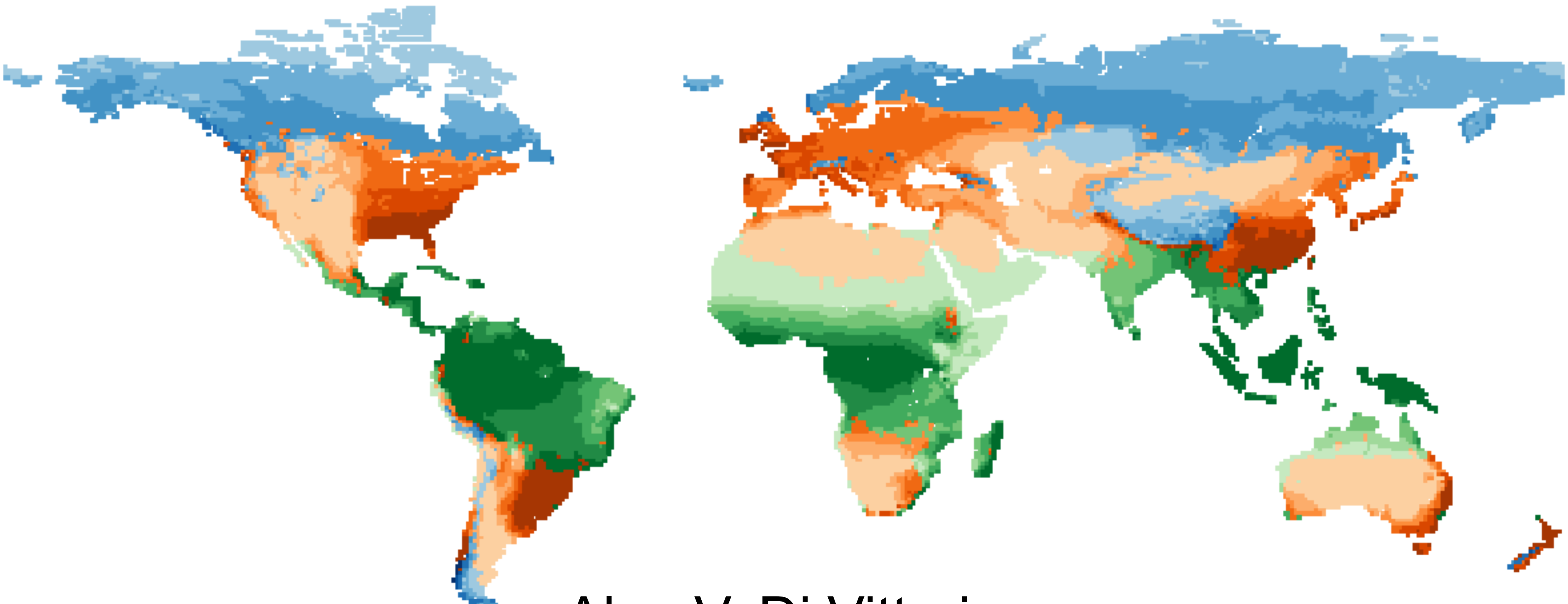
Uncertainty in land resource projection associated with constant, bioclimatic land units in an integrated assessment model



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With special thanks to Page Kyle and Pralit Patel

Joint LMWG/SDWG Meeting

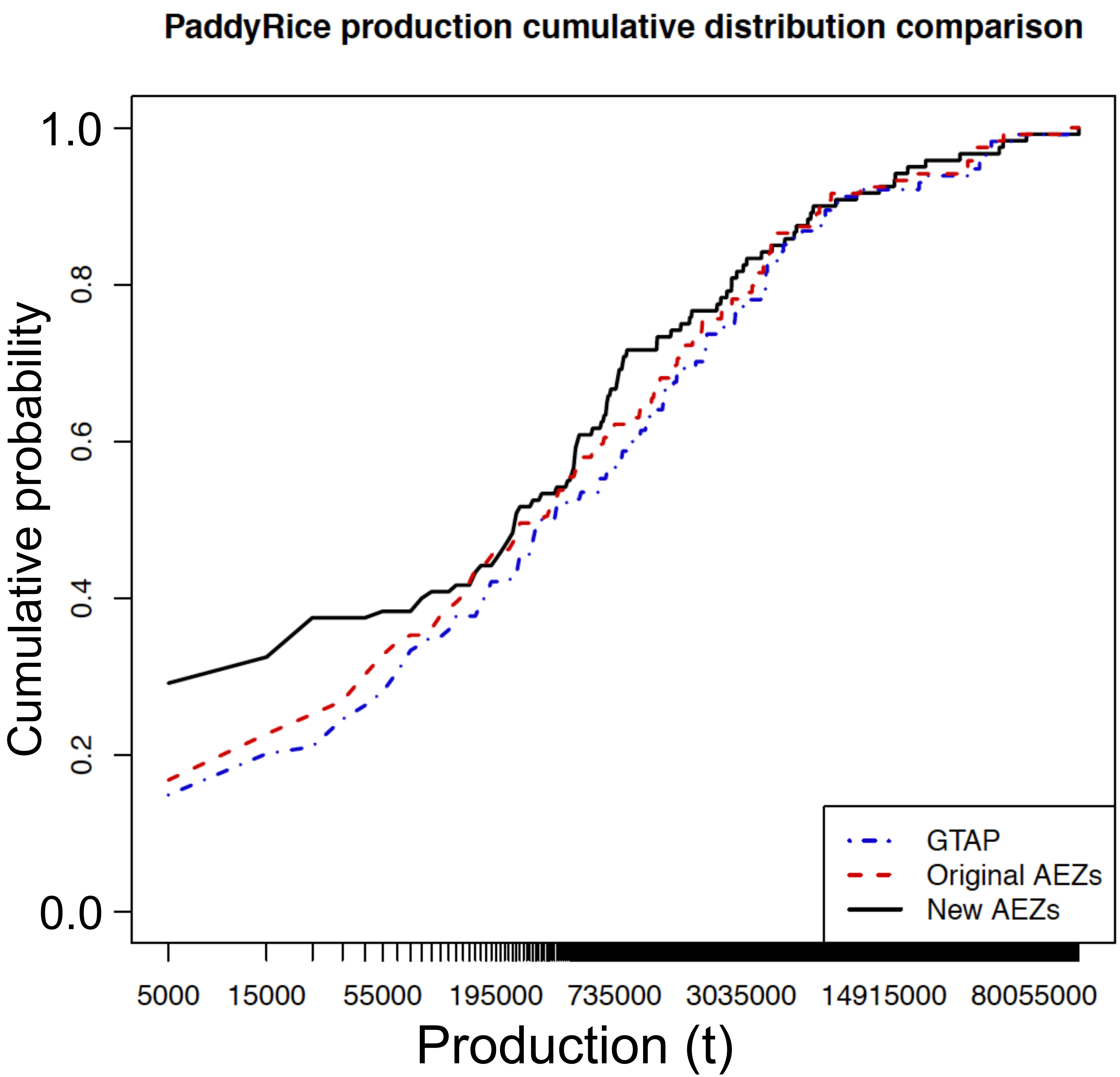
Boulder, CO, 4 March 2015

EARTH SCIENCES DIVISION

CLIMATE & CARBON SCIENCES PROGRAM

BERKELEY LAB

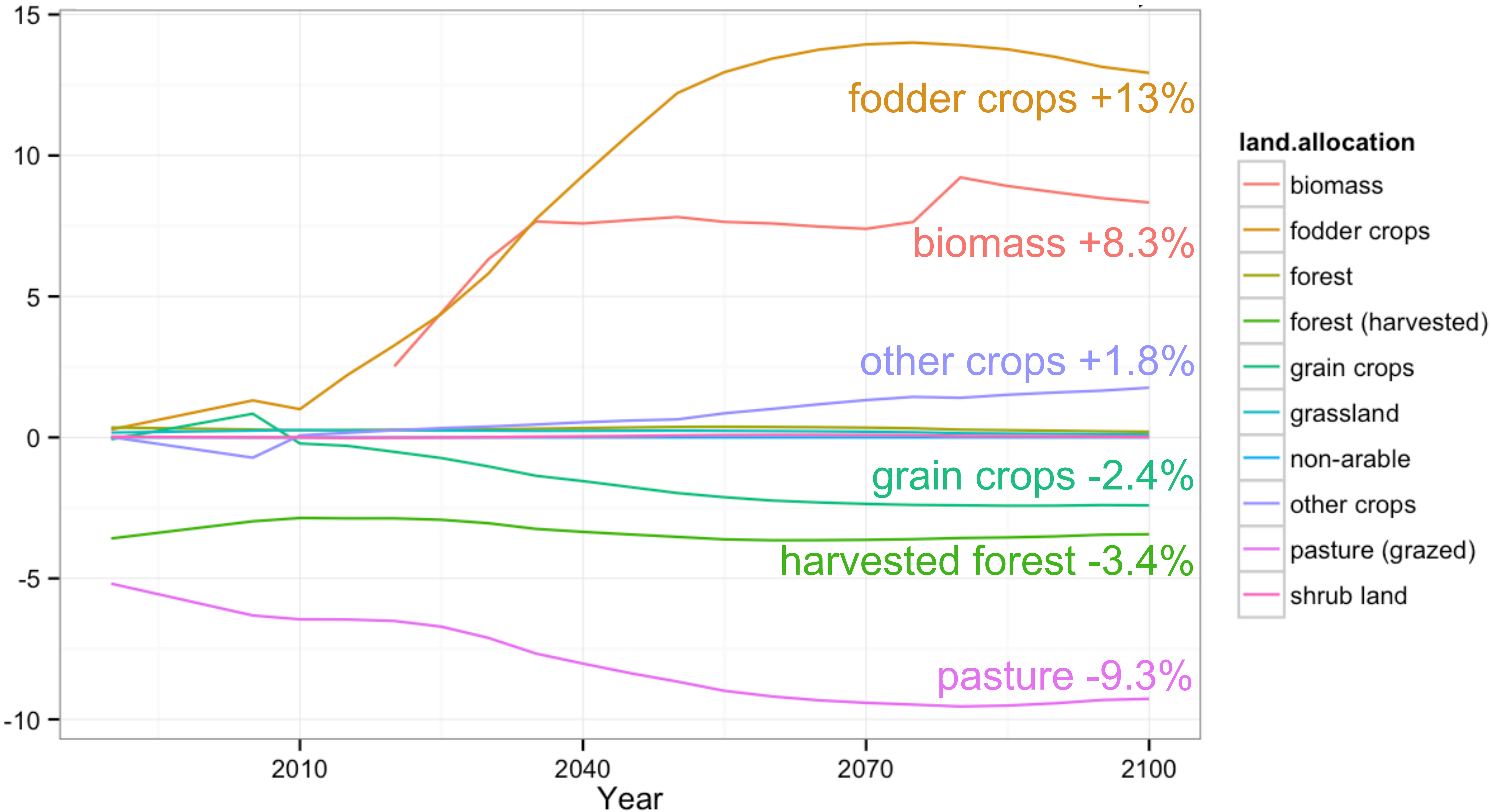
Global distributions of Paddy Rice Production



