Are oceanic and terrestrial sinks of CO_2 not able to keep up with emissions?

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The sky is falling….

Le Quéré et al., Saturation of the Southern Ocean CO2 sink due to recent climate change. (Science 2007)

Schuster and Watson, A variable and decreasing sink for atmospheric CO2 in the North Atlantic. (J. Geophys. Res. 2007)

Canadell et al., Contributions to accelerating atmospheric CO2 growth from economic activity, carbon intensity, and efficiency of natural sinks. (PNAS 2007)

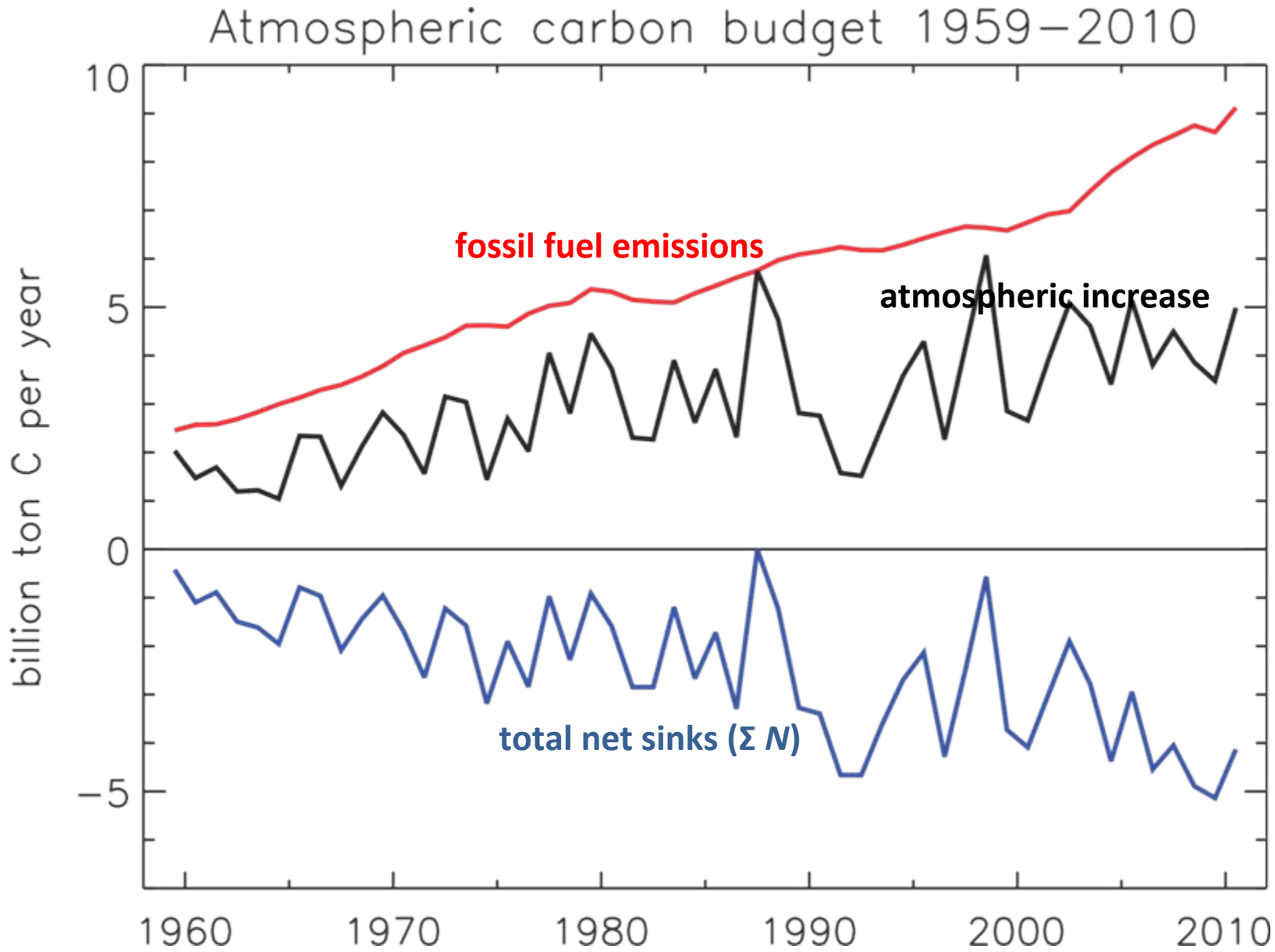
Piao et al., Net carbon dioxide losses of northern ecosystems in response to autumn warming. (Nature 2008)

