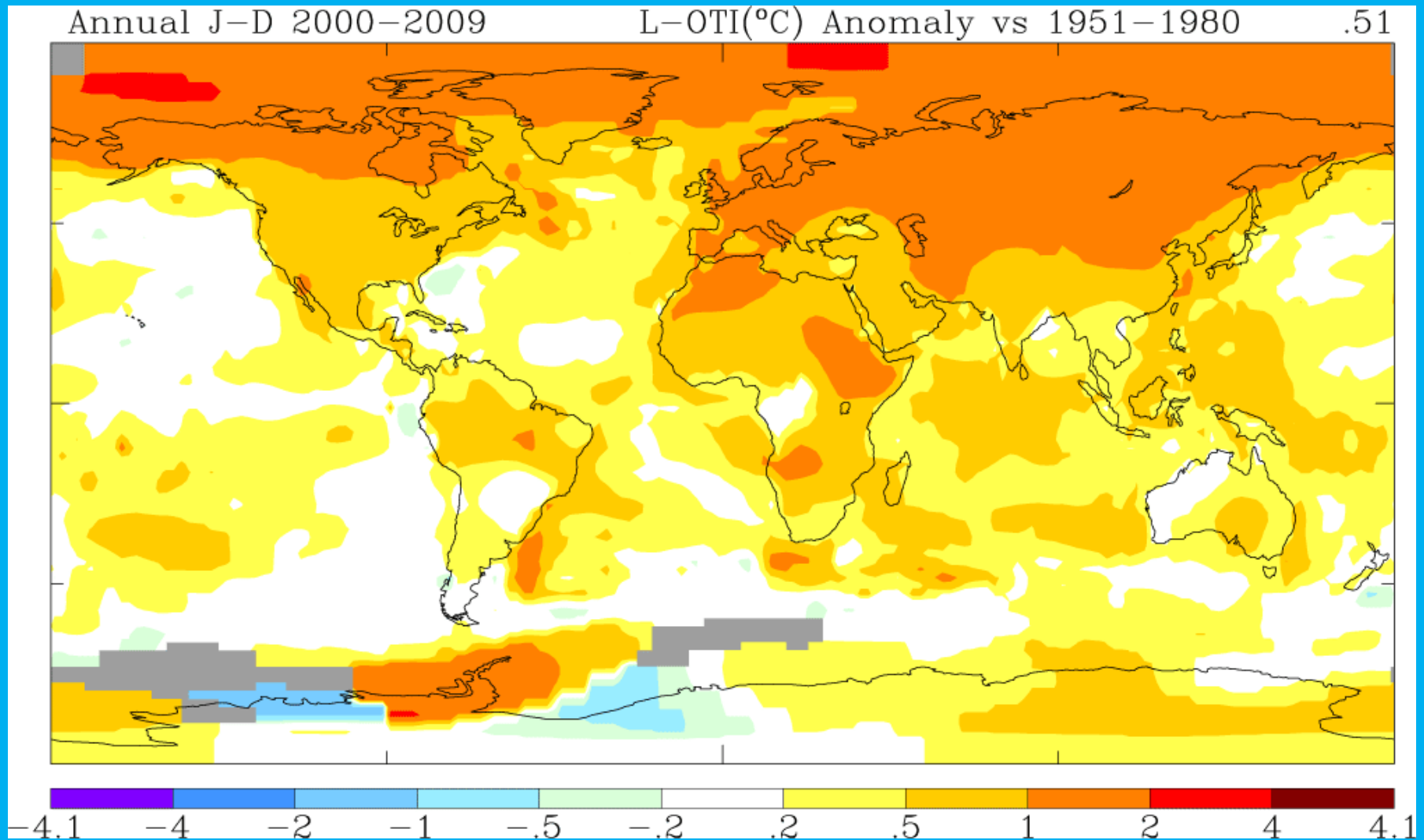
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Global and continental temperature change



