

Prognostic Land Use and Land Cover Change for CCSM: Coupling IMAGE and GCAM to CLM

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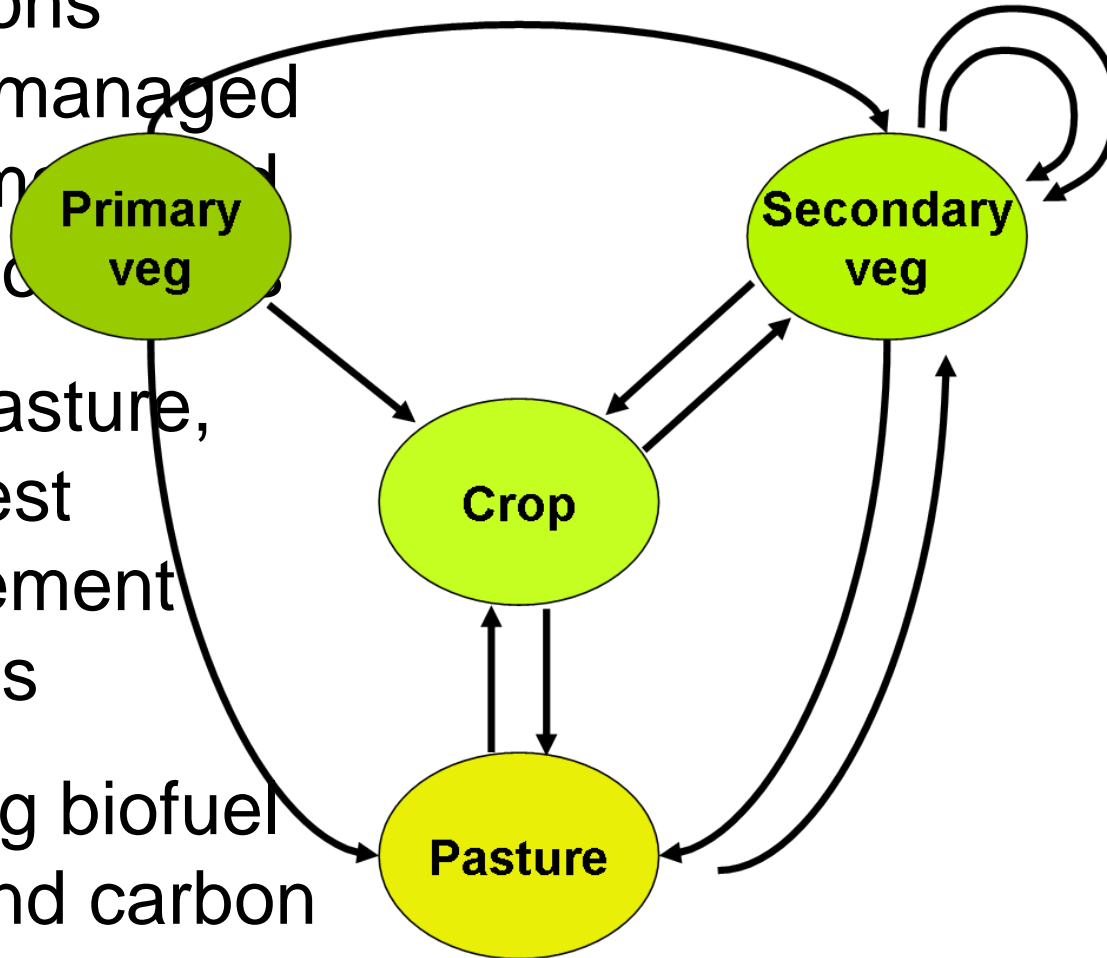
Objective

Improve knowledge of controls on future greenhouse gas concentrations and climate-biosphere feedbacks...

