Bayesian Spatial Models for Projecting Corn Yields

Objective

Climate change is anticipated to impact the productivity of corn crops, yet the inconsistencies in data and modeling methods result in divergent predictions of yield. We propose a scalable spatiotemporal statistical model that addresses these disparities by considering spatial correlation and parametric uncertainty.

Approach

We use two types of Bayesian statistical models that treat spatial correlation in county effects differently: a new approach with spatial basis functions and a commonly used random effect county intercepts model. The model comparisons are based on the relationships between weather variables and corn yields, predictive performance, and projections considering key uncertainties.

Impact

A novel spatial basis function model that accounts for climate forcing uncertainty is faster than the county intercepts model and could serve as a valuable tool for projecting crop yields. Our projections for the periods 2020–2049 and 2069–2098 confirm the downward trend in average corn yields from previous studies, yet they vary in the extent of the decline and the uncertainties involved.

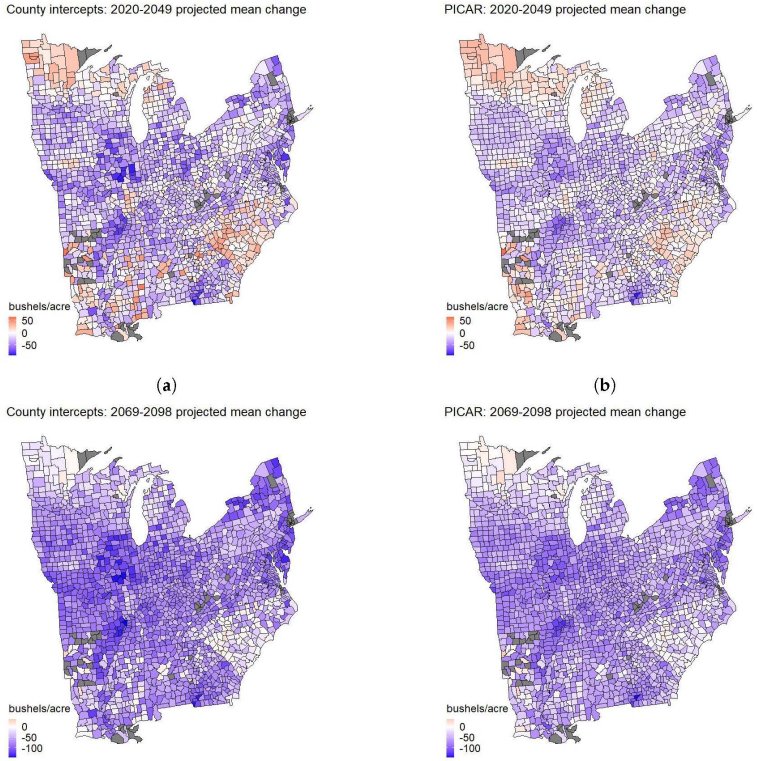

Figure: Difference between mean projected detrended yield for all years across all CMIP5 model projections in the near future (panels (a,c)) or the end of the century (panels (b,d)) and the estimated historical mean detrended yield with the county intercepts (panels (a,b)) and PICAR models (panels (c,d)). The difference between end-of-century projections and projections from the previous time period may be partly attributable to the removal of the by-state quadratic trends. The county intercepts model projects more severe corn yield decreases than the PICAR model in many counties.

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