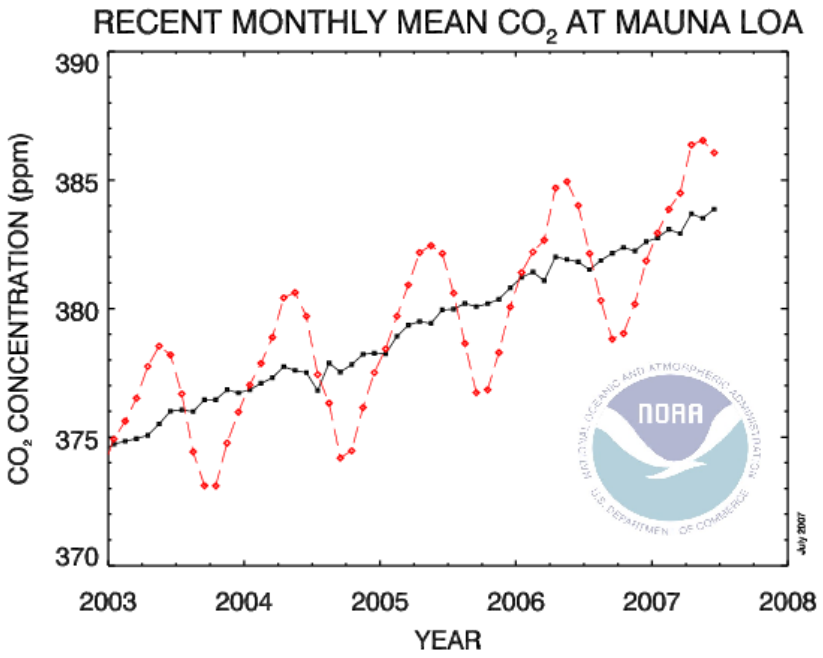
Musings on Carbon Dioxide

Carbon dioxide is 0.00038 or 0.038%% of our atmosphere by volume. Only 2.75% of atmospheric CO2 is anthropogenic in origin. The amount we emit is said to be up from 1% a decade ago. Despite that increase, our annual contribution each year is just 0.00001 or 0.001%% of our atmosphere by volume. If the atmosphere was a 100 story building, our anthropogenic CO2 contribution today would be equivalent to the linoleum on the first floor.

Despite the increase in emissions, the rate of change of atmospheric carbon dioxide at Mauna Loa remains the same as the long term average (+0.45%/year).



This may because the sinks (primarily the oceans) are readily able to absorb excess atmospheric CO2. Some believe the IPCC and their models greatly underestimate the buffer capacity of the oceans (said to be infinite – Segalstad). According to his estimates, burning all the fossil fuels could only increase CO2 by 20%. It could never double.

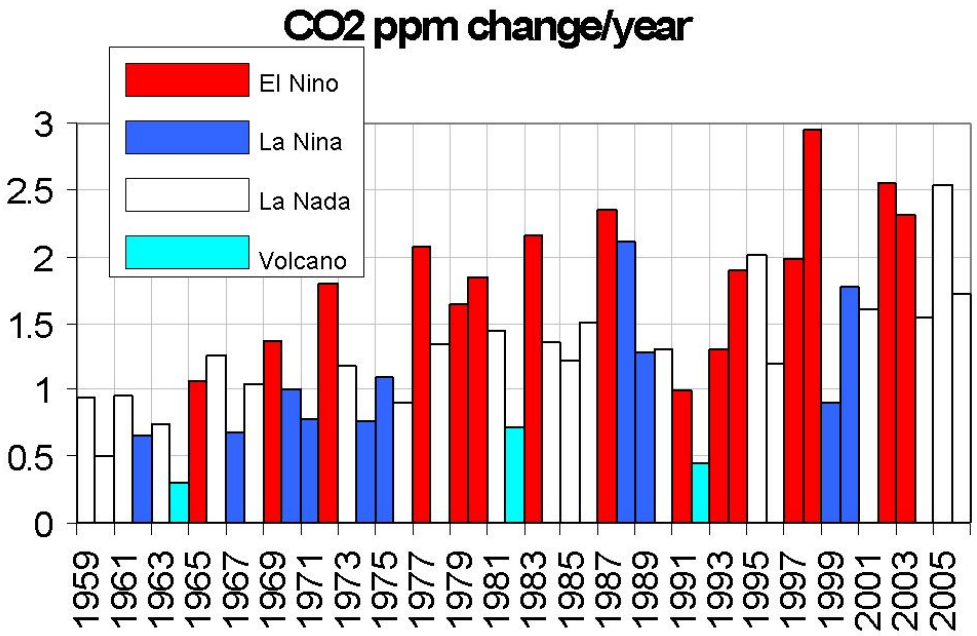
A meteorologist friend, Peter Leavitt, pointed out that the rate of change year to year varies quite a bit even though the average rate doesn't show much change.

