

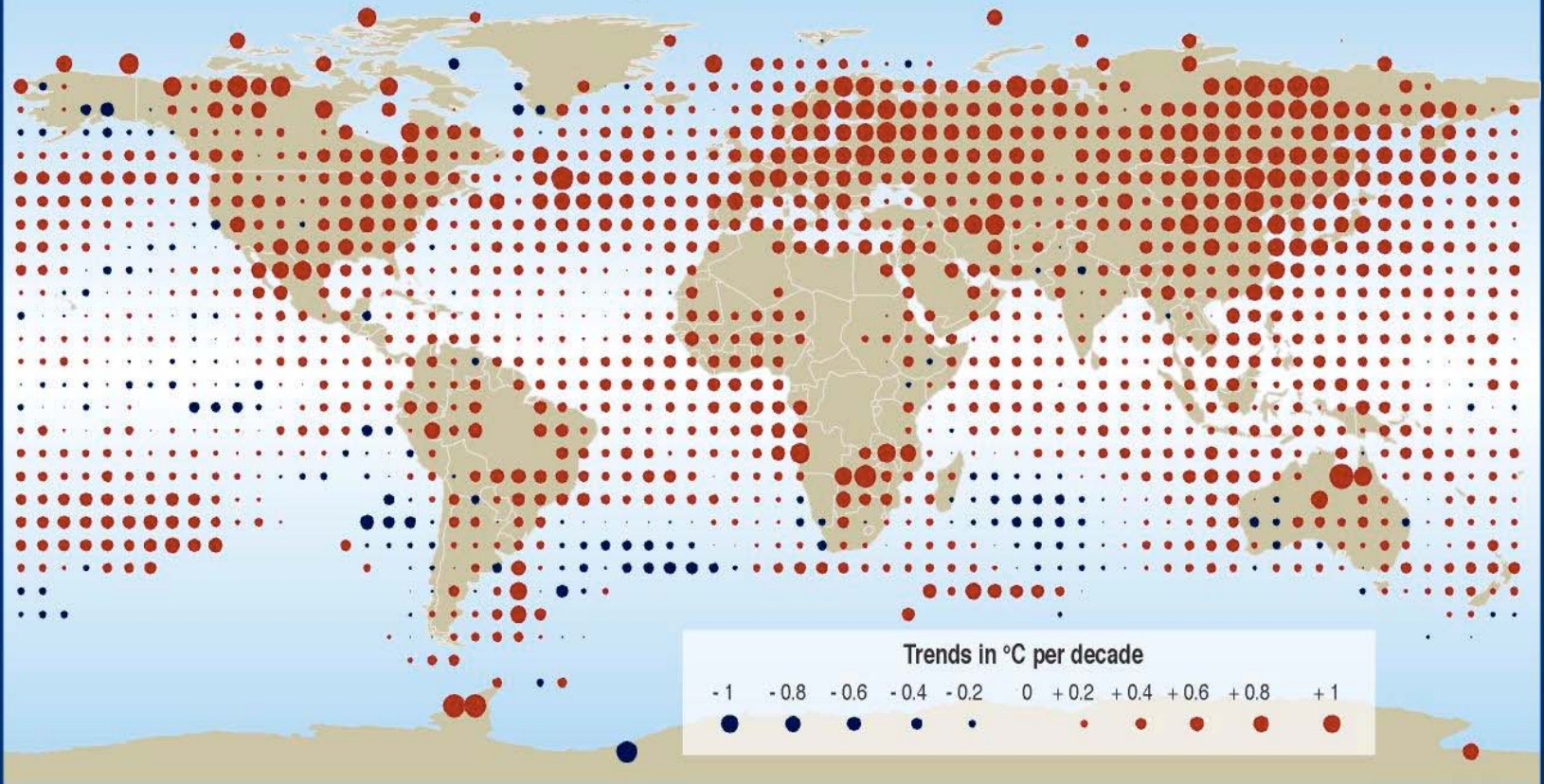
The role of the oceans on Earth's Climate

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INPE

II Simpósio Internacional em
Gestão Ambiental e Saúde.
SENAC-CETESB

20 October 2007

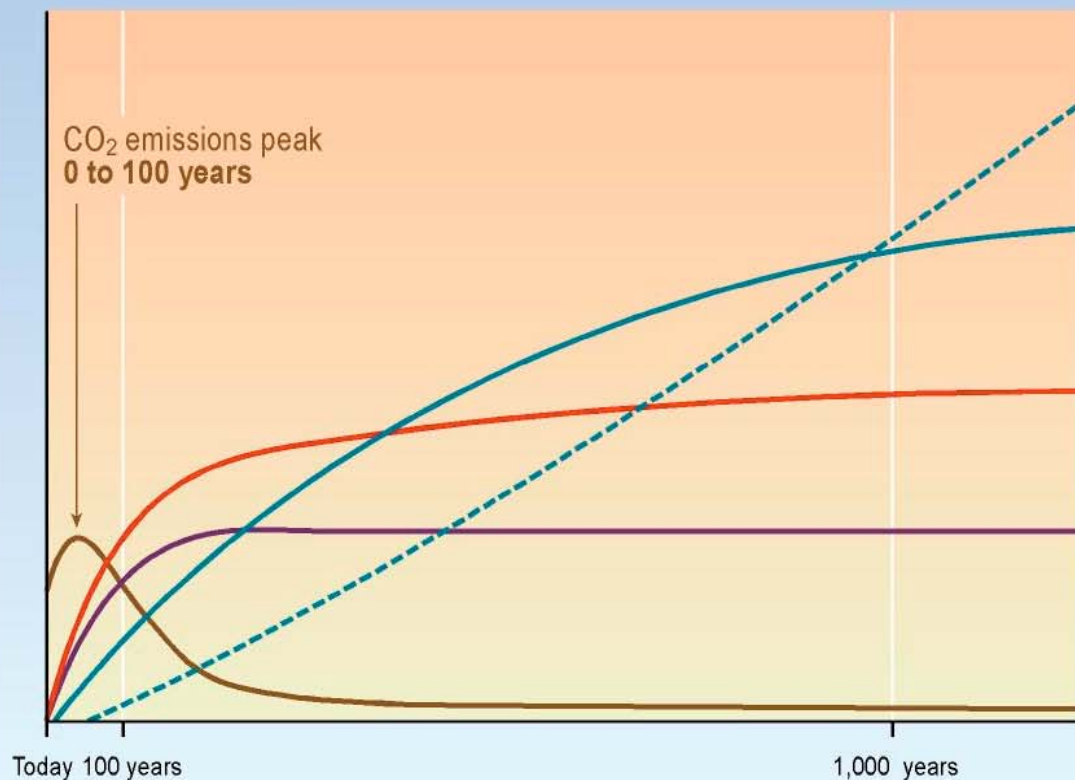
Annual temperature trends: 1976 to 2000



SYR - FIGURE 2-6b

CO₂ concentration, temperature, and sea level continue to rise long after emissions are reduced

