



U.S. DEPARTMENT OF
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Agricultural impacts in GCAM: Results from the iESM

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18th Annual CESM Workshop
Breckenridge, Colorado

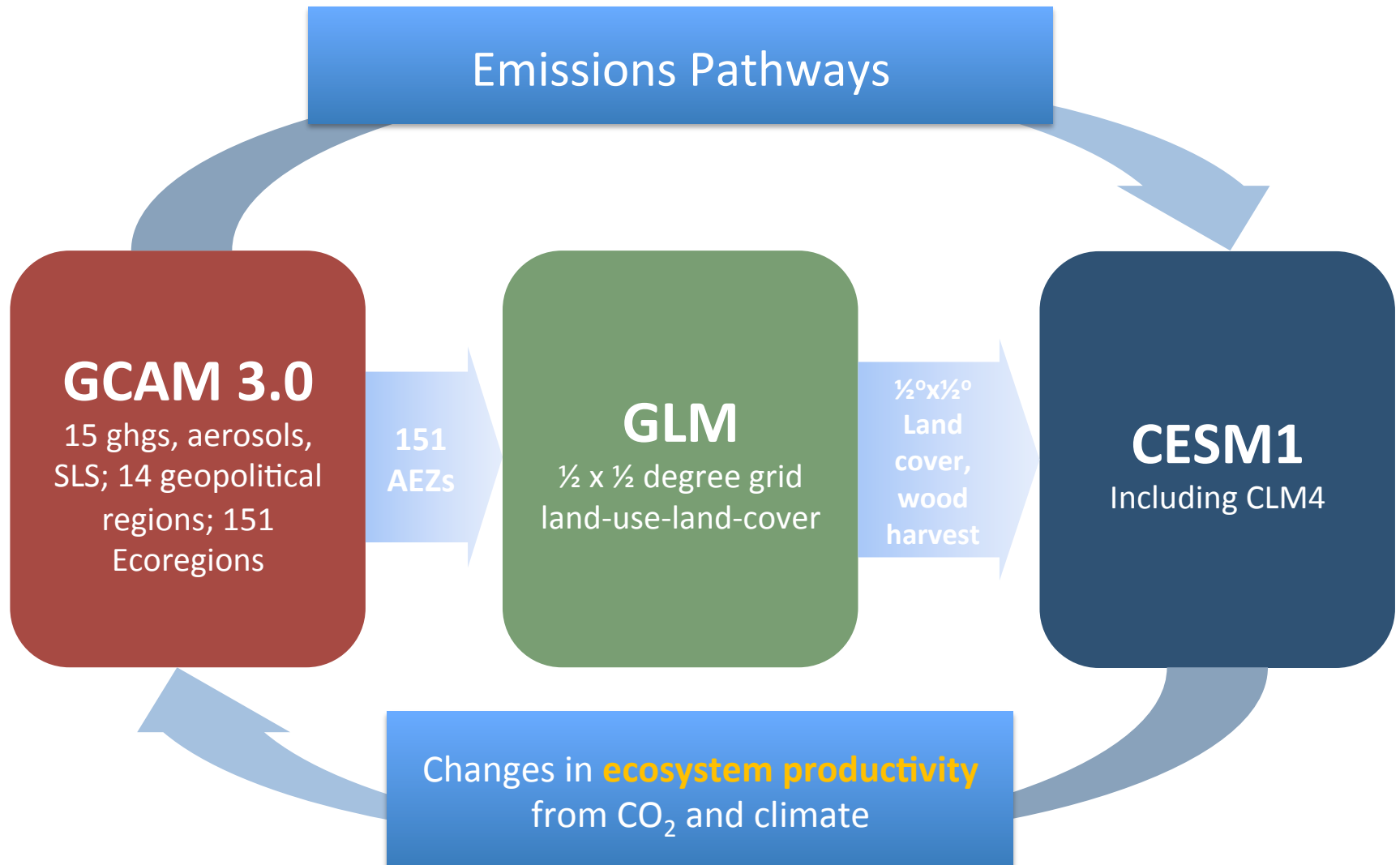
Thursday, June 20, 2013

The integrated Earth System Model (iESM)



