THE CARBON CYCLE

Many living plants and animals extract carbon from their nonliving environment to build themselves and their environment. The concentration of carbon in living matter (18%) is almost 100 times greater than its concentration in the earth (0.19%).

Carbon exists in the nonliving environment as:

- carbon dioxide in the atmosphere and dissolved in water (forming HCO_3^-)
- carbonate rocks (limestone and coral - $CaCO_3$)
- deposits of coal, petroleum, and natural gas derived from once-living things.
- dead organic matter, e.g., humus in the soil

Carbon enters the biotic world through the action of autotrophs:

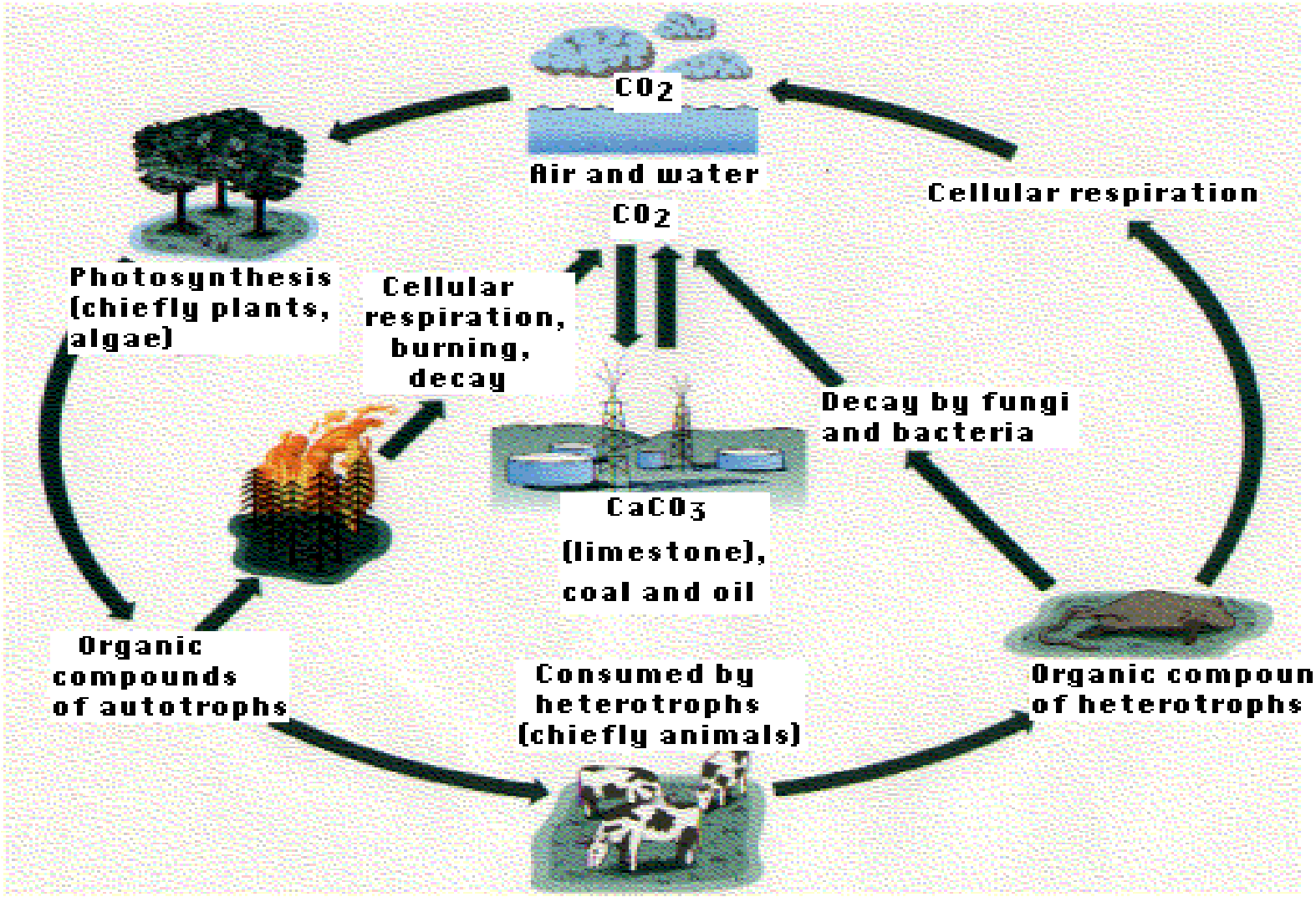
- primary photoautotrophs, like plants and algae, that use the energy of light to convert carbon dioxide to organic matter.
- and to a small extent, chemoautotrophs - bacteria and archaeans that do the same but use the energy derived from an oxidation of molecules in their substrate.

