Land Use for the Near-term Climate Forecast

Johannes Feddema
University of Kansas

Peter Lawrence
NCAR

Proposed AR5 Simulations

1. Four Representative Concentration Pathways (RCP) have been selected for IPCC future climate simulations that include emissions and land cover change scenarios.

2. Each future simulation is based on a different Integrated Assessment Model (IAM) simulation that makes specific assumptions about the human activities creating the RCP outcome.

3. Each Earth System Model (ESM) group will run a number of specified simulations and ensembles as resources permit:
   - Simulations for RCPs through 2100/2300 (priority 8.5, 2.6 then 4.5 and/or 6.0).
   - **High resolution (0.5 degree) "climate forecast" simulation from 1980 to 2030 (tentatively 4.5).**

Question:

Is the RCP 4.5 a good scenario for the "Climate Forecast" simulation from a land cover change perspective?
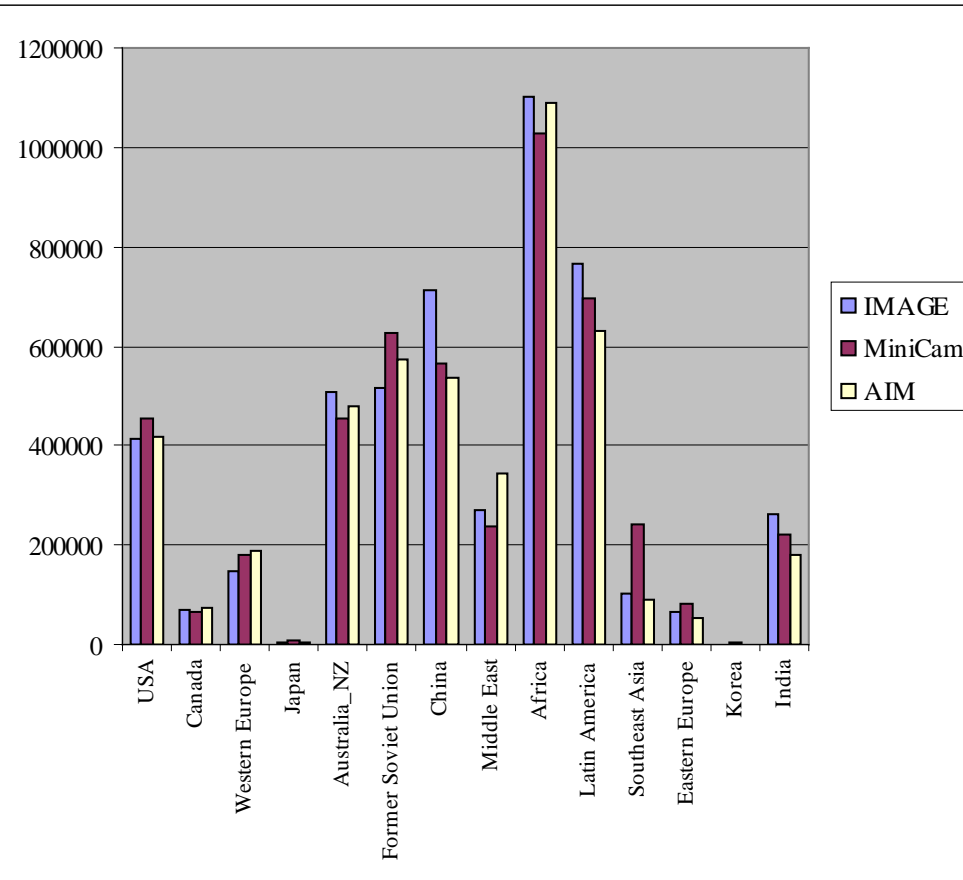
- How important is it that this be a realistic land cover scenario?
- Can the CLM effectively represent the projected conditions