3

AEZ boundaries affect projected land use/cover

Global percent change in land area (new minus old)



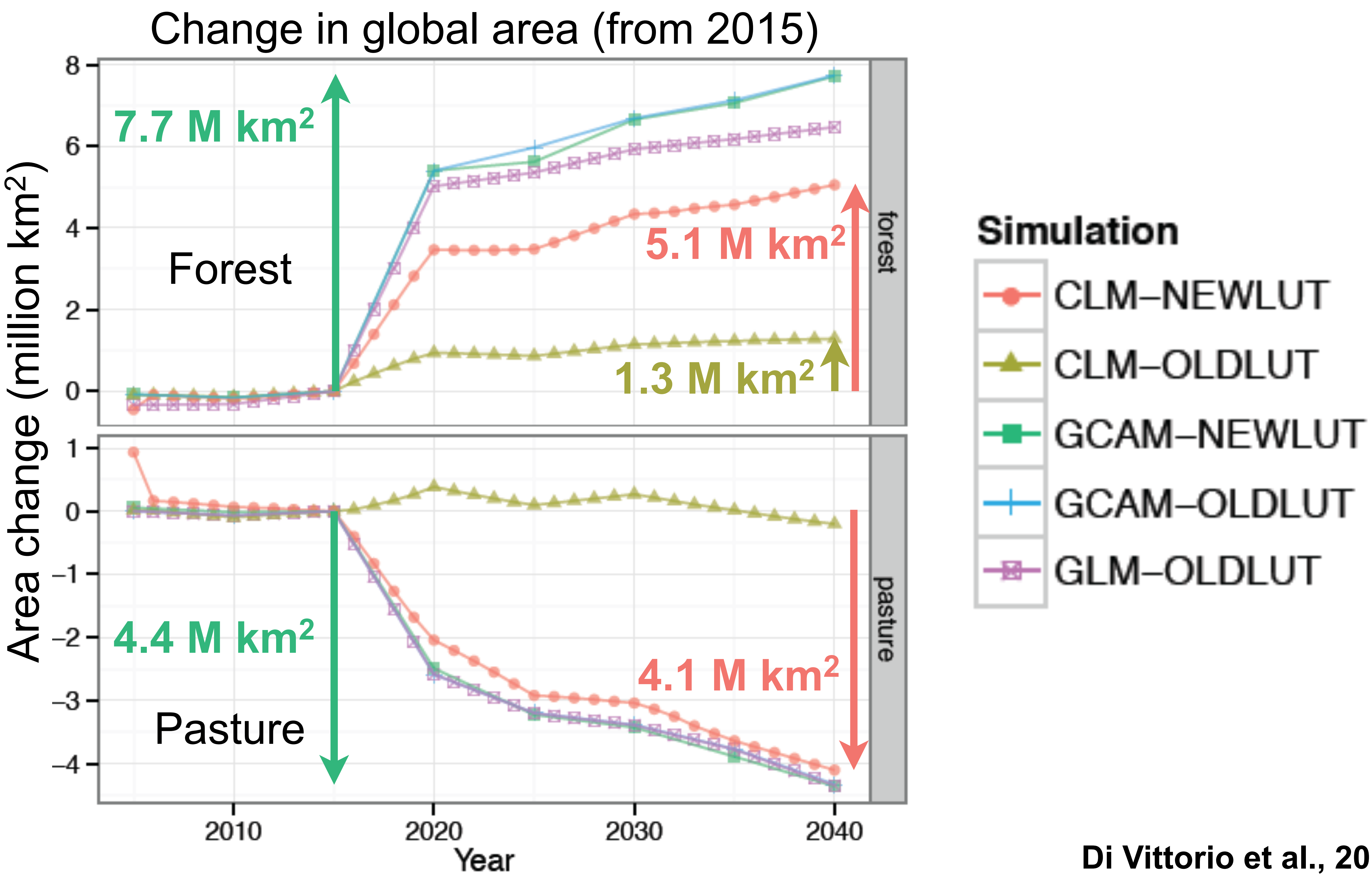
IAMs have different regions/land units

- Unquantified spatial uncertainty confounds inter-model comparison and ensemble analysis

Model	Regions	Land units for projection
IMAGE (RCP 2.6)	26	half-degree grid
MiniCAM (RCP 4.5)	14	GCAM: 151 land units
AIM (RCP 6.0)	24	half-degree grid
MESSAGE (RCP 8.5)	11	half-degree grid

5

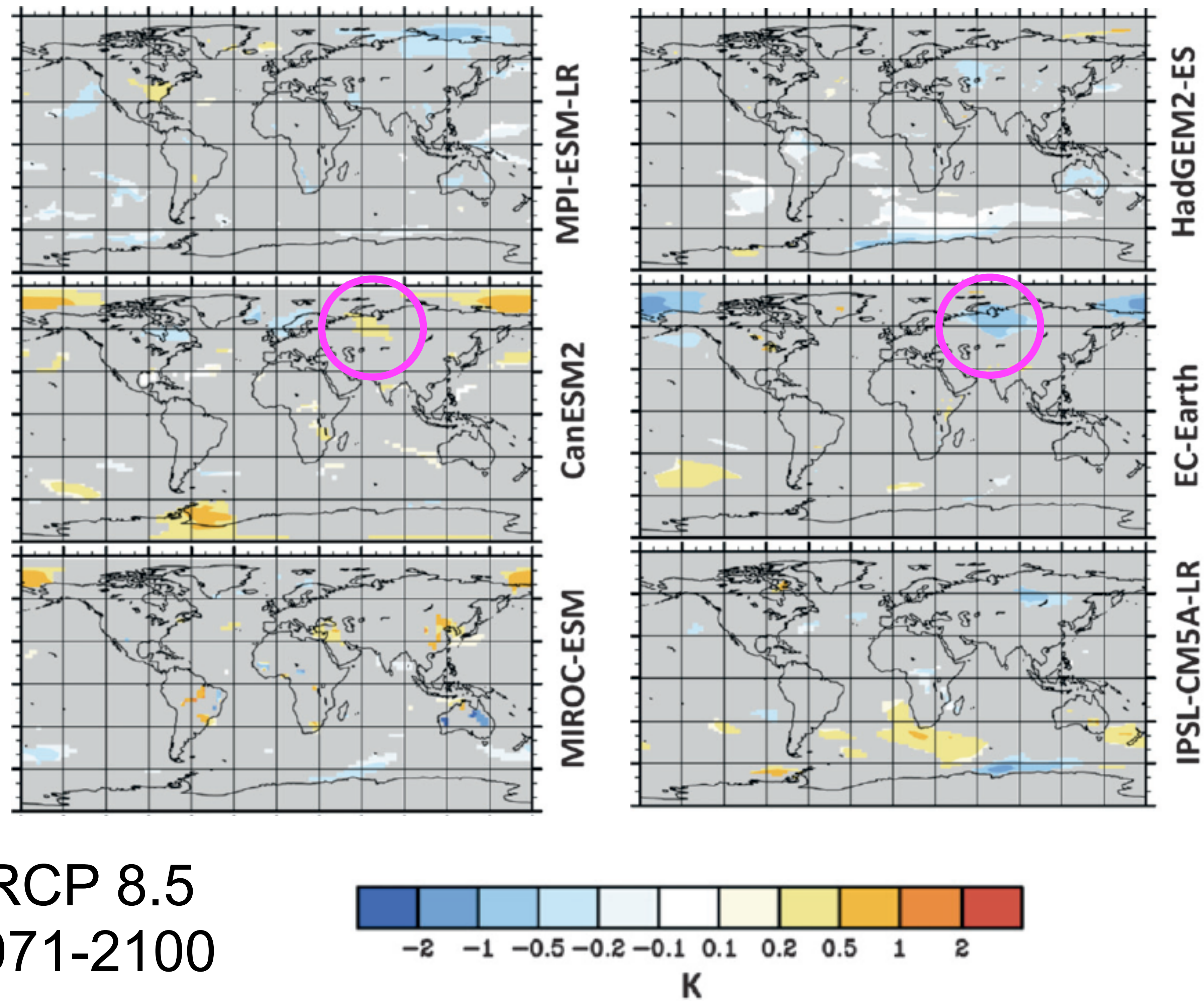
Land cover inconsistencies across IAMs and ESMs can alter the global carbon cycle



Di Vittorio et al., 2014

Different land use/cover representations in ESMs obscure land use change effects on regional climate

- Uncertainty chain:
  - IAM land use spatial uncertainty
  - Land use/cover translation
  - ESM land cover



Temperature effect of RCP 8.5 land use change for 2071-2100 (**Brovkin et al. 2013**)

In the context of coupled whole earth system modeling

- How do we make robust projections of land resources in the context of projected climate change?

