

Model Dependence of Land Cover Change Impacts on Climate lessons from CMIP5

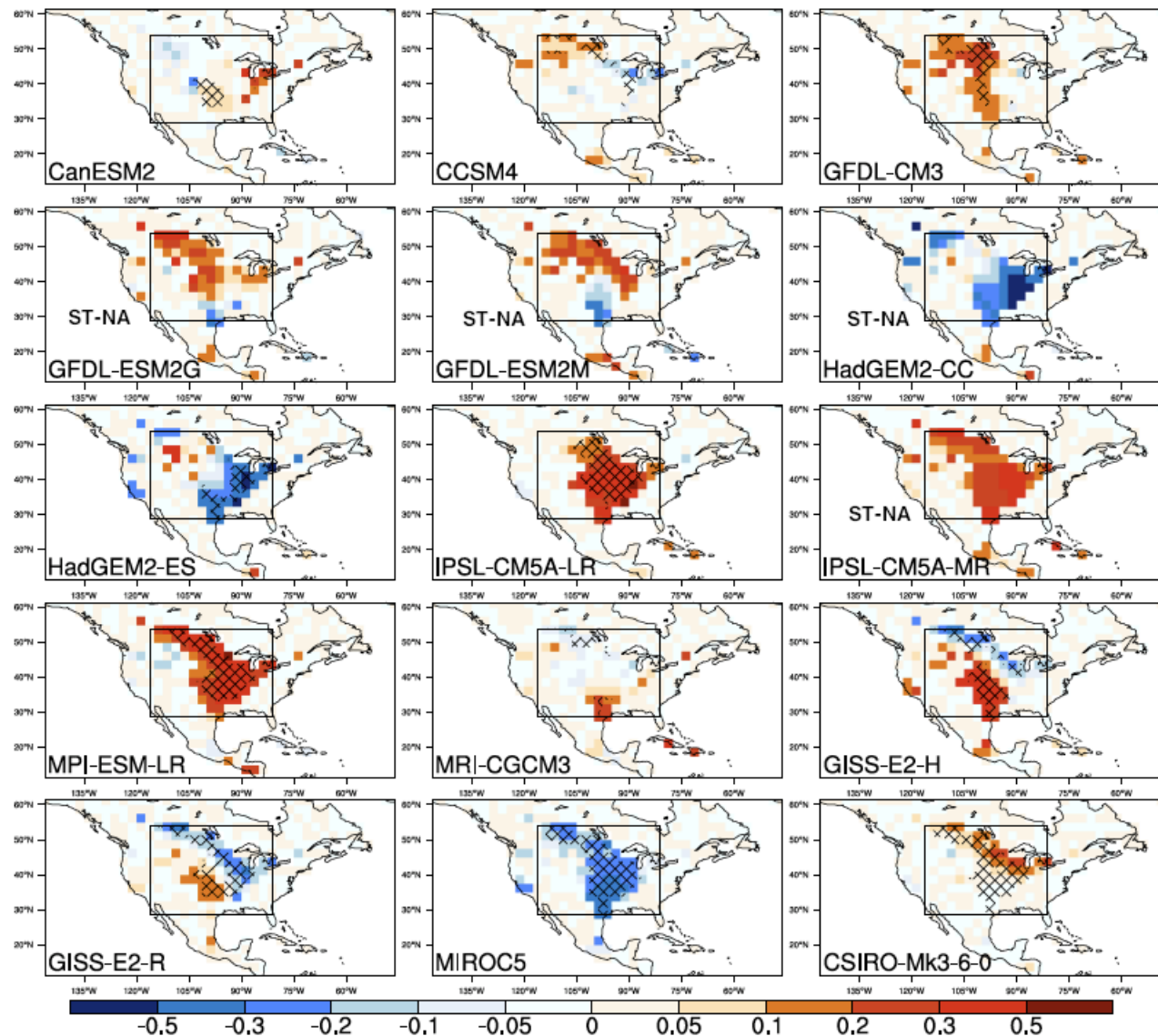
Dr. Peter Lawrence

Project Scientist

