ATOC 1060-002
OUR CHANGING ENVIRONMNET

Class 4: (Chapter 1)

Objectives of today's class:

a) Global change on short time scales (continue);

b) Global change on long time scales.

http://atoc.colorado.edu/~whan/ATOC1060

Announcement

HW1 begins today.

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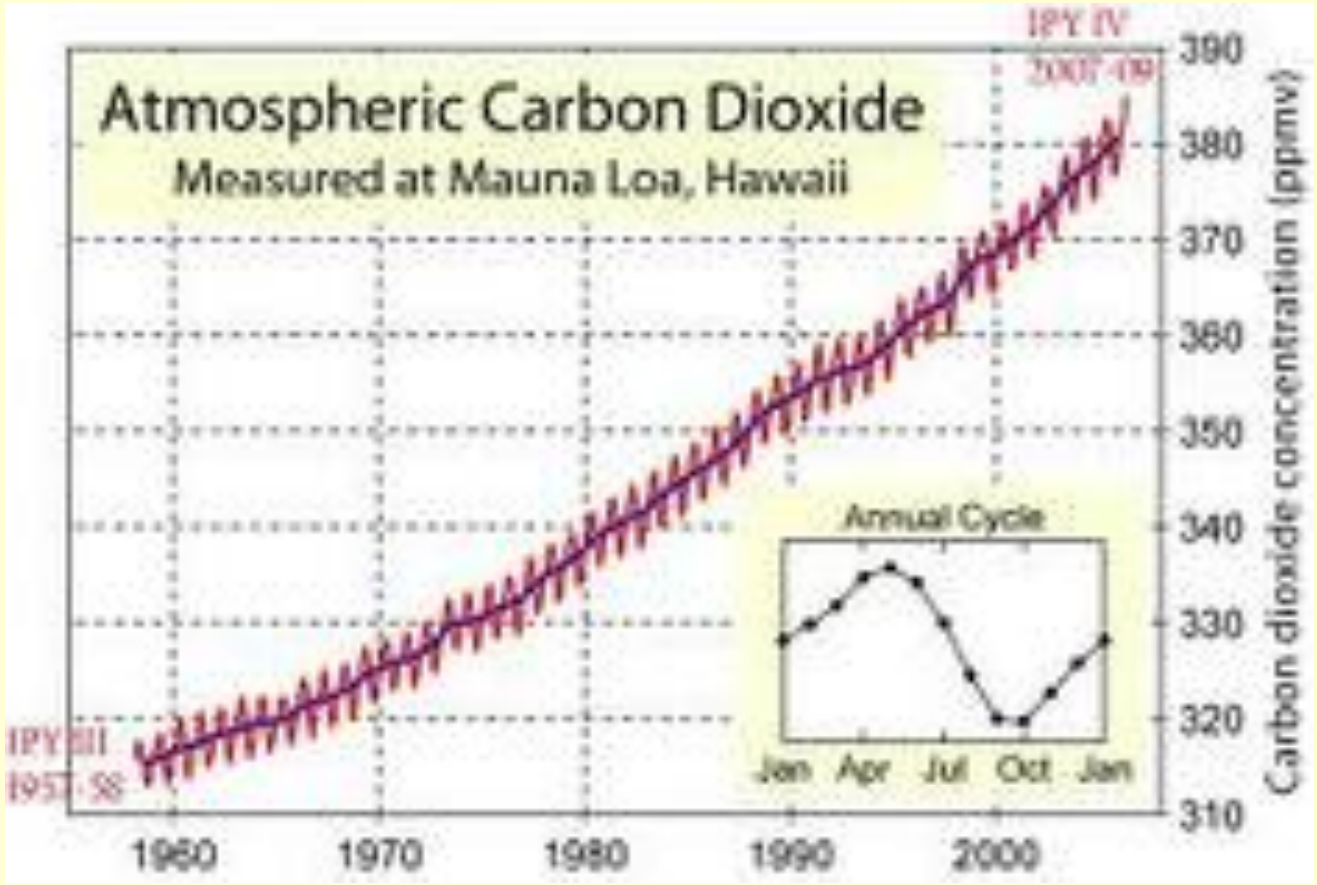
Clicker question 1

The Earth system is composed of the following 4 parts:

(a)Troposphere, stratosphere, biosphere, hydrosphere;
(b)Atmosphere, hydrosphere, biota, solid earth;
(c)Atmosphere, ocean, hydrosphere, biosphere;
(d)Atmosphere, ocean, sea ice, solid earth;

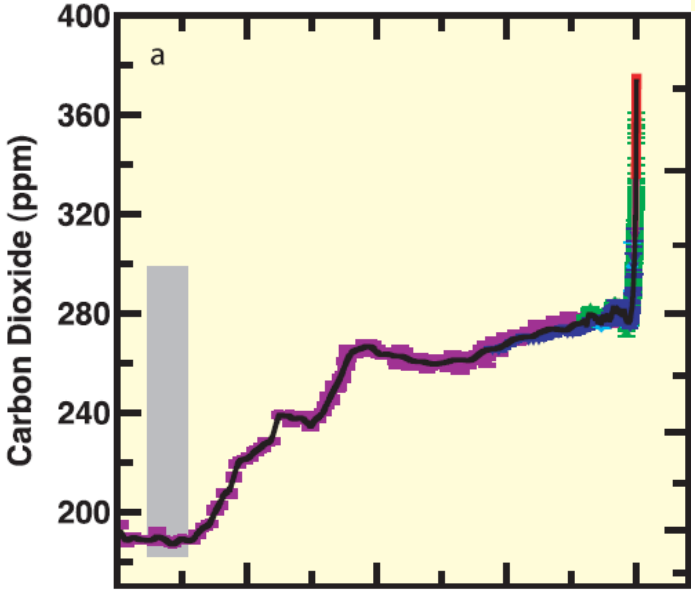
The Keeling Curve: Measurement of atmospheric CO_2

