Agricultural labor under future heat stress: productivity shocks and global agroeconomic consequences

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Motivation

- Agriculture is particularly vulnerable to climate change through multiple pathways
- Pathway 1: changes to **crop yields** from changes to temperature, precipitation, CO_2, etc. (Lobell et al., 2011; Nelson et al., 2014; Jägermeyr et al., 2021)
- Pathway 2: changes to **labor productivity** resulting from **heat stress** (Kjellstrom et al., 2009; Dunne et al., 2013)
  - Agricultural labor is severely heat stressed
  - More intensive, frequent, and regionally heterogeneous heat waves projected later in the century

Research question

What's the additional climate impact on agriculture through the labor pathway & the combined climate impact through both pathways?

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Experimental Design

1: Ref SSP2 & RCP6.0 No Biophysical Response	**3: Labor-only** Ref + Labor Response
2: Crop-only Ref + Crop Response	**4: Combined** Ref + Crop & Labor Response

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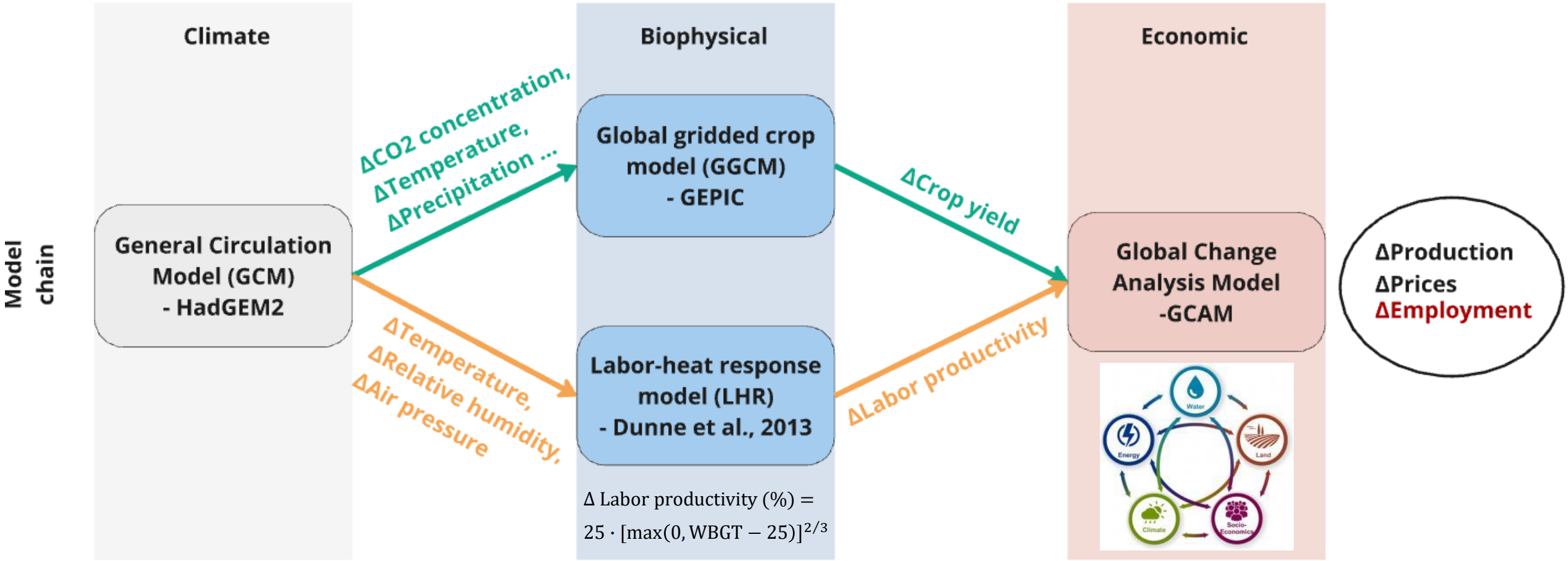
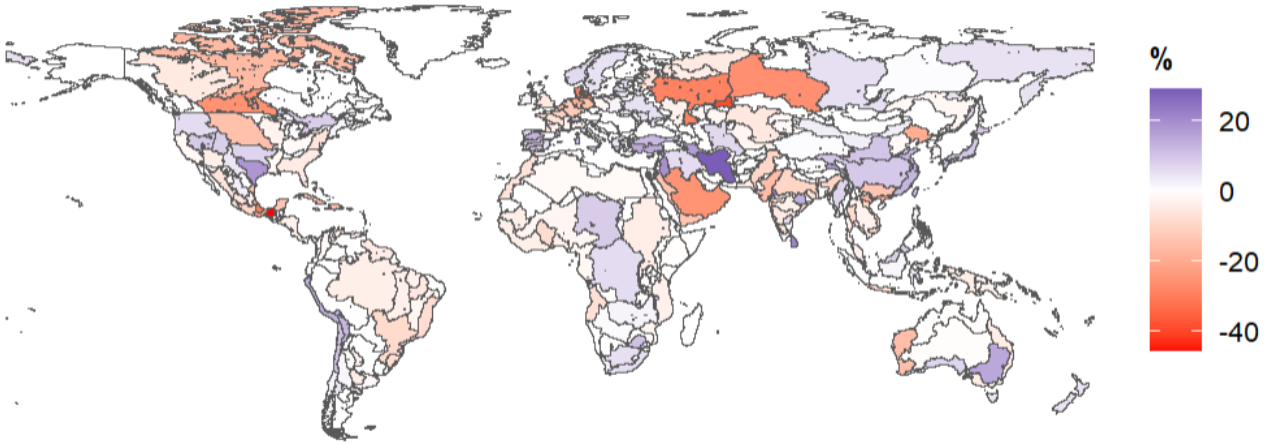
Methodology



Regional Climate Impacts on Crop Yields and Labor Productivity, SSP2-RCP6.0: 2100

