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Brief Introduction of the Authors

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Outline

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1. Background and Objectives

- More recently, food prices have increased rapidly, and many observers have attributed this in part to weather episodes.

- Global average temperatures have risen by roughly 0.13°C per decade since 1950, yet the impact this has had on agriculture is not well understood.

1. Background and Objectives

- Understanding the impacts of past trends can help us to gauge the importance of near-term climate change for supplies of key food commodities.

- Identifying the particular crops and regions that have been most affected by recent trends would assist efforts to measure and analyze ongoing efforts to adapt.

2. Materials and Methods

Materials: country-level FAO data on production quantity, yield (quantity per area), and harvested area for maize, rice, soy, and wheat.

2. Materials and Methods

Methods :We developed a database of yield response models to evaluate the impact of these recent climate trends on major crop yields at the country scale for the period 1980–2008.

Publicly available data sets on crop production, crop locations, growing seasons, and monthly temperature (T) and precipitation (P) were combined in a panel analysis of four crops for all countries in the world.

3. Results and Discussions
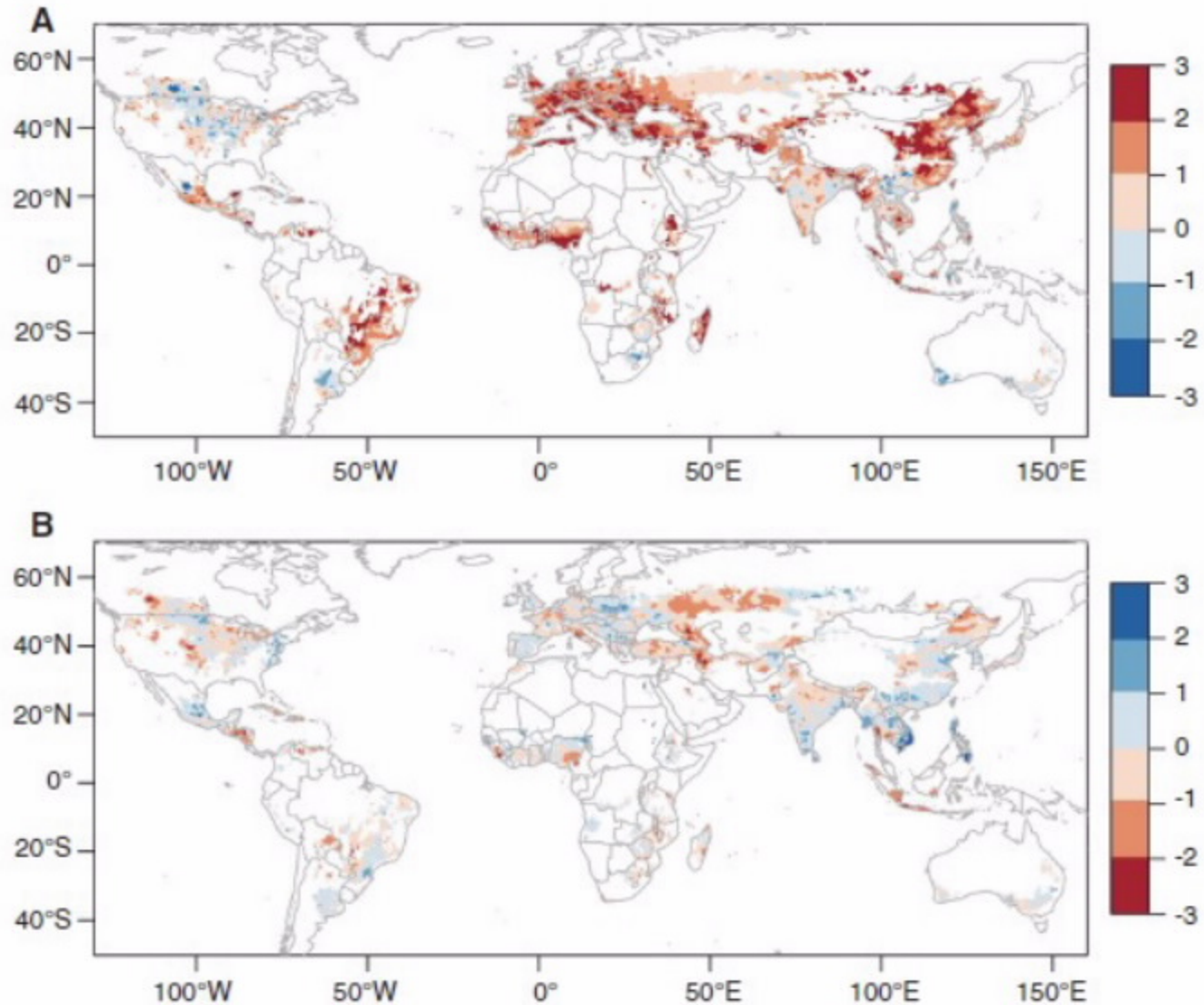
Fig. 1. (A and B) Maps of the 1980–2008 linear trend in temperature (A) and precipitation (B) for the growing season of the predominant crop (among maize, wheat, rice, and soybean) in each 0.5 × 0.5 grid cell.
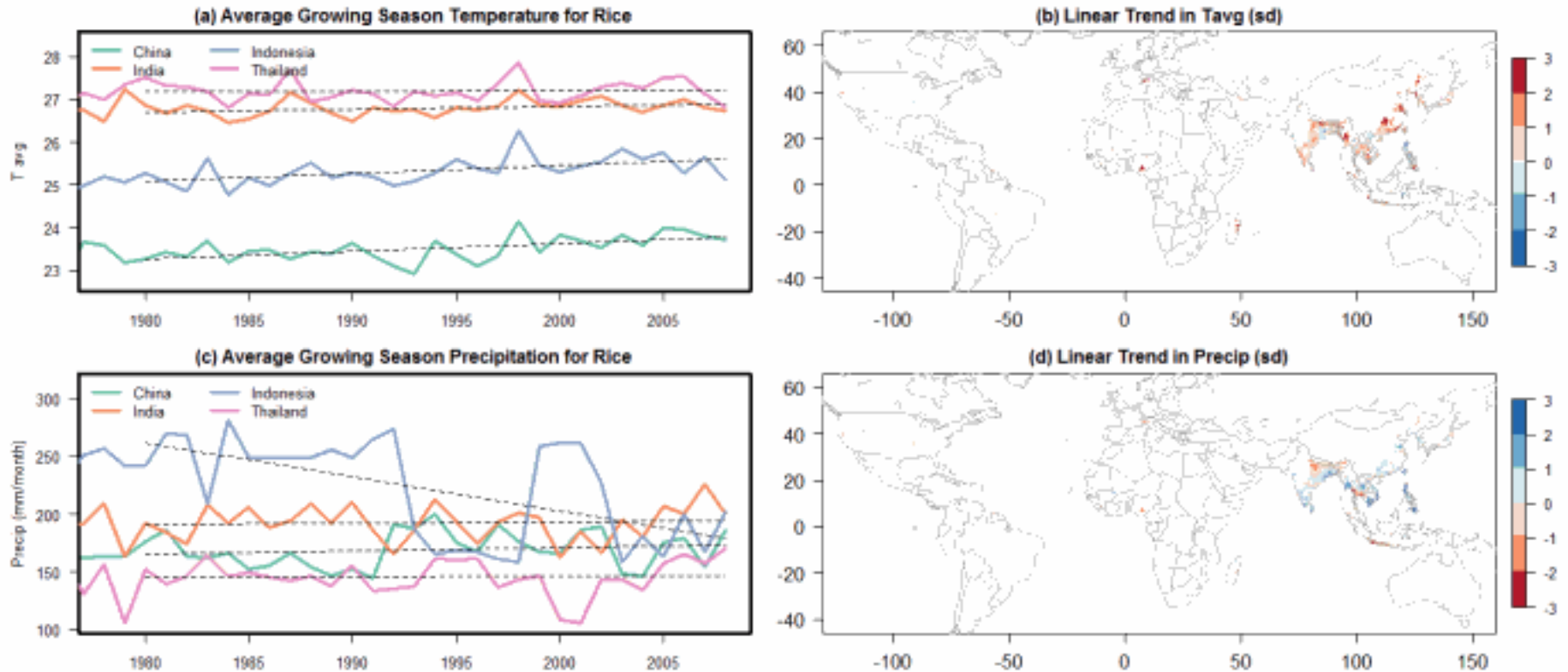
Fig.s1 (a) Time series of growing season average temperature for maize in four major producing countries and (b) maps of linear trend for 1980-2008 for major growing areas. (c)-(d) same as (a)-(b) but for precipitation.

