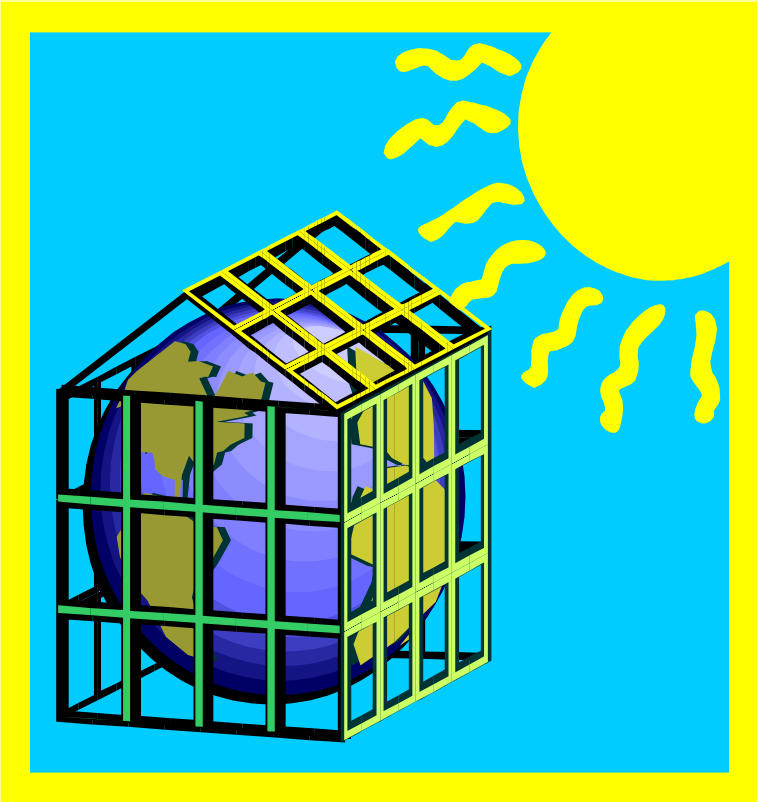
THE GREENHOUSE EFFECT

GREENHOUSE EFFECT

- The warming effect of the Earth's atmosphere is called the greenhouse effect .



HOW DOES THE GREENHOUSE EFFECT WORK?

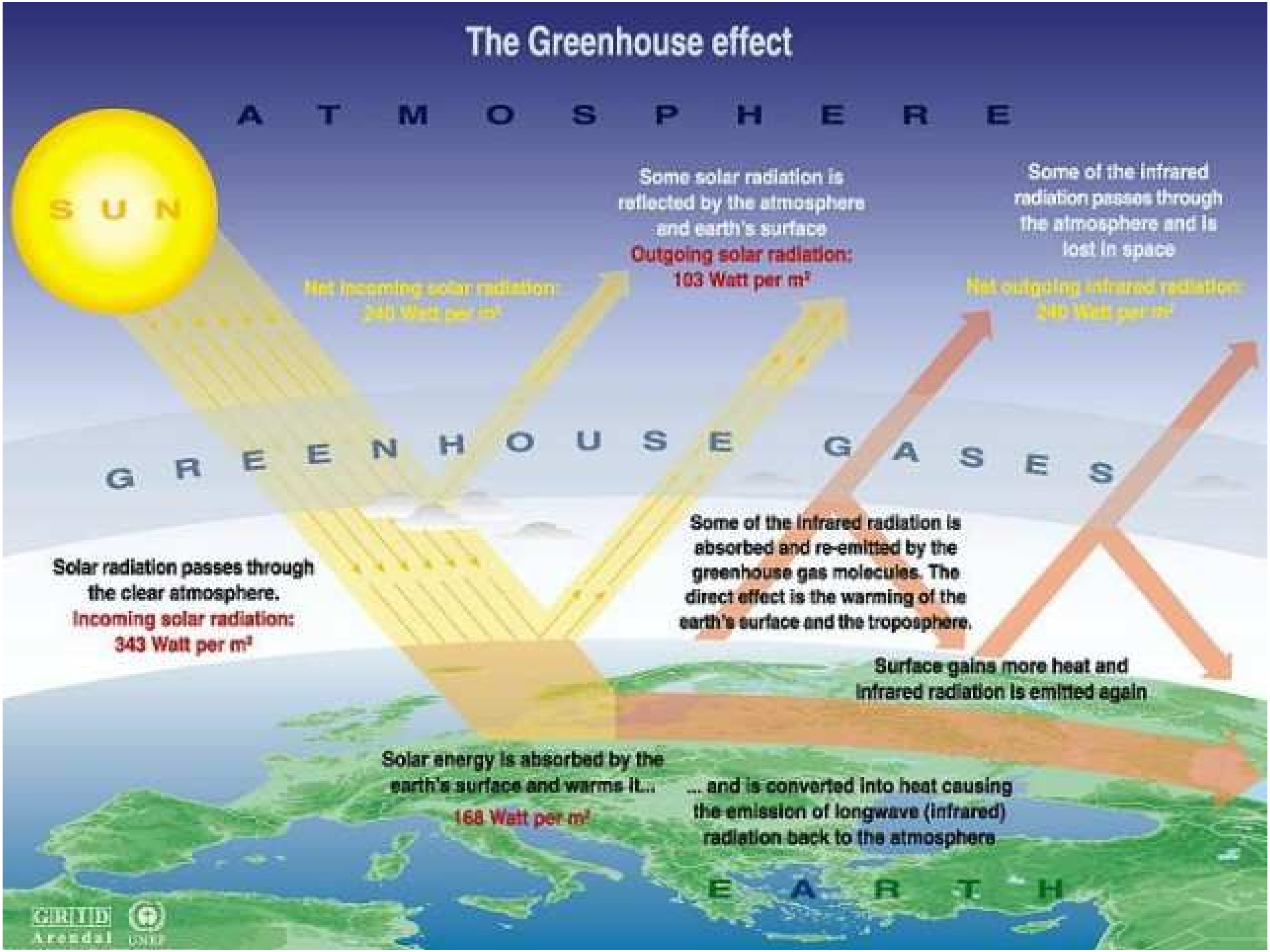
- Gases in the earth's atmosphere allow the sun's heat into our planet – but not out.
- The heat is then trapped in our atmosphere, slowly warming our planet.
- The greenhouse effect is critical in keeping a constant temperature on earth, but too much can be a bad thing.

GREENHOUSE GASES

- Earth's atmosphere – 99% oxygen + nitrogen.
- Greenhouse gases – water vapor, carbon dioxide, methane, N_2o, ozone & cfc's. (less than1% of earth's atmosphere)
- Earth's mean temp'- 15° Celsius.
- Without the natural greenhouse effect the mean earth temp' would be – -18 c°.

CONCLUSION

- The problem is not the greenhouse effect, a natural procedure warming earth's climate.
- The problem is the intensification of the warming process, due to human activities, continuing from the 1800 century- the beginning of the industrial revolution until today.


The Greenhouse effect
A T M O S P H E R E
S U N
Some solar radiation is reflected by the atmosphere and earth's surface
Outgoing solar radiation: 103 Watt per m²
Some of the infrared radiation passes through the atmosphere and is lost in space
Net incoming solar radiation: 240 Watt per m²
Net outgoing infrared radiation: 240 Watt per m²
G R E E N H O U S E G A S E S
Some of the infrared radiation is absorbed and re-emitted by the greenhouse gas molecules. The direct effect is the warming of the earth's surface and the troposphere.
Solar radiation passes through the clear atmosphere.
Incoming solar radiation: 343 Watt per m²
Surface gains more heat and infrared radiation is emitted again
Solar energy is absorbed by the earth's surface and warms it...
168 Watt per m²
... and is converted into heat causing the emission of longwave (infrared) radiation back to the atmosphere
E A R T H
GRID Arendal

METHAN (ch_4)

- Swamps/marshes- Anarobic biomass decomposition . A natural process without any human involvement.
- Rice fields (China & India) – the rice is grown under water in anarobic conditions. Since the 1940's the production of rice has more than doubled itself intensifying the emission of methane.
- Cattle & sheep digestive system- contain high levels of methane. Due to there increasing numbers the problem is becoming more serious.
- Fossil fuel wells & mines- the methane is emitted due to leaks in the air conditioning systems & in the gas pipe lines.
- Methane contributes 18% of total global warming- second only to carbon dioxide.

N_2O – NITROUS OXYGEN

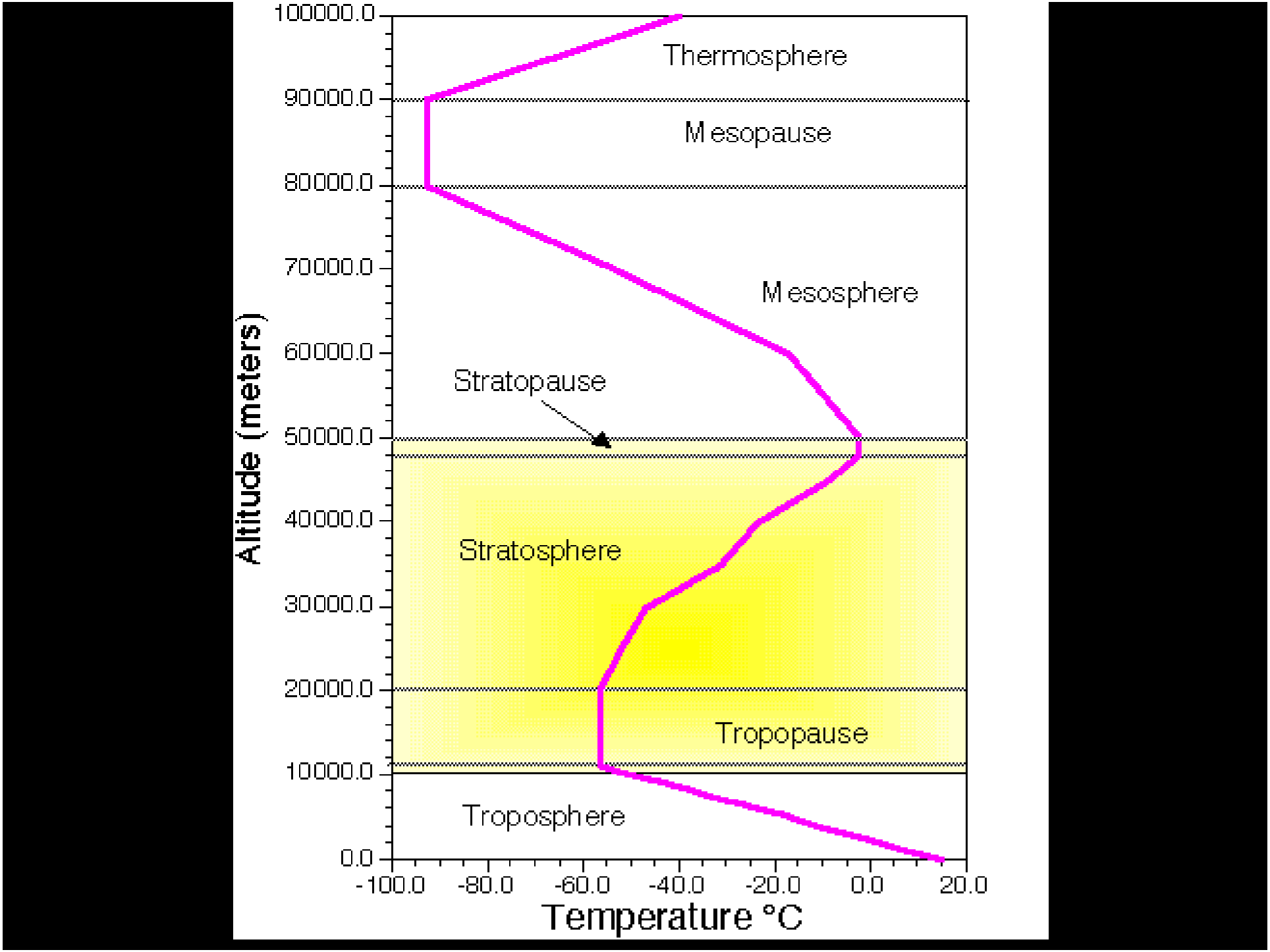
- Deforestation (burning rain forests).
- Burning of fossil fuels.
- Agriculture fertilizing chemicals.

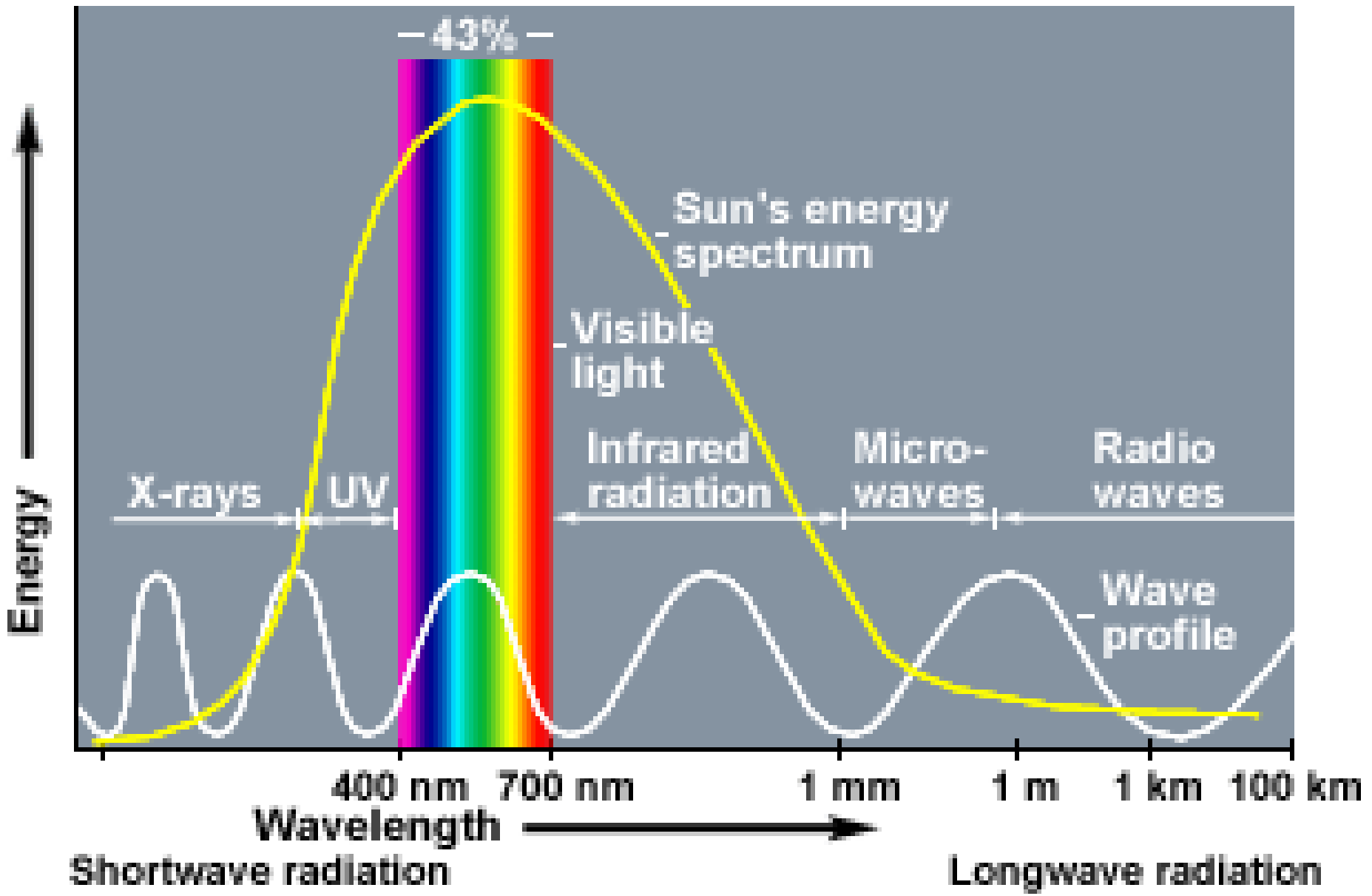
FLUORINATED COMPOUNDS- CFC'S

- Man made gases- Very stable, have no color, smell and are in flammable. Used mainly for air conditioning systems, deodorants & fire extinguish foams.
- Known as the gas responsible for the depletion of the ozone layer.
- 1987 The Montreal protocol- protection of the ozone layer.