Magnitude of response



Time taken to reach equilibrium

Sea-level rise due to ice melting:
several millennia

Sea-level rise due to thermal expansion:
centuries to millennia

Temperature stabilization:
a few centuries

CO₂ stabilization:
100 to 300 years

CO₂ emissions

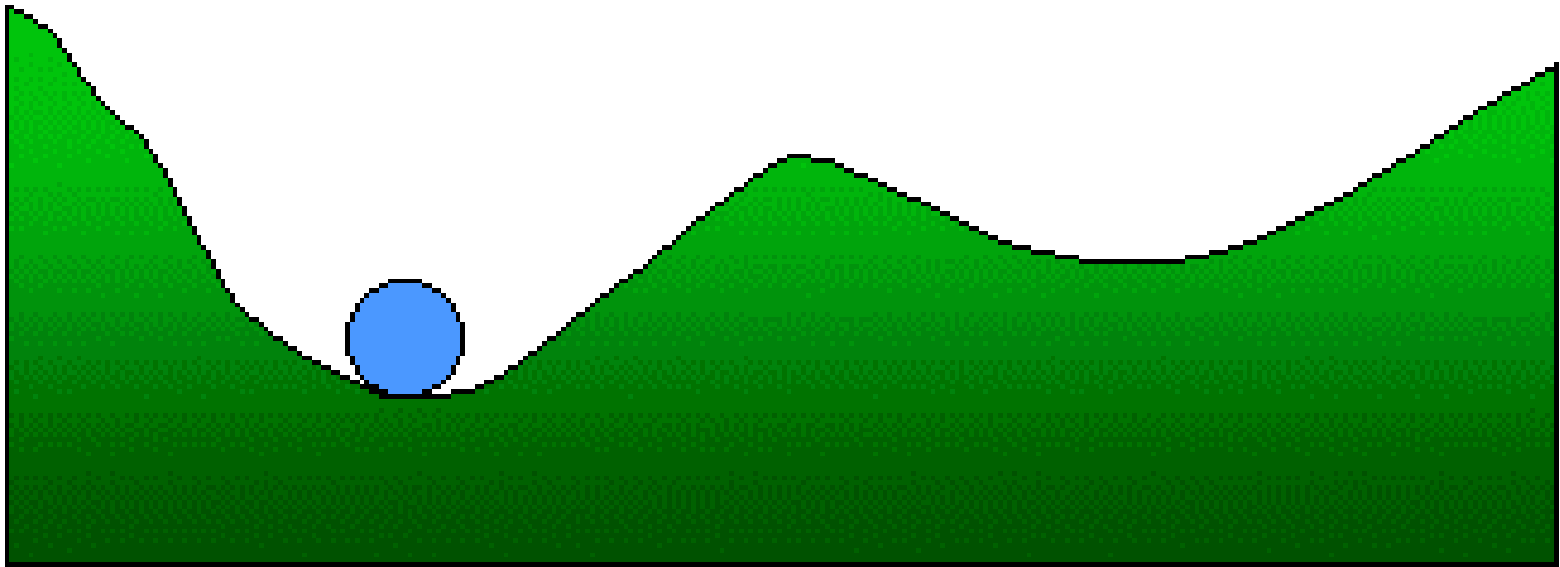
SYR - FIGURE 5-2



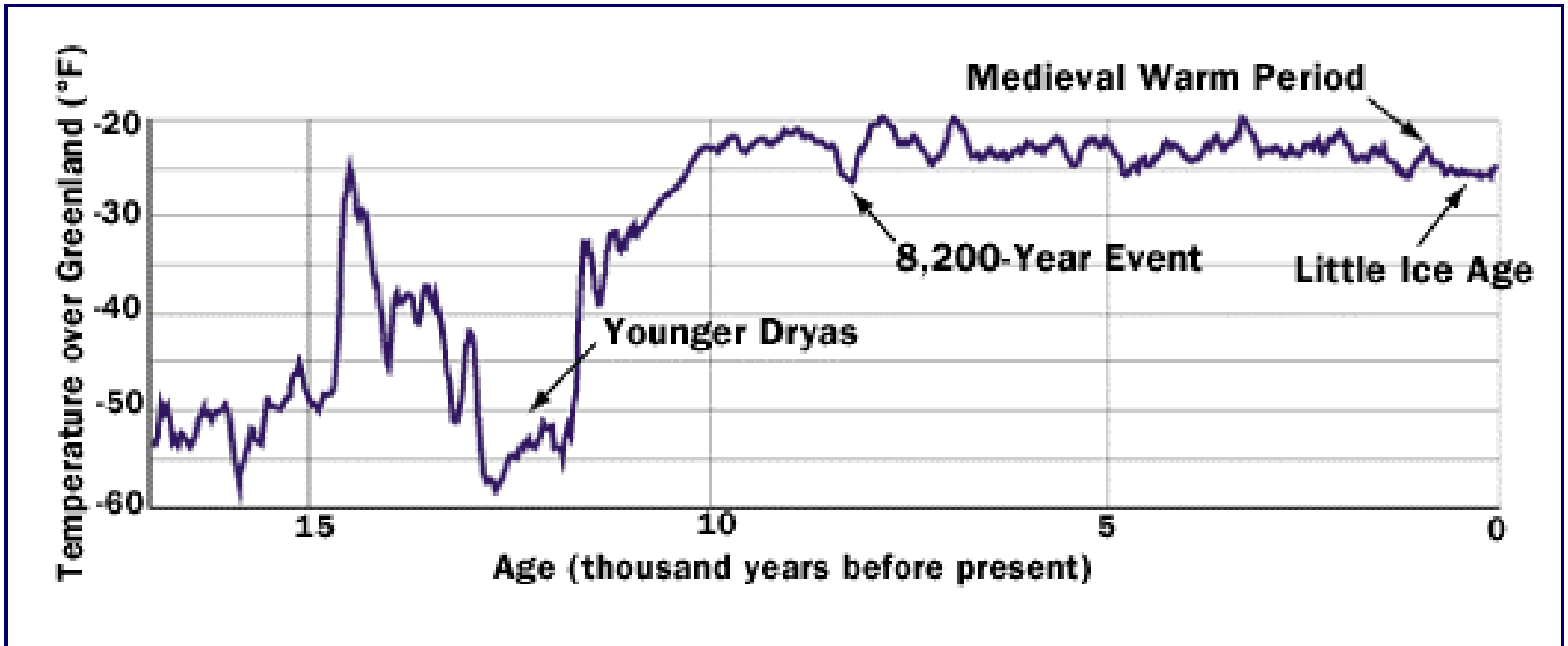


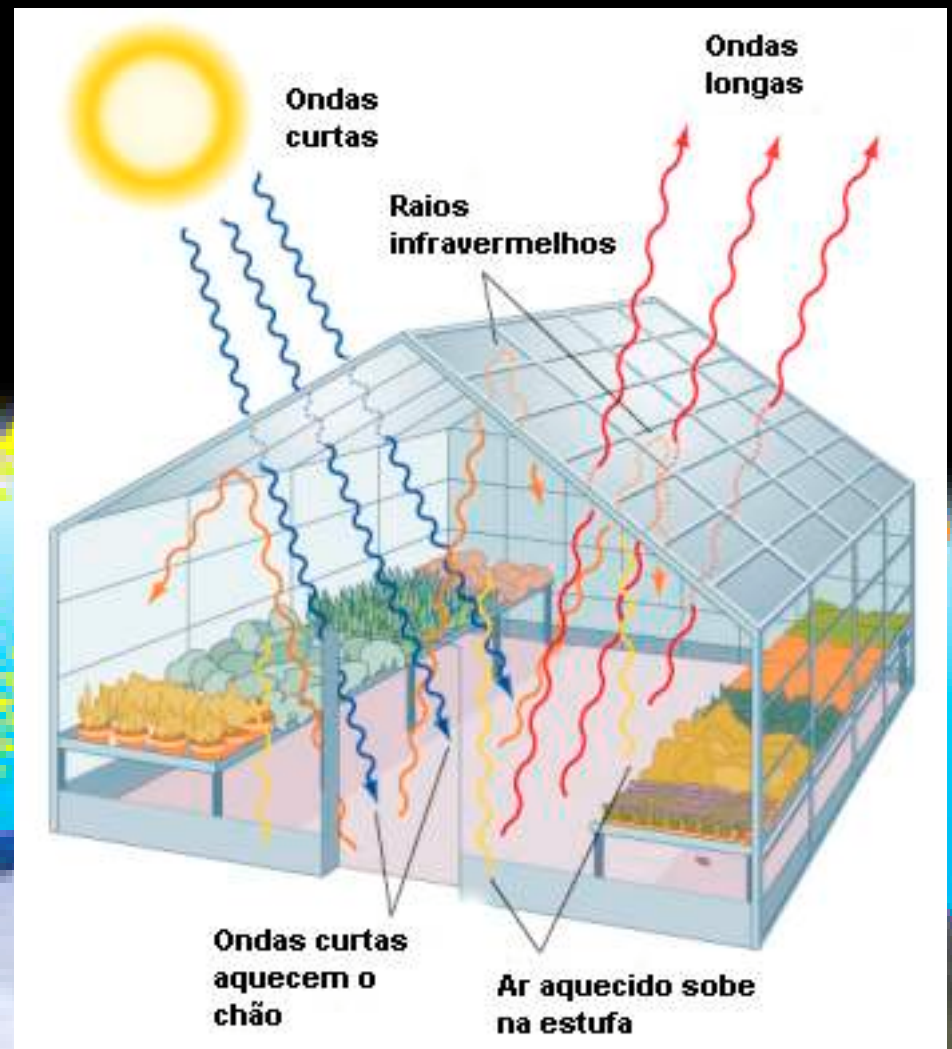
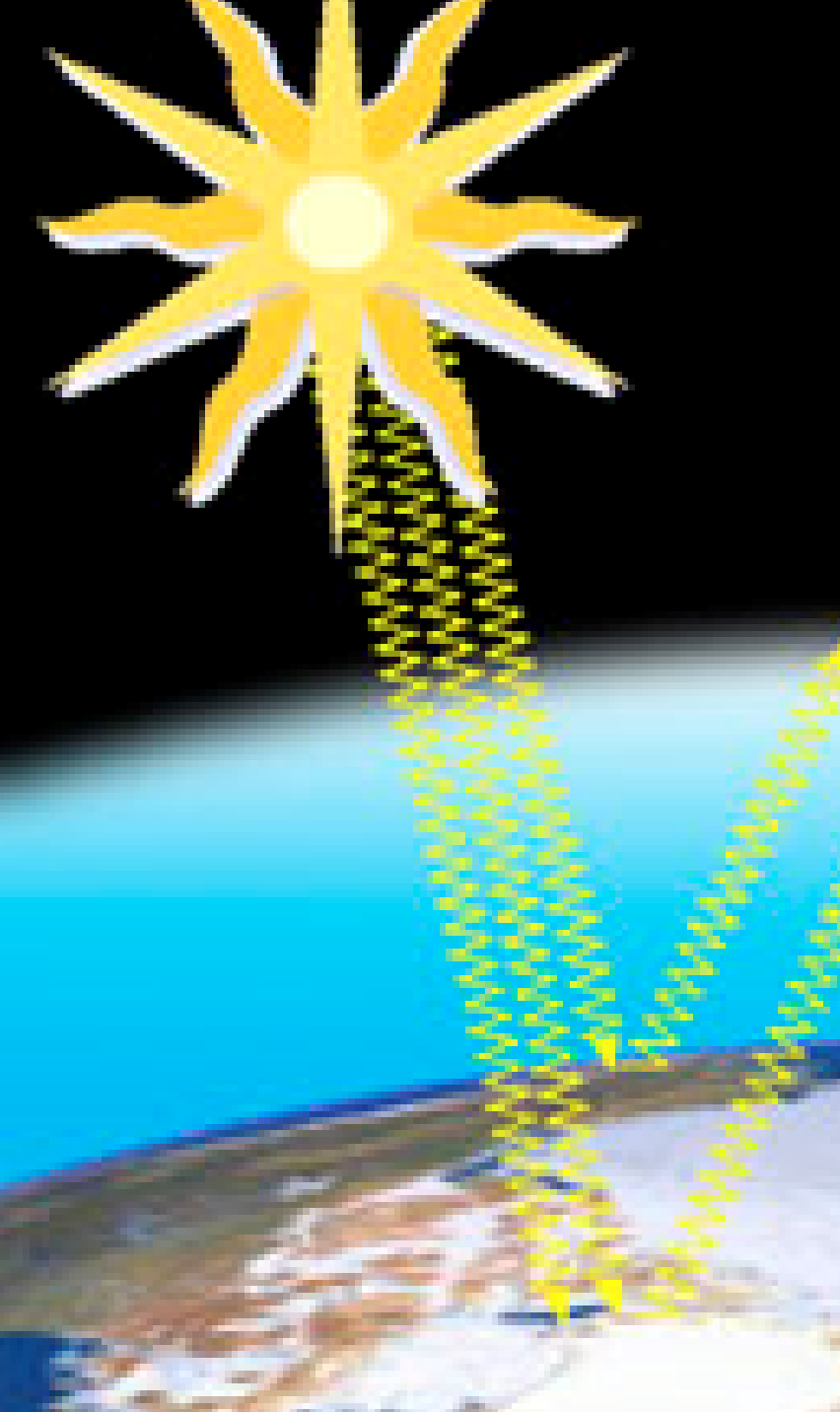
Should We Be Worried
About (Abrupt) Climate
Change?

Externally driven equilibrium change

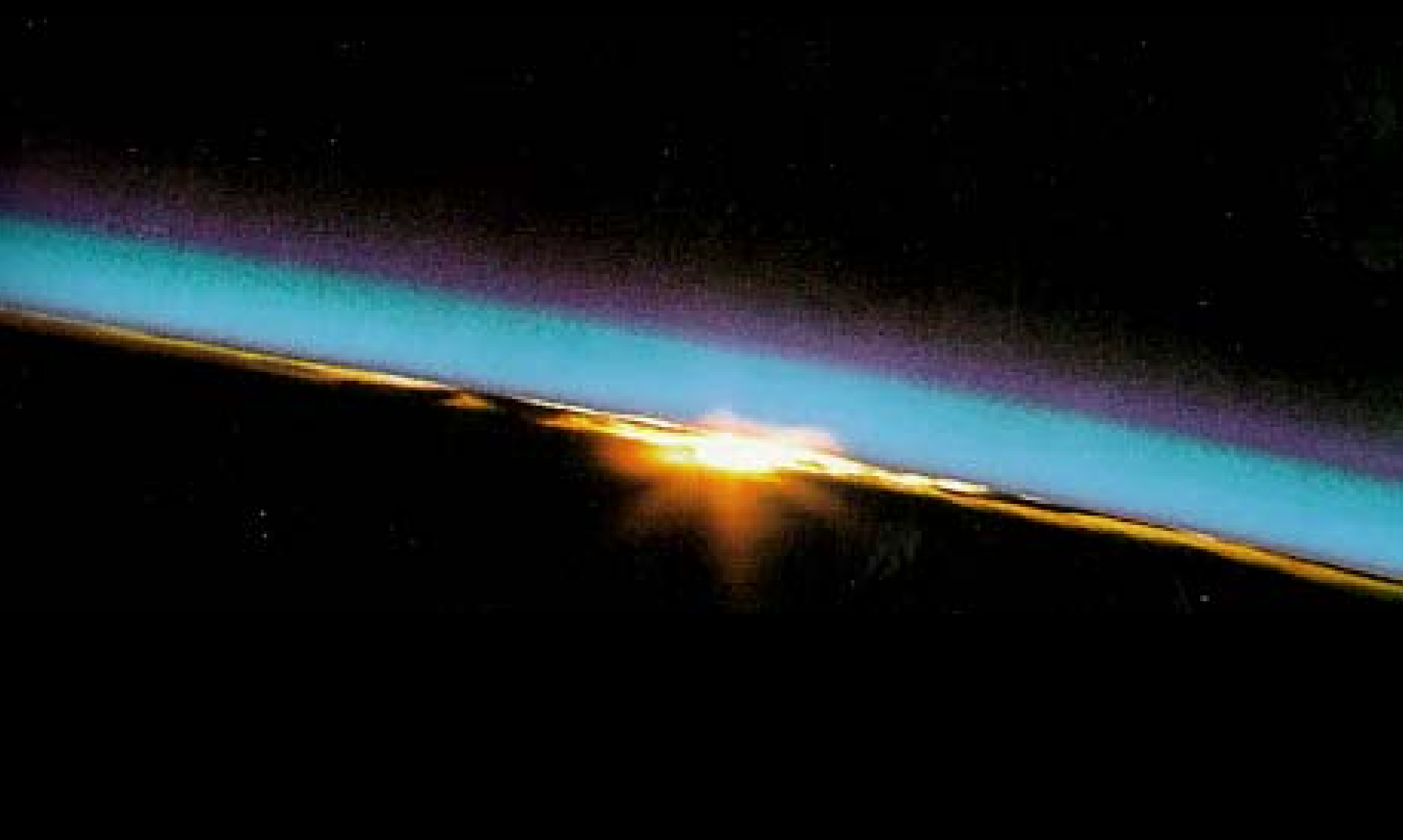


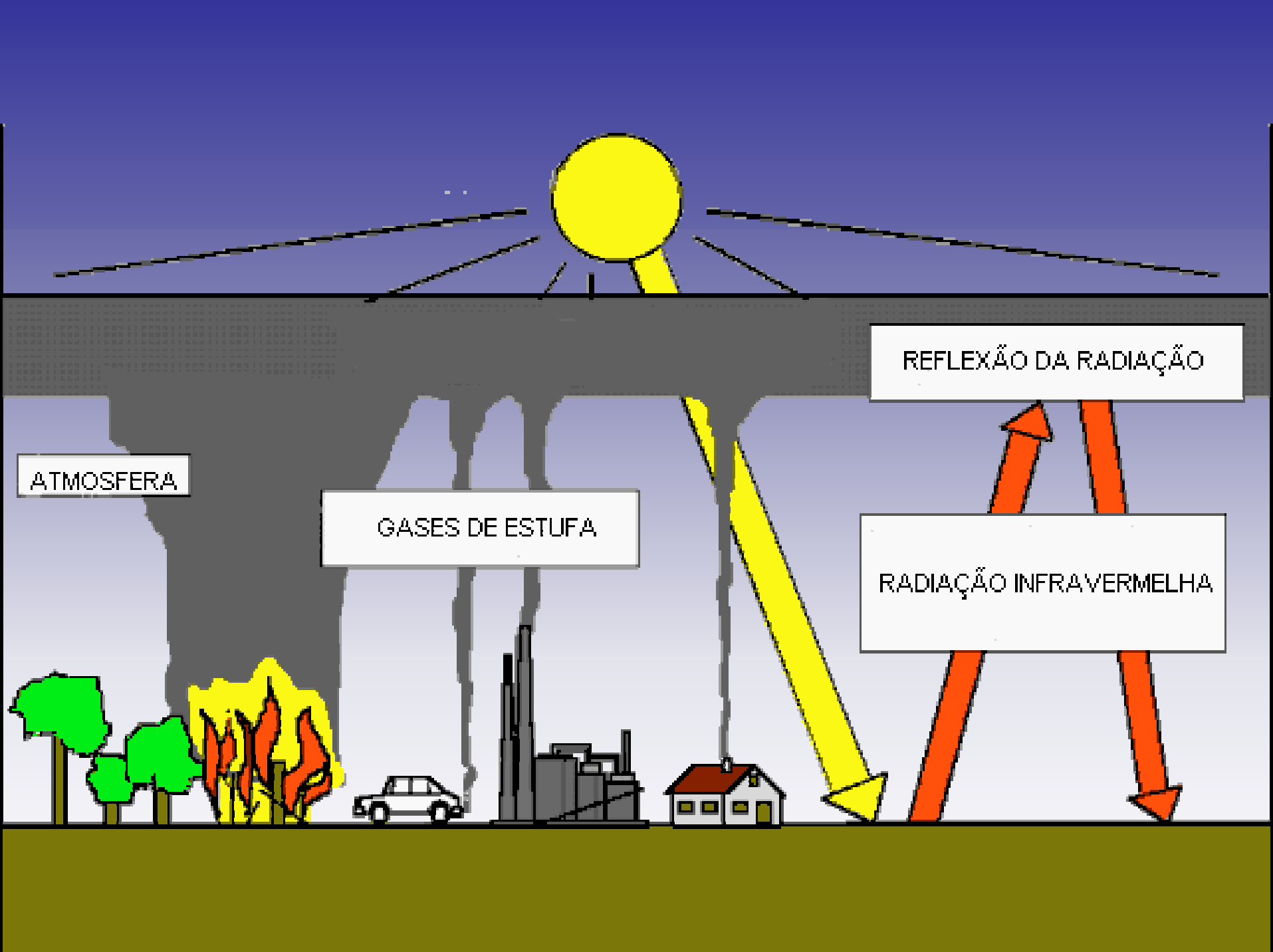
Abrupt Climate Changes in the past.





The Earth's atmosphere is very thin





REFLEXÃO DA RADIAÇÃO

ATMOSFERA

GASES DE ESTUFA

RADIAÇÃO INFRAVERMELHA



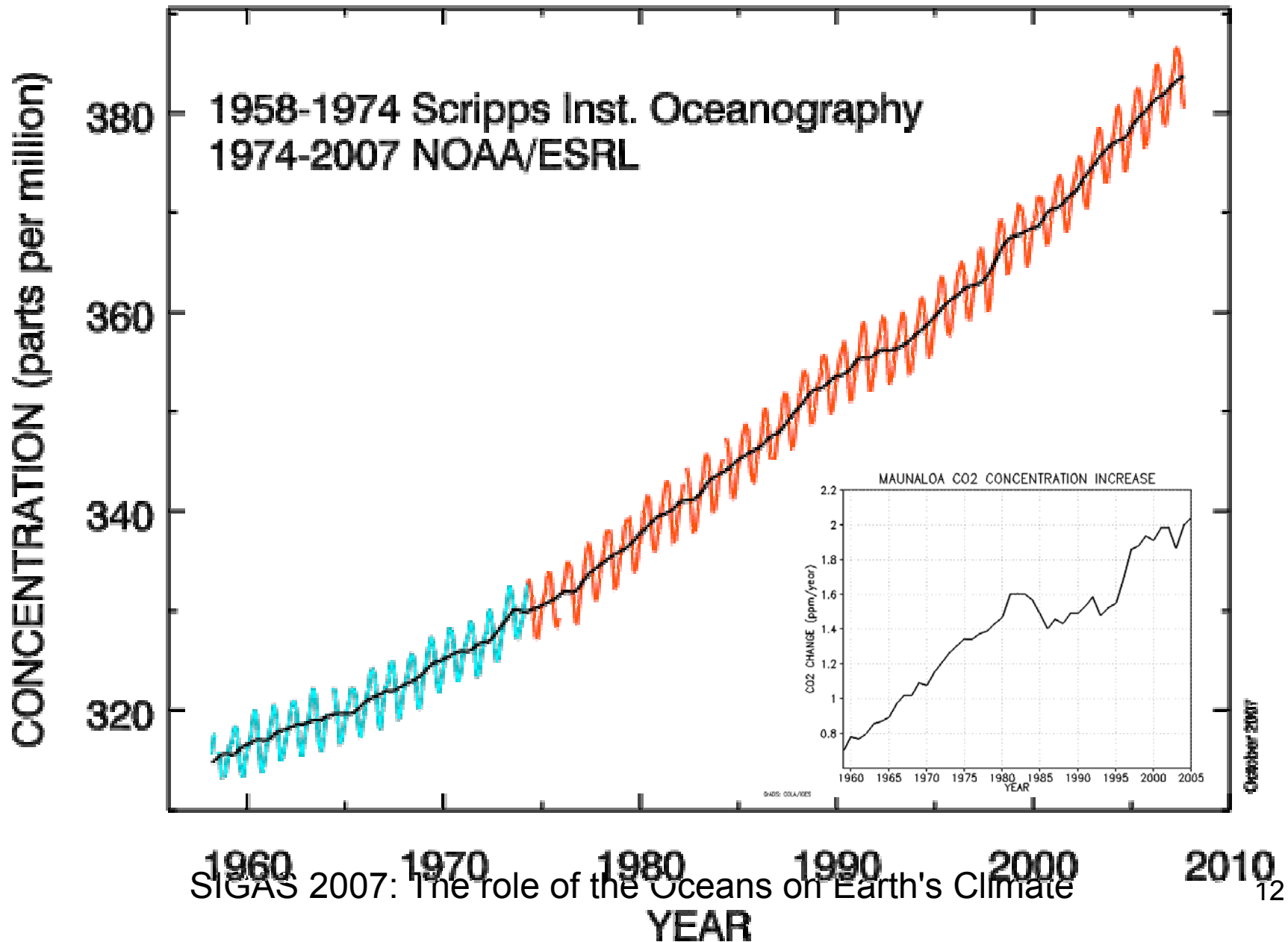
Anthropogenic CO₂
Sources sum up to
8 Billion Metric Tons per year



