Earth2Class Workshops for Teachers

Foundation of the Carbon Cycle Science: What we know and don't !

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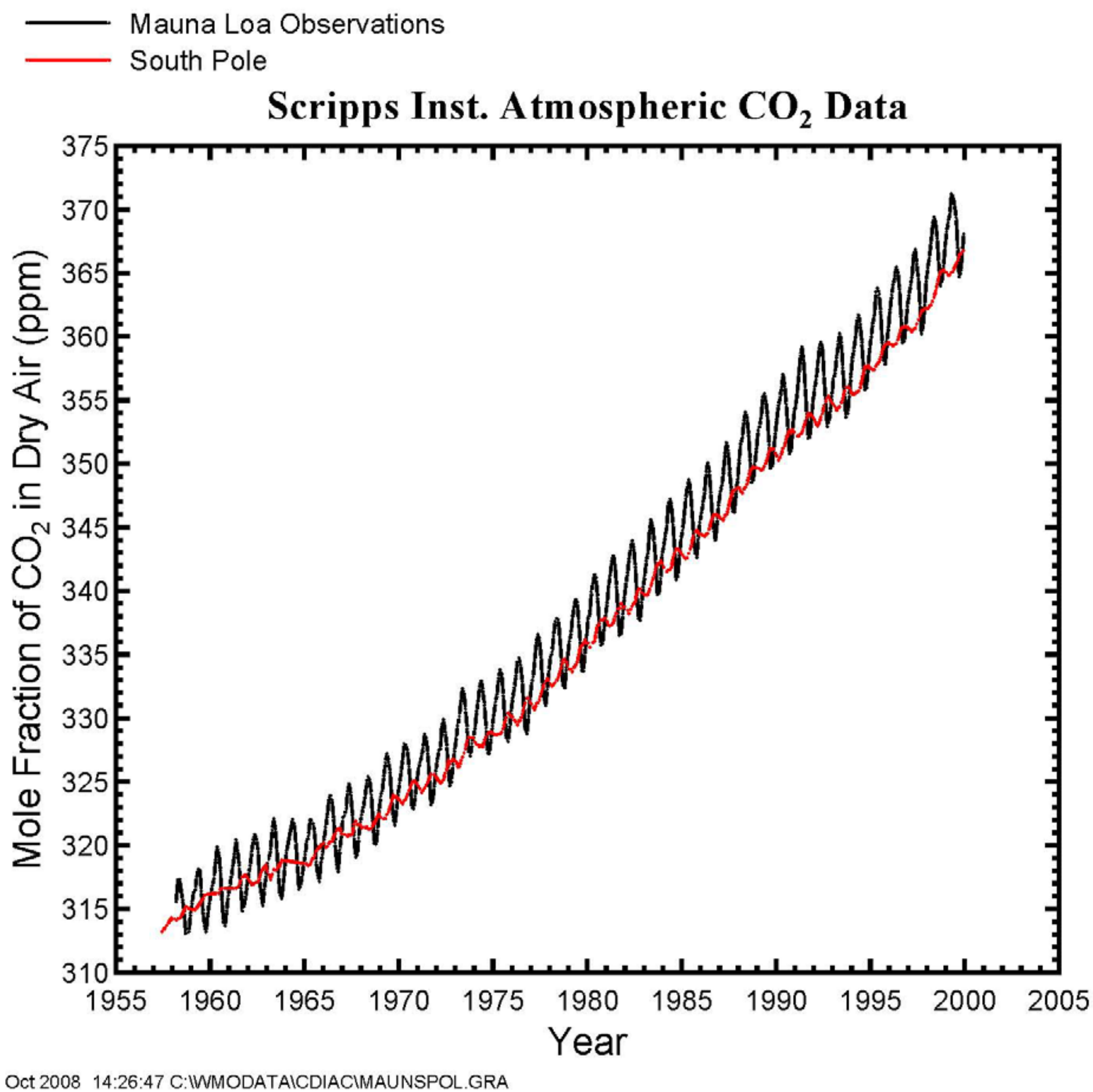
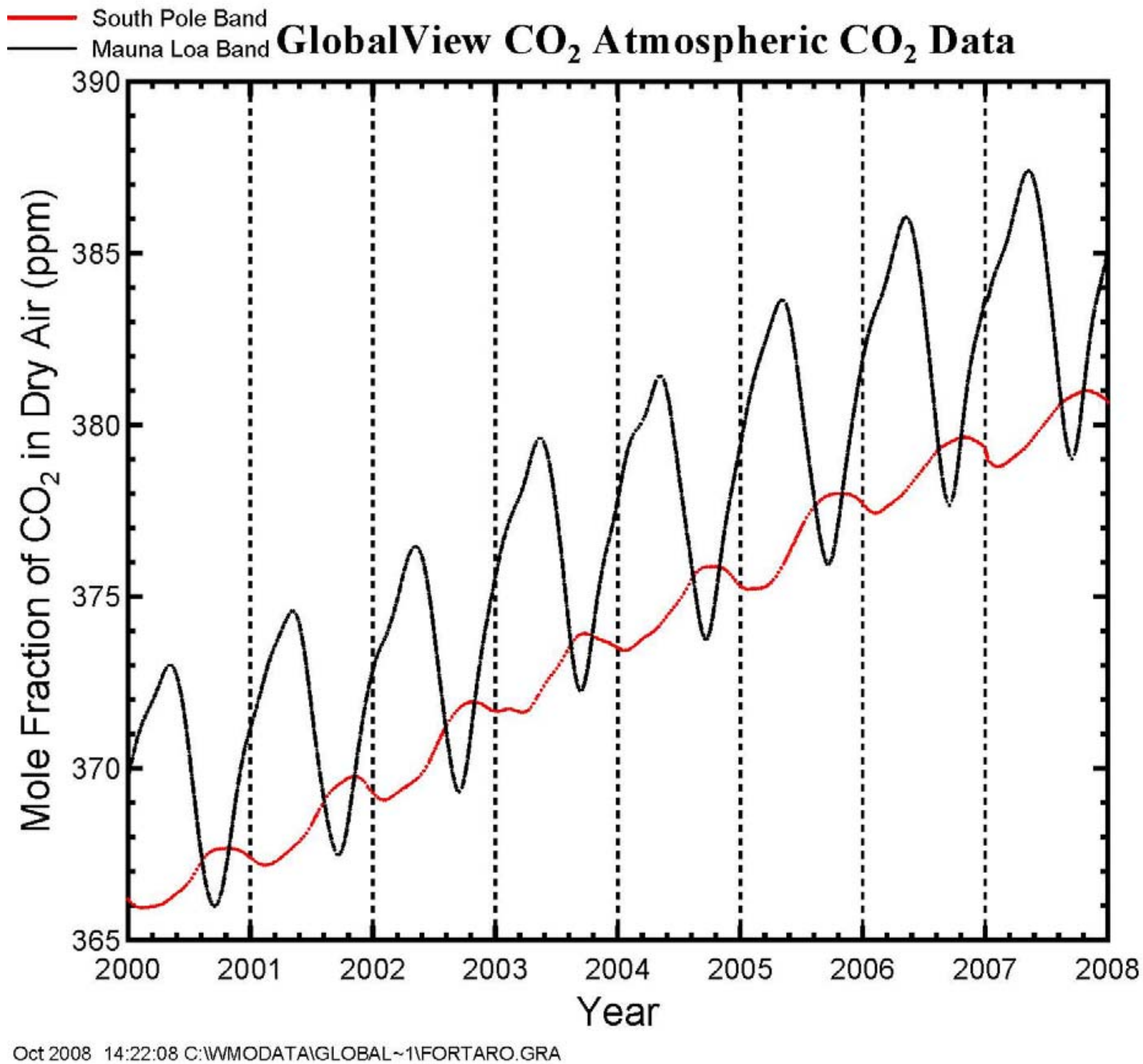
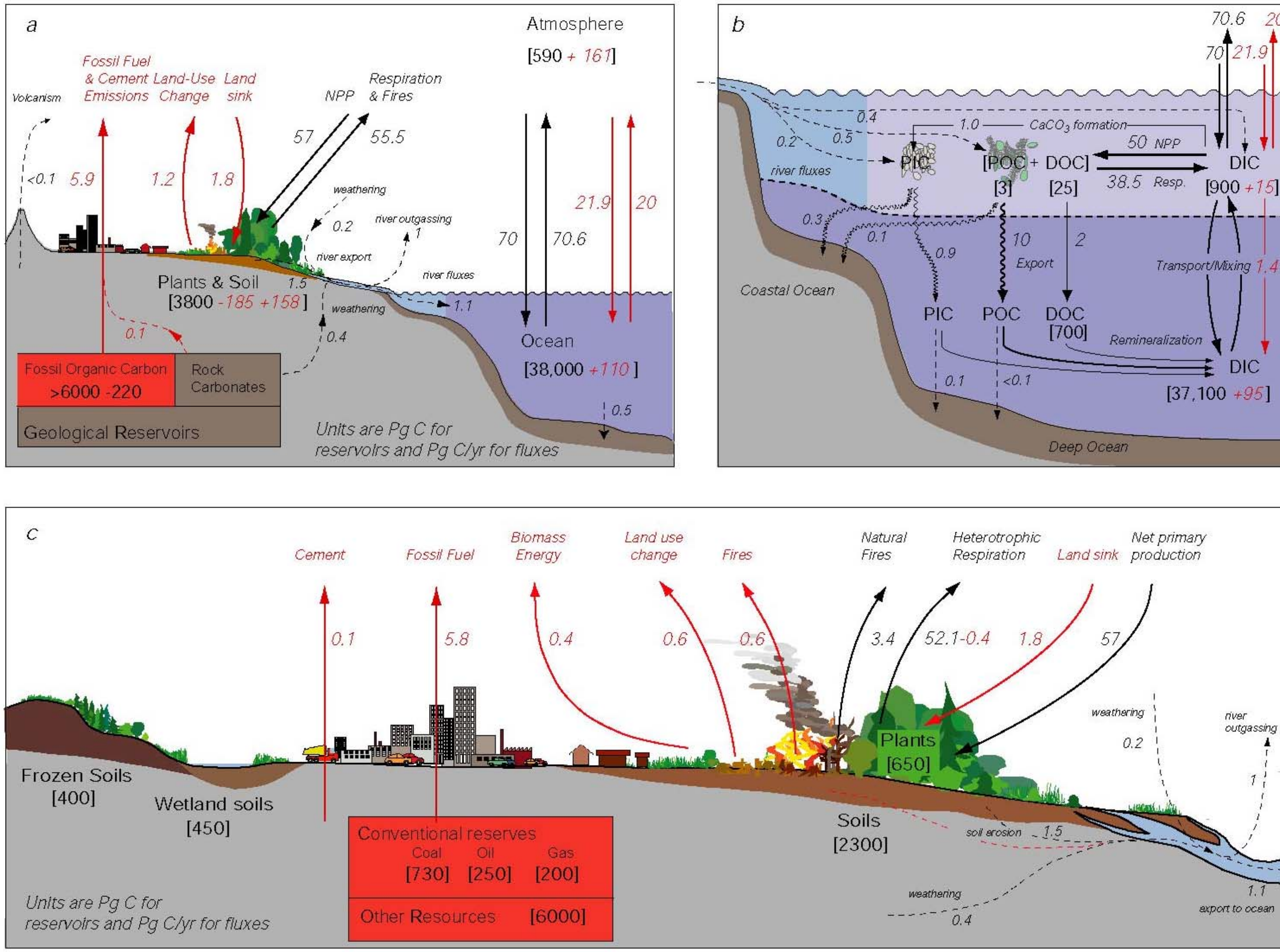
Air CO2 at Mauna Loa and South Pole, 1957-2000