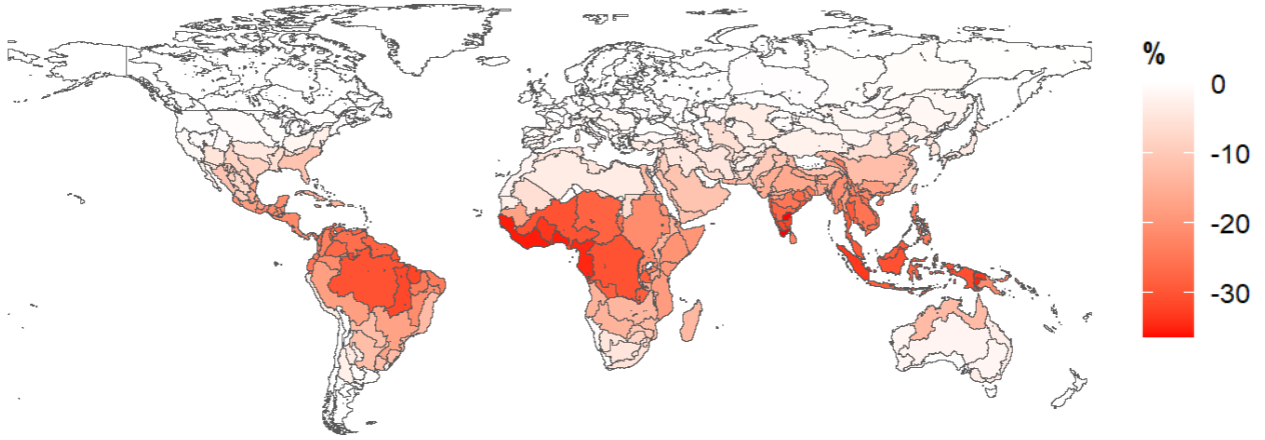
- By the end of century, **global mean crop yield** (weighted by initial land allocation) is projected to **decrease by 2.67%** with RCP 6.0

Change in Crop yield by Water Basin (HadGEM2-GEPIC)



- By the end of century, **global mean agricultural labor productivity** (weighted by initial labor allocation) **decline by 18%** with RCP 6.0
- Most **severe** impacts in **Southeast Asia** (27%), **Africa** (23%), and **South Asia** (20%)

Change in Labor Productivity by Water Basin due to Heat Stress



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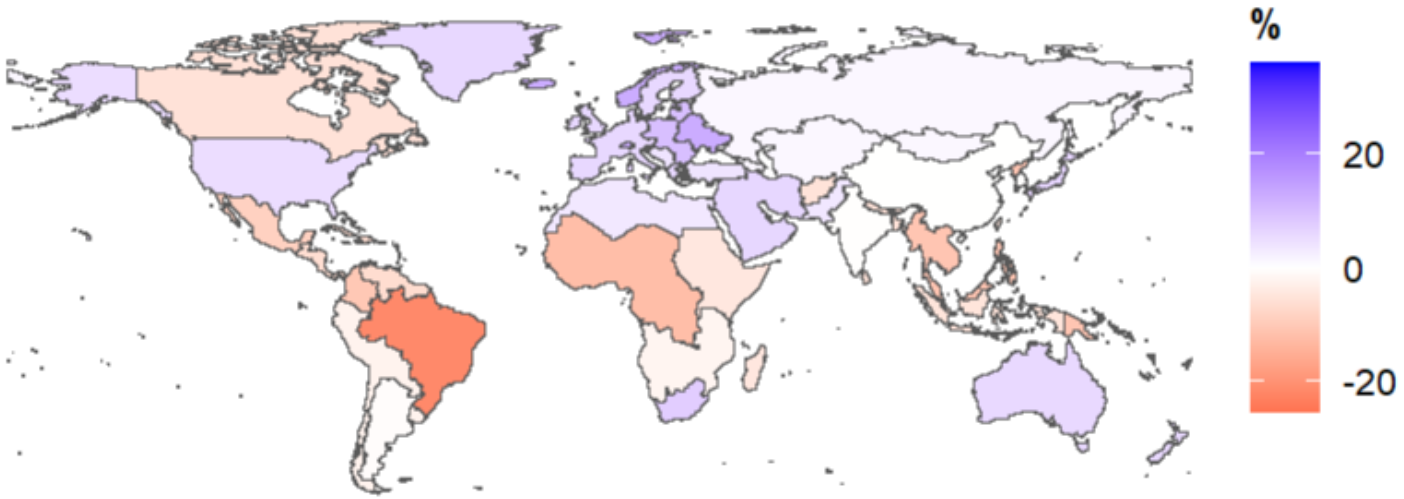
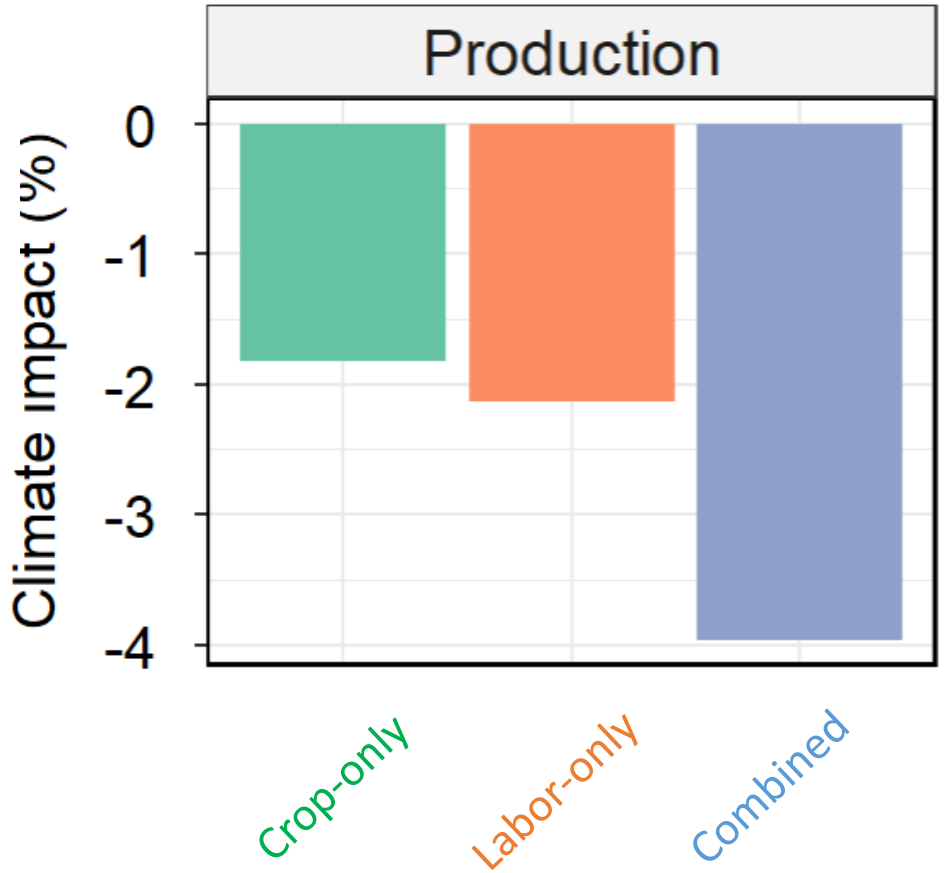
Combined Impacts on Major **Crop Production: 2100**