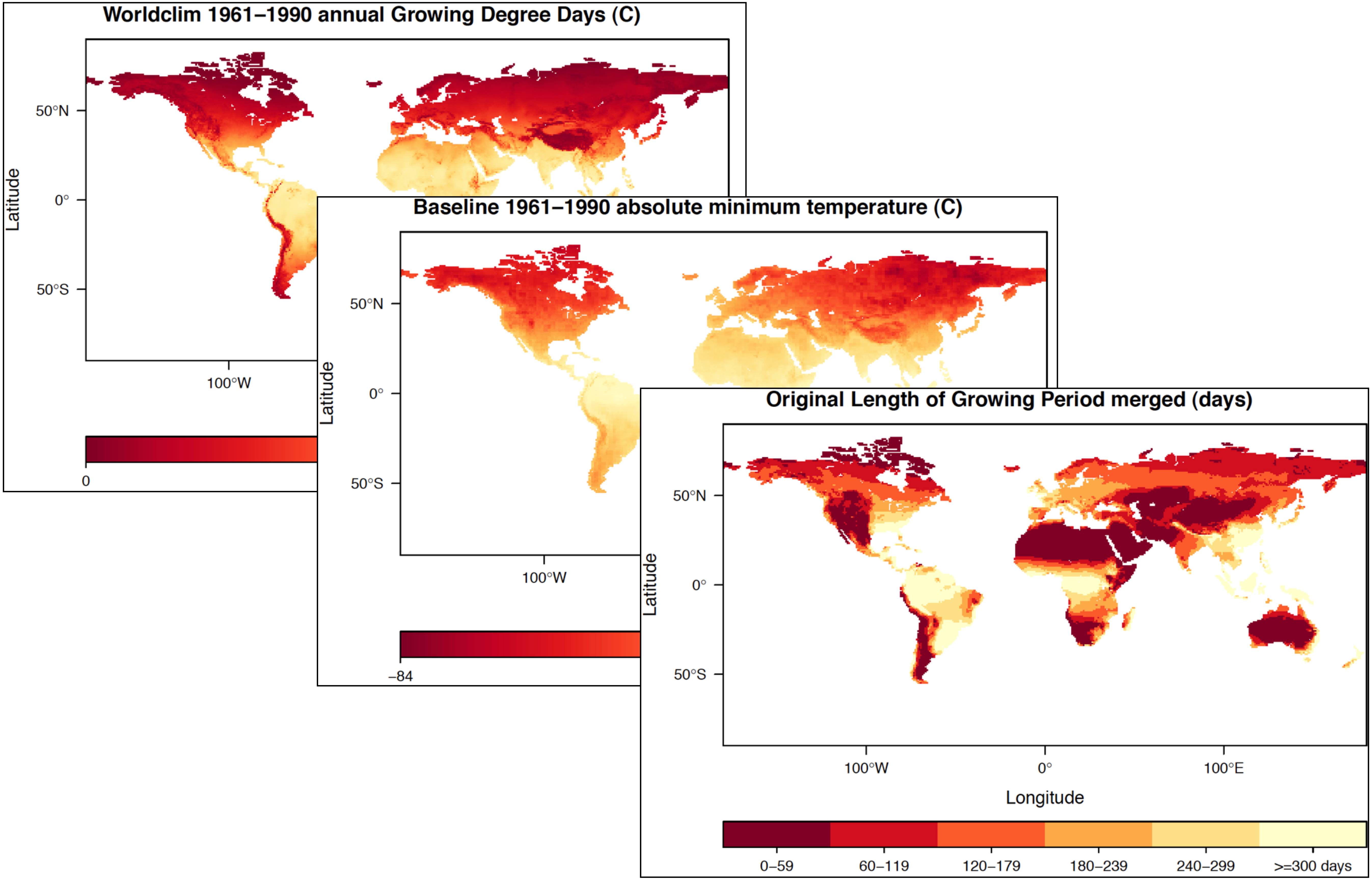
- **How do spatial boundaries influence land resource projection?**

SDWG principles

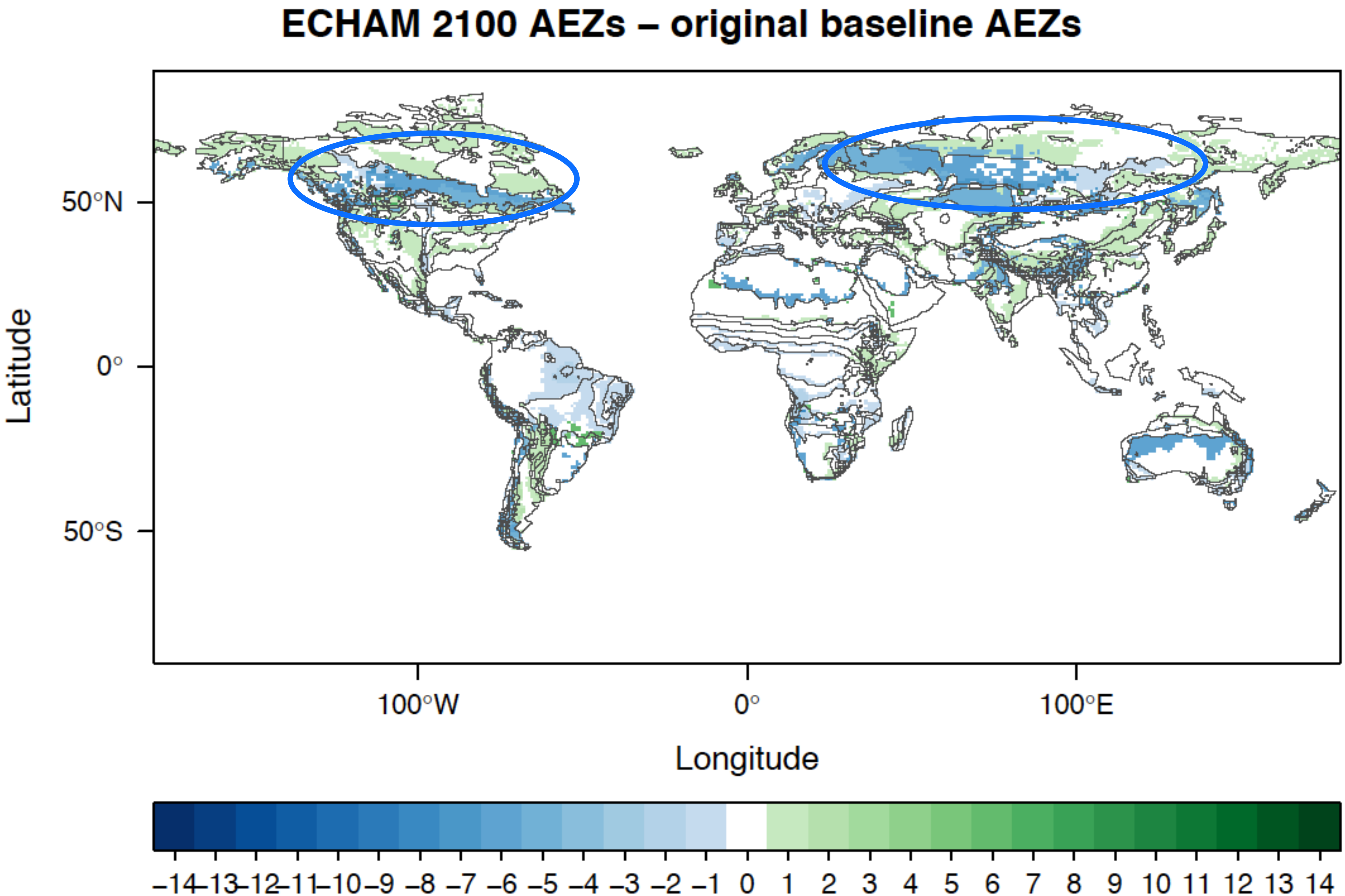
- Uncertainty in CESM inputs fosters dialogue

- Highlights need for CESM land use/cover/ management development

Agro-Ecological Zones (AEZs) are bio-climatically defined



Current land units become heterogeneous



Workflow to create new AgLU crop and land rent inputs

Data

Identify land cells

Optional: recalibrate to different FAO data year

Calculate crop **production** and **harvested area** per 18 AEZs X 226 GTAP countries

Aggregate original land rents by use sector to 87 GTAP countries

Disaggregate **crop land rents** to 18 AEZs based on **production** and price

Disaggregate **forest land rents** to 18 AEZs based on original land rents and forest area

Data required to create new AgLU crop and land rent inputs

Spatially explicit data

- VMAP0 countries (246)
- AEZ countries (160)

- SAGE data:
  - crop yield, area
  - cropland
  - pasture
  - land area
  - potential vegetation
- HYDE3.1 data:
  - urban
  - land area
- AEZ boundaries