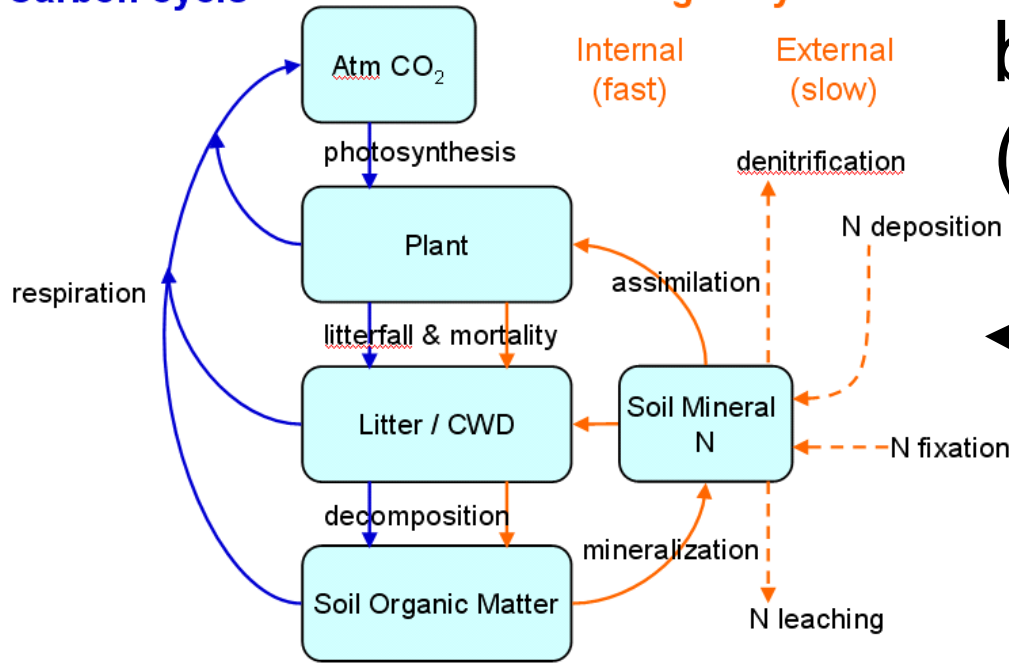
...by introducing predictions of human land use and land-cover change within a global climate-biogeochemistry model.

Project scope

- Transitions among managed and unmanaged vegetation
- Crop, pasture, and forest management practices
- Including biofuel crops and carbon plantations



Carbon cycle

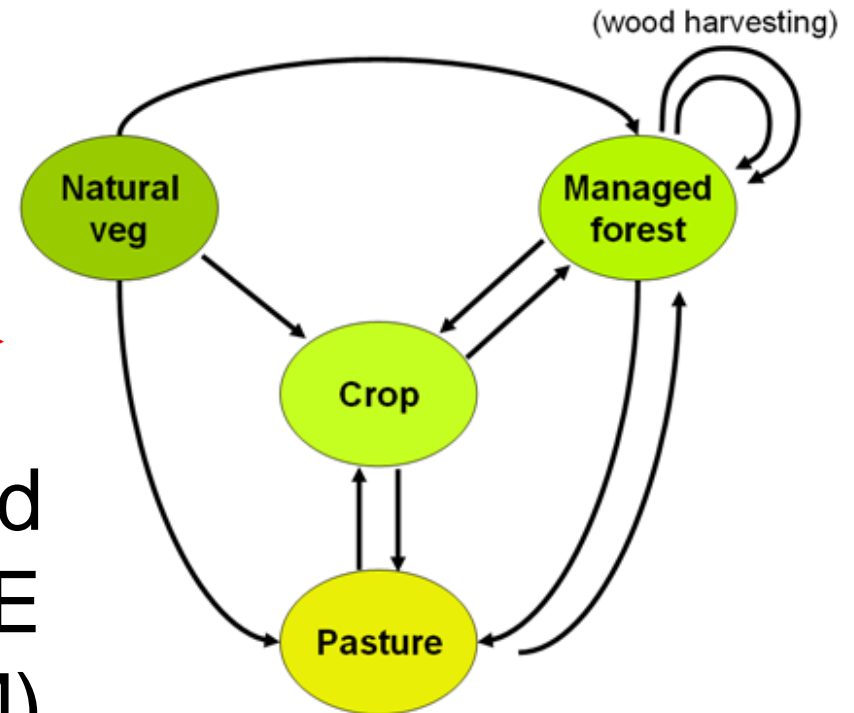


Prognostic biogeochemistry (CLM-CN)

