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Interactive comment on "The SUPECA kinetics for scaling redox reactions in networks of mixed substrates and consumers and an example application to aerobic soil respiration" *by* Jinyun Tang and William J. Riley

Anonymous Referee #1

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This is an elegant mathematical formulation of a generalized model that can be applied to a broad range of physico-chemical reactions. I enjoyed the thoroughness of the stepwise progress through the derivations needed to reject alternative approaches and develop the final SUPECA format. I also appreciate the applications, which demonstrate proof-of-concept. Nonetheless, I don't think many soil scientists will be convinced to use it or find it very useful, for several reasons (below).

From a soil ecology standpoint, some of assumptions were very constraining, while others were unrealistic. For example, the assumption that multiple substrate relation-

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ships with a single consumer do not have interactions (pg 11) is not realistic for either microbial-substrate interactions or enzyme-substrate interactions (e.g., pg 15). Alternatively, although true, it is not likely that earlier applications of the SU model have often been unreasonable because consumer abundances approached infinity. Some of these theoretical scenarios present real mathematical contradictions, but exist only when the basic equation is used in isolation from other system controls. In reality, consumers are unlikely to reach infinity for reasons apart from the SU equation, which other models variously attempt to capture.

By page 18, I became convinced that the matrix formulation would necessarily include many zeros for kinetic coefficients in a microbial-enzyme-substrate system, which also addresses a point made several times: whereas a superabundance of a substrate would eliminate a particular substrate-consumer interaction term, so would a K=0.

Other hierarchical interactions are ignored. Do the authors imagine other sets of functions and matrices of coefficients that could be used to capture controls exerted by other environmental conditions on these kinetic coefficients, such as pH, stoichiometry, CUE, etc.? This model rapidly becomes unwieldy.

The specific applications of this model demonstrated some utility. However, I am not convinced that the model is necessarily superior to other more common formulations that have been used in these ways despite SUPECA's analytical elegance. I suggest more effort to demonstrate the utility of this model as something more than a really elegant mathematical exercise. For example, the statement on line 21 page 29 is that SUPECA can scale reaction networks without changing mathematical formulation. Is this a utilitarian or theoretical accomplishment?

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