**Terrestrial Science Section
Climate and Global Dynamics Division**

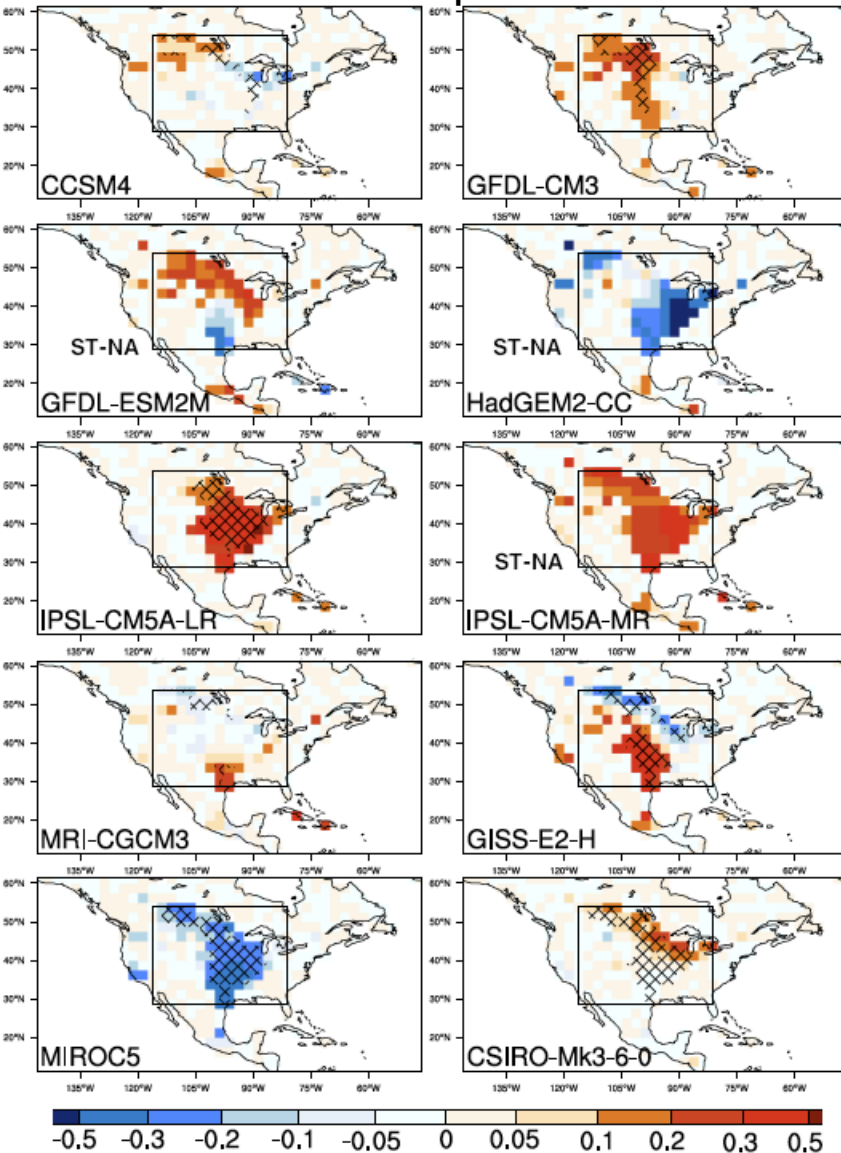


CMIP5 Land Surface Air Temperature Change due to Historical Land Cover Change – Kumar et al. 2013