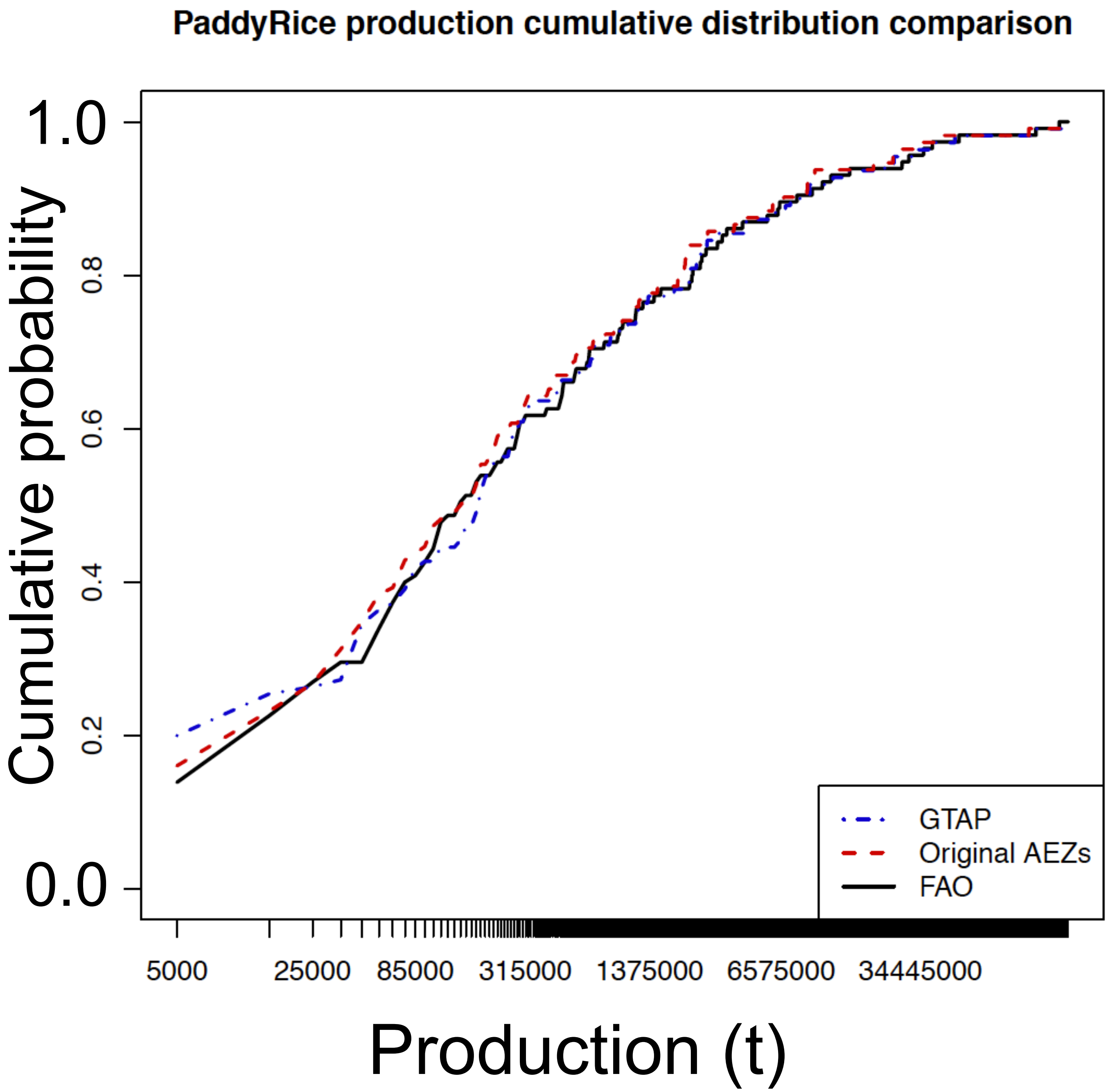
Tabular data

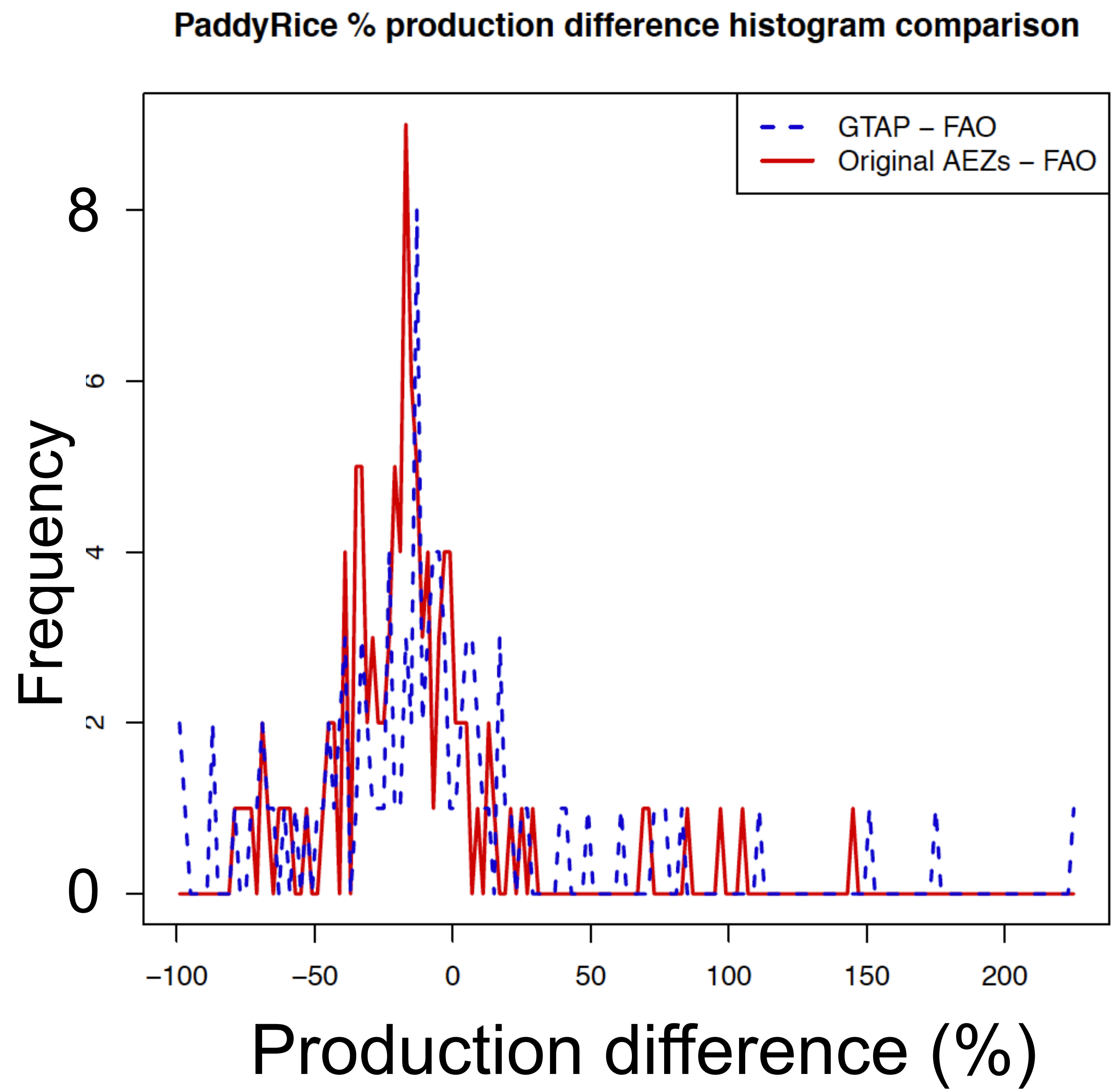
- GTAP countries (226, 87)
- FAO countries (241)

- GTAP (SAGE) crops
- GTAP use sector
- GTAP land rent
- FAO crops
- FAO crop production
- FAO producer prices
- FAO crop yield, area
  - for recalibration

New land data system is robust

e.g., Paddy Rice for 226 countries



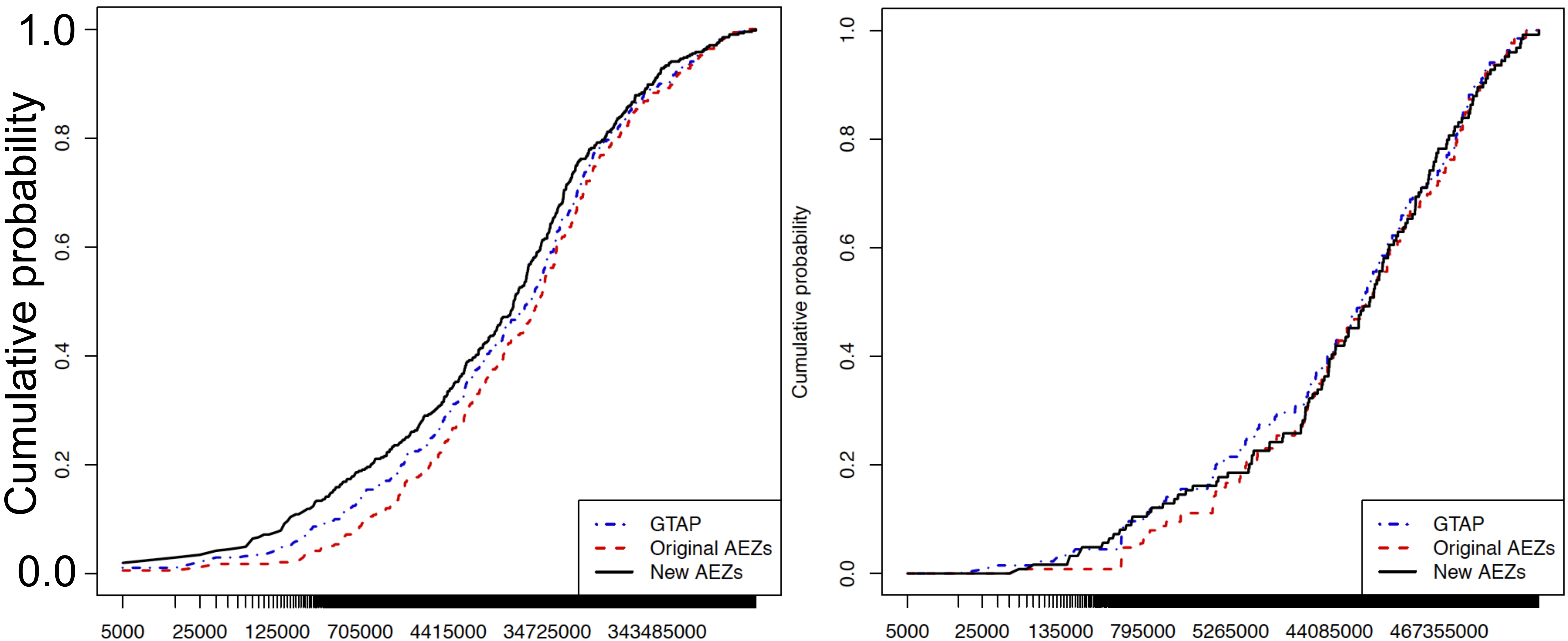


New land data system is robust

e.g., forest land rent

87 regions by AEZ

14 regions by AEZ



Land Rent (US$)

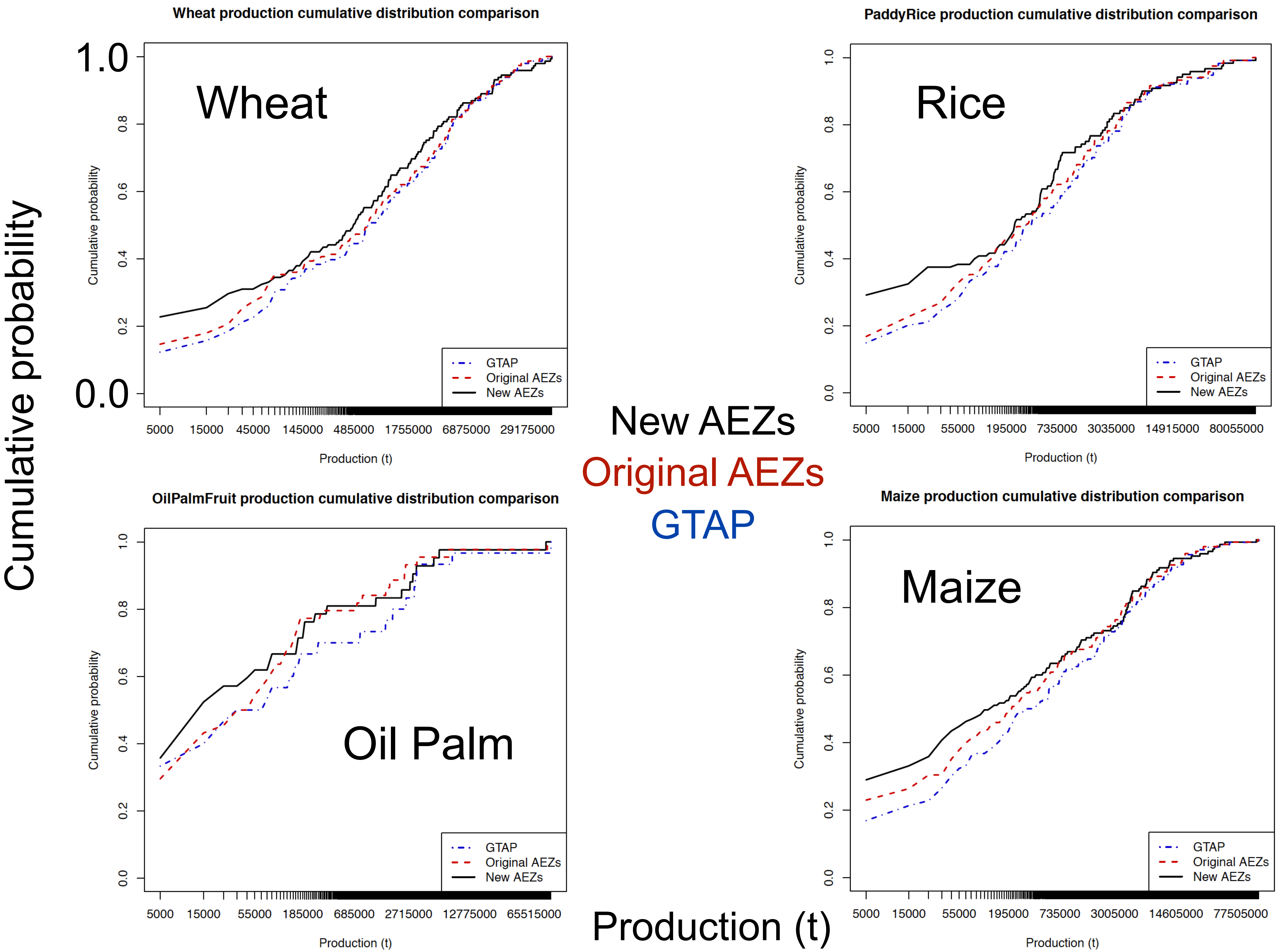
Land Rent (US$)