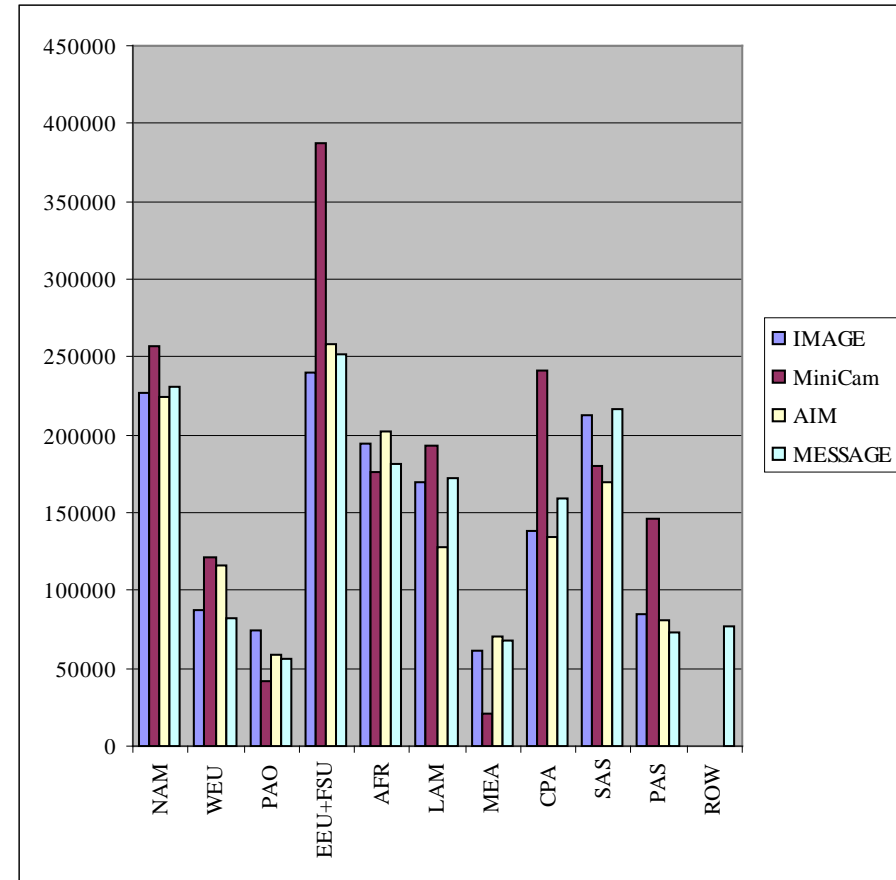# Selected RCP CO$_2$ Properties
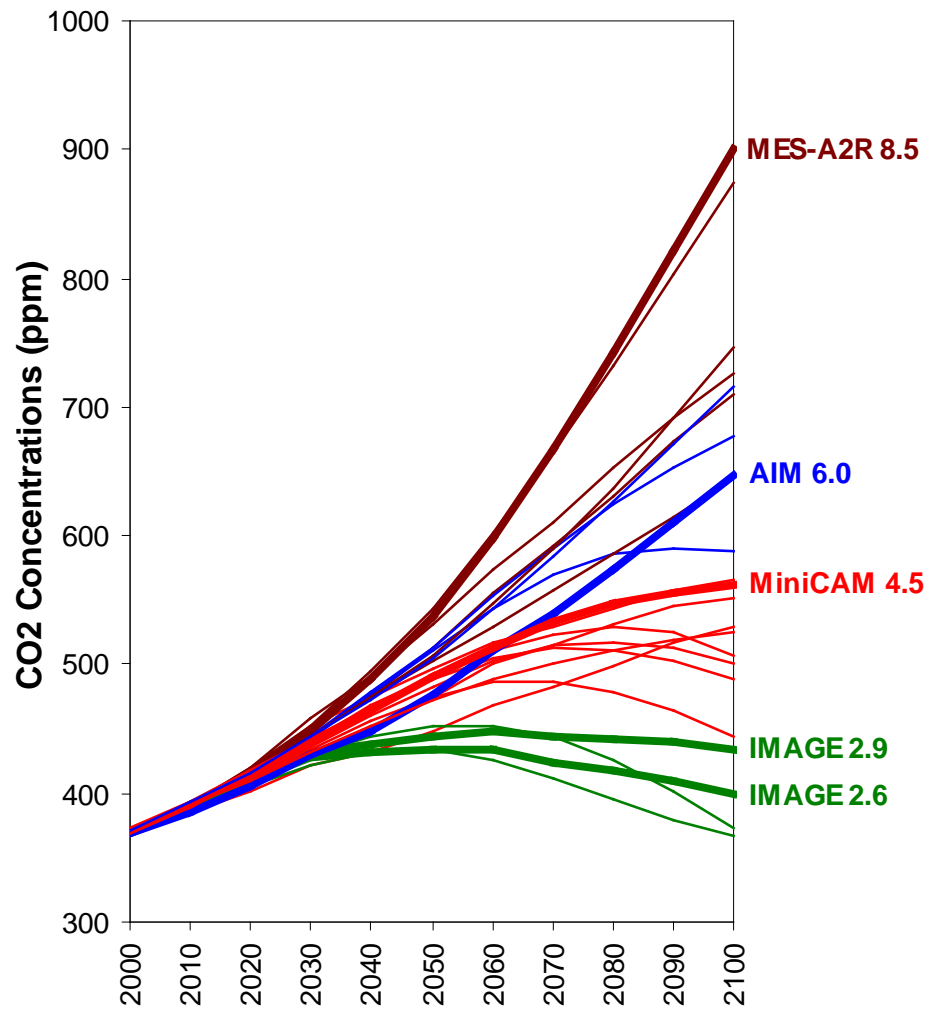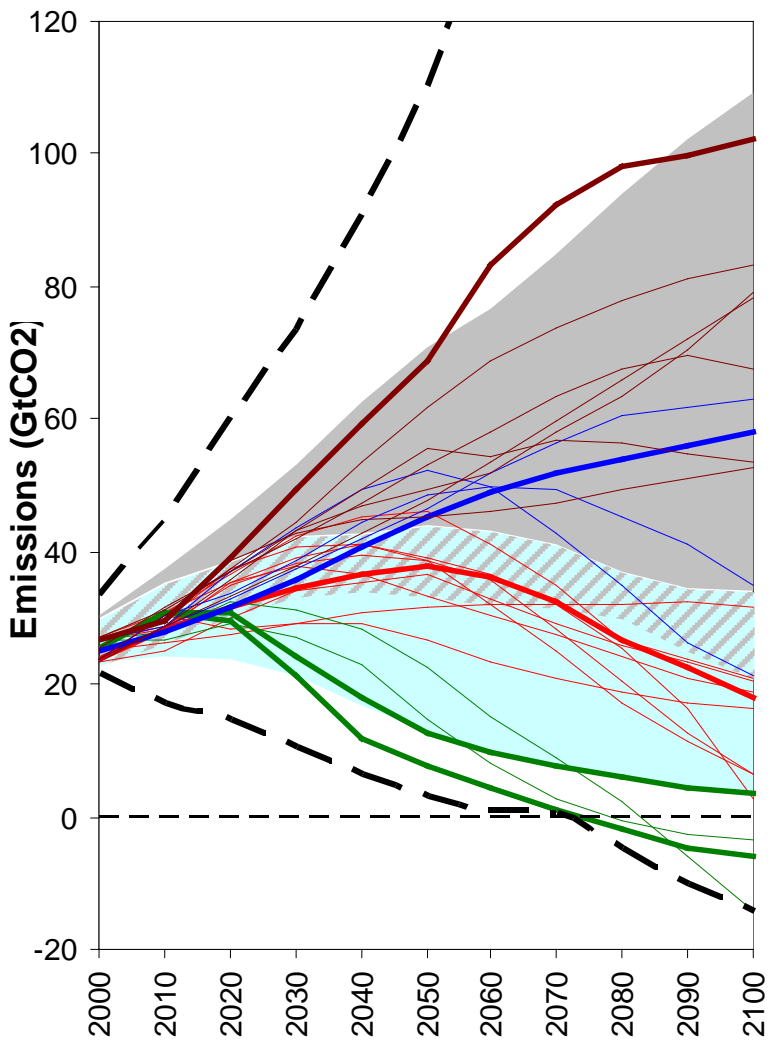
Native IAM Land Use Variability

## Total ag-land, 2000

Crop land, 2000

IPCC AR5 – RCP Standardization

1. All scenarios will use an identical 2005 land cover as a starting point

2. All pathways share the same historical trajectory to 2005. After 2005 they diverge following their own representative pathway.

3. For each RCP, <u>minimal</u> information related to land cover change will provide changes in four basic land units:
   - Primary Vegetation   (V)
   - Secondary Vegetation   (S)
   - Cropping   (C)
   - Pasture   (P)

4. Historical harvesting of biomass is also prescribed for both primary and secondary vegetation land units (Hurtt, 2006)

5. The University of New Hampshire (UNH) group is standardizing each scenario and the historical trajectory for harvest and land cover information