Regional Change: 2100



- Major crop production **shifts out from tropics** and **Canada**
- International trade alleviates climate impact on global major crop production

Global Aggregate Change: 2100



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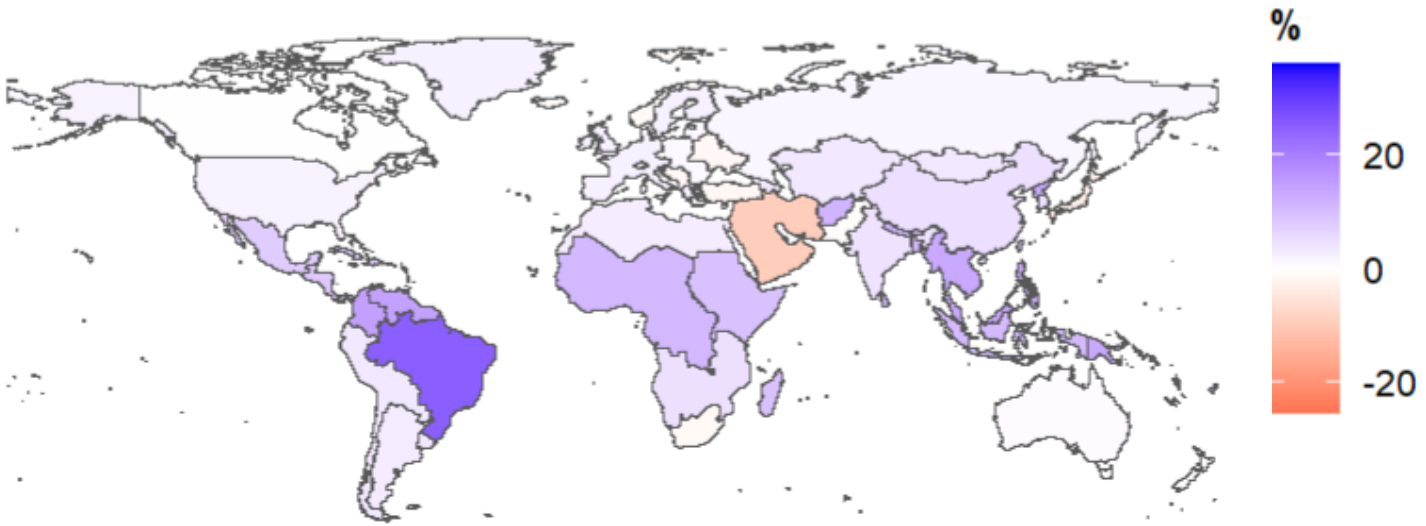
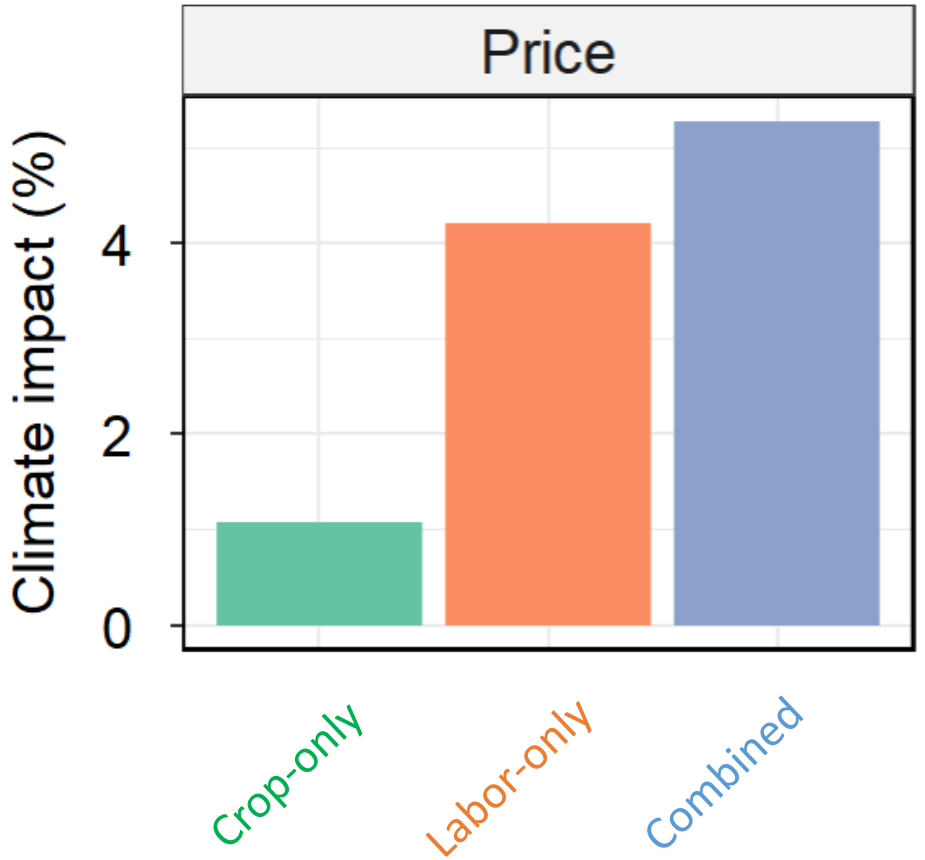
Combined Impacts on **Food Price: 2100**

