



LUMIP Historical Land Use Impacts in CLM5 and CESM 2



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and many others from the CESM community**



LUMIP Simulations available on ESGF

[illegible]

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 Fertilizer application

Fraction of cropland for biofuels

Crop rotations

Wood Harvest

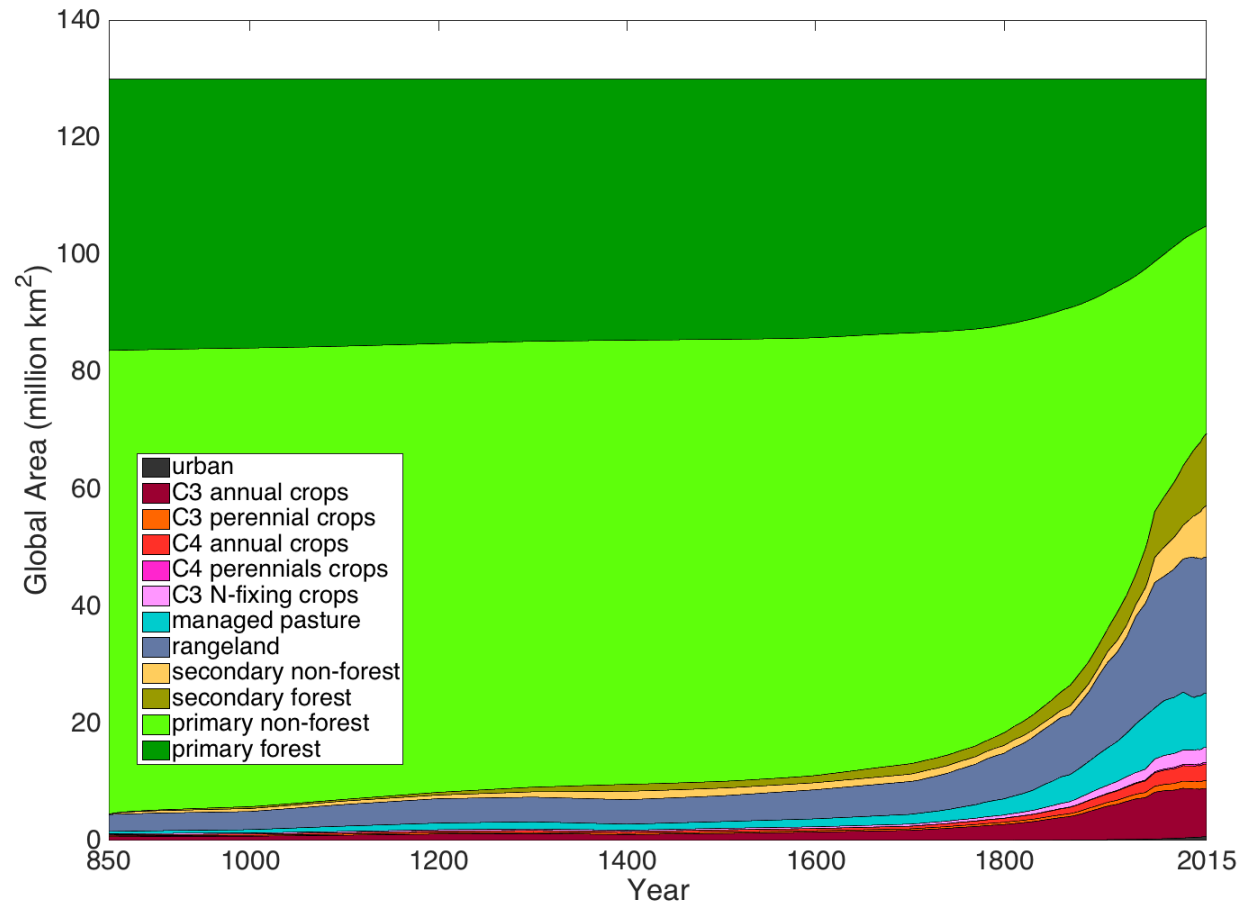
Fraction industrial products

Fraction commercial biofuels

Fraction fuelwood

New Future Scenarios

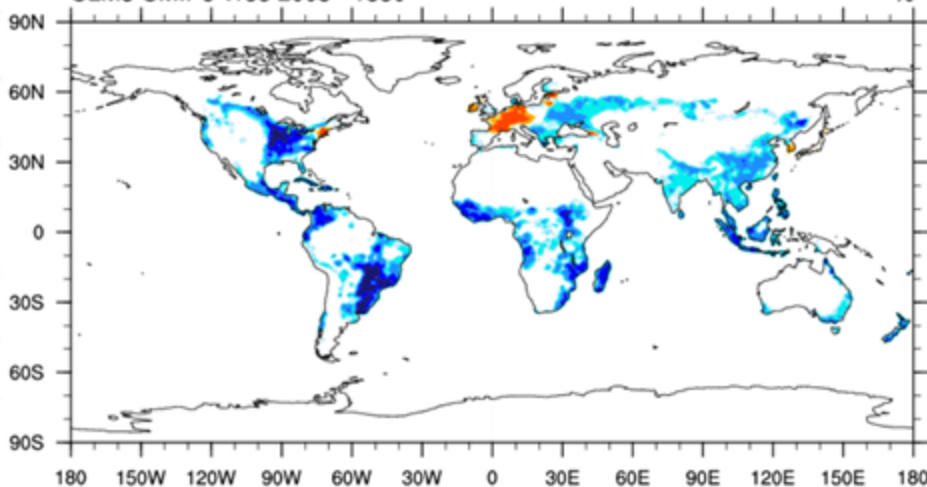
Six futures, SSP-based



CLM5 CMIP6/LUMIP Land Cover in 1850 – 2005

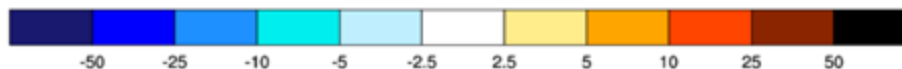
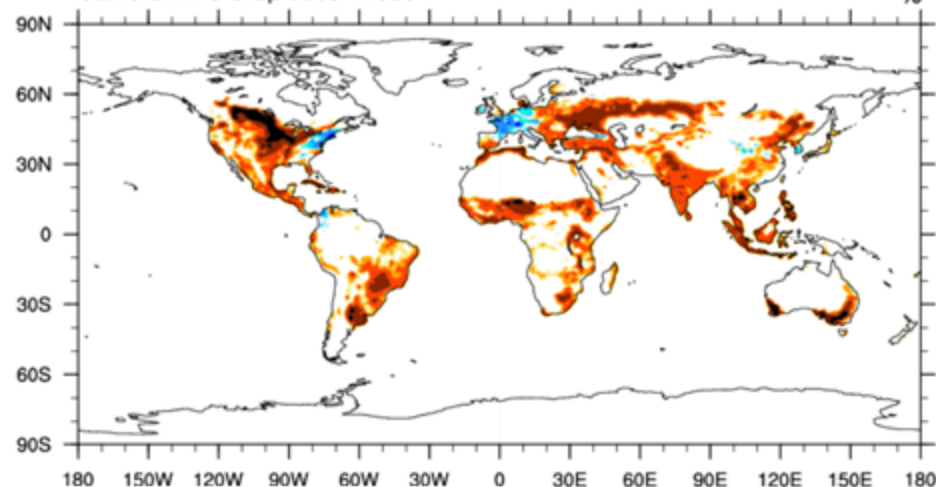
CLM5 CMIP6 Tree 2005 - 1850

%

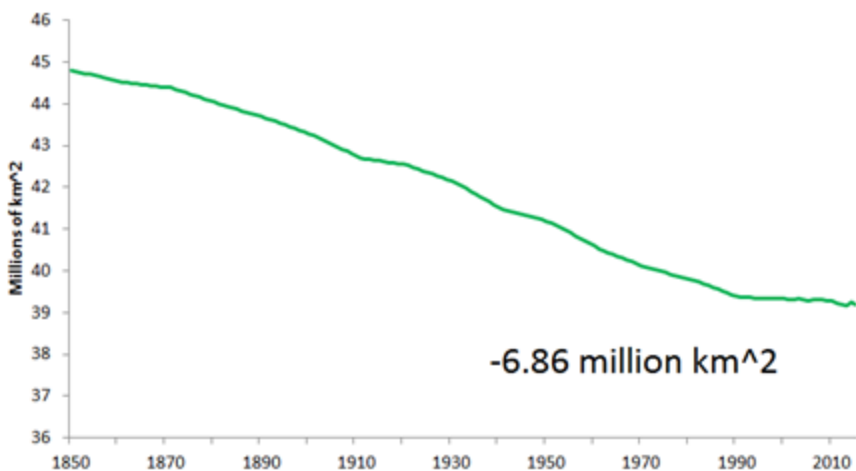


CLM5 CMIP6 Crop 2005 - 1850

%

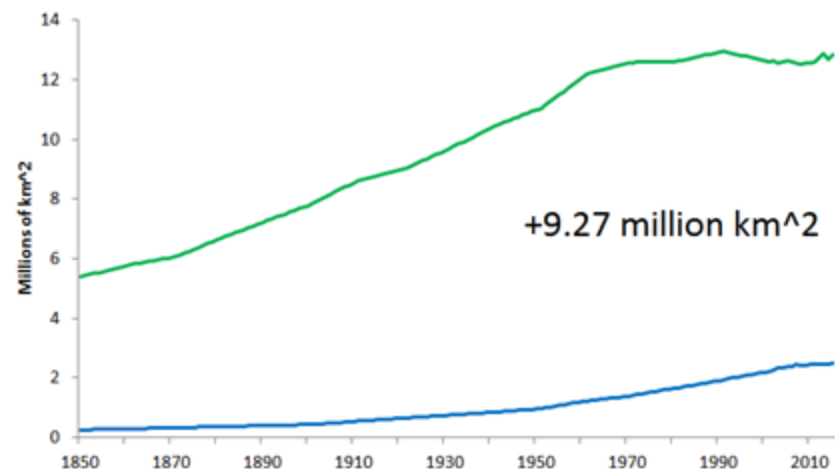


LUH2 CLM5 Tree PFT Area millions km²



-6.86 million km²

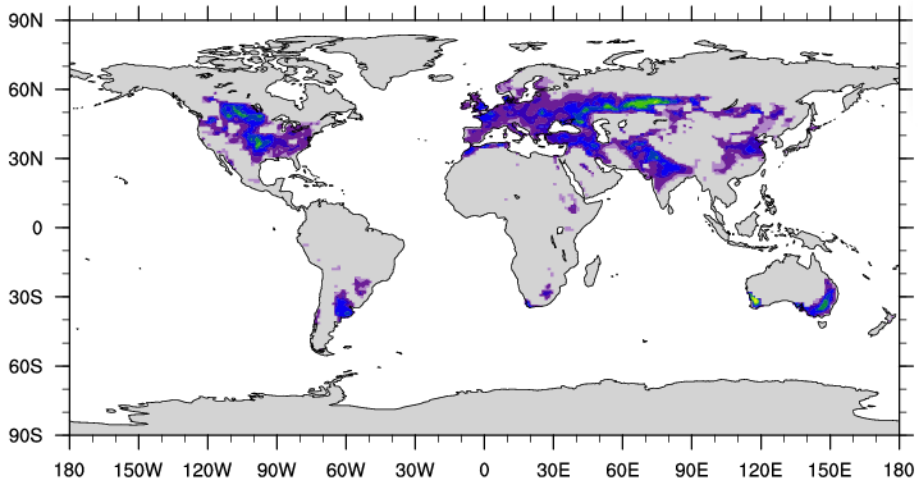
LUH2 CLM5 Crop Rainfed and Irrigated Area millions km²



