Accelerated Release of Carbon to the Atmosphere
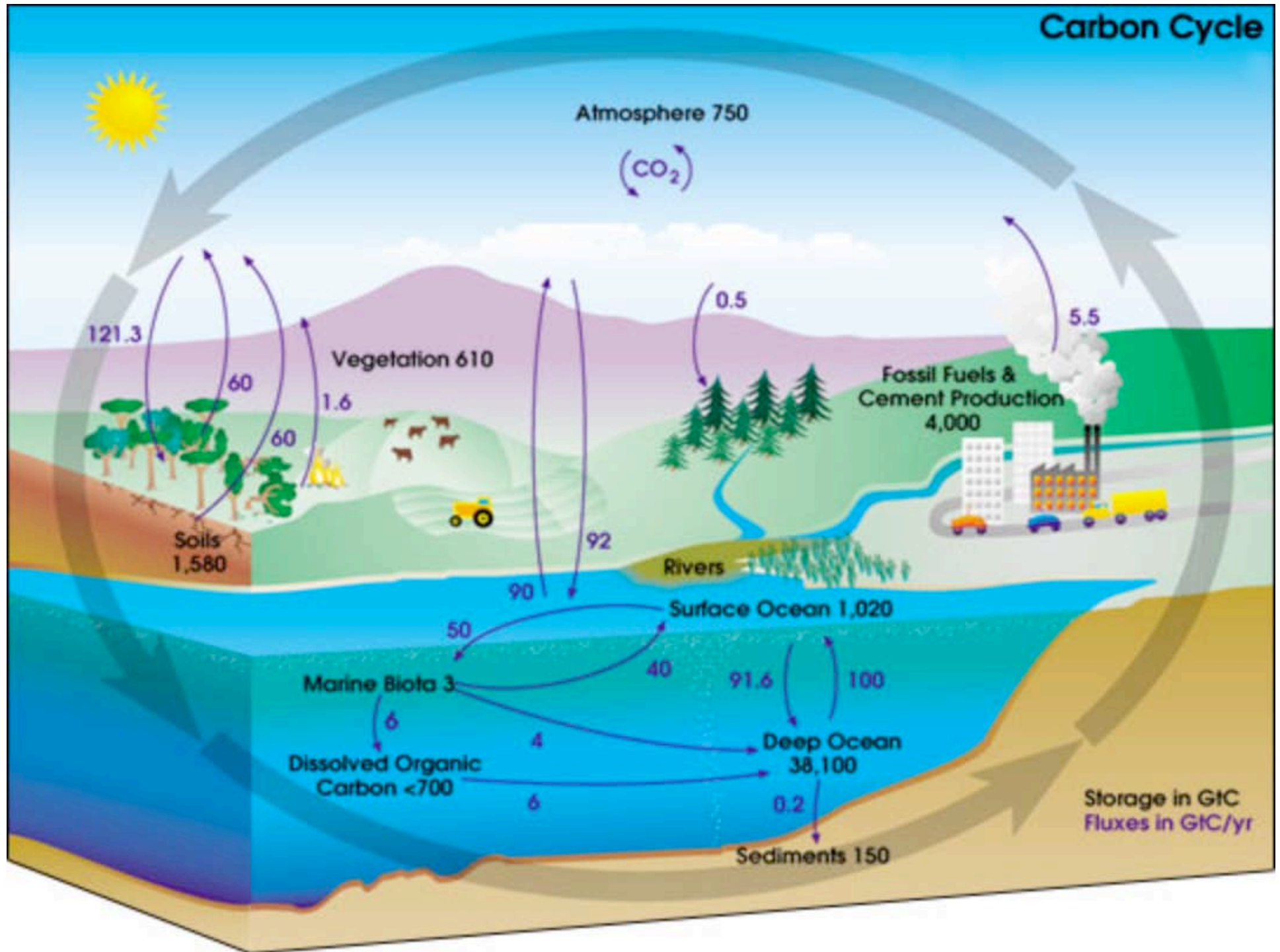