STATE

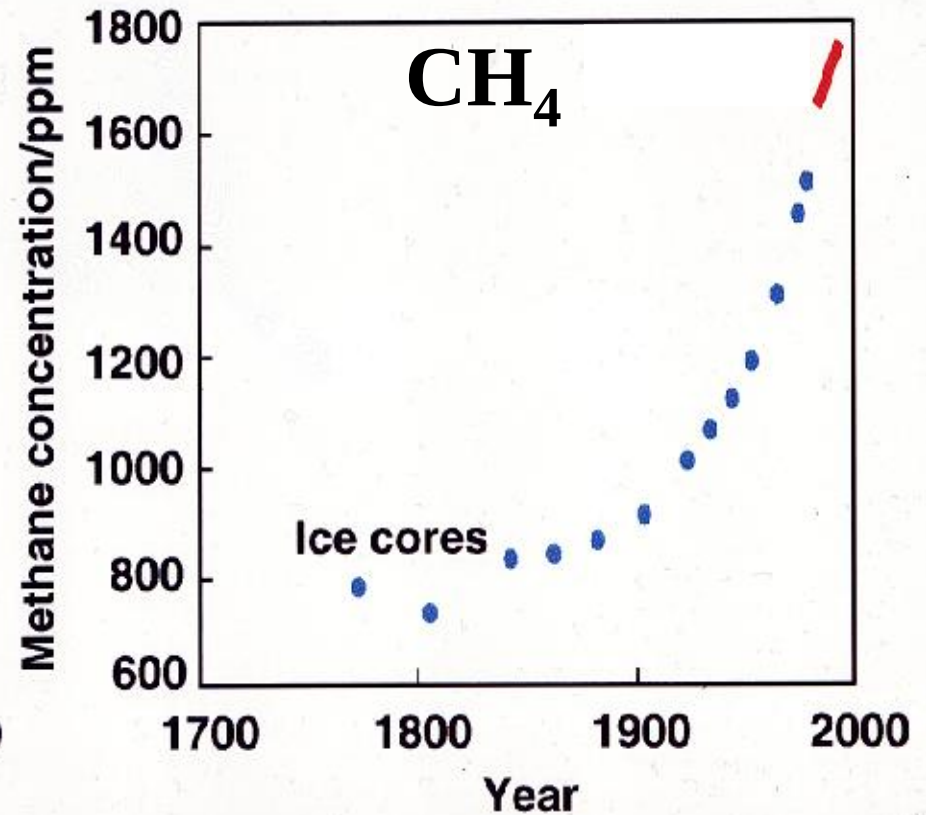
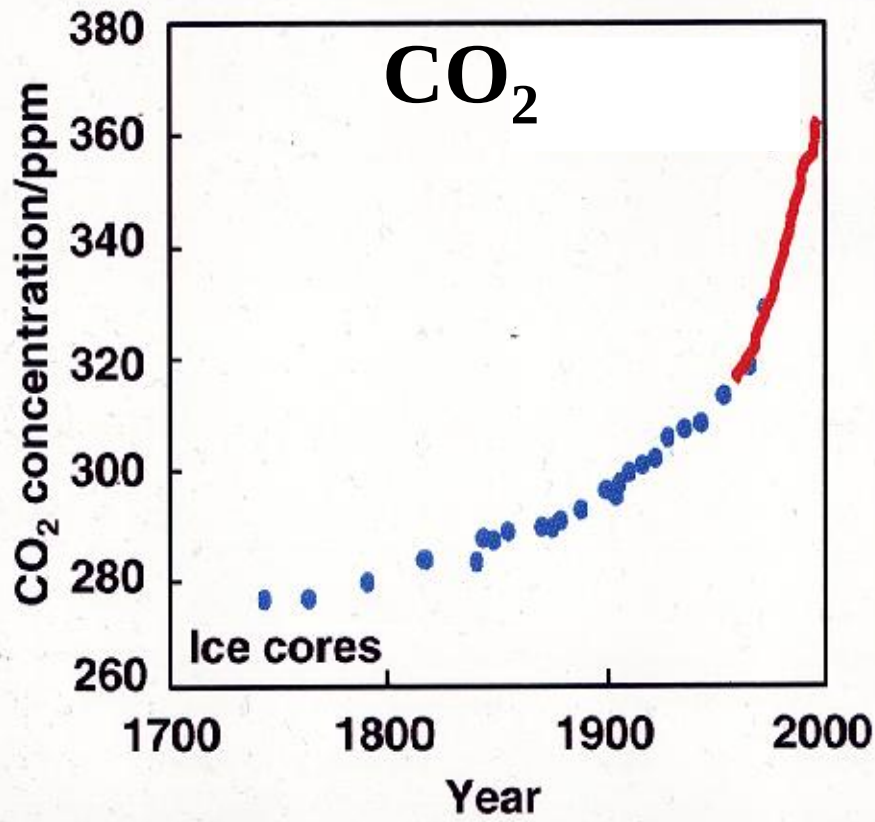
**10-year average (2000-2009) temperature anomaly relative to the 1951-1980 mean.
The largest temperature increases are in the Arctic and the Antarctic Peninsula.**



(Image credit: NASA/GISS)

