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INTEGRATED HUMAN-EARTH SYSTEM DYNAMICS

Separating planting and harvesting decisions in GCAM

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GCAM Meeting

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Pacific Northwest NATIONAL LABORATORY

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Perfect foresight or not?

Decisions in the real world	• Decisions of land allocation, irrigation, management • Time lag between planting and harvesting • Suboptimal decisions • Endogenous market fluctuations

Expectation scheme	• Incorporate expectation schemes from economic literature into GCAM
	• Adaptive expectation
	  • Adaptively adjust expectations based on new information
	  • Supported by empirical studies

Perfect foresight in economic modeling	• Ignore the time lag between planting and harvesting • Perfectly predict future climate (weather) and market conditions • Make adjustments in decisions immediately • Convenient assumption but criticized in economic literature

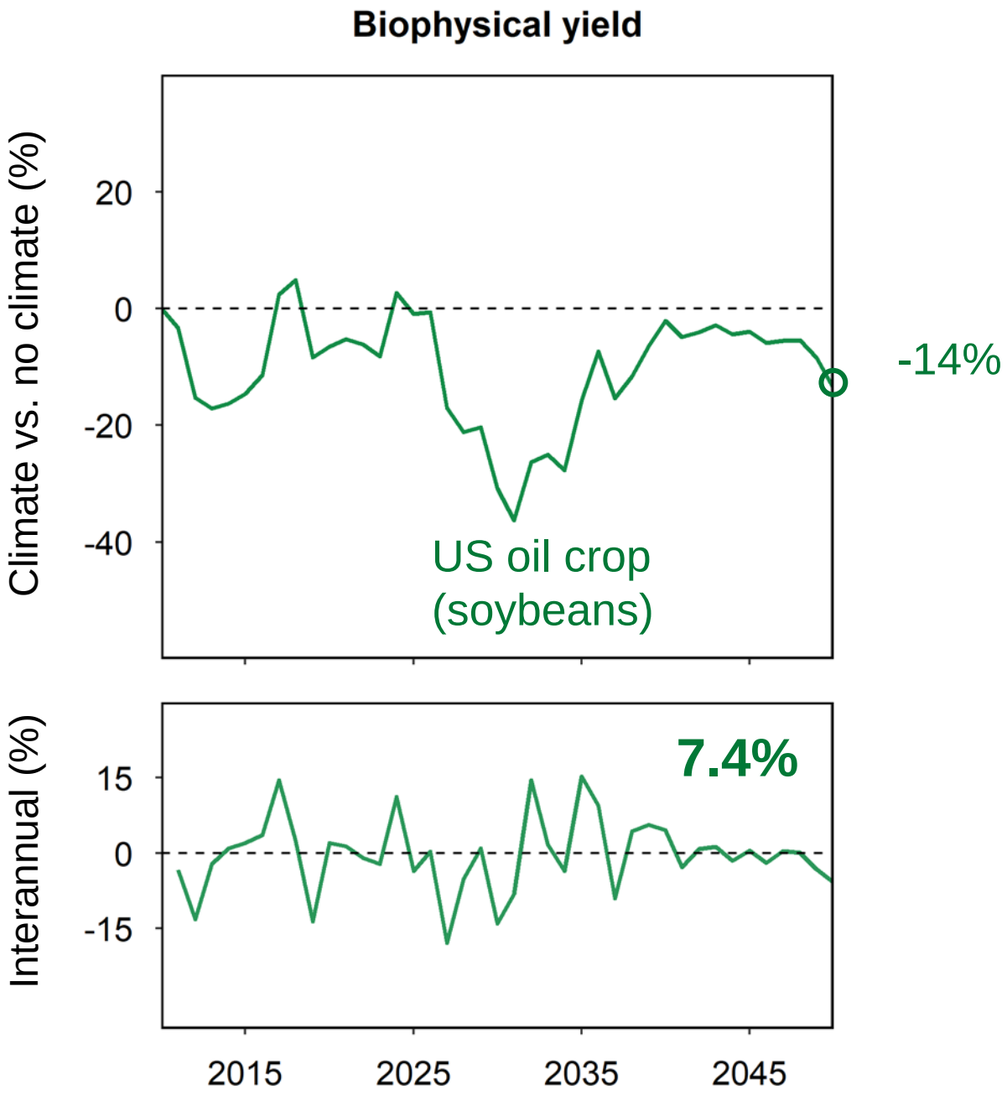
Why is separating planting & harvesting important?