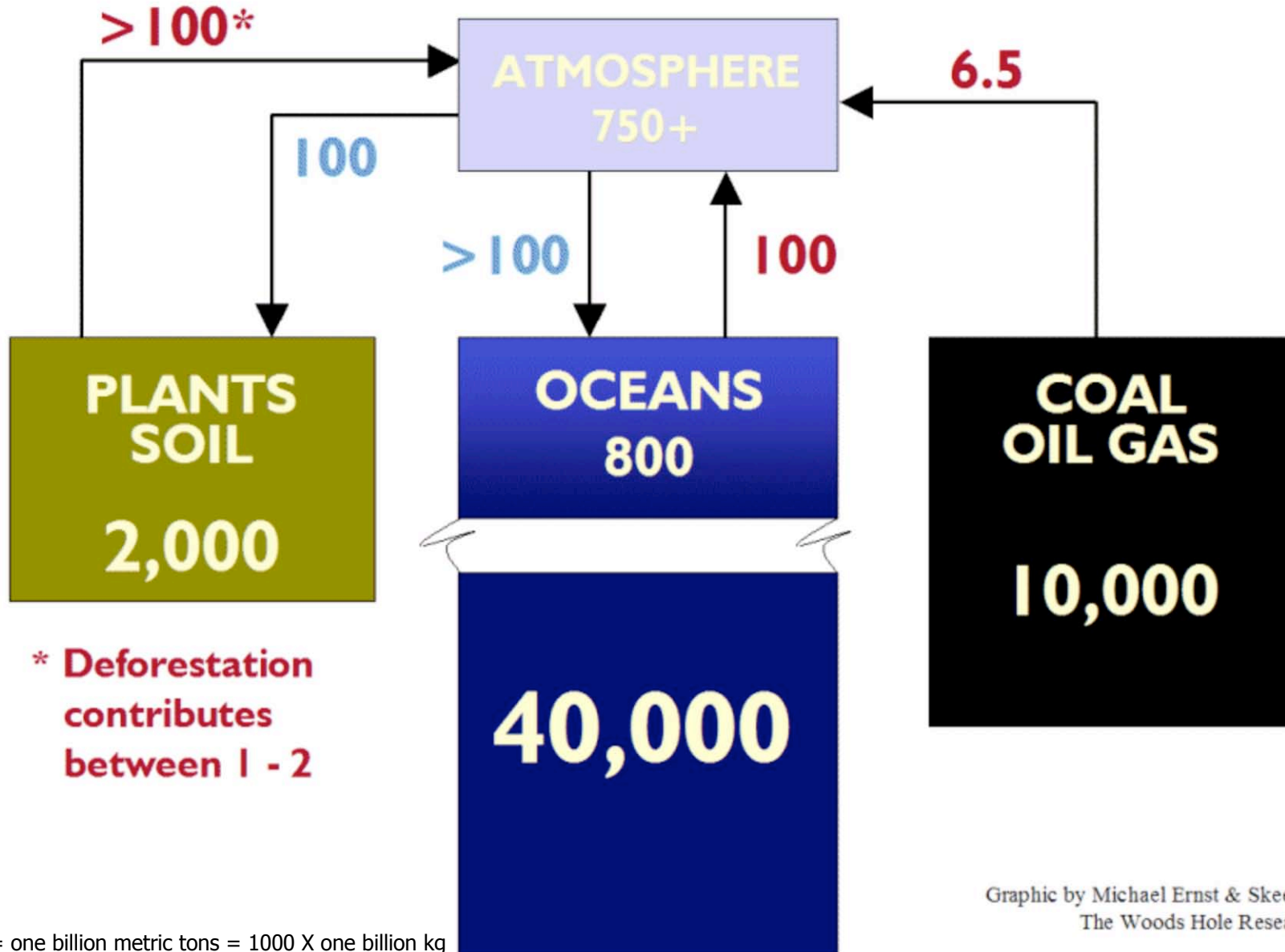
ARCSS Synthesis Retreat 2004
Lake Tahoe, CA
August 8-14, 2004