STATE

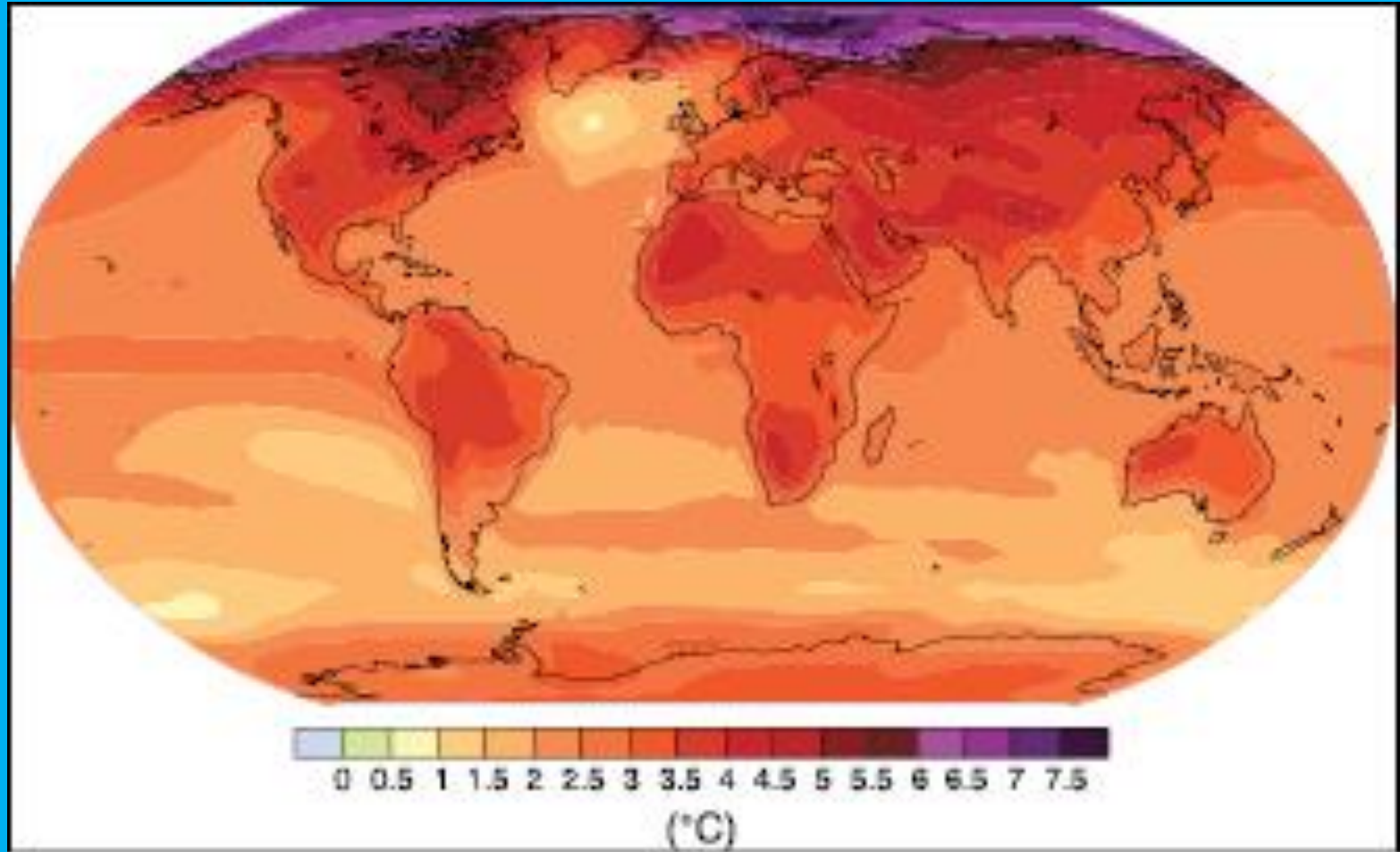
Atmospheric concentrations of GHGs



IMPACTS

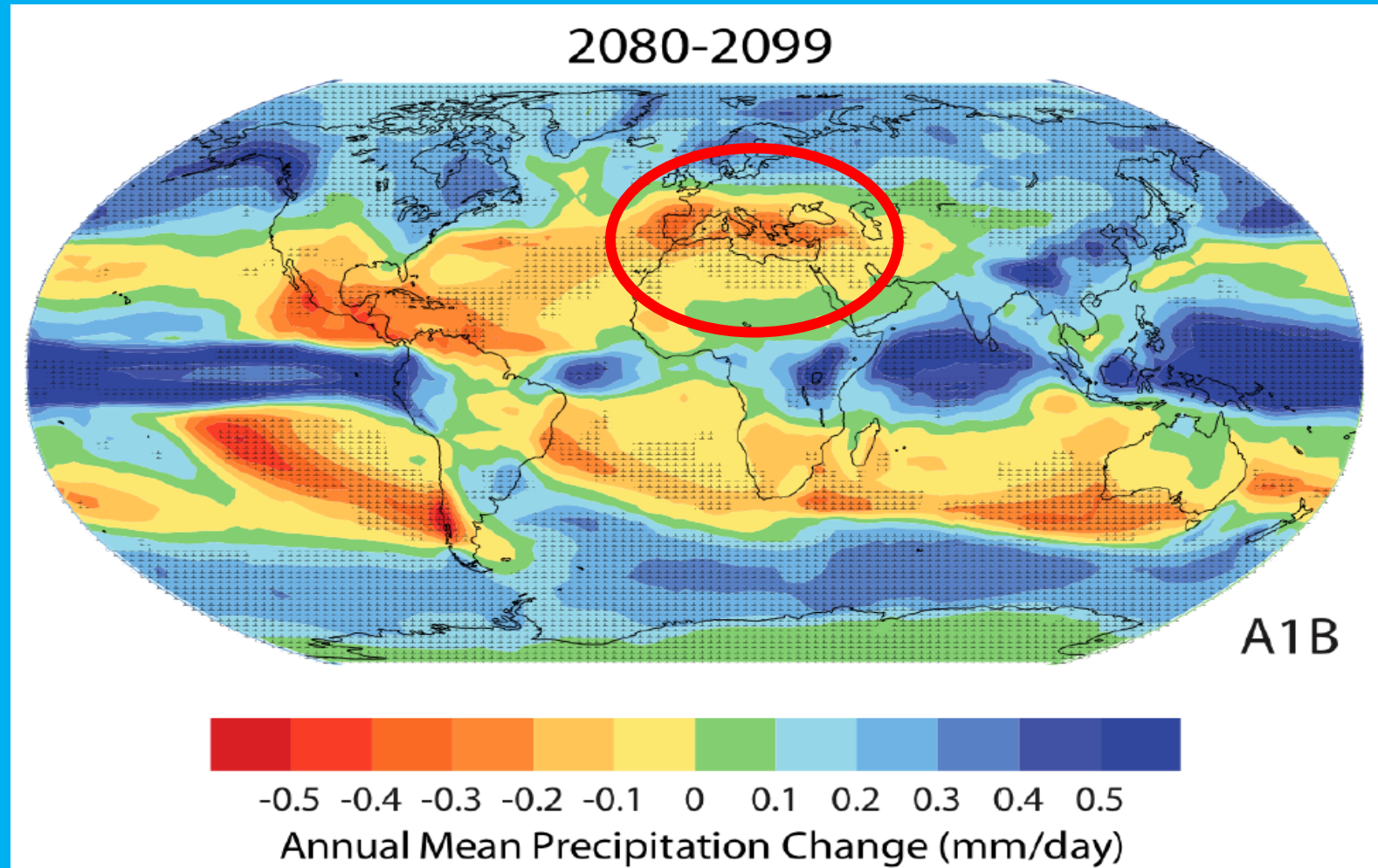
- How temperature and precipitation will change.
- How
 - Agriculture
 - Pastures and livestock production
 - Freshwater resourceswill be affected by climate changes

Surface temperature changes



Projected surface temperature changes for the late 21st century (2090-2099) by multi-AOGCM average projection for the A1B SRES scenario.

Annual mean precipitation change



Scenario A1B, ensemble average 20 models,

Projected global changes at the end of the 21st century

- **Average Global Temperature Rise: 2.8 °C**
1.7 – 4.4 °C from 1980-1999 (including cooling effects by sulfate aerosol)
- **Average Sea level rise: 21-48 cm**
- **Redistribution of precipitation**
- **Enhanced risk for extreme weather (floods, drought, heat waves)**

