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Nonlinear Processes in Geophysics
Discussions

Interactive comment on "Compound extremes in a changing climate - a Markov Chain approach" *by* K. Sedlmeier et al.

Anonymous Referee #2

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Compound extremes in a changing climate - a Markov Chain approach

by K. Sedlmeier et al.

The manuscript presents an interesting idea of studying compound extremes using the Markov chain model. The authors construct 4-state models by defining 2 states (extreme, nonextreme) for two variables. Thus they can follow combined extremes hot+dry in summer and cold+wet in winter. The dynamics of these compound extremes are characterized by 3 quantitative descriptors based on the constructed Markov models: persistence, recurrence time, entropy. Then they show how these descriptors change in two segments of experimental data and in model simulations.

The descriptors in this context are new and original. This is, of course, expected for a novel publication, however, one should demonstrate that new descriptors reasonably reflect underlying physical mechanisms. Before using any new measure for characterization of ongoing and expected climate change, one should investigate their variability in natural conditions. The authors use the gridded E-OBS dataset, however, they unfortunately chose just a few gridpoints in six different areas. It is a pity, since the E-OBS dataset gives an excellent opportunity to study spatial variability of any descriptor which has an ambition to characterize the temporal evolution of a physical quantity attributed to each gridpoint. I think the model is reasonably simple to compute full coverage for Europe for all three descriptors and map them. The simple visual evaluation would indicate if the descriptors reasonably reflects physical reality in the case the maps show interpretable smoothly changing patterns. Or, if the maps show just a colored grains or a sort of Pollock's paintings, than there is a problem with the descriptor and its connections to physical reality.

While E-OBS dataset can be used to test spatial variability, ECA&D station dataset offers a number of long-term records in which temporal variability can be tested. So one can relate the change of the introduced descriptor due to climate change to their changes due to natural variability in preindustrial era.

Real long-term records would reflect natural variability due to natural nonstationarity. One can test numerical variability of the descriptors by constructing appropriate surrogate data. E.g., FT surrogate data generation averages dynamics over whole record randomized, so one can get ranges for random variability of the descriptors in a stationary data.

Only after understanding how any new descriptor behaves, it can be used to quantify an evolution or change of interest.

Technical remarks:

P. 9, last para

....Fig. 4) all regions except Bulgaria...

Should not it be France?

p 10–, 4.2

The statistical treatment should be described in more details: Differences of the ensemble means are plotted, i.e. one get the mean and percentiles for each ensemble, then the difference of means is clearly defined, but what are the percentiles?

Is this an appropriate way to evaluate the significance of changes?

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