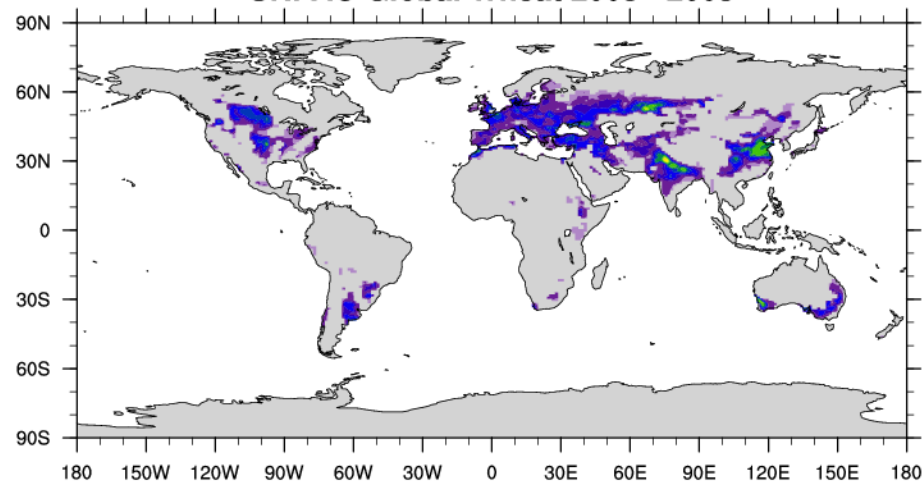
+9.27 million km²

CLM5 LUMIP Land Cover in 1850 – 2005 – Wheat

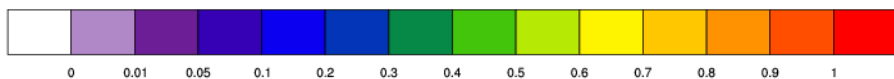
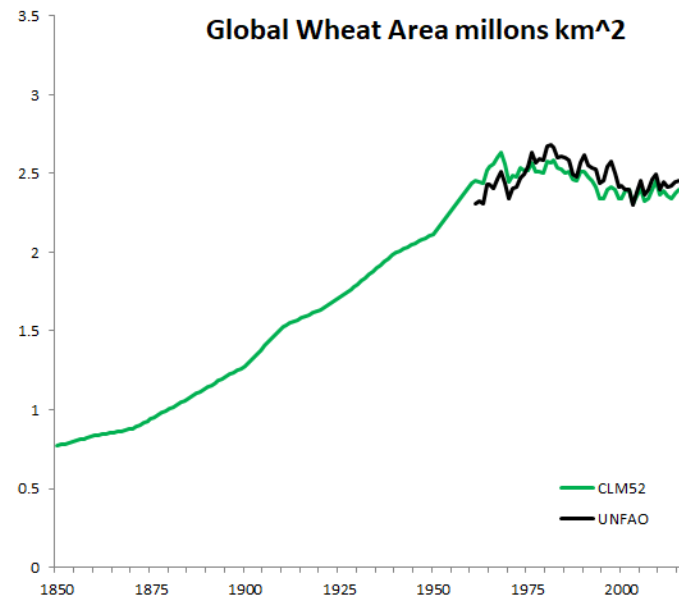
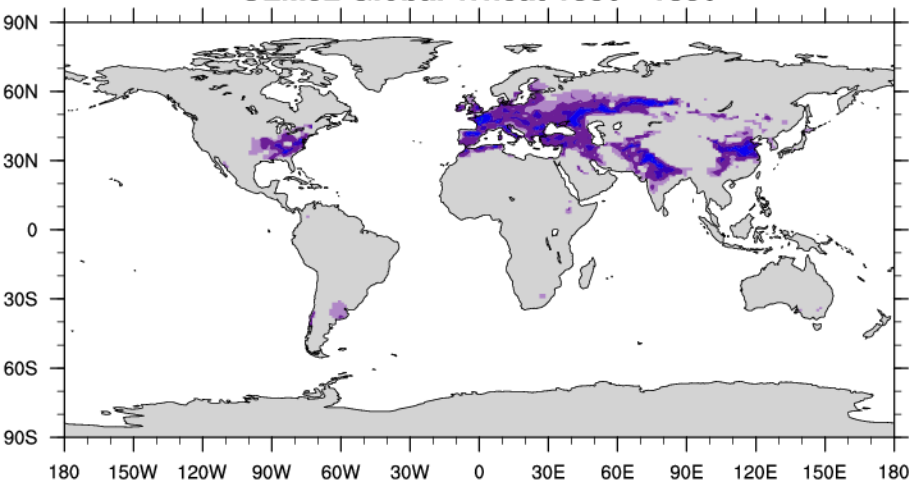
CLM52 Global Wheat 2005 - 2005