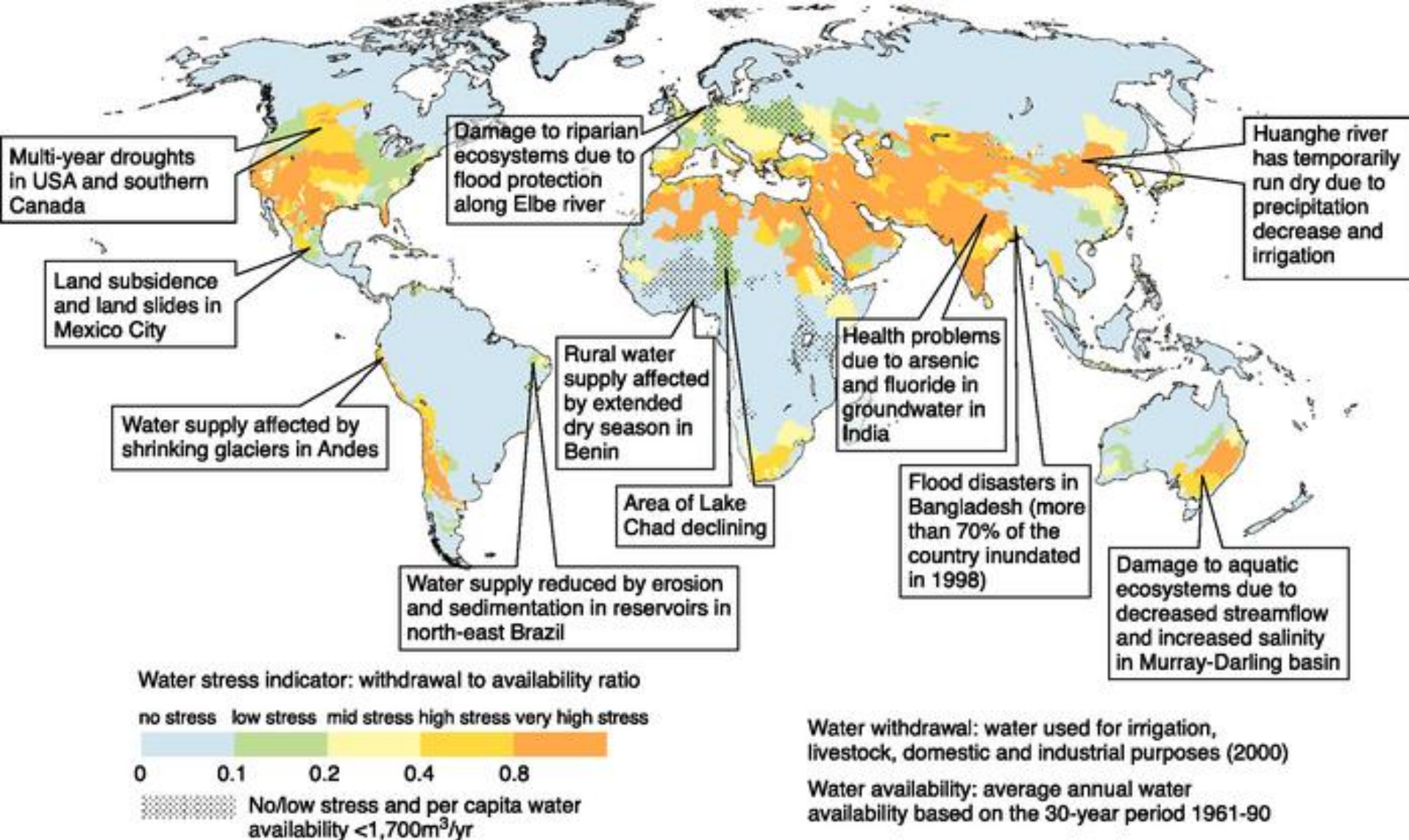
Impacts freshwater resources

Drylands are particularly exposed to the impacts of climate change on freshwater (high confidence).

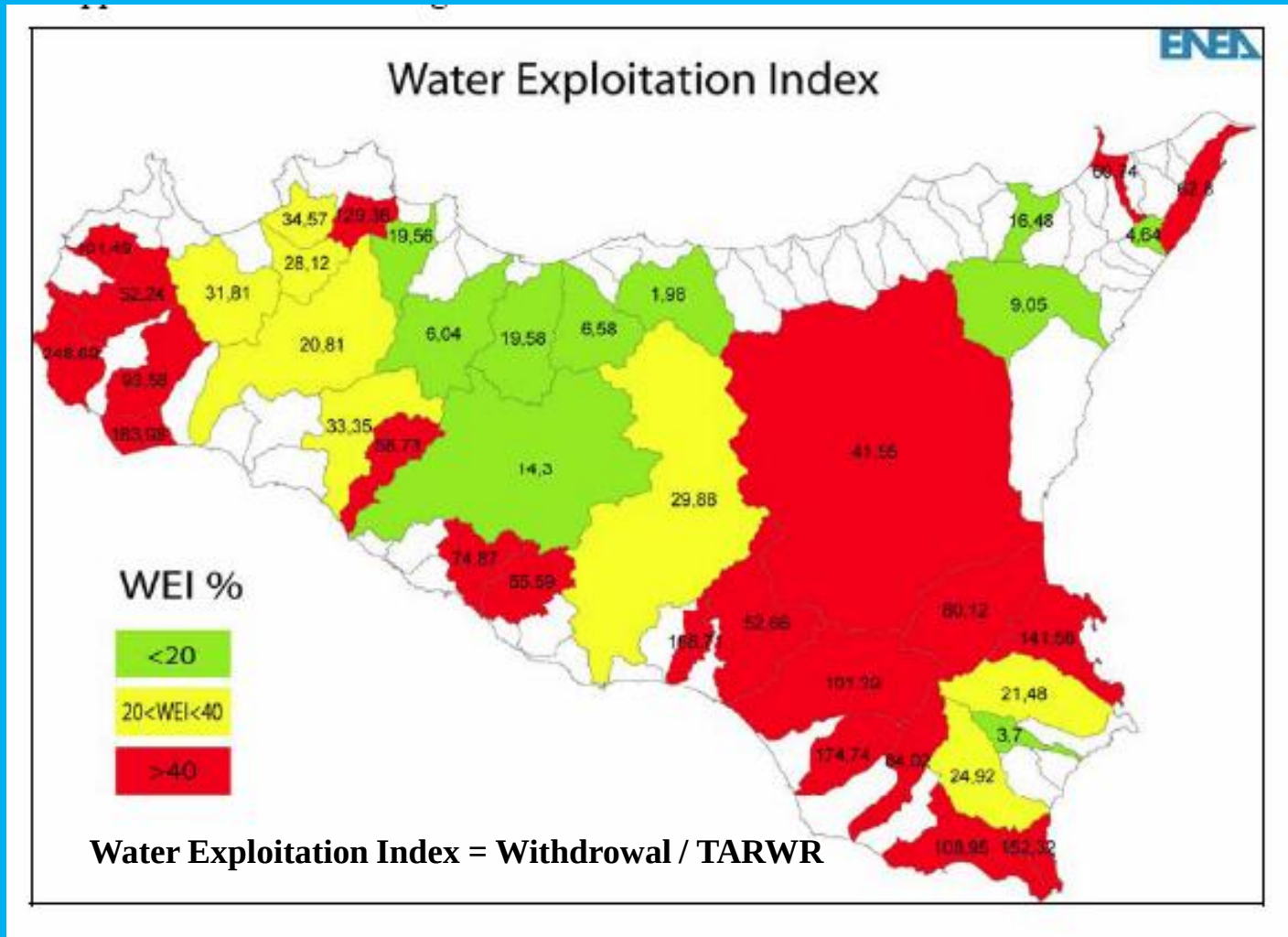
Higher water temperatures, increased precipitation intensity, and longer periods of low flows exacerbate many forms of water pollution, with impacts on ecosystems, human health, water system reliability and operating costs (high confidence).

