Probable bias in anthropogenic CO_2 emissions revealed by improved atmospheric growth rate data

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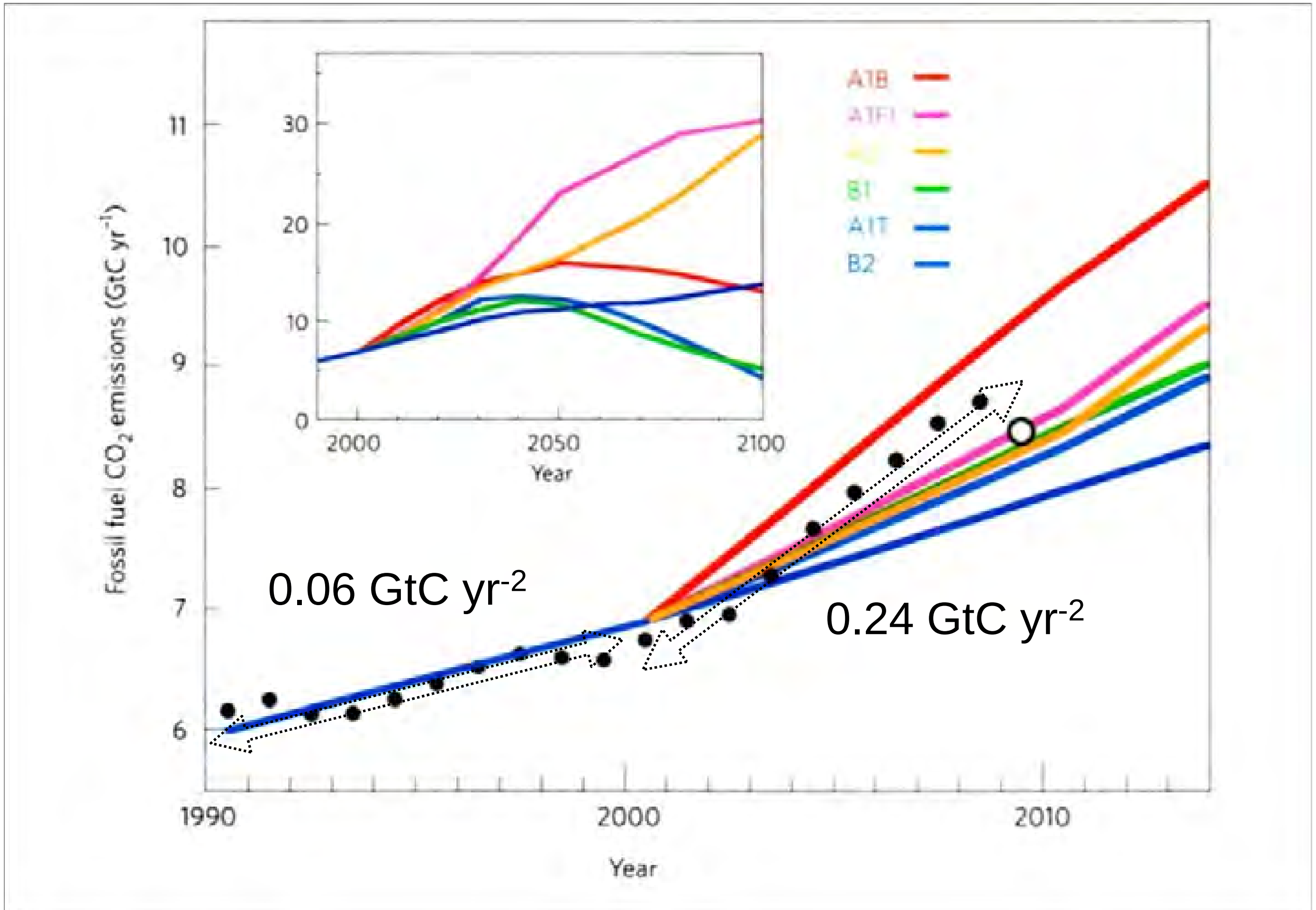
Sample Collection Collaboration: BoM, AAD, AIMS, ANSTO NOAA, Env. Canada

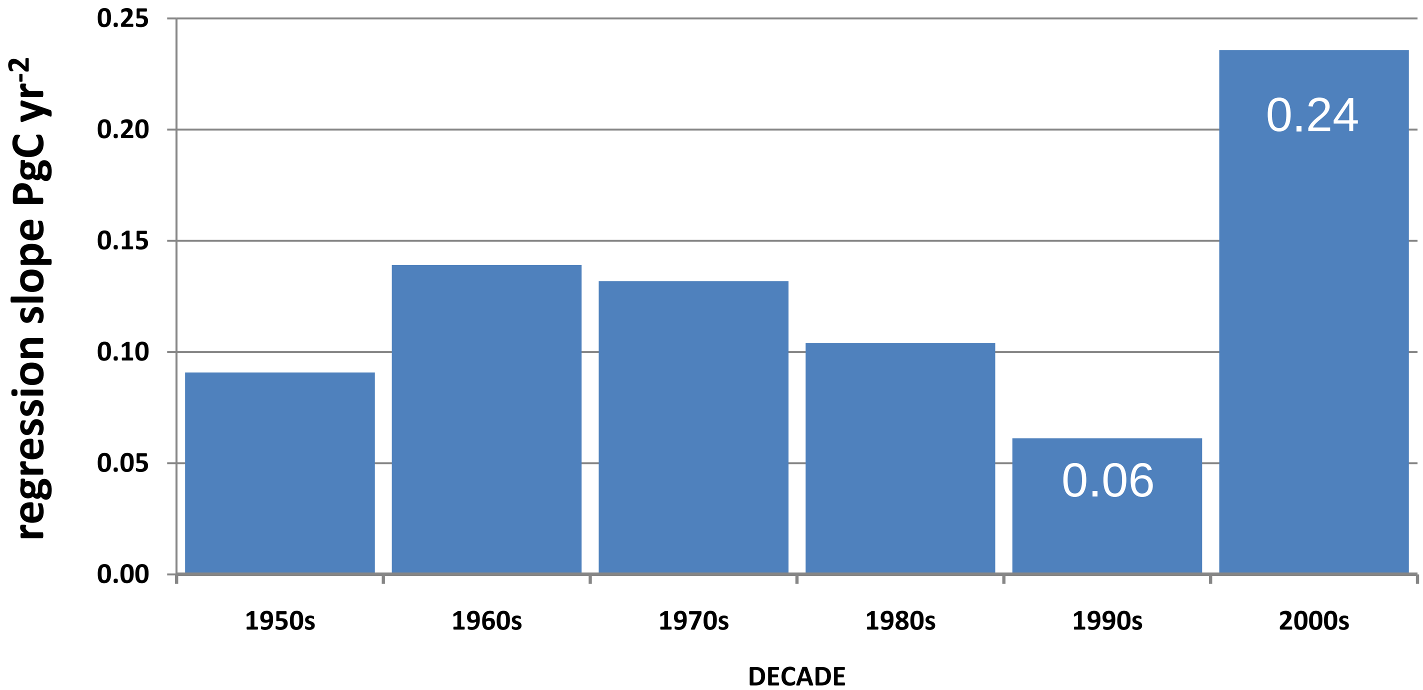


Manning et al.: *Misrepresentation of the IPCC CO_2 emission scenarios*.
Nature Geoscience, June 2010. (IPCC)

