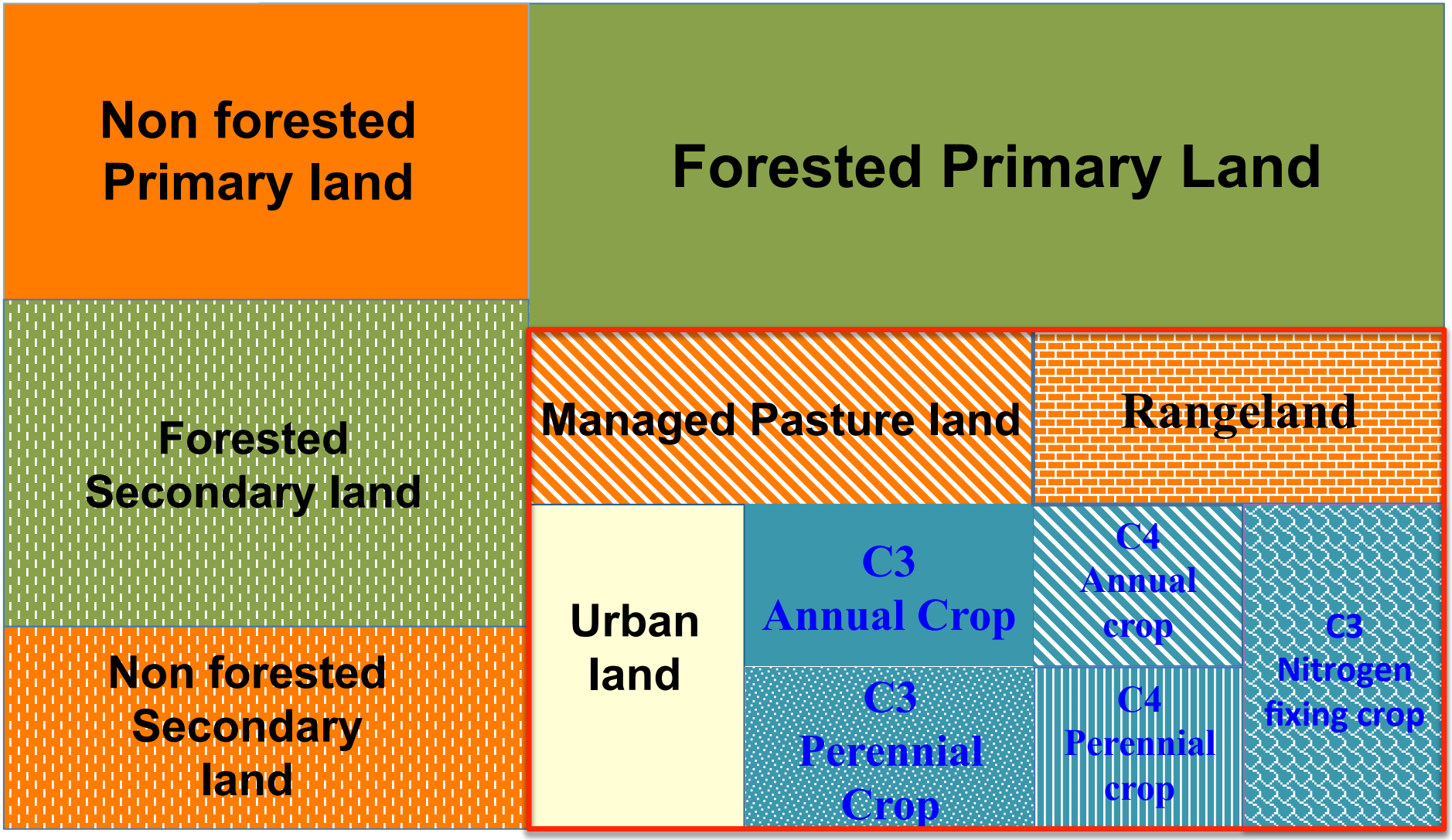
Usage des Sols dans CMIP6
Pré-travail IPSL + discussions CNRM

- **Coordination: LUMIP (Lawrence et al. submitted)**
- **Releases already done of past land-uses and six future scenarios**
- **What informations will we get?**
- **Some basic rules for implementation in both climate models (IPSL, ARPEGE)**
- **LUMIP simulations (partly supported by CRESCENDO ?)**

Provision of Land Uses for CMIP6 from LUMIP – Land units in each grid cell

http://luh.umd.edu/data.shtml



Provision of Land Uses for CMIP6 from LUMIP – Land management per grid cell

http://luh.umd.edu/data.shtml

New Management Layers

Agriculture

Fraction of cropland irrigated
Fraction of cropland flooded
Fraction of cropland fertilized
Fertilizer application rates
Fraction of cropland tilled
Fraction of cropland for biofuels

