

Interactive comment on “The 2009–2010 step in atmospheric CO₂ inter-hemispheric difference” by R. J. Francey and J. S. Frederiksen

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Comment to Francey and Frederiksen (2015)

The inter-hemispheric gradient (IHG) in atmospheric CO₂ provides a very useful top-down perspective on global carbon budget dynamics. The anomalous step change from 2009–2010, first reported by Francey et al. (2013), was particularly intriguing from the perspective of inter-annual changes in carbon sources and sinks, and that the step-change has been sustained prompts further investigation. The perspective in the current article by Francey and Frederiksen (2015) provides compelling evidence that changes in atmospheric exchange are largely responsible, but is the evidence sufficient to discount the role of the terrestrial biosphere in explaining the IHG anomaly?

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The authors state that the anomalous 2011 terrestrial sink (Poulter et al. 2014) was too late to explain the 2009–2010 step change, however, there are several lines of evidence that this is not the case. First, the 2010–2011 La Niña began in mid-2010 based on evidence from the Multivariate ENSO Index (Wolter and Timlin 1993), and from regional precipitation and sea surface temperature anomalies around Australia (Evans and Boyer-Souchet 2012). Thus in Australia, anomalously large net carbon uptake began mid-2010 and continued through 2011, as detected by regionally calibrated models (Haverd et al. 2013), remote sensing data (Bastos et al. 2013) and direct observations from eddy covariance methods (Cleverly et al. 2013). The earlier onset of the land sink (in mid 2010) than described in Francey and Frederiksen (2015) suggests that the Southern Hemisphere land sink would have had an affect on atmospheric CO₂ concentrations and the observable 2009 and 2010 IHG.

While the high-correlation between changes in atmospheric meridional transport and eddy mixing with the IHG anomaly may explain a large part of the 2009–2010 anomaly, considering the timing of the 2010–2011 La Niña more precisely suggests that the role of the terrestrial biosphere cannot be completely excluded.

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References Bastos, A., S. W. Running, C. Gouveia, and R. M. Trigo. 2013. The global NPP dependence on ENSO: La-Niña and the extraordinary year of 2011. *Journal of Geophysical Research*:doi: 10.1002/jgrg.20100.

Cleverly, J., N. Boulain, R. Villalobos-Vega, N. Grant, R. Faux, C. Wood, P. G. Cook, Q. Yu, A. Leigh, and D. Eamus. 2013. Dynamics of component carbon fluxes in a semi-arid Acacia woodland, central Australia. *Journal of Geophysical Research* 118:1–18.

Evans, J. P., and I. Boyer-Souchet. 2012. Local sea surface temperatures add to extreme precipitation in northeast Australia during La Niña. *Geophysical Research Letters* 39.

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Francey, R. J., and J. S. Frederiksen. 2015. The 2009–10 step in atmospheric CO₂ inter-hemispheric difference. *Biogeosciences* 12:15087–15109.

Francey, R. J., C. M. Trudinger, M. van der Schoot, R. M. Law, P. B. Krummel, R. L. Langenfelds, L. P. Steele, C. E. Allison, A. R. Stavert, R. J. Andres, and C. Rödenbeck. 2013. Atmospheric verification of anthropogenic CO₂ emission trends. *Nature Climate Change* 3:520-524.

Haverd, V., M. R. Raupach, P. R. Briggs, J. G. Canadell, P. Isaac, C. Pickett-Heaps, S. H. Roxburgh, E. van Gorsel, R. A. Viscarra Rossel, and Z. Wang. 2013. Multiple observation types reduce uncertainty in Australia's terrestrial carbon and water cycles. *Biogeosciences* 10:2011-2040.

Poulter, B., D. Frank, P. Ciais, R. B. Myneni, N. Andela, J. Bi, G. Broquet, J. G. Canadell, F. Chevallier, Y. Y. Liu, S. W. Running, S. Sitch, and G. R. van der Werf. 2014. Contribution of semi-arid ecosystems to interannual variability of the global carbon cycle. *Nature* 509:600-603.

Wolter, K., and M. S. Timlin. 1993. Monitoring ENSO in COADS with a seasonally adjusted principal component index. Pages 52-57 in *Proceedings of the 17th Climate Diagnostics Workshop*. NOAA/NMC/CAC, NSSL.

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