

Historical and Future Land Use and Land Cover Change in CLM5 for CMIP6

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CLM5 New Surface Data Time Series: Historical and Future

The new CLM5 capabilities and the LUMIP/CMIP6 scenarios require that annual grid cell data is provided that represents:

- The Forest / non forest information of the LUH2 time series
- Wood Harvest that is prescribed in a carbon amount to be extracted as wood rather than a fraction of trees
- The transient C3/C4 Crops of the time series in the CLM Crop model that are specified for individual crops for each grid cell and each year
- Fertilizer and irrigation management is specified by crop and grid cell every year
- Gross Unrepresented Land Cover Land Use Change that is not captured in the Net Changes resulting from differences in PFTs and CFTs from one year to the next.

CLM5 CMIP6 – New Land Surface Data Sets

1. The new Historical and SSP - RCP land use and land cover change time series are being compiled for through the Land Use and Scenario Model Intercomparison Projects (LUMIP and ScenarioMIP).
2. The Global Land Model (GLM) has been extended to 12 land units to better represent dynamics of agriculture and forests. The new land units include:
 - Primary Forest
 - Secondary Forest
 - Crop C3 Annual
 - Crop C3 Nitrogen Fixing
 - Crop C4 Perennial
 - Grazing Rangeland
 - Primary Non Forest
 - Secondary Non Forest
 - Crop C3 Perennial
 - Crop C4 Annual
 - Grazing Pasture
 - Urban
3. New management information for Crops and Forests is provided with transient N Fertilizer and Irrigation prescription, and new Wood Harvest

CMIP6 LUMIP CLM5 Land Use Harmonization (LUH2)

~ 50x information content of CMIP5!

New Resolution

0.25° grid-cell fraction

New History

Hyde 3.2, FAO based

Landsat F/NF

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

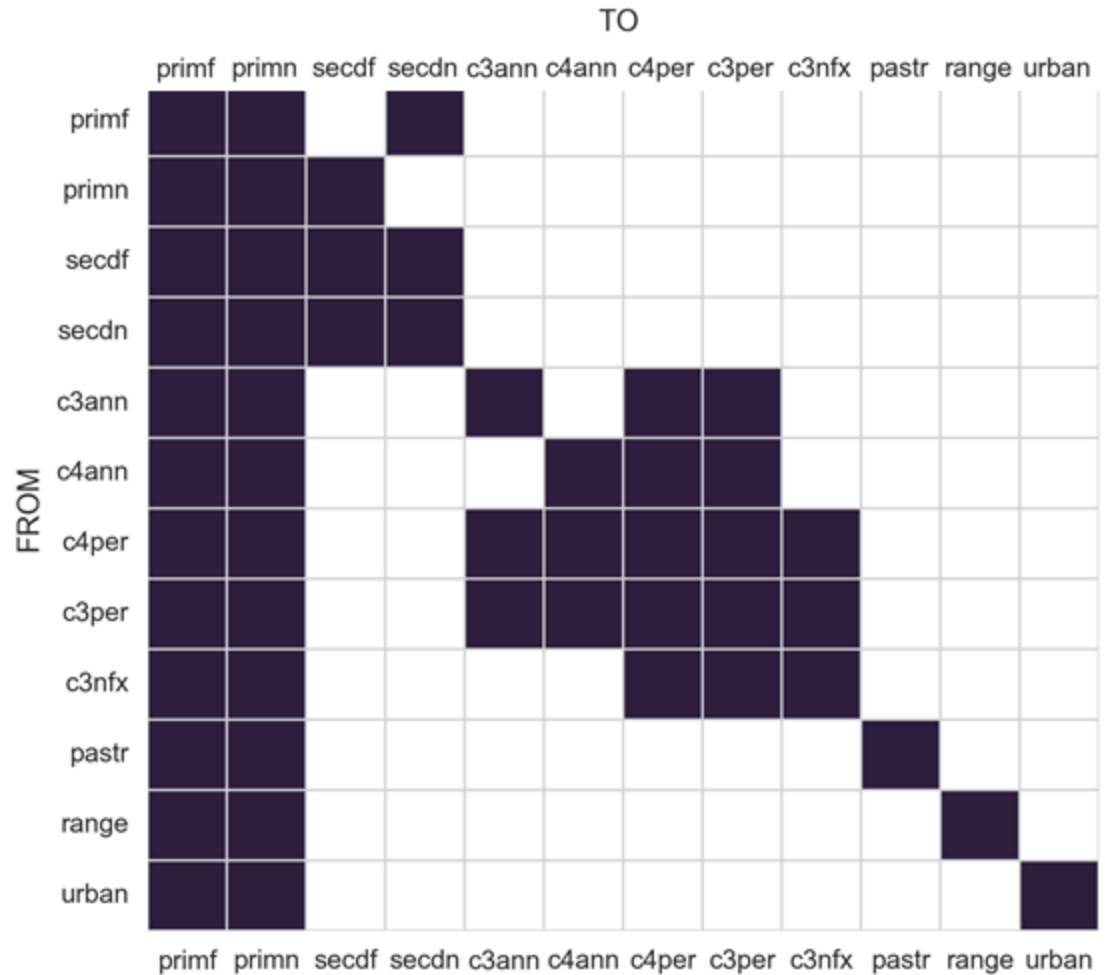
Fraction used for commercial biofuels

Fraction used for fuelwood

New Future Scenarios

Six futures, SSP-based

New Transition Matrix



1. CMIP6 LUMIP CLM5 Land Use Harmonization (LUH2)

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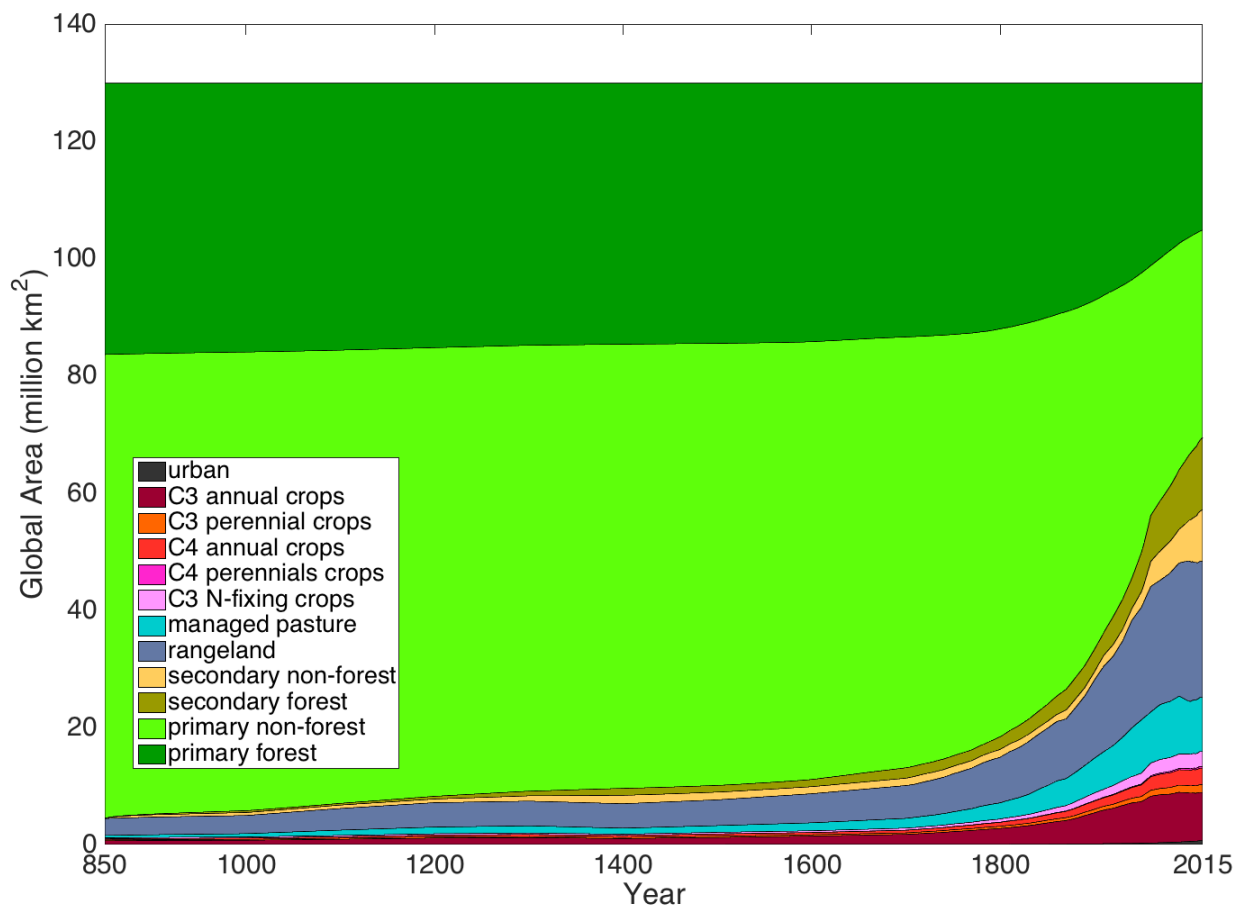
Fraction industrial products

Fraction commercial biofuels

Fraction fuelwood

New Future Scenarios

Six futures, SSP-based



Gridcell



Landunit



Vegetated



Lake



Urban



Glacier



Crop



Unirrig



Irrig



Unirrig



Irrig



Crop1



Crop1



Crop2



Crop2 ...