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

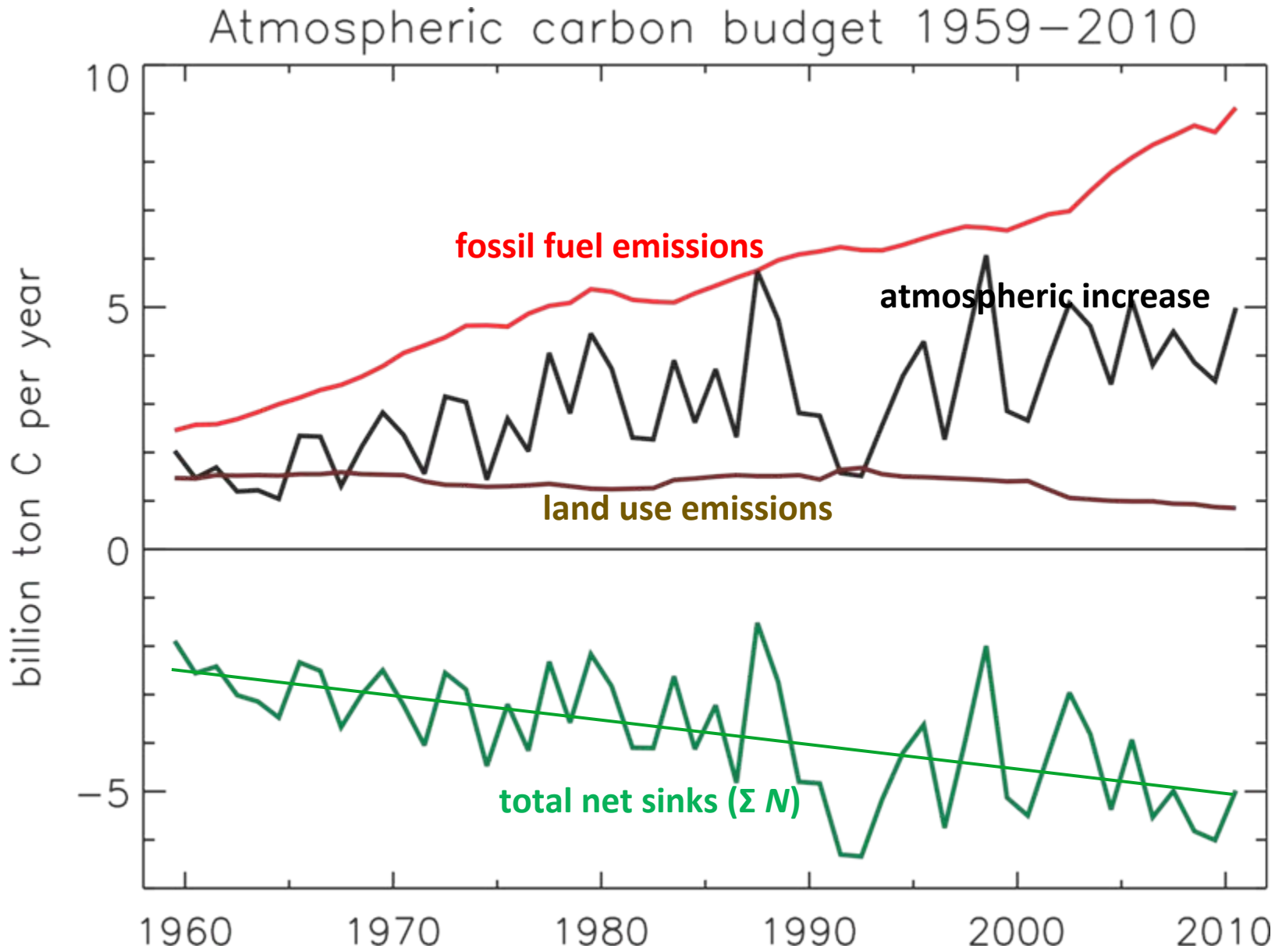
Zhao and Running, Drought-induced reduction in global terrestrial net primary production from 2000 through 2009. (Science 2010)

McKinley et al., Convergence of atmospheric and North Atlantic CO2 trends on multi-decadal time scales. (Nature Geoscience 2011)