TROPOSPHERIC OZONE - O_3

- The ozone in the troposphere acts as a greenhouse gas.
- The ozone is formed by a photo-chemical reaction- Dismantling of chemical compounds using the energy of the sun.
- A second degree pollutant – formed by the dismantling of air pollutants (NO_x , SO_x).

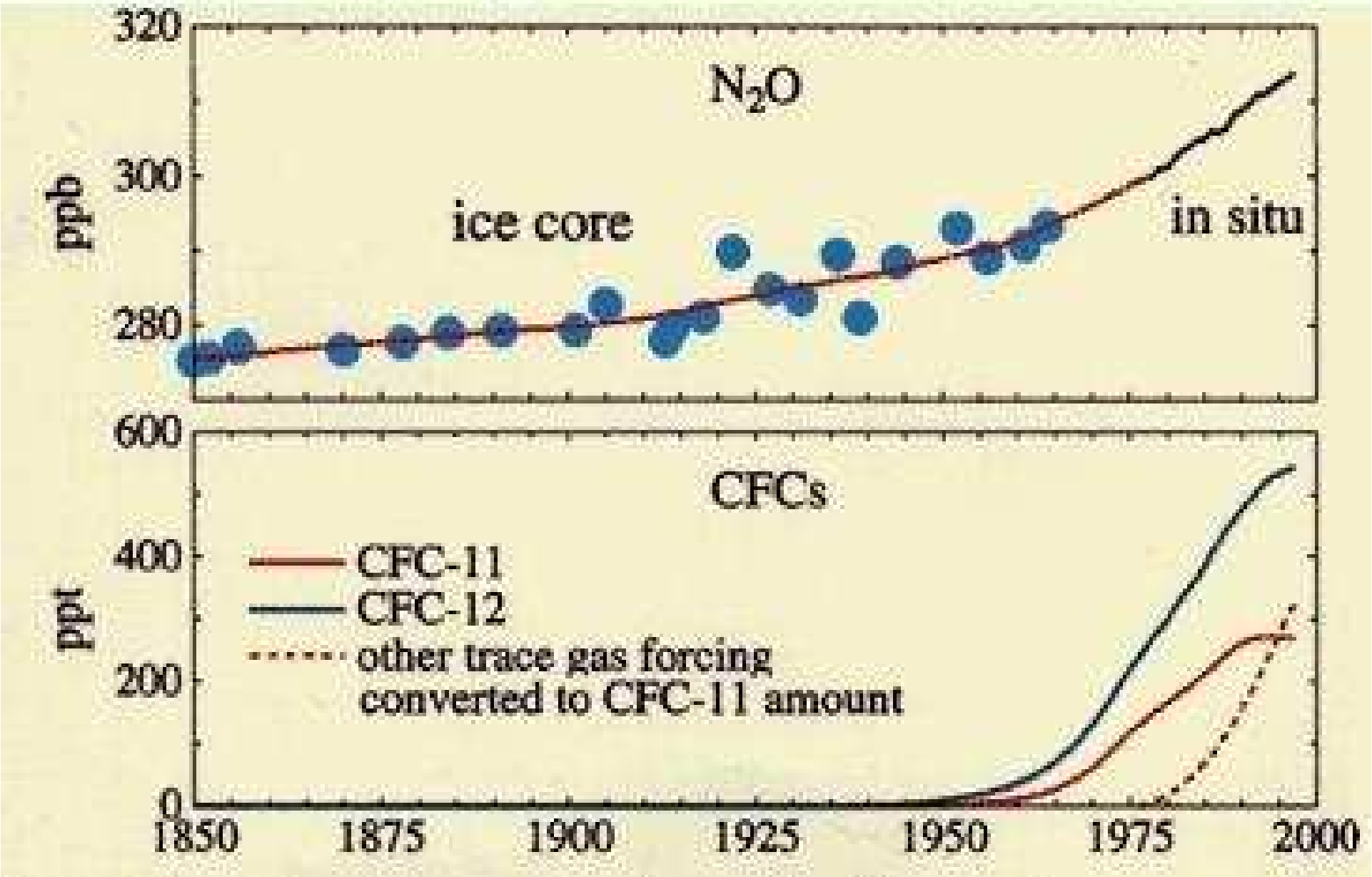

Thermosphere
Mesopause
Mesosphere
Stratopause
Stratosphere
Tropopause
Troposphere
Altitude (meters)
100000.0
90000.0
80000.0
70000.0
60000.0
50000.0
40000.0
30000.0
20000.0
10000.0
0.0
-100.0
-80.0
-60.0
-40.0
-20.0
0.0
20.0
Temperature °C



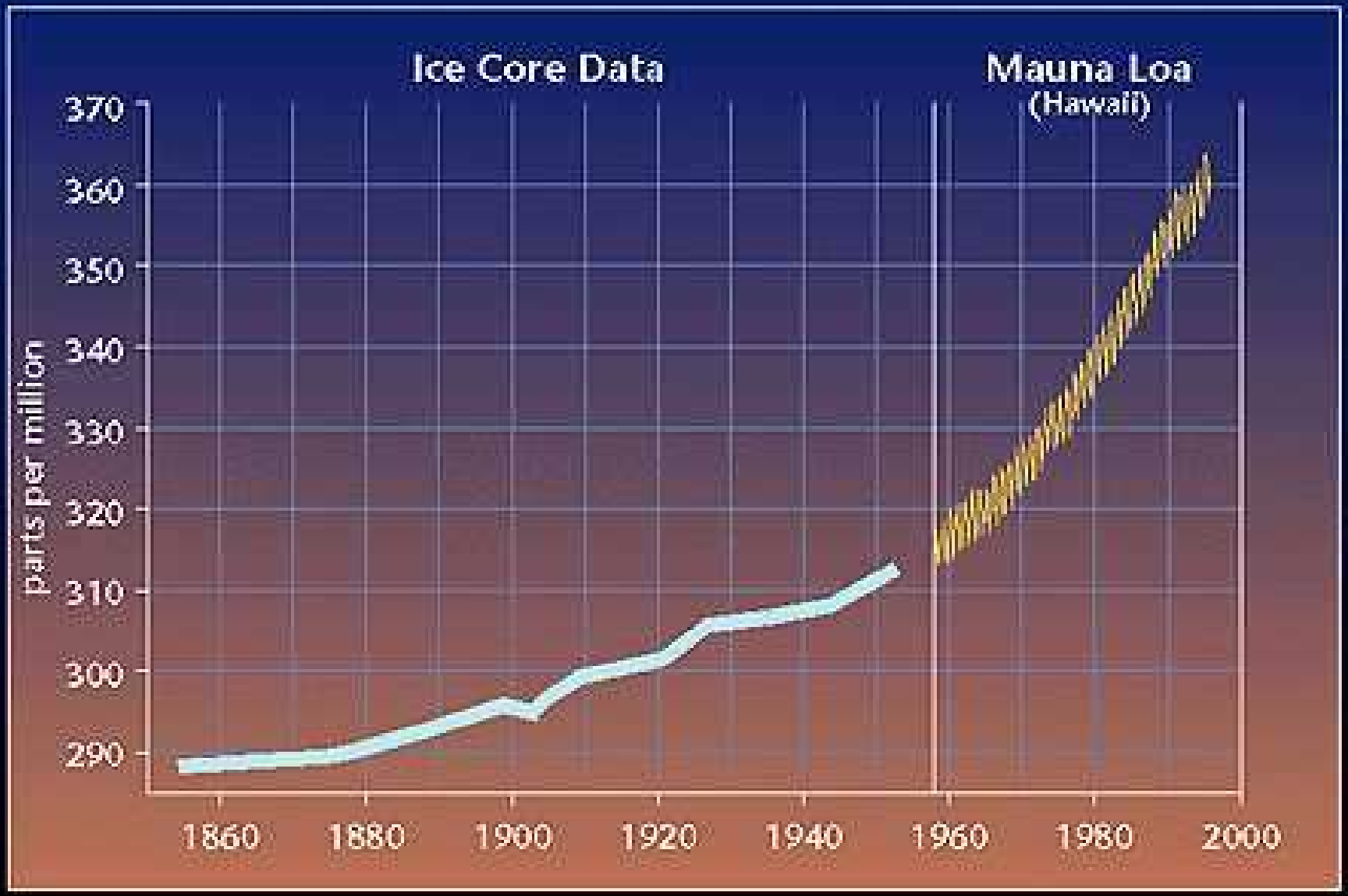
The COMET Program

CARBON DIOXIDE – CO_2

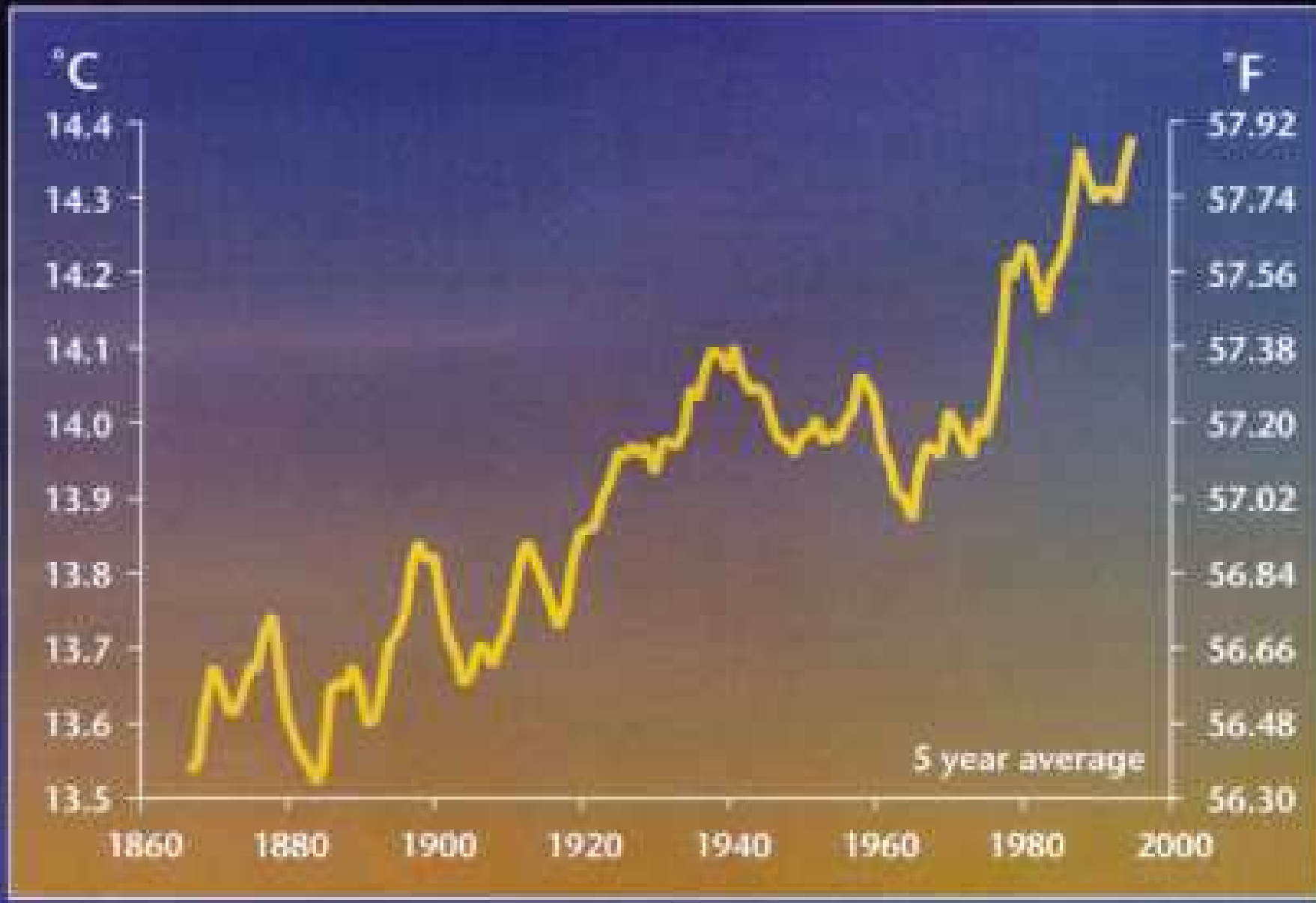
- Intensifying the burning of fossil fuels since the end of the 18th century- the beginning of the industrial revolution.
- Deforestation- Forest destruction due to expanding populations, agriculture and animal herds.
- The concentration of carbon dioxide in the atmosphere, the highest for over 160.000 years.


320
300
280
ppb
N_2O
ice core
in situ
600
400
200
0
ppt
CFCs
CFC-11
CFC-12
other trace gas forcing
converted to CFC-11 amount
1850
1875
1900
1925
1950
1975
2000