UNFAO Global Wheat 2005 - 2005

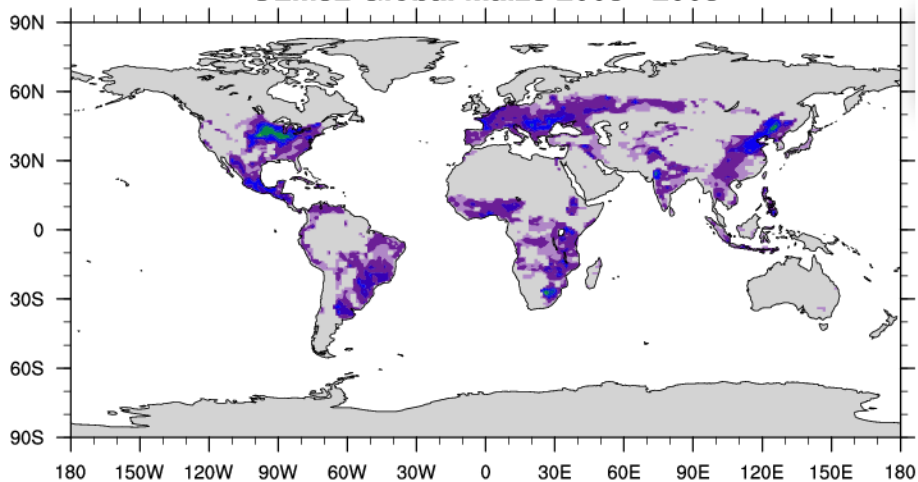


CLM52 Global Wheat 1850 - 1850

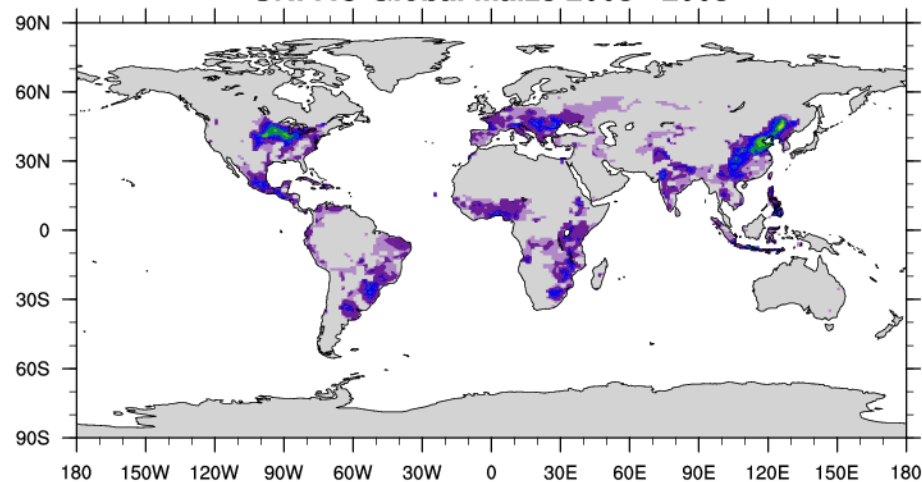


CLM5 LUMIP Land Cover in 1850 – 2005 – Maize

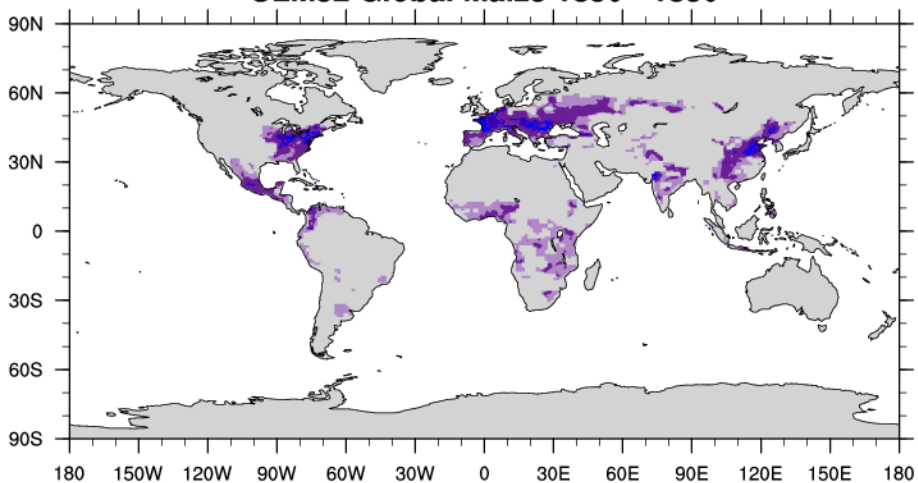
CLM52 Global Maize 2005 - 2005



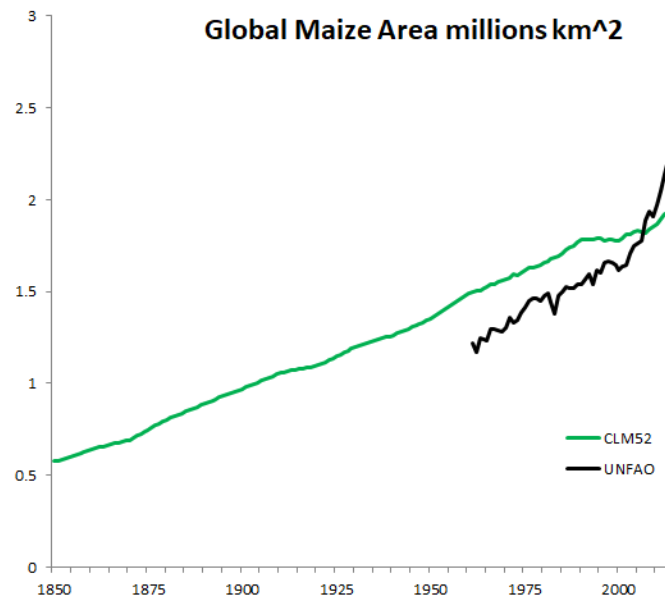
UNFAO Global Maize 2005 - 2005



CLM52 Global Maize 1850 - 1850

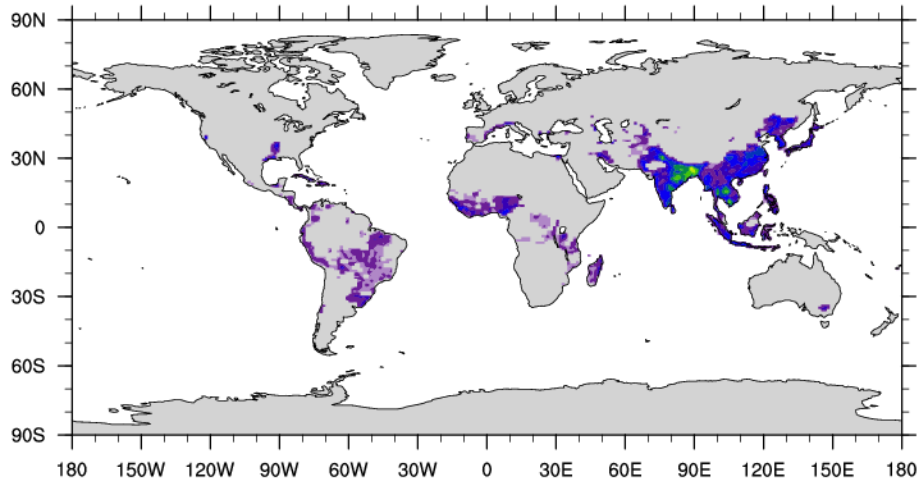


Global Maize Area millions km²

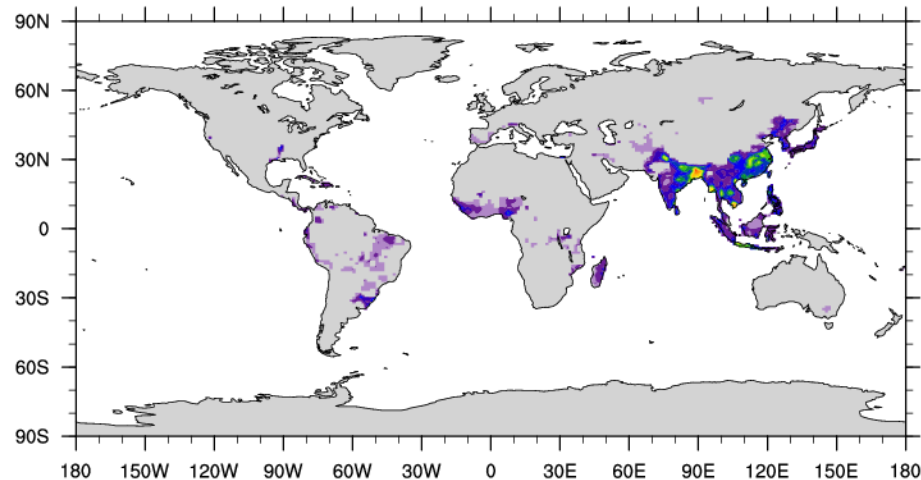


CLM5 LUMIP Land Cover in 1850 – 2005 – Rice

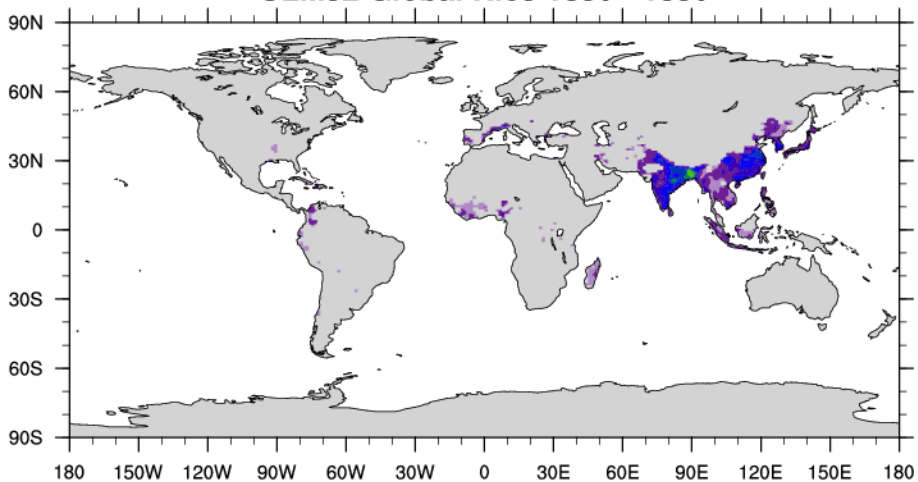
CLM52 Global Rice 2005 - 2005



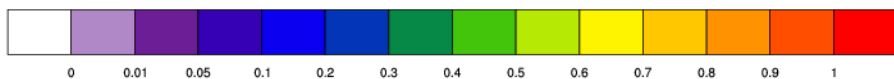
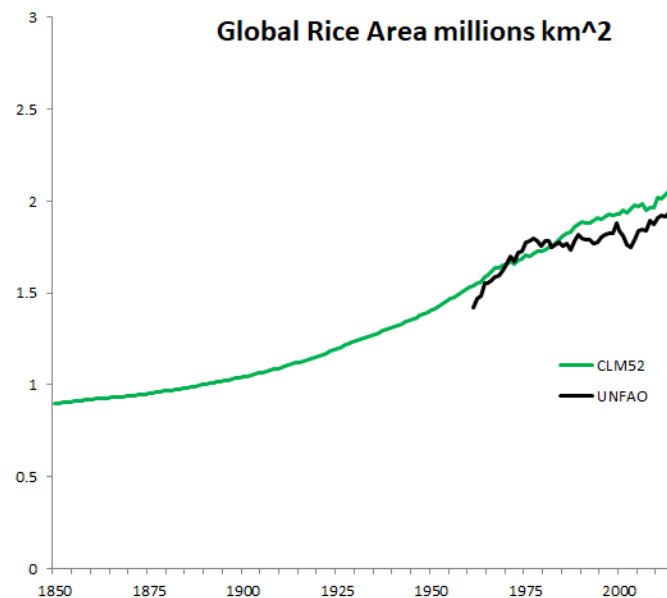
UNFAO Global Rice 2005 - 2005



CLM52 Global Rice 1850 - 1850

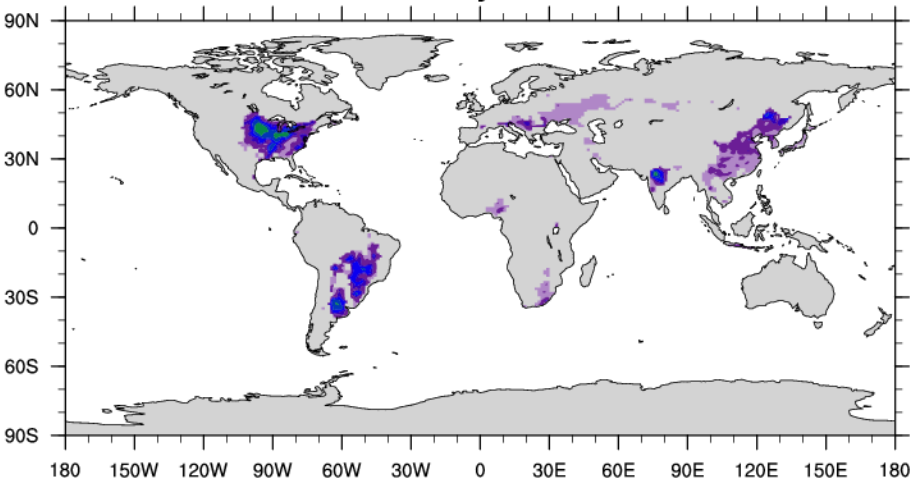


Global Rice Area millions km²

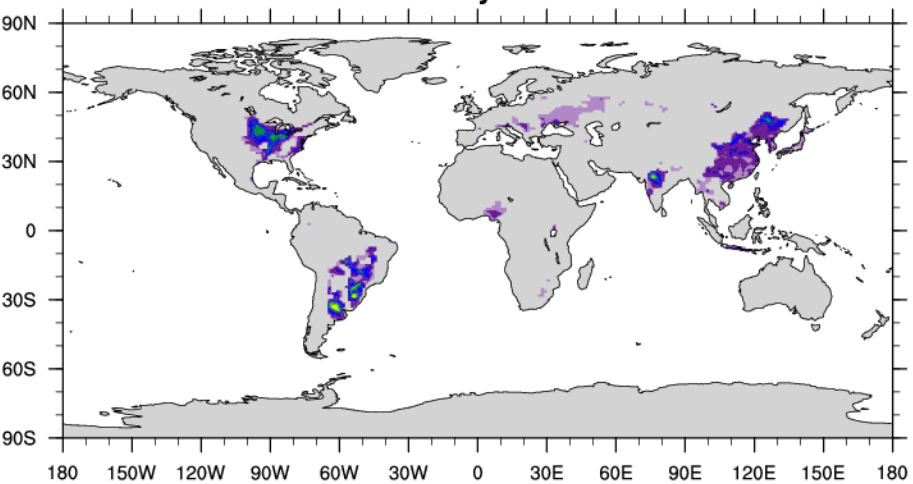


CLM5 LUMIP Land Cover in 1850 – 2005 – Soybean Soybean

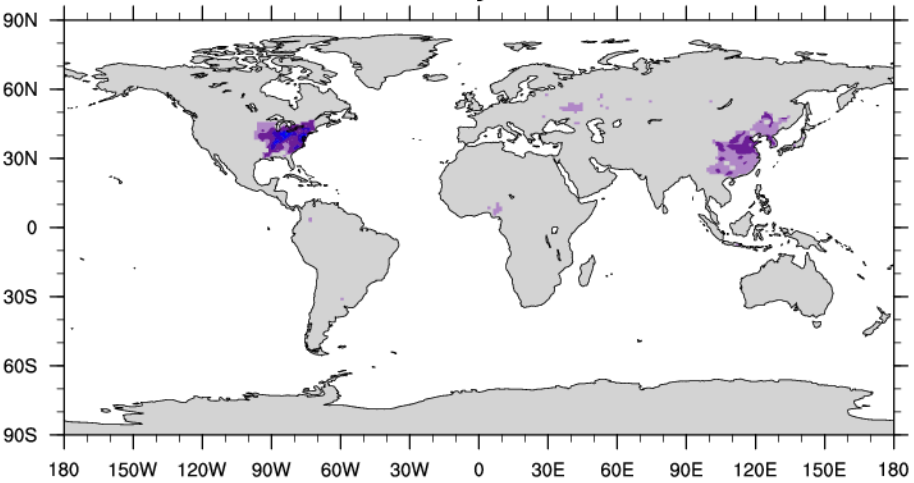
CLM52 Global Soybean 2005 - 2005



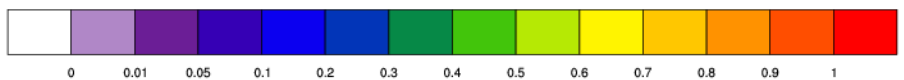
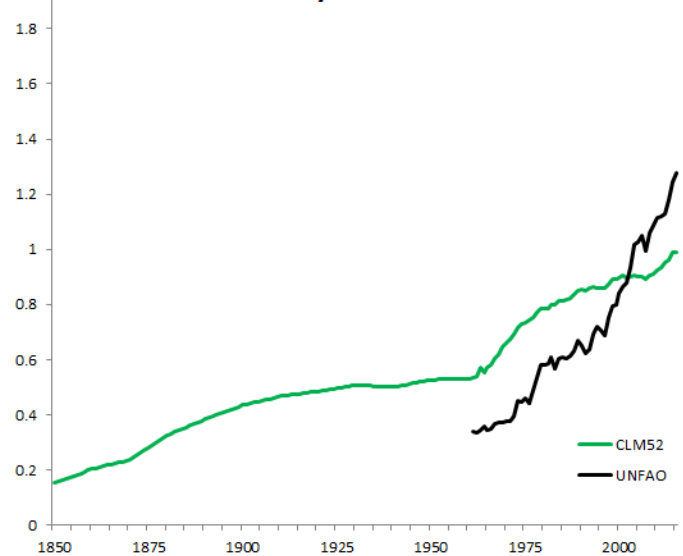
UNFAO Global Soybean 2005 - 2005



