

Getting Land Cover Change and Land Use into the Community Land Model (CLM 4.0) in preparation for IPCC AR5 climate experiments

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IPCC Assessment Report 5 – RCP Development

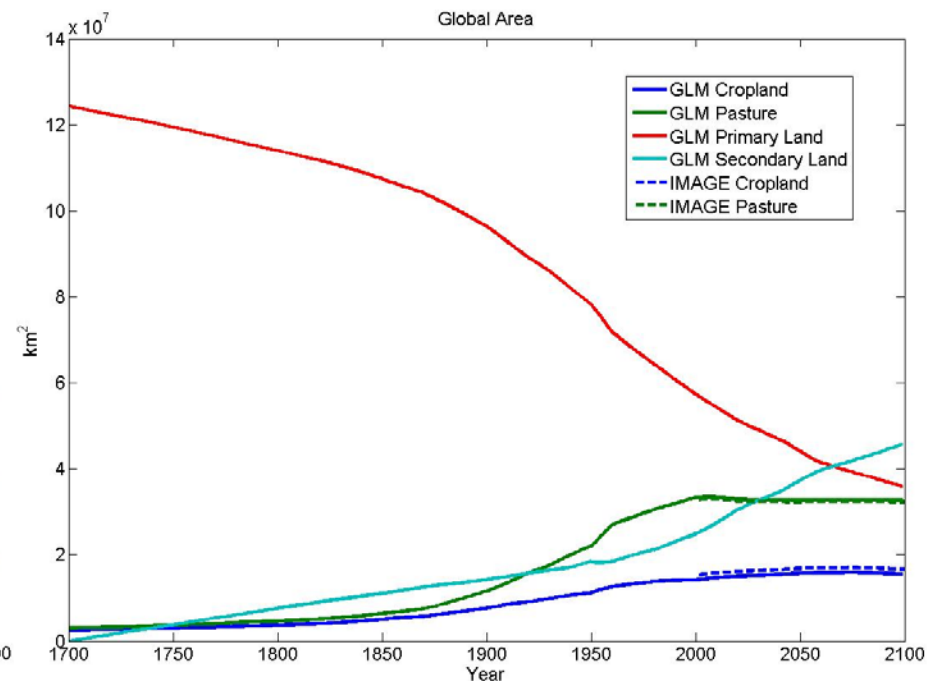
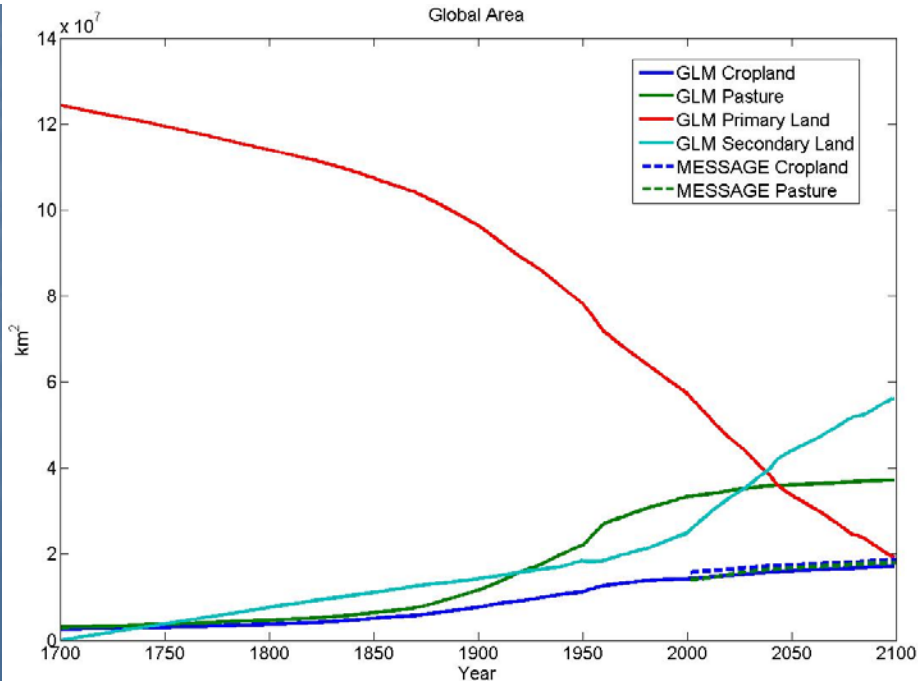
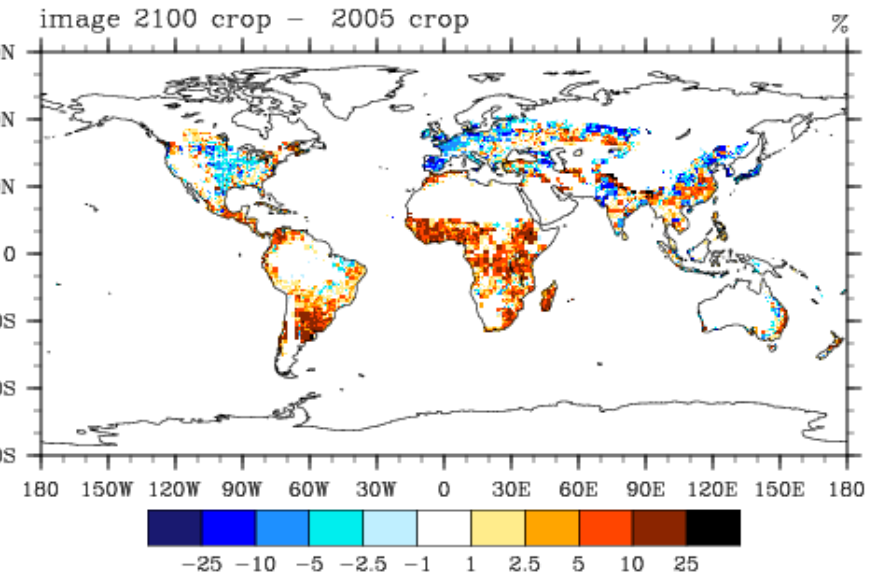
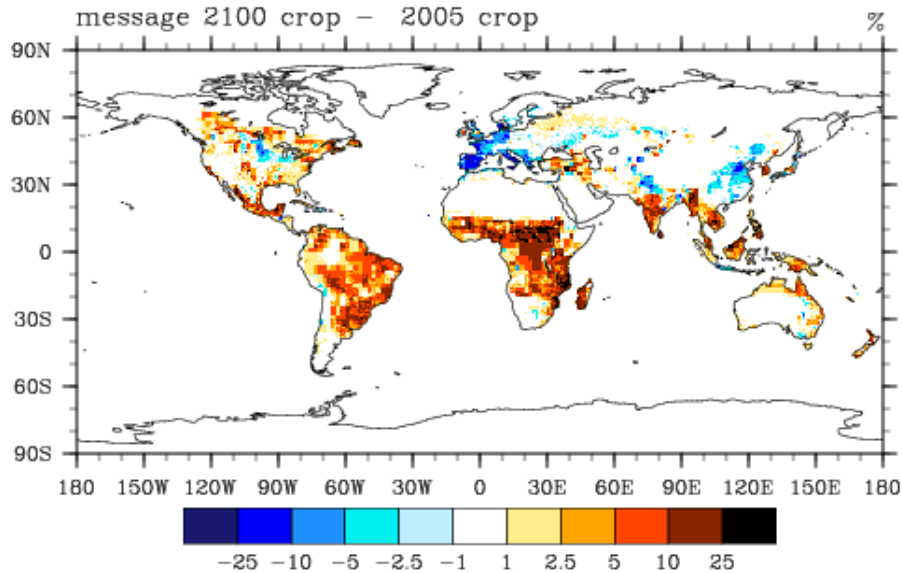
1. For IPCC AR5 land use and land cover change are to be described consistently with Representative Concentration Pathways (RCP) scenarios
2. All pathways share the same historical trajectory to 2005. After 2005 they diverge following own representative pathway.
3. For each RCP, land use that results in land cover change is described through annual changes in four basic land units:
 - Primary Vegetation (V)
 - Secondary Vegetation (S)
 - Cropping (C)
 - Pasture (P)
4. Harvesting of biomass is also prescribed for both primary and secondary vegetation land units