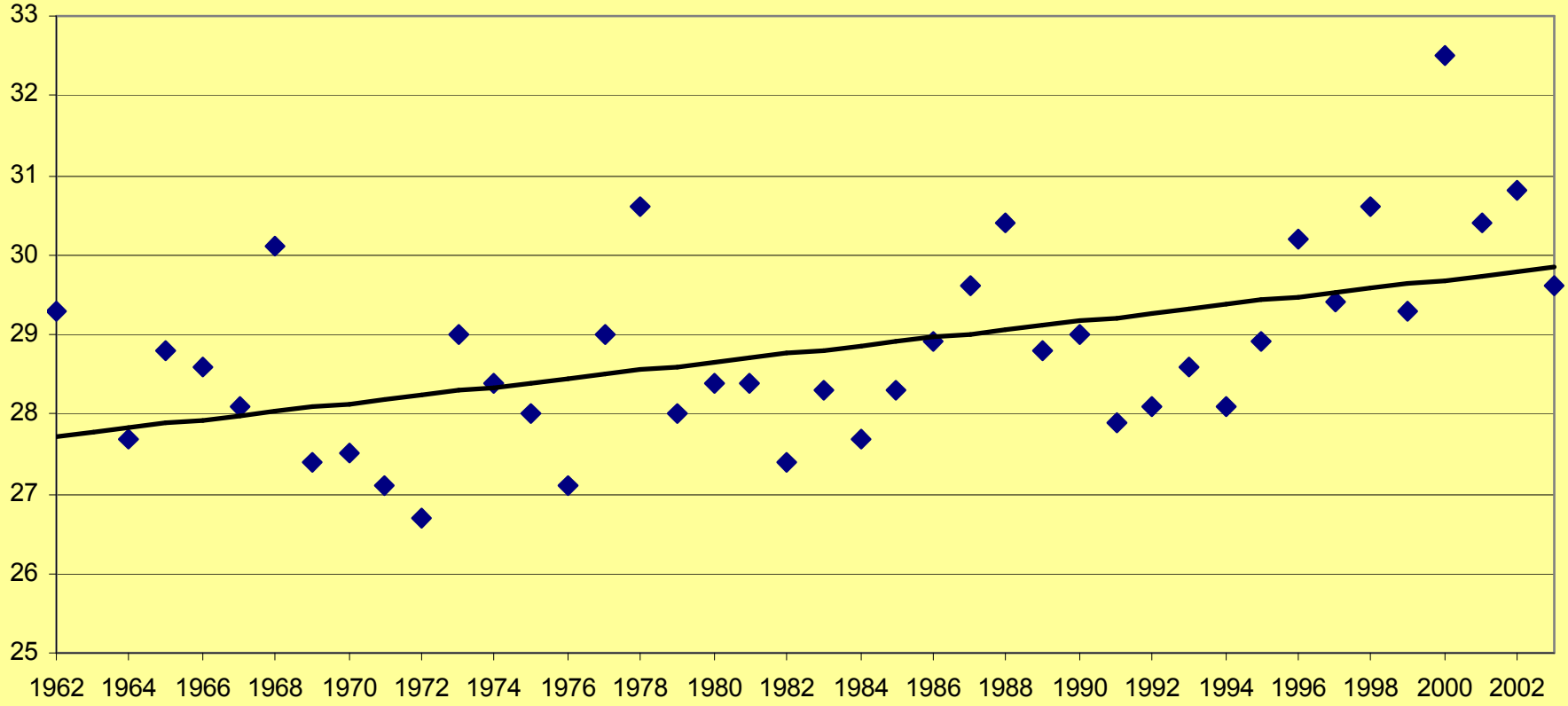
Carbon Dioxide Concentrations



Global Average Temperature

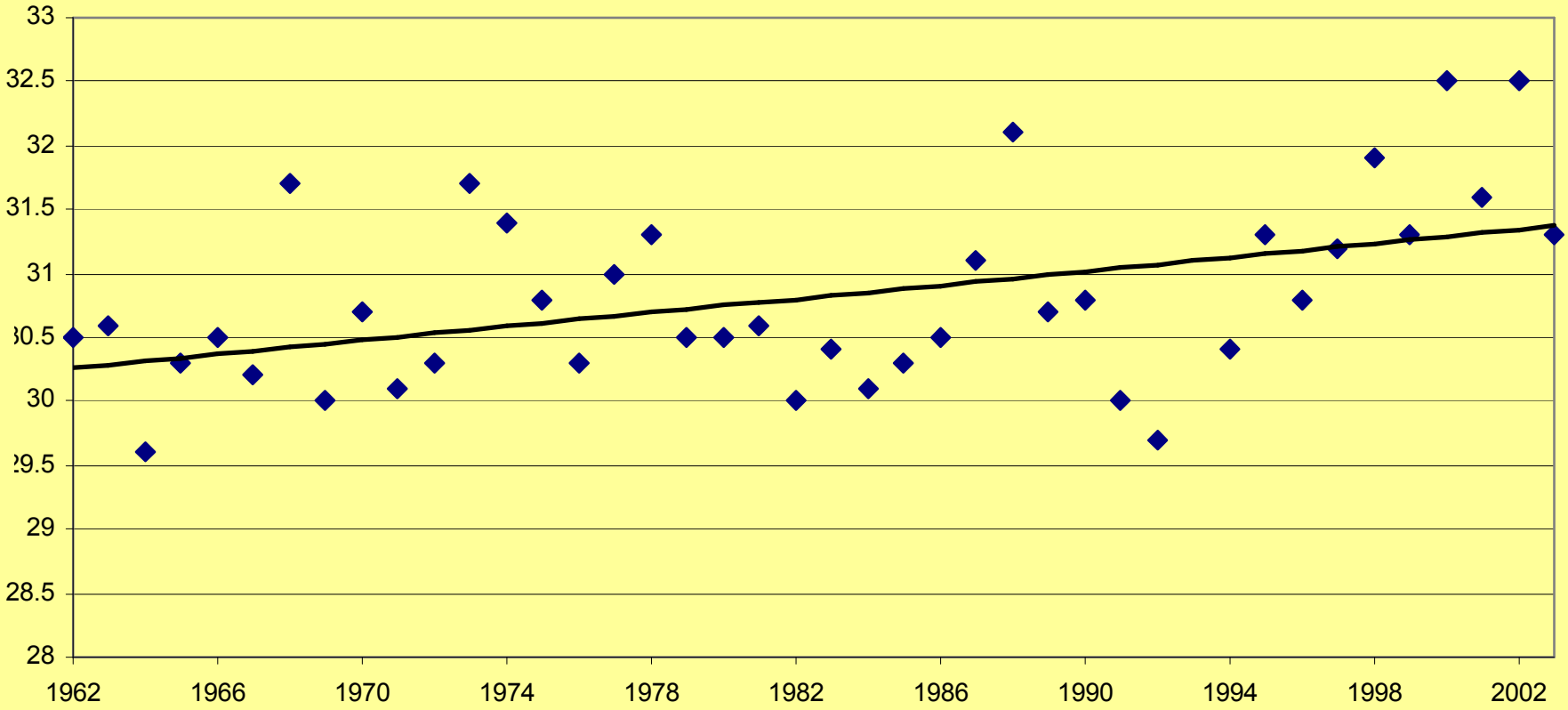


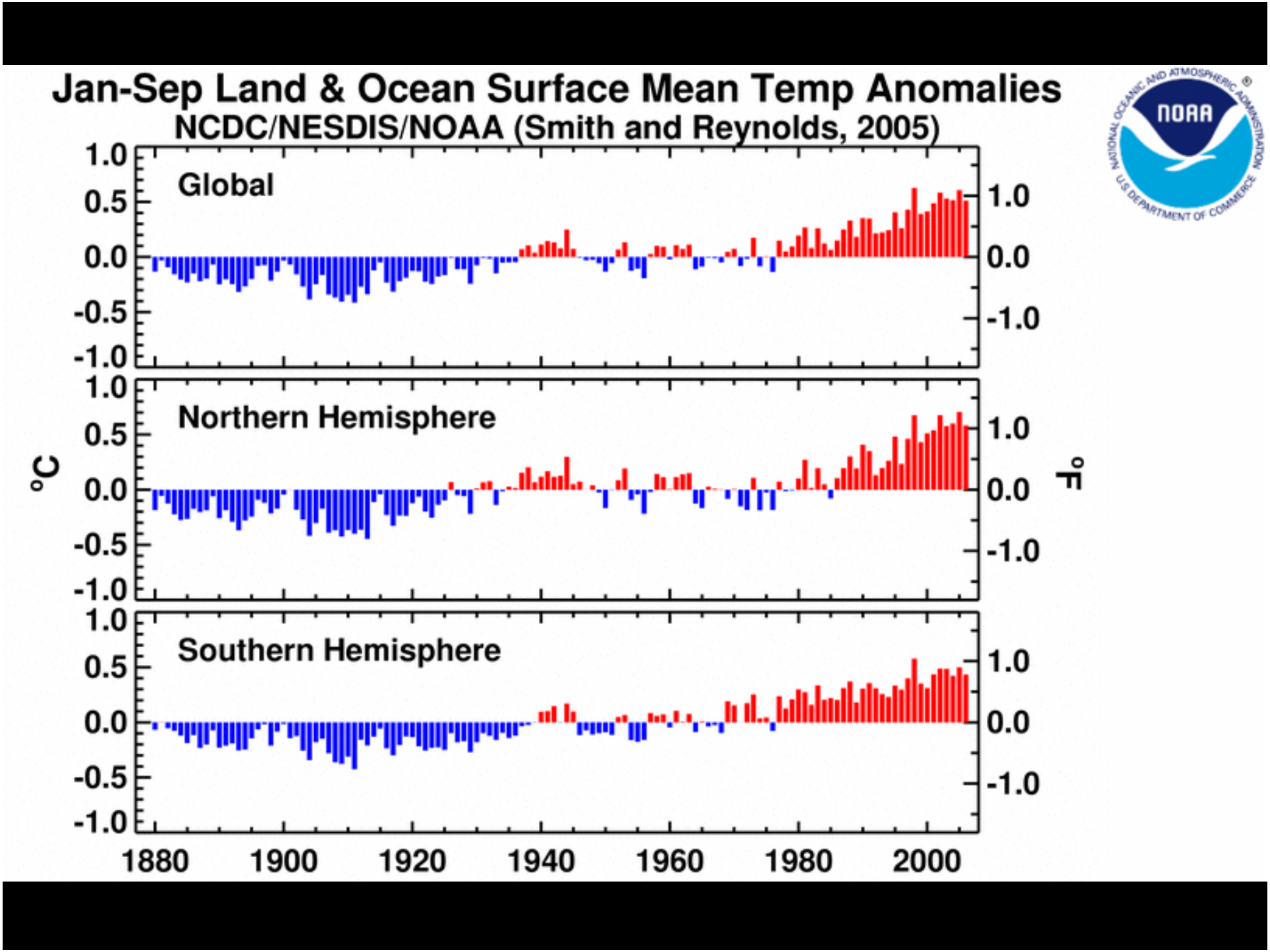
Jerusalem- avg July temp' 1962-2003

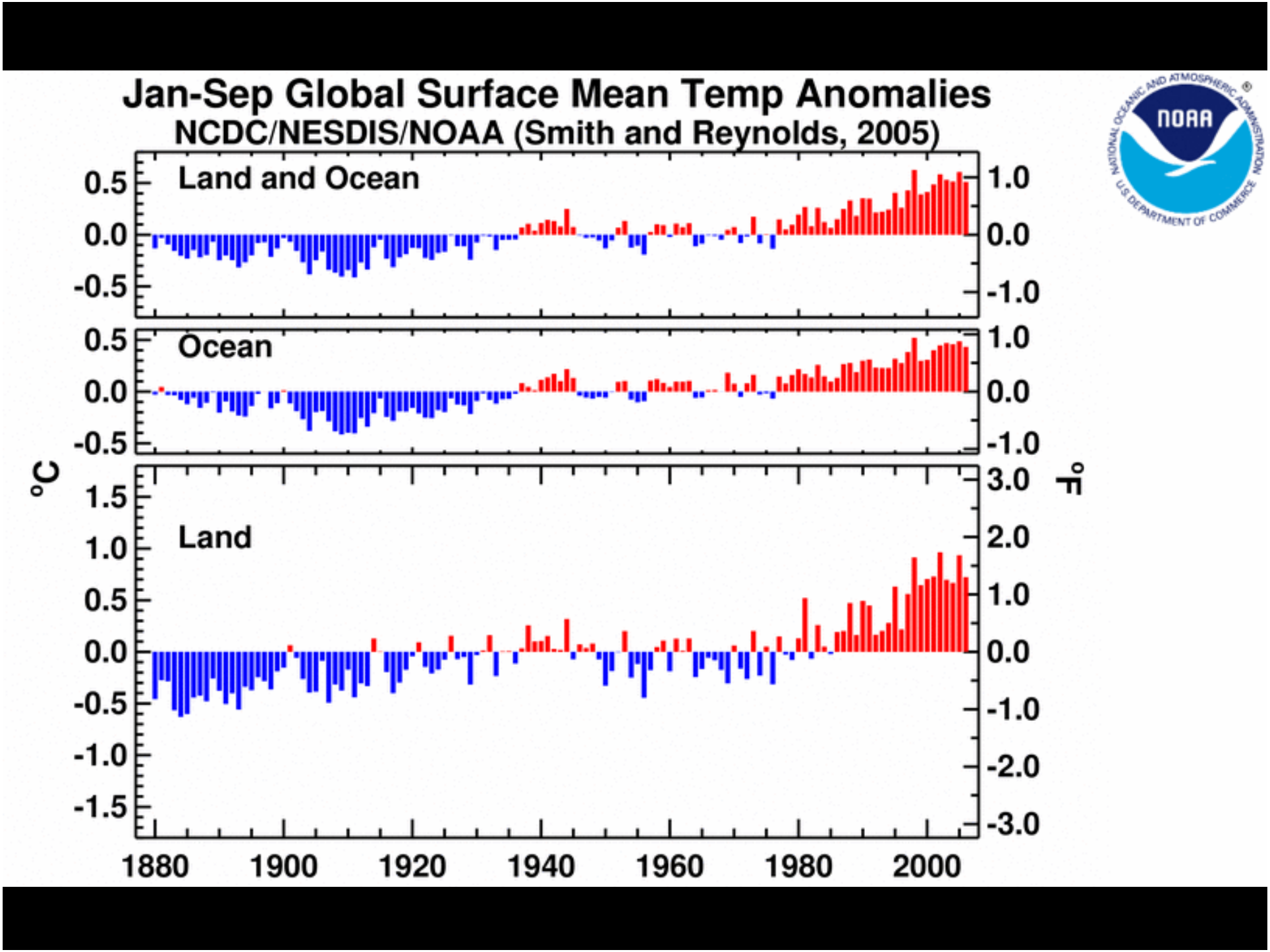


Years

Bet Dagan- avg July temp' 1962-2003



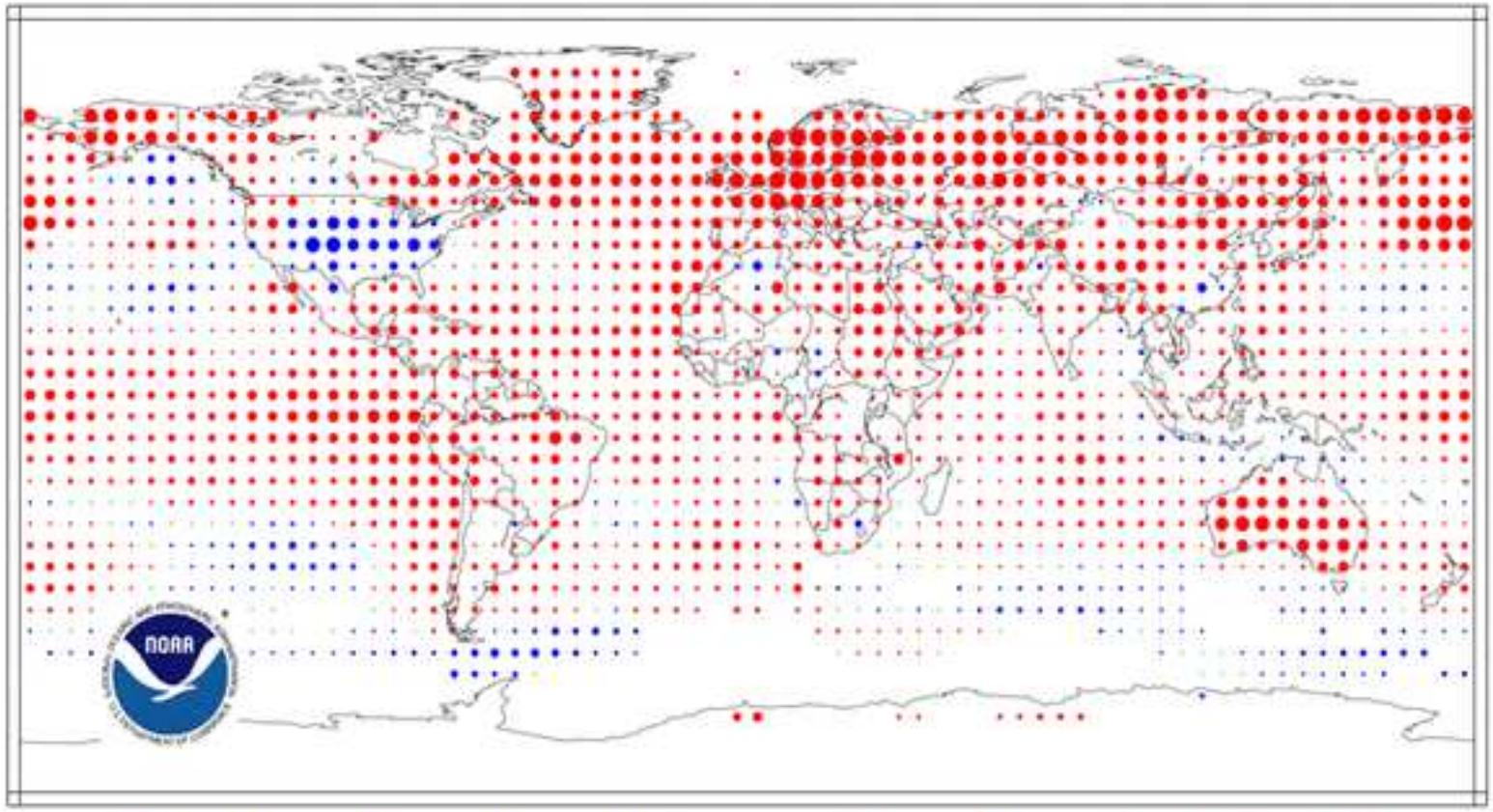

Jan-Sep Land & Ocean Surface Mean Temp Anomalies
NCDC/NESDIS/NOAA (Smith and Reynolds, 2005)
NOAA
Global
Northern Hemisphere
Southern Hemisphere
°C
°F
1.0
0.5
0.0
-0.5
-1.0
1880
1900
1920
1940
1960
1980
2000