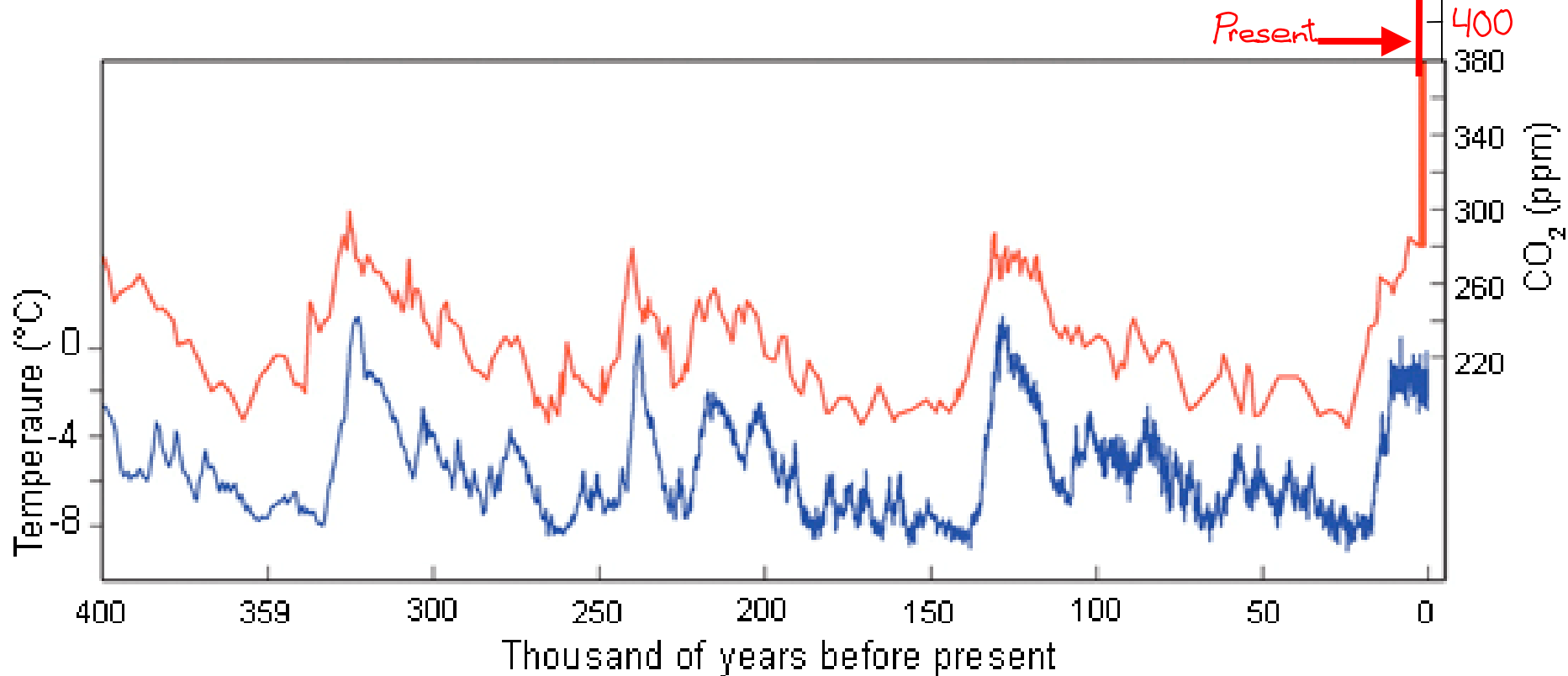
**4.8 billions tons are up taken by
the biosphere and the oceans ...**

**... leaving nearly 3.2 billion tons
in the atmosphere!**

Atmospheric CO₂ at Mauna Loa Observatory

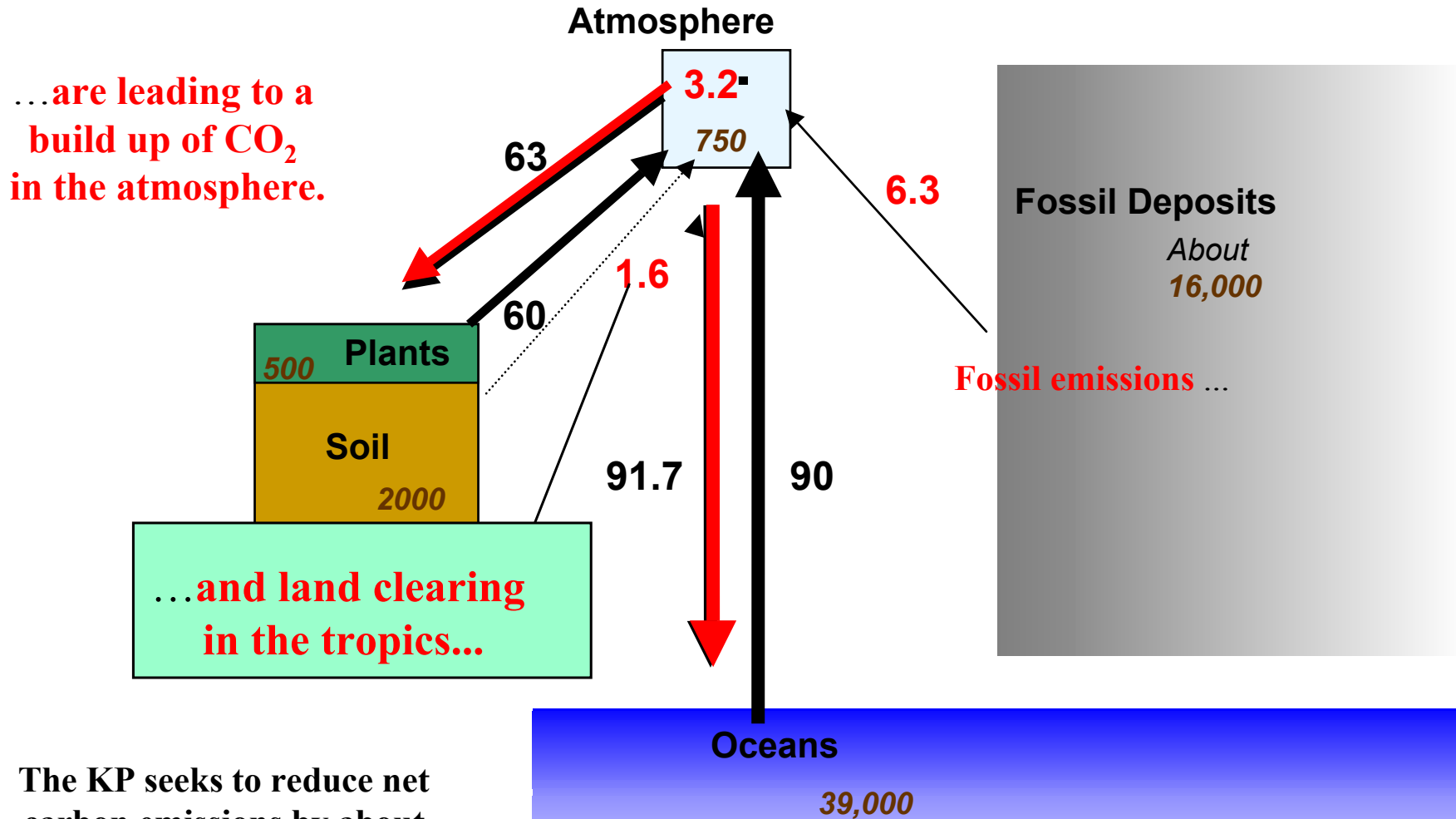


Global CO_2 Concentration & Air Temperature during the last 400,000 years



The Global Carbon Cycle - 1990s

Units Gt C and Gt C y⁻¹

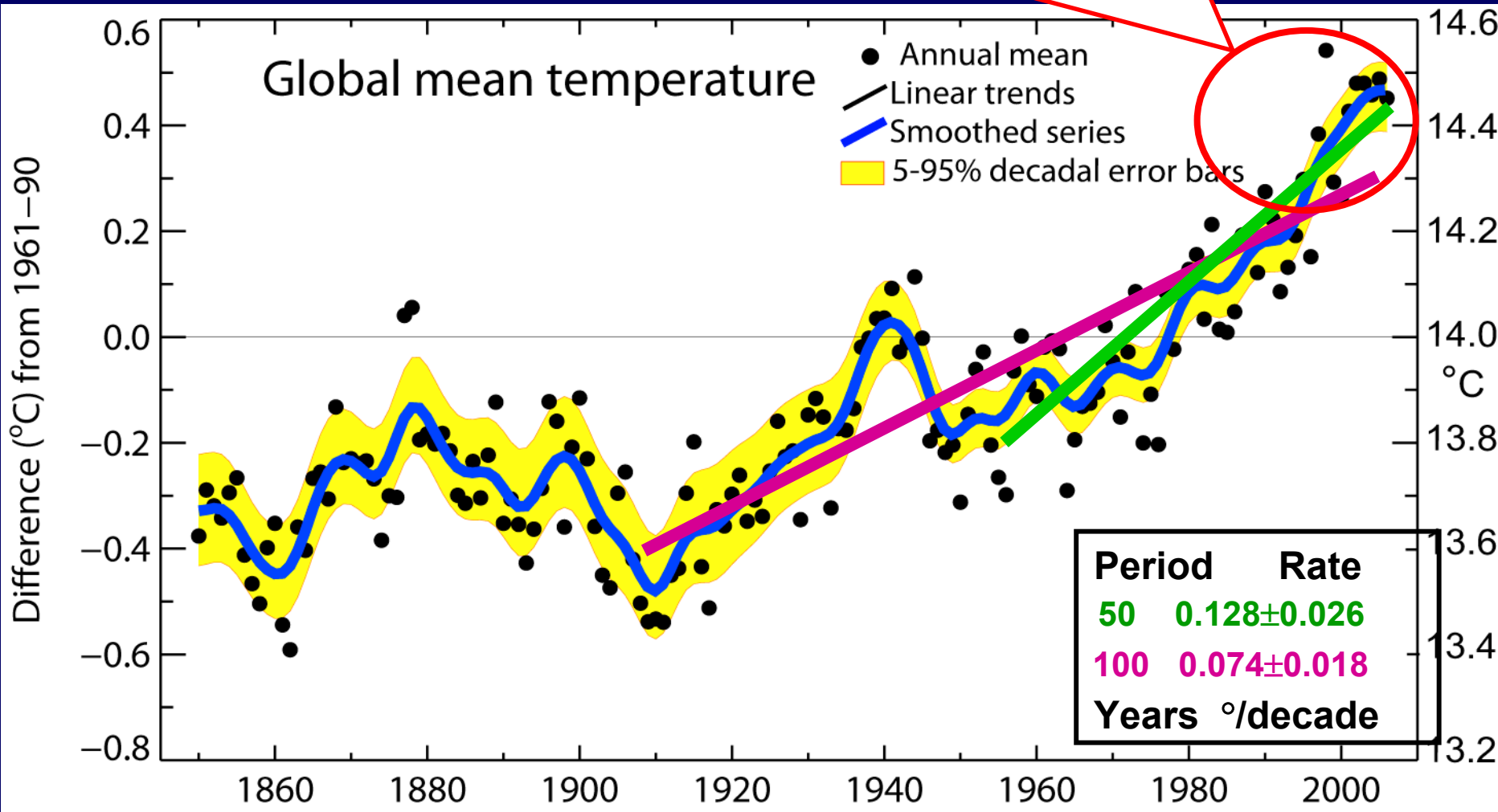


The KP seeks to reduce net carbon emissions by about 0.3 Gt C below 1990 levels from industrial countries. The role of the KP is to reduce net carbon emissions by about 0.3 Gt C below 1990 levels from industrial countries.

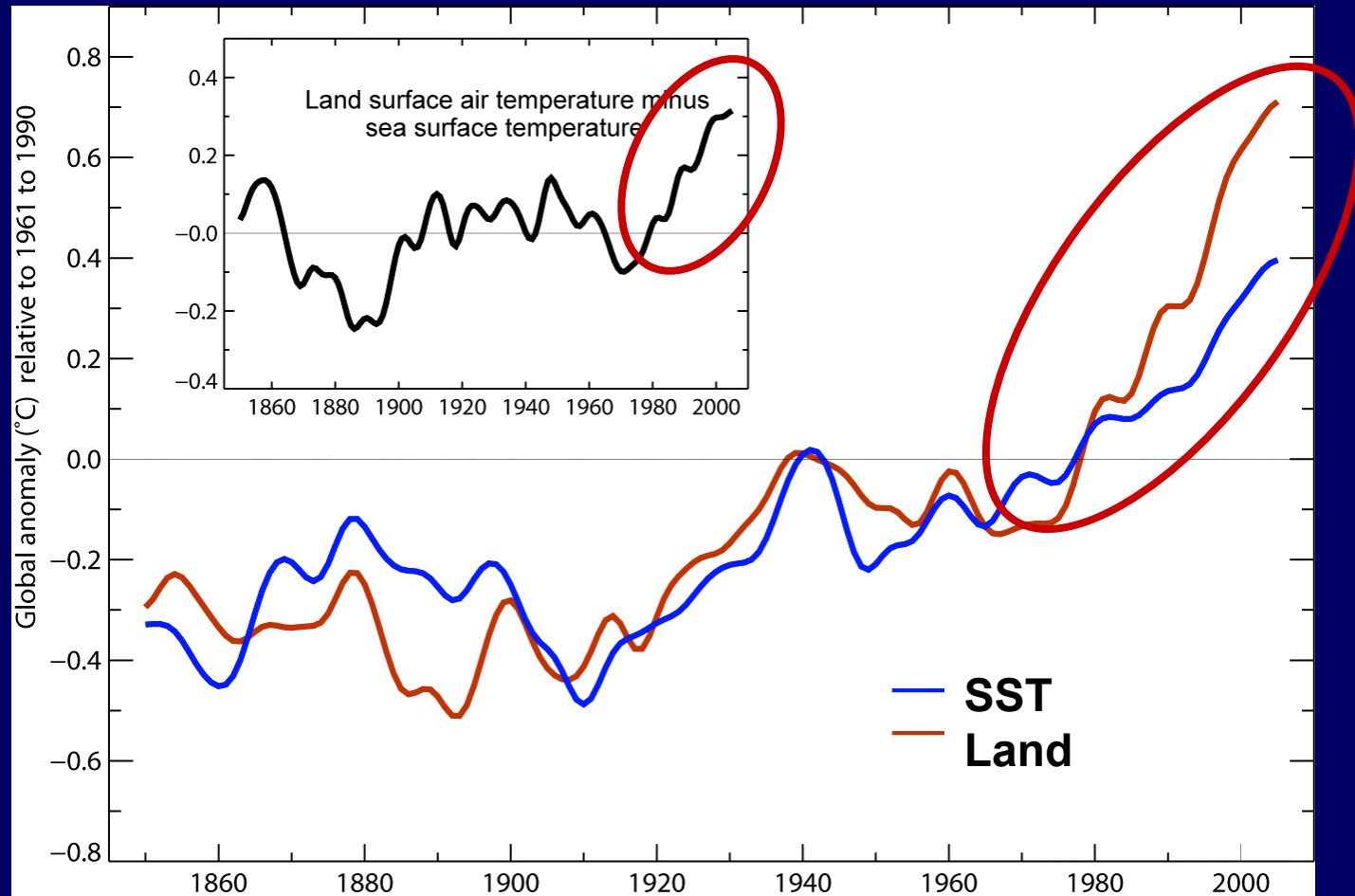
SIGAS 2007: The role of the KP is to reduce net carbon emissions by about 0.3 Gt C below 1990 levels from industrial countries.