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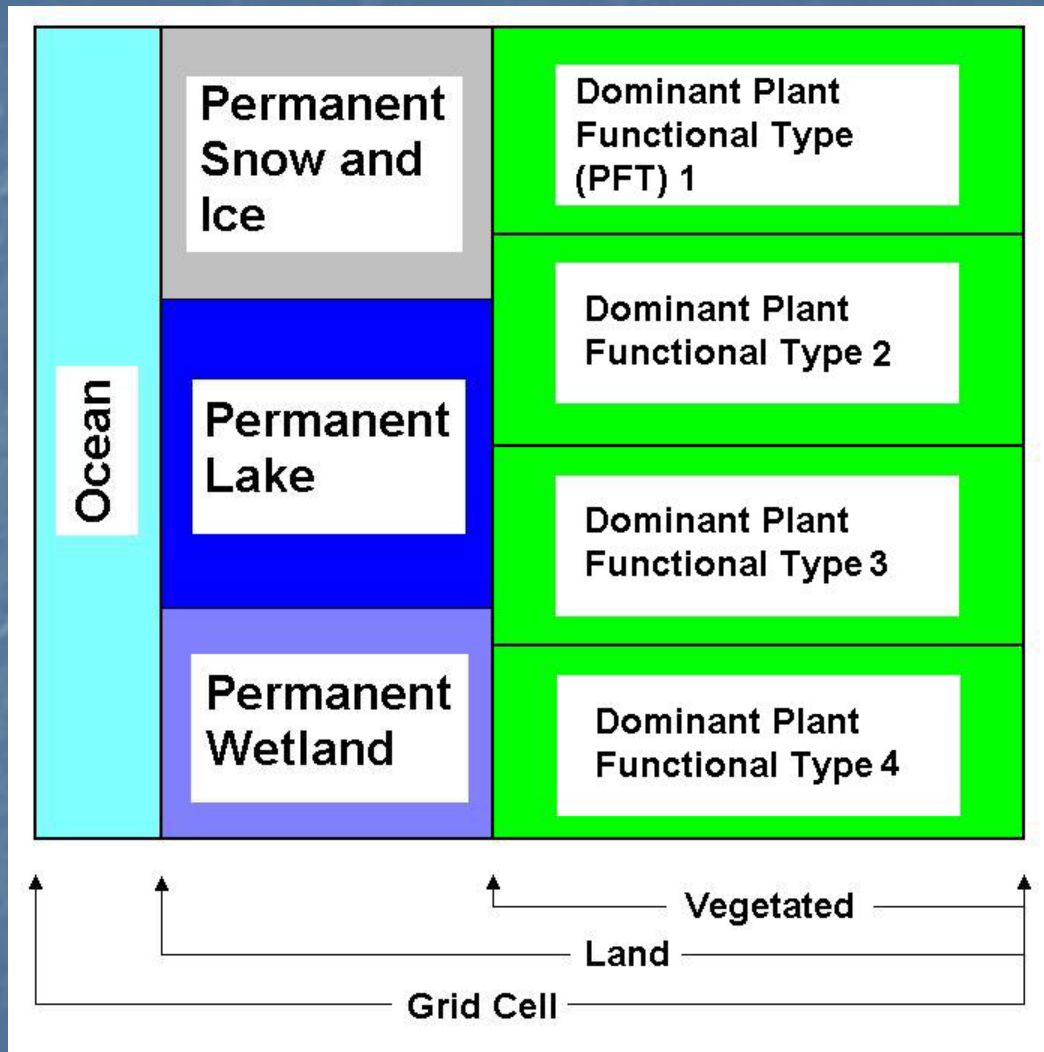
1. Development and management scenarios for the 21st Century Representative Concentration Pathways are:

	Pathway Description	IA Model Group
RCP8.5	Rising radiative forcing pathway leading to 8.5 W/m ² in 2100.	MESSAGE
RCP6	Stabilization without overshoot pathway to 6 W/m ² at stabilization after 2100	AIM
RCP4.5	Stabilization without overshoot pathway to 4.5 W/m ² at stabilization after 2100	MiniCAM
RCP3	Peak in radiative forcing at ~ 3 W/m ² before 2100 and decline	IMAGE