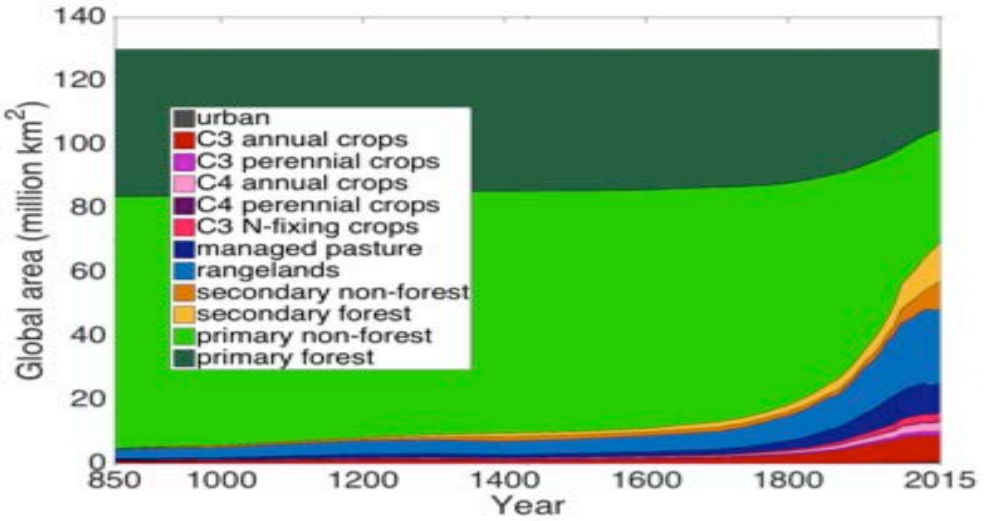
Wood Harvest

Fraction used for industrial products
Fraction used for commercial biofuels
Fraction used for fuelwood

Land-Use Harmonization (LUH2)

New Resolution
0.25° grid-cell fraction

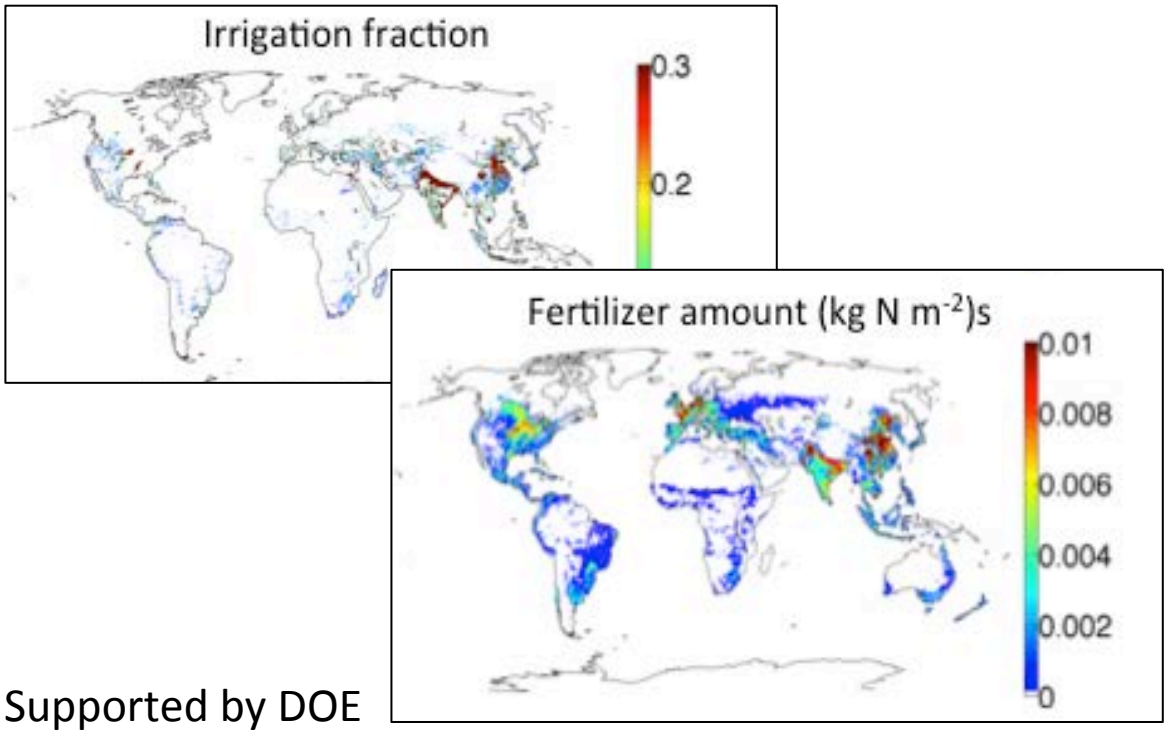
New History
Hyde 3.2, FAO based
Landsat F/NF constraint
Multiple crop types (5)
Multiple pasture types (2)
Updated Forest Cover/Biomass
Updated Wood harvest
Updated Shifting Cultivation
Extended time domain (850-2015)



New Management Layers

Agriculture
Fraction of cropland irrigated
Fraction of cropland flooded
Fraction of cropland fertilized (industrial)
Industrial Fertilizer application rates
Fraction of cropland for biofuels
Crop rotations

