Macroeconomic impact of agricultural Heat-Stress

Di Sheng, Xin Zhao, Jae Edmonds, Pralit Patel, Stephanie Morris

Pacific Northwest National Laboratory
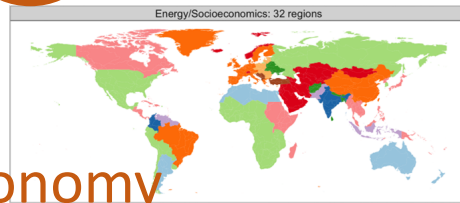
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DRAFT—Comments Welcome—Do not quote or cite
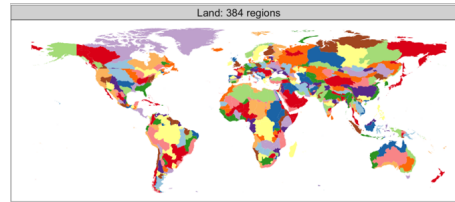
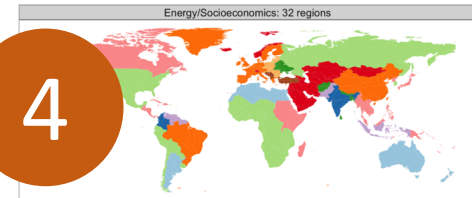# The Five Major Modules of GCAM

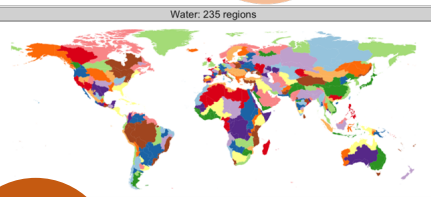**1** Energy
32 regions

2 Agriculture-Land-Use
384 regions
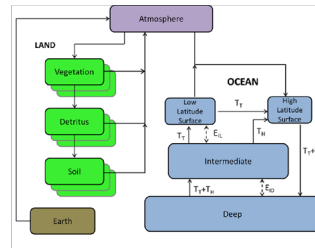
Macroeconomy

4

32 regions

Coupled in Code

3 Water
235 regions

**5** Physical Earth Systems
Global

GCAM Characteristics

- Economic model—supplies and demands in markets are equilibrated by prices

- Dynamic-recursive, (NOT optimization).

- Simultaneously resolves **energy**, **land**, **water**, and **economic** markets, and **physical Earth systems** **it solves in a single unified code**.