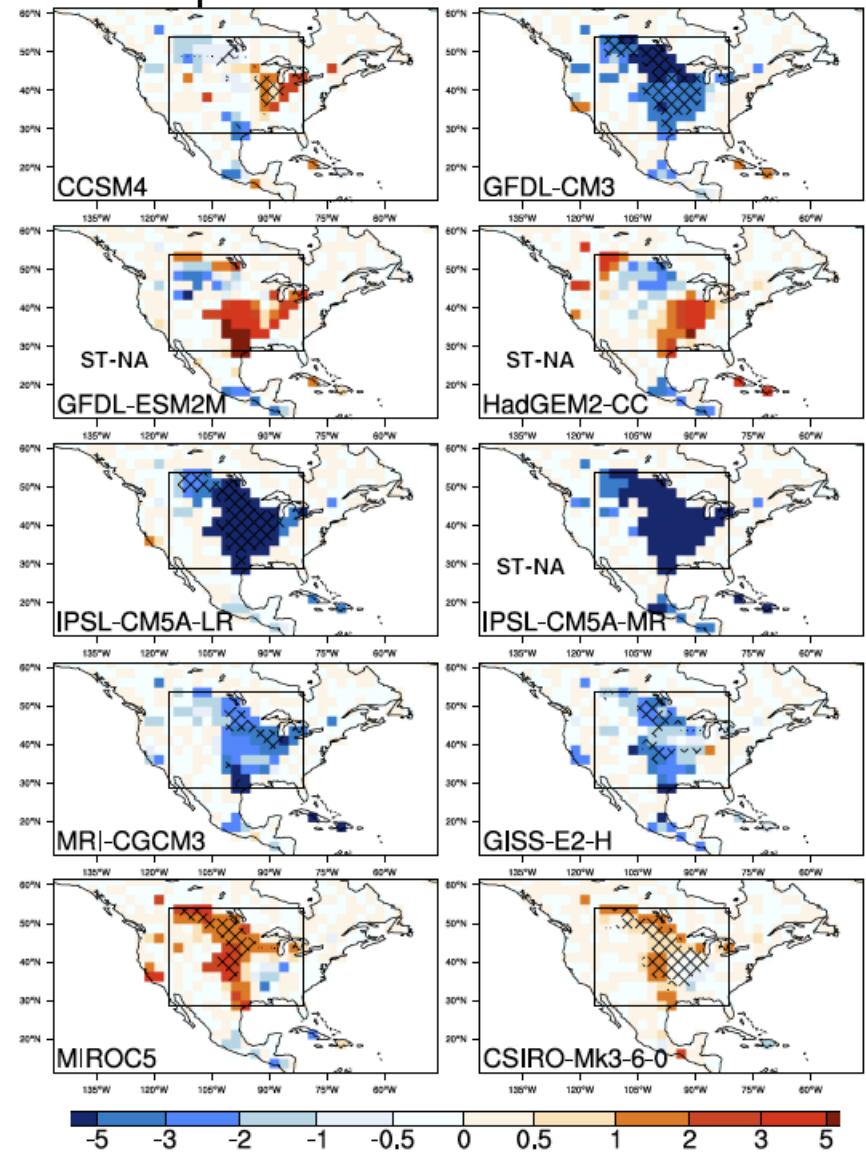


CMIP5 Air Temperature and Latent Heat Flux due to Historical Land Cover Change – Kumar et al. 2013