Air CO2 at Mauna Loa and South Pole, 2000-2008



Global Carbon Cycle



CO2 Concentrations in Deep Oceans

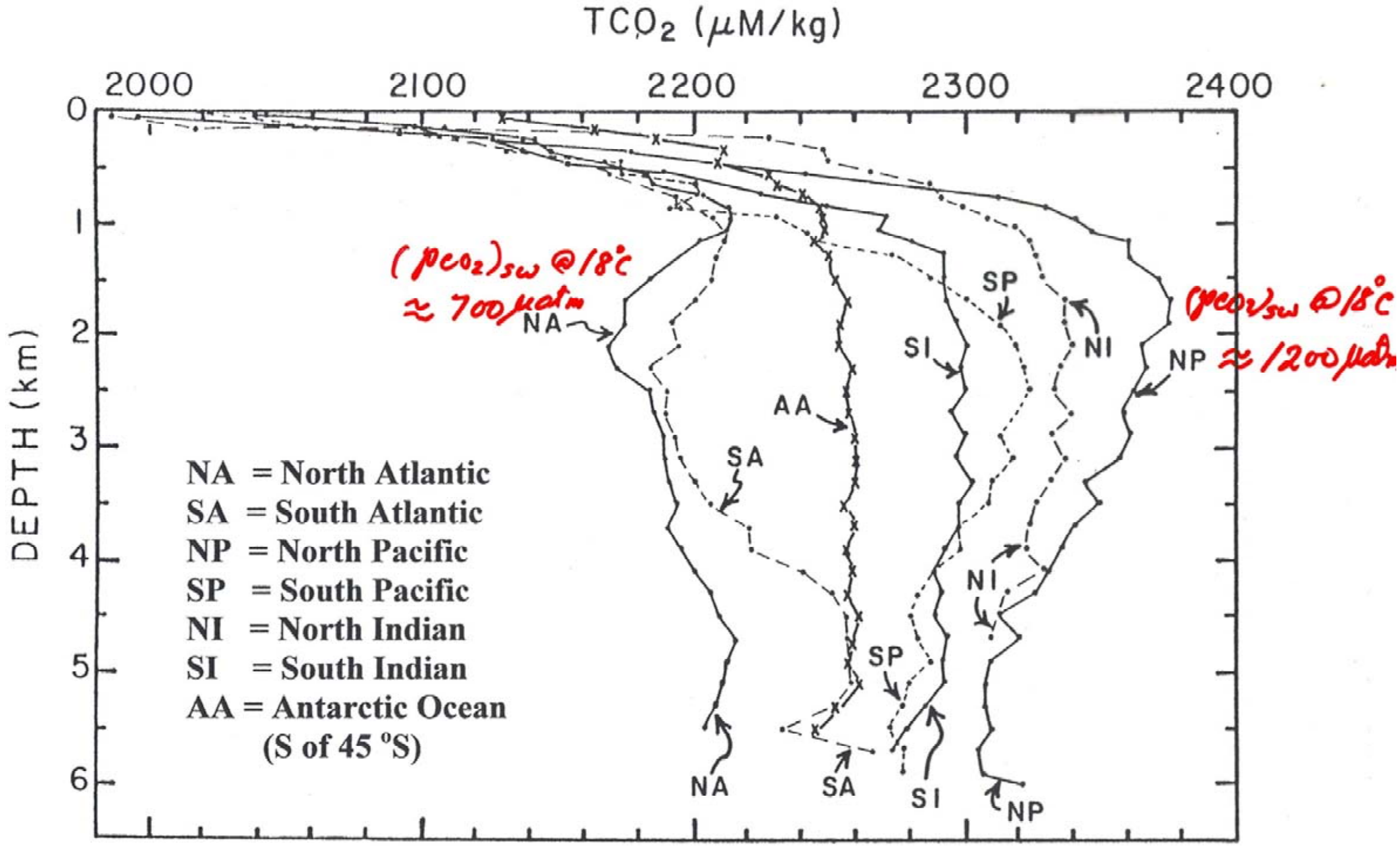
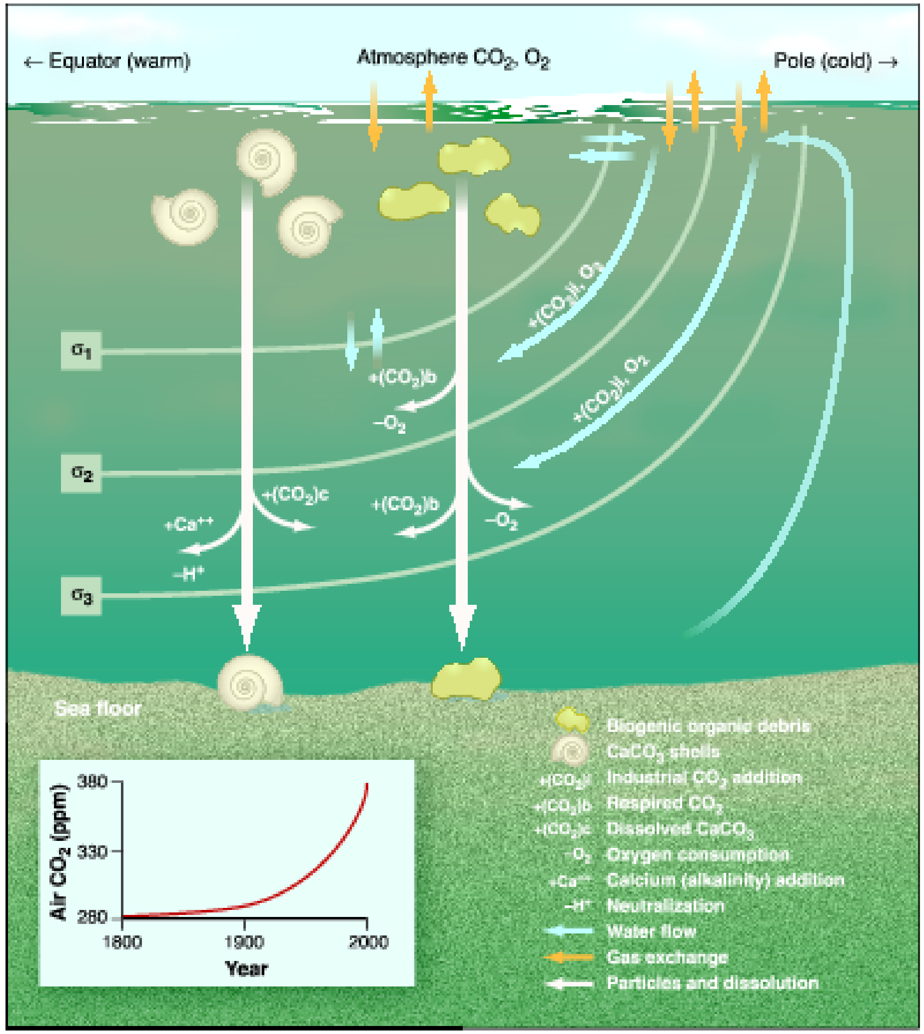