New AEZs

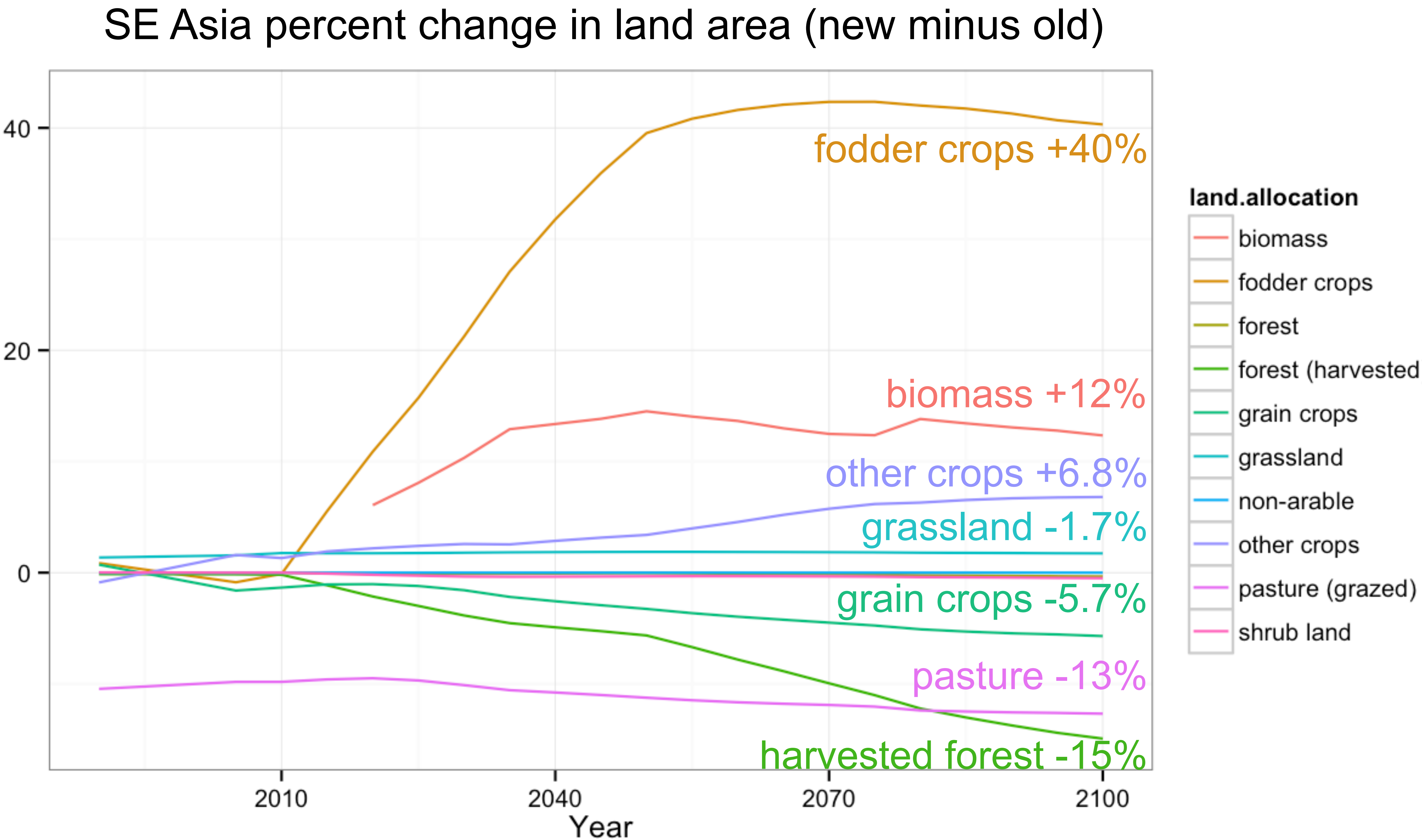
Original AEZs

GTAP

Each crop is uniquely affected by new land units

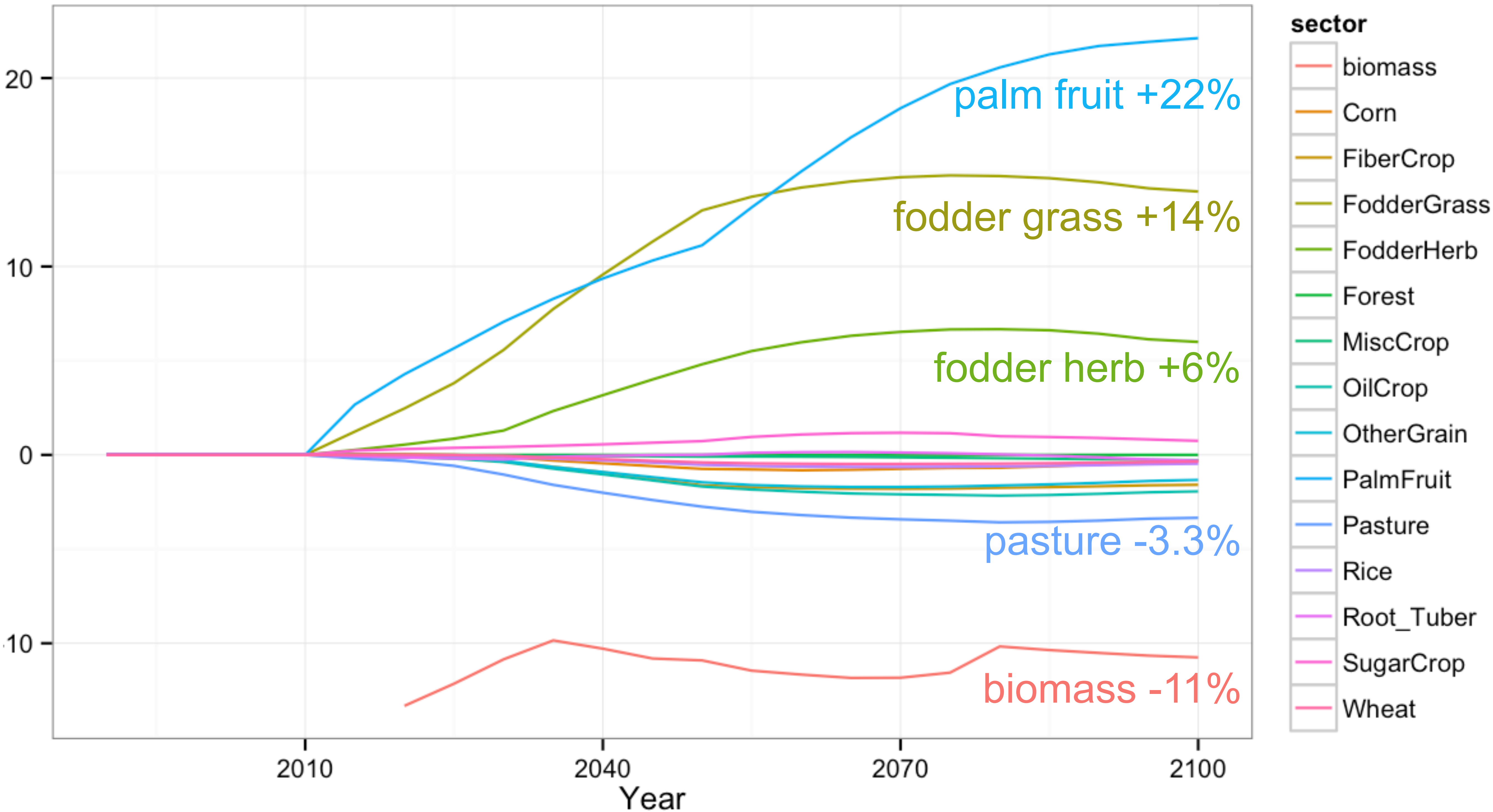


AEZ boundaries affect projected land use/cover



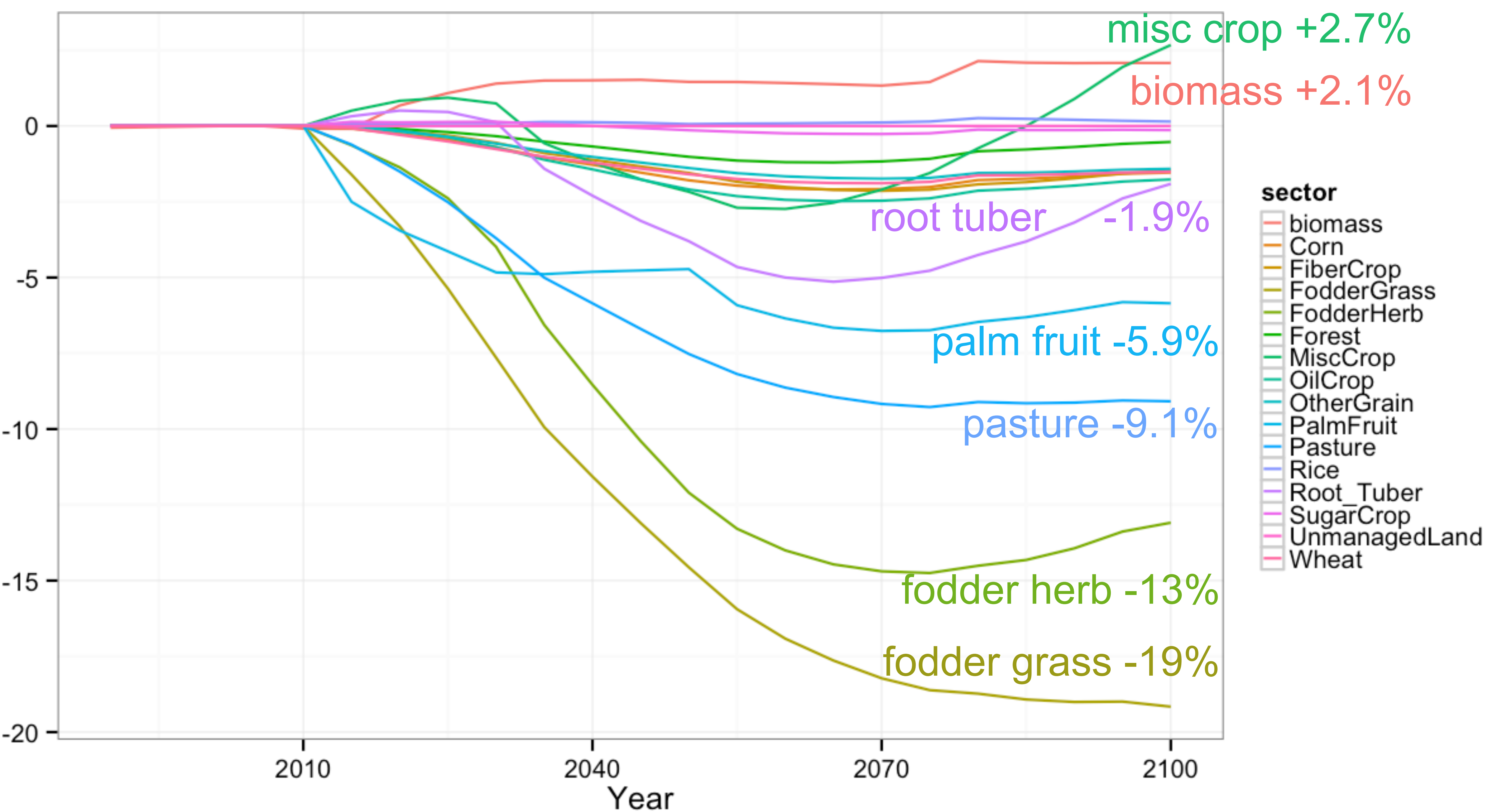
AEZ boundaries affect crop production

Global percent change in crop production (new minus old)