Exogenous coupling

Endogenous coupling

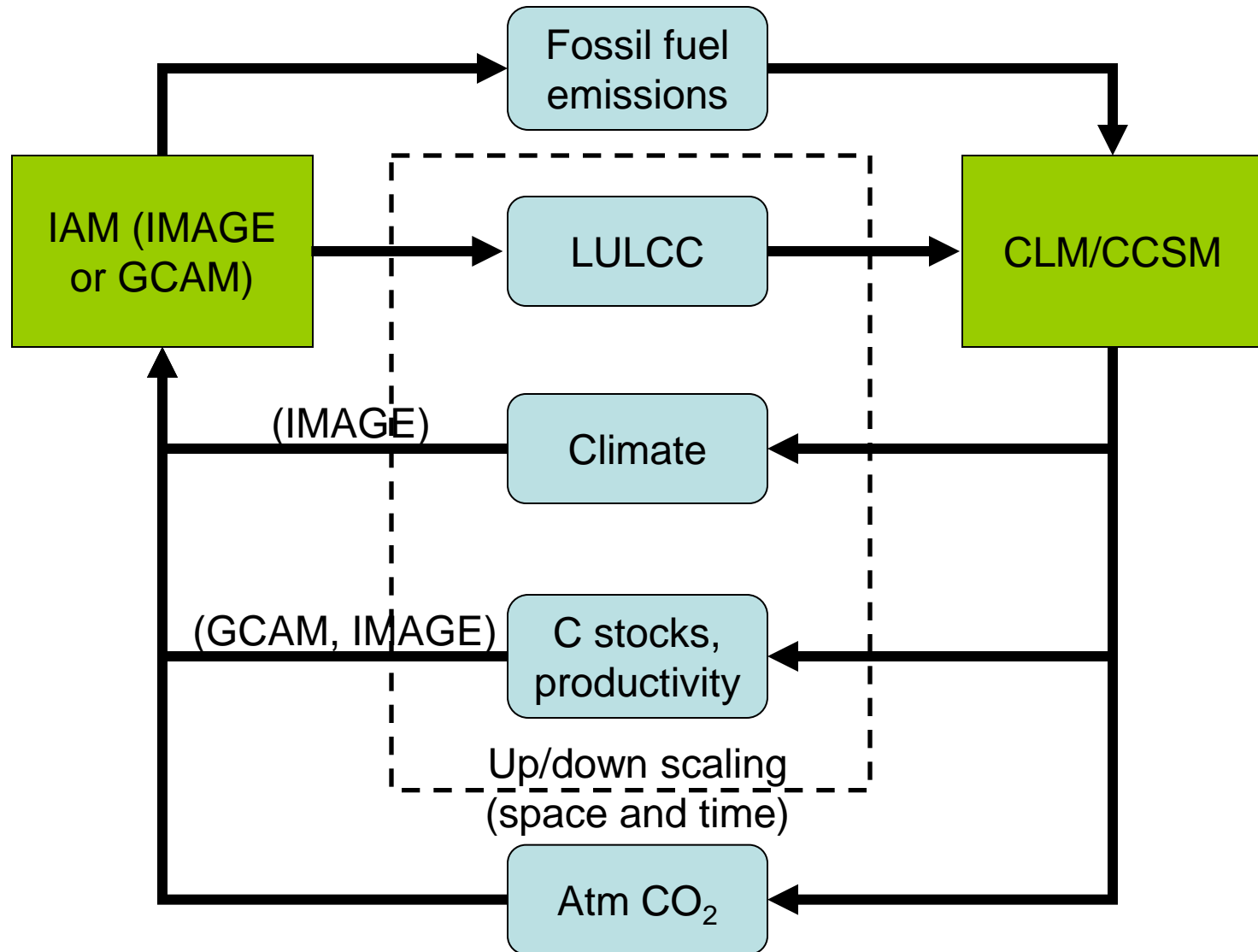
Prognostic land allocation (IMAGE or GCAM)