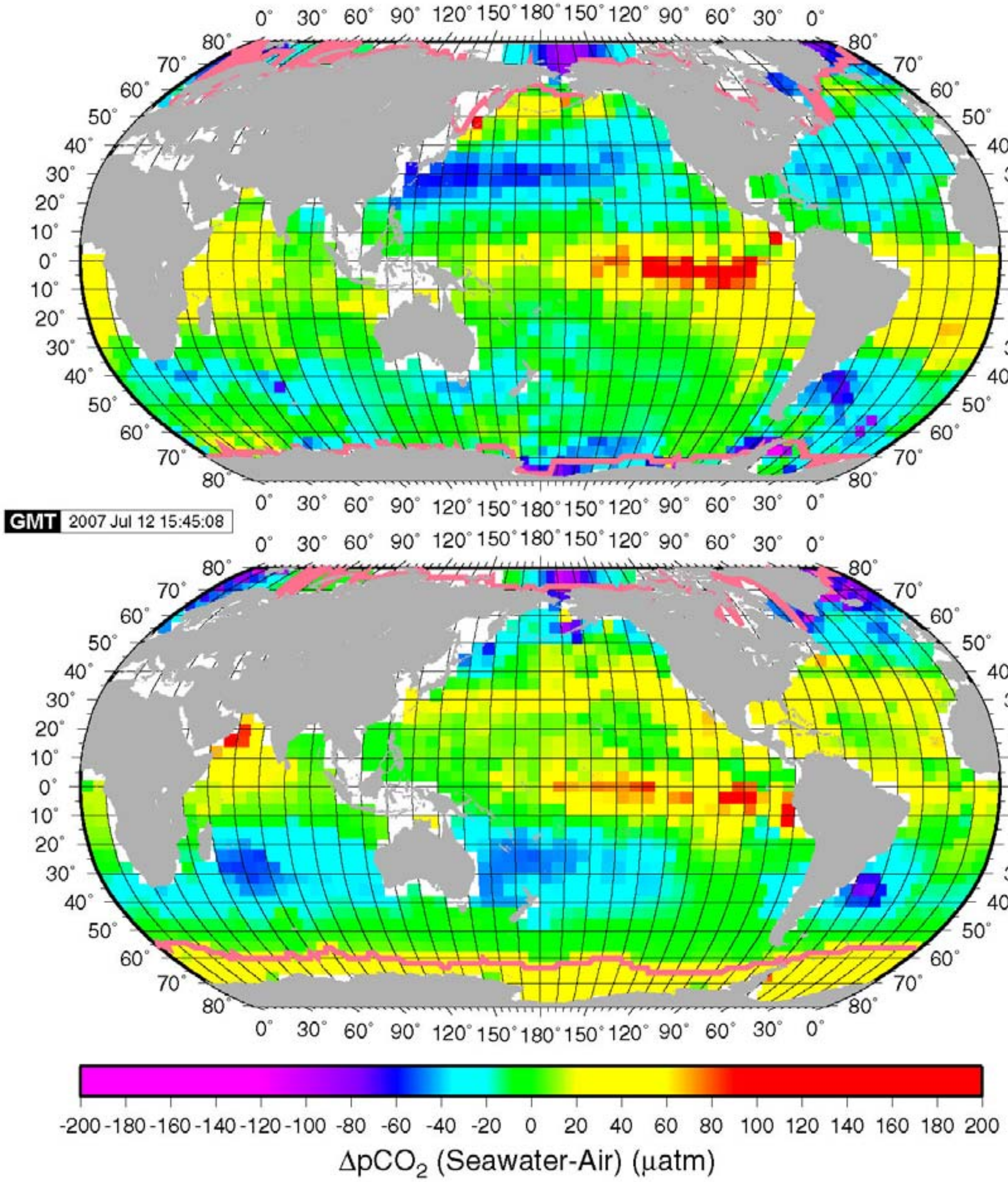
Figure 2: The mean vertical distribution of (a) the alkalinity and (b) the total CO_2 concentration in the seven regions of the world oceans. NA = North Atlantic, SA = South Atlantic, NP = North Pacific, SP = South Pacific, NI = North Indian, SI = South Indian, and AA = Antarctic