Carbon Cycle

Atmosphere 750

(CO_2)

121.3

60

60

Vegetation 610

1.6

0.5

Fossil Fuels & Cement Production 4,000

5.5

Soils 1,580

92

90

Rivers

Surface Ocean 1,020

50

40

91.6

100

Marine Biota 3

6

4

Deep Ocean 38,100

Dissolved Organic Carbon <700

6

0.2

Sediments 150

Storage in GtC
Fluxes in GtC/yr

Global Flows of Carbon
(Petagrams of Carbon/Year)

The Woods Hole Research Center

>100*

ATMOSPHERE 750+

6.5

100

>100   100

PLANTS SOIL 2,000

OCEANS 800

COAL OIL GAS 10,000

40,000

* Deforestation contributes between 1 - 2

Graphic by Michael Ernst & Skee Houghton
The Woods Hole Research Center

1 Pg = one billion metric tons = 1000 X one billion kg

Global Distribution of Atmospheric Carbon Dioxide

NOAA CMDL Carbon Cycle Greenhouse Gases
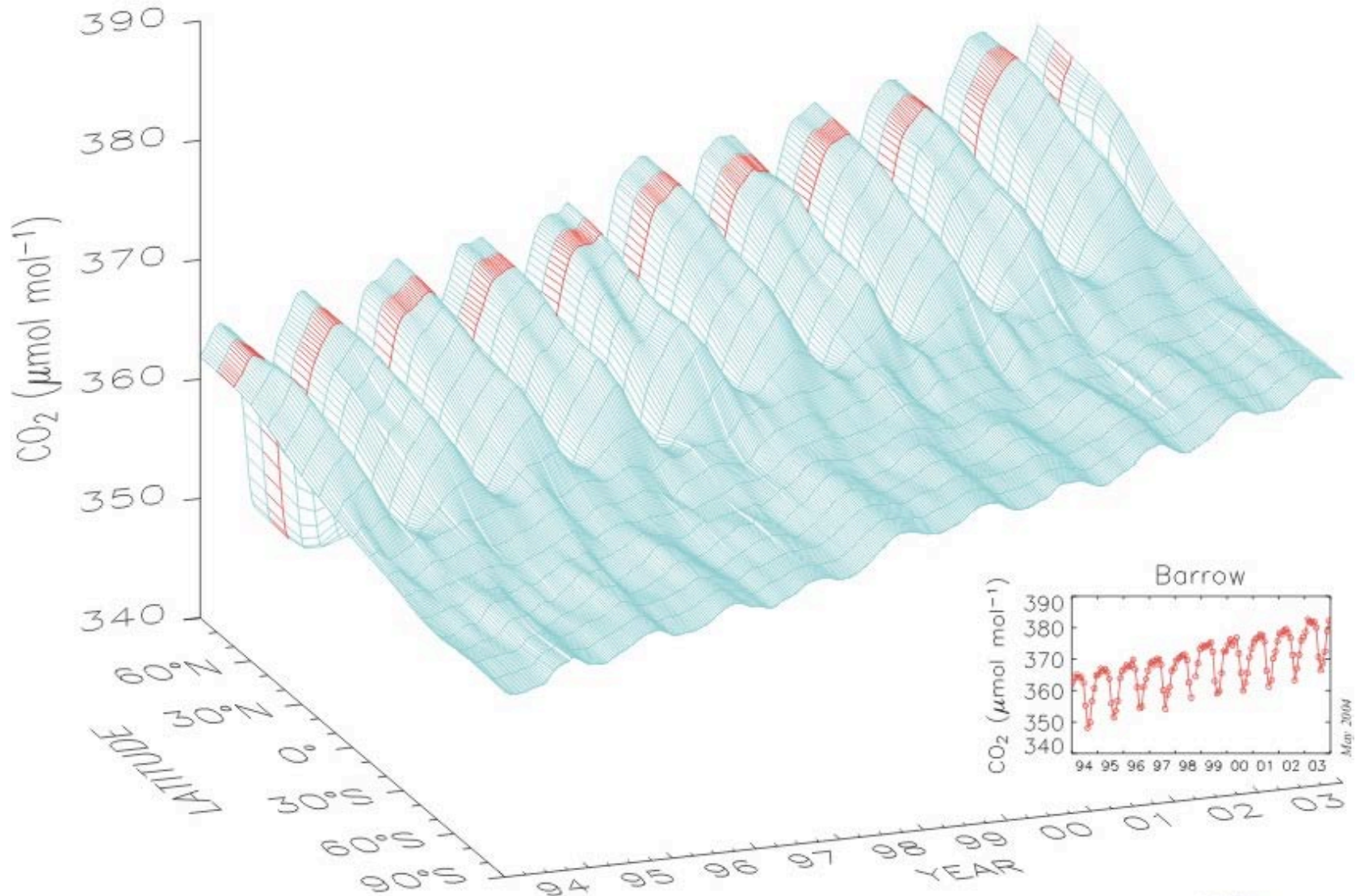
Three dimensional representation of the latitudinal distribution of atmospheric carbon dioxide in the marine boundary layer. Data from the NOAA CMDL cooperative air sampling network were used. The surface represents data smoothed in time and latitude. The contribution from the NOAA CMDL Barrow Observatory flask sampling effort is shown inset as flask monthly means. The 10 degree latitude zone in which Barrow resides is highlighted. Principal investigators: Pieter Tans and Thomas Conway, NOAA CMDL Carbon Cycle Greenhouse Gases, Boulder, Colorado, (303) 497-6678 (pieter.tans@noaa.gov, http://www.cmdl.noaa.gov/ccgg).
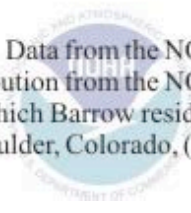
Arctic Carbon Pools

- 90-290 Pg: Upland boreal forest soils
- 120-460* Pg: Peatland soils
- 60-90 Pg: Arctic tundra soils
- Approximate Northern latitude totals:
  - 270-840 Pg C
- Roughly represents 20-60% of the global soil carbon pool

Schlesinger 1977; Post et al. 1982; Post *et al.* 1985; Oechel 1989; Gorham 1991; Chapin & Matthews 1992; Smith *et al.* 2004

How can the accelerated release of carbon to the atmosphere affect the Arctic system?

- Directly
  - Increase in atmospheric carbon
  - Decrease in the carbon pools

How can the accelerated release of carbon to the atmosphere affect the Arctic system?

- **Indirectly** (Changes in temperature, moisture)
  - Ecosystem structure
    - Permafrost (increased active layer depth)
    - Hydrology (wetting/drying)
    - Soil (organic content/quality)
    - Vegetation (changes/shifts)
    - Snow and ice
  - Ecosystem function
    - Net productivity (source/sink)
  - Timing
    - Extended "growing season"

Key Processes to Understand

- Ecosystem response to changes
  - Quick response to changes
  - Slow acclimation
- Soil carbon fluxes during the winter
  - Poorly understood, techniques problematic
- Landscape controls over carbon storage
  - Topography, fires, land use changes