Global mean temperatures

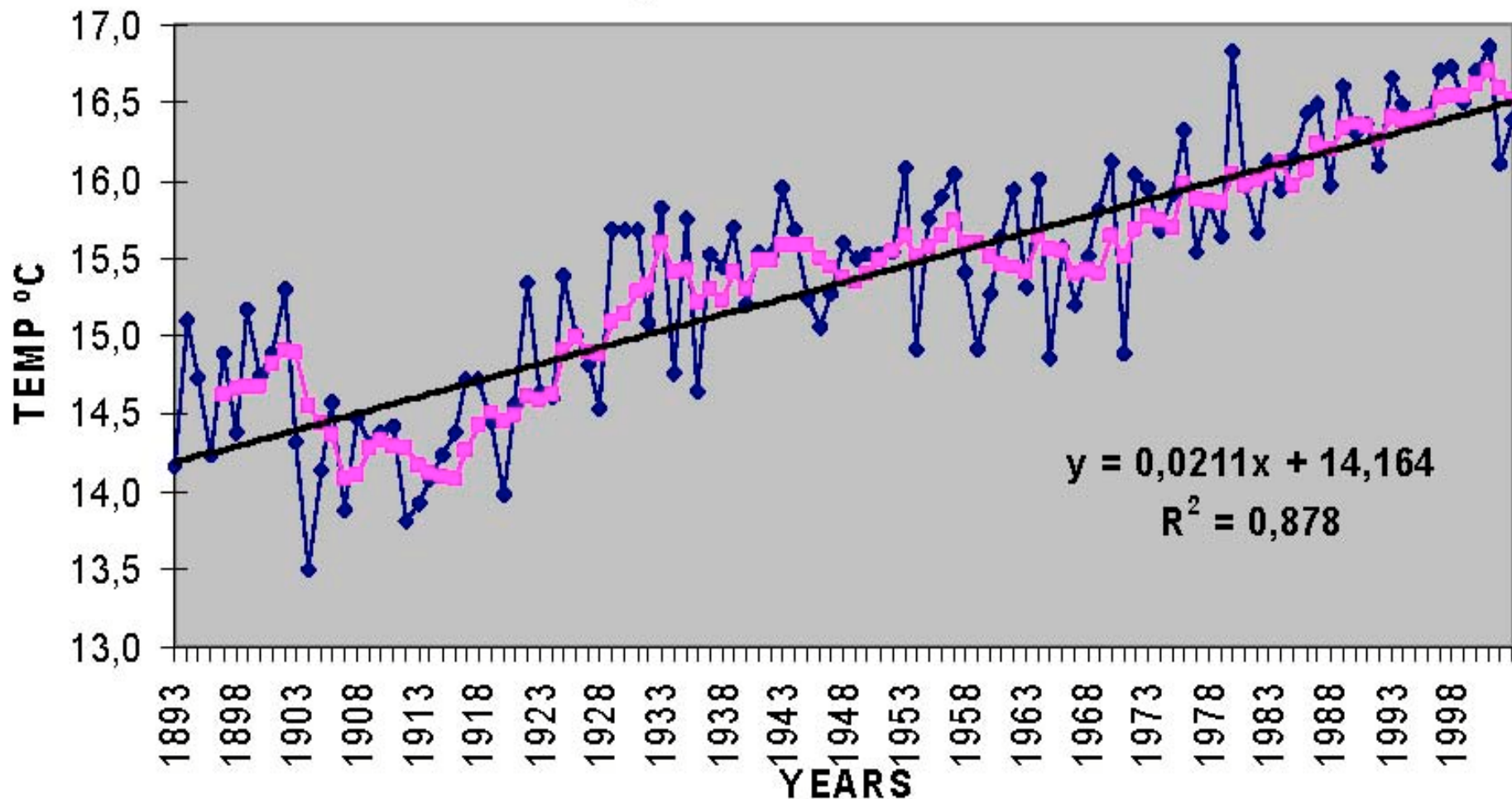
Warmest 12 years:
1998, 2005, 2003, 2002, 2004, 2006,
2001, 1997, 1995, 1999, 1990, 2000



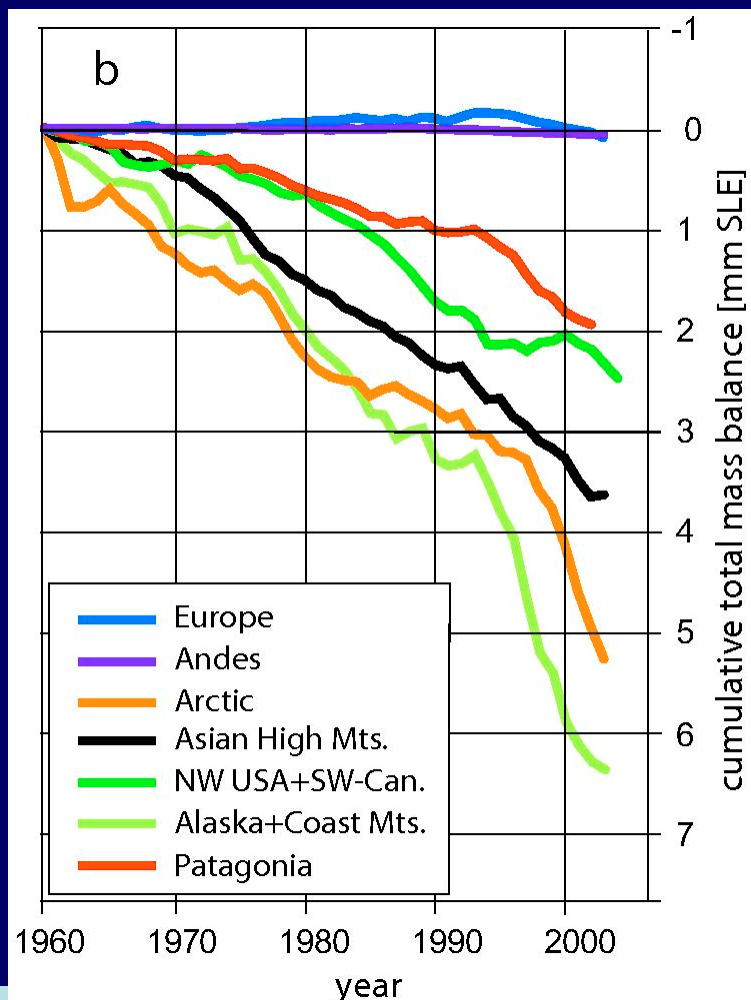
Land surface temperatures are rising faster than SSTs



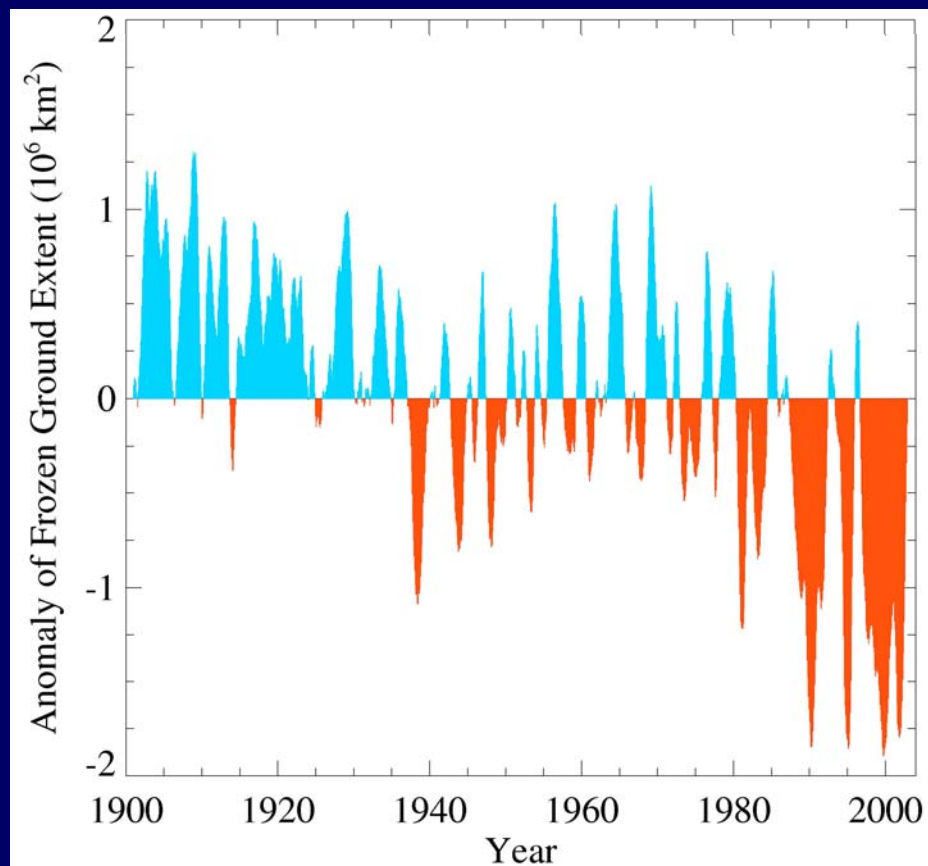
MEAN MINIMUM ANNUAL TEMPERATURES - CAMPINAS, SP.
Mov.Avg 5 - DATA SOURCE:IAC



Glaciers and frozen ground are receding



Increased Glacier retreat since the early 1990s



Area of seasonally frozen ground in NH has decreased by 7% from 1901 to 2002

Upsala Glacier

Argentina

1928



2004



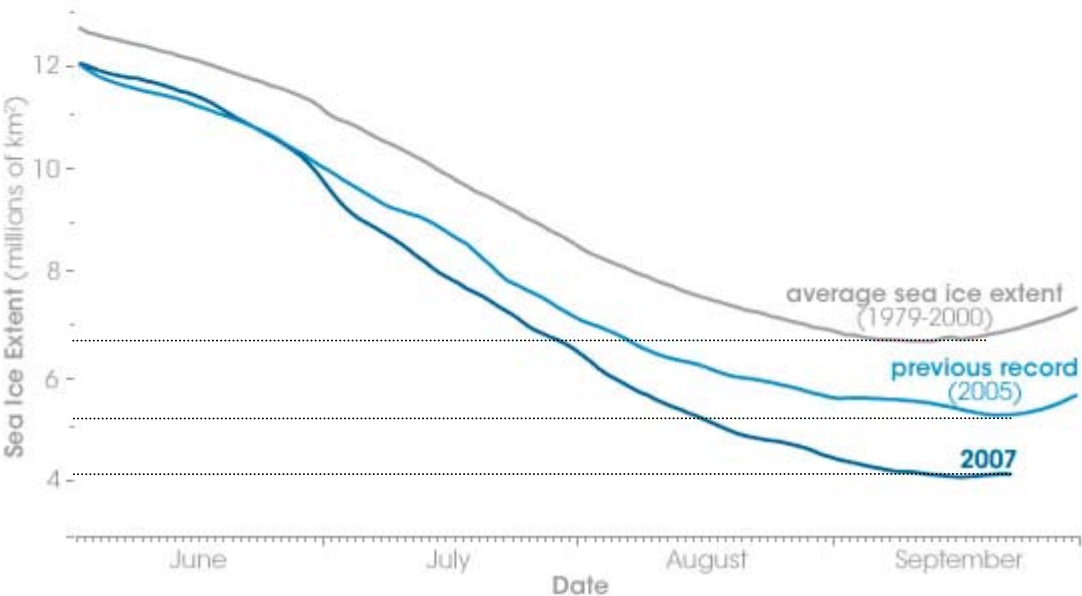
42 Km³ ice melting per year

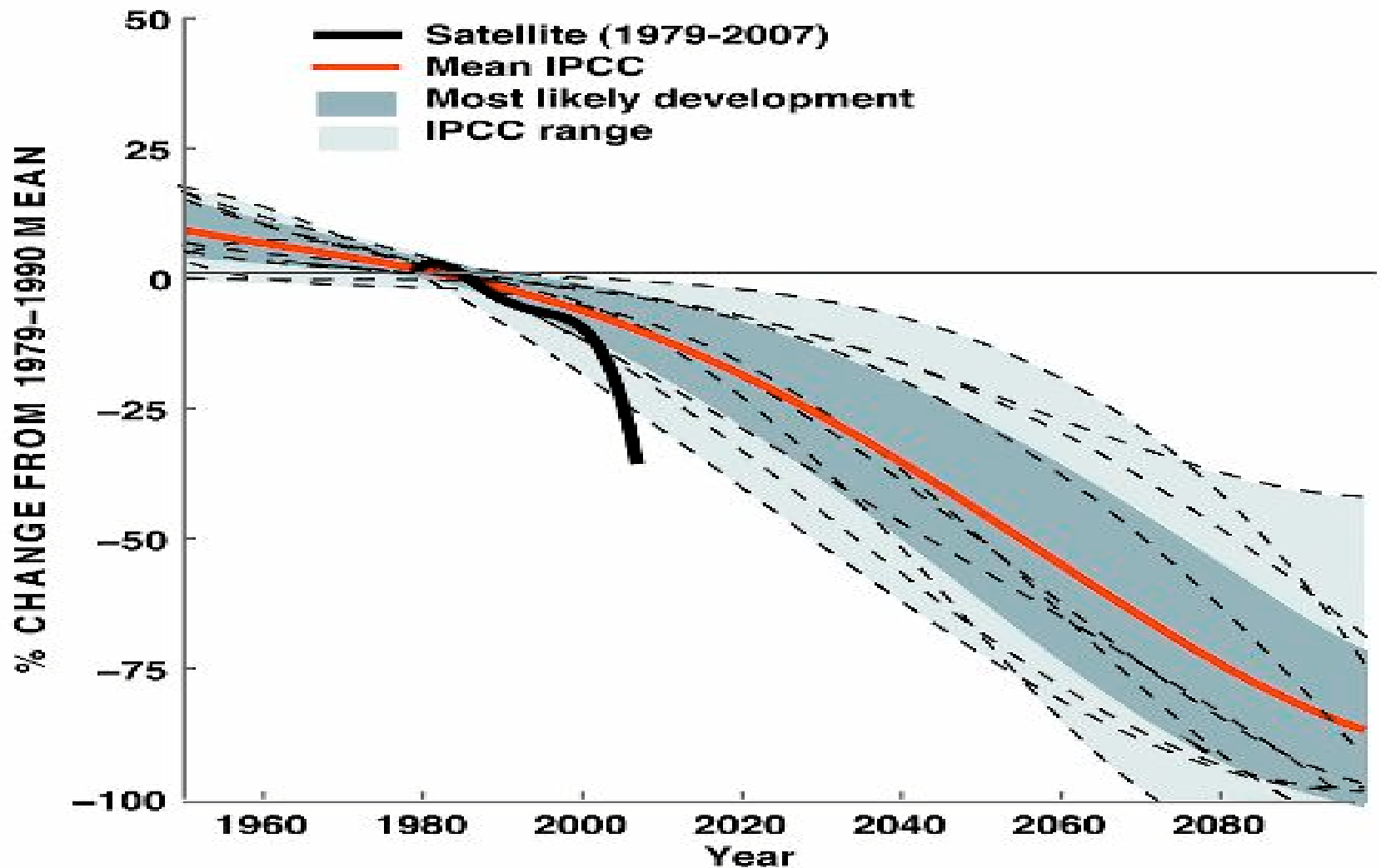
SIGAS 2007. The role of the Oceans on Earth's Climate