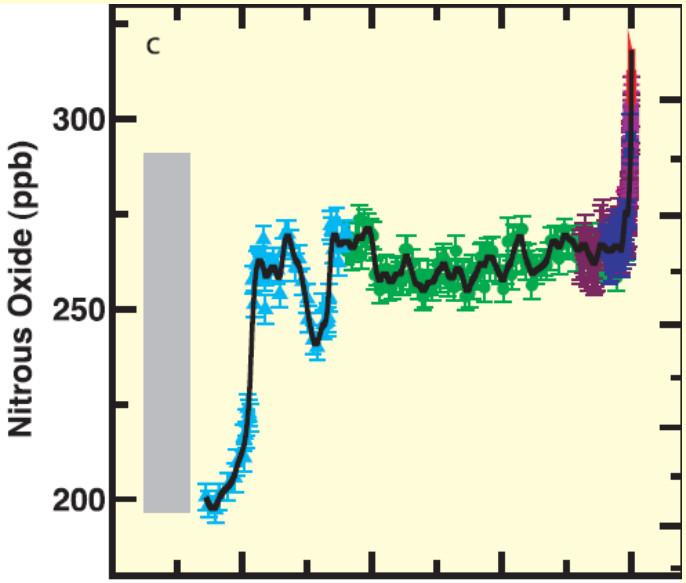


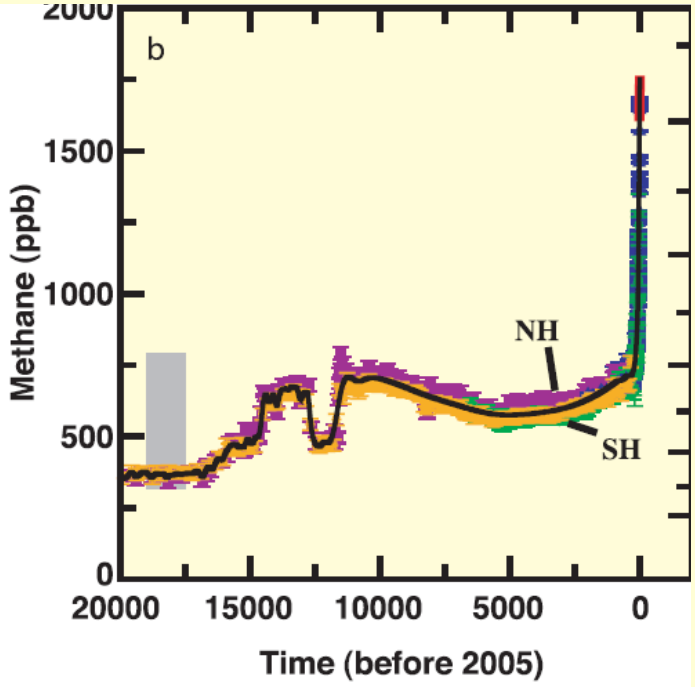
Seasonal change
5-6 ppm

Fig 1-2. Measurements of atmospheric carbon dioxide (CO_2) at the top of Mauna Loa (volcano) in Hawaii.