Carbon returns to the atmosphere and water by respiration (as CO_2)

- burning
- decay (producing CO_2 if oxygen is present, methane (CH_4) if it is not.

The problem is that the uptake and return of CO_2 are not in balance.

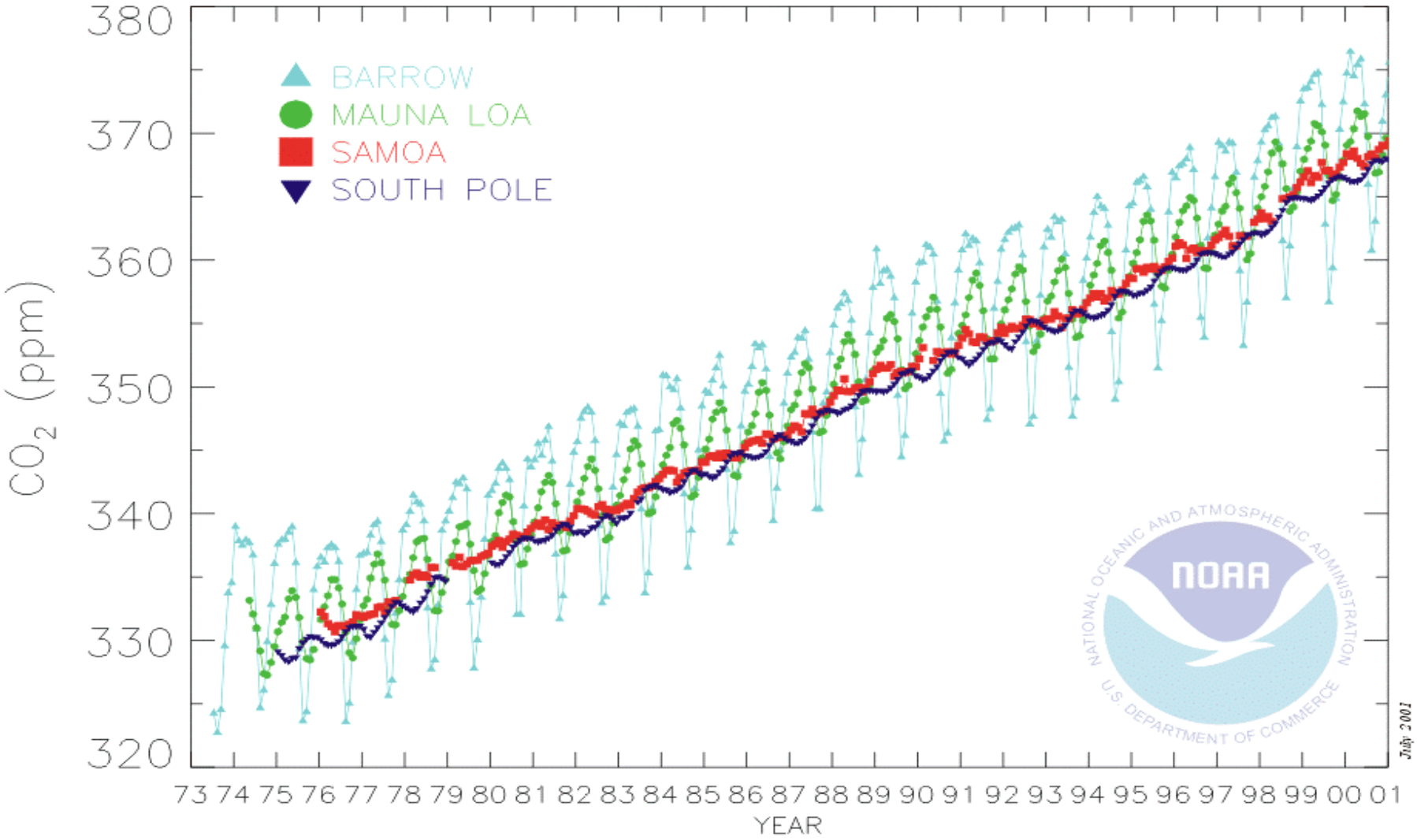
The proportion of carbon dioxide in the atmosphere is gradually and steadily increasing. The graph below from The Climate Monitoring and Diagnostics Laboratory (CMDL) of the National Oceanic and Atmospheric Administration (USA) shows the CO_2 concentration at the summit of Mauna Loa, Barrow Island, the South Pole and Samoa since 1973. The values are in parts per million (ppm) and the seasonal fluctuation is caused by the increased uptake of CO_2 by plants in summer.



