

EMF Workshop on Climate Change
Impacts and Integrated Assessment
Snowmass, CO
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Land-Use (& Land Cover Change), Biogeochemistry and Climate

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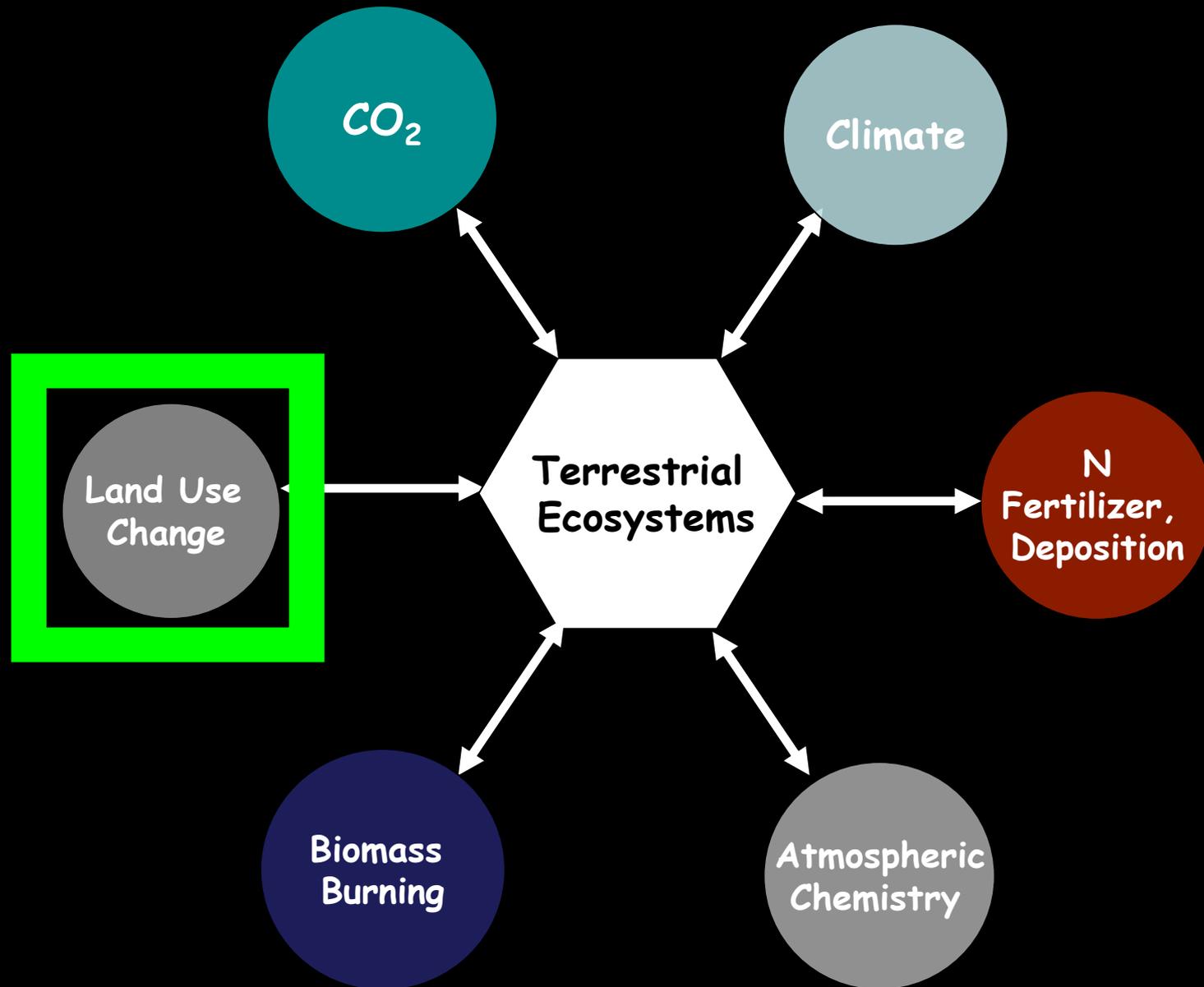
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LCLUC and Carbon (and Climate) Dynamics

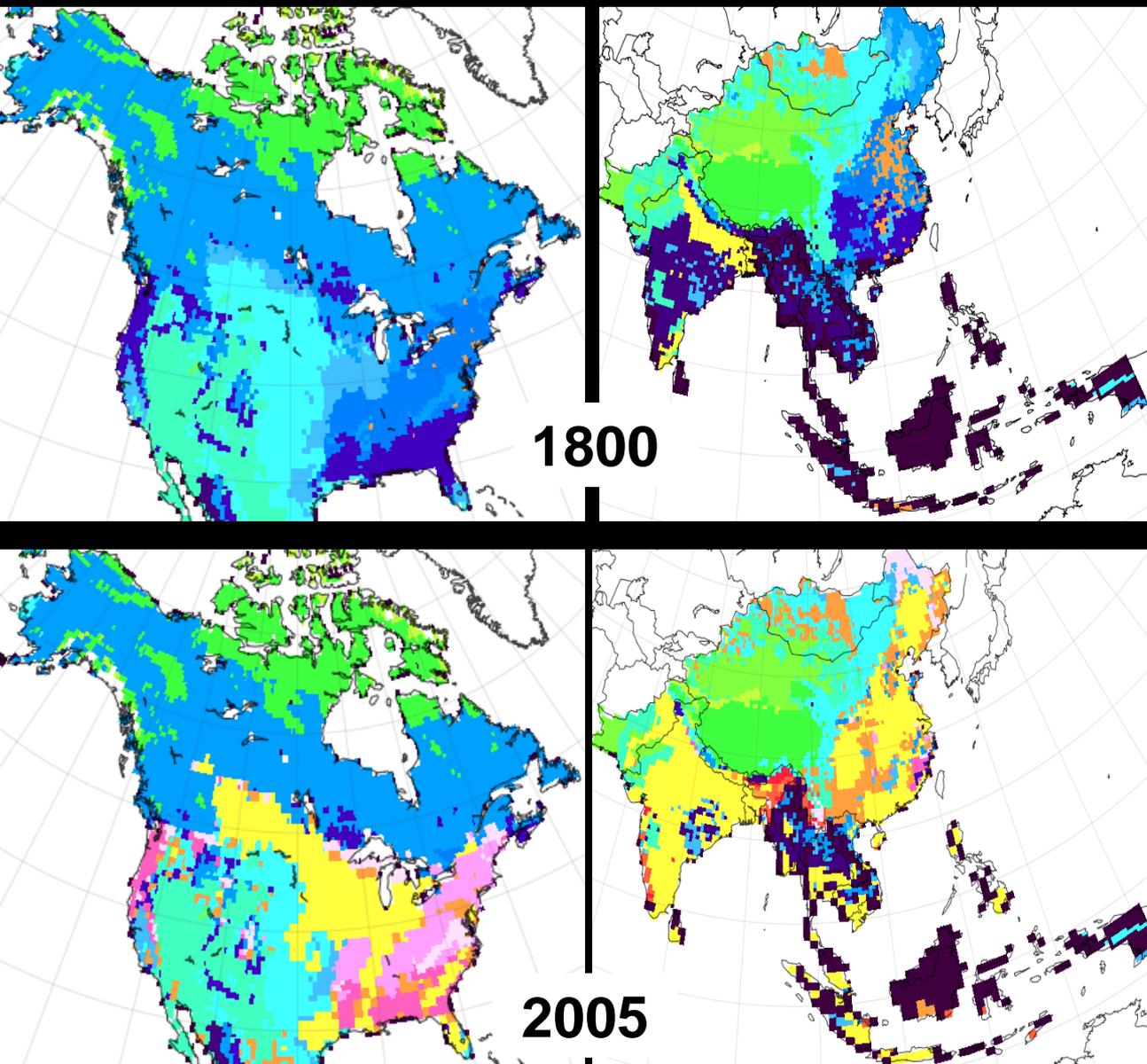
LCLUC activities impact our environment and climate

- source of atmospheric CO_2 and N_2O (Biogeochemistry)
- changes hydrological cycle and Earth's energy budget (Biogeophysics)

LCLUC, Terrestrial Ecosystems and Environmental Factors



Historical LCLUC - N America & SSEA

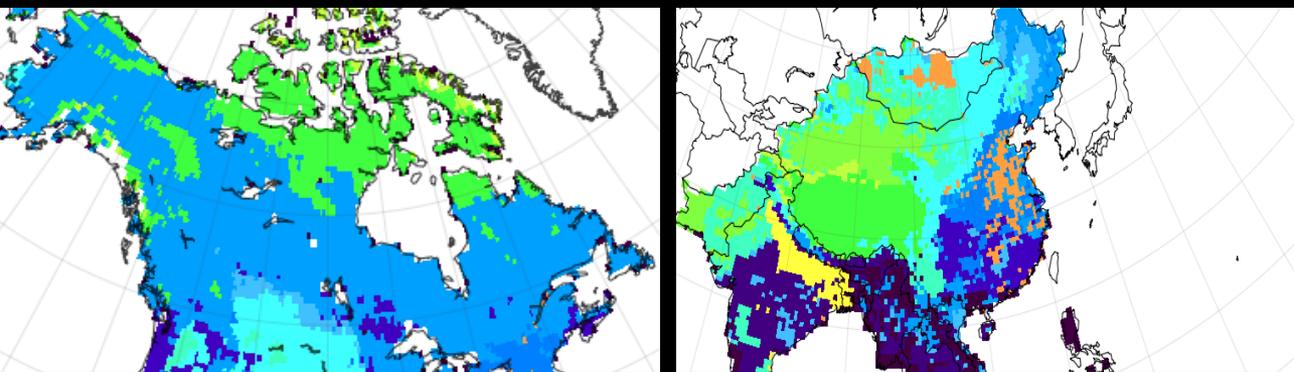


Biome Types

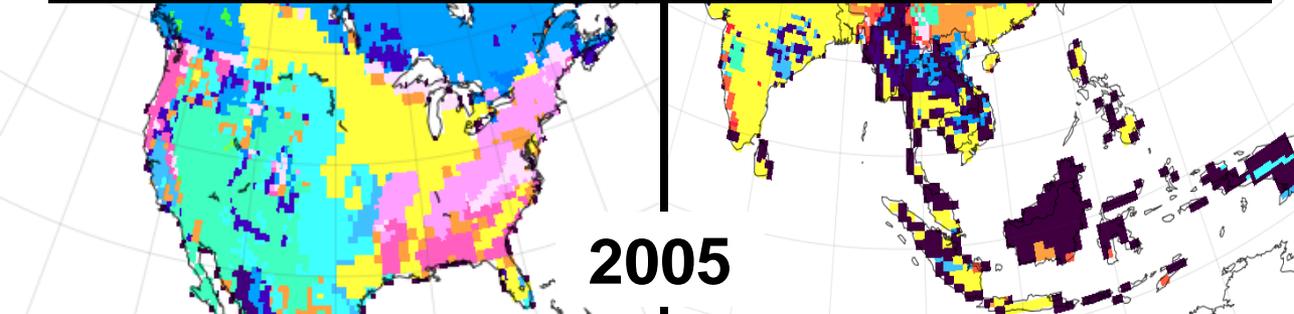
- Tropical Evergreen
- Tropical Deciduous
- Temperate Evergreen
- Temperate Deciduous
- Boreal Forest
- Savanna
- Grassland
- Shrubland
- Tundra
- Desert
- Polar Desert
- Cropland
- Pastureland
- Sec. Tropical Evergreen
- Sec. Tropical Deciduous
- Sec. Temperate Evergreen
- Sec. Temperate Deciduous
- Sec. Boreal Forest