Fig. 2. (A to D) Frequency distributions of country-level growingseason temperature trends (top) and precipitation trends (bottom) for the periods 1960–1980 (left) and 1980–2008 (right) for four major crops
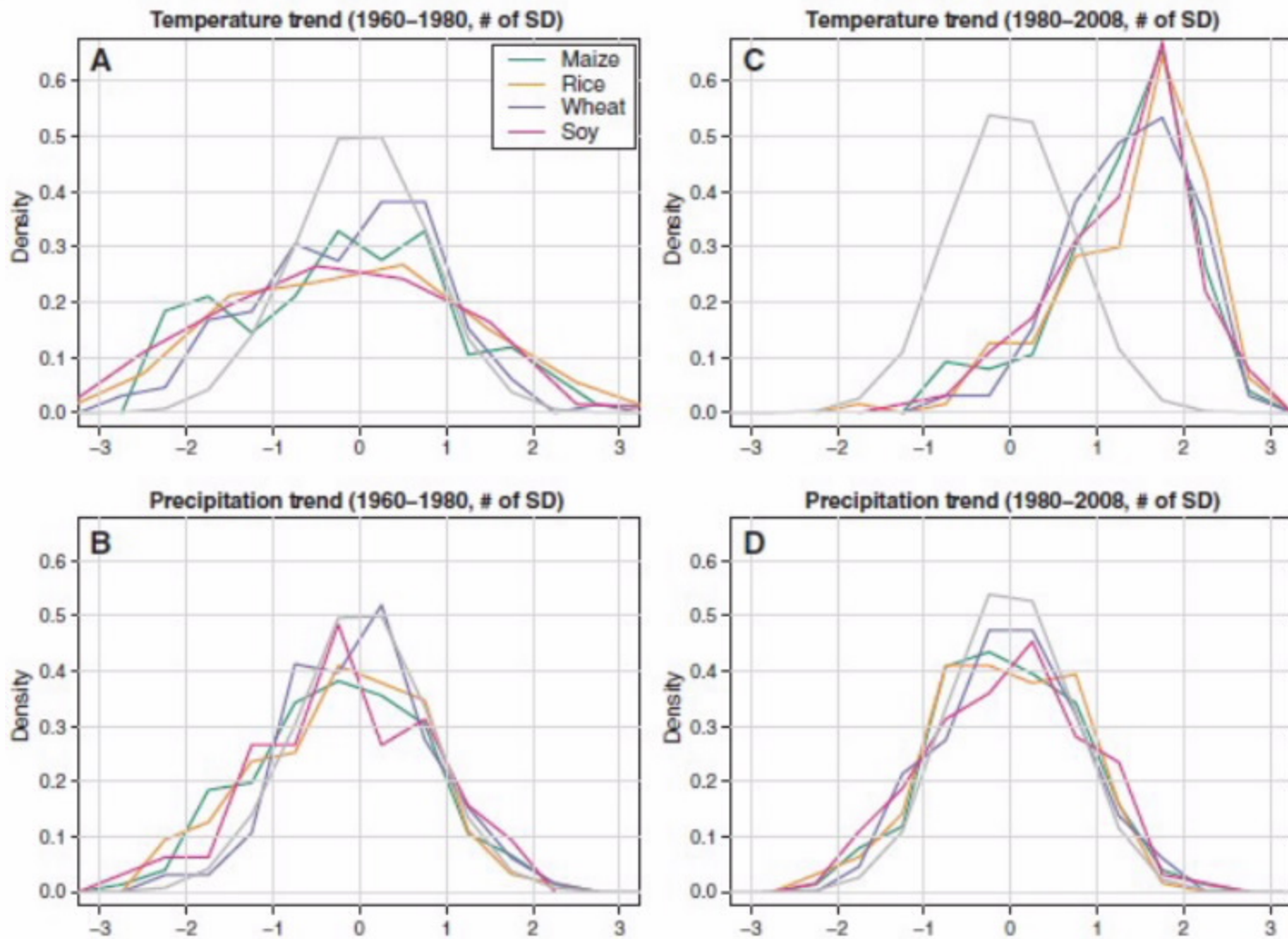
To estimate yield impacts of climate trends, we used the statistical models to predict annual yields for four scenarios of historical T and P:

- (i) actual T and actual P ,
- (ii) actual T and detrended P,
- (iii) detrended T and actual P,
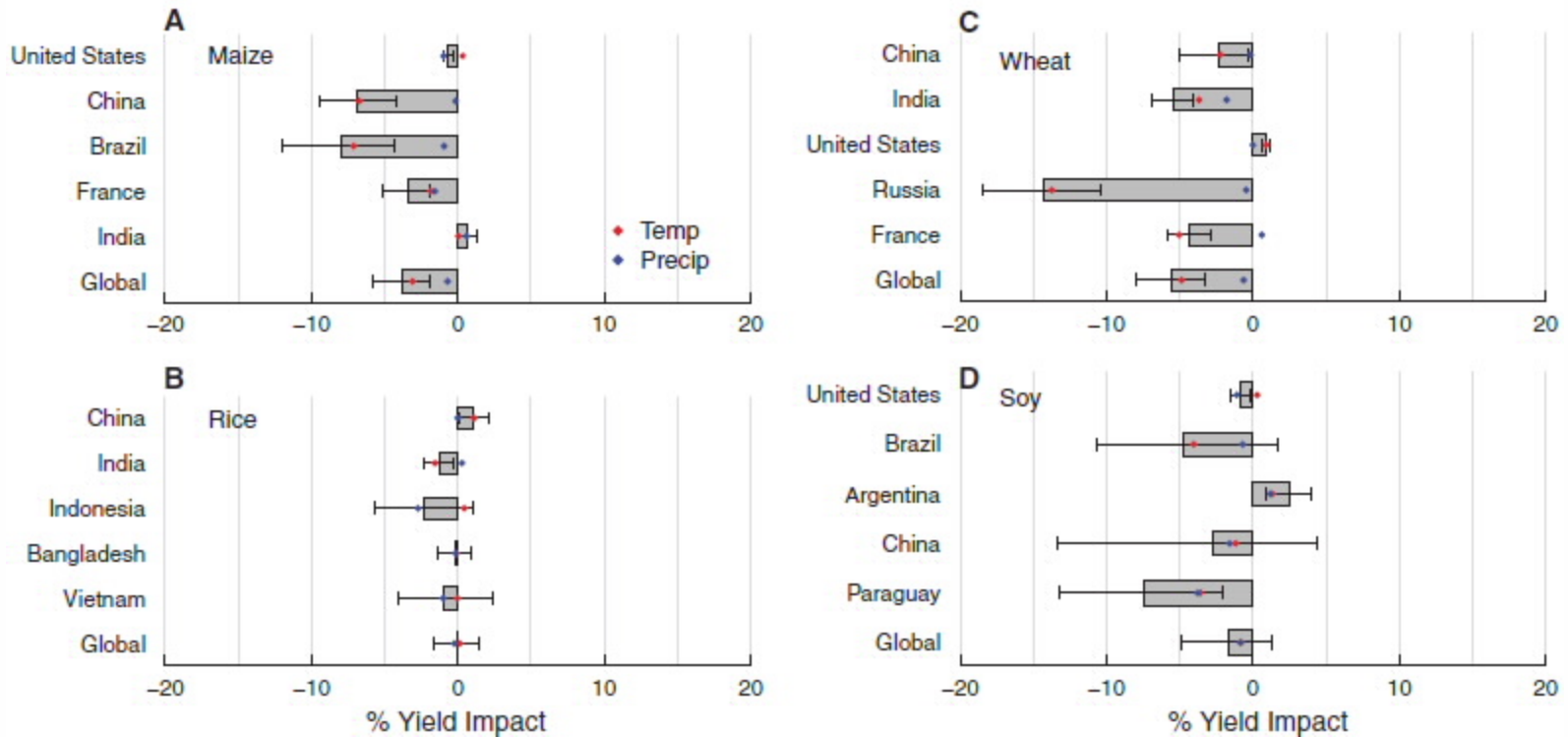- (iv) detrended T and detrended P.

