

Spatio-Temporal Crop Yield Prediction using Time-Varying Copula and Actuaries Climate IndexTM

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Climate anomalies pose significant threats to agricultural productivity and food security by severely disrupting crop yields. While weather conditions at harvest time are important, extreme climate anomalies occurring during the growing season often have cumulative and more detrimental effects on crop performance. This study models annual crop yields across U.S. states by incorporating extreme weather covariates, specifically the components of the Actuaries Climate IndexTM, which has gained recent popularity in climate-related risk applications. To capture the dynamic interdependence among weather variables, we use time-varying copula models that account for both spatial and temporal dependence structures. The resulting copula-based dependence parameters are subsequently integrated into a class of stochastic differential equations, enabling dynamic quantification of climate effects on crop yield outcomes. The proposed framework introduces a novel methodology for embedding complex climate dynamics into crop yield prediction.

Keywords: Stochastic differential equations, Time-varying copula, Crop yield prediction, Actuaries Climate Index, Spatio-temporal dependence