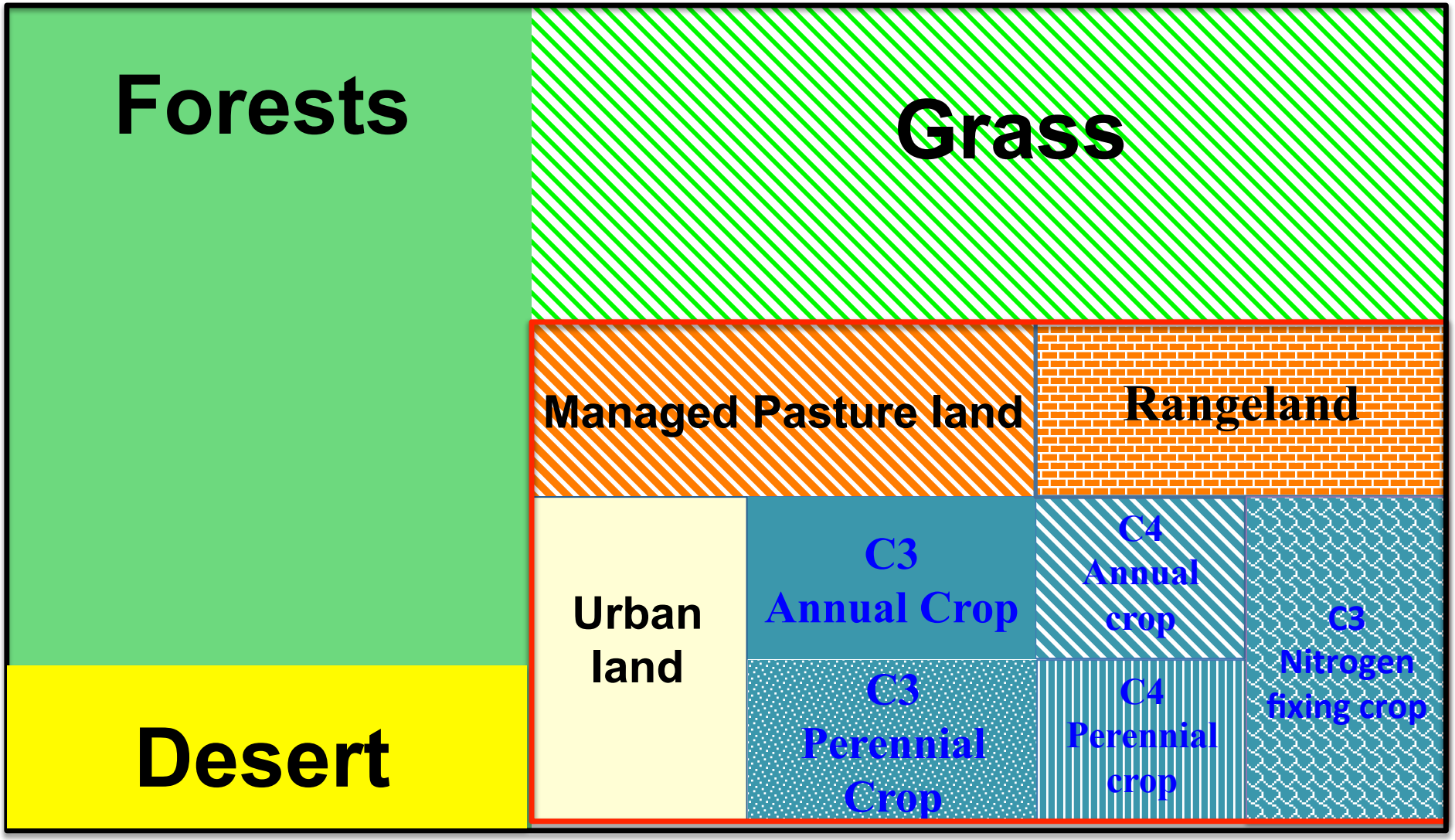
Wood Harvest
Fraction used for industrial products
Fraction used for commercial biofuels
Fraction used for fuelwood



