Global Carbon Cycle: Fluxes and Reservoirs of Carbon

Atmosphere – Ocean CO$_2$ Fluxes
At Equilibrium:

Atmospheric CO$_2$(g) $\leftrightarrow$ Ocean CO$_2$(g) $\leftrightarrow$ Carbonic Acid + Bicarbonate + Carbonate

“Solubility Pump”
Biological Pump

Carbon Fixation: Inorganic C → Organic Matter

• CO₂ (g) is “drawn down” from the atmosphere to the ocean.
• Inorganic C fixed to organic matter, which sinks into the deep sea.

JGOFS (Joint Global Ocean Flux Study) Objectives

• To determine on a global scale the processes controlling the carbon fluxes between the atmosphere, ocean, and seafloor.
• To develop a capability to predict the global response of ocean biogeochemistry to man-made disturbances in climate.
Field Methods

Water bottle sampling

Sediment traps

Global Sinks for Anthropogenic CO₂

- Currently, ocean and terrestrial biosphere take up about 2 Gt each of approx. 7.5 GT released annually.
- Oceanic sink accounts for all of the CO₂ that has not accumulated in atmosphere since beginning of industrial period.
- Although terrestrial biosphere is a sink for CO₂ at present, it has historically been a source.


Global Climate Engineering – The “Geritol Fix”

Priming Biological Pump by Adding Fe to Southern Ocean

- Most interest focused on the Southern Ocean, where up to 40% of the fixed organic C sinks into the deep sea.
- However, primary production is limited by the availability of iron.
Quick Fix to Global Warming?

Report Nixes “Geritol” Fix for Global Warming
Iron Experiments in Equatorial Pacific

Iron Ex Results
Iron Additions in the Southern Ocean

SOIREE (Southern Ocean Iron Release Experiment) was conducted during February 1999.

SOIREE confirmed iron limitation; however, there was no evidence of enhanced carbon export to the deep sea.

Iron Additions in the Southern Ocean

SOFEX (Southern Ocean Iron Experiment) was conducted during February 2002.

SOFEX confirmed iron limitation, enhanced export of carbon to the deep sea, and importance of co limitation by Si.