MESSAGE (RCP 8.5) vs IMAGE (RCP 3) Land Unit Change



Getting RCP Land Cover Change into CLM 4 – PFTs



Tree:

Needleleaf Evergreen Temperate
 Needleleaf Evergreen Boreal
 Needleleaf Deciduous Boreal
 Broadleaf Evergreen Tropical
 Broadleaf Evergreen Temperate
 Broadleaf Deciduous Tropical
 Broadleaf Deciduous Temperate
 Broadleaf Deciduous Boreal

Herbaceous / Understorey:

Evergreen Shrub
 Deciduous Temperate Shrub
 Deciduous Boreal Shrub
 C3 Arctic Grass
 C3 non-Arctic Grass
 C4 Grass
 Crop

Bare

Prescribing Transient RCP Land Cover in CLM 4

1. We need to take the annual RCP land units and make an annual time series of changing Plant Functional Types
2. To make this transition we describe the PFT composition of the individual grid cell land units from the Current Day and Potential Vegetation CLM 4.0 parameters of that grid cell
3. Current Day (2000) CLM 4 land surface parameters are derived from MODIS satellite data as described in *Lawrence and Chase 2007* (with forest herbaceous grass bias removed)
4. Potential vegetation CLM 4 parameters are bio-climatically modeled as described in *Lawrence and Chase 2009* (in review IJOC)

Prescribing Transient RCP Land Cover in CLM 4

1. For each year of the time series the Crop PFT is taken directly from RCP values
