

Land-use patterns for climate and socio-economic forcing data (ISIMIP3b Group III-PROCLIAS TG 1.1)

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ISIMIP3b Group III-PROCLIAS TG 1.1

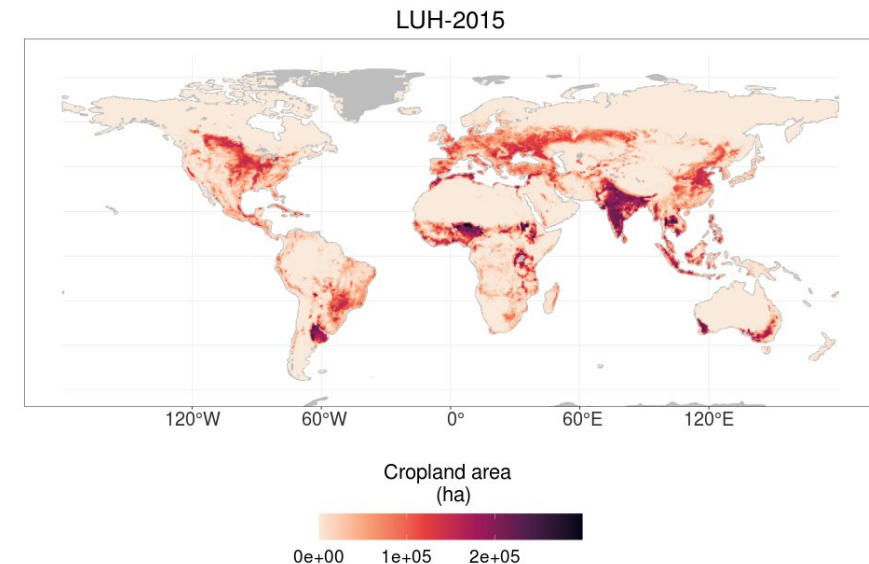
Harmonized land-use and agricultural management projections driven by global change at **0.25° x 0.25°** between 2015-2100

Key outputs:



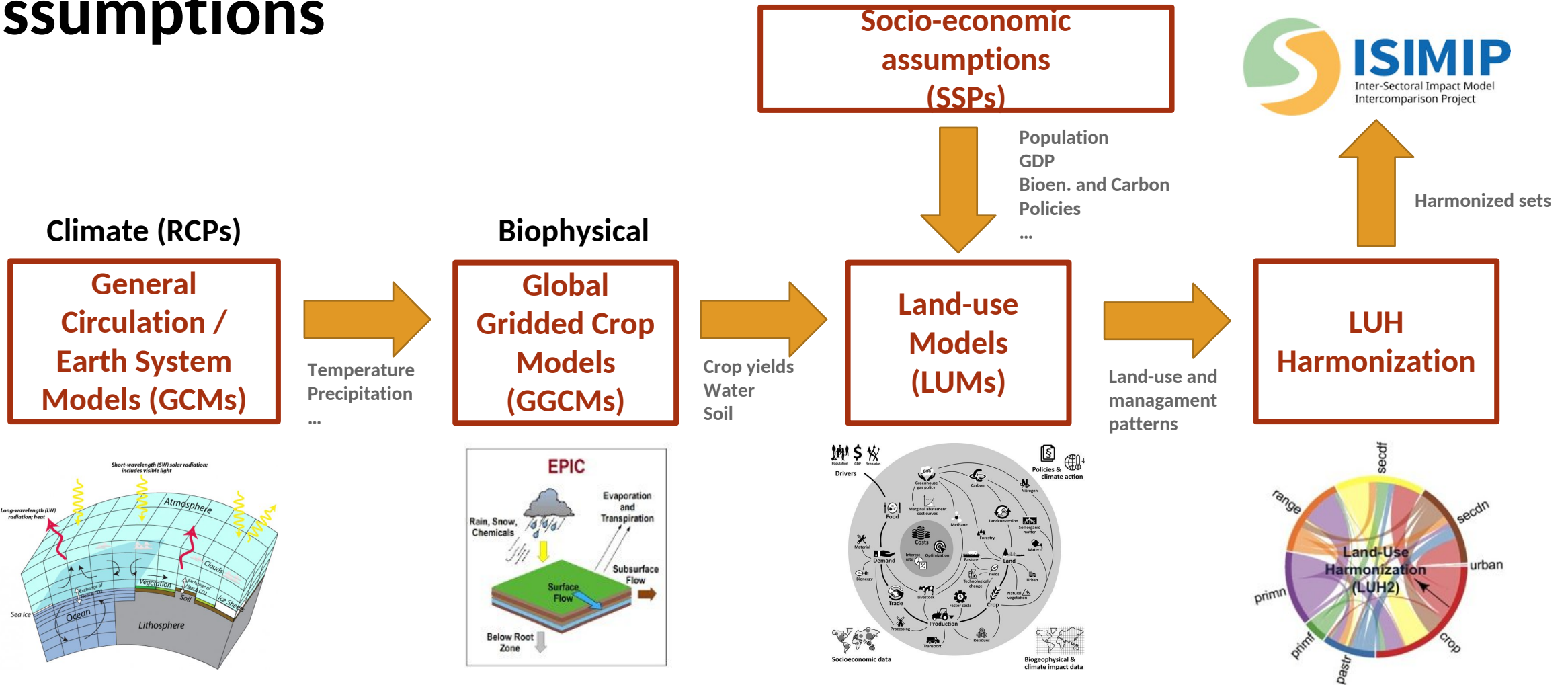
- **LU projections** (Cropland, forest, pastures, urban land, natural vegetation)
- **Bioenergy crops** (1st and 2nd generation)
- **Irrigated crop area** (per crop type)
- **Industrial N Fertilizer rates** (per crop type and ha)
- **Wood harvest**
- C3 annual **flooded** areas