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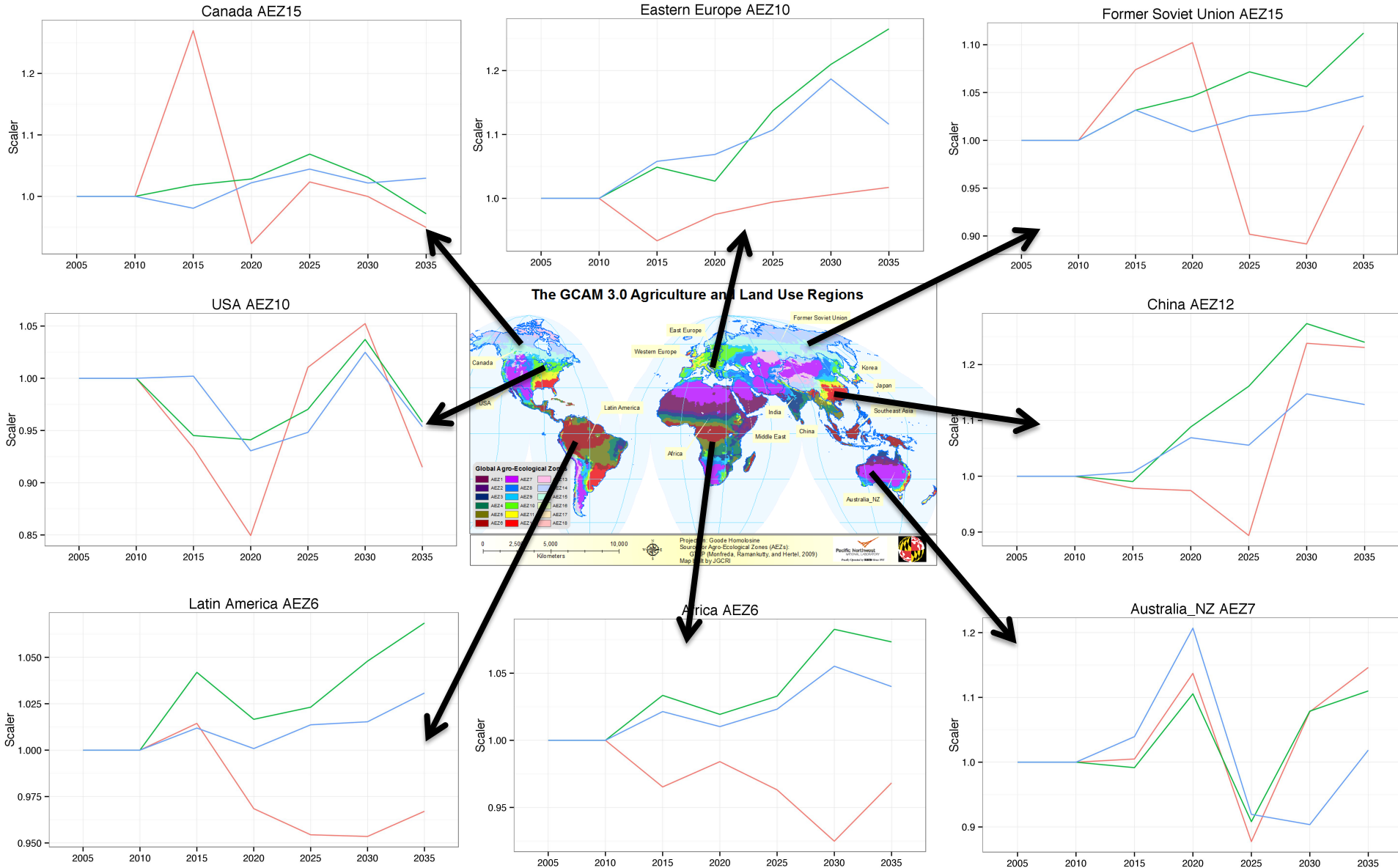
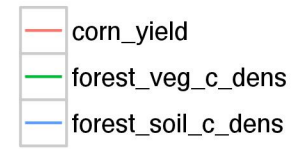
Changing Ecosystem Productivity

- ▶ Grid cell-specific NPP and heterotrophic respiration are used to adjust ecosystem productivity in GCAM.
 - Changes in NPP from the base year to the current year are used to adjust agricultural productivity and vegetation carbon density
 - Changes in heterotrophic respiration from the base year to the current year are used to adjust soil carbon density
- ▶ GCAM and CLM have different temporal & geospatial resolution and include different PFTs. We have to both aggregate (geospatial/PFTs) & disaggregate (PFTs) data between models.

	GCAM	CLM
PFTs	24	17
Geospatial	151	½° X ½°
Temporal	5-years	30 min

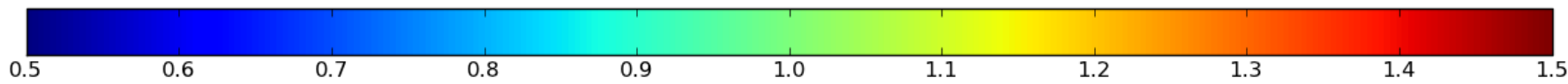
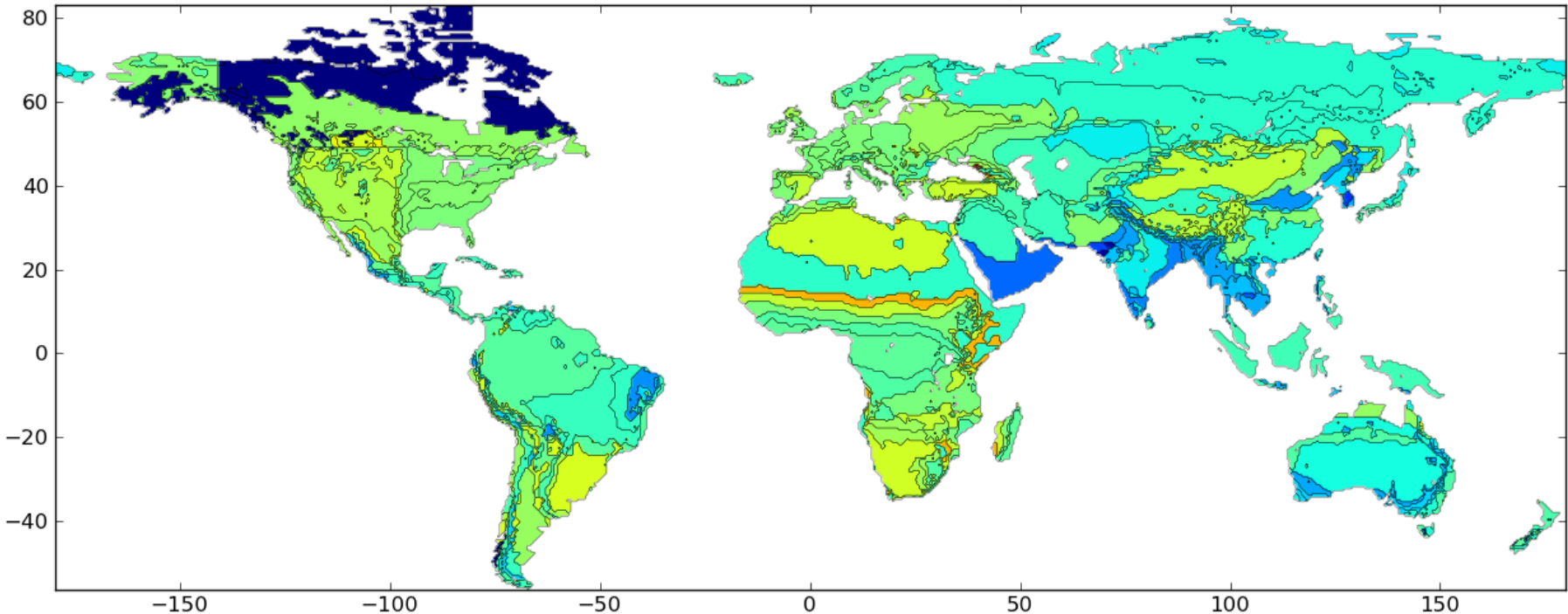
Climate Change Signal