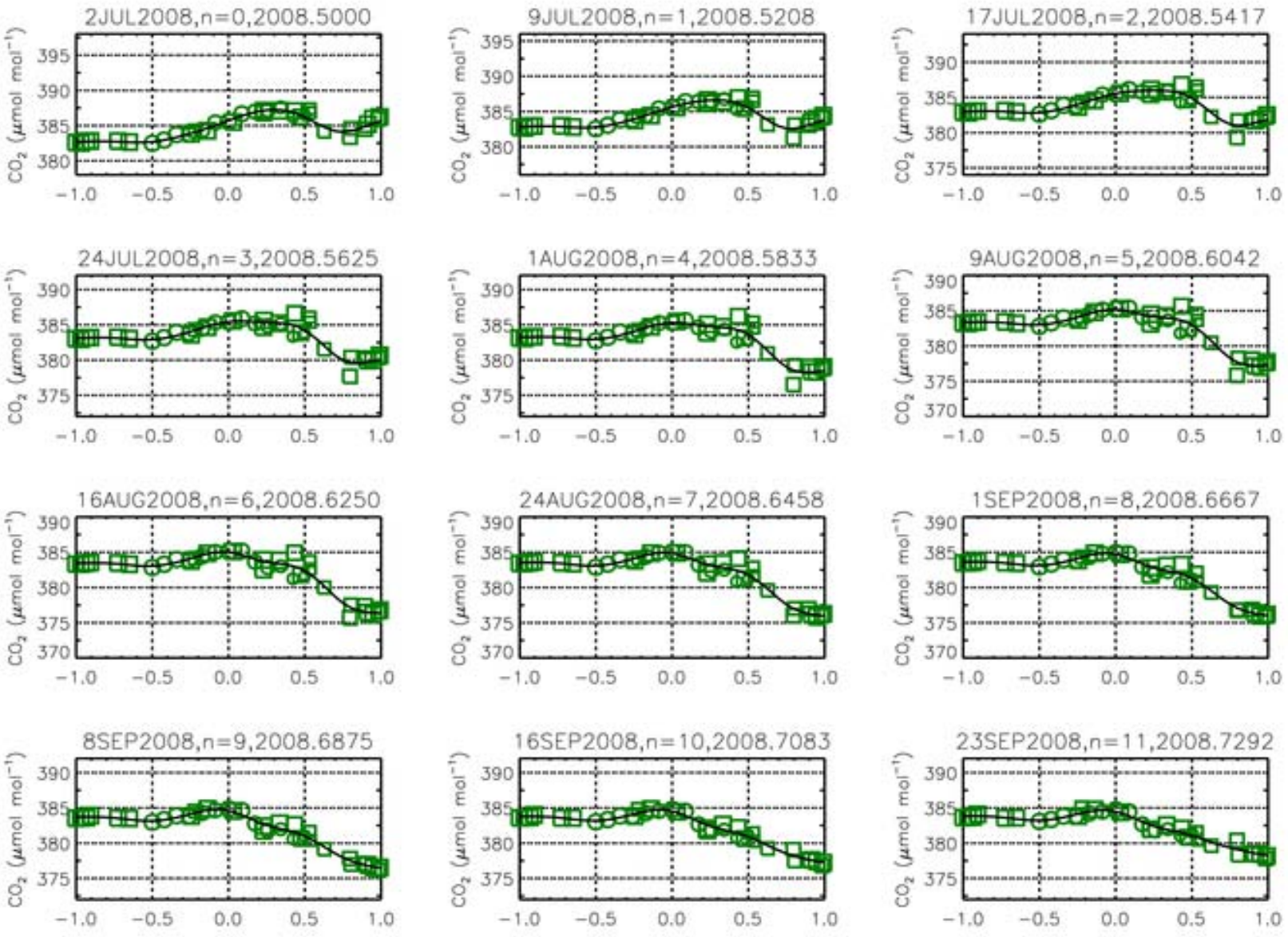
$$\frac{d(Atm)}{dt} = FF + \Sigma N$$



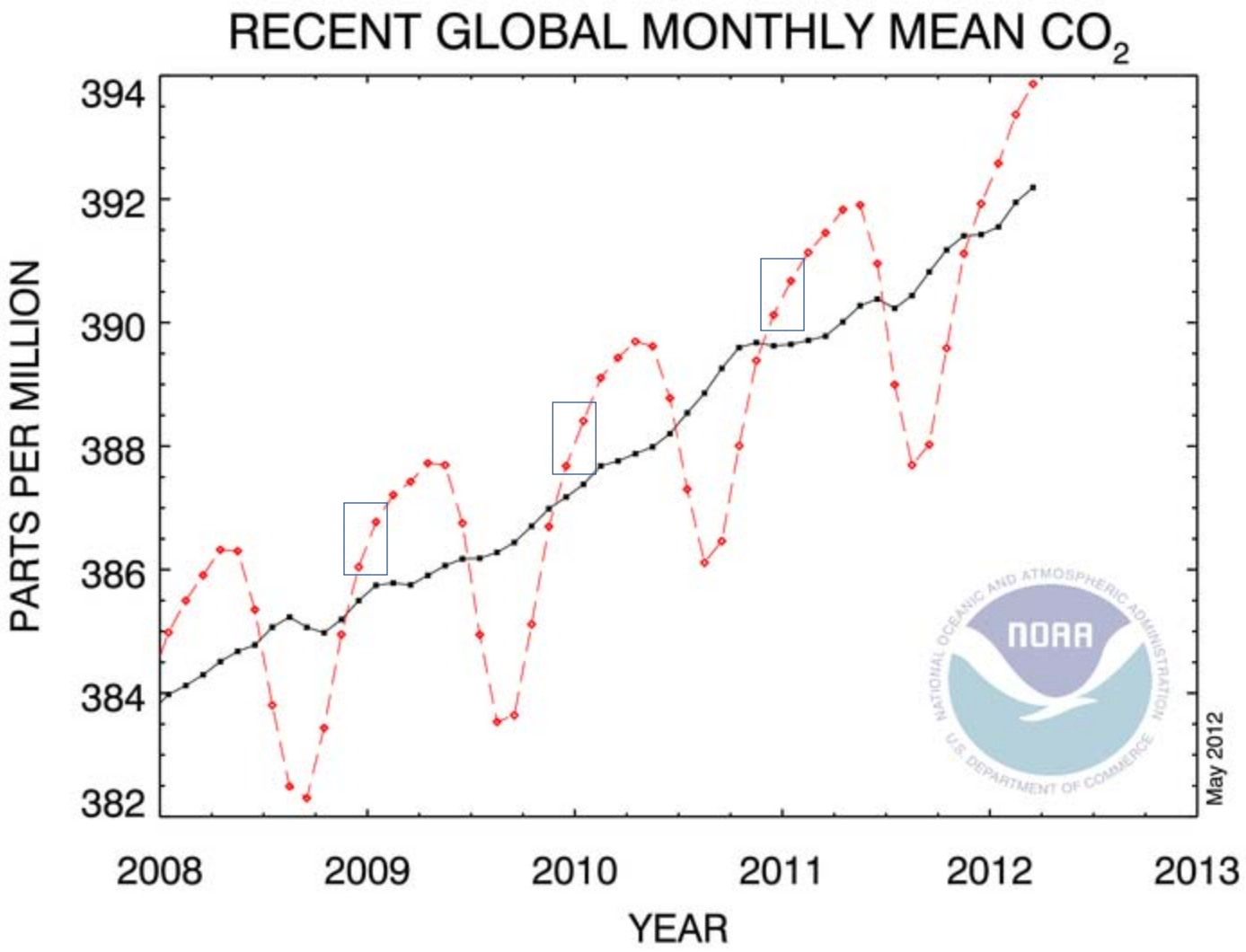
$$\frac{d(Atm)}{dt} = FF + LUC + \Sigma N$$



Marine boundary layer reference (time, sine of latitude)