CO2 Cycle in the Oceans



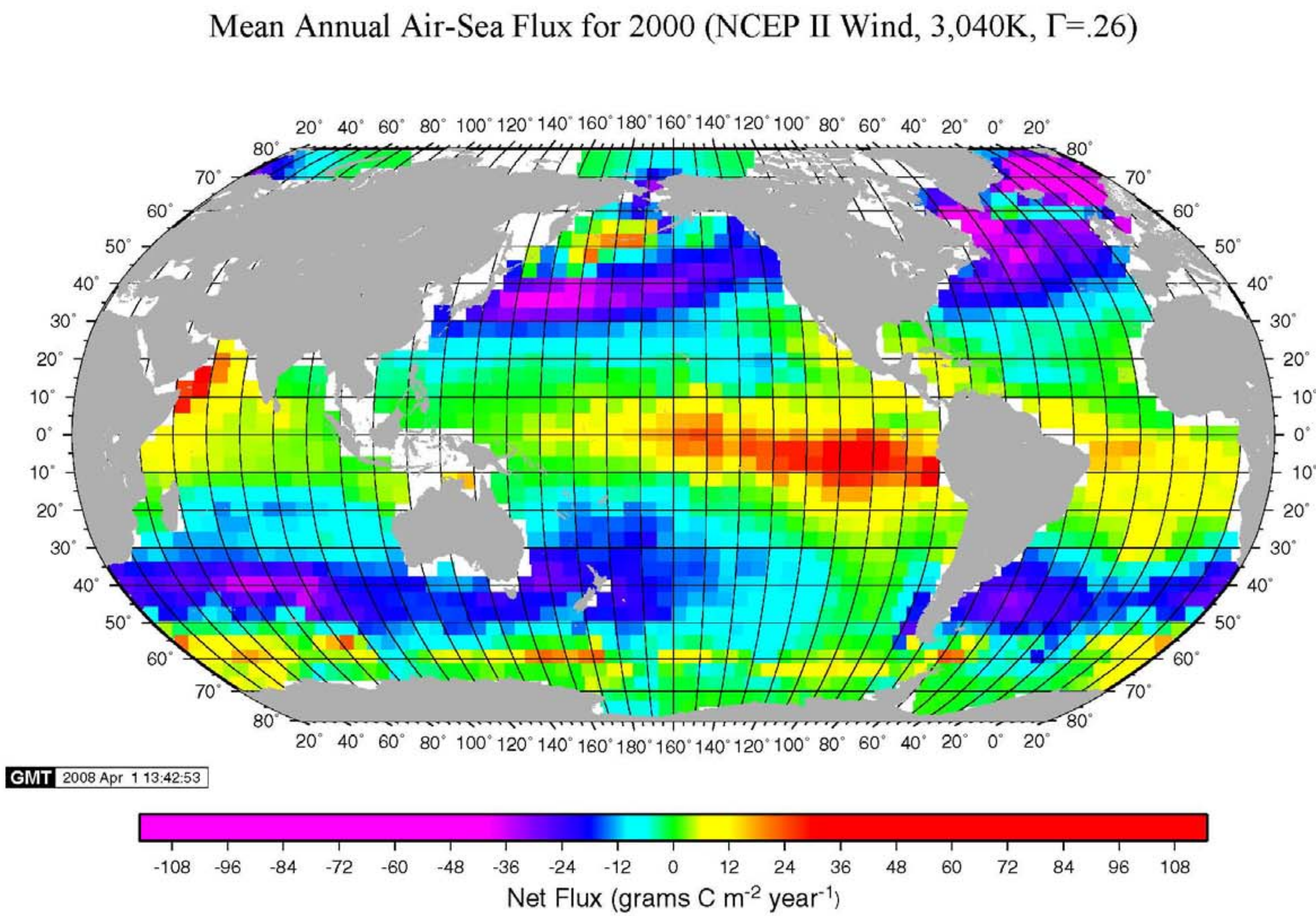
Takahashi (Science, 2004)