Le Quéré et al: *Trends in the sources and sinks of carbon dioxide.*
Nature Geoscience, Dec 2009. (GCP)

Decadal trends in fossil CO_2 emissions

(using Marland et al., 1999, 2008)

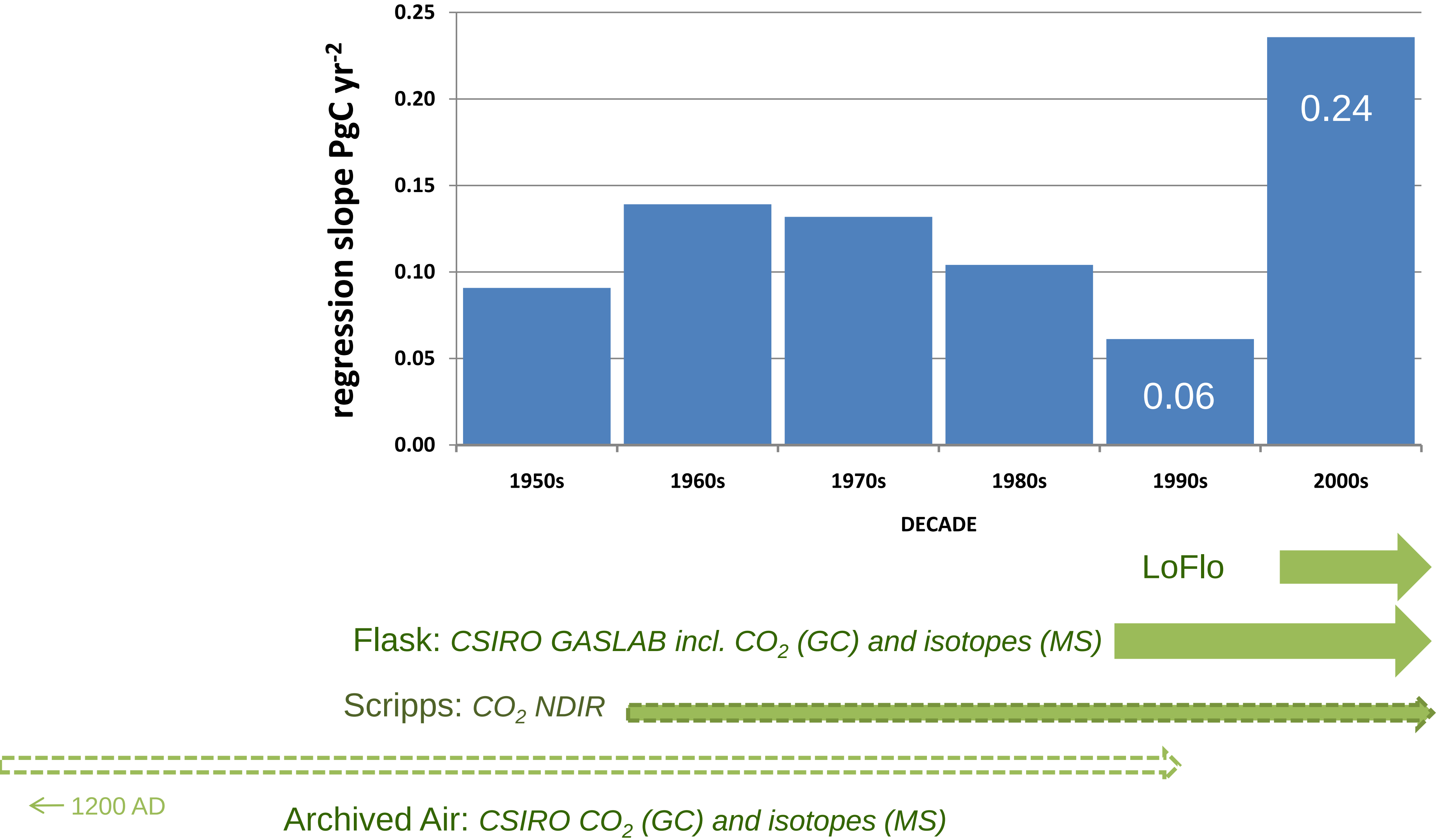


THE ECONOMIST 4 Mar 2010

“You might think that measuring the levels of greenhouse gases in the atmosphere would be a priority. If you did think that, though, you would be wrong”

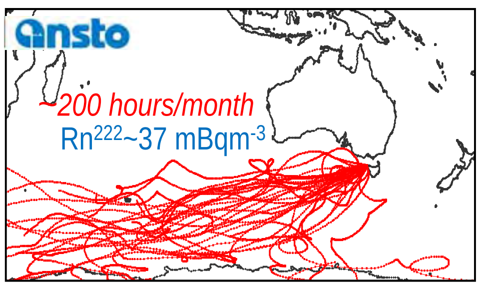
Decadal trends in fossil CO_2 emissions

(using Marland et al., 1999, 2008)