variable



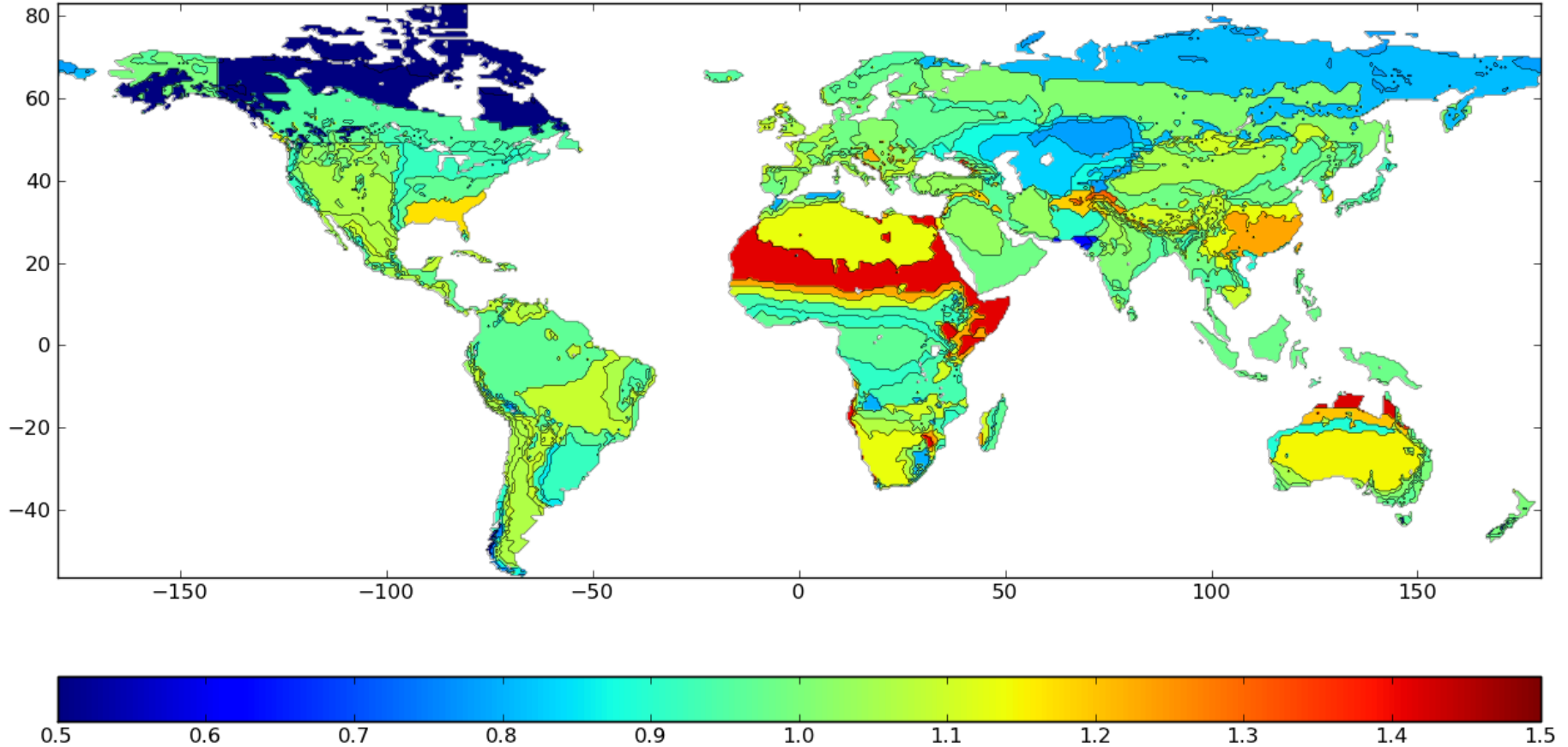
Climate Change Signal: 2025 Crop Yield

Yield Scaler, Corn (in Scalar) from scenario: iESM1p2,20



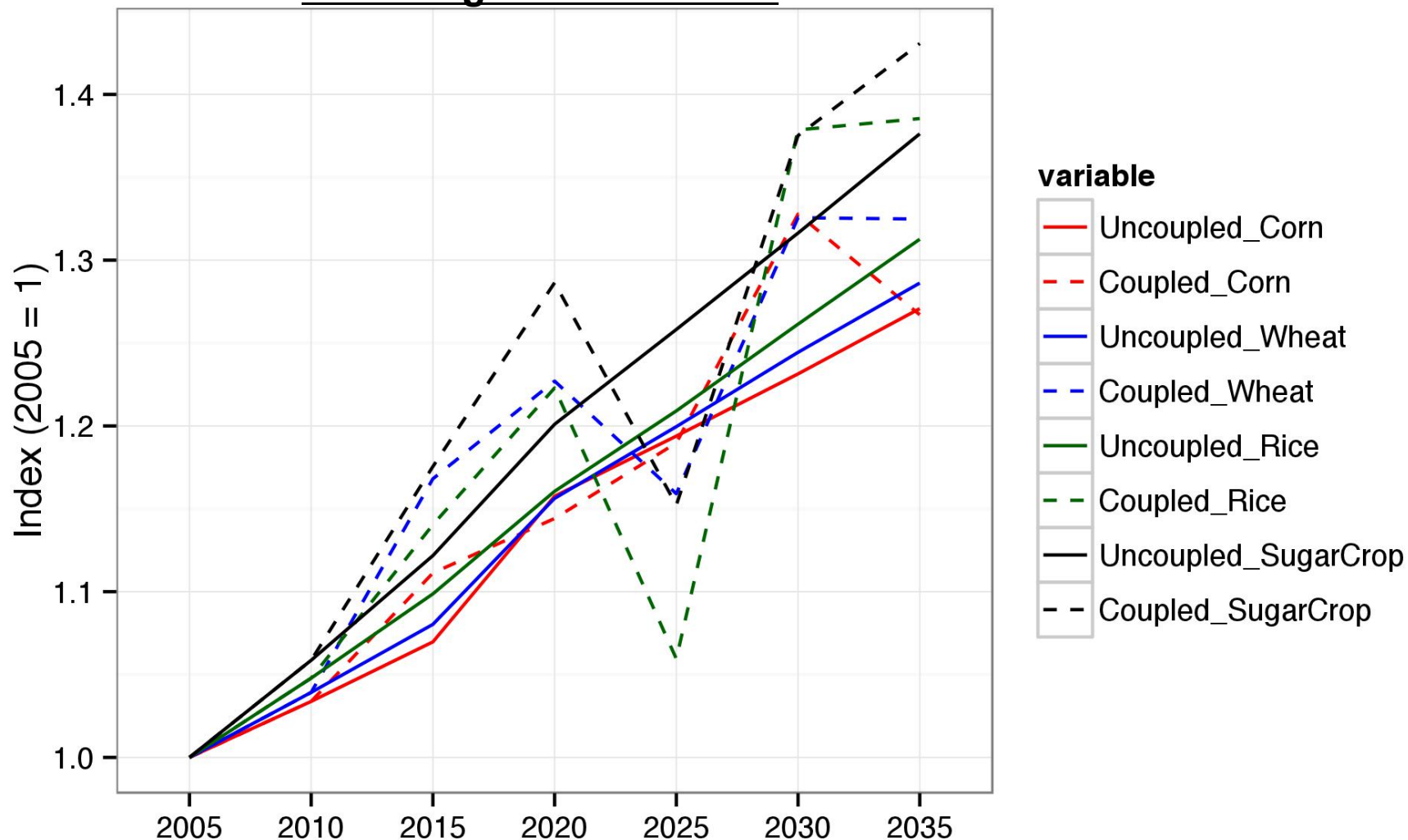
Climate Change Signal: 2035 Crop Yield

Yield Scaler, Corn (in Scalar) from scenario: iESM1p2,20



Global average yield, however, is affected by the climate signal.