- The macroeconomy is in general equilibrium

- **Hierarchical Model**
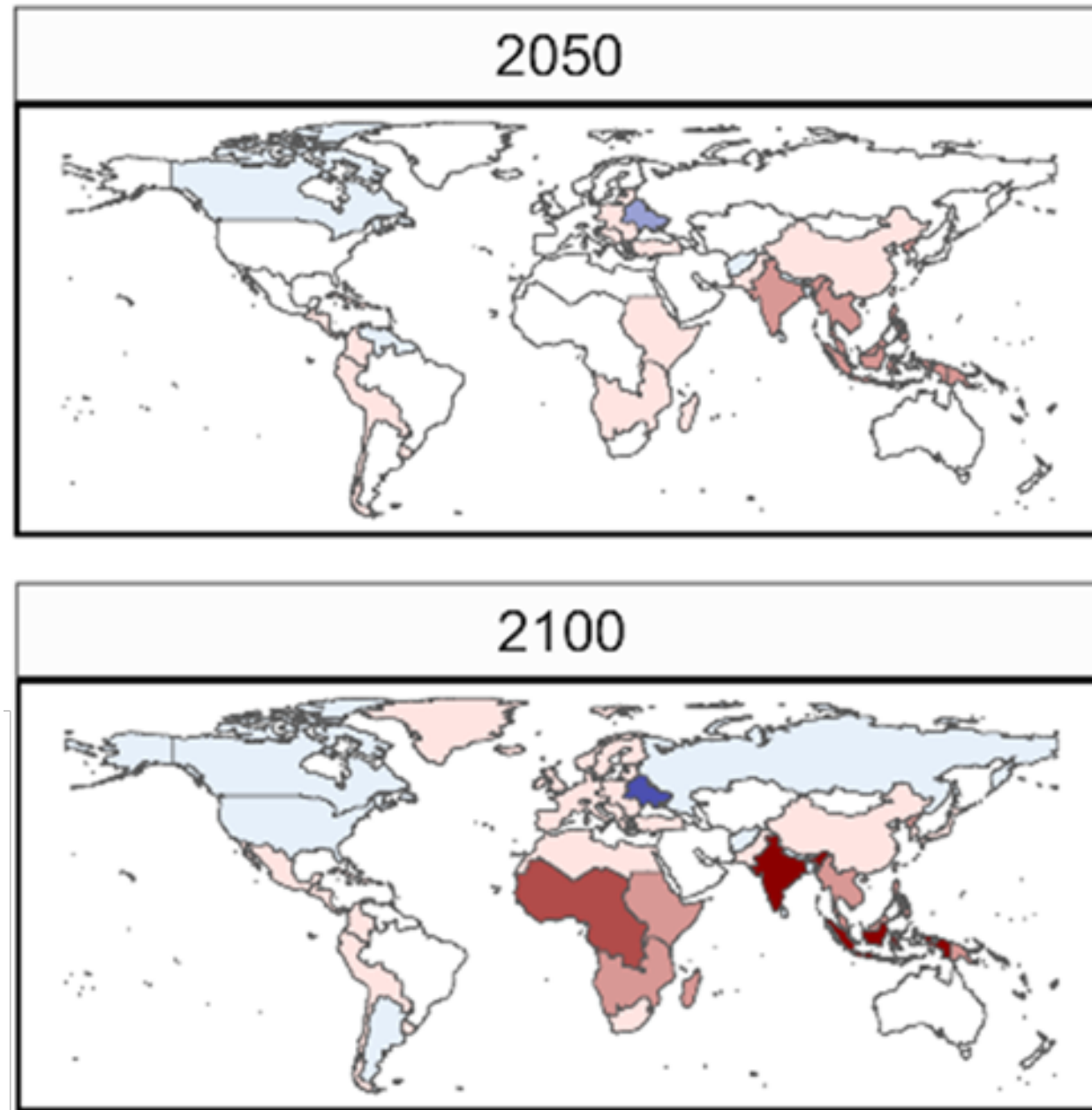
Approach to Modeling Agricultural Heat-Stress
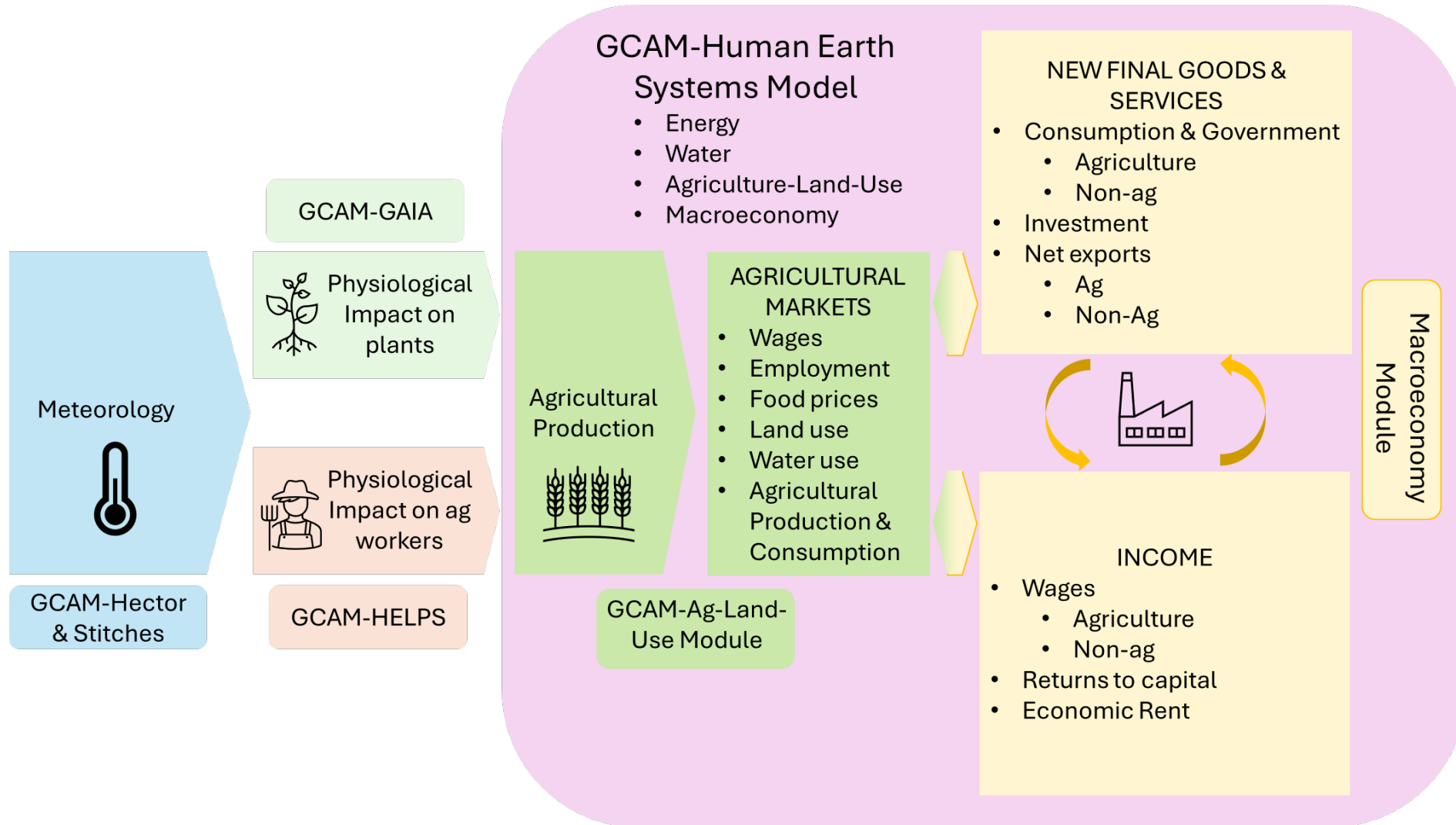
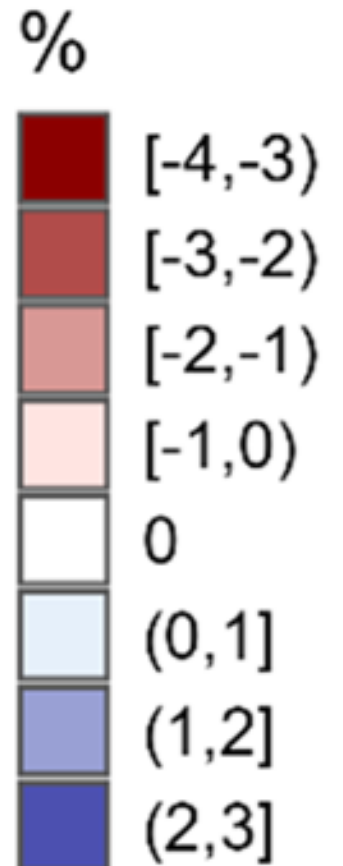# Biophysical shock in labor productivity and crop yield in 2100
