



Separating planting and harvesting decisions in GCAM

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GCAM Meeting

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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

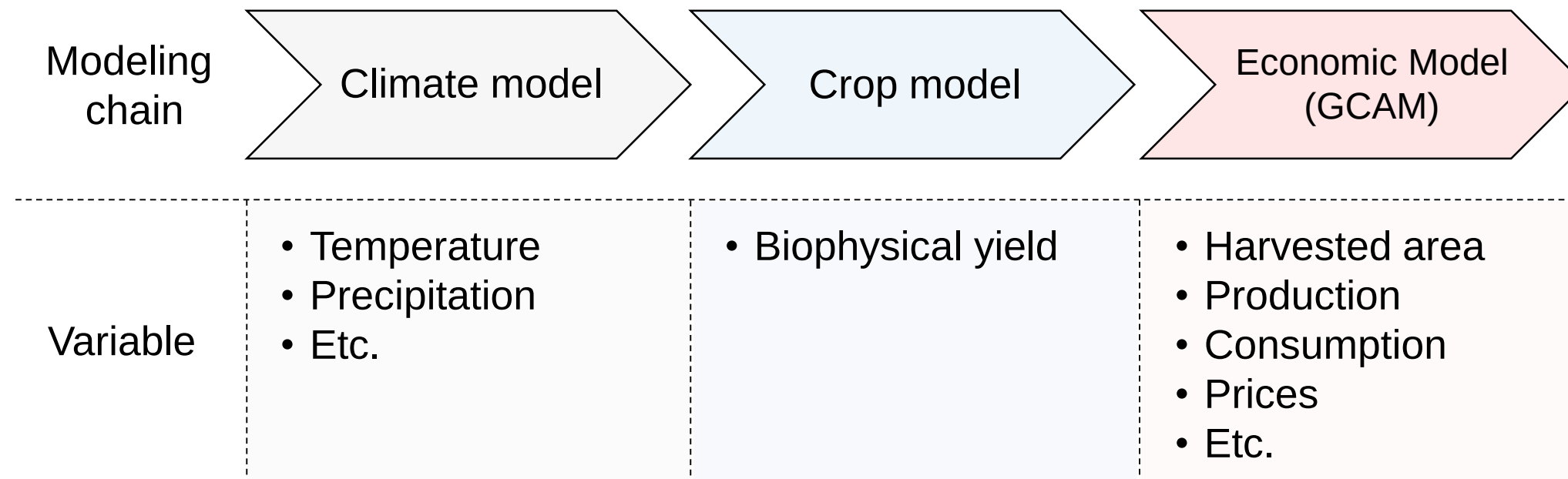
- Incorporate expectation schemes from economic literature into GCAM
- Adaptive expectation
 - Adaptively adjust expectations based on new information
 - Supported by empirical studies

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

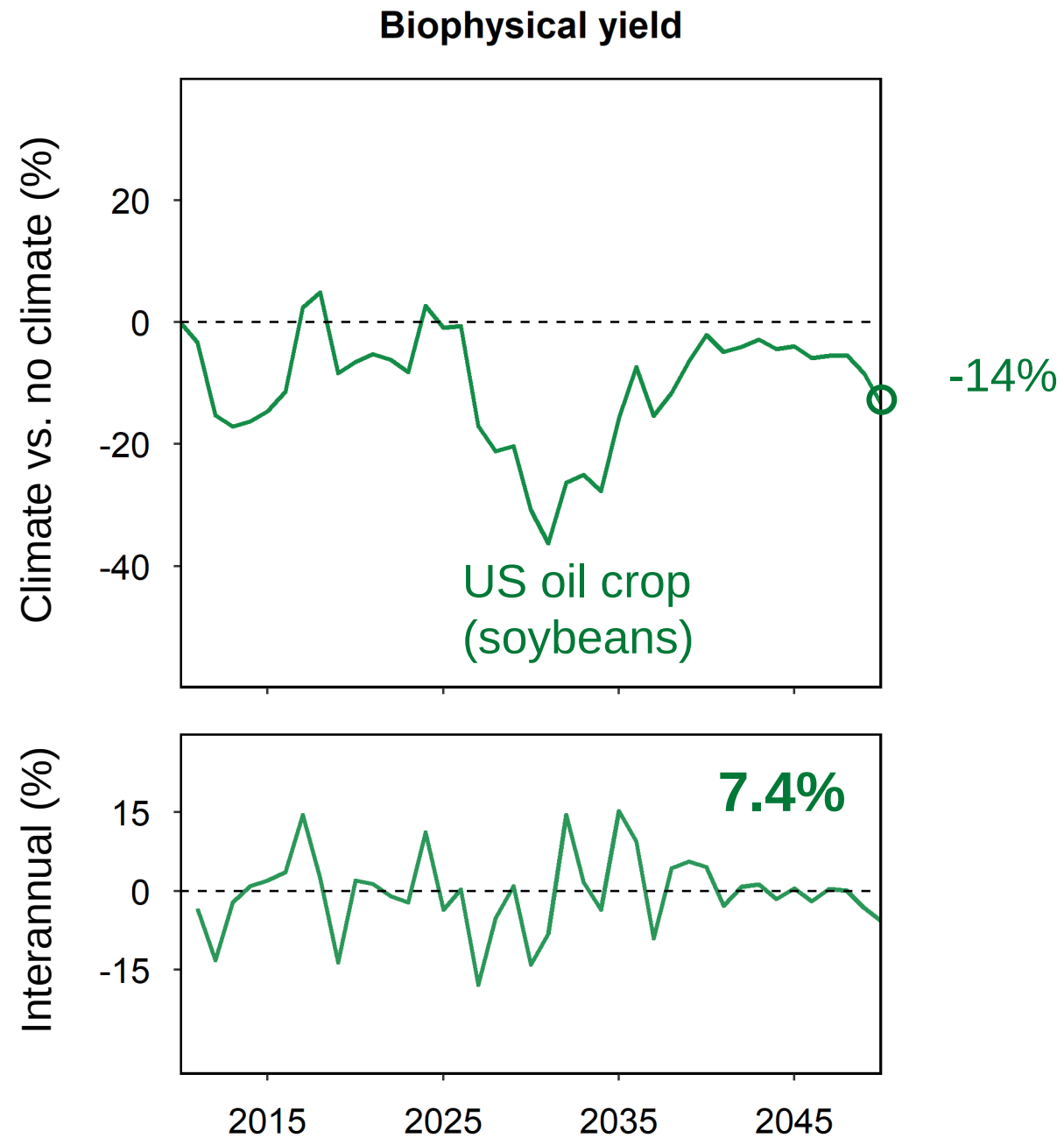
Why is separating planting & harvesting important?

