

# Global Economic Models: Up- and Downstream Linkages

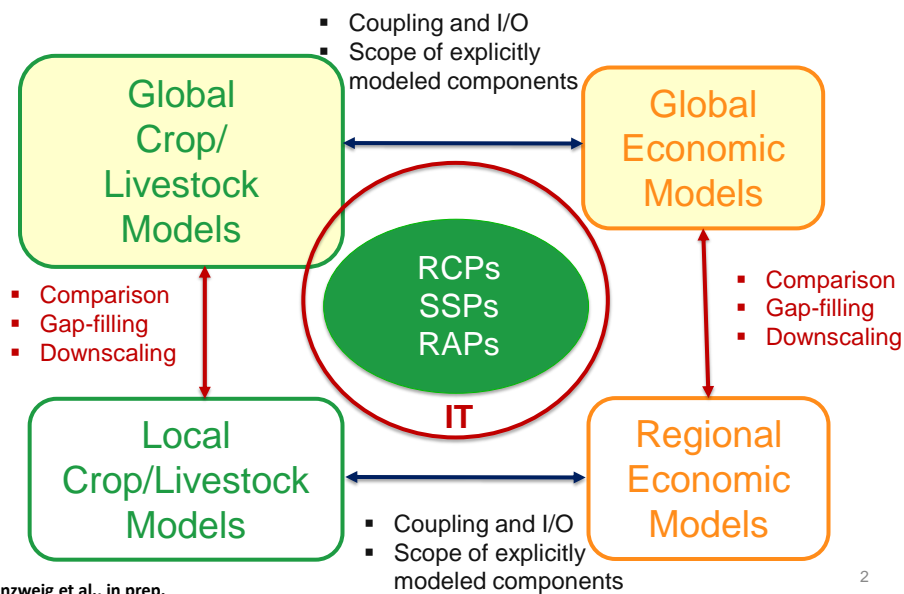
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with Keith Wiebe, Ronald Sands, Andrzej Tabeau, Anne Biewald, Benjamin Bodirsky, Shahnila Islam, Aikaterina Kavallari, Daniel Mason-D'Croz, Christoph Mueller, Alexander Popp, Richard Robertson, Sherman Robinson, Hans van Meijl, Dirk Willenbockel

Adaptation Futures  
Rotterdam, 12 May 2016



## Coordinated Global-Regional Assessments



## Key policy-relevant questions

- What is the future of agricultural prices?
- How will agricultural production and food consumption evolve?
- How will climate change impacts and mitigation affect...
  - Prices
  - Land use
  - Trade
  - Undernourishment

## What can AgMIP global economic models deliver?

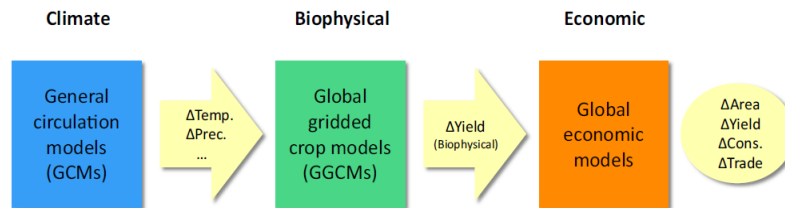
(as input for crop models and regional economic models)

- Changes in production, area, global and regional prices, demand, trade
  - For 5 major crop groups (wheat, coarse grains, rice, oilseeds, sugar) and major world regions
  - For meat and dairy products
  - Other crops: e.g. fruits & vegetables (by selected models)

### Further outputs (work in progress):

- Food security and inequality:
  - within-country income inequality
  - number of people affected by hunger
  - health impact from food consumption
- Changes in input use and input prices (e.g. fertilizer, chemicals, capital, wages, energy, land, carbon)

## Modeling climate impacts on agriculture: linking biophysical and economic effects (AgMIP Phase 1)



Source: Nelson et al., PNAS (2014)

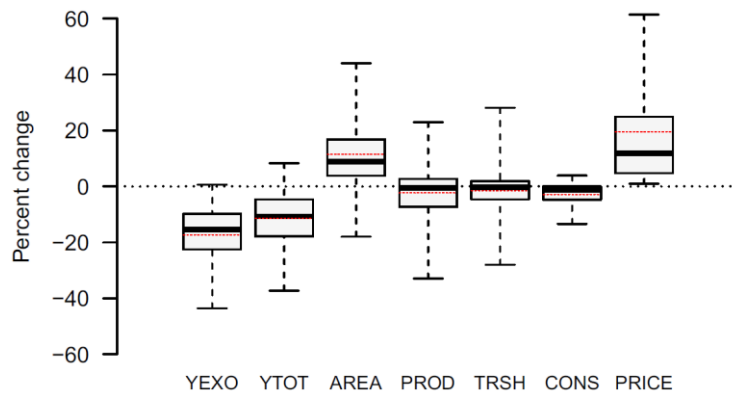
## AgMIP Global Economics (Phase 1)

