Biogeosciences
Discussions

Interactive comment on "Evaluating the potential of large scale simulations to predict carbon fluxes of terrestrial ecosystems over a European Eddy Covariance network" *by* M. Balzarolo et al.

M. Balzarolo et al.

manuela.balzarolo@uantwerpen.be

Received and published: 30 October 2013

The authors thank the anonymous reviewer #2 for his/her review of the manuscript and for the comments.

[General comments: This paper presents a study of land surface models in the application of NEE and GPP estimates comparing with eddy flux measurements. This is a very important issue currently. Therefore, this paper meets the scope of biogeoscience well. However, over all this is a very disappointing paper with several essential academic problems and was ugly written. It seems just a start of a proposal without clear conclusions. There's no significant scientific contribution at all. I strongly suggest that

this paper should not be published.]

RESPONSE

Reviewer #2 expresses strong criticism regarding the paper and feels that the paper is disappointing. We believe that the manuscript can be improved in order to dissipate these feelings. In a revised version of the manuscript, we will try to explain better the motivation of our research, and to give more details on the experimental set-up. The verification protocol aims at assessing current shortcomings of global and continental land carbon modeling systems that introduce inevitably a number of errors due to the lack of knowledge of local physiographic conditions, large-scale discretization, process misrepresentation, and finally local effects of the atmospheric forcing. These hypotheses, although labeled as "unacceptable" by Reviewer #2, are commensurate with what is currently achievable at continental to global scales. A publication that documents the current skills and limitation of those systems is therefore, in our opinion, meaningful. This study documents the benefits and shortcomings of large scale simulations. We strongly believe that such studies are of general interest to the ecosystem observation (e.g. FLUXNET) and Earth system modeling communities for better addressing priorities in the design of observing systems, process modeling developments, and data assimilation, at spatial resolutions compatible with current computing resources.

[Scientific problems]

[#1: Section 2.2: The two reasons they used gridded ERA-I data rather than observations are far from sufficiency. Indeed, site level evaluation work usually use site level environmental forcing variables observations. How to compare modeled results with measurements using unsuitable forcing variables? In some cases, there are no enough good records, a compare work need to be made first before using proxy data as drivers.]

RESPONSE

The use of ERA-Interim data is subject to limitations that are largely documented for re-analyses (Simmons et al. 2009, Dee et al. 2011). However, in extra-tropical continental areas, precipitation and radiation forcings show remarkable skills (Balsamo et al. 2010, Szczypta et al. 2011). The new Fig.1 provides some examples of the comparison of in-situ and ERA-Interim climatological variables (e.g. global radiation, vapor pressure deficit). This comparison confirms that ERA-Interim can be used as good proxy of in-situ meteorological data. Using local observations to force the land surface models is of course a possibility, but they are also affected by limitations such as missing data (LSM simulations need continuous atmospheric forcings), instrumental biases, and representativeness issues for a grid-size of several tens of kilometers. It was therefore decided in the verification protocol to use a gridded forcing that is usable by global monitoring systems, and to make use of local observations to evaluate the integrated errors. We also underline the fact that global re-analyses, such as ERA-Interim, are strongly constrained by millions of daily in-situ and remote-sensing observations that are consistently assimilated using statistically optimal schemes and a modeling system that ensures internal coherence of the physical/dynamical fields, therefore the adoption of a meteorological forcing from re-analyses should not be regarded as completely orthogonal to the use of observational forcing. By all means, the use of local observations is fully recognized as a "ground-truth" verification dataset and highly valued for the study and for monitoring the quality of land carbon modelling systems (in which in-situ observing networks have major role).

REFERENCE

Simmons, A.J., Willett, K.M., Jones, P.D. Thorne, P.W., and Dee, D.P: Low-frequency variations in surface atmospheric humidity, temperature, and precipitation: Inferences from re-analyses and monthly gridded observational data sets, J. Geophys. Res., 115 (D1), 2156-2202. DOI: 10.1029/2009JD012442, 2009.

Dee, D.P., Uppala, S.M., Simmons, A.J., Berrisford, P., Poli, P., Kobayashi, S., Andrae, U., Balmaseda, M.A., Balsamo, G., Bauer, P., Bechtold, P., Beljaars, A., van de Berg, L.,

Bidlot, J., Bormann, N., Delsol, C., Dragani, R., Fuentes, M., Geer, A.J., Haimberger, L., Healy, S., Hersbach, H., Holm, E.V., Isaksen, L., Kållberg, P., Köhler, M., Matricardi, M., McNally, A.P., Monge-Sanz, B.M., Morcrette, J.-J., Peubey, C., de Rosnay, P., Tavolato, C., Thépaut, J.-N. and Vitart F.: The ERA-Interim reanalysis: Configuration and performance of the data assimilation system, Q. J. Roy. Meteor. Soc., 137, 553-597, 2011.