Jan-Sep Global Surface Mean Temp Anomalies
NCDC/NESDIS/NOAA (Smith and Reynolds, 2005)
Land and Ocean
Ocean
Land
°C
°F
0.5
0.0
-0.5
1.0
0.0
-1.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
1880
1900
1920
1940
1960
1980
2000

September 2006 Temperature Anomalies

(with respect to a 1961-1990 base period)

National Climatic Data Center/NESDIS/NOAA



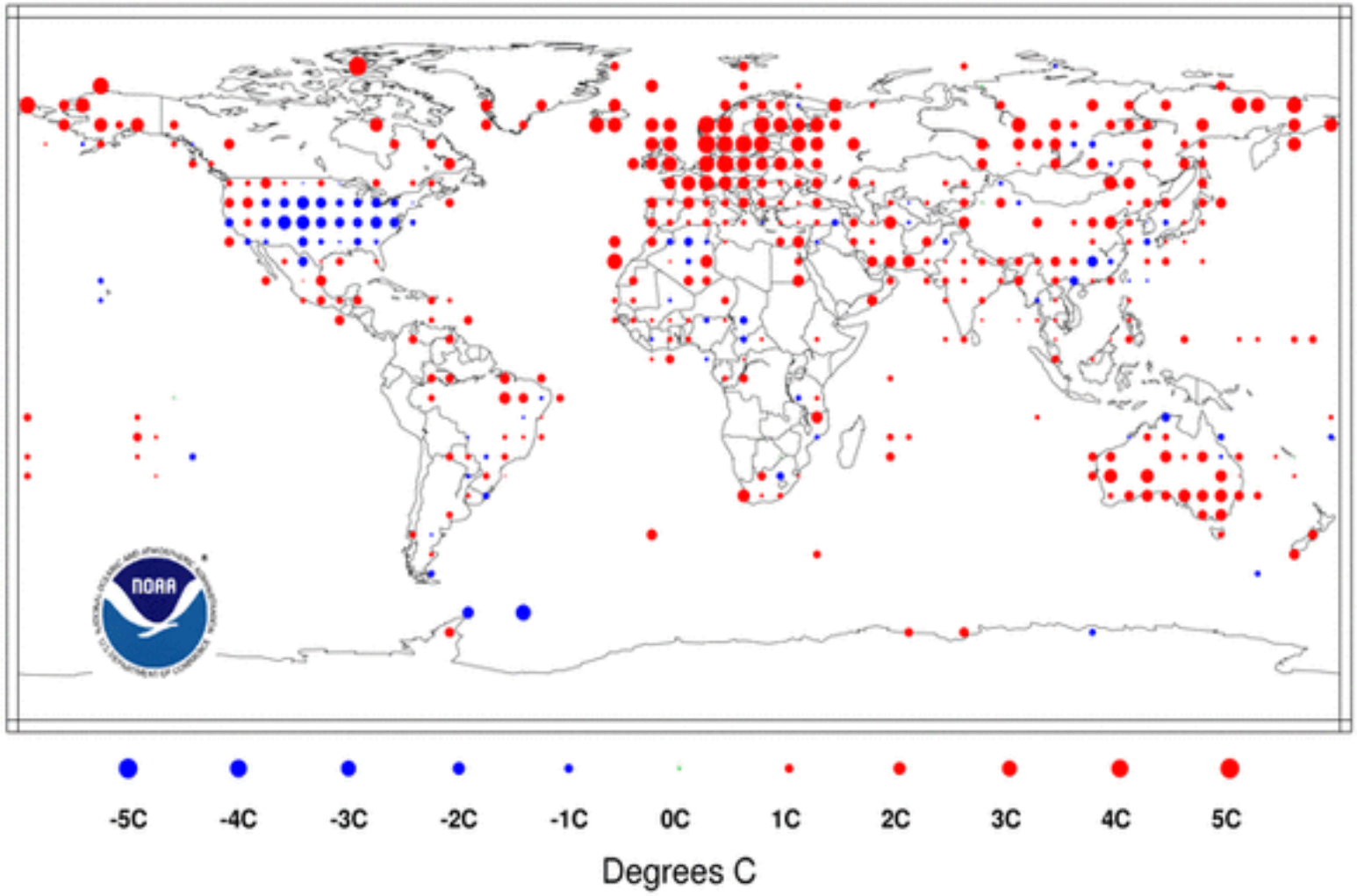
-5C -4C -3C -2C -1C 0C 1C 2C 3C 4C 5C

Degrees Celsius

Temperature Anomalies September 2006

(with respect to a 1961-1990 base period)

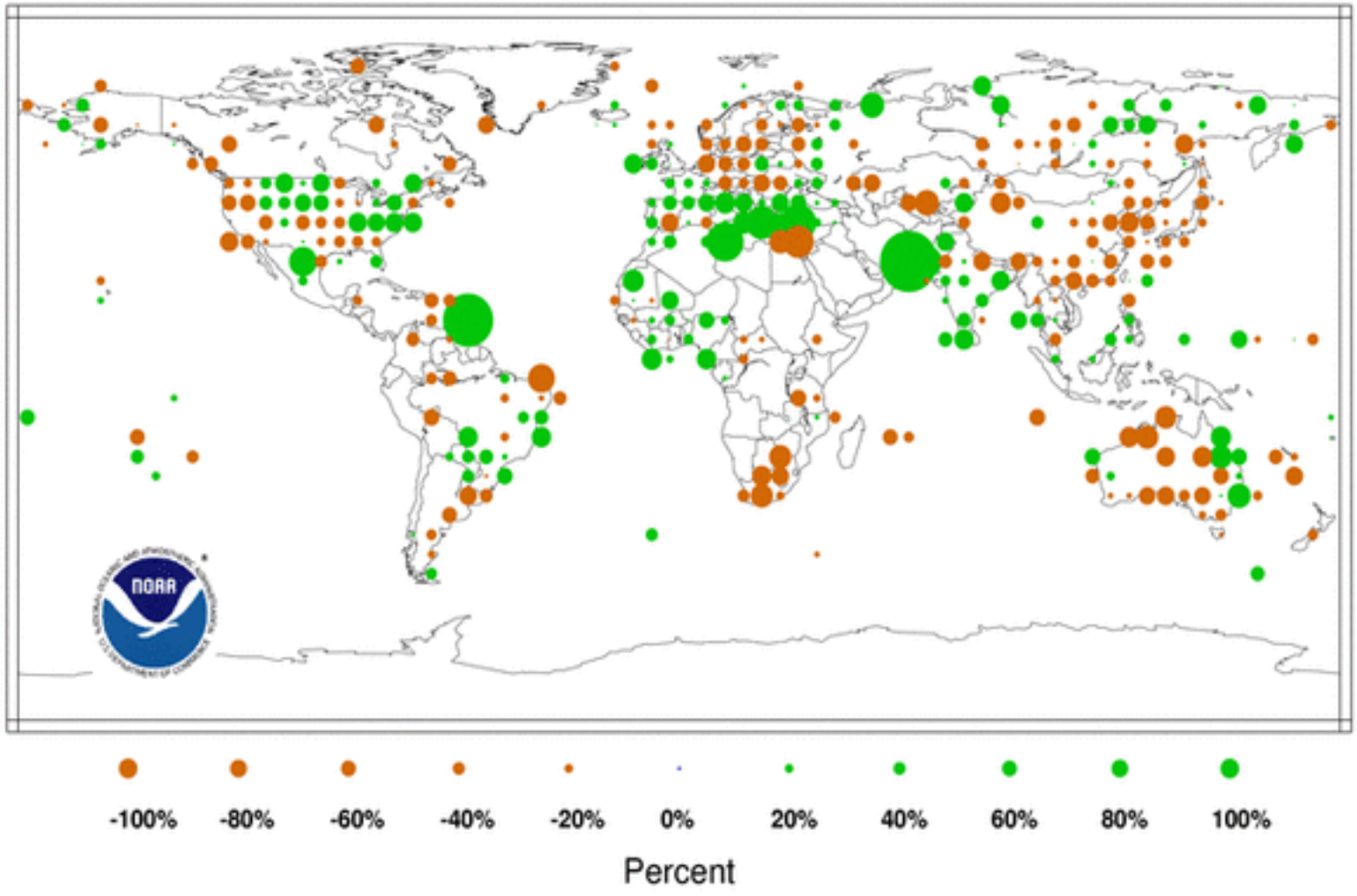
National Climatic Data Center/NESDIS/NOAA



Precipitation Anomalies September 2006

(percent departures with respect to a 1961-1990 base period)

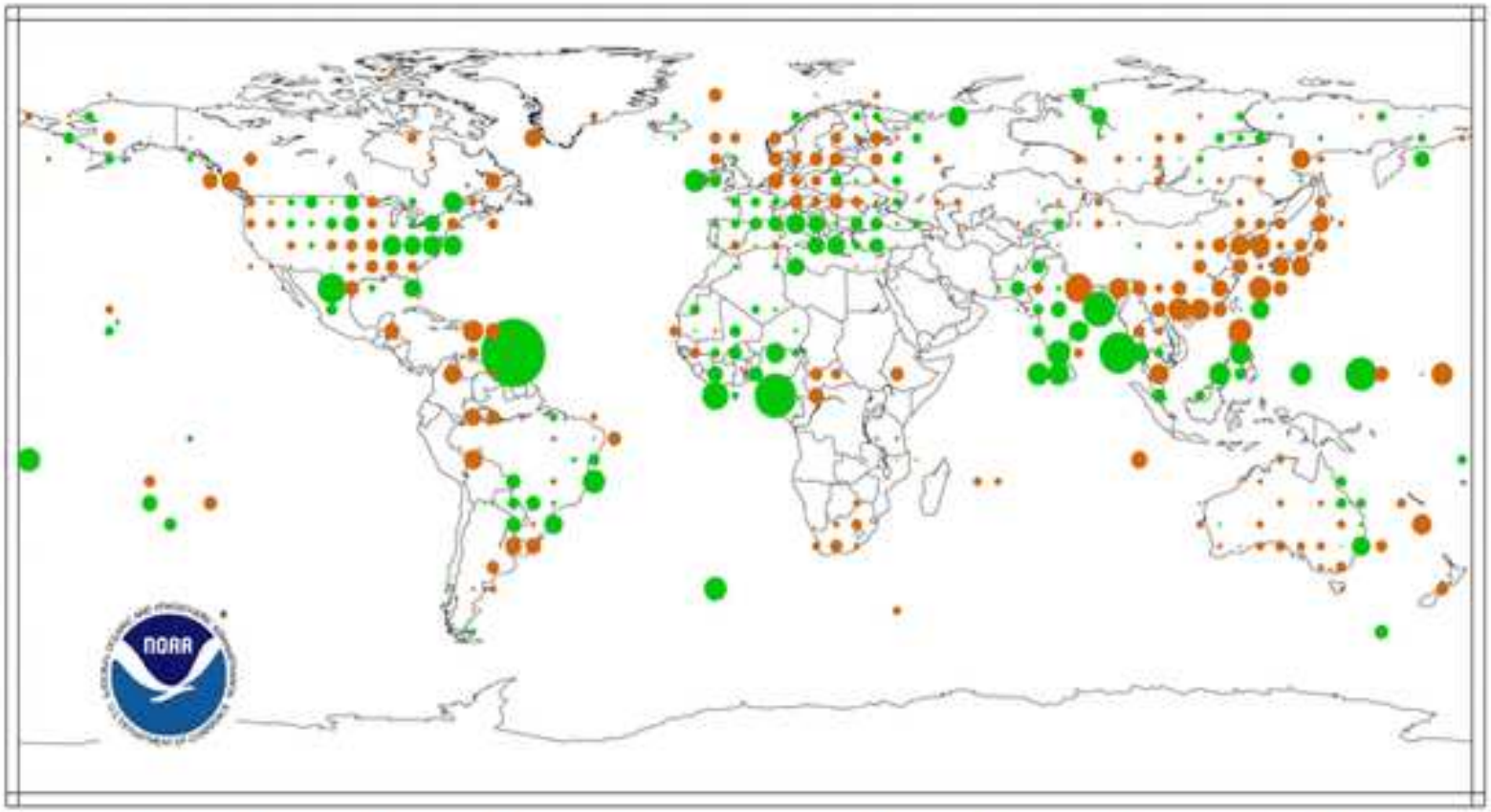
National Climatic Data Center/NESDIS/NOAA