Regional Change: 2100



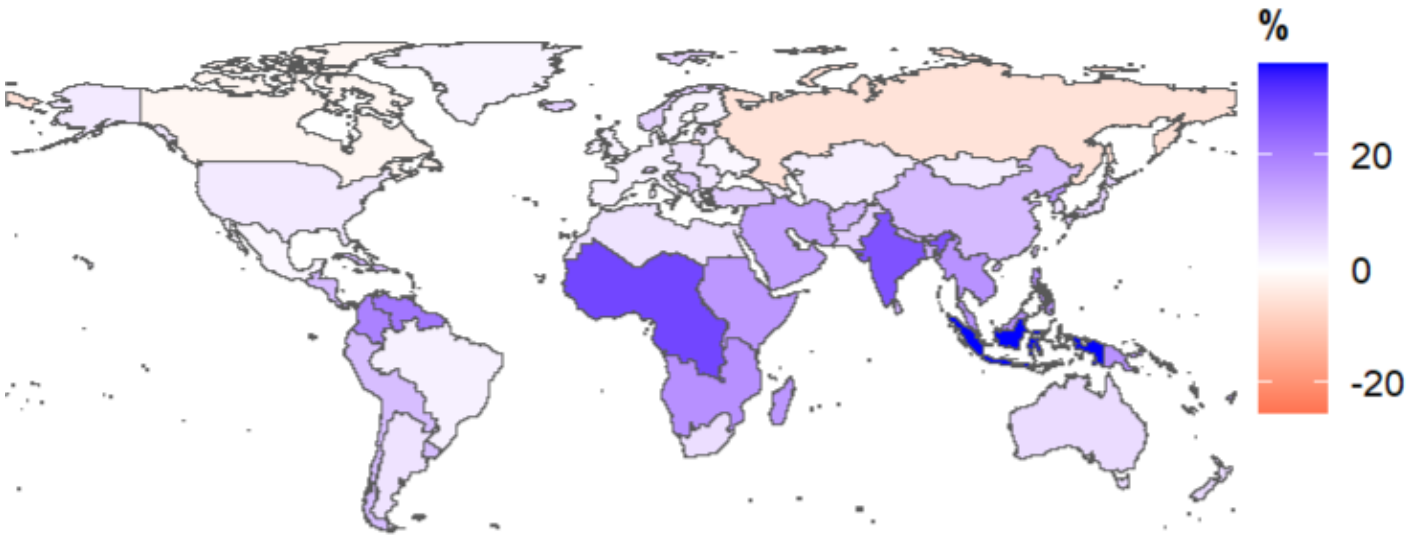
- **Food price increases** in most regions, except Middle East and South Africa

Global Aggregate Change: 2100



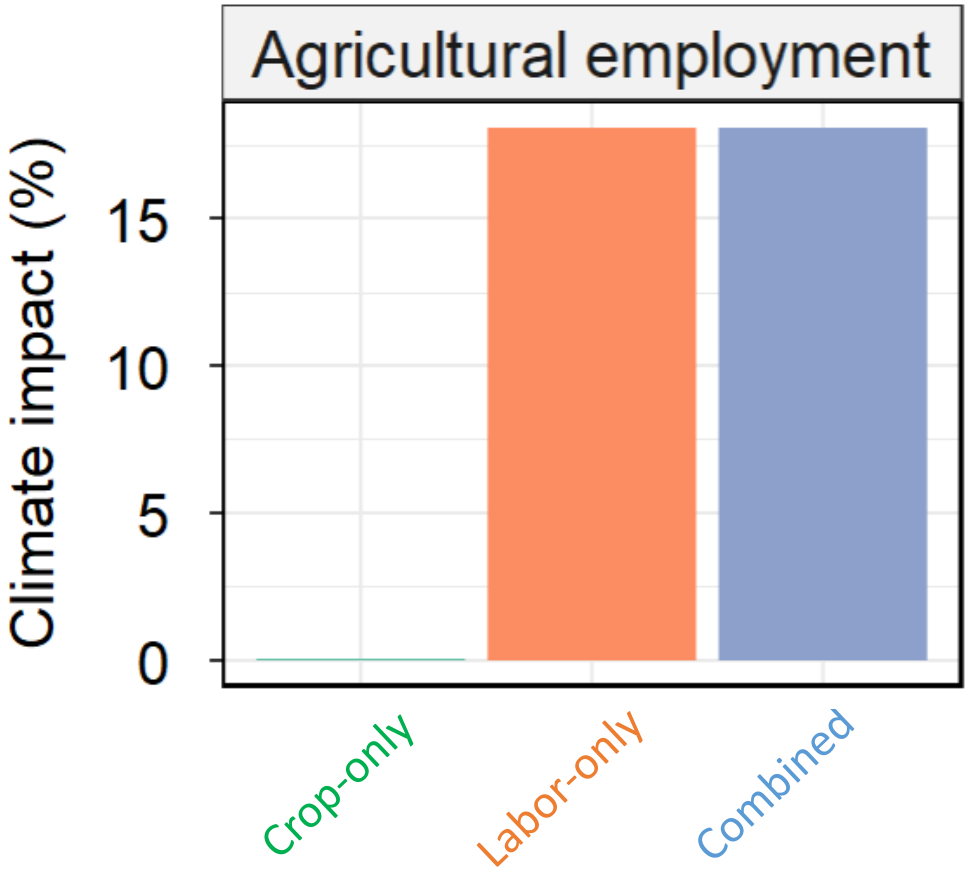
Combined Impacts on **Agricultural Employment: 2100**