CLIMATOLOGICAL MEAN SEA-AIR pCO_2 DIFFERENCES



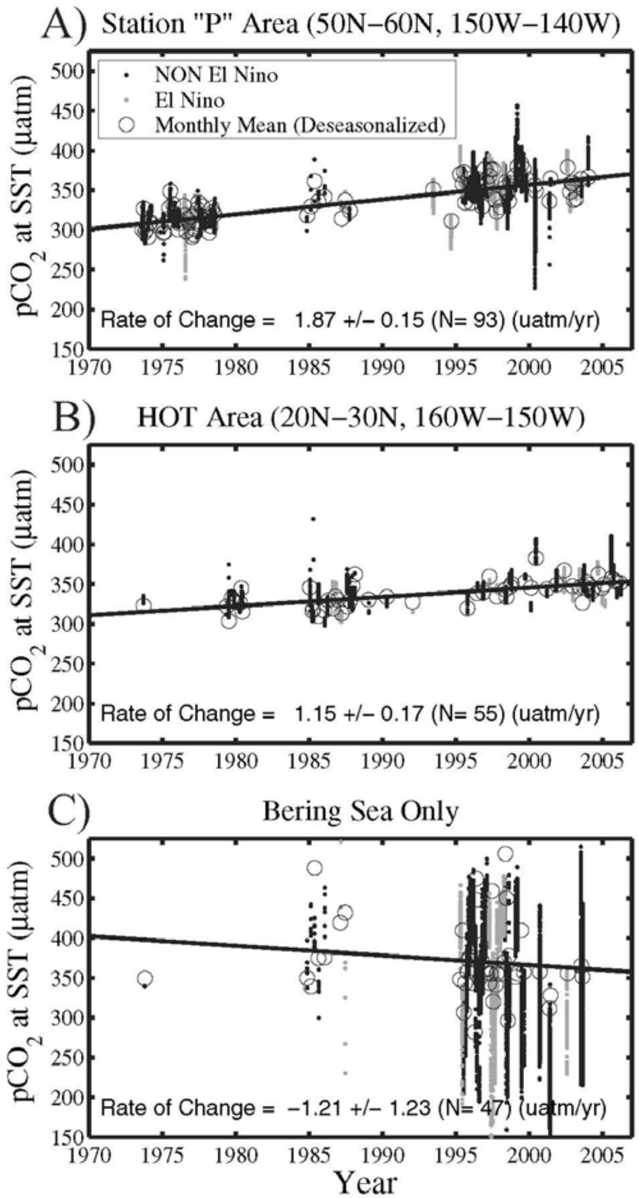
FEBRUARY, 2000

AUGUST, 2000



Takahashi et al. (Deep Sea Res., 2008)

Change in pCO2 of Surface Ocean Water in the Pacific Ocean



Takahashi et al.
(DSR, 2008)