2. Pasture is prescribed as herbaceous PFTs from the current day and potential vegetation following simple allocation rules based on Primary and Secondary land units
3. Remaining PFTs are allocated from current day and potential following the allocation rules and the Primary and Secondary land units

Getting RCP Land Cover Change into CLM 4 – PFTs

RCP Land Units for Year N

Primary (V)	
Secondary (S)	Crop (C)
	Pasture (P)



Describe Land Units in PFTs from CLM 4.0 PFTs

Potential Vegetation PFTs	
Current Day non Crop PFTs	Current Day Crop PFTs
	Current Day Herbaceous PFTs



Annual Land Unit PFTs combined to give average grid cell PFTs for Year N

Prescribing Transient RCP Land Cover in CLM 4

1. **Current status we have generated a series of snap shots of CLM 4 parameters along the IMAGE RCP timeline**
2. **We also have produced historical annual PFT transition files from 1850 - 2005**
3. **Standard CLM 4.0 parameters being used with CCSM 4.0 are consistent with the transient CLM 4.0 parameters with Pre-Industrial set at 1850 and Current Day as 2000**

IMAGE (RCP 3) Time series as CLM 4. PFTs - 1850

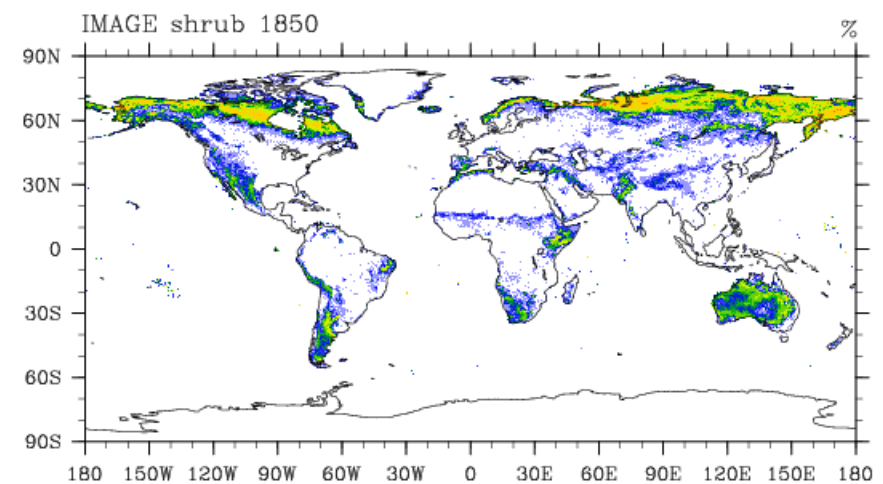
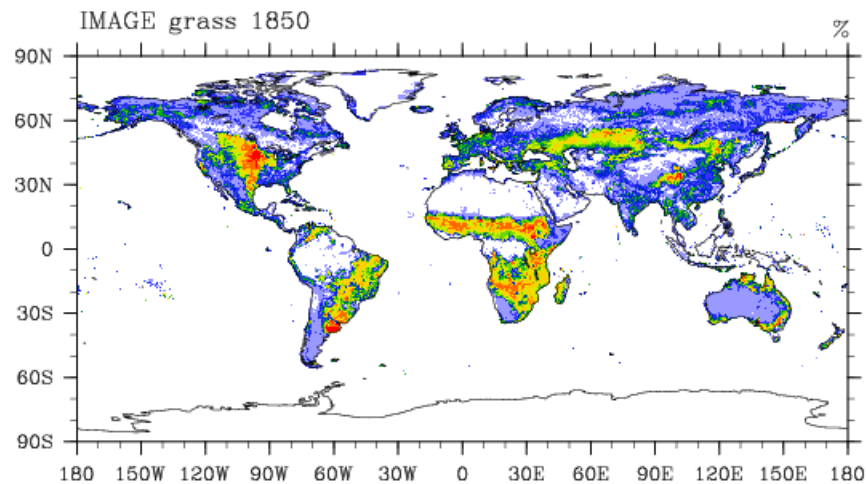
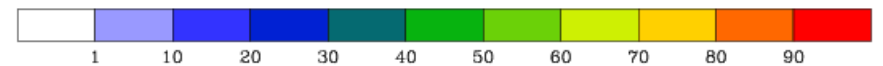
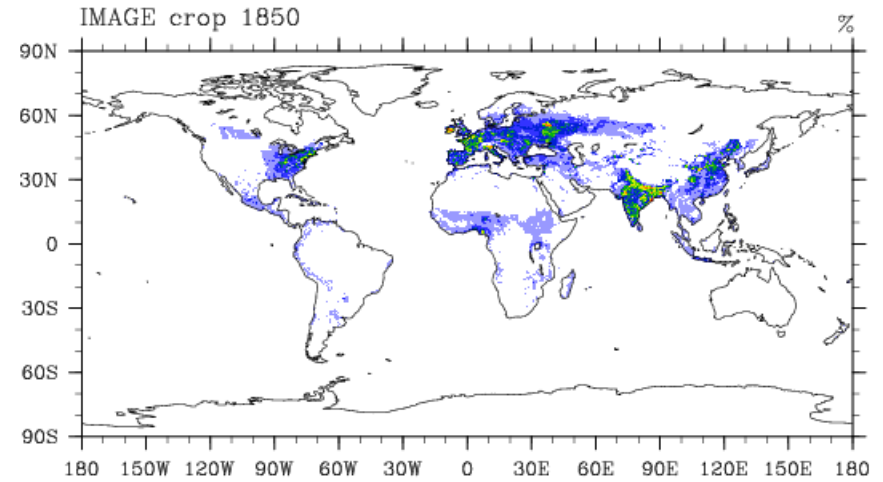
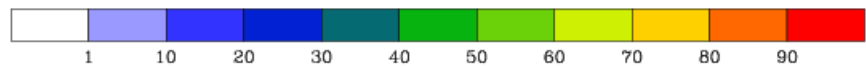
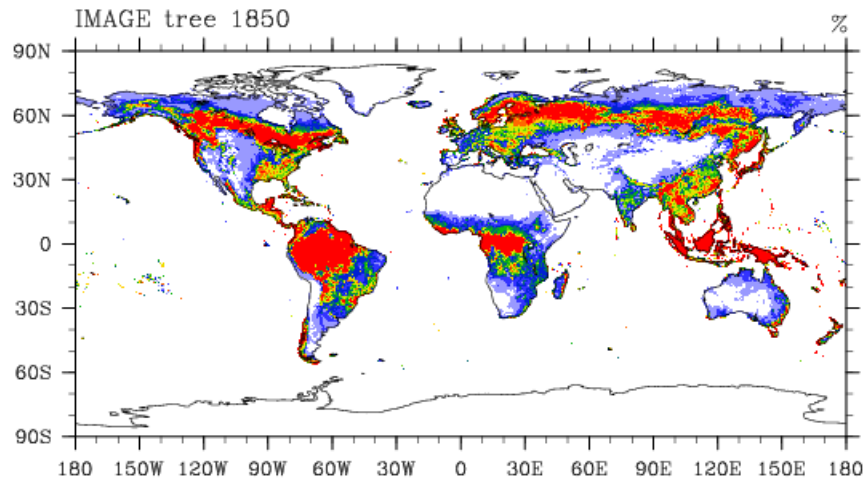


