

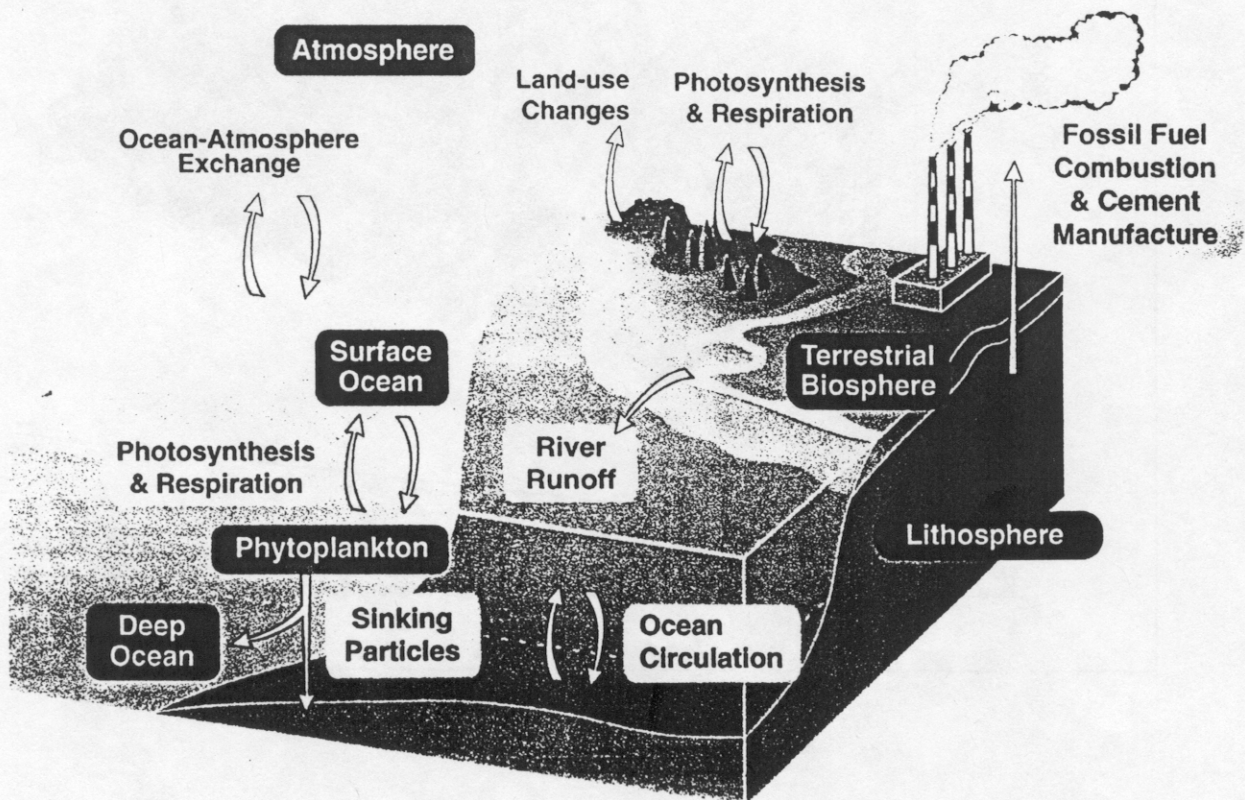
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ES10 The Global Carbon Cycle