Yang , Jain et al. (2010); Meiyappan and Jain (2012)

Historical LCLUC - N America & SSEA



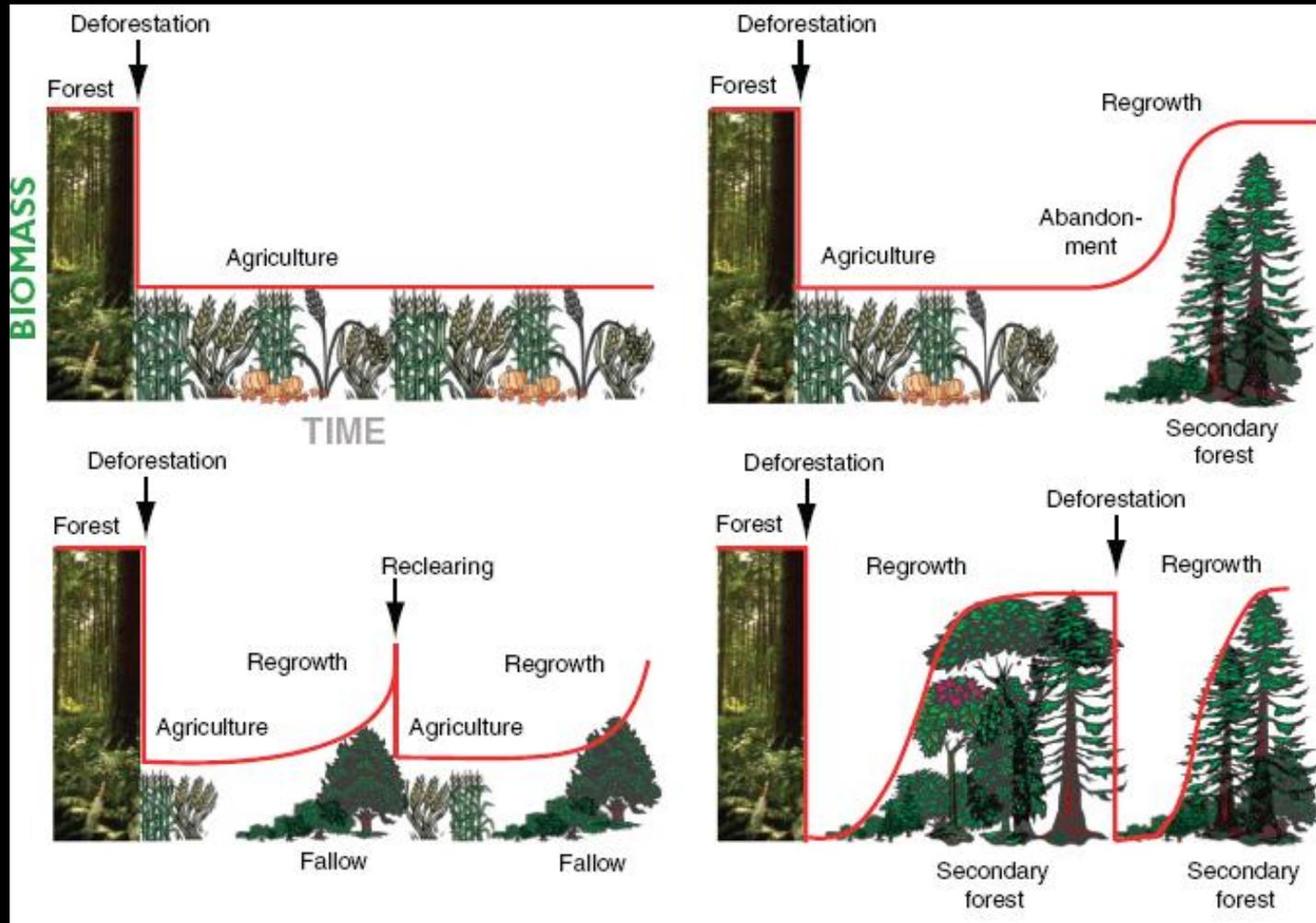
- Less primary land, more secondary land, more cropland and pastureland
- Land use alters : *Atmospheric CO₂, N & P cycles, albedo, runoff, soil water holding capacity etc.*



Biome Types



Different Pathways of Carbon Dynamics after Deforestation



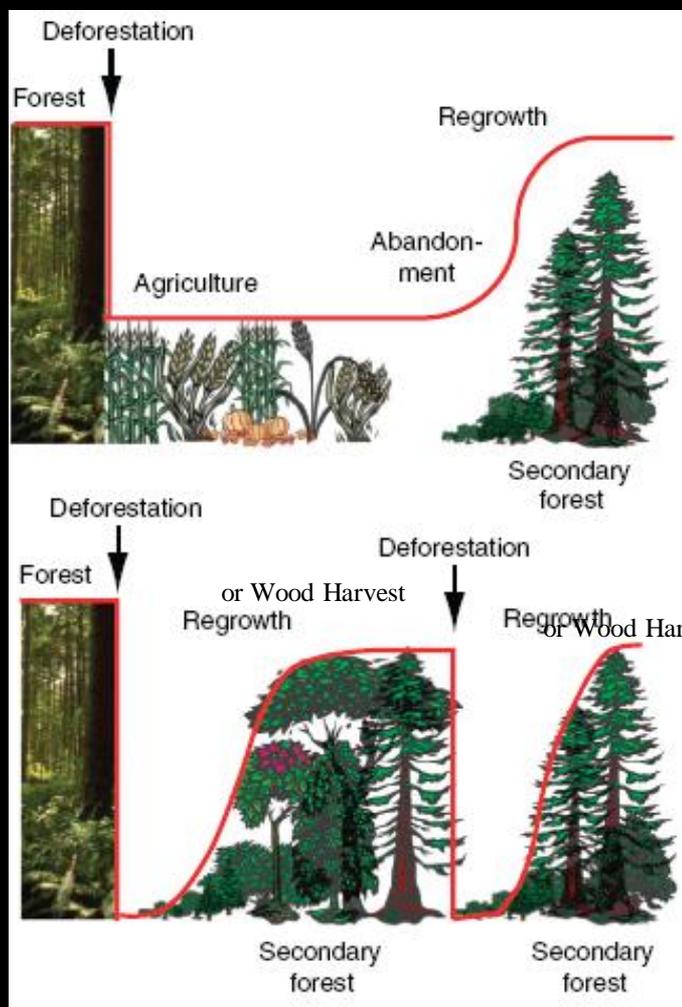
LCLUC and C and N Dynamics

- Instantaneous C release
- After abandonment C stored in secondary forest (SF)
- Stored C in SF could be enhanced due to CO₂ and N fertilizations

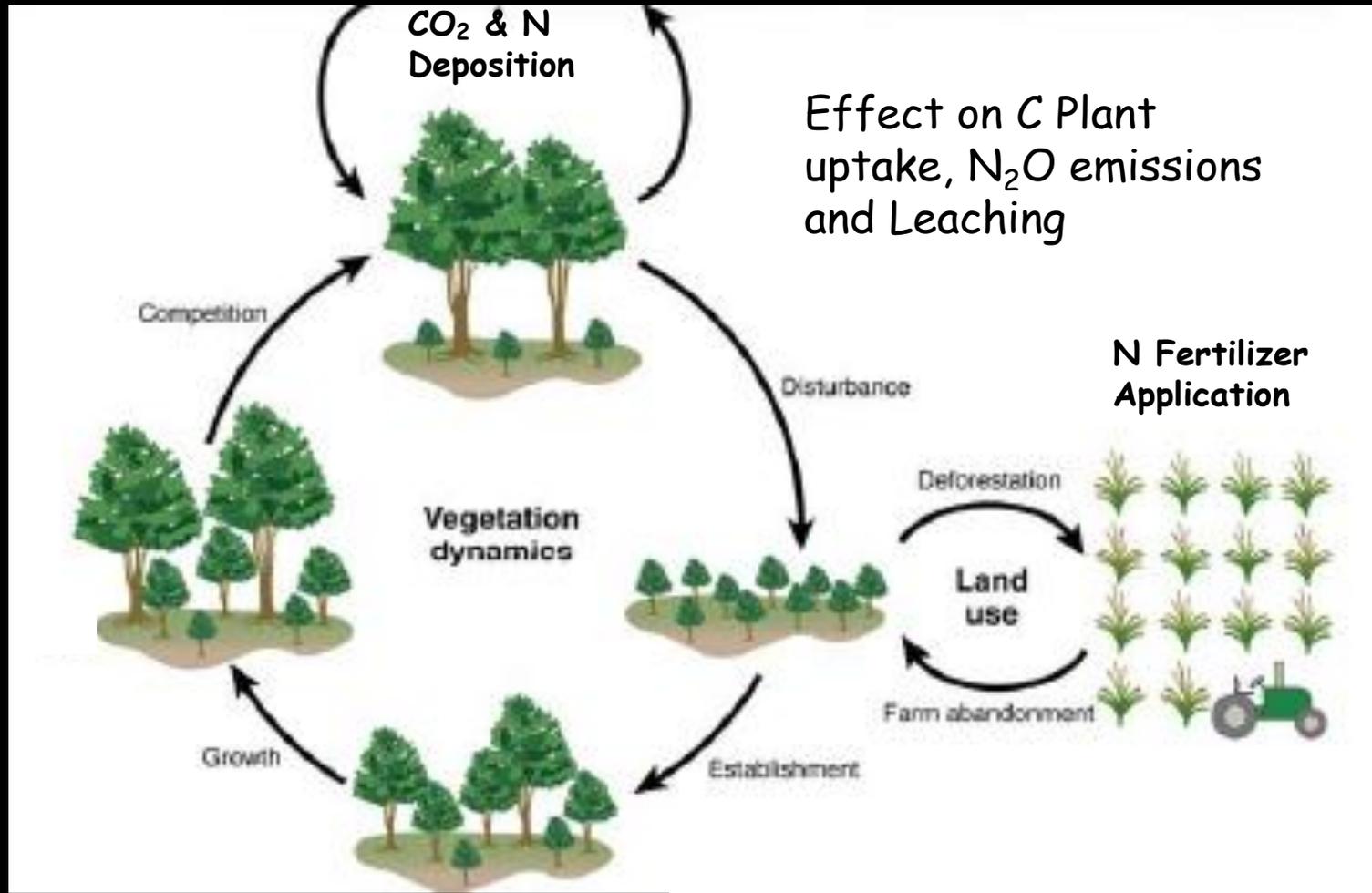
- C accumulation in SF could be constrained due to nutrient limitation (N & P)