Regional Change: 2100



- **Agricultural employment increases in most regions, except Canada (-2%) and Russia (-5%)**

Global Aggregate Change: 2100



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Including Heat Stress on Agricultural Labor

- **Is particularly acute in tropical regions**
- **Reduces global food production and increases global food prices**
- **Shifts workers into agriculture and out of the rest of the economy, particularly in the tropics**

Future work

Explore other climate scenarios

Region-specific labor-heat response functions

Include heat stress on livestock

Couple to the macroeconomy

Wednesday Poster Session

#029

Sheng et al. (2024)

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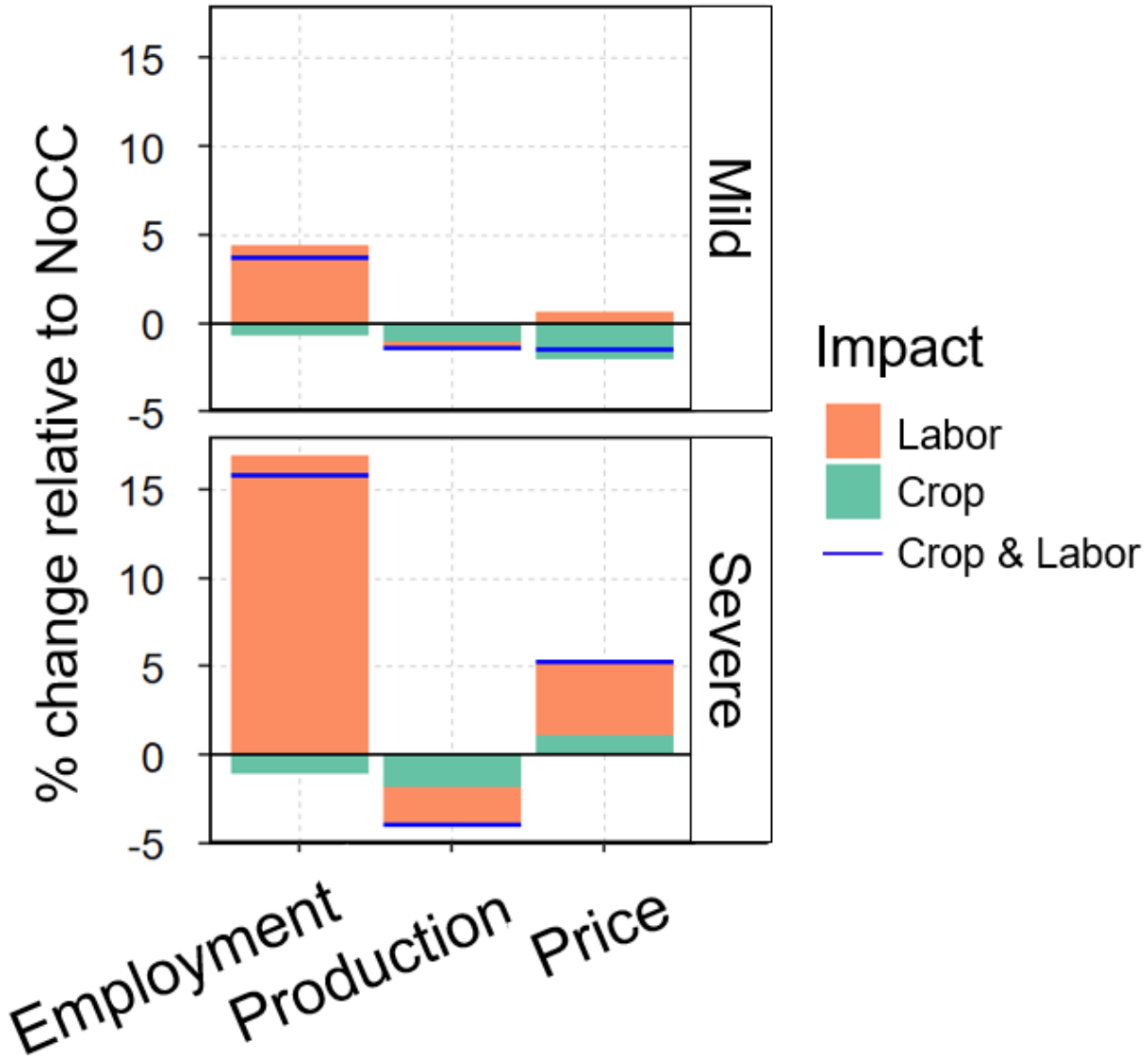
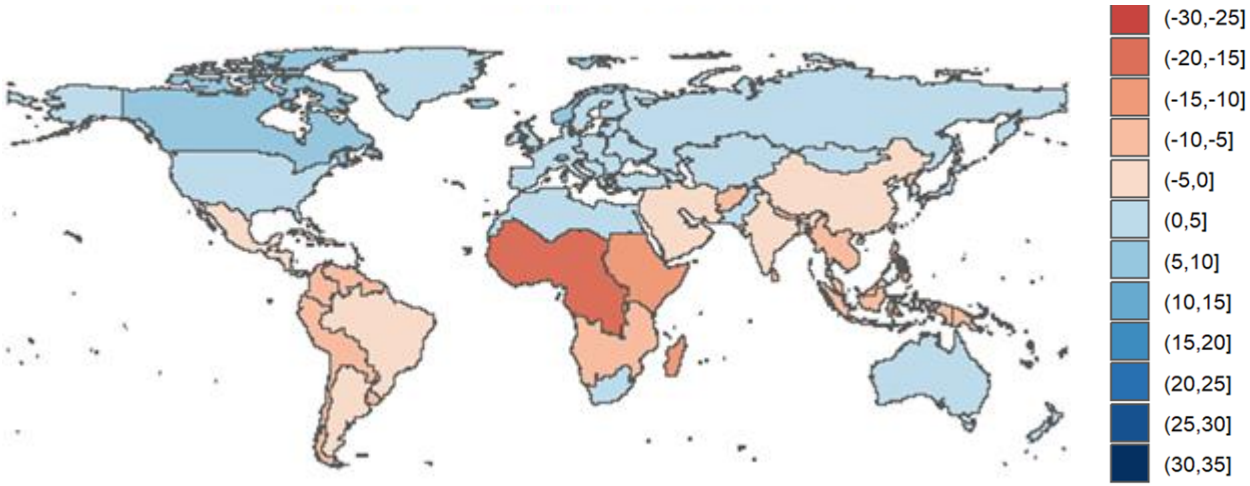
Severe vs Mild