New Future Scenarios
Six futures, SSP-based

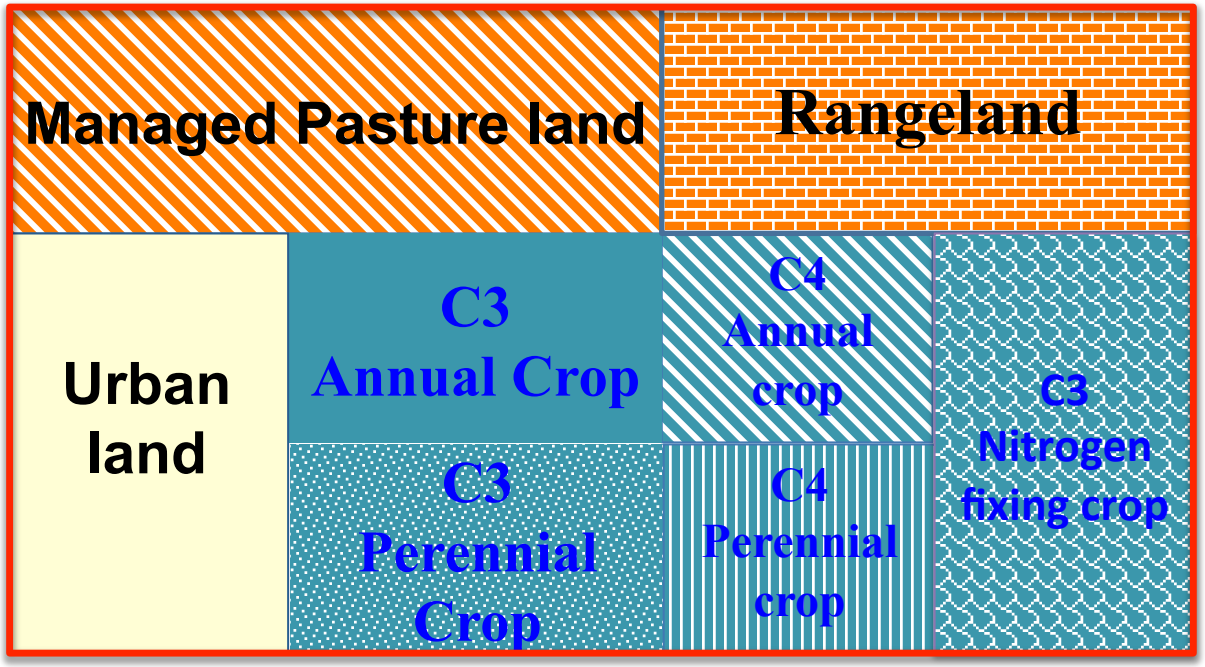
Supported by DOE

Land units in each grid cell of the land model



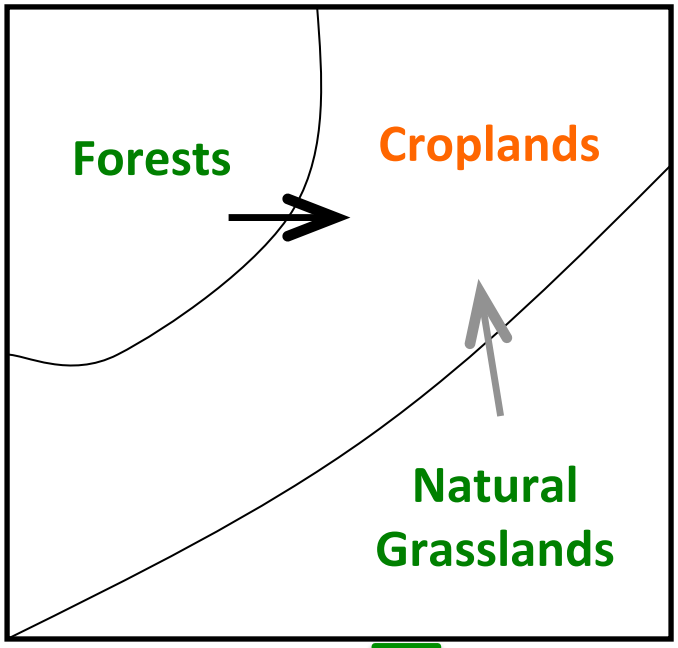
Implementing Land Use Changes first basic rules to follow

- Anthropogenic area is imposed from the provided dataset [***even at present-day … i.e. even in the control simulation!***]



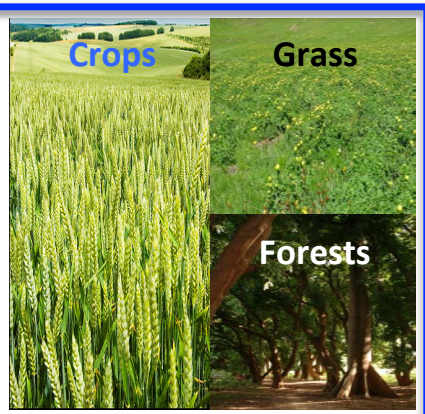
In the past, different Implementation Strategies

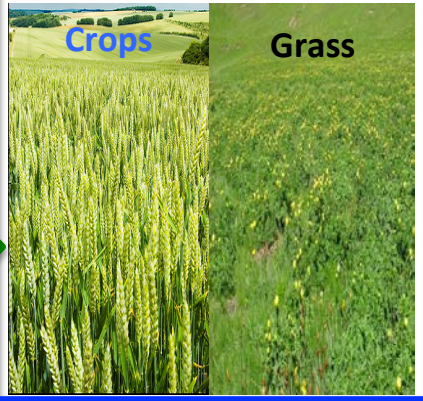
where do/did croplands/pastures come from?