- N Deposition can enhanced the C accumulation

- After LCLUC soil C and N are increased for a short while, but soil C soon decreases because litter input from the deforested land is typically lower



The Impact of N Deposition and Fertilizer



Carbon Emissions from Land Use Changes

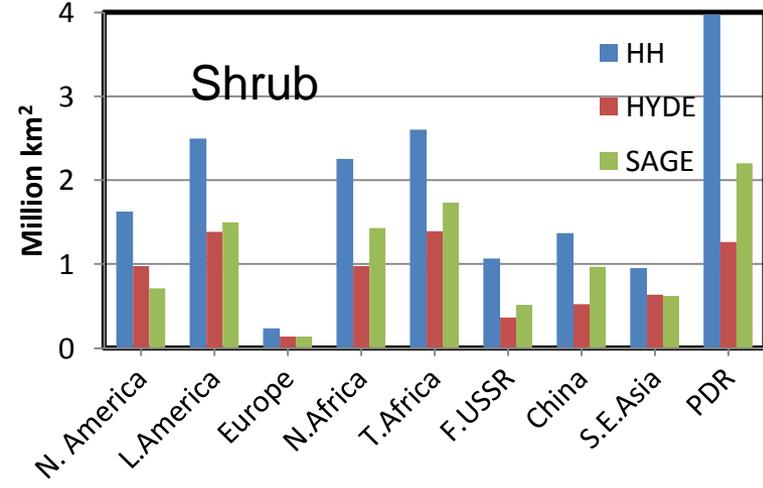
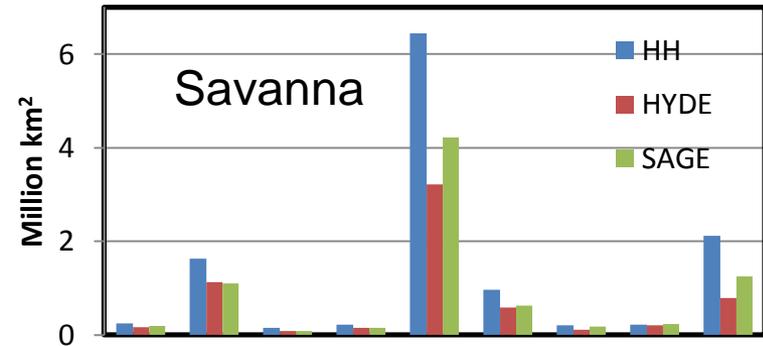
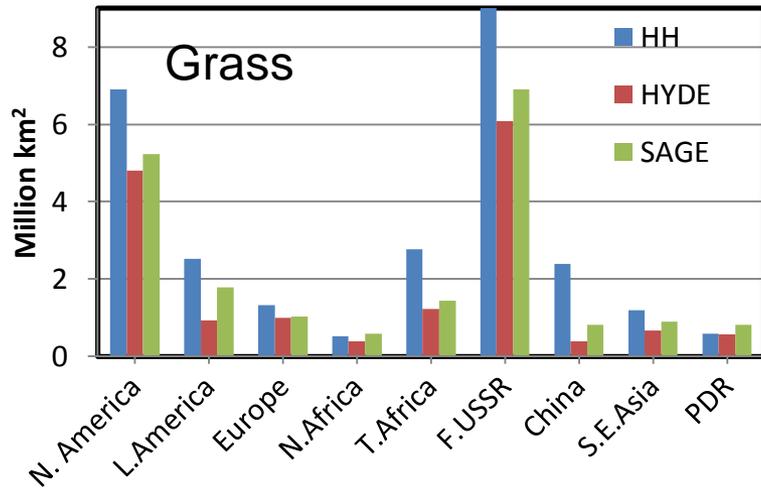
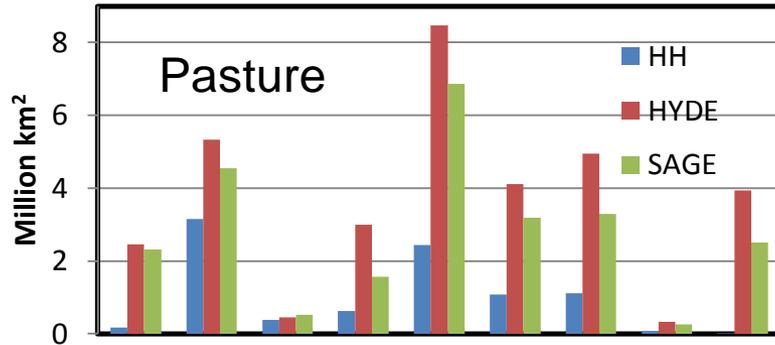
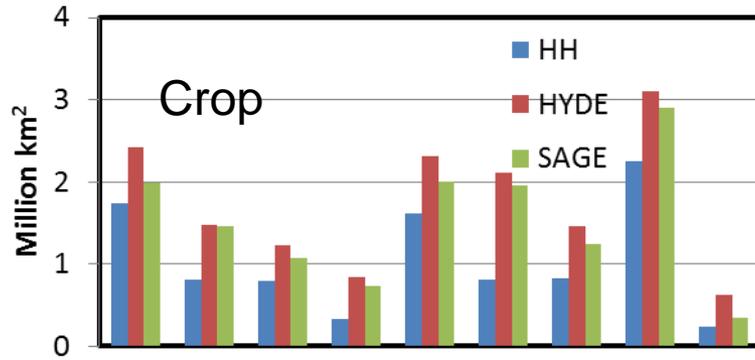
Uncertainties in LU Emissions....

- Rates of land-use change
 - Deforestation, afforestation, abandonment
 - Other changes in land use
- The processes and feedbacks included in the analyses computing the flux.
- Density of carbon stocks in the areas affected by management

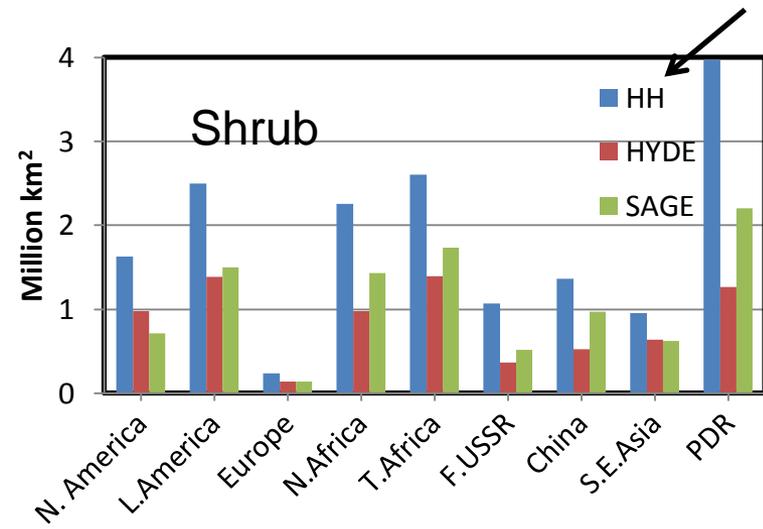
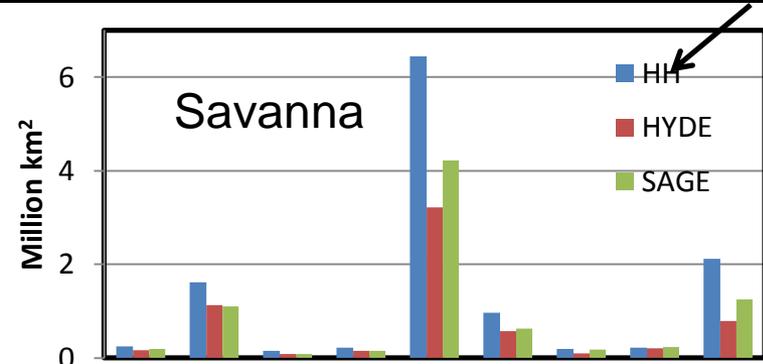
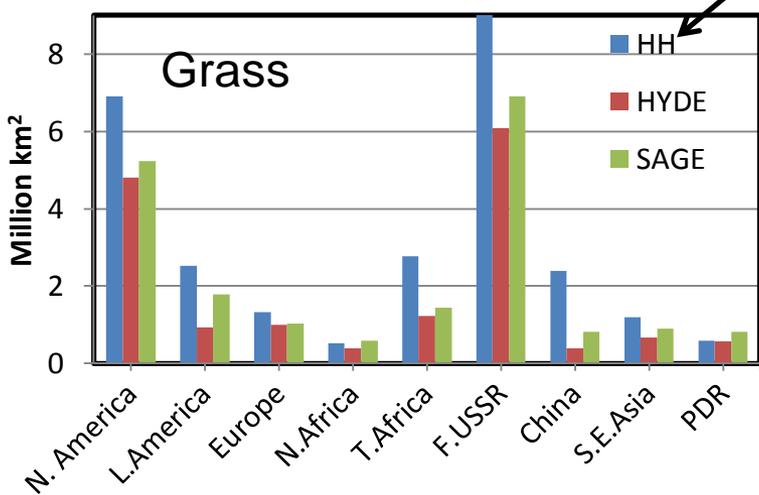
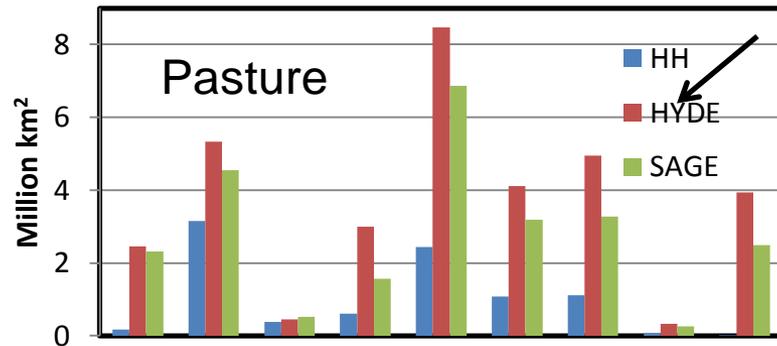
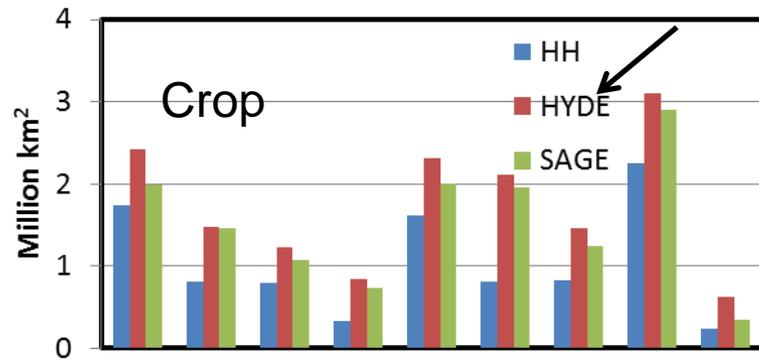
Various Land Use Change History

