Earth System Dynamics Discussions

Earth Syst. Dynam. Discuss., community comment CC5
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Reply on RC3

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Community comment on "ESD Ideas: planetary antifragility: a new dimension in the definition of the safe operating space for humanity" by Oliver López-Corona et al., Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2021-26-CC5, 2021

Reply to Reviewer #2:

I have copied Reviewer #2's comments, and added my responses in bold. ----

Does the paper address relevant scientific questions within the scope of ESD?

This paper addresses relevant scientific questions within the scope of ESD, and it is a vanguard study that aims to explore new scientific perspectives more than presents finish results. With an interdisciplinary approach, this article integrates knowledge and methods from different disciplines to create a unity of intellectual frameworks beyond the disciplinary perspectives. More than analysing technical content, this approach is highly pertinent because it uses photon dissipation as a proxy to understand how Safe Operating Space for Humanity is being modelled, and why these models need to evolve. Through planetary albedo, it understands and critically identifies several problems in state values of Planetary Boundaries. More than physics and geosciences, it is possible to understand how socio-natural systems are connected and how the current epistemological approach globally affects ecosystem stability, fragility, and resilience.

Of course this paper addresses relevant scientific questions within the scope of ESD, but that says nothing about the validity of the analysis. Unfortunately, not a single sentence in the above paragraph makes sense in terms of physics and the actual content of the Planetary Boundaries, especially climate change. The English is also terrible.

Does the paper present novel concepts, ideas, tools, or data?

The paper presents new data about changes of shortwave global albedo anomalies to introduce planetary antifragility as a fundamental concept in the time variability of the biosphere response due to human action. It uses the dynamic interpretation of Fisher Information Theory as a tool to support new interpretations and conclusions about the necessity of updated ideas from old paradigms. The title clearly reflects the components of the paper and abstract, which is concise and complete.

Unfortunately, looking at Figure 2 in the original paper, we see that the authors are distorting their own results. They emphasize the 47% reduction in albedo at certain wavelengths from 1988 to 2010, but don't make clear that the entire drop was in the two year period from 1988-1990, with basically no further drop from 1990-2010. This fact from their own results undermines their entire argument that these kinds of changes in albedo somehow tell us something about the fragility of the planet, because climate change for one impact on the planet has been increasing fairly steadily from 1988-2010. Thus, their Figure #2 does not track climate change at all over this time period, and the authors do not say what it tracks. It certainly does not track the time variability of the biosphere as Reviewer #2 claims.

Are substantial conclusions reached?

Substantial conclusions are reached. With the Cybernetic Revolution and anticipating the current crisis of truth, Information Theory rescues (from the Greco-Roman) the importance of entropy in science as well as the organised development of the complexity sciences, absent from the epistemological discussions and philosophy of the sciences, by centuries. With scientific methods and assumption valid and clearly outlined, this paper shows that Planetary Boundaries are not interdependent. Individual Planetary Limits do not establish proper threshold configuration. That is why it is necessary to have a metric of the interaction.

The above paragraph makes no sense at all.

There is no such thing as the certainty of transgressing a defined tipping point and an incompatible human survival certainty. Ideas are conveyed and substantiated, as in the philosophical, conceptual, and organisational issues. In addition to the technical part, there is a whole part of fundamental science - the structure of thought and credibility. Authors analyse with new data and scientific methods that the concept of resilience is a particular and limited case of Antifragility.

The above paragraph makes no sense at all.

Concluding that Safe Operating Space for Humanity should also include planetary Antifragility is a tremendous act of bravery of the authors. Ironically, living in a society where entropy measures are omitted in the communication of changes and modelling of systems is equivalent to construction where there is also no freedom - in scientific, social and political structures. Since grounding scientific certainty is an age-old failure, logic points to the disruption and collapse of its own civilisational system as inevitable.

More than representing a physical phenomenon, it is crucial to see in the exact and physical sciences the possibility of representing social models and applying exact and physical science methodologies to objects formerly exclusive to the social sciences. Avoiding the moralisation of science, true or false are just qualities of language and not things. Without language, there is neither truth nor lies (Thomas Hobbes, Leviathan, 1651). This paper presents a unique way of understanding the whole question of ecosystems and society by considering all its interconnections (stability, fragility, resilience, etc.) in a global measure of entropy production, giving rise to, for example, homeostasis. Like António Damasio or Edgar Mourin say, cell biology shows us that the cell dies due to incapacity for homeostasis when this happens.

Again, the above two paragraphs seem to be discussing the culture of science, but have nothing to do with the article under review. This reviewer is not performing their job properly to review the article under consideration by ESD.

Are the scientific methods and assumptions are valid and clearly outlined?