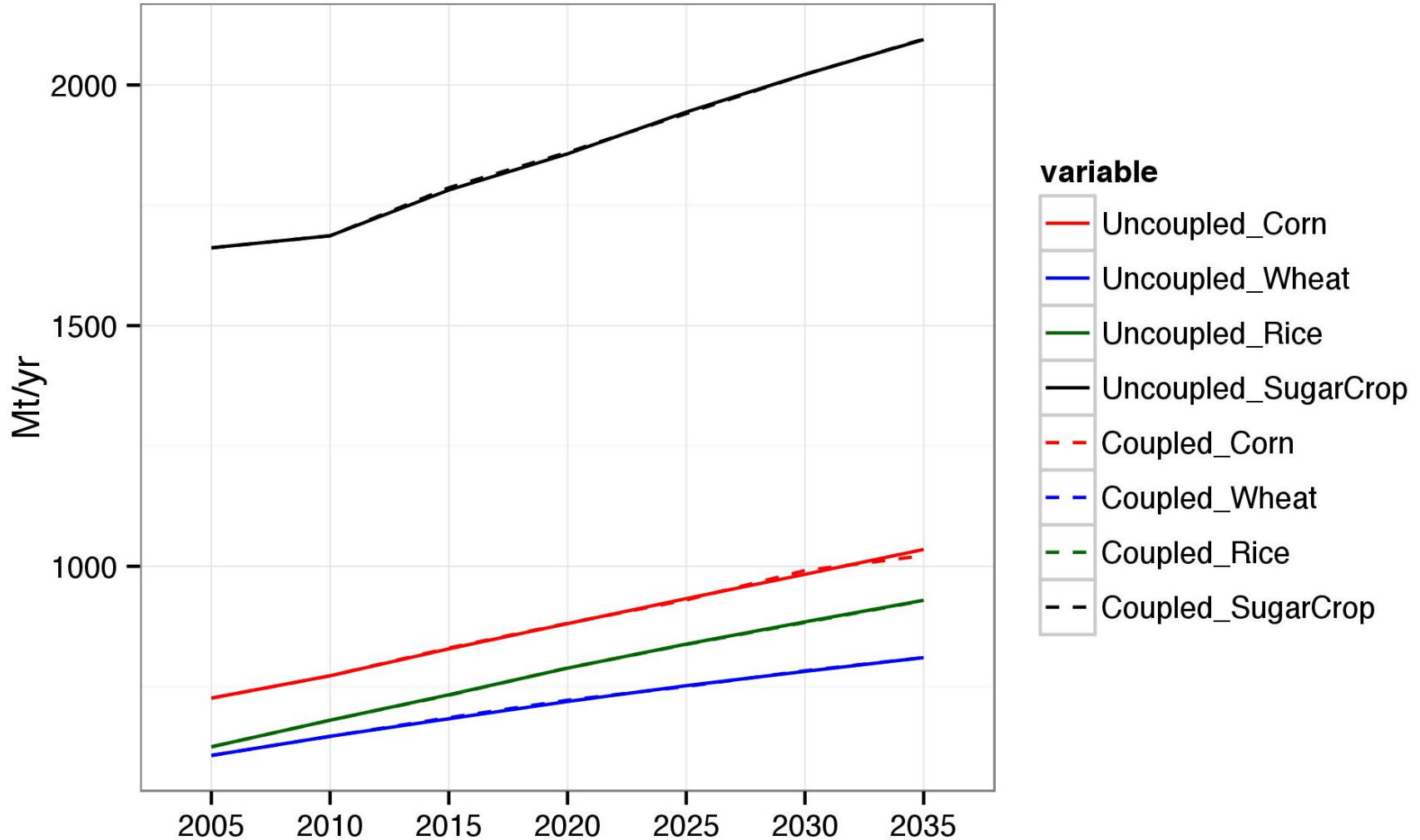
Global Agricultural Yields



Food demand is fairly rigid, so global agricultural production is similar across scenarios

