

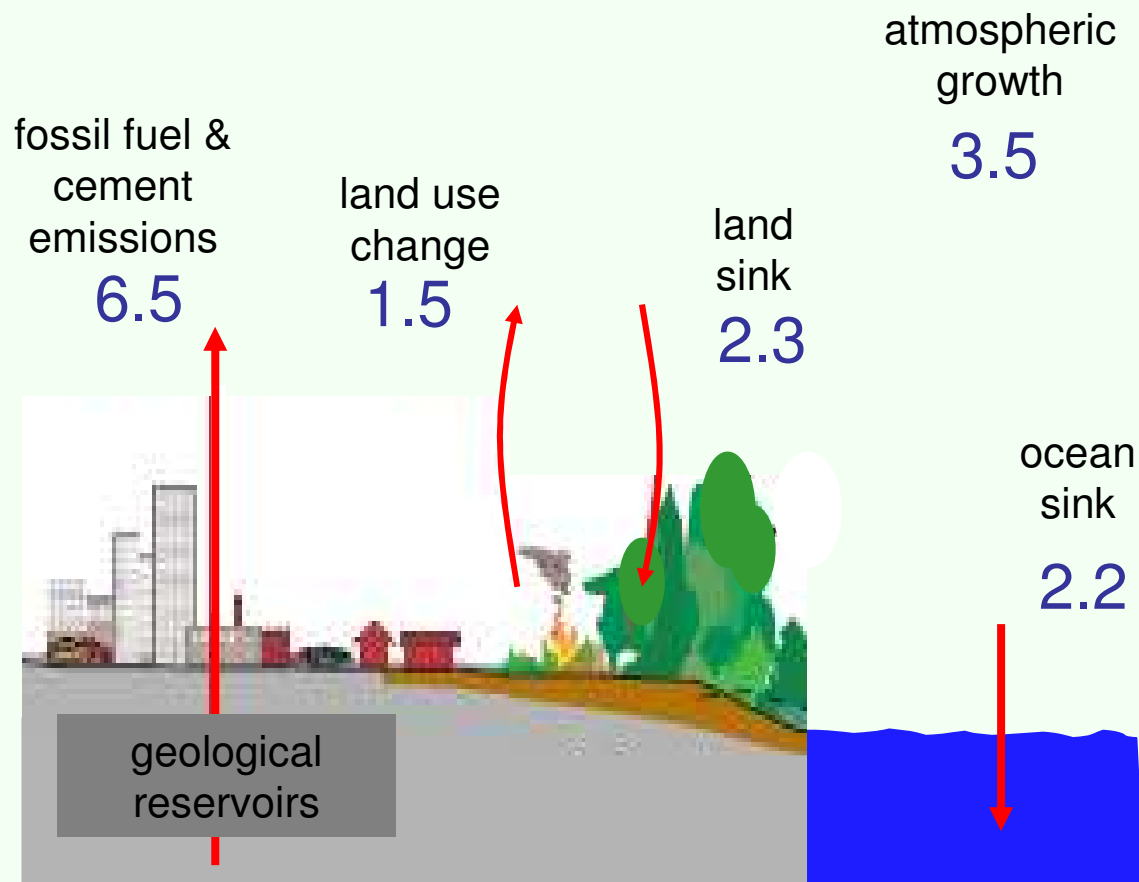
Constraints on annual emissions and sinks of CO₂

A. Durant, C. Le Quéré, C. Hope, A. Friend

with contributions from M. Raupach, J. Canadell, G. Marland, L. Bopp, P. Ciais, T. Conway, S. Doney, R. Feely, P. Foster, P. Friedlingstein, K. Gurney, R. Houghton, J. House, C. Huntingford, P. Levy, M. Lomas, J. Majkut, N. Metzler, J. Ometto, G. Peters, C. Prentice, J. Randerson, C. Rödenbeck, S. Running, J. Sarmiento, U. Schuster, S. Sitch, T. Takahashi, N. Viovy, G. van der Werf, F. Woodward

global CO₂ budget (PgC/y)

1980-2008

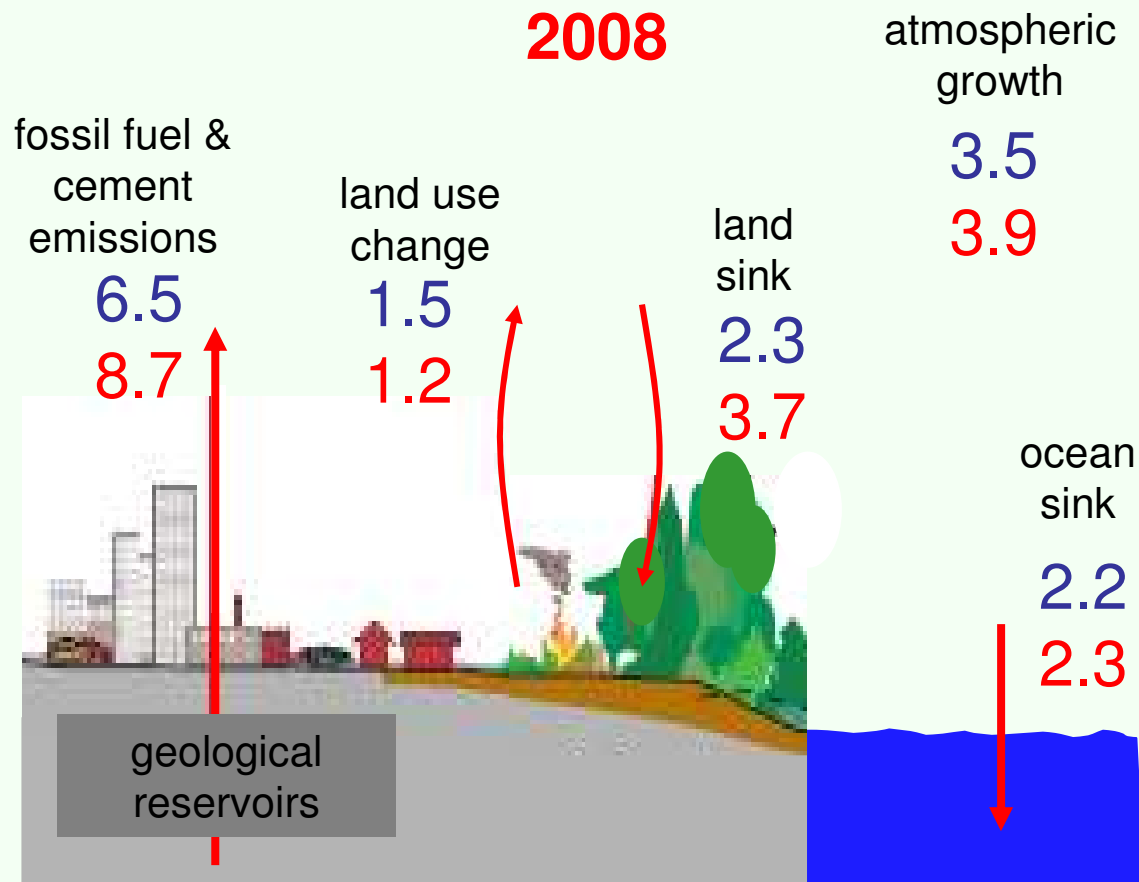


1 PgC = 1 GtC = 3.7 Gt CO₂ = 10¹⁵ g C

global CO₂ budget (PgC/y)