Science Questions:

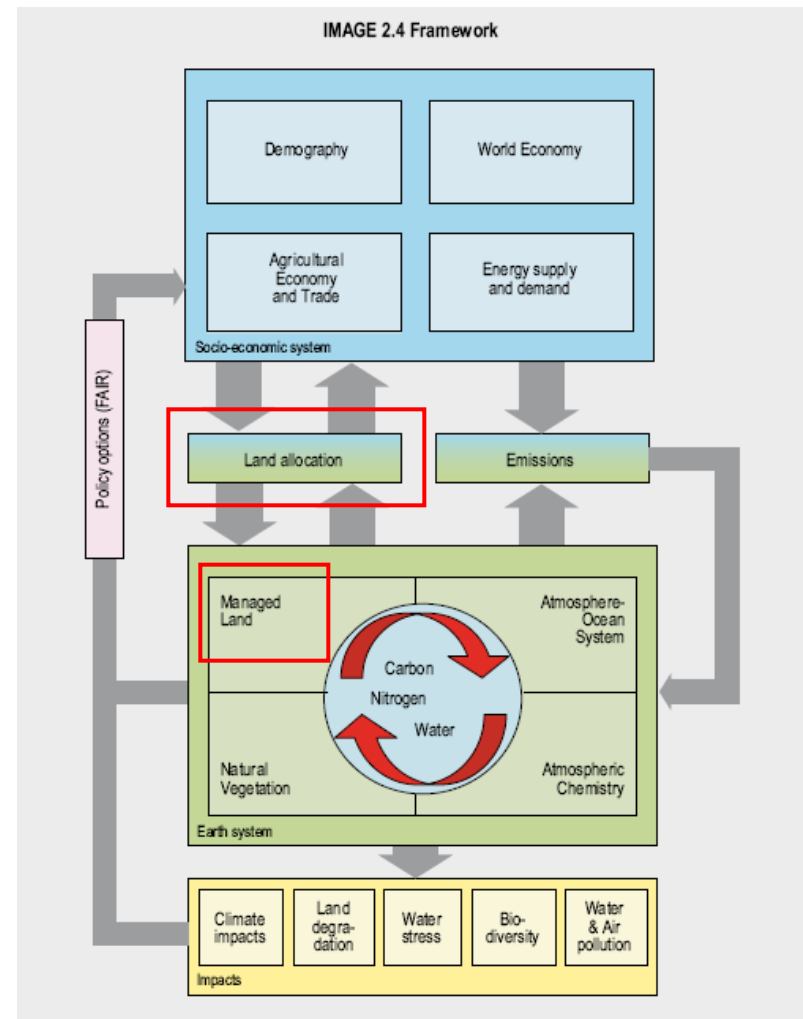
1. How sensitive are predicted land use change trajectories to inconsistencies in climate and BGC components of IAM & CCSM?
2. How sensitive are modeled climate-carbon cycle feedbacks to on-line vs. off-line representations of land use and land cover change?