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Topics

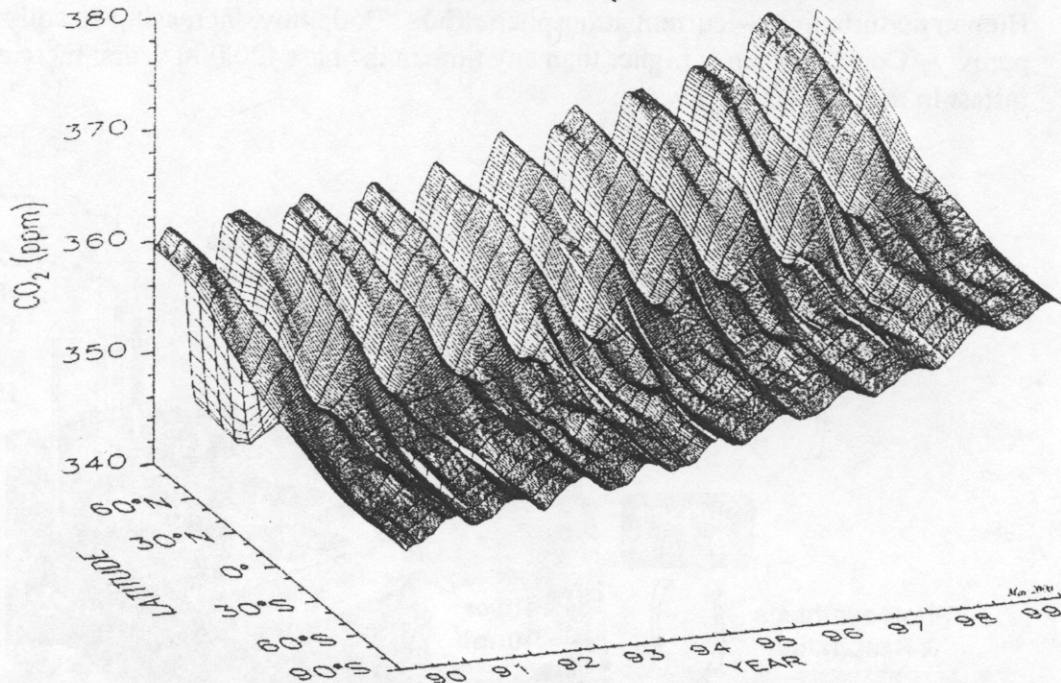
1. Inventory, fluxes, turnover times: the atmosphere is the smallest of all the carbon reservoirs. Turnover times of carbon in the other reservoirs provide information about the time scale at which the reservoir's CO₂ exchange dominates variations in the atmosphere.
2. Fast cycling (~1 year) – gas exchange with the surface oceans
 $CO_2 + H_2O \leftrightarrow H^+ + HCO_3^-$
 $CO_3^{2-} + H^+ \leftrightarrow HCO_3^-$
3. Short-term cycling (~10 years on land)
Photosynthesis: $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6 O_2$
Respiration: reverse
4. Long-term cycling (million years) - weathering and volcanic eruptions
 $CaCO_3 + CO_2 + H_2O \leftrightarrow Ca^{++} + 2HCO_3^-$
 $CaSiO_3 + 2CO_2 + H_2O \leftrightarrow Ca^{++} + 2HCO_3^- + SiO_2$
5. Medium-term cycling: Organic matter that escapes decay is transformed by pressure and temperature into coal, oil and gas. Coal is found in paleo-swampy environments. The Persian Gulf oil and gas reservoirs were formed from marine plants and animals in the Cretaceous-Cenozoic. Tectonic uplift exposes buried coal, oil and gas, which then oxidizes.
6. Natural variations in the global carbon cycle are tied to variations in climate – e.g. CO₂ varied between 180 ppmv and 280 ppmv between glacial and interglacial periods of the last 420,000 years.
7. Human perturbations – current atmospheric CO₂ >350ppmv, increasing steadily at 1.5 ppmv/y. Concentration is higher than any time in the past 420,000 years; increase rate is also fastest in the past 420,000 years.



Carbon Reservoir	Inventory (PgC)	Annual Fluxes into and out of reservoir (PgC/yr)	Turnover time (years)
Atmosphere	720		
Ocean	38,400	+/- 90	700
Total Inorganic C	37,400		
Surface Layer		670	
Deep Ocean		36,730	
Total Organic C	1,000		
Aquatic Biosphere		1-2	+/- 50
			<0.04
Land Biosphere	2,000	+/- 60	35
Live biomass	800		15
Dead biomass	1,200		20
Lithosphere	>75,000,000	+/- 0.1 - 0.2	>400 million
Sedimentary carbonates	>60,000,000		
Kerogens	15,000,000		
Fossil Fuels	4,130	-5 - 10	

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. Principal investigators: Pieter Tans and Thomas Conway, NOAA CMDL Carbon Cycle Greenhouse Gases, Boulder, Colorado, (303) 497-6678. ptans@cmdl.noaa.gov