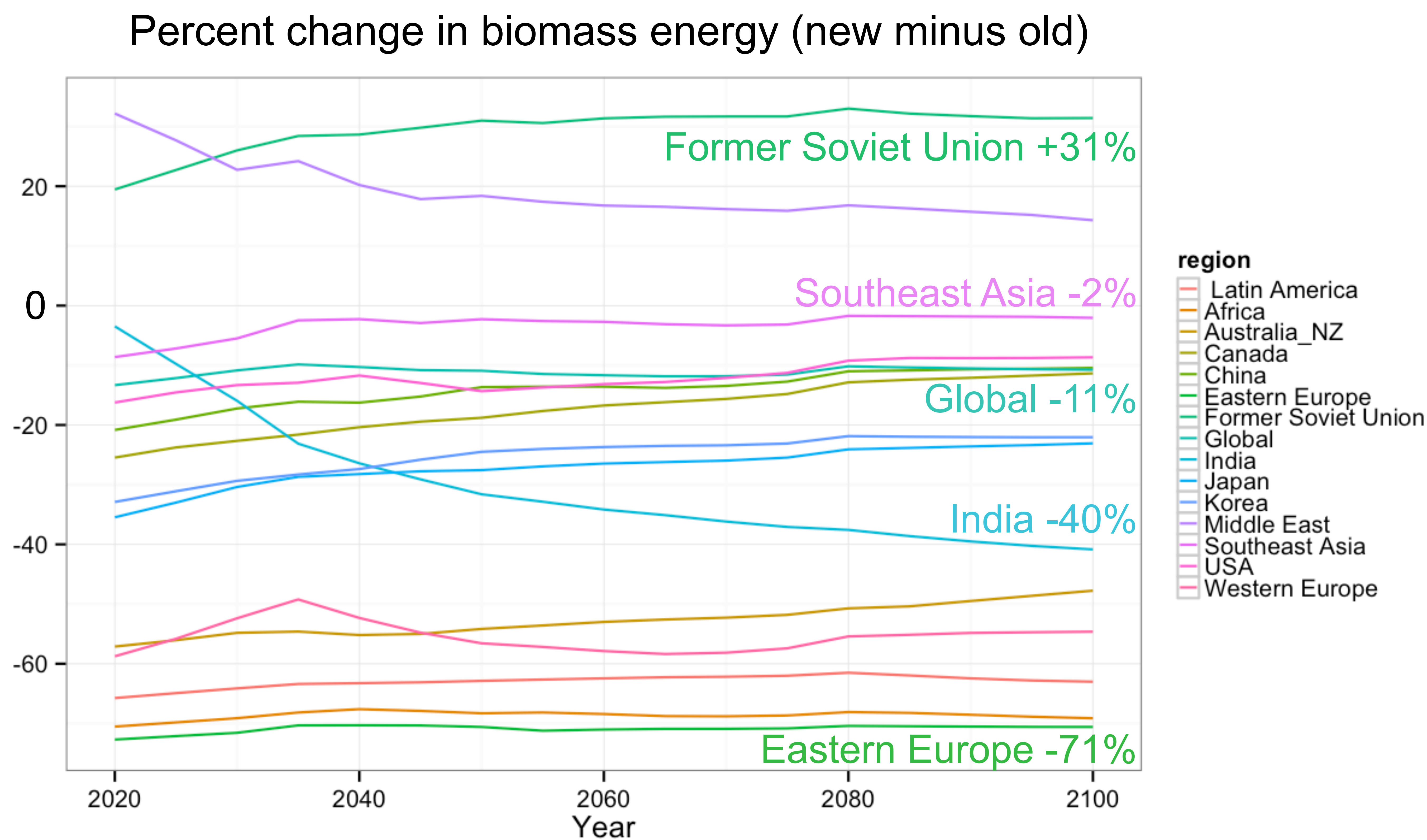


AEZ boundaries affect crop prices

Global percent change in crop prices (new minus old)

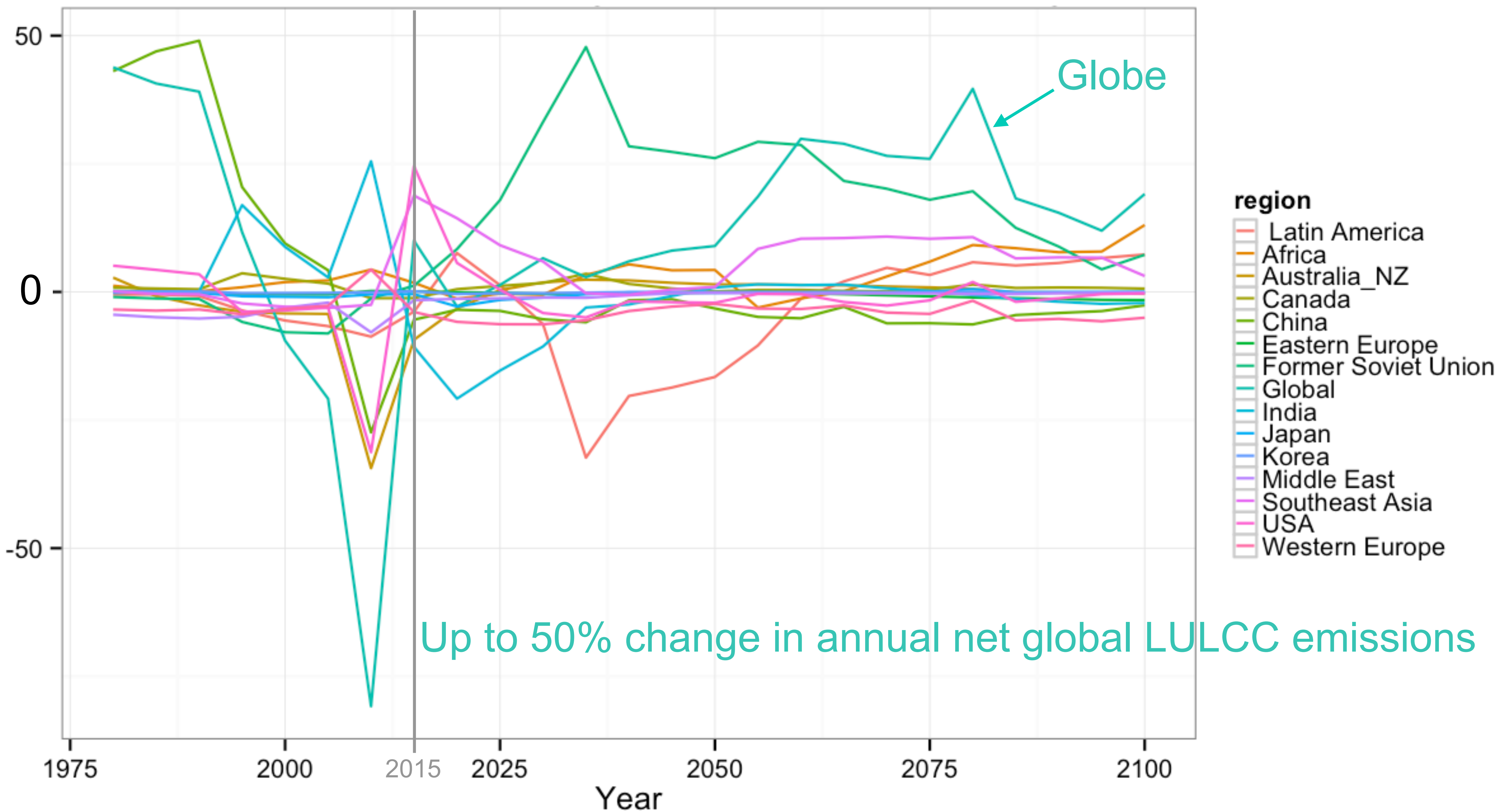


AEZ boundaries affect biomass energy



AEZ boundaries affect LULCC emissions

Change in LULCC emissions (MtC/yr) (new minus old)



Summary

- AEZ-based land units do not consistently meet homogeneity assumption for land use projection
- Reproducibility: New land data system performs better than GTAP with respect to FAO data
- Global distributions of crop production, harvested area, and forest land rent are different between the original and new land units
- Global and regional land resource projections are different between original and new land units
- Feedbacks: climate, impact, and land use