6. Each ESM group will have to construct land cover datasets by blending their own natural land cover with the prescribed human activities
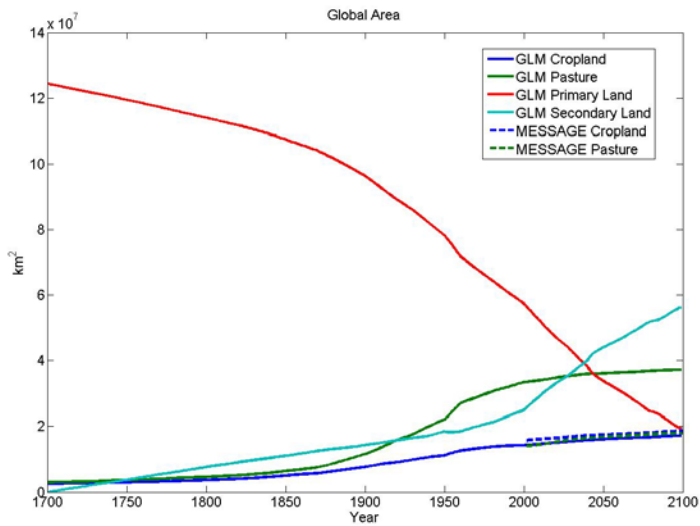
Issues of definitions
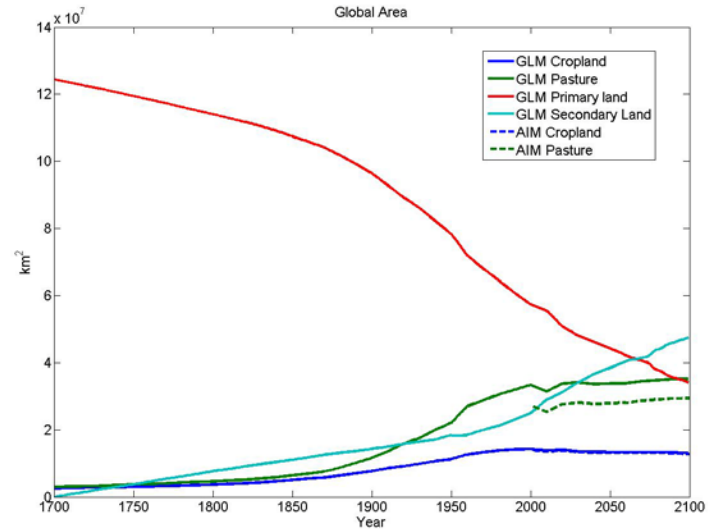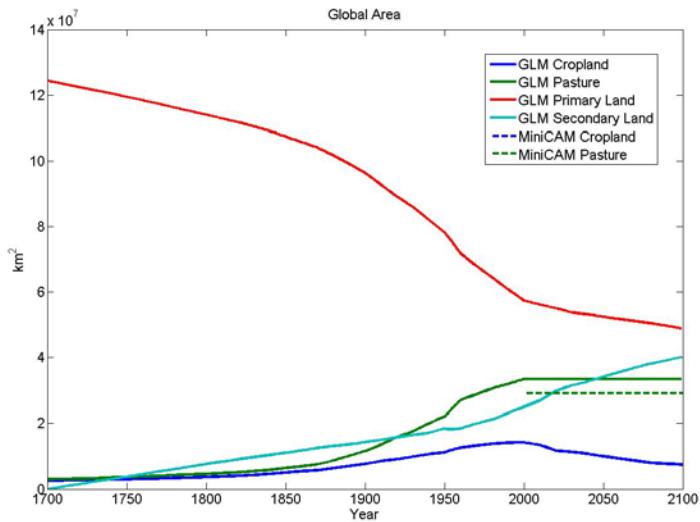
e.g. What is Pasture/Grazing
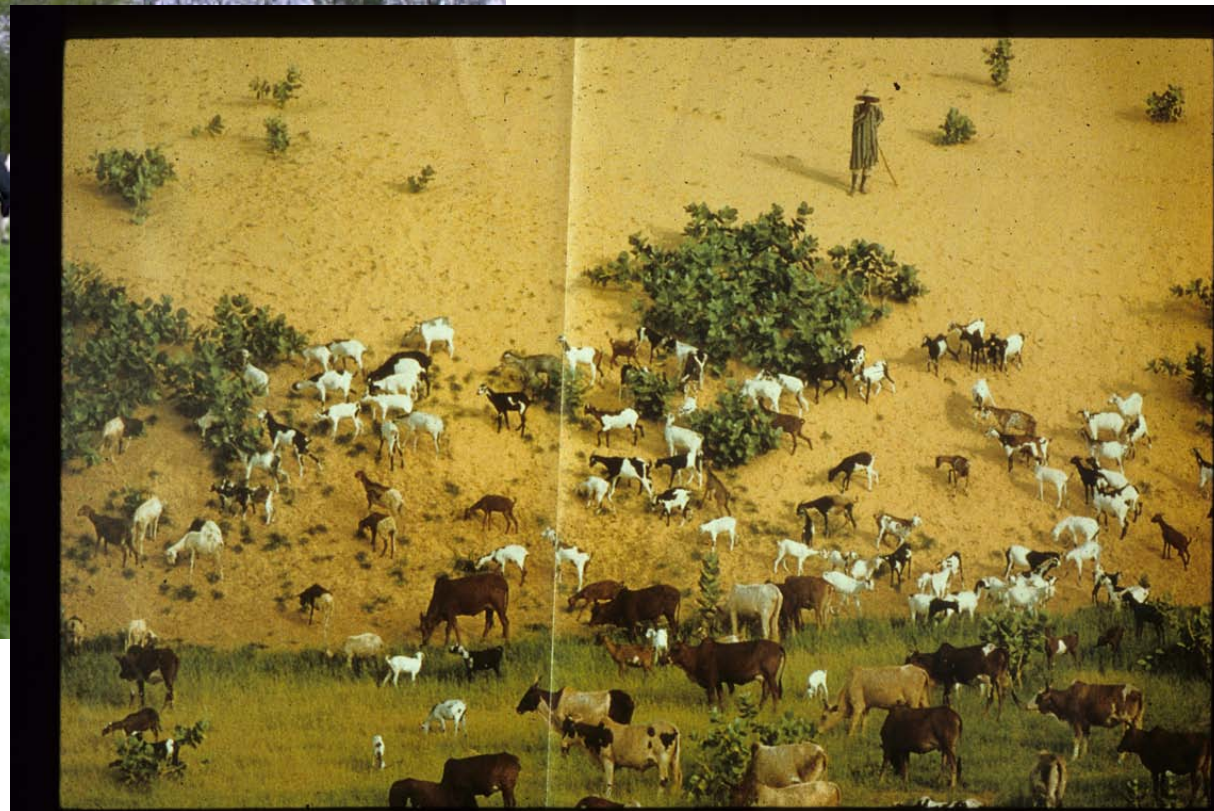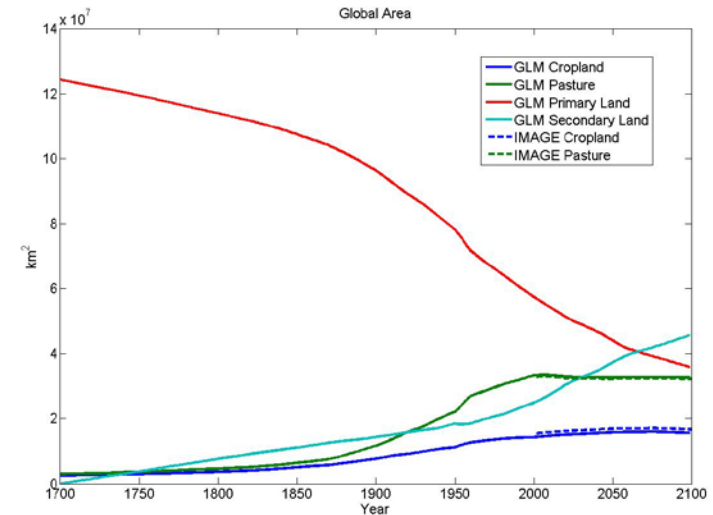
RCP Comparisons