1980-2008

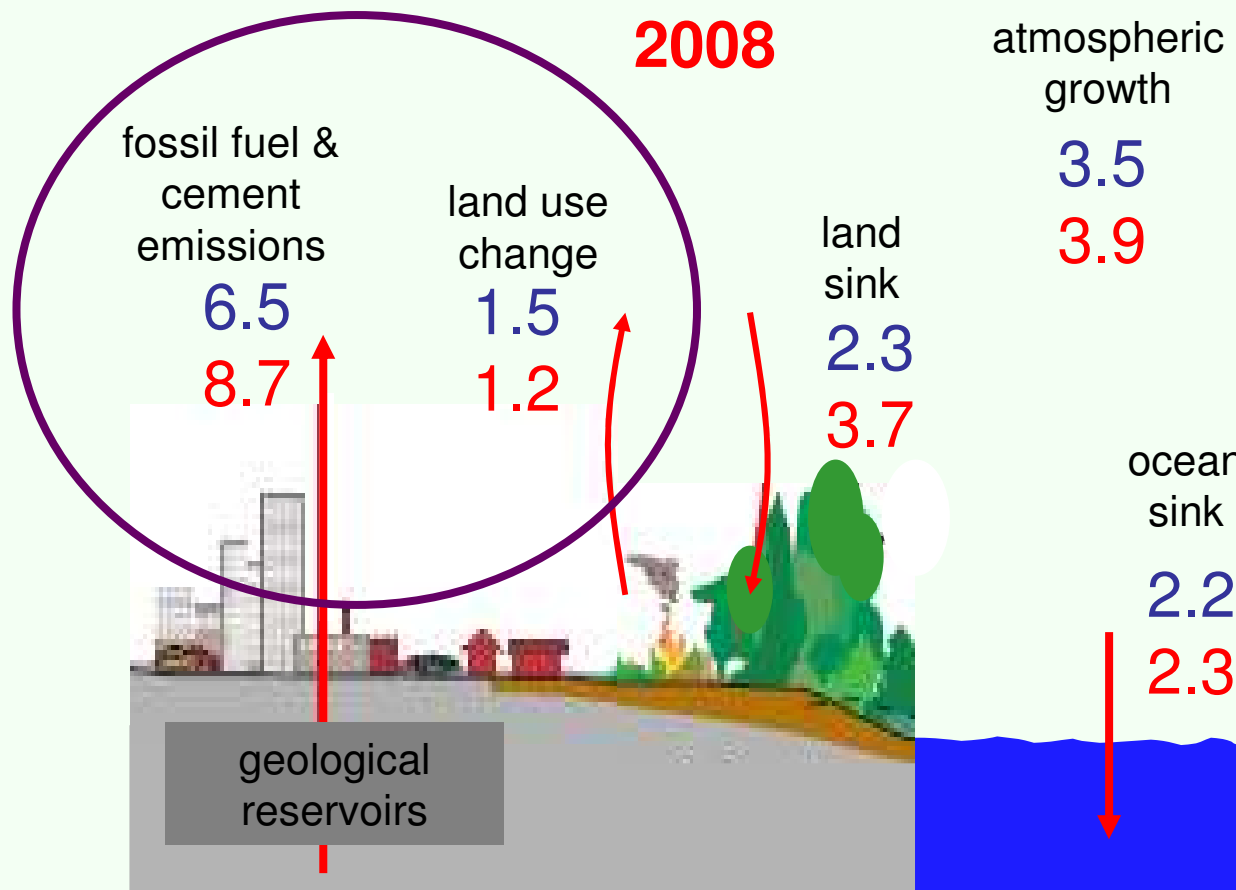
2008



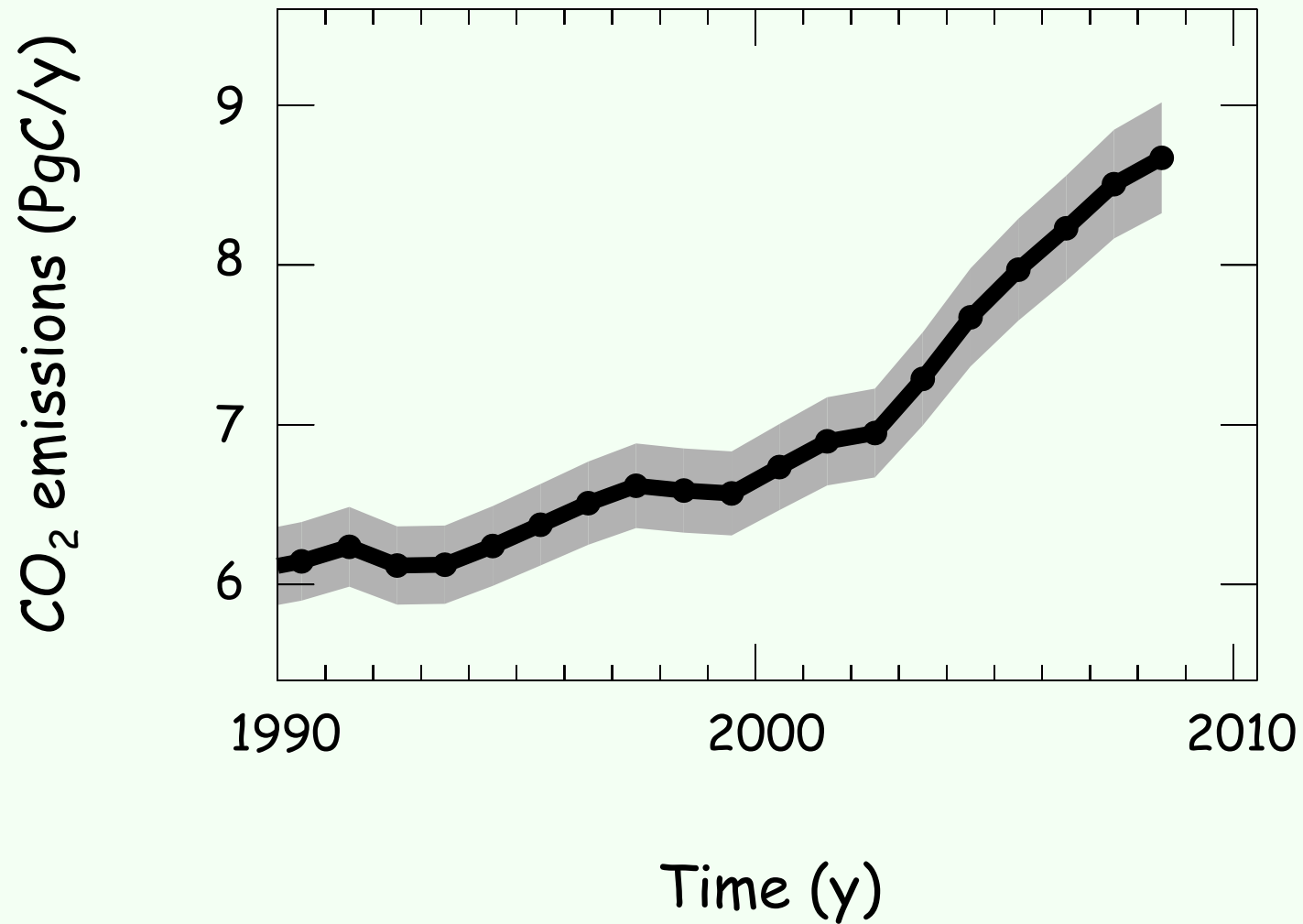
global CO₂ budget (PgC/y)