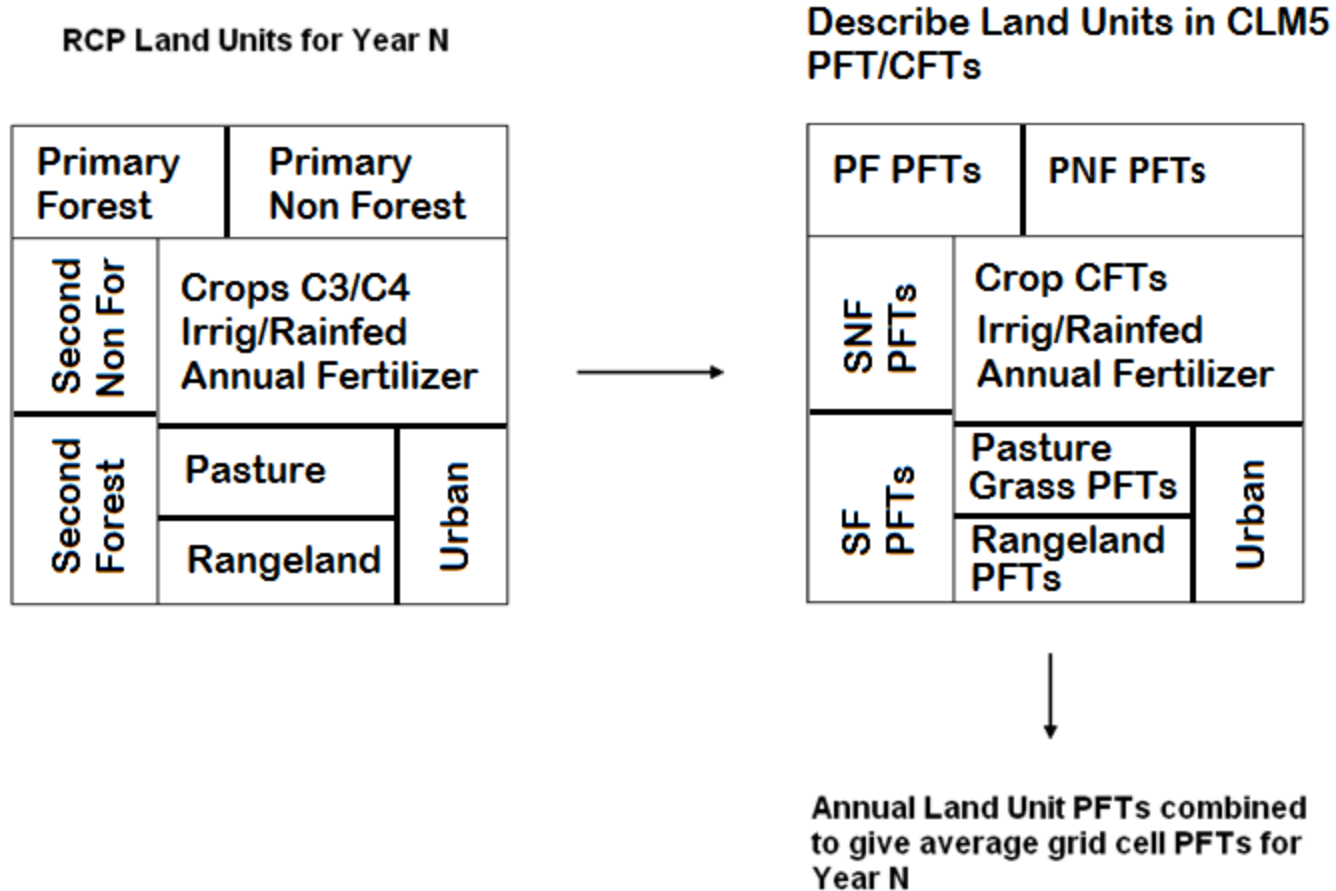
3. CMIP6 LUMIP CLM5

1. The CLM group has developed new LUMIP CMIP6 CLM transient natural vegetation and crop simulation capability with prescribed annual crop N fertilizer and irrigation. New landuse.timeseries files.

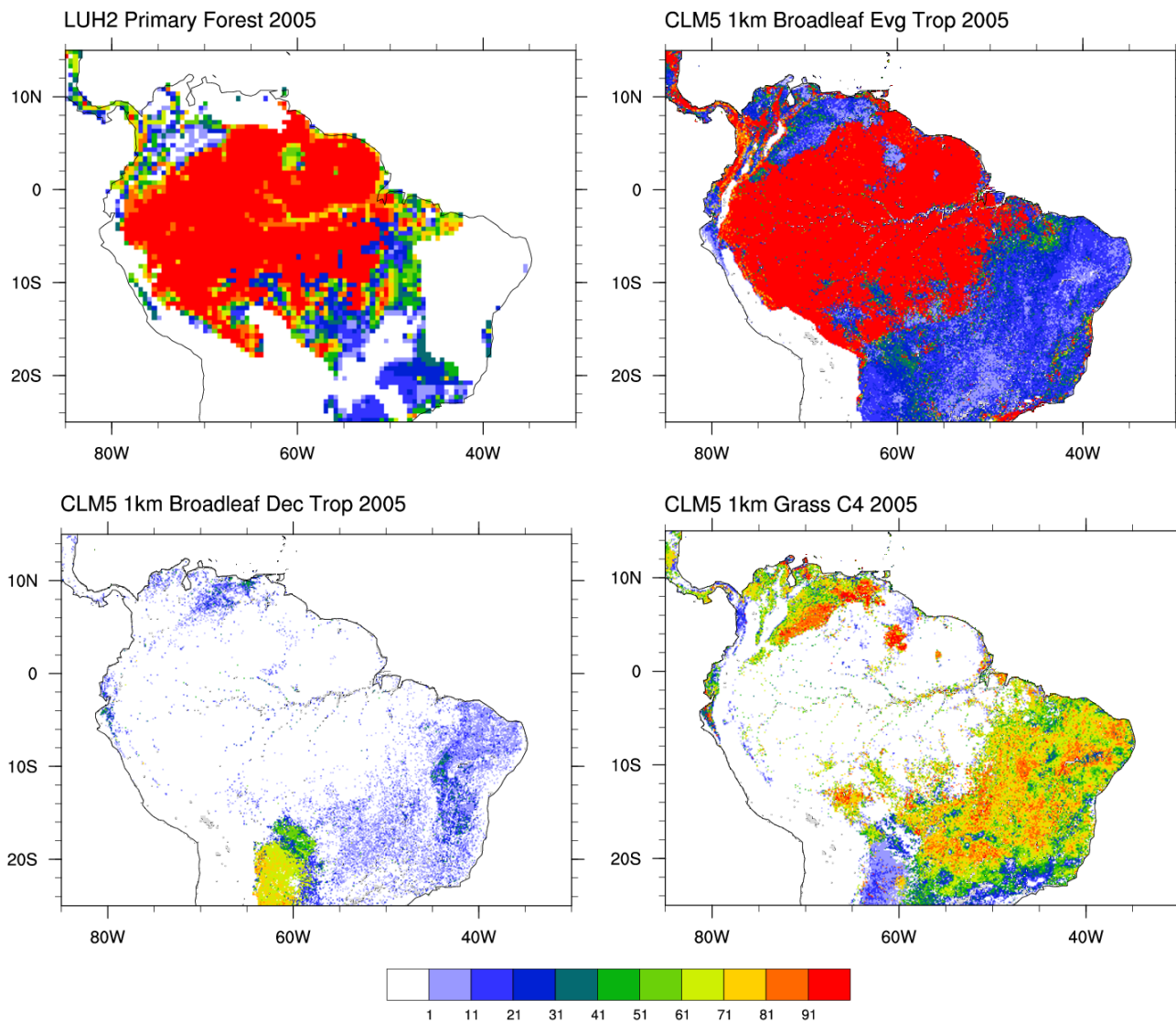
For each year of LUMIP/CMIP6 time series specify for each grid cell:

- PCT_NATVEG – percent of gridcell as natural vegetation land unit
- PCT_CROP – percent of gridcell as crop land unit
- PCT_NAT_PFT – percent of natural vegetated land unit for each PFT
- PCT_CFT – percent of crop land unit for each CFT (irrigated/rainfed)
- FERTNITRO_CFT – gN/m²/yr N Fertilizer for each CFT
- HARVEST_PRIMARY_FOR – gC/m²/yr Wood harvest Primary Forest
- HARVEST_PRIMARY_NFOR – gC/m²/yr Wood harvest Primary Non Forest
- HARVEST_SECONDARY_MFOR – gC/m²/yr Wood harvest Second Mature For
- HARVEST_SECONDARY_YFOR – gC/m²/yr Wood harvest Second Young Forest
- HARVEST_SECONDARY_NFOR – gC/m²/yr Wood harvest Second Non Forest
- UNREPRESENTED_PFT_LULCC – percent of PFT unrepresented in Net LULCC
- UNREPRESENTED_CFT_LULCC – percent of CFT unrepresented in Net LULCC

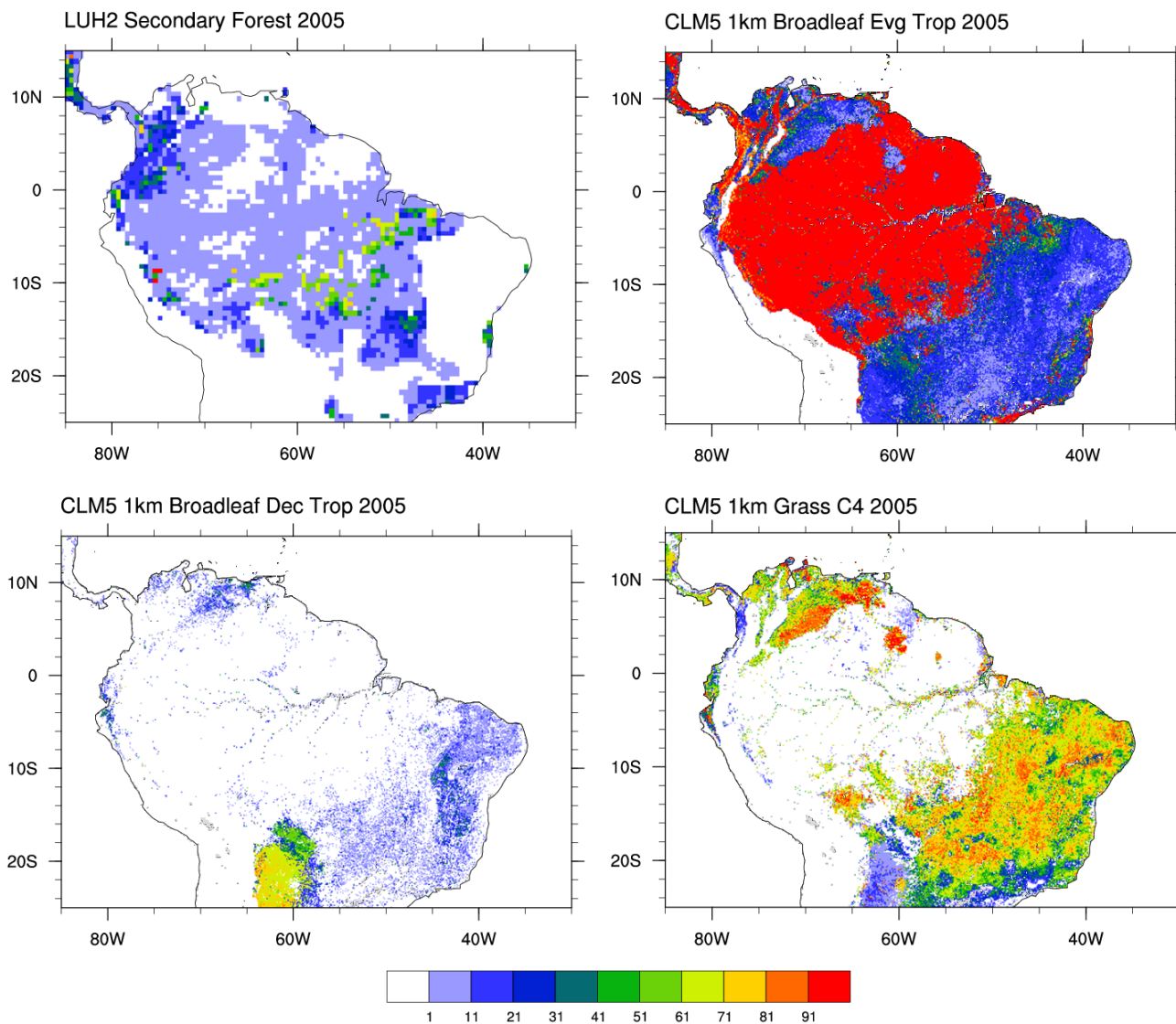
2. Generating CMIP6 Transient Land Cover in CLM 5 PFTs Method GLM 0.25 Degree -> CLM5 PFTs and CFTs