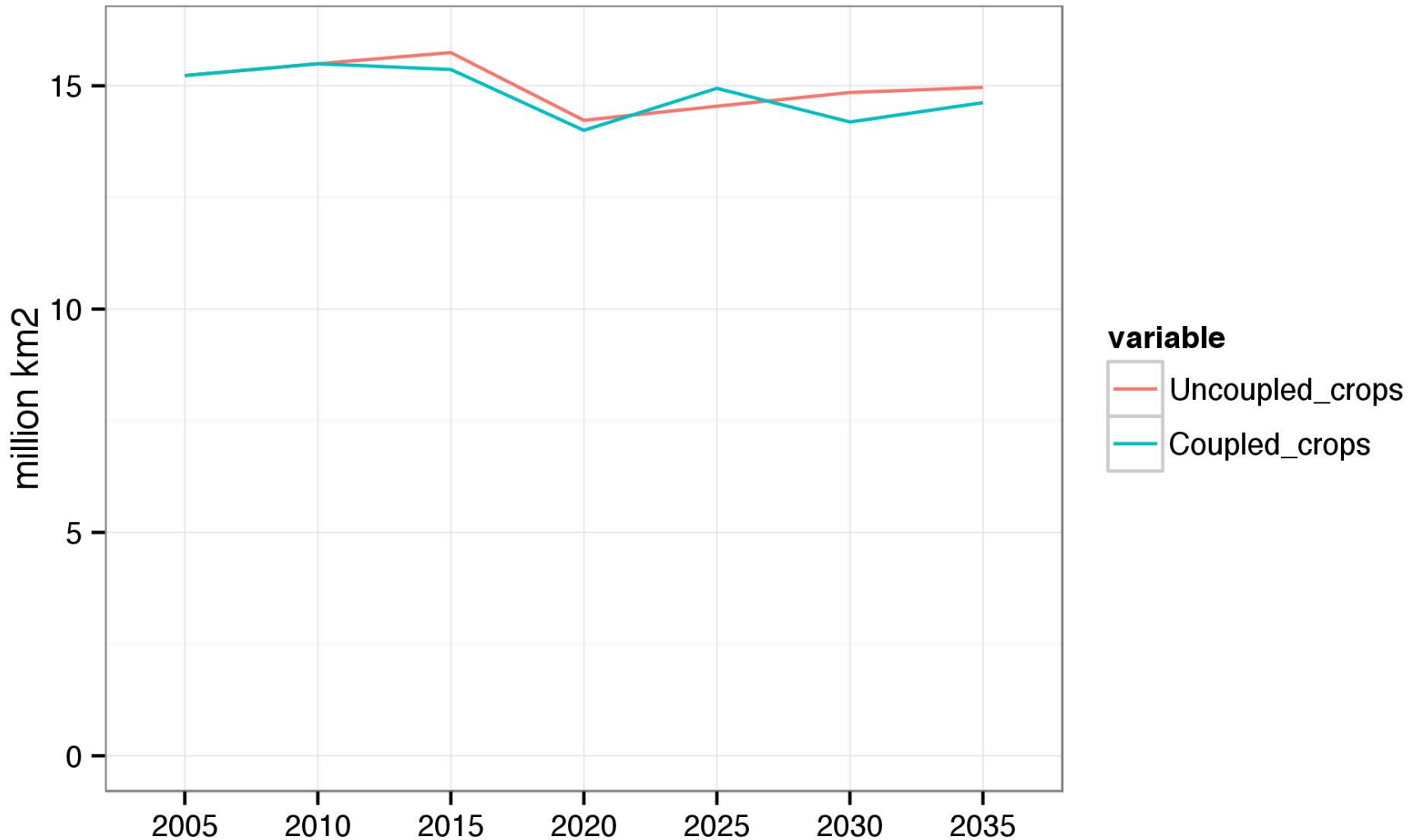


Global Agricultural Production



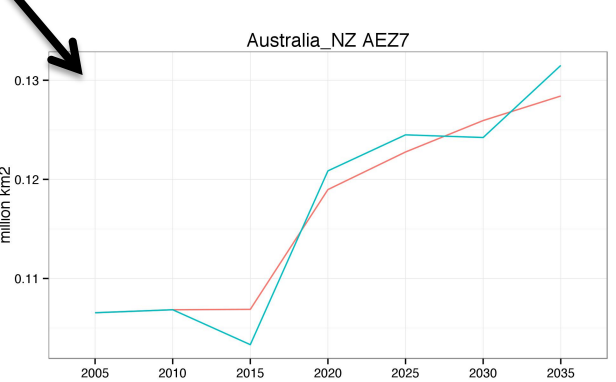
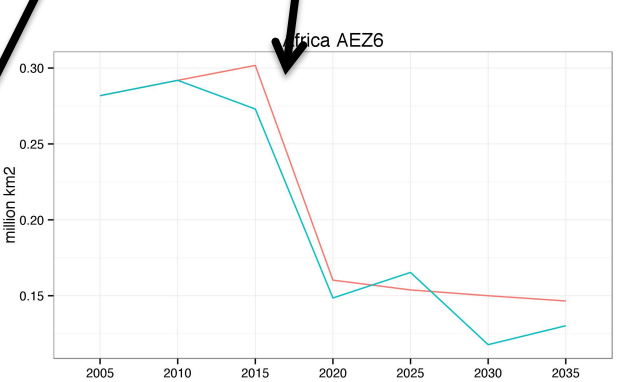
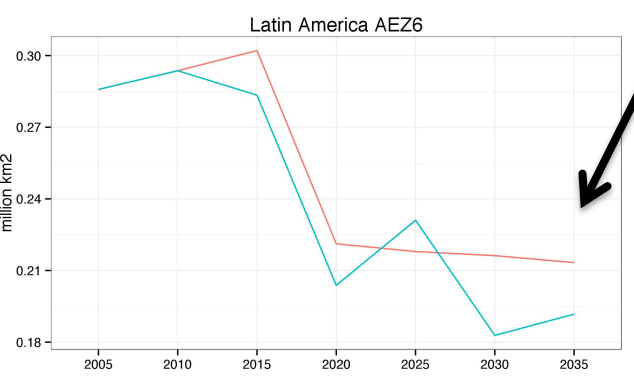
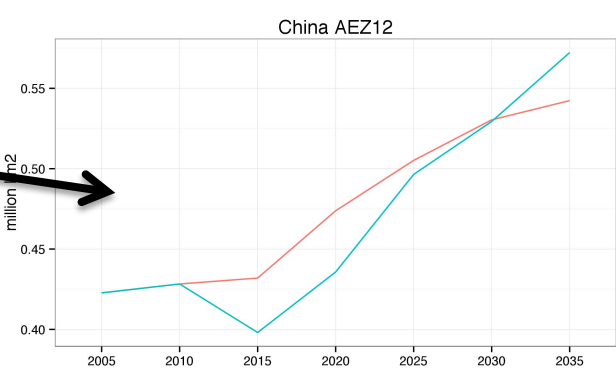
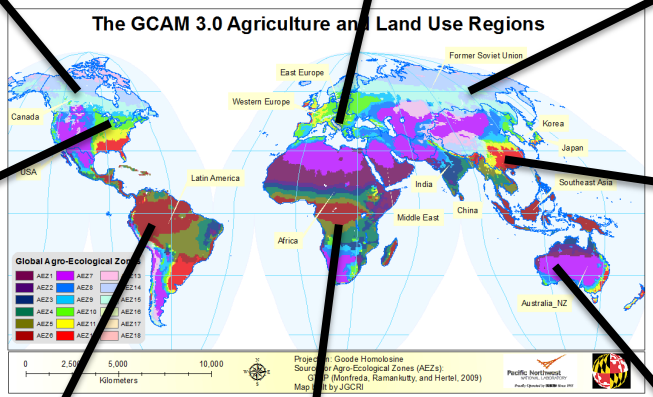