Impacts freshwater resources

- More than one-sixth of the world's population live in glacier- or snowmelt-fed river basins and will be affected by the seasonal shift in streamflow, an increase in the ratio of winter to annual flows, and possibly the reduction in low flows caused by decreased glacier extent or snow water storage (high confidence) .
- Sea-level rise will extend areas of salinisation of groundwater and estuaries, resulting in a decrease in freshwater availability for humans and ecosystems in coastal areas (very high confidence) .
- Increased precipitation intensity and variability is projected to increase the risks of flooding and drought in many areas (high confidence).



Examples of current vulnerabilities of freshwater resources and their management and a global water stress map.



Current level of stress of freshwater resources in Sicily based on the Water Exploitation Index .

Impacts on Agriculture

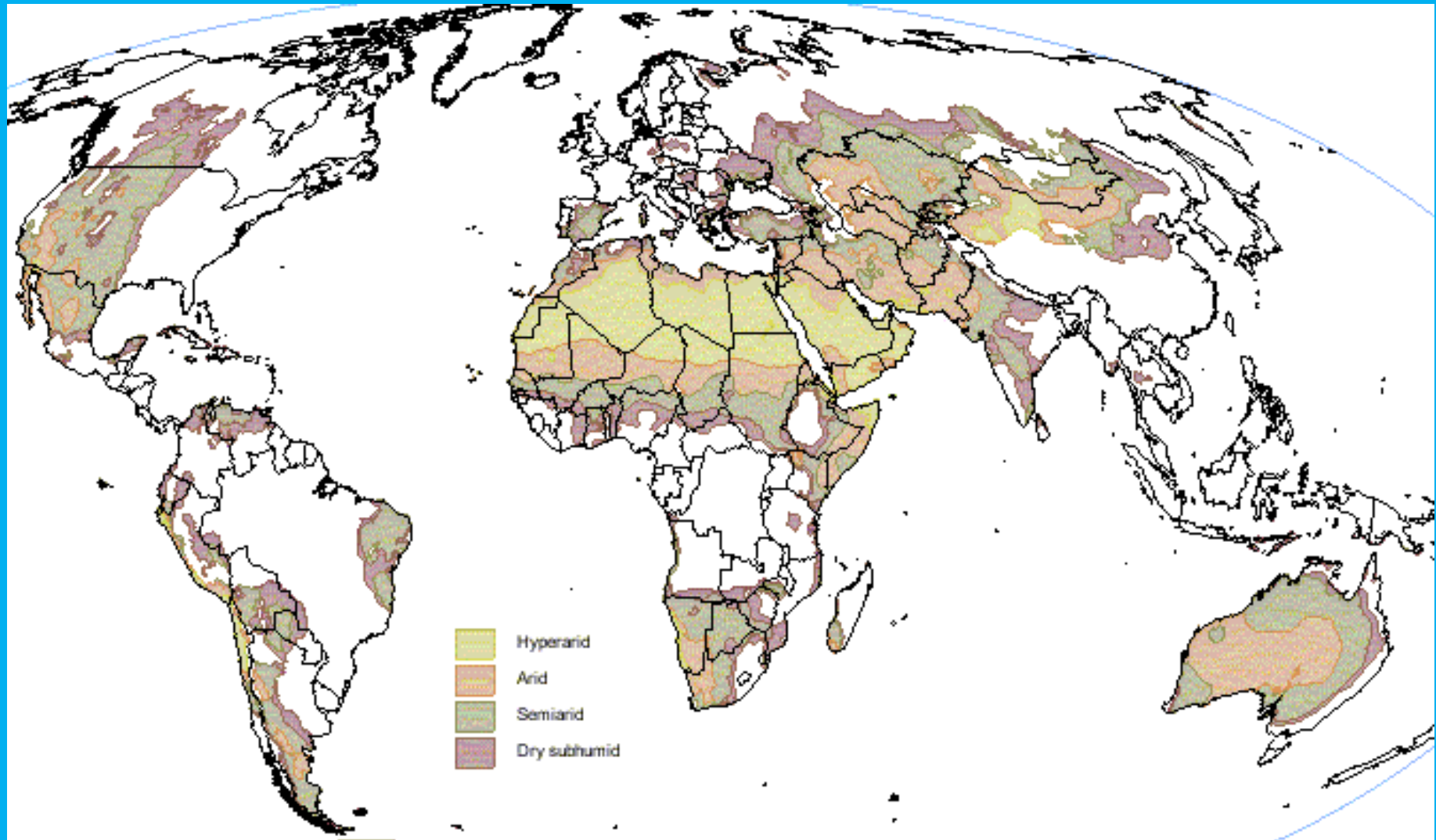
In mid- to high-latitude regions, moderate warming benefits crop and pasture yields, but even slight warming decreases yields in seasonally dry and low-latitude regions (medium confidence).