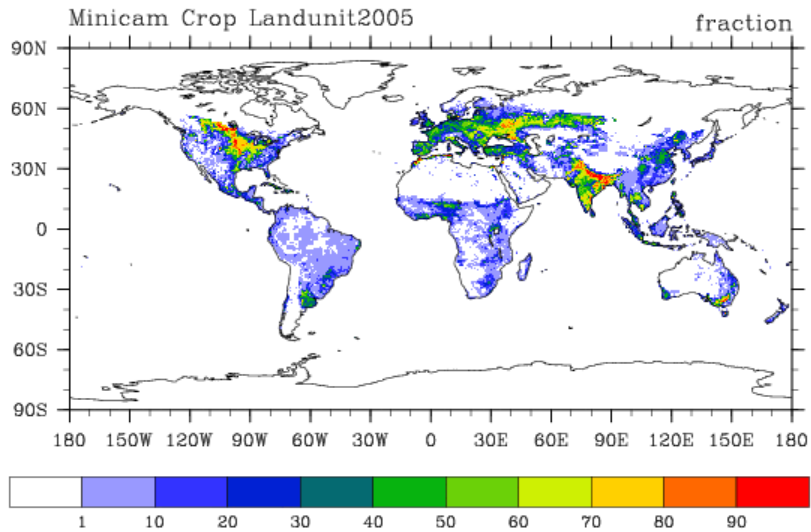## RCP 8.5: Message

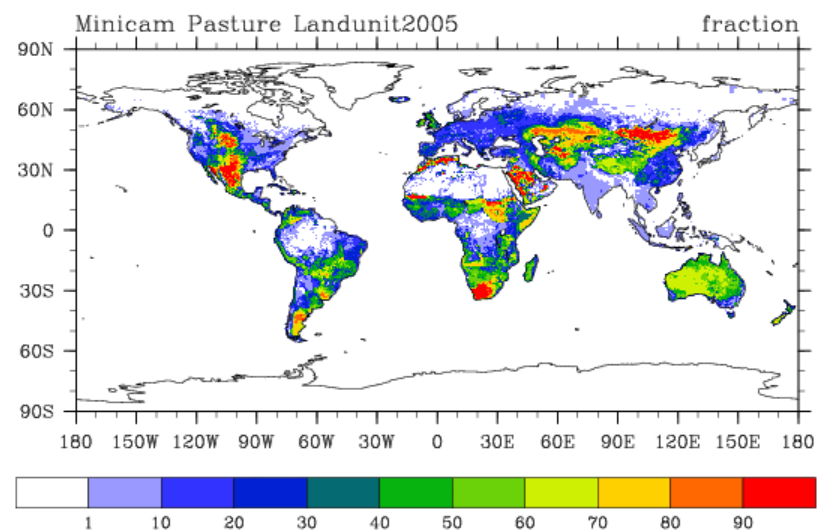

RCP 6.0: AIM

RCP 4.5: Mini-Cam

RCP 2.6: IMAGE

Mini-Cam (RCP 4.5 Wm^{-2}): 2005 Land Cover

Crop

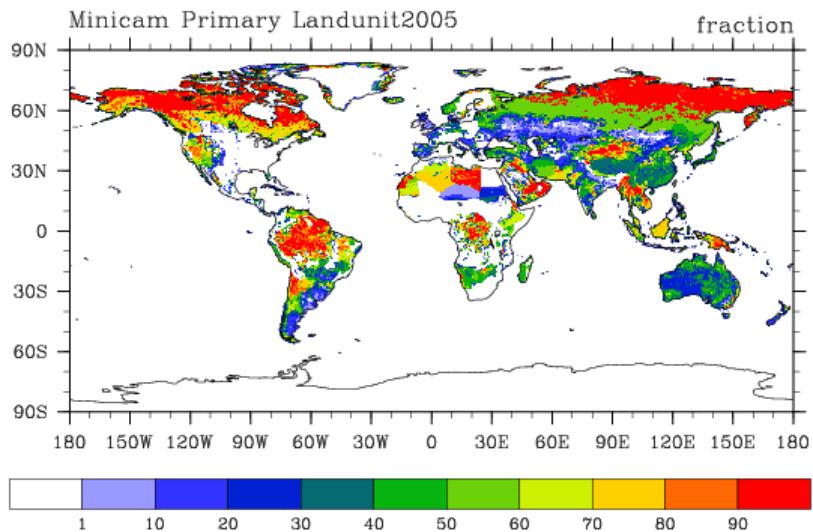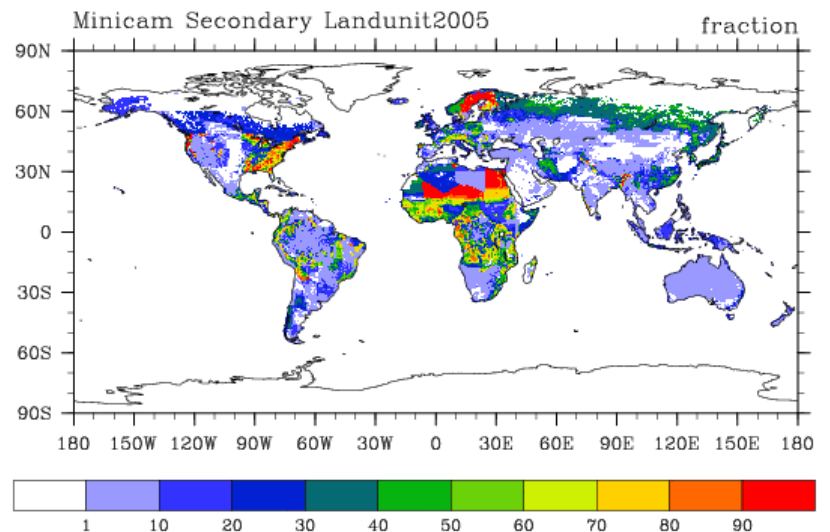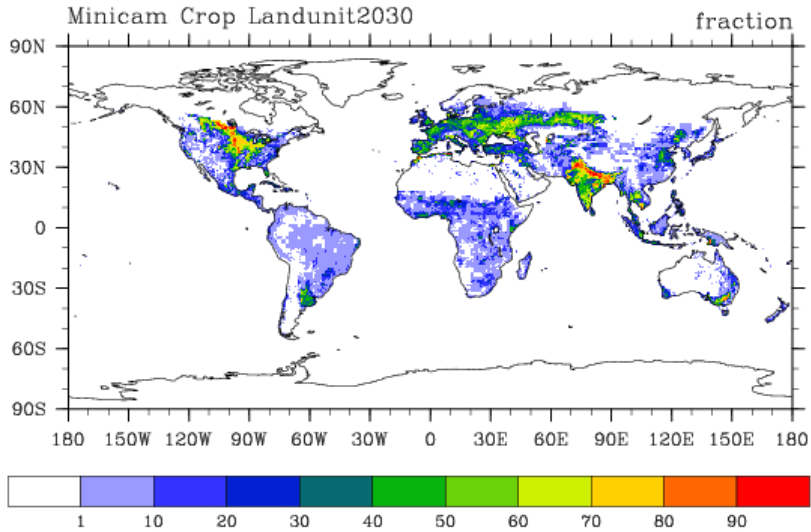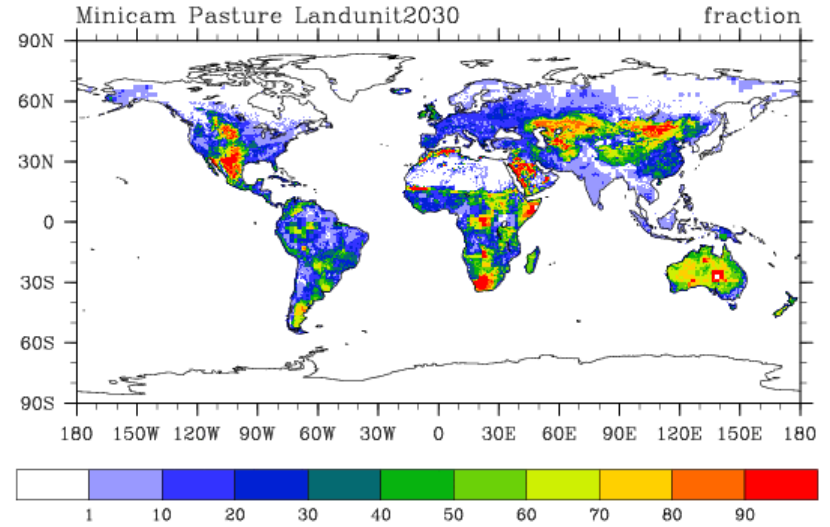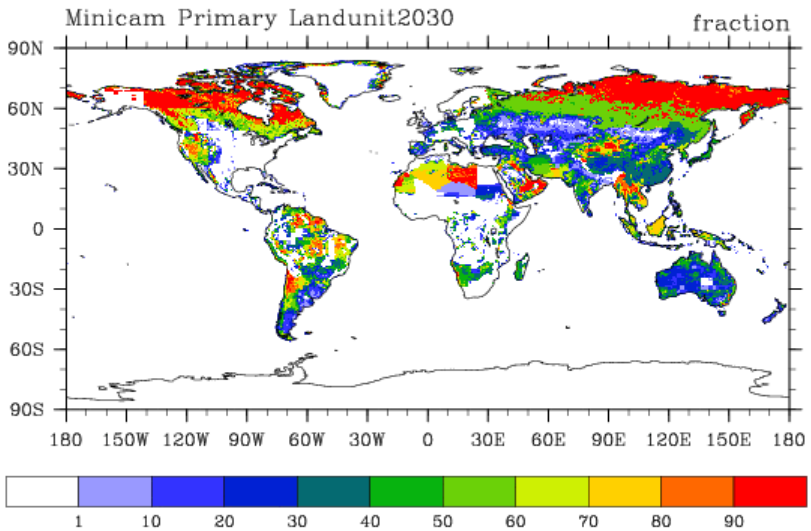
Pasture