1980-2008

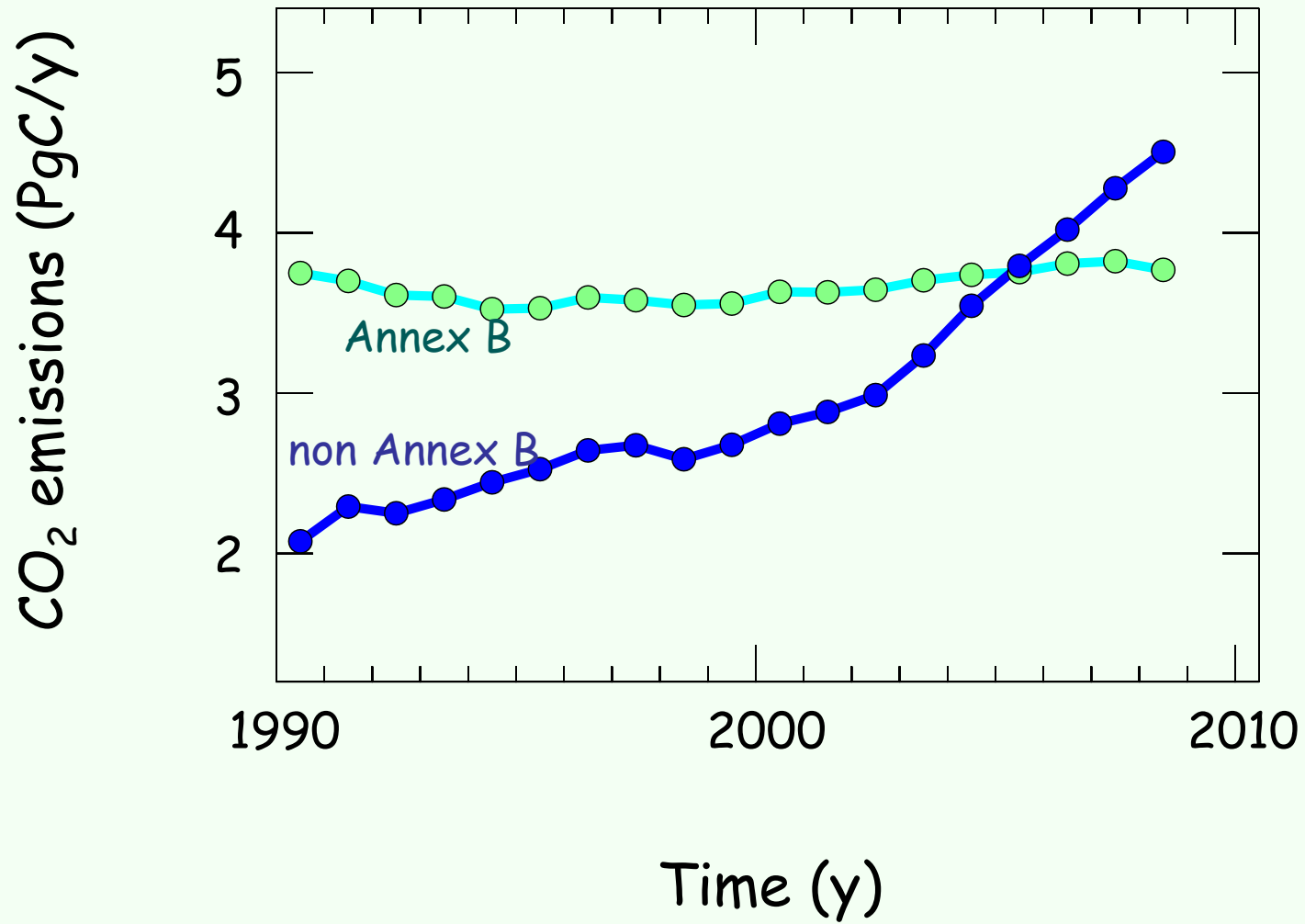
2008



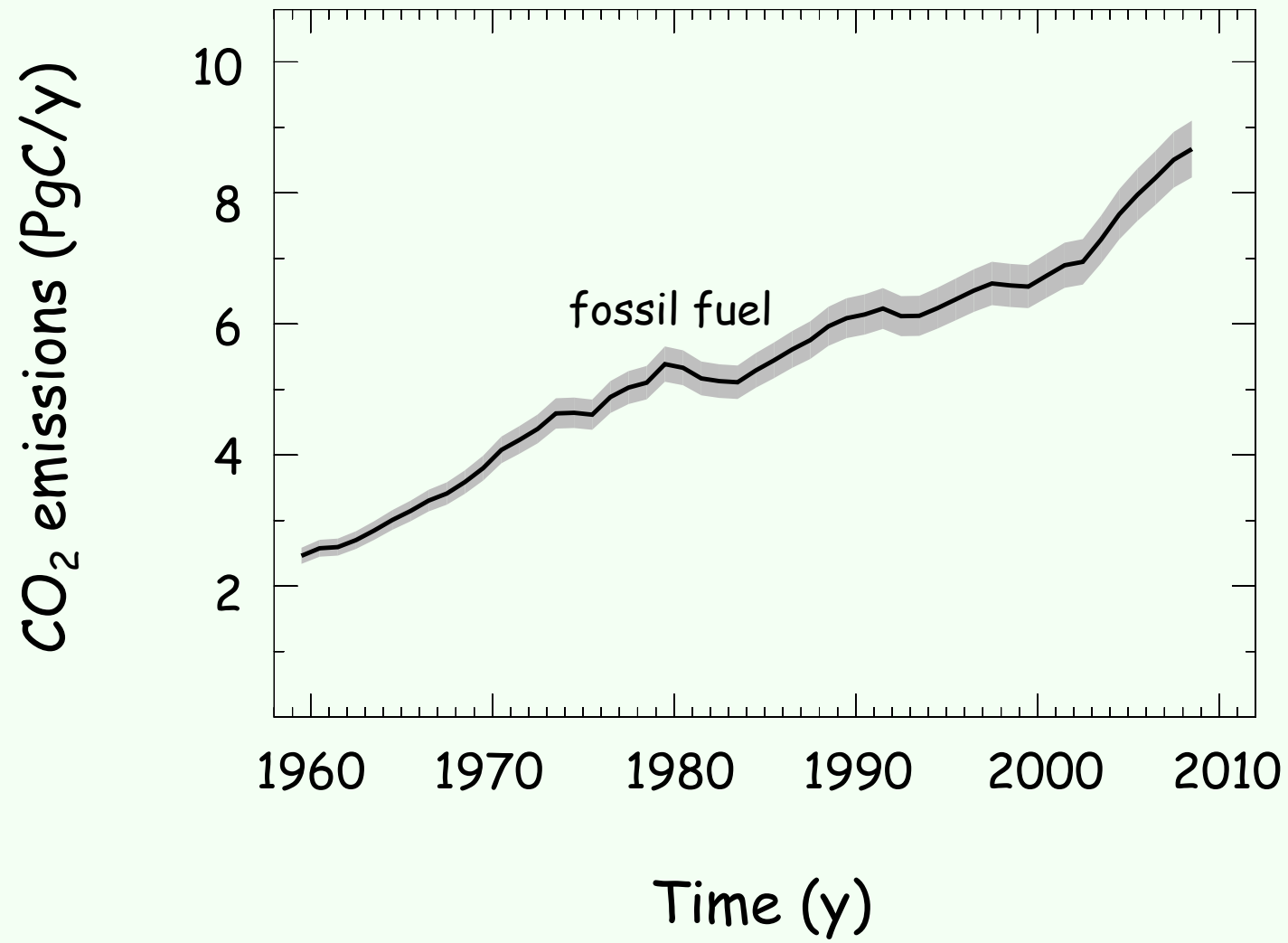
Fossil fuel plus cement production

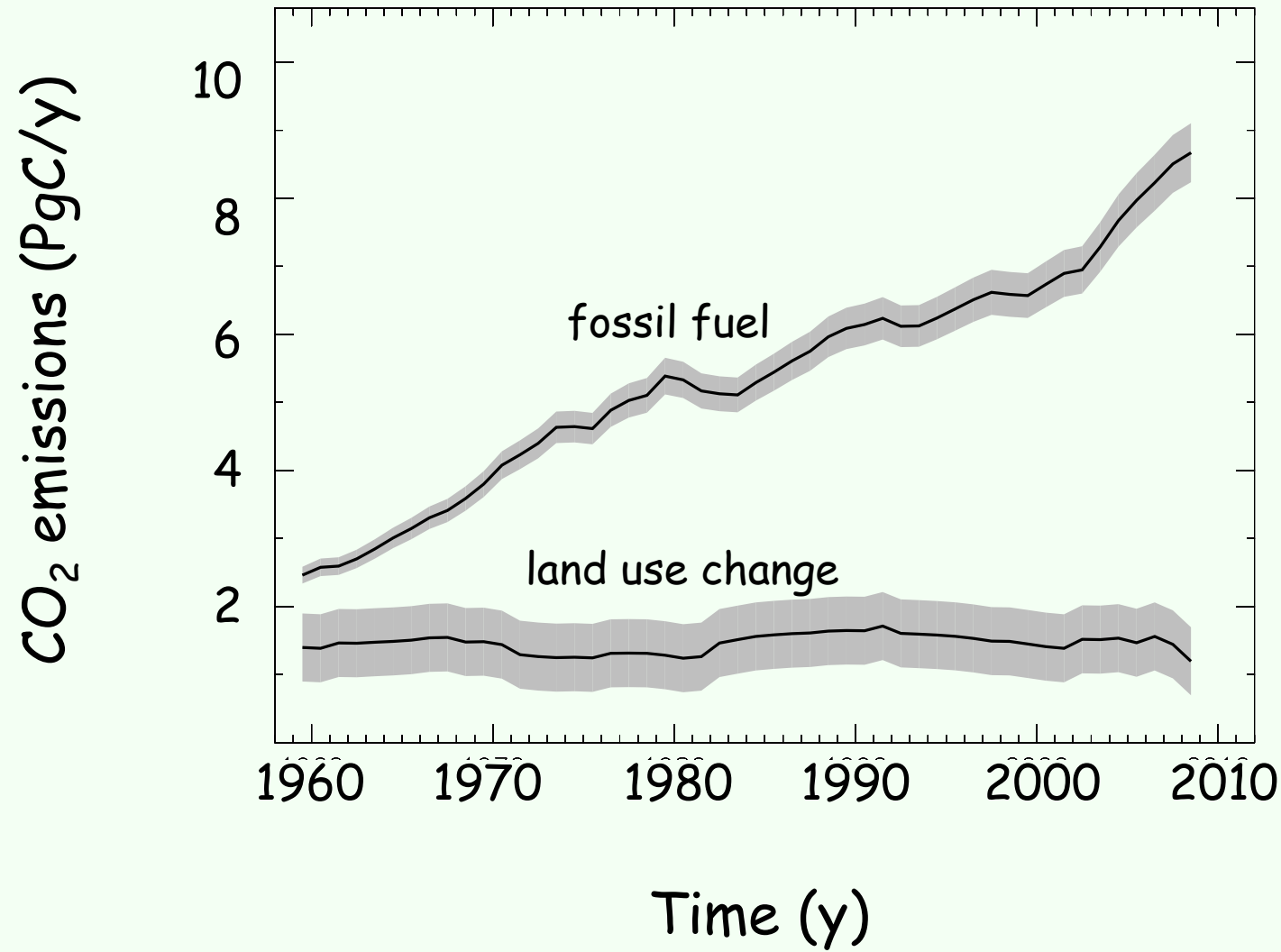


Data: Carbon Dioxide Information Analysis Center (CDIAC)