Cape Grim LoFlo

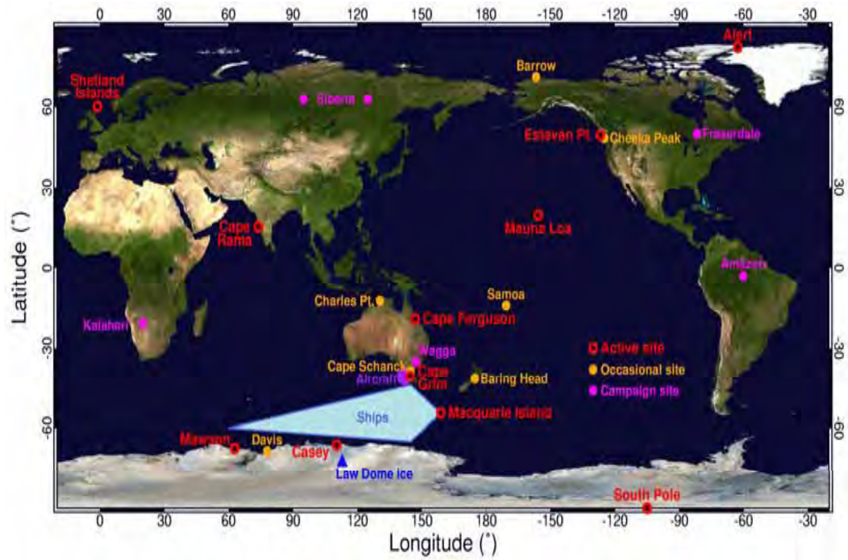
LoFlo: continuous CO_2 by NDIR



Zahorowski et al. Tellus 2003

Da Costa & Steele *WMO/TD* 1999,
Francey & Steele *AQA* 2003

Flask network



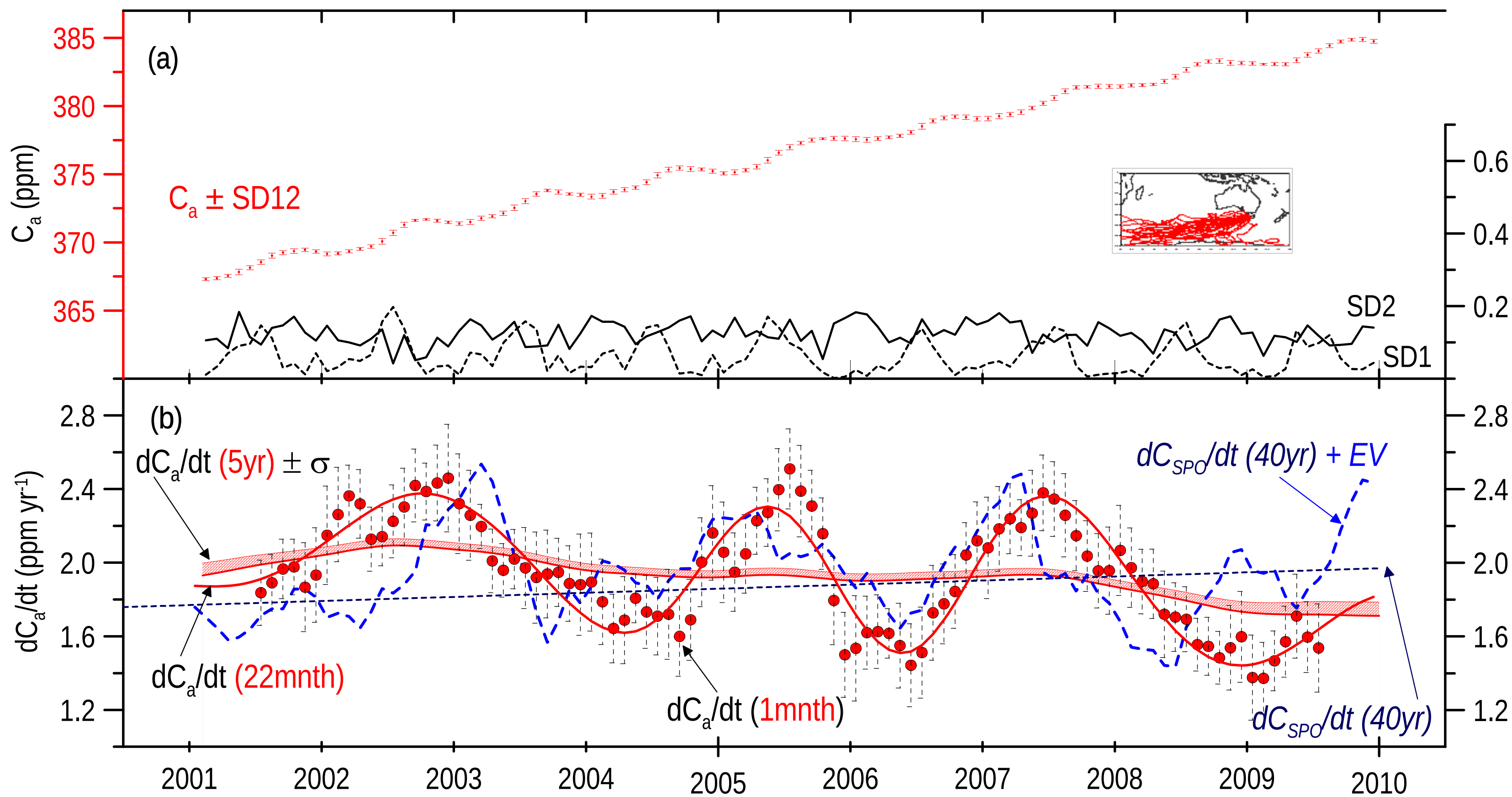
Flask: CO_2, CH_4, N_2O, CO, H_2 by gc
CO_2 isotopes by ms

GASLAB
Francey et al., *BAP (Aus 93)* 1996

CO_2 growth since 2001

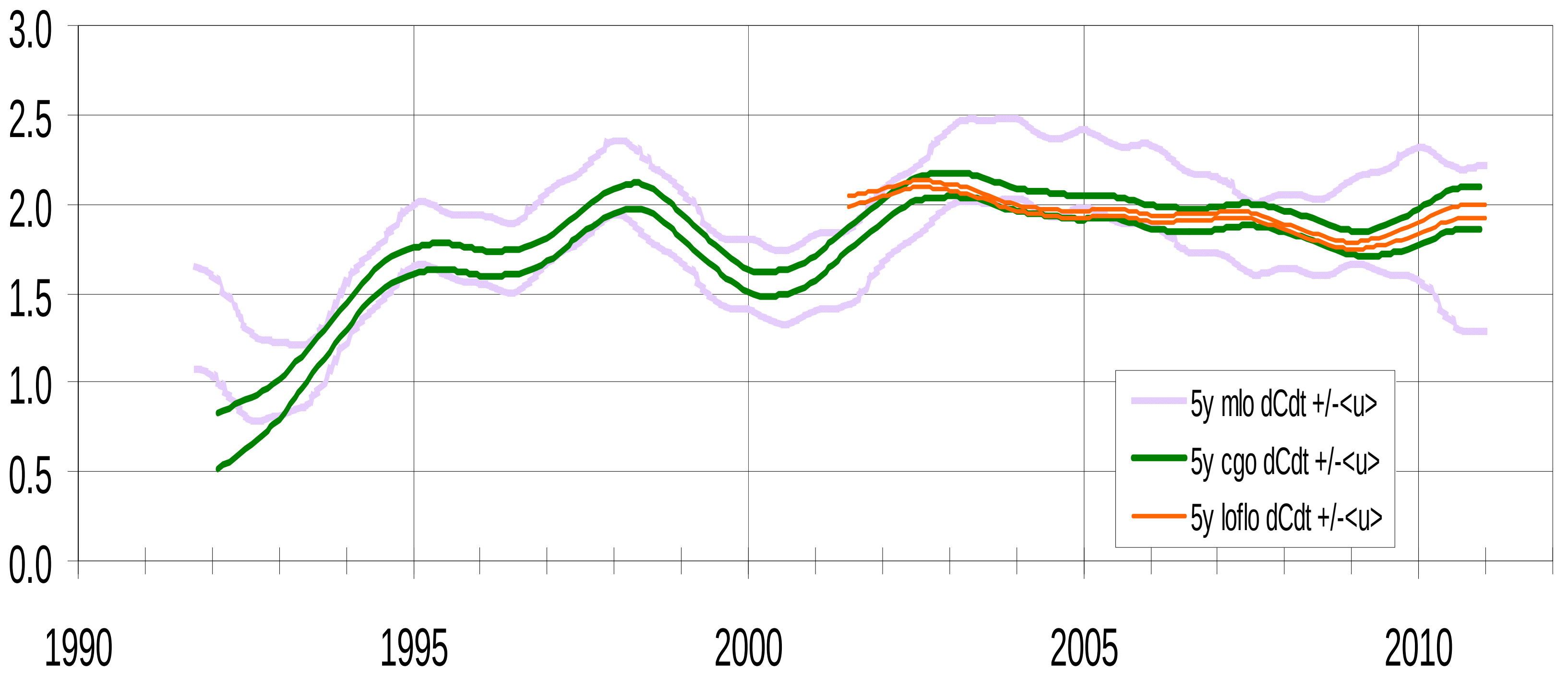
*Francey et al. TELLUS B, **62**, 316–328 (2010)*