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



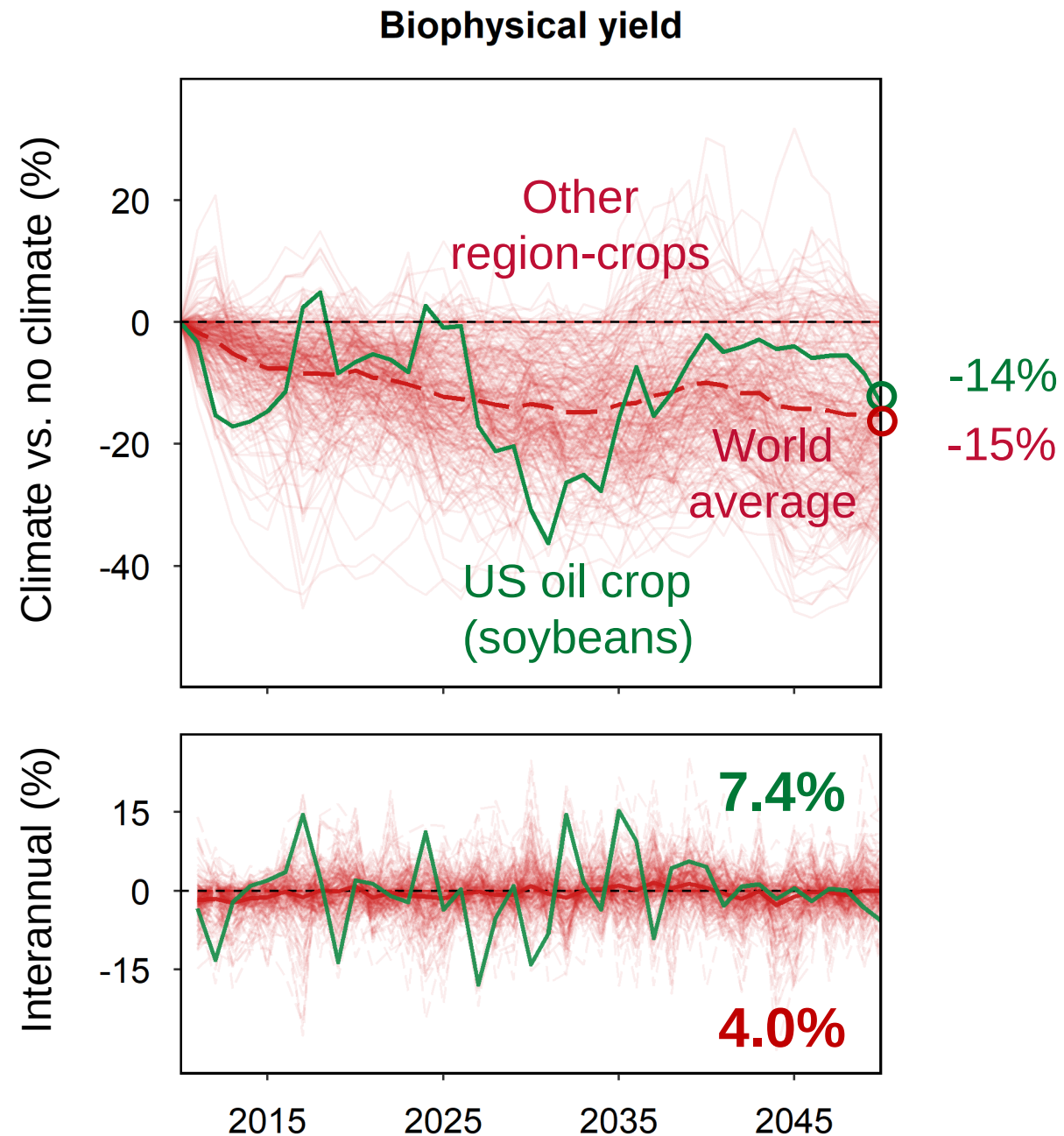
- Biophysical yield is an agronomic representation of all climate variables
- Annual projections of biophysical yield were not used
 - Longer time steps in economic models (focused on 2050)
 - Perfect foresight assumption

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

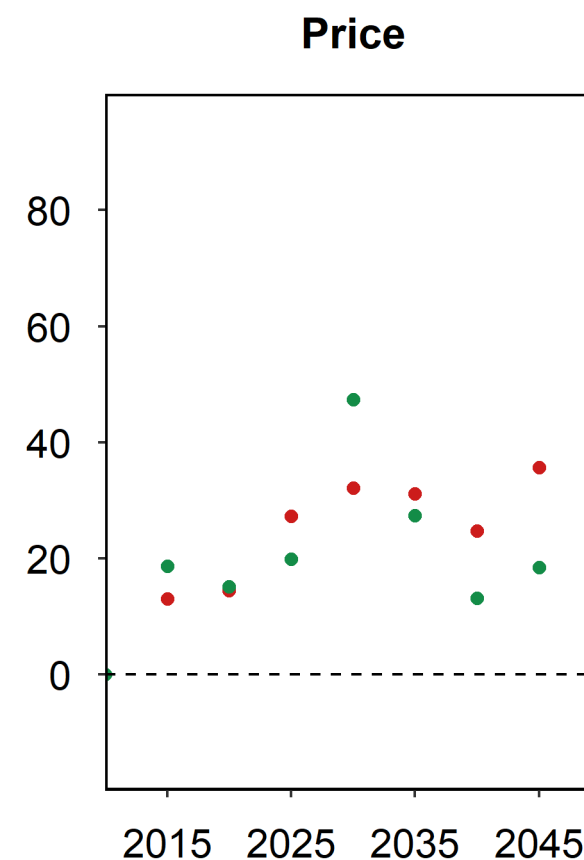
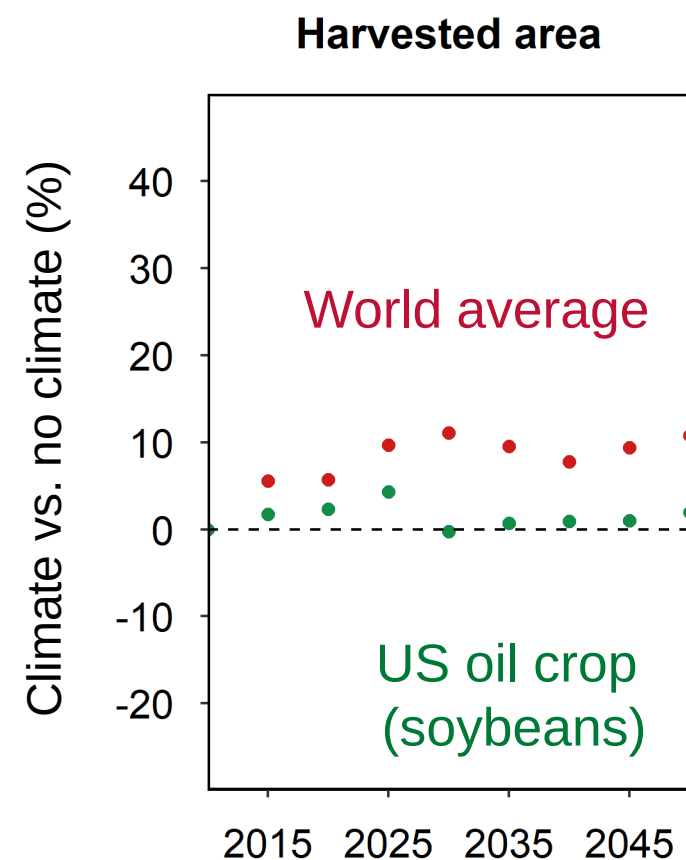
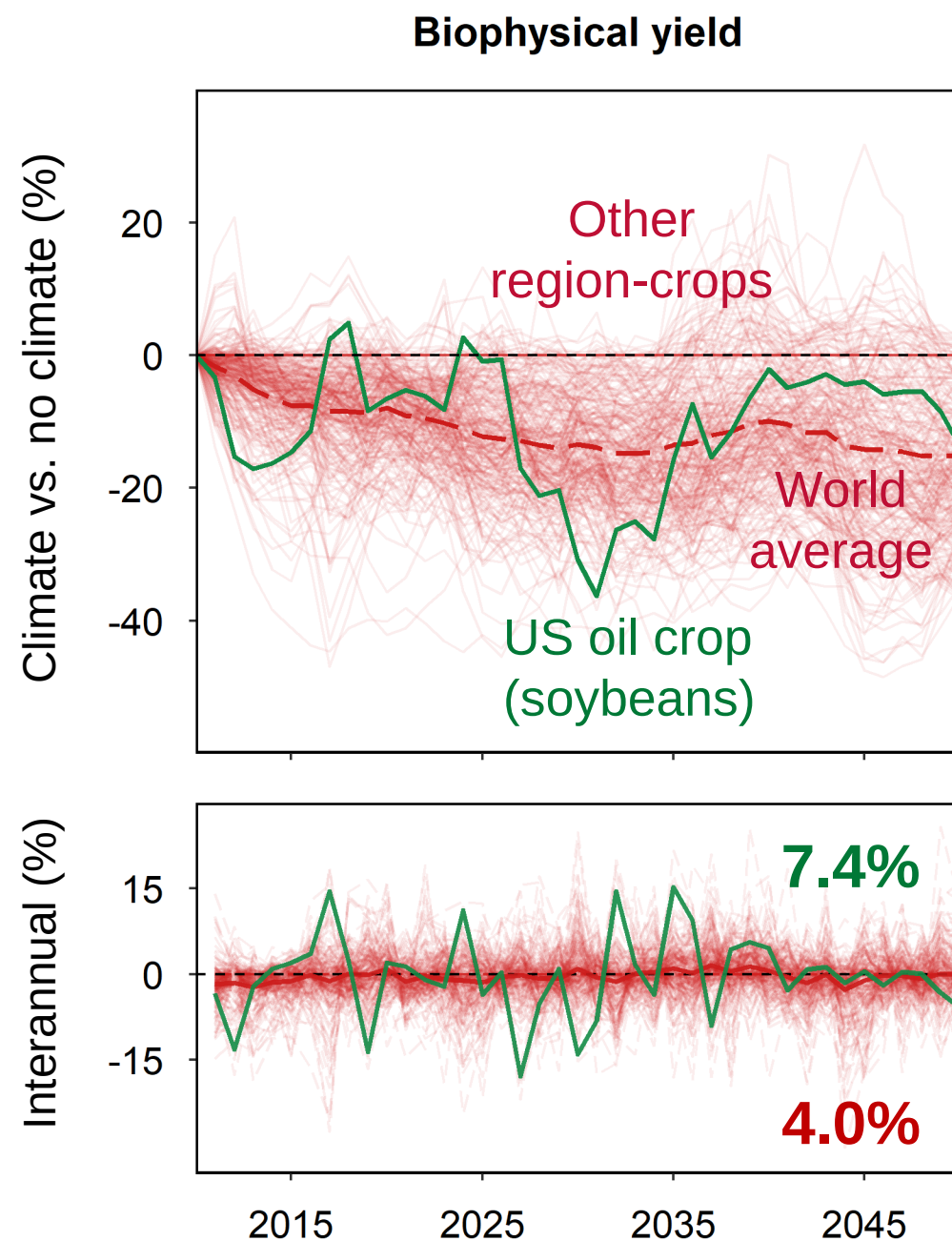
- RCP8.5 & GFDL-EPIC