Multi-phase coupling strategy

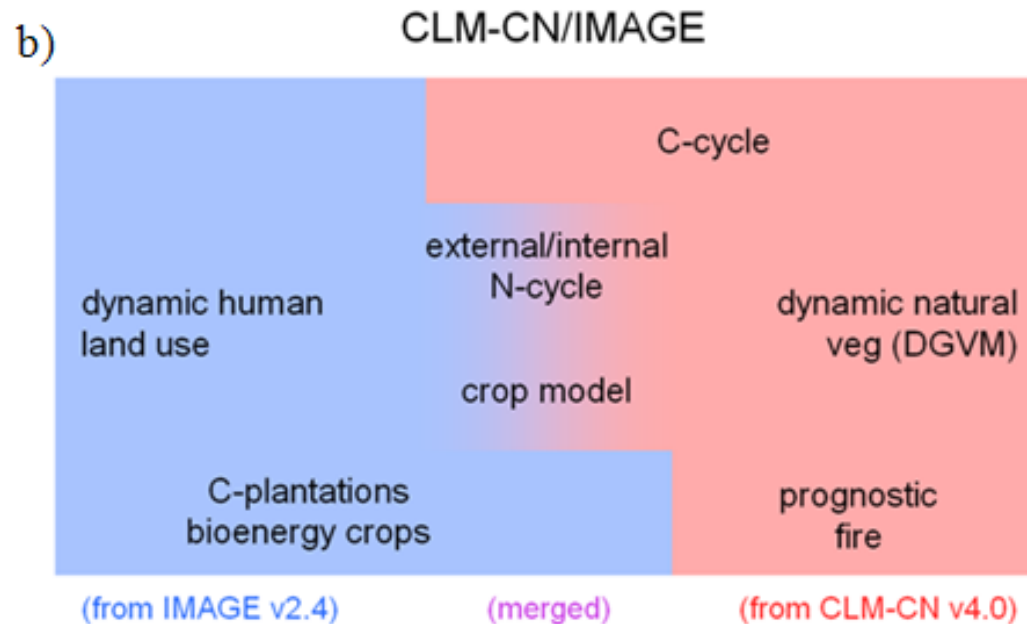
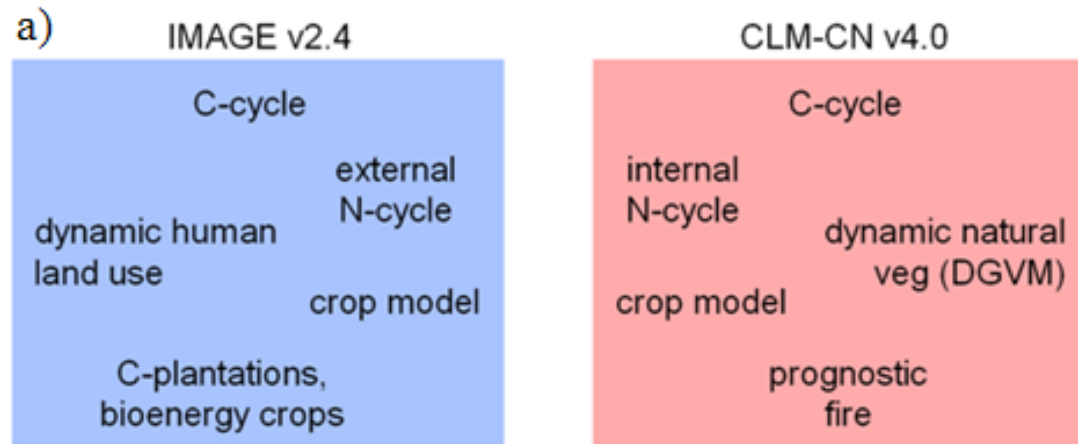


Integrated Model to Assess the Global Environment (IMAGE v2.4)

- Dynamic land allocation algorithm
- Detailed treatment of managed land types
- Crops (7), pasture (2), carbon plantations, bioenergy crops
- External nitrogen cycle
- 0.5 degree grid