year	ppm/yr
1959	0.94
1960	0.50
1961	0.96
1962	0.65
1963	0.74

1964	0.30
1965	1.07
1966	1.26
1967	0.68
1968	1.04
1969	1.37
1970	1.00
1971	0.78
1972	1.79
1973	1.18
1974	0.76
1975	1.09
1976	0.90
1977	2.07
1978	1.34
1979	1.64
1980	1.84
1981	1.44
1982	0.71
1983	2.16
1984	1.35
1985	1.22
1986	1.51
1987	2.35
1988	2.11
1989	1.28
1990	1.31
1991	0.99
1992	0.45
1993	1.31
1994	1.89
1995	2.01
1996	1.19
1997	1.98
1998	2.95
1999	0.91
2000	1.77
2001	1.61
2002	2.55
2003	2.31
2004	1.54
2005	2.54
2006	1.72

It appears that the variances may relate to factors like ENSO and volcanic eruptions which clearly affect the ocean temperatures and perhaps precipitation patterns over land (and thus vegetation growth).

Taking a look at the rate and colorizing the years by the state of ENSO and for major eruptions, we see the following.



Notice a pattern? The annual rates of increase in carbon dioxide El Ninos tend to be more, La Nina less, volcanic years least.

For El Ninos the average increase has been 1.80ppm/year, La Ninas over 40% less at 1.03. For years after major volcanic eruptions (Agung, Mt St Helens, El Chichon, Pinatubo, Cerro Hudson) the average increase is just 0.61 ppm. For ENSO (eliminating major volcano years), the Pearson correlation is a moderately strong 0.67 with the CO2 changes.

The reason the rate increases during El Ninos is that El Ninos cause global land and sea temperatures to rise. As oceans warm, they release more of the stored carbon dioxide. The CO2 rate of increase diminishes after La Ninas and volcanic eruptions as land and sea cool. As the oceans cool, they take in more carbon dioxide.

This rapid response supports the notion of a shorter lifetime for CO2 (5 to 7 years) as suggested by Segalstad and 35 other studies he compiled, far short of the 150-200 years the IPCC claims.

Effective atmospheric CO_2 lifetime

Authors [publication year]	Residence time (years)
Based on natural carbon-14	
Craig [1957]	7 +/- 3
Revelle & Suess [1957]	7
Arnold & Anderson [1957]	10
including living and dead biosphere (Siegenthaler, 1989)	4-9
Craig [1958]	7 +/- 5
Bolin & Eriksson [1959]	5
Broecker [1963], recalc. by Broecker & Peng [1974]	8
Craig [1963]	5-15
Keeling [1973b]	7
Broecker [1974]	9.2
Oeschger et al. [1975]	6-9
Keeling [1979]	7.53
Peng et al. [1979]	7.6 (5.5-9.4)
Siegenthaler et al. [1980]	7.5
Lal & Suess [1983]	3-25
Siegenthaler [1983]	7.9-10.6
Kratz et al. [1983]	6.7
Based on Suess Effect	
Ferguson [1958]	2 (1-8)
Bacastow & Keeling [1973]	6.3-7.0

The effective lifetime for CO_2 in the atmosphere, can be determined by the help of radioactive, radiogenic, and stable isotopes.

Based on bomb carbon-14	
Bien & Suess [1967]	>10
Münnich & Roether [1967]	5.4
Nydal [1968]	5-10
Young & Fairhall [1968]	4-6
Rafter & O'Brian [1970]	12
Machta (1972)	2
Broecker et al. [1980a]	6.2-8.8
Stuiver [1980]	6.8
Quay & Stuiver [1980]	7.5
Delibrias [1980]	6.0
Druffel & Suess [1983]	12.5
Siegenthaler [1983]	6.99-7.54
Based on radon-222	
Broecker & Peng [1974]	8
Peng et al. [1979]	7.8-13.2
Peng et al. [1983]	8.4
Based on solubility data	
Murray (1992)	5.4
Based on carbon-13/carbon-12 mass balance	
Segalstad (1992)	5.4

All measurements with different methods show short effective lifetimes for atmospheric CO_2, only ca. **5 - 6 years**.

Sundquist (1985); Segalstad (1998)

If this more rapid atmospheric response and shorter residence times are correct, it is another flaw in the global climate models that may exaggerate the changes upcoming.