UNCERTAINTY OF ATMOSPHERIC ANNUAL GROWTH RATE



www.esrl.noaa.gov/gmd/ccgg/trends/

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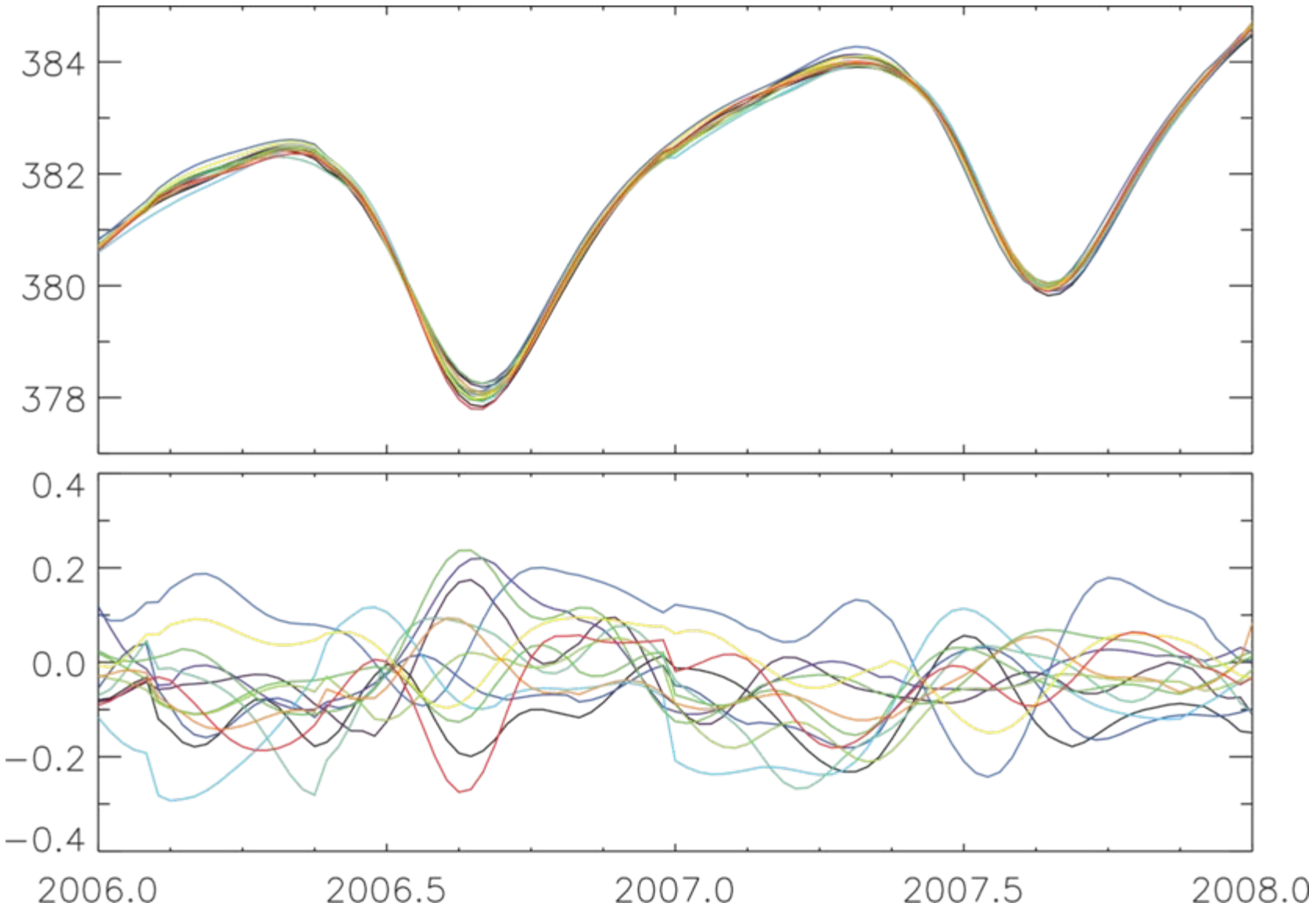
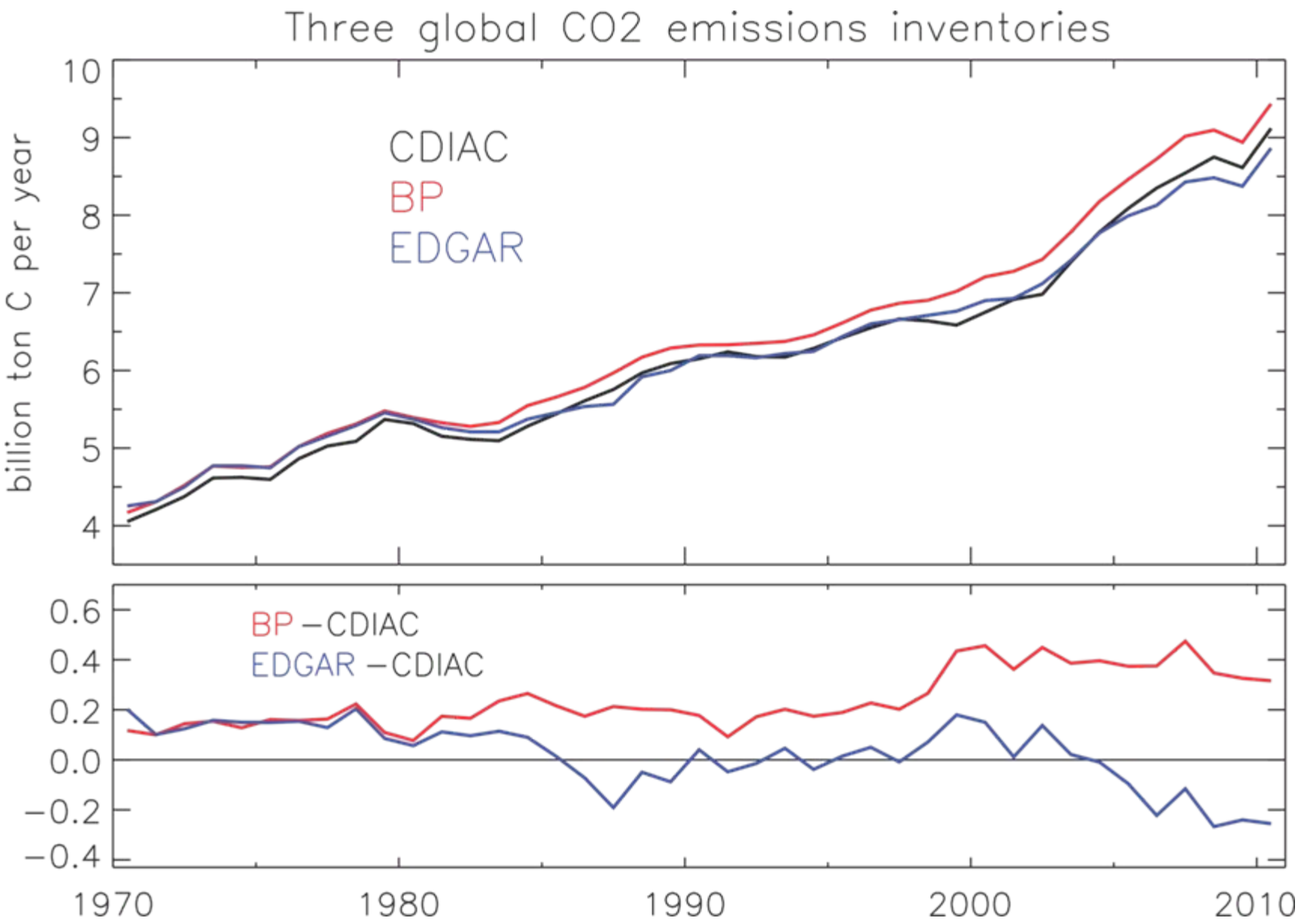
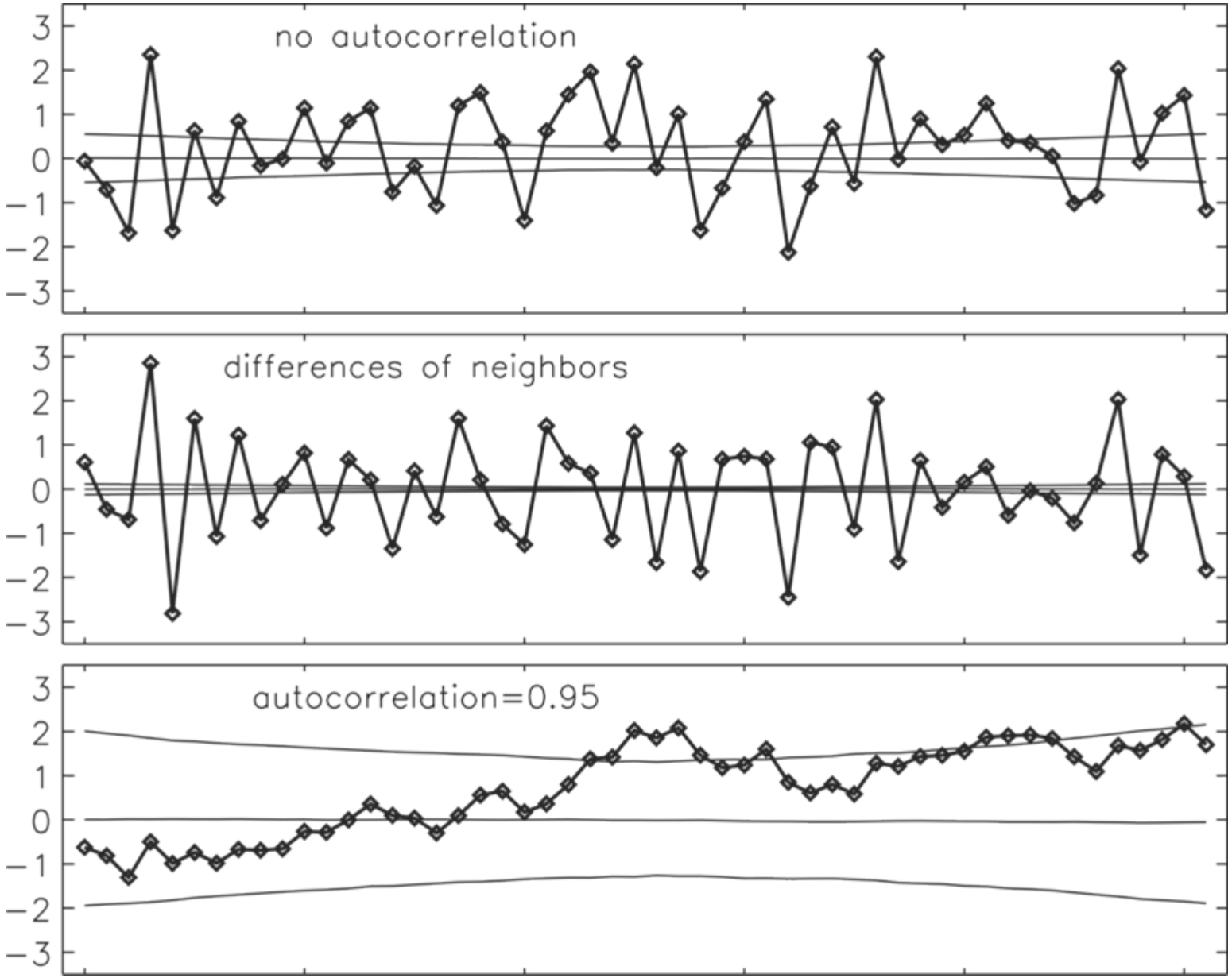