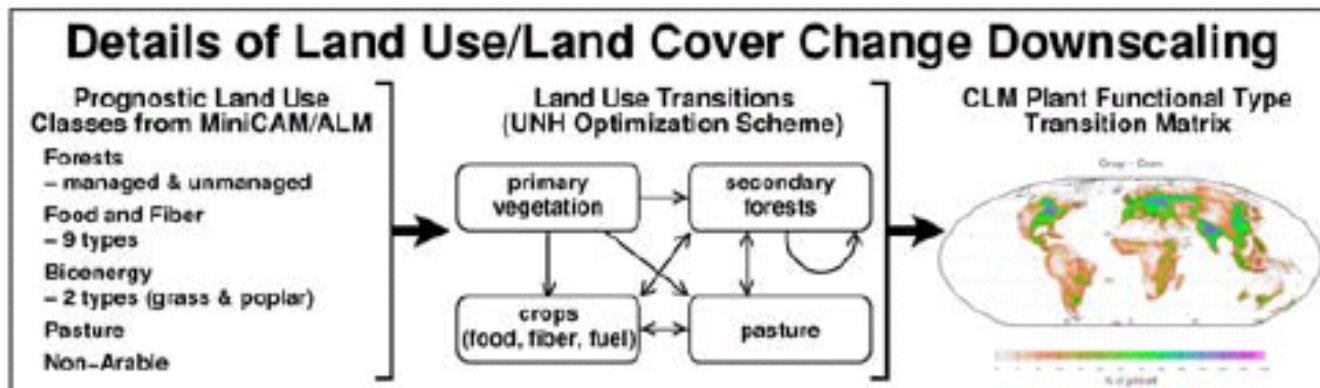
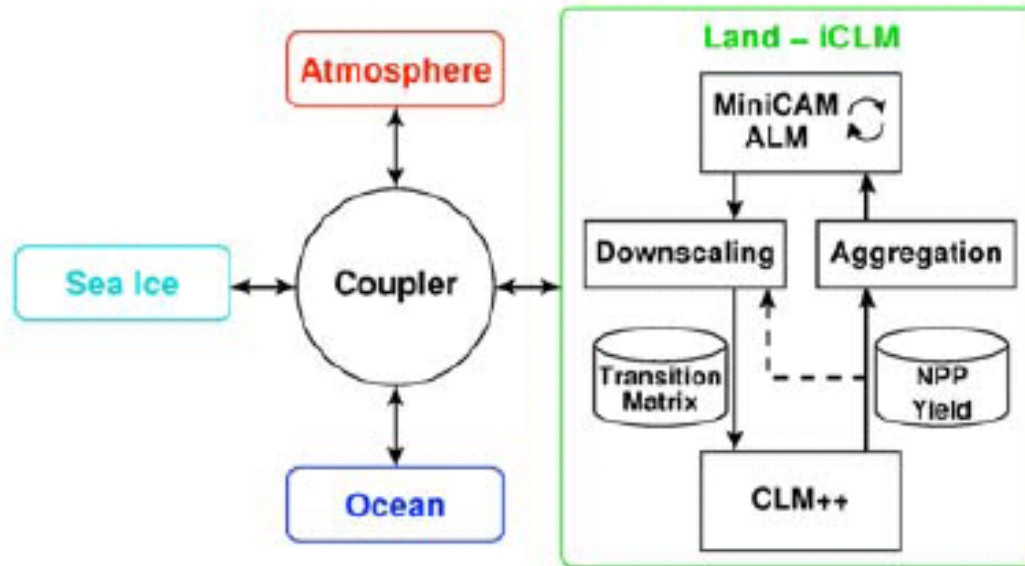


Coupling details: IMAGE + CLM



Coupling details GCAM + CLM

The iESM



Model Development Tasks

1. Bring new plant functional types into CLM-CN (food crops, C-plantations, bioenergy crops).
2. Integrate internal N-cycle (CLM-CN) with external N-cycle (IMAGE).
3. Integration of historical datasets with expanded CLM-CN vegetation types from 1.
4. Integrate up/down scaling into CLM.

Next steps...