Changes in Greenhouse Gases from Ice Core and Modern Data

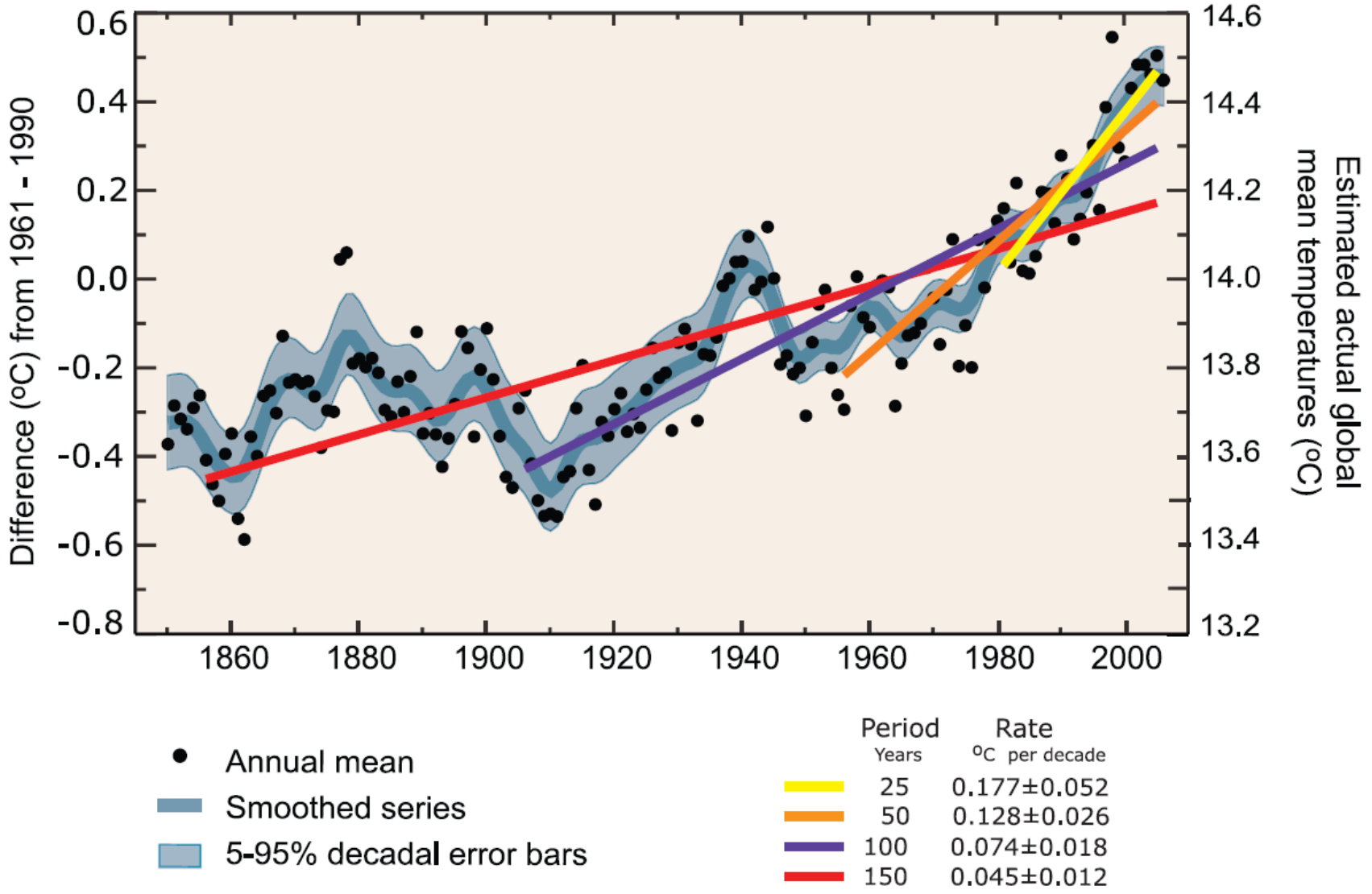






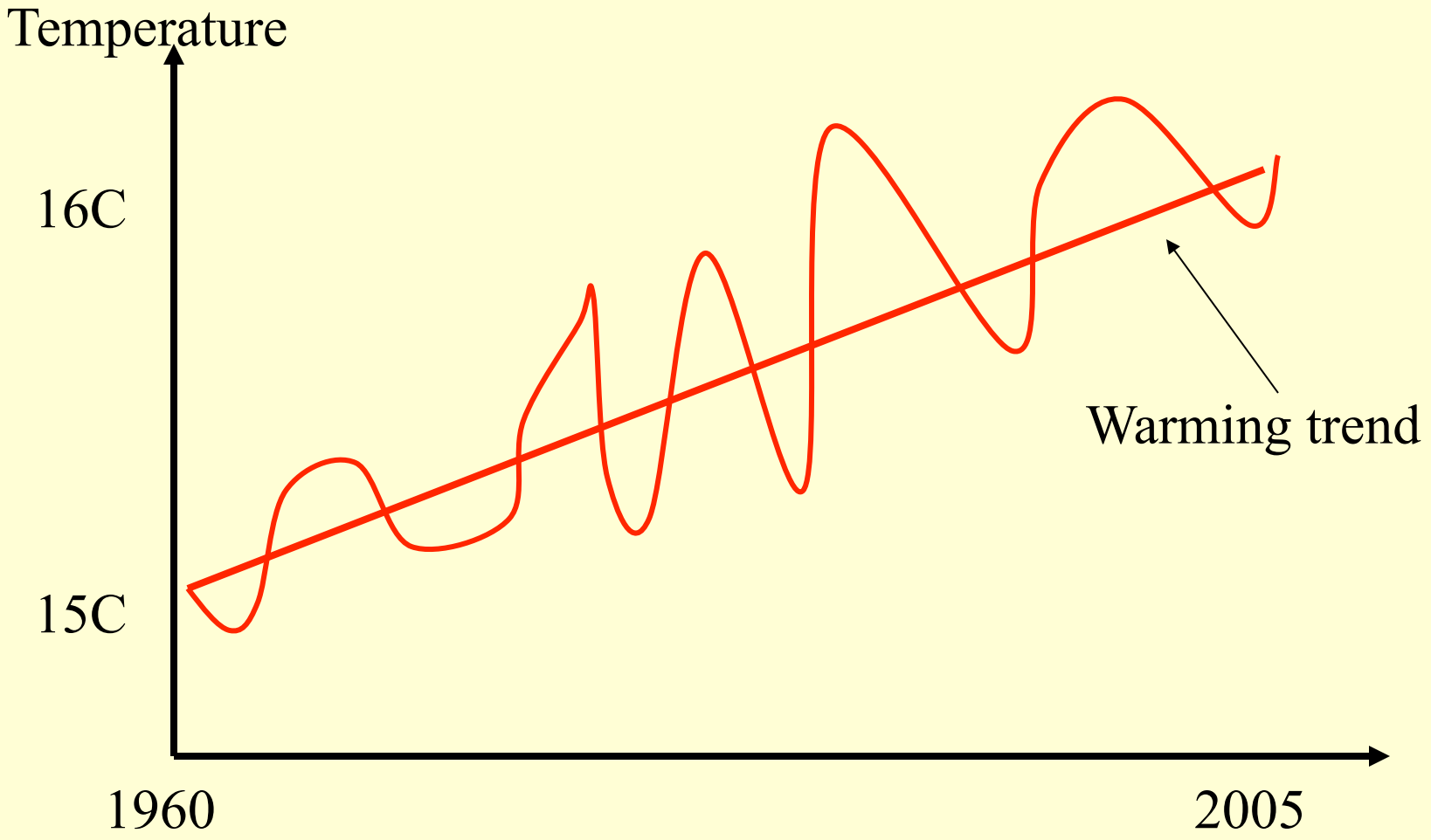
IPCC AR4 (Intergovernmental Panel on Climate Change, 4th Assessment Report). Atmospheric greenhouse gases concentrations over the past 20,000 years, as determined from ice cores and from direct atmospheric Measurements.

2. Global temperature



IPCC AR4. Annual global mean temperatures (black dots) with linear fi ts to the data. The left hand axis shows temperature anomalies relative to the 1961 to 1990 average and the right hand axis shows estimated actual temperatures, both in °C. Linear trends are shown for the last 25 (yellow), 50 (orange), 100 (purple) and 150 years (red). The smooth blue curve shows decadal variations, with the decadal 90% errorr ange shown as a pale blue band about that line.

Schematic diagram to demonstrate the trend



Clicker question 2

Observations show that:

(a)Atmospheric CO_2 has been persistently increasing from 1850 to present;

(b) Like CO_2, the Earth's temperature has been persistenly increasing from 1850 to present;

(c) The Earth's temperature has a decreasing trend in the past century;

(d)Both CO_2 and the Earth's temperature had decreased somewhat during 1950-1970.