- Interannual variability

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

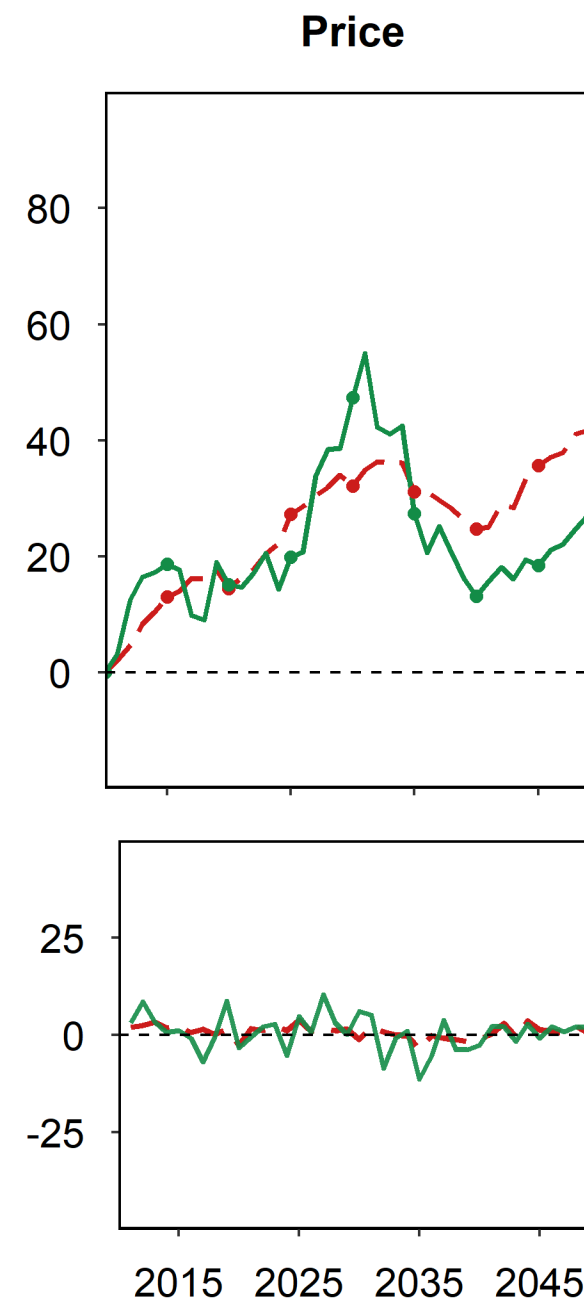
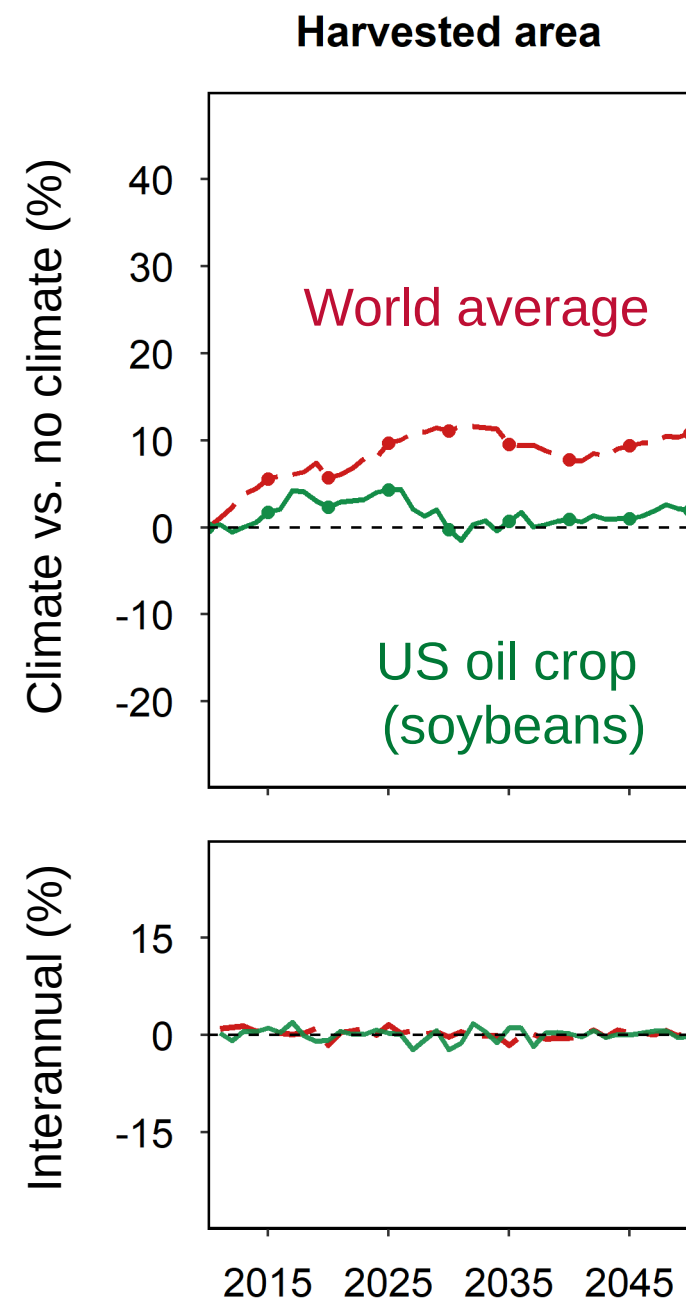
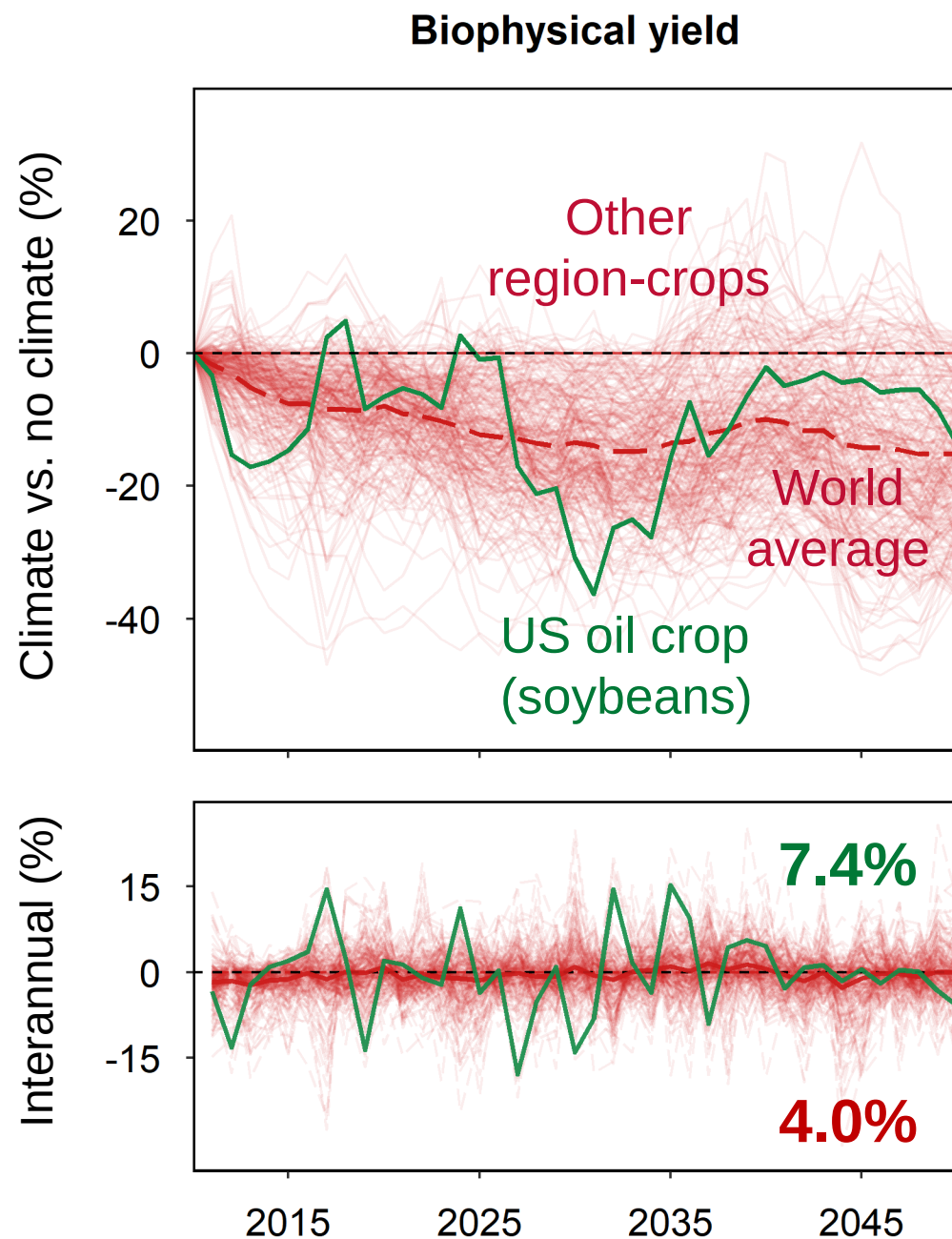
Climate impacts on agriculture

