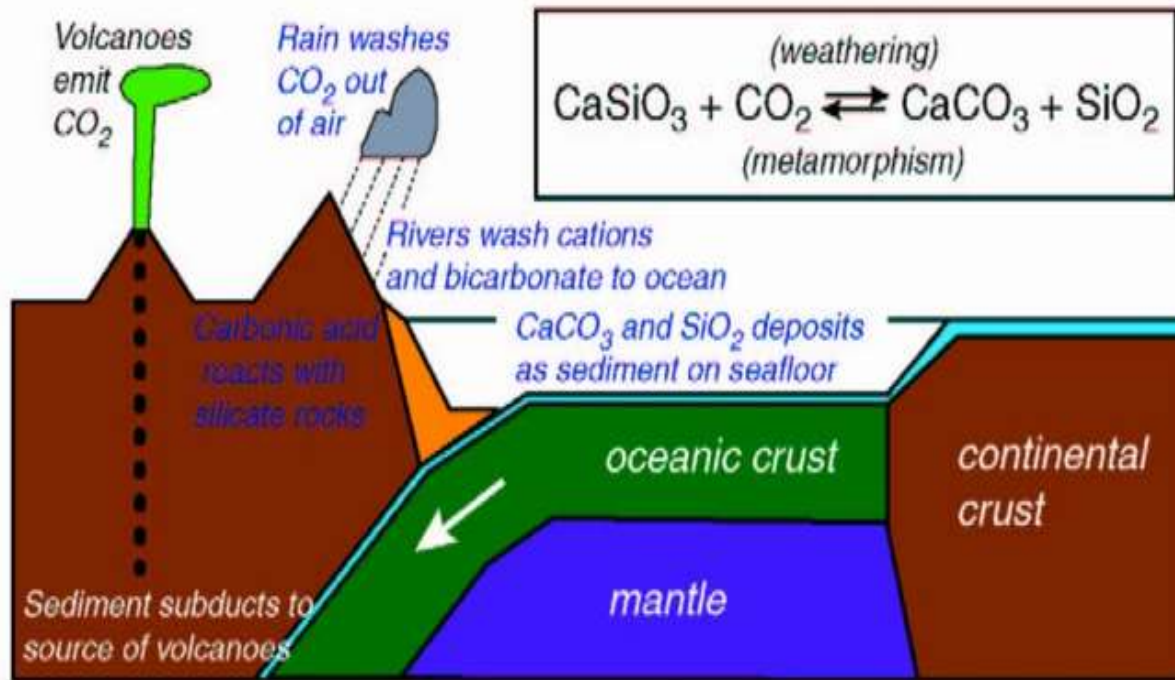


Hoffman and Schrag, 1999

## THE CARBON CYCLE



[Processes lettered in blue are absent in a snowball Earth]

Timescale:

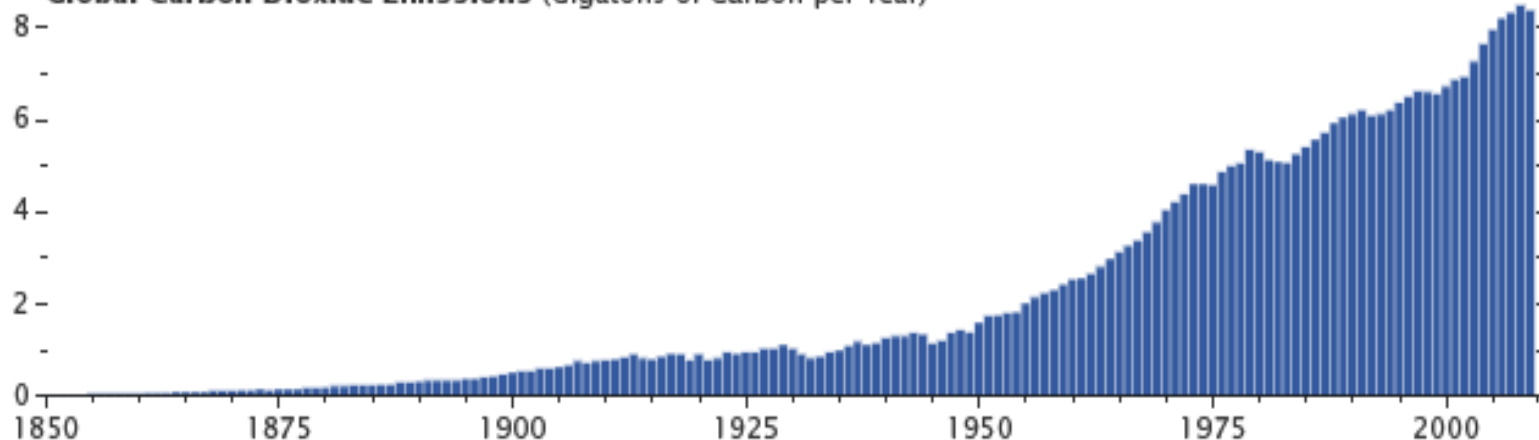
~100's Kyr

Geologic Carbon Cycle:  $10^{13}$ - $10^{14}$  gC/yr

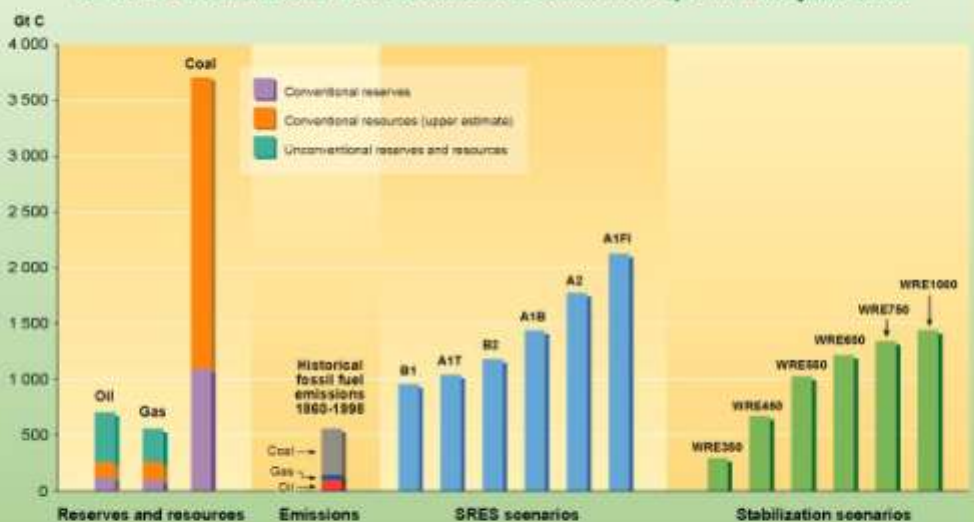
Anthropogenic Emissions:  $10^{15}$  gC/yr

Fast Carbon Cycle:  $10^{16}$ - $10^{17}$  gC/yr

## Global Carbon Dioxide Emissions (Gigatons of Carbon per Year)



## Carbon in fossil fuel reserves and resources compared with historical fossil fuel carbon emissions, and with cumulative carbon emissions from a range of SRES scenario and TAR stabilization scenarios up until the year 2100



SYR - FIGURE 7-5

Emissions of carbon dioxide by humanity (primarily from the burning of fossil fuels, with a contribution from cement production) have been growing steadily since the onset of the industrial revolution. About half of these emissions are removed by the fast carbon cycle each year, the rest remain in the atmosphere. (Graph by Robert Simmon, using data from the Carbon Dioxide Information Analysis Center and Global Carbon Project.)