### 10 global economic modeling groups participated

- Australian Bureau of Agricultural and Resource Economics and Sciences – GTEM
  - Food and Agriculture Organization of the UN – ENVISAGE
  - International Food Policy Research Institute – IMPACT
  - International Institute of Applied Systems Analysis – GLOBIOM
  - LEI Wageningen UR – MAGNET
  - MIT – EPPA
  - National Institute for Environmental Studies (Japan) – AIM
  - Potsdam Institute for Climate Impact Research – MAgPIE
  - PNNL/Maryland Joint Global Change Research Institute – GCAM
  - USDA Economic Research Service – FARM
- [Note: JRC CAPRI team ran all scenarios after Phase 1]

## Climate change impacts in 2050 (Phase 1)

(percent change **relative to baseline** without climate change in 2050,  
2 GCMs x 5 crop models)



Source: Nelson et al., PNAS (2014)

## AgMIP Global Economics (Phase 2.1)

5 global economic modeling groups contributed to  
USDA poverty report:

- International Food Policy Research Institute – IMPACT
- LEI Wageningen UR – MAGNET
- Potsdam Institute for Climate Impact Research – MAGPIE
- Purdue University/Global Trade Analysis Project & Food and Agriculture Organization of the UN – ENVISAGE
- USDA Economic Research Service – FARM

Source: Wiebe et al., ERL 2015

## Scenario definition

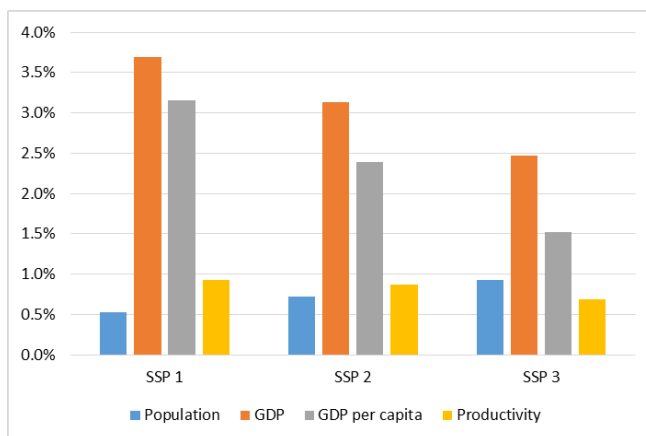
(3 GCMs x 1 crop model (LPJmL))

Scenario	SSP	Climate	GCM	Trade policy	Economic model
1.0	SSP 1	No change	none	No change	ENVISAGE, FARM, IMPACT, MAGNET, MAgPIE
1.1		RCP 4.5	HadGEM		
1.2			IPSL		
1.3			MIROC		
1.4			HadGEM		
2.0	SSP 2	No change	none	No change	ENVISAGE, FARM, IMPACT, MAGNET, MAgPIE
2.1		RCP 6.0	HadGEM		
2.2			IPSL		
2.3			MIROC		
3.0	SSP 3	No change	none	No change	ENVISAGE, FARM, IMPACT, MAGNET, MAgPIE
3.1		RCP 8.5	HadGEM		
3.2			IPSL		
3.3			MIROC		
3.4			HadGEM		

Source: Wiebe et al., ERL 2015

## For this paper: simplified representation of Shared Socioeconomic Pathways (SSPs)

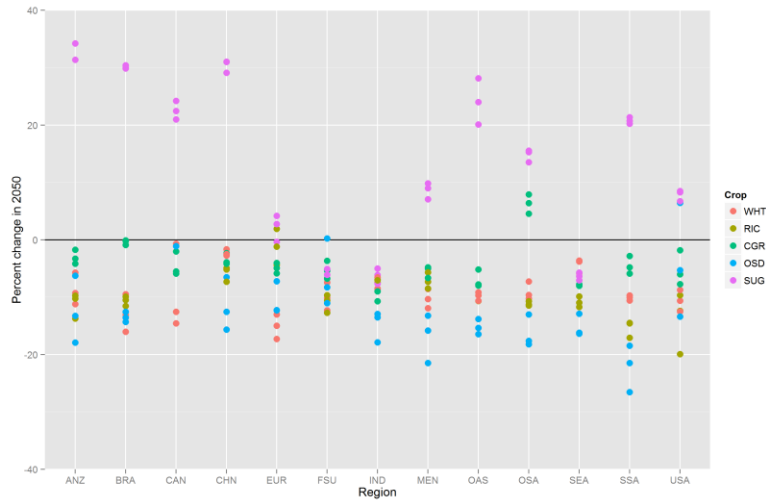
Population, GDP and agricultural productivity assumptions by SSP (annual percentage change, 2010 – 2050)