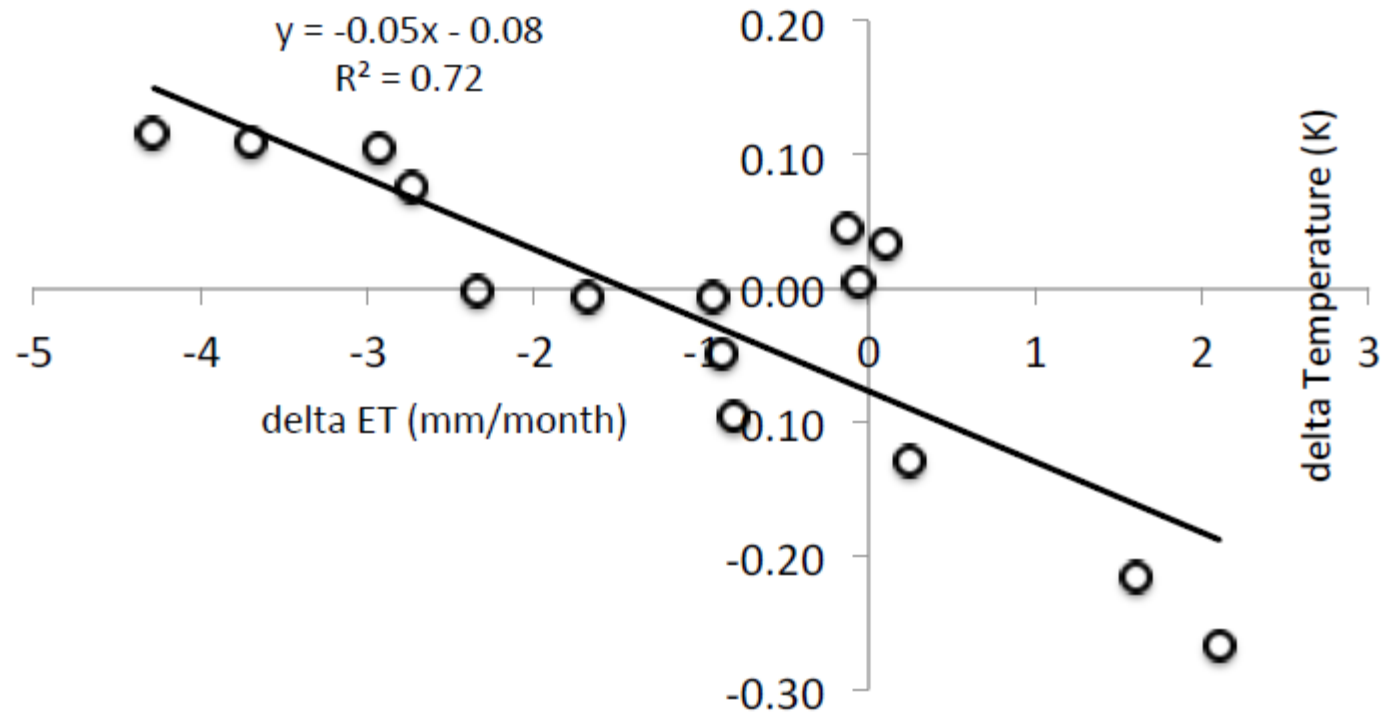
Surface Air Temperature



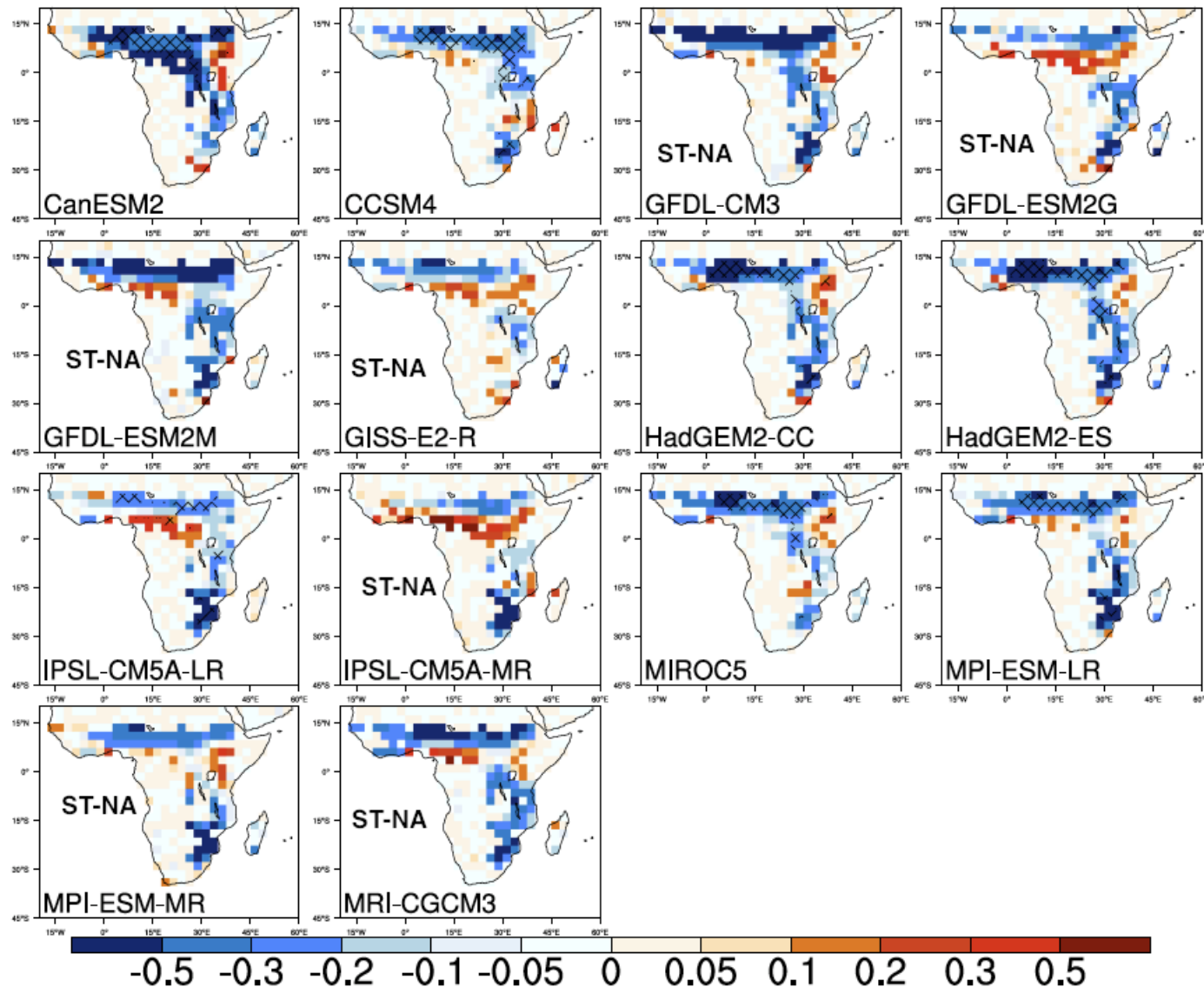
Evapo-Trans / Latent Heat Flux