- Assessing the interannual variability of climate impacts on agriculture and land use
  - Relationship between climate variability and economic responses

Modeling chain	Climate model	Crop model	Economic Model (GCAM)
Variable	• Temperature • Precipitation • Etc.	• Biophysical yield	• Harvested area • Production • Consumption • Prices • Etc.

  - Biophysical yield is an agronomic representation of all climate variables
  - Annual projections of biophysical yield were not used
    - Longer time steps in economic models (focused on 2050)
    - Perfect foresight assumption

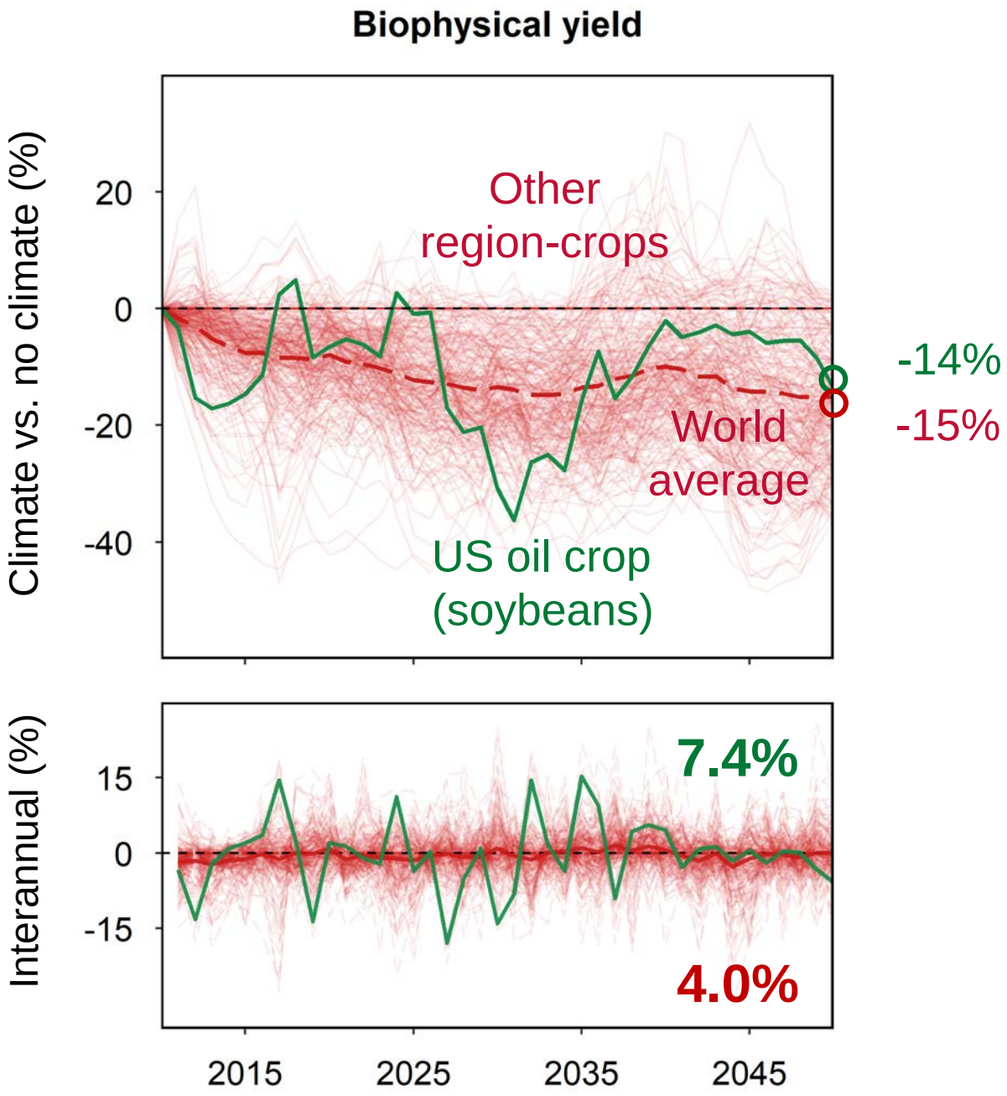
Biophysical yield shocks



- A high-emissions scenario
  - RCP8.5 & GFDL-EPIC

- Interannual variability
  - SD of annual percent change
  - US oil crop (soybeans): 7.4%