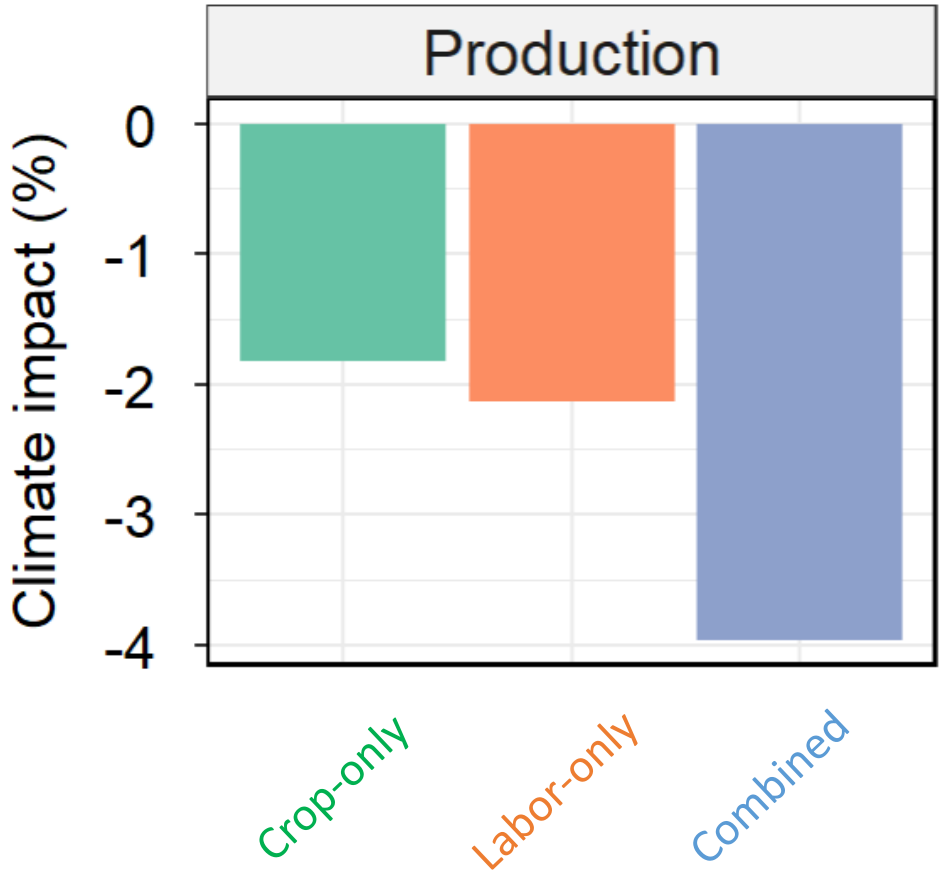
Climate Impacts on Major **Crop Production: 2100**

Regional Change due to Labor pathway: 2100



- **Major crop production shifts out from tropics**
- **International trade alleviates climate impact on global major crop production**