To analyse if scientific methods and assumptions are valid and clearly outlined is essential to understand that developing something unknown in the borderline between the known and the unknown has consequences. Basically agree, but this sentence is not well written. Frontier investigations address issues about which there is intense controversy in the scientific community in the field in which they are developed. They work with difficult questions, at least with mainstream methodological approaches, and they use methodologies and concepts atypical in their area. This kind of research implies starting from unexpected results that question the dominant paradigm and highlight issues whose solution is fundamental to confirm (or refute) the current paradigm. Investigations have a very high level of uncertainty about their success, but they nurture a high potential for transformation and renewal of knowledge.

Yes, but the paper under review does not achieve these lofty goals.

Are the results sufficient to support the interpretations and conclusions?

This paper concludes that components of planetary boundaries are not interdependent, and the interaction among them matters. There is a perturbation response in the capacity dimension, and it is necessary to underly the Antifragility framework in systems dynamics measure of this perturbation response capacity. The net reduction of 47.63% loss in Antifragility is a satisfactory result [again this reviewer must not have studied Figure #2] to support interpretations and conclusions of this compounding problem (human perturbations vs planet capacity to respond to them) about core biogeochemical processes with Planetary Boundaries.

Humanity has become an active agent in shaping physical climates worldwide through cultural, social, political and ethical practices that reinterpret what "climate change" or

other "geophysical processes changing" means. Modernity has always kept the discussion of entropy and complexity absent from epistemological discussions and science philosophy. The dream of turning scientific theories into axioms and giving them an absolute rationale was lived.

The discussion of certainty/entropy in science and the demarcation between science and non-science considered philosophy an empty discourse (Hilbert, Popper, Kuhn, Feyrabend or Lakanos). However, after years of research, Popper concluded that the concept of science is no longer synonymous with certainty. Actually, it becomes synonymous with uncertainty, or rather, reliability (a measure of entropy). Regarding the discussions on the classification criteria of what science is, Popper (1963) concluded that a theory that is not refutable by any event, whatever it may be, is devoid of a scientific character. Nine years later, he said that science is a method of bold conjectures and ingenious and severe attempts to refute them. This paper is a precious example of science in his terms.

The above two paragraphs are not relevant to this article, and they belong in a philosophy of science article.

Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)?

Regarding traceability of results, this manuscript's most important contribution is not about allowing the reproduction by fellow scientists about absolute, precisely and sufficiently complete descriptions of experiments and calculations. Within the scope of ESD, experiments and calculations of this paper contribute to the traceability of ideas. The most important result is the "ideas" and not precise quantitative numbers. The authors guarantee the traceability of results: 1) representing natural, technical and social phenomena as complex coevolutionary systems, using mathematical formulation to systematise their interdisciplinary and dynamic structure, as well as spatiotemporal interaction; 2) promote and understanding of the dynamics of emerging, transitional and extreme regimes, together with the associated entropy and evolutionary predictability - frame the changing core biogeochemical processes with Planetary Boundaries and Safe Operating Space for Humanity. 3) Develop learning techniques for Machine Learning and Artificial Intelligence for interdisciplinary analysis and model design beyond the mechanistic paradigm, 4) Using mathematical methods to improve dynamic decision support structures, incorporating natural, social and technical risks.

Do the authors give proper credit to related work and clearly indicate their own new/original contribution? Are the number and quality of references appropriate? Is the amount and quality of supplementary material appropriate?

Frontier Science has difficulties in penetrating the scientific community, whether through dissemination in the form of publications or communications, and, for the same reasons, has challenges in finding funding. As exciting and attractive as IDEAS are, creative and innovative potential researchers have, life in frontier science is not a path that most scientists can choose. The authors give proper credit to related work and clearly indicate

their own new/original contribution. The number and quality of references and quality of supplementary material are appropriate.

A precise consequence of the current paradigm, science promotion systems severely penalise the risk of failure, which adds to the intrinsic difficulty that accompanies frontier investigations. The intensity of this type's investigation is low compared to the mainstream (Kuhn's normal science). However, frontier science emerges in moments of crisis – Thomas Kuhn says. This paper is the perfect example. Suppose we want an authentic transformation of knowledge. In that case, it is necessary to promote cutting-edge research and recognise and foster the curious and critical spirit in academia and research centres. In addition to the excellent technical training provided by conventional science, new ideas and methodological and conceptual approaches must emerge from the academic world. Frontier Science can bring a future to the present, even when even those who practice it cannot anticipate it. An answer to the next question, the following unexpected result, the next innovative challenge, the knowledge that R&D systems and financing mechanisms can imagine.

That is why the scope of ESD is so essential, and papers like these are so crucial in academia and scientific society. This manuscript has interdisciplinarity, scientific merits, technical quality and suitability.

The remainder of this review is both incoherent, and not an appropriate scientific review of this paper. Reviewer #2 is not an appropriate reviewer for papers submitted to ESD!