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Dependence of drivers affects risks associated with compound events

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Compound climate extremes are receiving increasing attention because of their disproportionate impacts on humans and ecosystems. Risks assessments, however, generally focus on univariate statistics even when multiple stressors are considered. Concurrent extreme droughts and heatwaves have been observed to cause a suite of extreme impacts on natural and human systems alike. For example, they can substantially affect vegetation health, prompting tree mortality, and thereby facilitating insect outbreaks and fires. In addition, hot droughts have the potential to trigger and intensify fires and can cause severe economical damage. By promoting disease spread, extremely hot and dry conditions also strongly affect human health. We analyse the co-occurrence of dry and hot summers and show that these are strongly correlated for many regions, inducing a much higher frequency of concurrent hot and dry summers than what would be assumed from the independent combination of the univariate statistics. Our results demonstrate how the dependence structure between variables affects the occurrence frequency of multivariate extremes. Assessments based on univariate statistics can thus strongly underestimate risks associated with given extremes, if impacts depend on multiple (dependent) variables. We conclude that a multivariate perspective is necessary in order to appropriately assess changes in climate extremes and their impacts, and to design adaptation strategies.