UNCERTAINTY OF EMISSIONS



Impact of correlation on error of trend estimation



Global trends of atmospheric CO2, emissions, and transfers to ocean and biosphere

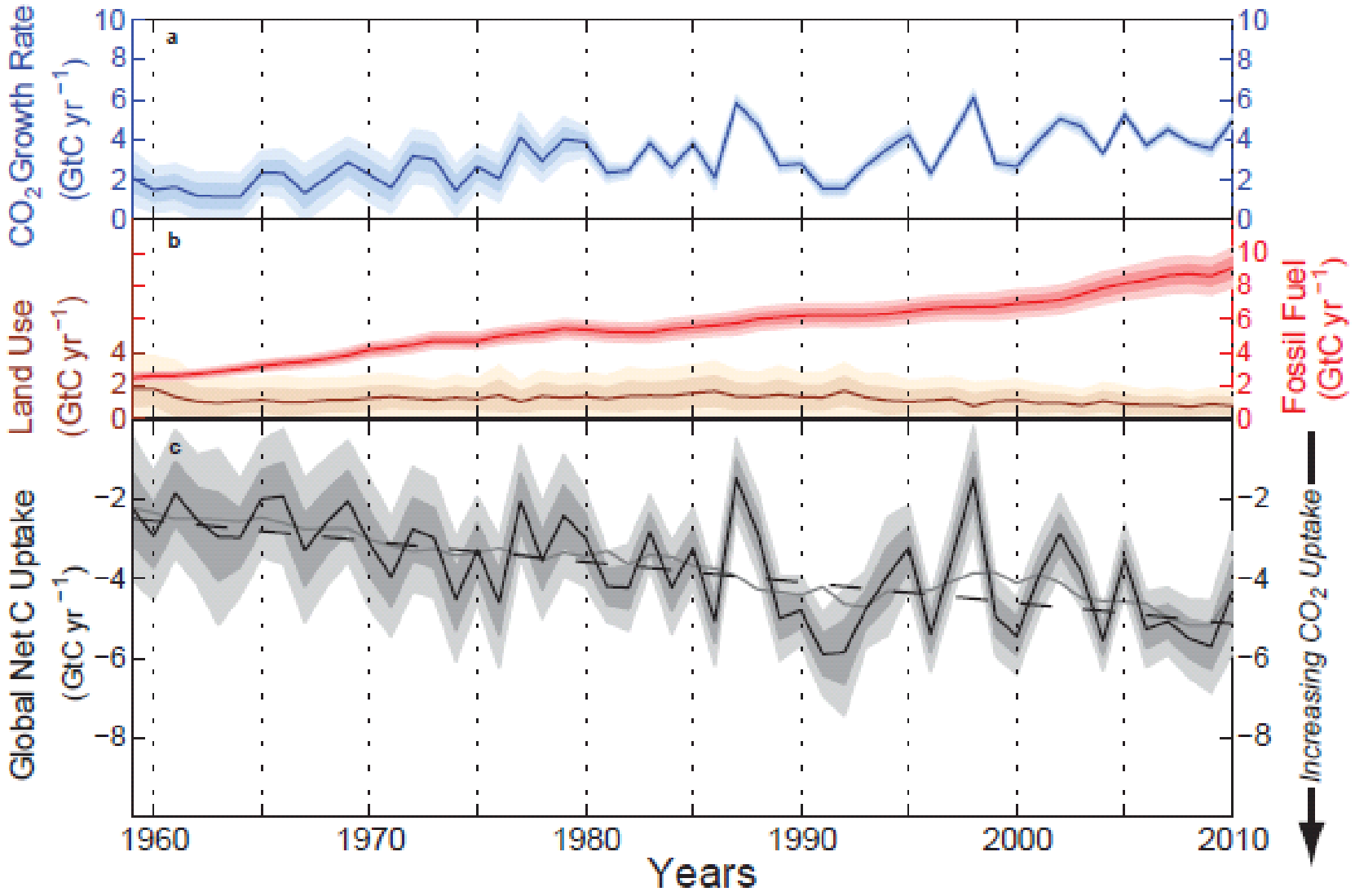


Figure: Ashley Ballantyne

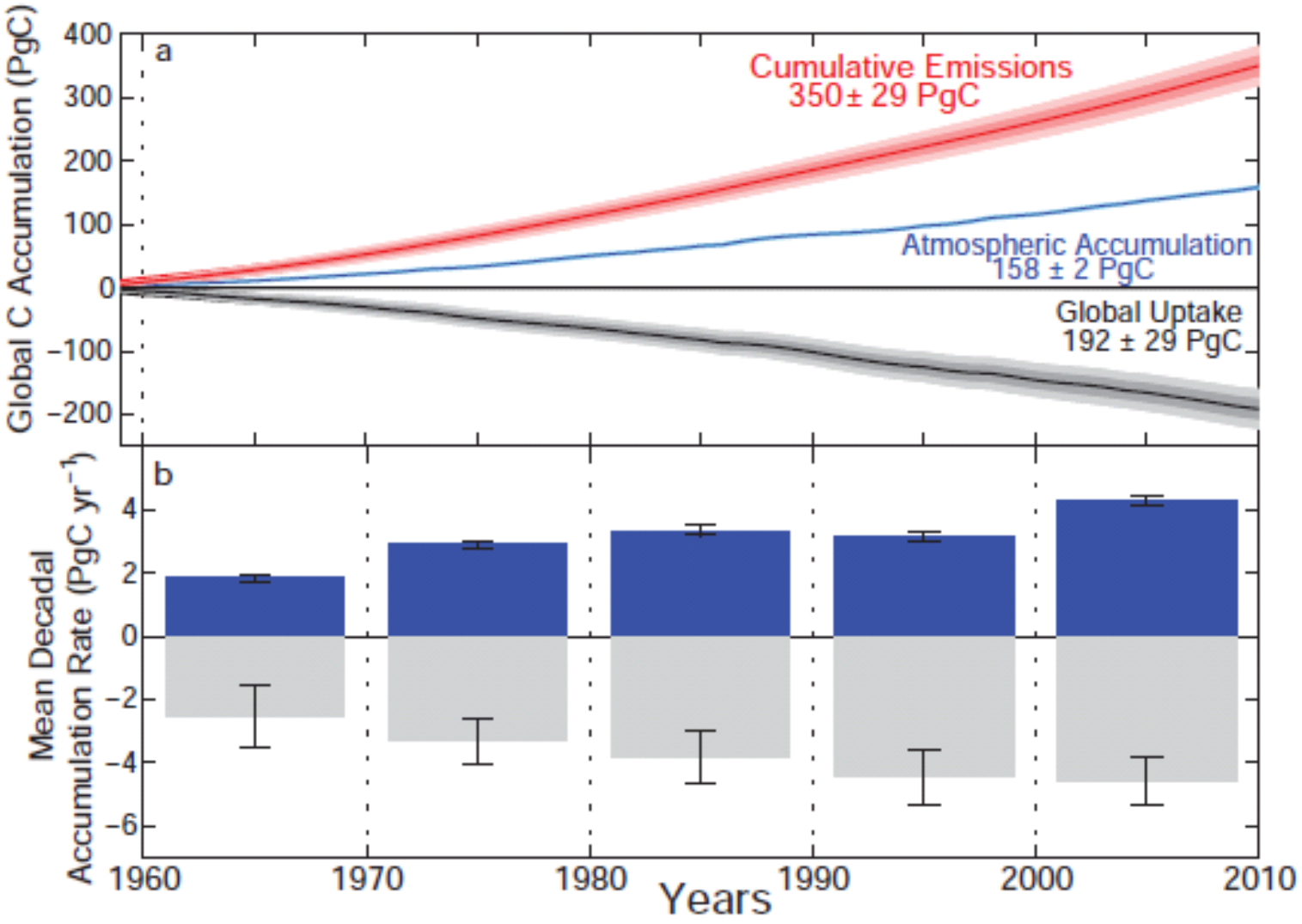
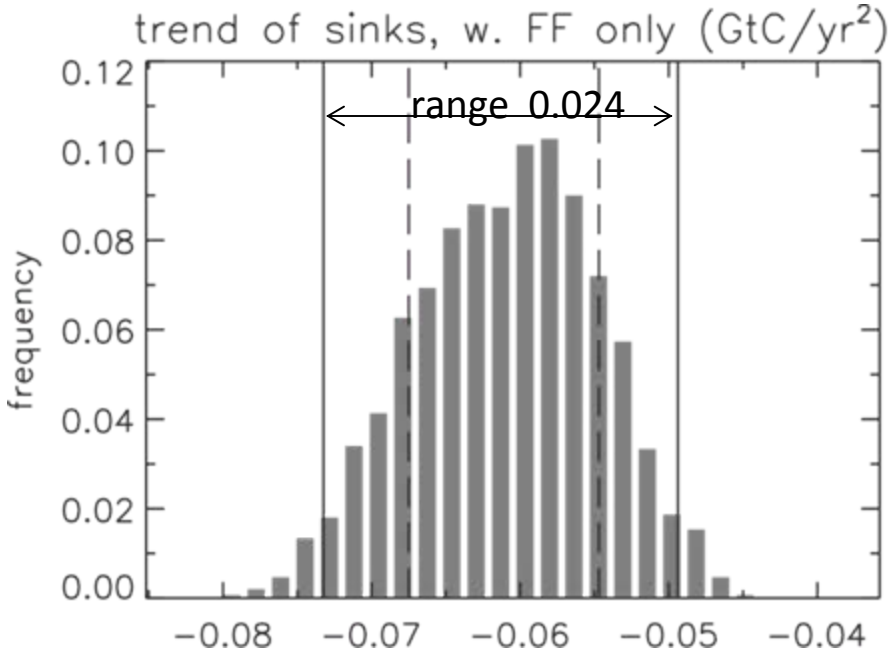