Global Aggregate Change: 2100



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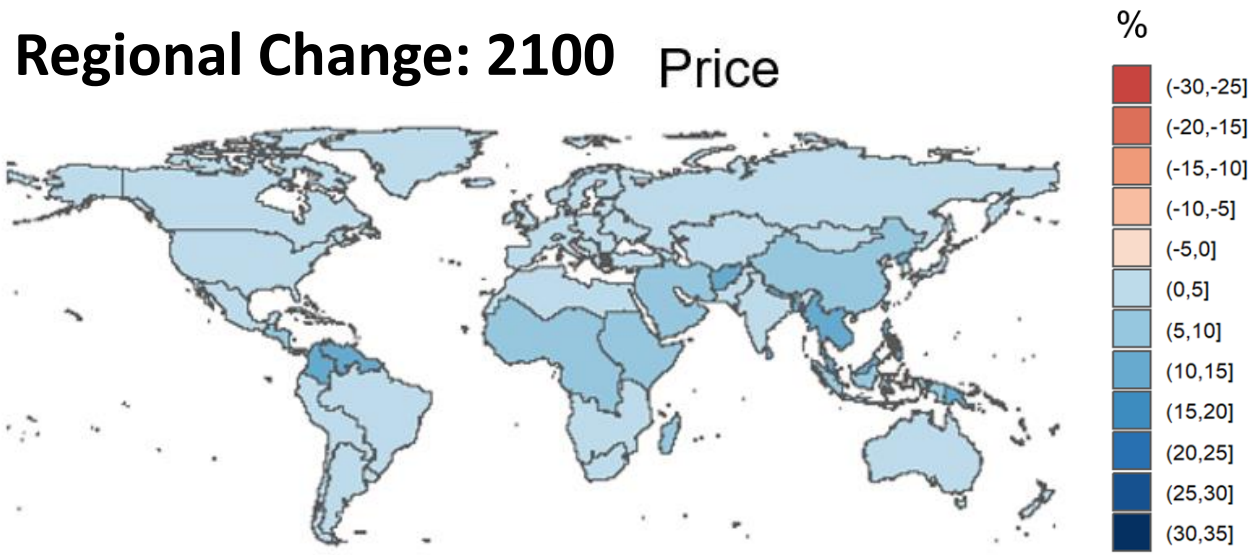
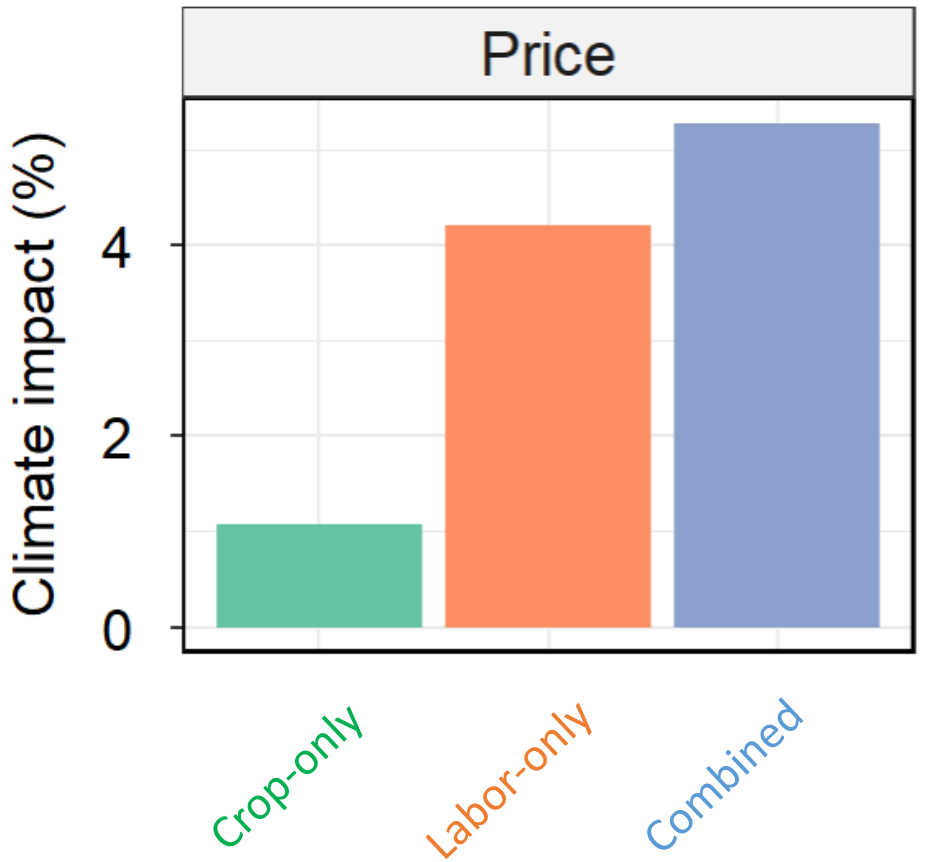
Combined Impacts on **Food Prices: 2100**

