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Discussions

Interactive comment on "Oscillatory behavior of two nonlinear microbial models of soil carbon decomposition" *by* Y. P. Wang et al.

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We appreciate the constructive comments by reviewer 3. We have revised the manuscript by carefully taking account of all comments.

(D1) In respect to the oscillations present in the microbial models, I agree with the comments by Allison that this feature is an important component of microbial models. One could even argue that the lack of oscillation in linear models is problematic given empirical evidence for seasonal fluctuation in microbial biomass pools. Reply: We agree the oscillation is an important component of microbial model. The response of microbial biomass pool to a step change in carbon input is oscillatory for both two-pool and three-pool models. However the response of SOC is oscillatory only for the two-pool model and is monotonic for the three-pool model. We think that the response of

two-pool is unrealistic. This is now clarified (see new text on L409-411)

(D2) Logically, it makes sense that following a reduction in microbial biomass and soil C that these pools would exhibit opposite responses with declines or increases in microbial biomass leading to increased or decreased soil C until equilibrium is again reached. The troubling aspect here that the authors stress is the timescale over which this occurs. One key analysis that would strengthen this argument would be to examine the sensitivity of these oscillations to variations in the perturbation size. A 10% decline in soil C or microbial biomass is not a small perturbation when you consider that 10% of the global soil C pool is 100 Pg C. The key question here is whether the long period of oscillation is conserved at smaller perturbations. Reply: The frequency of oscillation is proportional to in the two-pool model, and to in the three-pool model (see L29-30). These analytic results are good approximations for a 10% change in microbial biomass or soil carbon, we have checked these numerically. No changes are made.

(D3) Thus, a better recommendation for moving forward would be to incorporate these protection mechanisms in the models to dampen these oscillations while limiting model complexity. Simply combining the stability of the traditional linear models with the dynamics of the microbial models is unlikely to capture protection mechanisms. Reply. Agreed. Oscillation of microbial biomass pool but not the SOC as in three-pool nonlinear soil model is not a significant issue at all for studying global soil carbon dynamics, therefore there is no need to dampen that oscillation in the three-pool nonlinear model. However we agree that capturing the protection mechanism is important for studying global soil carbon dynamics at decadal or longer time scales (see changes on L507-508).

(D4) The authors should provide both lines of evidence in the discussion. However, highlighting the lack of sensitivity to shifts in NPP by the non-linear models remains important as these models may be getting the right answer for the wrong reason. Reply: see our reply to the second comment by Dr Steve Allison and new text on L459-464.

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