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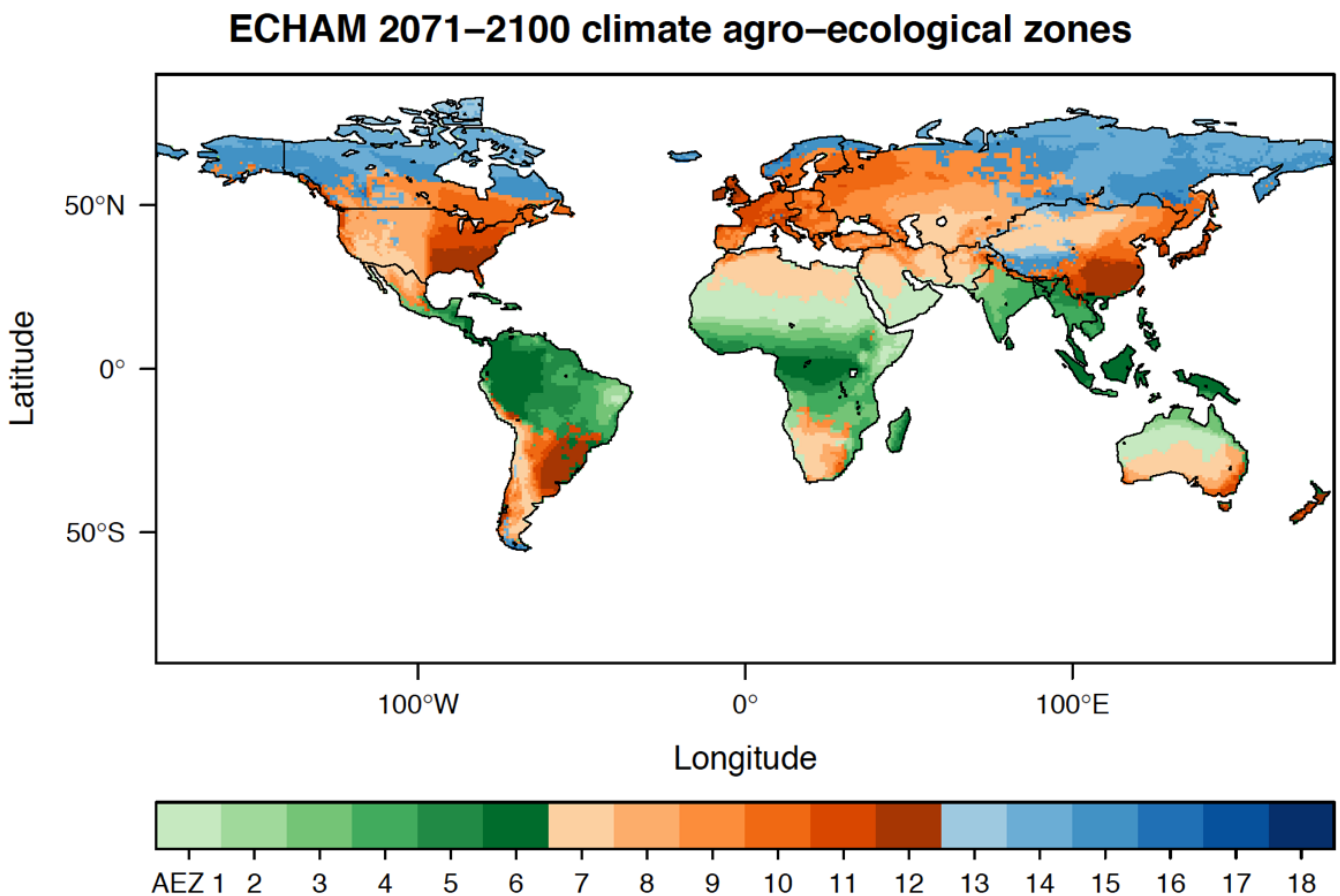
Questions?



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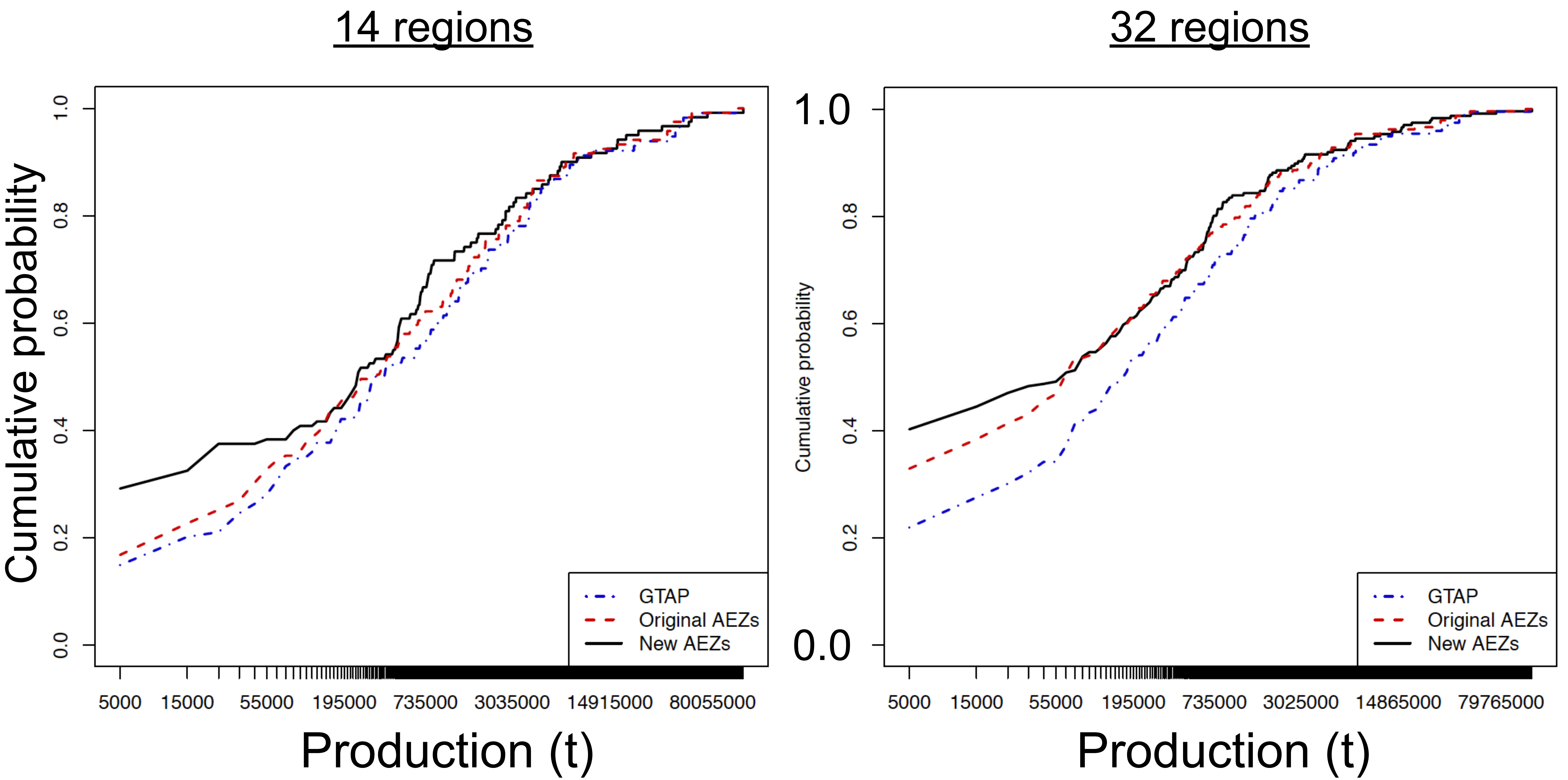
E1

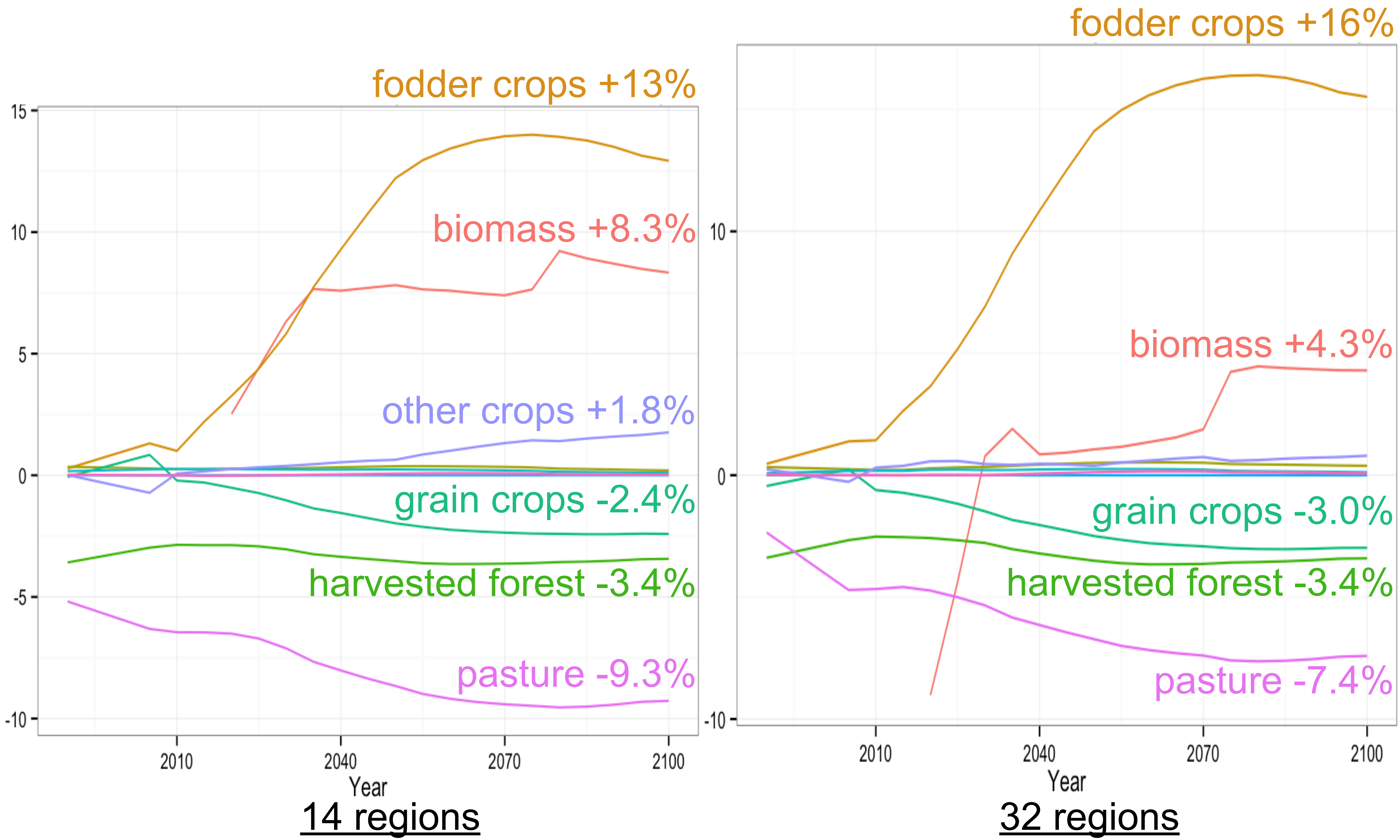
Global distributions of Paddy Rice Production



