Have you seen the economic recession in the atmospheric CO_2 record?

Accounting for emissions and the resulting radiative forcing of climate.

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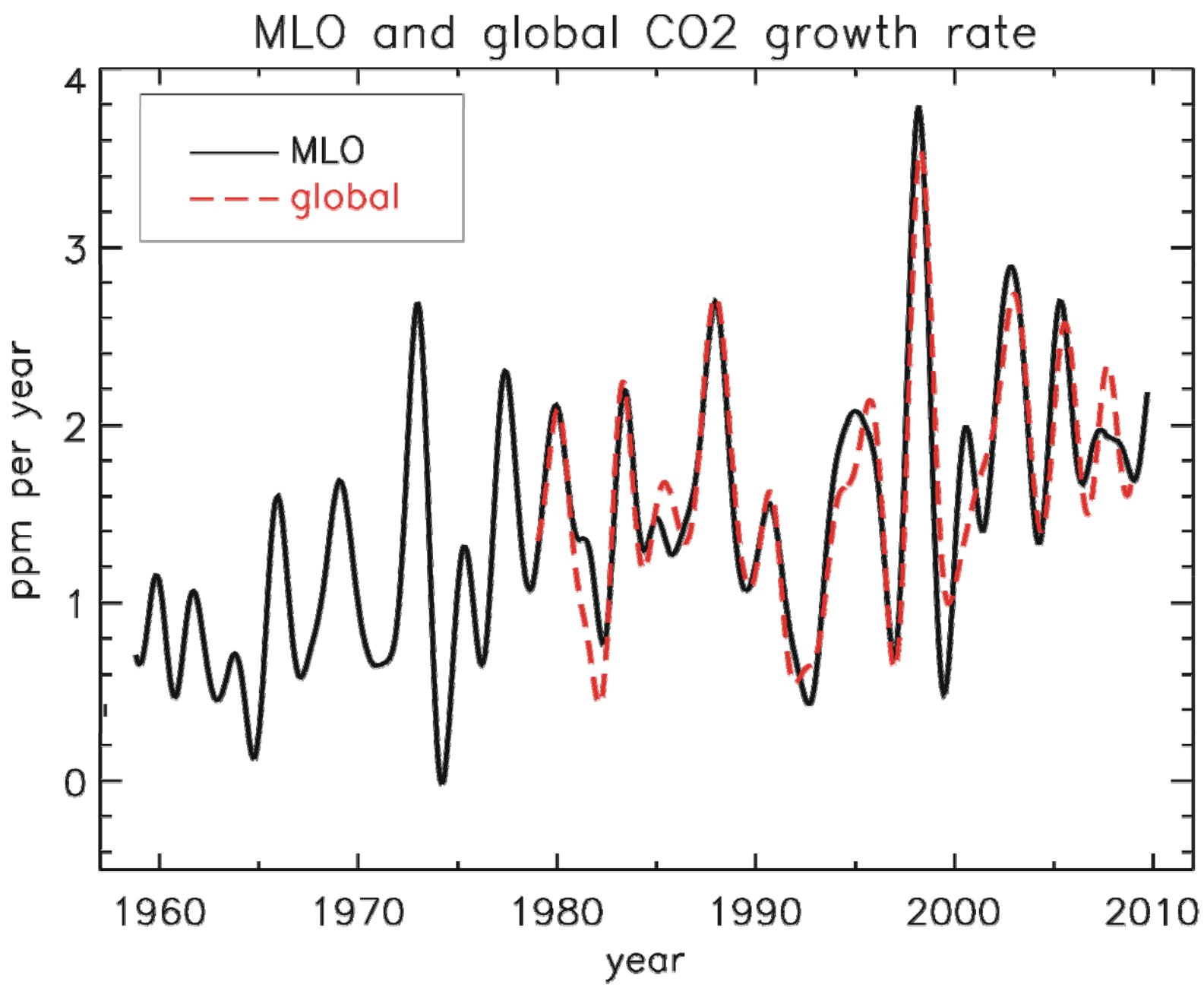
