

## ***Interactive comment on “Designing a network of critical zone observatories to explore the living skin of the terrestrial Earth” by Susan L. Brantley et al.***

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I enjoyed reading this summary of the many insights and successes that have come about through the use of a 'Critical Zone' science framing. The paper is well-suited to ESurf readership, and the writing is generally clear, concise and free of grammatical issues. I believe the structure could be improved to help readers who may not be familiar with the CZ science framework; I have provided some general comments that may help with the flow of ideas.

(1) The organization of the first 3-4 sections could be improved: Section 1 provides an overview of the CZ science framework and summarizes the many metrics of success

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for CZ science. Section 2 begins as a review of 'investigative approaches' (line 112), but then veers into models of funding research (e.g. single year, single investigator vs. multi-year, multi-researcher campaign vs centralized funding). I was anticipating a summary of the intellectual heritage of inter-disciplinary CZ science, rather than a review of evolving government funding strategies (at this point in the paper). The former is surely more important in focusing and developing the objective of this review, i.e. developing the observatory network. The evolution of funding should come later, building toward the future proposed design of the network. Section 3 provides the intellectual context that I was looking for, and I think this should be brought forward: the idea of place-based and integrative science should be introduced early, particularly as it relates to the evolution of scientific thinking. The emerging framework's deep roots in applied research are brought out here, as well as the important links to social science. In Section 4, the four common elements of CZOs are illuminating (p.8 ln. 273), and these could be given a more prominent place, earlier in the paper.

(2) I don't see that the title fully matches the content of the paper, in its current form. This is an ambitious retrospective review of the Critical Zone framework with its many strengths and opportunities, but the question of 'designing an observatory network' only makes an appearance in the latest stages of the paper (Section 8). This could be remedied with some re-organization of the first 3-4 sections of the paper, reminding the reader of the intent to 'develop a network', with a stronger framing of the text.

(3) CZ science is referred to as an 'interdisciplinary experiment', but there is very little context provided in lines 87-92 and 113. I presume the term 'experiment' is being used colloquially? If so, perhaps it is better described as a venture, endeavour or initiative. At any rate, some clarification of terminology is needed, here. Such terminology is important when working in inter-disciplinary spaces.

(4) The word 'paradigm' is bandied about rather loosely, in my opinion, without adequate consideration of the philosophical criteria for true paradigm change. The Critical Zone approach might be considered a new paradigm (line 79), though methodological

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innovations that come about through successful inter-disciplinary work do not necessarily constitute true paradigm change. You should convince the reader that the criteria have been met, in a succinct summary. The three 'emergent paradigms' in Section 6 are tantalizing and novel, but I do not see how they constitute new paradigms, at least, not as they are explained. The list of emergent hypotheses in Table 4 are similarly intriguing, but they are not 'transformative', in the sense that they are pursued using fairly conventional scientific epistemology. Nonetheless, the paper makes an excellent case for the transformative potential of the CZ approach, and will be helpful in stimulating the conversation regarding next steps for this exciting venture.

### Some Specific Comments:

Pg 10, In 355: "...to investigate process-based mechanisms in across various CZ environments". Could say 'process-based changes' or simply 'mechanisms'. Note: 'in [and] across various CZ environments' Figure 1 appears to be a fairly conventional watershed science diagram. Could it further emphasize canopy and biological elements? Figure 3 caption mentions five countries, but pins are placed in a dozen or more. Explain the relationships. Table 2 does not back up your point about long-term measurements. It would be more helpful to see the length of these records, rather than a smattering of similar measurements that may or may not relate to broader hypotheses being tested across CZOs. Pg 9, In 307 makes reference to the "extremely long" duration of the datasets - this could use some quantification. Table 3 seems to catalog a broad array of models, most of which were not specifically designed for CZ research. It would be more interesting to list emerging numerical models, or amalgamations of existing models, next to the specific CZ questions being pursued. Table 4 is missing any mention of hypotheses related to the social science aspects of the CZ ('human impacts' aside), one of the stated strengths of the approach. It would be good to see how this strand of the research fits in!

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