

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

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We appreciate the reviews and the editorial work.

We have taken very seriously both reviews and have substantially rewritten most of the ms. We have internationalized the authorship with scientists from Europe, Mexico, Argentina, Africa, India, and China. The text is internationalized in many ways as well. While we retain much of the historical context of the biogeosciences, which we frankly see as fundamental, we have attempted to make the paper as all encompassing to as many disciplines and audiences as possible. We seem to have been interpreted in our previous version as favoring one environmental network over another. As this was not our message, we have explicitly addressed this fact and have adopted a much more

C1

positive tone throughout. We are on the side of the biogeosciences, not on the side of any one network. By adding the FLUXNET network to theILTERs, EONs, and CZOs, we believe we have further defused any possibility of being seen to be partisan for one network over another.

We believe you will see that this is much improved ms. Because we were not seen to be advancing all long-term environmental research networks (specifically ILTERs, CZOs, EONs, and FLUXNETs), we have recruited a number of international co-authors and substantially re-written the text.

Responses to review #1. Reviewer comments start with R; Authors responses begin with A.

RThe 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.

AThanks for the review and for the complements on "a very important manuscript."

RI 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 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.

AFair enough. We went back to the drawing board and have substantially revised the ms. We have given the ms a new tone for sure, making it much more positive throughout.

C2

RThis 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:

AWith all due respect, our opportunity is to advance the biogeosciences and long-term environmental research networks.

RFirst 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.

AAs co-authors are leaders in the ILTERs, CZOs, NEON, and FLUXNET, we have emphasized during the revision that we will minimize "biases" in how the networks were to be presented. The point is NOT to advocate for one approach or another, the point is to get the most out of all environmental research networks! We are earnestly convinced that the biogeosciences offers great opportunities for science and for engaging larger

C3

scientific and public audiences.

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

AWe respectfully have not presented a scientific evaluation of the strengths and weaknesses of the networks and do not see that as being in line with our objectives, which are clearly to promote more integrative biogeoscience within the networks.

ROther 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.

AWe carefully have reword these descriptions of question-based, hypothesis-based, etc.. We have checked the literature and included new citations of discussions that compare these networks (Lindenmayer, Likens, Franklin) to ensure we describe the networks accurately.

RThe 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.

AWe have reorganized the paper, hopefully making it more integrated. We respectfully disagree about the jumps from idea to idea. We kept this comment in mind in the revision, so that the story better told.

C4

RIIf 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.

APerhaps the reviewer is correct on the overlap of the contemporary EON-early LTER literature. What has struck the authors is that the early LTER literature was reaching out in space and time, and occasionally the audience was explicitly the Earth science community. We have cited these examples and one of the figures demonstrates this in spades (Fig. 5) from the classic paper by John Magnuson on lake productivity being controlled by groundwater flow paths through glacial moraines with contrasting carbonate chemistries.

RAuthors 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.

ANot sure what the reviewer is driving at here. We have certainly no critiquas on the shortcomings of EONs. That is not part of the paper's mission. specific (nitpicky) comments

L112, what 'new systems analyses'?, best to define it a tad more.

OMITTED.

L122, what 'critical zone scientists'?, best to define it a tad more.

NOT APPLICABLE IN THE REVISION.

L129, the acronym of 'ILTER' is not really defined

C5

DEFINED AND EXPLAINED.

L133, doesn't 'EOS' stand for something? In Greek mythology, Eos is goddess of the dawn.

It is the name of AGU's newspaper. It is correctly spelled "Eos" in the new version.

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?

We have deleted this discussion from the new version and the new version uses Tom Callahan (1984) to discuss time scales and ecological research.

L141, what 'NEON'?, best to define it a tad more. Peters et al. 2014 provides a working description of 'EONs' and other ecological infrastructures.

Thanks for the suggested citation. We have overhauled our description of EONs and NEON in particular.

L143, what about temporal scales?, re. designed to scale in both time and space. . .

Temporal scales are interesting in EONs as they span the near instantaneous to the decadal.

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

C6

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)

While we discuss briefly international EONs including TERN in Australia and mention GEO projects, the paper is not about biology, and thus biodiversity is mentioned briefly. We respectfully do not see ourselves discussing EONs that are designed as biological networks, EONs/BONs. Our field is the biogeosciences.

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.

We have carefully reworded these statements, and certainly meant no "disservice to the community and emergent culture". Our purpose is the help build community and advance the networks.

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. . .'

While we appreciate the suggested citation, we no longer make this argument that the environmental networks resemble space telescopes, seismic recorders, and the like.

L167, what does 'best of the biogeosciences' mean? best to be a tad more concise in the writing and a little less arm-wavy.

We omitted these phrases entirely.

L170 the comment '...to work across these networks to help solve pressing en-

C7

vironmental problems and puzzles.' confusates 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.

These phrases are omitted and no longer a part of the ms.

L170, the voice and tone. . . reads tad self-serving. The idea to integrate 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 under- standing, 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.