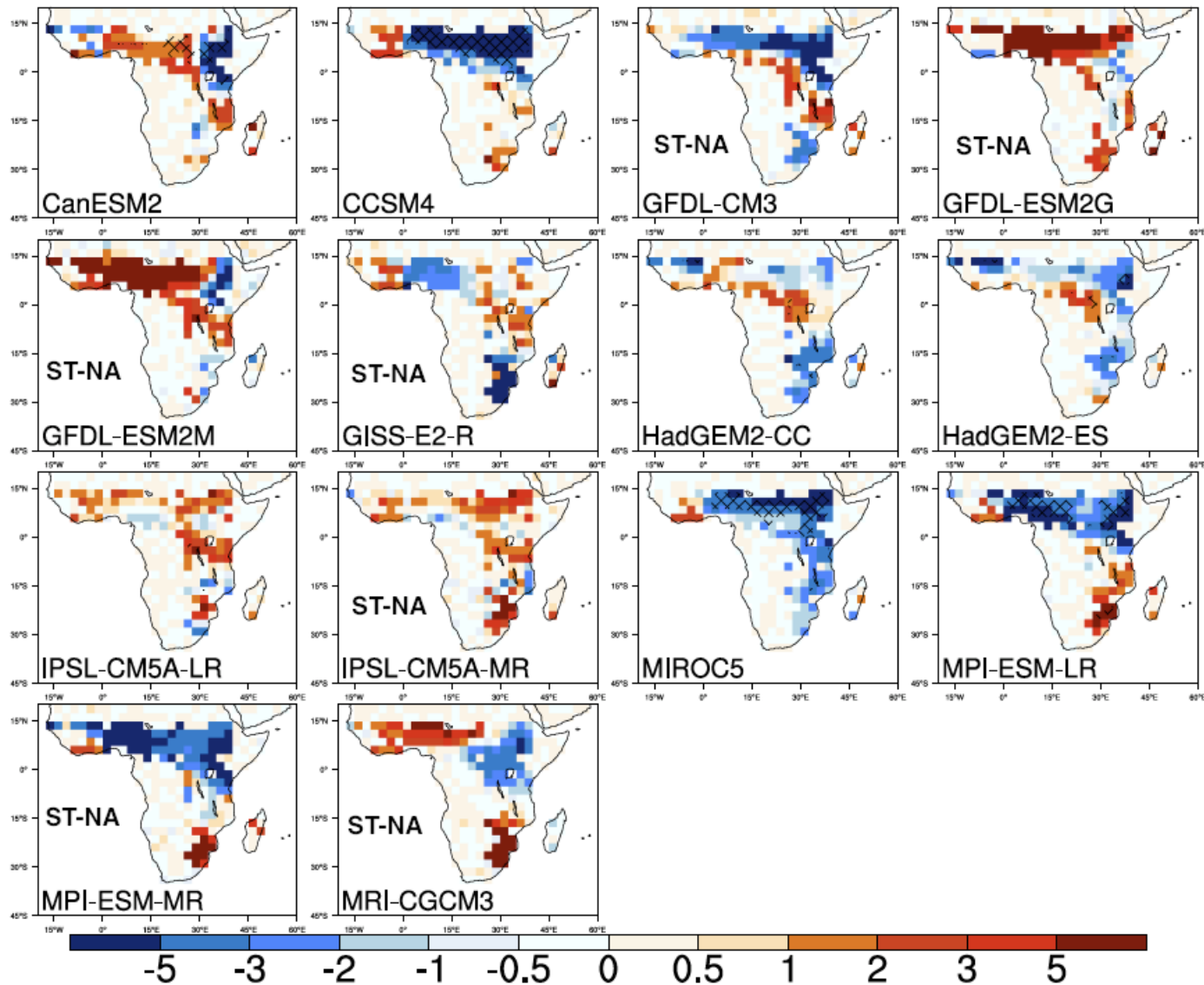
CMIP5 Air Temperature and Latent Heat Flux due to Historical Land Cover Change – Kumar et al. 2013