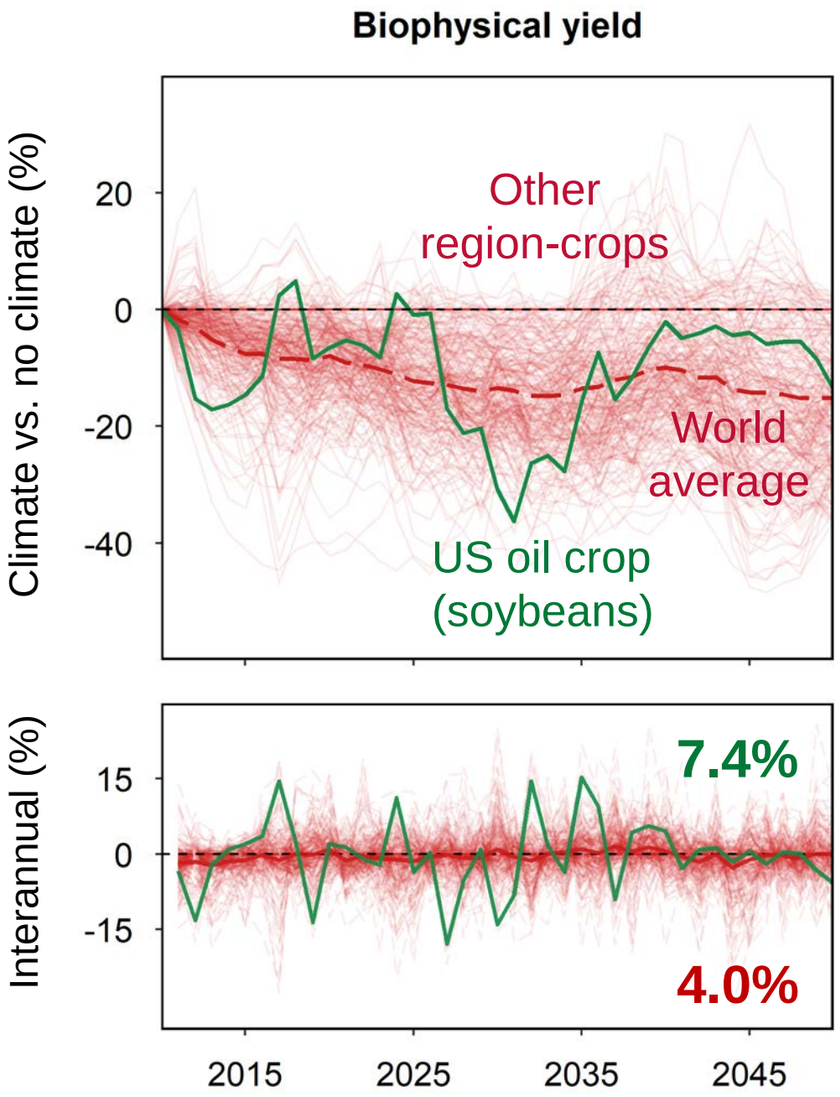
Biophysical yield shocks

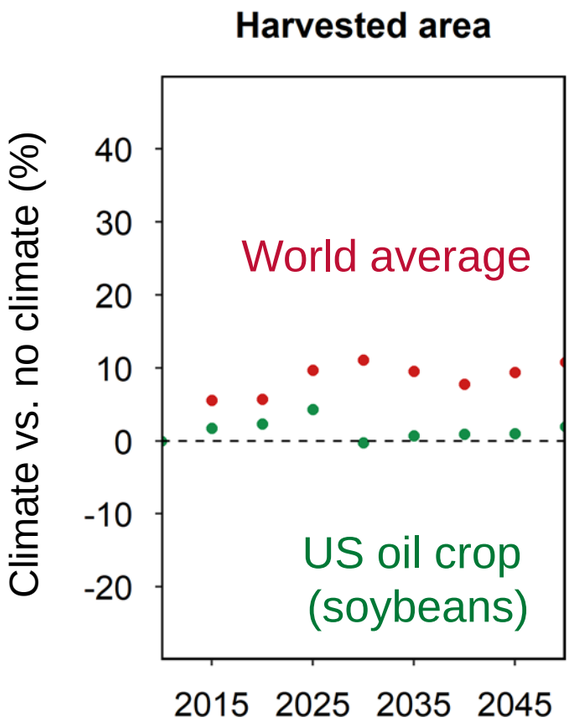


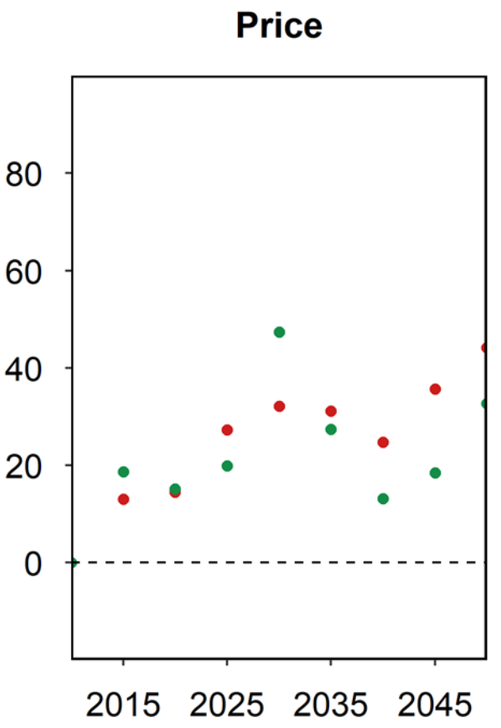
- A high-emissions scenario
  - RCP8.5 & GFDL-EPIC

- Interannual variability
  - SD of annual percent change
  - US oil crop (soybeans): 7.4%
  - World: 4%