Harmonization to ensure a smooth transition between the historical data sets (LUH2)¹ and the projected futures.



1. Hurtt, George C., et al. "Harmonization of global land use change and management for the period 850–2100 (LUH2) for CMIP6." *Geoscientific Model Development* 13.11 (2020): 5425-5464.

LUMs combine biophysical and socioeconomic assumptions



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Credit: Dietrich et al. licensed under CC BY- 4.0

Credit: LUH, University of Maryland

ISIMIP3b includes adaptation, 3 LUMs, and CO₂ fertilization

Differences between ISIMIP rounds:

	ISIMIP2b	ISIMIP3b
Scope	Impacts	Impacts
	Mitigation	Mitigation Adaptation
Scenarios	SSP2-RCP6.0	SSP1-RCP2.6
	SSP2-RCP2.6	SSP3-RCP7.0
		SSP5-RCP8.5
LUMs	MAgPIE	MAgPIE GLOBIOM IMAGE
		LPJmL EPIC IMAGE-LPJmL
Crop models	LPJmL	
Climate models	CMIP5	CMIP6

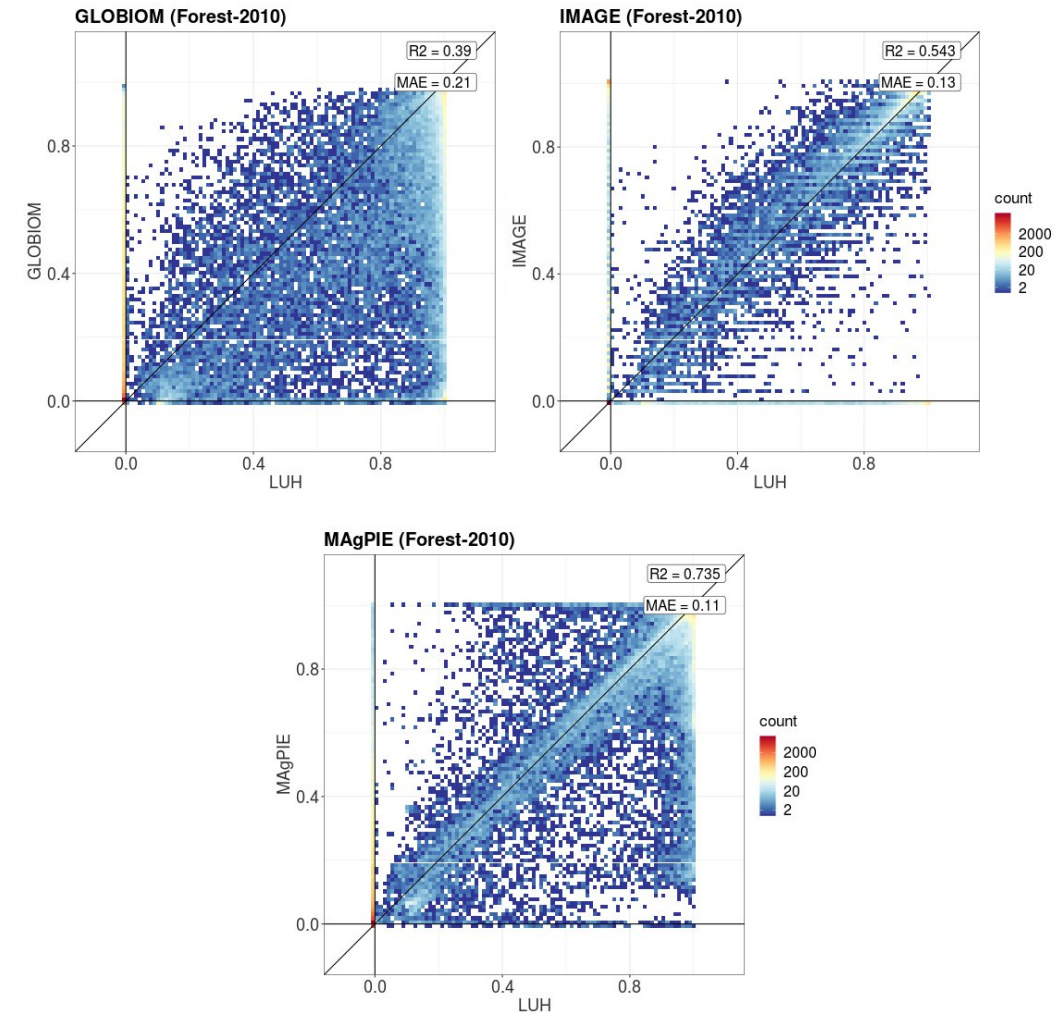
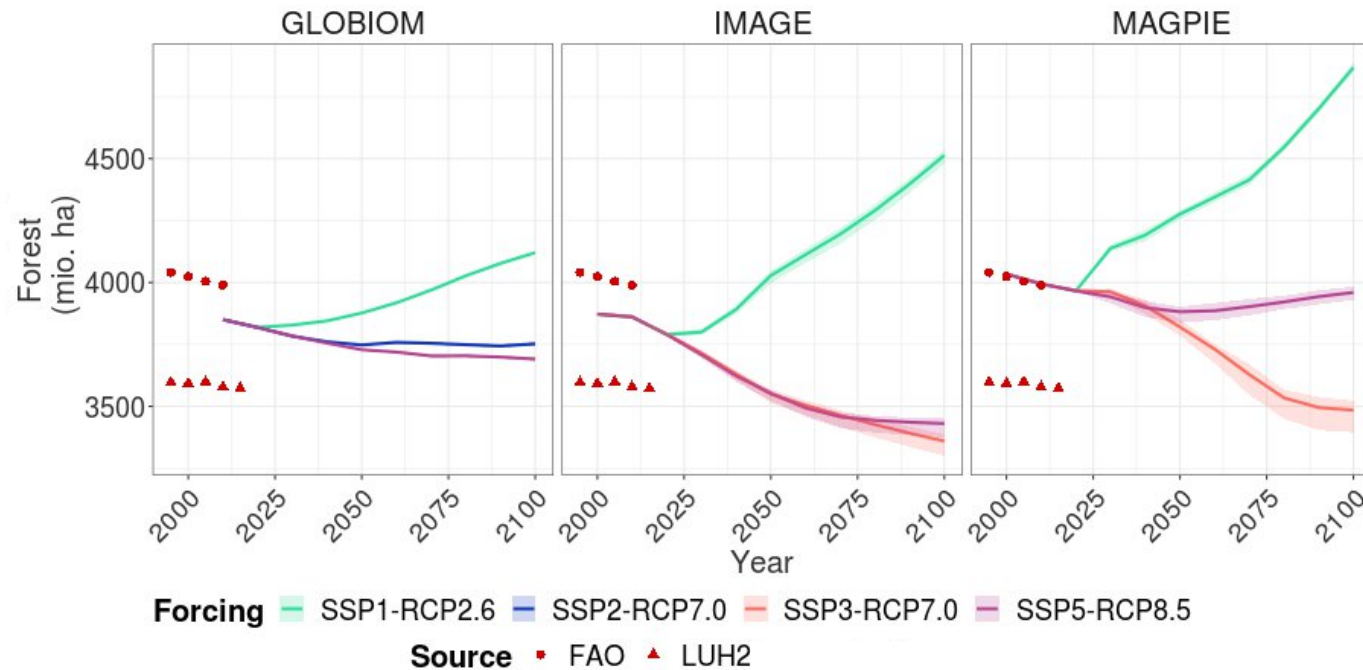
Scenarios