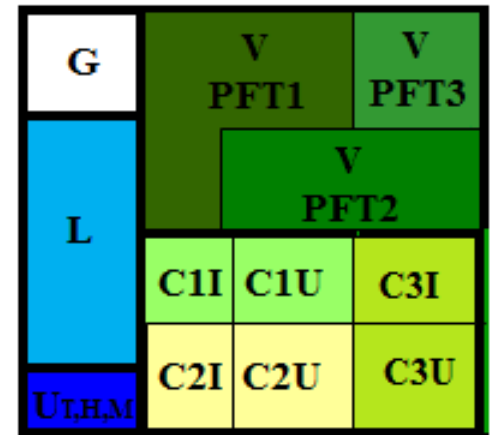
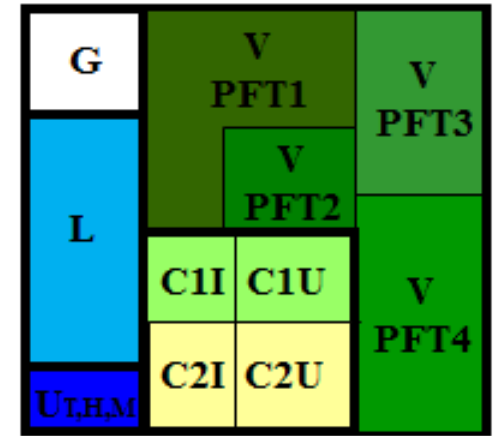
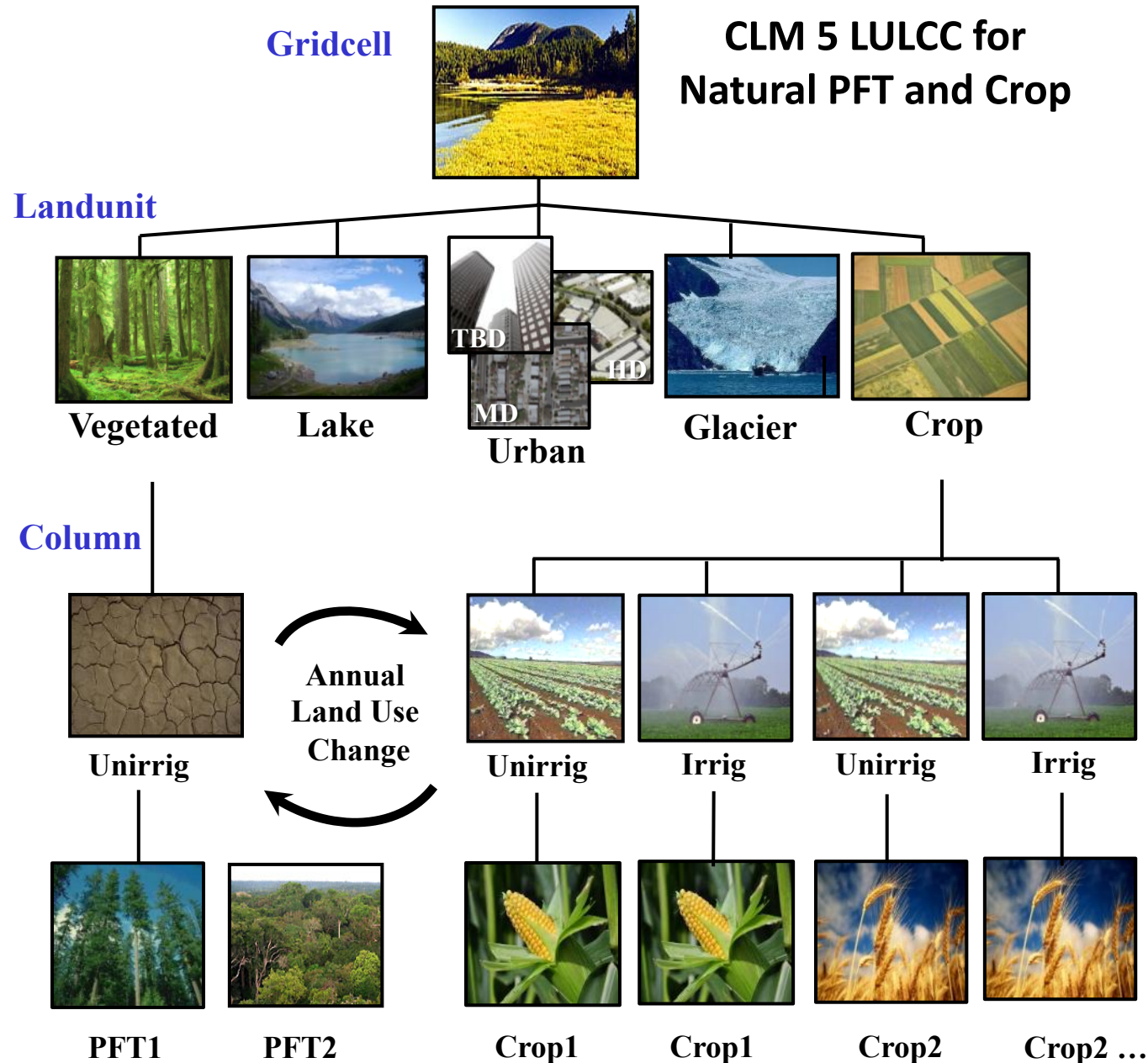
CLM52 Global Soybean 1850 - 1850



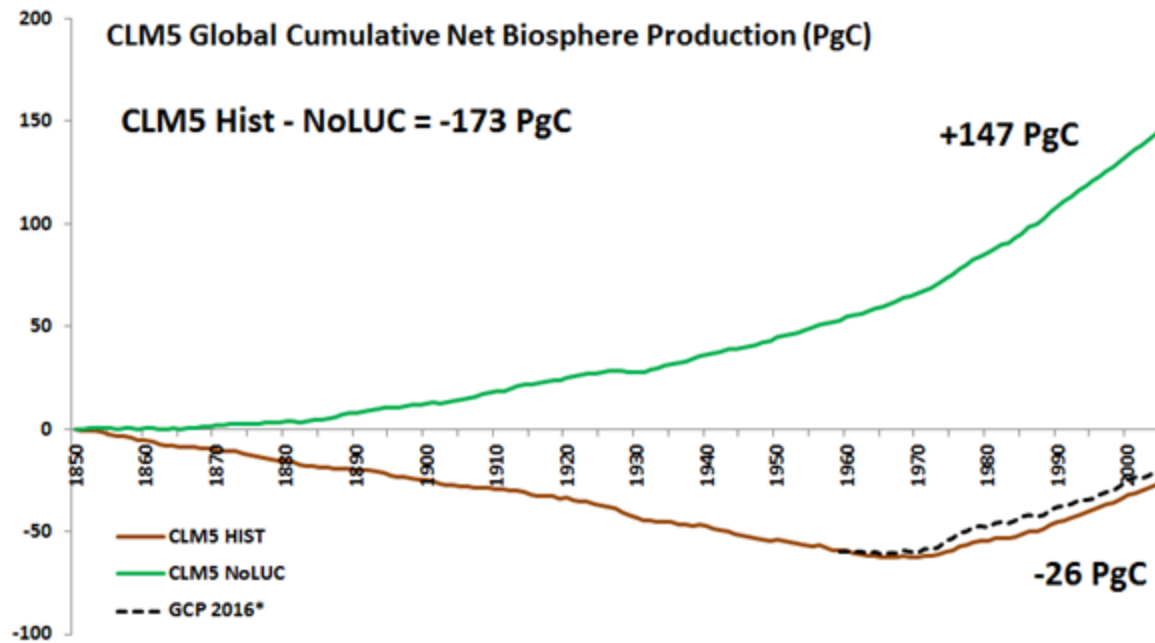
Global Soybean Area million km²



5. CLM5 Land Cover Change – Prescribed Annual Changes



CLM5 LUMIP LULCC vs no LULCC – NBP Carbon

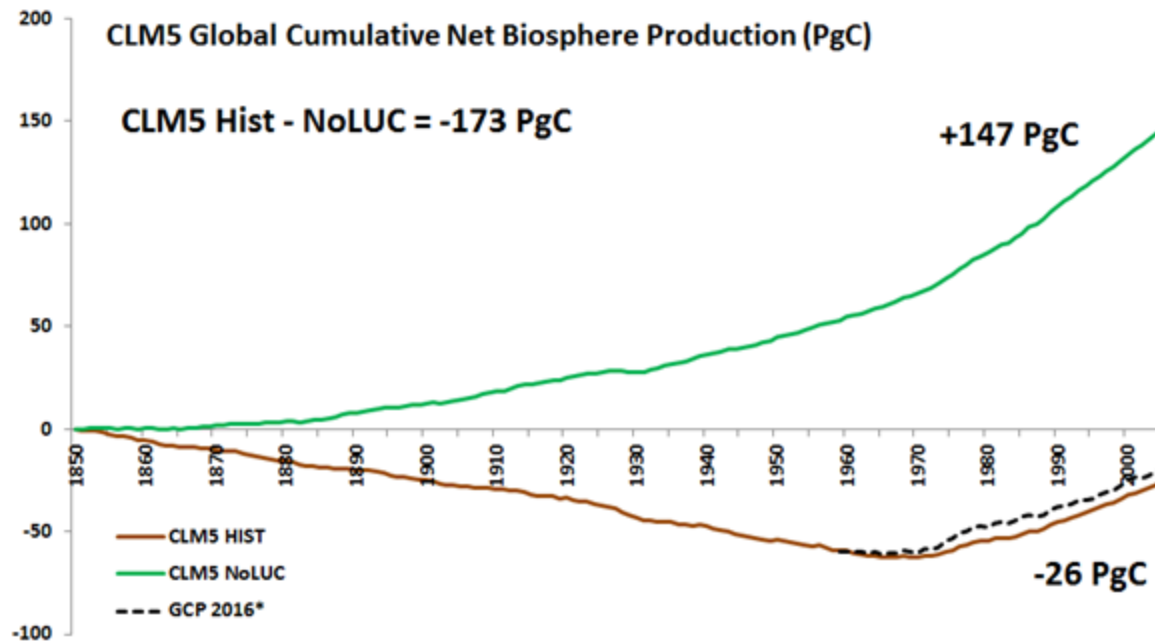


CLM5 NoLUC had large uptake of carbon from CO₂ fertilization, Climate and N Deposition
CLM5 +147 PgC