Original GCAM results



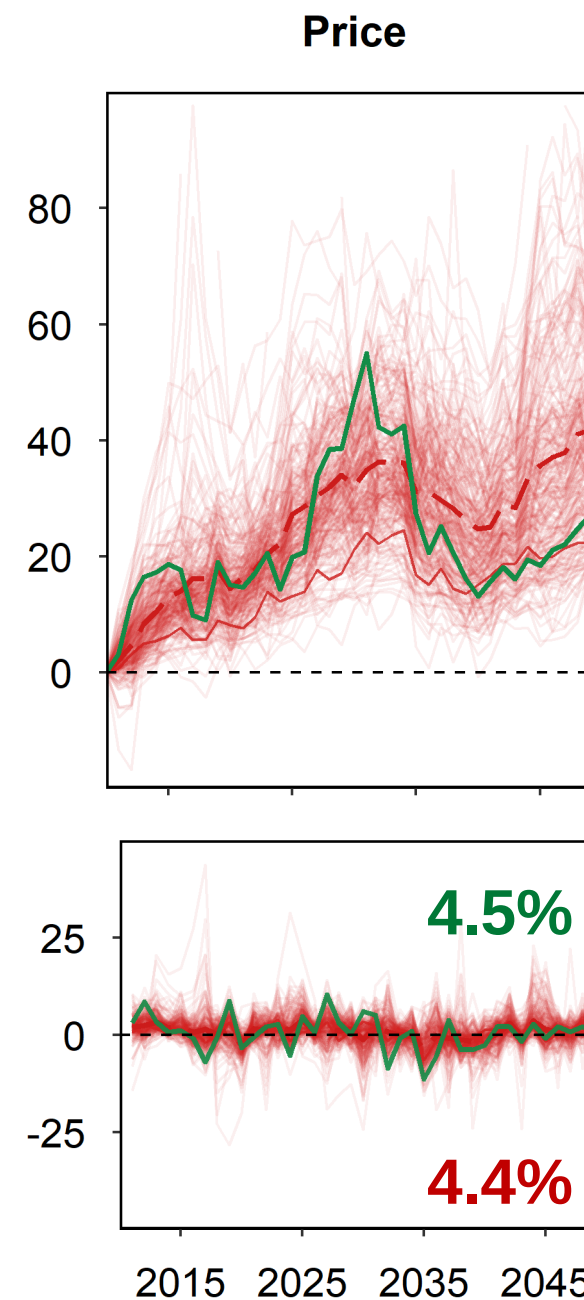
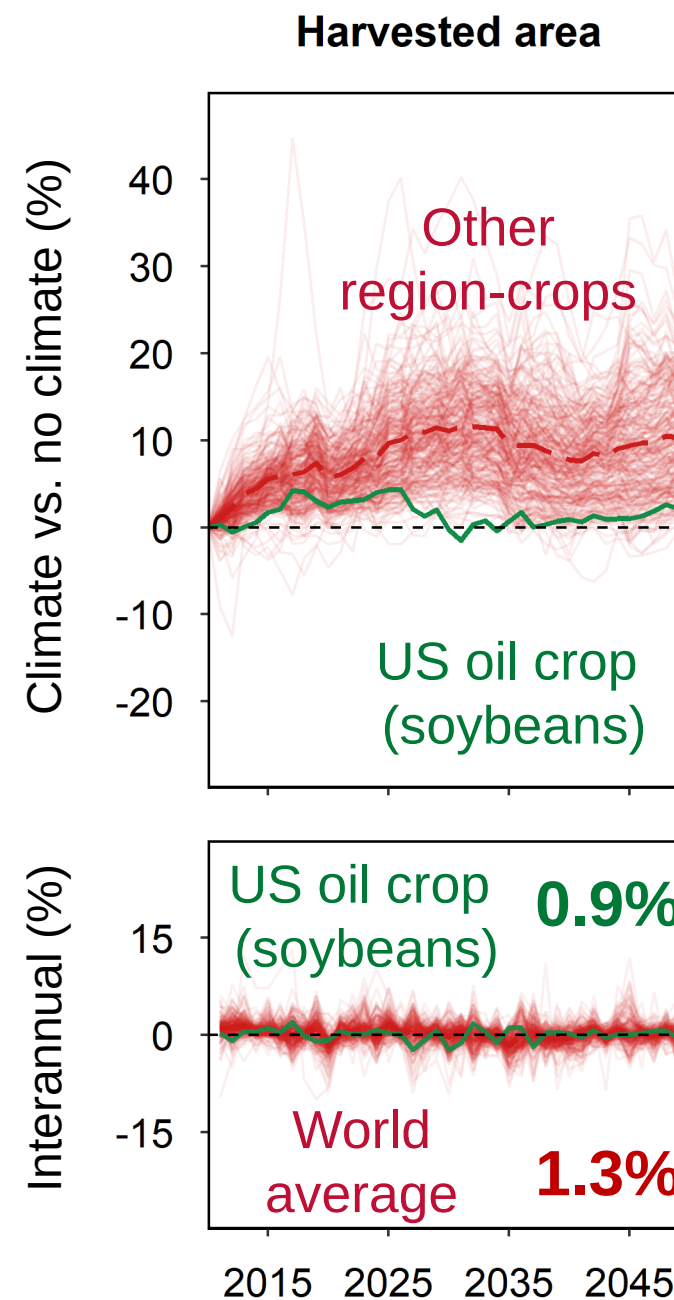
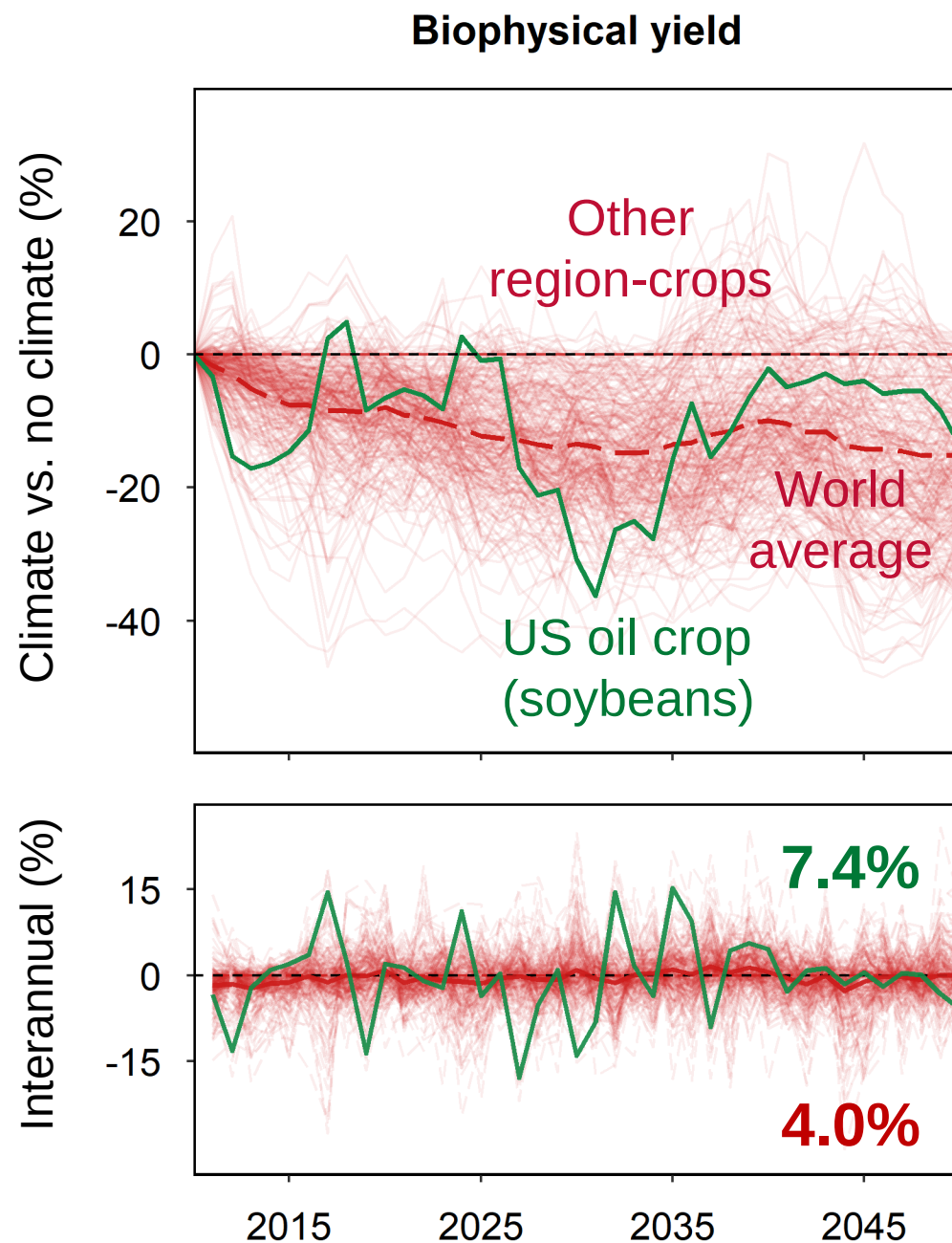
Climate impacts on agriculture