LoFlo analyser at Cape Grim



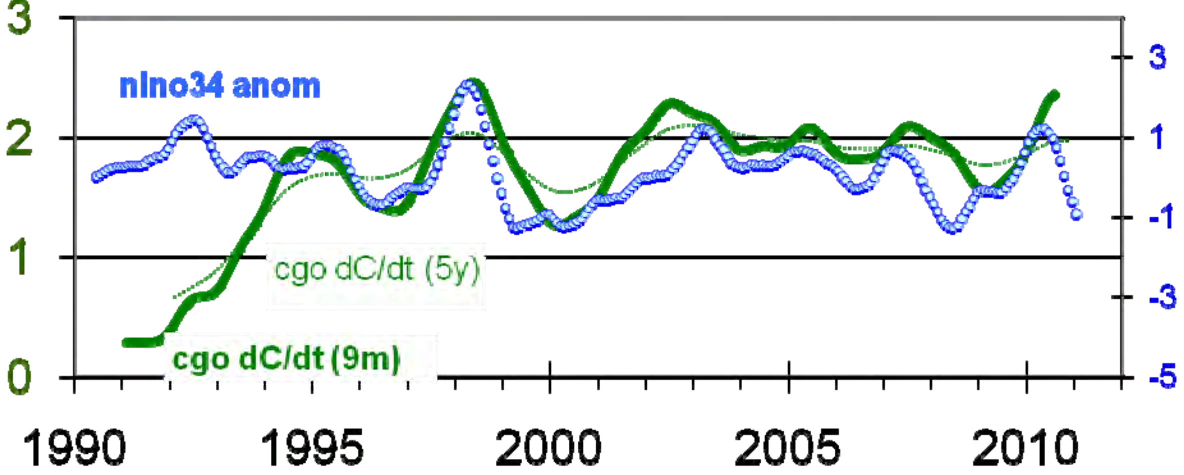
*Enting, I. G. et al., 2006, Propagating data uncertainty through smoothing spline fits. Tellus B **58**, 4, 305-309.*

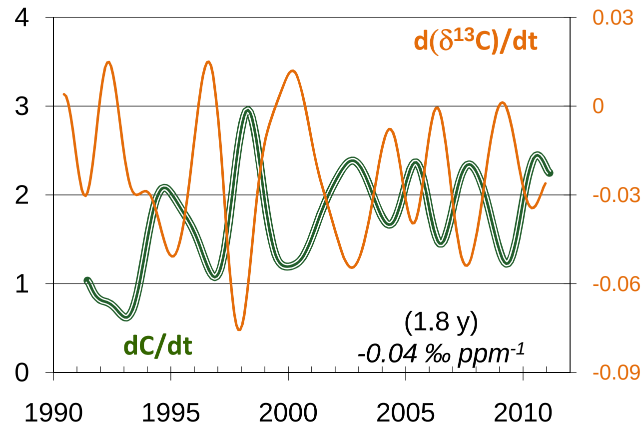
Temporal and Spatial extension of the 5y-growth trends (ppm/yr)



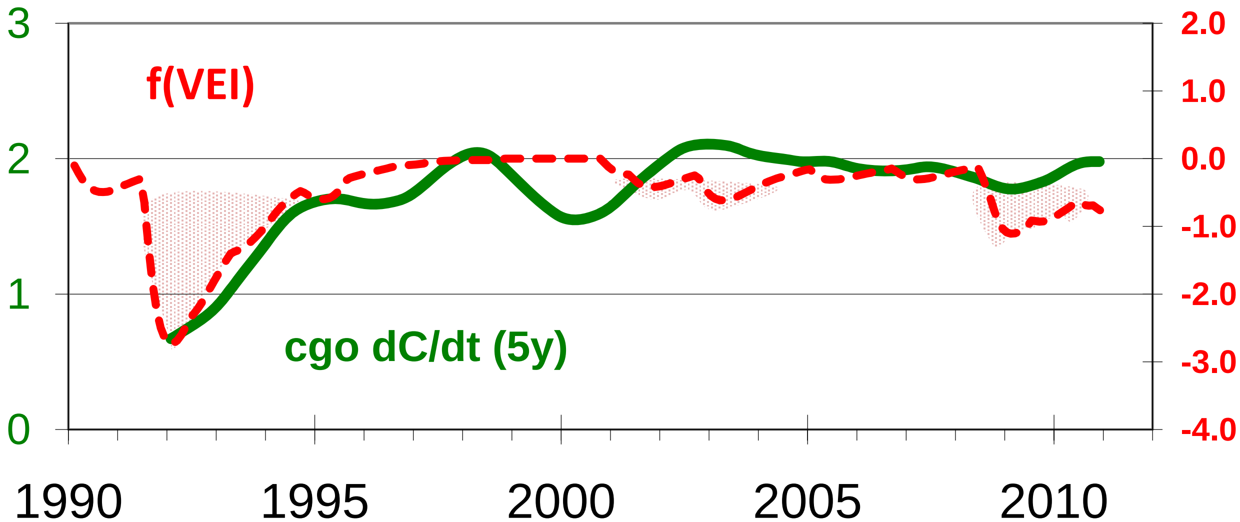
	Cape Grim (*LoFlo*)	Cape Grim (*cgo*)	Mauna Loa (*mlo*)
2002.6	**2.11±0.02**	2.07±0.13	2.20±0.41
2008.5	**1.84±0.02**	1.85±0.16	1.68±0.53