- Richard Houghton (HH)
 - *Cropland, Pastureland*
- HYDE
 - *Cropland, Pastureland, Urban land*
- SAGE
 - *Cropland, Pastureland*
- Hurtt et al. (GLM)
 - *Wood Harvest*

Comparison of Different Biome Areas (2001-2005)

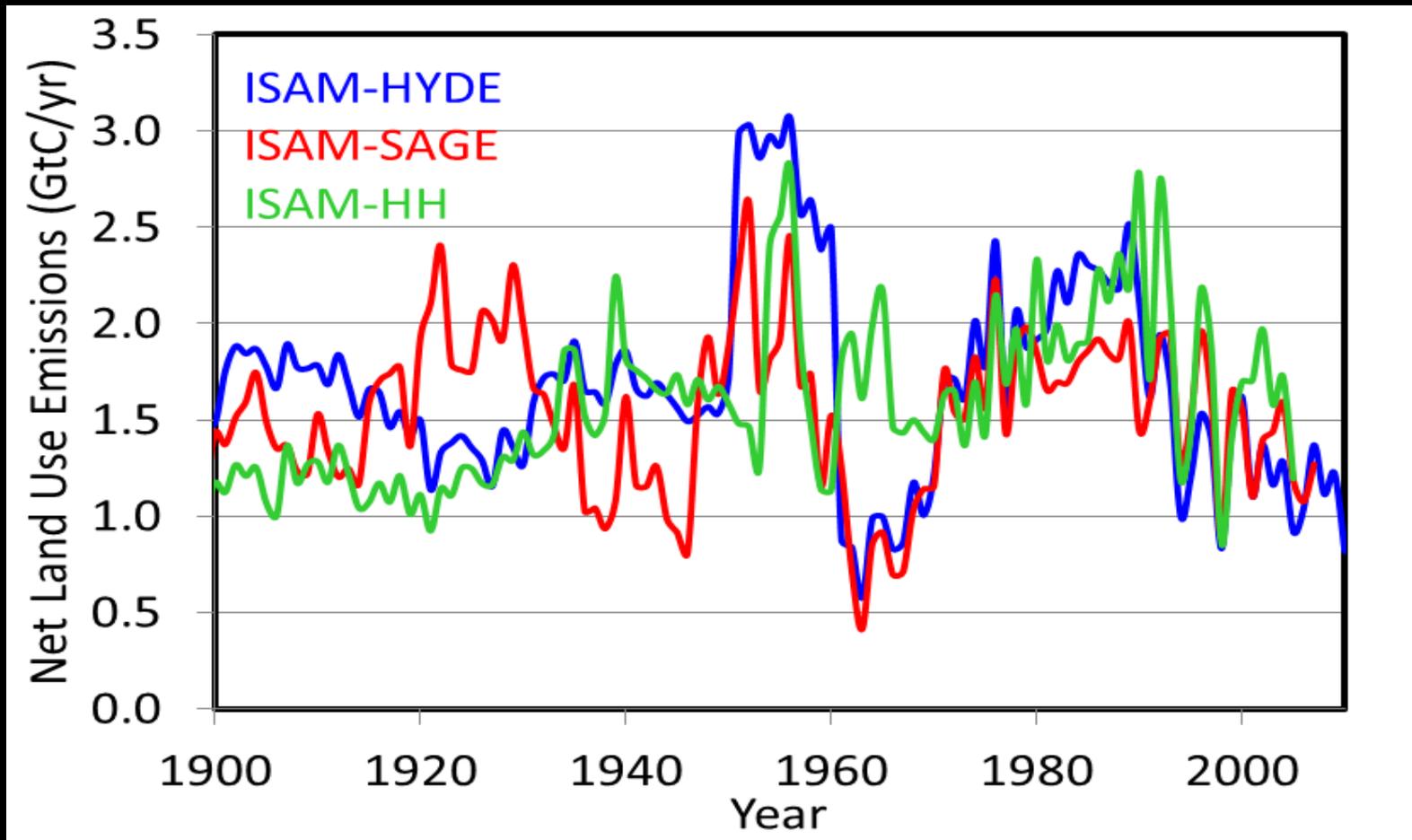


Comparison of Different Biome Areas (2001-2005)