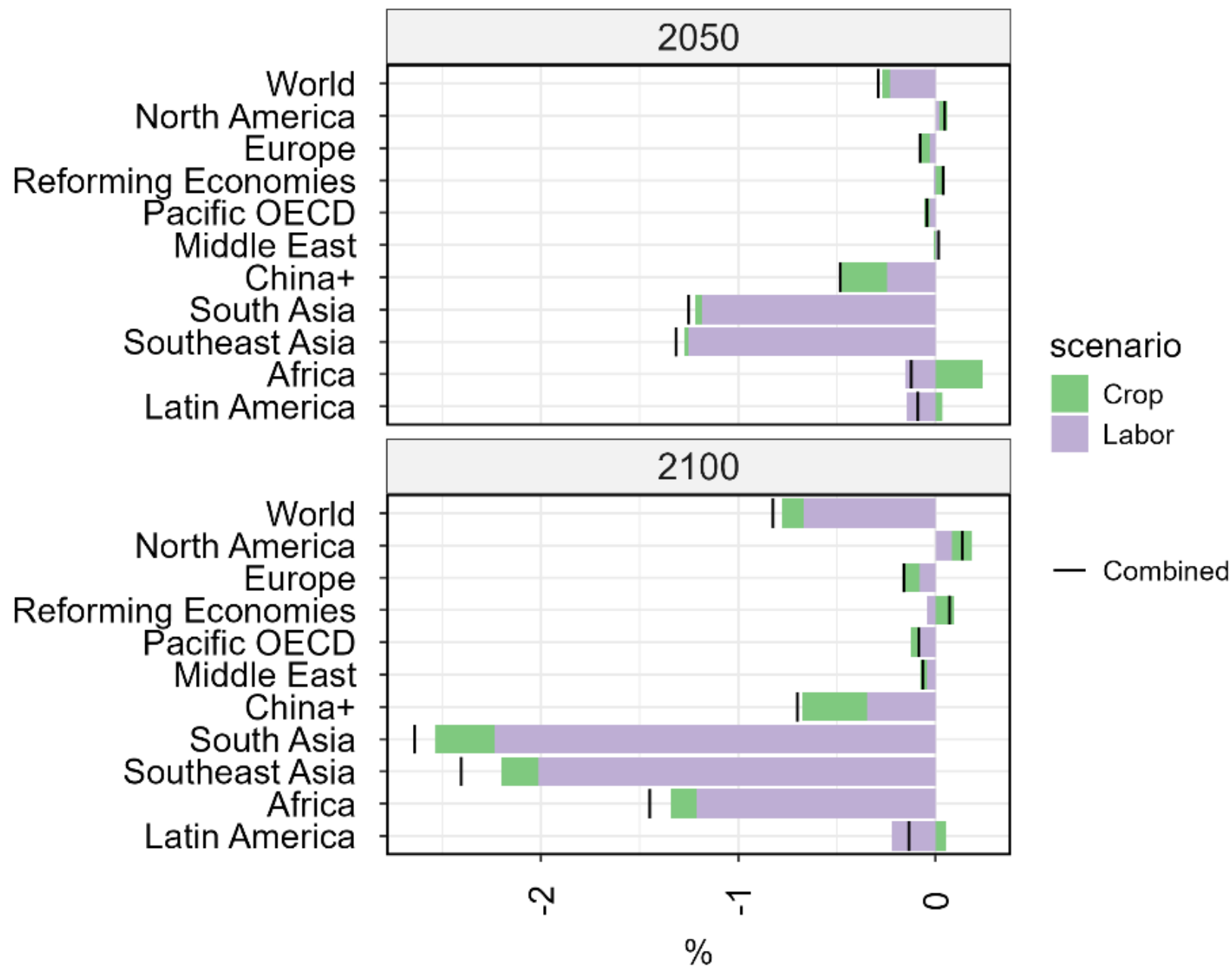
$
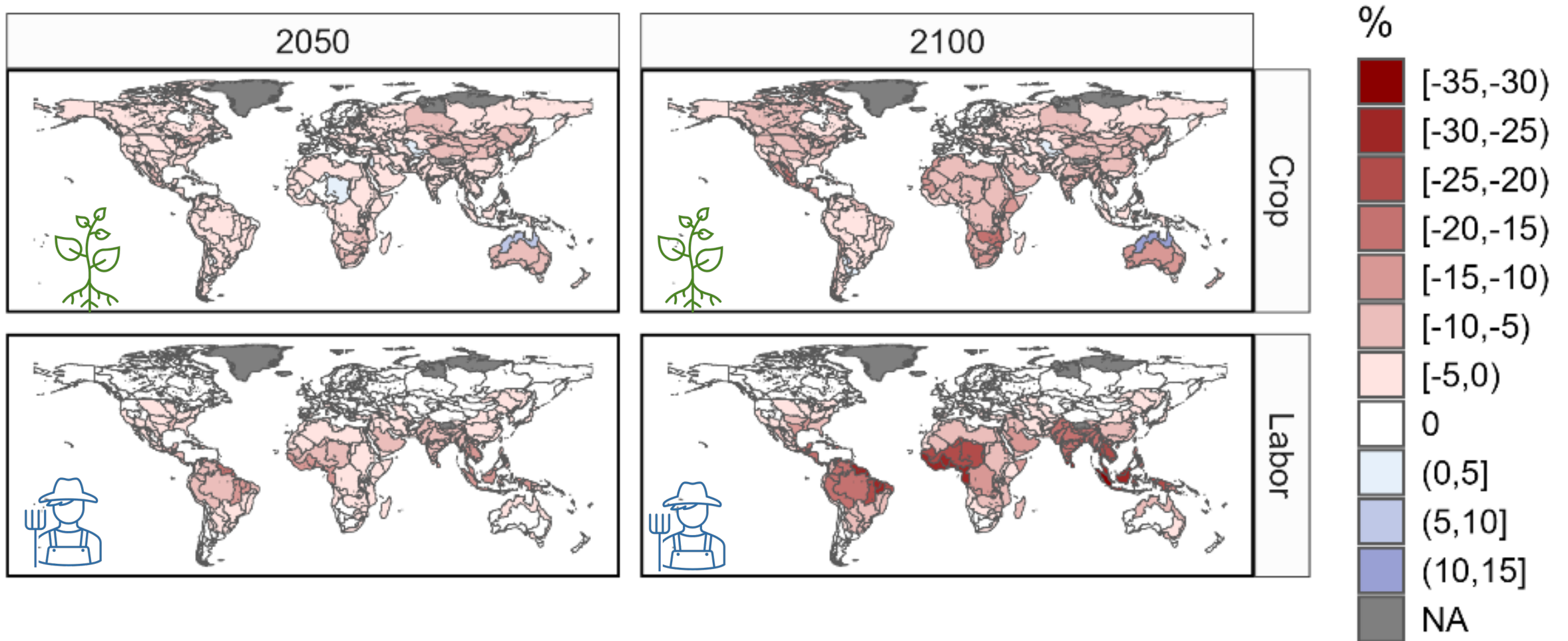
Relative changes in GDP (Ref=0) in 2100
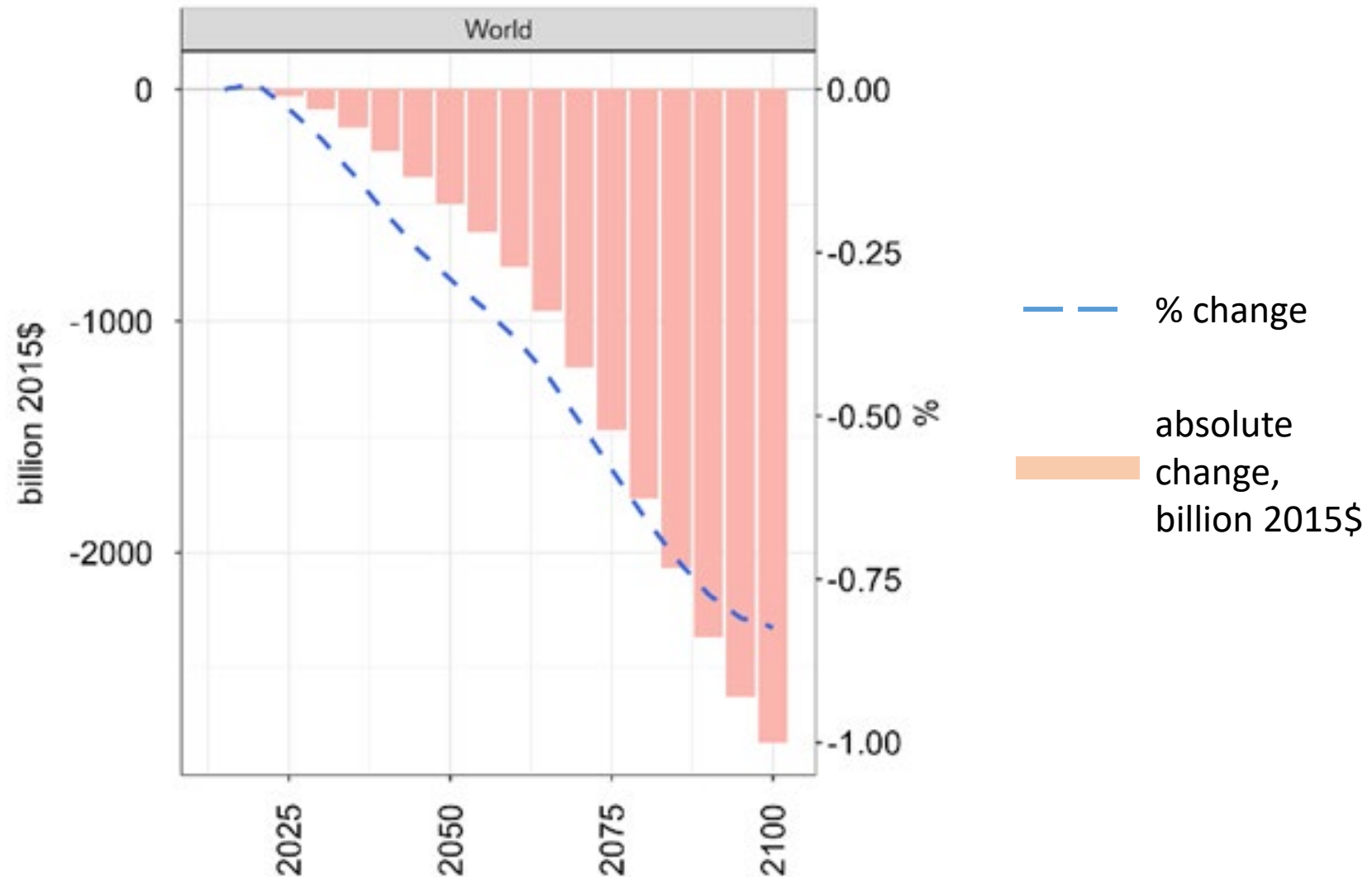
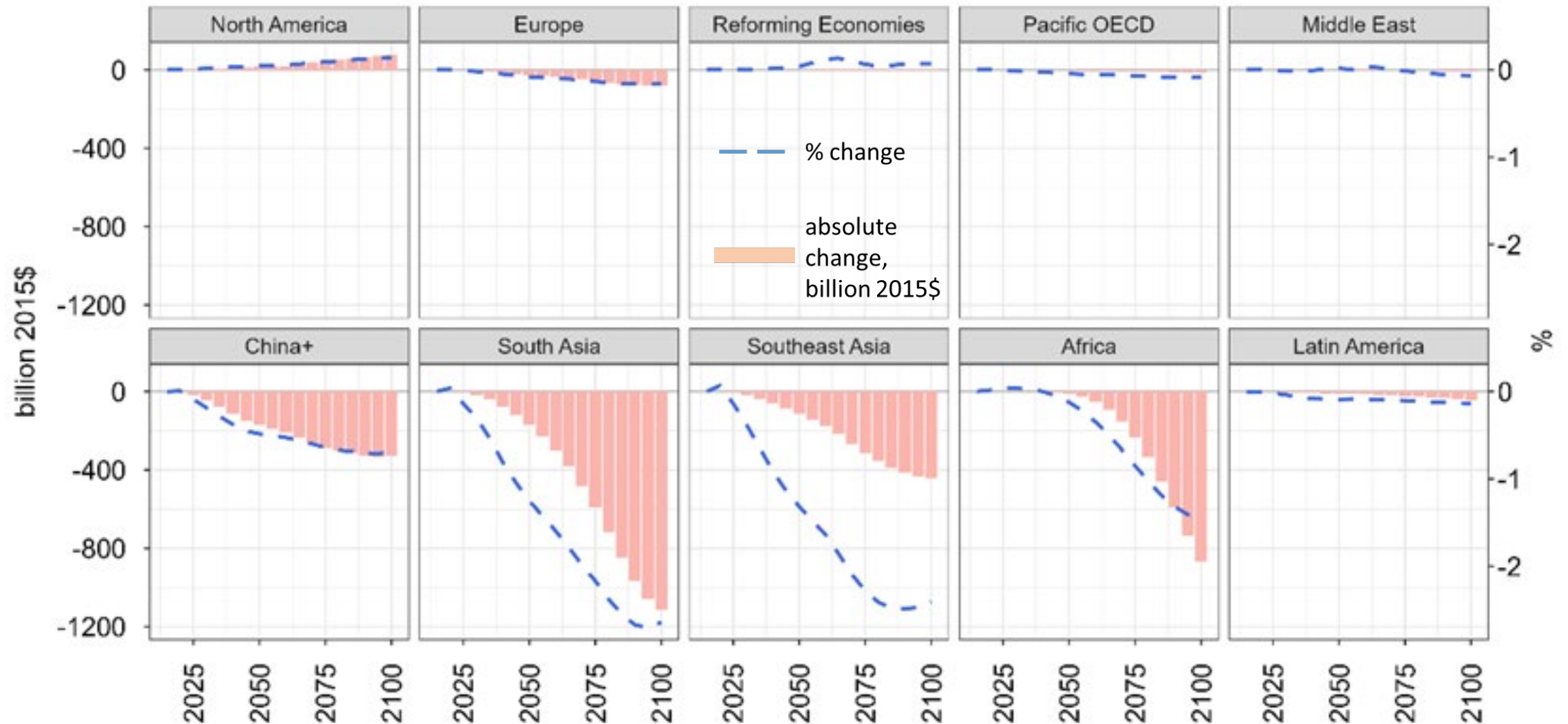GDP response through alternative heat stress pathways: Crops, Labor