The Carbon Cycle (From Kimball's Biology Pages at www.ultranet.com)

Monthly Mean Carbon Dioxide

NOAA CMDL Carbon Cycle Greenhouse Gases



Atmospheric carbon dioxide mixing ratios determined from the continuous monitoring programs at the 4 NOAA CMDL baseline observatories. Principal investigator: Dr. Pieter Tans, NOAA CMDL Carbon Cycle Greenhouse Gases, Boulder, Colorado, (303) 497-6678. ptans@cmdl.noaa.gov.

The increase in CO2 most likely began with the start of the industrial revolution as samples of air trapped over the centuries in the glacial ice of Greenland show virtually no change in CO2 content until 300 years ago.

Since measurements of atmospheric CO2 began late in the nineteenth century, it's concentration has risen over 20%. This increase is most likely "anthropogenic"; that is, caused by human activities such as:

- burning fossil fuels (coal, oil, natural gas) which returns to the atmosphere carbon that has been locked within the earth for millions of years.
- clearing and burning of forests, especially in the tropics. In recent decades, large areas of the Amazon rain forest have been cleared for agriculture and cattle grazing.

Curiously, the increase in atmospheric CO2 is only about one-half of what would have been expected from the amount of fossil fuel consumption and forest burning.

Where has the rest gone?

Research has shown that increased CO2 levels lead to increased net production by photoautotrophs. There is some evidence that the missing CO2 has been incorporated by

- increased growth of forests, esp. in North America.
- increased amounts of phytoplankton in the oceans.