E2

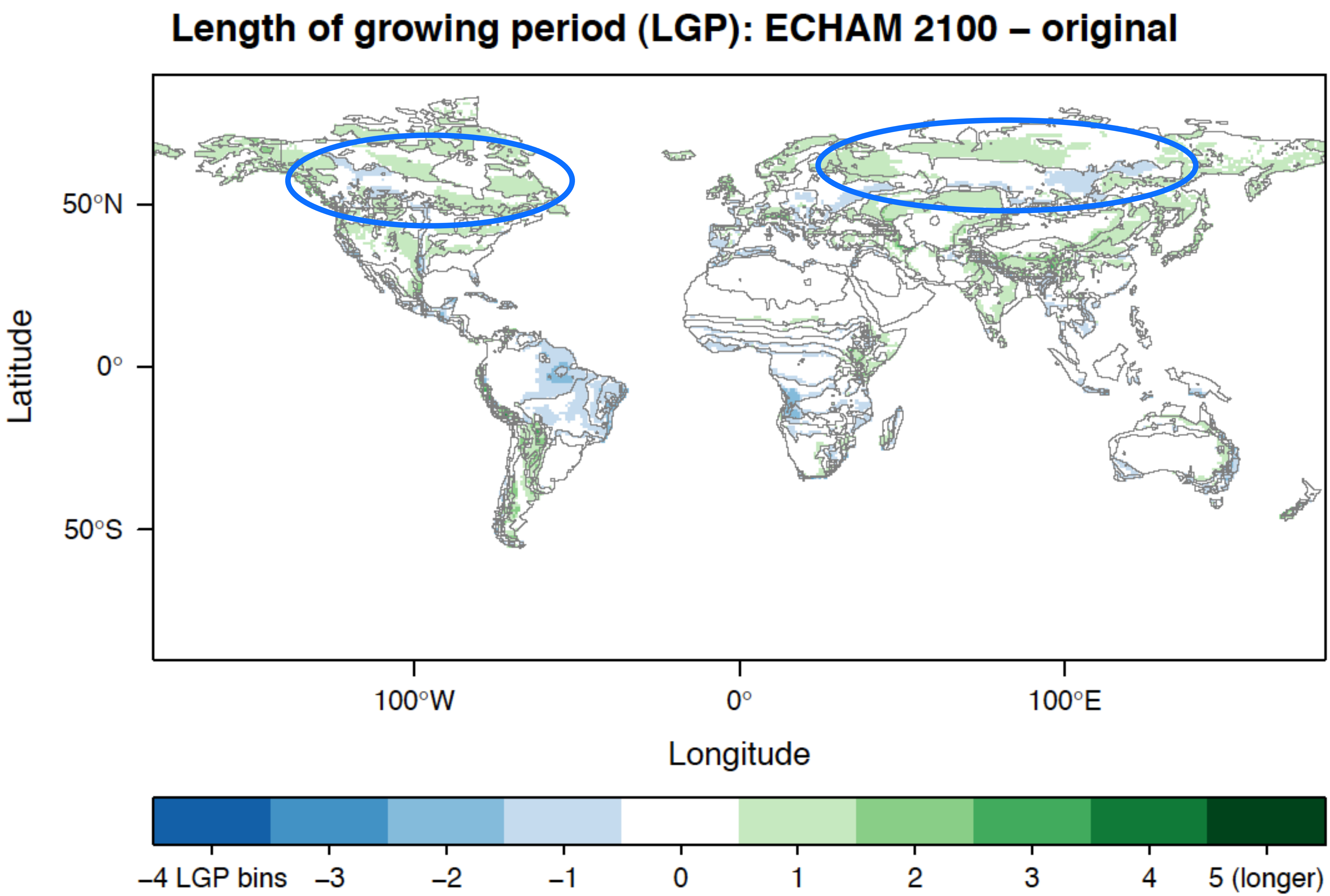
AEZ boundaries affect projected land use/cover

Global change in land area (percent; new minus old)



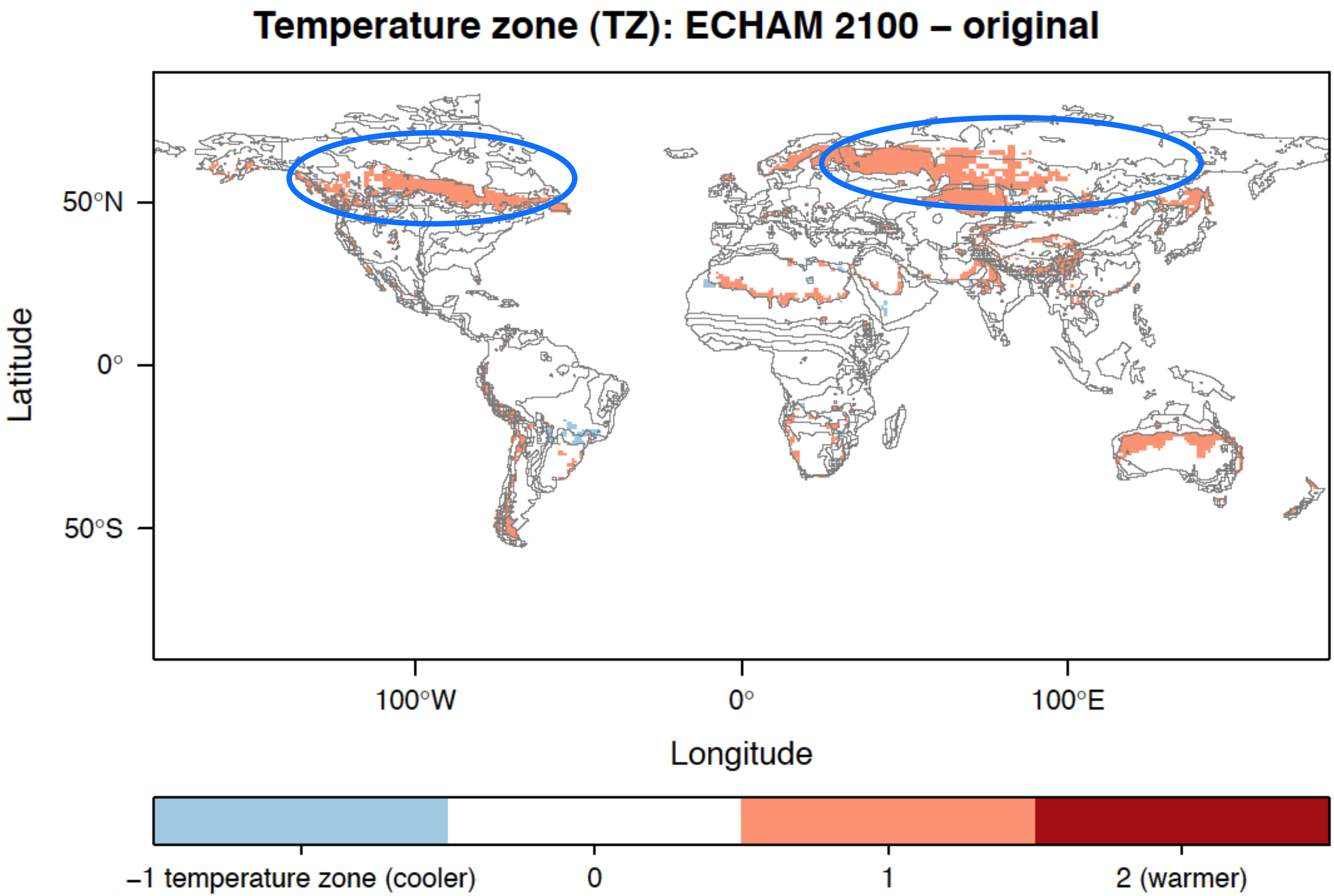
E3

Current land units become heterogeneous



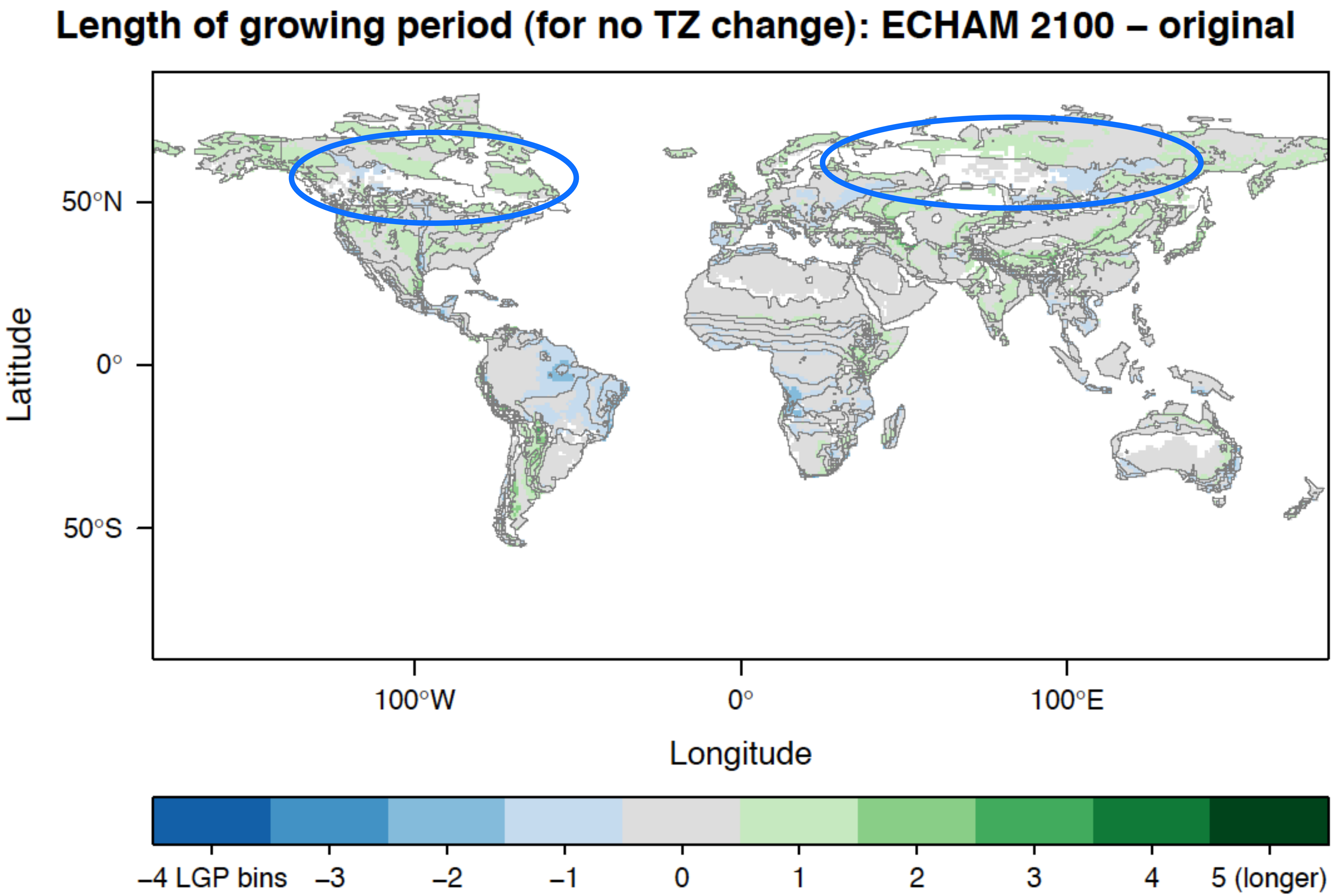
E4

Current AEZs become heterogeneous



E5

Current AEZs become heterogeneous



E6

Current AEZs become heterogeneous