Primary

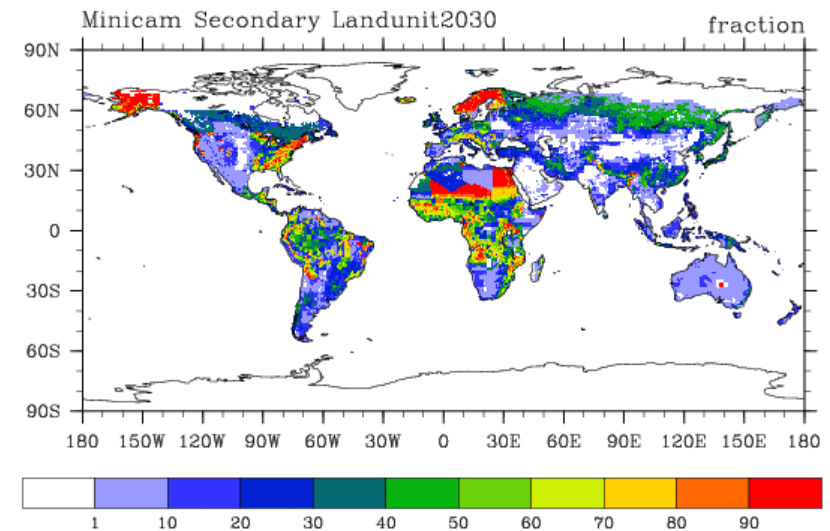
Secondary

Mini-Cam (RCP 4.5 Wm^{-2}): 2030 Land Cover

Crop

Pasture

Primary
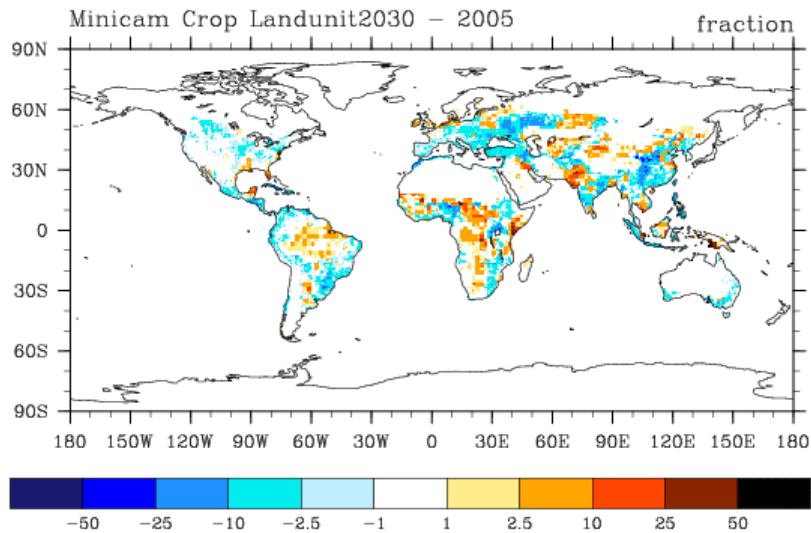

Secondary
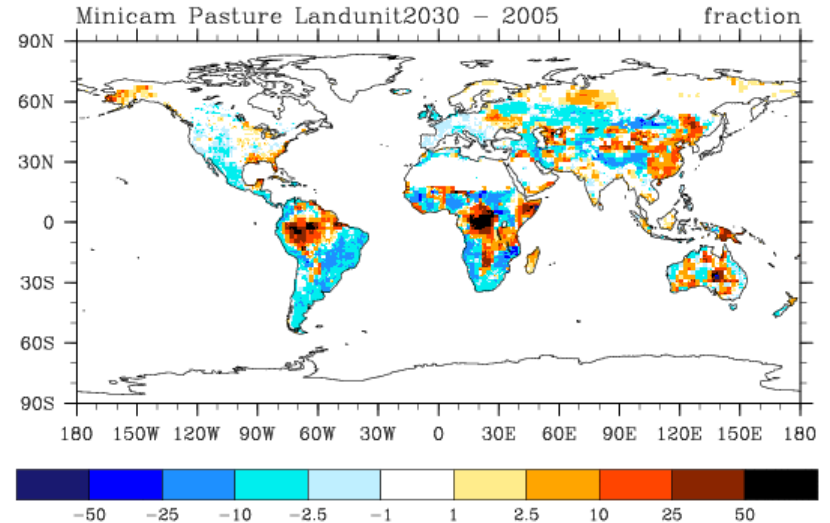