Run GCAM annually



Climate impacts on agriculture

Run GCAM annually + all region-crops

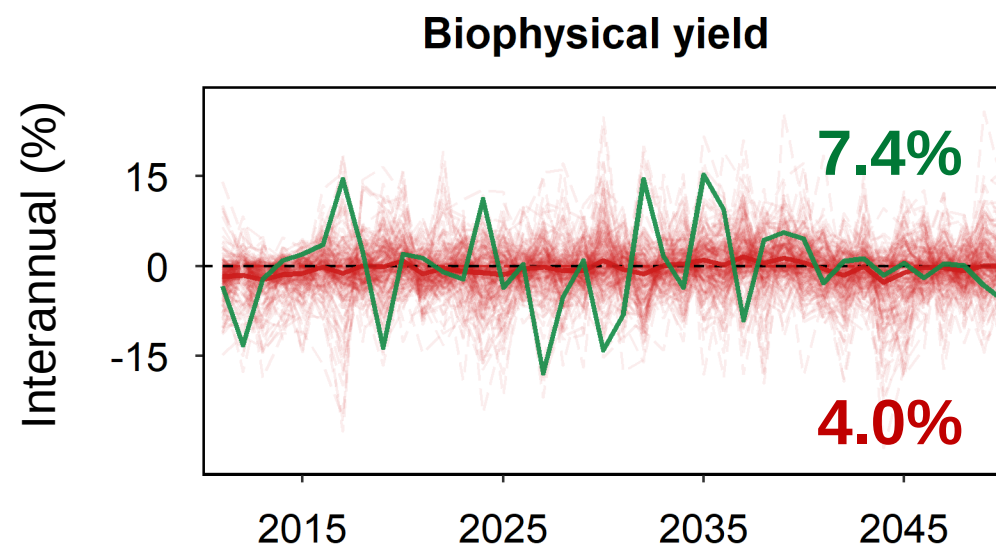
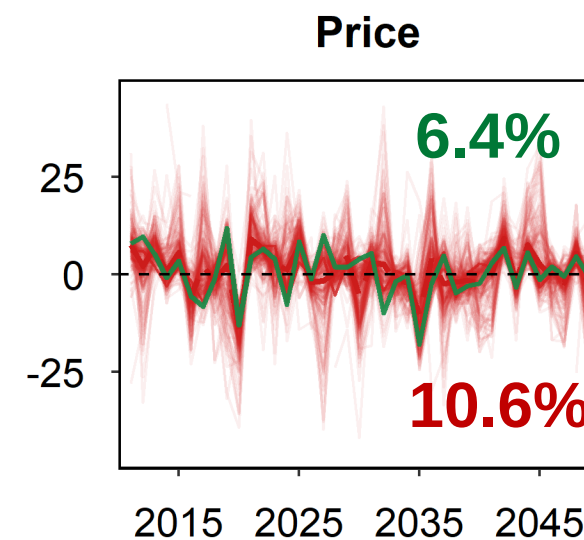
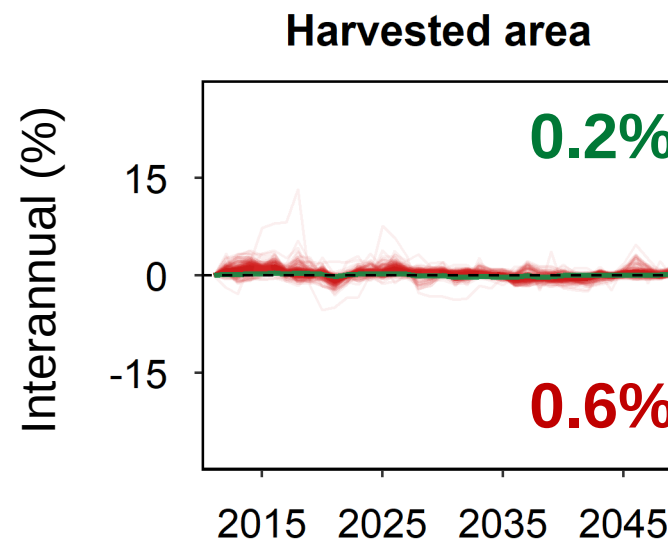


Climate impacts on agriculture

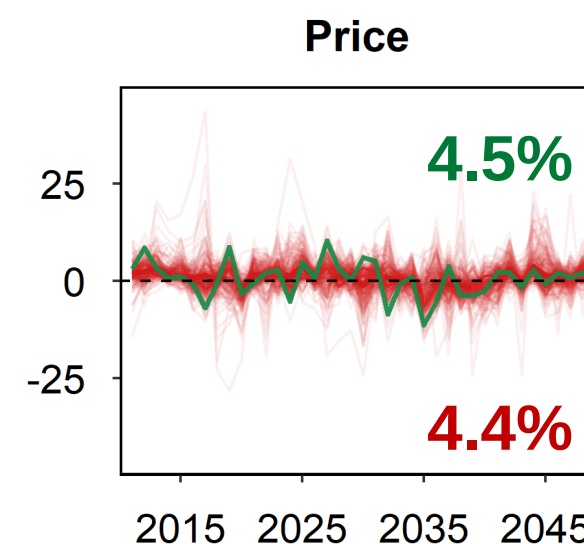
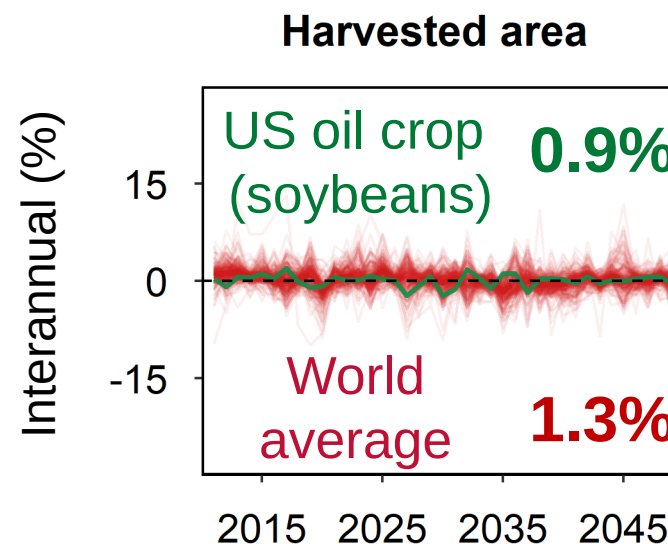
Adaptive expectations

