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Earth System Dynamics
Discussions

Interactive comment on "Topology of sustainable management in dynamical Earth system models with desirable states" *by* J. Heitzig and T. Kittel

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GENERAL COMMENTS

In this article, the authors propose a general framework for the qualitative dynamics of dynamical systems with regard to the system's ability to reach a desirable ("sunny") region of state space. Given the planetary boundaries framework, and others that the authors identify, that define desirable regions of global indicator variables, this contribution is very timely and potentially highly useful. The framework is rigorously analysed and some properties of the framework are proved. The bulk of the paper then consists of an analysis of a large number of examples.

My main concerns with the paper are with regards its presentation. Although the quality

of the language is excellent, the structure of the paper (which appears to be written for a mathematics journal) does not lend itself to easy understanding of the framework. Such matters of presentation may seem to be superficial, but when it is the framework that is (in my understanding) the main point of this paper, it needs to be presented clearly and in a manner appropriate for the intended audience if it is to be taken up and used by that audience.

The relevance of the framework to Earth system dynamics, and the relevance of the results for earth system governance, is also not sufficiently elaborated.

SPECIFIC COMMENTS

The first thing I miss is a figure clearly presenting the framework. Figures 1 and 3 (both parts) attempt to do this but they are not sufficiently clear. One problem with Fig 1 is that it's hard to connect the labels sitting high and low to the seemingly arbitrary dynamics of the blue line. Figure 3(top) is better but the alternating light and dark regions seems highly arbitrary. My tentative suggestion is to sketch a two-dimensional phase space with a single contiguous sunny region, together with stylised trajectories illustrating the different concepts. This figure may need to be repeated for the different partitions of the state space that the authors develop throughout the paper.

The usefulness of having so many examples is not clear to me. The first couple are useful exercises in order to work through the concepts but the remainder appear superfluous. The authors should be careful to illustrate the importance of each example, for example to introduce a new concept such as ports. Unneeded examples should be deleted or moved to supplementary information.

Why does Example 3 have no figure? I struggle to understand it without one. But then this is one of the examples whose point I do not see.

It is also highly confusing to have terminology used in the figures before the concepts are illustrated in the text (e.g. Fig 2). Especially in the figures that illustrate the exam-

ples, this terminology should be left out. If the authors particularly want to illustrate that terminology for the figure, the figure should be repeated later on.

The relevance of the concepts for earth system governance, or decision-making at a more local level, should be better emphasised. The dilemmas, which are a great concept, are particularly ripe territory here. Can the authors illustrate the concept with real-world decisions that have happened in the past? That may need to be taken in the future? What implications does the 'main sequence' have for governance? How important is it to identify which phase we are in?

TECHNICAL CORRECTIONS

I suggest running a spell check over the document. There are a handful of words that are misspelled, and one or two German words that have crept in (e.g. "beim"). While the word "dilemmata" is technically a correct plural of "dilemma", in my experience it is rarely used and rather distracting. The plainer "dilemmas" would be better.

Some of the figures, in the PDF I received, are much too small to clearly read. P451 lines 24-25: using the equal sign to identify a set is confusing. It took me several times to realise this was an interval and not a point in a two-dimensional state space. Can some alternative notation (e.g. brackets) be used?

P453 line 10: having $y < 0$ is surely unphysical in this case?

P464 line 5: This is good discussion but I would like it to be more specific, as discussed above. What situations in the Earth system might correspond to lakes, glades, etc.?

Interactive comment on Earth Syst. Dynam. Discuss., 6, 435, 2015.