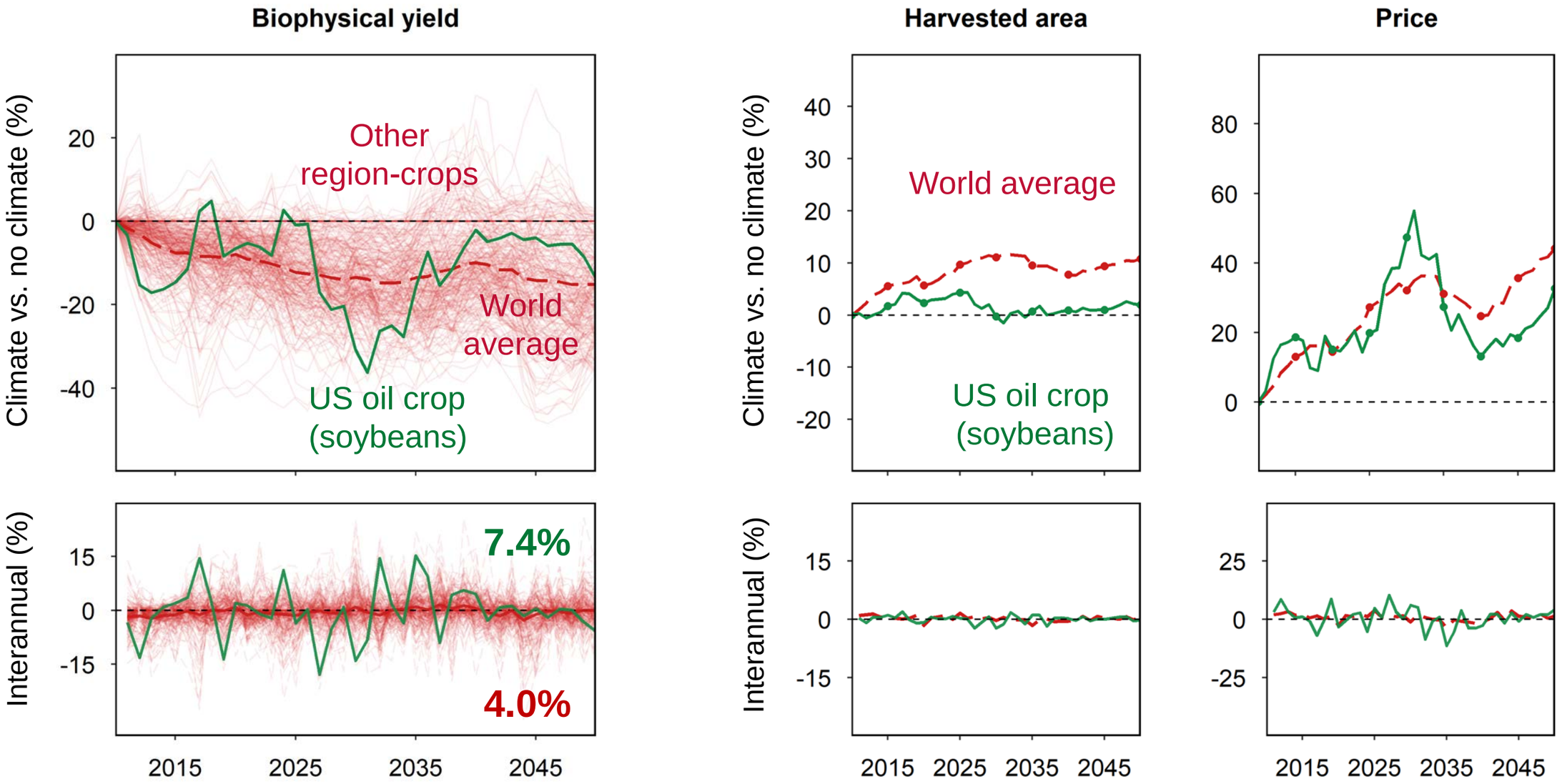
Climate impacts on agriculture
Original GCAM results