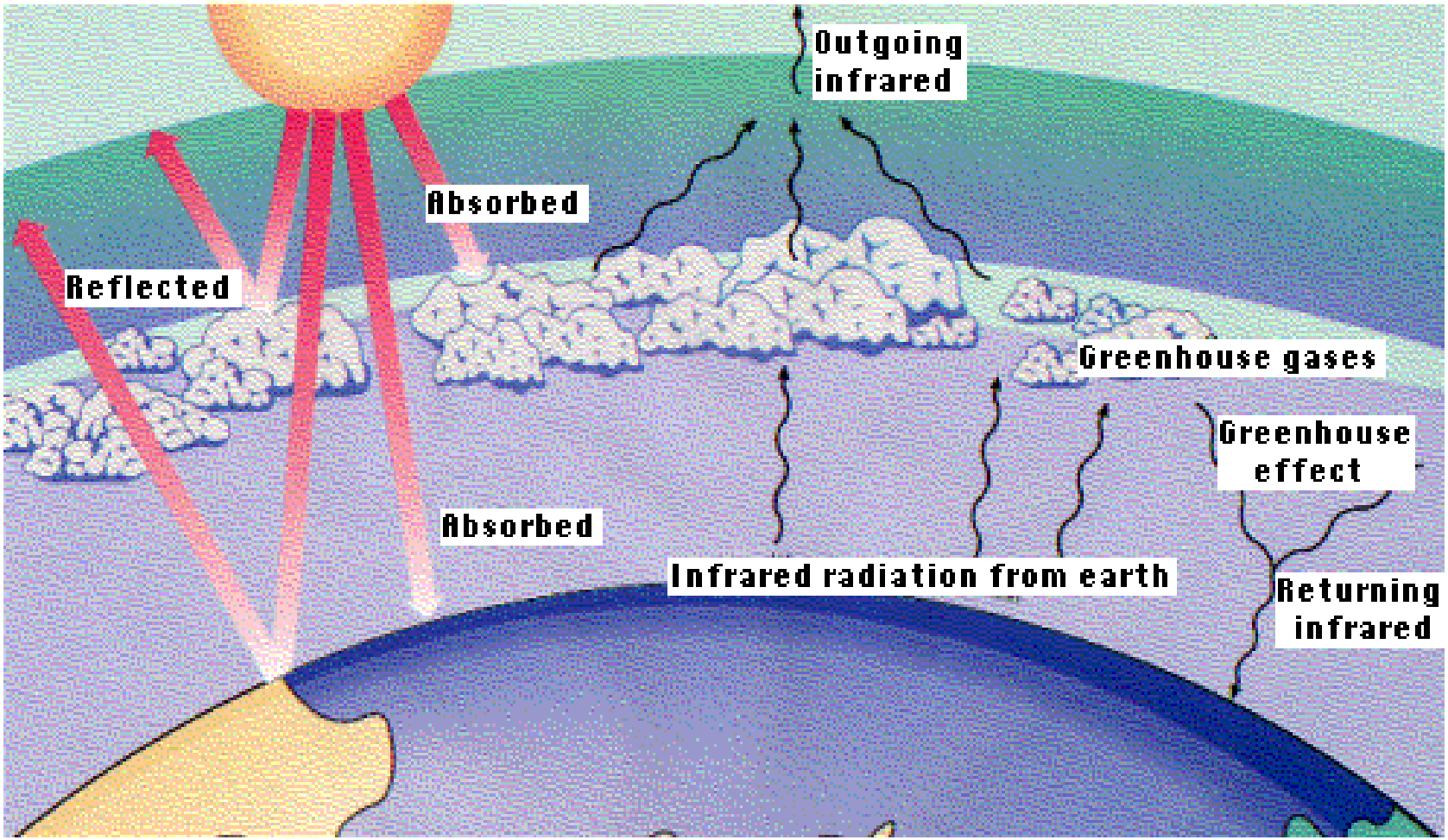
But the earth is getting warmer so something else is happening.

The Greenhouse Effect and Global Warming

Despite these "sinks" for our greatly increased CO_2 production, the concentration of atmospheric CO_2 continues to rise. We should be worried because carbon dioxide is transparent to light but rather opaque to heat rays. CO_2 in the atmosphere therefore retards the radiation of heat from the earth back into space. This phenomenon is referred to as "the greenhouse effect".

Has the increase in carbon dioxide lead to global warming?

The answer depends on limited data and what assumptions are made. The very activities that deposit CO2 in the air also deposit dust particles that impede the passage of light through the atmosphere so more is reflected back into space. Air pollution thus appears to reduce the arrival of energy as well as its departure. Whether these opposing effects cancel each other out is not yet known. Average temperatures have seemed to have increased slightly in recent decades however.