This is offset by LULCC in CLM5 = 173 PgC
Global Estimates ~160 PgC

*Global Carbon Project
Land Sink - LULCC
1959 – 2016

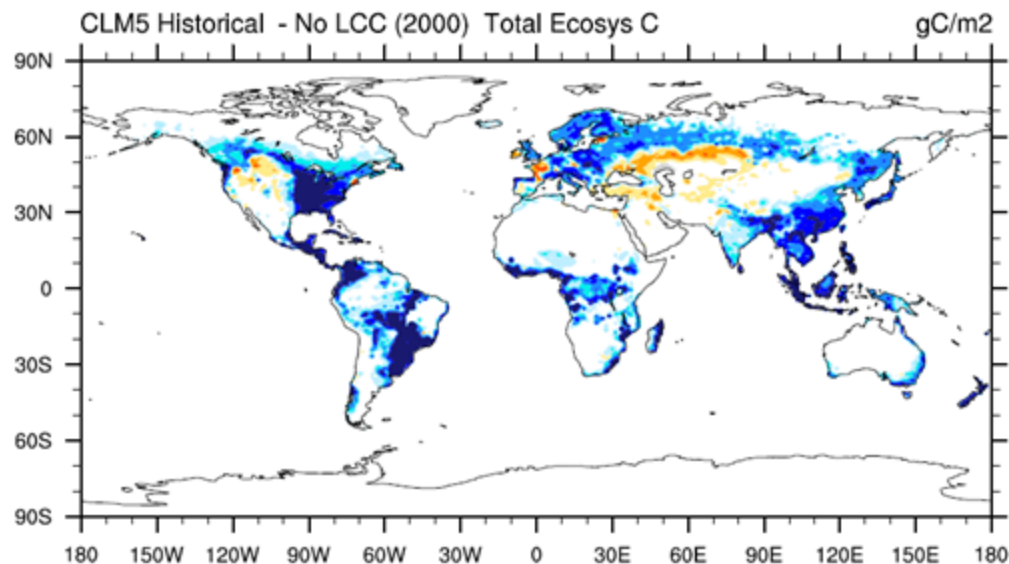
CLM5 LUMIP LULCC vs no LULCC – NBP Carbon



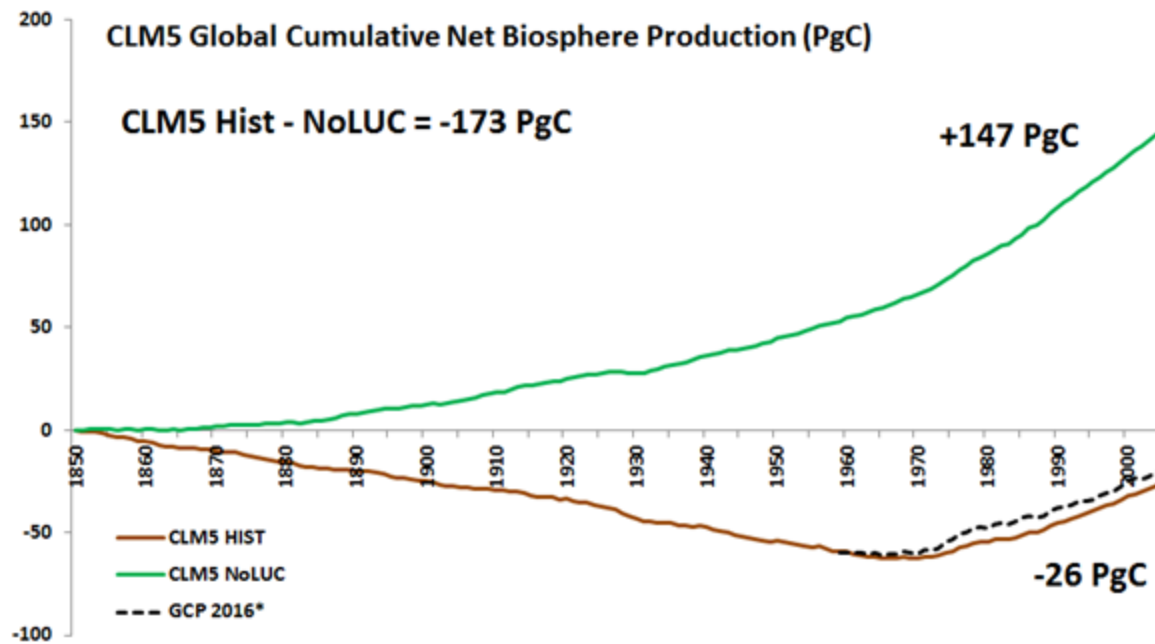
CLM5 NoLUC had large uptake of carbon from CO₂ fertilization, Climate and N Deposition
CLM5 +147 PgC

This is offset by LULCC in CLM5 = 173 PgC
Global Estimates ~160 PgC

*Global Carbon Project
Land Sink - LULCC
1959 – 2016



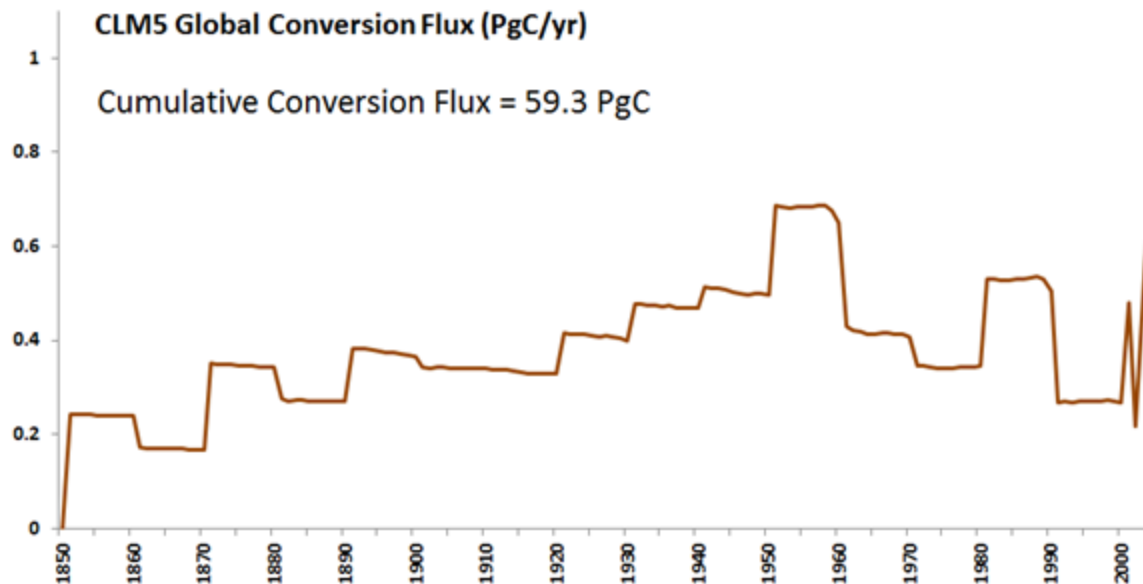
CLM5 LUMIP LULCC vs no LULCC – Conversion Flux



CLM5 NoLUC had large uptake of carbon from CO₂ fertilization, Climate and N Deposition
CLM5 +147 PgC

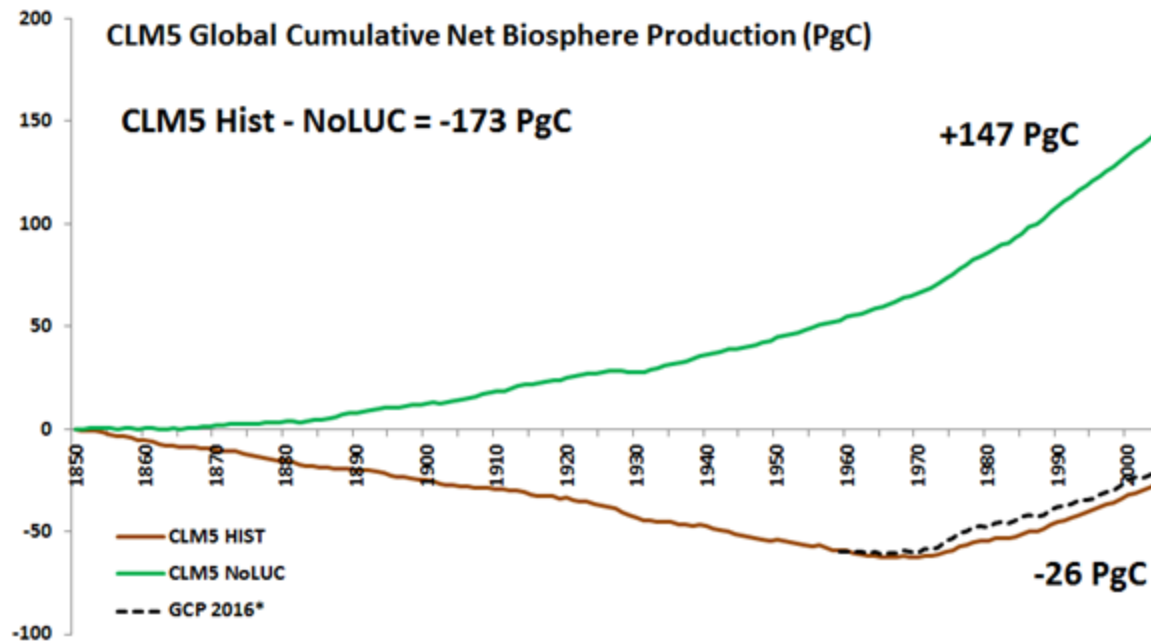
This is offset by LULCC in CLM5 = 173 PgC
Global Estimates ~160 PgC

