Atmos. Chem. Phys. Discuss., 12, C8946–C8949, 2012
www.atmos-chem-phys-discuss.net/12/C8946/2012/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Quantifying the constraint of biospheric process parameters by CO_2 concentration and flux measurement networks through a carbon cycle data assimilation system" *by* E. Koffi et al.

Anonymous Referee #1

Received and published: 3 November 2012

Koffi et al present results from a well-executed application of the established CCDAS system to atmospheric CO2 concentration measurements and synthetic high frequency estimates of CO2 flux. The main aim is to quantify the relative information content of the two different data types, and assess data-acquisition network design, for constraining parameters of a terrestrial carbon cycle model. The manuscript is well written and the results clearly presented. There are some issues with how the experimental design was set up that should be addressed and potentially affect the interpretation of the results.

Major issues:

The authors use the BETHY model to generate synthetic data at sites in either an existing or synthetic observation network. They then use that BETHY-generated data to constrain parameters in the BETHY model and compare constraint to that obtained when also using observed atmospheric concentration data. It is therefore not surprising that the BETHY generated fluxes provide more constraint on BETHY than the concentration observations. If real flux observations were used, would the results be the same?

A potential problem here is that it is assumed that the BETHY generated fluxes are correct, and can be related to the observed concentrations. Many conclusions are based on this assumption. E.g., from the abstract: "Indeed, CO2 concentration sensitivities relevant for such high frequency fluxes are found to be largely confined in the vicinity of the corresponding fluxes, and are therefore not well observed by background monitoring stations." The same result could be explained by the fact that BETHY does not reproduce the observed fluxes at the tower sites very well. The authors may argue that it does, or has been show to in previous publications, but I would argue that that needs to be shown here for these specific runs of BETHY for the sites used. I recognize that it is no minor task to do so, and the data is not necessarily freely available. Without showing that the BETHY model fluxes are comparable to observations, then significant reconsideration of the interpretation of results would be needed.

Throughout the text, the BETHY-generated fluxes used in CCDAS are presented as 'flux measurements' or 'observations (BETHY-FLUXNET). This is misleading and needs to be addressed. The manner in which the FLUXNET locations are presented could lead the reader to understand that data from these sites are being used. E.g. in the footer of Fig. 2, 'The network of flux measurements we are using', could be understood to mean that flux measurements are being used, which is not the case.

The authors argue that both fluxes and concentrations are needed to constrain the

model, which of course makes sense. Does the story stop there though? Many studies have shown that flux data alone can constrain only a limited number of parameters in carbon cycle models. Ancillary information on the distribution of carbon pool sizes within the system, and their turnover times, are essential for constraining parameters that govern fluxes over longer time scales. Quantifying the relative importance of such constraints is of course beyond the scope of the manuscript, but some discussion should be included in order to avoid giving the impression that with flux and concentration we've got it all.

Minor Comments:

Page 24132 Line 22-23: "a large suite of measurements ... is gathered". Consider rephrasing. The statement suggests that this suite of measurements has been consolidated somewhere in a single database. If that's the case, give the reference.

P 24133 Line 12: It might be worth giving a bit of background information on CCDAS here. The authors say only that it can ingest many different data sets. But what is it?

Line 21: See Kuppel et al., 2012 Biogeosciences for a more detailed analysis of between site variability http://www.biogeosciences.net/9/3757/2012/bg-9-3757-2012.pdf

Line 25: 'A series of papers have shown'

P 24134 Line 15-16: Please reiterate here that you are talking about atmospheric concentration data.

Line 25: A large impact on what? A large improvement in parameter constraint? Please specify.

P24135

Line 5: I agree with the authors and consider the evaluation of variability at shorter time scales a very laudable goal. That said, I would question whether considering fluxes at the daily time scale is sufficient. Daily integrated flux incorporates two very different

processes, respiration and photosynthesis. These can be effectively separated by considering night- and day-time fluxes separately (e.g., Sacks et al 2007 showed the solution of SipNET to be severely degraded if data were aggregated to the daily timestep because separate information about photosynthesis and respiration was lost). So, why use daily instead of hourly or at least a day-night separation?

Line 21: Constraint can not be provided by BETHY daily fluxes. I assume you mean daily flux integrals.

Line 21 (iii): As far as I can tell, no hourly flux measurements are being used in this study. Synthetic hourly flux estimates are being used, which is an entirely different thing. This presentation of synthetic flux estimates as actual measurements comes up a lot in the text, and needs to be addressed.

P -24136 Line 6: Assumed or estimated? Uncertainty in measurements does not necessarily have to be assumed. In particular for eddy-covariance data it is well characterized.

Line 18: It would be good to state what the base temporal resolution of simulations is.

p- 24139 Line 23. This is the first time the fact that the study uses only synthetic data is mentioned. This should be clarified throughout the manuscript.

p- 24141 Line 12:14. Actually, the uncertainty in flux measurements is well characterized, and is known to be heteroskedastic. See work by Hollinger and Richardson, 2005; Richardson et al., 2008) This would seem to be quite important, as the level of measurement uncertainty will directly affect the magnitude of the retrieved parameter uncertainties.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 24131, 2012.