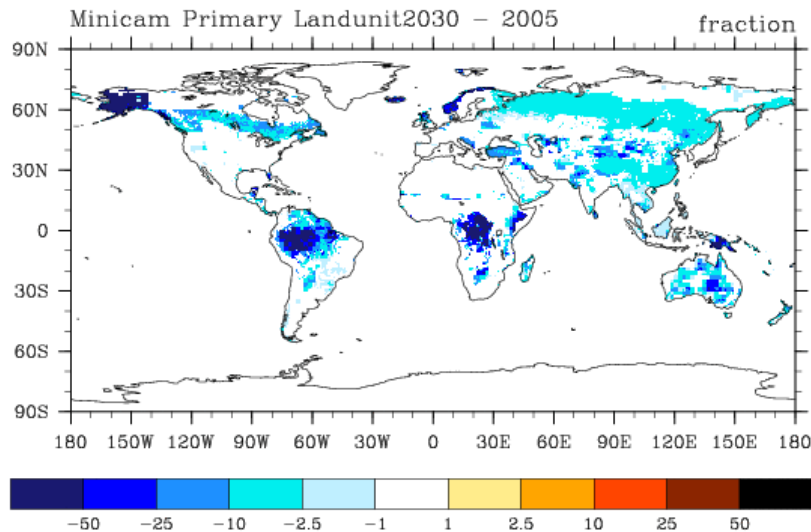
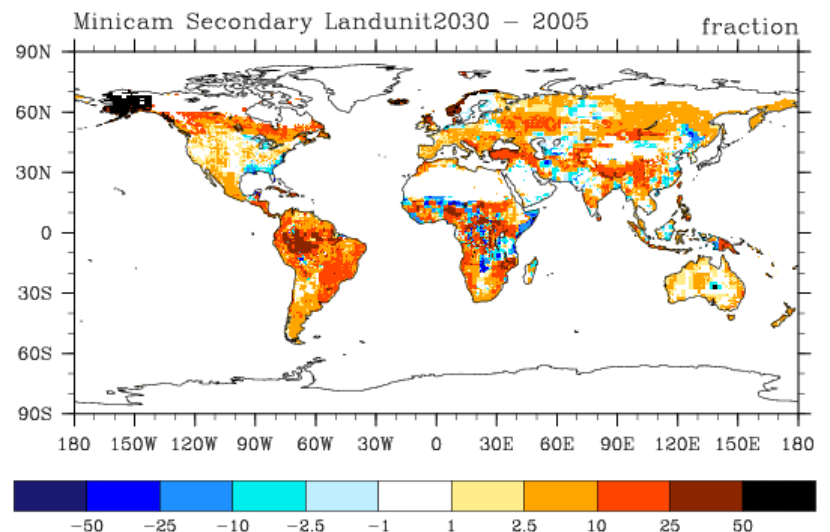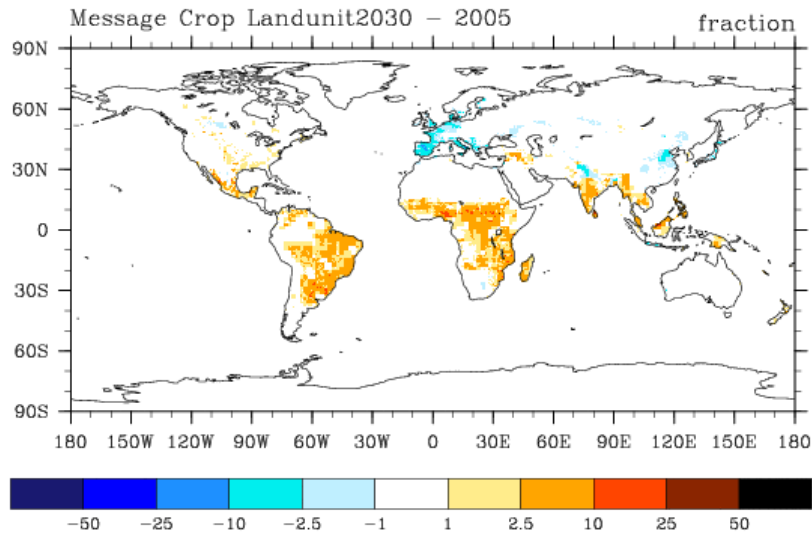# Mini-Cam (RCP 4.5 Wm^{-2}): Land cover change 2005-2030
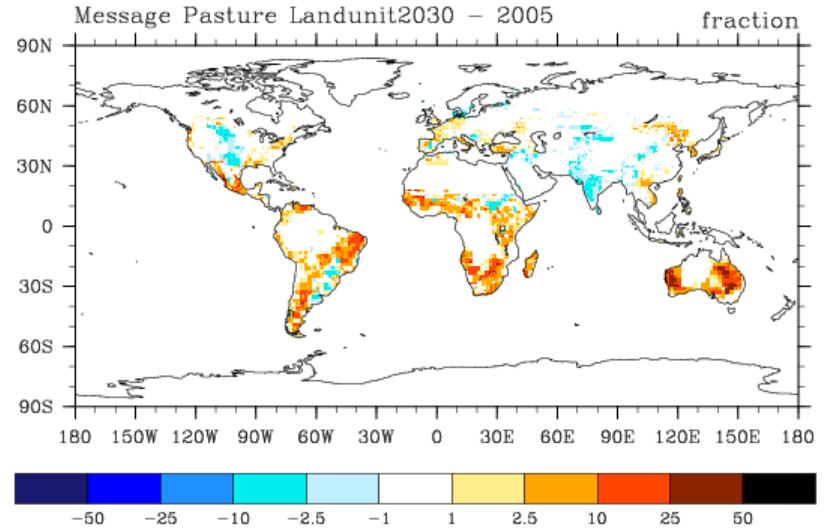
Crop