Relative and absolute changes (Ref = 0) in GDP over time
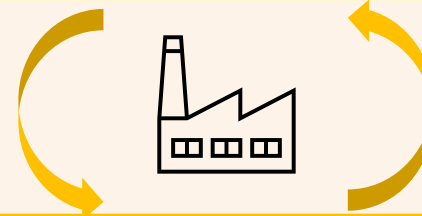
Relative and absolute changes (Ref = 0) in GDP over time

Decomposition of absolute GDP changes: Factor Rewards
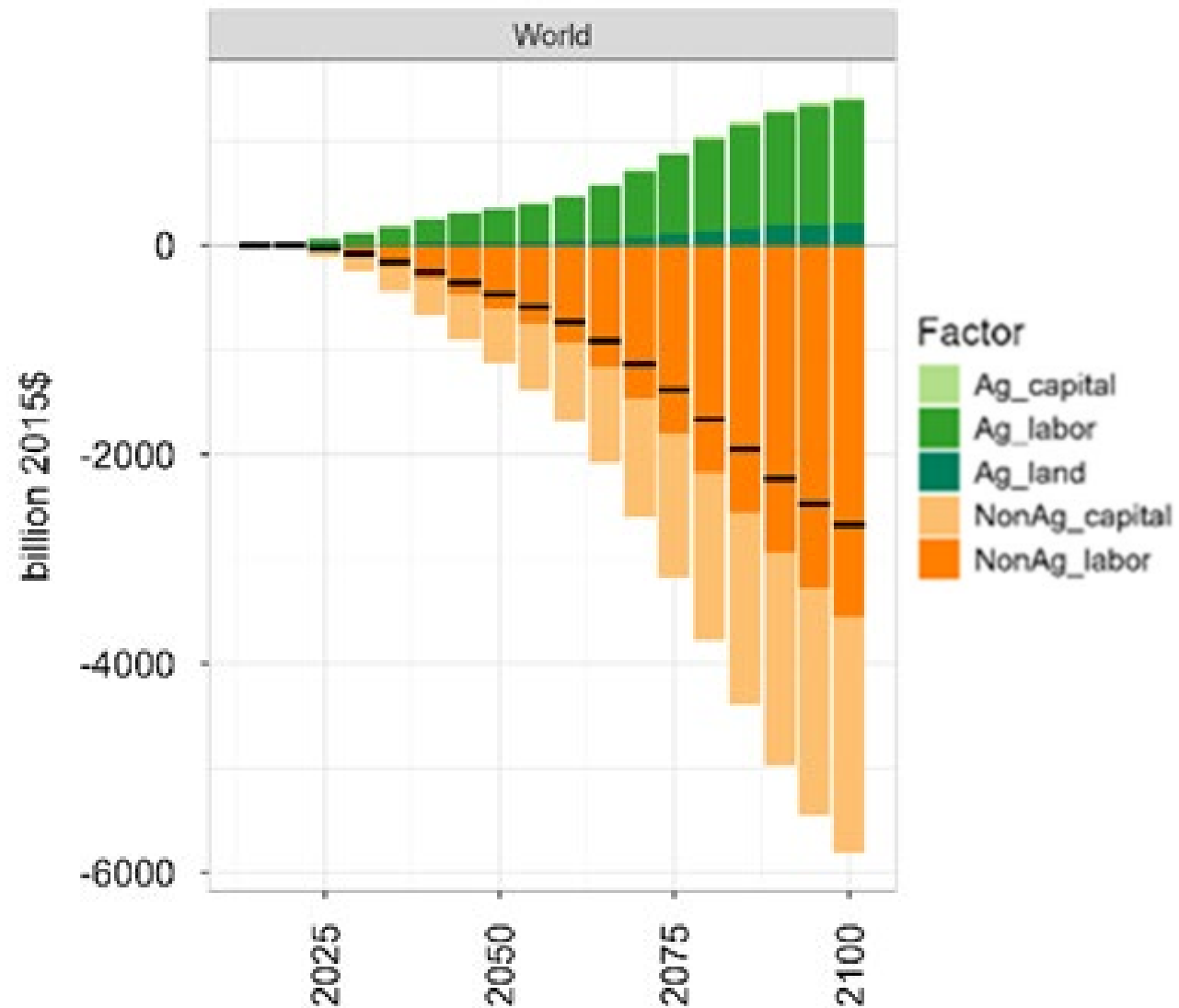
NEW FINAL GOODS & SERVICES
- Consumption & Government
  - Agriculture
  - Non-ag
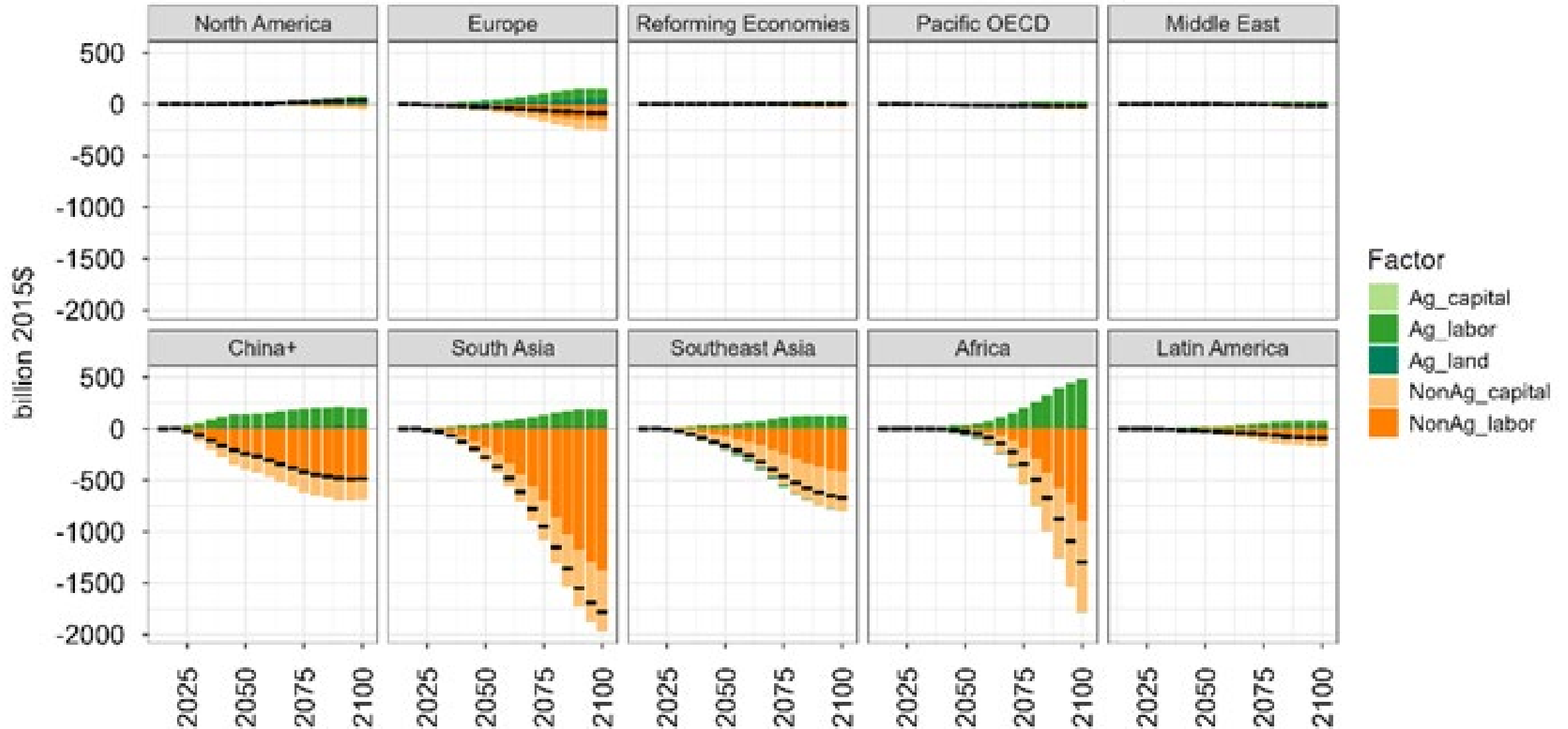- Investment
- Net exports
  - Ag
  - Non-Ag

FACTOR REWARDS
- Wages
  - Agriculture
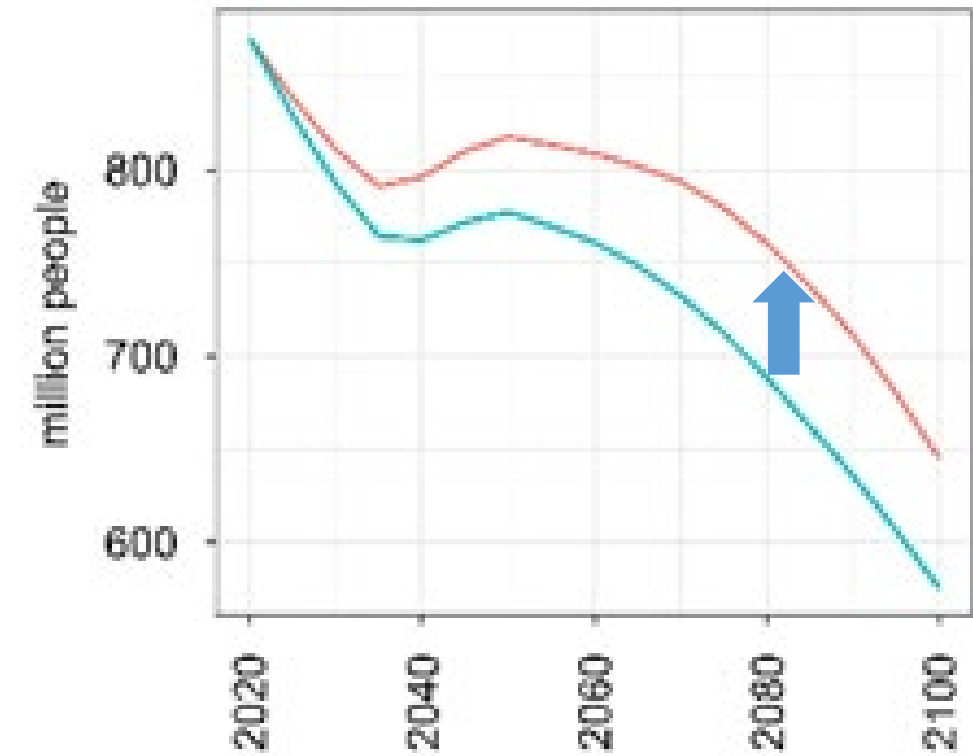 - Non-ag
- Returns to capital
- Economic Rent

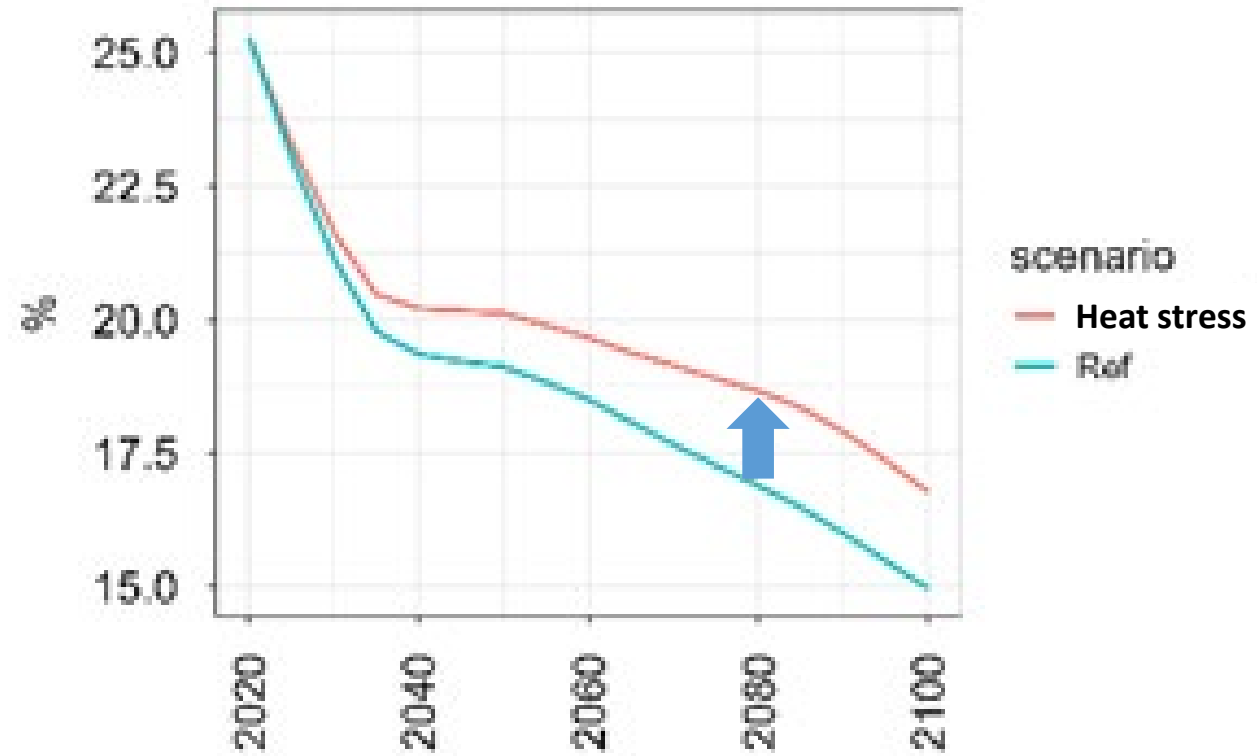# Decomposition of absolute global GDP changes:
Factor Reward Approach