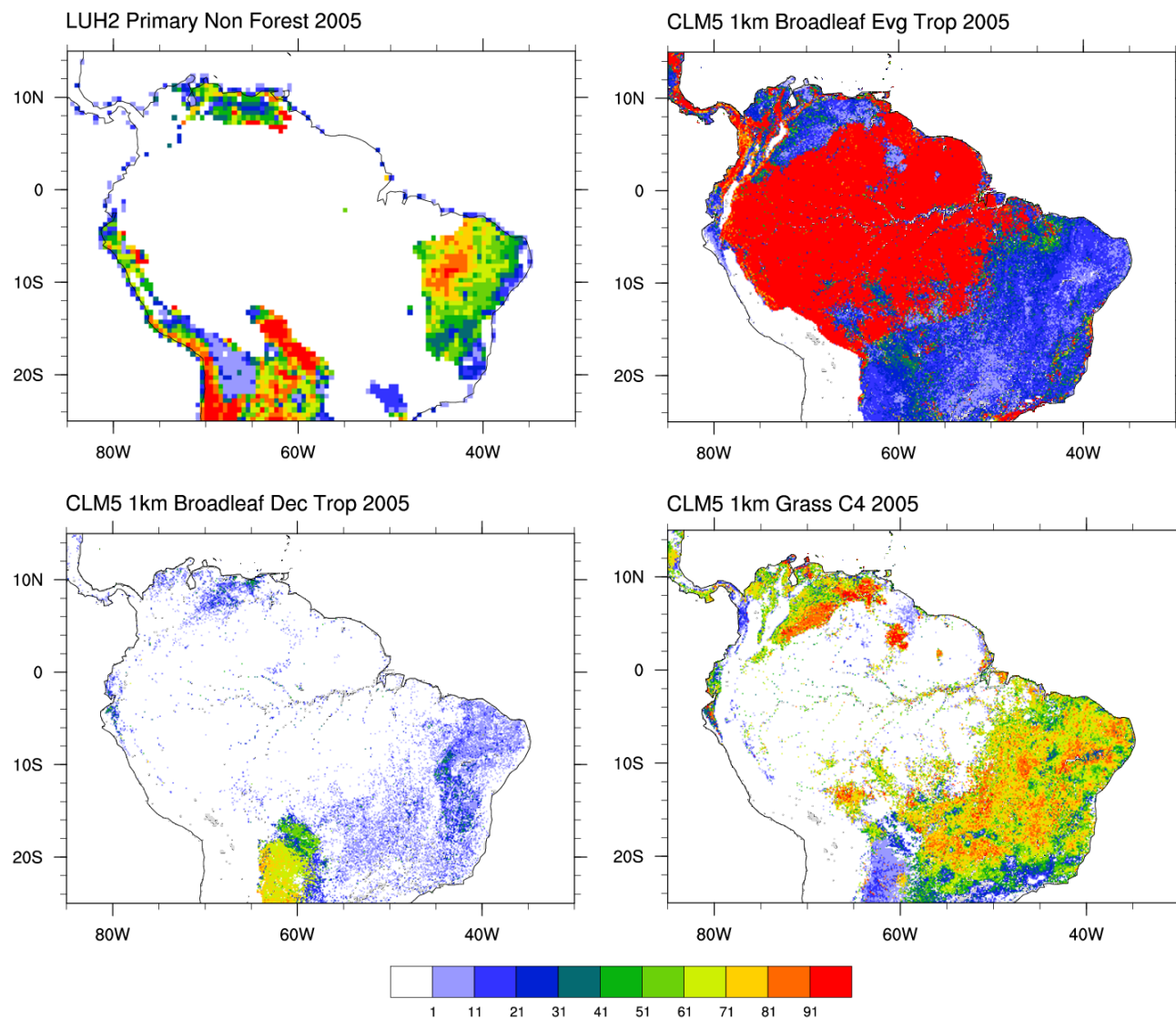
2. CMIP6 Transient Land Cover in CLM 5 PFTs Current Day High Resolution MODIS and LUH2 Time Series