2. Ozone depletion

$$Cl + O_3 \longrightarrow ClO + O_2$$

Atomic chlorine

Chlorine monoxide

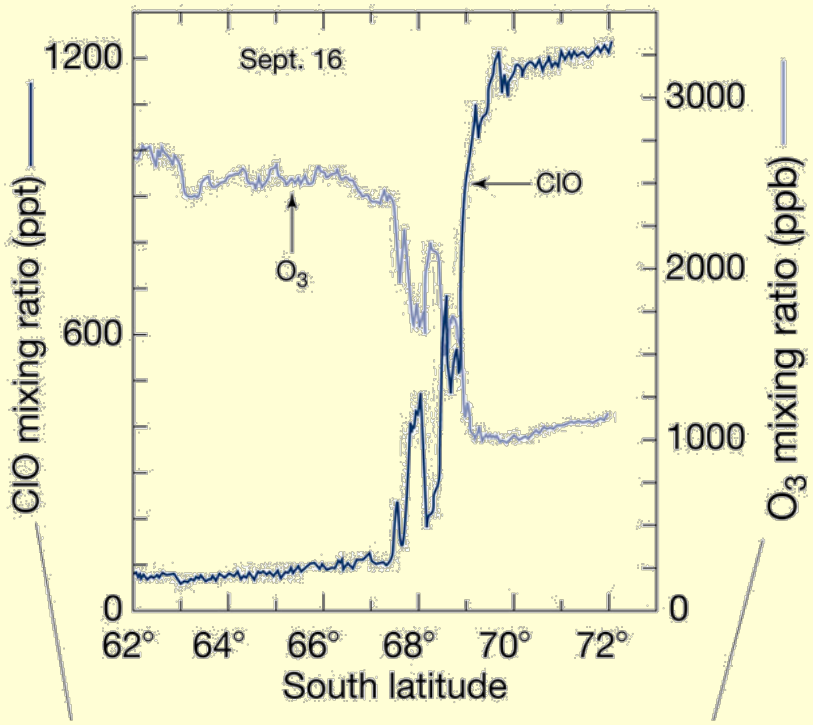


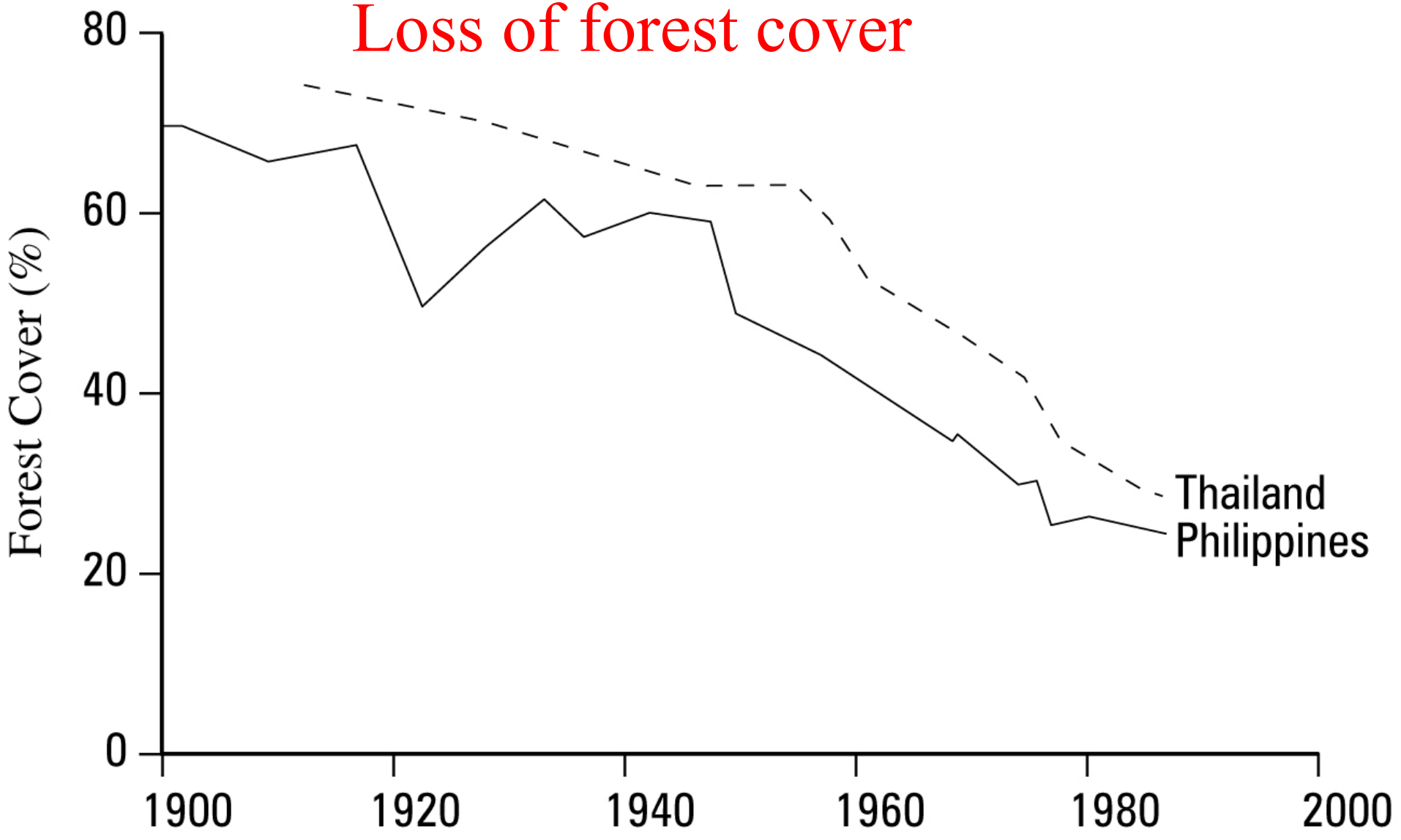
Fig 1-6 Observed Ozone (O3) and chlorine monoxide (ClO). NASA aircraft September 1987.

3.Today's class: Deforestation and loss of biodiversity

Since 10,000 years ago, humans farmed
=> alter land surface. Tropical deforestation rate ~1.8% per year recently.



Loss of forest cover



Deforestation → lost plant species → lost of animals and microorganisms that live there.

New species may replace them, but normally the number of species decreases → reduce biodiversity.

Which changes should concern us the most?

Ozone depletion => skin cancer: immediate concern;

Global warming => sea level increase; extreme weather immediate concern;

Deforestation => loss of species=> loss of medicines fighting cancel and other diseases, but not as immediate;

Deforestation, however, increases CO_2, => global warming.

Recovering timescale: loss of species takes the longest time to recover! Maybe the most important!