- **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

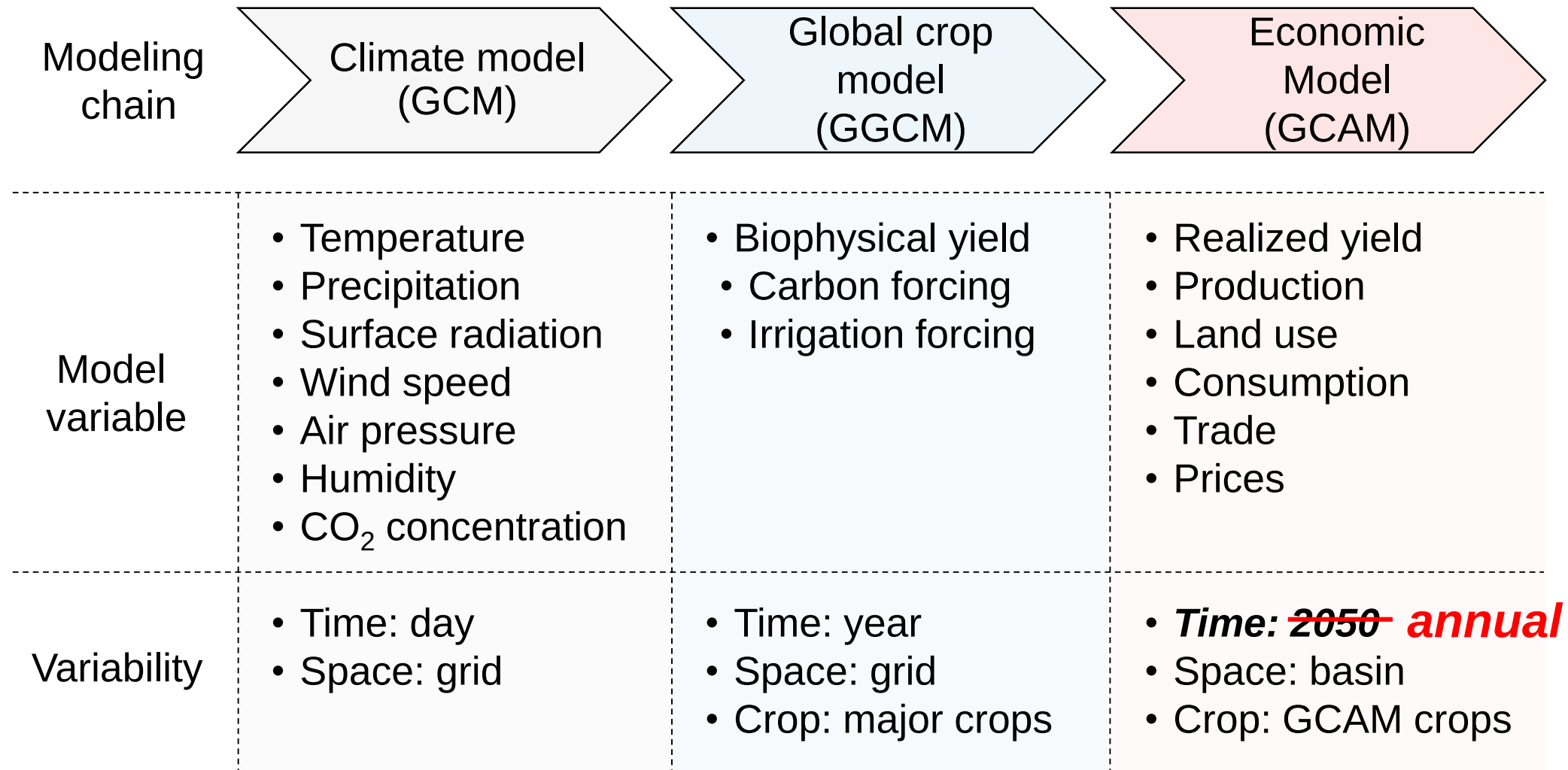
- Regional interannual variation is mediated through trade.
- Net importing (food insecurity) regions are more vulnerable to climate variability.
- See paper for more details
 - Results are consistent across climate scenarios
 - Interannual variability in climate and biophysical shocks are transformed 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