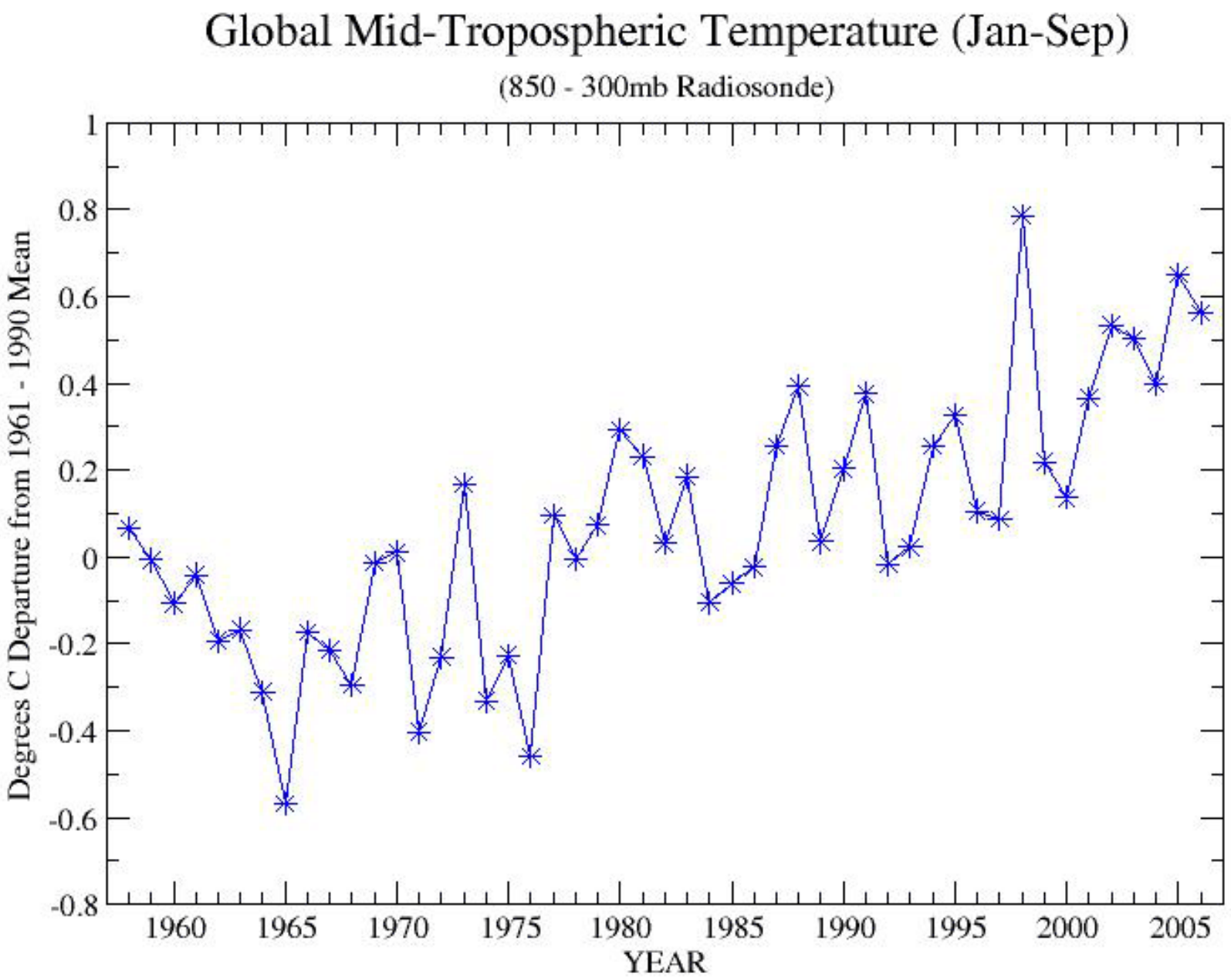


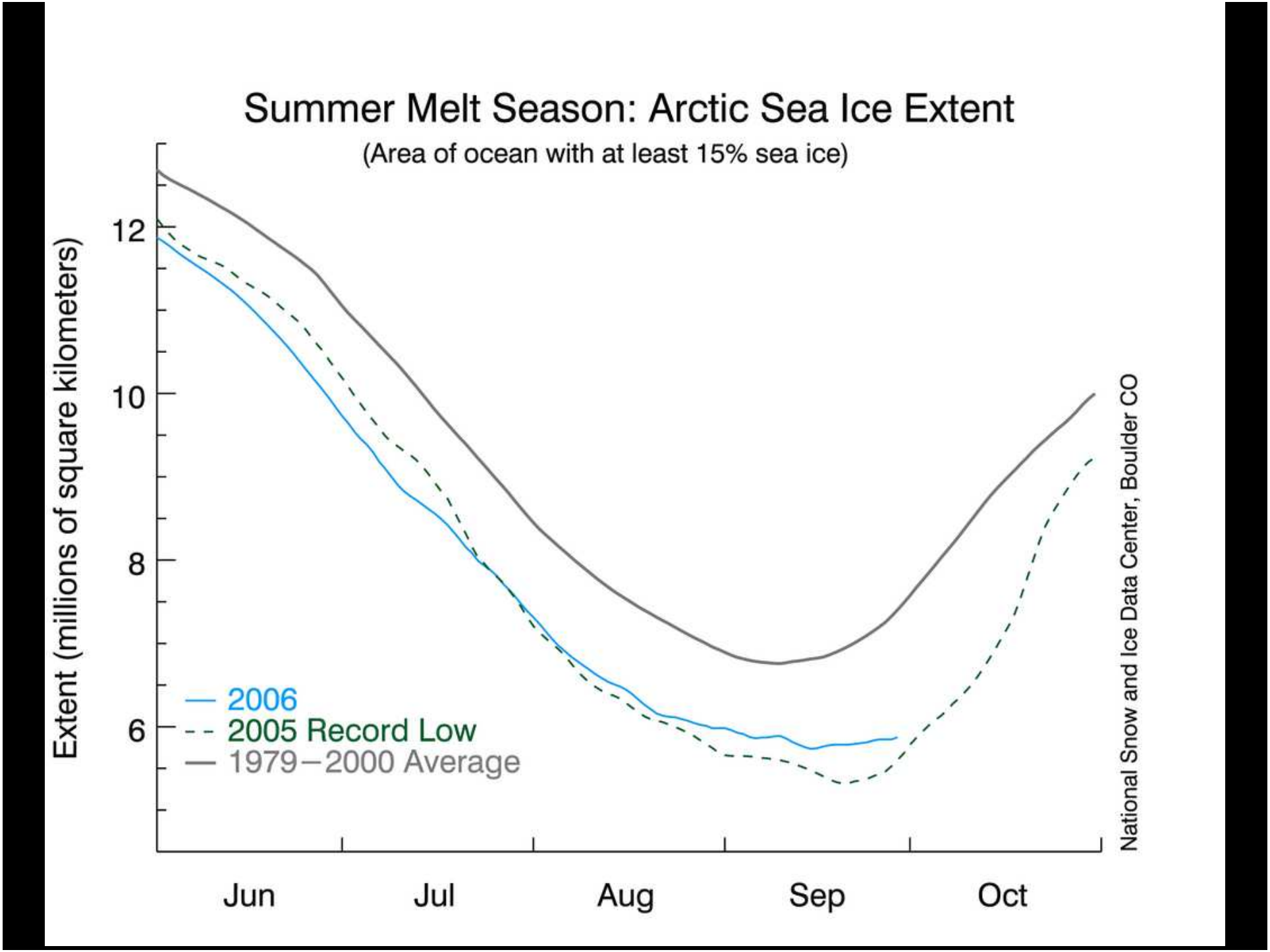
Precipitation Anomalies September 2006

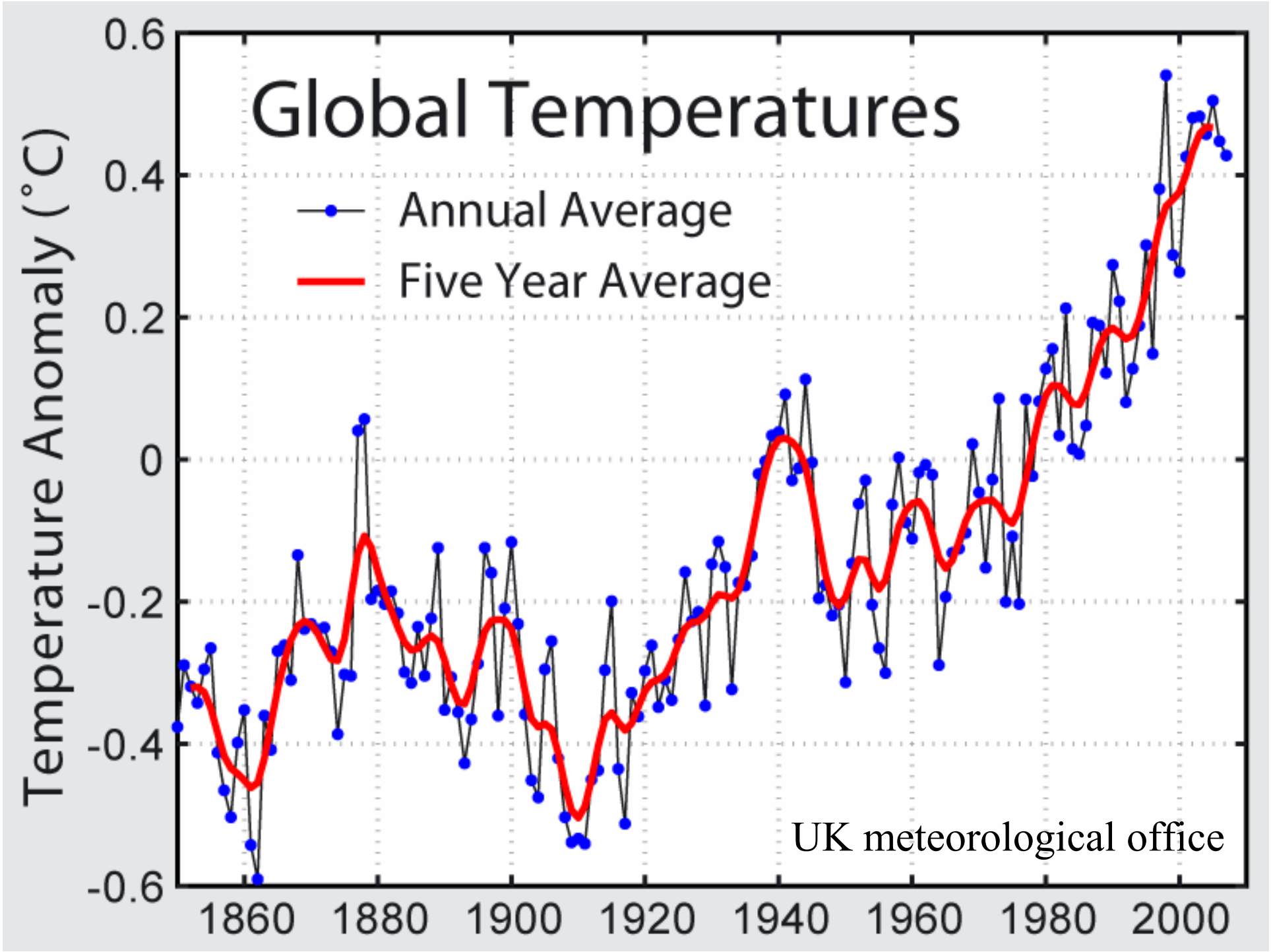
(with respect to a 1961-1990 base period)

National Climatic Data Center/NESDIS/NOAA




Global Mid-Tropospheric Temperature (Jan-Sep)
(850 - 300mb Radiosonde)
Degrees C Departure from 1961 - 1990 Mean
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
YEAR


Summer Melt Season: Arctic Sea Ice Extent
(Area of ocean with at least 15% sea ice)
Extent (millions of square kilometers)
12
10
8
6
2006
2005 Record Low
1979–2000 Average
Jun
Jul
Aug
Sep
Oct
National Snow and Ice Data Center, Boulder CO


Global Temperatures
Annual Average
Five Year Average
Temperature Anomaly (°C)
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
1860
1880
1900
1920
1940
1960
1980
2000
UK meteorological office


© Gary Braasch Photography
2001
© Gary Braasch Photography
1859

from "Rhone-Glacier and its Ice Grotto" M. Carlen & Fotohaus Geiger


Portage Glacier AK, 1914 • NOAA


Portage Glacier AK
© 2004 Gary Braasch
(aerial estimation of 1914)


February 17, 1993
February 21, 2000


Source: E. Oehler: Kilimanjaro. 1912


1928
2004


1985
2002
© GARY BRAASCH


Pasterze Glacier 1875
Univ. of Innsbruck Archives


Pasterze Glacier (site), Austria
© 2004 Gary Braasch


14 8 2002


AP

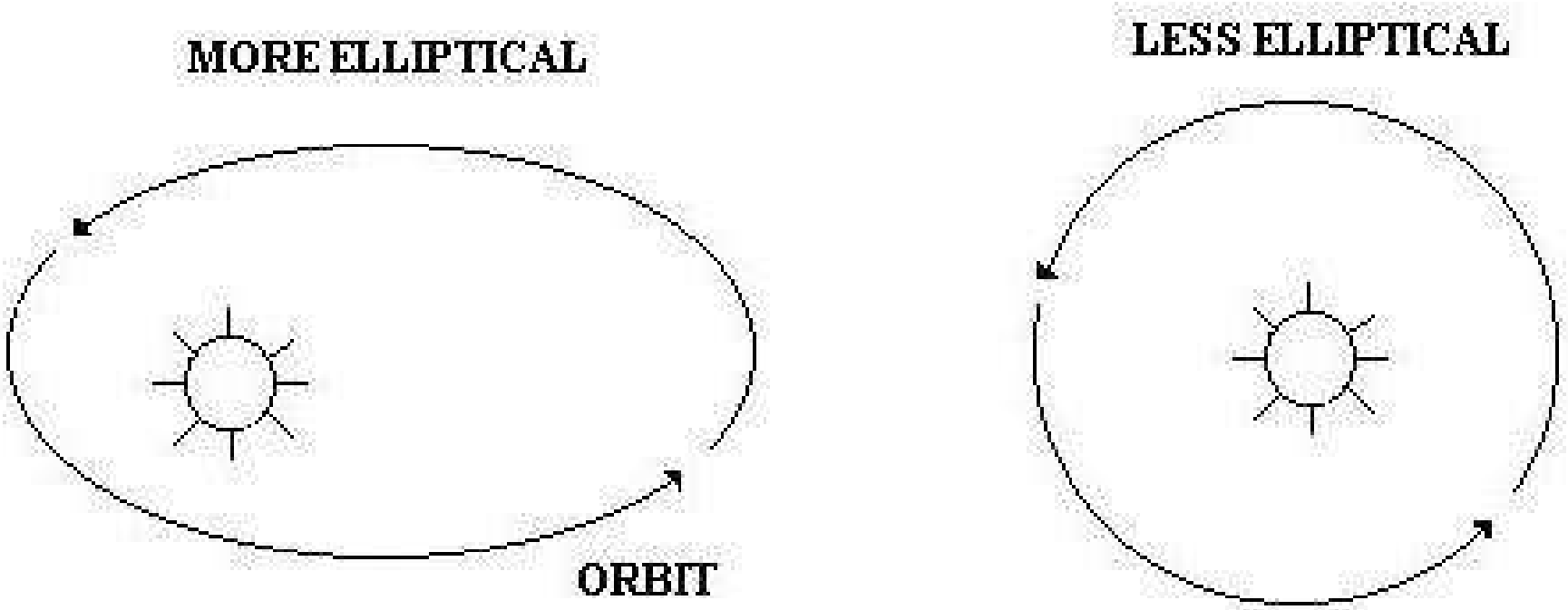
THE MILANKOVICH CYCLES – NATURAL CLIMATE CHANGES

- Changes in Earth's orbit around the sun-During a period of 100.000 years, Earths orbit around the sun changes from an elliptical orbit to a more evenly round orbit. This phenomena Causes drastic changes to earths radiation balance.

- Changes in earths axial tilt- During a period of 40.000 years earths axial tilt towards the sun changes from 21.5 degrees to 24.5°. At present earths tilt is 23.5°.

- Change in the direction of Earths tilt- A phenomena that occurs every 20000 years.This cycle has no effect on Earths radiation balance but can change the timing of seasons.

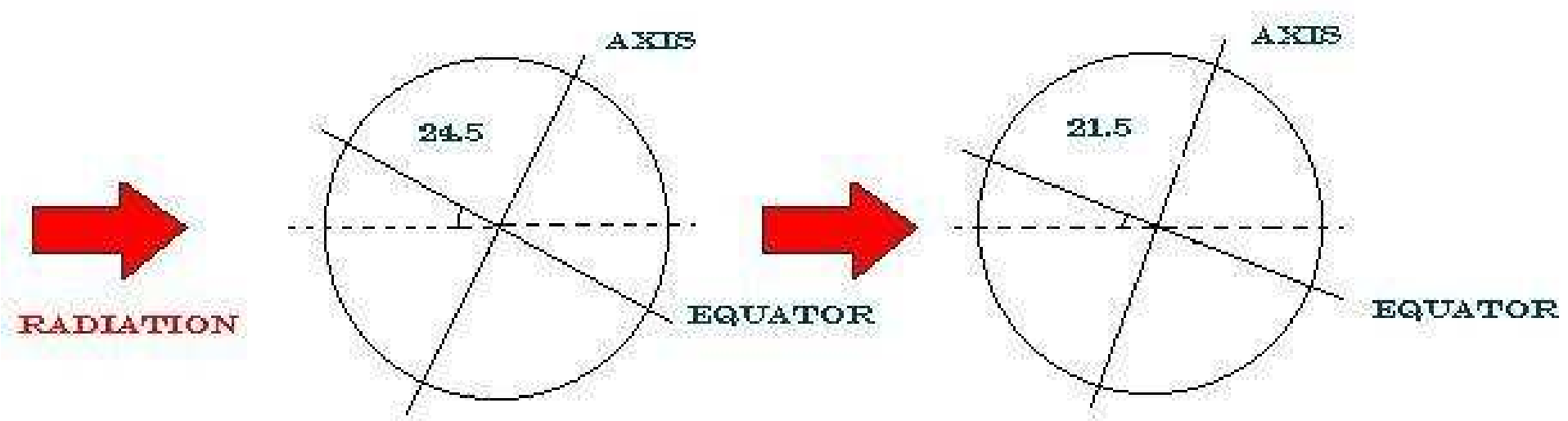
ECCENTRICITY



PERIODICITY:

