Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2018-98-AC3, 2018

Biogeosciences
Discussions

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

Yang Qu et al.

qu30@purdue.edu

Received and published: 15 May 2018

Authors introduce many variables in Section 2.2, but most of them are not well illustrated. I feel confused about the difference between k-1/2and k-1 in Eq. 12. If the spin-up is driven by monthly climatology, to my understanding, the Jk matrix should depend on a constant matrix of transfer rate among pools and a matrix of pool size for each time step (k) in a specific year. It is vague and confusing that how to calculate the matrix of mean process rate constants (Line 104) for time step k (J(k-1/2)). Section2.2 is the core of this new method, but authors simply list equations and do not explainhow actually they have used it. Additionally, in line 109, Eq. 12 can't be written as Eq. 15

when using yk=τf(k-1/2), bu tit is valid by using yk=τf(k-1). Authors should carefully check all the equations before submission.

Response: In this revision, we clarified the definition of half-step Jacobian matrix and the way to compute it. Process rates depend on temperature and the process rate constants are time dependent, Index k-1/2 is introduced due to solving x(k)-x(k-1)= τ*(g(k-1/2)*x(k-1)+h(k-1/2)), which, as reviewer noted, would be commonly written as x(k)-x(k-1)= τ *(g(k-1)*x(k-1)+h(k-1)) in a purely explicit scheme. However, it can be shown that using process rates at midpoint (k-1/2) is no less accurate than in purely explicit form with (k-1), which is obvious for h(k-1/2). The term h(k-1/2) simply represents the value at the half-time step for function h. For Section 2.2, we revised it to show how each step is being done and how the next step is related to previous time step.

Line 115, please spell out LU Response: LU (Lower and Upper) decomposition refers to a matrix transformation to a Lower or Upper triangular form.

In line 111, the cyclic boundary condition of this method is x1=x(T+1). As stated in the manuscript, when spin up is made at the monthly time step, T equals to 12 and x1 is the size of carbon pools in January. That means boundary condition is only applied to January carbon pools. This study mainly uses the Harvard Forest site (even though the authors listed seven sites in Table 1) which PFT is deciduous forests. The fluctuation of carbon pool/flux is the largest during the growing seasons. The method is not designed to reach a steady state for all state and flux variables during other months. As this method aims to derive a cyclic steady state, it is supposed to set a threshold or a boundary condition for each month/day or seasonal cycles, as well as for annual carbon balance (NEP)

Response: Our model simulations are at a monthly step and we assume that, in a steady state, the pool sizes of x in December of the previous year shall equal the values in January of the next year. This treatment allow us reformulate the eq. 15 to eq. 15a to efficiently obtain solutions for x. In addition, we still used the annual NEP to judge if the model has reached a steady state. In this revision, we revised the text to clearly state that our method is not to reach a monthly steady state for pools and fluxes, rather, we still target a steady state for the system at annual time step, in the end of the Section 2.2.

Authors only present one table (Table 2) that contains the result of the proposed method, and other figures/tables are results from the original spin-up method. I didn't get the idea why to do this. In the Introduction (Line 42-43), it says that 'the model will check the stability of the simulated carbon and nitrogen fluxes as well as state variables with specified threshold values'. I didn't see much of these in Section 2 and 3.Authors list seven sites to apply the new method, but I only see the results at Harvard Forest site, what about the results at other sites?

Response: In this revision, more details are added to the Result/Discussion sections. We also revise Table 2 to show the site-level results not only using the new method, but also other spin-up methods including a semi-analytical method and the original TEM spin-up method. To save space for a technical note paper, we intentionally only show the results at one site (Harvard forests) with Figure 2. We state that, similar results are also found for other sites in Table 1. In addition, we used Figure 3 to show regional results in North America to demonstrate the performance of the new method.

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2018-98/bg-2018-98-AC3-supplement.zip

---

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2018-98, 2018.