Fig. 3. (A to D) Estimated net impact of climate trends for 1980–2008 on crop yields for major producers and for global production. Values are expressed as percent of average yield. Gray bars show median estimate; error bars show 5% to 95% confidence interval from bootstrap resampling with 500 replicates. Red and blue dots show median estimate of impact for T trend and P trend, respectively.

Table 1. Median estimates of global impacts of temperature and precipitation trends, 1980–2008, on average yields for four major crops. Estimates of the 47 ppm increase in CO_2 over the time period were derived from data in (21). Values in parentheses show 5% to 95% confidence interval estimated by bootstrap resampling over all samples.

Crop	Global production, 1998–2002 average (millions of metric tons)	Global yield impact of temperature trends (%)	Global yield impact of precipitation trends (%)	Subtotal	Global yield impact of CO_2 trends (%)	Total
Maize	607	−3.1 (−4.9, −1.4)	−0.7 (−1.2, 0.2)	−3.8 (−5.8, −1.9)	0.0	−3.8
Rice	591	0.1 (−0.9, 1.2)	−0.2 (−1.0, 0.5)	−0.1 (−1.6, 1.4)	3.0	2.9
Wheat	586	−4.9 (−7.2, −2.8)	−0.6 (−1.3, 0.1)	−5.5 (−8.0, −3.3)	3.0	−2.5
Soybean	168	−0.8 (−3.8, 1.9)	−0.9 (−1.5, −0.2)	−1.7 (−4.9, 1.2)	3.0	1.3