100,000 YEARS

AXIAL TILT



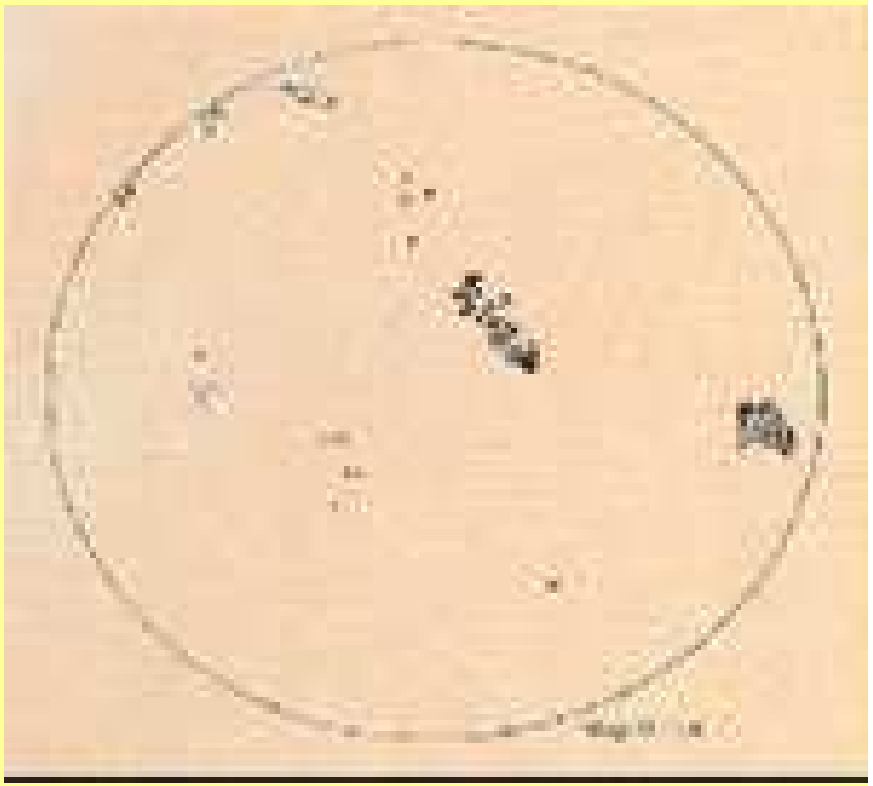
PERIODICITY:

41,000 YEARS

LITTLE ICE AGE

- Duration:
  - 14th – 18th century.
- Intensity:
  - Drop of 1 degree Celsius in the northern hemisphere.
- Cause: Drop in solar radiation:
  - Volcanic activity.
  - Extremely low solar activity. (sun spots)

SUN SPOTS

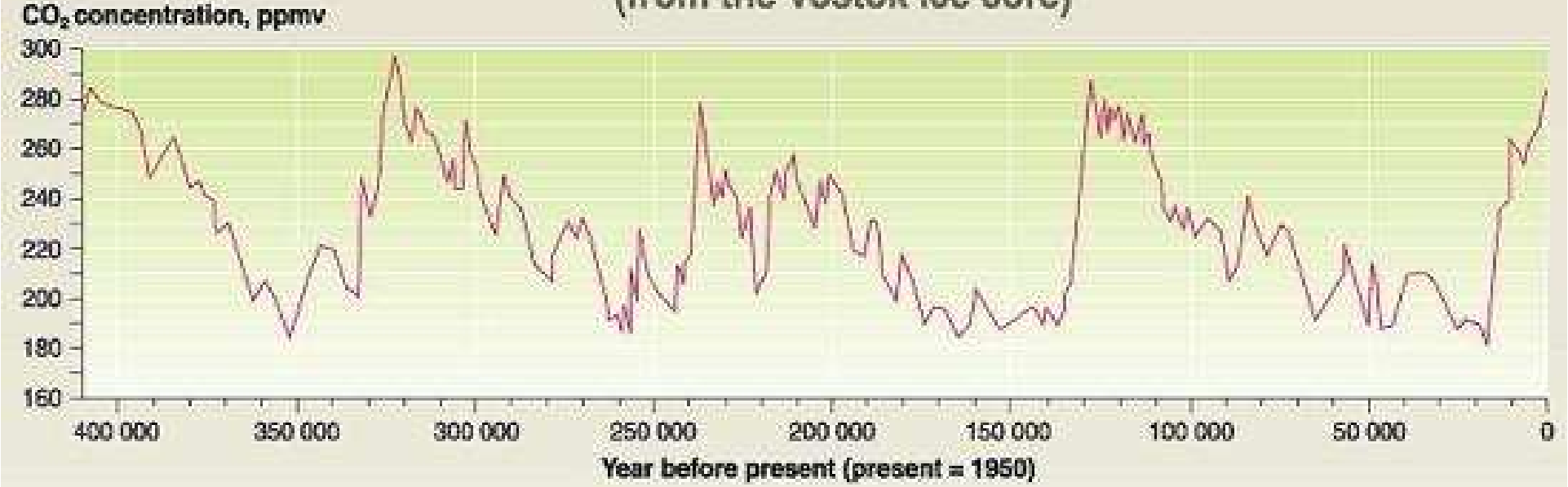


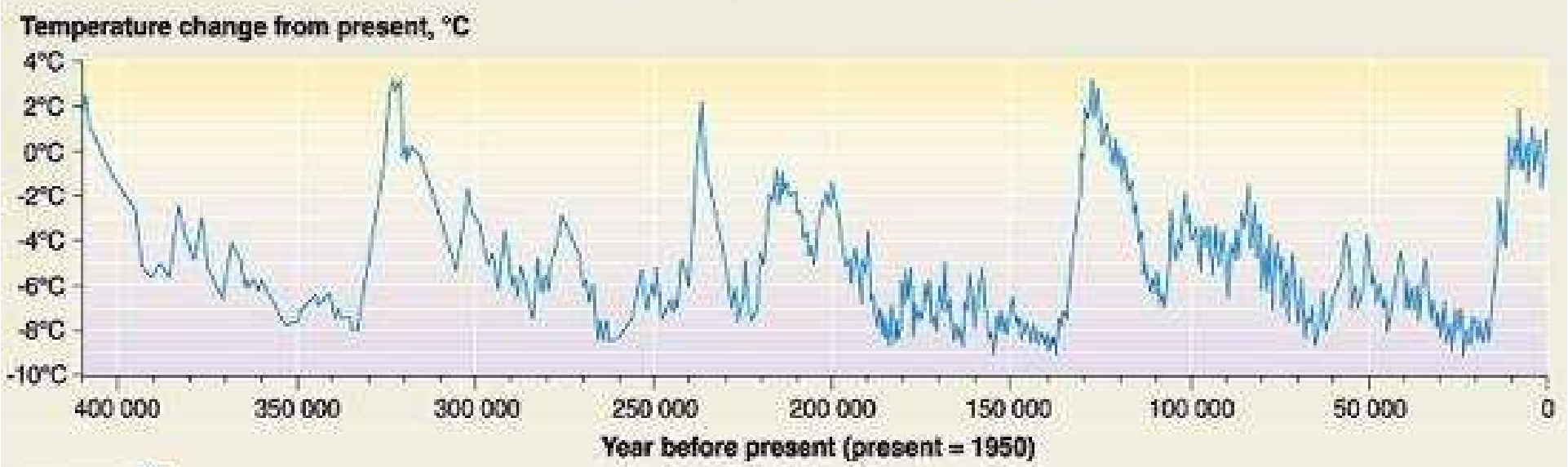
AMSTERDAM (HENDRICK AVERCAMP)

AMSTERDAM IN THE LIA

WASHINGTON CROSSING THE DELEWARE

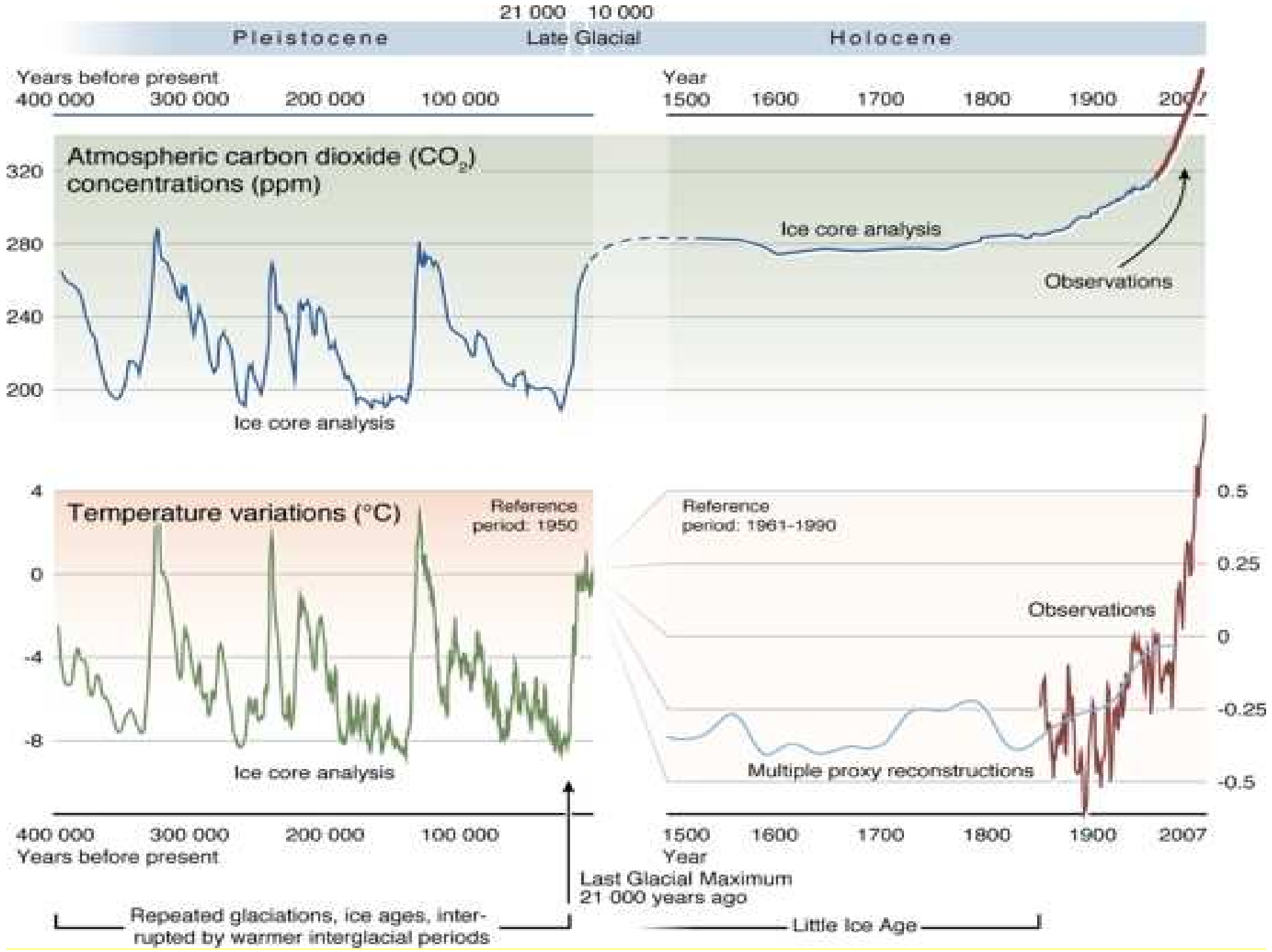
Temperature and CO_2 concentration in the atmosphere over the past 400 000 years (from the Vostok ice core)



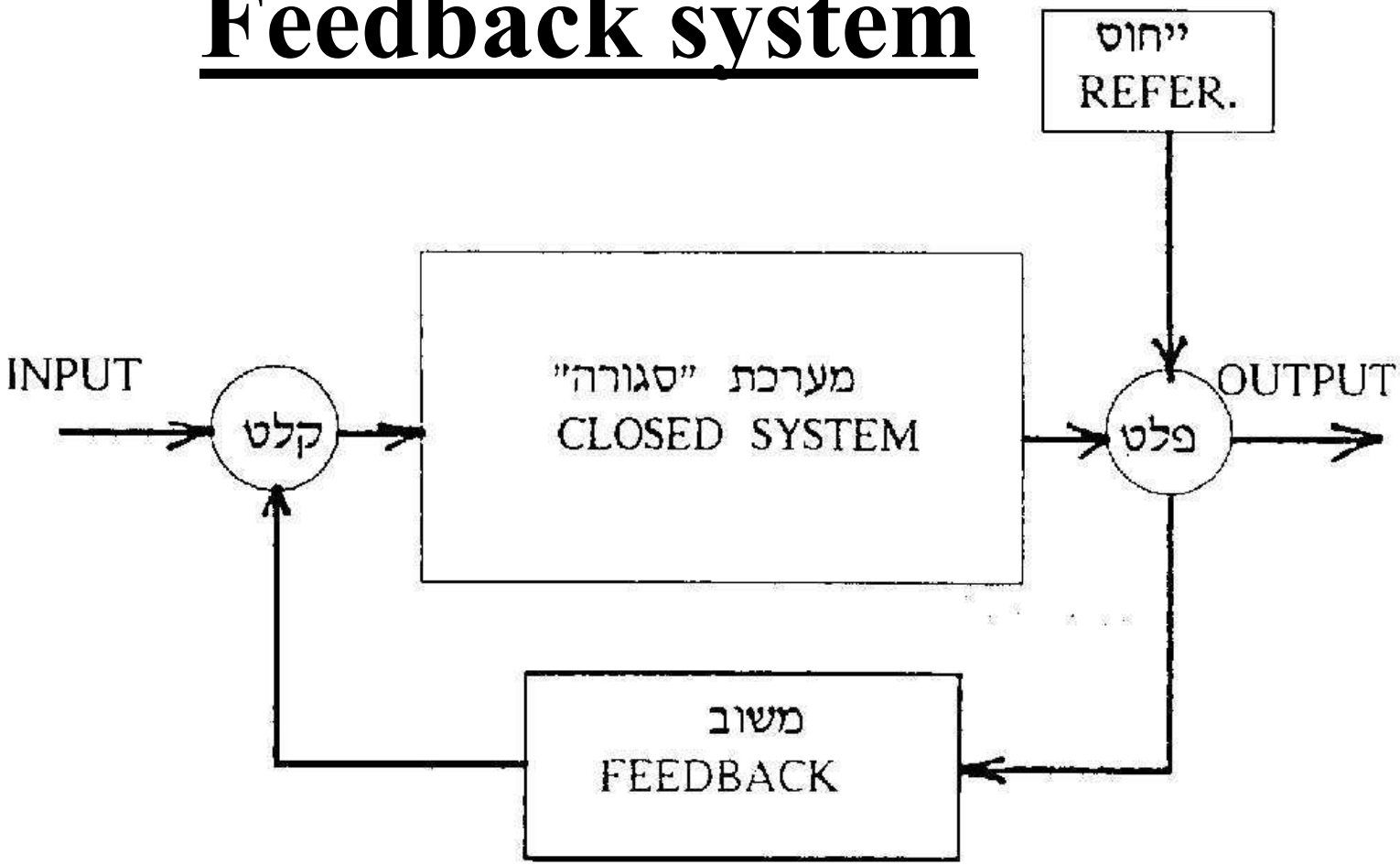


GRID Arendal UNEP

Source: J.R. Petit, J. Jouzel, et al. Climate and atmospheric history of the past 420 000 years from the Vostok ice core in Antarctica, Nature 399 (3JUne), pp 429-436, 1999.