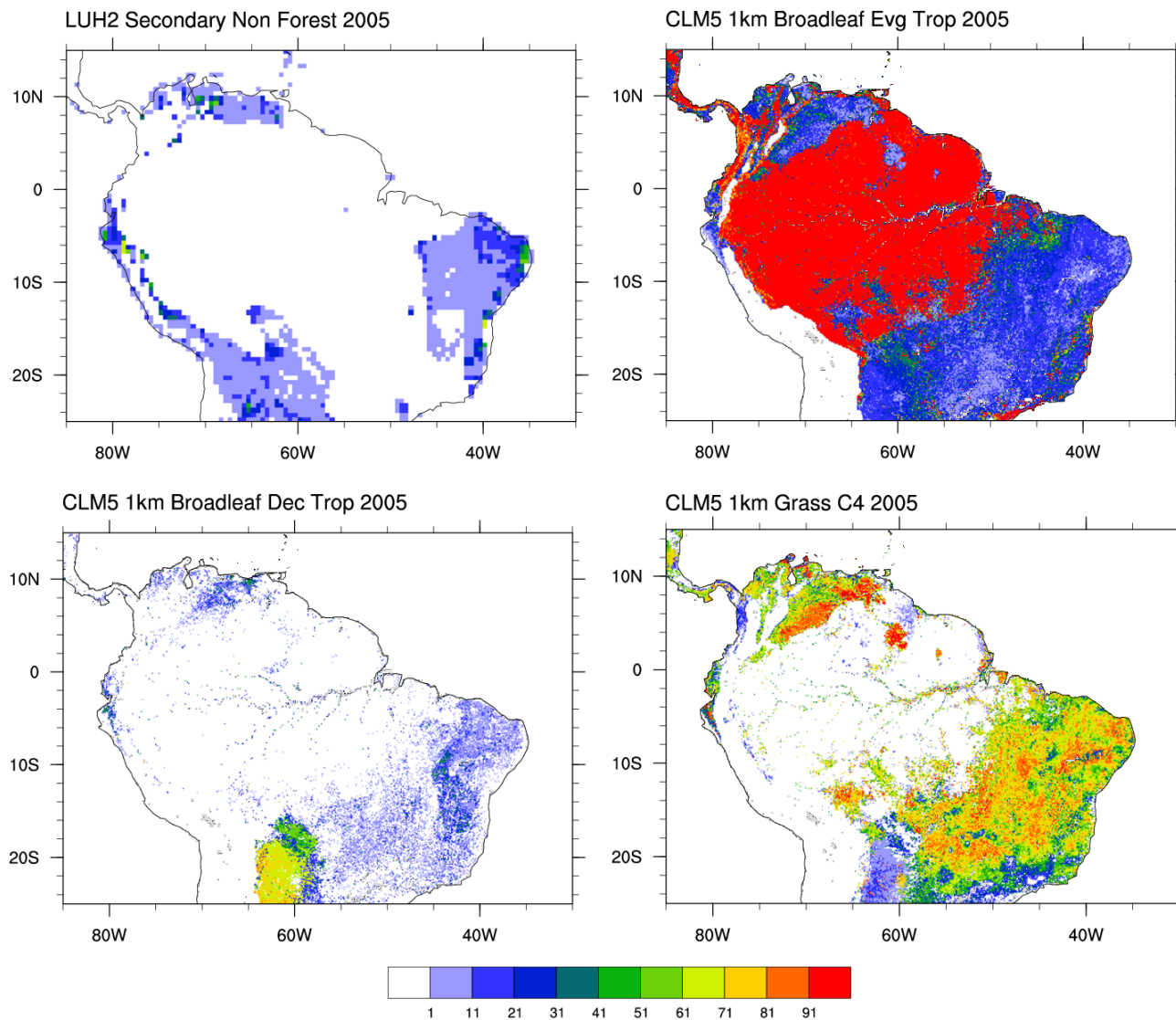
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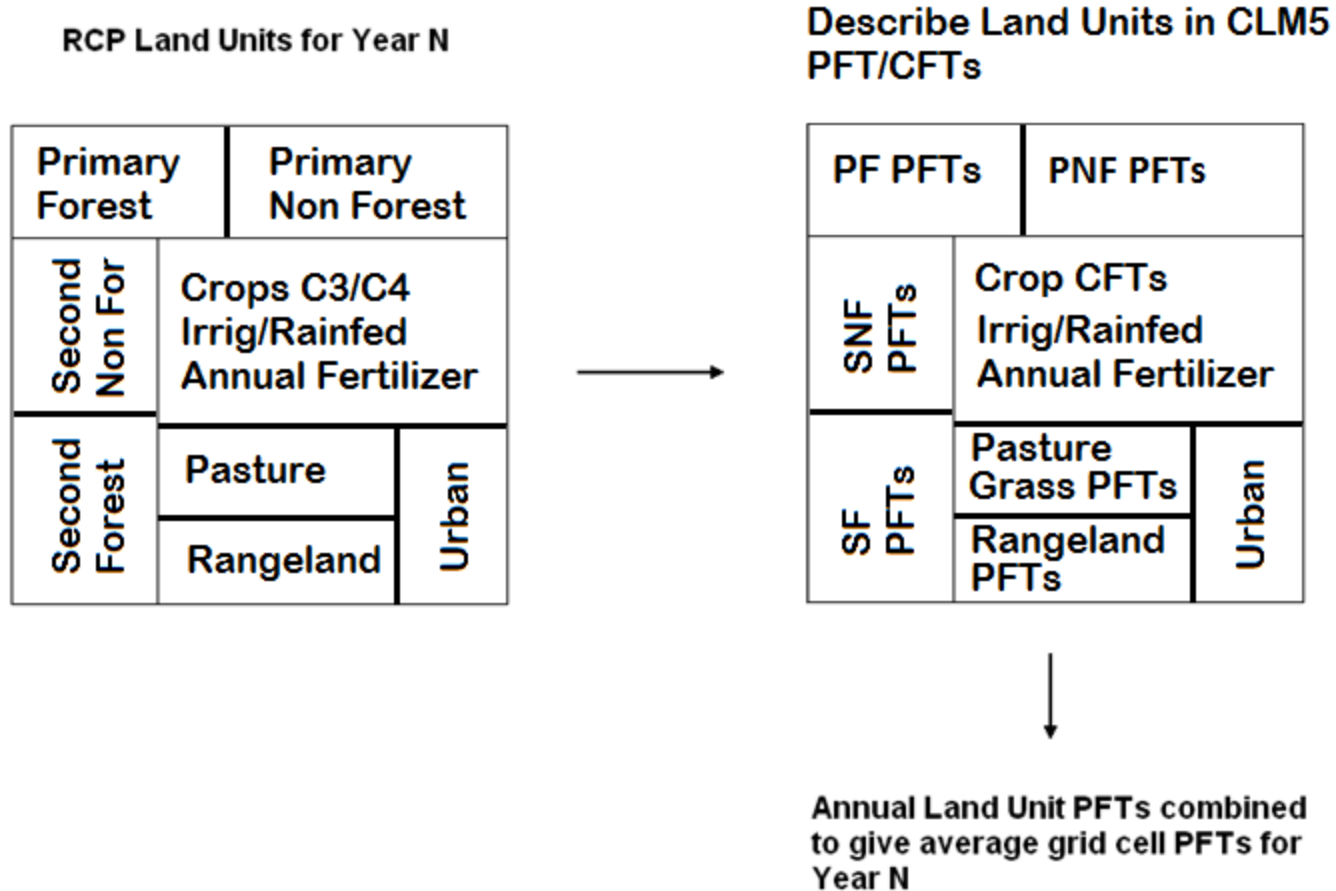
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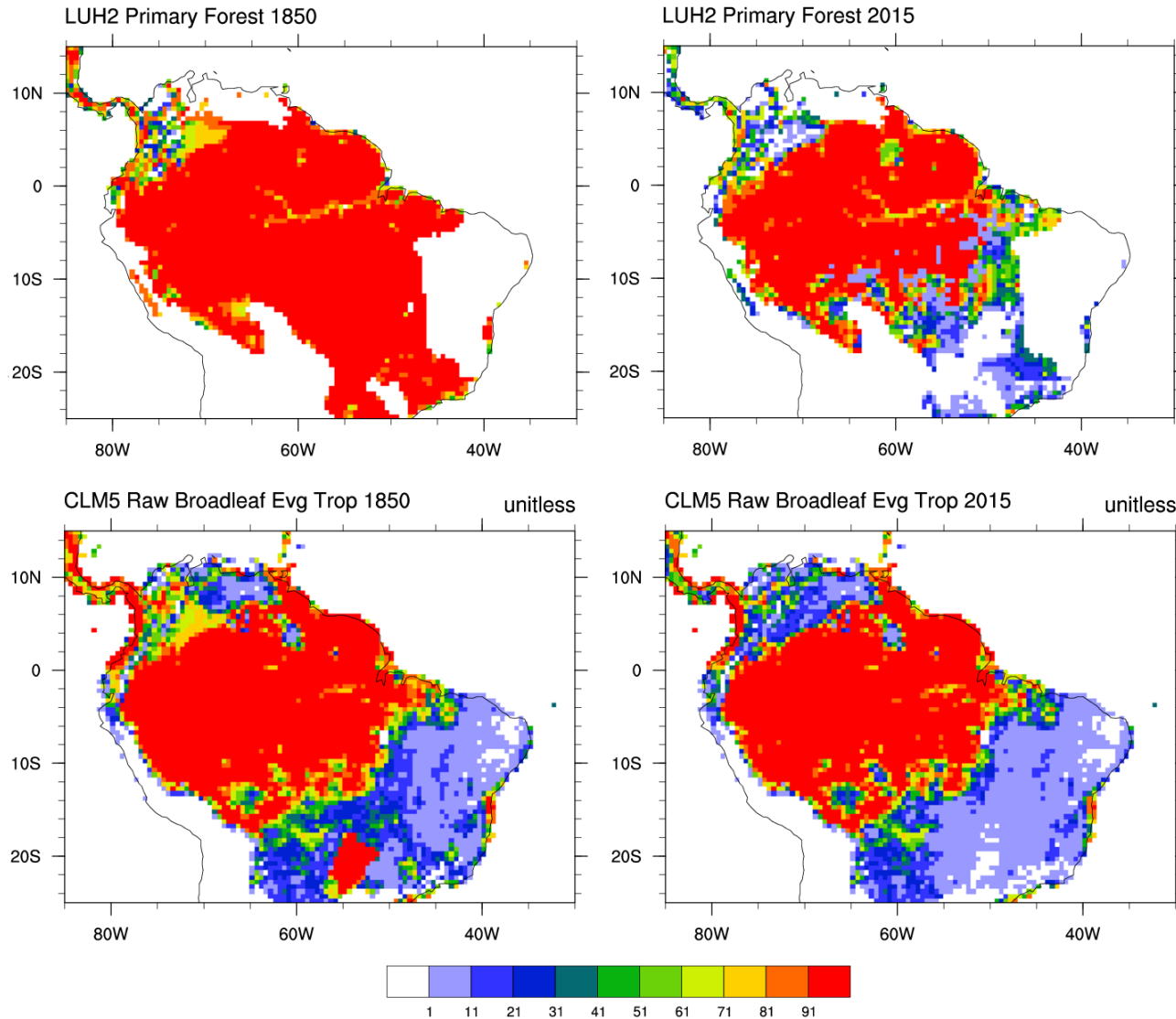
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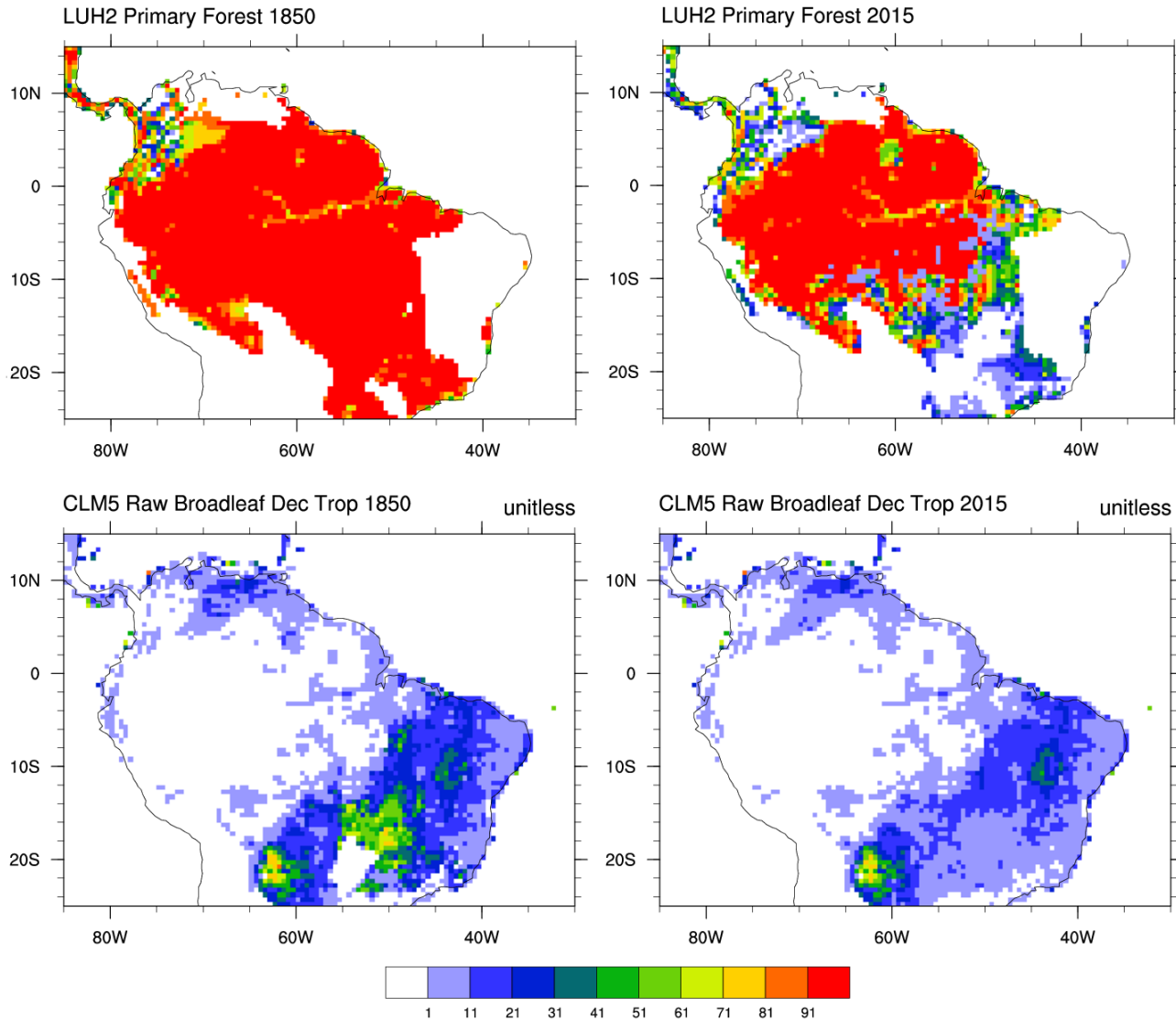
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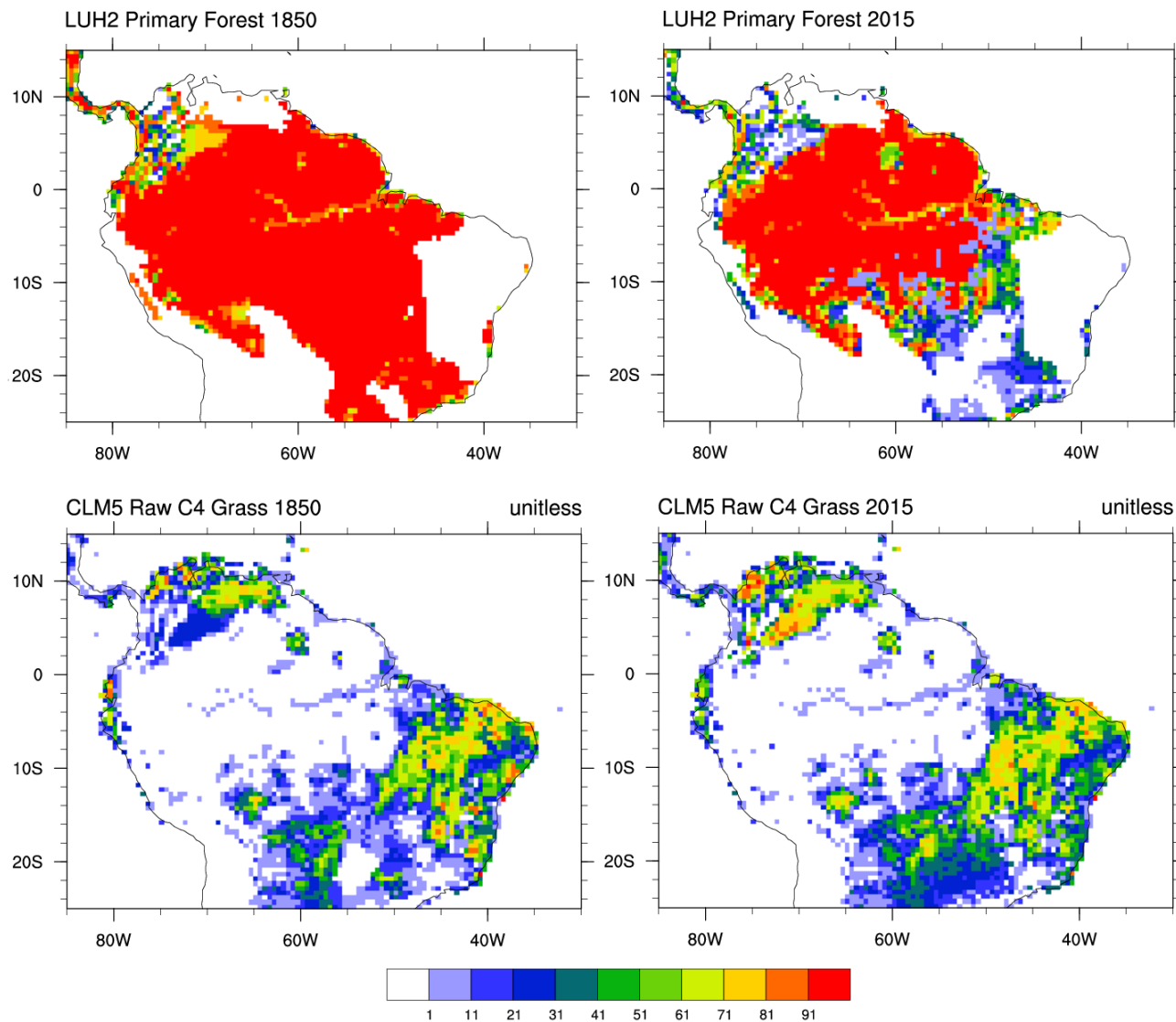
2. CMIP6 Transient Land Cover in CLM 5 PFTs Apply the Current Day Description of Land Units through time