Balsamo, G., Boussetta, S., Lopez, P., and Ferranti, L.: Evaluation of ERA-Interim and ERA-Interim-GPCP-rescaled precipitation over the U.S.A., ERA Report Series, n. 5, pp10, 2010.

Szczypta, C., Calvet, J.-C., Albergel, C., Balsamo, G., Boussetta, S., Carrer, D., Lafont, S., and Meurey, C.: Verification of the new ECMWF ERA-Interim reanalysis over France, Hydrol. Earth Syst. Sci., 15, 647–666, doi:10.5194/hess-15-647-2011, 2011.

[#2: How to distinguish these impacts together as "a system (P11864, L21)"? Does that mean at the beginning the authors know they will get bad/different results comparing tower measurements? The last paragraph in section 2.2 seems conflict with previous statements.]

RESPONSE

This is consistent with the verification protocol that aims at assessing global and continental modeling systems suitable for land carbon monitoring purposes. Possible misrepresentation of (1) local physiography (related to the field-site, its aspects and exposition), (2) local meteorological effects (e.g. local turbulence, presence of breeze, isolated precipitation), and (3) the full complexity of the bio-geophysical processes controlling land carbon emission, are all subject to approximations and are likely to result in errors when comparing the model outputs to flux tower data. Knowledge of the existence of those errors does not limit the value of the current study but in our opinion it is an important point to make to the reader to distinguish our work of verification, from a CAL/VAL study in which models are configured and tuned to achieve the best

performance at a given site. In light to this comment, we envisage to rewrite Sect. 2.2 giving more details on the verification protocols.

[#3: P11864, L14"For that reason, also the model vegetation type selection for a particular tower location is according to the model climate data set rather than the vegetation type of the tower location." This is unacceptable at all. In this way, wrong vegetation types were used during modeling. This will lead the results nonsense except there's another experiment for comparison.]

RESPONSE

ISBA-A-gs provided simulations consistent with the local FLUXNET vegetation type. For ORCHIDEE only the PFT that seems the nearest to the class attribute of the FLUXNET site is considered, as reported in the the Fig.2. For CTESSEL the global physiography dataset (GLCC, Loveland et al. 2000) based on a remote sensing retrieval algorithm provide the land-use type. At the grid-scale considered (80km), the dominant high vegetation and low vegetation types are represented in the model and can differ from the local physiography (this is not the case in homogeneous field-site locations as several forested sites). A misrepresentation of the local physiography is integral part of the modeling system errors. The evaluation of CTESSEL was also made with actual tower vegetation type. Fig.3 shows the statistics computed by using the two methods to select the vegetation type: (1) CTESSEL from a satellite based map and (2) CTESSEL_obs from tower vegetation type. From this analysis we can affirm that the overall error in simulating NEE, GPP and Reco coming from a satellite derived global map and the actual tower vegetation type is very small. All these aspects will be discussed in Sect. 2.2 in the revised version of the manuscript.

Also the following reference will be added:

Loveland T.R., Reed, B.C., Brown, J.F., Ohlen, D.O., Zhu, Z., Yang, L., Merchant, J.W.: Development of a global land cover characteristics database and IGBP DISCover from 1 km AVHRR data, Int. J. of Remote Sens., 21, 1303-1330, 2000.

[#4: The authors brought "system" errors in this study and used other papers to explain something (P11870-P11872) or just make some conclusions without proofs. For example: P11870, L7: "which impact stomatal conductance and photosynthetic activity (Schaefer et al., 2012)." P11870, L24: "Therefore, errors in any of the atmospheric variables can have a marked impact on LAI (Szczypta, 2012). P11871, L7: "This analysis confirms that the performance of the models in predicting NEE is closely related to climate and site characteristics." P11872, L16: "It could be linked to an incorrect phenological and LAI description." In this way, there's nothing could be archived because there's no quantification made by this paper.]

RESPONSE

The objective of these statements was to provide an interpretation of the results and we agree with the referee that they are less suitable for the Results Section. In the revised manuscript, we will include a distinct Discussion Section in which the results will be interpreted in a more consistent way.