2007's Arctic Record Ice Loss:

1 Million Km²
higher than
2005's record



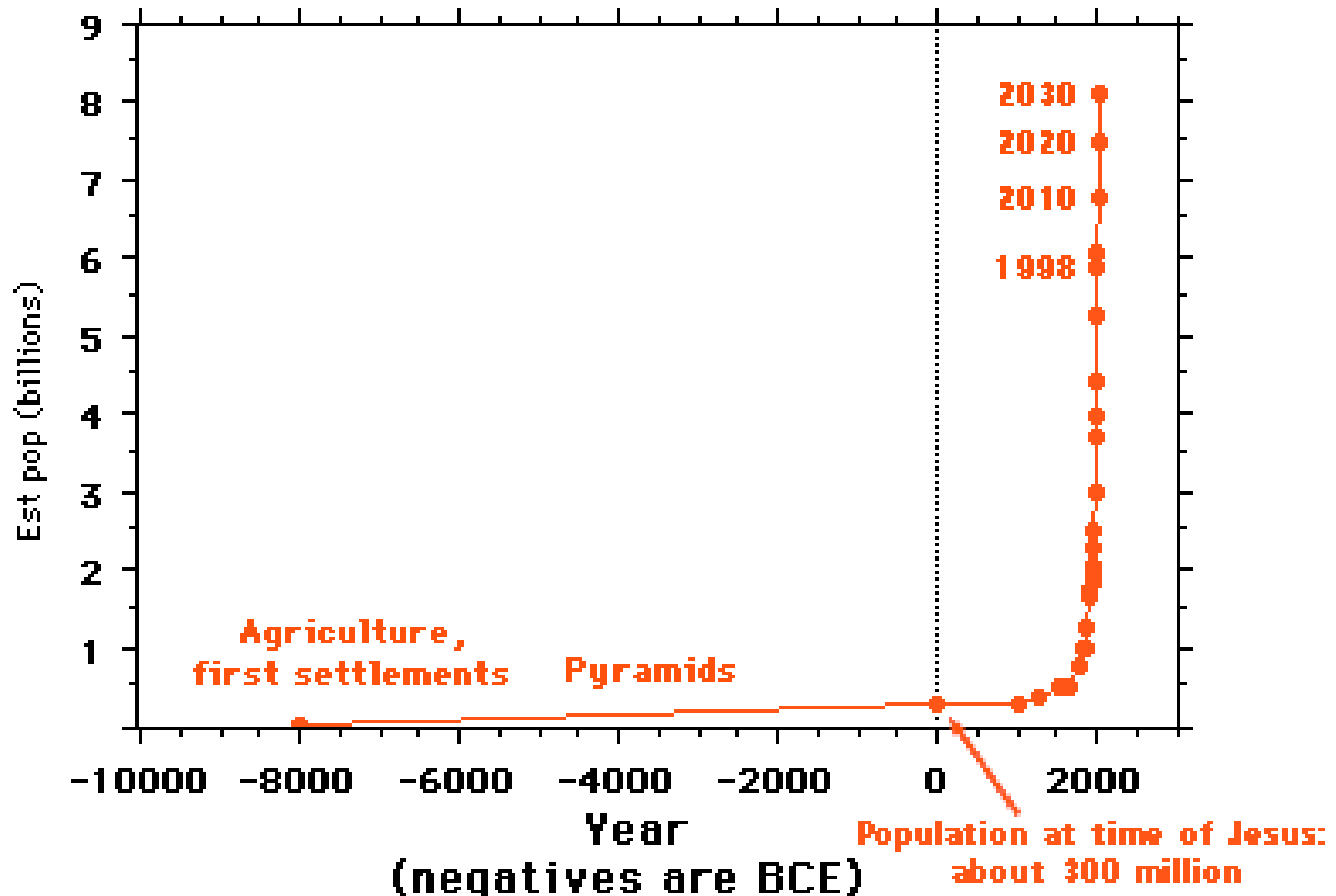


Arctic sea ice loss compared to IPCC models

Arctic ice extent loss to September 2007 compared to IPCC modelled changes using the SRES A2 CO2 scenario (IPCC high CO2 scenario). September loss data from satellite observations. Data smoothed with a 4th order polynomial to smooth out the year-to-year variability. Chart courtesy Dr Asgeir Sorteberg, Bjerknes Centre for Climate Research and University Center at Svalbard, Norway.

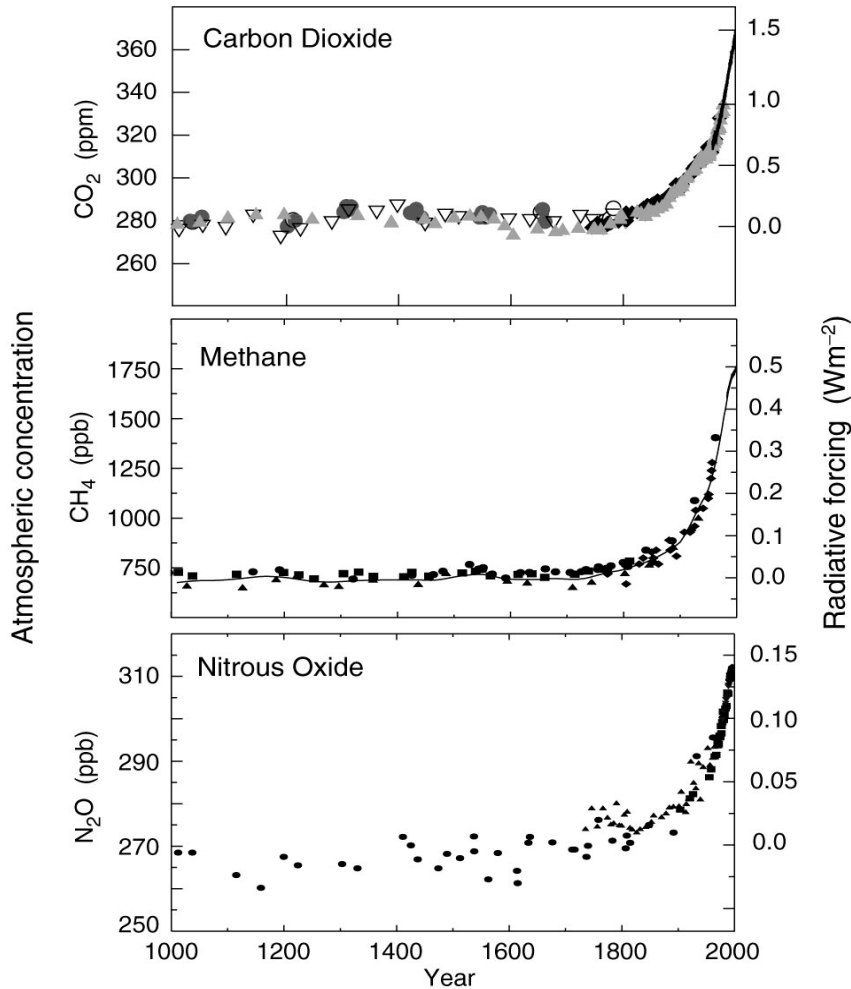
Date: 23 September 2007 www.carbonequity.info/images/seaice07.jpg

World Population

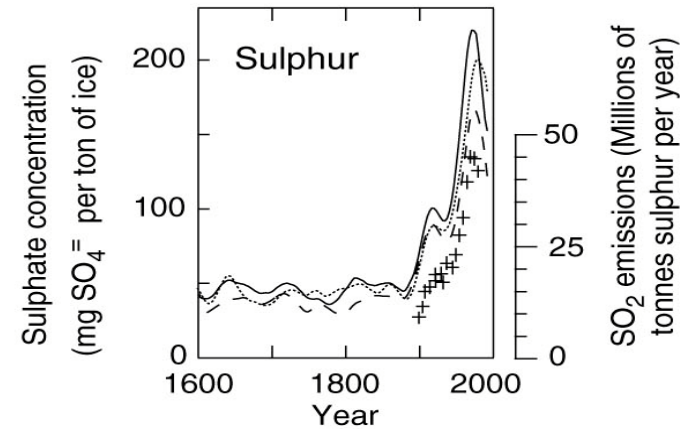


Indicators of the Human Influence on the Atmosphere during the Industrial Era

(a) Global atmospheric concentrations of three well mixed greenhouse gases



(b) Sulphate aerosols deposited in Greenland ice



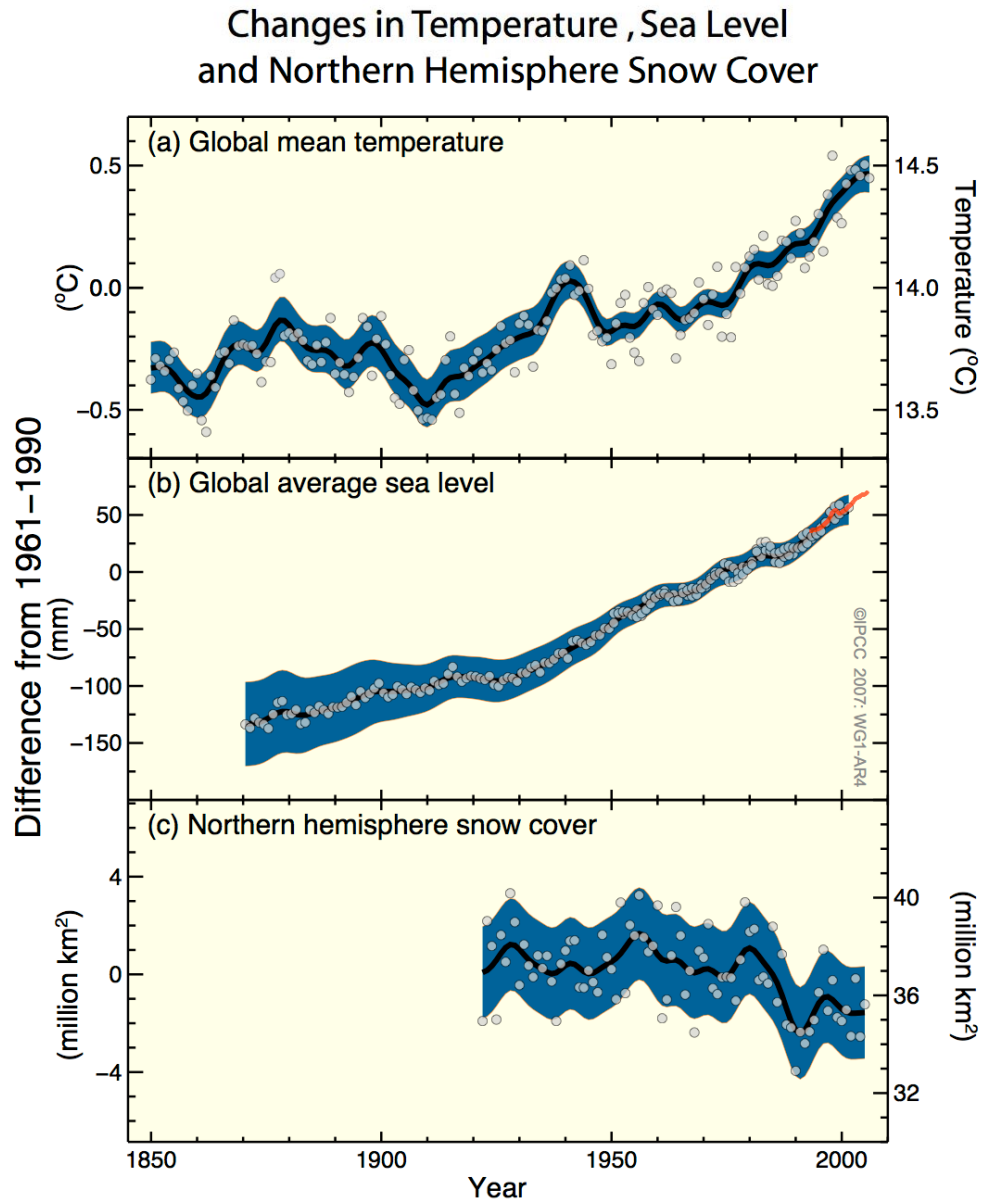
Direct Observations of Recent Climate Change