Regional Change: 2100



- **Food price increases across regions**

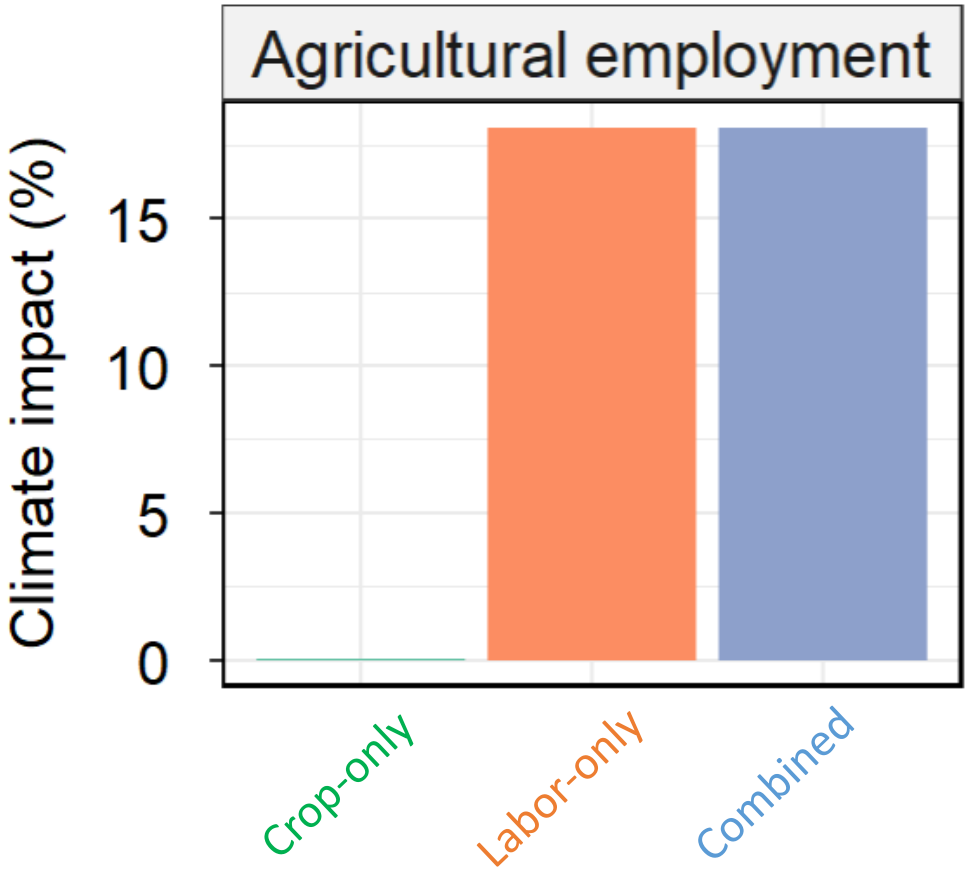
Global Aggregate Change: 2100



Climate Impacts on
Agricultural Employment: 2100

Regional Change due to Labor pathway: 2100

Global Aggregate Change: 2100



- **Agricultural employment increases across regions**

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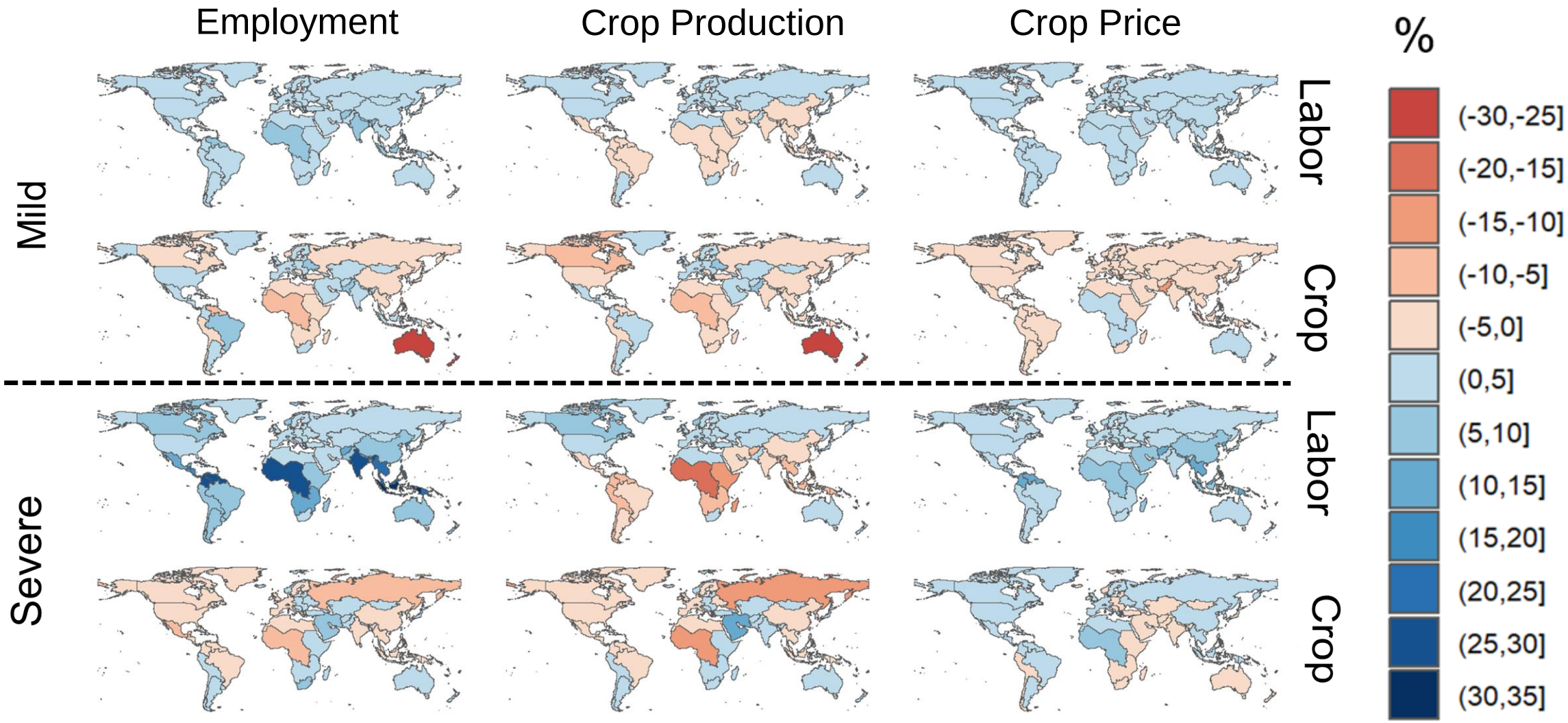
Comparisons across scenarios



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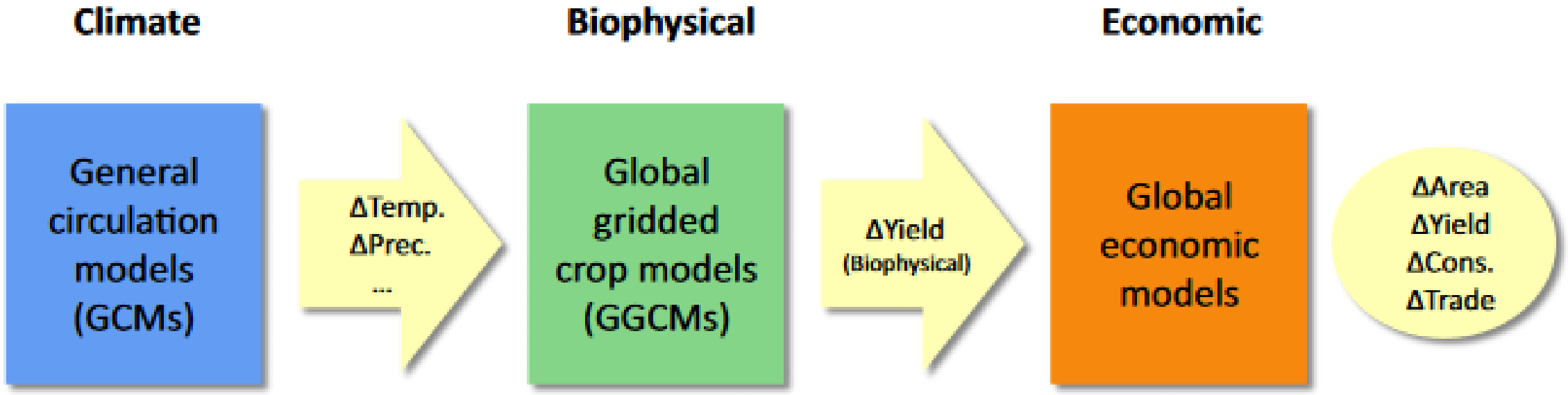
Incorporating Biophysical Responses in MSD



Source: Nelson et al. (2014)