EGU24-8594, updated on 20 May 2024
https://doi.org/10.5194/egusphere-egu24-8594
EGU General Assembly 2024

Reconstructing compound events from crop variability in Europe

Niklas Luther[1], Arthur Hrast Essenfelder[2], Andrej Ceglar[3], Andrea Toreti[2], Odysseas Vlachopoulos[1], and Elena Xoplaki[1,4]

[1]Centre for International Development and Environmental Research, Justus Liebig University Giessen, Giessen, Germany
[2]European Commission, Joint Research Centre (JRC), Ispra, Italy
[3]Climate Change Centre, European Central Bank, Frankfurt am Main, Germany
[4]Department of Geography, Justus Liebig University, Giessen, Germany

Many studies have shown that compounding extreme events are likely to exacerbate socio-economic risks compared to single extremes. Despite this important fact, studies focussing on the connectivity of extreme events and their associated impacts frequently have some shortcomings. First, extreme events such as droughts and heat waves are often predefined through thresholds, restricting the class of meteorological events leading to the observed impacts. The choice of threshold for defining these extreme events is also often of meteorological and/or statistical nature and thus potentially unsuitable for the holistic identification of the associated impacts. Furthermore, impacts can arise from combinations of non-extreme events that might fall short of the threshold-based identification, thereby limiting the ability to account for key dynamics that determine the risk associated with compound events. Our study aims to overcome those shortcomings by linking climate events with their observed impacts in agriculture. We analyse wet and warm late winters followed by dry and hot springs, and the associated agricultural damages in Europe with the aim of reconstructing these compound events based on the observed impact. A first analysis is conducted for winter wheat impacts in France, the largest European winter wheat producer. We identify agro-climatic zones based on multivariate time series clustering and employ a regularized generalized canonical correlation analysis to identify the large-scale drivers of crop variability for these regions. The patterns that emerge from the analysis are characterized by wet and warm conditions in January and February linked to a positive North Atlantic Oscillation (NAO) state, followed by warm and dry conditions in April induced by a tripole with a blocking high over Central Europe. Using imbalanced random forests, we construct objective bounds and define thresholds to identify which temperatures are warm enough or which water balances are low enough to be associated with significant effect on crop yield reduction. Our results indicate that imbalanced random forests can predict these types of events reasonably well at the local scale, and that the derived thresholds are mostly lower than the commonly used thresholds for detecting similar extreme events. The latter illustrates that the combination of non-extreme climate events can indeed be detrimental to agricultural production in Europe, which is also crucial as the analysed types of events are predicted to occur more often in the future as a result of climate change.