The relationship between extreme weather and low crop yields

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Background

Around 1/3 of global crop yield variation is explained by weather (Ray et al. 2015, Vogel et al. 2019)

Large regional differences in weather impacts

-> Idea is to explore the climatological drivers and differences in different regions

-> Here, climatological variations are described through soil moisture and temperature

Data

Daily **minimum and maximum temperature**: AgMerra (Ruane et al. 2015)

Daily **soil moisture** data from GLEAM (Martens et al. 2017)

Include data only for growing season based on **planting and harvesting dates** from AgMIP (Müller et al. 2017)

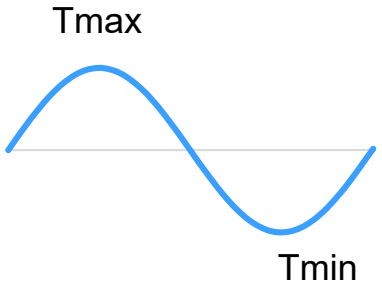
Rasterized **maize yield** data from Deepak Ray, University of Minnesota

Maize-specific **regional climate classification** (100 regions based on average growing degree days and soil moisture conditions, Mueller et al. 2012)

Timespan 1980-2010, due to climate data availability

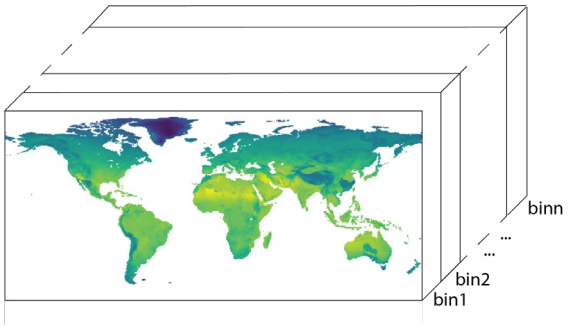
Methods

Sinusodial interpolation of daily temperatures, based on minimum and maximum



Growing season weather cube

- Allocate growing season weather to bins
- **Unit is days per bin**



Statistical analyses with Random Forest regression

- **Explain maize yield anomalies** with soil moisture and temperature variability
- Splitting data to **training (75%) and testing (25%)** sets

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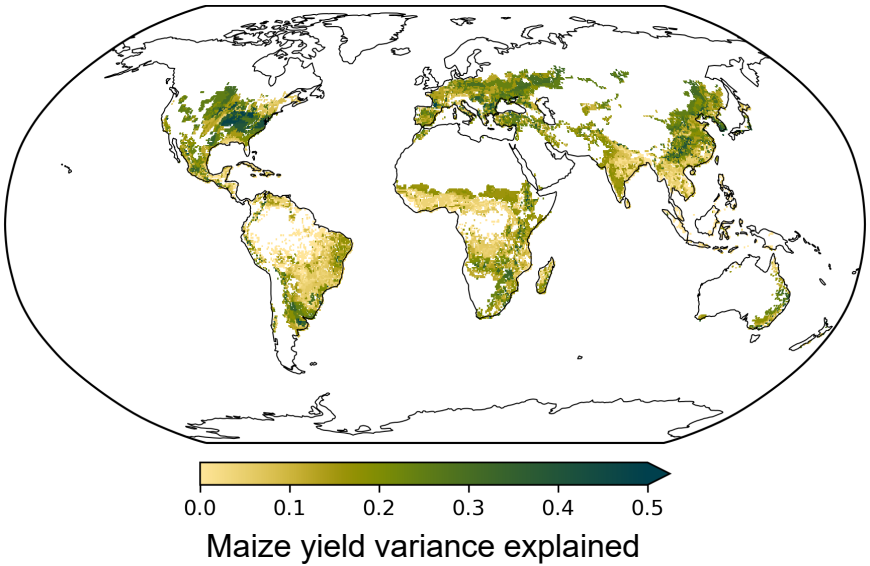
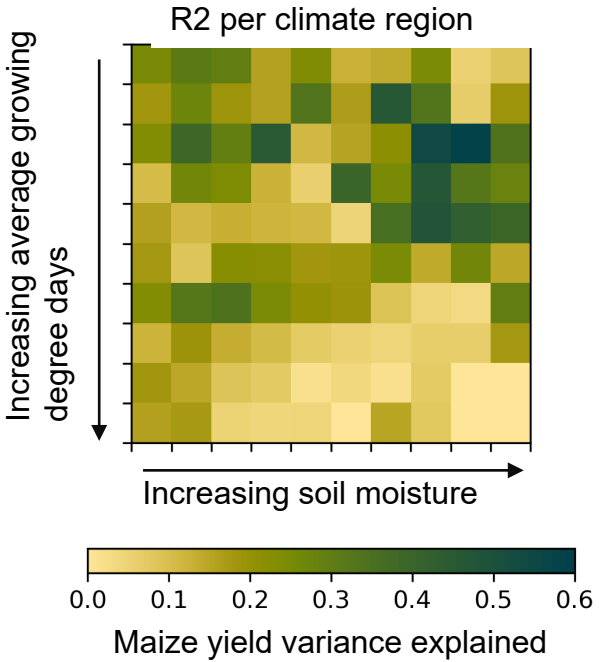
Cool and wet regions most susceptible to soil moisture and temperature variability