Clues about the natural causes of multi-year variability in dCO_2/dt





Rayner et al., GBC, 2008



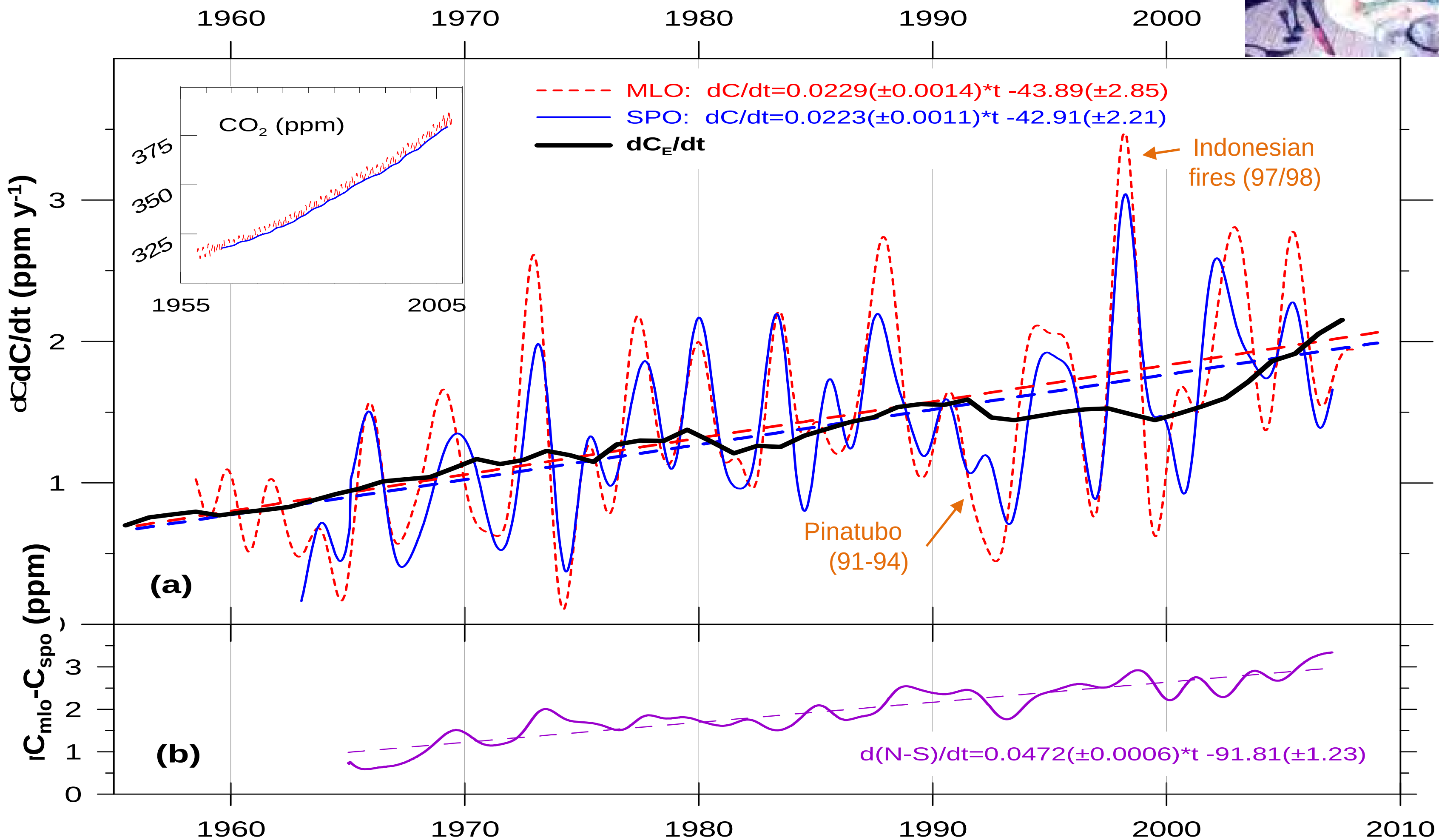
Pinatubo 6
Cerro Hudson 5

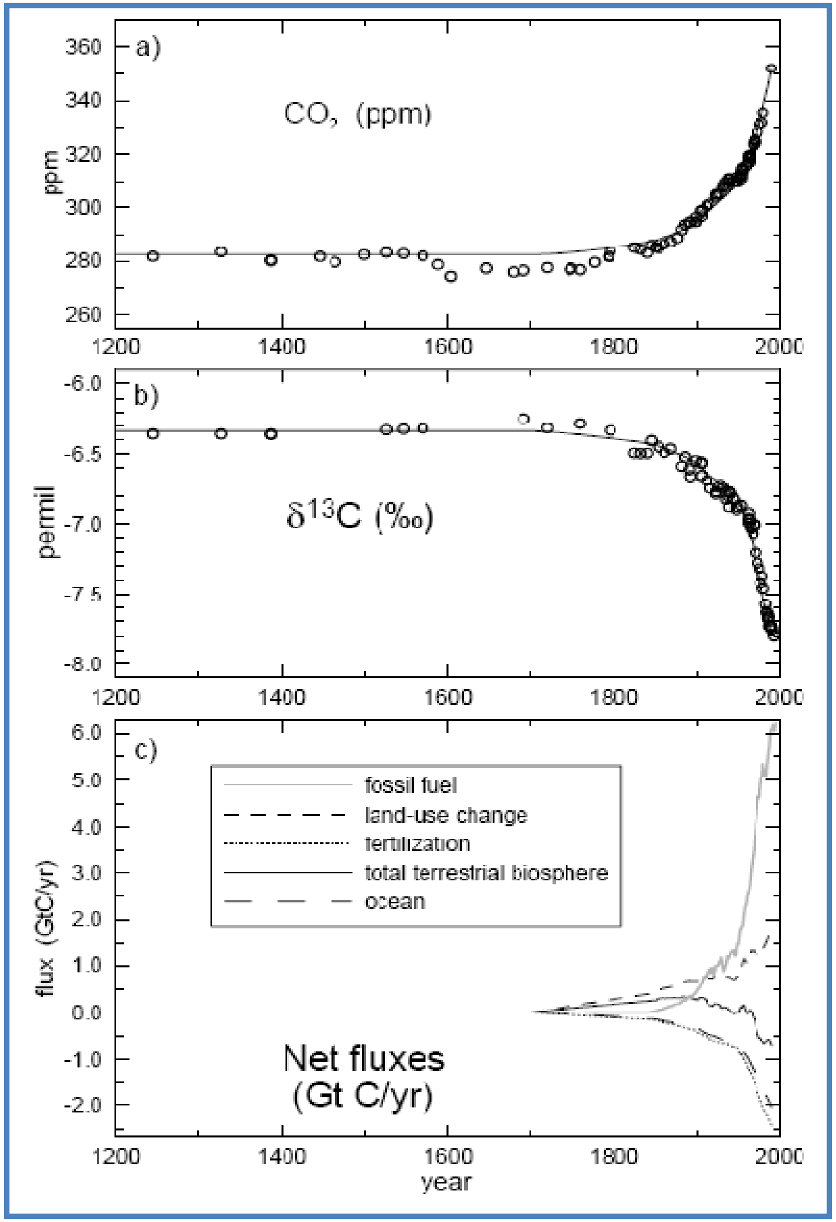
Shivaluk 4
Ruang 4,
Reventador 4
Manam 4

