

## ***Interactive comment on “Identifying global patterns of stochasticity and nonlinearity in the Earth System” by F. Arizmendi et al.***

**Anonymous Referee #1**

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First at all, the manuscript contains important formal deficiencies, mainly in the figures and captions, that make difficult to follow it. A partial list of these problems is:

- The figure panels are referenced with letters a), b) ... but none of the figures have indeed those labels on them.
- In the caption of Fig. 2 the mention to panel b seems to be to panel a instead.
- In the caption of fig 3 top and bottom should be right and left, and the last sentence has no meaning.
- The 'Supplement' file containing Supplementary Information is not mentioned in the text. In caption to fig 1 of Suppl. Information the second 'left' should be 'right', and in the caption of fig 4 left and right seem to be interchanged.

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With all these caveats, I am not sure I have understood the paper properly. It is clear that at least these formal aspects should be corrected before resubmission. Nevertheless, assuming I have understood the paper, here are some additional comments on the scientific part:

- Relationship in Eq. (1) is a very particular one. The authors identify deviations from it as 'nonlinearity'. Please note that standard linear relationships such as  $y(t) = \int_0^t g(t-t') x(t') dt$  are also linear but different from (1). The authors should comment or state that they are looking at linear relationships involving only the present time and one past time, instead of a more general linear relationship involving a distribution of delays.
- The authors do not state with precision their discretization procedure to define the entropy measure. And the precise form of the discretization is determinant for the entropy values. It is puzzling to read the statement that the presence of outliers 'decreases entropy'. This is exactly the effect contrary to what one should expect from outliers, since the outliers broaden the distribution. Perhaps the authors are adapting the range of values of SATA to the changing range of extreme values at different positions? Only in this way one could expect some entropy decrease with outliers, but this procedure completely destroys any possibility of inter-site comparison. Since there is no statement of neither the range of discretization nor of bin size (only number of bins is stated) there is no way to check the origin of the reported increase of entropy. For fixed bin size and range across the different locations, appearance of extreme values can only increase entropy.
- Page 3: 'this gives approximately the same number of data points per bin': this should apply not to each bin, but to some average value, right?
- The authors attribute the difference in behaviour of the tropical zones to the use of solar radiation in evaporation instead of heating. This sounds reasonable. But one can imagine other possible explanations contributing to this, as for example the smaller amplitude of the variation in solar forcing, or the fact that between the tropics the annual

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cycle has two oscillations in solar intensity instead of only one. The authors should comment on that. In general, the identification of the physical phenomena that could be responsible for the observations reported in the paper are rather superficial.

- I found difficult to recognize that the different time series in fig 3 correspond to the different locations inside the stated coordinate range. Perhaps this should be explicitly stated.

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