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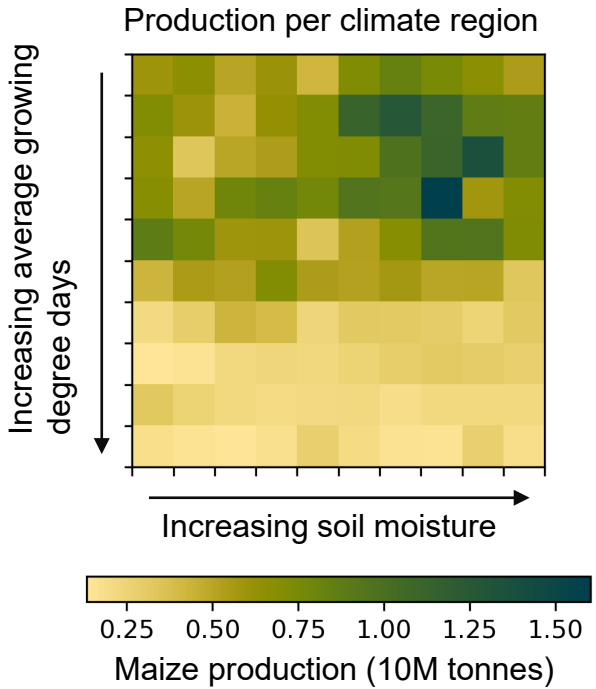
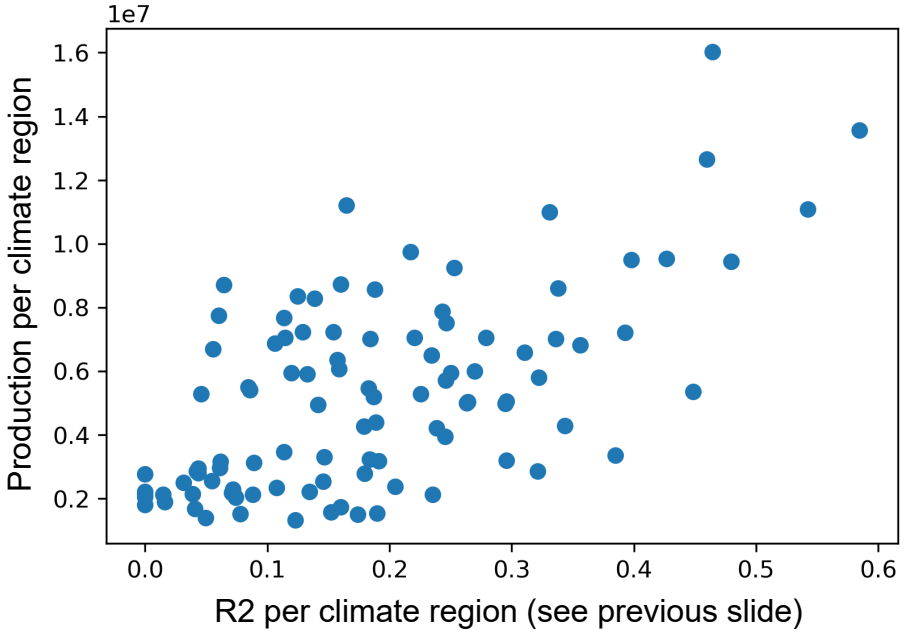
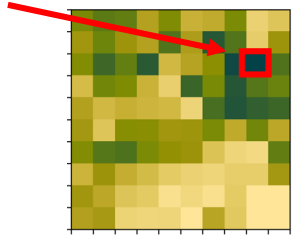
Most susceptible areas are also those with largest production

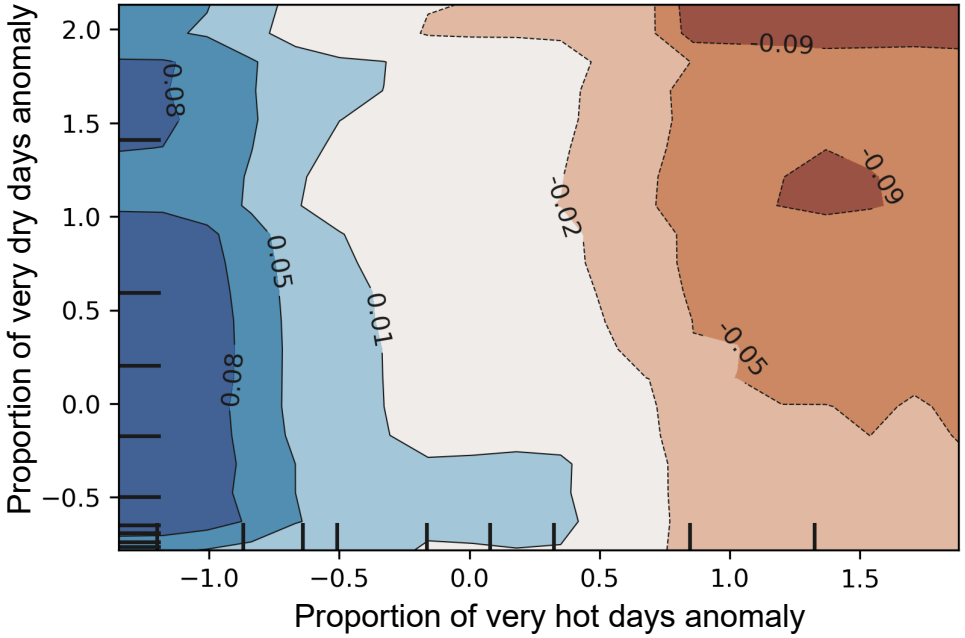




At least in cool and wet climate regions, high temperatures and low soil moisture seem to reduce crop yields especially when occuring together



Maize yield anomaly as a function of very hot and dry days (above 90th percentile) during the growing season



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Final notes

Analyses and results are still preliminary

Next ideas: run the analyses for early and late growing seasons separately and for different crop types

Compare impacts irrigated and rainfed areas

Inspect the importance of the explanatory variables (wet, cold, dry, hot, etc.) in different areas

References

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