GCM/ESM	CO ₂ fert.	SSPs-RCPs	GGCMs-IAMs
IPSL-MC6A-LR	+		
MPI-ESM1-2-HR	+	SSP1-RCP2.6	
UKESM1-0-LL	+	SSP3-RCP7.0	LPJmL-MAgPIE-REMIND
MRI-ESM2-0	+	SSP5-RCP8.5	EPIC-GLOBIOM-MESSAGE
GFDL-ESM4	+		LPJmL-IMAGE-MAGNET
constant 2015	Const	SSPx-NoCC	
GFDL-ESM4	-	SSP5-RCP8.5	

Outputs (per LUM): In total, **19** simulations, LU and management harmonized **maps**, at **0.25° x 0.25°** resolution, **until 2100** (from 2015 on) per LUM.

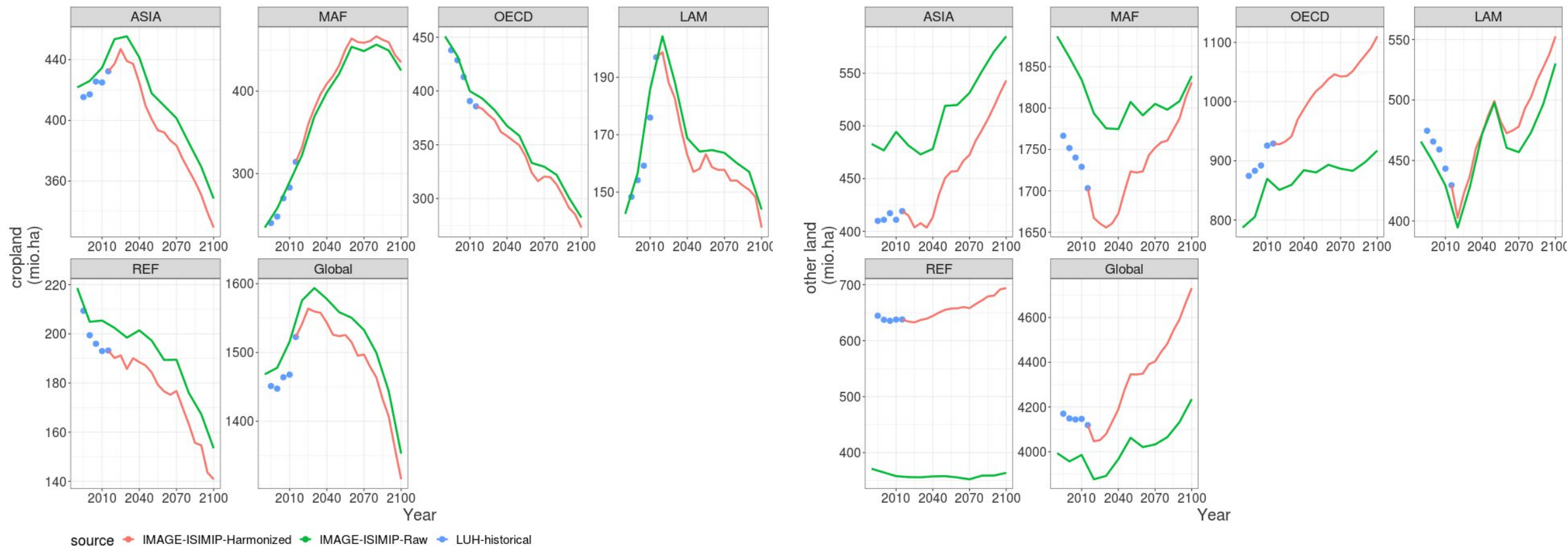
Agreement in cropland, differences in definitions and initial maps in other land types

