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Interactive comment on "Global atmospheric carbon budget: results from an ensemble of atmospheric CO₂ inversions" *by* P. Peylin et al.

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The year of this publication marks the 50th anniversary of the first attempt at CO_2 inversion, by Bolin and Keeling (1963). On such an occasion, it is gratifying to see such an excellent compilation of work demonstrating the state-of-the art in CO_2 inversions. (There is of course much on-going research activity, pushing the boundaries of the science, most notably in the area of improved statistical characterisation of model and observational error (e.g. Berchet et al., 2013; Kuppel et al., 2103)).

It is however important to note the differences between a model intercomparison study (i.e. Transcom) and model applications aimed elucidating real world issues. As an

intercomparison, Transcom embodied some simplifications that impinge minimally on model comparisons, but which are problematic for real-world studies. In particular:

- many of the inversions treat the fossil component as known exactly;
- most if not all of the inversions ignore the atmospheric transport of reduced carbon. This is discussed in more detail below.

Since this paper is part of the special issue on RECCAP (REgional Carbon Cycle Assessment and Processes) (Canadell et al., 2011), there should be more emphasis on how this paper sits within the RECCAP structure. The following comments draw heavily on the RECCAP paper on uncertainties (Enting et al., 2012).

RECCAP (see http://www.globalcarbonproject.org/reccap) proposes various 'synthesis of syntheses'. For this it is important to note that the flux estimates given in this paper represent a synthesis of top-down inversion with bottom-up estimates from priors. Thus the estimates will not be independent of the 'bottom-up' estimates produced in many of the other RECCAP contributions.

The neglect of atmospheric transport of reduced carbon represents a systematic bias in many (or all?) of the calculations reported here. It means that in general that the top-down fit is (approximately) a 'CO_2 budget', while the bottom-up constraints are more generally those of a 'carbon budget'. (The approximation arises from treating all CO_2 sources and sinks as being at the earth's surface — this is not true for oxidation of reduced carbon compounds). Although the studies that introduced Bayesian synthesis inversion for CO_2 (Enting et al., 1993, 1995) did include a crude representation of reduced carbon, this component was generally neglected in Transcom studies. For intercomparisons addressing transport error, the neglect of reduced carbon matters little, but such neglect causes biases estimates of regional carbon budgets. An initial study showing the latitudinal distribution of the bias was given by Enting and Mansbridge (1991). A more recent analysis, using 3-D modelling, is given by Suntharalingam et al.

(2005). There is also a requirement for consistency between top-down vs bottom-up (priors) in the treatment of other lateral carbon transport through rivers and trade (Enting et al., 2012).

In passing, it is worth noting that the term 'carbon budget' has acquired a new meaning. There is the long-standing use in the carbon cycle community for a description of the partitioning of CO_2 (or carbon) fluxes to and from the atmosphere (as in this paper and in the various budget estimates from the global carbon project (e.g. Le Quéré et al., 2009)). A new meaning of carbon budget is the cumulative amount of CO_2 emissions consistent with stabilising concentrations. This concept (which is an approximation) comes from work such as Matthews and Caldeira (2008) and Allen et al. (2009). The concept achieved wider usage after being used in the the Stern Report.

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File peylin4bgs.tex, tested by inclusion in file shell2.tex.

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References

Allen, M. R., Frame, D. J., Huntingford, C., Jones, C. D., Lowe, J. A., Meinshausen, M., and Meinshausen, N.: Warming caused by cumulative carbon emissions towards the trillionth tonne, Nature, 458, 1163–1166, doi:10.1038/nature08 019, 2009.

Berchet, A., Pison, I., Chevallier, F., Bousquet, P., Conil, S., Geever, M., Laurila, T., Lavric, J., Lopez, M., Moncrieff, J., Necki, J., Ramonet, M., Schmidt, M., Steinbacher, M., and Tarniewicz, J.: Towards better error statistics for atmospheric inversions of methane surface fluxes, Atmos. Chem. Phys. Discuss., 13, 3735–3782, 2013.

Bolin, B. and Keeling, C. D.: Large-scale atmospheric mixing as deduced from the seasonal and meridional variations of carbon dioxide., J. Geophys. Res., 68, 3899–3920, 1963.

Canadell, J. G., Ciais, P., Gurney, K., Le Quéré, C., Piao, S., Raupach, M. R., and Sabine,

C. L.: An International effort to quantify regional carbon fluxes, EOS, Trans. AGU, 92, 81–82, 8 March, 2011.

Enting, I. G. and Mansbridge, J. V.: Latitudinal distribution of sources and sinks of CO_2: Results of an inversion study., Tellus, 43B, 156–170, 1991.

Enting, I. G., Francey, R. J., Trudinger, C. M., and Granek, H.: Synthesis Inversion of Atmospheric CO_2 Using the GISS Tracer Transport Model., Tech. Rep. Technical Paper no. 29, CSIRO Division of Atmospheric Research, 1993.

Enting, I. G., Trudinger, C. M., and Francey, R. J.: A synthesis inversion of the concentration and δ^{13}C of atmospheric CO_2., Tellus, 47B, 35–52, 1995.

Enting, I. G., Rayner, P. J., and Ciais, P.: Carbon Cycle Uncertainty in REgional Carbon Cycle Assessment and Processes (RECCAP), Biogeosciences, 9, 2889–2904, doi:10.5194/bg–9–2889–2012, 2012.

Kuppel, S., Chevallier, F., and Peylin, P.: Quantifying the model structural error in carbon cycle data assimilation systems, Geosci. Model Dev., 6, 45–55, 2103.

Le Quéré, C., Raupach, M. R., Canadell, J. G., Marland, G., Bopp, L., Ciais, P., Conway, T. J., Doney, S. C., Feely, R. A., Foster, P., Friedlingstein, P., Gurney, K., Houghton, R. A., House, J. I., Huntingford, C., Levy, P. E., Lomas, M. R., Majkut, J., Metzl, N., Ometto, J. P., Peters, G. P., Prentice, I. C., Randerson, J. T., Running, S. W., Sarmiento, J. L., Schuster, U., Sitch, S., Takahashi, T., Viovy, N., van der Werf, G. R., and Woodward, F. I.: Trends in the sources and sinks of carbon dioxide, Nature Geoscience, 2, 831–836, 2009.

Matthews, H. D. and Caldeira, K.: Stabilizing climate requires near-zero emissions, Geophysical Research Letters, 35, L04 705, doi;10.1029/2007/GL032 388, 2008.

Suntharalingam, P., Randerson, J. T., Krakaeur, N., Jacob, D. J., and Logan, J. A.: Influence of reduced carbon emissions and oxidation on the distribution of atmospheric CO_2: Implications for inversion analyses, Global Biogeochemical Cycles, 19, GB4003, doi:10.1029/2005GB002 493, 2005.

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