Clicker's question 3

Tropical deforestation will

(a) increase biodiversity;

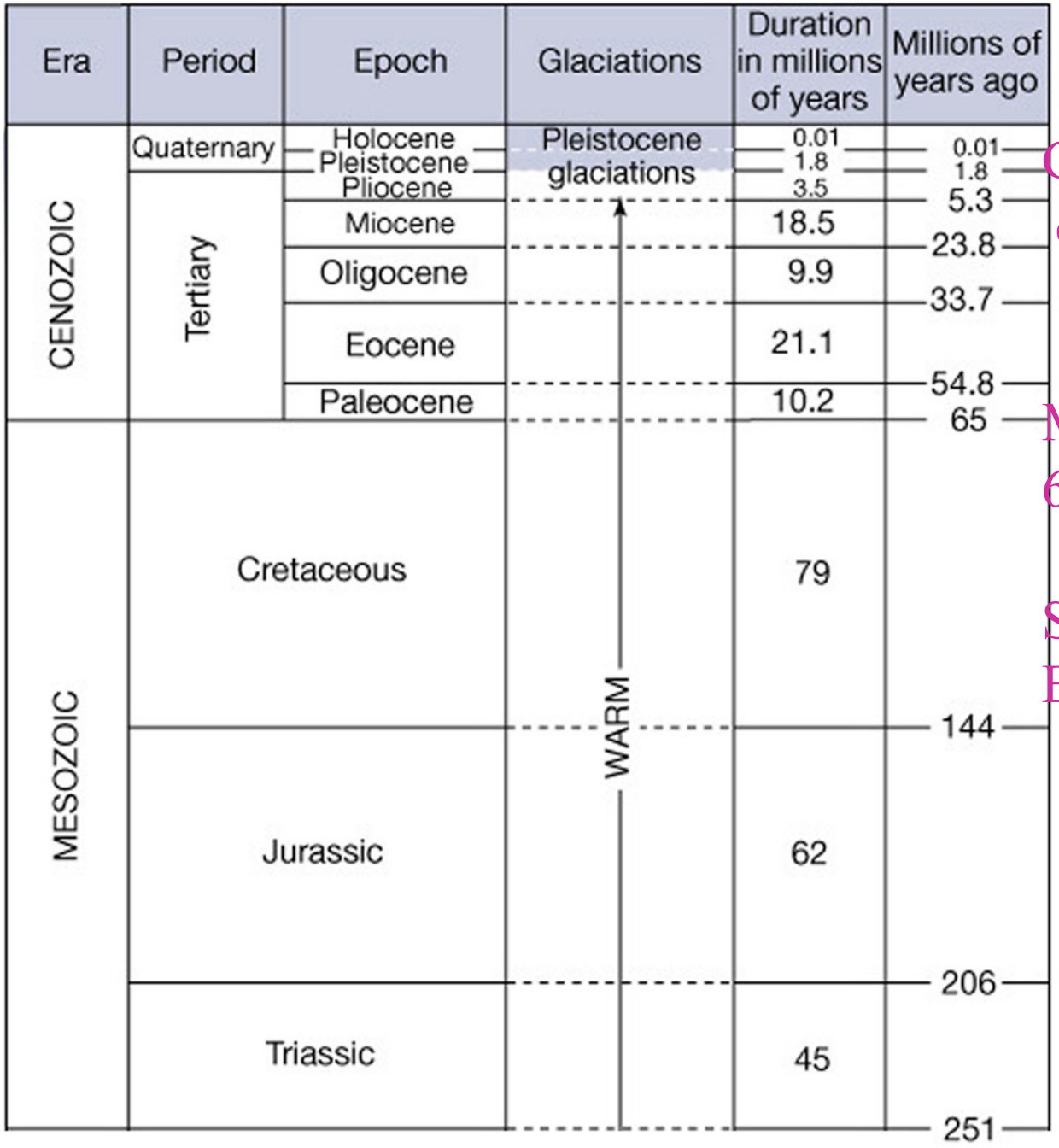
(b) reduce biodiversity and may enhance global warming;

(c) reduce biodiversity and slow down global warming;

(d) increase biodiversity and enhance global warming.

Global change on long time scales:

a) Past global change: glacial-interglacial cycles;
b) Mass extinction;
c) Changes in solar luminosity.



Glacial-interglacial cycles: 2.5million-10,000

Mass extinction; 65 millions

Solar luminosity: all 4.5 Billion years.

Geological Timescales:

Eon, Era, Period, epoch

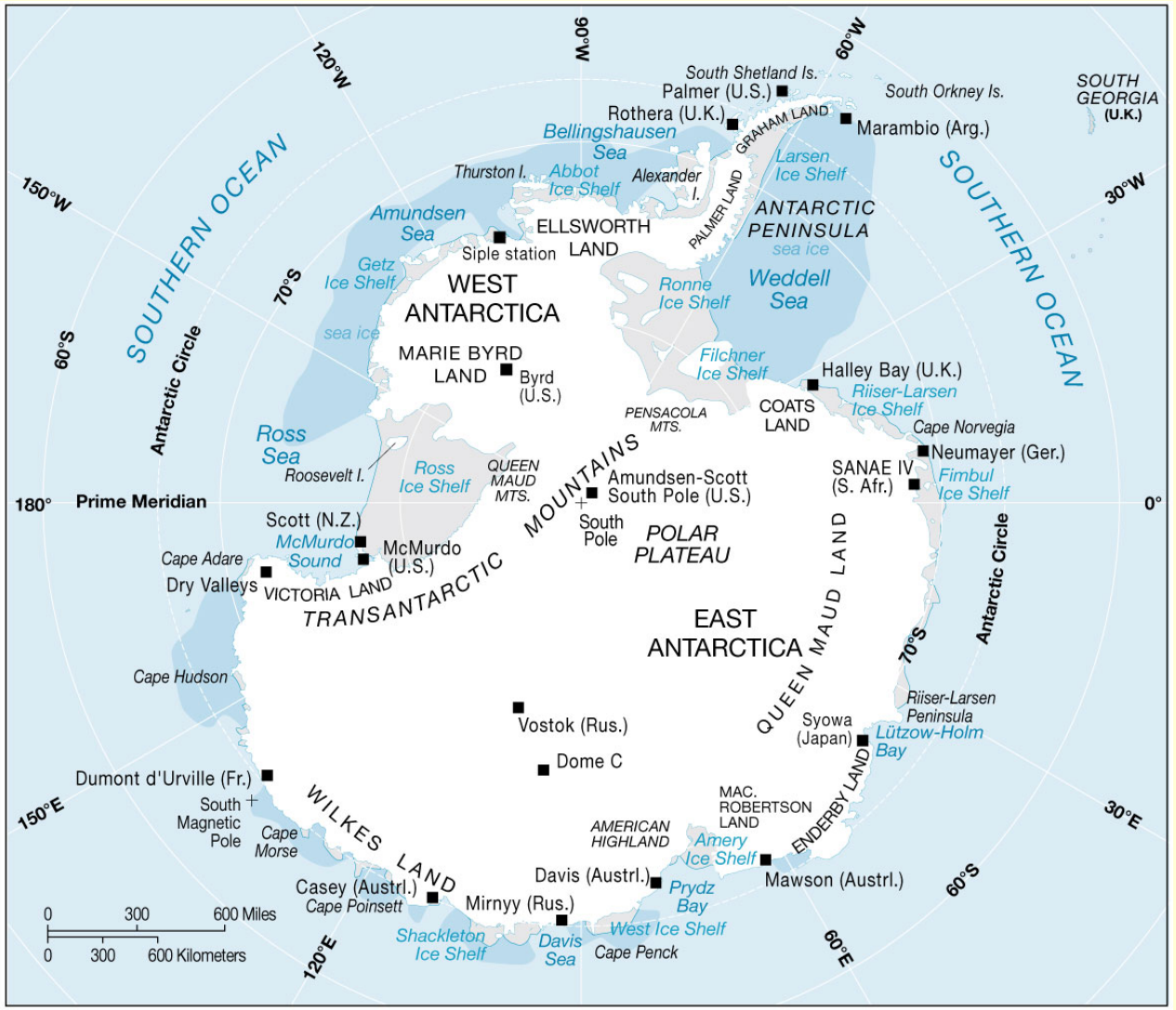
Global change in the past & present

Past: before human intervention.
what geological period we are currently at?

Glacial-interglacial cycles: 2.5 million-10,000 years ago,Pliocene and Pleistocene epochs.

Mass distinction: between the Cretaceous and Tertiary periods;65 million years ago.

Solar luminosity: 4.5 billion years Earth history.

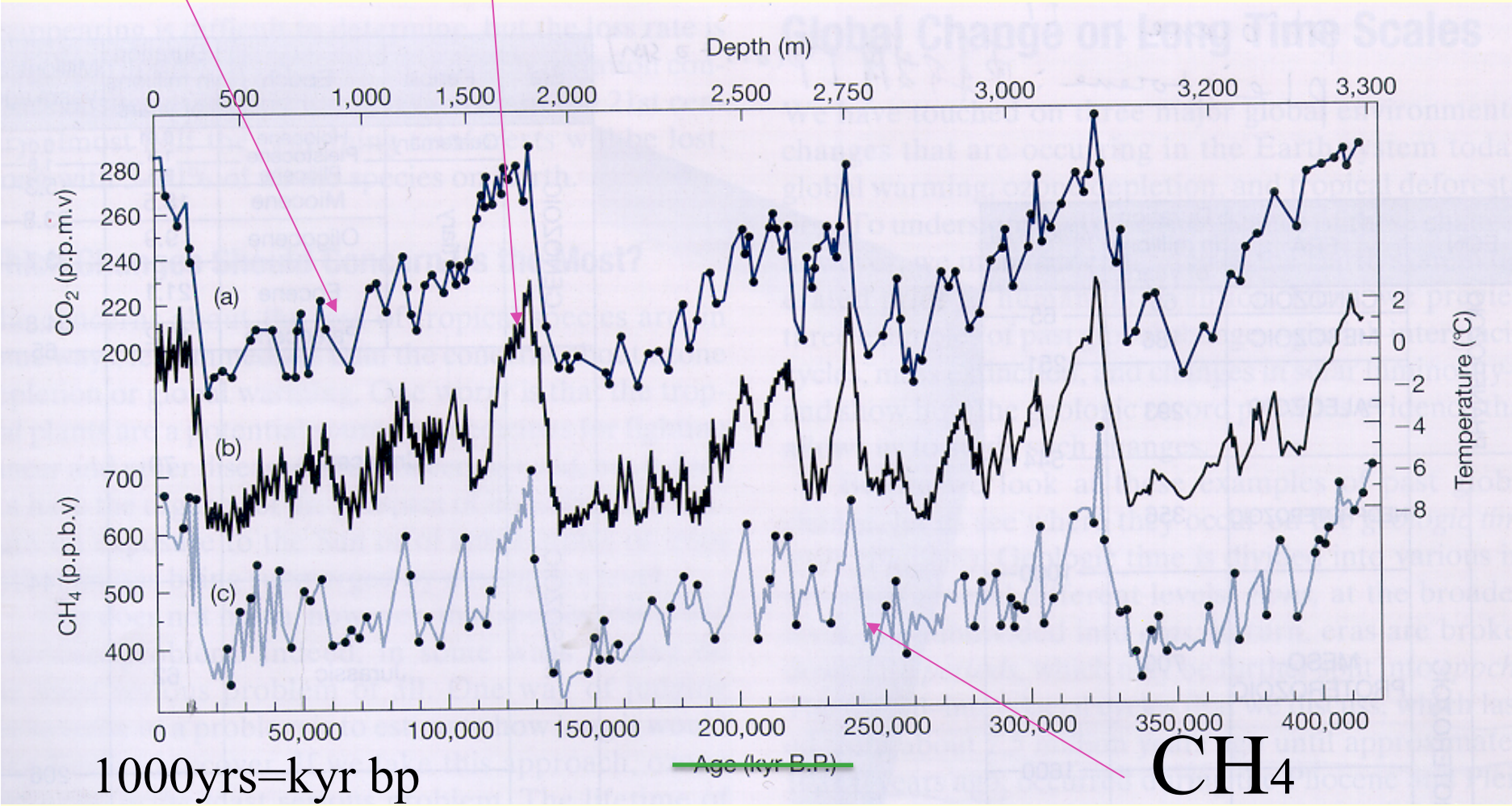


(a)