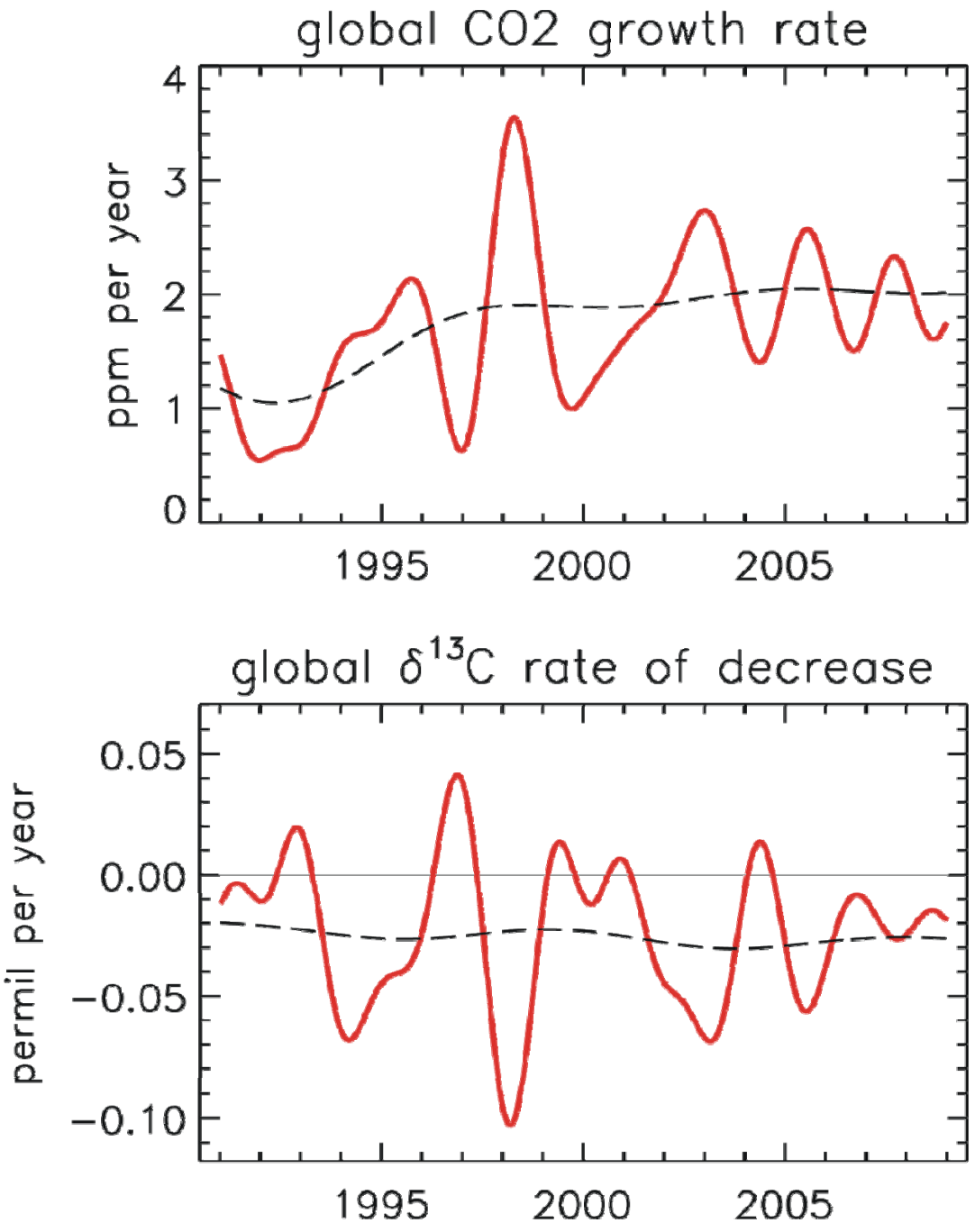
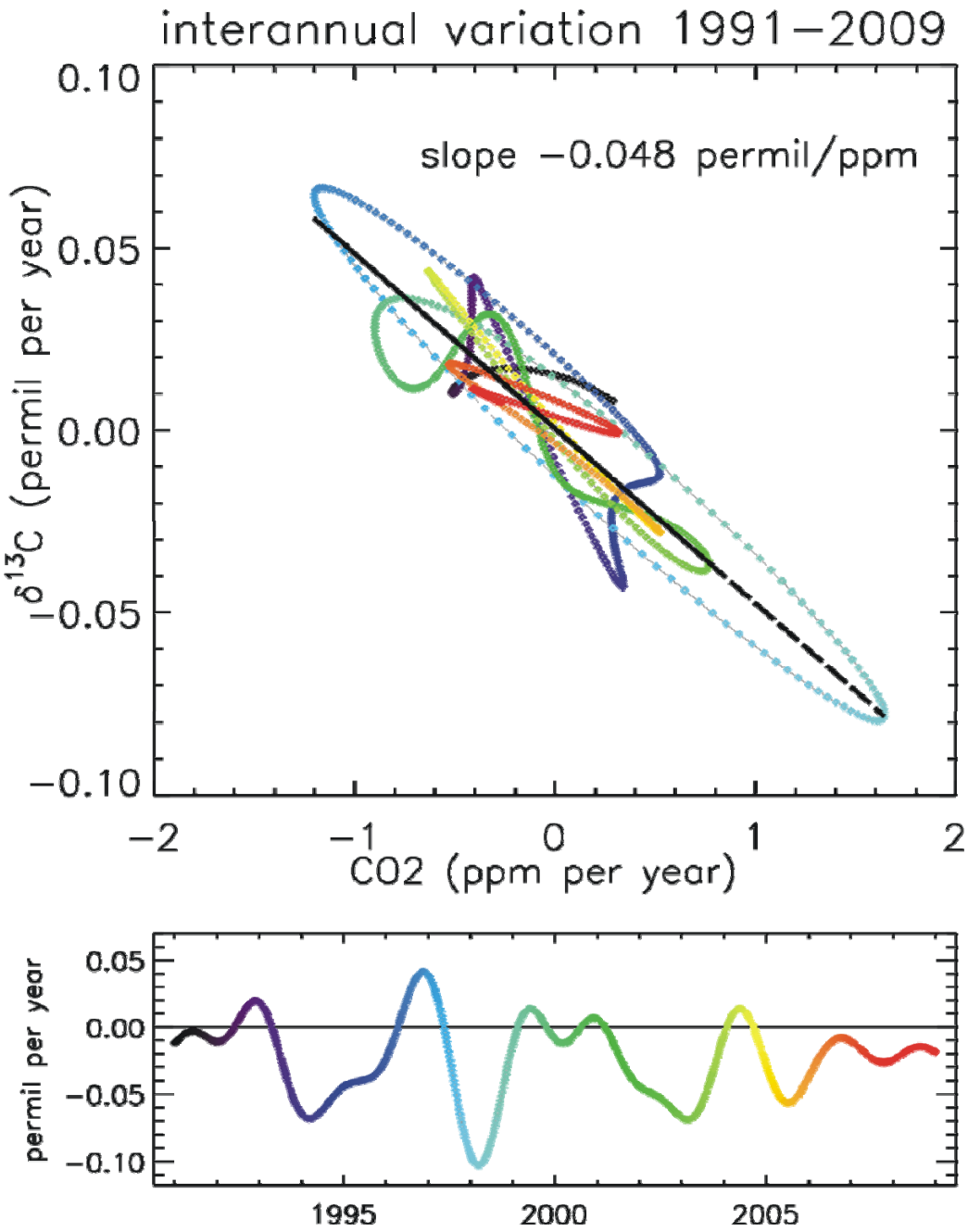
