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Time and period of emergence of compound events in France

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Compound events (CE) are the combination of climate phenomena which, taken individually, are not necessarily extreme but whose (concurrent or sequential) composition can cause very strong impacts and damages. Hence, the understanding of their potential past and future changes and evolutions are of great importance and, thus, more and more research is being carried out on this issue ([1], [2]). However, these questions are still rarely addressed over France, especially at high spatial resolution, even though they are necessary for the development of adaptation strategies. The present study focuses on historical multivariate compound events (several events occurring at the same time and same location), like hot and dry events or extreme wind and precipitation events, and aims to detect past changes in probability of such events over France. ERA5 reanalyses [3] are then used on the 1950-2022 period.

The first question that arises is: Where and when did these signals emerge in France? Are patterns forming? This issue is addressed through the analysis of “times” and “periods” of emergence, corresponding to moments when the change in probability of a specific CE is out of its natural variability [4]. The second question that comes up is: “What drives the emergence? What are the contributions of the changes in the marginal distributions and in the dependence structure to the change of compound events probability?” The study tries to answer this question thanks to the copula theory, allowing to decompose these different contributions. Copula functions are used to model bivariate joint probabilities, and are increasingly applied to hydroclimatic variables ([5], [6]).

Depending on the intensity and the type of the compound, the results indicate that (1) maps of time of emergence show clear spatial patterns and (2) that the changes in marginal distributions play a much more significant role than the changes in dependence during the emergence. This work opens perspectives for future projects, such as investigating physical phenomena driving these patterns and more deeply understanding changes in dependence between the different climate variables. Then analyzing climate model ability to reproduce the results would enable the application of the methodology to attribution framework and a better assessment of the risks associated with past and future climate change.

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