Pasture

Primary

Secondary

Message (RCP 8.5 Wm^{-2}): Land cover change 2005-2030
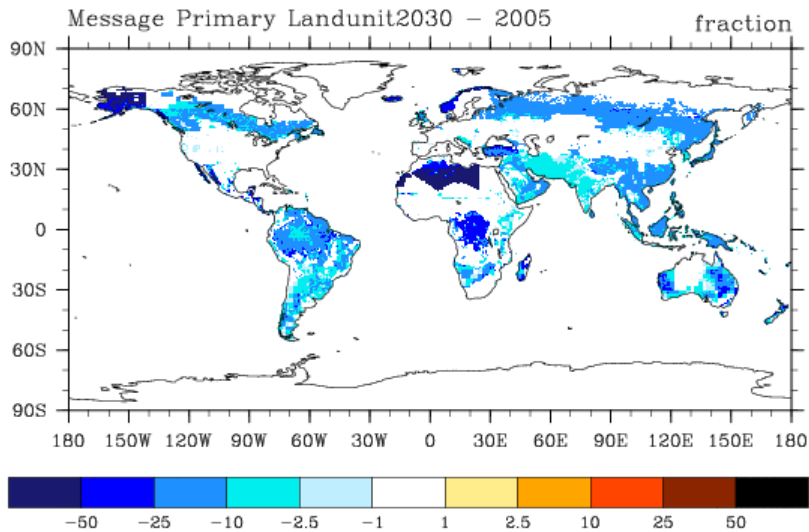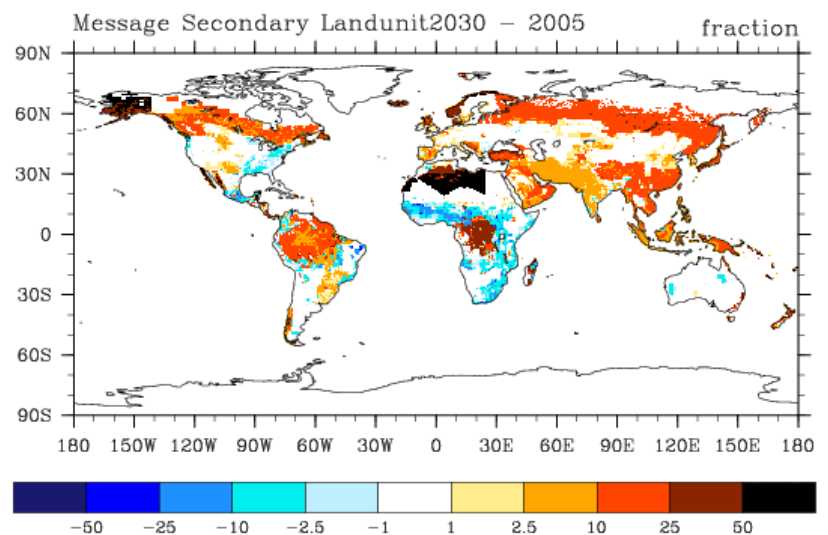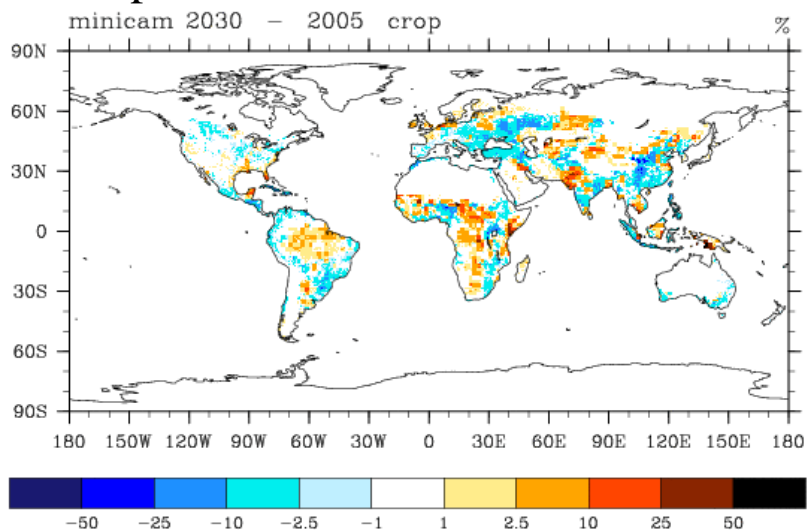
Crop

Pasture

Primary

Secondary

Converting UNH land cover to CLM land cover

Present day PFT allocation using Peter Lawrence (PL) present day PFT as starting point

1. Assign glacier, wetland, lake and urban land units

2. Assume that present day PFT distribution will determine the final allocation of UNH LU classes. Process in the following order (i.e. order of entry):
   a)   Crops (assign crop PFTs)
   b)   Primary (assign "potential PFT distribution" to the area)
   c)   Secondary (assign "present day non human use PFT distribution"
   d)   Assign Pasture areas to:
      I.   grass and shrub areas of Primary and Secondary land
      II.   Then optionally:
         i.   In dry-land areas leave as is (assume bare ground is included in grazing area)
         ii.   In other areas remove secondary forest and replace with grasses

3. Transitions from "primary to secondary" and "secondary to secondary" land determine forest harvest rates and C extraction. Note: Pasture could interfere with forest harvest rates depending on how it is assigned
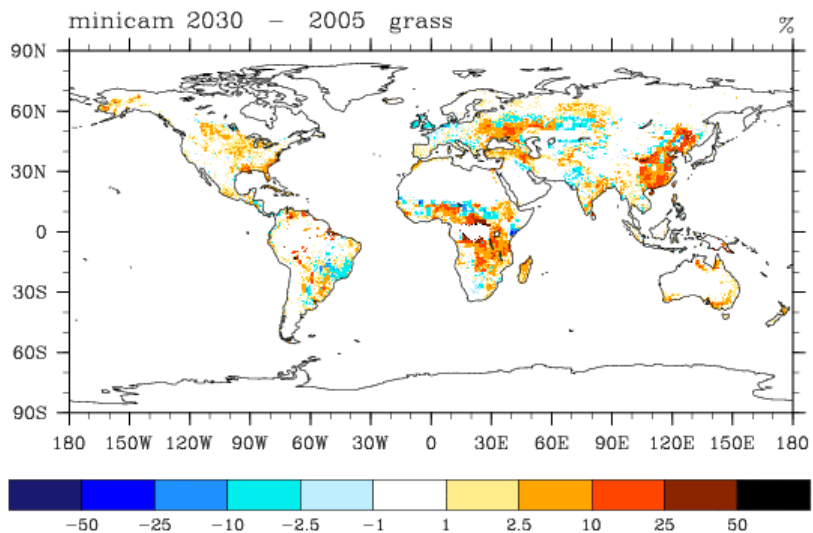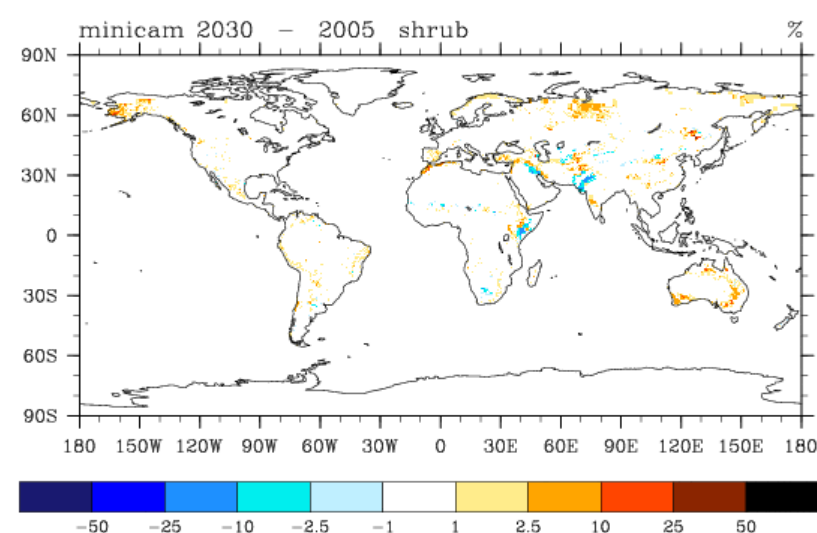
Mini-Cam (RCP 4.5 Wm⁻²): PFT change 2005-2030
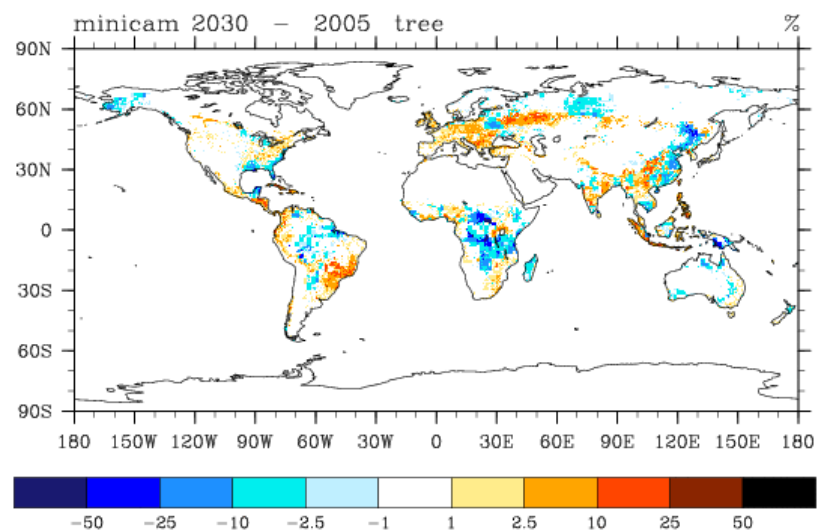
Crop