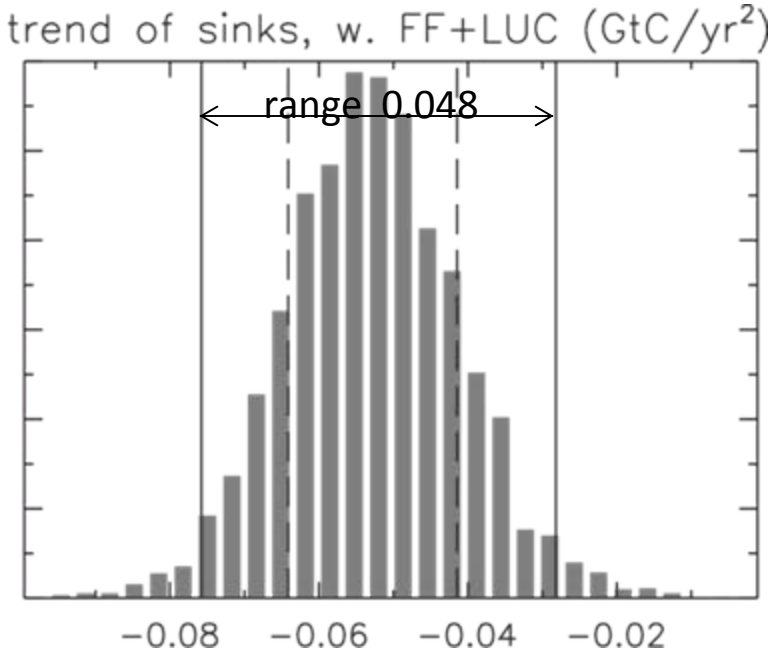
Figure: Ashley Ballentyne

sum of oceanic and terrestrial sinks

$$\Sigma N = \frac{d(Atm)}{dt} - FF$$

$$\Sigma N = \frac{d(Atm)}{dt} - FF - LUC$$

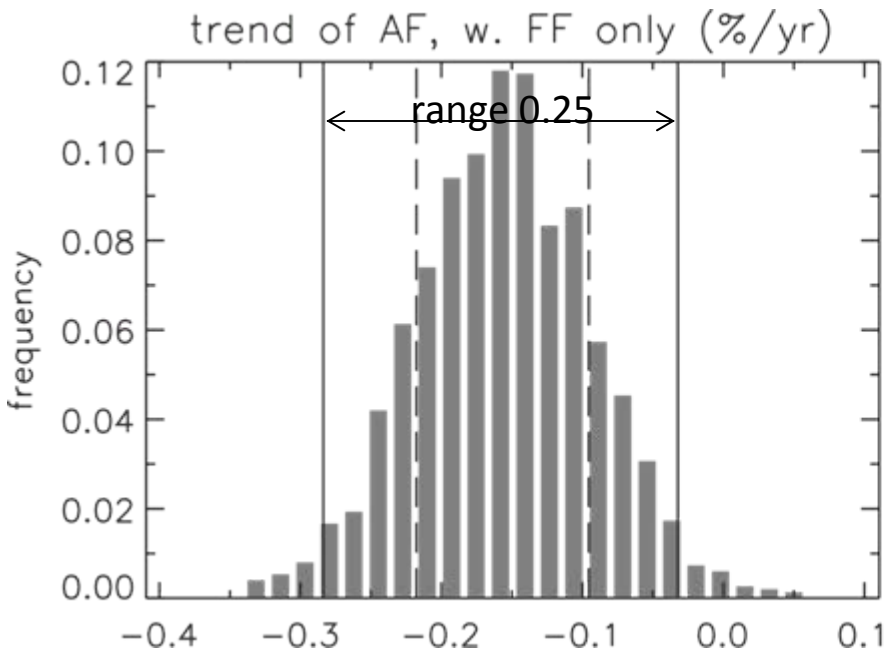


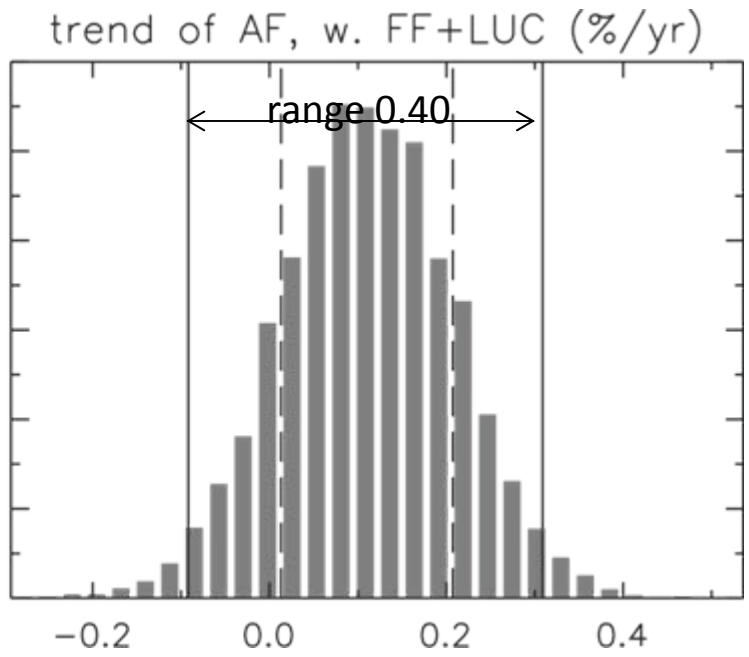


airborne fraction

$$AF = \frac{d(Atm)/dt}{FF} \quad (avg = 56\%)$$

$$AF = \frac{d(Atm)/dt}{(FF + LUC)} \quad (avg = 45\%)$$





Conclusions:

Large missing sinks are alive and well.

Fossil fuel emissions are an ever more dominant factor in the carbon cycle.

For credible projections of the response of the carbon cycle to climate change, research needs to focus more on sinks.

Much better emissions estimates, even on a global scale, are needed to better quantify how the carbon cycle is responding to ongoing climate change and management practices.