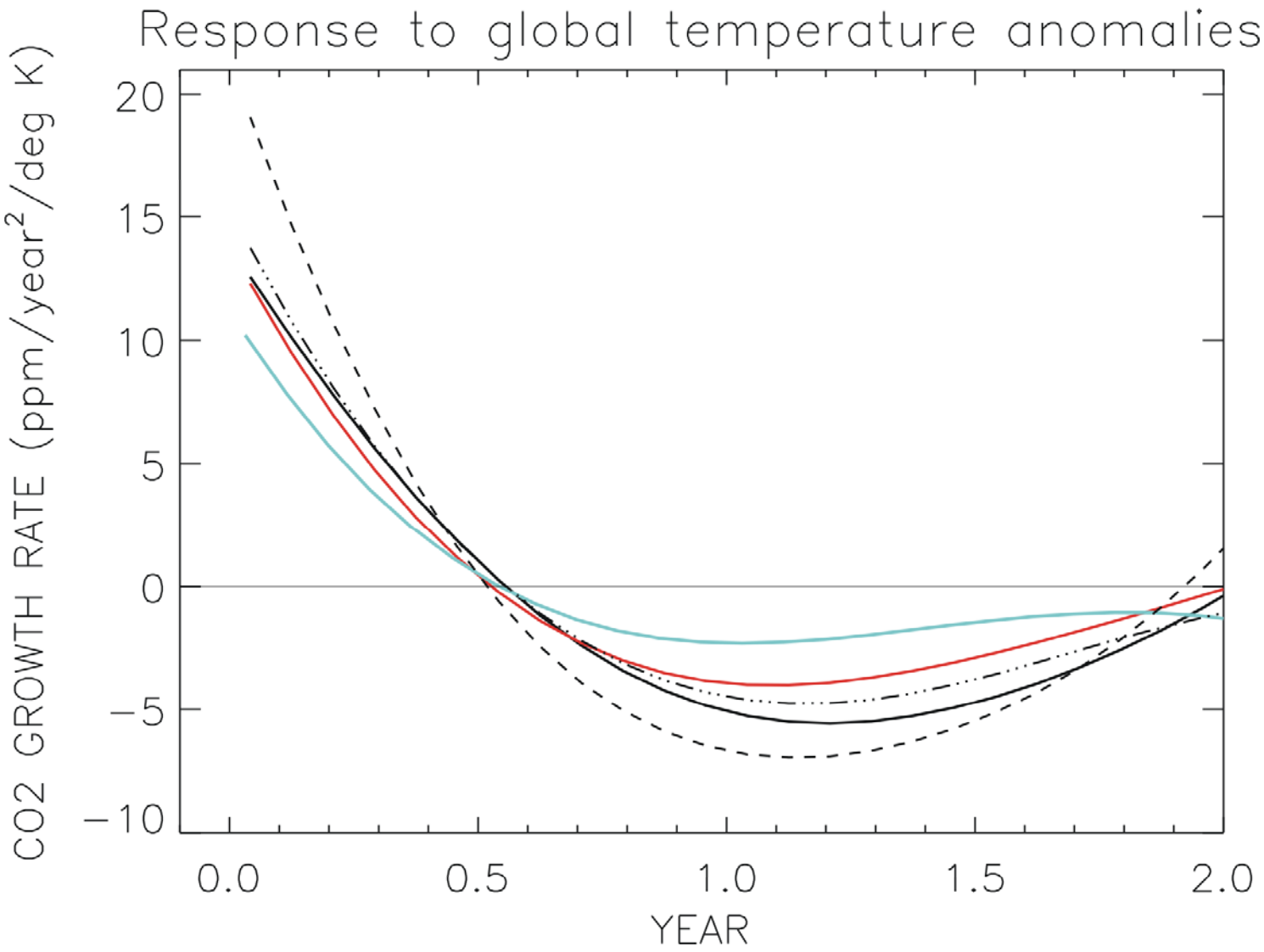
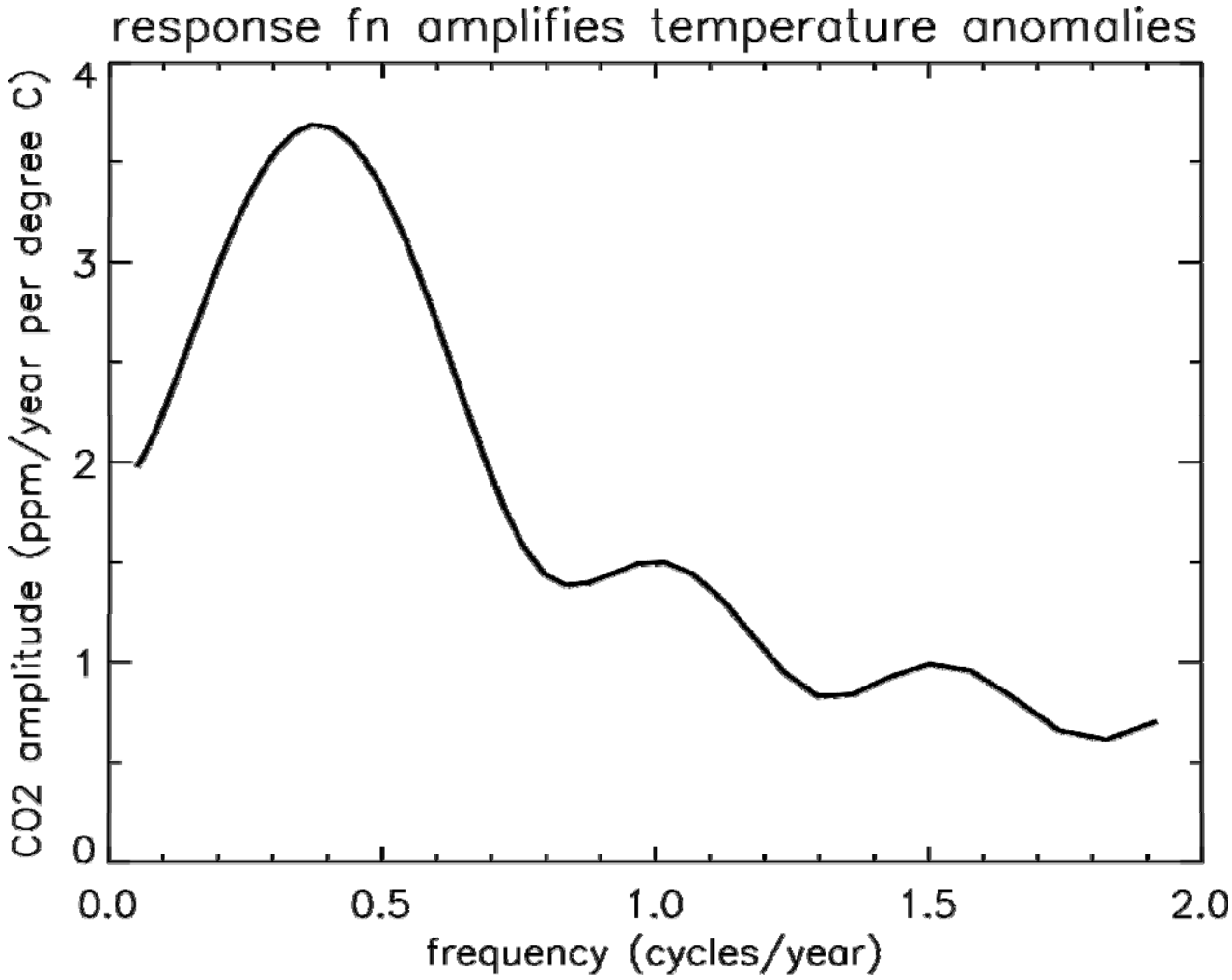
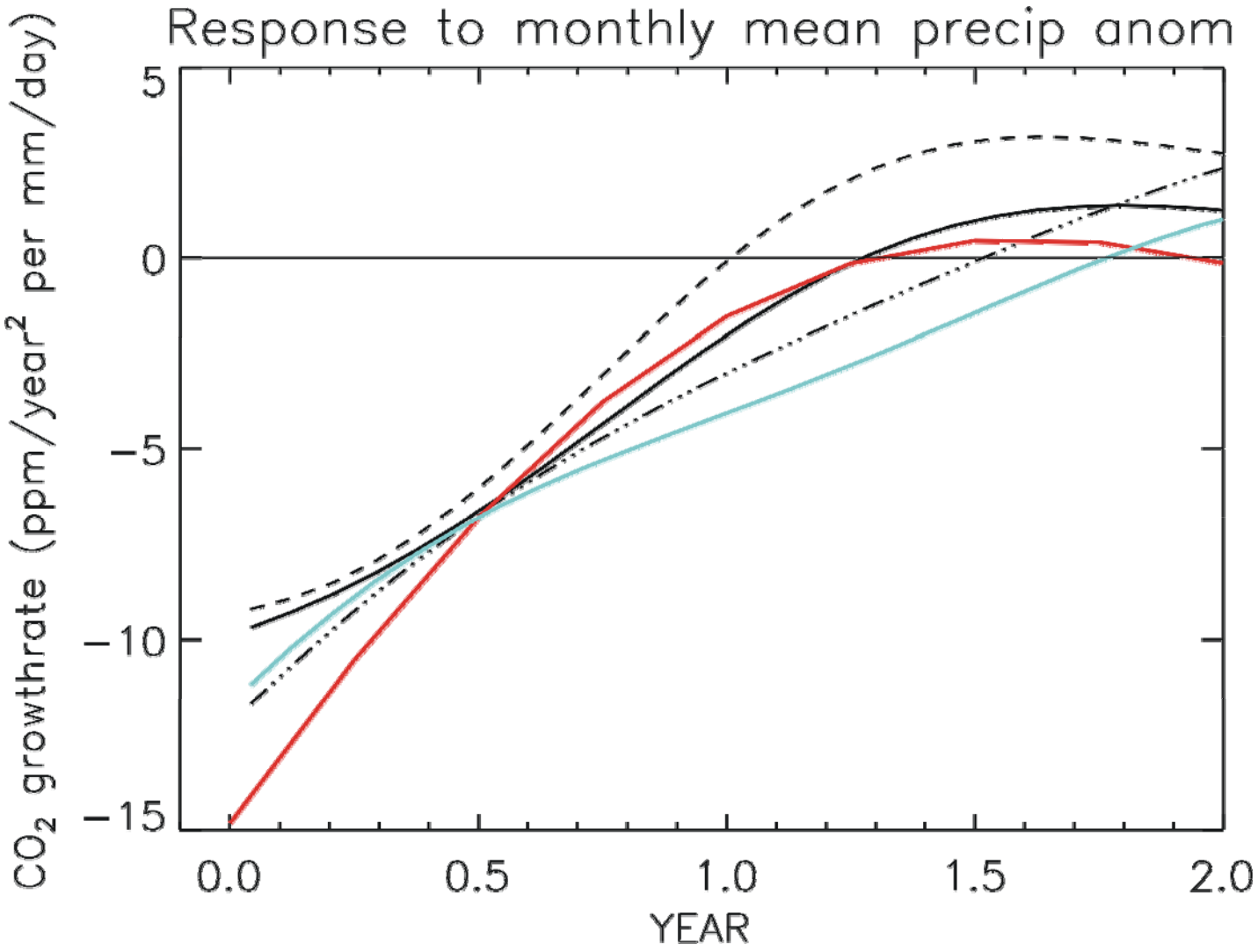