ATMOSPHERIC CO2 – MARINE PHOTOSYNTHESIS - CALCIFIERS

$$CaCO_3 + CO_2 + H_2O = Ca^{++} + 2\,HCO_3^-$$

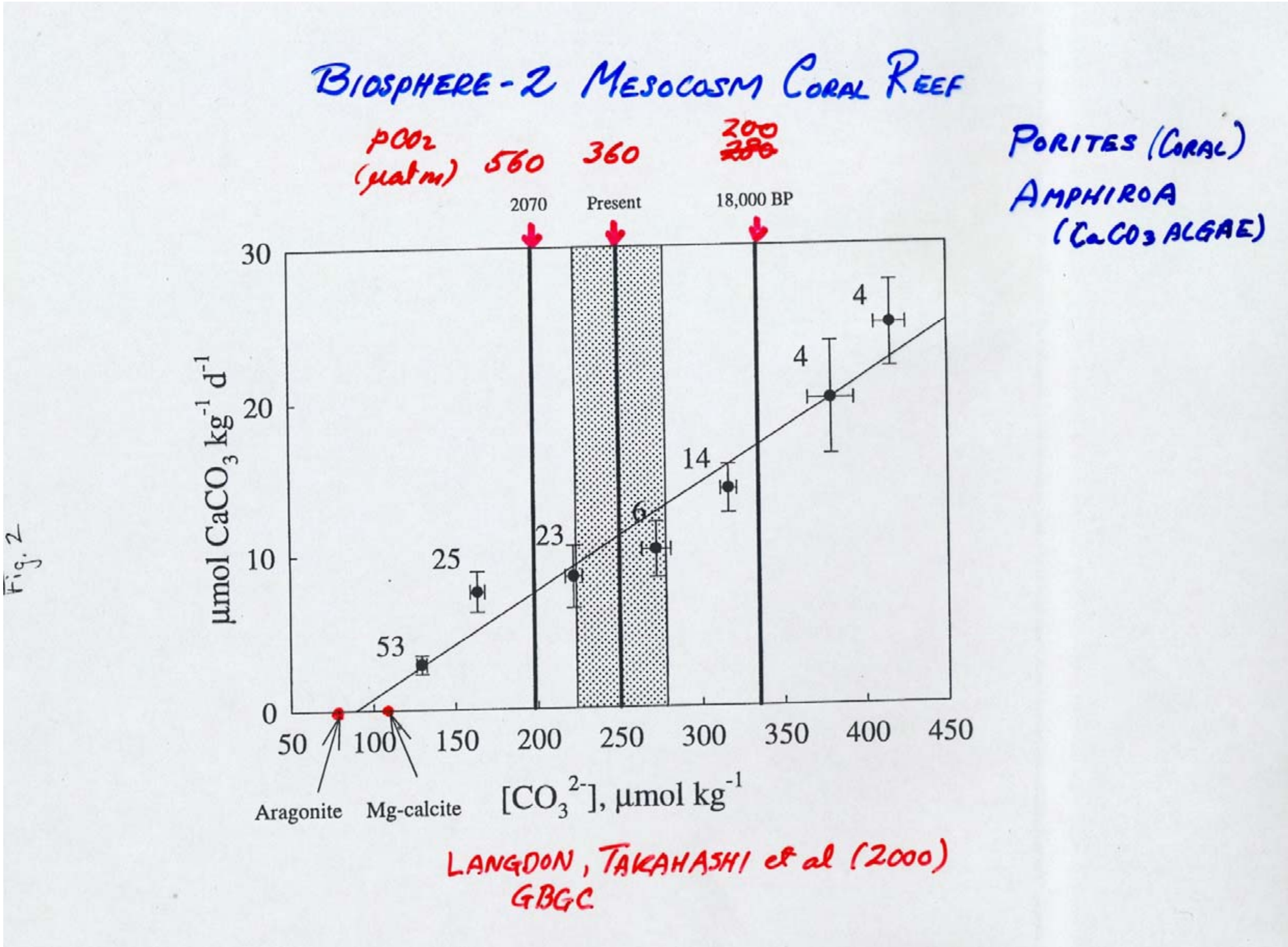
SHELLS FORAMINIFERA COCCOLITHS CORALS	AIR/SEA	OCEAN	DISSOLVED

Increase in atmospheric CO_2 causes dissolution of $CaCO_3$. (The reaction goes to right)

Increase in the photosynthetic utilization of CO_2 encourages The growth of $CaCO_3$. (The reaction goes to left.)

Precipitation of $CaCO_3$ causes seawater to lose CO_2 to air. (The reaction goes to left.)

pCO2 and Coral Growth Rate



Volume of Liquid CO_2 Emissions and Sequestration Capacity

Global CO_2 Emissions	~ 6 Gigatons-C/yr

(1 Gigaton = 1 billion tons = 10^{15} grams)

