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Biogeosciences Discussions

Interactive comment on "The 2009–2010 step in atmospheric CO_2 inter-hemispheric difference" *by* R. J. Francey and J. S. Frederiksen

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Reply to Anonymous Referee#1: We have presented evidence of covariation or concurrence of mlo-cgo CO2 using baseline selected measurements with independent variables that referee #1 describes as interesting and stimulating. At the same time, there is a recommendation of "careful extension of the demonstration and possible mitigation" prior to publication. The referee also supports the conclusions of Patra and Poulter re the timing of a SH terrestrial response to climate in 2010, but as argued in our response to Poulter, the more relevant factor is that the magnitude of the response is inadequate to influence cgo baseline CO2 (also an anomaly in mlo CO2 does occur at this time).

The specific points referee #1 uses to demonstrate his/her concerns are addressed one by one.

âĂć p. 15088, l. 16-17: I cannot find this statement in the Francey et al. (2013). The statement was "failure of a global carbon cycle inversion model to reach consistency between the NH-SH (DC) measurements and reported source–sink changes".

We replace this with: Figure 4b of Francey et al. (2013) demonstrates the inability of inversion models to match the mlo-cgo measurements with reported fossil fuel emissions, and the inability of these models to distinguish between fossil emission trends and NH terrestrial biosphere trends. The CSIRO model inversions coped with the 2009/10 DC by distributing an unverifiable 2010 NH source in the Asian region (Rachel Law, private communication). Additionally, in the context of comparing the fossil emission trends with atmospheric CO2 growth rate, Francey et al. (2013) attempted an empirical correction for natural influences on CO2 growth. This involved multiple regression of reported wild fires, volcanoes and ENSO with CO2 records (described in some detail in their Supporting Information). None of these reported influences showed statistically significant anomalous behaviour in 2009/2010.

âĂć Figure 1: comparing a concentration difference to a concentration derivative is not trivial. Why not showing the derivative of the concentration difference?

Inversions of CO2 data interpret both temporal and spatial CO2 differences in terms of surface exchanges. The rationale of Figure 1 was simply to illustrate each type of difference in quality data with maximum spatial representation. As such, it is the basis for discussion in Section 3. For example, it highlights the absence of significant IHG influences at times of growth anomalies, if the anomalies are of equatorial origin.

âĂć p. 15089, l. 6: the sentence suggests that the role of the equatorial land biosphere can be seen on the figure, but this statement seems to come from the literature: the sentence should be split.

The dC/dt in Fig. 1b show inter-annual variability on 3 to 5 year El Niño–Southern Oscillation (ENSO) timeframes. Using a transport model to invert CO2 and d13CO2 observations, Rayner et al. (2008) concluded that it is forced primarily by climate variability on the equatorial land biosphere, a conclusion consistent with the observation of limited influence on IHG for equatorial exchanges in Figure 1b of Francey&Frederiksen.

âĂć p. 15089, l. 7-8: the origin of this statement is not clear. Please explain it in the main text.

The statement was “This variability is largely suppressed in DC when resulting CO2 is mixed into both hemispheres.”

This is addressed in responses to the previous two comments.

âĂć p. 15089, l. 10-13: the first and the last words of the sentence together suggest that the MLO-CGO difference is close to zero.

The statement was: “The hemispheric representativeness of extra-tropical baseline data from the selected monitoring sites is supported by a study of aircraft vertical profiles at 12 global sites, identifying mlo and cgo as being the least affected by surface CO2 exchanges in their respective hemispheres (Stephens et al., 2007)”.

The hemispheric representativeness of extra-tropical baseline data from the selected monitoring sites is supported by a study of aircraft vertical profiles at 12 global sites. The lower levels (<1-2 km) of all 12 vertical profiles exhibited seasonal variation resulting from climate influence on regional surface carbon reservoirs. The amplitudes of the seasonal variation at mlo and cgo were the least in their respective hemispheres, which aids definition of inter-annual variability at these sites (The attribution of cgo surface seasonality has been the topic of a number of studies, e.g. at Cape Grim by Pak, 2001).

âĂć Section 2: for specialists only. Please expand. For instance the first line suggests that fossil fuel emissions are part of the terrestrial biosphere, “systematic nature” and

“random nature” are too elliptic, and the meaning of the last paragraph is opaque to me.

To address concerns of Referee #1 about section 2, we reference the paper by Still et al. (2003) which gives a comprehensive summary of the substantial previous literature on the use of stable carbon isotopes in global carbon budgeting, and provides a convenient graphical representation of the global budget which illustrates the relative 13C and 12C changes for the major budget terms. To avoid interrupting the flow of the main argument, concerning the concurrence of anomalies in CO2 and inter-hemispheric exchange, our preferred solution is to restructure the paper so that the isotopic evidence is presented after the current section 5 i.e. the section that details the inter-hemispheric exchange mechanism. The advantage of this is that the isotopic signature of the inter-hemispheric exchange process will have the isotopic labelling of the dominant annual hemispheric flux, fossil emissions in the NH. This labelling is clear in the CSIRO isotope results, reducing the need to dwell on mechanisms (described in detail by Still et al.) that are incapable of achieving this result. When discussing differences between measurement laboratories we rely both on the correlation coefficients and an anticipation of correlation from known possible processes.

âĂć Section 3: the term “event” is defined at the start as “surface flux event”, but the noun is too vague for this abbreviation to work well for the reader.

The noun can be dispensed with in favour of specific identification of each selected flux anomaly.

âĂć p. 15094, l. 16: “in” missing. Noted.

New References: Pak, B. C. (2001) Vertical structure of atmospheric trace gases over Southeast Australia PhD Thesis, University of Melbourne, School of Earth Sciences

Still, C. J, J. A. Berry, G. J. Collatz, and R. S. DeFries. 2003. Global distribution of C3 and C4 vegetation: Carbon cycle implications, Global Biogeochemical Cycles, 17, 1,

1006-1020. doi:10.1029/2001GB001807, 2003.

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