Decomposition of absolute regional GDP changes: Factor Reward Approach

Global agricultural labor
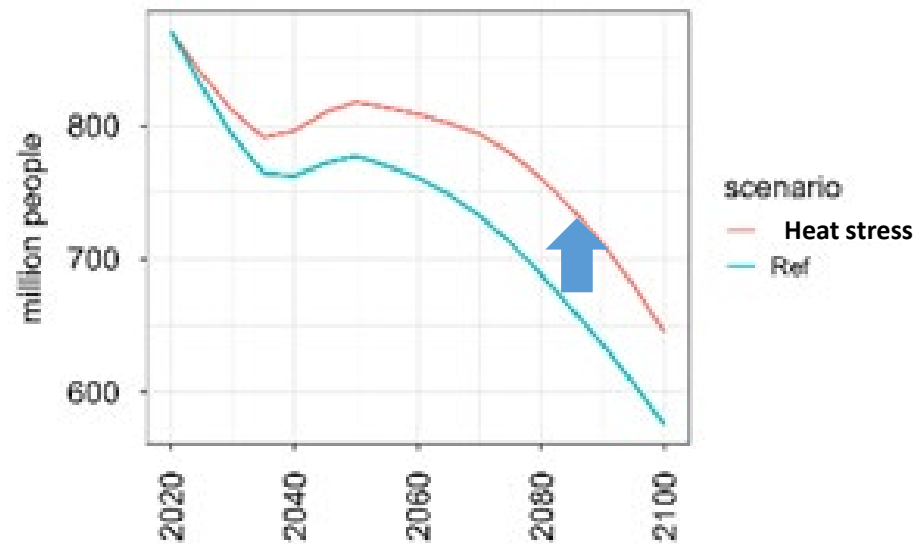
Absolute changes in agricultural labor
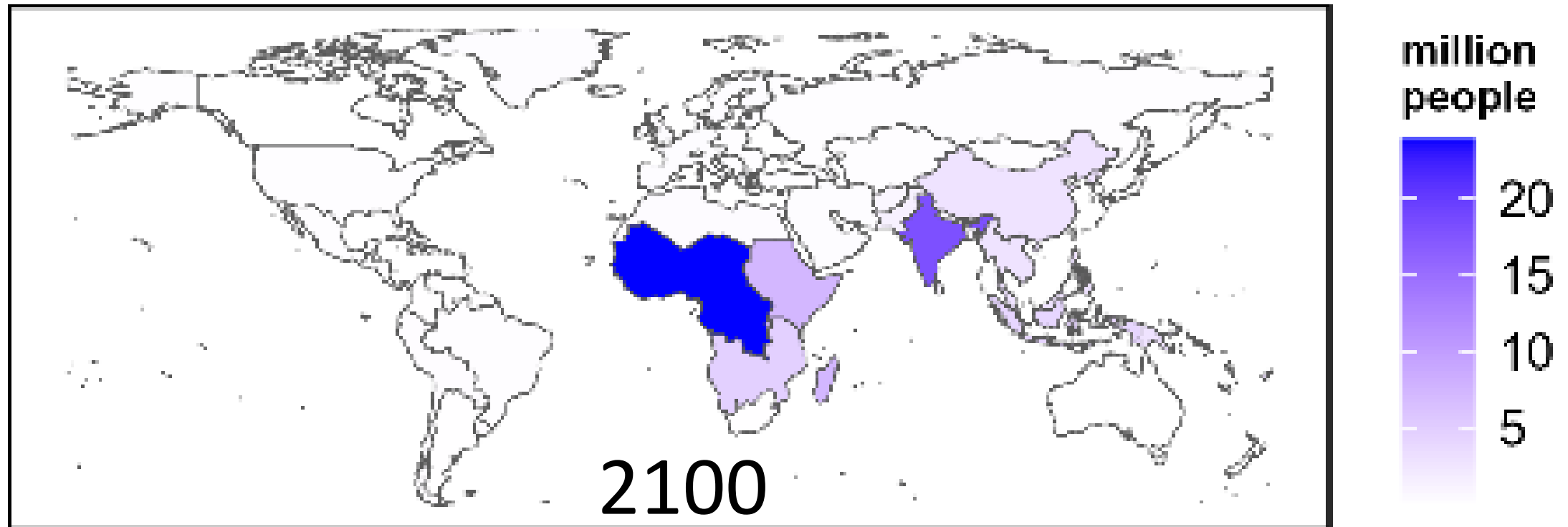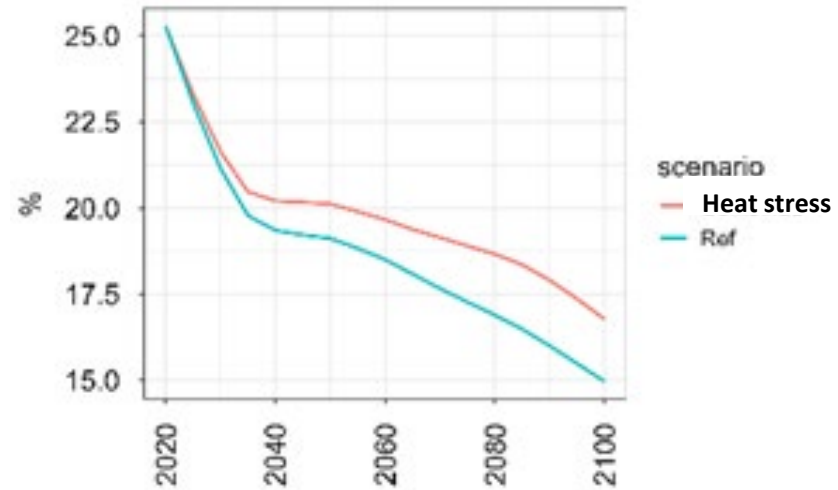
Changes in the agricultural labor share of the total labor force