Volume as liquid CO_2 ~ 30 ft x 50 miles x 50 miles

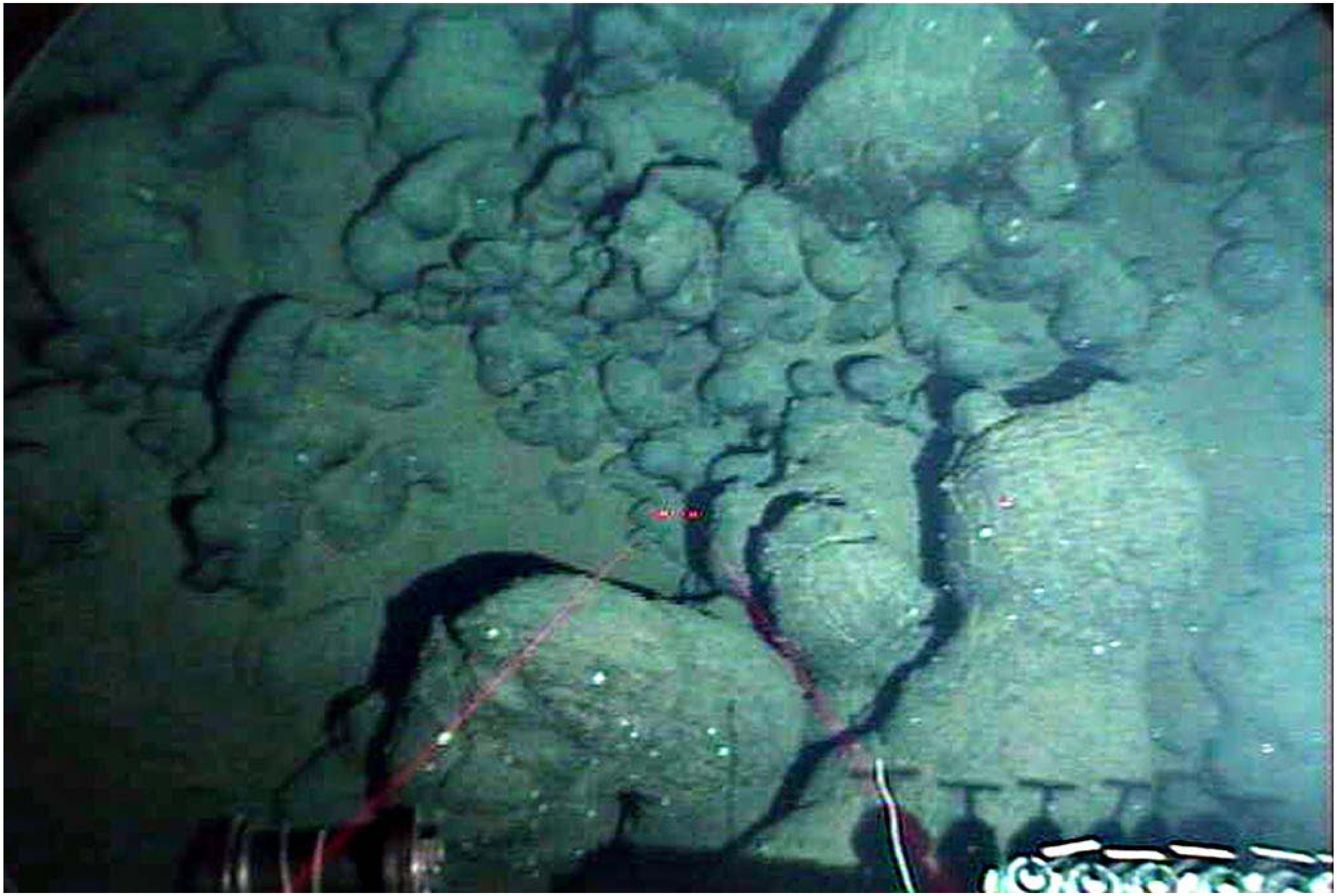
U. S. Emissions	~1.3 Gigatons-C/yr

Volume as liquid CO_2 ~ 30 ft x 10 miles x 10 miles

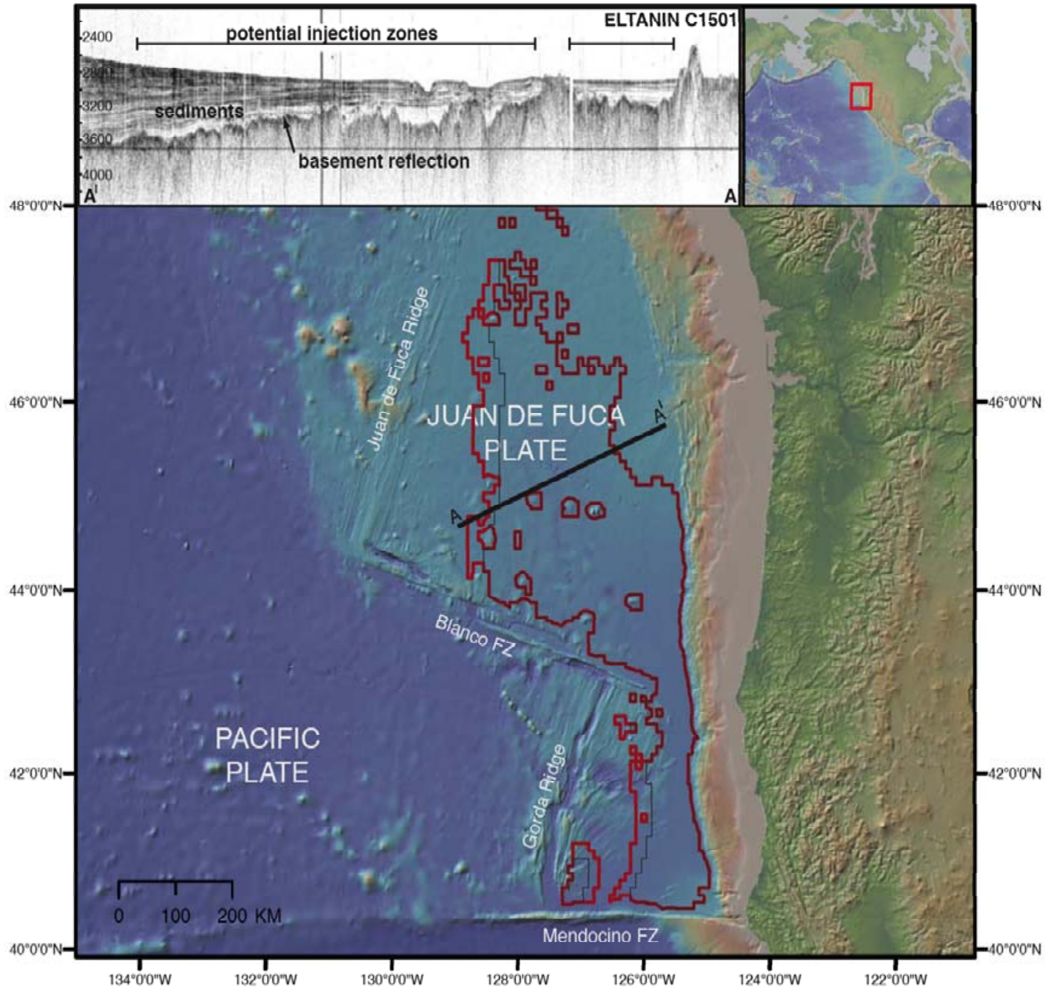
(3600 x Giant Stadium)

Depleted gas reservoirs	0.5 – 170 Gigaton-C
"Depleted" oil reservoirs	3 – 80 Gigatons-C
Land aquifers	50 – 14,000 Gigatons-C
Juan de Fuca Ridge	250 Gigaton-C
Deep ocean rocks	Very large ?

Sea Floor Basalt at the Juan de Fuca Ridge (Water Depth ~2700 meters)



Juan de Fuca Ridge Area for CO2 Sequestration



Map of Juan de Fuca region. Red outline shows region where water depths are ≥ 2700 m and sediment thickness is ≥ 200 m, covering an area of 101,009 km^2. Black outline shows decrease in area by considering ≥ 300 m of sediment, for a total area of 88,341 km^2. The region excludes seamounts with >100 m of topographic relief and is restricted to 10 km from the surrounding plate boundaries and the base of the continental shelf. Heavy black line shows location of a single-channel seismic profile through the potential injection zone (Eltanin C1501, inset).

Goldberg, Takahashi & Slagle (2008) Proc. National Academy of Sciences