Initial state: 50% grass, 50% forests

Final imposed state: 50% crops implemented



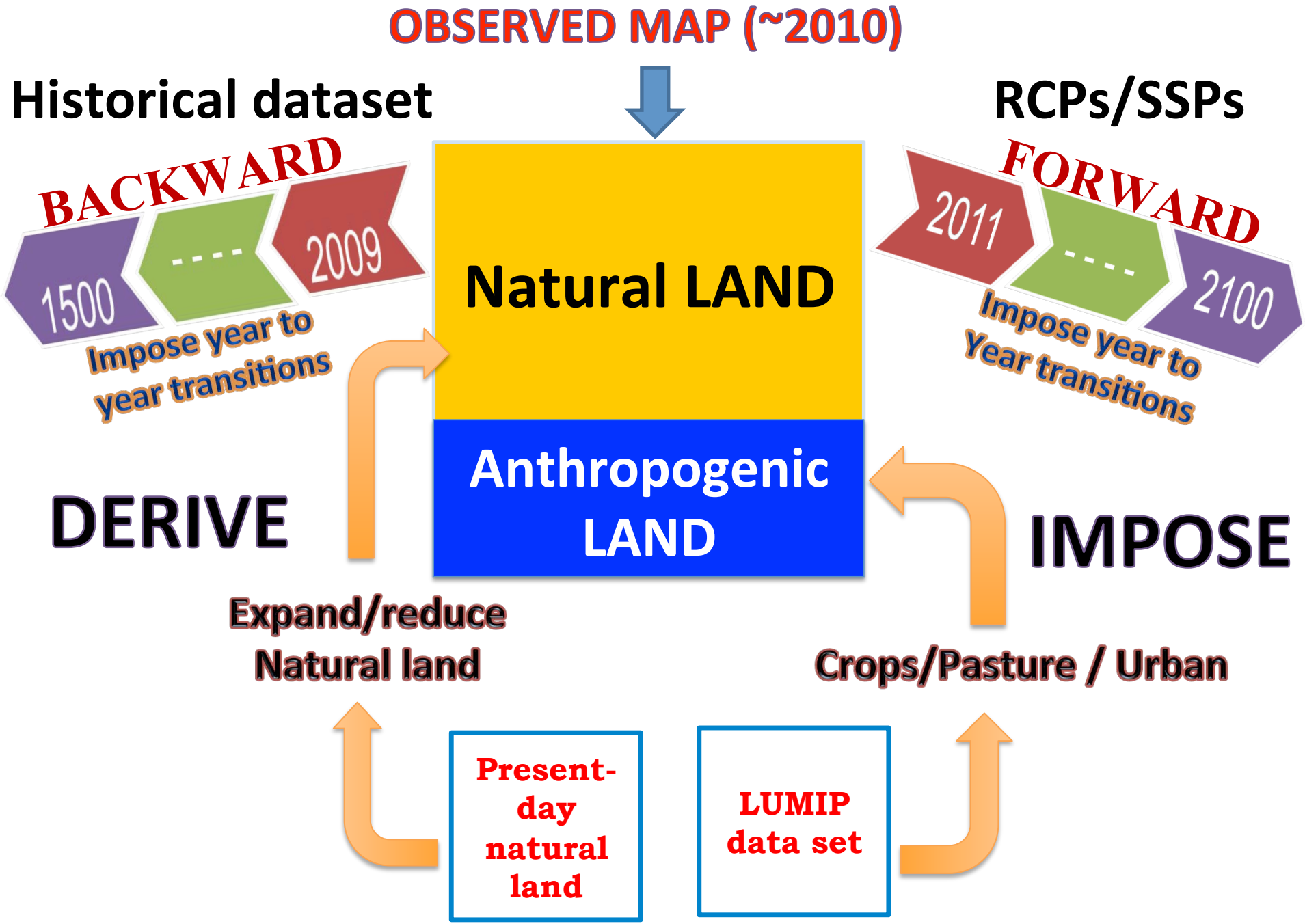


Implementing Land Use Changes, second basic rules to follow Make use of informations regarding transitions

From year i to year i+1

- ANTH = Anthropogenic Land Fraction
- do not change desert area if possible,

  i.e. if $\Delta(\text{ANTH}) \leq \text{Forest}_{\text{model,i}} + \text{Grass}_{\text{model,i}}$
- $\Delta\text{Forest}_{\text{lumip}} = \Delta(\text{primary + secondary})\text{Forest}$
- $\Delta\text{Grass}_{\text{lumip}} = \Delta(\text{primary + secondary})\text{NonForest}$
- Use $\Delta\text{Grass}_{\text{lumip}}$ and $\Delta\text{Forest}_{\text{lumip}}$ to constrain ther changes in forest and natural grass area in our model
- Keep our proportions of forest and grass types as in standard map


OBSERVED MAP (~2010)
Historical dataset
RCPs/SSPs
BACKWARD
1500

2009
Impose year to year transitions
FORWARD
2011

2100
Impose year to Year transitions
Natural LAND
Anthropogenic LAND
DERIVE
IMPOSE
Expand/reduce Natural land
Crops/Pasture / Urban
Present-day natural land
LUMIP data set

Coupled simulations Proposed by LUMIP

Overall Approach:

Two phases: 1) idealized simulations, 2) realistic simulations

Phase 1 Idealized model experiments:

Improve process understanding/assessment of how models represent impact of changes in land state on climate;

Quantify model sensitivity to potential land cover and land management changes

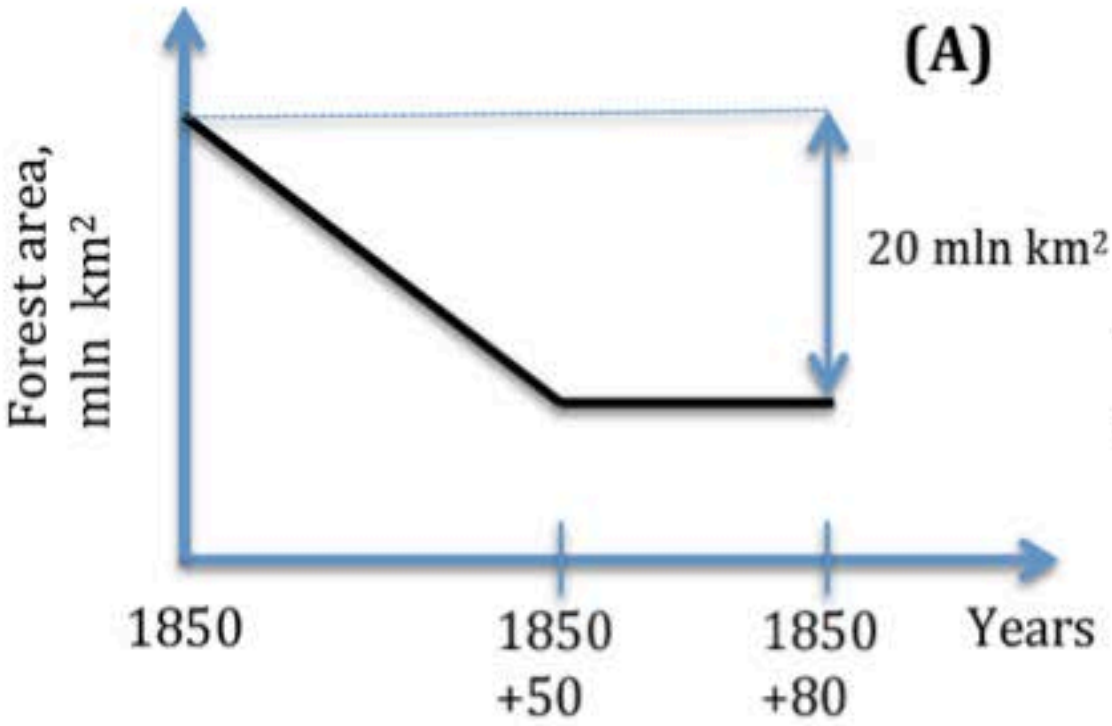
Phase 2 Realistic model experiments:

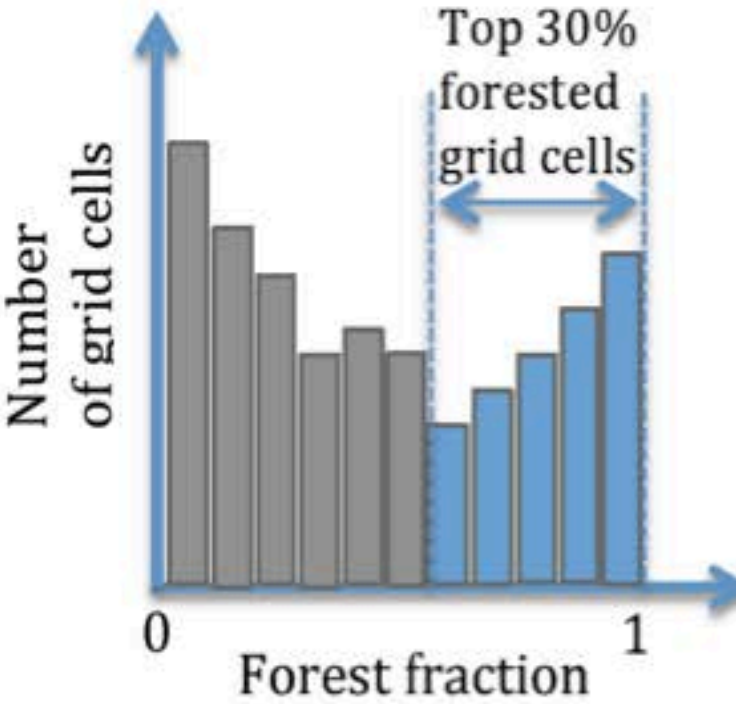
Isolate the role of historical and future land cover/use change on climate relative to other forcings, assess potential for climate mitigation through land use

Lawrence et al., GMD, subm.

Phase 1: idealized simulations

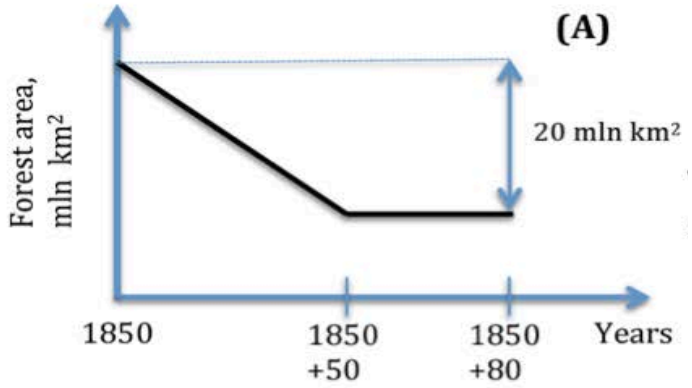
Tier	Name	Description	Model setup	Years	Forcings
1	**idealized_deforest**	50+20 yrs deforestation	C-driven coupled	1851-1920 starting from PI	Keep as in PI Control except tree cover

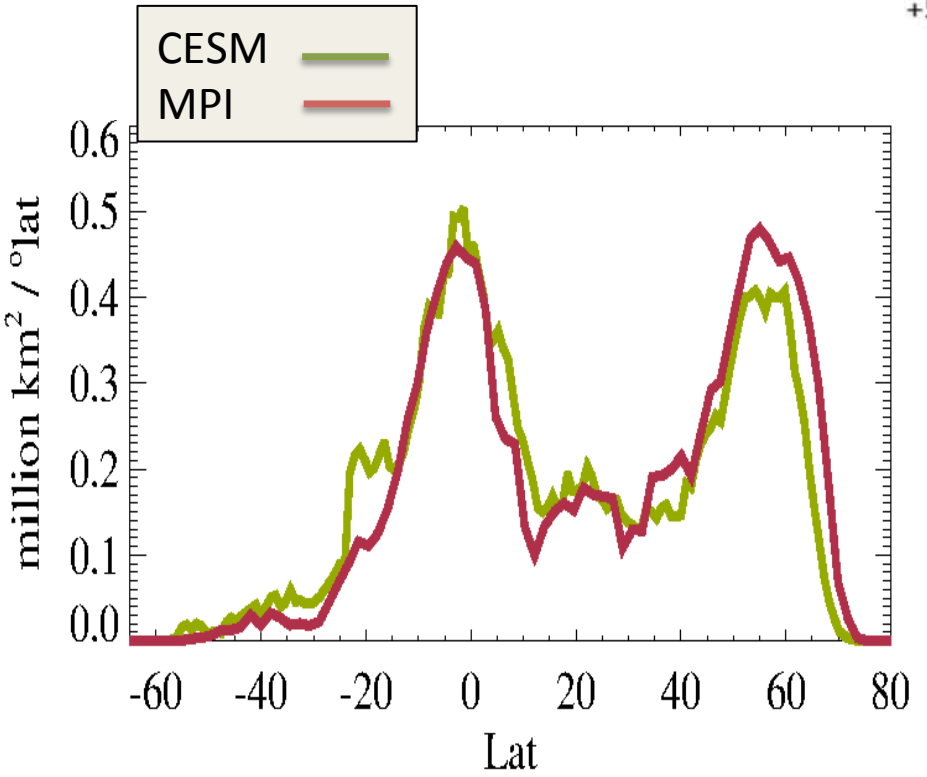




Lawrence et al., GMD, subm.