2100
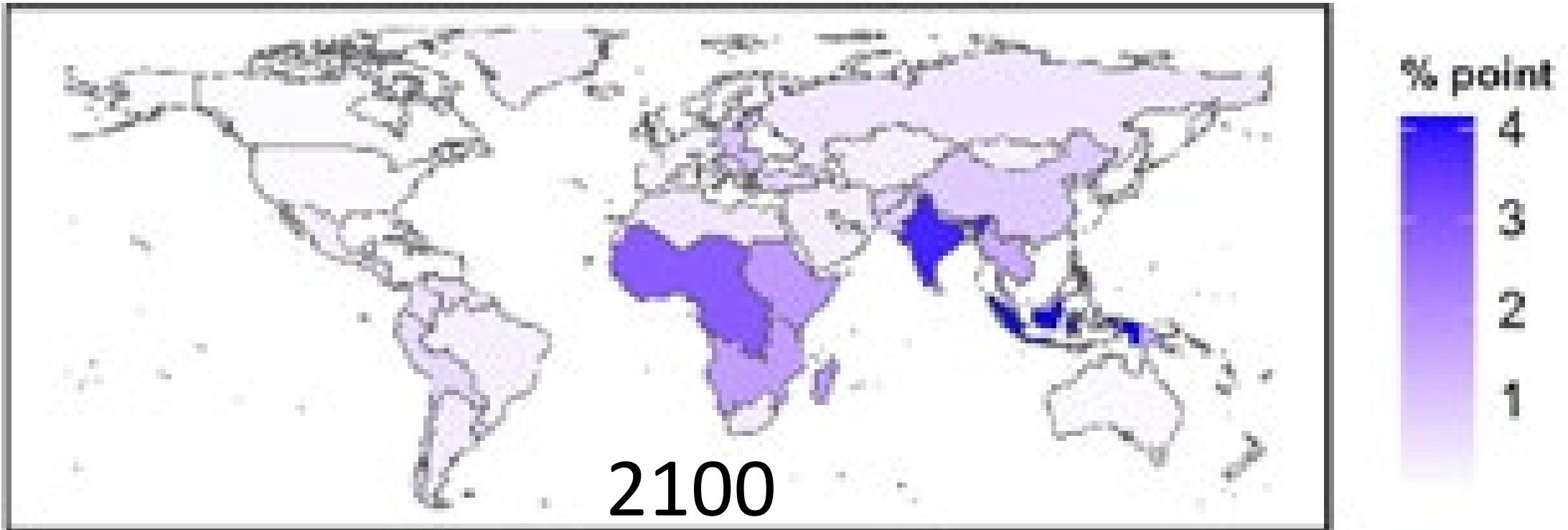
Relative changes in total return to labor from heat stress
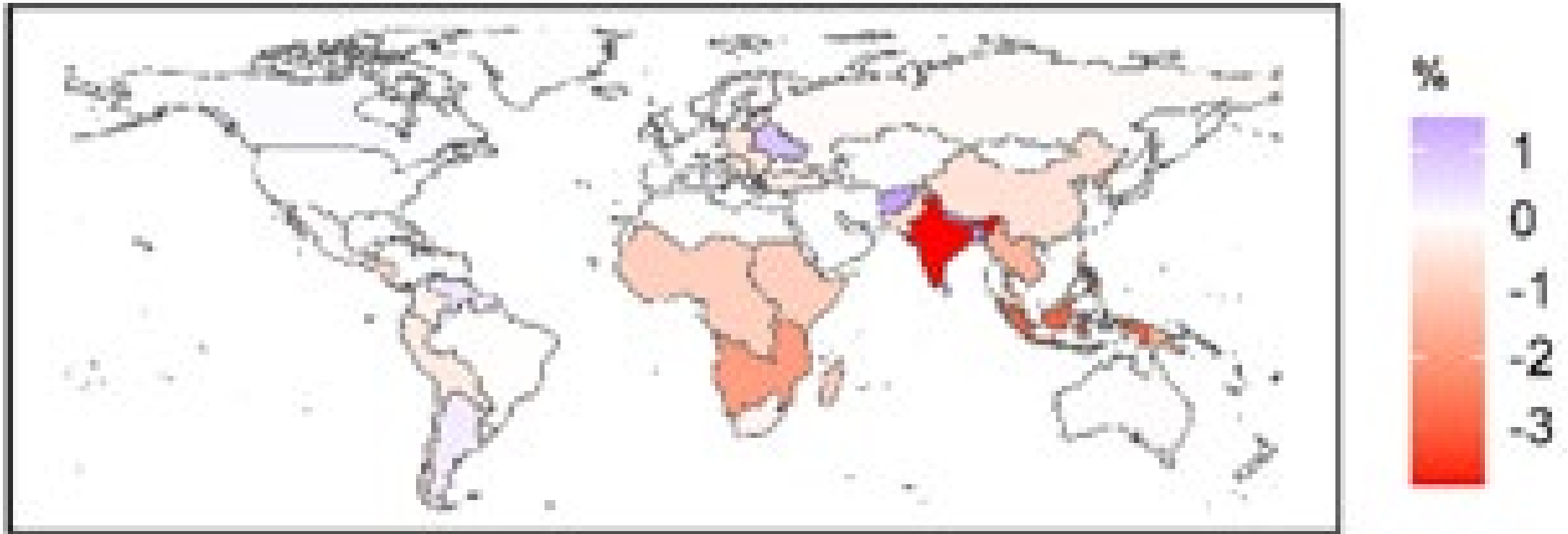
Absolute land use change due to heat stress
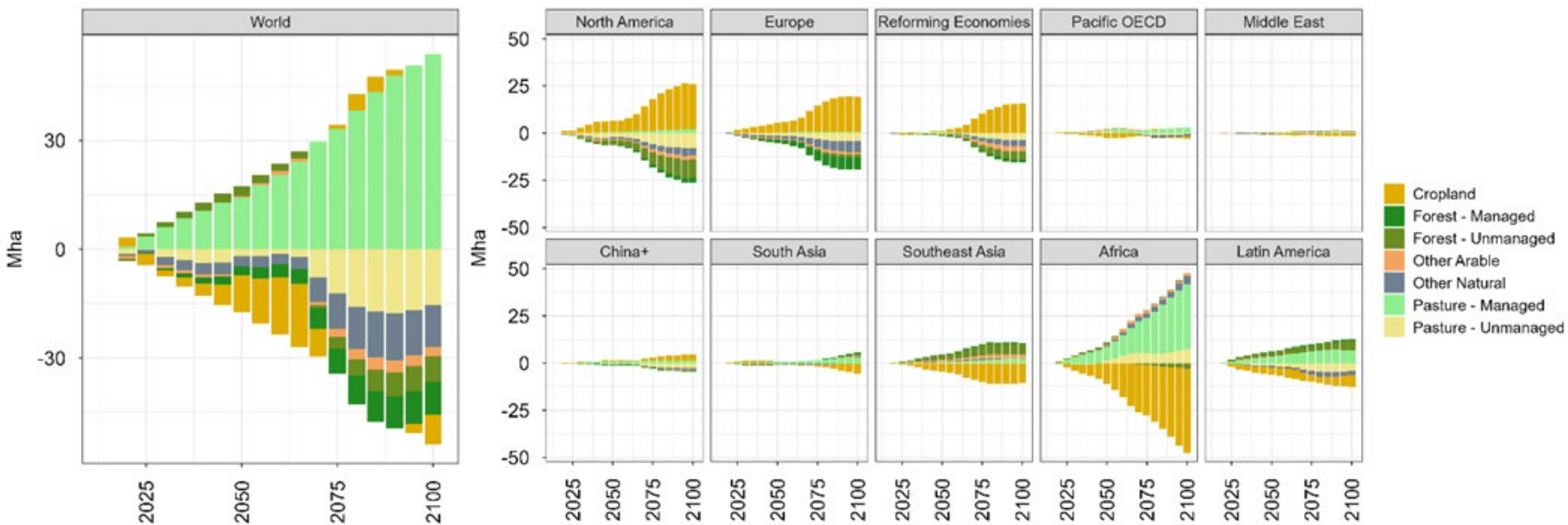
Relative changes in cropland due to heat stress
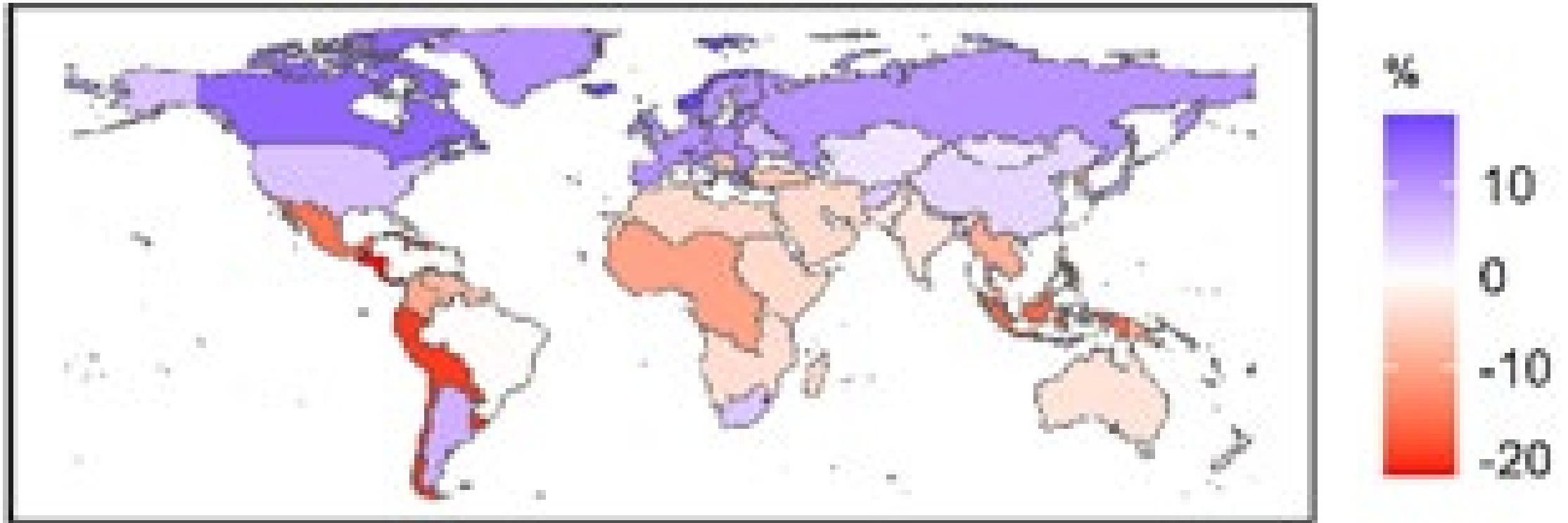
Decomposition of absolute GDP changes: New, Final Goods & Services

NEW FINAL GOODS & SERVICES
Consumption & Government
- Agriculture
- Non-ag

   Investment

   Net exports
- Ag
- Non-Ag
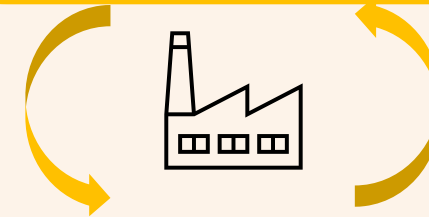
FACTOR REWARDS
- Wages

   Agriculture

   Non-ag
- Returns to capital
- Economic Rent

Decomposition of absolute GDP changes the composition of new, final goods and services due to heat stress