MLO and global CO2 growth rate
MLO
global
ppm per year
year
0
1
2
3
4
1960
1970
1980
1990
2000
2010

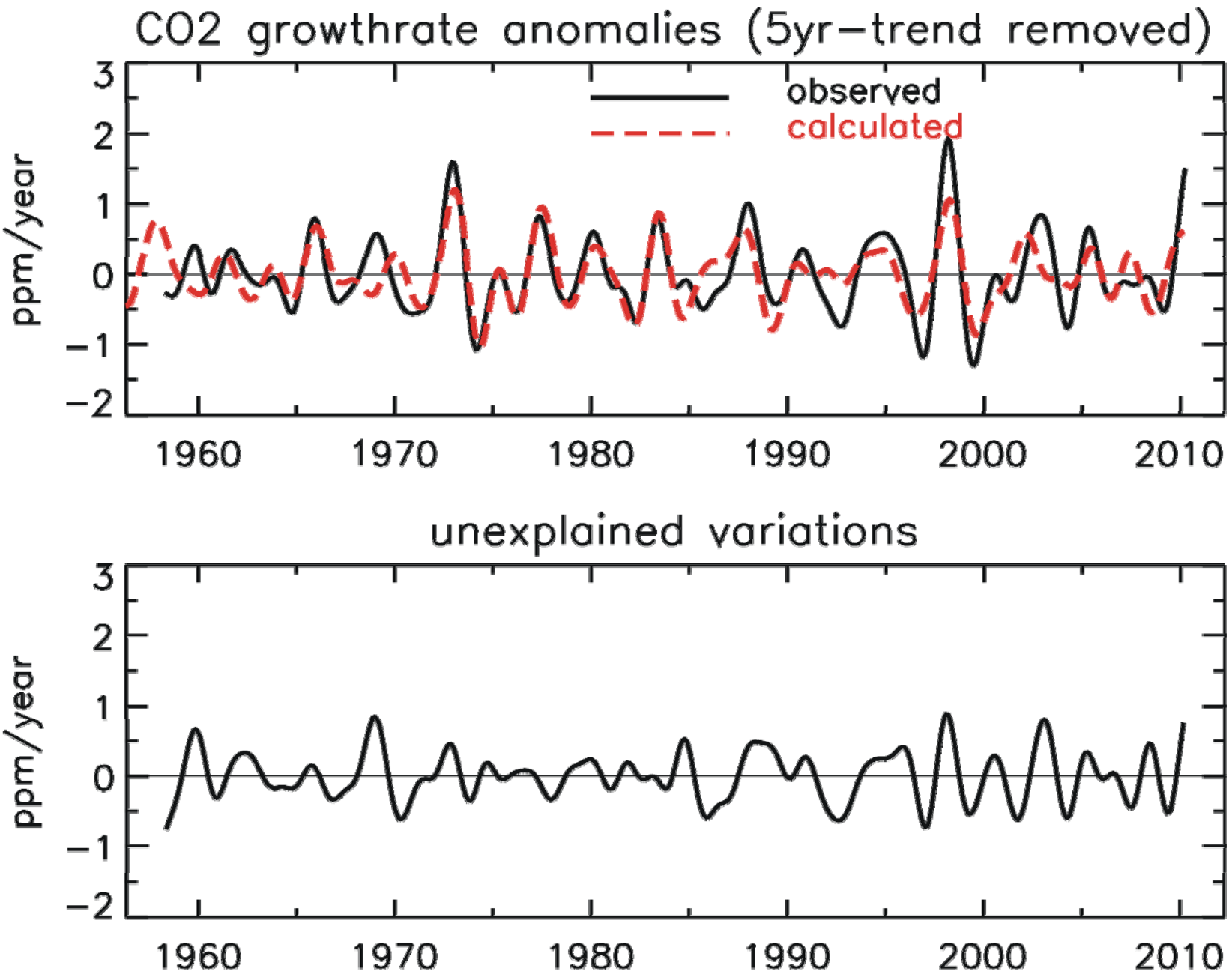

global CO2 growth rate
ppm per year
4
3
2
1
0
1995
2000
2005
global δ13C rate of decrease
permil per year
0.05
0.00
−0.05
−0.10
1995
2000
2005


interannual variation 1991–2009
slope −0.048 permil/ppm
0.10
0.05
0.00
−0.05
−0.10
δ13C (permil per year)
−2
−1
0
1
2
CO2 (ppm per year)
permil per year
0.05
0.00
−0.05
−0.10
1995
2000
2005


Response to global temperature anomalies
CO2 GROWTH RATE (ppm/year²/deg K)
20
15
10
5
0
−5
−10
0.0
0.5
1.0
1.5
2.0
YEAR


response fn amplifies temperature anomalies
CO2 amplitude (ppm/year per degree C)
0
1
2
3
4
0.0
0.5
1.0
1.5
2.0
frequency (cycles/year)


Response to monthly mean precip anom
CO2 growthrate (ppm/year2 per mm/day)
5
0
−5
−10
−15
0.0
0.5
1.0
1.5
2.0
YEAR


CO2 growthrate anomalies (5yr−trend removed)
observed
calculated
ppm/year
3
2
1
0
−1
−2
1960
1970
1980
1990
2000
2010
unexplained variations
ppm/year
3
2
1
0
−1
−2
1960
1970
1980
1990
2000
2010

Mass balance:
FF + net terrestrial = atmos + ocean

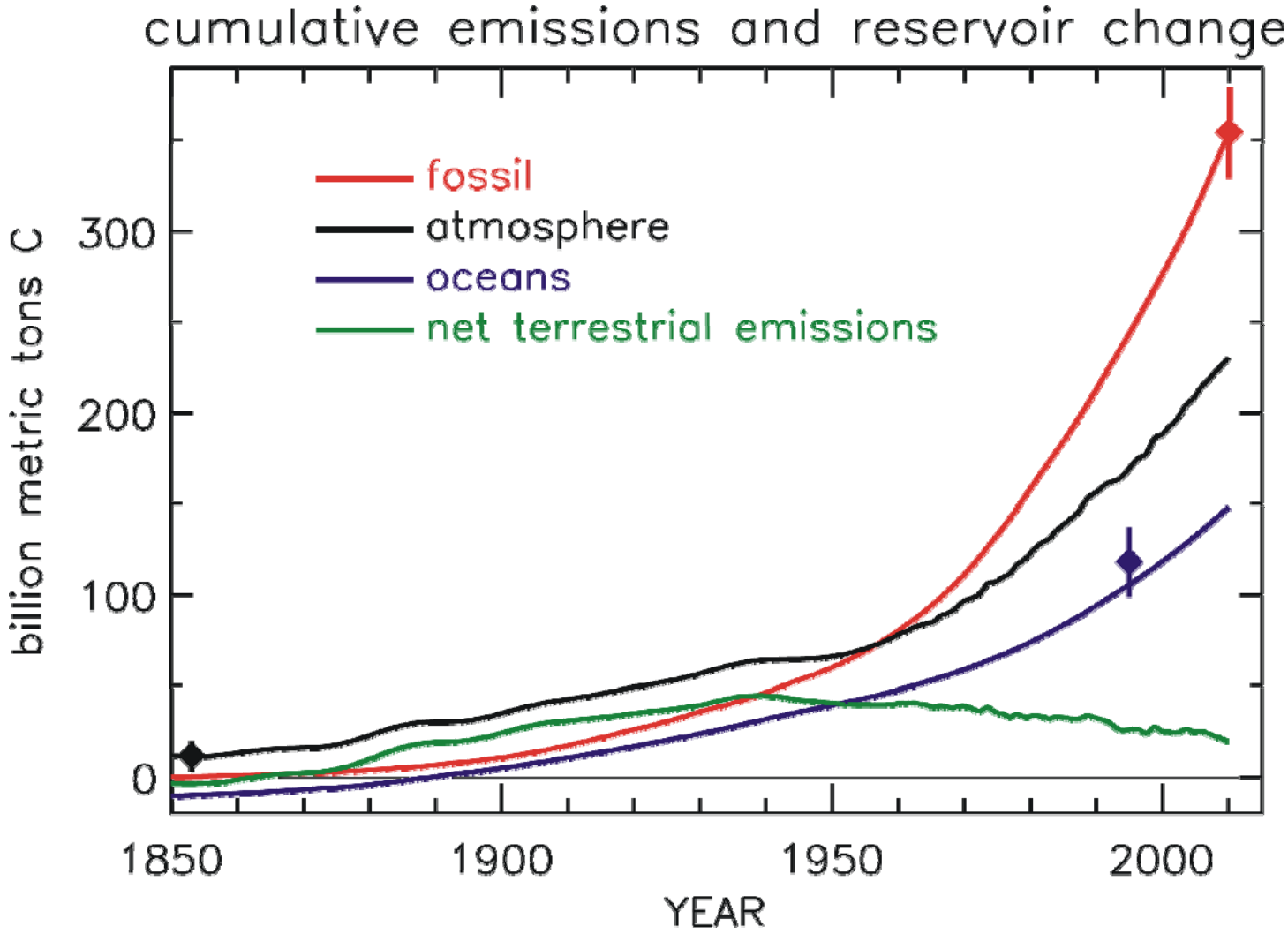
fossil emissions + (land use emissions minus ecosystem uptake)
= atmospheric increase + oceanic increase