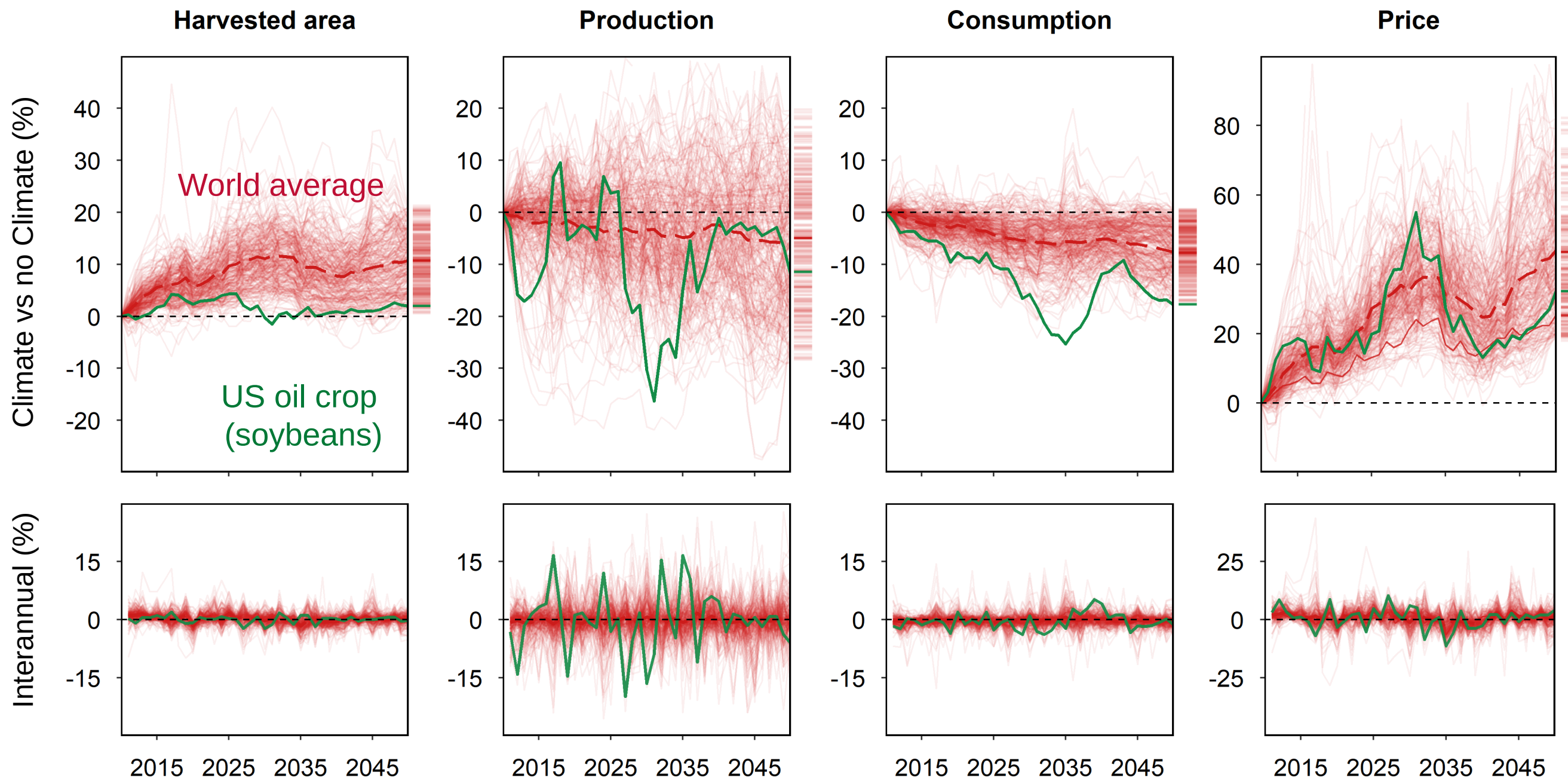
Thank you

Assessing climate impacts on AgLU



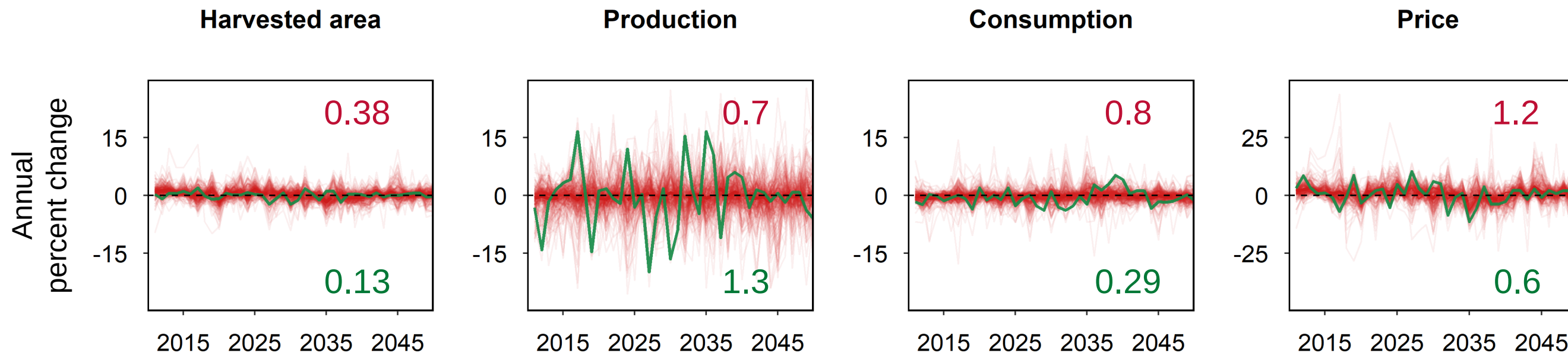
- Biophysical yield is an agronomic representation of all climate variables
- Variability in biophysical yield shocks mirrors climate variability

Climate impacts on agricultural economics

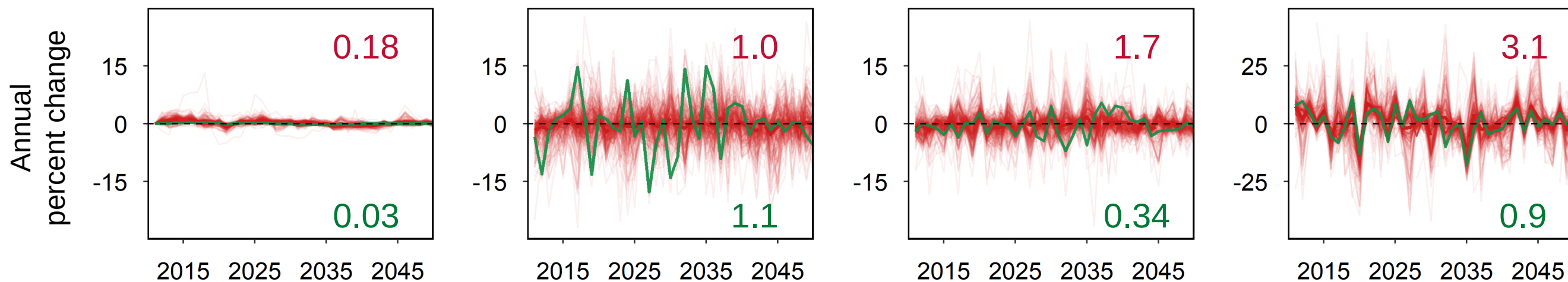


Relative interannual variability

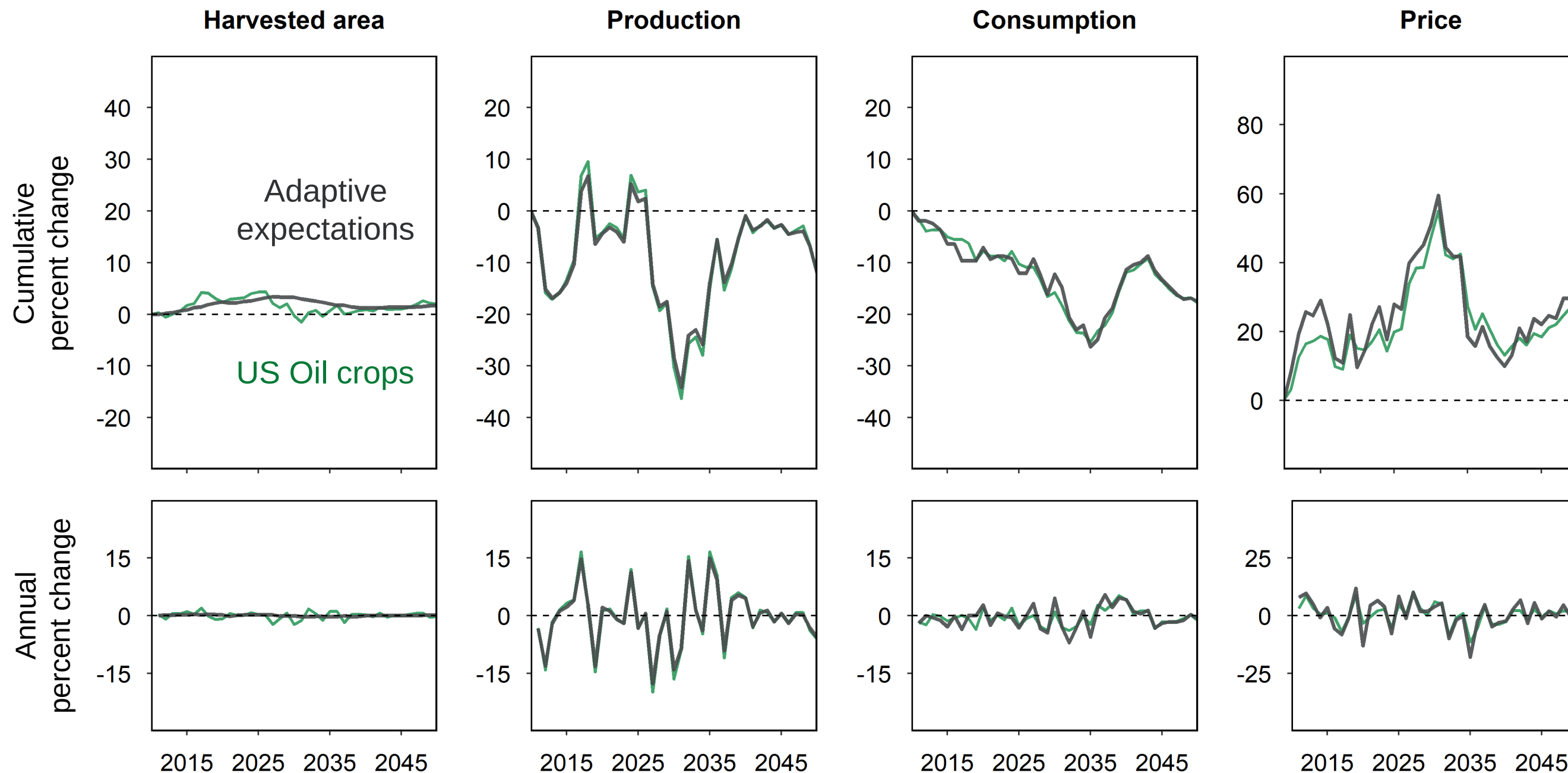
- Perfect foresight*



- Adaptive expectation*



Incorporating adaptive expectations



Relative interannual variability

- Relative interannual variability (RIV)

$$RIV = \frac{IV_{economic\ variable}}{IV_{biophysical\ yield}} = \frac{Beta\ coeff.}{Correlation\ coeff.}$$

$$IV = SD[\log(variable_t) - \log(variable_{t-1})]$$

- Vulnerability to climate variability
 - For a crop-region under a climate scenario