Relative changes in agricultural market outcomes

Relative changes in agricultural trade outcomes

Absolute changes in agricultural trade volume
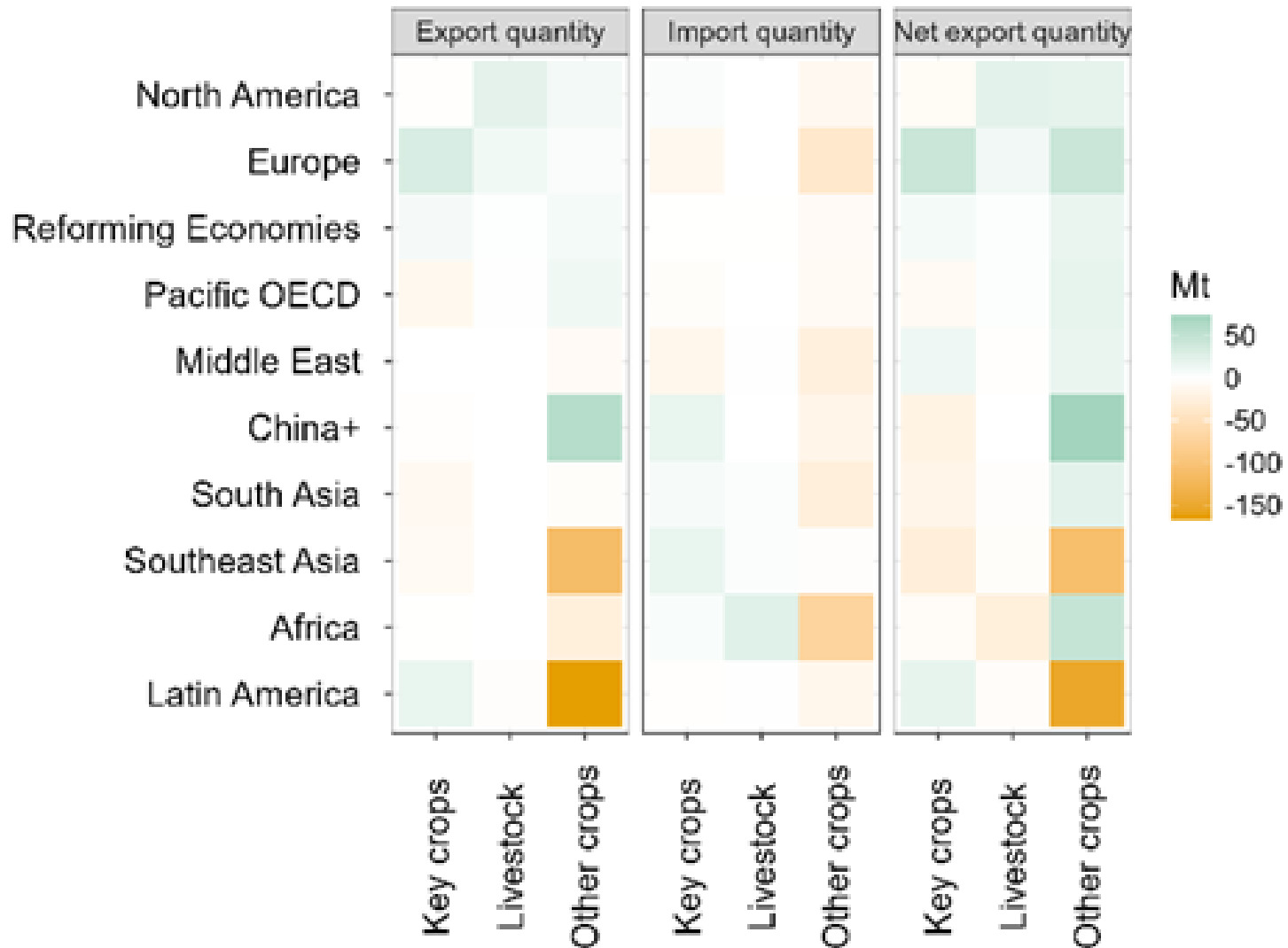
Absolute changes in agricultural trade value
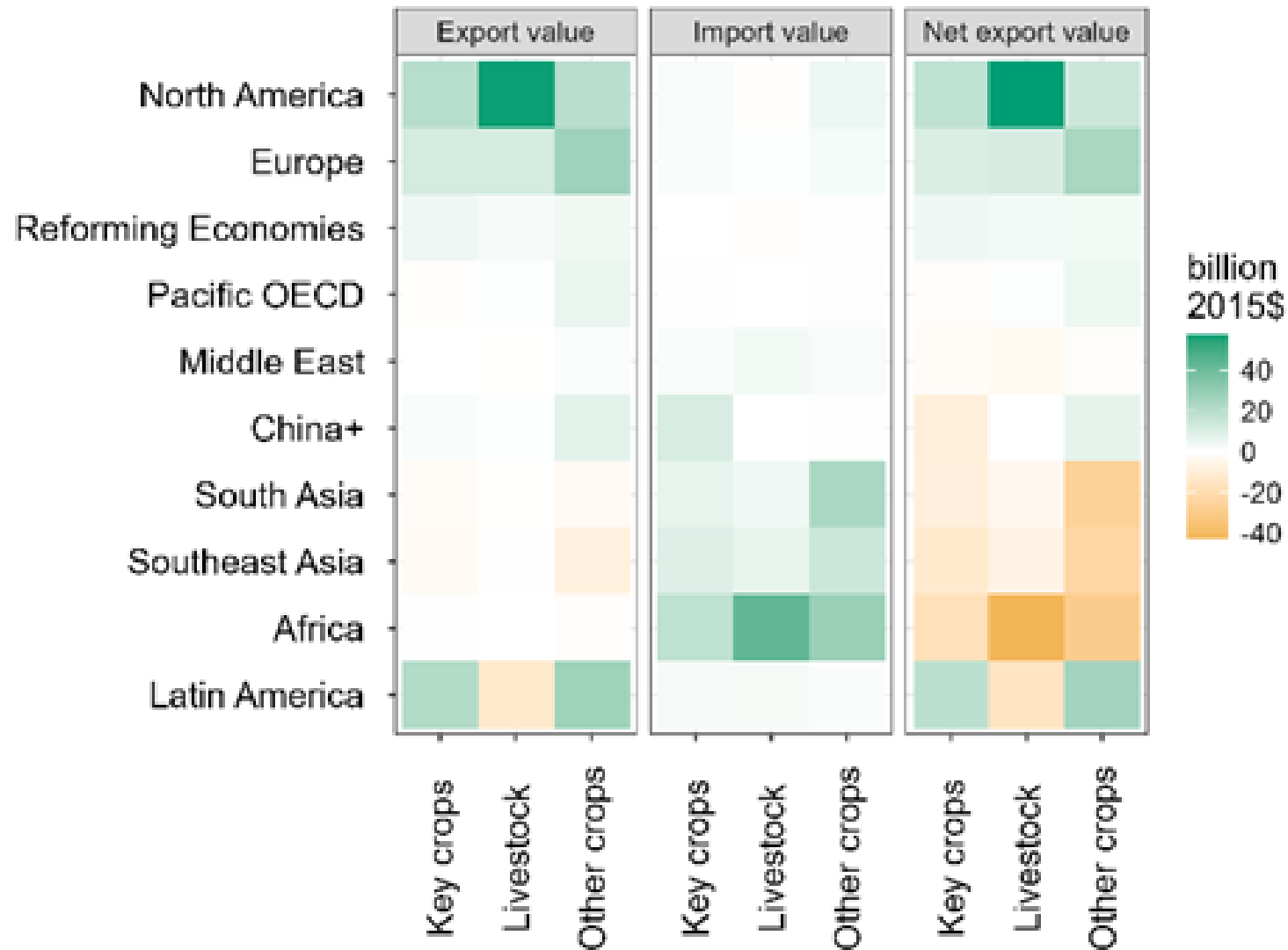
Key Findings

