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Interactive comment on "Elevating the biogeosciences within environmental research networks" *by* Daniel D. Richter et al.

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The authors present a very important manuscript advocating better integration of Observatories (EONs) and networks (LTER and CZO) through the biogeosciences. I strongly agree with the authors that this advocacy is needed. The topic of this manuscript is timely and pertinent. I greatly appreciate all the hard work that has gone into this crafting this manuscript.

I am very familiar with most all the co-authors, the observatories and networks, the scientific rationale(s), and working in these organizations. I am also quite familiar with the subject matter. I feel I have broad knowledge of this area of research and development, and feel this is a fair and honest review. I feel that if a reviewer has constructive

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and collegial comments, they should not hide behind anonymity. Hence, I do not wish to remain anonymous, and please consider this review signed, Hank Loescher. At this time, I recommend a major revision.

This is a great opportunity to advance Earth system science, but with all due respect to my esteemed colleagues, I think you have missed the point:

First and most importantly, what is being advocated is as much cultural issue in conducting science as anything. I have seen the direct effects of different scientific cultures in numerous, recent meetings with members of the EONS, LTER, CZO and other networks present. In that the authors are well respected members of the ecological community, there is a large responsibility to communicate your message correctly and with an awareness of the cultural and political sensitivities. Advocating change will be best served by communicating your ideas in a way that can be heard by all the respective user communities. As it is written, I find obvious biases in how each of the research structures are described, and this does a disservice to the goals of the paper and to the future user communities. Authors hold onto an old paradigm of how science is best performed (e.g., no faults to the LTER approach), clearly contain their own bias, and do not present a meaningful path forward. There are a lot of misnomers and imprecise statements that also show this bias, and if published as is, would propagate these biases to the user communities. The issues at hand are not about perpetuating the LTER paradigms in the use of 'hypotheses questions' moving forward, but embracing (and owning as a community) new institutionalized approaches (networks and observatories) to challenge our current approaches (get out of our current boxes) and move the science forward with new tools. I do not see that the authors take ownership if this problem. Second, the authors do not clearly and objectively describe the respective strengths, weakness and complementarity of all these research organizations. I strongly recommend an unvarnished assessment of the attributes and approaches of the respective organizations. The manuscript would be better served if the authors provide specific science themes together with the approaches that can integrate the

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data and advance our understanding across disciplines, processes, time, and space.

Other key issues EONs (NEON) and networks (CZO/LTER) are BOTH question based. But how they are applied (EONs to inform requirements and top down designs) and Networks (bottom up tradition hypothesis testing) differ. Both utilize the same suite of questions, the nuance is HOW they are implemented. And I fully agree that there has to be a structure in place to revisit, revise, and update the EON capabilities against the rubric of frontier science questions.

The text often jumps from idea to idea, from concept to concept without really discussing the issues or core mechanisms to really bridge disciplines and integrate concepts. Narrative structure needs more synthesis-style of writing.

If you look at the original planning documents for LTER, they look a heck of a lot more similar to an EON than what their organizational structure and function are today. Why is that? The change in organizational approach of networks (LTER) over time is natural in its evolution/development. Acknowledging this and advocating for change in the context of biogeosciences among networks is very natural–and messy way that we do science. Maybe state as much.

Authors do not really take ownership of the issues at hand, or the process of integrative change in EON structures. Rather, they pointing out the shortcomings and advocate the same old, the same old. The only difference in this manuscript is that biogeosciences is being broadly advocated as the integrative theme without any real specifics in how to do this.

specific (nitpicky) comments L112, what 'new systems analyses'?, best to define it a tad more. L122, what 'critical zone scientists'?, best to define it a tad more. L129, the acronym of 'ILTER' is not really defined L133, doesn't 'EOS' stand for something? L135, what 'is a time scale in LTER'?, what is a 'time-scale' in a network? do y'all mean 'site-based LTER science'? or something like that? L141, what 'NEON'?, best to define it a tad more. Peters et al. 2014 provides a working description of 'EONs'

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and other ecological infrastructures. L143, what about temporal scales?, re. designed to scale in both time and space... L144, I think the statement of 'ecological conditions and biodiversity' falls at tad short. (i) does not embody the philosophical approach of cause and effect, and (ii) in the case of NEON there are 7 grand challenge areas that were adopted by the NAS 2001, 2003 reports. Moreover, many would argue that no EON can estimate 'biodiversity' very well. The specific approach and rationale for biodiversity observations have to be taken into account, and towards what end? Moreover, biogeochemistry (that y'all are arguing for) is also being measured in NEON, though maybe not necessarily measuring what individual investigators want, or to a desired fidelity. The EON design criteria includes; (i) to be applicable to a broad user community, (ii) to be considered data product/approach broadly accepted by the user community, (iii) data product/approach not be considered experimental, and (iv) under pragmatic and fiscal constraints. All EONs have the same design issue. Best to highlight that there are other EONS internationally (just like that noted for iLTER and iCZOs) L146, 'question-driven' implies that 'EONs' are not question driven. This is not true, and does a disservice to the community and emergent culture of integrated research infrastructures. See note above. L156, while it is nice to see the whole book referenced, (re. Chabbi and Loescher 2017), the point that y'all made was in the chapter; Loescher, H. W., E. Kelly, and R. Lea, 2017 National Ecological Observatory Network: Beginnings, Programmatic and Scientific Challenges, and Ecological Forecasting. In: Terrestrial Ecosystem Research Infrastructures: Challenges and Opportunities. Eds. A. Chabbi, H.W. Loescher. CRC Press, Taylor Francis Group, Boca Raton, FL, pp. 27-48. ISBN 9781498751315. L165, consider '...and Earth scientists, alike...' L167, what does 'best of the biogeosciences' mean? best to be a tad more concise in the writing and a little less arm-wavy. L170 the comment '...to work across these networks to help solve pressing environmental problems and puzzles.' confuscates the difference between the need to advance basic science and understanding with the need to demonstrate societal benefit, economic value and an applied approach. Which is it? Best to be a tad more concise. L170, the voice and tone... reads tad self-serving. The idea to in-