Chaiten 4+
Okmok 4,
Kasatochi 4,
Sarychev 4
Eyjafjallajokull 4
Merapi 4

Dave Keeling
Scripps Institution of Oceanography

Global 5-decade perspective



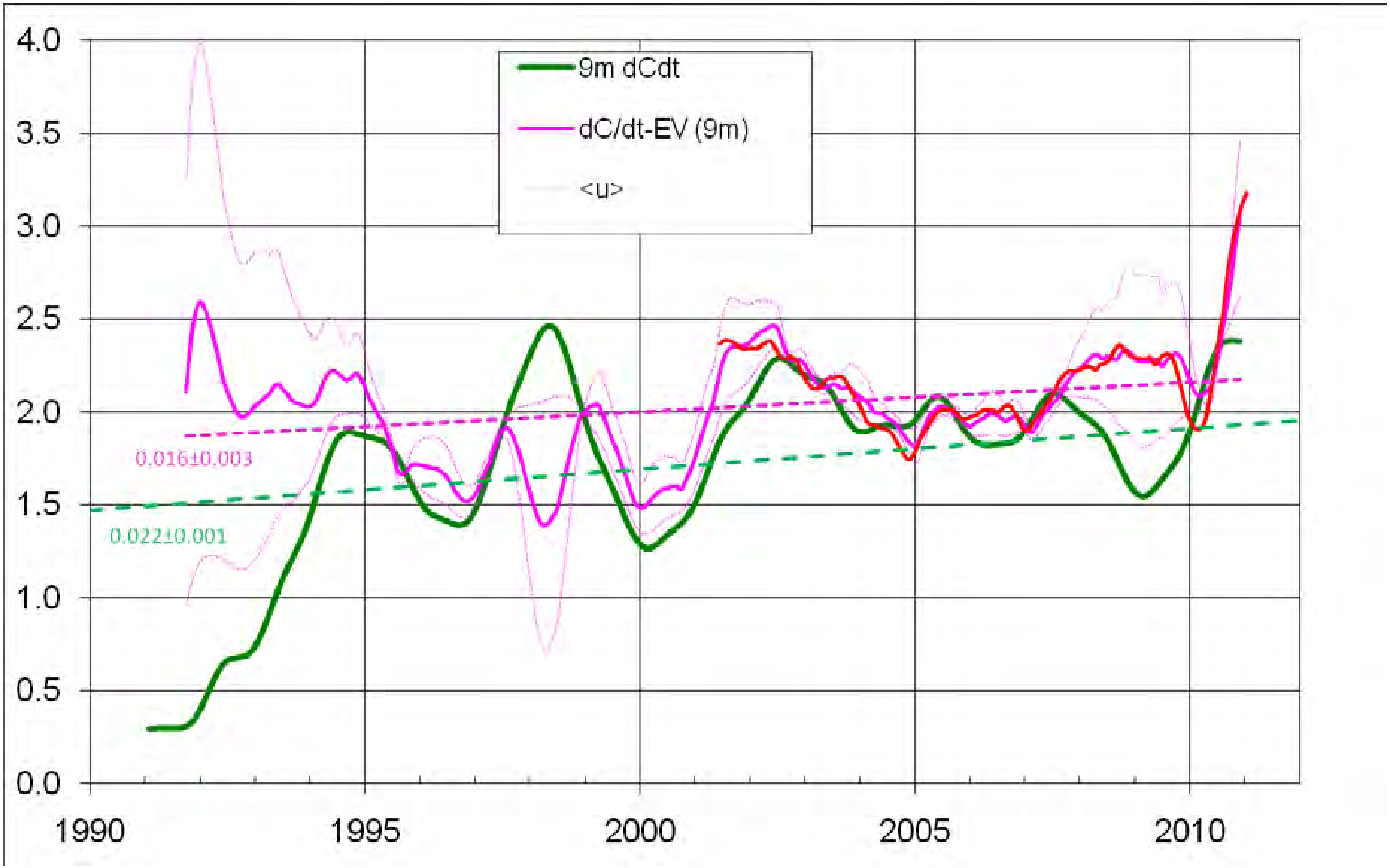


Etheridge et al. (1996)
Natural and anthropogenic changes in atmospheric CO_2 over the last 1000 years from air in Antarctic ice and firn
J. Geophys. Res., 101, 4115-4128 & update MacFarling Muere et al. (2006) GRL 33, L14810.

Francey et al. (1999)
A 1000 year high precision record of $\delta^{13}C$ in atmospheric CO_2
Tellus, 51B, 170-193.

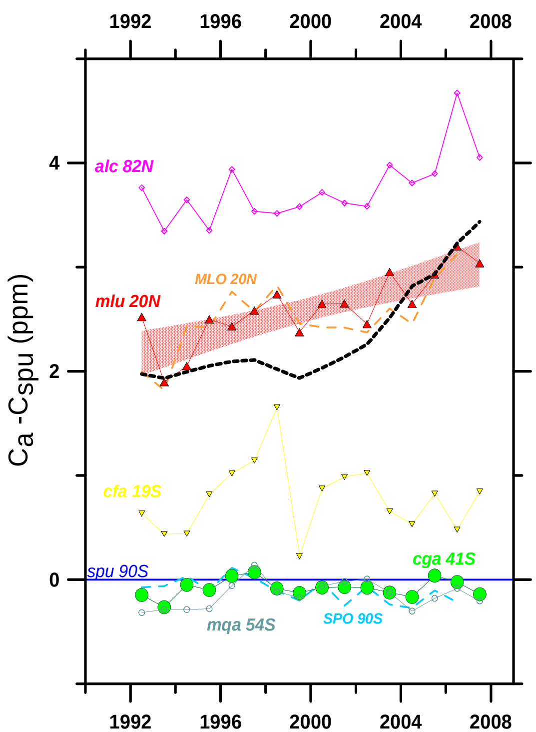
Trudinger et al (1999)
Long term variability in the global carbon cycle inferred from a high precision CO_2 and $\delta^{13}C$ ice core record
Tellus, 51B, 233-248.

Adjustment to dCO_2/dt to suppress the natural forcing



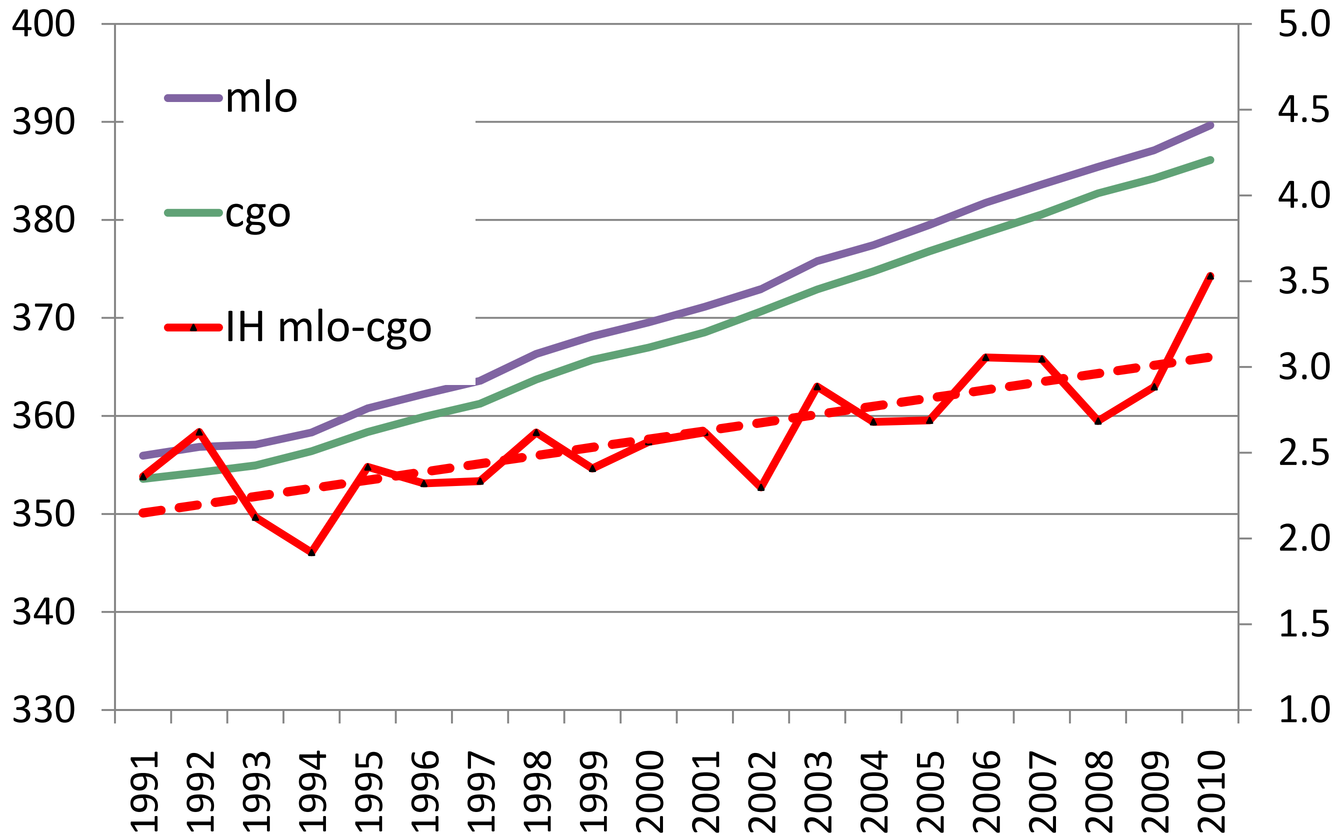
Inter-hemispheric CO_2 gradient

*Latitudinal **trends***
*Francey et al. TELLUS B, **62**, 316–328 (2010)*



Annual Averages - South Pole (ppm)