- Agricultural Heat Stress reduces Global GDP and disproportionately in tropical regions.
- The preponderance of GDP loss comes through lost agricultural labor productivity.
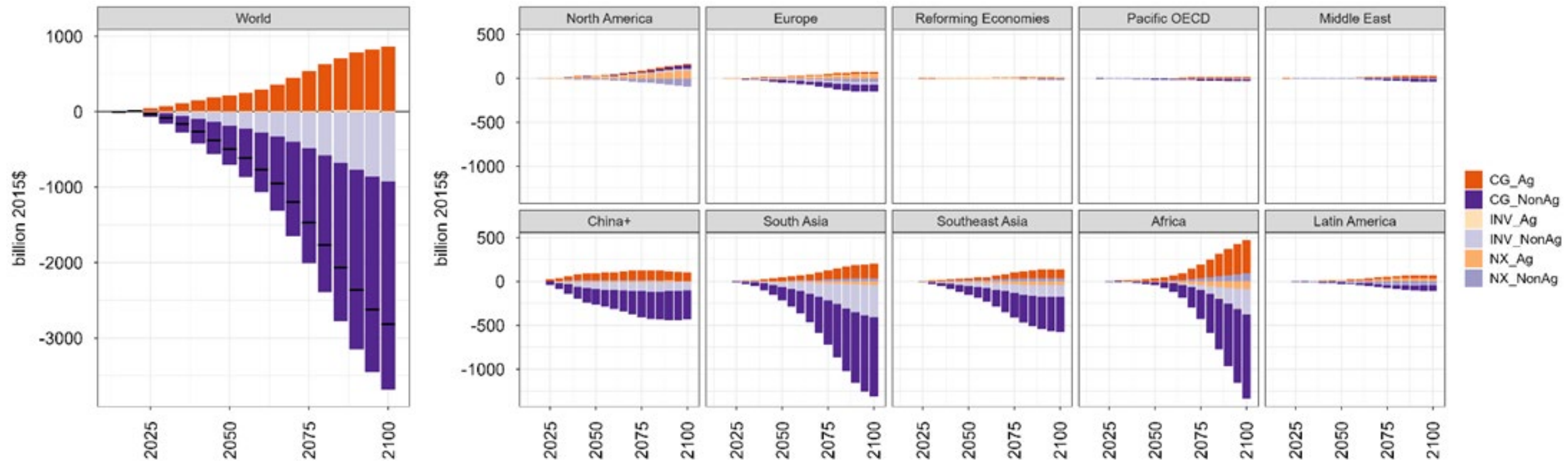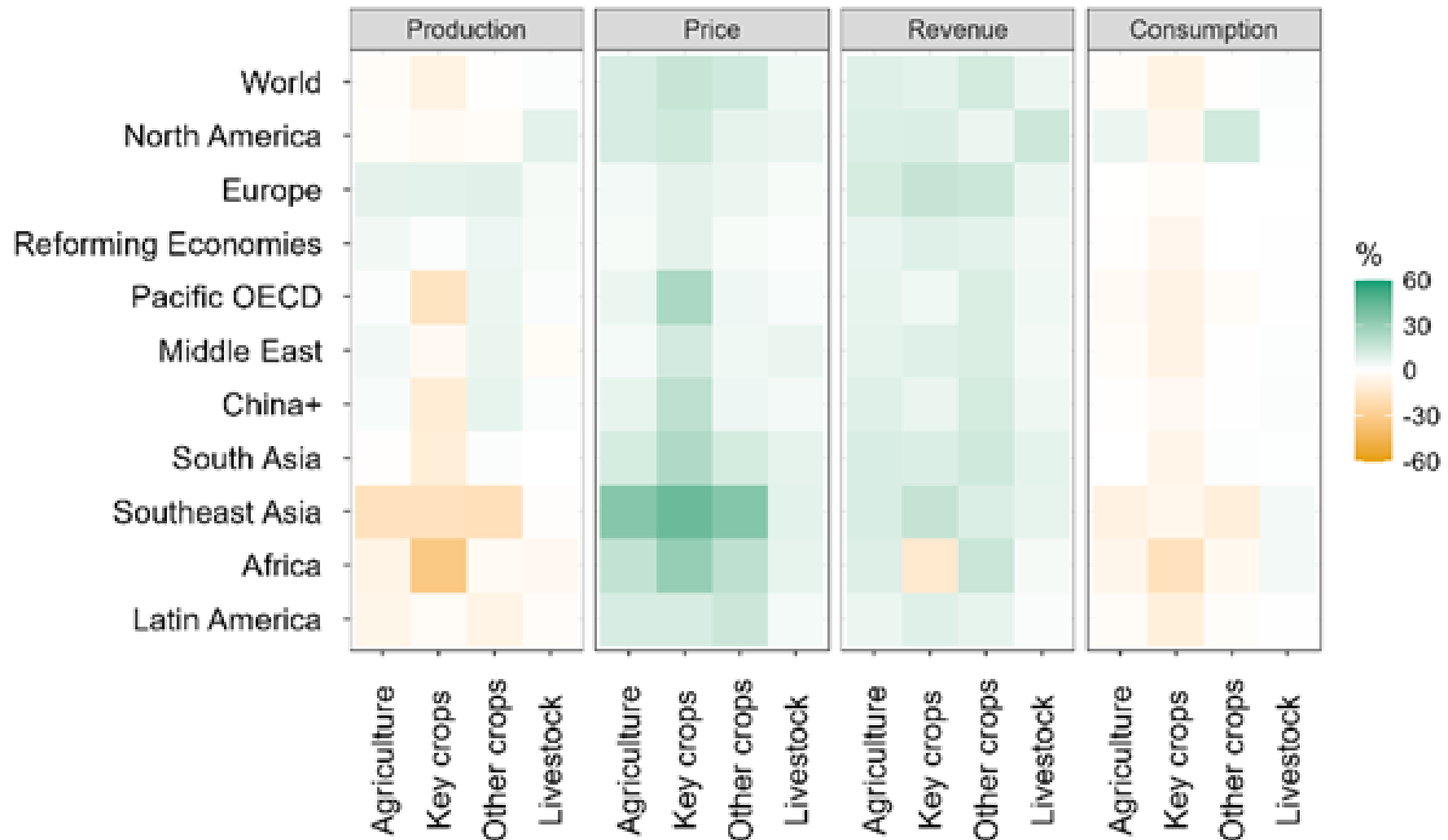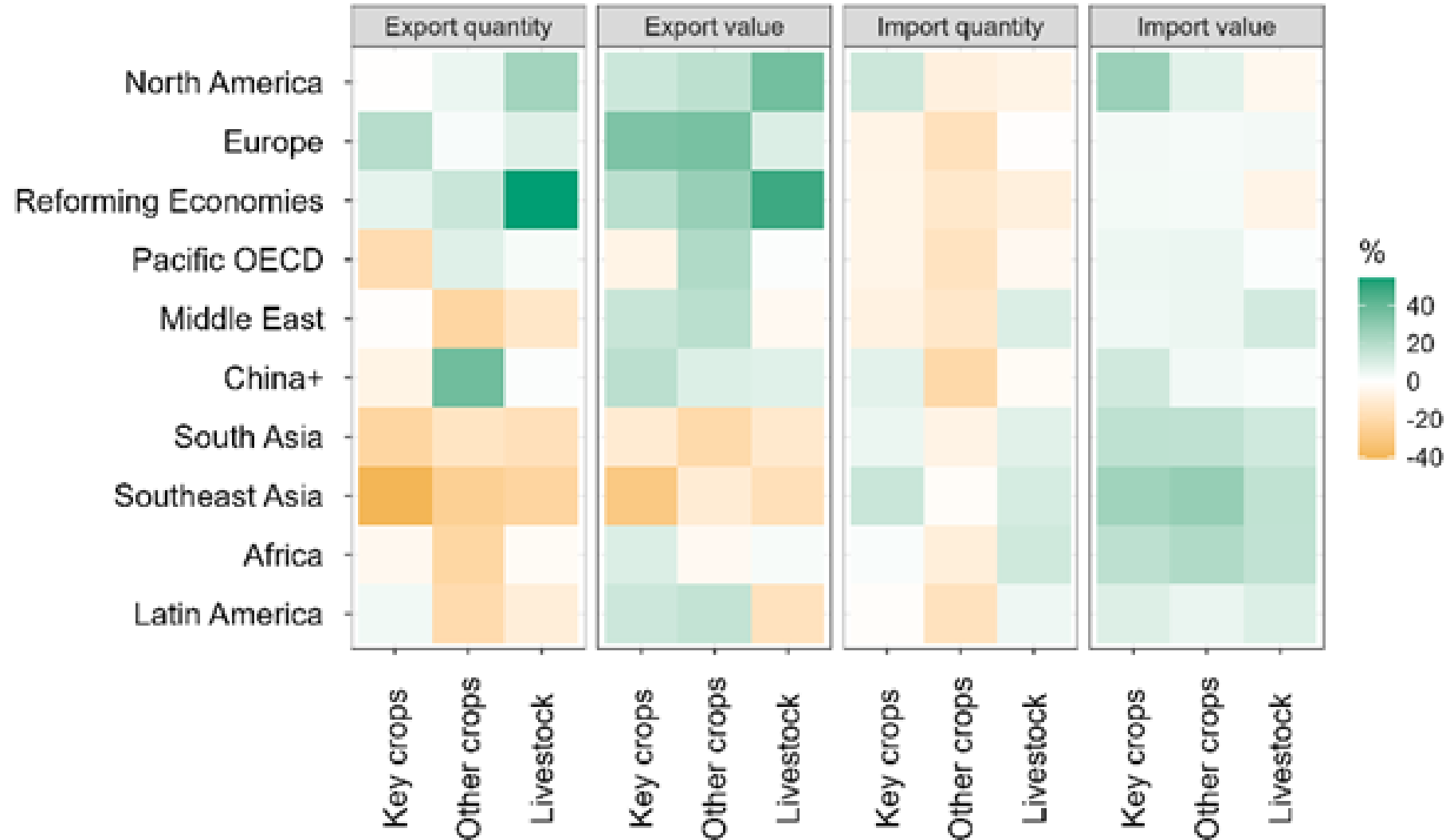- Labor is shifted toward the agricultural sector to make up for lost productivity.
  - Agricultural wages per hour worked rise.
  - Aggregate returns to labor decline.
- The value of agricultural output increases.
  - Higher prices more than offset reduced production.
- The value of agricultural sector exports declines in tropical regions and rises in temperate regions.

DISCUSSION

GCAM-Human Earth Systems Model
- Energy
- Water
- Agriculture-Land-Use
- Macroeconomy

GCAM-GAIA

Physiological Impact on plants

Physiological Impact on ag workers

GCAM-Hector & Stitches

GCAM-HELPS

Meteorology

Agricultural Production

GCAM-Ag-Land-Use Module

AGRICULTURAL MARKETS
- Wages
- Employment
- Food prices
- Land use
- Water use
- Agricultural Production & Consumption

NEW FINAL GOODS & SERVICES
- Consumption & Government
  - Agriculture
  - Non-ag
- Investment
- Net exports
  - Ag
  - Non-Ag

INCOME
- Wages
  - Agriculture
  - Non-ag
- Returns to capital
- Economic Rent

Relative changes in GDP (Ref=0) in 2100