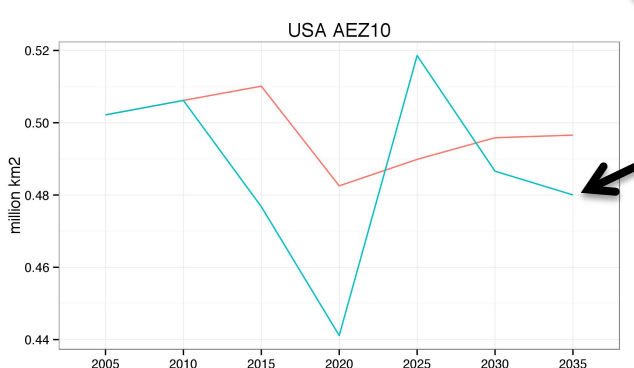
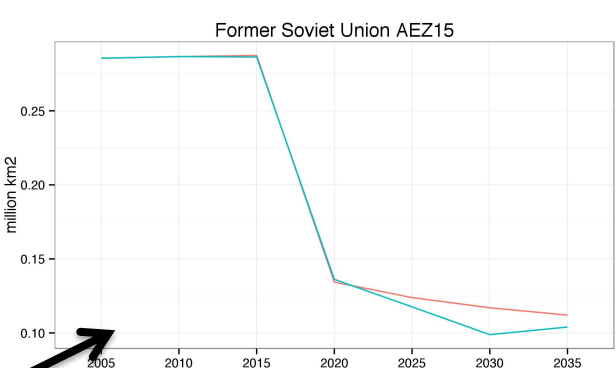
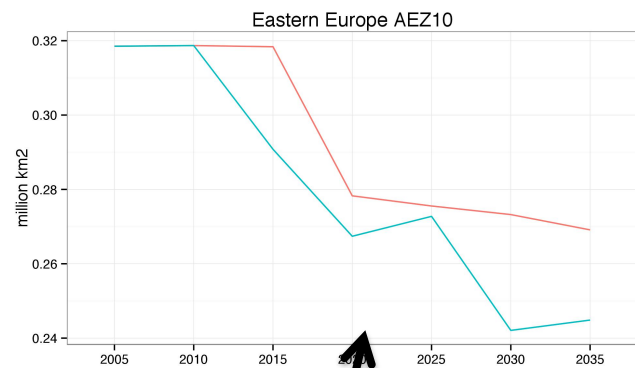
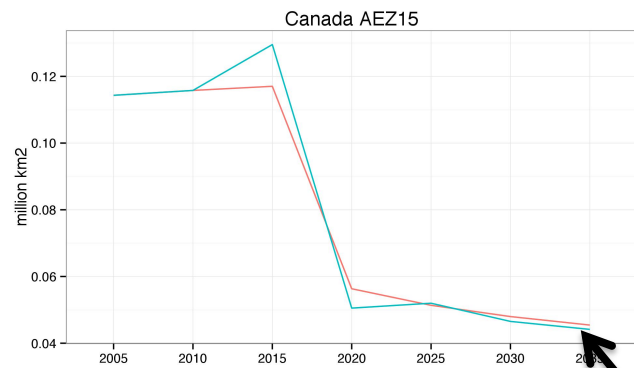
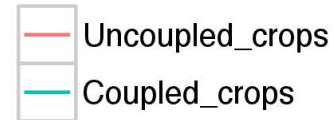
As a result, cropland area responds (slightly) to the climate signal.