IMAGE (RCP 3) Time series CLM 4. PFTs 1900 - 1850

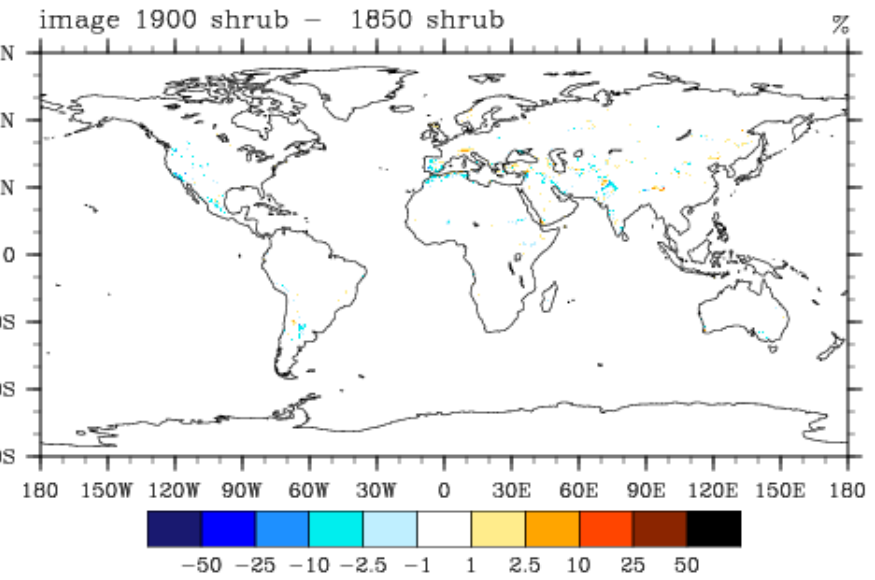
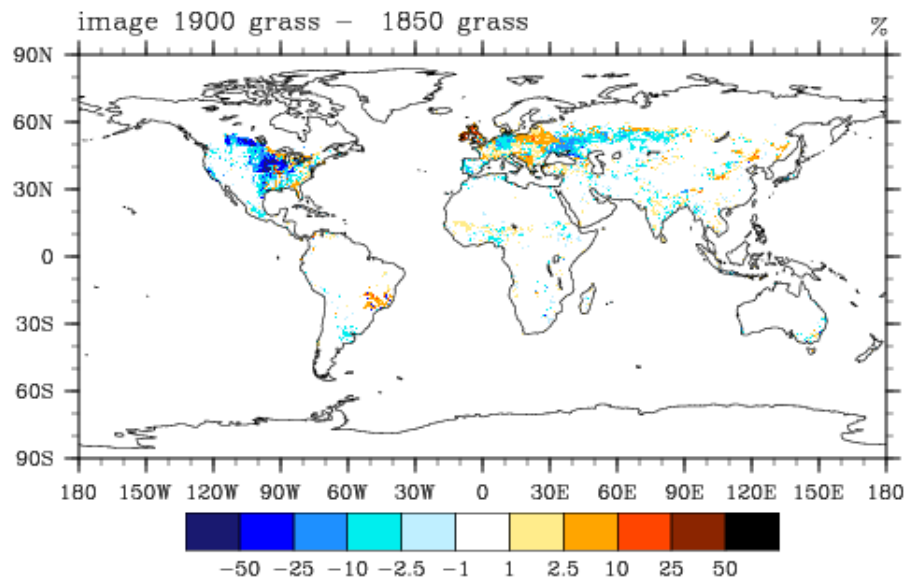
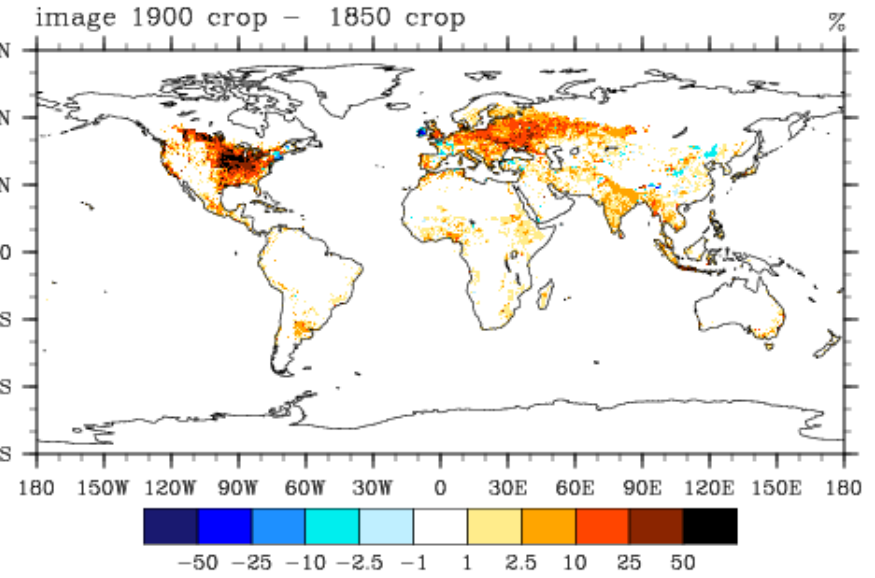
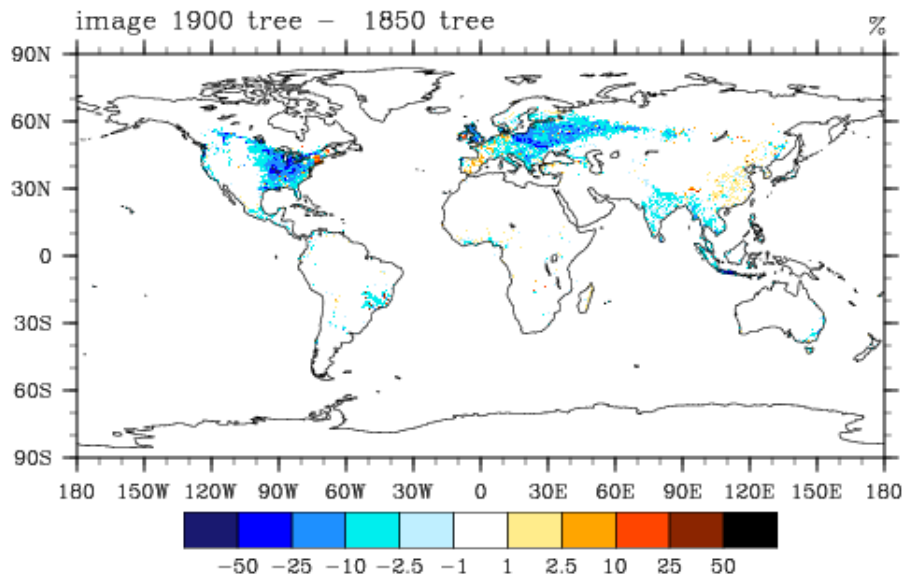