We stand behind our use of reductionism in the brief historical description of the evolution of biology and geology as departments, disciplines, and frames for organizing research and education (Section 2, paragraph 2) . Most of the rest of these points not longer pertain to the revised ms as the verbiage and ideas surrounding line 170 has been removed from the ms.

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 fore- casting. Pub. NEON Inc., Boulder CO. pp 55. [webpage citation] is a more appropriate reference.

Thank you for the suggested citation. The networks are introduced in an entirely different manner and citation is not as relevant in new version.

L227, why are 'field experiments',Âa Ìimportant? What is the philosophical context

C8

that becomes important in your narrative? Someone can say, so what, LTER has experiments?, towards what end?

The conventional reply is that field experiments in many Long Term Ecological Research sites test hypotheses about processes that affect ecological change over a number of years to several decades.

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 sites regardless of its utility to public policy. See comment above.

We need a variety of approaches to do environmental science well. We need NEON's and TERN's approach, placed-based research sites, modeling, and targeted short-term projects too.

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.

Yes, we agree, NEON is a large facility, though I do not believe we get into these NSF-details in our new version.

L240, it is not a have '30-y vision', it has an NSB approved operational timeline of 30-y. This is a very different thing.

We stand corrected, and omit the entire reference to 30 years.

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

C9

comment above.

We no longer so explicitly state that "EONs are not question-based or hypothesis-testing projects."

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, rigorously QA/QC'd, to assure robust cross site analyses?

We have reworded this point focusing NEON's "control" on protocols and instrumentation. CZOs and LTERs measure pH of water for example, but not with the same instruments and sensors. That is the control NEON exerts over its instruments!

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.

Ok, but that is a fact of history, as "network" is in the name NEON.

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 performing 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.

The authors fully understand these points. It is the community's job to do the analysis and forecasting. The first version was perhaps not written as clearly as it needed to be.

L253, what does ' . . .tightly controlled. . .' mean?, all NEON, TERN, SAEON data is open access. . . please be concise in your meaning here.

This is a similar point to the comment made about L237 above. Control is about protocol and instrumentation.

L255, 'short time scales'? Not quite as concise and embracing a narrative that you

C10

could use. If you are discussing these data with an ecosystem scientists, they would potentially think decadal 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.

We agree with the reviewer to be more explicit is framing short-term and long-term etc. Our co-authors who are "micromet specialists" and "ecosystem scientists" are certainly interested in far more than is suggested in the comment. Our micromet specialists, ecosystem scientists, and geoscientists have conventional interests about time scales but they are also interested in the full range of time scales as presented in Fig. 6.

L257-60, NEON's current design does little to accommodate change. I do not disagree. But the verbiage is adversarial, rather than engaging.

The new version has NO adversarial verbiage. Please excuse our former writing if you took it as such.

L276, 'NSF' is not defined,

DEFINED.

L278-287, awkward sentences, suggest re-crafting it.

OMISSION IS the best way to edit awkwardly written verbiage!

L290, verb missing?, '. . .pertinent to [understand?] critical zone structure and function.' I do not think a study itself is pertinent to the CZO structure.

Omitted entirely.

L291-298, awkward sentence, suggest re-crafting it.

Omitted entirely. Thank you for suggestion!

L298-305 seems like a laundry list without any real syntheses of why these are impor-

C11

tant. 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.

This "laundry list" is omitted.

L310-313, redundant, re-write or remove

More carefully written. We stand behind this statement and have added a classic citation (Evans 1956).

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?

"MICROMETIOROLOGY" IT IS, "EARLY CAREER" IT IS. Thank you.

L320, interests? Unclear.

We may disagree. Because ecologists and Earth scientists have many shared interests. This is the basis for our Tansley Essay (2015) on why Tansley's ecosystem is so similar to Earth scientist's "critical zone." We need to capitalize on the fact that our core concepts overlap so much.

L323, 'informational and physical' = good!

Thanks for the compliment!

L323, last clause '...and, expertise across LTERs, ...' seems out of place and a vestige from edits.

Edited out of the ms.

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. . .

C12

We've omitted this entirely.

L340, what happened to atmospheric?

It was carelessly not included. We've omitted this line of reasoning.

L390, 'full bloom' is jargon and very odd choice of wording. Suggest crafting the text with more approachable narrative structure.

Omitted this phrase. We've also very substantially revised the narrative.

L392-L395, while there are interesting points here, the text fails to synthesize 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?

Thanks for the compliment. We have reorganized and given structure to these arguments. See new Section: 5.1.3

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.

As stated immediately above, we've given a structure to discussing opportunities. Here we are in the new version's Section 5.1.1.

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.

We agree, and have re-articulated this "call" in a very different manner. We are NOT out to homogenize networks. Diversity of networks may be a good thing. However, networks need to get the most out of their investments and opportunities for interdisciplinary research at individual sites or across networks can be great for the networks, for science, and for engagement by the public!

C13

L465, no Acknowledgements?

On new page 21.

L469, seems like a verb is missing.

Reworded.

L592, is Josh Schimel, not O Schimel.

Corrected, thanks.

Interactive comment on Biogeosciences Discuss., <https://doi.org/10.5194/bg-2018-67>, 2018.

C14