21 000
10 000
Pleistocene
Late Glacial
Holocene
Years before present
400 000
300 000
200 000
100 000
Year
1500
1600
1700
1800
1900
Atmospheric carbon dioxide (CO_2) concentrations (ppm)
320
280
240
200
Ice core analysis
Ice core analysis
Observations
Temperature variations (°C)
Reference period: 1950
4
0
-4
-8
Ice core analysis
Reference period: 1961-1990
0.5
0.25
0
-0.25
-0.5
Observations
Multiple proxy reconstructions
400 000
300 000
200 000
100 000
Years before present
1500
1600
1700
1800
1900
2007
Year
Last Glacial Maximum
21 000 years ago
Repeated glaciations, ice ages, interrupted by warmer interglacial periods
Little Ice Age

Feedback system



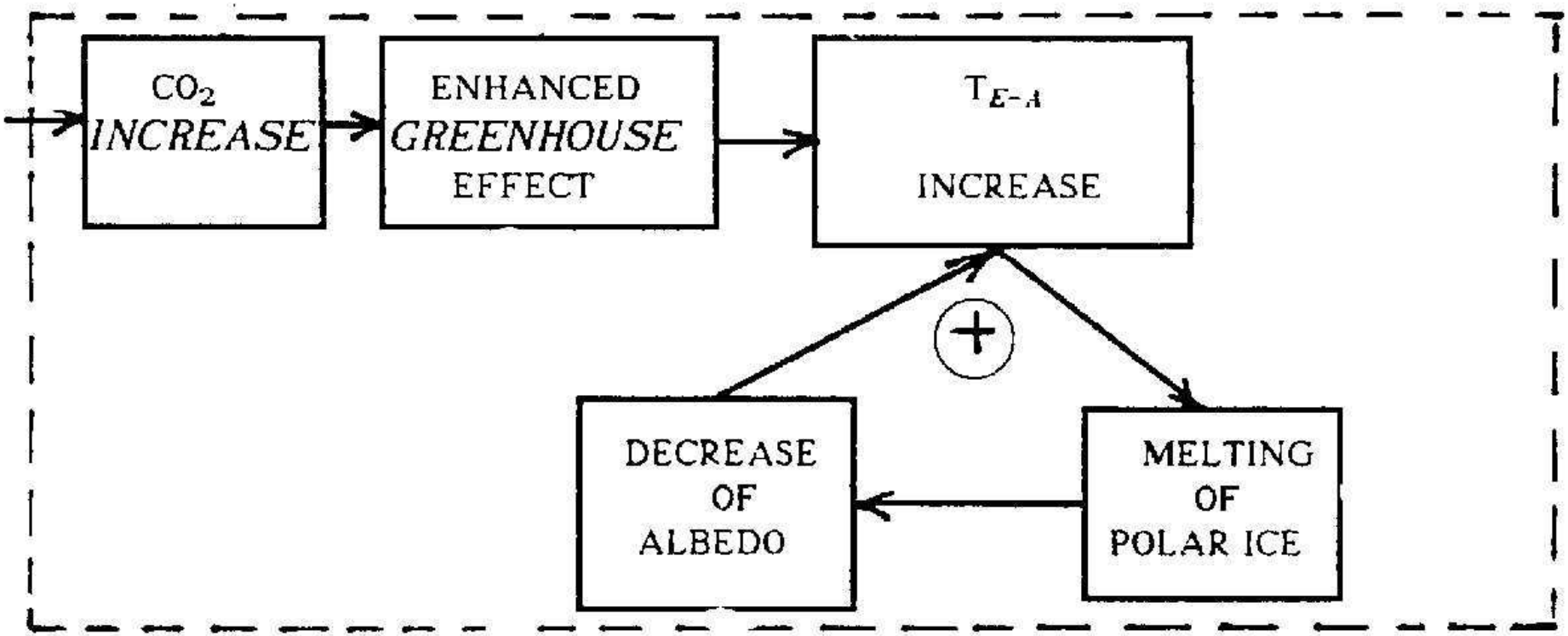
NEGATIVE FEEDBACK: $\Delta F = f(out) - f(in)$

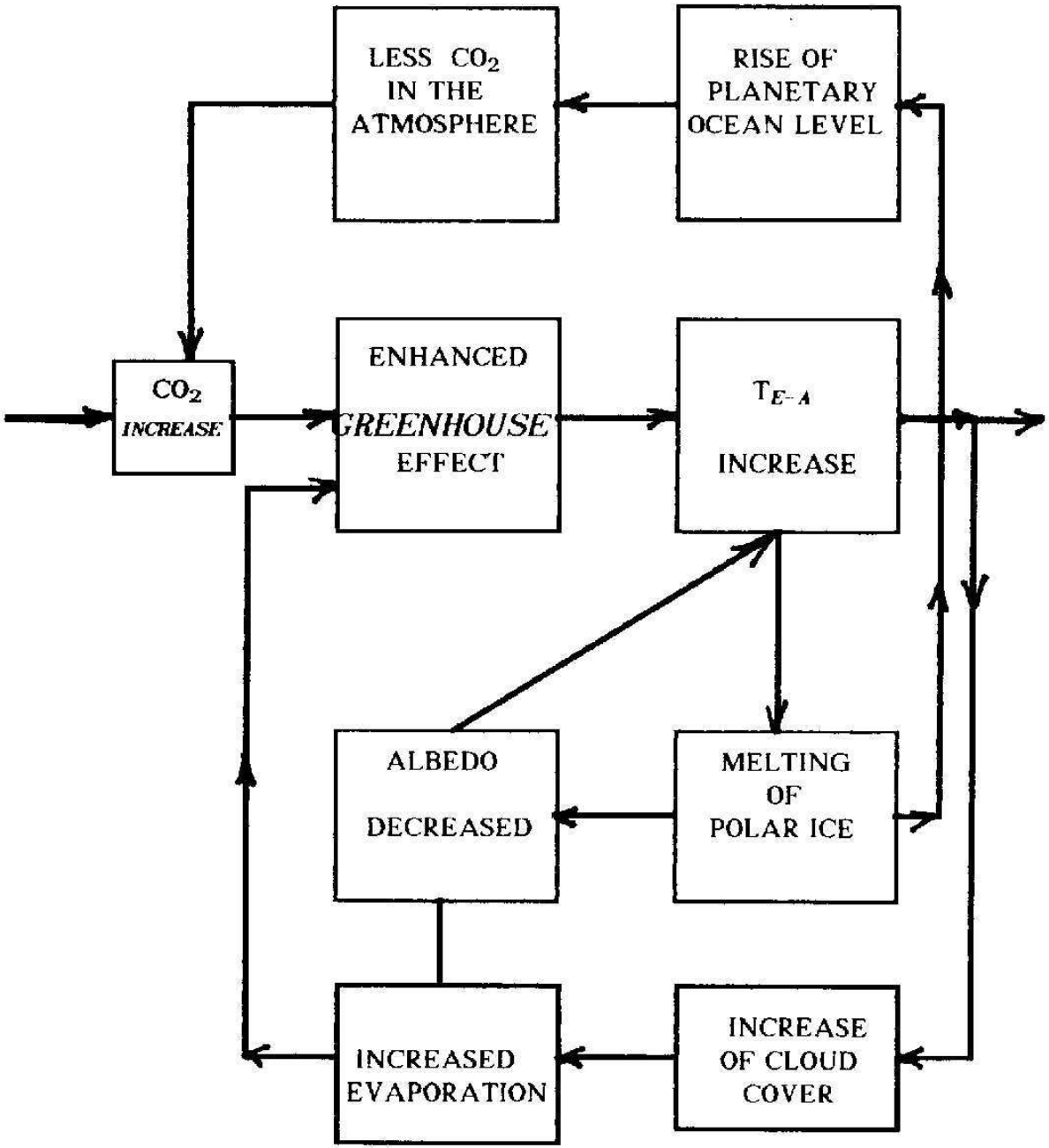
POSITIVE FEEDBACK: $\Delta F = f(out) + f(in)$

CLIMATE FEEDBACK'S

- Glacier feedback.
- Air vapor feedback.
- Cloud cover feedback.
- Ocean feedback.
- Biomass feedback.
- Methane feedback.

