

Interactive comment on “Biosphere-atmosphere exchange of CO₂ in relation to climate: a cross-biome analysis across multiple time scales” by P. C. Stoy et al.

Anonymous Referee #1

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General Comments

The paper presents a time series analysis of comprehensive CO₂-flux measurements. It addresses the question of whether ecosystem dynamics can explain variability in the biosphere-atmosphere exchange of CO₂ at the global level. Three hypotheses are tested, namely that: (1) a significant gap emerges in the power spectrum of the CO₂-flux at inter-annual time scales; (2) plant functional types (PFT) can explain differences in flux variability and co-variability with climate at the seasonal scale; and (3) discrimination in terms of PFTs is a logical way to categorize responses to climate forcing.

Spectra and co-spectra are obtained mainly through application of orthonormal wavelet

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transformation, and the ecosystem response to climate forcing is examined from the point of view of information transfer theory.

While the analysis is carried out on the background of a very rich data set – version 2 of the La Thuille FLUXNET database – and is probably unique in this sense, the results do not really disclose new aspects of the terrestrial carbon dynamics. Overall the discussion comes short in explaining how different mechanisms at the ecosystem levels act to mediate the climate signal at the various time scales. I am thinking here in particular at differences between plant and soil microbial processes – which are key to understand the specific behaviour of gross ecosystem productivity (GEP) and ecosystem respiration (RE) – as well as long-term (seasonal and longer) changes in the ecosystem composition (and possibly PFTs). For instance, given the contribution of soil respiration to RE, it is not surprising that the hypothesis of a characterization of RE variability in terms of PFTs at the seasonal and longer time scales is not supported by the results.

The working hypothesis that ecosystem spectral transfer is a useful concept for analysis the spectral response also requires some additional explanations. As mentioned by the authors in the footnote on p. 4105, in information theory the concept is primarily applied to linear, time-invariant systems. In view of the complexity of ecosystem dynamics, the assumption that terrestrial ecosystems can be considered as linear and time-invariant should be motivated and not taken for granted.

From a formal point of view, the paper is well written; in this sense I have no specific comments. Nonetheless, I believe that the main message can be conveyed more concisely. I therefore recommend shortening the manuscript.

Technical comments

Relevant results (significance of differences between among climate drivers or PFT)

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are displayed with horizontal bars in the Figs. 3, 5 and 6. This is a very effective way to pack the information, but in practice it is not always easy to discern the details – unless the figures are greatly magnified. (This applies in particular to colour-blind persons.) In addition, while this approach does indeed show whether there is or not a difference, it does not indicate which is the difference. As it is difficult to propose an alternative that is as concise as this one but less difficult to read, in view of my second comment I was wondering whether the horizontal lines could be skipped altogether, and the relevant information simply provided in the text.

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