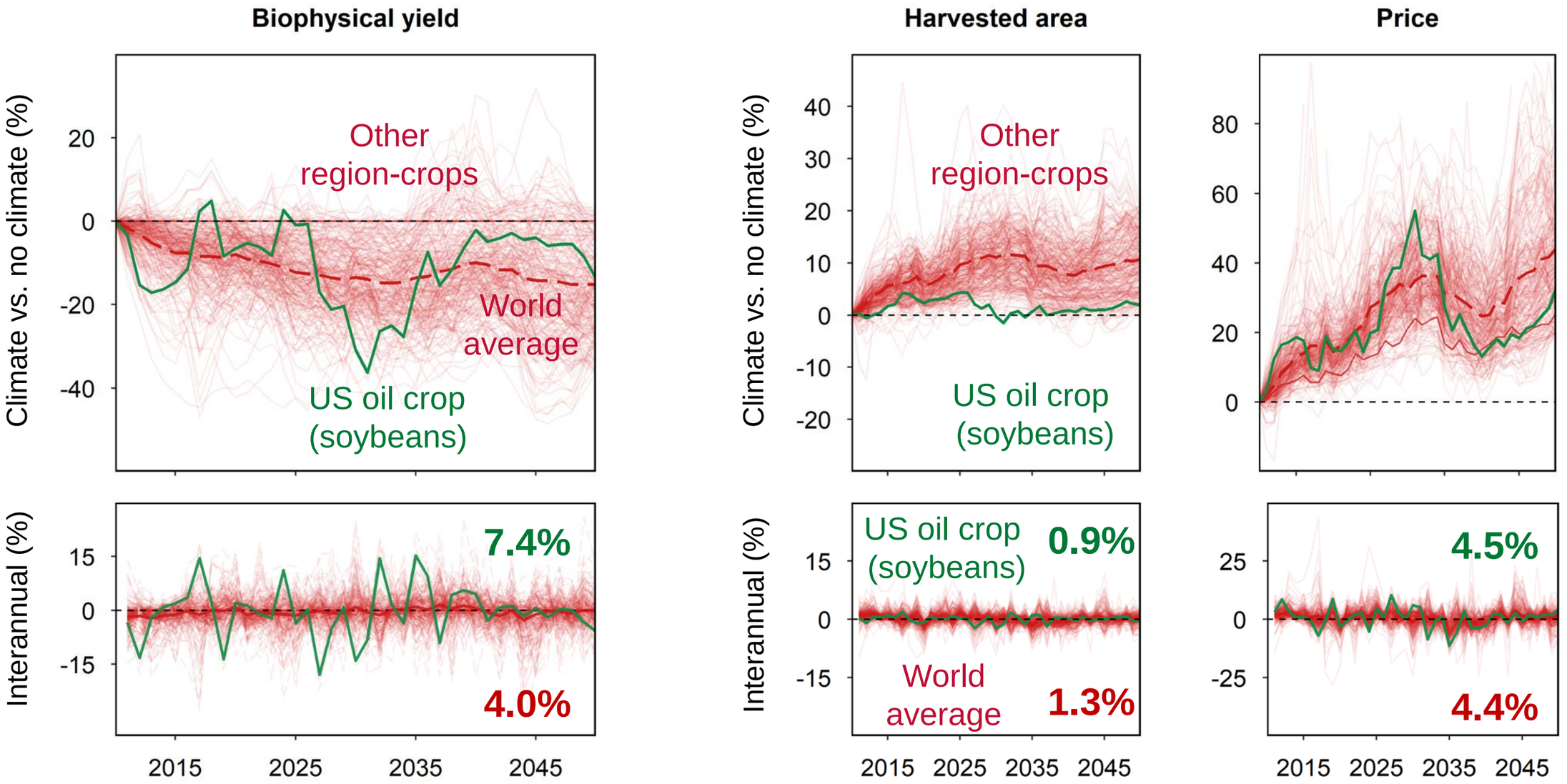




Climate impacts on agriculture
Run GCAM annually

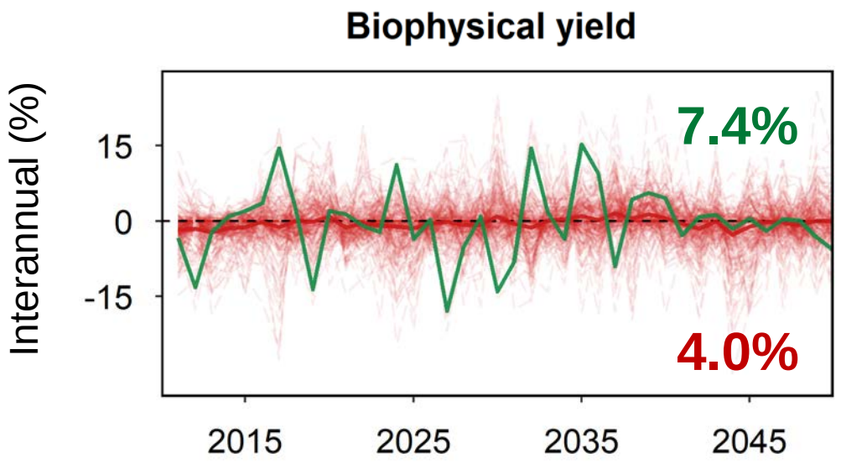


Climate impacts on agriculture
Run GCAM annually + all region-crops

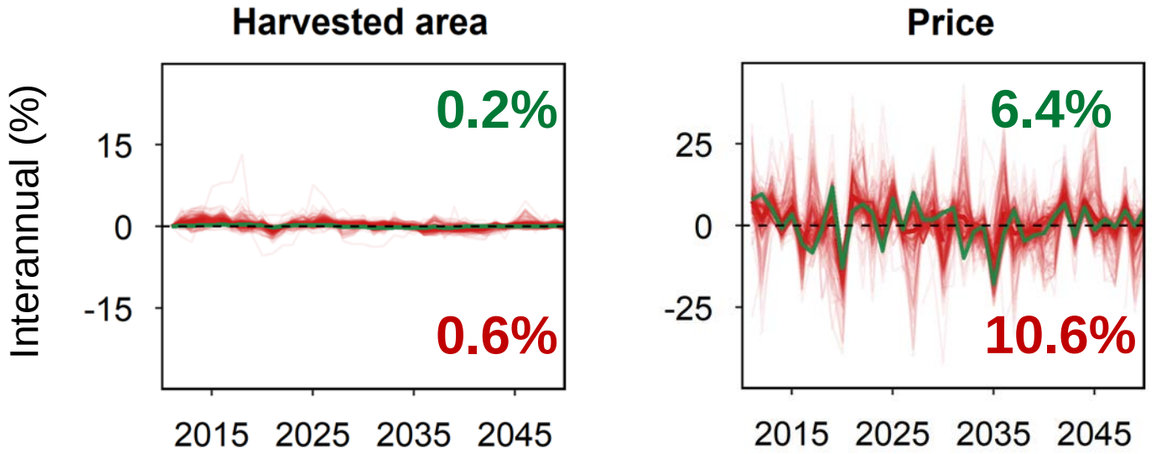


Climate impacts on agriculture
Adaptive expectations

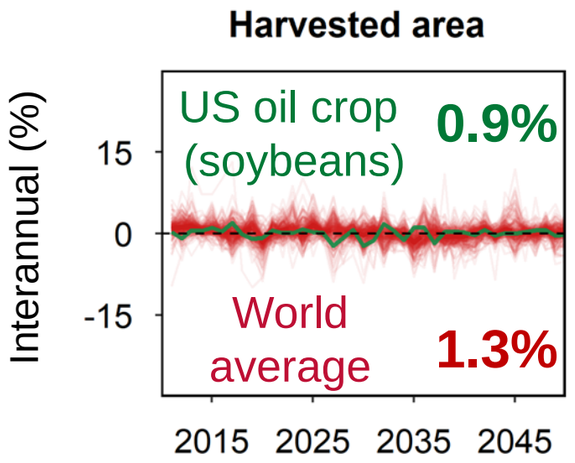
- **Imperfect foresight**
- Smaller variation for area
  - Slower adaptation
  - Effectively more rigid acreage responses
- Higher price volatility
  - Endogenous market fluctuation

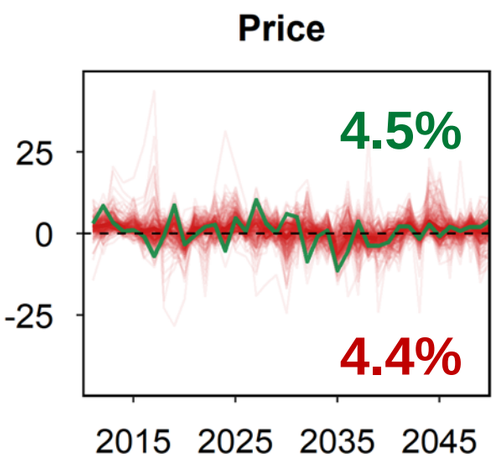


Adaptive expectation



Perfect foresight





Regional heterogeneity in variability

- Regional interannual variation is mediated through trade.
- Net importing (food insecurity) regions are more vulnerable to climate variability.

- Poster: “Sensitivity of agricultural economics to future climate and biophysical variability”
  - Results are consistent across climate scenarios
  - Interannual variability in climate and biophysical shocks are transformed and transferred to crop market, and magnified by endogenous market fluctuations.

Why is separating planting & harvesting important?

- The trend and variability of climate impacts can be more useful than point estimations

- Parameter calibration
  - Better hindcast performance with planting and harvesting separated

- Other applications
  - Value of better predictions/forecasts
  - Extreme weather events
  - Risk aversion behaviors

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Thank you

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