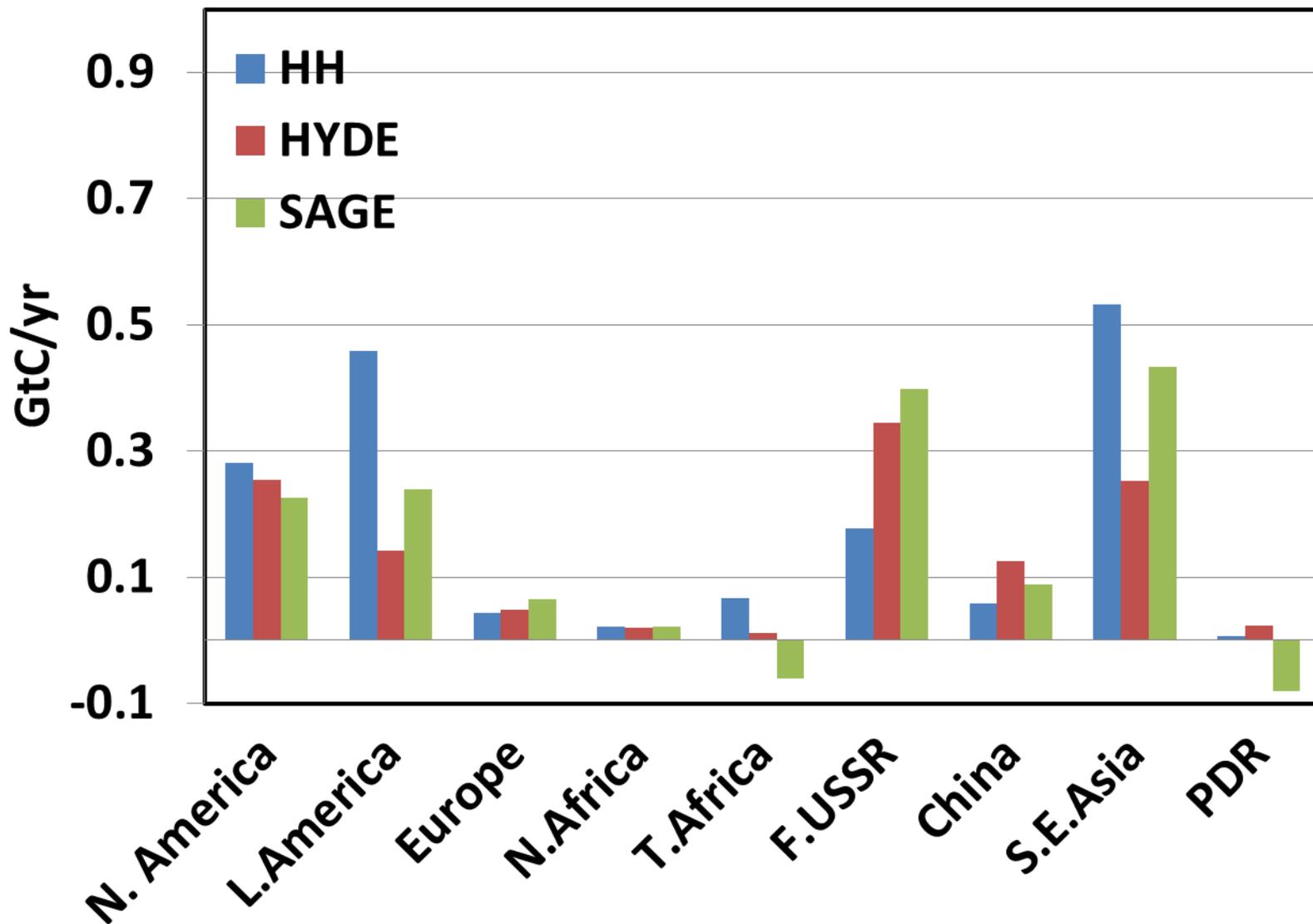


Arrows indicate the data set with highest area for individual biome

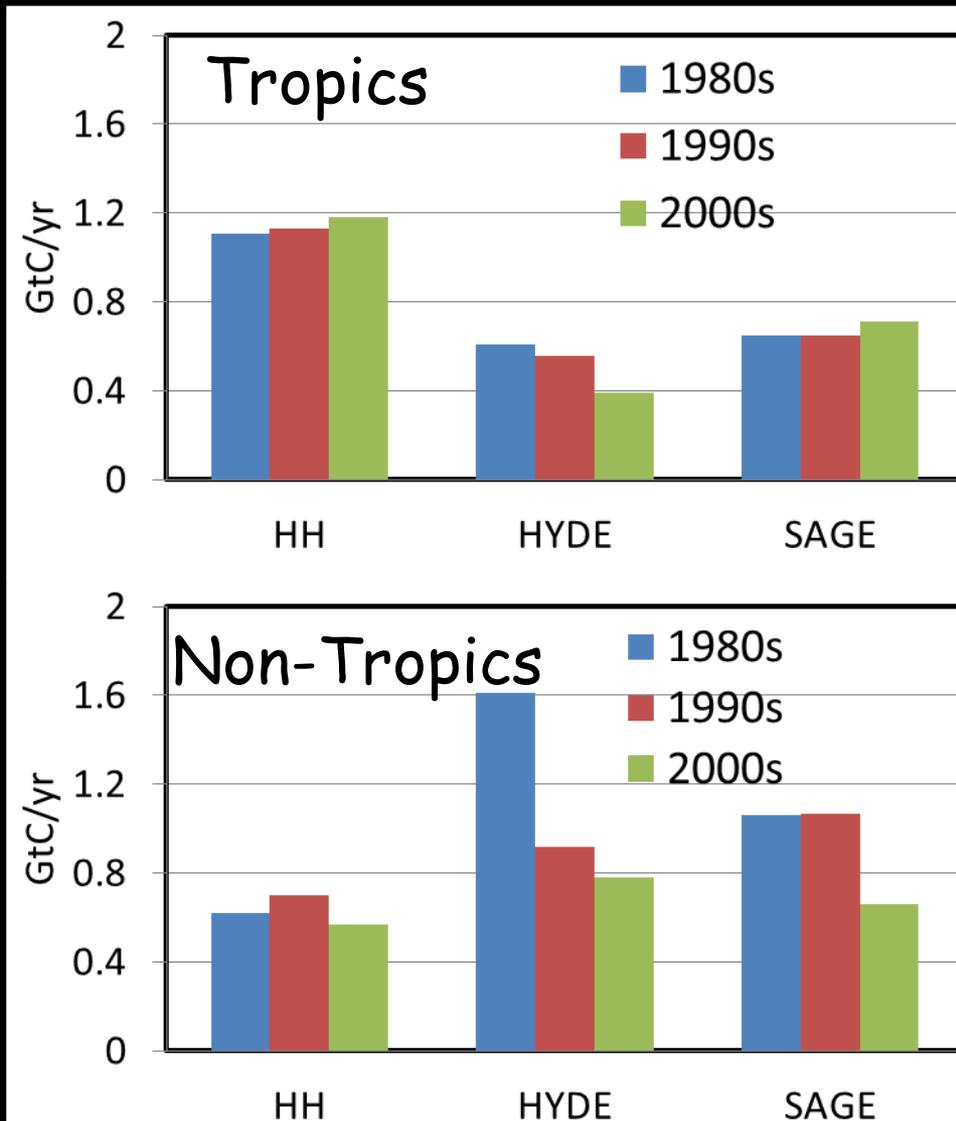
ISAM Model Estimated Global Land-Use Emissions (GtC/yr)



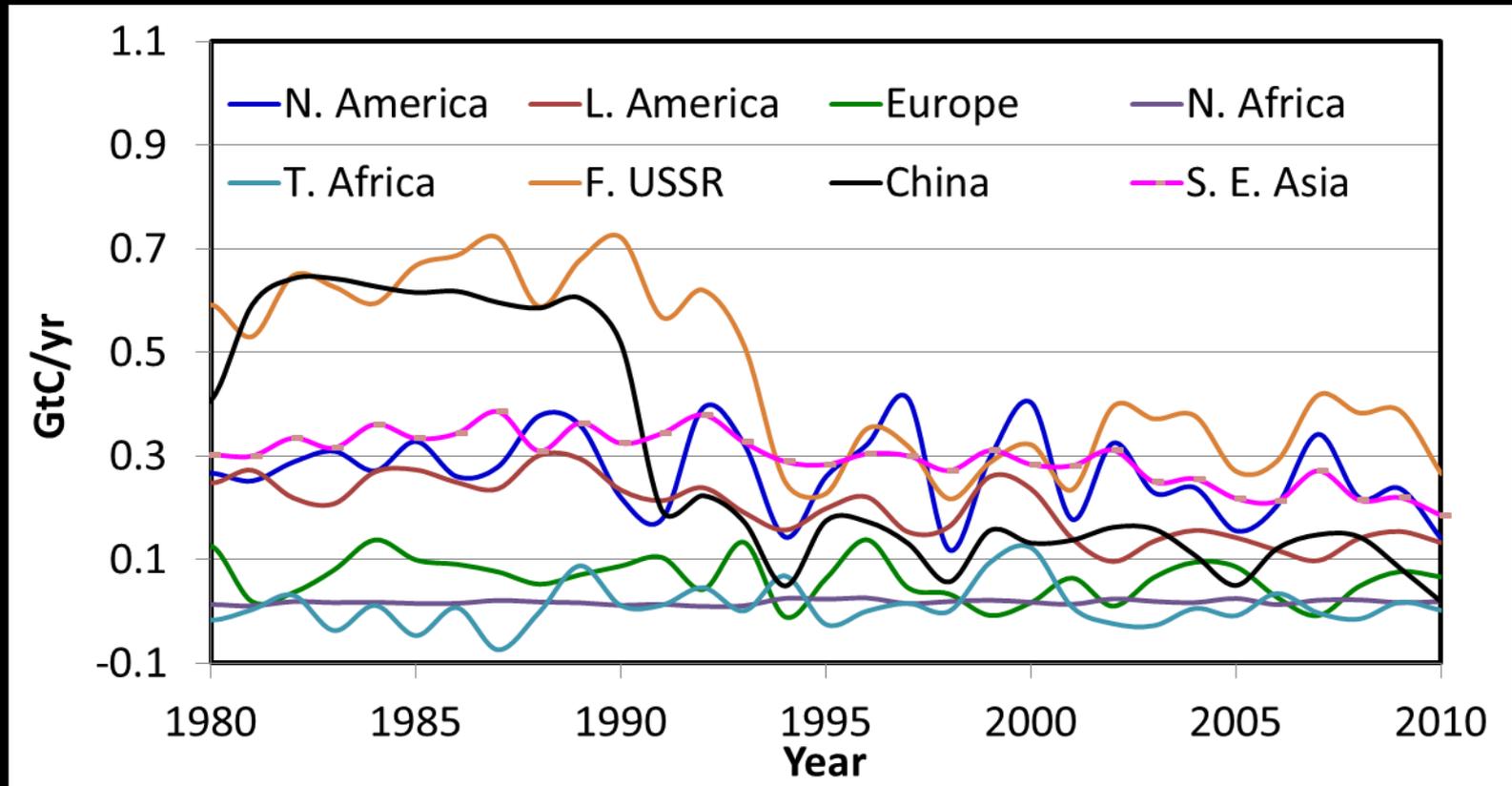
ISAM Estimated Regional Land-Use Emissions for 2000s (GtC/yr)



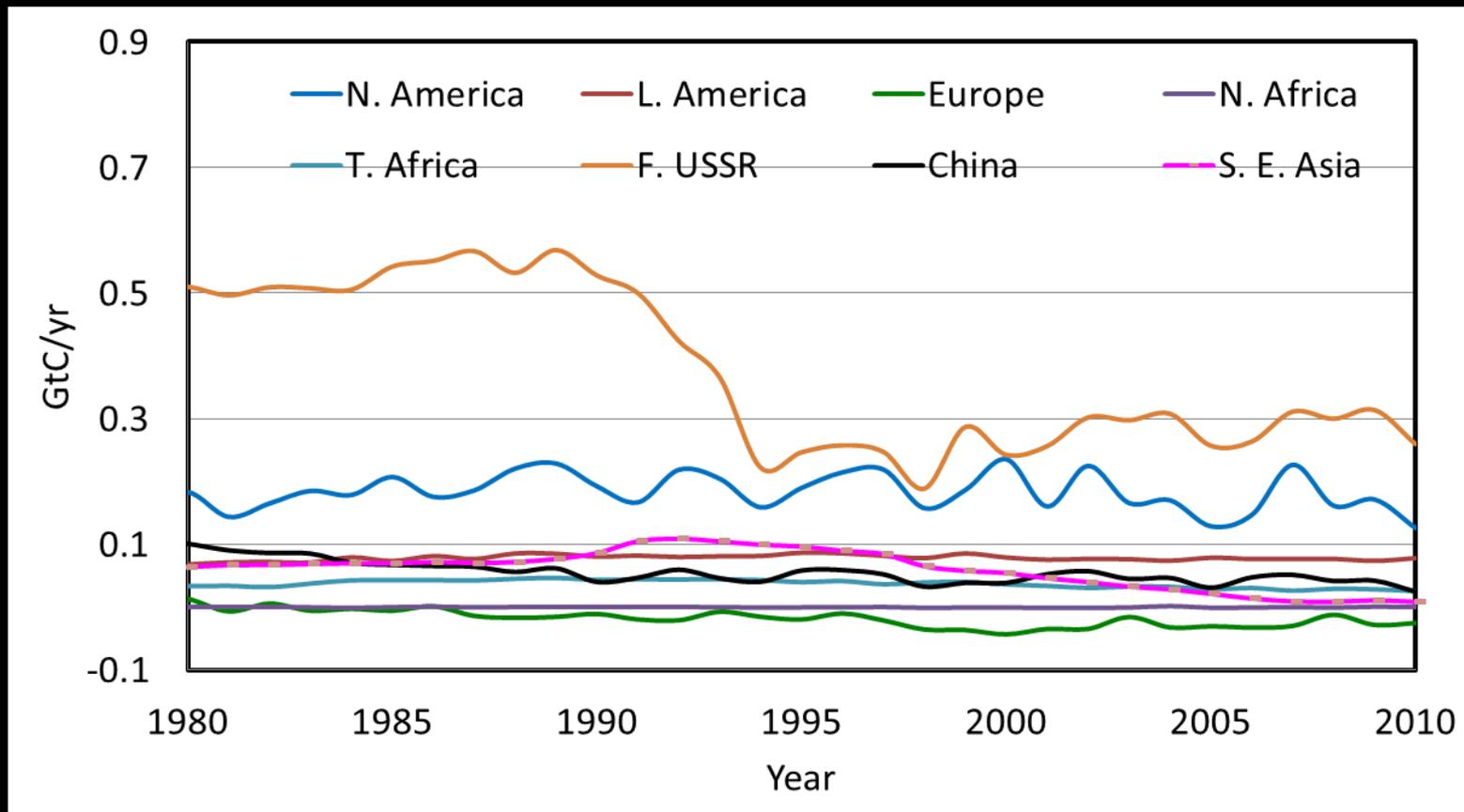
ISAM Estimated Land-Use Emissions for Tropics and Non-Tropics (GtC/yr)