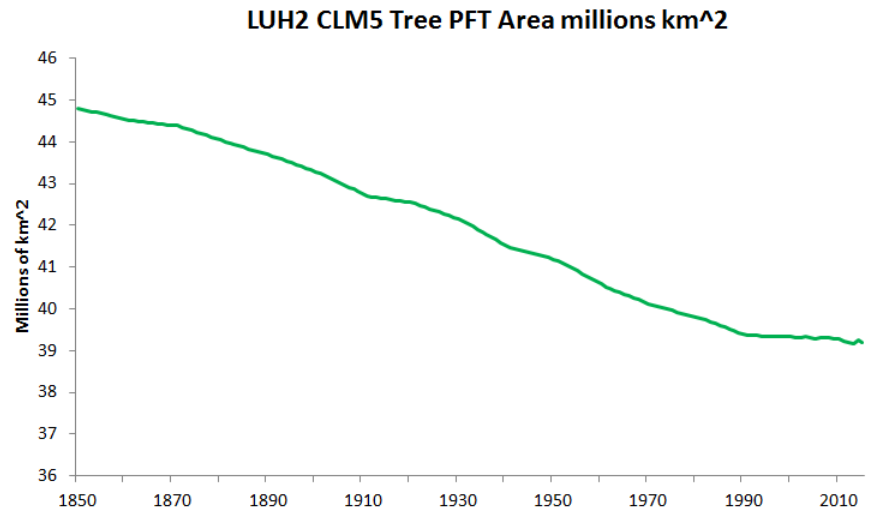
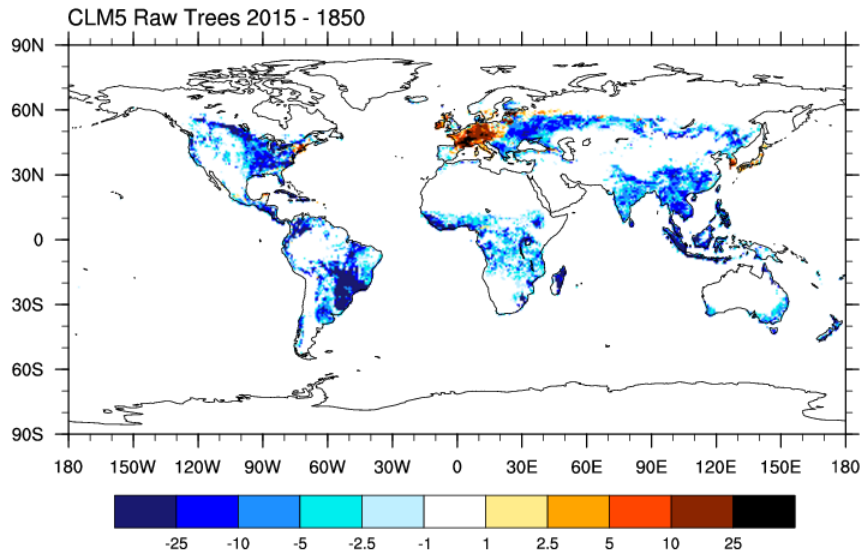
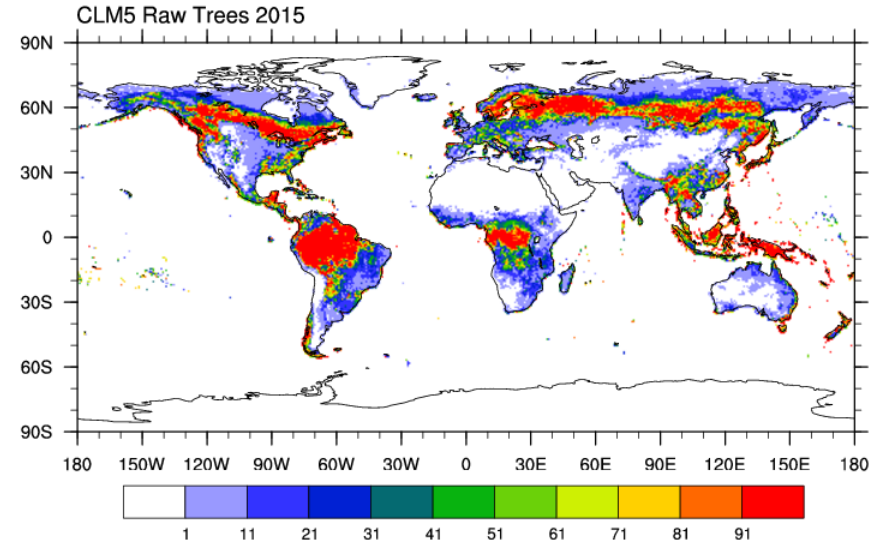
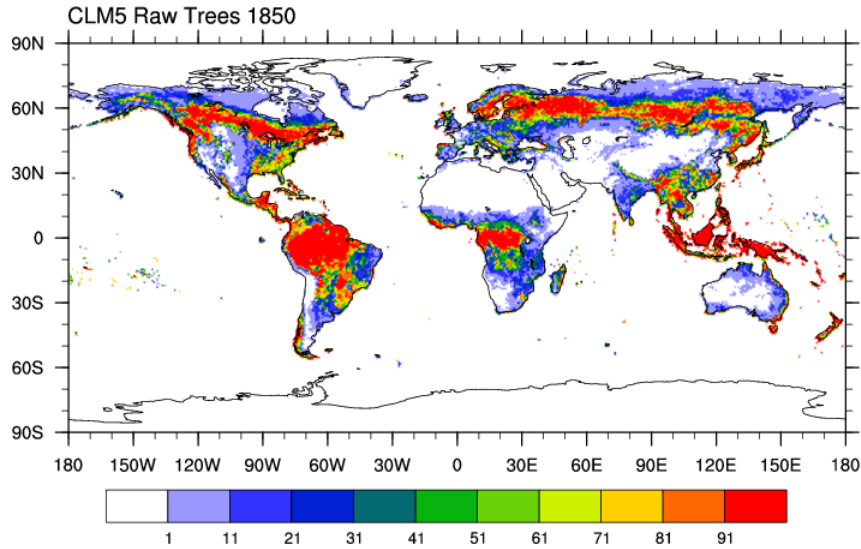
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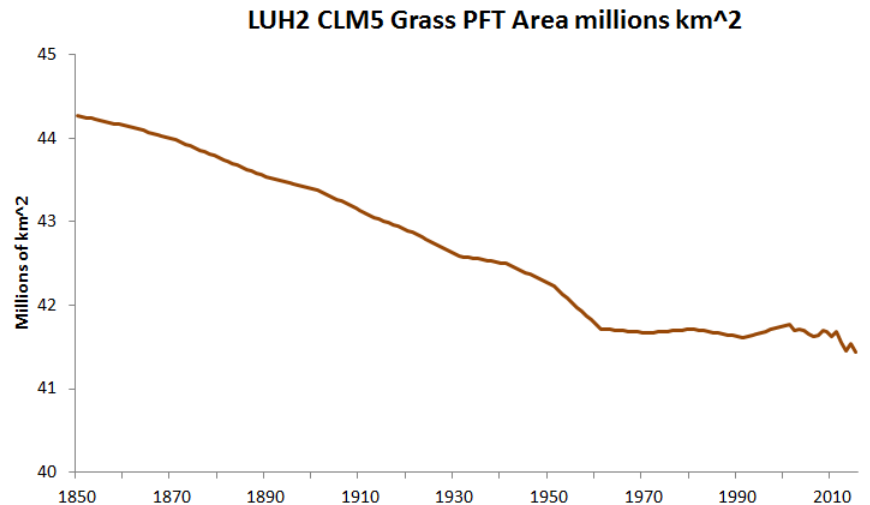
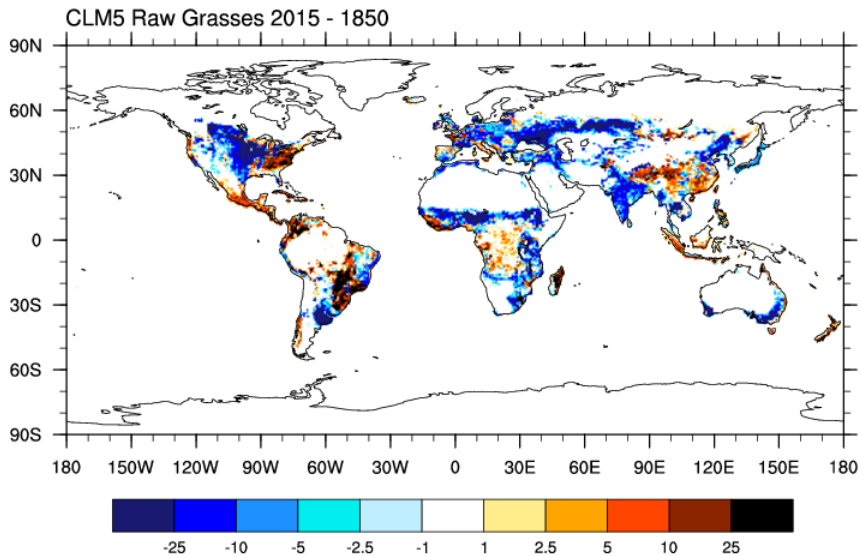