## Changes Since Pre-Industrial Era

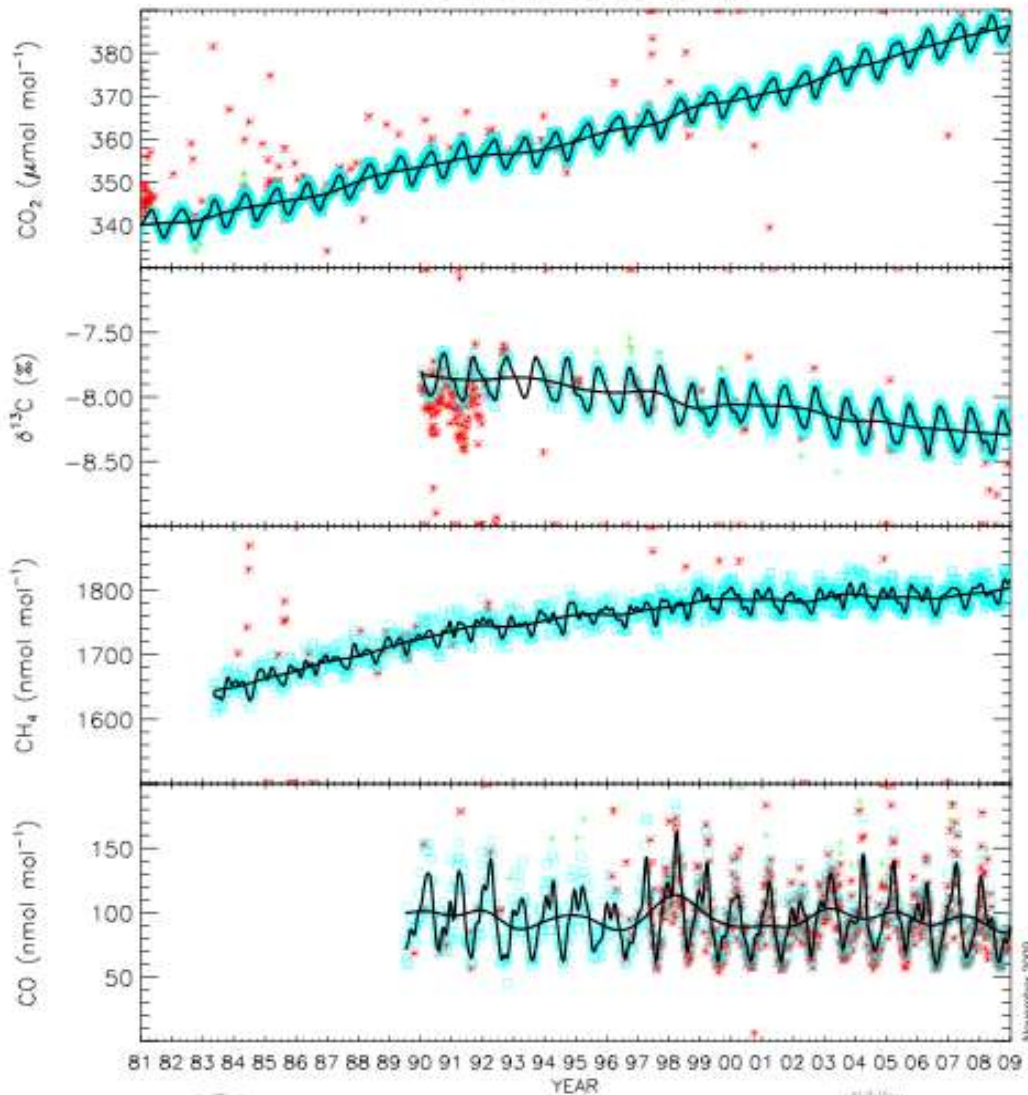
CO<sub>2</sub>: 280ppm to 387ppm  
(not seen for 2 My!)

CH<sub>4</sub>: 715 ppb to 1800 ppb  
(highest in 650Kyr!)

### Climate Feedbacks

Permafrost is thought to contain ~1,700 Pg of Carbon.  
If only 10% thaws,  
another 1.3° F increase  
could result

### Mauna Loa, Hawaii NOAA ESRL Carbon Cycle



Time series showing atmospheric carbon dioxide, the carbon-13/carbon-12 isotopic ratio of carbon dioxide, methane and carbon monoxide from air collected weekly in glass containers. The isotope measurements are made at the University of Colorado INSTAAR, all others are made at NOAA. Samples that are regionally representative (square), influenced by local effects (plus), and rejected because of sample collection or analytical problems (asterisk) are shown. A smooth curve and long-term trend are fitted to the representative measurements (square). Contact: Dr. Pieter Tans, NOAA ESRL Carbon Cycle, (303) 497-6678, pieter.tans@noaa.gov, <http://www.esrl.noaa.gov/gmd/ccgg/>.

## Φιναλ Ρεμαρκσ

- Inversion results must be interpreted with care, some useful diagnostics were shown.
- Information about high-latitude sources and variability is possible to retrieve with the current network/assimilation system. Tropics are still under-observed and not-well resolved by assimilation scheme.
- Boreal Eurasia appears to be the main origin of elevated growth in 2007 with a smaller contribution from Boreal N. America.
- Coming soon: CarbonTracker-CH<sub>4</sub> web site.

## 2001 Emissions: 526Tg/yr (Current Inversion Priors)

Coal	30	(TgCH <sub>4</sub> /yr)	
Oil/Gas	50		
Enteric Fermentation/Manure	100		
Rice	59		
<b>Biomass Burning</b>	<b>32</b>		
Waste	74		
<b>Wetlands</b>	<b>174</b>		
Wild Animals		5	
Termites	19		
Soil	-38		
Oceans	17		
Photochemical Loss (mostly reaction w/ OH)		$\tau \sim 10$ yrs	$\sim 500$
Tg/yr			