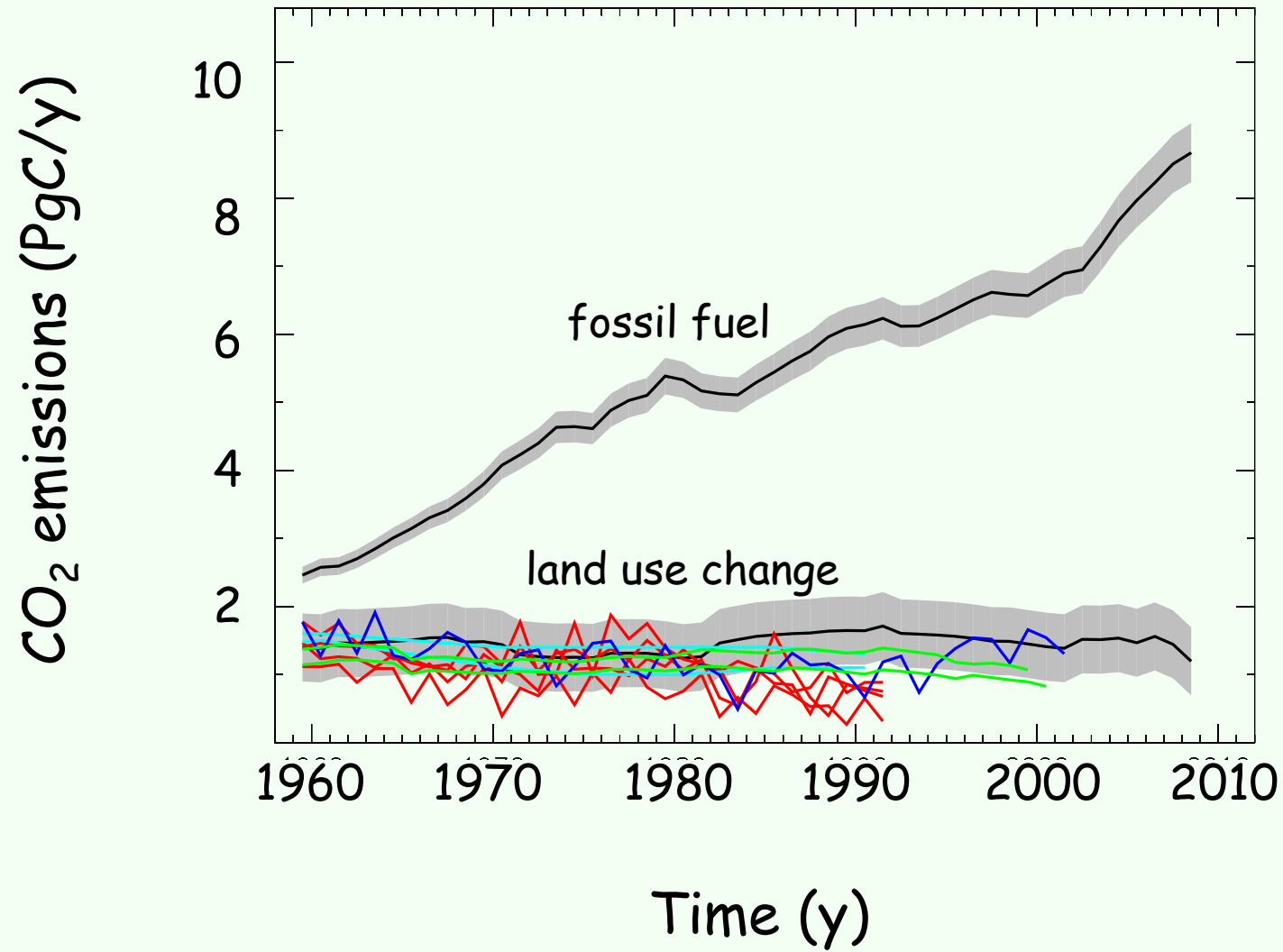


Data: Carbon Dioxide Information Analysis Center (CDIAC)

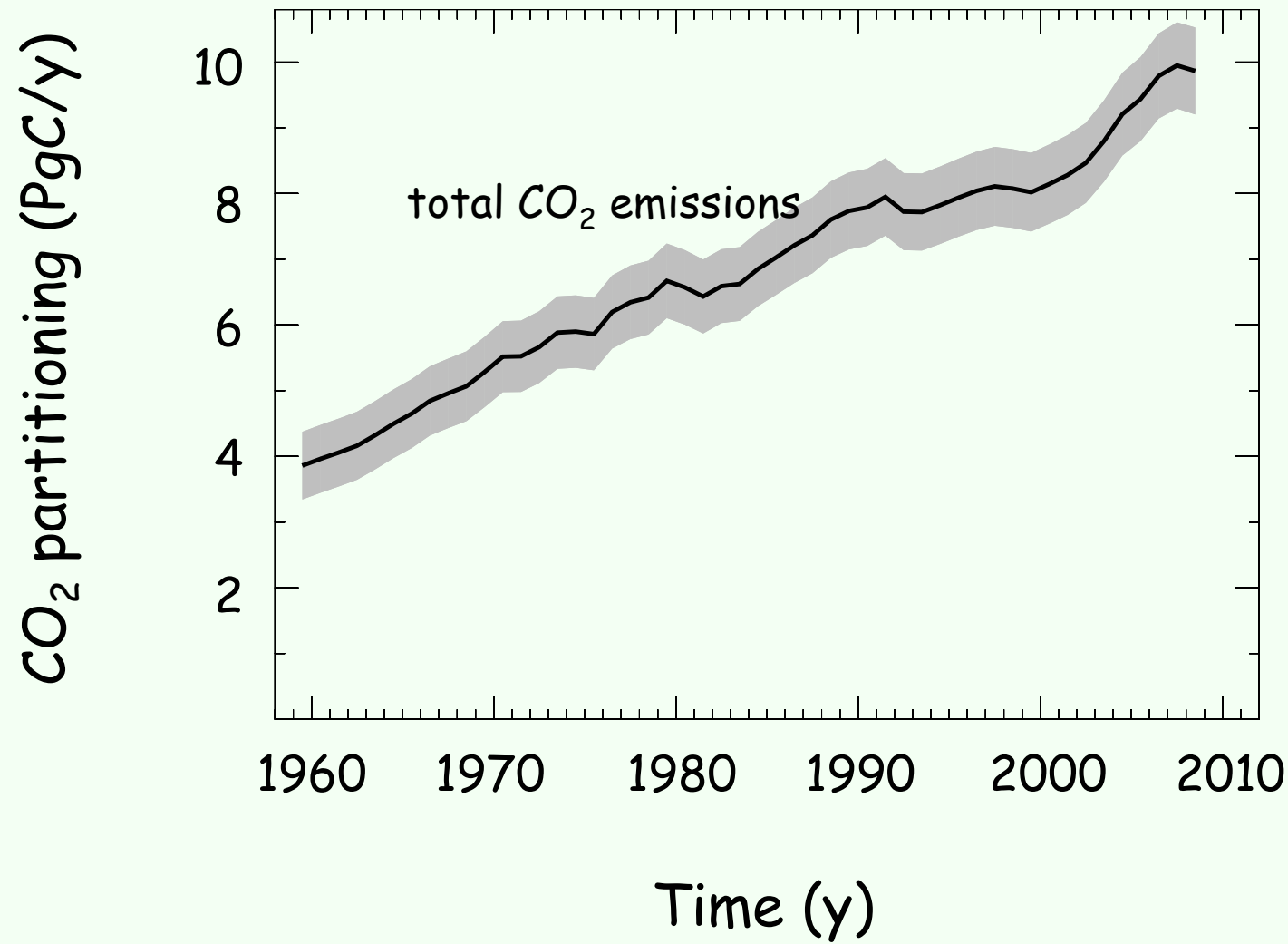




Data: Oak Ridge National Laboratory and Woods Hole Research Center



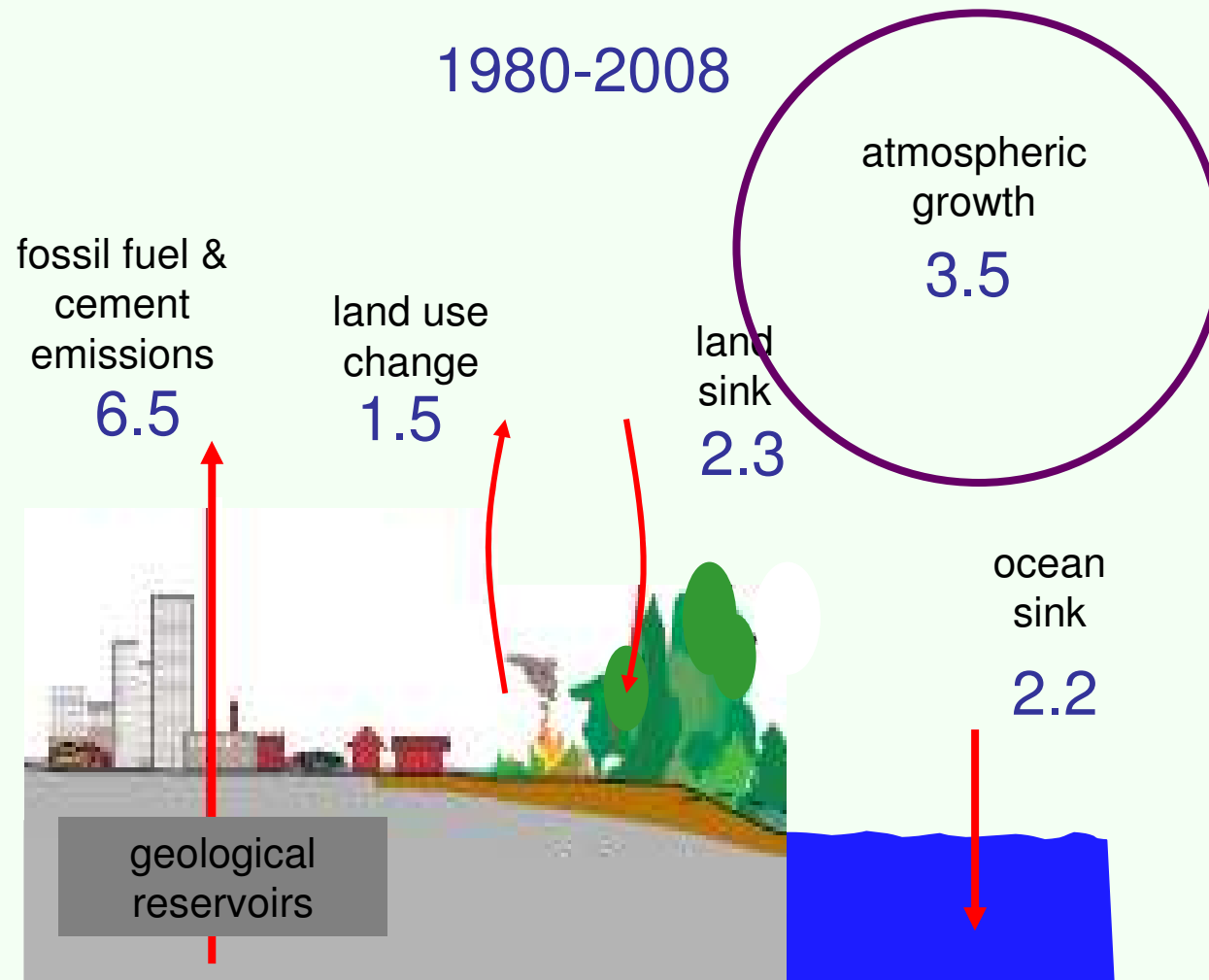
Data: McGuire et al 2001; Van Minnen et al. 2009; Piao et al. 2009; Shevliakova et al. 2009