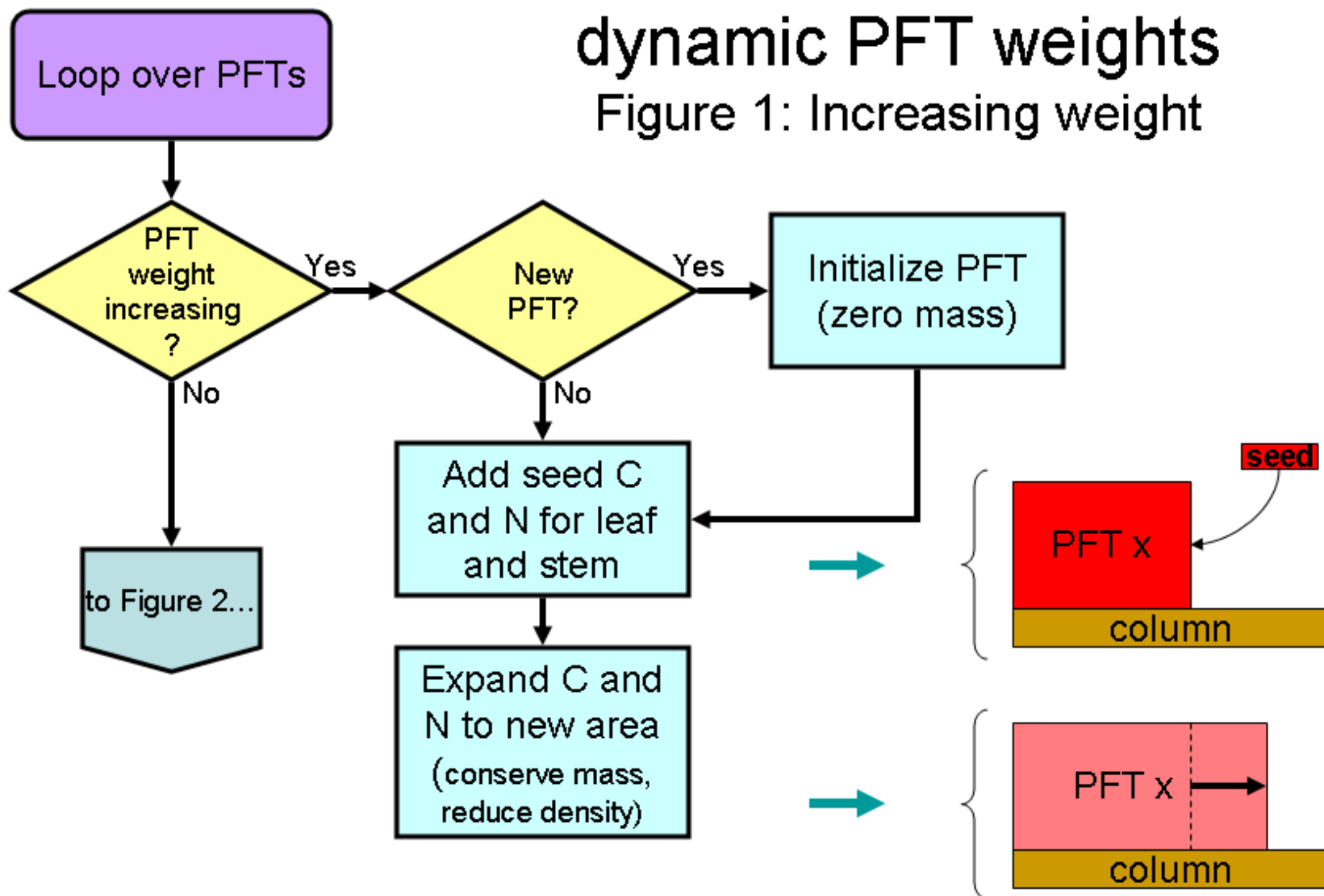
1. First phase coupling experiments:
 - Climate coupling with IMAGE (RCP 2.6)
 - C stock coupling with GCAM (RCP 4.5)
2. Second phase coupling experiments
 - C stock coupling with IMAGE
 - Climate coupling with GCAM
3. Tighten coupling
 - Integrate GLM/Peter Lawrence codes within CLM
 - Call IAMs as CLM subroutine
4. Introduce new CLM managed PFTs

CLM land cover transition logic

1. Coordinate CLM-CN land cover change data stream with “harmonization” approach for IPCC AR5.
2. Algorithms for handling both increases and decreases in area fractions, while conserving mass and energy.
3. New logic accepted as default approach for CCSM contributions to AR5.