Global Cropland



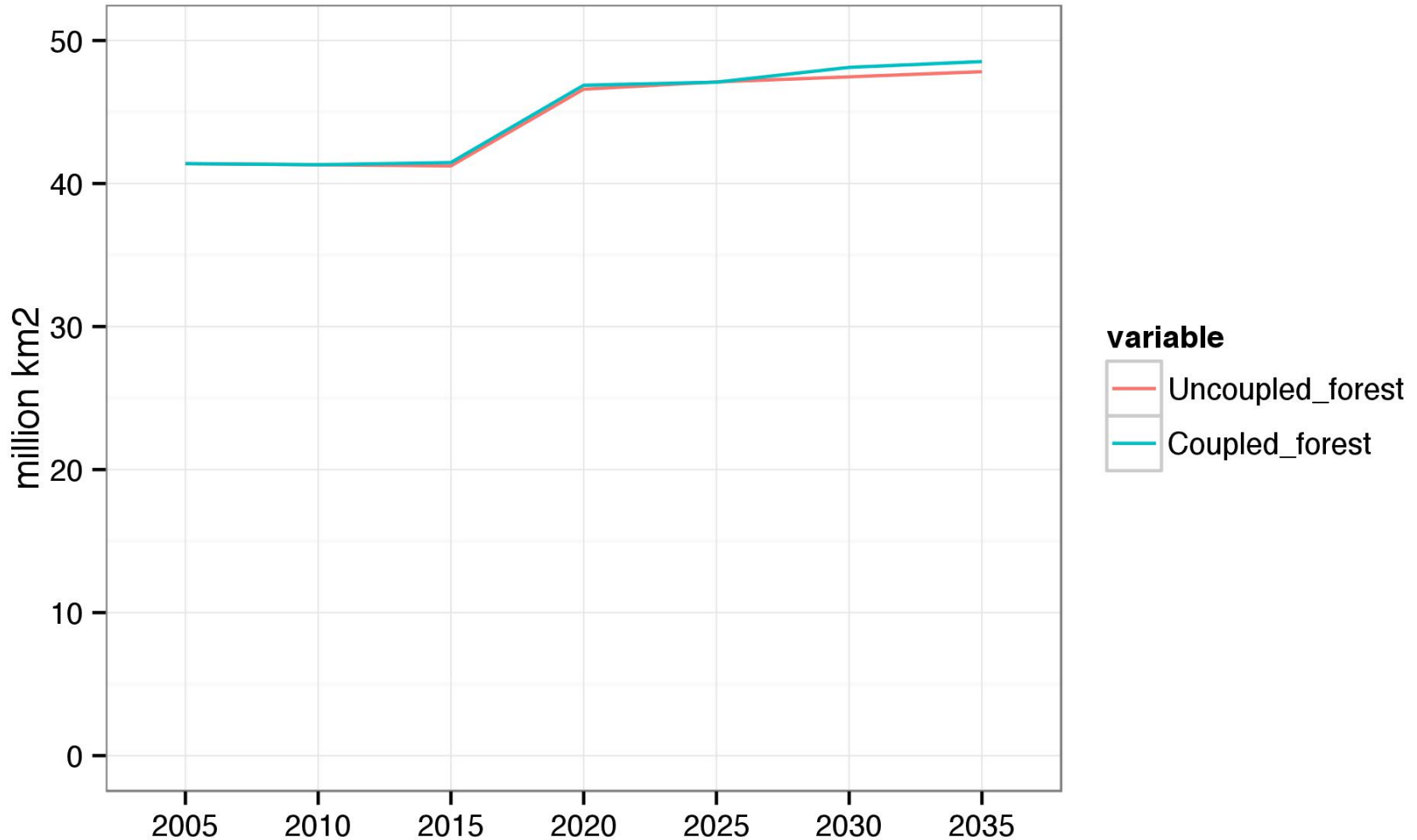
The effect on regional cropland is varied.