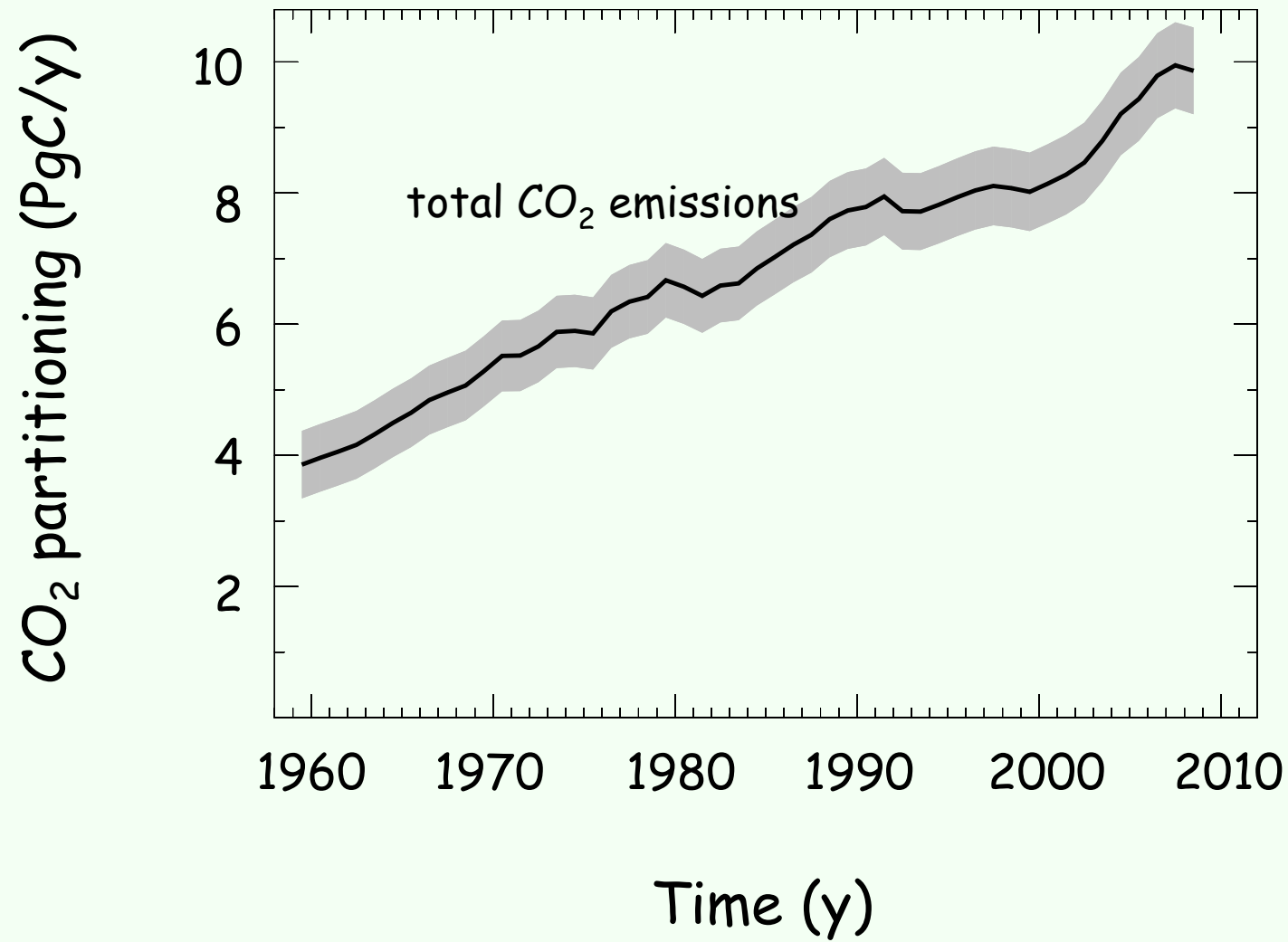


Data: Global Carbon Project 2009

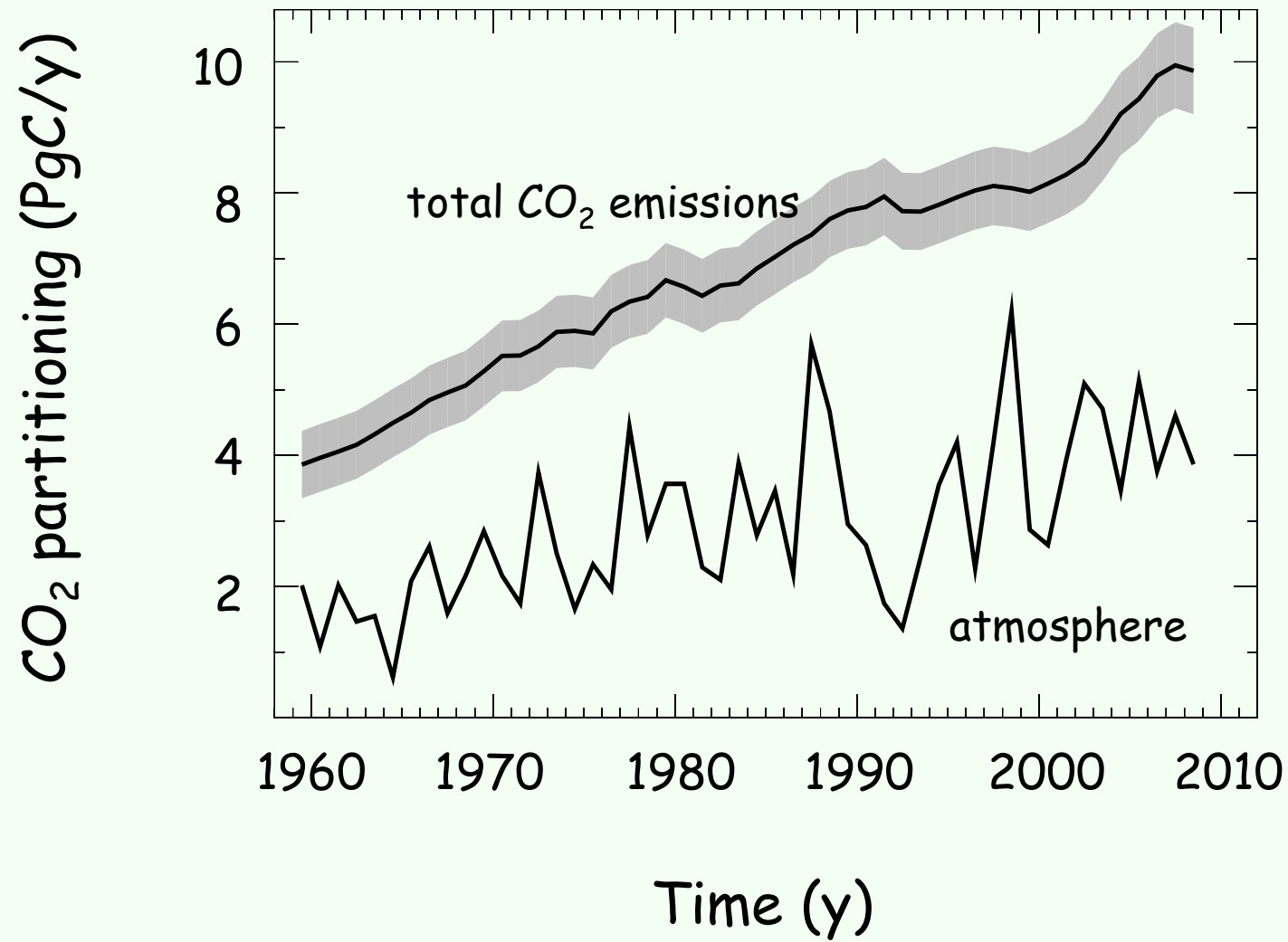
global CO₂ budget (PgC/y)