Preliminary results:

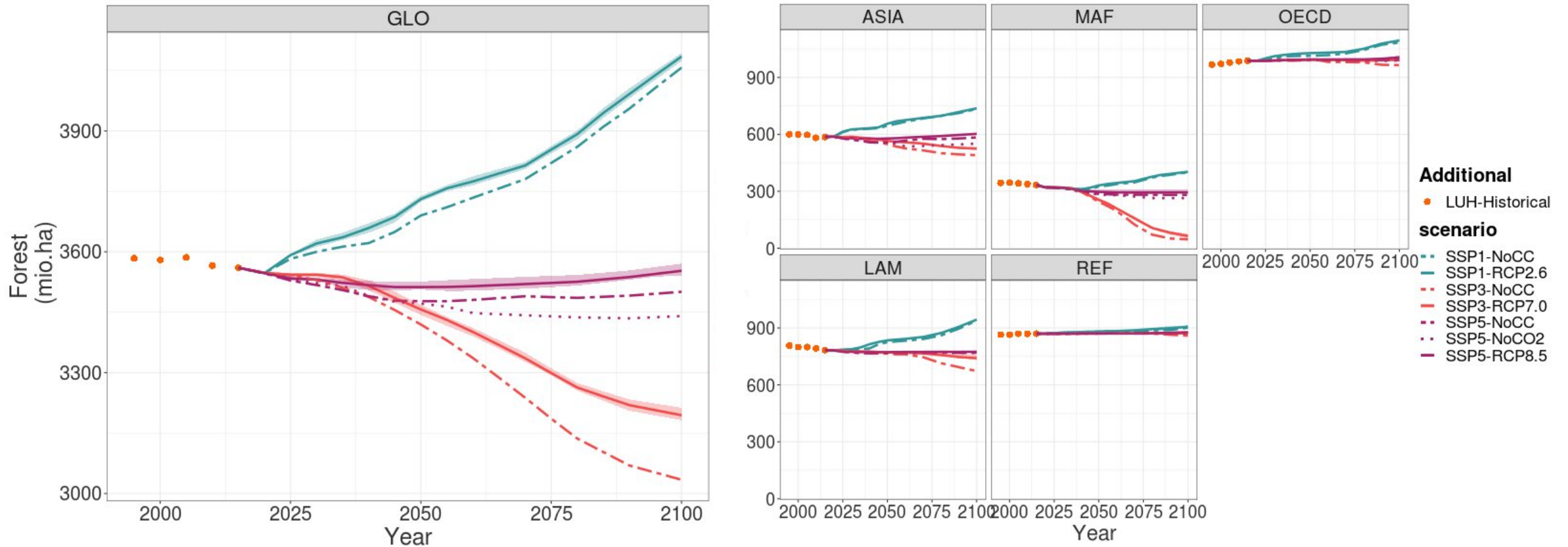


Direct harmonization of cropland, pastures, urban area Natural vegetation (Forest and other land) calculated