Projected changes in the frequency and severity of extreme climate events have significant consequences for food and forestry production, and food insecurity, in addition to impacts of projected mean climate (high confidence).

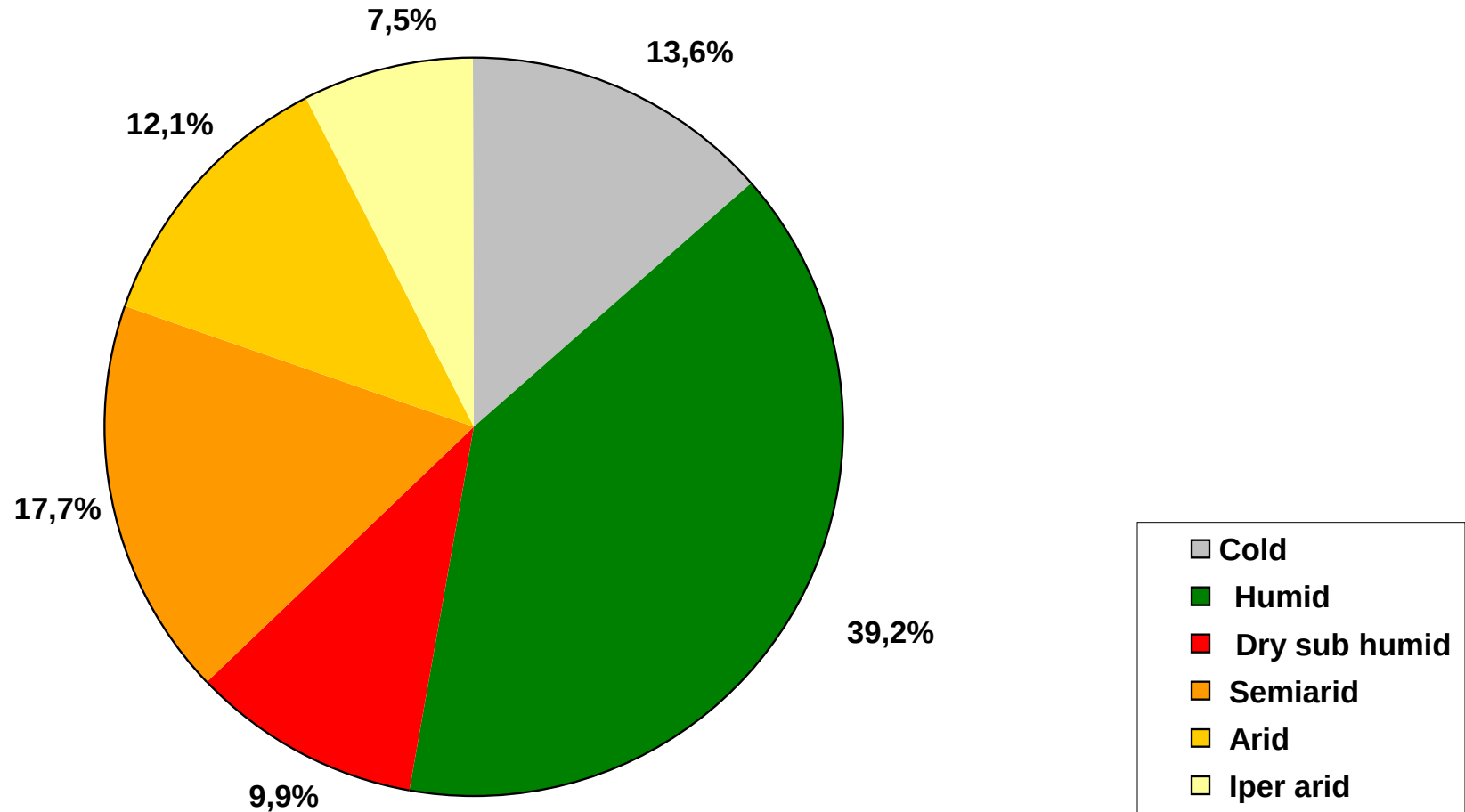
Impacts on pastures and livestock production

