Non-linear relationships between daily temperature extremes and US agricultural yields uncovered by global gridded meteorological datasets

Objective

Global agricultural commodity markets are highly integrated among major producers. Prices are driven by aggregate supply rather than what happens in individual countries in isolation. We test whether global daily temperature data (GMFD & ERA5-Land) uncover the same nonlinear relationship found using more detailed country-specific datasets (e.g., PRISM for the US).

Approach

Statistical non-linear relationships between temperature and corn or soybean yields were estimated using both the daily global datasets as well as alternatives used before. Model performance was compared across datasets while controlling for precipitation, technological change (time trends), and time invariant confounding factors (fixed effects).

Impact

While global datasets showed slightly less predictive power, they captured the non-linear relationships between heat and crop yields similarly to the high-resolution data. All 3 datasets and model specifications agreed on the effect of extreme temperatures on crops, highlighting the value of daily temperature data in global datasets. Using average temperatures over the growing season significantly reduces predictive power.

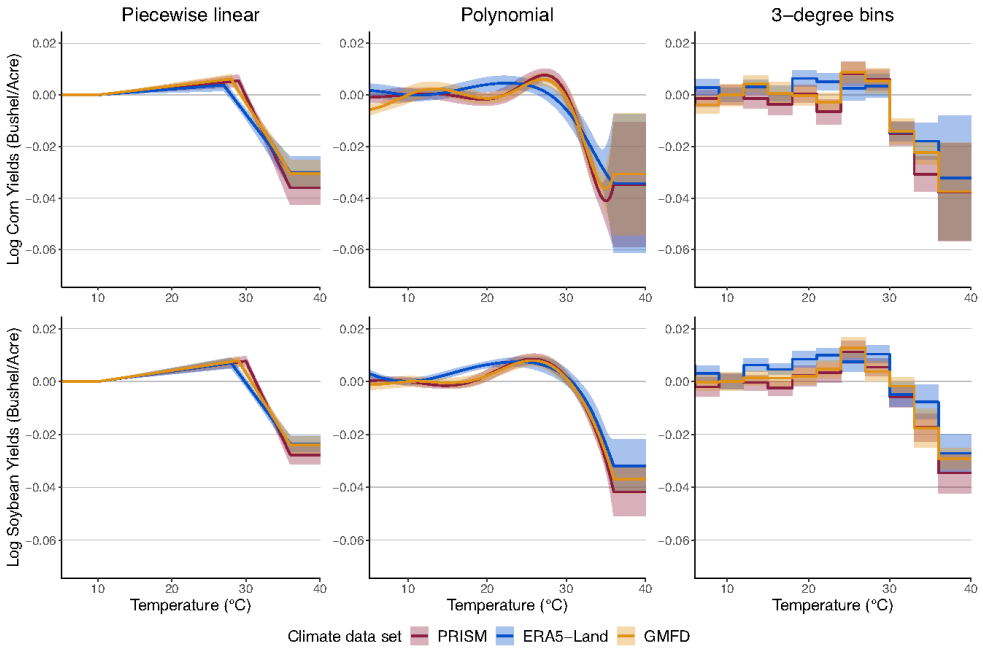

Figure: Comparing the yield-temperature response across the three weather data sets. Each graph estimates the relationship between US yields and temperature using both the fine-scaled PRISM data set (shown in red) as well as the more aggregate but globally available ERA5-Land (shown in blue) and GMFD (shown in yellow). Lines indicate estimated response functions from the panel regression models and bands indicate the 95% confidence intervals. The top row provides results for corn yields, while the bottom row gives the results for soybean yields. The left column estimates a piecewise linear function, the middle column an 8th order polynomial in temperature, and the right column uses temperature bins.

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