Glacial-interglacial cycles

CO_2

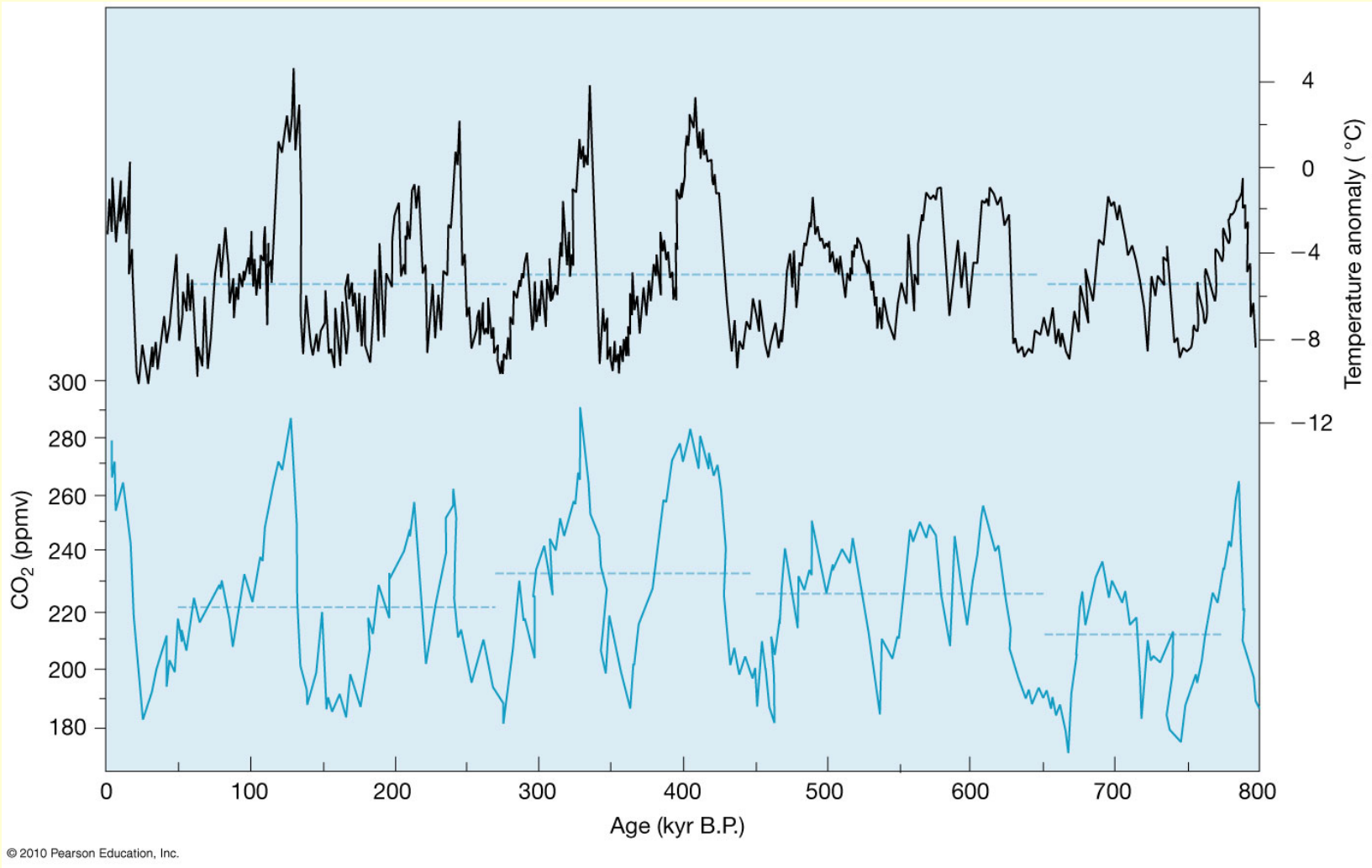
Temperature change



1000yrs=kyr bp

CH_4

Fig. 1-10 Ice-core record at Vostok, Antarctica. Total 420kyrs=420,000yrs


4
0
−4
−8
−12
Temperature anomaly (°C)
300
280
260
240
220
200
180
CO_2 (ppmv)
0
100
200
300
400
500
600
700
800
Age (kyr B.P.)
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Why does the CO_2 and CH_4 increases?

Not human induced at that time!

Deep ocean circulation; => co_2 concentration;

⇒Climate change => ocean circulation.

⇒A system in which components are tightly coupled. System approach.

Clicker's question 4

Choose the correct statement.

(a) Our present climate is in glacial period;

(b) Our present climate is in interglacial period;

(c) Even before the industrial age, atmospheric CO_2 concentration increased along with the increase of the Earth's temperature.

(d) Both (b) and (c).

Mass Extinction: Iridium and the K-T Boundary

Dinosaurs: lived 150 million years in mesozoic era; Ended 65 million Years ago. Others:died!