IPCC identified that the combination of increases in CO₂ concentration, in conjunction with changes in rainfall and temperature, were likely to have significant impacts on grasslands and rangelands, with production increases in humid temperate grasslands, but decreases in arid and semiarid regions.

Negative climate change impacts will be more relevant in drylands



Drylands , non including deserts, were 37,7 % of global surface in the years 1951-1980



Source: World atlas of desertification

RESPONCES

Policy initiatives

- Intergovernmental Panel on Climate Change (IPCC)
- UN Framework Convention on Climate Change (UNFCCC)
- Kyoto Protocol
- 20/20/20 EU strategy

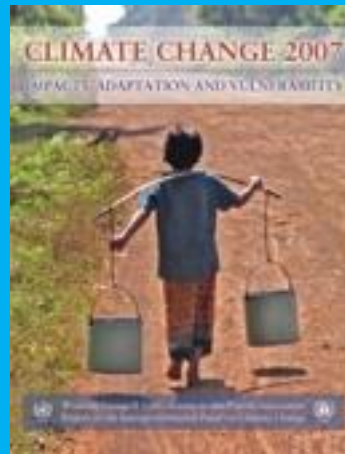
IPCC: the source of information on climate change

- The IPCC is a scientific body. It reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. It does not conduct any research nor does it monitor climate related data or parameters.....
.....Differing viewpoints existing within the scientific community are reflected in the IPCC reports.

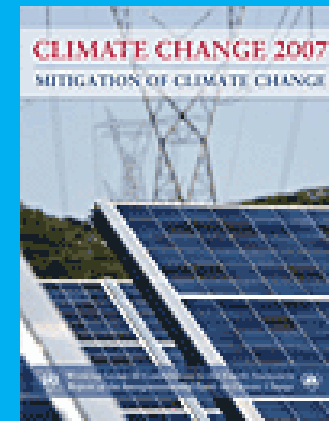
IPCC: the source of information on climate change



WG I
**The physical
science basis**



WG II
**Impacts
Adaptation and
vulnerability**



WG III
**Mitigation of
climate change**

The UNFCCC

- In 1992, the United Nation Convention on Climate Change was adopted as the basis for a global response to the problem. The ultimate objective of the Convention is to stabilize greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system.

The Kyoto Protocol

- The UNFCCC is complemented by the 1997 Kyoto Protocol, which has 184 Parties. Under this treaty, 37 industrialized countries and the European Community have committed to reducing their emissions by an average of 5% by 2012 against 1990 levels.

IPCC conclusions

- **Projected changes in the frequency and severity of extreme climate events will have more serious consequences for food and forestry production, and food insecurity, than will changes in projected means of temperature and precipitation (high confidence).**
- **Climate change increases the number of people at risk of hunger (high confidence) particularly in sub-Saharan Africa.**
- **While moderate warming benefits crop and pasture yields in mid- to high-latitude regions, even slight warming decreases yields in seasonally dry and low-latitude regions (medium confidence).**

Attributing climate change

“The balance of evidence suggests a discernable human influence on global climate“ (IPCC, 1995)

“Most of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations” (IPCC, 2001)

“Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. It is likely that there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica) “ (IPCC , 2007)

Climate skeptic main issues

- whether humankind has contributed significantly to the increased global average air temperature, especially since the mid-20th century.
- whether the warming trend is unprecedented or within normal climatic variations,
- whether the increase is wholly or partially an artifact of poor measurements,
- climate simulation models are not sufficiently reliable and their projection cannot be considered as basis for policy decisions

Conclusions

Whatever is the cause of the observed climate change and whatever will be future of climate we have to prepare to adapt to new conditions that will stress both natural and human environment.



Thank you