Regional Land-Use Emissions Based on HYDE Data

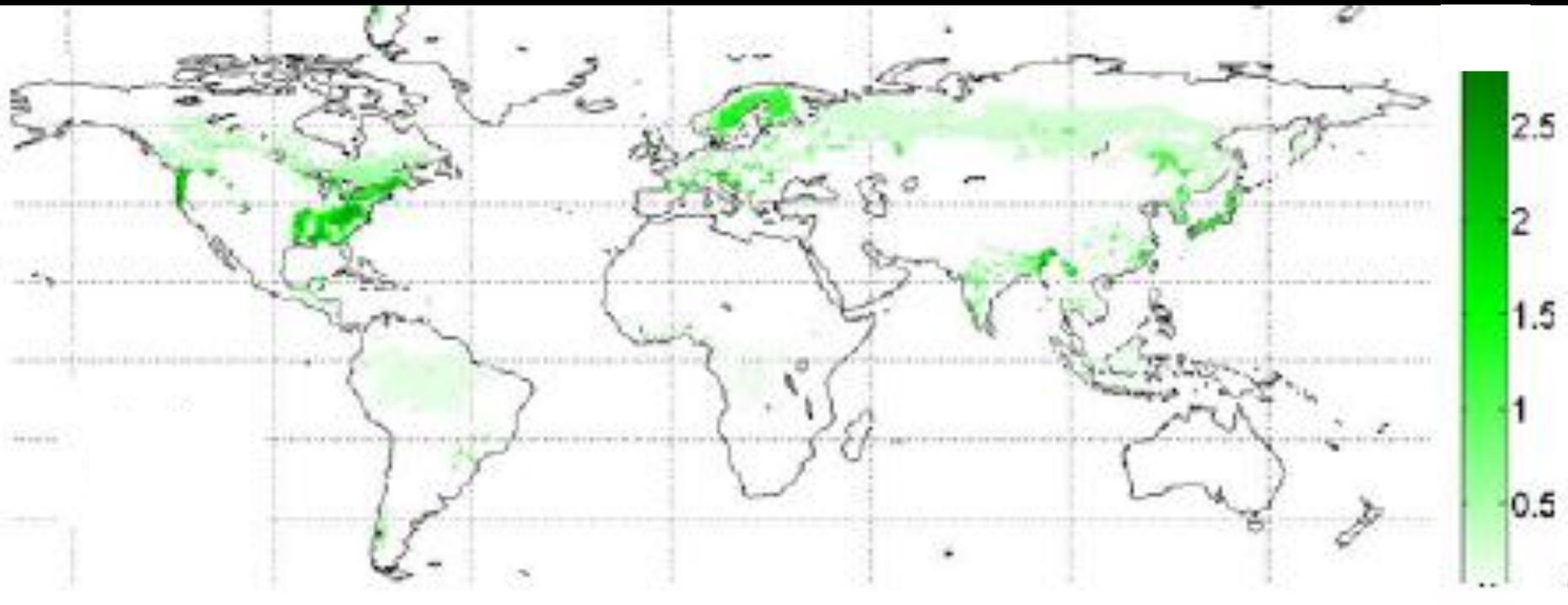


Contribution of Wood Harvest to Regional Land-Use Emissions



Contribution of Secondary Forest and N Deposition to Net C Sink

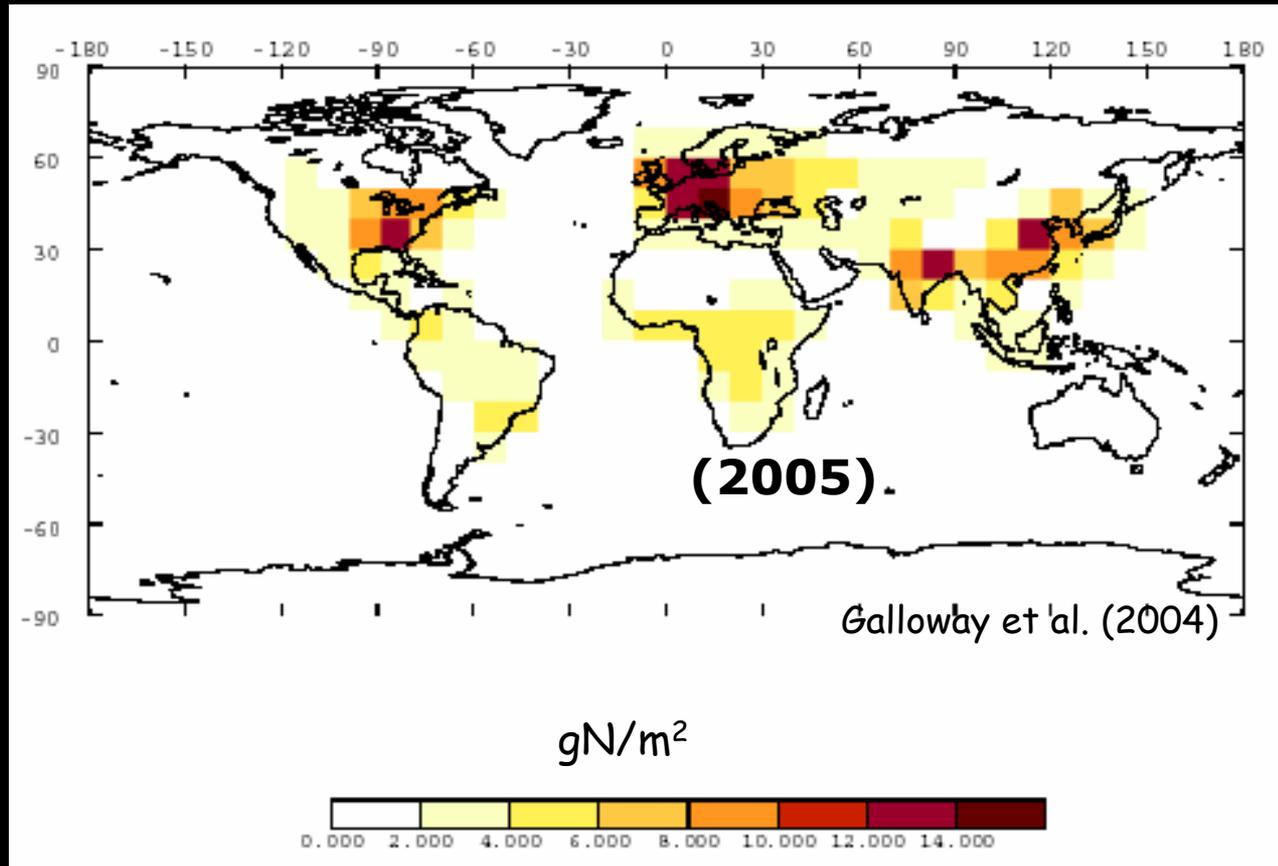
Secondary Forest Area (1990s) (Unit: 10^9 m^2)



The distribution of secondary forest area regrown from

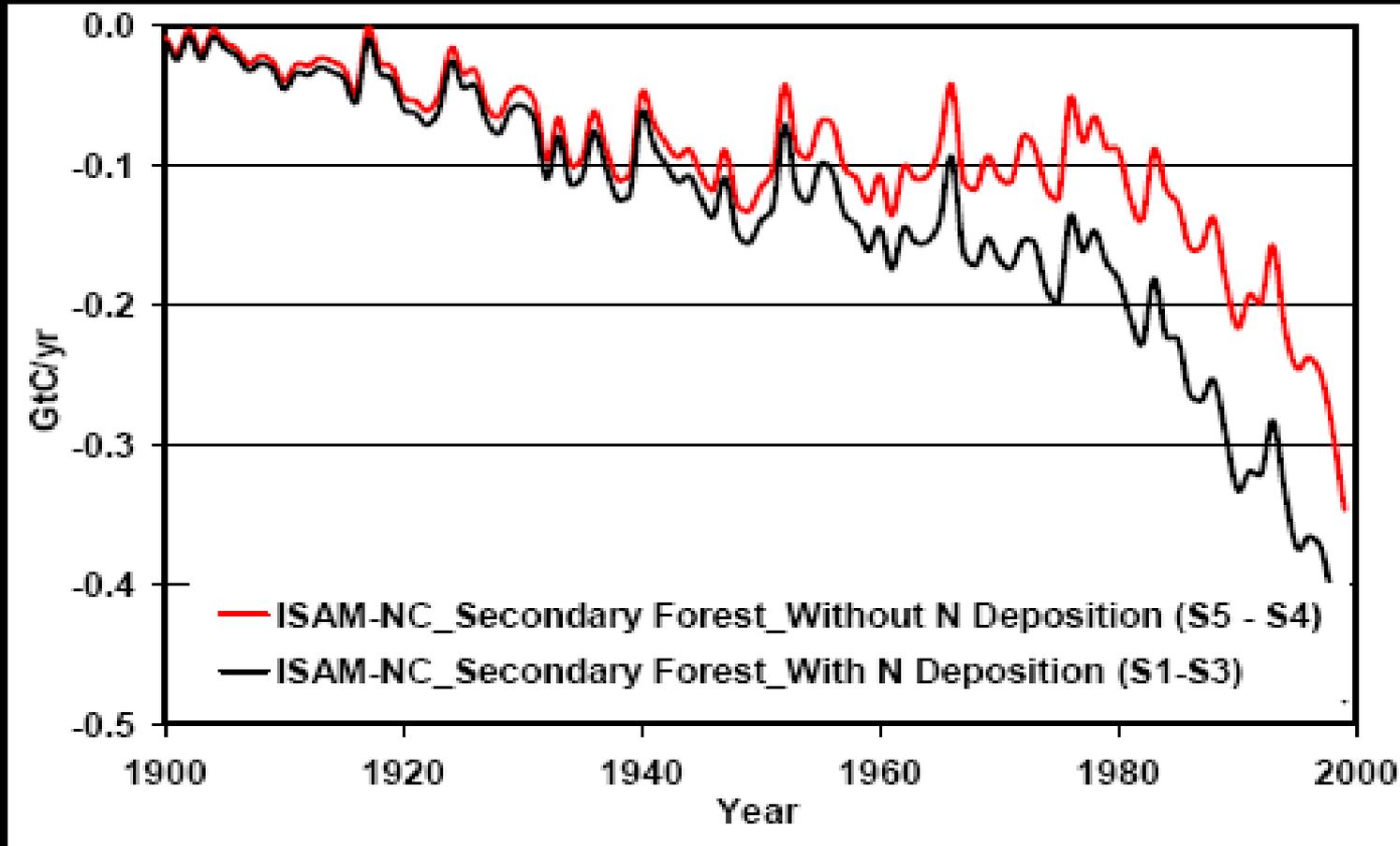
- cropland abandonment,
- pastureland abandonment,
- wood harvest

