Geosci. Model Dev. Discuss., 7, C1616–C1621, 2014
www.geosci-model-dev-discuss.net/7/C1616/2014/

Geoscientific
Model Development
Discussions
Open Access

Interactive comment on "Model–data fusion across ecosystems: from multi-site optimizations to global simulations" *by* S. Kuppel et al.

S. Kuppel et al.

sylvain.kuppel@lsce.ipsl.fr

Received and published: 8 September 2014

The authors would like to thank M. Smith for his helpful comments and suggestions. They have been taken into consideration in the revised manuscript. We answer all of them individually in the following, merging the two parts of the posted review.

General comments

This study constrains a global ecosystem model (estimates of the most likely parameters) using multiple datasets from multiple sites and shows resulting improvements in model predictive performance in predicting the CO2 fluxes as well

as other performance metrics at multiple sites. Investigations of where predictive performance has been improved or made worse reveal insights into how the process has influenced the general applicability of the model – it has improved at capturing CO2 fluxed at tropical and temperate sites but has identifiable weaknesses in predicting tropical evergreen broadleaf forest dynamics which leads to the identification of new areas for research. They also illustrate the efficacy of the model at predicting CO2 flux dynamics for a wider set of test sites and conduct a global scale evaluation. In sum, this to me is an excellent end-to-end analysis of the costs and benefits of undertaking this more sophisticated and improved model fitting approach and I recommend it for publication.

Specific comments

It is perhaps worth noting in the results and discussion that, as far as I can see, none of your effects from parameter estimation lead to qualitative differences in the predictions of the model. They simply lead to quantitative improvements. This implies to me that when we are moving towards a situation that we have multiple data-constrained DGVMs being used in climate simulations, each will demonstrably predict the present day data better, but their predictions of the future, and the differences in their predictions of the present, will still vary widely. This to me implies that while you are improving the parameterisation under the assumed model structure, you are not improving the assumed model structure to make it better suited to modelling reality and it is this which needs more focus of the attention of DGVMers.

Although the improvements are indeed mostly quantitative, note for example that the interannuality of the simulated atmospheric CO2 concentrations has been improved, although modestly. This results emerges for time series much longer (20 years) than those used for the ORCHIDEE LSM optimization. It suggests that although parameter optimization always remains by definition within the limits of the model structure, simulations outside the time periods used for optimization can be corrected with this tool, to some extent. Further work is needed to assess more accurately how large exactly the aforementioned extent is, in the case of the ORCHIDEE model see Santaren et al., (2013).

However, we agree with the M. Smith that a crucial question is whether applying data assimilation to all models (used for instance in the CMIP5 exercise for the IPCC report) would decrease or not the spread in the future predictions of the carbon cycle and, consequently, in climate predictions. Although the differences after optimization of the ORCHIDEE model lead to quantitative improvement but no large qualitative changes, it is difficult to assess their impact under climate change. For instance, an ongoing study based on the assimilation of flux tower data (this work) and satellite NDVI data, with the same model, led to significant changes of the soil carbon stocks after 2050 when used with future climate projections (from CMIP5). The changes appeared when climate warming reached a certain level, where the modified parameters start to induce large flux differences (heterotrophic respiration). The non-linearity of the model is in this case crucial.

1. Table 1 legend - nothing is underlined, I think you mean bold

Yes, this typesetting mistake has been corrected in the table caption for the revised version:

'*Table 1. Parameters of ORCHIDEE optimized in this study. The prior values are given for each PFT, and multi-site posterior values are in bold font. A hyphen means that the parameter is not optimized, spinup that the spinup value is taken, and **site** that the posterior value is site-specific.*'

2. Could you please indicate for your figures and tables (e.g. Table 3) whether these assessments are for independent evaluation data or for the data the model was trained to.

The legends of Figs. 1 and 2 have been modified to emphasize that we present the training data as observations, while Figs. 5, 6 and 7 (the latter replacing Table 3 in the revised manuscript) have been modified state that they present evaluative (and independent for Figs. 5 and 6) data:

'*Figure 1. Model-data **(A)** RMSD and **(B)** bias for the daily NEE time series at each site (filled circles), grouped and averaged by PFT (horizontal bars), in three cases: prior model (green), multi-site optimization (blue) and single-site optimization (orange). **(C)** PFT-averaged mean seasonal cycle of NEE, for the training observations (black) and the three aforementioned cases, smoothed with a 15-day-moving-average window.*

*Figure 2. Model-data **(A)** RMSD and **(B)** bias for the daily LE time series at each site (filled circles), grouped and averaged by PFT (horizontal bars), in three cases: prior model (green), multi-site optimization (blue) and single-site optimization (orange). **(C)** PFT-averaged mean seasonal cycle of LE, for the training observations (black) and the three aforementioned cases, smoothed with a 15-day-moving-average window.*

*Figure 5. PFT-averaged mean seasonal cycles of **(A)** the photosynthetic carbon flux and **(B)** the respiration flux, smoothed with a 15-day-moving-average window. The simulations using prior (green), single-site (orange) and multi-site (blue) parameterizations are compared to the evaluative observation-derived flux estimates (black).*

*Figure 6. Detrended mean seasonal cycle of the atmospheric CO2 concentrations at **(A)** Alert, **(B)** South Pole and **(C)** Mauna Loa locations during the 1989-2009 period: the optimization-independent concentrations records (black) are compared to simulations where the biospheric contribution is calculated using the ORCHIDEE model with default (green) and multi-site (blue) parameterization, with the model-data RMSD given between brackets. **(D)** Regional contributions to the mean seasonal cycle simulated at*

Alert.

Figure 7. Correlation factor between weekly time series of modeled FAPAR and independent measurements of NDVI, for the 2000-2010 period. The results are grouped using the dominant PFT at each pixel, for global simulations with default (green) and multi-site parameterization (blue). The central horizontal bar indicates the median value, the top and bottom of the boxes correspond to the first and last quartile, and the 5- and 95-percentile are given by the 'error bars'.'

3. ALL FIGs - it is not clear to me whether the figures relate to an average across PFTs, which specific years were considered or anything. While these fits look good, I have little idea what places in space and time they specifically relate to. You need to improve the legends to these figures to explain this.

The distinction between site-level and PFT-averaged values are made in the caption of Figs. 1, 2, 3, 4 and 5. Color legends have been added to Figs. 1, 2, 3, 4, and 5 to better distinguish whether the displayed quantities relate to prior, multi-site or single-site cases, or to the observations. Finally, to make clearer whether the full-length of the time series or the mean seasonal cycle of carbon and water fluxes are considered, the captions of Figs. 1, 2 and 3 have been modified in the revised manuscript:

Figs. 1 & 2: see above response.

'*Figure 3. PFT-averaged model phase coefficient versus model-to-data amplitude ratio, for the detrended smooth seasonal cycles of* ***(A)*** *NEE and* ***(B)*** *LE fluxes. Simulations using prior parameters (green) are compared to multi-site (blue) and single-site (orange) optimizations, with the measured reference indicated by the intersection of the dashed lines.*'

References

Santaren, D., Peylin, P., Bacour, C., Ciais, P. and Longdoz, B.: Ecosystem model optimization using in-situ flux observations: benefit of monte-carlo vs. variational schemes and analyses of the year-to-year model performances, Biogeosciences Discuss., 10(11), 18009–18064, 2013.

Interactive comment on Geosci. Model Dev. Discuss., 7, 2961, 2014.