IMAGE (RCP 3) Time series CLM 4. PFTs 2000 - 1900

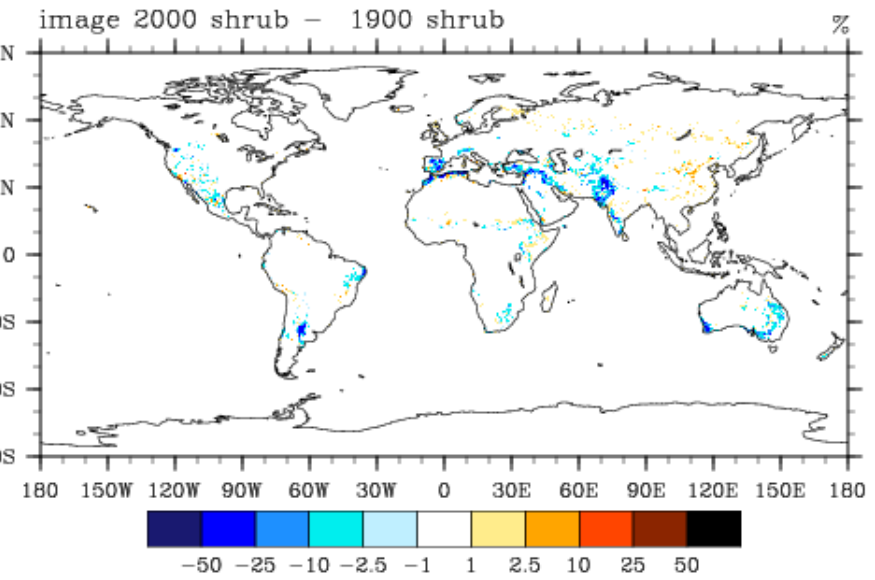
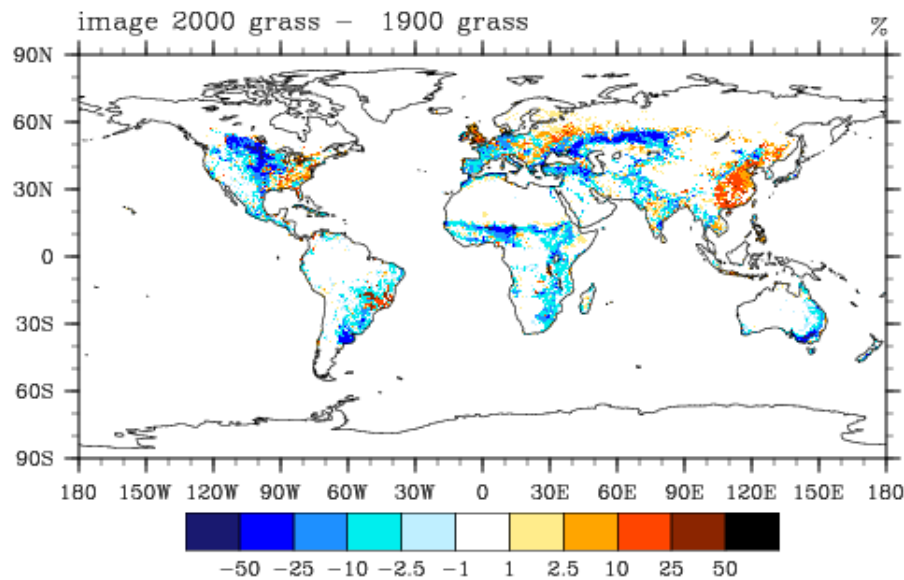
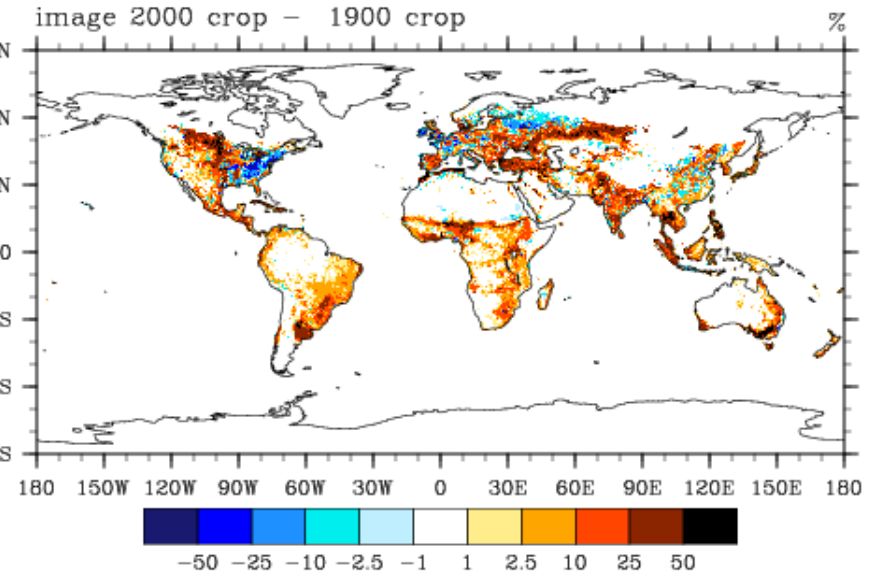
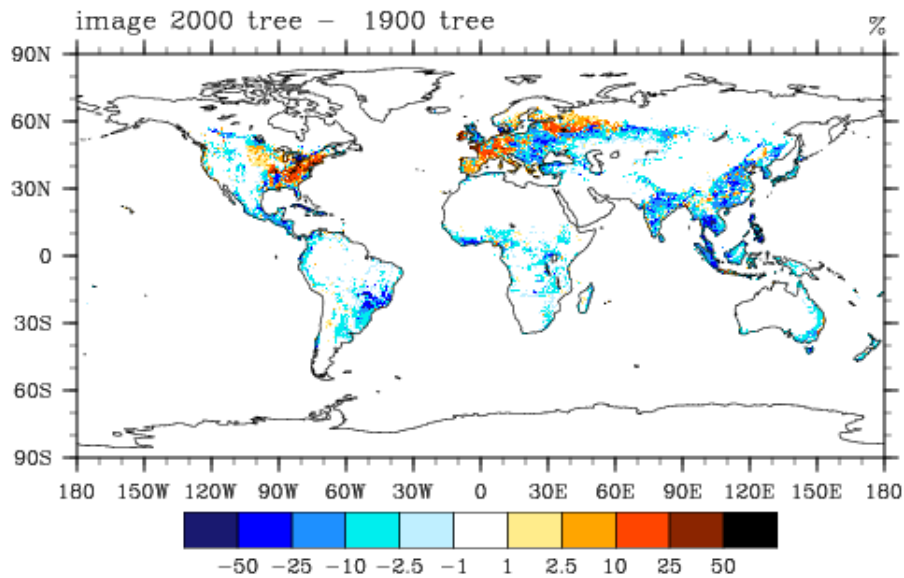
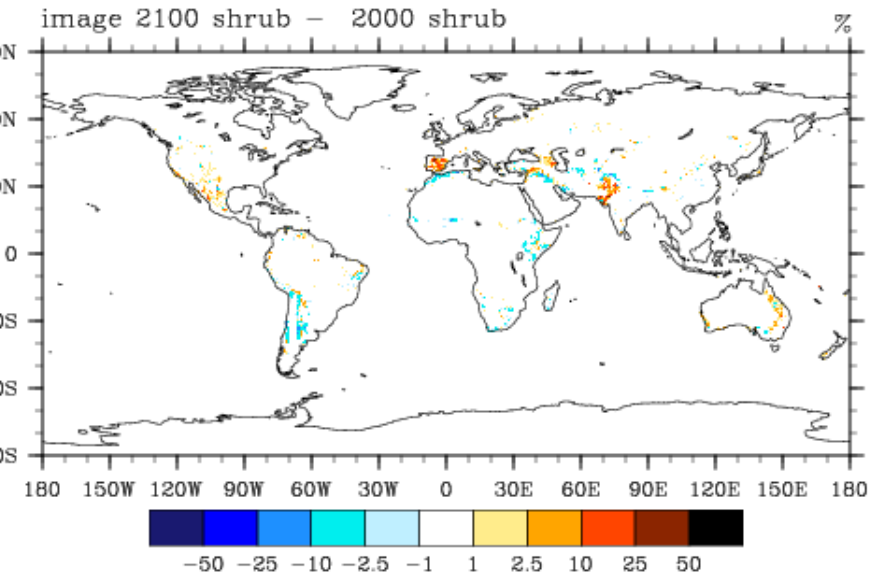
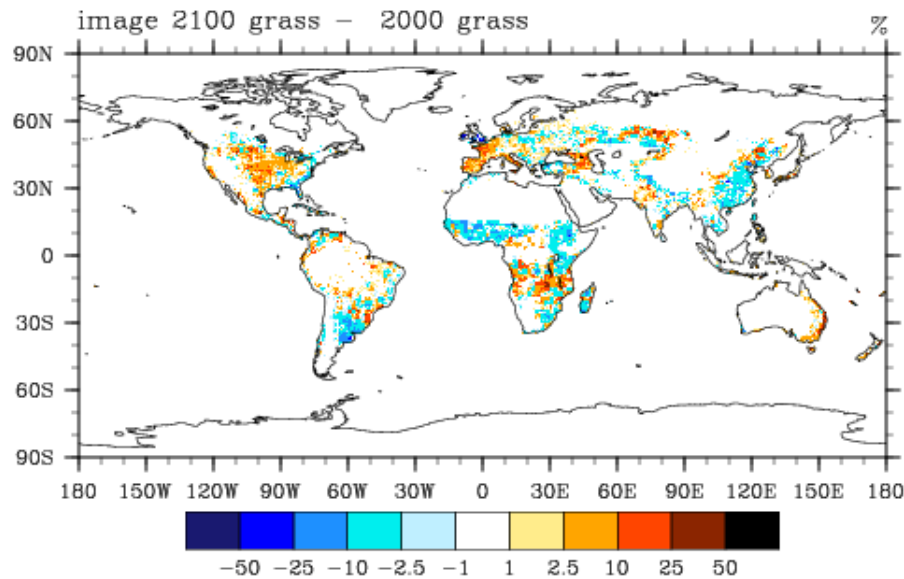
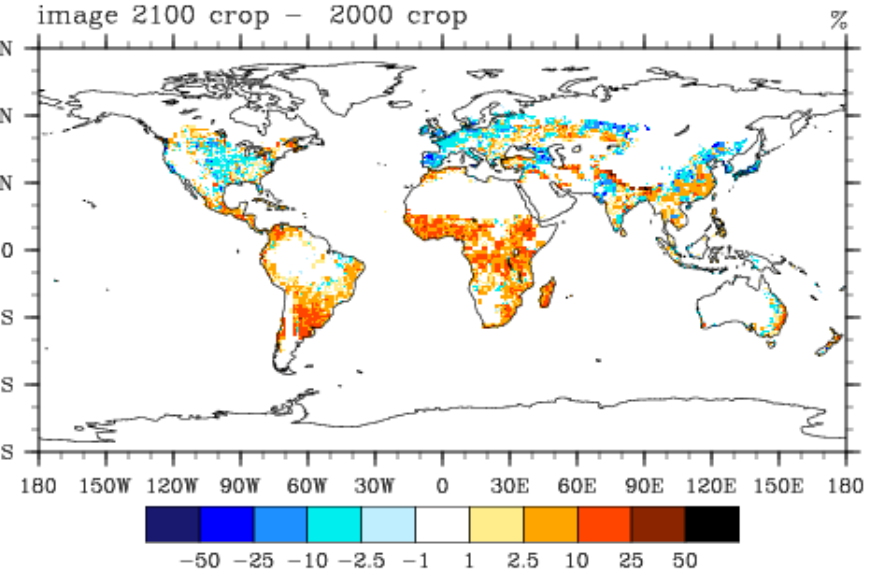
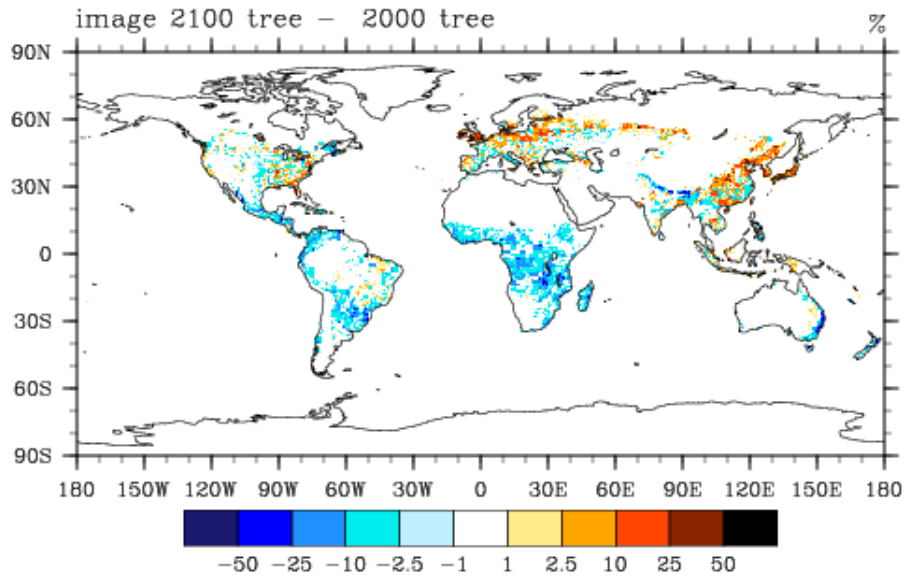