*Global Carbon Project
Land Sink - LULCC
1959 – 2016



CLM5 conversion of PFTs and CFTs results in a cumulative loss of 59.3 PgC

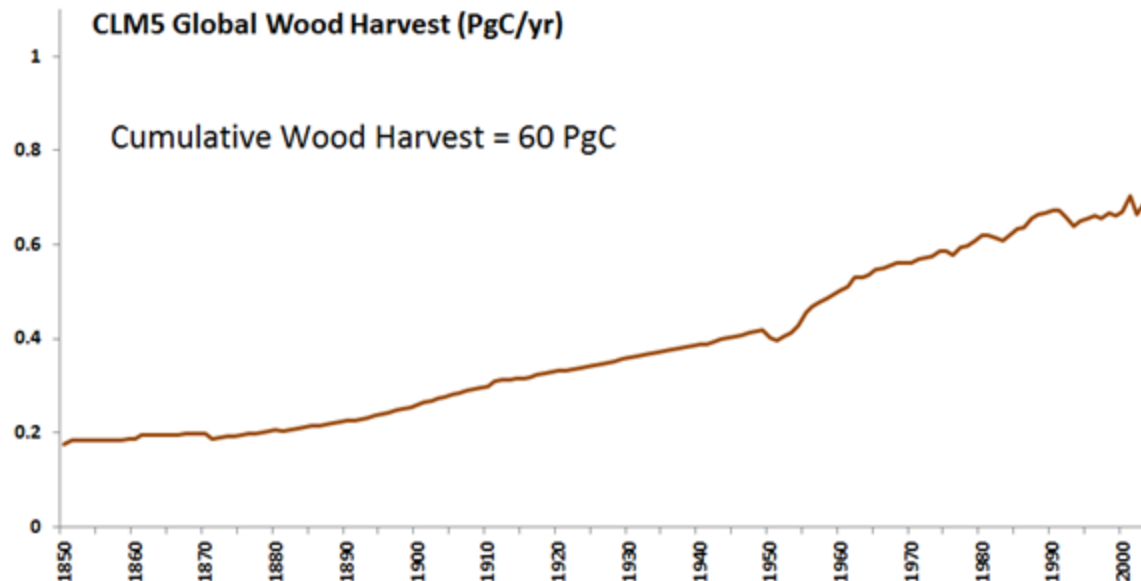
CLM5 LUMIP LULCC vs no LULCC – Wood Harvest



CLM5 NoLUC had large uptake of carbon from CO₂ fertilization, Climate and N Deposition
CLM5 +147 PgC

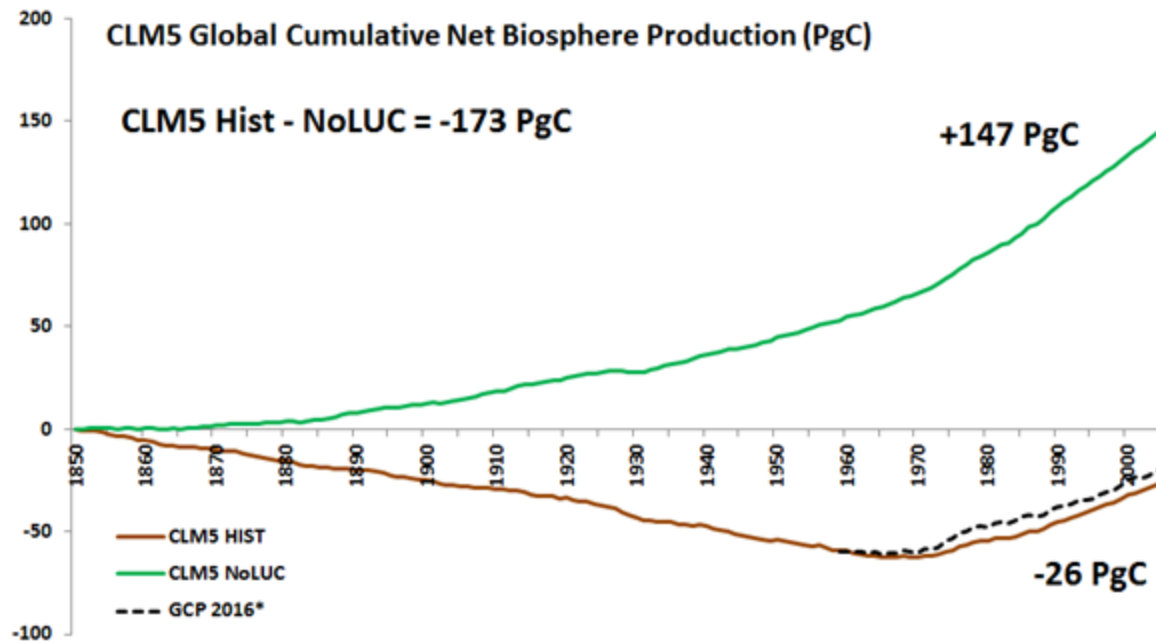
This is offset by LULCC in CLM5 = 173 PgC
Global Estimates ~160 PgC

*Global Carbon Project
Land Sink - LULCC
1959 – 2016



CLM5 wood harvest of tree PFTs results in a cumulative loss of 60 PgC over the period.

CLM5 LUMIP LULCC vs no LULCC – Wildfire Flux

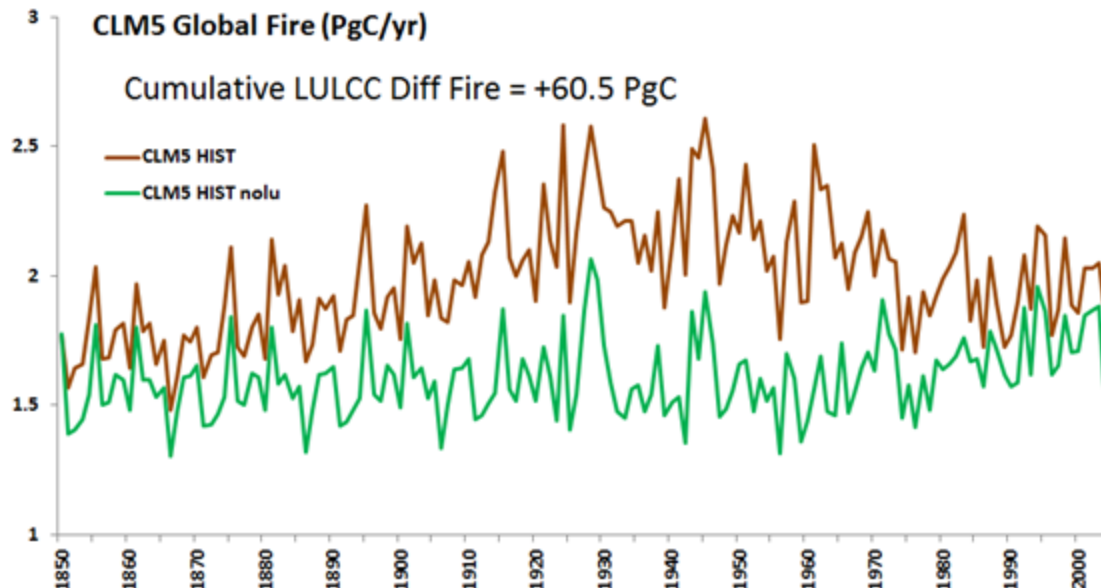


CLM5 NoLUC had large uptake of carbon from CO₂ fertilization, Climate and N Deposition
CLM5 +147 PgC

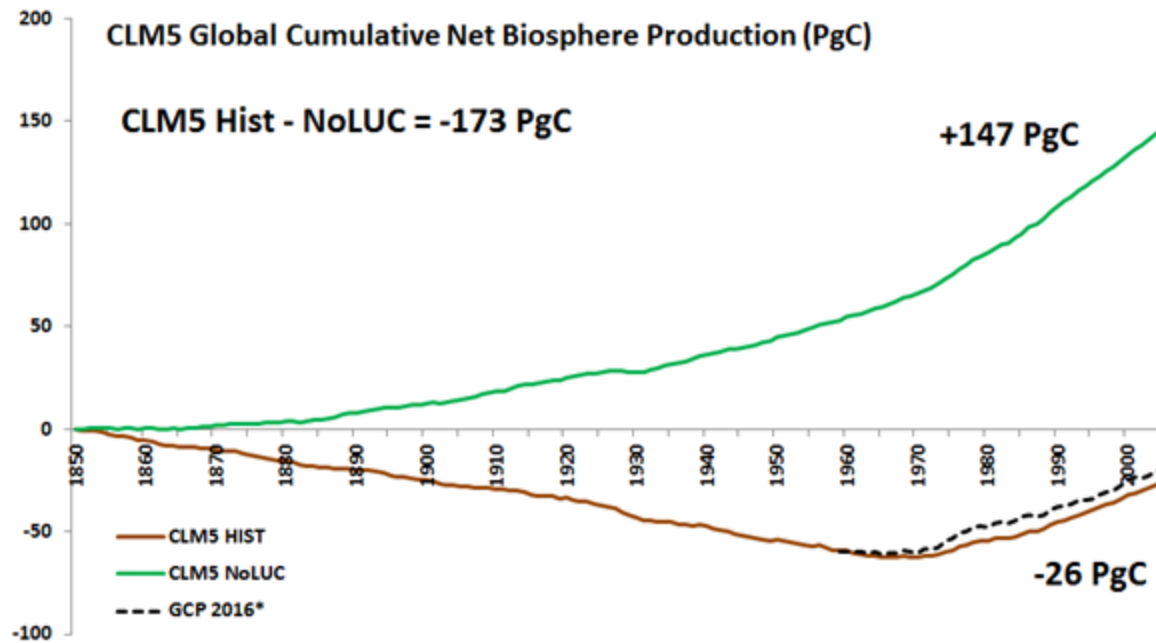
This is offset by LULCC in CLM5 = 173 PgC
Global Estimates ~160 PgC

*Global Carbon Project
Land Sink - LULCC
1959 – 2016

CLM5 LULCC results in large increase in carbon loss through increased fire of +60.5 PgC



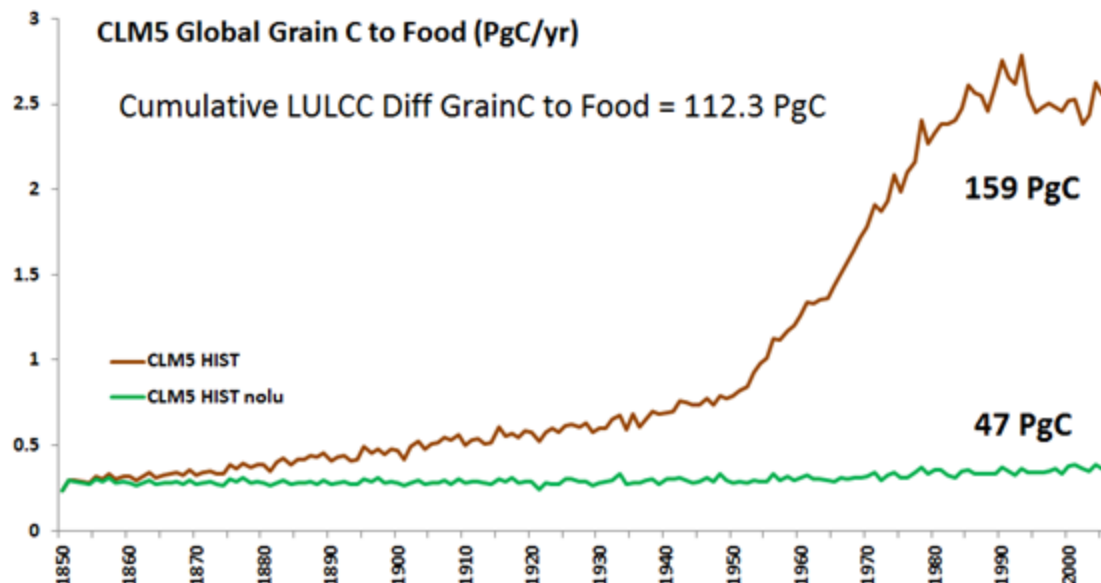
CLM5 LUMIP – Crop Harvest Grain Carbon



CLM5 NoLUC had large uptake of carbon from CO₂ fertilization, Climate and N Deposition
CLM5 +147 PgC