1. Idealized global deforestation experiment

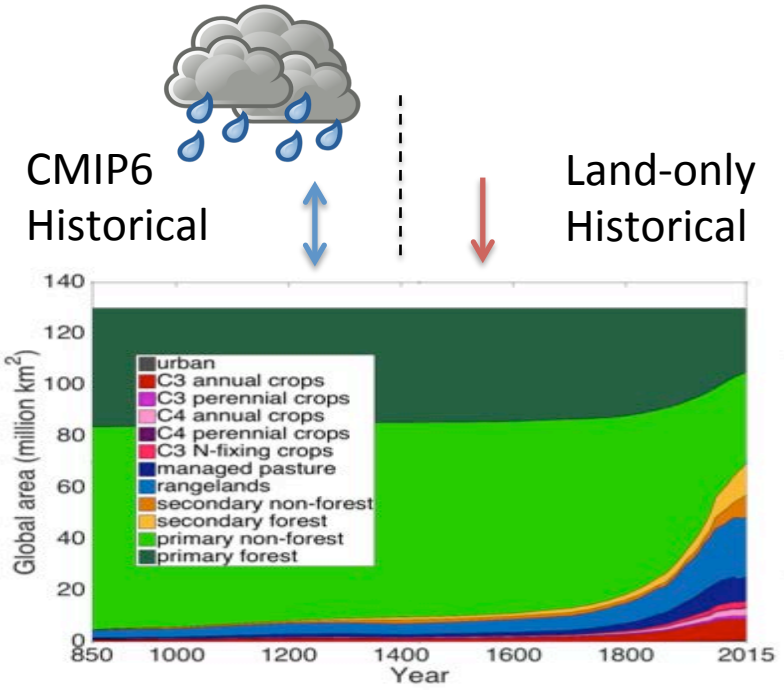


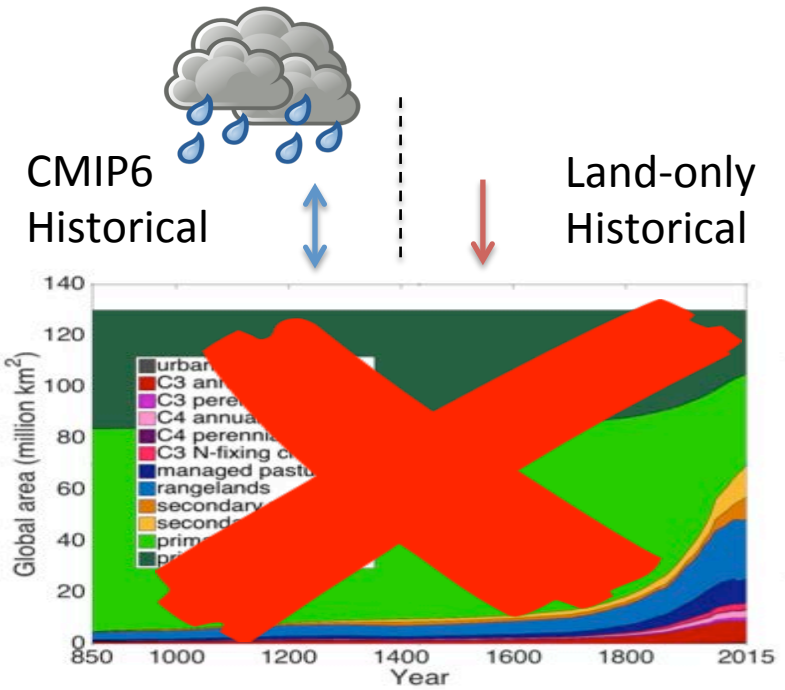


- Remove 20 million km^2 forest over 50 years from top 30% forest area grid cells, starting from 1850 control
- Controlled assessment of coupled model response to deforestation

2. No LULCC experiments: Historic period 1850-2015
Coupled and land-only

- Assess impact of LULCC in historical period for water, carbon, energy fluxes and climate (C4MIP, LS3MIP)
- Assess land-only vs coupled response to historic LULCC (LS3MIP)
- Assess how land-atmosphere coupling strength modulates climate, weather, extremes response to LULCC (LS3MIP)
- Relevant for detection and attribution (DAMIP)





3. Land-cover vs land-management change experiments

Set of land-only historic simulations (variants of land-Hist) with one-at-a-time inclusion of particular aspects of land management