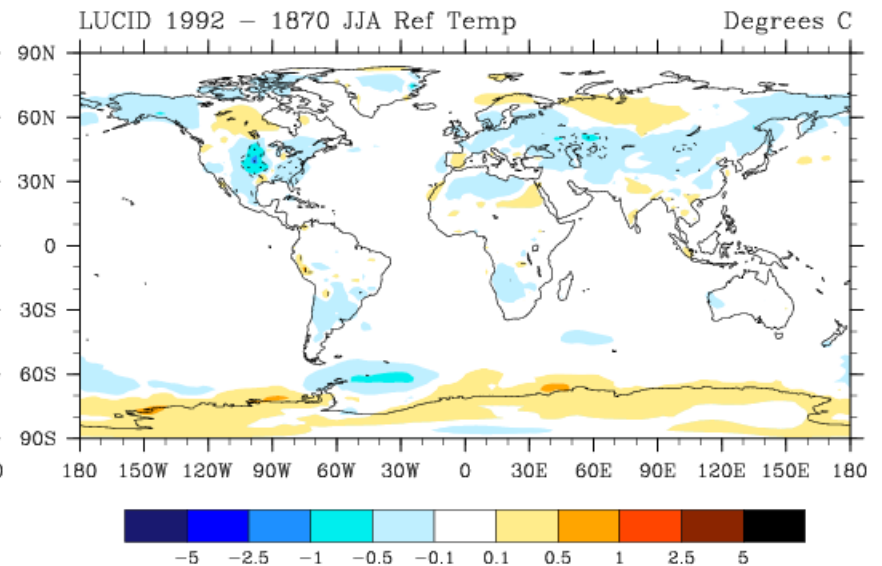
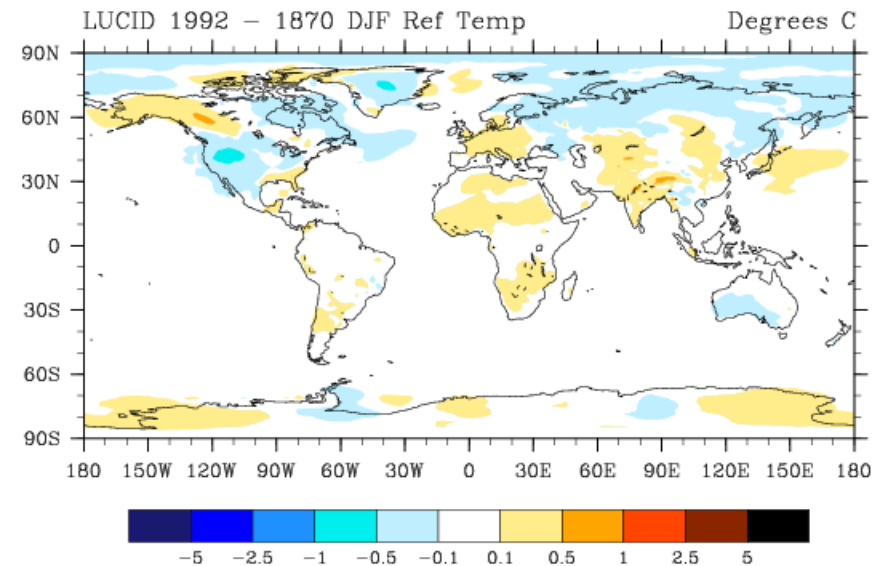
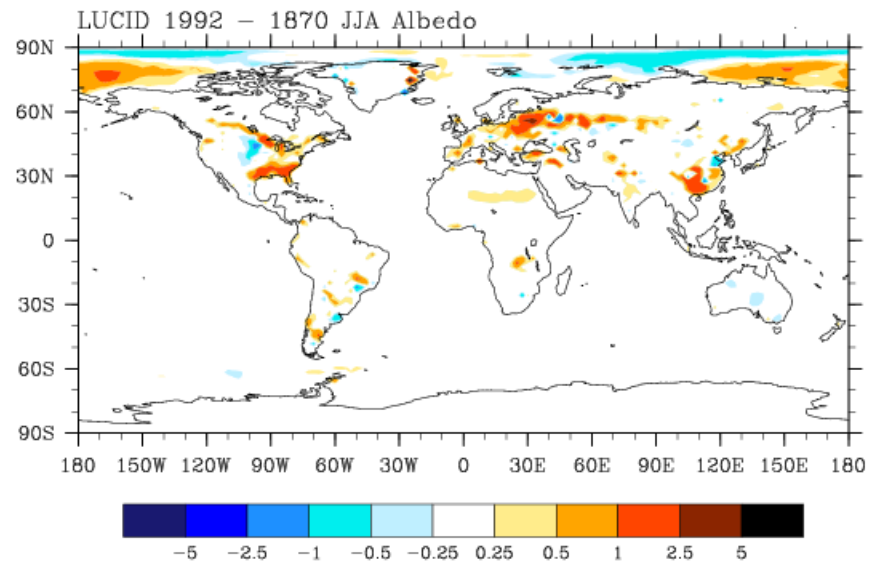
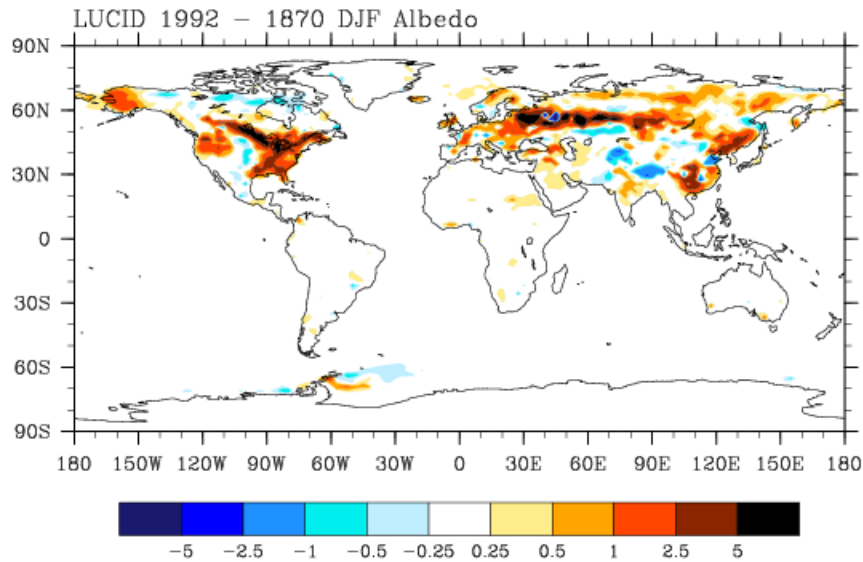


IMAGE (RCP 3) Time series CLM 4. PFTs 2100 - 2000



LUCID – Albedo and Temp 1992 - 1870



Conclusion

1. We have methods in place to take the AR5 Representative Concentration Pathway Land Cover Change scenarios and create CLM 4.0 land surface parameters
2. Currently done both as snap shots for IMAGE and as a transient time series for historical 1850 - 2005
3. CCSM 4.0 land surface parameters will be consistent with the transient PFT parameters for a given time period
4. Preliminary experiments done with CLM 3.5 show good forcing in respect to albedo
5. Further experiments required to investigate biogeochemical impacts of land cover change