

Interactive comment on “Transient Dynamics of Terrestrial Carbon Storage: Mathematical foundation and Numeric Examples” by Yiqi Luo et al.

Anonymous Referee #1

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General remarks:

The authors present a paper showing that a matrix equation can replicate the output of a comprehensive carbon cycle model. In particular they find that the force driving the ecosystem C storage is the C storage capacity. In general the article is well written and organized and fits into the scope of the journal. Using such a simple matrix equation as a physical emulator of comprehensive models has the potential to save a lot of computing time and gains a deeper understanding of the underlying mechanisms. The authors state in their summary that this would revolutionize model evaluations. I have some concern about this: The matrix equation has to be fitted to a simulation of the complex model with a specified fixed climate scenario. It would be interesting to know

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whether this parameter set can be used for a different climate scenario. In particular some parameters in the matrix equation are time-dependent and this time-dependence might change for different climate scenarios. Then the complex model can really be replaced by the matrix equation. Otherwise the matrix equation allows only a more convenient analysis of the model output. Non-linearities in the complex model might lead to a deviation from the linearized matrix representation. It would be nice if the authors could comment on that.

More specific remarks:

Abstract: The authors are talking about a 3-D parameter space. These 3 parameters, however, are not simple scalars, but are itself vectors (e.g., residence time and storage potential).

Page 4: The authors state that most carbon cycle models follow a mathematical formulation of ordinary differential equations. Many of the dynamic global vegetation models (DGVM) are ab initio formulated as a time discrete model calculating, e.g., NPP on a daily level and carbon allocation to different vegetation pools on annually using some (non-linear) allocation rules. Moreover, the authors should mention these DGVMs.

Page 9: The authors should describe which algorithms are necessary in order to develop the matrix equation from the output of the TECO model. In particular how they determined matrix A and K. Technical comment:

Page 29, line 586: A “to” is missing: The emulators allow us TO analyze. . .

In summary the article is suitable for publication if the above-mentioned comments are incorporated.

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