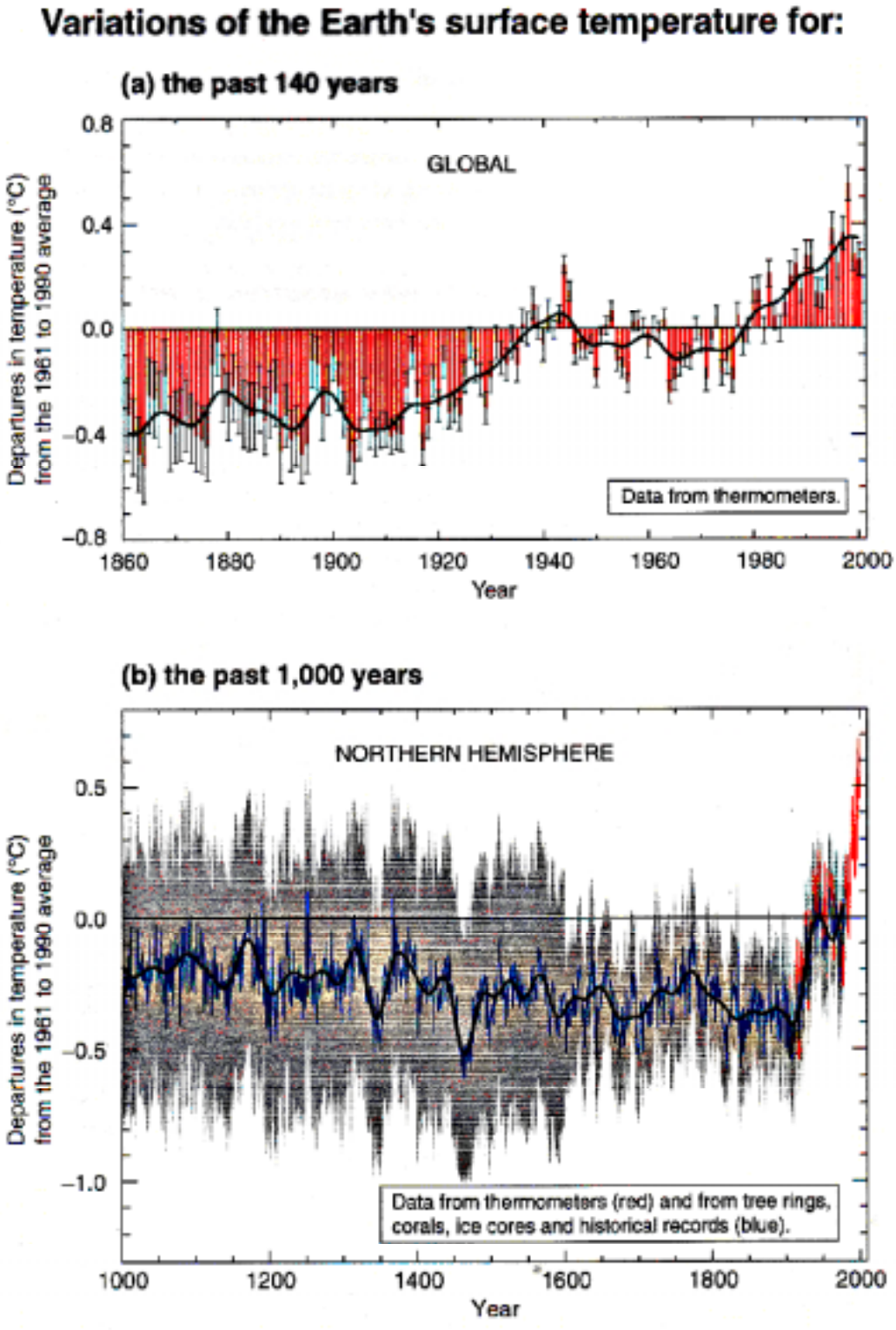
The Greenhouse Affect (From Kimball's Biology Pages at www.ultranet.com)

Other evidence of global warming includes:

- Careful monitoring of both ocean and land temperatures.
- Many glaciers and ice sheets are receding.
- Woody shrubs are now growing in areas of northern Alaska that 50 years ago were barren tundra.
- Many species of birds and butterflies are moving north and breeding earlier in the spring.

But throughout its history the earth has gone through many periods of climatic change (e.g., ice ages). Whether the present change is a result of human activities or of long-term changes over which we have no control is still uncertain. A developing consensus is that it is better to be safe than sorry, so we need to think of ways to either reduce emissions or sequester carbon.

This is what TecEco have done by mimicking nature and using carbon as a source molecule for our own built environment.



Temperature Changes – From A Report by Working Group 1 – Intergovernmental Panel on climate Change.