The Community Terrestrial System Model
a unified model for research and prediction in climate, weather, water, and ecosystems

CTSM (unification) benefits:
- extend NCAR leadership in community modeling
- reverse trends of model proliferation and shantytown syndrome
- more efficient use of NCAR and community model development resources
- integrate and expand land modeling research
- accelerate advances, improve science through multiple hypothesis testing
Spatial resolutions

- Global (low and high resolution)
- Regional
- Single point (tower site)
- Irregular grids (cubed sphere, basin)

Temporal resolutions

- Fixed vegetation distributions (paleo, current day)
- Annual Land Use and Land Cover Change specified for time periods (historical, scenarios, alternatives)
- Model states and fluxes updated at 30 minute time step with some adaptive time stepping and accumulating state variables

Model Complexity

- SP (satellite phenology, prescribed vegetation)
- BGC (prognostic carbon, vegetation)
- BGC-crop (default in CESM2, same as BGC with crops)
- BGC no-anthro
- BGC FATES
- Simplified SP (reduced pfts and soil layers) for use in weather prediction
CTSM Sub Grid Heterogeneity - Tiling

Gridcell

Landunit
- Vegetated
- Lake
- Urban
- Glacier
- Crop

Column
- Soil
- Roof
- Sun Wall
- Shade Wall
- Impervious

PFT
- PFT1
- PFT2
- PFT3
- PFT4 ...

G

V
PFT1

V
PFT2

V
PFT3

V
PFT4

L

C1I

C1U

C2I

C2U

UT,H,M

Unirrig

Irrig

Unirrig

Irrig

Crop1

Crop1

Crop2

Crop2 ...
CTSM Land Cover Change – Prescribed Annual Changes

Gridcell

Landunit
- Vegetated
- Lake
- Urban
- Glacier
- Crop

Column
- Unirrig
- Irrig

Annual Land Use Change

CLM 5 LULCC for Natural PFT and Crop

Prescribed Annual Changes

PFT1
PFT2
Crop1
Crop1
Crop2
Crop2 ...

Unirrig
Unirrig
Unirrig
Irrig
Irrig

C1I C1U
C2I C2U
C3I C3U

V PFT1
V PFT2
V PFT3
V PFT4
CTSM Land Use – Crop Model Prescribed Management

Gridcell

Landunit
- Vegetated
- Lake
- Urban
- Glacier
- Crop

Crop Model
- Planting
- Leaf emergence
- Irrig / Fertilize
- Harvest
- Grain fill
- Unirrig
- Irrig

CLM 5 LULCC for Natural PFT and Crop

Crop Model Prescribed Management
CTSM Land Use and Land Cover Data

CLM5 Data

Data

Current day cropping (CFTs) 1961 - 2015

Historical or future land use time series

CLM Land Use Data Tool

CLM5 raw CFT/PFT files

“mksrf “ CLM Land Surface Properties Tool

Current day vegetation (PFTs) 2000 - 2015

Data

LUMIP format:
12 land units
Transitions Management

CLM5 format:
14 Plant Types
32 Crop Types
(Wood Harvest
Shifting Cultivation
Irrigation and
N Fertilizer)

CLM/CESM
CTSM Land Use and Land Cover Data 1km

MODIS Land Cover - IGBP Classes (2003 - 2012)

CLM5 Percent Tree Cover 2005
CTSM Land Use and Land Cover Data 1km

CLM5 Oil Palm 2005

CLM5 Coffee 2005
CTSM – Soil Moisture Heterogeneity
Spatial covariation across hillslopes
Hillslope Multicolumn Configuration:
Individual columns interact via lateral flow.