Geosci. Model Dev. Discuss., 4, C892–C896, 2011
www.geosci-model-dev-discuss.net/4/C892/2011/

Geoscientific Model Development Discussions

Interactive comment on "Development of an ensemble-adjoint optimization approach to derive uncertainties in net carbon fluxes" *by* T. Ziehn et al.

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Received and published: 19 October 2011

Reply to Anonymous Referee #1

We would like to thank the referee for the review of our manuscript and the constructive comments. Below, each comment (in quotation marks) is followed by an individual response.

"p1515, line 25 and p1516 line 18: How do the authors determine that 4DVar is the most advanced method in parameter estimation? I think this is an unnecessary judgement that adds nothing to the paper, and would probably be contested by people that use other methods such as MCMC. If they want to make this statement, the authors should

give reasons, but I would prefer it be removed."

We agree with the reviewer's comment and the statement will be removed in the revised version.

"p1518, line 19: Are uncertainties in the background fluxes treated in this analysis or ignored? The study produces very small uncertainties for the decadal NEP, would these be larger if uncertainties in the background fluxes were considered? Could the same method be used to consider uncertainties in background fluxes as is used for the uncertainty in other parameters?"

Uncertainties in the background fluxes are not included in this study. In principle, uncertainties in background fluxes could be considered and investigating the effects of uncertainties in the background fluxes on target quantities would make an interesting study on its own.

"p1521, line 1: 'We can then propogate the posterior uncertainties ...' the way it is written, it is not clear whether propogation of uncertainties is part of the second of third stage. This sentence sounds like the third stage, yet mentioning it in the second stage is confusing, or is it something different?"

The propagation of the posterior parameters uncertainties to the output target quantity is included in the CCDAS framework and is therefore part of the second stage. This is done by making use of the Jacobian (first order derivative) of the BETHY model which allows us to estimate uncertainties and covariances for output target quantities such as the net carbon flux.

We will clarify this point in the revised manuscript and also provide a reference where the propagation of uncertainties within CCDAS is described in detail.

"eqn 7: As this equation for superimposing the PDFs is critical to the paper, can the authors provide any justification for the form of the equation? If it is a standard method then is there a reference descrribing it in a textbook perhaps?"

Equations (6) and (7) describe the superposition of individual PDFs with a normal distribution. The sum over all individual PDFs (Eq. 7) is normalised by their total number (Eq. 6) so that the integral over the final (superimposed) PDF is one. We discretize the PDFs using a step length of 1x10-4 PgC and then calculate the sum of all discrete points divided by the total number of PDFs for each step in order to obtain the final PDF.

This explanation will be added to the revised manuscript

"p1523, line 6: for clarity, add 'individual years/months in' or whatever is the case, at the end of the line, to help the reader understand what elements of the covariance matrix are negatively correlated."

It should be individual years and we will add this in the revised version.

"p1523: Could the authors tell us what are the estimates (and range) of NPP and soil respiration?"

We will provide a time series plot of the net primary productivity (NPP) including error bars in the revised manuscript. However, the main focus of this paper is on developing a new optimization framework for terrestrial ecosystem models, which is demonstrated here using the net ecosystem productivity (NEP) as a target output quantity. Soil respiration is a different target output quantity and we feel that providing estimates for a second target output quantity is not the scope of this paper.

Figure 1 (NPP times series) caption: Time series of the global mean net primary productivity (NPP). Median and error bars are calculated from the 170 NPP fields (first stage of the ensemble-adjoint optimization approach), which are then used as input fields for CCDAS. Error bars represent the lower and upper percentiles equivalent to one standard deviation (i.e. 15.9th percentile and 84.1th percentile respectively).

"p1524, line 15: How would this be done? Estimate the NPP parameters first, then use the pdf in a calculation like the one described here? A minor change to the wording of

this sentence would make that clear."

We derive posterior uncertainties for the NPP related parameters first by constraining the Farquhar photosynthesis model using an extensive set of plant traits. Instead of using the prior uncertainties for the NPP related parameters in stage 1 (ensemble runs) we suggest to use the posterior uncertainties for the same parameters. The proposed ensemble-adjoint framework remains the same.

We will reformulate the sentences in the revised version to make it clearer for the reader.

"Fig 2 caption: be more specific in the brackets, it is unnecessarily too short (which used prior photosynthesis parameters, and was not part of the ensemble)"

We will change the caption for Fig. 2 as suggested by the reviewer in the revised version.

"Typos: p1516, line 10: following p1516, line 16: allows us"

This will be corrected in the revised manuscript.

Interactive comment on Geosci. Model Dev. Discuss., 4, 1513, 2011.

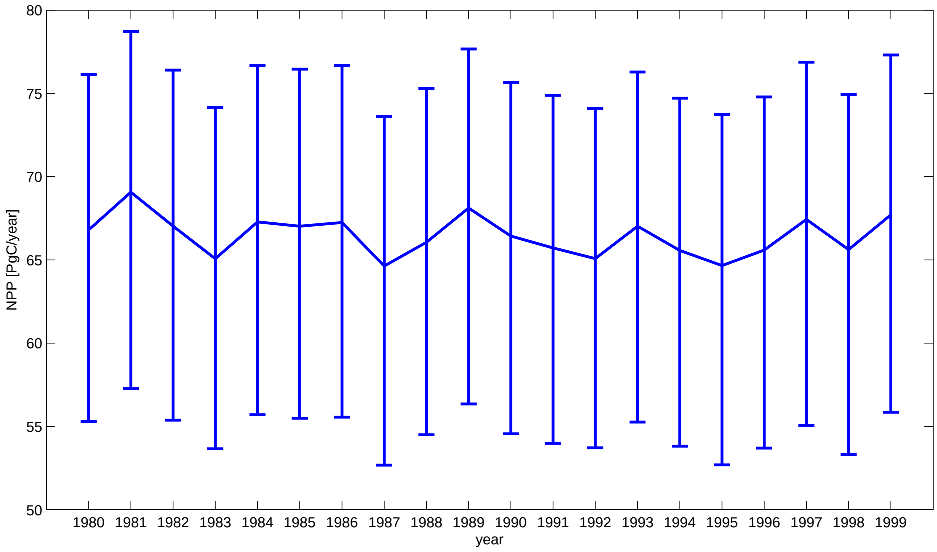

Fig. 1. Time series of the global mean net primary productivity (NPP) including error bars.