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Interactive comment on "Technical Note: An efficient method for accelerating the spin-up process for process-based biogeochemistry models" *by* Yang Qu et al.

Anonymous Referee #2

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The spin-up issue is one of the technical bottlenecks for the modeling of biogeochemistry on the global scale. Using analytical approach to accelerate the spin-up of global biogeochemical models is promising, and this study provides a new approach with the TEM model. The method is novel and it can save ~90% of the spin-up time. However, I have a few major concerns on the current version of the manuscript. A substantial revision is suggested before this work is considered for publication.

First, the section 2.2 is the core of this work, so the equations need more details and a double check. The equations (15) and (15a) are the fundamental equations in this method, but it is unclear how these two equations were derived from (12) and (13),

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respectively. One major reason for the confusion is that the authors introduced the k-1/2 as a half time step. I encourage the authors to more carefully double check the equations.

Second, even the equations are all corrected, it is the authors' obligation to illustrate that how this approach could be adopted by other models. As we know, the structure of biogeochemistry in TEM used in this work is much simpler than those in many global land-surface models. For example, there are only two C pools and three N pools (see page 4), this makes the mathematical solution for the steady state much easier than those century-type models. I suggest the authors to add a section to discuss how their approach could be used in other models.

Third, the authors compared their new approach to the semi-analytical spin-up (SASU) method. The SASU method has shown that using analytical approach can dramatically save the spin-up time. However, many models still use the traditional methods of long-term iteration or some others, such as the accelerated decomposition (please see the technical note for the CLM4.5/5). The reason is that coding the analytical methods into the original model is time consuming. It would be great to see whether this method can save more time than those widely-used simple methods.

Forth, as shown in the Table 2, it seems the original TEM model reached the steady state very fast ($\sim$200-500 years). This might be due to the short turnover times in the model (or the B components in the equation 16). Obviously the turnover of soil C is very slow at northern high latitudes. So it is not clear how the method will perform if the parameterizations for the soil module is realistic.

Below are some minor comments: 1. Pleask check eqn. (15) and (15a); 2. Page 4, Line 68-70: add a diagram to show the C-N structure of TEM would be helpful. 3. Page 6, Line 86: h is a vector of GPP? What is the difference between ""carbon input from the atmosphere" and "GPP"? 4. Page 9, Line 136: explain the "Vc"; 5. Fig. 1: please explain the contents in each box briefly in the figure leg-

end. 6. Fig. 3: unclear. The figures show the “spin-up time” or the steady-state C pool?

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2018-98/bg-2018-98-RC2-supplement.pdf

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