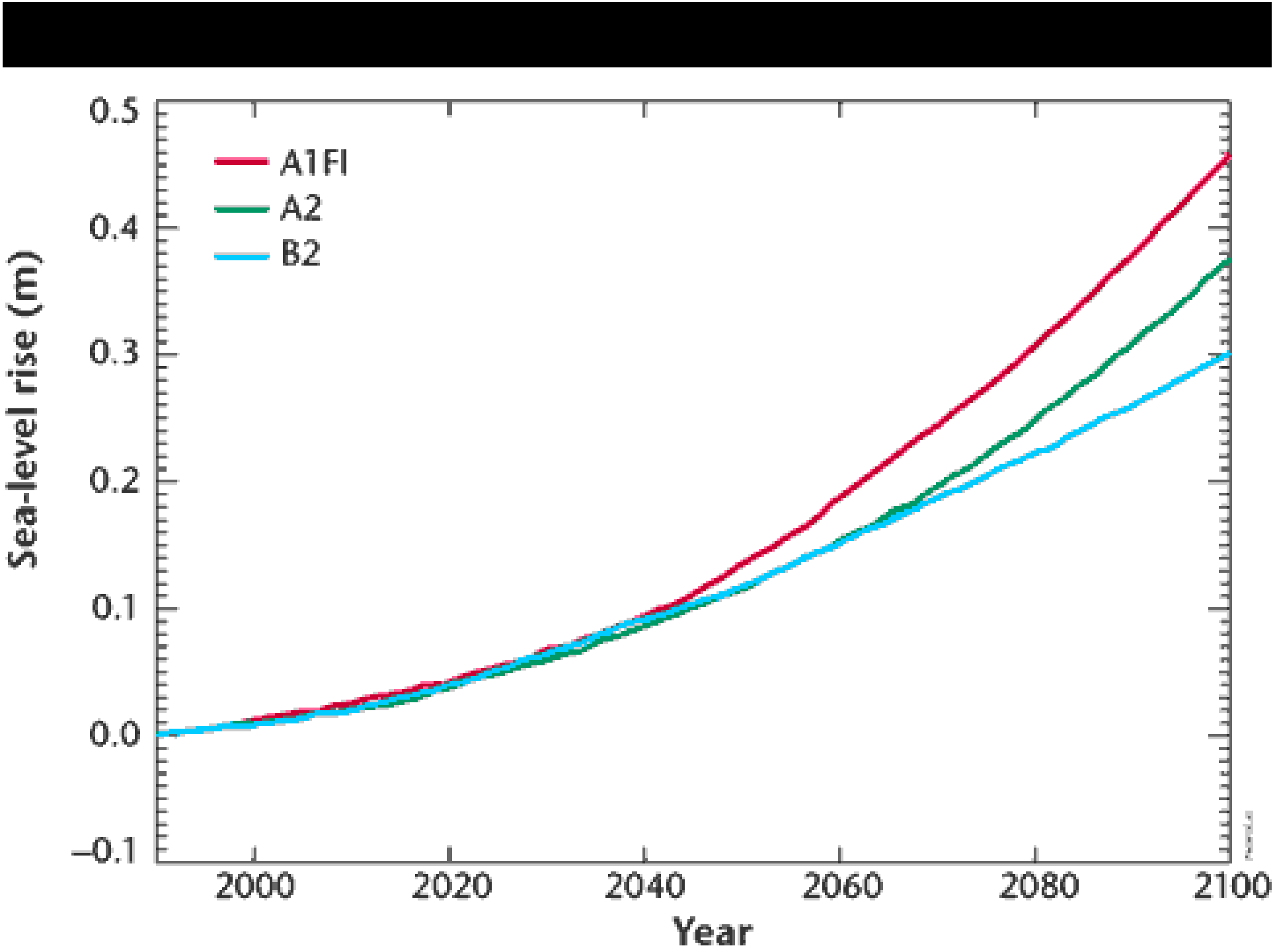
GLACIER FEEDBACK

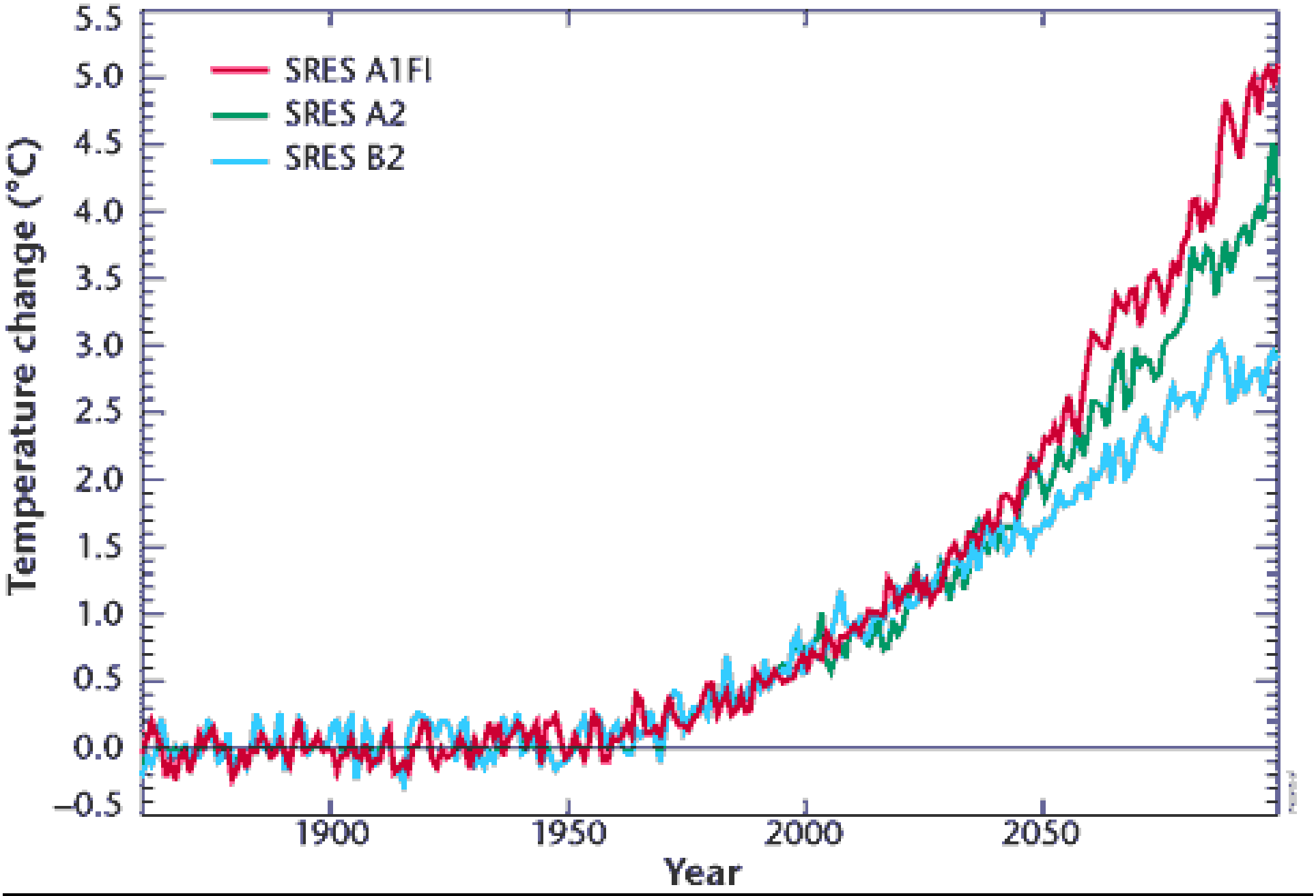


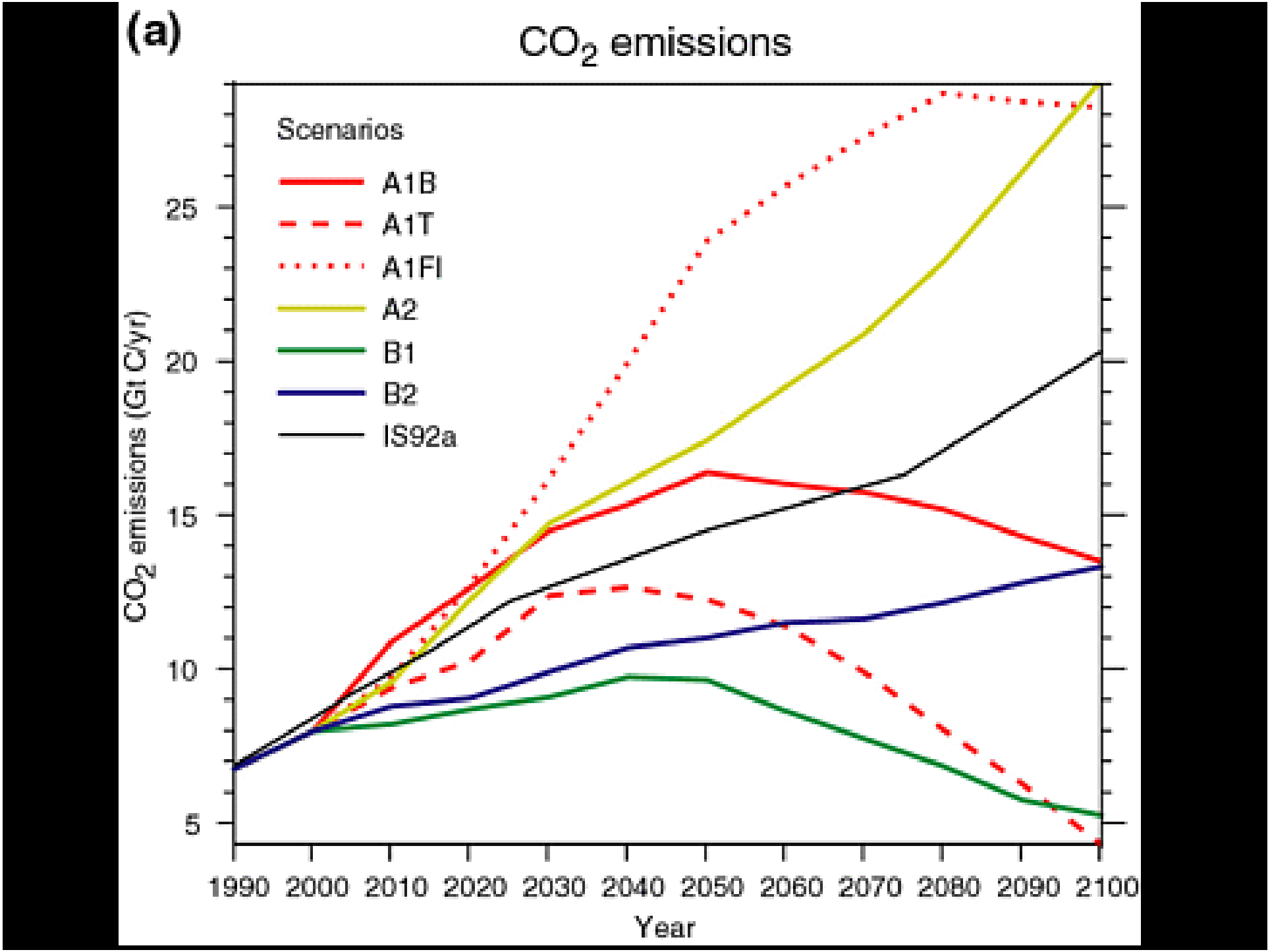

LESS CO_2 IN THE ATMOSPHERE
RISE OF PLANETARY OCEAN LEVEL
CO_2 INCREASE
ENHANCED GREENHOUSE EFFECT
T_{E-A} INCREASE
ALBEDO DECREASED
MELTING OF POLAR ICE
INCREASED EVAPORATION
INCREASE OF CLOUD COVER

EMISSIONS SCENARIOS

- A1F1- Continuation of fossil fuels as a main energy force. Population growth up till the middle of the century and then a decline.
- B1- Introduction of clean & efficient technologies into the economy.
- A2- population rises continuously throughout the 21st century. The introduction of clean & efficient technologies is less rapid than in other scenarios.
- B2- population & economic growth at a lower rate than A2 throughout the 21st century.


A1FI
A2
B2
Sea-level rise (m)
0.5
0.4
0.3
0.2
0.1
0.0
–0.1
2000
2020
2040
2060
2080
2100
Year


SRES A1FI
SRES A2
SRES B2
Temperature change (°C)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
–0.5
1900
1950
2000
2050
Year


(a)
CO_2 emissions
Scenarios
A1B
A1T
A1FI
A2
B1
B2
IS92a
CO_2 emissions (Gt C/yr)
5
10
15
20
25
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
Year

GLOBAL WARMING SUMMARY (IPCC)

- **1995-2006 - 11 OUT OF 12 WARMEST YEARS MEASURED SINCE 1850.**
- **A RISE OF 0.74° CELSIUS IN GLOBAL TEMPERATURES.**
- **SINCE 1960 A 1.8 M"M RISE IN GLOBAL SEA LEVEL.**
- **DURING THE LAST 3 DECADES A 2.7% DECREASE IN ARCTIC ICE COVER.**
  - **THE IPCC ESTIMATION IS THAT BY THE MID 21st CENTURY THE ARCTIC GLACIER WILL TOTALLY MELT DURING THE SUMMER.**
- **1980-2004- 1.4 TRILION DOLLAR COST OF DAMAGES CAUSED BY EXTREME WEATHER EVENTS.**

IMPLICATIONS OF GLOBAL WARMING (IPCC)

- **A DROP IN PRECIPITATION:**
  - **THE MEDITERRANEAN, SAHEL, SOUTH AFRICA, SOUTH ASIA, WEST USA, & AREAS IN SOUTH AMERICA.**
  - **A DROP IN RIVER FLOW, GROUND WATER LEVEL & DRYING OUT RESERVOIRS.**
- **A RISE IN PRECIPITATION:**
  - **NORTH AMERICA, EAST EUROPE & CENTRAL ASIA.**
- **MORE FREQUENT & STRONGER TROPICAL STORMS MAINLY OVER THE NORTH ATLANTIC.**
- **WARMER MINIMUM TEMPERATURES- LESS FROST EVENTS.**

THE EFFECT ON AGRICULTURE

- **A RISE IN GLOBAL TEMPERATURES:**
  - **A RISE IN CROP YIELDS IN HIGH LATITUDES.**
  - **A DROP IN CROP YIELDS IN LOW LATITUDES (EQUATORIAL STATES).**
- **HEAT WAVES:**
  - **DAMAGE TO CROPS AND LIVE STOCK.**
  - **A HIGHER RISK OF FIELD FIRE OUT BREAKS.**
- **A RISE IN RAIN INTENSITY:**
  - **FLOODING, SOIL EROSION & SALIFICATION, CROP & INFRASTRUCTURE DAMAGE.**
- **DROUGHT: (LESS AVAILABLE WATER)**
  - **SOIL EROSION & SALIFICATION, DAMAGE TO UNIRRIGATED CROPS, DEATH TO CATTLE & SHEEP HEARDS.**
- **A RISE IN ATMOSPHERIC CO2:**
  - **GOOD FOR MOST CROPS.**

PLANT GROUPS

- C3 plants (trees, wheat, rice, barley, cassava, and potato).
- C4 plants (tropical grasses, maize, sugarcane and sorghum)
- Higher CO_2 concentration will likely improve water-use efficiency and growth in C_3 plants in water-limited environments.

IMPACT ON PLANT PROCESS

- **LESS AVAILABLE WATER. (PROJECTED TO HAVE THE GREATEST IMPACT)**
- **HIGHER TEMPERATURES.**
- **HIGHER CONCENTRATIONS OF ATMOSPHERIC CO2.**

GLOBAL GRAIN YIELDS IN A WARMER CLIMATE

- **PREDICTED RISE IN GLOBAL TEMPERATURES 1°-3.5° CELSIUS. (IPCC)**
- **MULTIPLYING ATMOSPHERIC CO2.**

- **GRAIN YIELS REPRESENT AN INDEX FOR GLOBAL FOOD PRODUCTION- THEY CONTAIN MORE THAN HALF OF THE WORLD CALORIE CONSUMTION.**

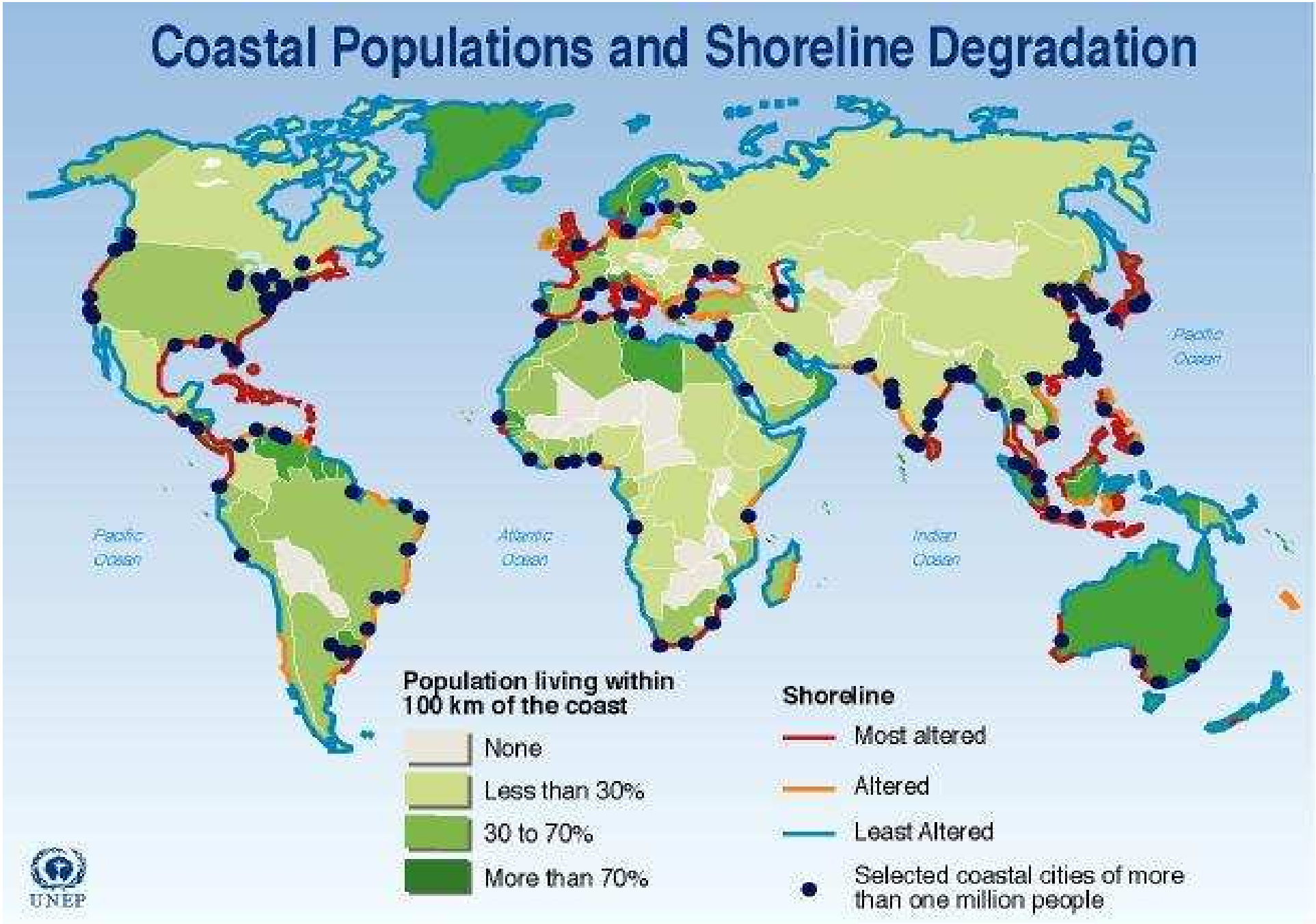
THE RESEARCH RESULTS (IPCC)

- **PHYSICAL EFFECTS:**
  - **DEVELOPED COUNTRIES:**
    - **MOST DEVELOPED COUNTRIES ARE LOCATED IN THE HIGHER LATITUDES. A RISE IN TEMPERATURES AND ATMOSPHRIC CO2 CONCENTRATIONS, WILL BENEFIT MOST CROPS.**
  - **DEVELOPING COUNTRIES:**
    - **SITUATED MAINLY IN EQUATORIAL AREAS. A FARTHER RISE IN TEMPERATURES WILL ONLY DAMAGE CROPS.**
- **ECONOMICAL EFFECTS:**
  - **DEVELOPED COUNTRIES:**
    - **HAVE THE ECONOMIC STRENGTH AND AGRICULTURAL KNOWLEDGE TO PREPARE FOR THE CHANGING WEATHER CONDITIONS.**
  - **DEVELOPED COUNTRIES:**
    - **HAVE TO BECOME MORE EFFICIENT (IMPROVED INFRASTRUCTURE, MARKETING, IRRIGATION METHODS & THE DEVELOPMENT OF DURABLE SPECIES.**

THE EFFECT OF RISING GLOBAL SEA LEVELS ON AGRICULTURE

- **REDUCTION IN AGRICULTUR LAND.**
- **SOIL SALIFICATION.**
- **GROUND WATER SALIFICATION.**
- **DAMAGE MARINE ECOLOGY SYSTEMS.**
- **A NEGATIVE EFFECT ON THE FISHING INDUSTRY.**

Coastal Populations and Shoreline Degradation



Source: Burke et al., World Resources Institute, Washington DC, 2001; Paul Harrison, Fred Pearce, *AAAS Atlas of Population and Environment 2001*, American Association for the Advancement of Science, University of California Press, Berkeley.

THE EFFECT OF GLOBAL WARMING ON THE MILK INDUSTRY

- **LONGER DRY SEASON.**
- **MORE HOURS OF SEVERE HEAT STRESS. (THI)**
- **EXTENDED HEAT WAVES ALSO OVER HIGHER LATITUDES.**
- **A GREATER INVESTMENT IN ENERGY IN ORDER TO COPE WITH THE RISING TEMPERATURES.**
- **LONG AND INTENSE DROUGHTS WILL CAUSE A SHORTAGE IN ANIMAL FEED.**
- **HIGH TEMPERATURES INTENSIFY THE DEVELOPMENT OF DISEASE BACTERIA.**
- **INTERNATIONAL SUPERVISION OVER FOOD INGREDIENTS FOR CATTLE & SHEEP.**
- **SUPERVISION OVER ORGANIC WASTE.**

LONG TERM PLANNING

- **MATCHING CROP VARIETY & SPECIES ACCORDING TO THE CHANGING CLIMATIC CONDITIONS.**
- **CHANGING SOWING & HARVESTING DATES.**
- **UTILIZATION OF LOCAL CLIMATIC ADVANTAGES (WARM WINTERS, ANNUAL RADIATION LEVELS, PRECIPITATION AMOUNTS).**
- **CREATING MICRO CLIMATES:**
  - **GREEN HOUSES WITH CLIMATE CONTROL.**
  - **NETS.**
- **INCREASING AVAILABLE WATER QUANTITY:**
  - **BUILDING RESERVOIRS.**
  - **DESALINATION.**
  - **UTILIZATION OF RECYCLED WATER.**
- **AGRICULTURE CONTRIBUTES 18% OF GLOBAL GREEN HOUSE GAS EMISSIONS:**
  - **RISE TERRACES & BURNING BIOMASS.**
  - **INCREASING NUMBERS OF CATTLE & CHEEP.**
  - **FERTILIZING COMPOUNDS.**
  - **IT IS VERY IMPORTANT THAT WE IMPROVE WORKING METHODS IN ORDER TO DO LESS ENVIRONMENTAL DAMAGE !!!**

THE EFFECT OF CLIMATE CHANGE ON ISRAEL

- Most of the population live along the coast line. A rise in the sea level will cause severs problems.
- A rise in days and hours that conditions of high heat stress prevail.
- Israel is located close to the world desert belt. A drop in precipitation could intensify a desertification process.
- A change in the seasons- the summer (hot months) will become longer.
- Reptiles and pests thrive in hot climates.
- Changes in climate averages – Farmers will have to reassess there conventional approach towards crop selection and seasonal planning.