1980-2008





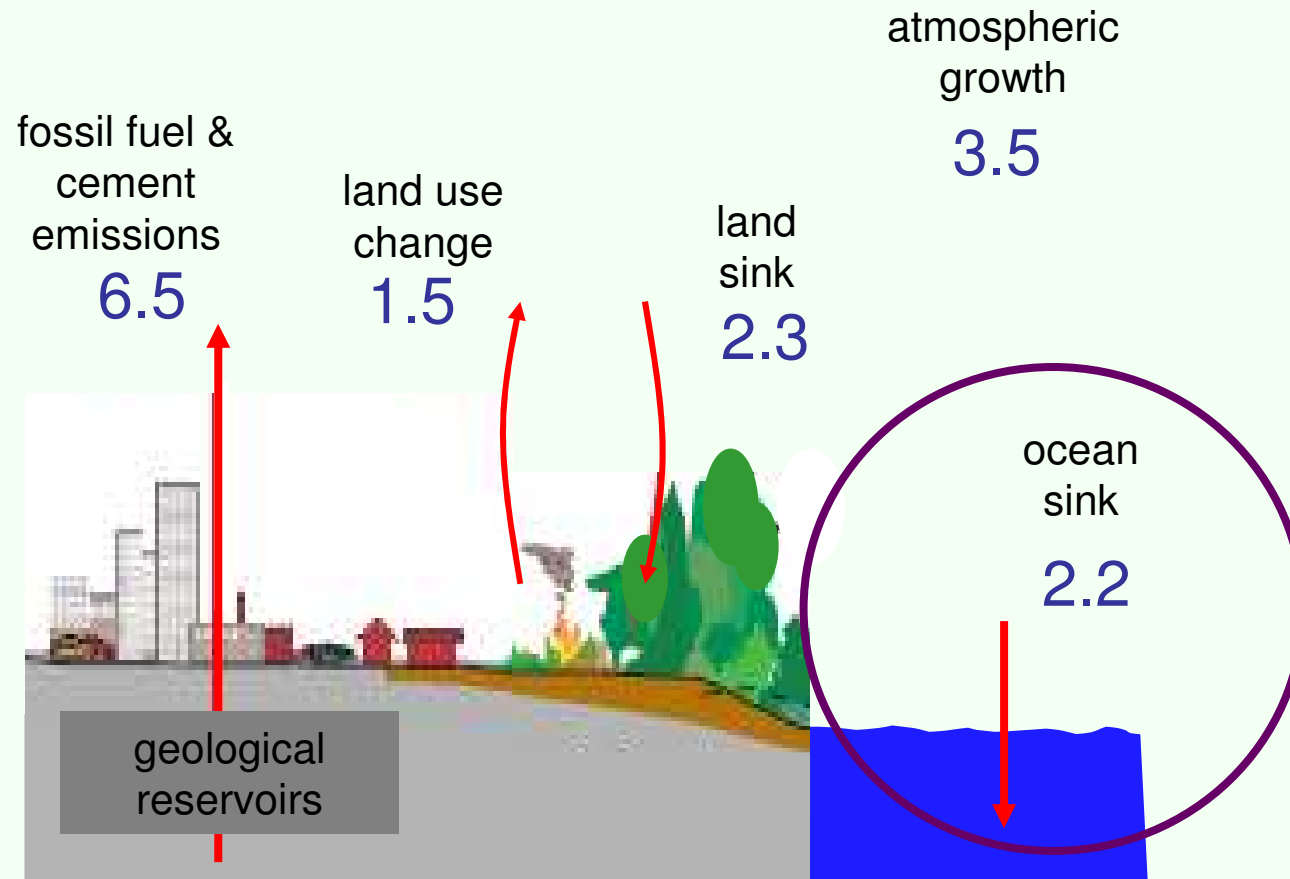
Data: Global Carbon Project 2009

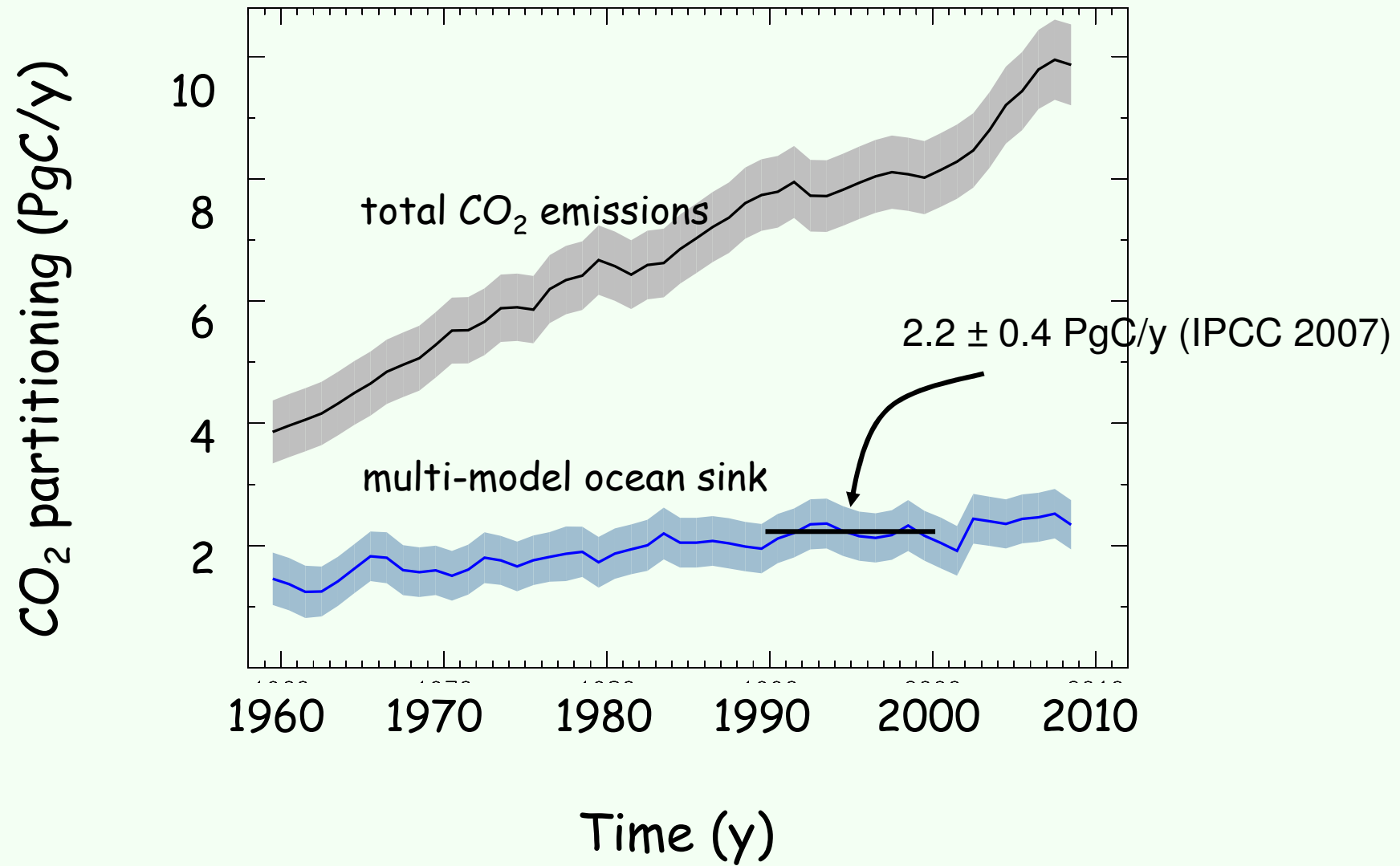


data: National Oceanic and Atmospheric Administration (NOAA), Earth System Research Laboratory

global CO₂ budget (PgC/y)