variable



Global forest cover increases slightly due to declines in cropland requirements

Global Forest Cover

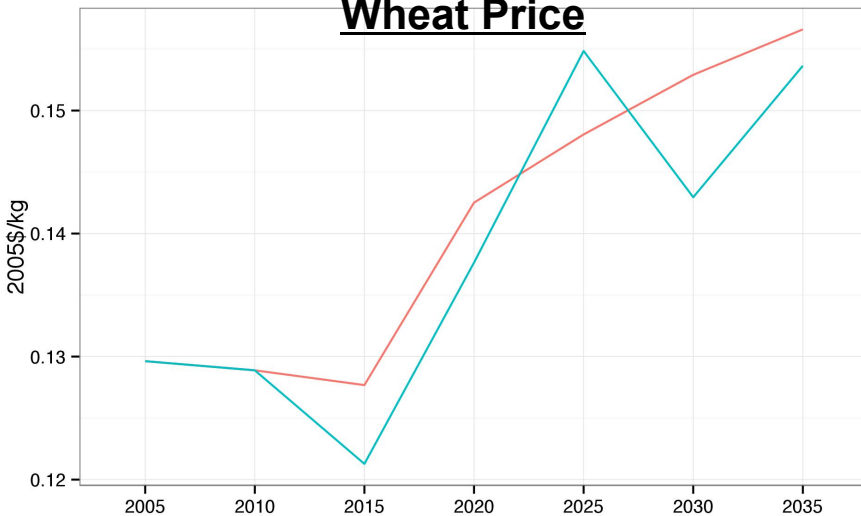


Climate change can also affect prices, food demand, bioenergy use, and emissions

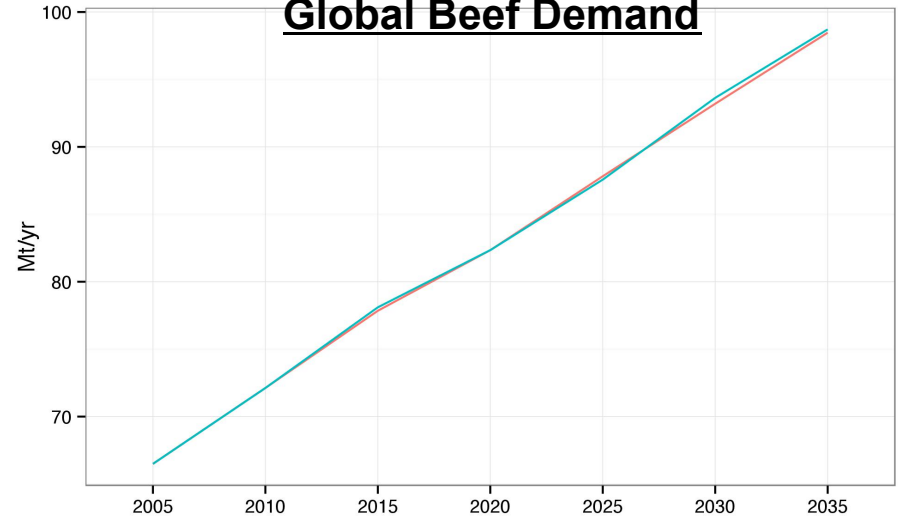
variable

- Uncoupled
- Coupled

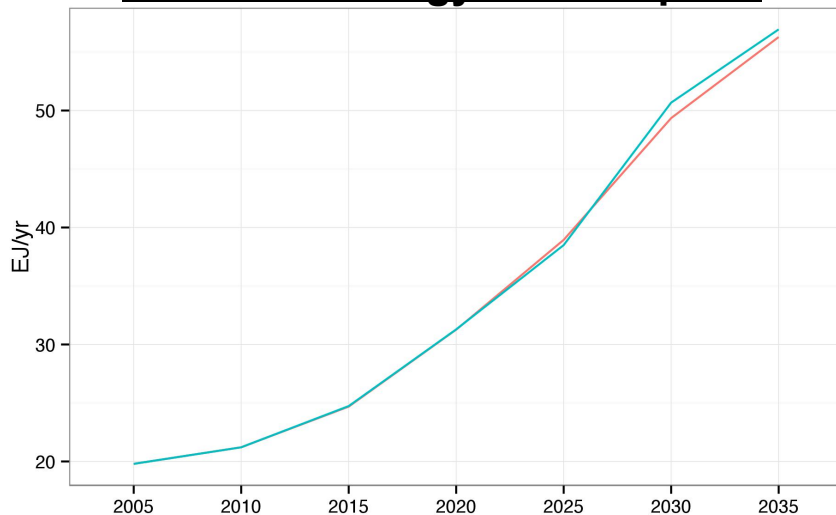
Wheat Price



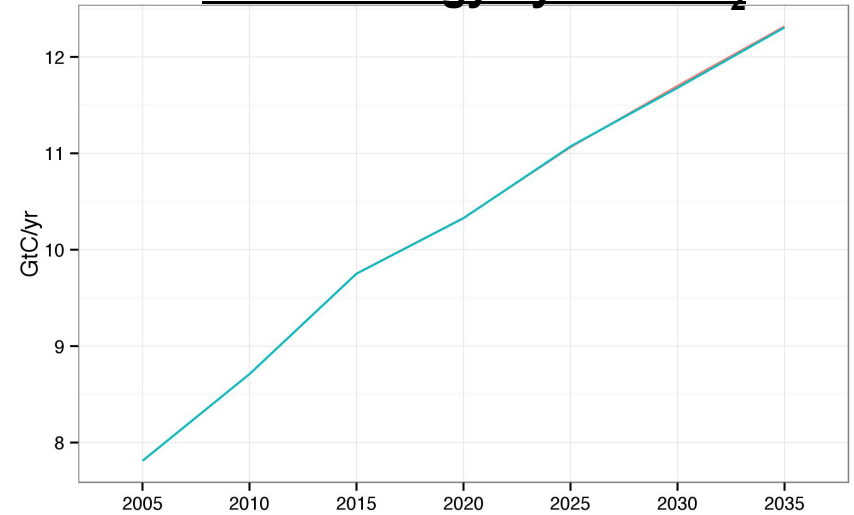
Global Beef Demand



Global Bioenergy Consumption



Global Energy System CO₂



- ▶ We are using CLM to adjust ecosystem productivity within an integrated assessment model.

- ▶ Changes in ecosystem productivity can induce:
 - Changes in cropland cover (both regional and global)
 - Changes in forest cover (both regional and global)
 - Changes in the price, and consequently the demand, of food
 - Changes in the production and use of bioenergy
 - Changes in energy & agricultural emissions

- ▶ The direction and magnitude of these changes depends on the direction and magnitude of the change in ecosystem productivity



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DISCUSSION