Biogeosciences Discuss., 10, C1040–C1043, 2013
www.biogeosciences-discuss.net/10/C1040/2013/
© Author(s) 2013. This work is distributed under
the Creative Commons Attribute 3.0 License.

Biogeosciences Discussions

Interactive comment on "Evaluating the agreement between measurements and models of net ecosystem exchange at different times and time scales using wavelet coherence: an example using data from the North American Carbon Program Site-Level Interim Synthesis" *by* P. C. Stoy et al.

Anonymous Referee #2

Received and published: 18 April 2013

I read the paper of Stoy and colleagues with considerable interest, as it aims at providing a new tool for an important aspect of earth system sciences: the evaluation of model performance with the objective to understand structural deficiencies in models. Overall the paper is well written, the scope of the study clearly stated and the results are thoroughly discussed.

Methodological Issues:

As the paper does propose a new methodology for diagnostic model evaluation it is crucial that all techniques are employed in a rigorous manner, with a strong grounding in the relevant methodological literature. At this point I am sorry to say that the paper suffers from severe methodological issues (listed below) that prevent med from recommending it for publication in its present form.

Application of wavelet analysis to time series with missing values

This is a recurrent feature for several analyzed time series (see e.g. "constant" areas in Figures 1, 6, 7, 8, 9). I assume that the corresponding time steps have been filled with constant values (e.g. zero). This leads to spurious patterns in wavelet coherence. For high frequencies (small scales) these artifacts are easily visible and the authors do avoid interpretation. However, for low frequencies these artifacts are more difficult to separate from real effects, rendering interpretation difficult. For more information see the arguments on "the cone of influence" in the relevant literature. Thus, the authors must either avoid the analysis of time series with missing values or mask the areas where wavelet coherence is influenced by such effects.

Significance testing

The significance-testing of wavelet coherence in this study does closely follow the suggestion of Grinsted et al. (2004). (Based on simulation of stochastic processes and subsequent application of wavelet-coherence). Unfortunately recent methodological research (Maraun & Kurths, 2004 and Maraun et al., 2007) has demonstrated that this approach is prone to discover "large significant areas" even if pure noise is analyzed. (For an impressive illustration of this effect see Figure 8 in Maraun et al., 2007). As the

presented study relies heavily on the identification of significant locations in the wavelet space, I cannot recommend this study for publication without this issue being resolved. (For possible approaches to this issue see Maraun et al., 2007). Note also, it is not sufficient to state that only “large” areas are considered for interpretation, this renders a formal significant test arbitrary, making it essentially useless (as it then depends on the investigators will and not on transparent rules).

General comment on wavelet techniques in this context

Overall I am not sure if wavelet-coherence is the best available too to solve the objective of the study (model evaluation with respect to distinct frequency bands). The main advantage of wavelet approaches compared to conventional spectral analysis is the ability to track changes in spectral properties over time. However, the authors do mainly interpret coherence between observations and models for distinct spectral bands (e.g. seasonal, annual), without considering time varying phenomena. Therefore I wonder whether the same findings (identifying in which frequency band models are (not) close to observations) could have been obtained with (conventional) cross-spectral analysis. In comparison to wavelet-coherence cross spectral analysis has a more robust theoretical grounding, avoiding many of the mentioned issues related to significance testing.

Thus I suggest to the authors to reconsider their choice of methods, possibly replacing wavelet-coherence with conventional cross-spectral (cross spectra, coherence) methods. This would likely yield more stable results and make the analysis more transparent. If the results presented in the manuscript are robust, a re-evaluation should not change the findings. This would allow for a change of methods with minimal writing effort.

Some specific comments

1. Most readers will not be familiar with wavelet analysis. Therefore introducing wavelet-coherence (Eq. 1) without a definition of the wavelet coefficients is somewhat “useless”. Therefore I would suggest to briefly introduce the wavelet transform, either in the main text or in an appendix. (If the authors choose to stick with this method, see comment above)
2. It would be helpful if scale axis in the wavelet figures would have an indication for days, months, years.

References

Grinsted, A.; Moore, J. C. & Jevrejeva, S. Application of the cross wavelet transform and wavelet coherence to geophysical time series Nonlinear Processes in Geophysics, 2004, 11, 561-566

Maraun, D. & Kurths, J. Cross wavelet analysis: significance testing and pitfalls Nonlinear Processes in Geophysics, 2004, 11, 505-514

Maraun, D.; Kurths, J. & Holschneider, M. Nonstationary Gaussian processes in wavelet domain: Synthesis, estimation, and significance testing Physical Review E (Statistical, Nonlinear, and Soft Matter Physics), APS, 2007, 75, 016707

Interactive comment on Biogeosciences Discuss., 10, 3039, 2013.