$$C_{atm}(t) = \int_{-\infty}^{t} dt' E(t') \left[x_0 + \sum_{i=1}^{3} x_i \exp[a_i (t'-t)] \right] \qquad \text{with} \sum x_i = 1$$

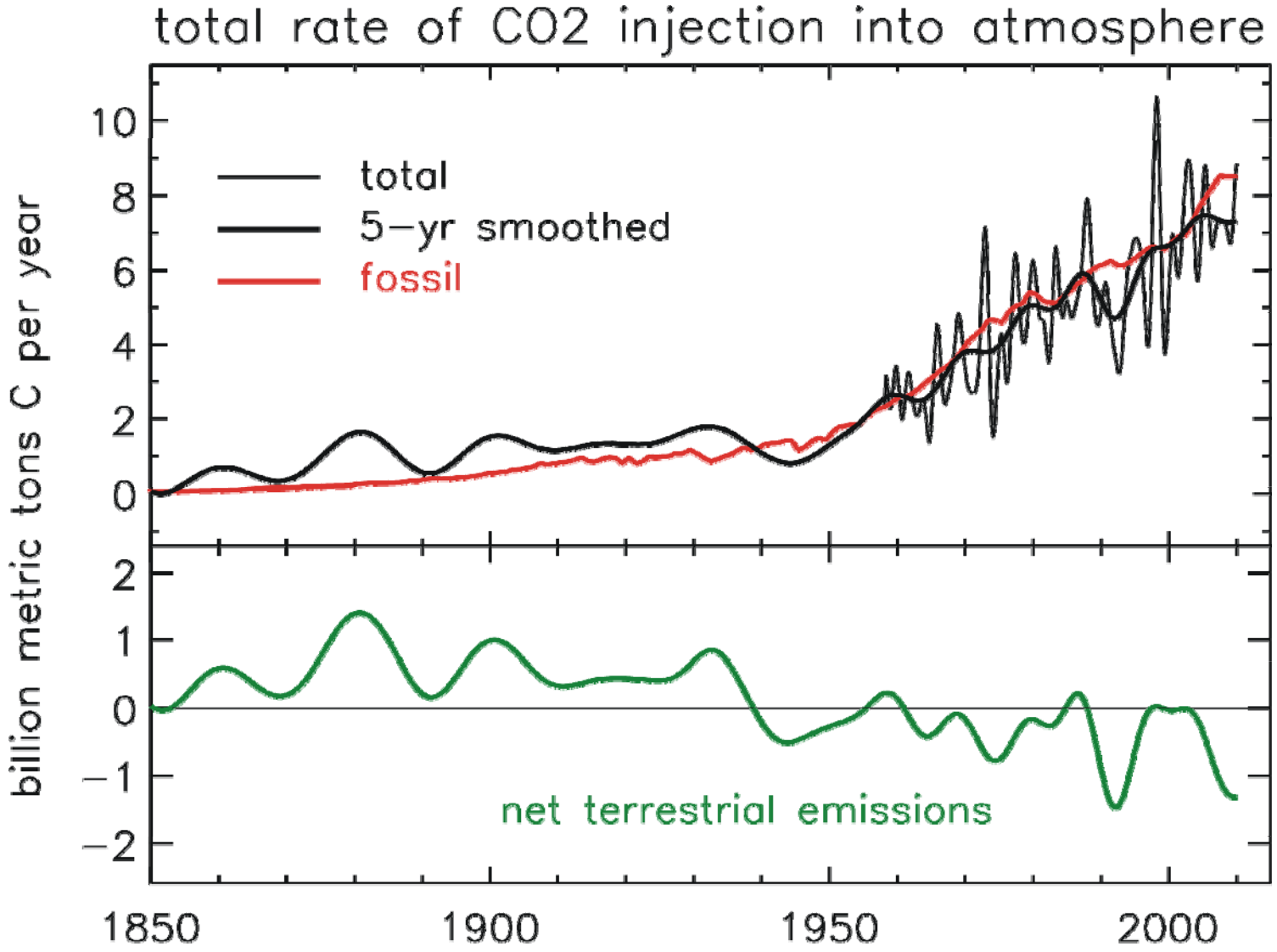
$$C_{oce}(t) = \int_{-\infty}^{t} dt' E(t') \left[1 - x_0 - \sum_{i=1}^{3} x_i \exp[a_i (t'-t)] \right]$$

The coefficients x_i and time constants a_i are subject to two independent constraints:

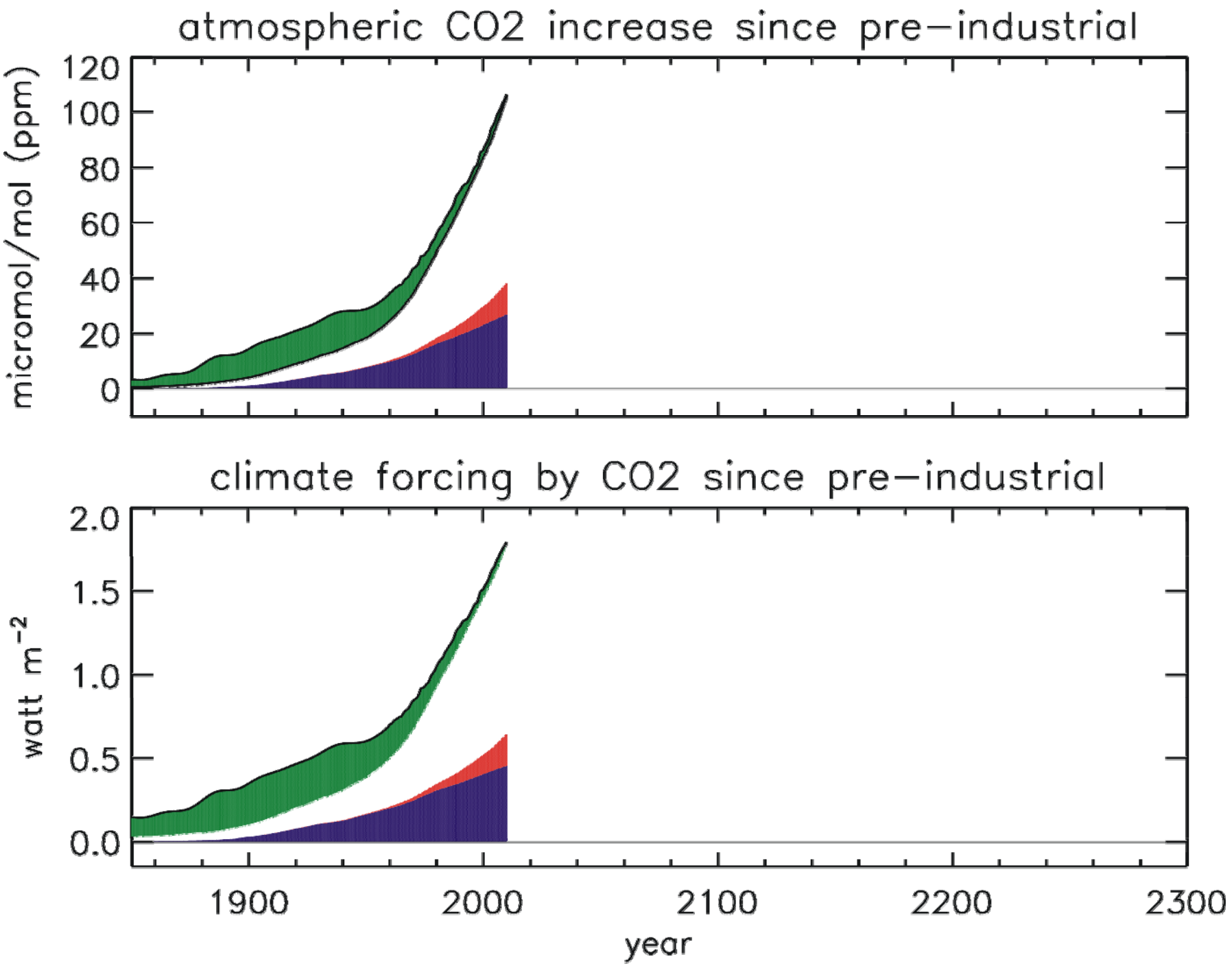
1. Observed cumulative increase of carbon in the oceans through 1994
   (118±19 GtonC, Sabine et al., Science 2004)
2. Observed average rate of uptake by the oceans during 1993-2002
   (2.2±0.6 GtonC/year, Manning and Keeling, Tellus 2006)

