

Nonlin. Processes Geophys. Discuss., referee comment RC2  
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## **Comment on npg-2021-10**

Anonymous Referee #2

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Referee comment on "Identification of linear response functions from arbitrary perturbation experiments in the presence of noise – Part 2: Application to the land carbon cycle in the MPI Earth System Model" by Guilherme L. Torres Mendonça et al., Nonlin. Processes Geophys. Discuss., <https://doi.org/10.5194/npg-2021-10-RC2>, 2021

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Review of: Identification of linear response functions from arbitrary perturbation experiments in the presence of noise –Part II. Application to the land carbon cycle in the MPI Earth System Model

Torres Mendonça et al.

### Overall Assessment:

The paper presents an application of novel mathematical technique used to derive linear response functions from an arbitrary climate model experiment. The methods is applied to MPI-ESM output to derive C4MIP type climate feedback parameters, and used to produce of spectrum for responses. The technique tuned to one climate model experiment is shown to be able to replicate other climate experiments from the same Earth System Model. The method is shown to be robust and could have a variety of applications to future research. I recommend that the paper be accepted for publication following revisions.

### General Comments:

(1) It would be useful to add a section to the introduction explaining why linear response functions are useful. This is actually done in the outlook section, but it would be better placed in the introduction so readers understand why all of the dense mathematics is useful.

(2) Throughout the manuscript non-linearities are treated as a annoying problem to to overcome. However, Earth system models were build to study coupled climate carbon cycle feedbacks and to explore for the potential of non-linear behaviour in the Earth system. Thus the manuscript has a bit of a 'we linearized the system of equations and thereafter found everything to be linear' vibe. The manuscript need to be clearer about what non-linearities are and why they are important.

(3) The manuscript has a bizarre way of referring to subplots as 'subfigure (x)' only giving the letter of the panel as x, without the figure number referred to. Please change these everywhere to the conventional Figure 1a, Fig 2b ext.

Specific comments:

Line 10: The sentence "By taking instead of CO2 the resulting Net Primary Production as forcing, the response is approximately linear until CO2 perturbations of about 850 ppm." confusing, please rewrite.

Line 32: Sentence is confusing.

Line 33: Change 'is' to 'are'

Line 50: You should include a full explanation in the introduction of what  $\gamma$  and  $\beta$  are. You have assumed the reader knows what they are. In many cases this will be true but including a full explanation means you will lose less people, the paper will be less intimidating and the technique will be more likely to be used.

Line 61: The original C4MIP (Friedlingstein et al 2006) used a modified SRES scenario, not the 1pctCO2 experiment.

Line 62: "performed with several" the 1pctCO2 experiment is part of DECK and is a required experiment for admittance to CMIP6.

Line 65 to 69: Confusing long sentence. Break up for clarity.

Line 81: Delete 'But while'. In general do not start sentences, let alone paragraphs, with 'but' in English. 'However' is acceptable.

Line 113: Most of the audience will not know what 'ansatz' means.

Table 1: Clarify that % is compounded to cause and exponential rise in CO2 concentration.

Line 156: "cursed" is not the correct word to use here.

Figure 2: Is the error metric non-dimensional? If so make this clear. 'Relative prediction error' may be clearer.

Figure 2: Be careful how you use the word 'forcing'. Many readers will assume radiative forcing unless this is specified otherwise.

Equation 12: Lowercase 'c' is terrible notation for atmospheric CO<sub>2</sub>. C<sub>A</sub> or C<sub>atm</sub> would be clearer.

Line 291: Why use NPP instead of GPP. GPP is a direct measure of photosynthesis.

Line 295: "land carbon only via changes in photosynthetic productivity." This is not true. At higher atmospheric CO<sub>2</sub> concentration plants are able to close their stomata more often, allowing higher retention of water. This decreases the rate of evapotranspiration, which feeds-back onto ground water supply and atmospheric processes dependent of water vapour flux. This is well known and well studied phenomena.

432: This is not a Gregory plot, and calling it a Gregory plot is confusing. Do not refer to these as Gregory plots. Gregory plots are based on simple energy balance, these plots are not.

Line 569 to 570: This is not a complete sentence.