Global mean temperature

Global average sea level

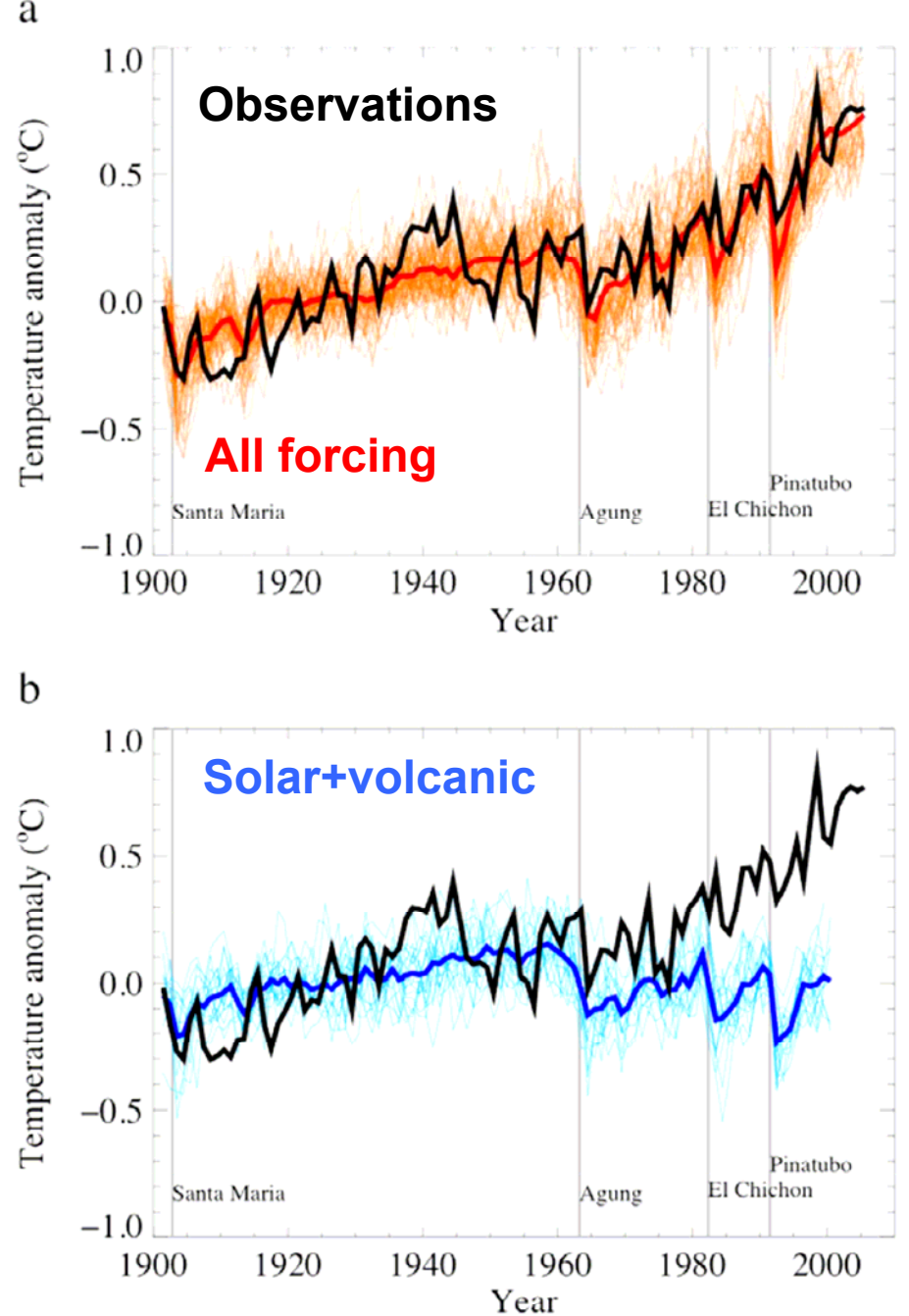
Northern hemisphere snow cover

SIGAS 2007: The role

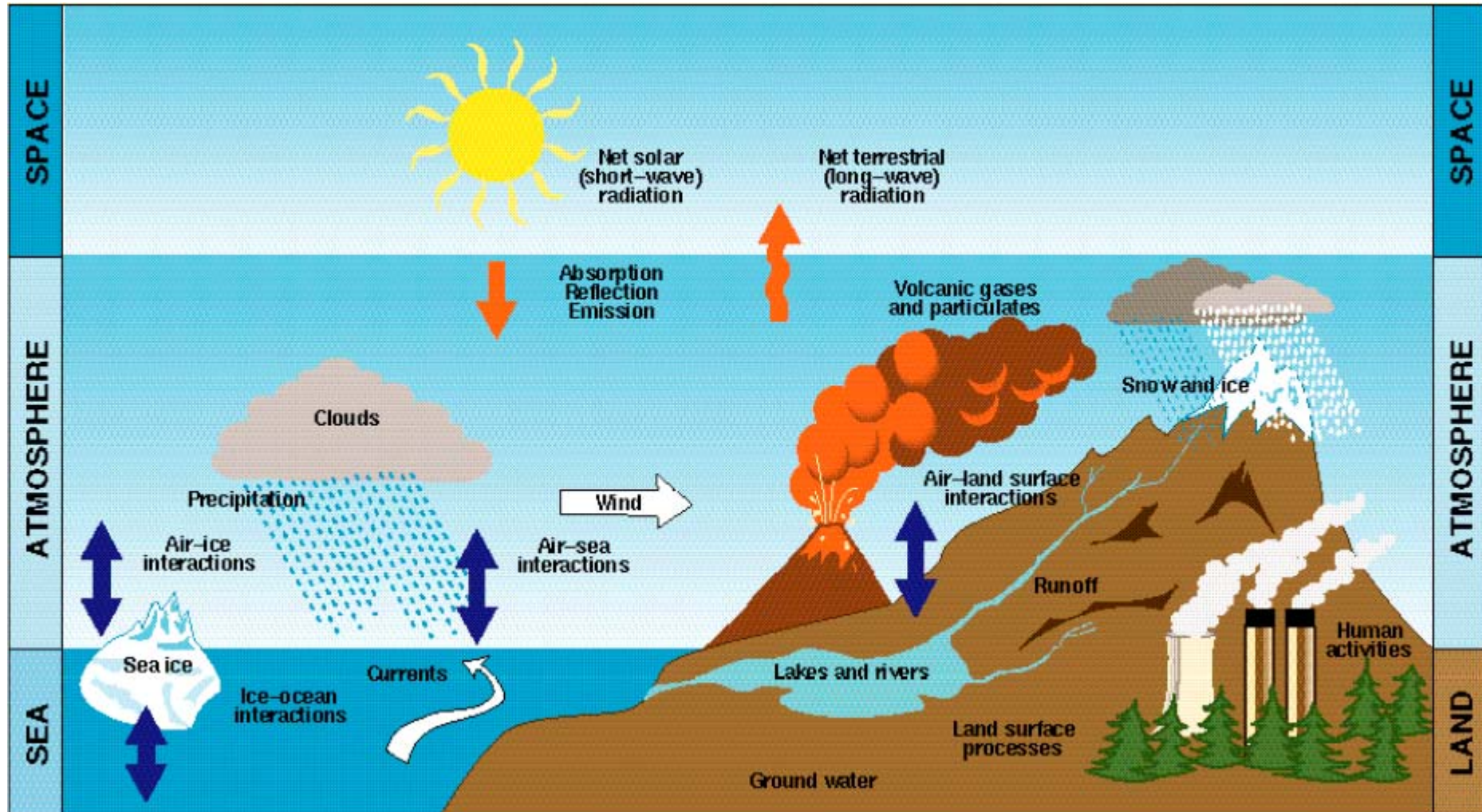


Attribution

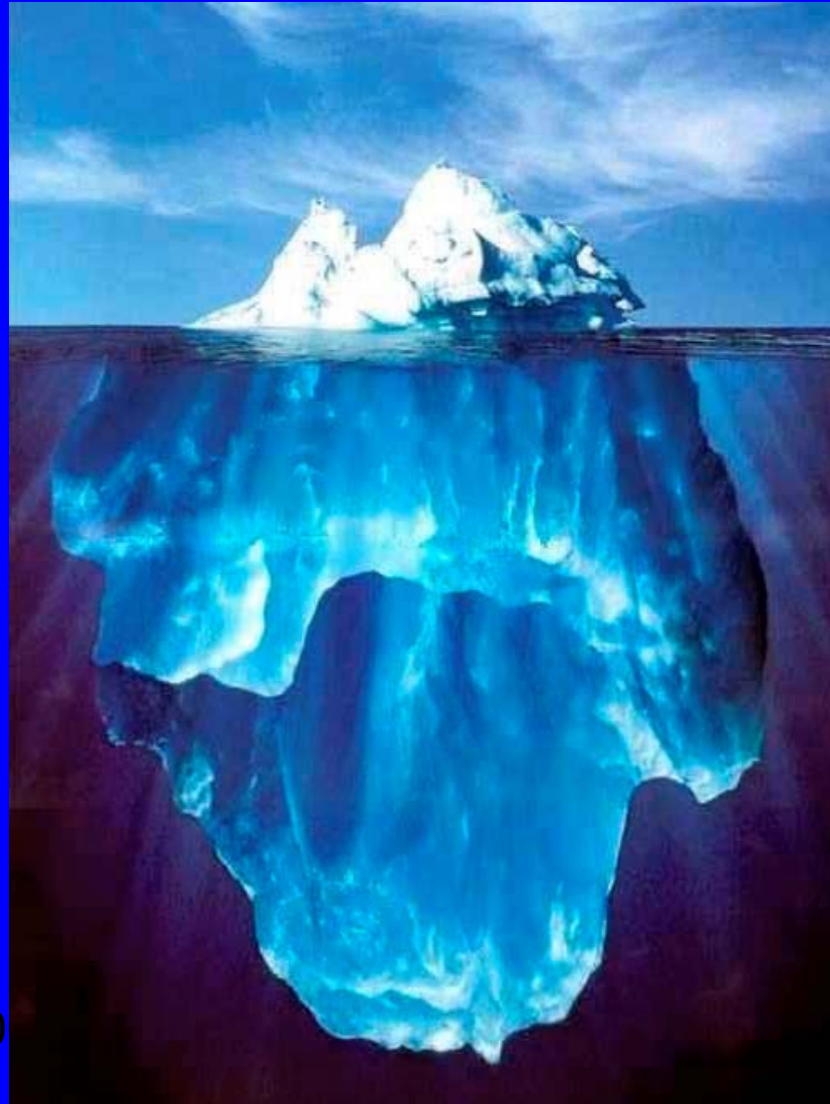
- are observed changes consistent with
 - ✍ expected responses to forcings
 - ✋ inconsistent with alternative explanations



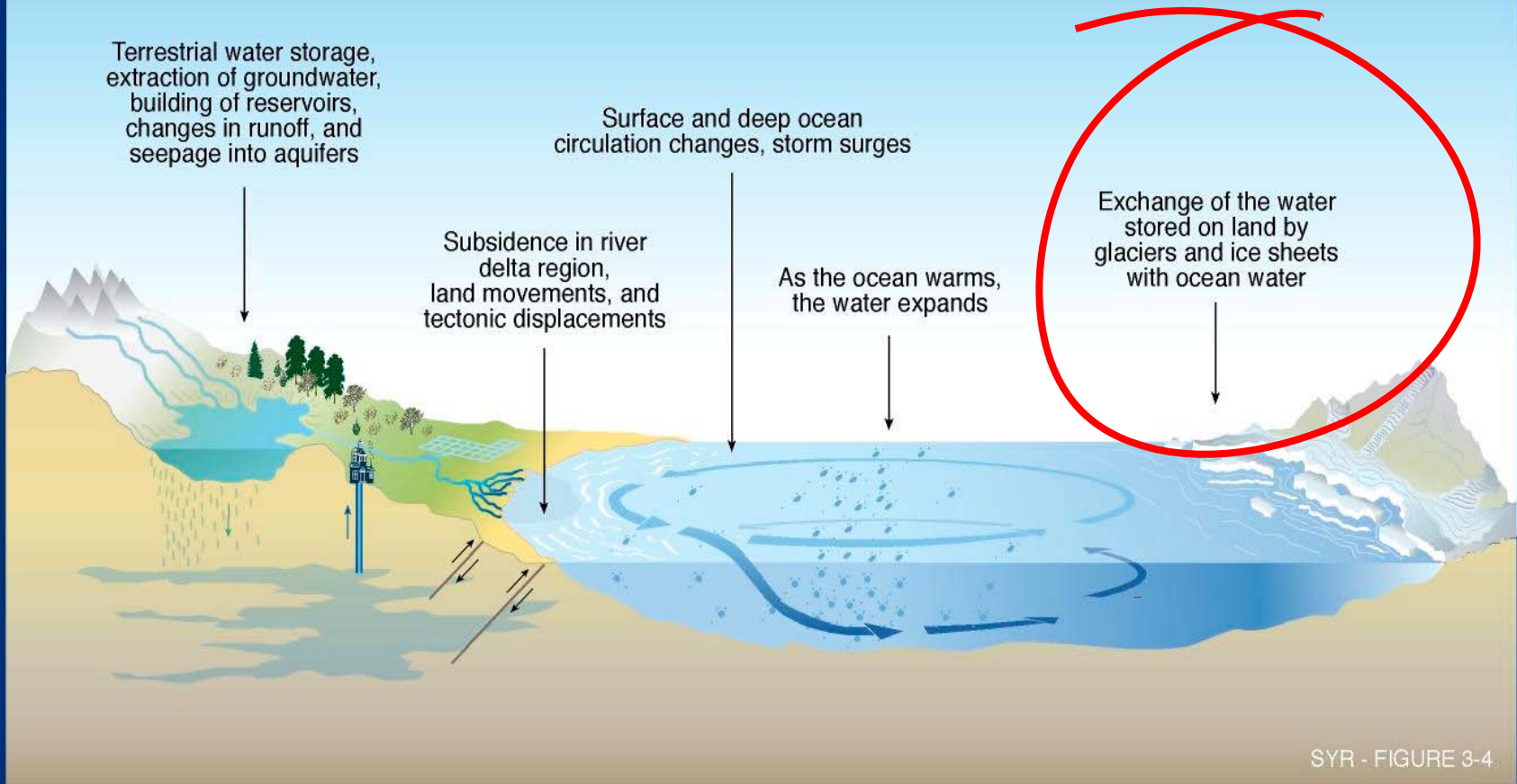
Elements of the Earth's Climate



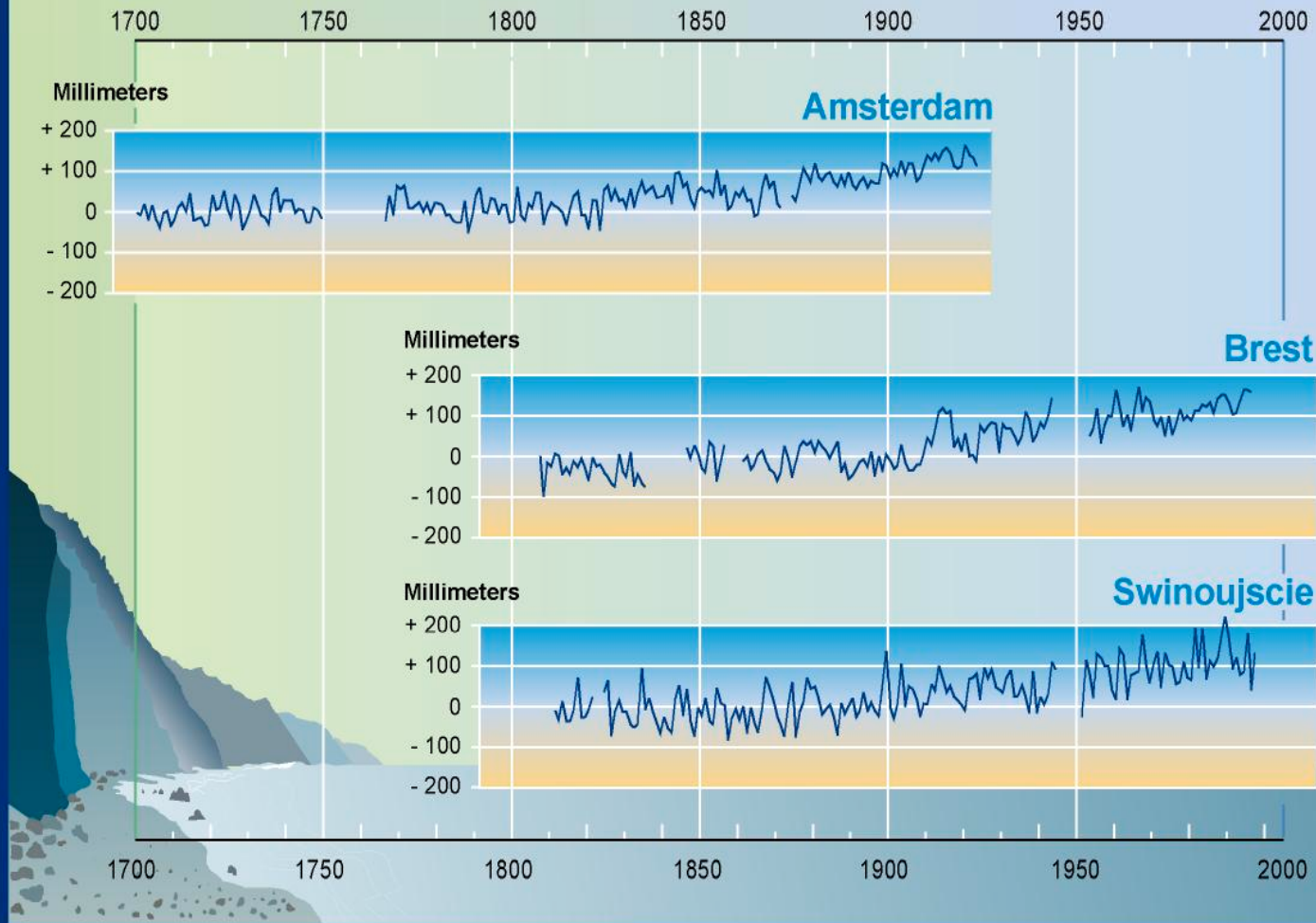
The deep oceans are filled with
As a consequence that
liquid water!



What causes the sea level to change?