Probe impact of land use on fluxes of water, energy, and carbon

① **Year 1700 instead of 1850 start**

② **No LULCC change**

③ Net LUC transitions instead of gross

④ **Crop and pasture as unmanaged grassland**

⑤ Crops with crop model but no irrigation/fertilization

⑥ No irrigation

⑦ No fertilization

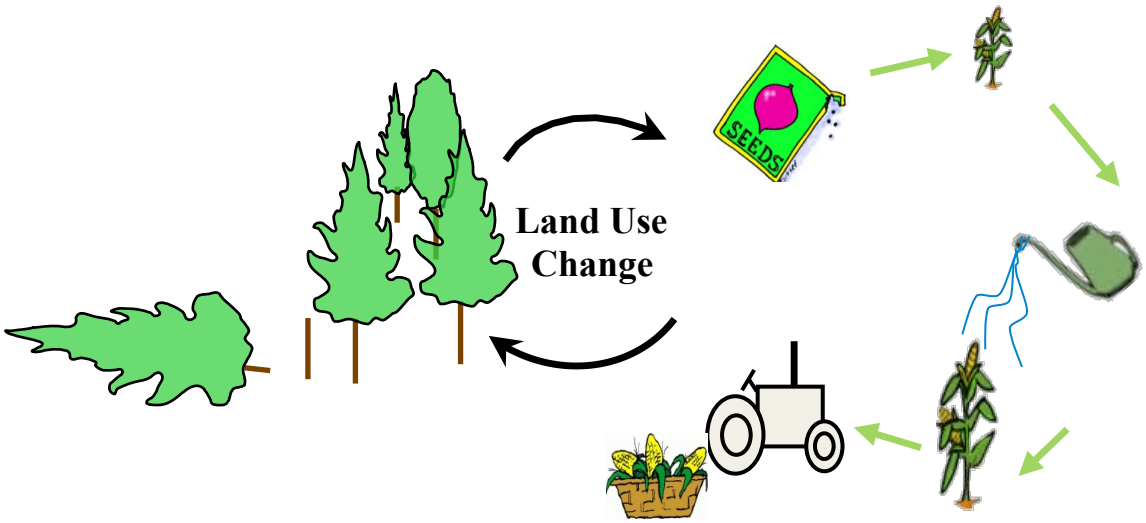
⑧ No wood harvest

⑨ No grazing on pastureland

⑩ No human fire ignition/suppression

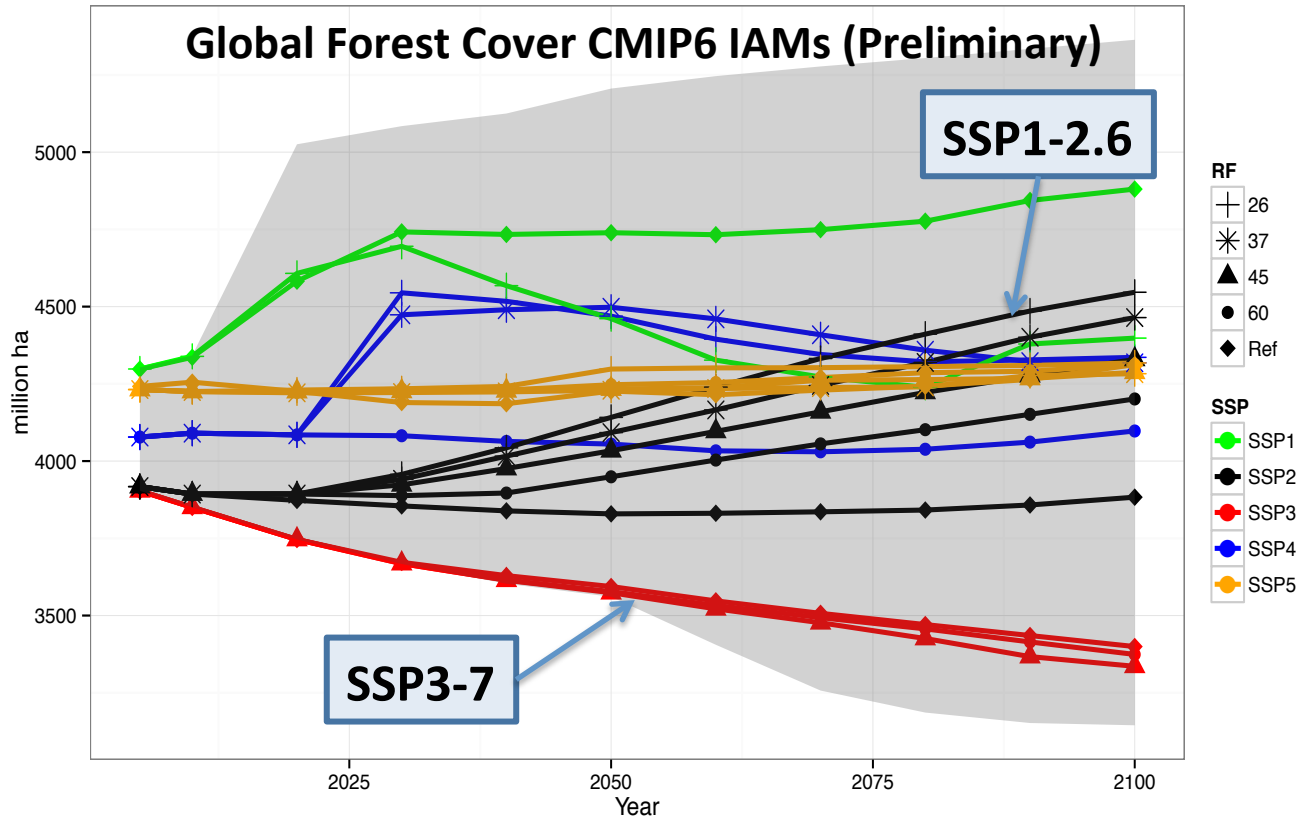
11 **Constant 1850 CO_2 (N dep?) (TRENDY)**

12 **Constant climate (TRENDY)**



Phase 2: more realistic simulations

ScenarioMIP	**SSP3-7 (conc. driven)**	**SSP1-2.6 (conc. driven)**	**SSP5-8.5 (emis. driven)**
LUMIP	**Afforestation** w/ SSP1-2.6 land use	**Deforestation** w/ SSP3-7 land use	**Afforestation *and* mitigation** w/ SSP1-2.6 land use



assess the potential of land-use for climate mitigation, reduction of adverse effects

Lawrence et al., GMD, subm.

MERCI