Nitrogen Deposition



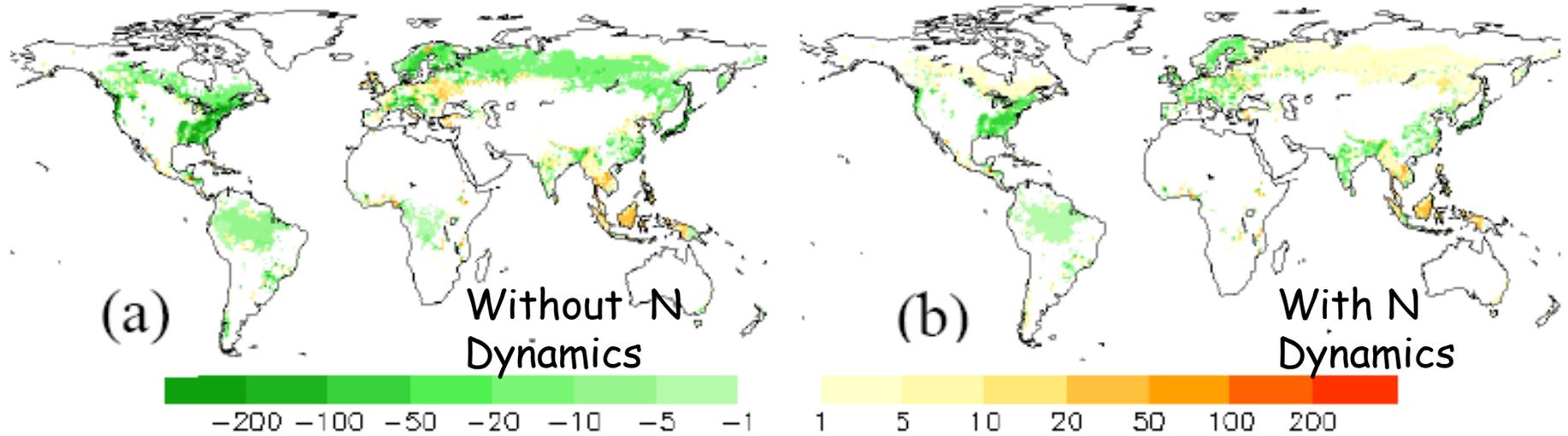
N inputs effect C plant uptake - specially in secondary forest regions

Estimated Global Carbon Flux, Comparing With and Without N Depositions



- C sink associated with the secondary forests is 0.36 GtC/yr in the 1990s
- N deposition contribution is 0.13 GtC/yr

Estimated Net Exchange of C ($\text{gC}/\text{m}^2/\text{yr}$) for the 1990s in Secondary Forests



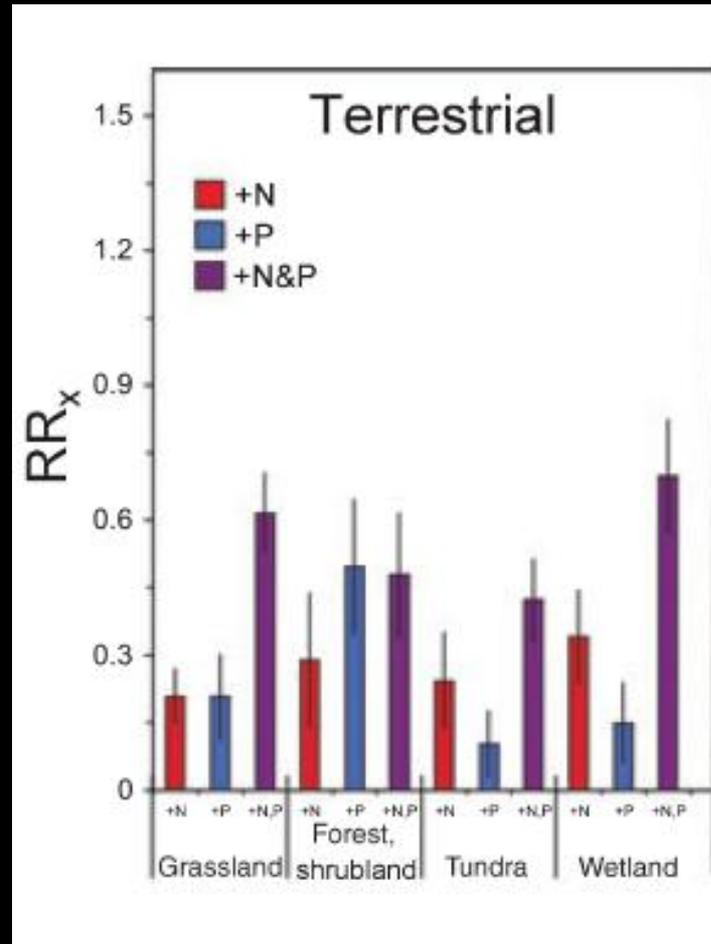
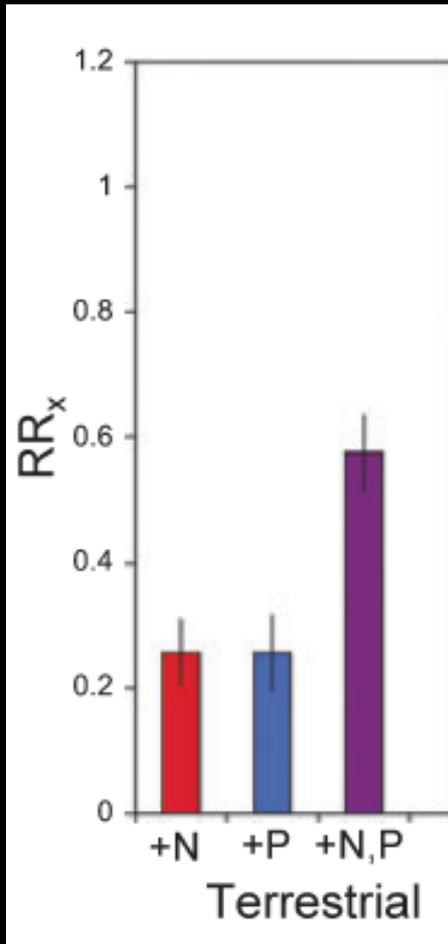
- C stocks in forests are increasing in recent years due to reforestation and afforestation

- In some regions accumulation of C is reduced where N is a limiting nutrient or enhanced if the additional N is deposited in the forest regrowing regions

Positive values represent net C release to the atmosphere and negative values represent net C storage in terrestrial biosphere