1980-2008

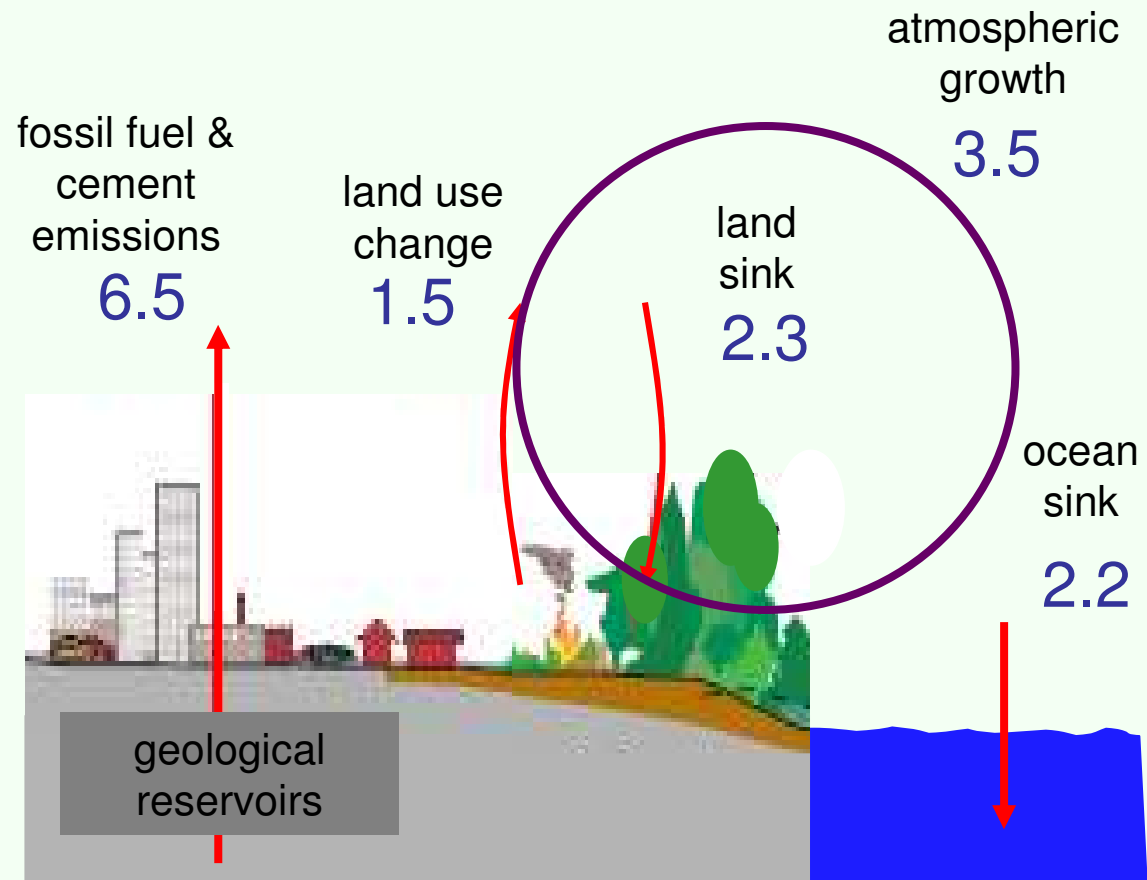


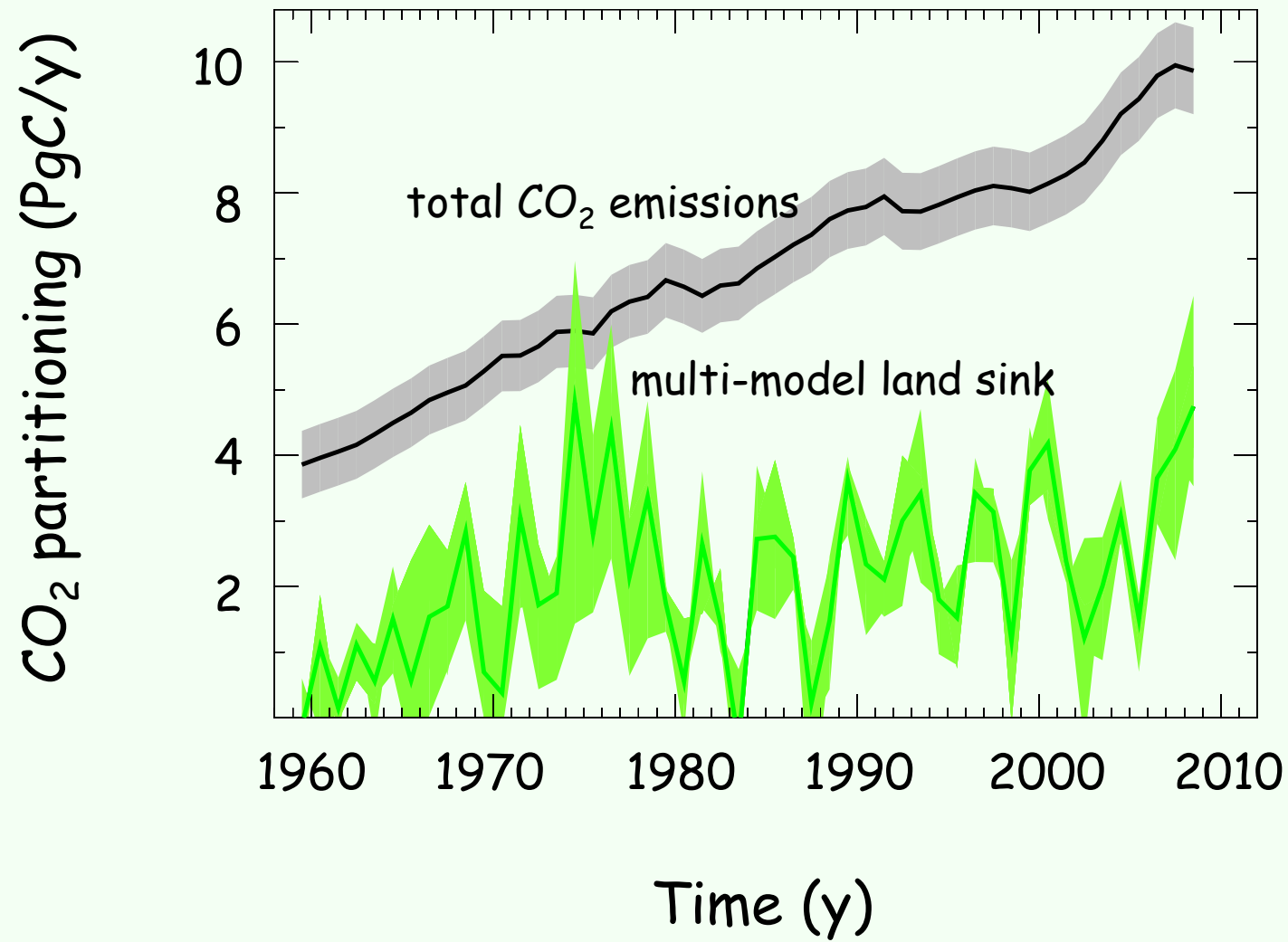


Models from: LSCE, Woods Hole, Princeton, UEA/BAS

global CO₂ budget (PgC/y)