Source: IIASA; OECD; Wiebe et al. ERL 2015

# Exogenous impacts on crop yields

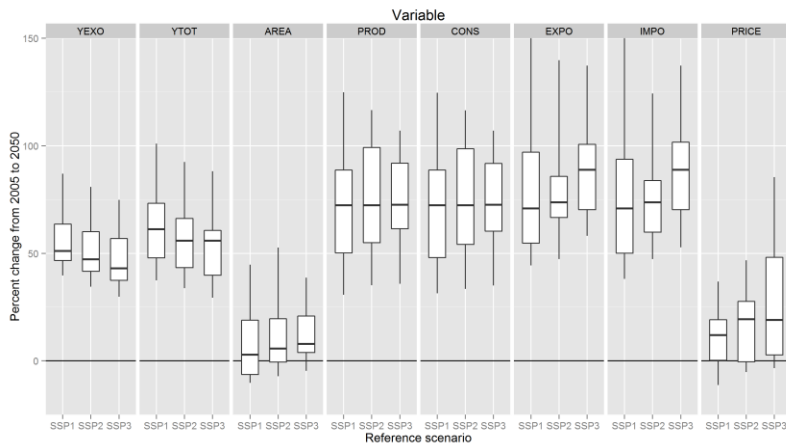
Climate impacts for RCP 6.0 (with SSP 2)  
 (3 GCMs x 1 crop model, LPJmL)



Source: Wiebe et al., ERL 2015

# Baseline results for SSP1, 2 and 3

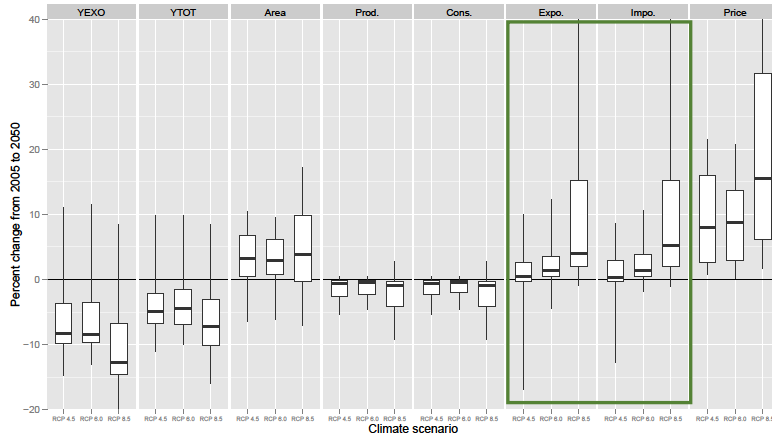
Baseline increases in global yields, area, production, consumption, exports, imports and prices of coarse grains, rice, wheat, oilseeds and sugar in 2050 (% change relative to 2005 values)



Source: Wiebe et al., ERL 2015

# Climate change impacts in 2050

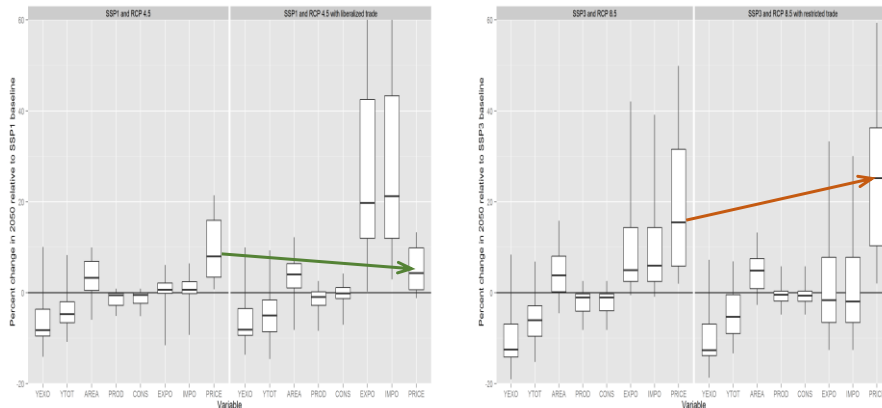
Climate change impacts on global yields, area, production, consumption, exports, imports and prices of coarse grains, rice, wheat, oilseeds and sugar in 2050 (% change relative to 2050 baseline values)  
 (3 GCMs x 1 crop model, LPJmL)