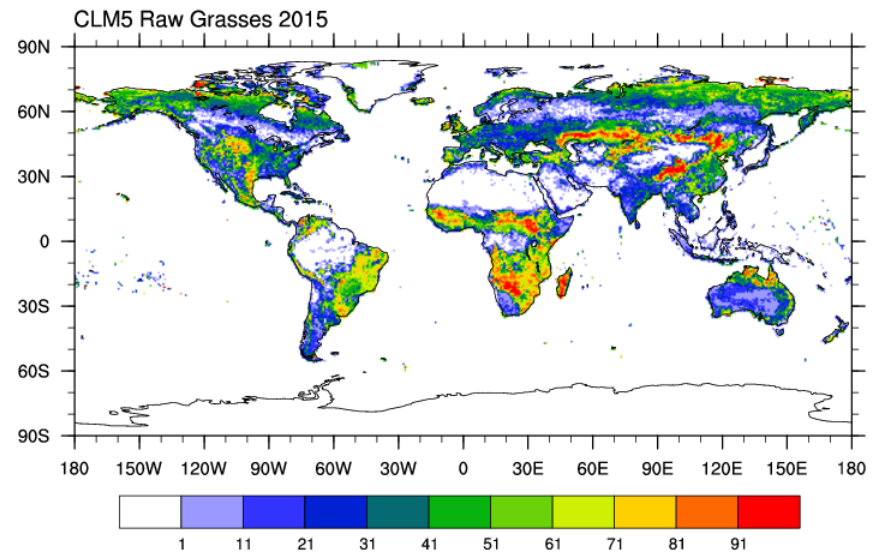
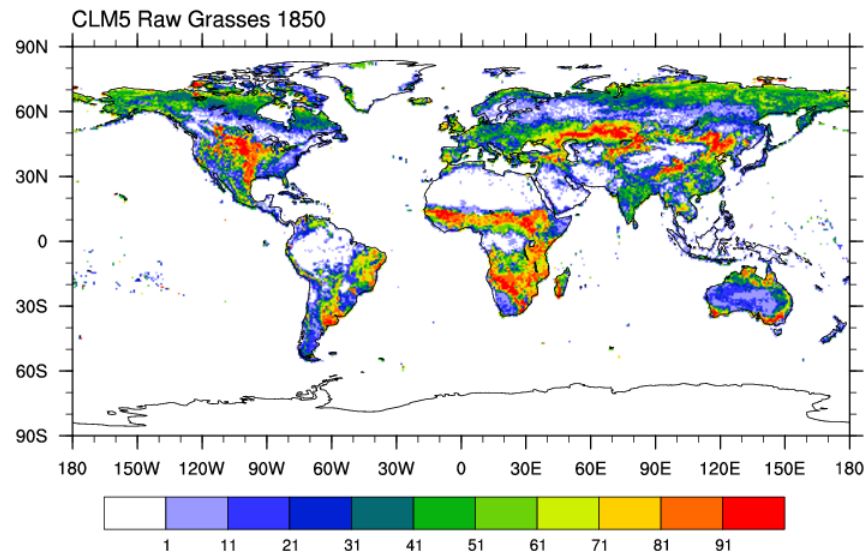
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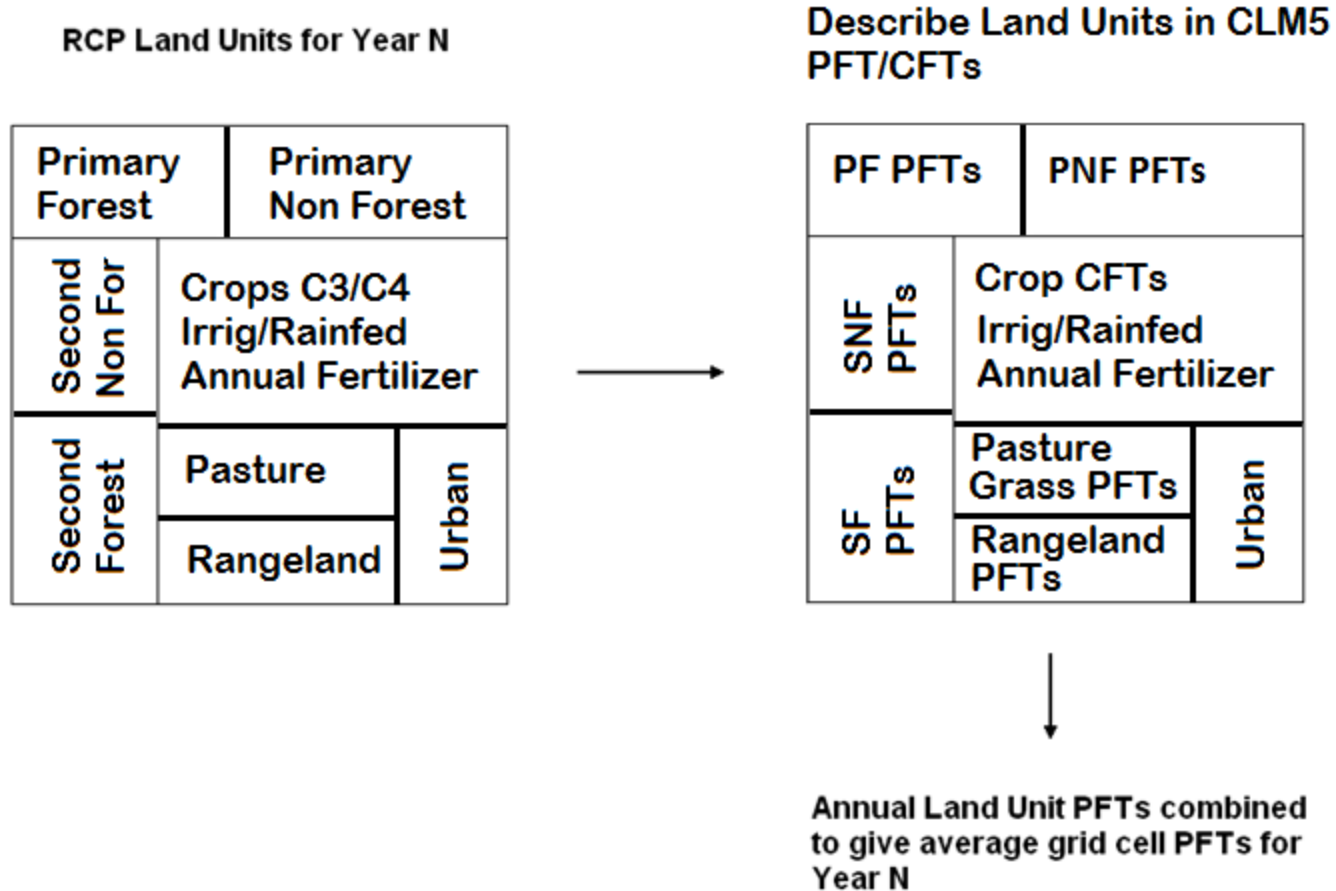
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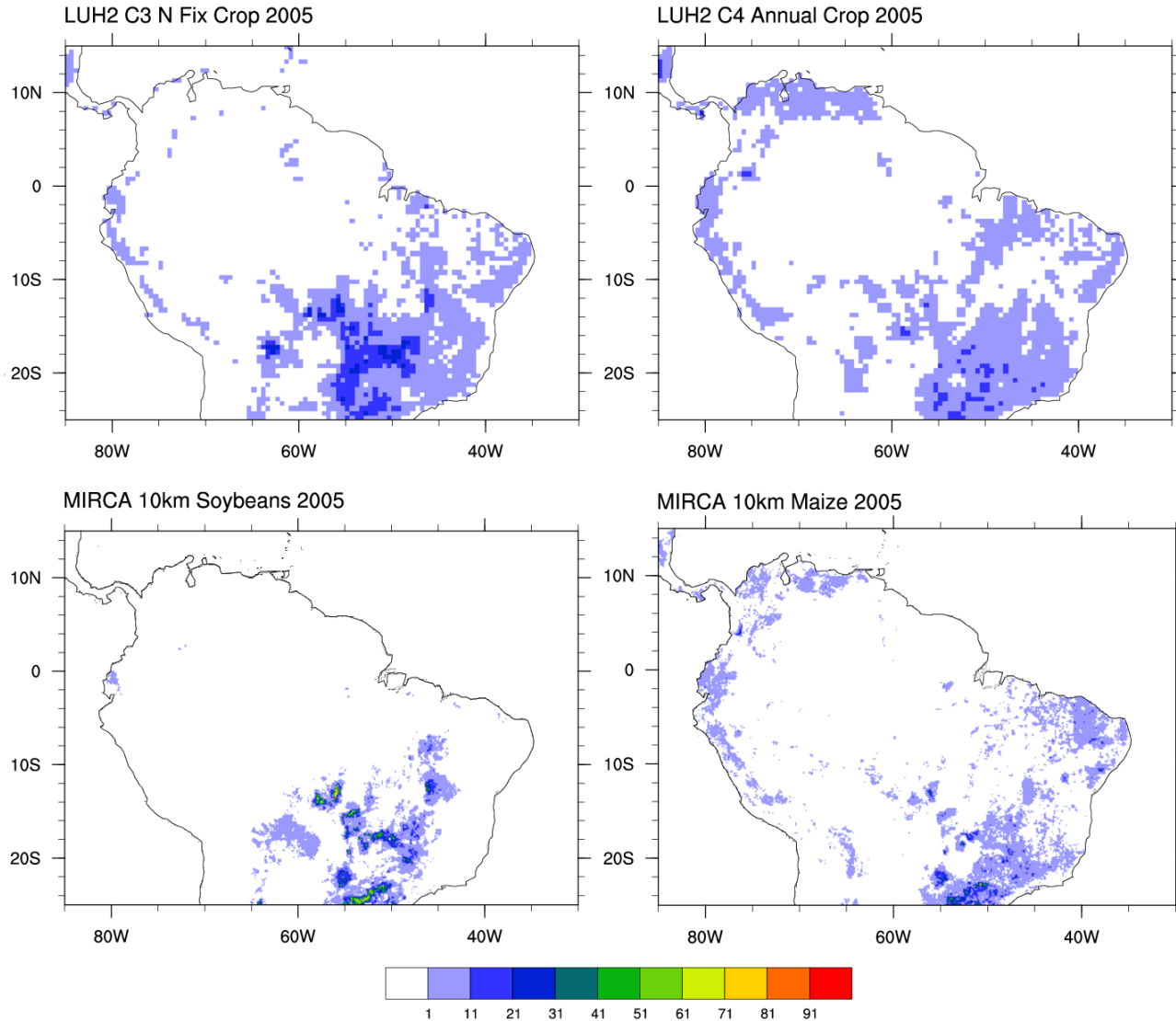
CMIP6 LUMIP CLM5 – CLM Crop Model