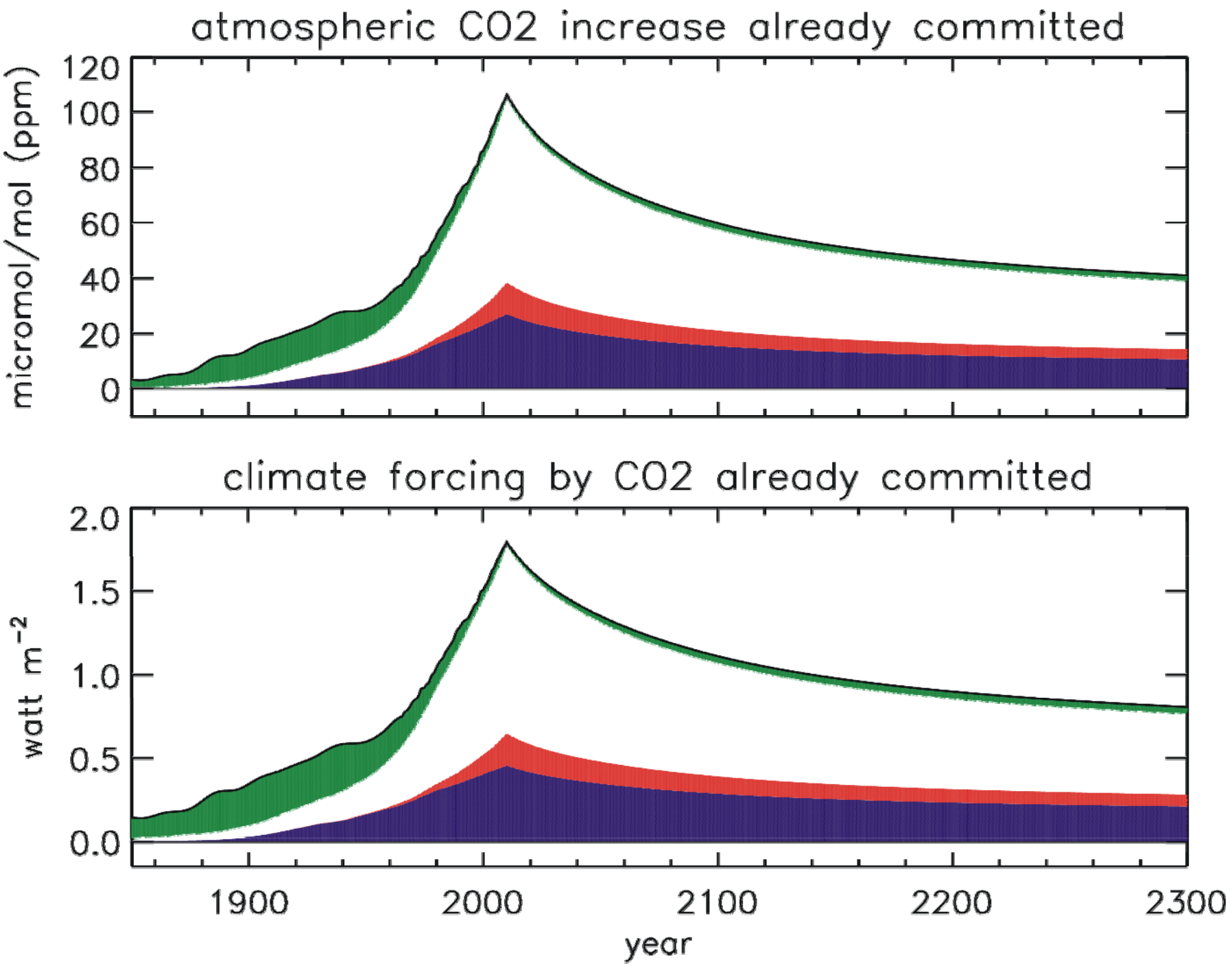


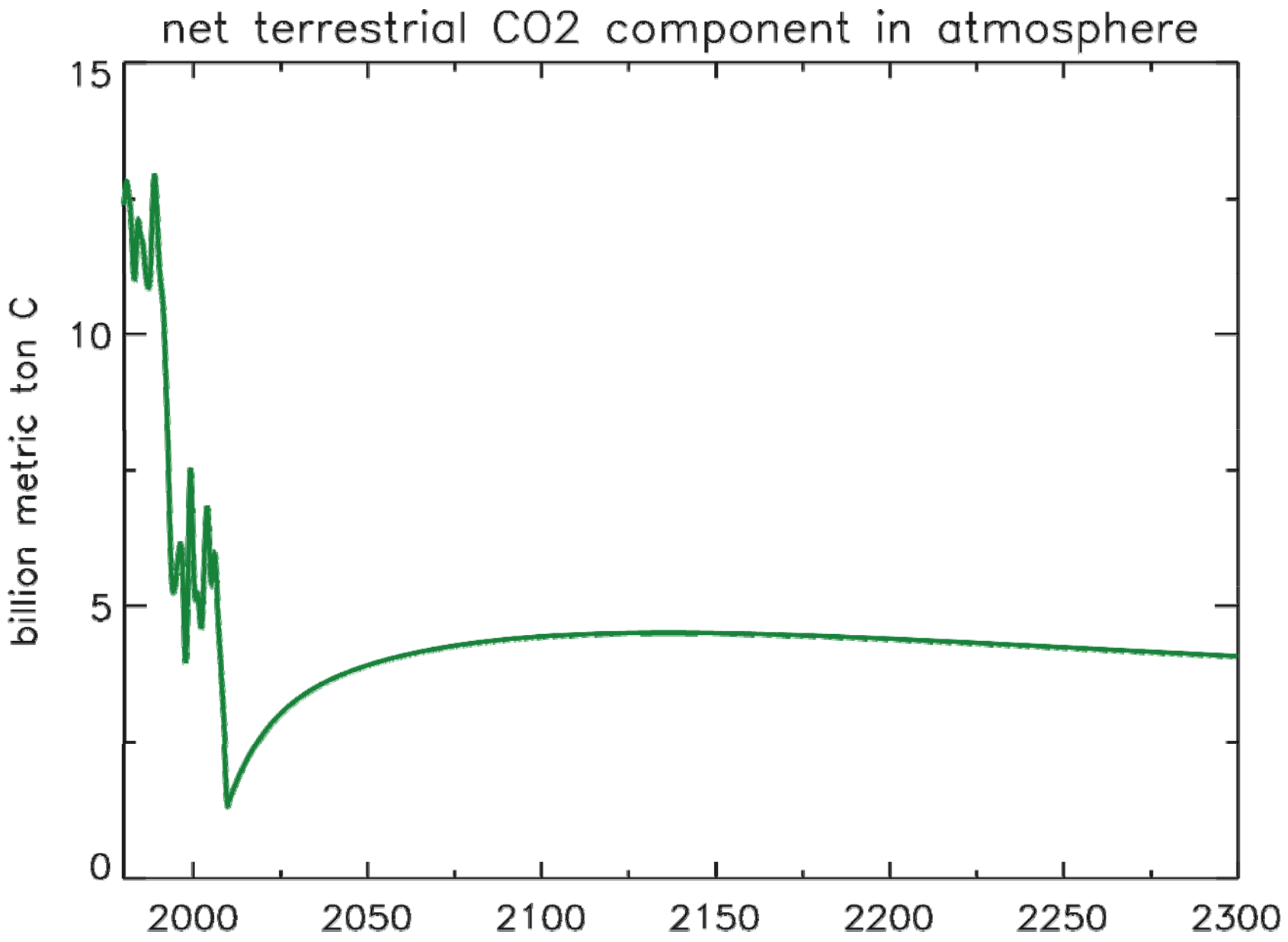
fossil emissions + (land use emissions minus ecosystem uptake)
= atmospheric increase + oceanic increase



P. Tans, Oceanography 22, 26-35 (2009)


atmospheric CO2 increase since pre-industrial
micromol/mol (ppm)
120
100
80
60
40
20
0
climate forcing by CO2 since pre-industrial
watt m-2
2.0
1.5
1.0
0.5
0.0
1900
2000
2100
2200
2300
year


atmospheric CO2 increase already committed
micromol/mol (ppm)
120
100
80
60
40
20
0
climate forcing by CO2 already committed
watt m-2
2.0
1.5
1.0
0.5
0.0
1900
2000
2100
2200
2300
year


net terrestrial CO2 component in atmosphere
billion metric ton C
15
10
5
0
2000
2050
2100
2150
2200
2250
2300

Conclusions:

On a **decadal** time scale *mankind* has a dominant influence on the carbon cycle.

On **sub-decadal** time scales the response of *terrestrial ecosystems* to climate variations is the dominant influence on atmospheric carbon.

Current globally averaged climate forcing by historical U.S. CO2 emissions up to 2010 equals 0.451 W m^{-2}, and time-integrated forcing until *2010* equals 22.5 Watt-years m^{-2} .
For PR China these numbers are 0.192 W m^{-2} and 3.5 Watt-years m^{-2}.

Historical U.S. emissions until 2010 have already committed the global climate system until the year *2300* to time-integrated forcing of 101 Watt-years m^{-2} .
For PR China the same measure is 32 Watt-years m^{-2} .

The concept of a 100-year atmospheric time horizon for CO2 is misleading to the public and to most scientists. It should be abandoned.