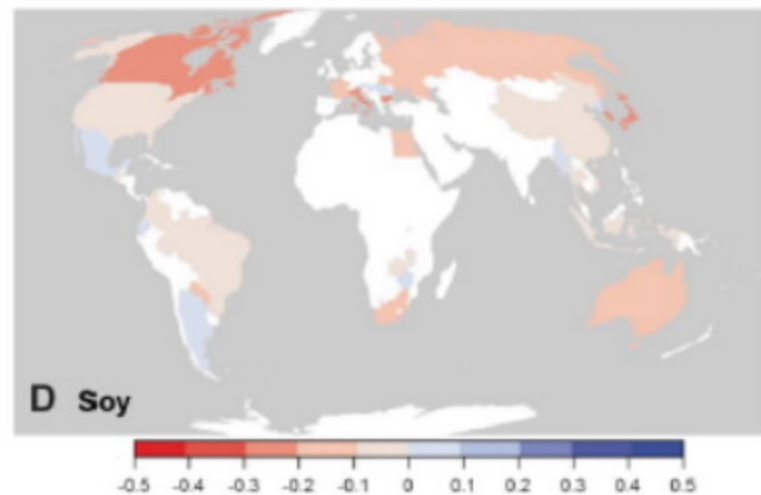Fig.s10 Sensitivity of T and P trends to different start and end years, for top five producers of each crop.
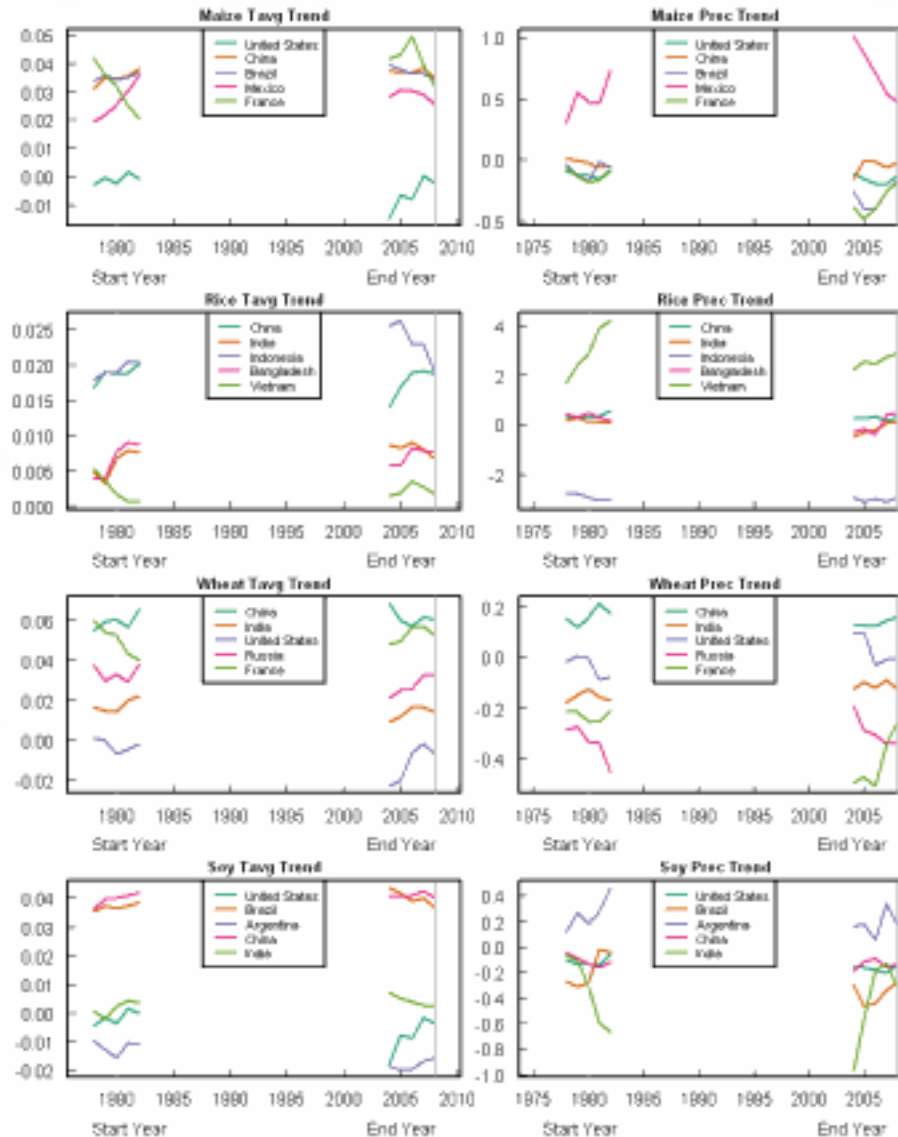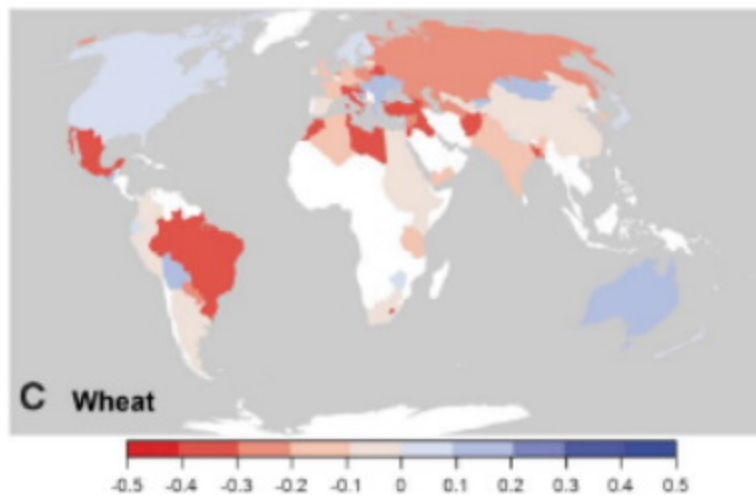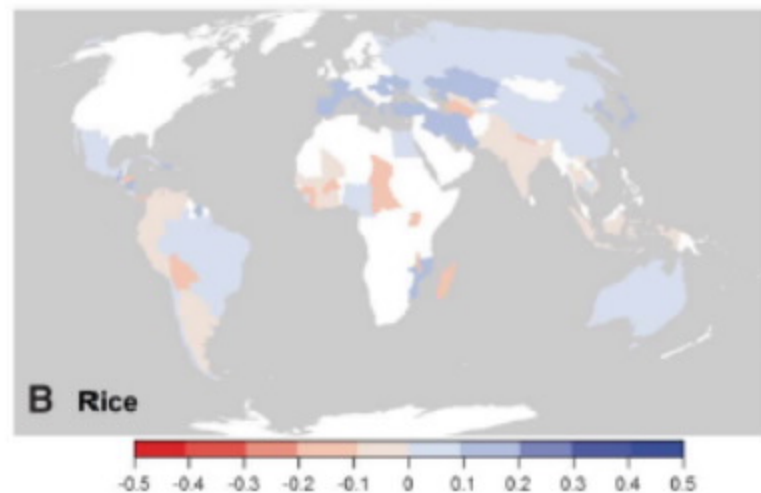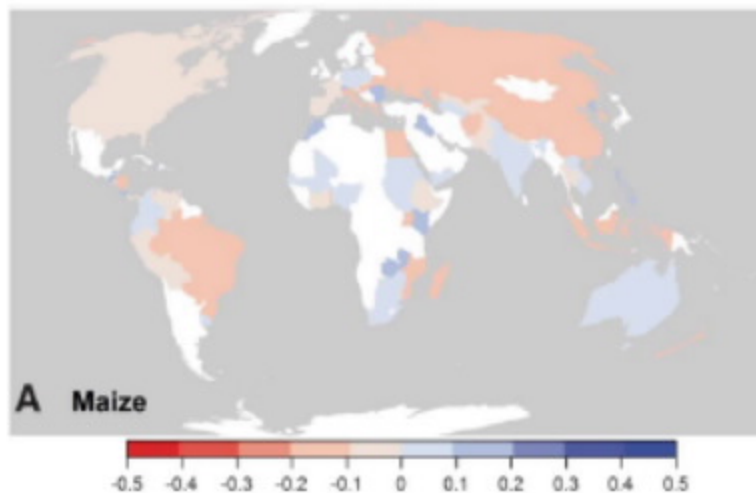
To assess how these impacts of climate trends compare to other factors over the same time period, we divided the climateinduced yield trend by the overall yield trend for 1980–2008 in each country.

Fig. 4. (A to D) Estimated net impact of climate trends for 1980–2008 on crop yields by country, divided by the overall yield trend per year for 1980–2008.

4. Limitations and Positive Significance

4.1 Limitations

- The approach may be overly pessimistic because it does not fully incorporate long-term adaptations.

- The estimates may be overly optimistic because data limitations prevent us from explicitly modeling effects of extreme temperature or precipitation events within the growing season.

4.1.Limitations

- The study does not estimate the direct effect of elevated CO_2 on crop yields that are captured in the smooth time trends.

- There are many important questions at subnational scales that the models cannot address, many important foods beyond the four modeled here, and many important factors other than food production that determine food security.

4.2 Positive Significance

- Periodic assessments of how climate trends are affecting global food production can provide some useful insights for scientists and policy makers.

- By identifying countries where the pace of climate change and associated yield pressures are especially fast, the study should facilitate these future analyses.Without successful adaptation, and given the persistent rise in demand for maize and wheat, the sizable yield setback from climate change is likely incurring large economic and health costs.

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Thank you ！