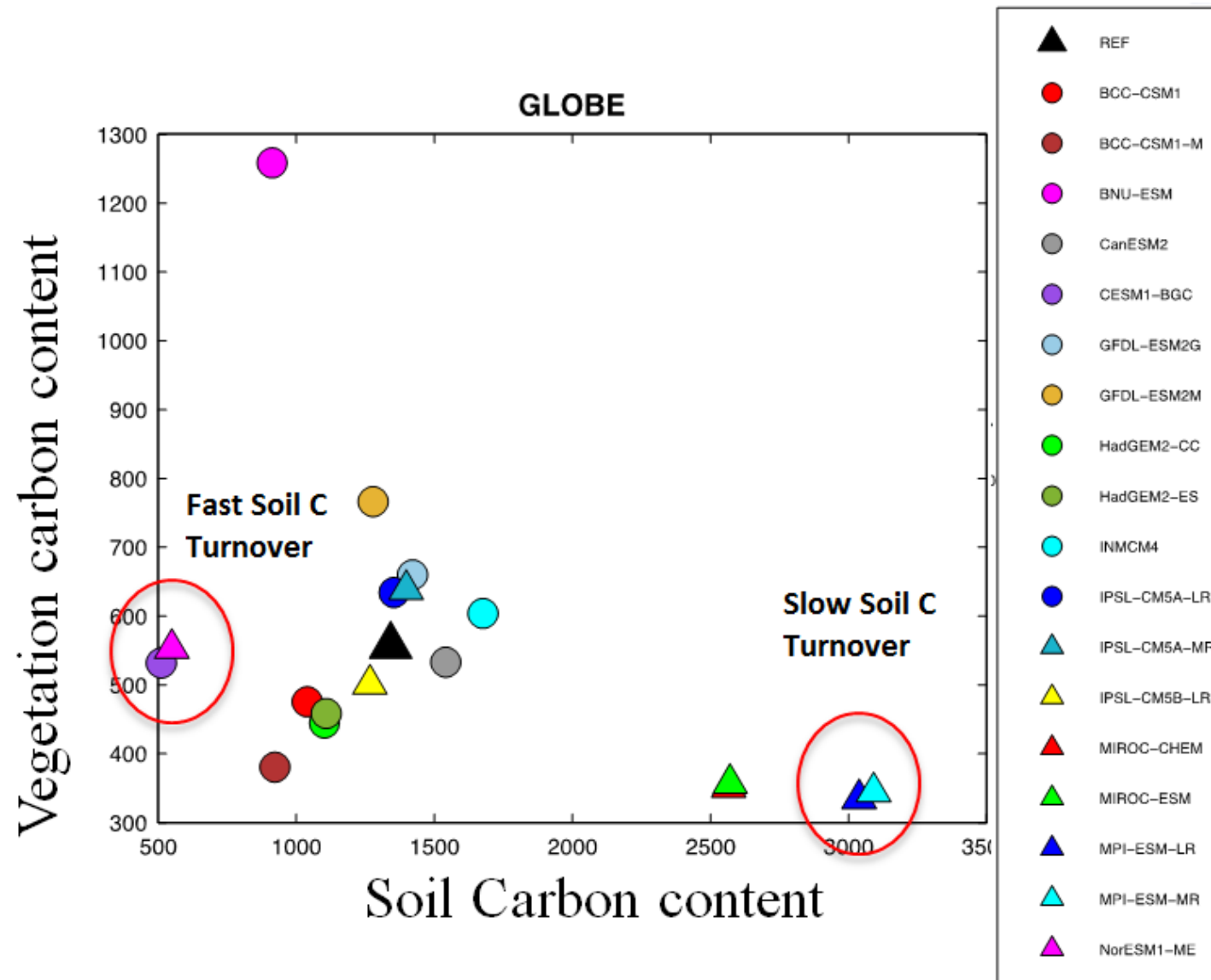
CMIP5 Land Surface Air Temperature Change due to Historical Land Cover Change – Kumar et al. 2013