This is offset by LULCC in CLM5 = 173 PgC
Global Estimates ~160 PgC

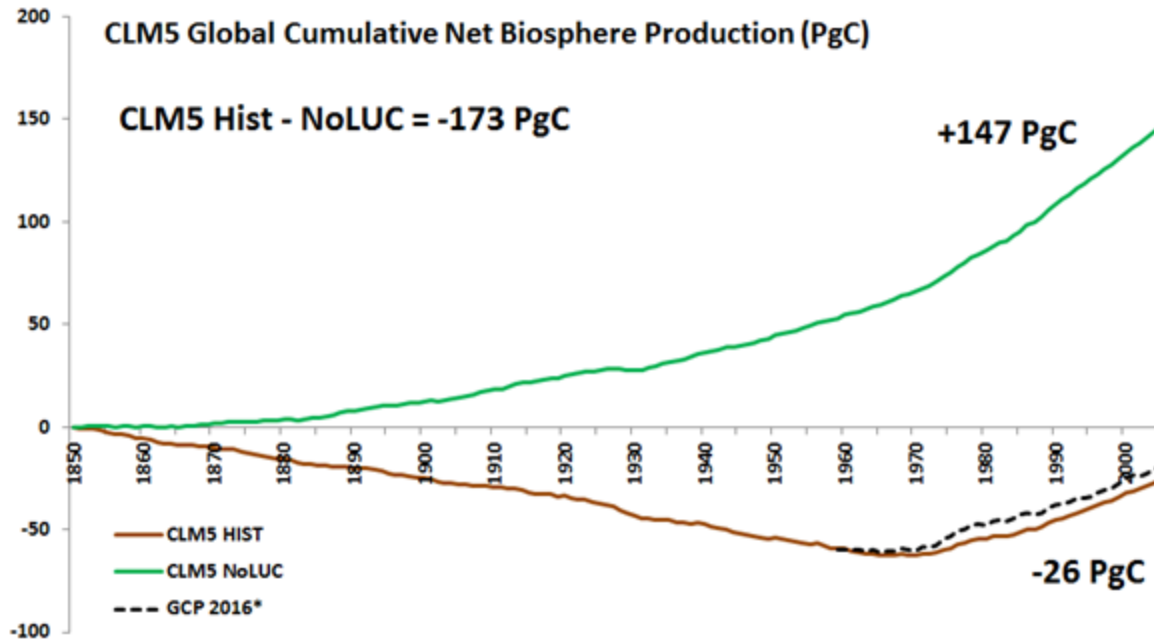
*Global Carbon Project
Land Sink - LULCC
1959 – 2016



CLM5 LULCC results in large crop harvest flux out of the land of 159 PgC

Much of the crop harvest flux is offset in the LULCC simulation by higher NPP from fertilizer and lower heterotrophic respiration (organic matter decay) from harvest and residue management.

CLM5 LUMIP LULCC vs no LULCC – NPP



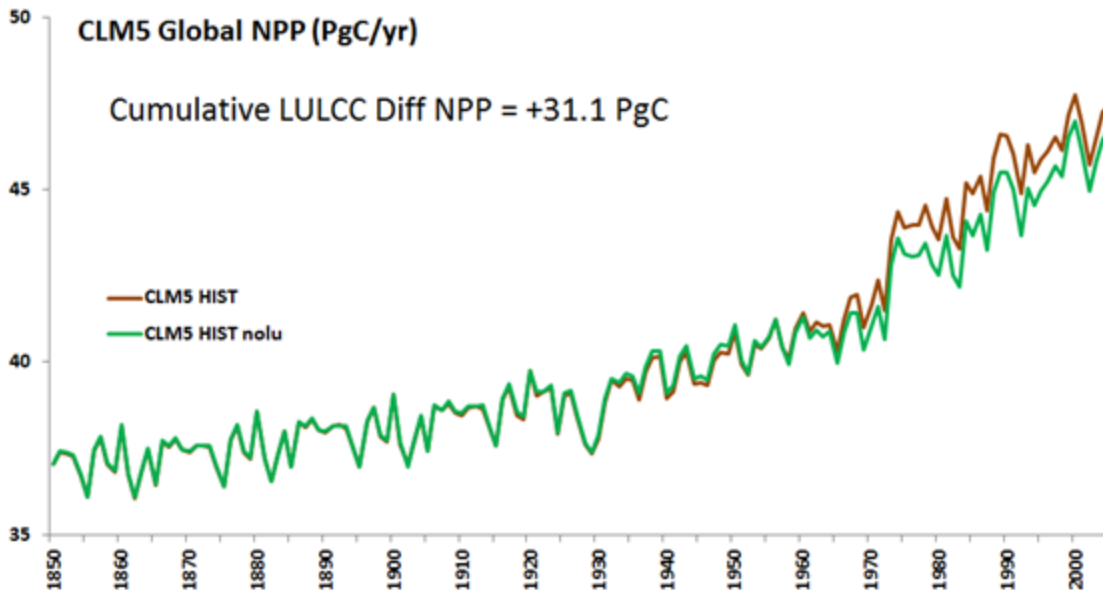
CLM5 NoLUC had large uptake of carbon from CO₂ fertilization, Climate and N Deposition
CLM5 +147 PgC

This is offset by LULCC in CLM5 = 173 PgC
Global Estimates ~160 PgC

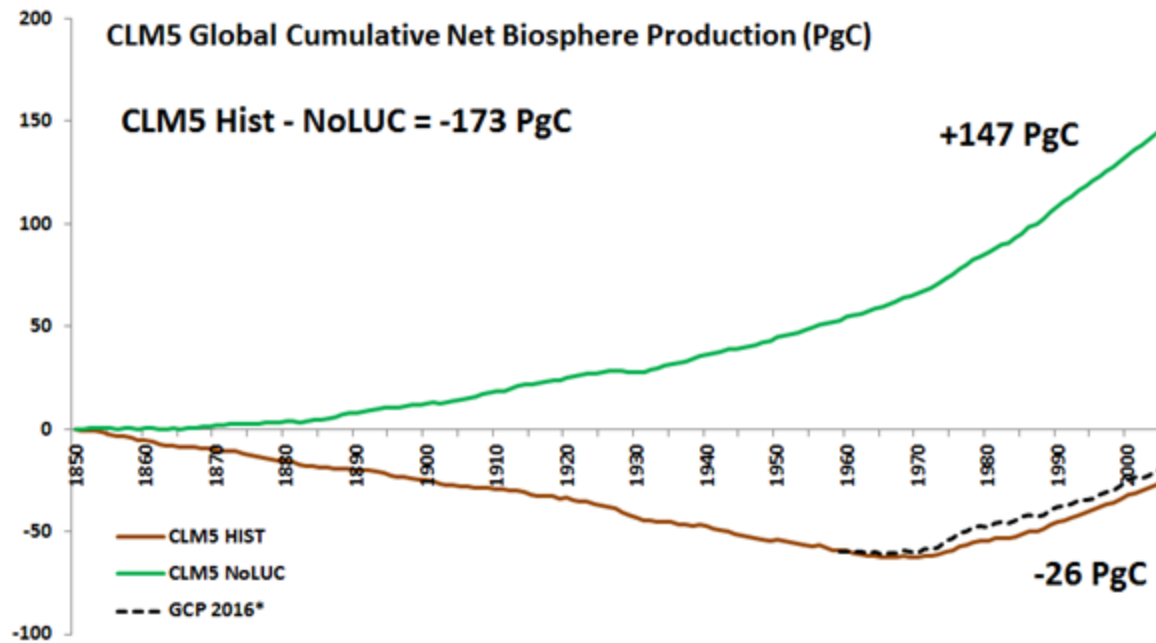
*Global Carbon Project
Land Sink - LULCC
1959 – 2016

CLM5 LULCC results in Increased Net Primary Productivity uptake of carbon by the land of +31 PgC

CLM5 LULCC cropping with N fertilizer and irrigation increases NPP over previous vegetation



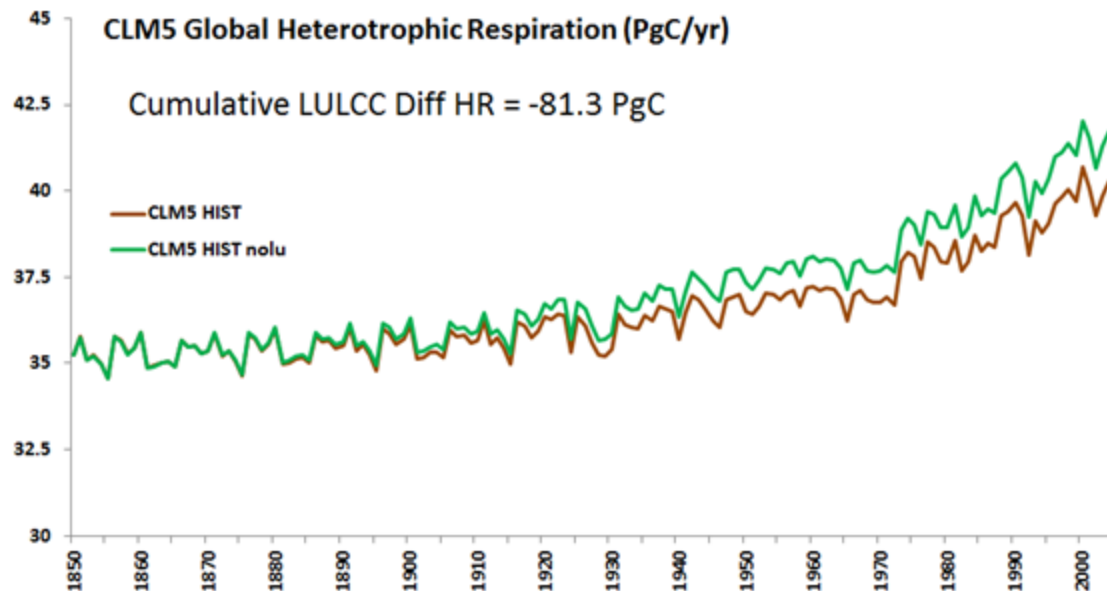
CLM5 LUMIP LULCC vs no LULCC – Het. Respiration



CLM5 NoLUC had large uptake of carbon from CO₂ fertilization, Climate and N Deposition
CLM5 +147 PgC

