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Earth System Dynamics
Discussions

Interactive comment on "The synergistic impact of ENSO and IOD on the Indian Summer Monsoon Rainfall in observations and climate simulations – an information theory perspective" *by* Praveen Kumar Pothapakula et al.

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In this work, the authors presented a new method for understanding the synergistic, unique, and redundant information exchange from the ENSO and IOD phenomena on the Indian Summer Monsoon rainfall. For this propose, they employed some tools from information theory, the mutual information, and entropy to estimate how two other sources can estimate a third variable, quantifying the unique information, redundant information, and synergistic information contributions. The authors considered three estimation techniques and showed how well their approach works and makes sense in

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Discussion paper

three linear and one non-linear artificial systems. After that, they used several sources of real data from observational and reanalysis data sets. They showed that their technique obtains similar conclusions about ENSO and IOD's synergistic impact on the Indian Summer Monsoon Rainfall. Further, they evaluated their initial conclusions from observational data in global and regional climate models.

The work has its merits, is interesting and relevant for the area, with the potential of future works and interdisciplinary developments. The manuscript is clear and easy to follow, but quite extensive, in which the structure and order of the sections could be improved. First, in the Introduction, the sentences: "Shannon (1948) ïňĄrst introduced the concept of information entropy, which quantiïňĄes the average uncertainty of a given random variable. The IE between two subsystems X and Y can be understood as the average uncertainty reduction about X in knowing Y or vice versa." and all the part of "The IE in a system composed of two-source systems Y and Z ... alone but by jointly knowing their states together." are adequate to the Material and Methods section than the Introduction. Please, consider moving these parts to the method Section and refer to it in the Introduction if necessary. This reviewer also suggests moving the Material and Method sections to be the last part of the manuscript and promptly presenting the results of the work. Besides, the authors can move some broadly and detailed concepts to the supplemental material.

Before recommending the article's acceptance, there is a further analysis that this reviewer will ask the authors. Could you please run the same analysis in observational data for the same regions but instead considering an outside temporal season (e.g., DJFM)? In this way, we can get more insides and understanding of the proposed method and how well are the behaviors and results. For example, if one wants to check other regions and phenomena, to discover new dynamical/physical connections, it would be feasible to apply this method and found if there are pieces of evidence of physical connection or not, (like can be done with many other approaches and knowing their drawbacks). With a negative test in real data, the authors can show the robust-

ness of their method and the ability to be used to test other systems.

Minor comments:

"provides an lowerbound for..." => "provides a lowerbound for..."

In lines 417 and 422, is it IE(...) or should be I(...)?

In lines 358 and 429, why the authors did not include these figures in the Supplemental material?

About the estimator K-nearest neighbors (called here as Kraskov), how was the approach employed to find the best k by the authors? Did they try all possible values and choose the best one? How did they define or evaluate the best k?

In terms of code availability, it is a big plus and highly recommended that the authors publicly available their code in open source platforms (like GitHub, for instance). Therefore, other scholars and the community can use it to replicate the conclusions and compare it with their methods in future works.

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