[#5 the conclusion section. As I mentioned in #4, the results of this paper could not lead such a conclusion as the authors said. P11874, L6-9: On one hand, the authors want to evaluated "the accuracy of three different LSMs"; On the other hand, they bring "system errors" together using tower-unrelated forcing variables and tower-unrelated vegetation types. Therefore, their "more comprehensive validation" is not real. They need to show many more comparative experiments to make such conclusions. This big mistake can be very visible and clear if the authors separate the results and discussion sections. They just offered a "plan (LAI, land management, drought : : :)" or guessed something. The essential mistake is that they brought "system" errors but did quantify each part clearly. So, there is no significant scientific contribution. This draft seems like a simple start of a proposal, and it is far from a scientific paper for publication.]

RESPONSE

The quality of ERA-Interim forcing variables has been discussed in Szczypta et al.

(2011) and Balsamo et al. (2010), showing good skill in describing radiation and precipitation in the Northern Hemisphere. The comparison between in-situ and ERA-Interim forcing variables reported in Fig.1 shows that global radiation, air temperature and vapor pressure deficit are reproduced correctly by ERAI-Interim. The lowest r value (r=0.75) for IT-Ren is probably due to a mismatch in altitude, as mountainous areas are not represented well in low resolution atmospheric analyses. It confirms that ERA-Interim can be a good proxy of in-situ meteorological data. As mentioned above by answering to comment #3, the ISBA-A-gs and ORCHIDEE groups provided simulations consistent with the local vegetation type. The performance of the CTESSEL runs with vegetation type from the actual tower vegetation location is showed in Fig.3. As reported in Fig.3, the overall average error coming from using a satellite derived global PFT map and the average error when using the real in-situ vegetation are comparable. Results of the comparison analysis between in-situ and ERA-Interim forcing variables help us to confirm that ERA-interim forcing variables are consistent with tower in situ observations. In addition, the comparison between CTESSEL and CTESSEL_obs runs confirms that the simulations performed by selecting vegetation type using a satellite-derived map and actual tower vegetation type are similar. These experiments help to explain the consistency of our evaluation. In the revised version of the manuscript we will add these details in Sect. 2.2. We will also add a discussion about the representativeness error of the flux tower data versus the simulated fluxes by referring to the work of Zhao et al. (2012). In their appendix B, they discussed the differences in simulating carbon fluxes between a virtual 80x80 km2 grid with homogeneous vegetation type and a 1x1 km2 grid for the same vegetation type.

Moreover, in the revised manuscript we will remove the discussion elements from the Results Section.

REFERENCE

Zhao, Y., Ciais, P., Peylin, P., Viovy, N., Longdoz, B., Bonnefond, J. M., Rambal, S., Klumpp, K., Olioso, A., Cellier, P., Maignan, F., Eglin, T., and Calvet, J. C.: How errors

on meteorological variables impact simulated ecosystem fluxes: a case study for six French sites, Biogeosciences, 9, 2537-2564, doi:10.5194/bg-9-2537-2012, 2012.

[Writing problems (I only list a few of them)]

RESPONSE

To improve clarity and readability, the authors will work on the quality of grammar and the English language.

[#1, P11858, L1: first sentence is too long.]

RESPONSE

Thanks, it will be changed in the revised version of the manuscript.

[#2: about the efficiency E in section 2.4, could the authors offer some references? It seems like variance contribution.]

RESPONSE

We refer to Weglarczyk (1998) and this reference will be added to the manuscript text and to reference list.

Weglarczyk, S.: The interdependence and applicability of some statistical quality measures for hydrological models. J. Hydrol., 206, 98-103, 1998.

[#3: P11860, L19, where's Zhao et al., 2012 in the references section?!]

RESPONSE

Thanks, the correct reference is:

Zhao, Y., Ciais, P., Peylin, P., Viovy, N., Longdoz, B., Bonnefond, J. M., Rambal, S., Klumpp, K., Olioso, A., Cellier, P., Maignan, F., Eglin, T., and Calvet, J. C: How errors on meteorological variables impact simulated ecosystem fluxes: a case study for six French sites, Biogeosciences, 9, 2537–2564, doi:10.5194/bg-9-2537-2012, 2012.

[#4: P11868, L5-15, using the word "anomalies" could simplify this verbose paragraph about IAV.]

RESPONSE

Thanks for the suggestions. We agree and we will use "anomalies" instead to IAV in the related paragraph.

[#5: The author used "-1to 1 (P11867, L11)" at first, but 50% was used in result section (P11869, L20-22). Be coherent please!]

RESPONSE

We agree and we will correct it in the revised version of the manuscript.

[#6: (P11872, L4-7), please do not repeat the figure caption.]