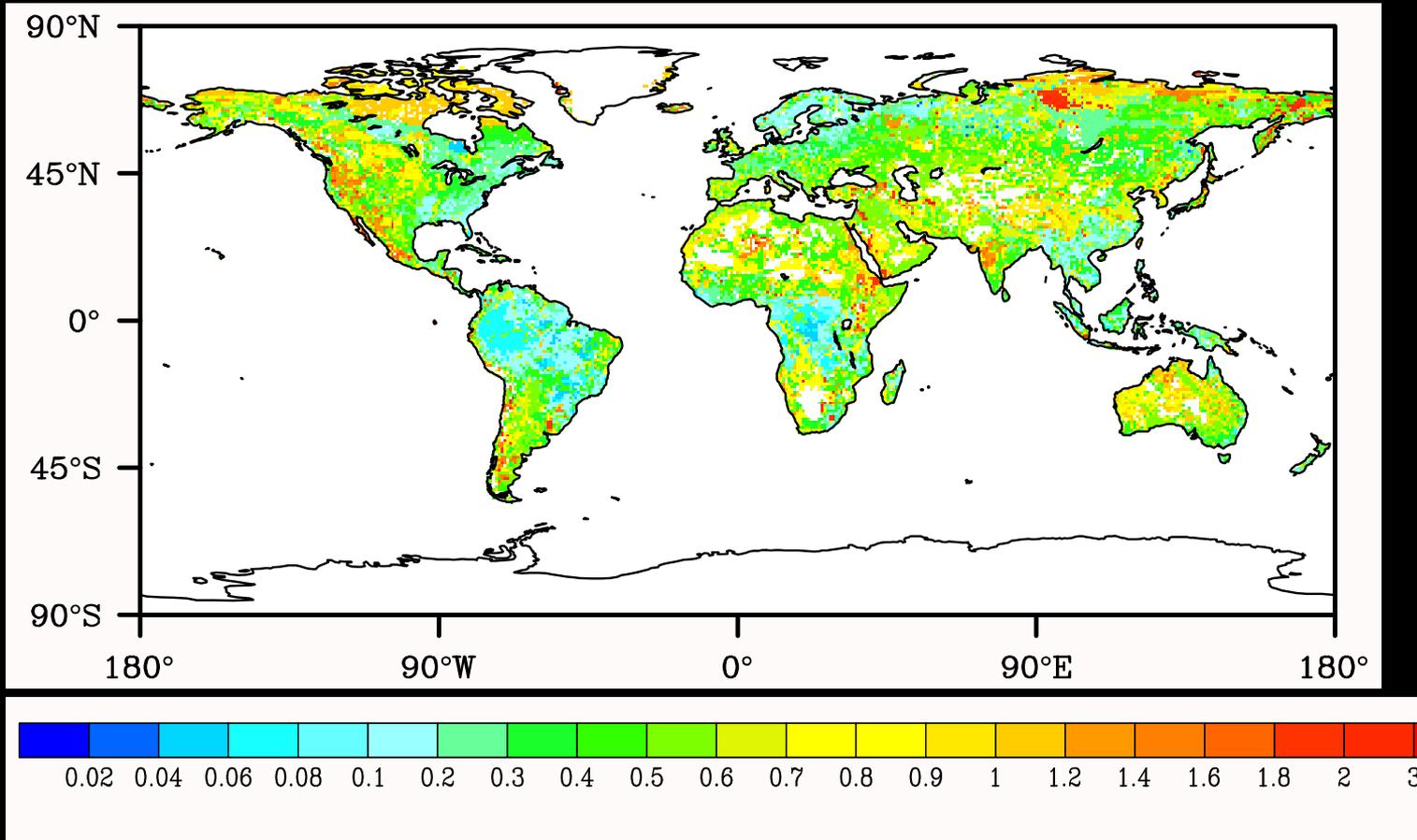
P Cycle

Widespread P limitation in terrestrial ecosystems, especially in lowland tropical forests

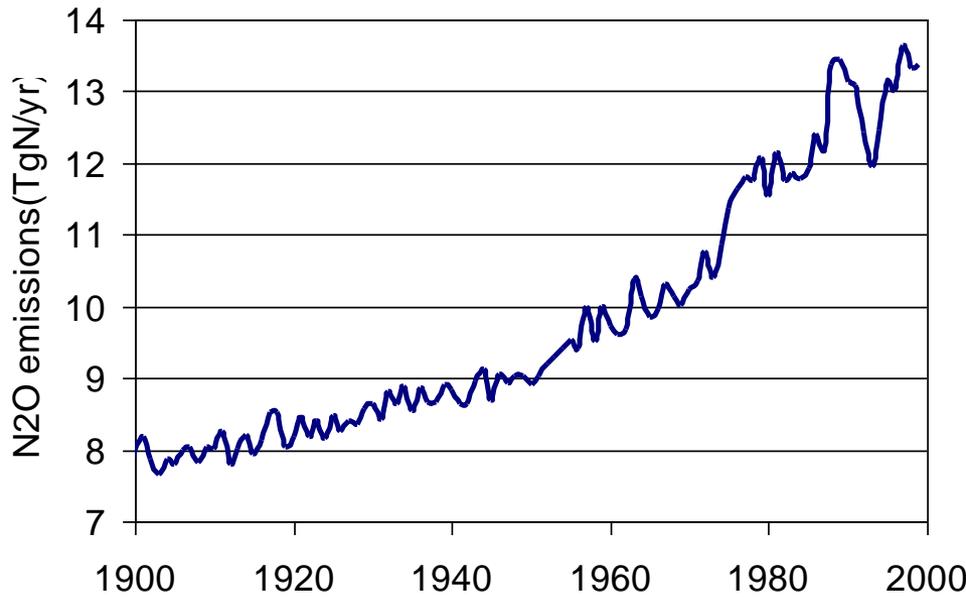


natural-log transformed response ratios (RR_x) in which autotroph biomass or production in the enriched treatment is divided by its value in the control treatment and then ln transformed

Global Distribution of P (KgP/m²)

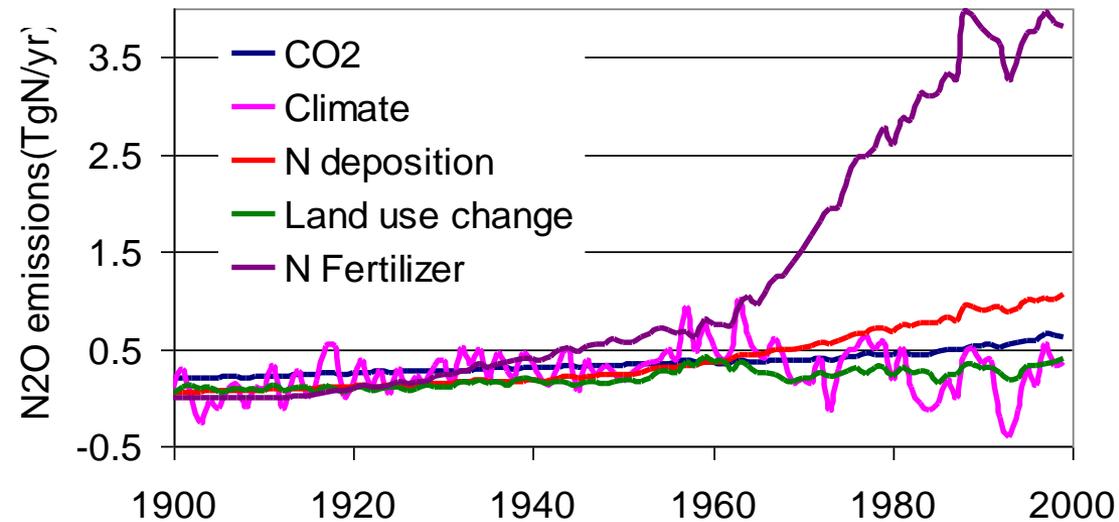


N₂O Emissions (TgN/yr)

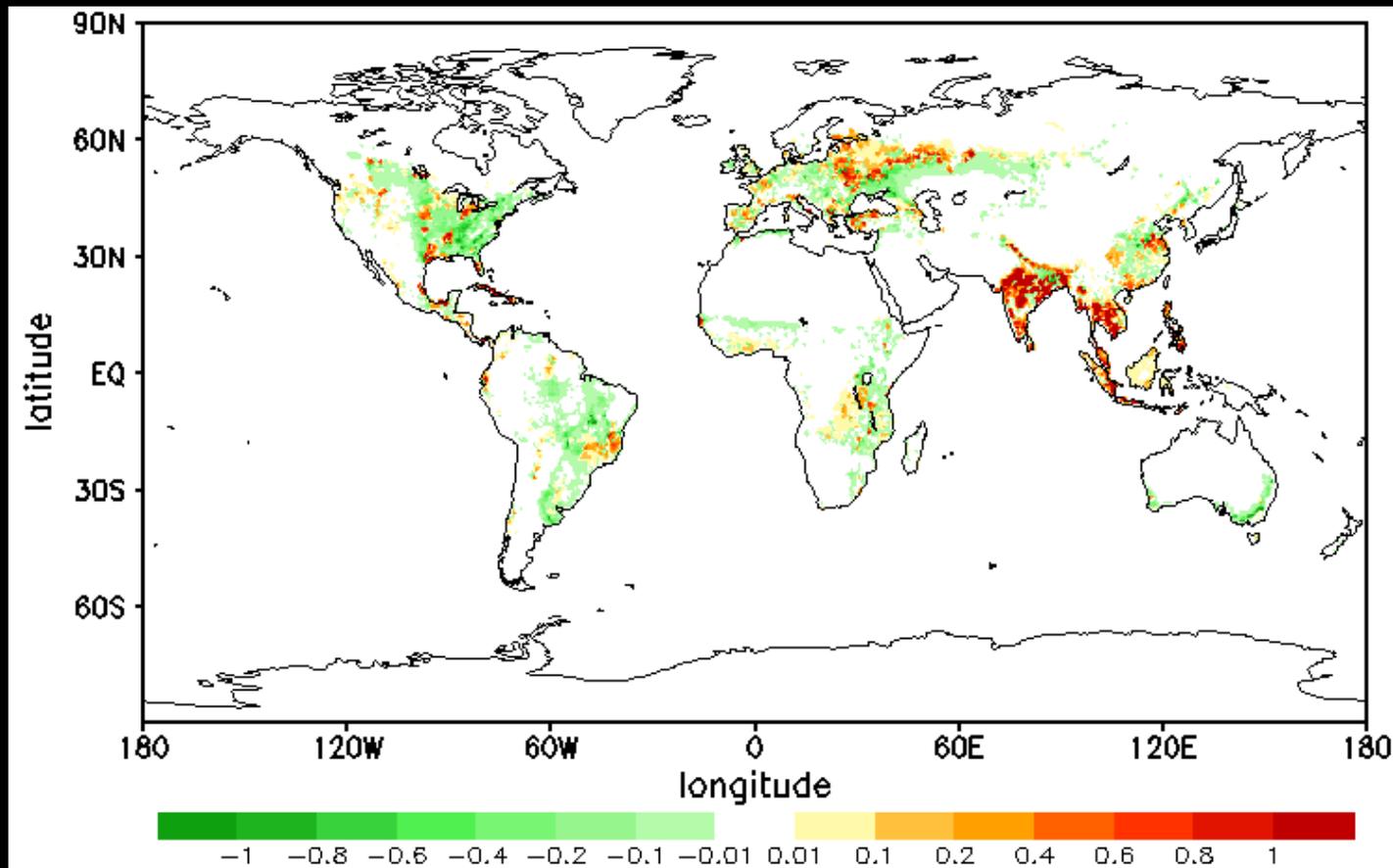


Total Emissions

Contribution of Environmental Factors and N Fertilizer



Contribution of Land-Use Changes to N_2O Emissions in the 1990s (KgN/ha/yr)



Land-Use Management

- LCLUC would be defined broadly to include
 - human-induced changes in land cover,
 - land management
 - No tillage practices
 - fire management
 - draining of peatlands
 - fertilizer use
 - shifting cultivation
 - selective logging

Discussion