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Hydrology and Earth System Sciences Discussions

Interactive comment on "Dynamics of resource production and utilisation in two-component biosphere-human and terrestrial carbon systems" *by* M. R. Raupach

V. Brovkin (Referee)

victor.brovkin@pik-potsdam.de

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The manuscript by M.R.Raupach is a mature, well-written paper. It is focused on analysis and interpretation of two-dimensional dynamical systems often used in ecological applications. The first model for biosphere-human interactions is of Lotka-Volterra type and it may exhibit a cyclic behavior. The second model for plant-soil carbon dynamics could have two steady states which might be irregularly visited under stochastic external forcing. The manuscript can be published after accounting for the following, rather minor comments.

Model of human-biosphere interactions

Suggested model of biosphere-human interactions could be easily criticized for exploring Malthusian approach of direct link between population dynamics and food availability. This simple approach neglects intrinsic society feedbacks, like reduction of population growth in industrial societies. The author stresses correctly that the simple model cannot capture a complex system behavior, but does not specify a spatial and temporal scale on which results of this model can be reasonably interpreted. I guess that the model can be applicable for a case of colonization of isolated island, for example the Easter Island (Diamond, 2005), but the author can illustrate the reach dynamic behavior of the model with more examples from the past societies.

An amount of food (biomass) available for population can be controlled by society, for example, as a result of the Green Revolution. This means that productivity, p, is a function of population, h, and this may lead to a different system behavior. A work by Wirtz and Lemmen on society dynamics (2003) includes agricultural technology as a state variable. A comment on this would be useful.

Model of biomass and soil carbon dynamics

This model correctly includes a stimulating effect of soil carbon (x2) on biomass (x1) though enhancement of water and nutrients availability. Unfortunately, this effect is mostly neglected in the global-scale vegetation models (e.g., Cramer et al., 2001). The "dormant-biosphere" solution might be important for desert ecosystem dynamics. At the same time, the bare soil solution in areas with high productivity (temperate regions, tropics) seems to be unstable. A comment on this is welcome.

Other comments

Most of material reported in the Section 2 can be found in the standard textbooks on dynamical systems. This section looks fine but it can be omitted without major disturbance in case of space limitation.

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Page 8: “The model has three dimensions: biomass [B], humans [H] and time [T].” Usually, dimension of dynamical system is defined in accordance with a number of phase variables (two in this case). To avoid the reader’s confusion, it would be good to comment that the system (11-12) is called two-dimensional dynamical system in the standard textbooks.

References

Cramer W., A. Bondeau, F.I. Woodward, I.C. Prentice, R.A. Betts, V. Brovkin, P.M. Cox, V. Fisher, J. Foley, A.D. Friend, C. Kucharik, M.R. Lomas, N. Ramankutty, S. Sitch, B. Smith, A. White, C. Young-Molling, 2001. Dynamic responses of global terrestrial ecosystems to changes in CO2 and climate. Global Change Biology, 7, 357-373.
Wirtz, K., and Lemmen, C., 2003. A global dynamic model for the Neolithic transition, Climatic Change 59: 333-367.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 3, 2279, 2006.