1. CLM5 Crop will be used to simulate the C3/C4 irrigated/rainfed annual/perennial crops specified in GLM time series with fertilizer rates.
2. Crops simulated currently include:
Temperate corn, tropical corn, cotton, rice, sugarcane, temperate soybean, tropical soybean, spring wheat (rainfed and irrigated)
3. Mapping of GLM crop information to CLM5 Crop CFTs based on closest current day crops in CLM Crop of the corresponding type from MIRCA 2000 (Portmann et al 2010)

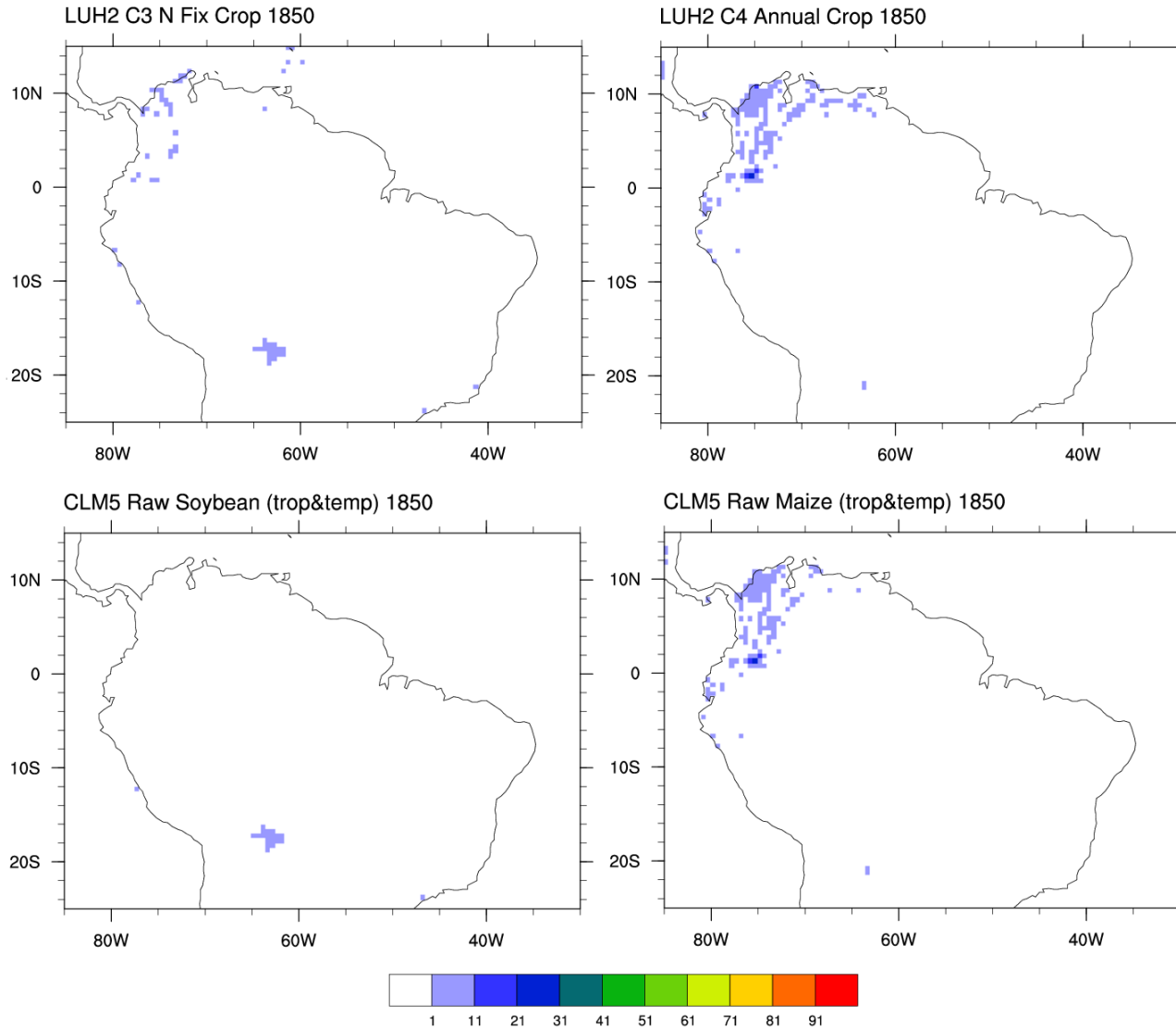
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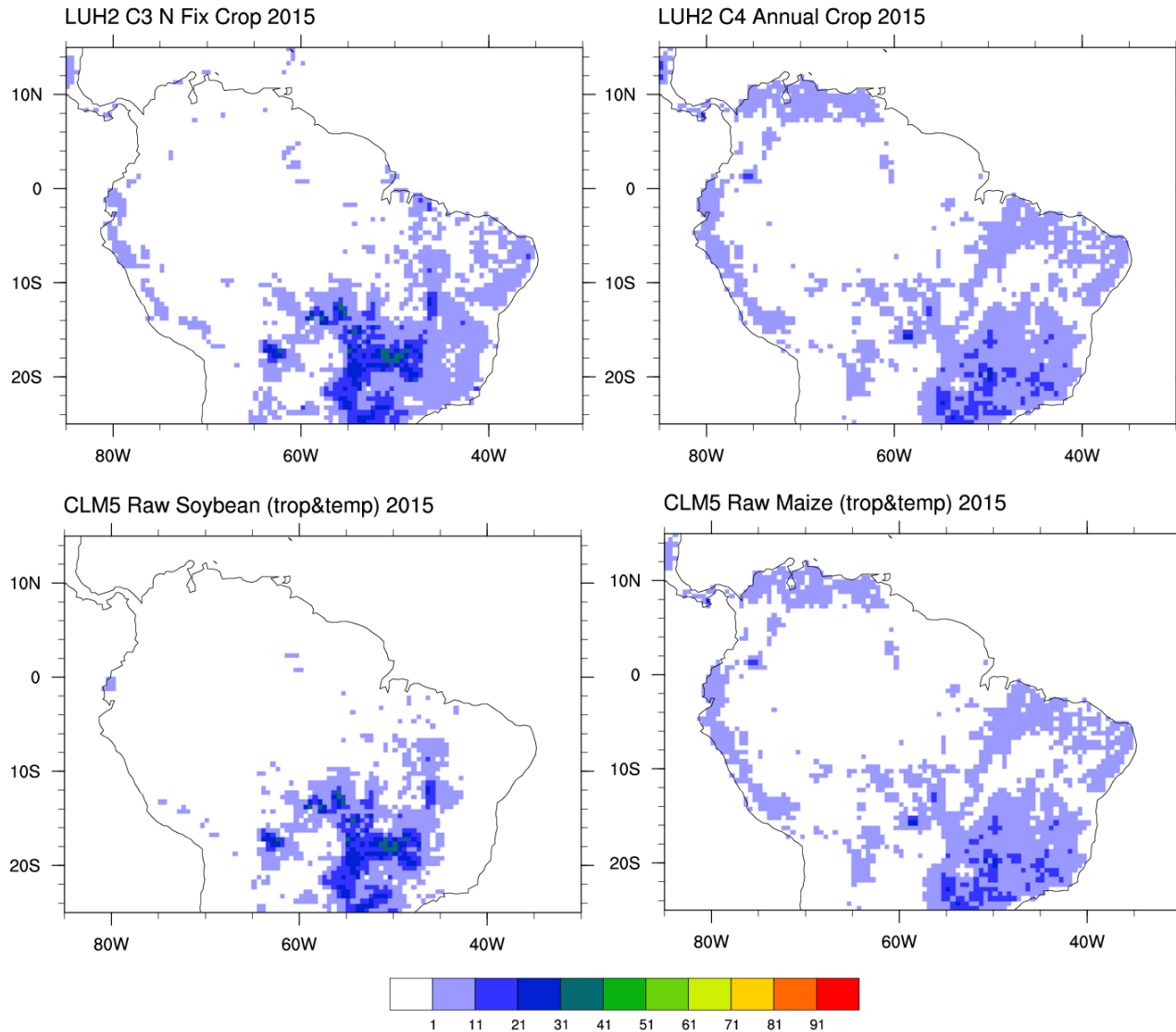
2. CMIP6 Transient Land Cover in CLM 5 CFTs from MIRCA Current Day Crop Distribution