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tegrate biogeosciences among several science disciplines has been around for a long time. Authors are correct to point out that reductionism plays a part (historically), but also note that a resistance to change current approaches is much more of an issue today. It seems as though there are a lot of issues are raised without fully embracing a synthetic statement or path forward... (i) basic science, developing a are understanding, and discovery, (ii) applied science toward decision makers (natural resource management), and (iii) policy driven science, all of which have different implication of how science is being done in the context of a network or infrastructure. L181, Schimel, D., M. Keller, S. Berukoff, R. Kao, H. W. Loescher, H. Powell, T. Kampe, D. Moore, and W. Gram, 2011. NEON Science Strategy; Enabling continental-scale ecological forecasting. Pub. NEON Inc., Boulder CO. pp 55. [webpage citation] is a more appropriate reference. L227, why are 'field experiments',Âăimportant? What is the philosophical context that becomes important in your narrative? Someone can say, so what, LTER has experiments?, towards what end? L227 while LTER research embraces different themes, PI based research is question/hypotheses driven, which also can be seen as a limitation, because of its lack of integration among other science that is being done at and among sitesâĂŤregardless of its utility to public policy. See comment above. L233, EON's in operations are not 'projects', particularly in the eyes of NSF. They are Large Facilities, or operational Research Infrastructures. Best to change the text to reflect this. L240, it is not a have '30-y vision', it has an NSB approved operational timelime of 30-y. This is a very different thing. L235, I strongly disagree with the statement 'EONs are not question-based or hypothesis-testing projects', and it does a large disservice to the user communities. They have been informed by grand challenge questions (from NAS in the case of NEON), and investigator based hypotheses. HOW they use them in the design is different. And I fully agree that there has to be a structure in place to revisit, revise, and update the EON capabilities against the rubric of frontier science questions. See comment above. L237, what is a 'highly controlled measurement'?, not a very concise statement. Do y'all mean measured in the same way across all the sites, with the same sources and magnitude of uncertainty, rigor-

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ously QA/QC'd, to assure robust cross site analyses? L238, L249, 'intended' sounds a bit arbitrary and argumentative, I would suggest to use 'designed'. L241, not really a network, NSF prefers 'Facility', 'Infrastructure' or Observatory. See comment above. L247, L250-251 it is definitely NOT 'NEON's mission is to analyze and forecast impacts of. . .'. NEON is charged to provide the data to enable an ecological forecasting. NEON is NOT preforming any of the data analyses or forecast ecological processes– that is for the community to do. I am quite surprised that this narrative was crafted this way, given that some of the co-authors are intimately aware of this point. L253, what does '. . .tightly controlled. . .' mean?, all NEON, TERN, SAEON data is open access. . . please be concise in your meaning here. L255, 'short time scales'? Not quite as concise and embracing a narrative that you could use. If you are discussing these data with an ecosystem scientists, they would potentially think decal scale data is very long, if chatting with micrometeorologists, they would think decadal scales would be infinite! I suggest to qualify this statement as something like . . . 'short time scales when compared to geological timescales that CZO community is accustomed to.', or something towards that effect. L257-60, NEON's current design does little to accommodate change. I do not disagree. But the verbiage is adversarial, rather than engaging. L276, 'NSF' is not defined L278-287, awkward sentences, suggest re-crafting it. L290, verb missing?, '. . .pertinent to [understand?] critical zone structure and function.' I do not think a study itself is pertinent to the CZO structure. L291-298, awkward sentence, suggest re-crafting it. L298-305 seems like a laundry list without any real syntheses of why these are important. Moreover, the paragraph begins w/ US CZO and then China, Mexico, France and India are mentioned. Best introduce there is a iCZO network analogous to iLTER. L310-313, redundant, re-write or remove L314, I disagree. A meteorologist is concerned at the synoptic or orographic time scales. Some CZO sites measure the turbulent exchange (much shorter timescales), hence it would be more concise to state 'micrometeorologist'. L316, are they really 'young', or early career? L320, interests? Unclear. L323, 'informational and physical' = good! L323, last clause '. . .and, expertise across LTERs, . . .' seems out of place and a vestige from

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edits. L324-333, seems arm wavy, what is different here than already being done (to play devil's advocate) what is really new here? What is the nitty gritty here? Just saying we need it, is not different from what current scientists do... L340, what happened to atmospheric? L390, 'full bloom' is jargon and very odd choice of wording. Suggest crafting the test with more approachable narrative structure. L392-L395, while there are interesting points here, the text fails to synthesis the core integral concepts that are needed to advance our science. Stating that instantaneous to millennial timescales are addressed, but fails to discuss how this is done and to what end. What is the nitty gritty here? L399, what 'benefits'?, and L402, what 'great opportunities'? just stating so, does not make it so. L418-420, How are these ideas being integrated?, merely stating so does not make reality. L431, Advocating a call to action to 'research agencies' is parochial at best. Suggest figuring out a different way to articulate this. Rarely does such a statement effect change in the programmatic activities or funding opportunities of an agency. L465, no Acknowledgements? L469, seems like a verb is missing. L592, is Josh Schimel, not O Schimel.

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