Source: Wiebe et al., ERL 2015

# Climate change impacts and trade

Impacts of climate change and trade policy on yields, area, production, exports and prices of five commodities, (% deviation from baseline values in 2050 without climate change)  
 (3 GCMs x 1 crop model, LPJmL)



Source: Wiebe et al., ERL 2015

Towards global “Representative Agricultural Pathways”:  
various elements of the SSP storylines will be implemented in  
global economic models

Element	Indicator	SSP1	SSP2	SSP3	SSP4	SSP5
Population		from SSP database				
GDP		from SSP database				
Productivity	Crop yields (IPR)	high	medium	Low	low	high
	Livestock efficiency	high	medium	Low	low	high
	Nutrient efficiency	high	medium	Low	low	high
Environment	Forest protection/ nature conservation rate	high	medium	Low	medium	medium
Globalization	Trade liberalization	fast	medium	slow	fragmen- ted	fast
	Domestic ag. policies, eg removal of subsidies	constant (tbd)	constant (tbd)	constant (tbd)	constant (tbd)	constant (tbd)
Diet changes	Income elasticity of total food demand	low	medium	high	medium	medium
	Animal calorie share in total food demand	low	medium	high	medium	medium

Source: Popp et al., under review

Towards global “Representative Agricultural Pathways”:  
additional SSP x RCP combinations will be quantified by  
global economic models in AgMIP Phase 2.2

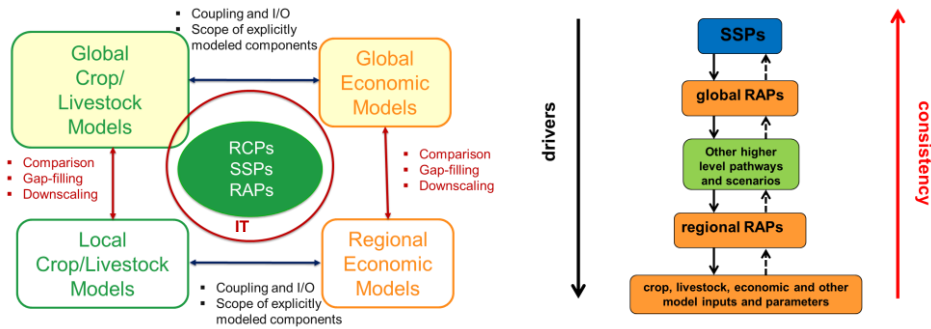
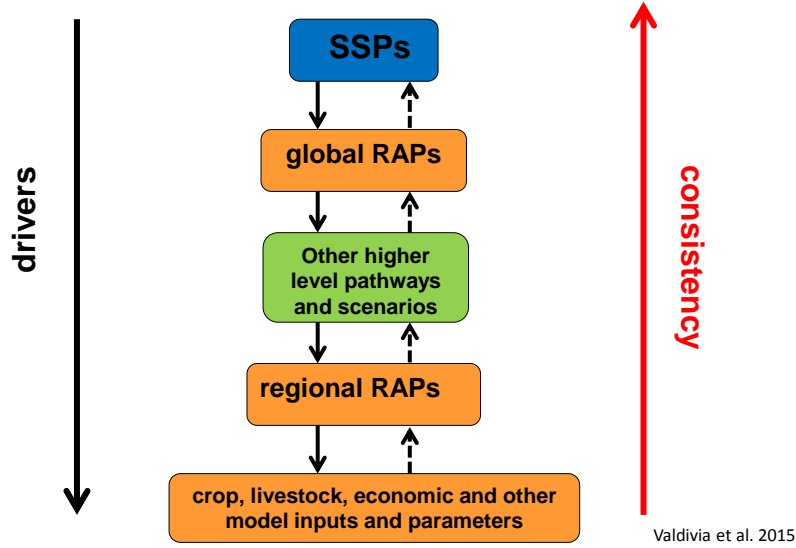
	SSP 1	SSP 2	SSP 3	SSP 4	SSP 5
RCP 8.5		Phase 1	Phase 2.1		Phase 2.2?
RCP 6.0		Phase 2.1	Phase 2.2?	Phase 2.2?	
RCP 4.5	Phase 2.1				
RCP 2.6	Phase 2.2?	Phase 2.2?	Phase 2.2?		Phase 2.2?
NoCC	Phase 2.1	Phase 1 Phase 2.1	Phase 1 Phase 2.1		

**This scenario setting will be used to assess:**

- Climate change impacts on agriculture
- Adaptation options: e.g. trade, land expansion, irrigation, new technologies
- Ambitious mitigation scenarios (bioenergy use, avoided deforestation, GHG emission taxes, dietary change)



# Interaction across scales between global and regional models



## Global Economic Models: Up- and Downstream Linkages

Thank you!