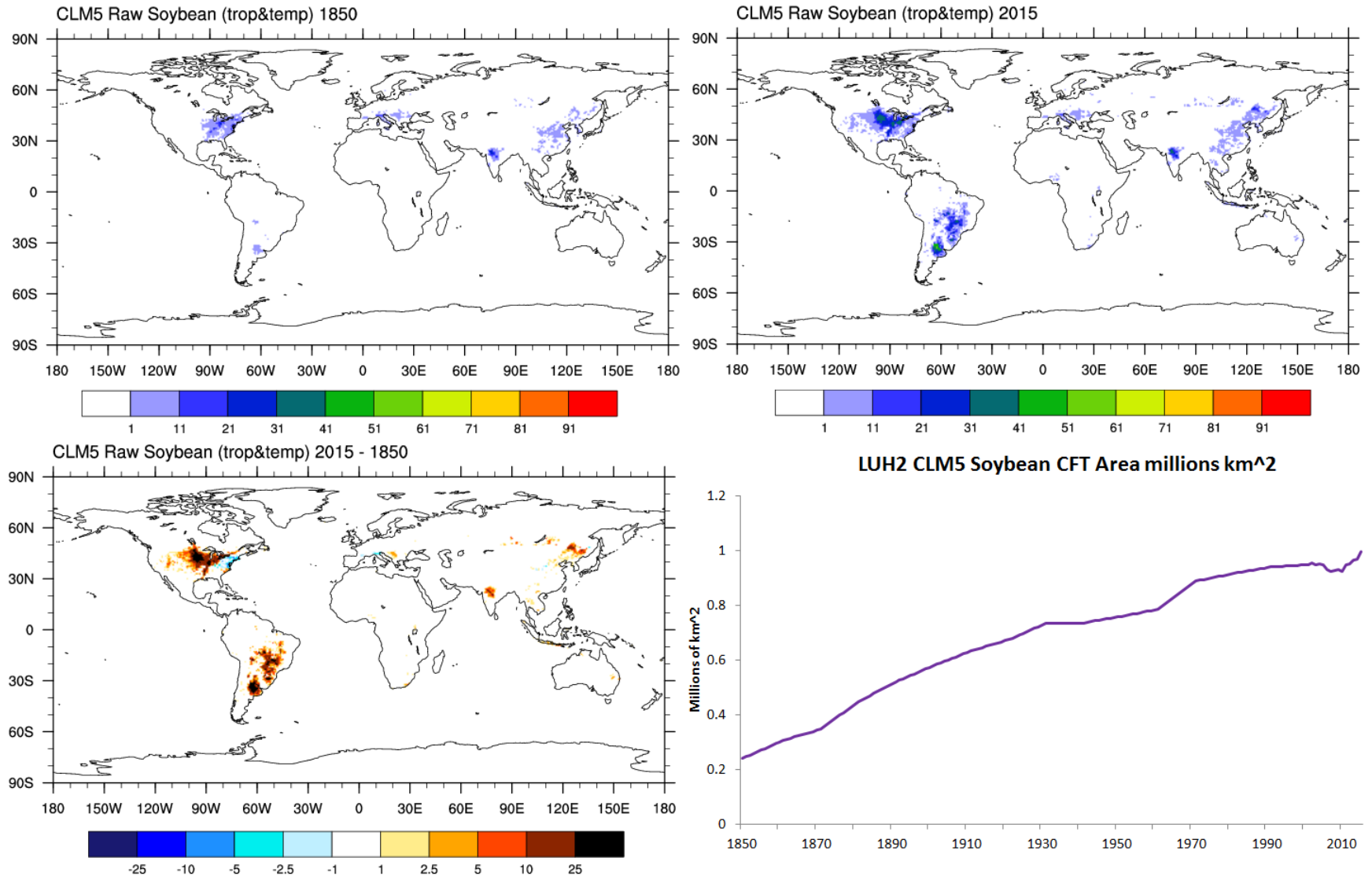
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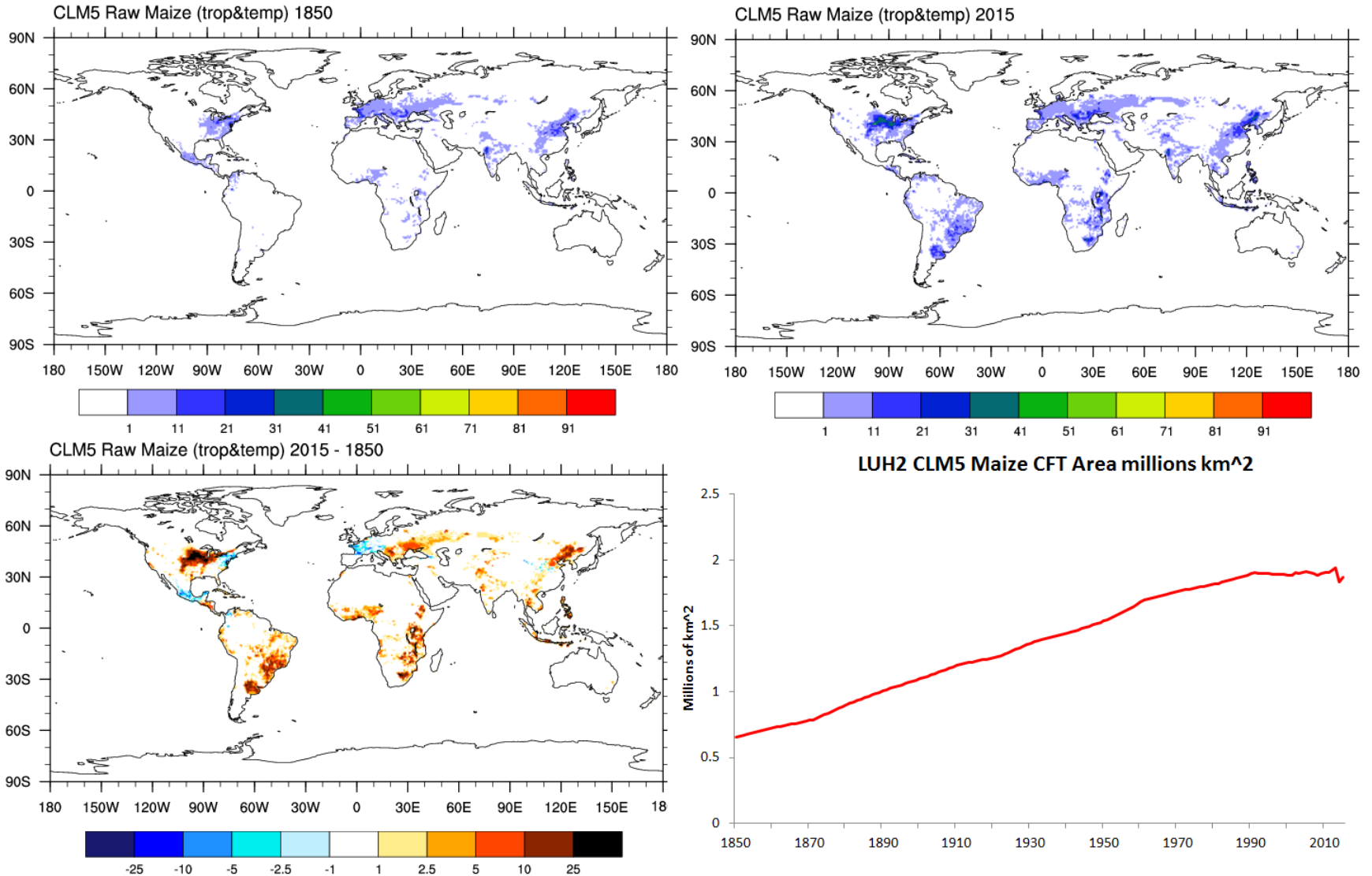
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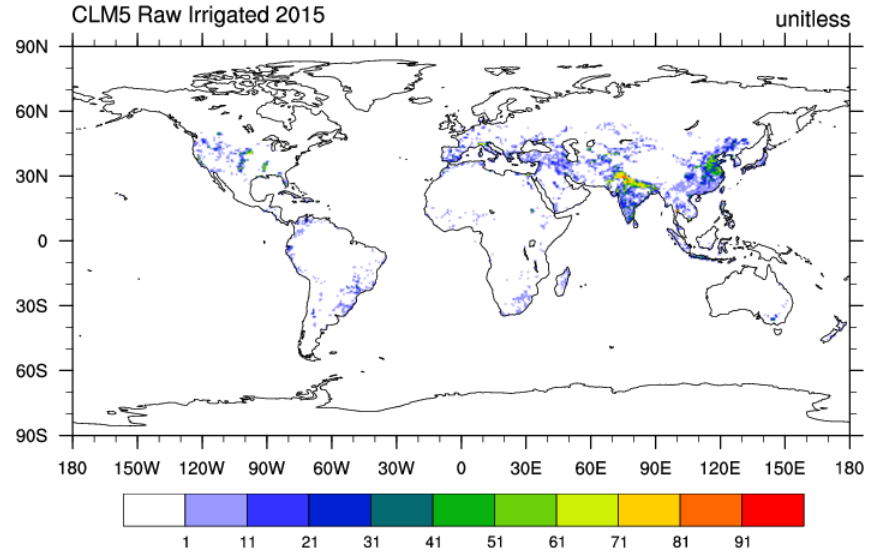
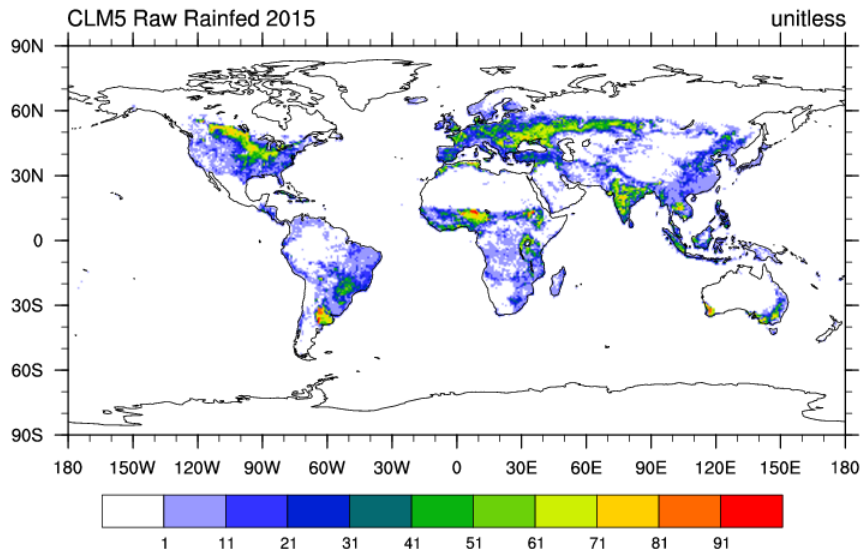
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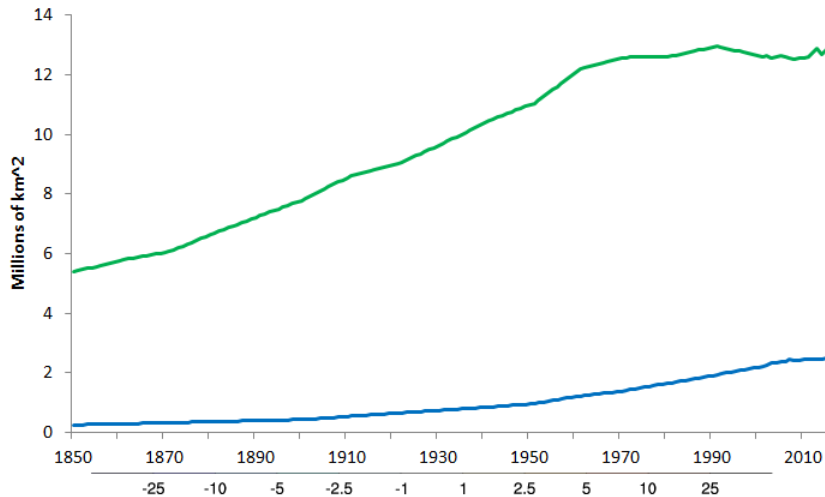
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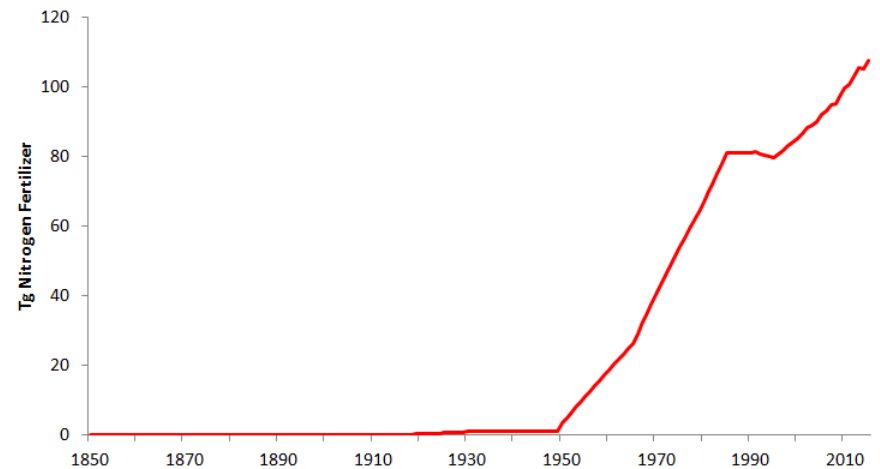
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LUH2 CLM5 Crop Rainfed and Irrigated Area millions km²



LUH2 CLM5 Fertilizer CFT Application



CMIP6 LUMIP CLM5 – CLM Crop Model

1. Crops simulated currently include:
Temperate corn, tropical corn, cotton, rice, sugarcane, temperate soybean, tropical soybean, spring wheat (rainfed and irrigated)
2. Many of the current day CLM5 Crop CFTs need to be remapped to a surrogate crop inside the CLM5 Crop model if that crop is not currently simulated.
3. We are using UNFAO yield data along with MODIS LAI and FLUXNET GPP to build remapping table to find corresponding active CLM Crop CFT
4. Danica Lombardozzi will continue the CLM5 Crop Investigation after the break

CLM5 - MIRCA 2000 Remapping inside CLM5 Crop

| CFT | CFT | CFT | CFT | CFT |
|---|--|---|---|---|
| 15. C3 Generic Crop | 29. Rye 19. Spring Wheat | 43. Datepalm 41. Cotton | 57. Pulses 19. Spring Wheat | 71. Miscanthus 17. Temperate Corn |
| 16. C3 Generic Crop Irrigated | 30. Rye Irrigated 20. Spring Wheat Irrigated | 44. Datepalm Irrigated 42. Cotton Irrigated | 58. Pulses Irrigated 20. Spring Wheat Irrigated | 72. Miscanthus Irrigated 18. Temperate Corn Irrigated |
| 17. Temperate Corn | 31. Winter Rye 19. Spring Wheat | 45. Foddergrass 19. Spring Wheat | 59. Rapeseed 19. Spring Wheat | 73. Switchgrass 17. Temperate Corn |
| 18. Temperate Corn Irrigated | 32. Winter Rye Irrigated 20. Spring Wheat Irrigated | 46. Foddergrass Irrigated 20. Spring Wheat Irrigated | 60. Rapeseed Irrigated 20. Spring Wheat Irrigated | 74. Switchgrass Irrigated 18. Temperate Corn Irrigated |
| 19. Spring Wheat | 33. Cassava 61. Rice | 47. Grapes 19. Spring Wheat | 61. Rice | 75. Tropical Corn |
| 20. Spring Wheat Irrigated | 34. Cassava Irrigated 62. Rice Irrigated | 48. Grapes Irrigated 20. Spring Wheat Irrigated | 62. Rice Irrigated | 76. Tropical Corn Irrigated |
| 21. Winter Wheat 19. Spring Wheat | 35. Citrus 19. Spring Wheat | 49. Groundnuts 61. Rice | 63. Sorghum 75. Tropical Corn | 77. Tropical Soybean |
| 22. Winter Wheat Irrigated 20. Spring Wheat Irrigated | 36. Citrus Irrigated 20. Spring Wheat Irrigated | 50. Groundnuts Irrigated 62. Rice Irrigated | 64. Sorghum Irrigated 76. Tropical Corn Irrigated | 78. Tropical Soybean Irrigated |
| 23. Temperate Soybean | 37. Cocoa 61. Rice | 51. Millet 75. Tropical Corn | 65. Sugarbeet 19. Spring Wheat | |
| 24. Temperate Soybean Irrigated | 38. Cocoa Irrigated 62. Rice Irrigated | 52. Millet Irrigated 76. Tropical Corn Irrigated | 66. Sugarbeet Irrigated 20. Spring Wheat Irrigated | |
| 25. Barley 19. Spring Wheat | 39. Coffee 61. Rice | 53. Oilpalm 61. Rice | 67. Sugarcane | |
| 26. Barley Irrigated 20. Spring Wheat Irrigated | 40. Coffee Irrigated 62. Rice Irrigated | 54. Oilpalm Irrigated 62. Rice Irrigated | 68. Sugarcane Irrigated | |
| 27. Winter Barley 19. Spring Wheat | 41. Cotton | 55. Potatoes 19. Spring Wheat | 69. Sunflower 19. Spring Wheat | |
| 28. Winter Barley Irrigated 20. Spring Wheat Irrigated | 42. Cotton Irrigated | 56. Potatoes Irrigated 20. Spring Wheat Irrigated | 70. Sunflower Irrigated 20. Spring Wheat Irrigated | |