This is offset by LULCC in CLM5 = 173 PgC
Global Estimates ~160 PgC

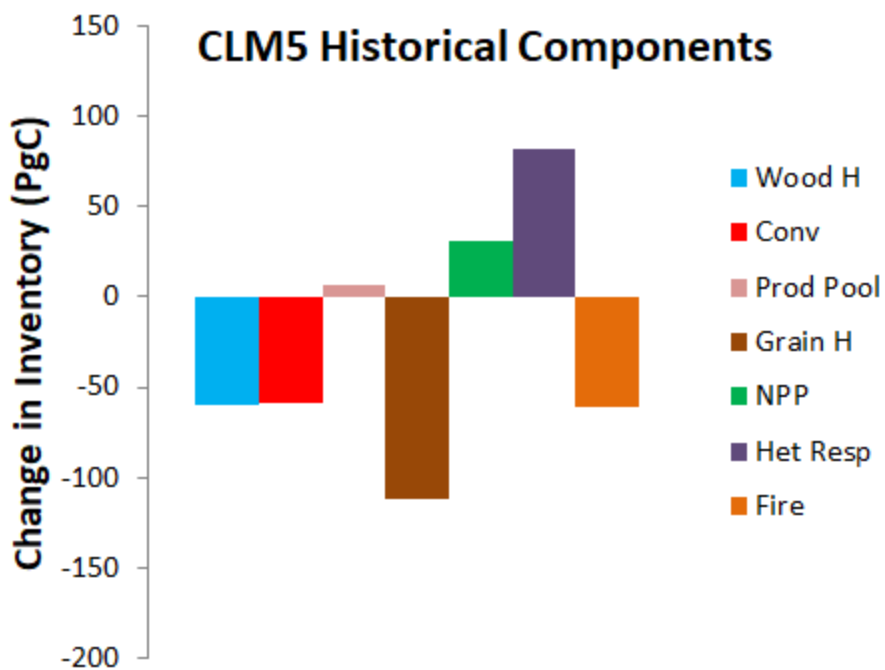
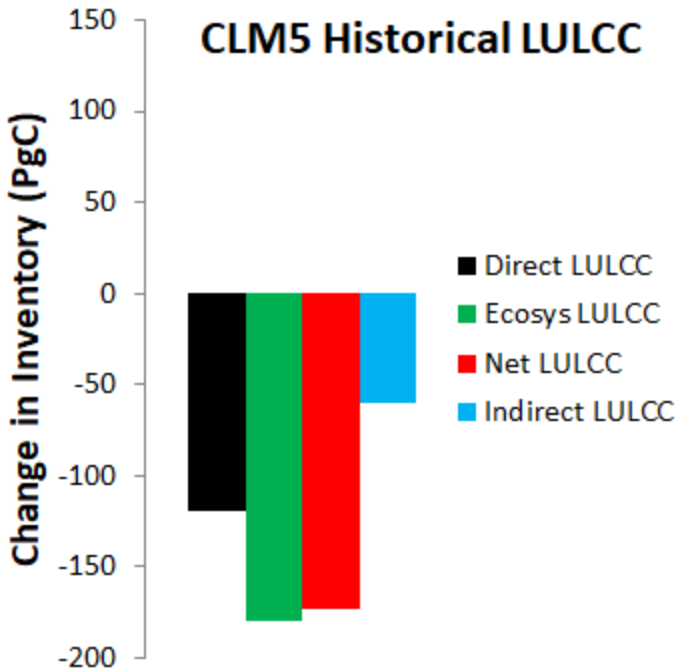
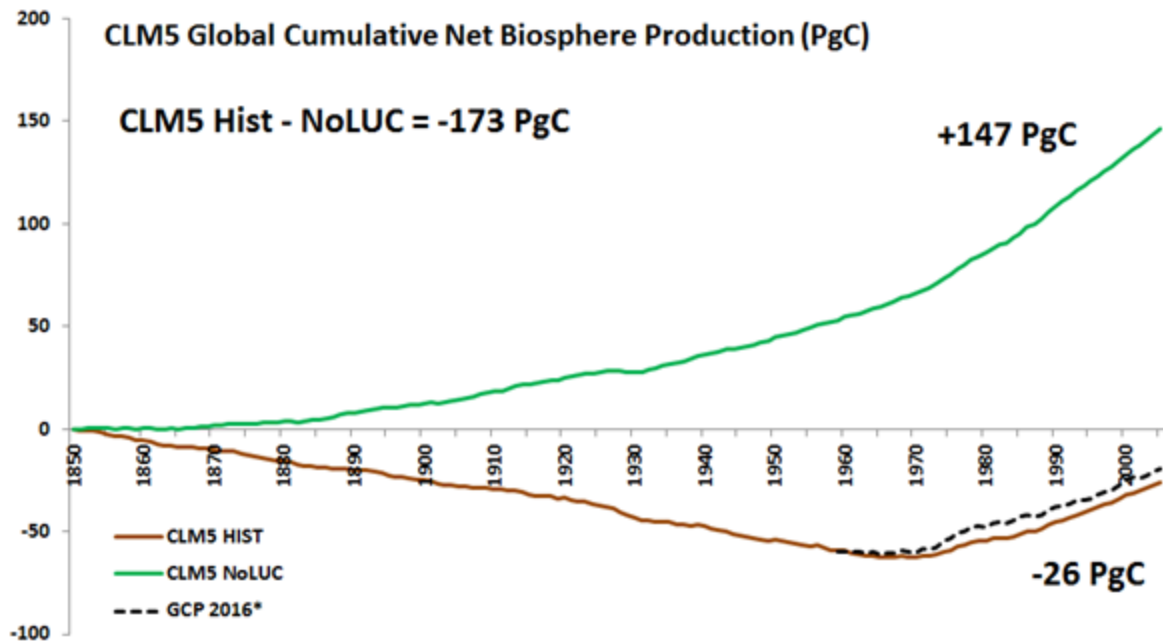
*Global Carbon Project
Land Sink - LULCC
1959 – 2016



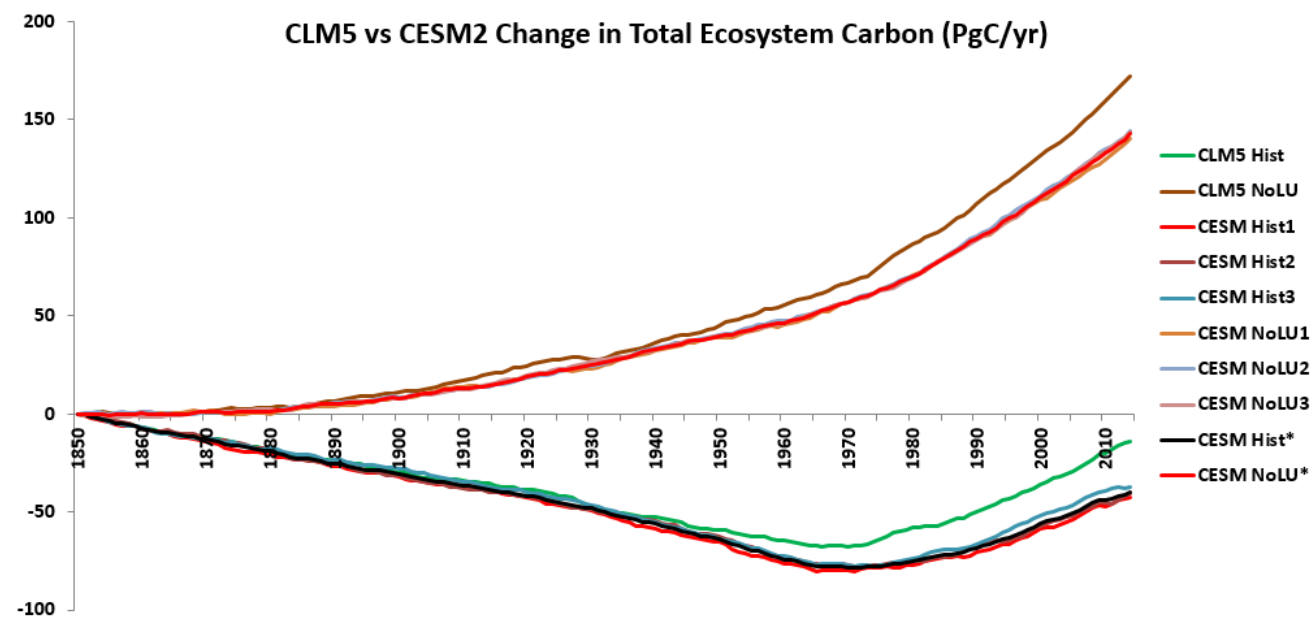
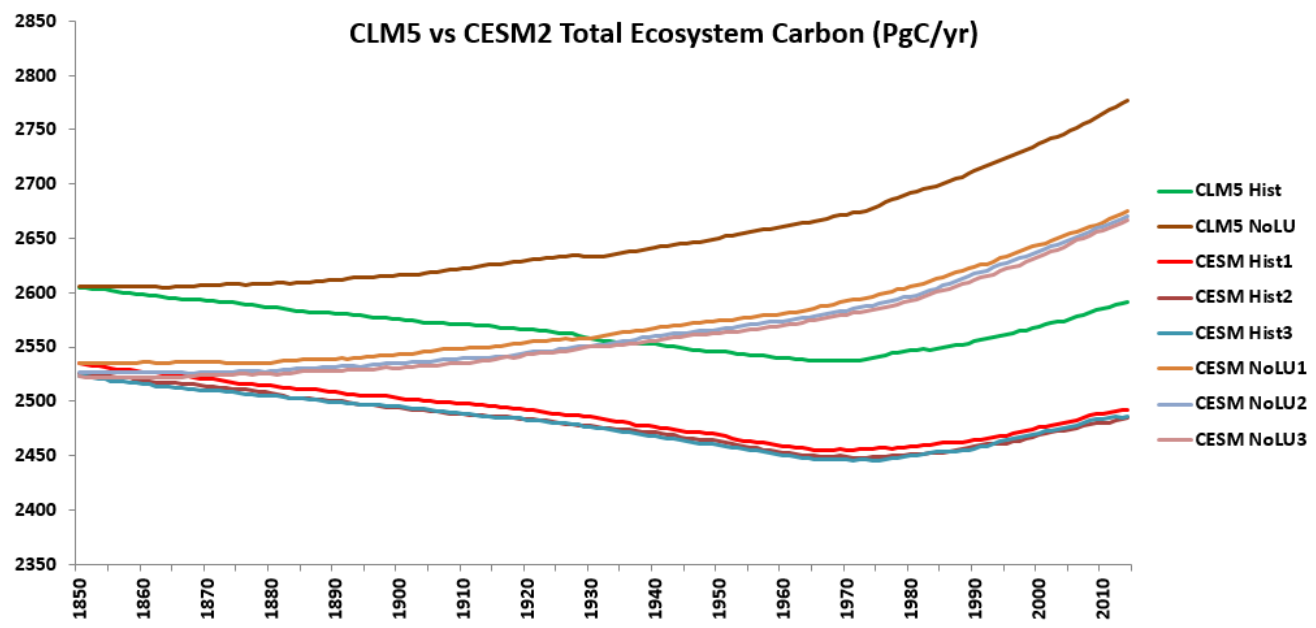
CLM5 LULCC results in Reduced Heterotrophic Respiration loss of carbon by -81.3 PgC

CLM5 LULCC deforestation, crop harvest and fire changes result in less litter, coarse woody debris and soil carbon to decay

CLM5 LUMIP LULCC vs no LULCC – Cumulative



CLM5 vs CESM LUMIP LULCC vs no LULCC – Total Ecosys C



CLM5 vs CESM LUMIP LULCC vs no LULCC – Total Ecosys C