RESPONSE
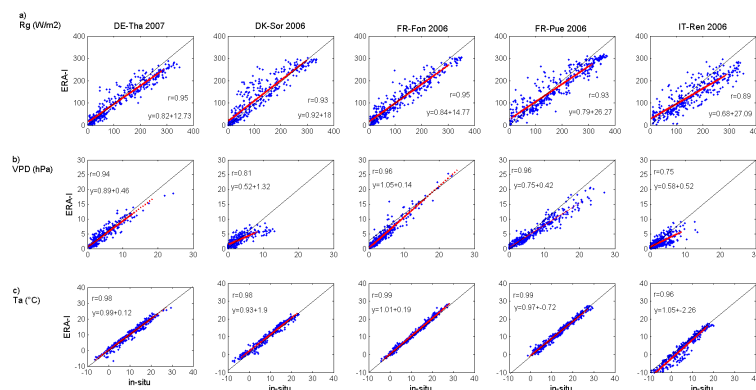
We agree and we will delete this part from the text.

[#7: The authors should be very careful with references. Otherwise, such an "easy search topic" paper will mislead the young PhDs when they follow the story outline. For example, (P 11859, L3), Jung et al (2010) report a decline in evapotranspiration using FLUXNET measurements, and attribute this trend to limited soil moisture. There's no relation between this paper and author's statements "the mechanisms that drive the net carbon uptake : : :"]

RESPONSE

Sorry for misinterpreting this reference. We will delete this reference from the revised manuscript.

Interactive comment on Biogeosciences Discuss., 10, 11857, 2013.

Comparison of in-situ and ERA-I climatological forcing: (a) global radiation (Rg); (b) vapor pressure deficit (VPD); and (c) air temperature (Ta). Red lines represent the linear interpolation function and the black lines are 1:1 lines.

Fig. 1. Comparison of in-situ and ERA-I climatological forcing: (a) global radiation (Rg); (b) vapor pressure deficit (VPD); and (c) air temperature (Ta)

FLUXNET class	ORCHIDEE PFT
CRO	C3 Agriculture
GRA	C3 Grass
DBF, MF, WET	Temperate Broad-leaved Summergreen
EBF	Temperate Broad-leaved Evergreen
ENF	Temperate Needleleaf Evergreen

Fig. 2. PFT classes defined in ORCHIDEE model

Performance of the CTESSEL runs in simulating daily carbon fluxes for all PFTs selecting tower vegetation type from a satellite derived global map (CTESSEL) and the actual tower vegetation type (CTESSEL_obs): ENF—Evergreen Needleleaf Forest; EBF—Evergreen Broadleaf Forest; DBF—Deciduous Broadleaf Forest; GRA—Grassland; and CRO—Cropland. N.Site—Number of available sites for each PFT; N.Data—Number of available days; CORR—Correlation Coefficient; RMSE—Root Mean Square Error; Bias.

PFT	Model	N. Site	N. Data	NEE			GPP			Reco		
				CORR (-)	RMSE (gC/m2 d)	Bias (gC/m2 d)	CORR (-)	RMSE (gC/m2 d)	Bias (gC/m2 d)	CORR (-)	RMSE (gC/m2 d)	Bias (gC/m2 d)
ENF	CTESSEL	5	10811	0.64	1.88	-0.13	0.81	2.89	-1.76	0.78	2.63	-1.89
	CTESSEL_obs		10811	0.55	2.48	1.39	0.82	2.95	-1.87	0.79	1.52	-0.49
EBF	CTESSEL	2	3554	0.50	2.11	1.00	0.65	1.92	-0.97	0.41	1.75	0.03
	CTESSEL_obs		3554	0.34	2.05	-0.14	0.61	2.03	-0.60	0.62	1.31	-0.75
DBF	CTESSEL	4	6313	0.51	2.59	-0.01	0.80	4.47	-2.48	0.57	3.56	-2.50
	CTESSEL_obs		6313	0.49	2.69	-0.21	0.83	3.35	-1.31	0.41	3.01	-1.54
GRA	CTESSEL	13	13203	0.50	2.03	-0.93	0.77	2.43	-0.86	0.54	2.73	-1.80
	CTESSEL_obs		13203	0.27	3.12	-0.62	0.49	3.55	-0.53	0.28	2.81	-1.15
CRO	CTESSEL	8	10226	0.23	3.53	-0.54	0.51	4.42	-1.02	0.72	2.42	-1.56
	CTESSEL_obs		10226	0.24	3.86	-1.18	0.47	4.43	-0.27	0.71	2.35	-1.45
All	CTESSEL	32	88214	0.48	2.43	-0.13	0.71	3.22	-1.42	0.60	2.62	-1.54
	CTESSEL_obs	32	88214	0.38	2.84	-0.15	0.64	3.26	-0.92	0.56	2.20	-1.08

Fig. 3. Performance of the CTESSEL runs in simulating daily carbon fluxes