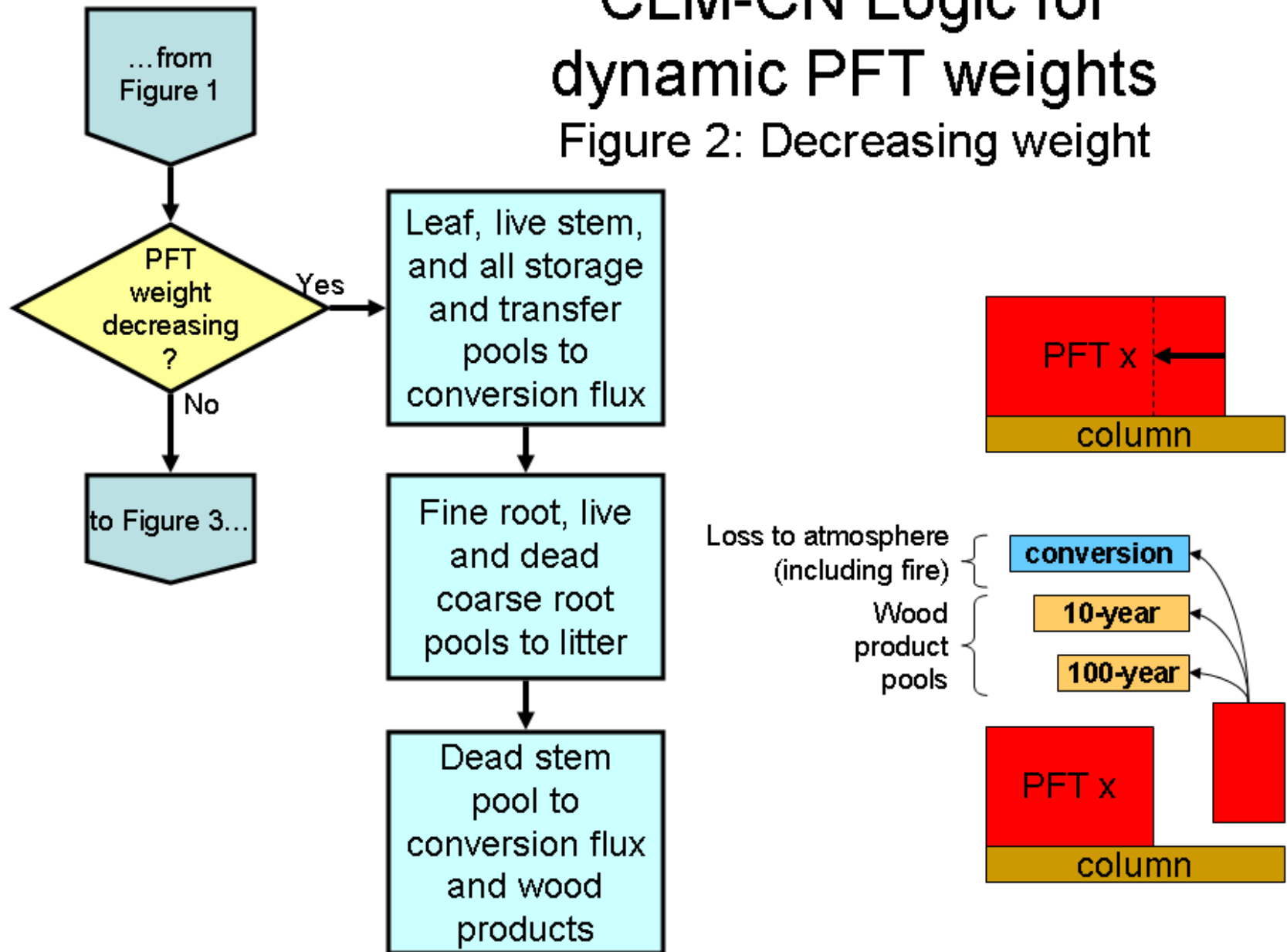
CLM-CN Logic for dynamic PFT weights

Figure 1: Increasing weight



CLM-CN Logic for dynamic PFT weights

Figure 2: Decreasing weight



Task 3 summary...

CLM-CN Logic for dynamic PFT weights

Figure 3: Rotation harvest