IMAGE (SSP1-2.6-GFDL-ESM4)



LPJmL in the positive side of impacts, less cropland when including climate change impacts in MAgPIE

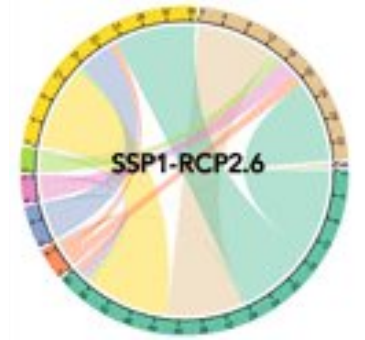


Timeline

1. Harmonization to LUH2 values (feedback between teams)
2. Data publication goal date: Fall
3. Papers summarizing protocol, main findings and uncertainty (Focus on land-use types).

Thank you!

LUH2 harmonization at grid and country level



Convert **LUMs data** to a **standardized format** (Annual $0.25^{\circ} \times 0.25^{\circ}$)

Aggregate LU types to large categories (Cropland, managed pasture, rangelands and urban) and calculate annual land changes

Apply the land changes to the patterns of the previous time step, starting with the end of the historical period

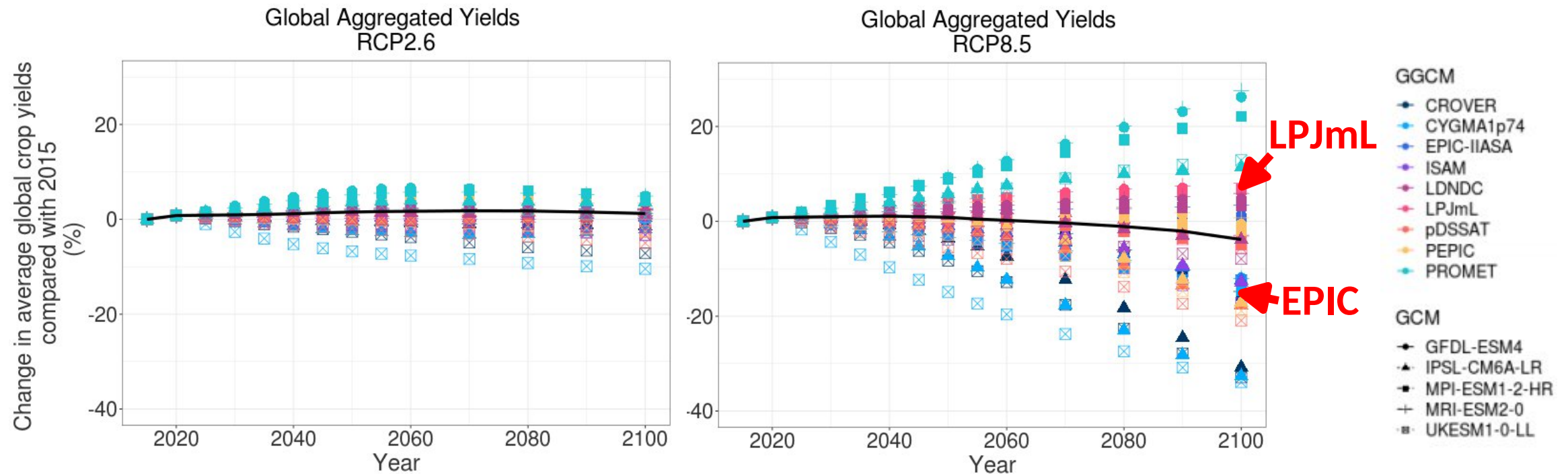
Disaggregate and calculate other subtypes (Crop functional types, natural vegetations, management...)