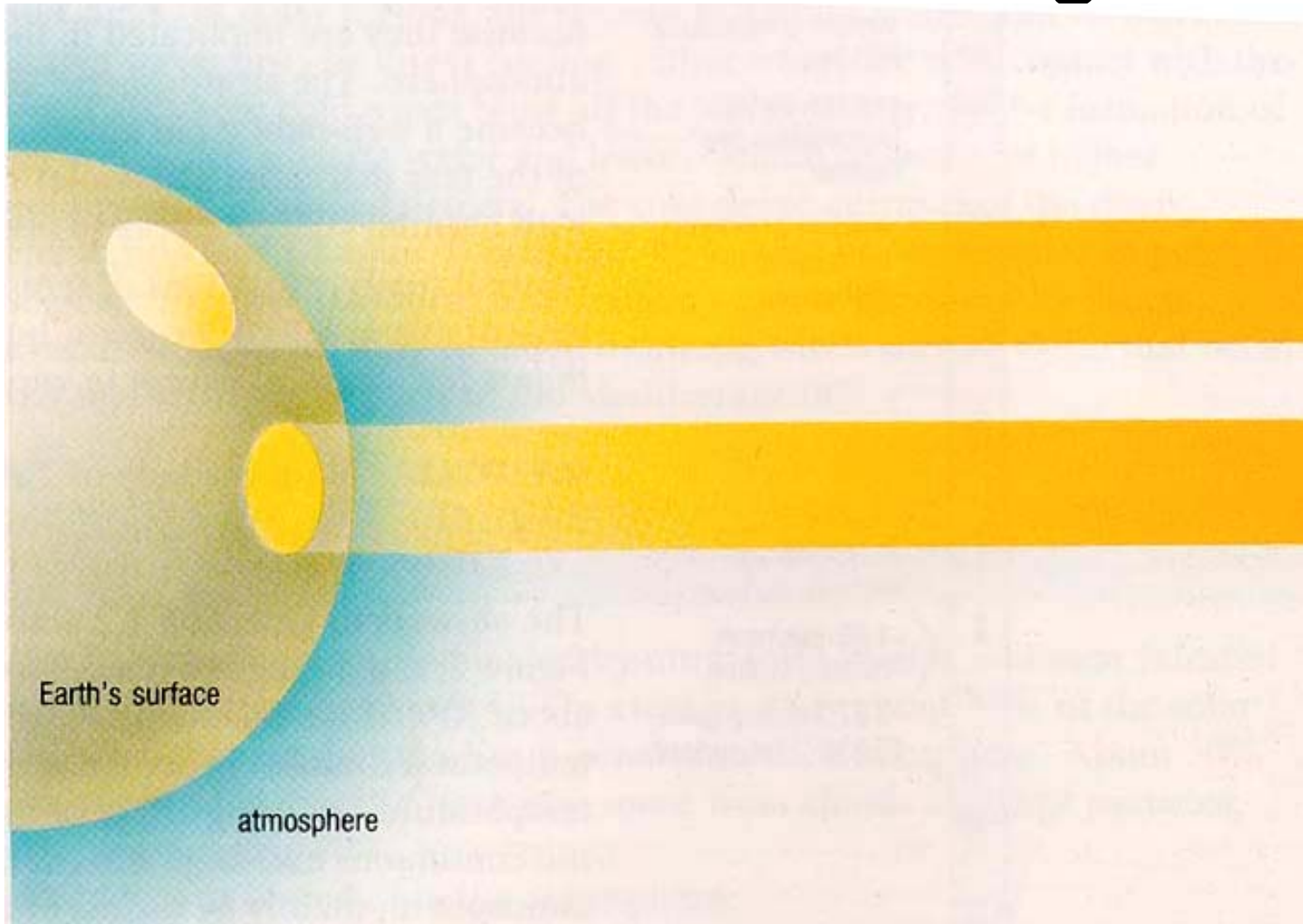


Relative sea level over the last 300 years

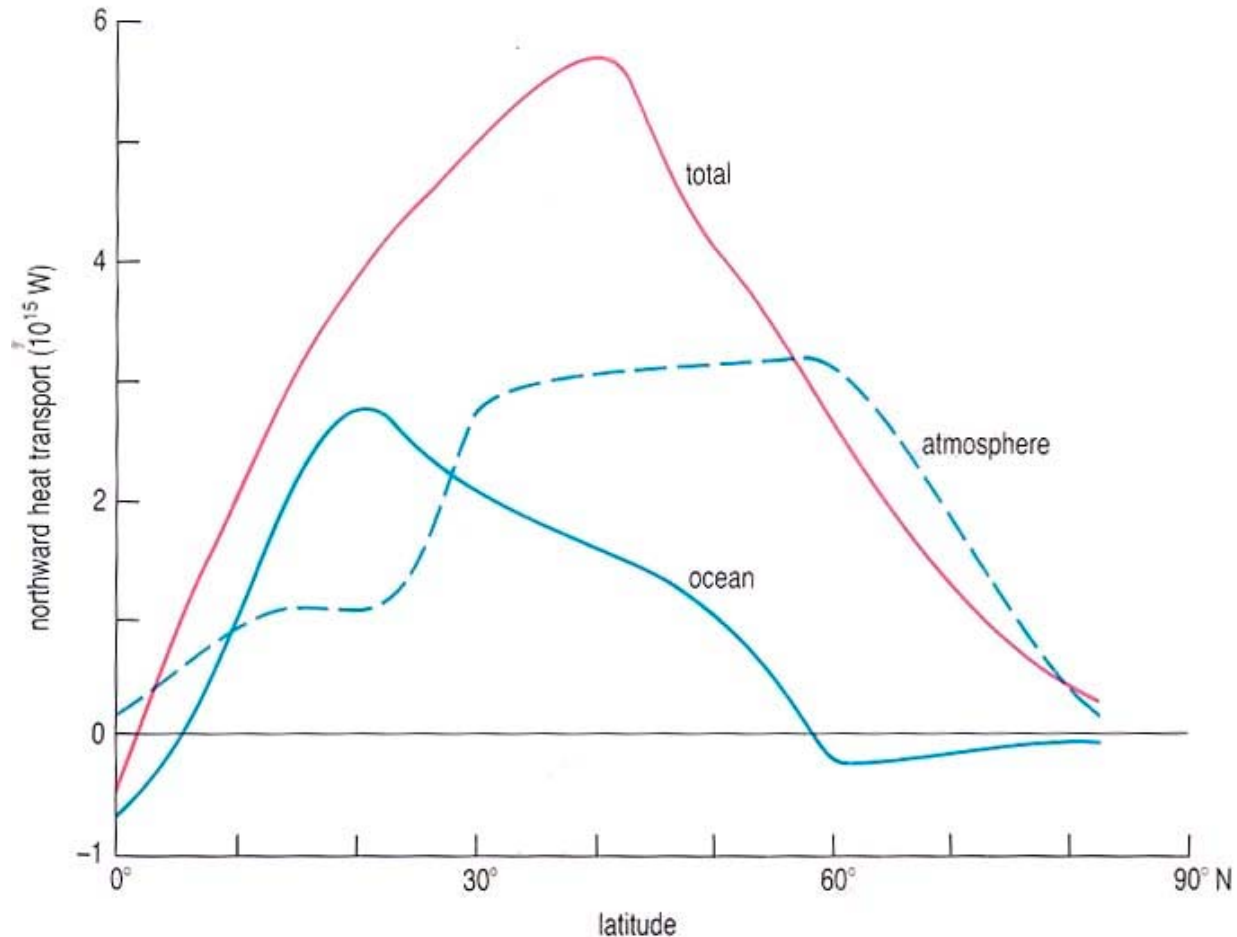


SYR - FIGURE 2-5

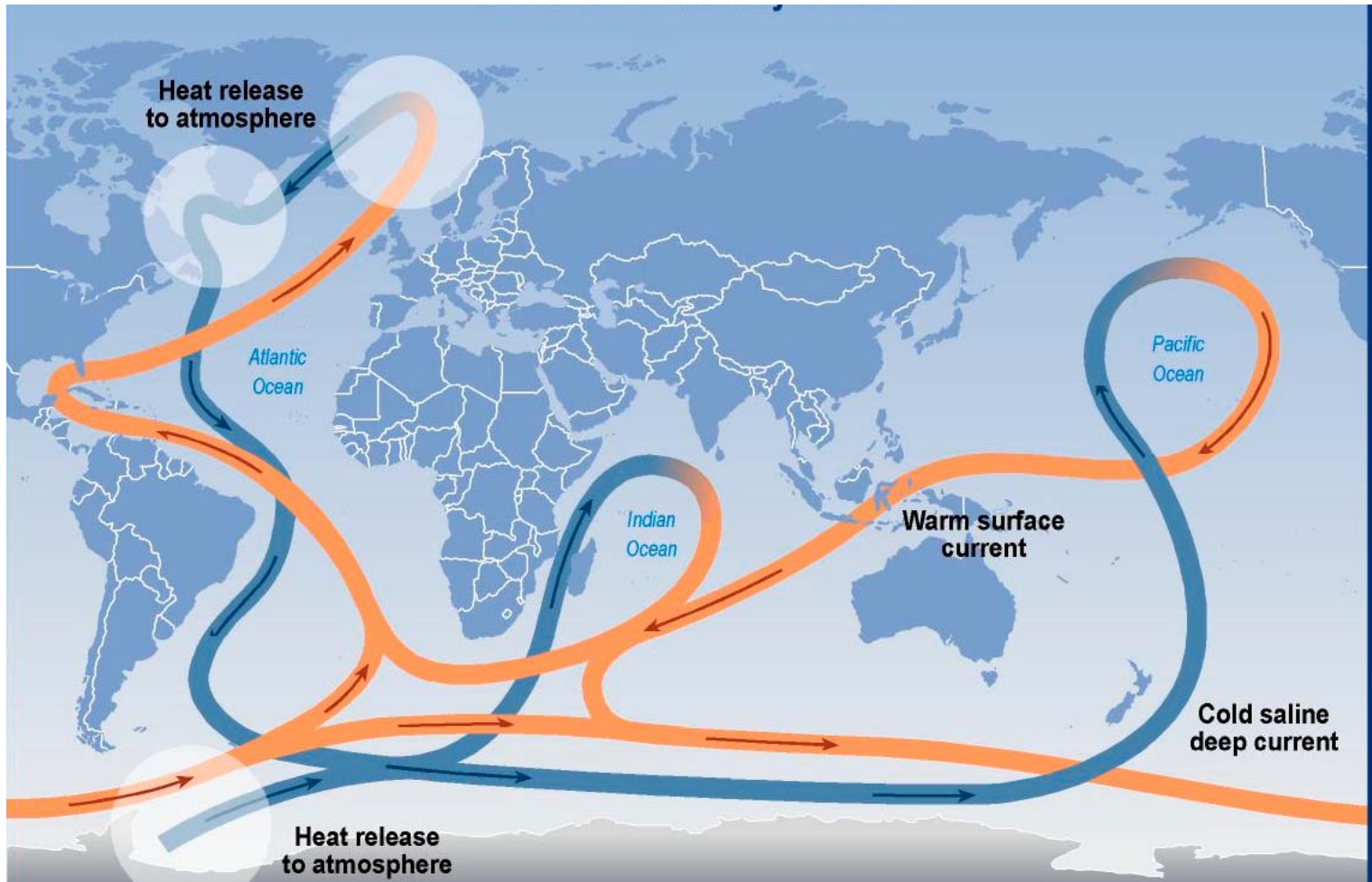
Earth's Solar Heating



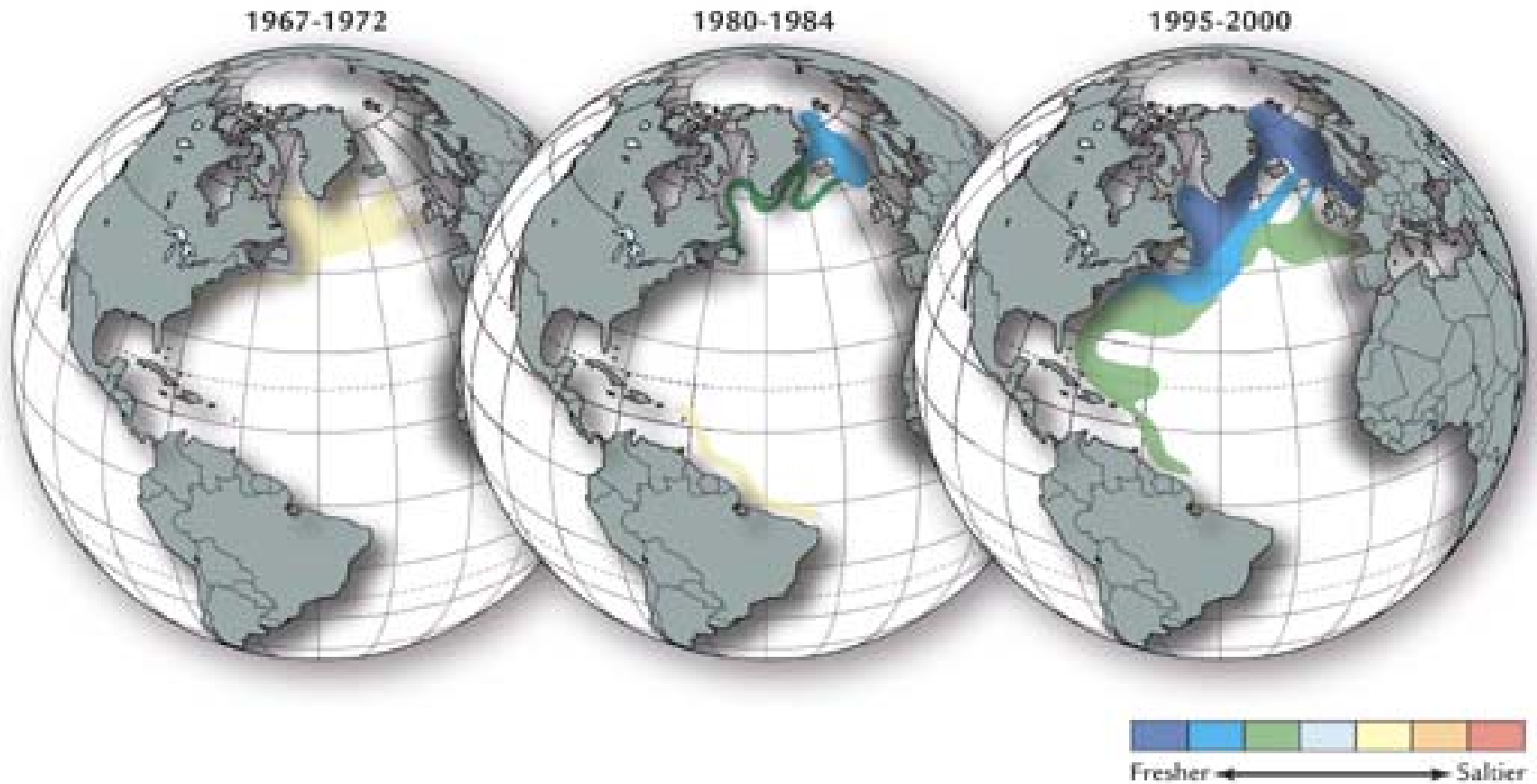
Poleward Heat Transport



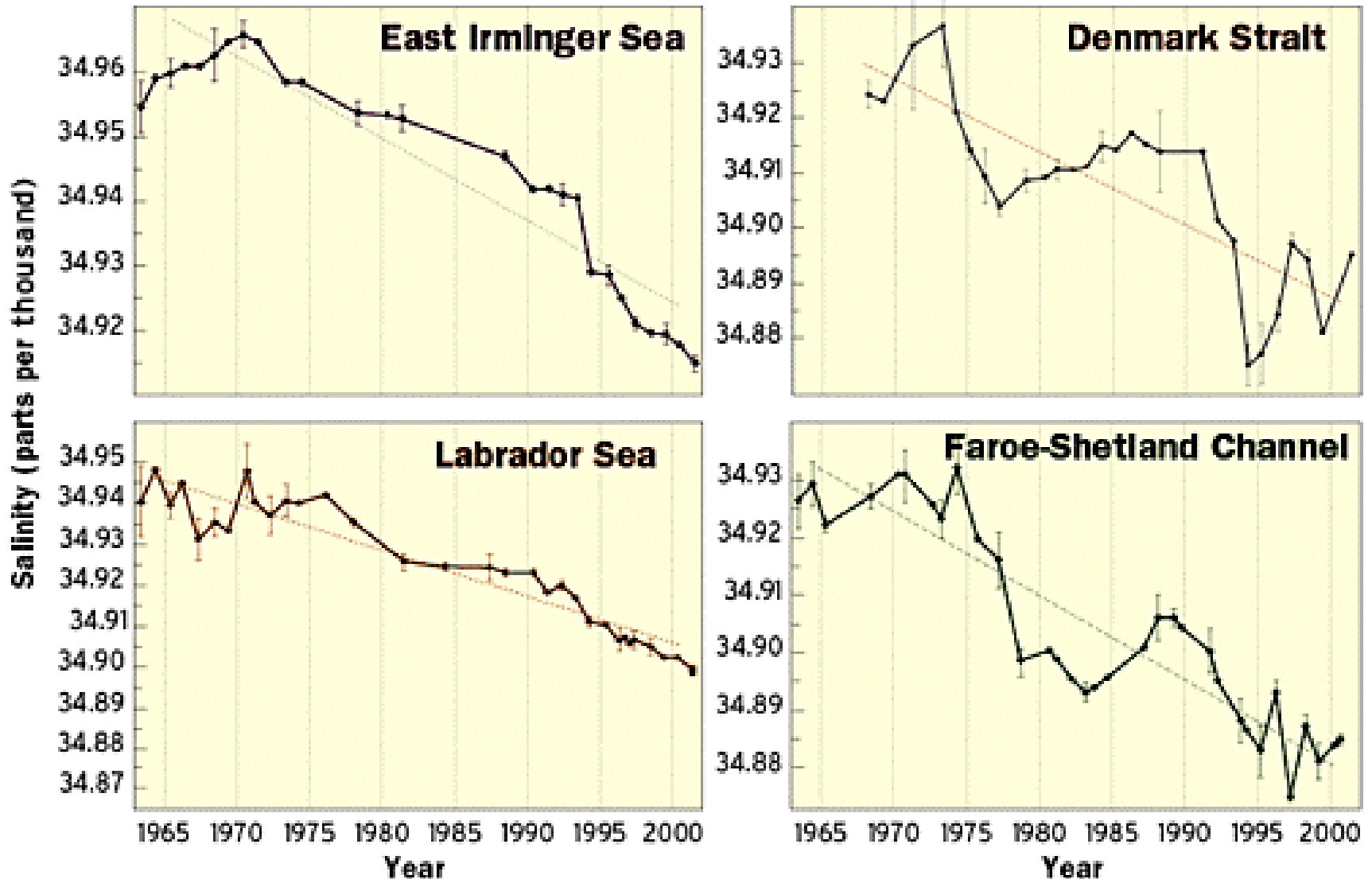
The Global Ocean Conveyor Belt



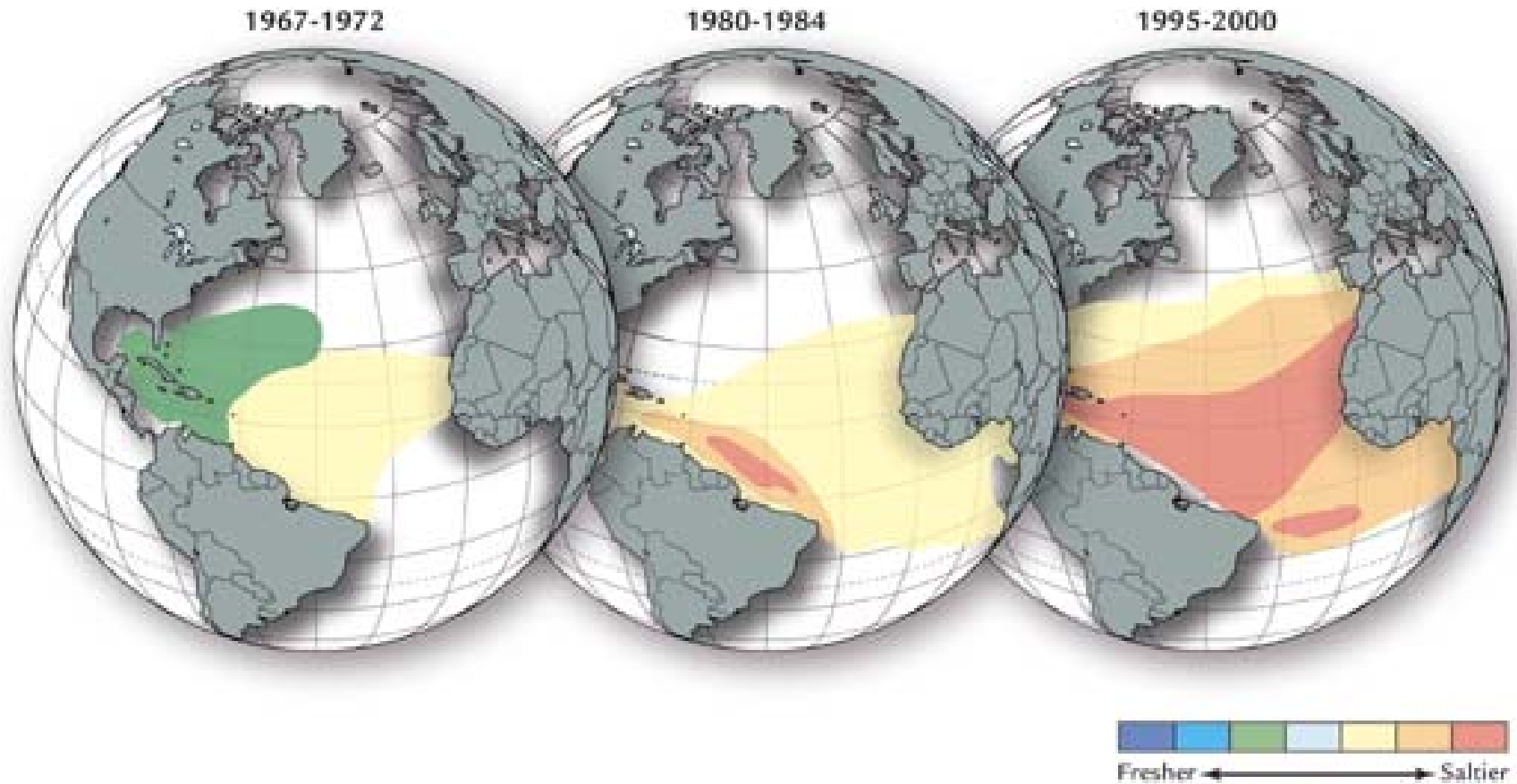
The North Atlantic is Freshening...



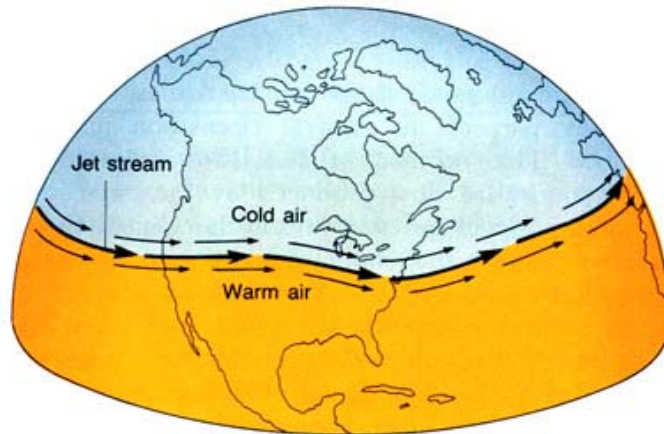
The North Atlantic is Freshening...



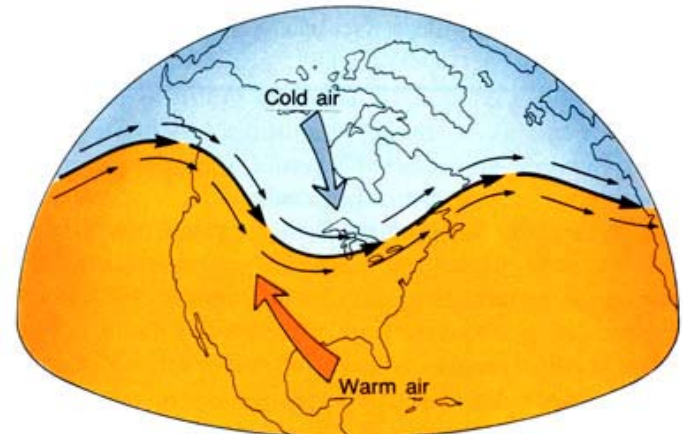
The Tropical Atlantic is getting Saltier



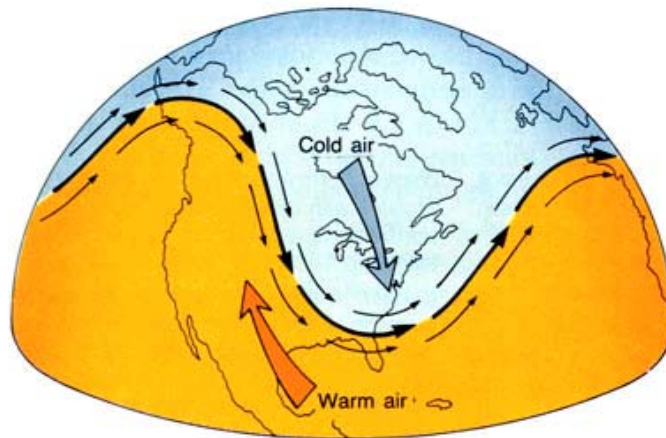
Poleward atmospheric heat transport (warms the polar and cools the equatorial regions)



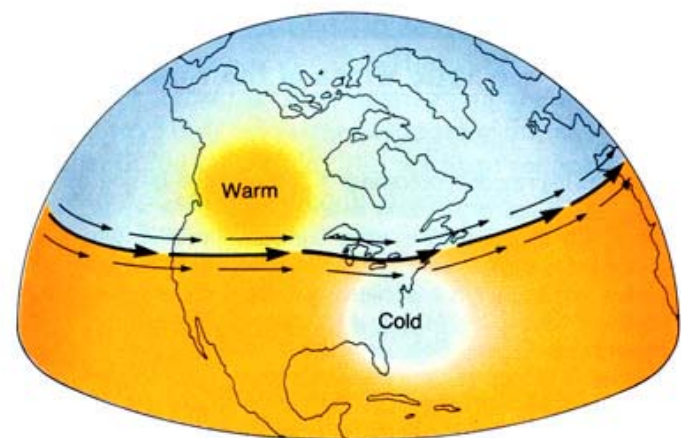
(a)



(b)



(c)



(d)

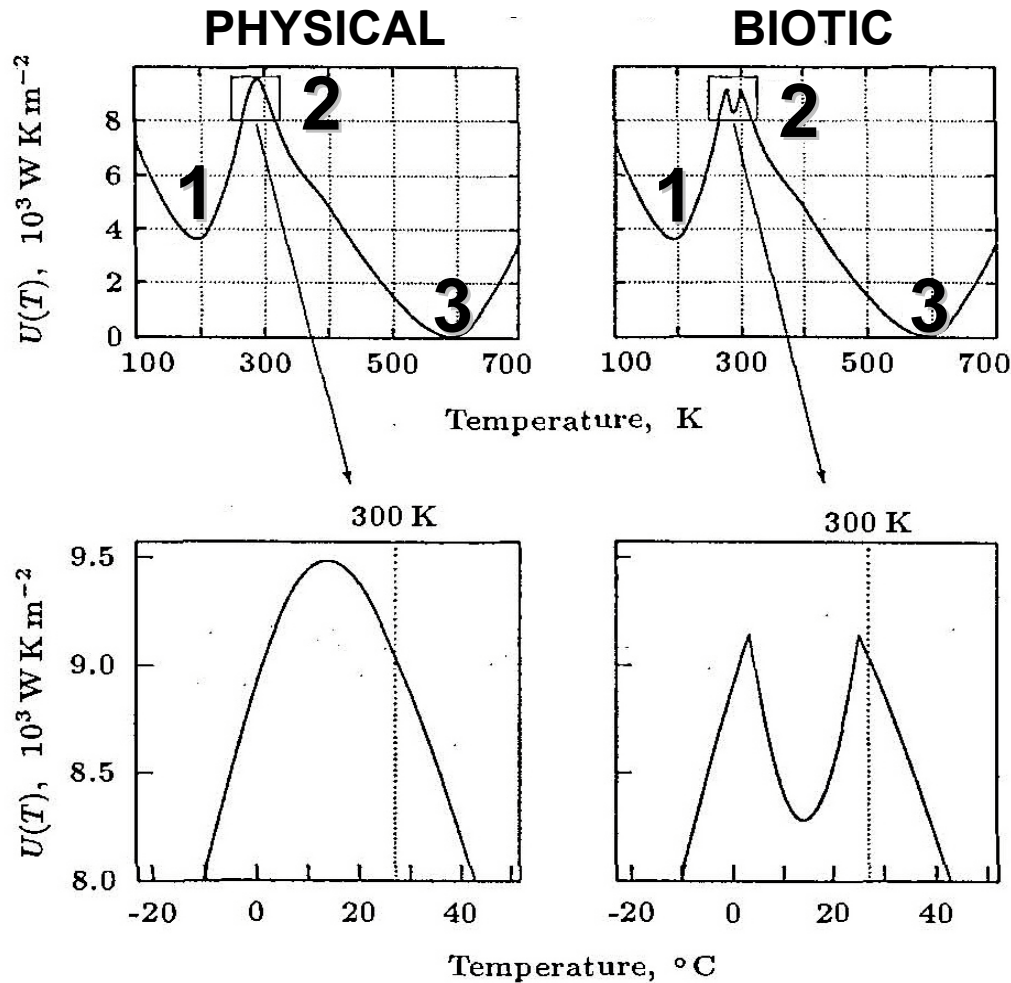
As a consequence of the relaxed deep ocean circulation...

- It is likely that the meteorological extreme events associated with atmospheric disturbances responsible for poleward heat transport shall become more intense;
- Storm tracks shall be displaced, changing the rainfall distribution pattern over the continents.

The green ocean effect:

- The Amazon rainforest has a stabilizing effect on global climate due to:
 - CO₂ sink;
 - Thermal regulation due to photosynthesis;
 - Modulation of global atmospheric circulation and variability.

Earth's Climate Stability



The Planet Earth

- **Human activities have induced significant climate change, with lasting effects on the environment.**
- **Present-day life conditions on Earth depends on the stabilizing effects of the forests and the oceans.**
- **Never before, a change of attitude of the humankind toward life has been so deemed necessary.**
- **Tropical Rainforest deforestation is a crime against humanity (and the Planet).**

There is still time to avoid the worst impacts of climate change, if we take strong action now.

The scientific evidence is now overwhelming: climate change is a serious global threat, and it demands an urgent global response.

STERN REVIEW: The Economics of Climate Change

The benefits of
strong and early action
far outweigh
the economic costs of
not acting.

The Stern Review