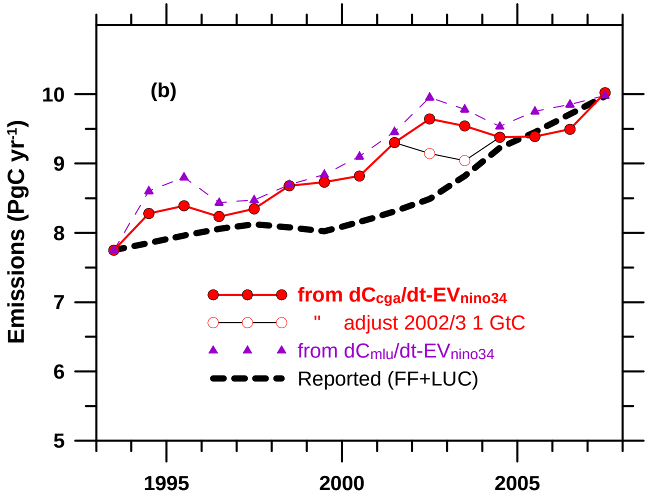
Annual Averages (ppm)



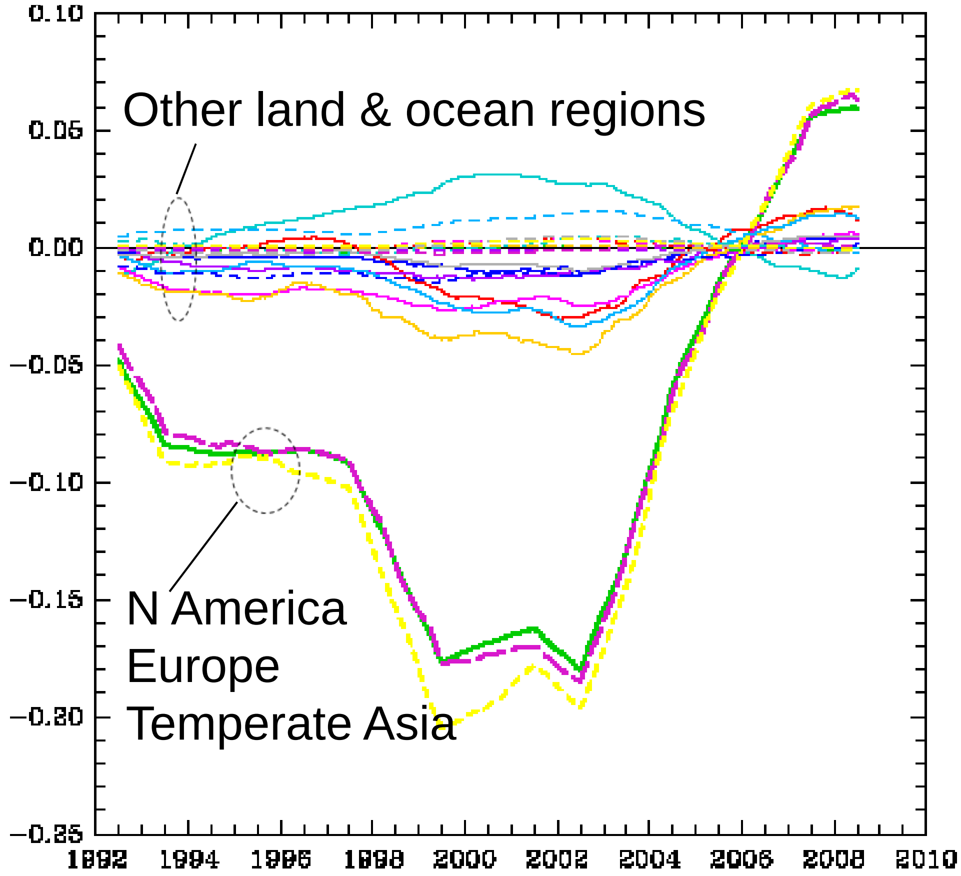
3D model runs with different FF trends

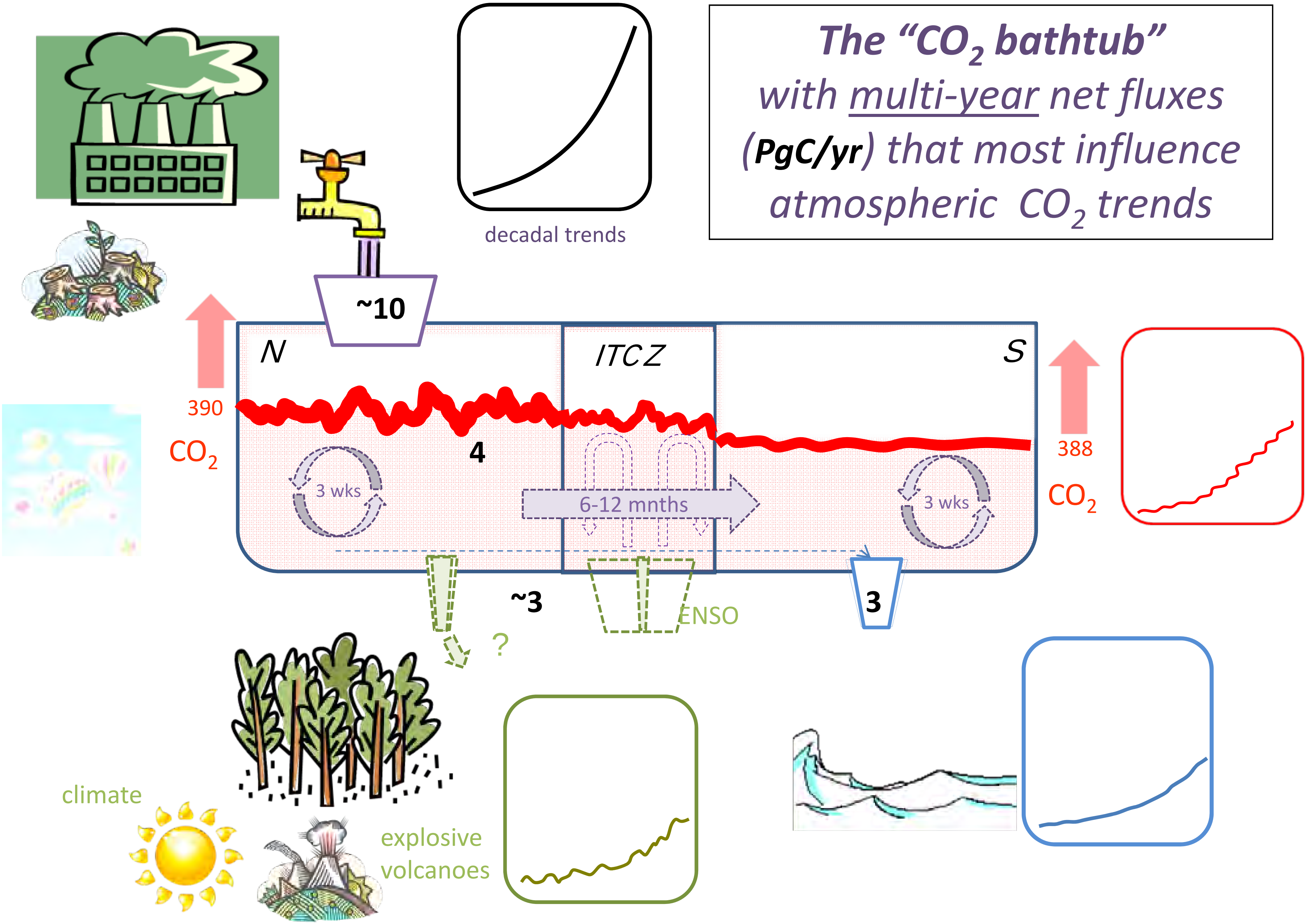
Revised fossil emissions

*Francey et al. TELLUS B, **62**, 316–328 (2010)*



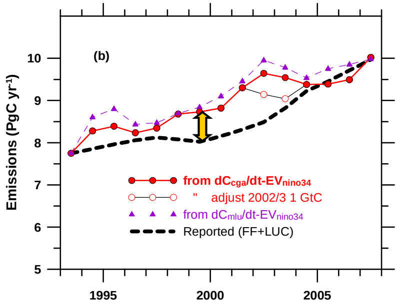
Difference (PgC/y) in model regional sinks



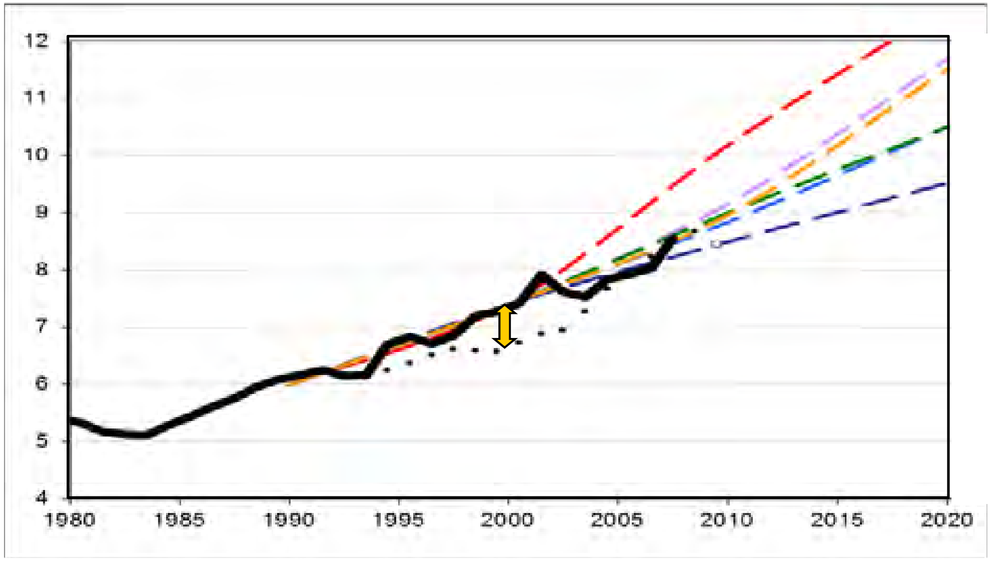


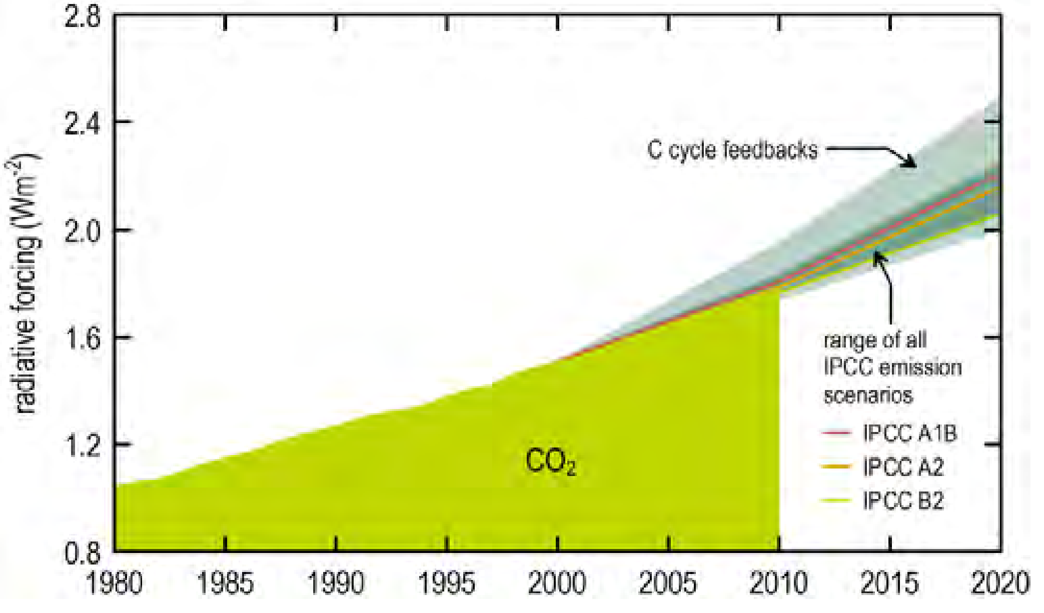
The "CO_2 bathtub" with multi-year net fluxes (PgC/yr) that most influence atmospheric CO_2 trends
decadal trends
~10
N
ITCZ
S
390
CO_2
388
CO_2
4
3 wks
6-12 mnths
3 wks
~3
ENSO
3
?
climate
explosive volcanoes

Adjust SRES to match 2000 observations:



..Francey et al. (2010)
Match to 2000 emissions from
CO_2 growth rates





..Fraser (pers. comm.)
Match to 2000 CO_2 concentrations,
converted to radiative forcing

CONCLUSIONS

- We get consistency between reported annual emissions and emissions derived from atmospheric CO_2 trends after 2004.
- By postulating a 6% underestimate in the reported 1994-2002 fossil fuel emissions (within their estimate uncertainties) we achieve consistency between emissions and atmospheric CO_2 growth throughout the last 20 years and before.
- This provides a first top-down verification of recent global emission trends, and also suggests we have been tracking the mid-range of the socio-economic scenarios in the IPCC *Special Report on Emissions Scenarios* (*SRES*).

CONCLUSIONS ctd.

- It is achieved by assuming continuing robustness in the total global sink (i.e. a near constant air-borne fraction); i.e. it does not require a decadal flip-flop between anthropogenic emissions and nearby natural sinks, which characterises behaviour in complex 3D inversion models that use the reported emissions.

- Then, atmospheric CO_2 data indicate a steady reduction in annual global emissions after 2002/3. The dip in CO_2 growth-rate around 2008, and subsequent increase, can be largely accounted for by recent increased volcanic activity.

- The N-S gradient, and high 2010/11 growth despite La Nina conditions, may be providing first indication of an acceleration in global Northern Hemisphere emissions large enough to exceed the long term growth trend.

THANK YOU