Trees

Grasses

Shrubs
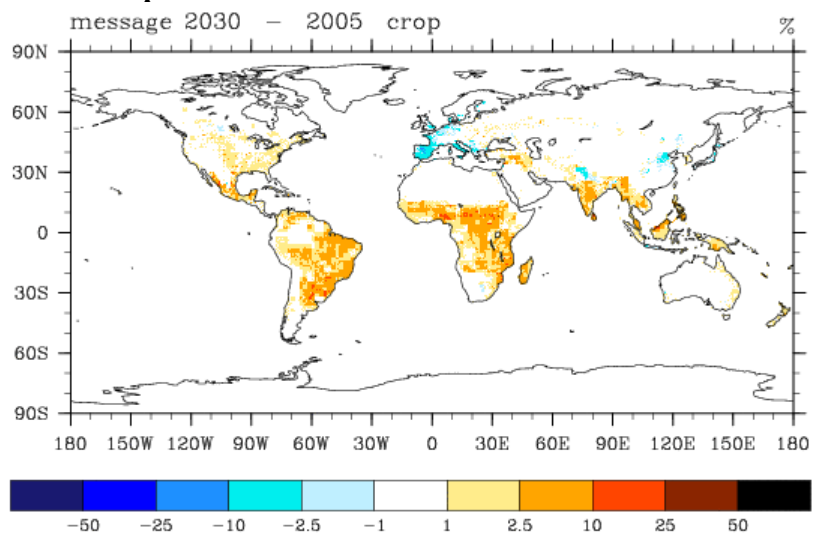
Message (RCP 8.5 Wm^{-2}): PFT change 2005-2030
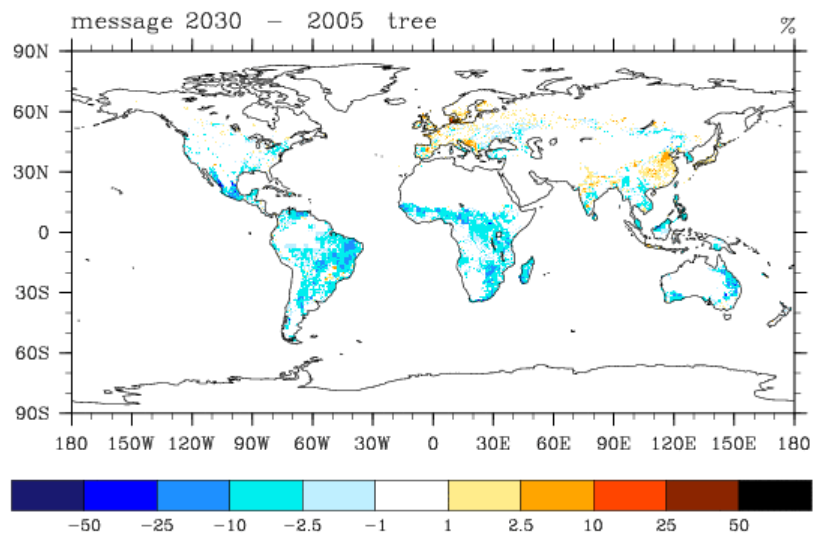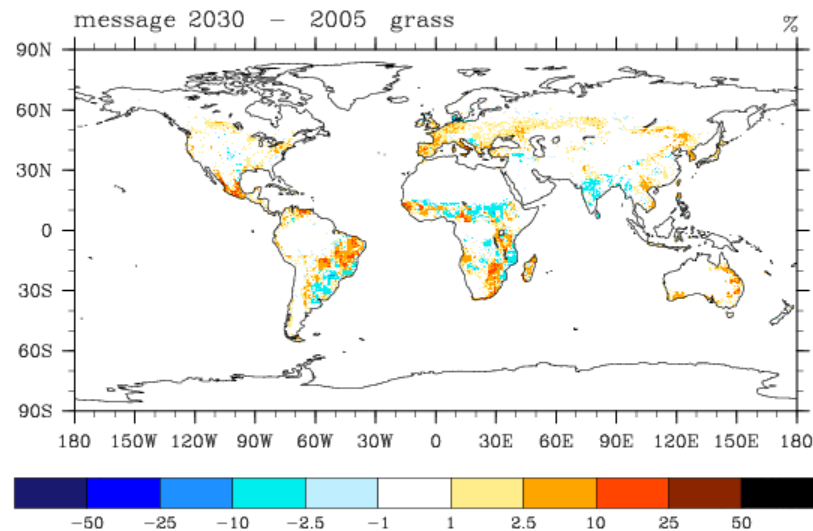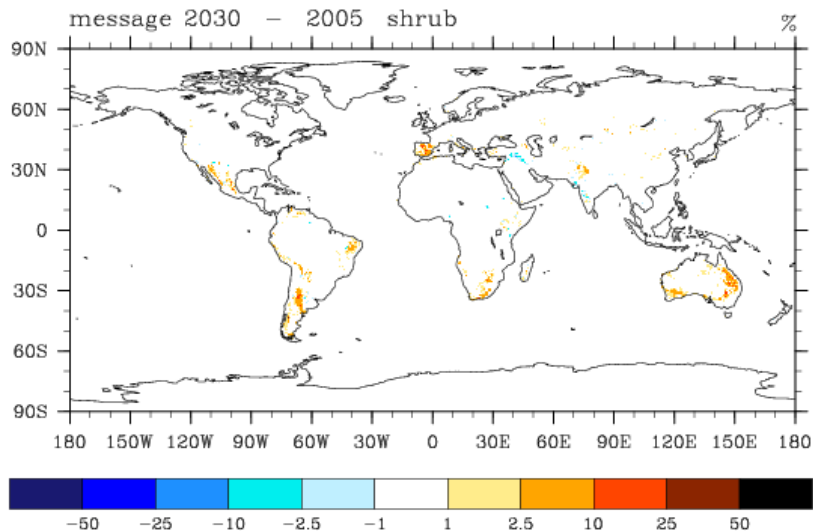
Crop

Trees

Grasses

Shrubs

Discussion

1. The high resolution (0.5 degree) "Climate Forecast" simulations are ideal for land cover change experiments.

2. The proposed RCP 4.5 is a very aggressive land cover change scenario, aimed to maximize bio-fuel production.

3. This projected land cover change does not seem likely, given current trends.

4. Is this an appropriate scenario for the "climate forecast" simulation?

5. Should BGC be turned on for this simulation?

IPCC AR5 – RCPs

	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**