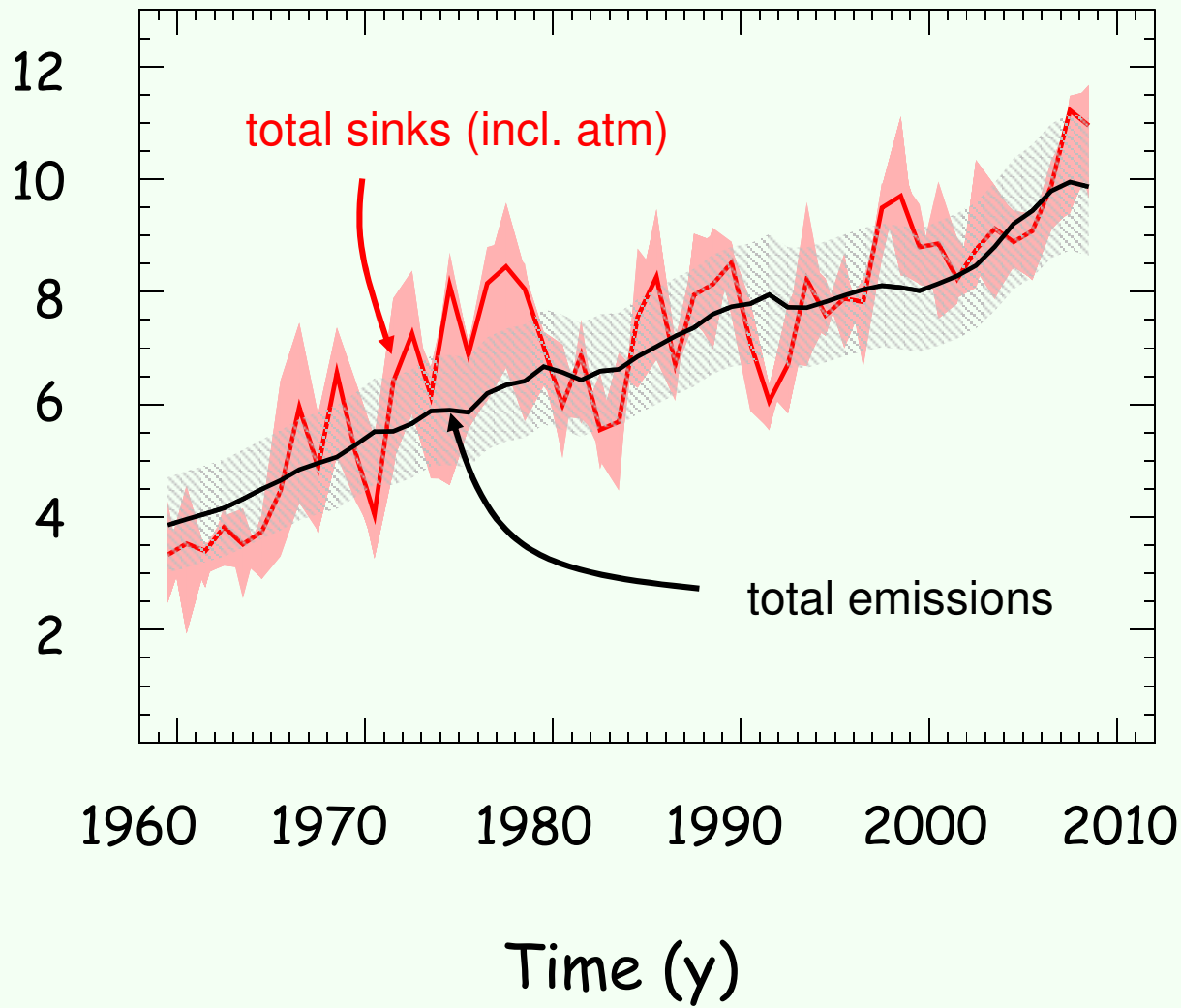
1980-2008





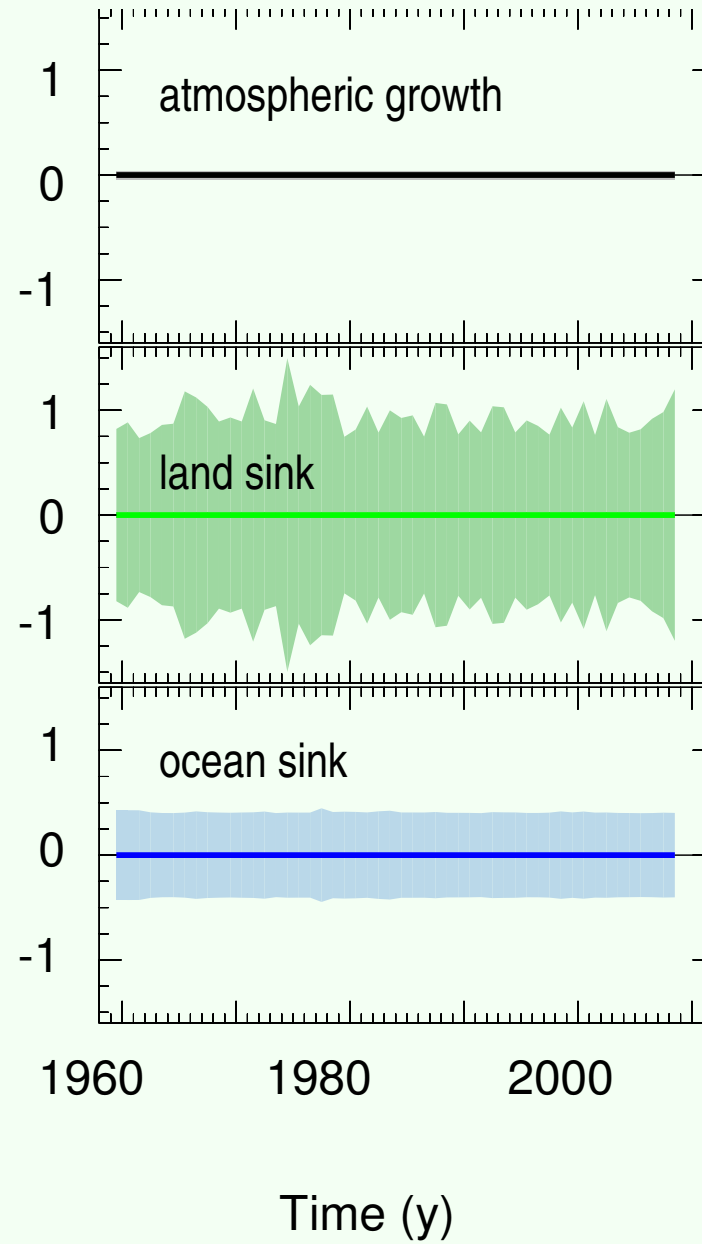
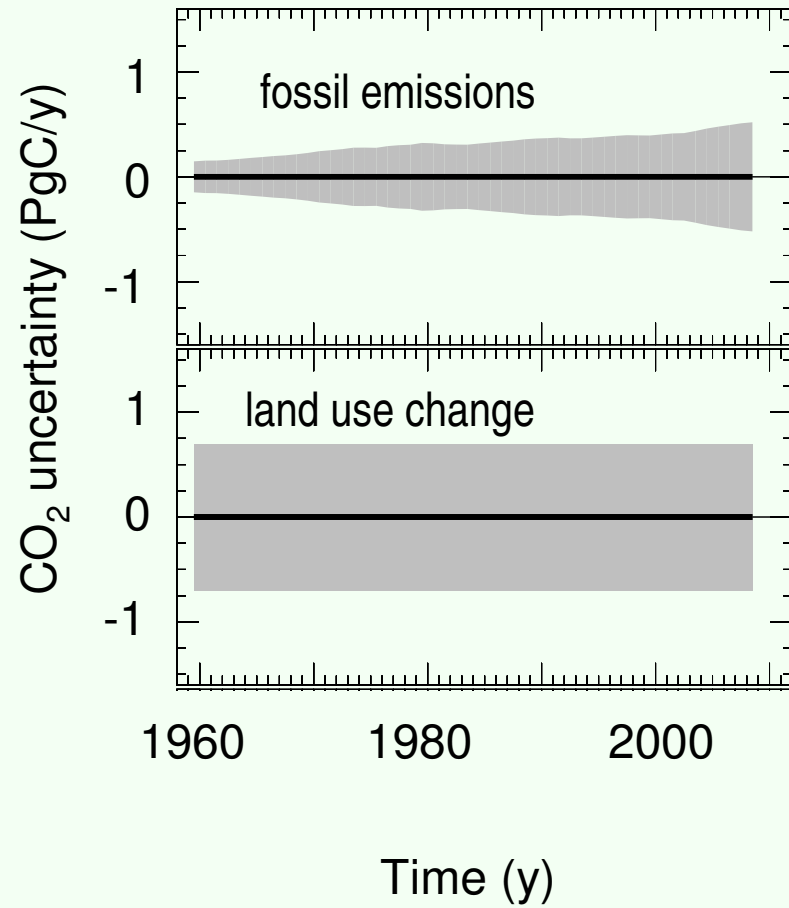
Models from Sitch et al. (2008): Orchidee, LPJ, Hyland, SDGVM, Triffid

CO₂ partitioning (PgC/y)

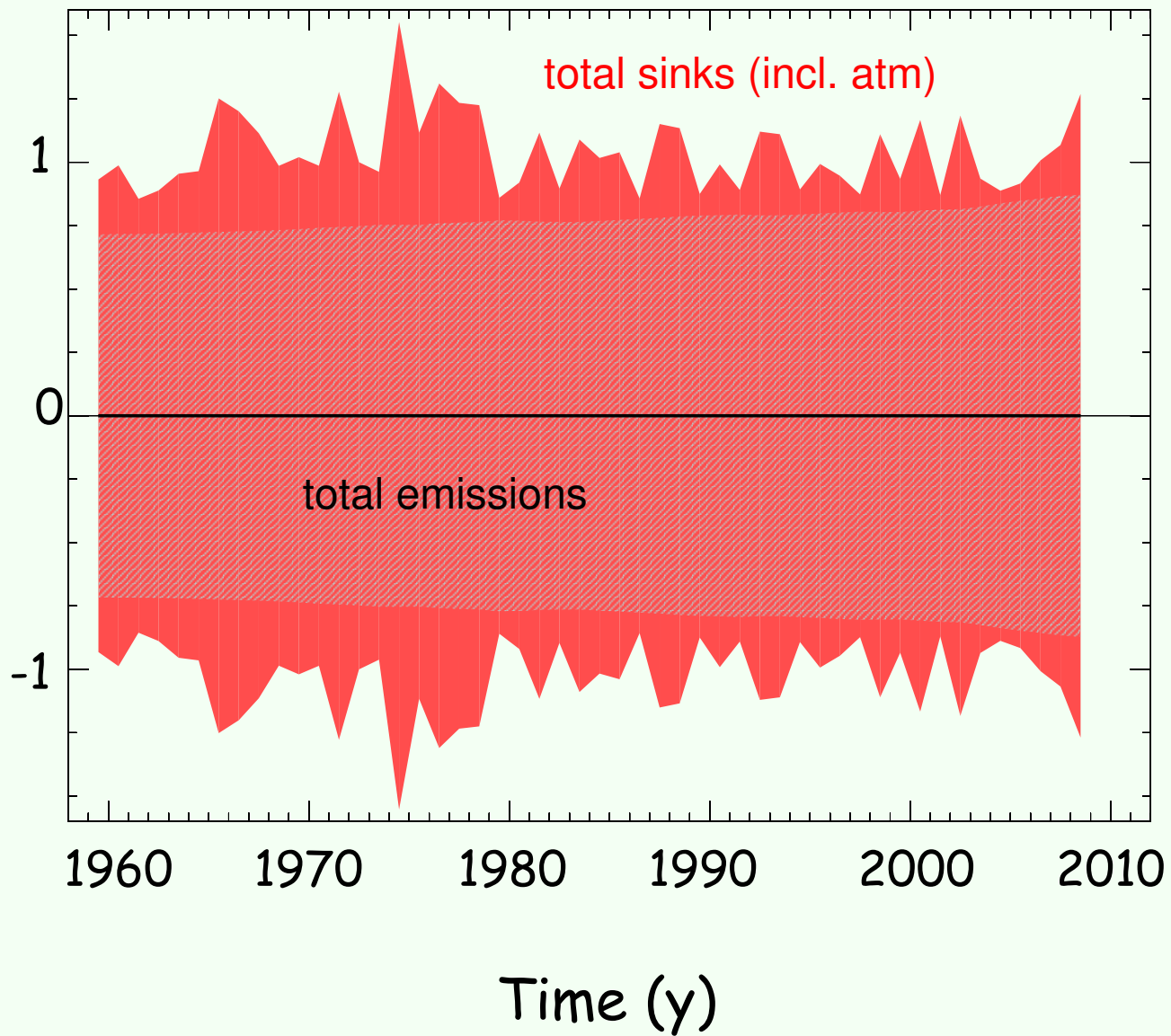


minimum
useful
uncertainty

evolution of the uncertainty through time



CO₂ uncertainty (PgC/y)



minimum
useful
uncertainty

Potential for reducing the uncertainty

	Uncertainty (PgC/y)	Potential	Method	Cost
Fossil fuel	± 0.5	L	improve infrastructure	H
Land use	± 0.7	M	improve statistics w satellite, improve models	M

L = low M = medium H = high

Potential for reducing the uncertainty

	Uncertainty (PgC/y)	Potential	Method	Cost
Fossil fuel	± 0.5	L	improve infrastructure	H
Land use	± 0.7	M	improve statistics w satellite, improve models	M
Atmosphere	$<\pm 0.1$	L	maintain efforts	L
Ocean	± 0.5	M	expand surveys, improve models	L
Land	± 1.5	H	improve models	L

(note: improving models also implies
improving data for input and validation)

L = low M = medium H = high

Conclusions

1. The minimum useful uncertainty could be reached with the expansion of existing methods.
2. A better annual budget could provide early warning for
 - problems in reported emissions, or
 - unexpected responses of the CO₂ sinks.
3. The cost of monitoring global CO₂ is far less than the potential impact of exceeded emissions.