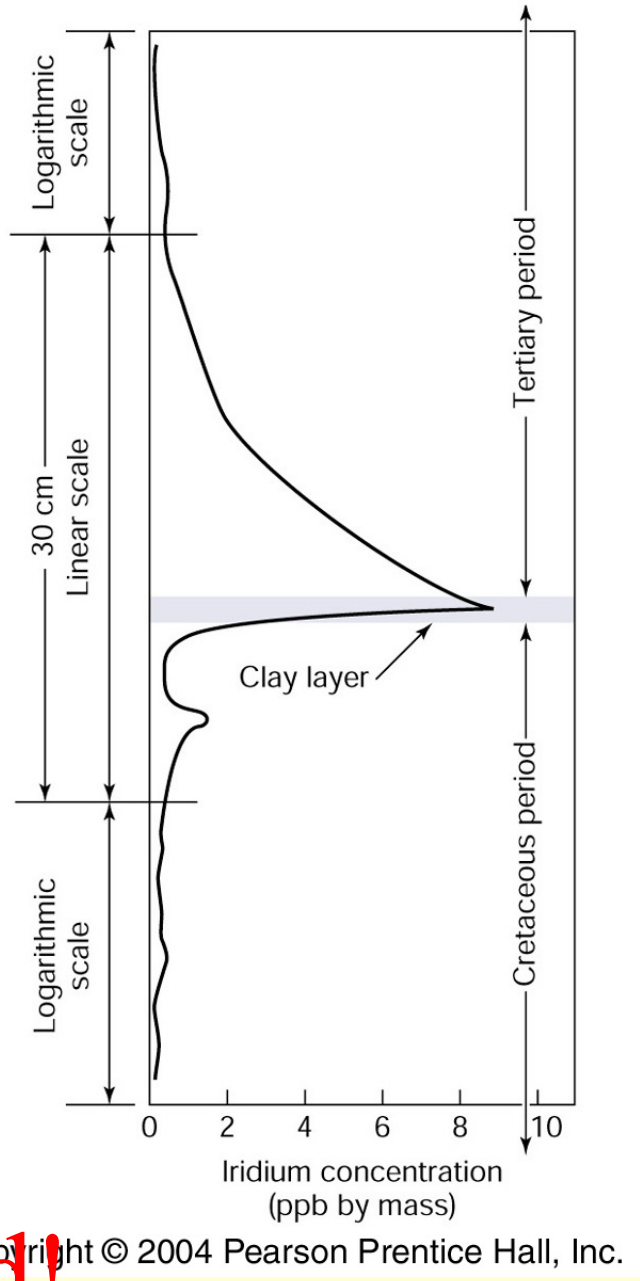

Fig. 1-11

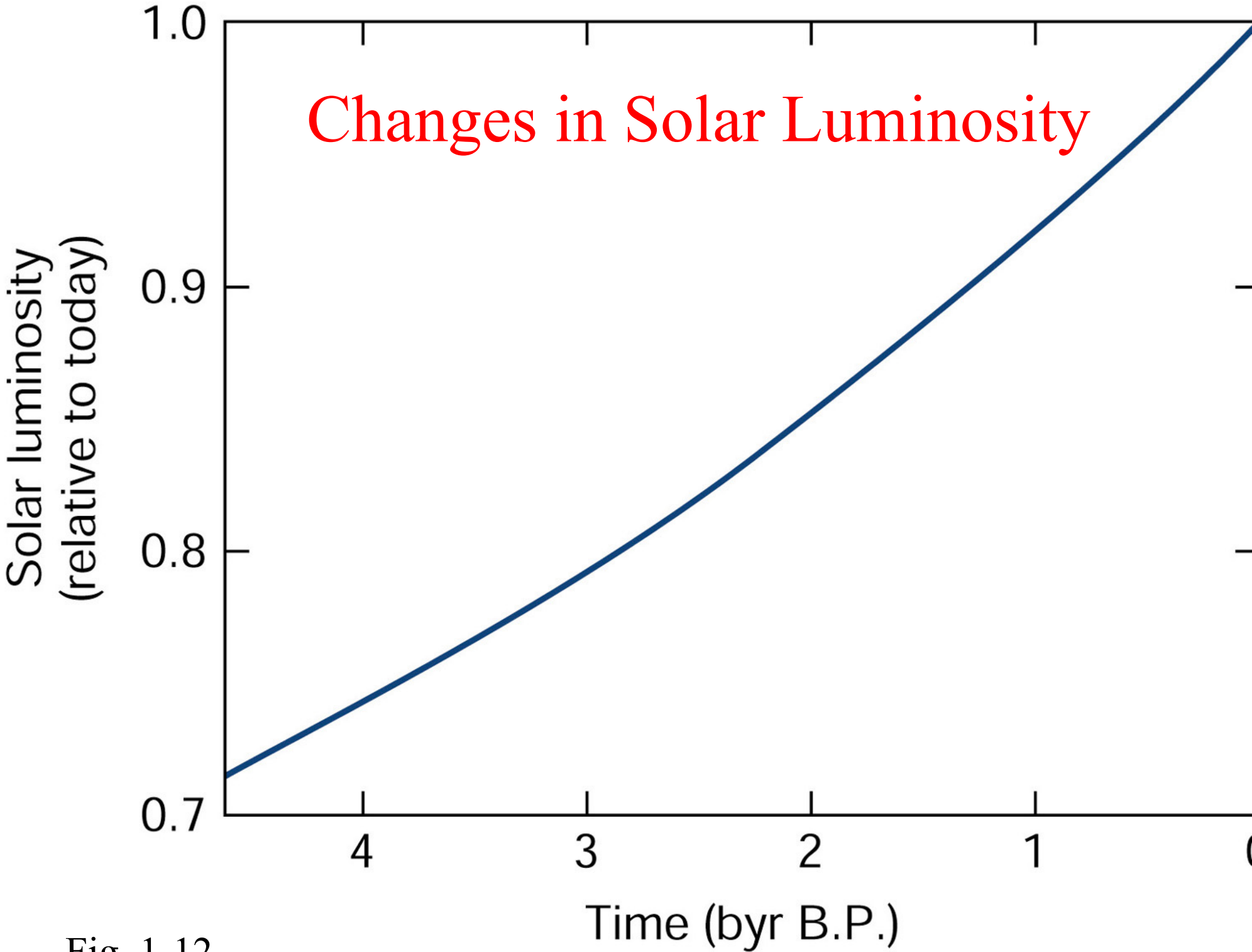
Changes in Solar Luminosity
Solar luminosity
(relative to today)
1.0
0.9
0.8
0.7
4
3
2
1
Time (byr B.P.)

Fig. 1.12

Faint young Sun paradox:
earlier earth, cold because of low luminosity of the Sun;

The Gaia Hypothesis: life maintains climate stability. Photosynthesis, consume CO_2, producing organic Matter. Earlier time: more CO_2. Self-regulating System, stable => Earth System!

Clicker's question 5

Choose the correct statement:

(a) Solar luminosity has been decreasing in the past 4.6BY;

(b) Dinosaurs flourished in the Tertiary period;

(c) Dinosaurs went extinction at the K-T boundary;

(d) In the past 2.5-million years, the earth's temperature has kept constant.

Chapter 1 Summary

Modern global environmental issues;

Past global change;

Behavior of Earth's systems.