LUH2 harmonization at grid and country level

Points to consider:

- **Good matches (global, regional, spatially explicit) for cropland, pastures, and urban land.**
- **Natural vegetation is not directly harmonized (Forests and other land).**
- **Crop types are disaggregated based on harmonized cropland area. Trends match for dominant crop types, and other types might not perfectly fit.**
- **Irrigation, flooded area, wood harvest, and fuelwood fraction are harmonized on the country level.**
- **First-generation bioenergy based on 2015 fraction.**

Aggregated and harmonized crop yields (range in yields)



Source: Molina Bacca et al. (in review). "Land-use adaptation uncertainty persists although new crop model projections suggest reduced average impacts under high warming". Submitted to Nature Communications Earth & Environment.

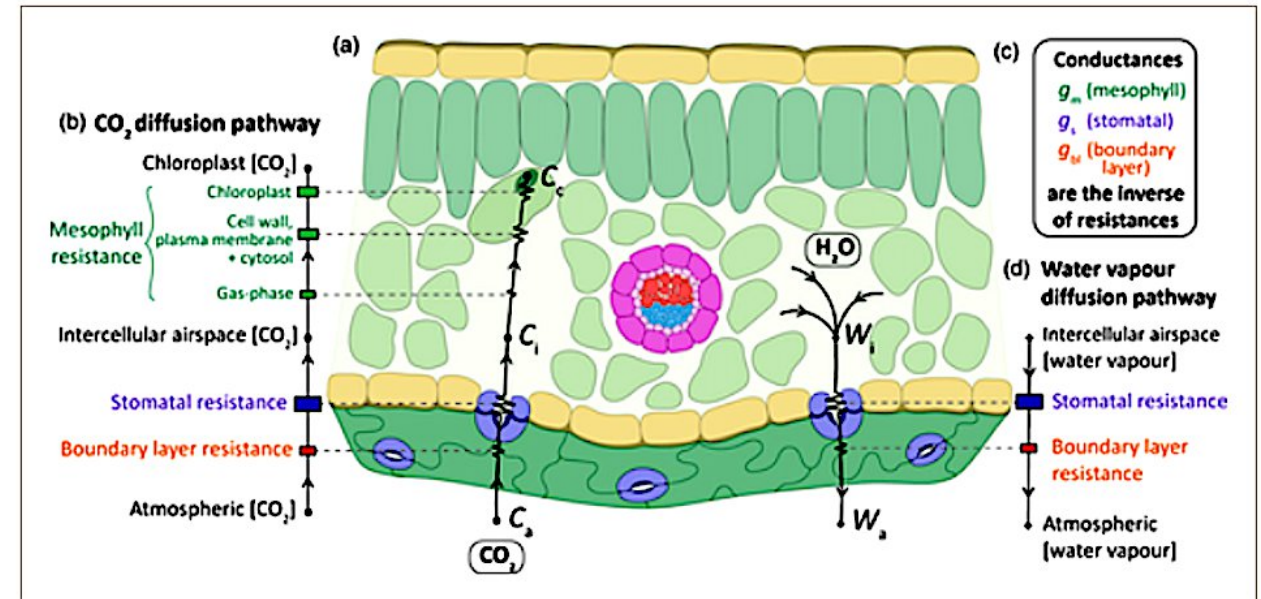
CO₂ fertilization

Direct effect: acceleration of photosynthesis due to increased supply of CO₂, increasing vegetation productivity.

Indirect effect: Reduction of water loss due to reduced stomatal conductance.

However:

- Benefits are constrained by local water and nutrient availability (N,P,...)
- Not all plants benefit equally
- Challenges in measuring effects for high CO₂ concentrations (reduced number of experimental data).



Source: <https://plantstomata.files.wordpress.com/2019/11/screen-shot-2019-11-24-at-21.29.29.png>

Three Land-use models

- **GLOBIOM** – Global Biosphere Management Model (International Institute for Applied Systems Analysis - IIASA)
- **IMAGE** – Integrated Model to Assess the Global Environment (Netherlands Environmental Assessment Agency- PBL)
- **MAGPIE** – Model of Agricultural Production and its Impact on the Environment (Potsdam Institute for Climate Impact Research- PIK)



Credit: © © Globiom