CMIP5 Evapo-Trans/Latent Heat Flux Change due to Historical Land Cover Change – Kumar et al. 2013

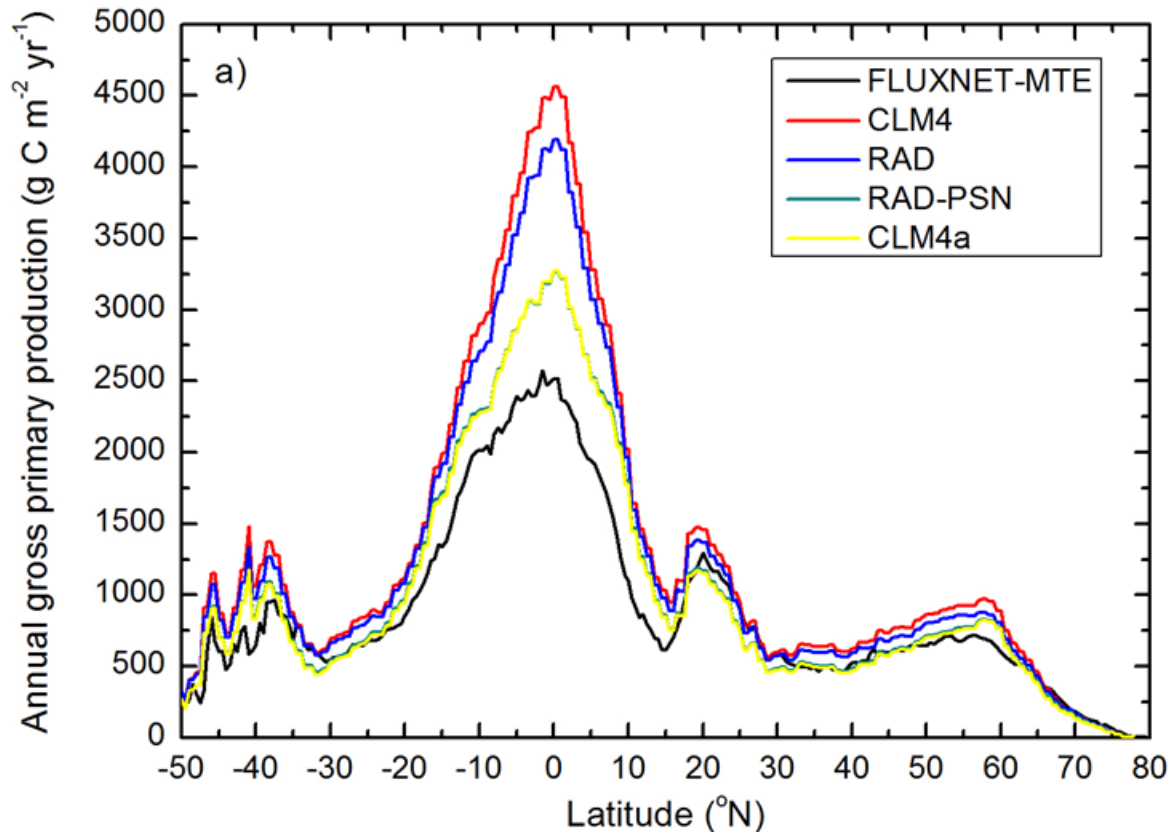


CMIP5 Current Day Land Carbon Simulations and Historical Land Cover Change – Anav et al. 2012

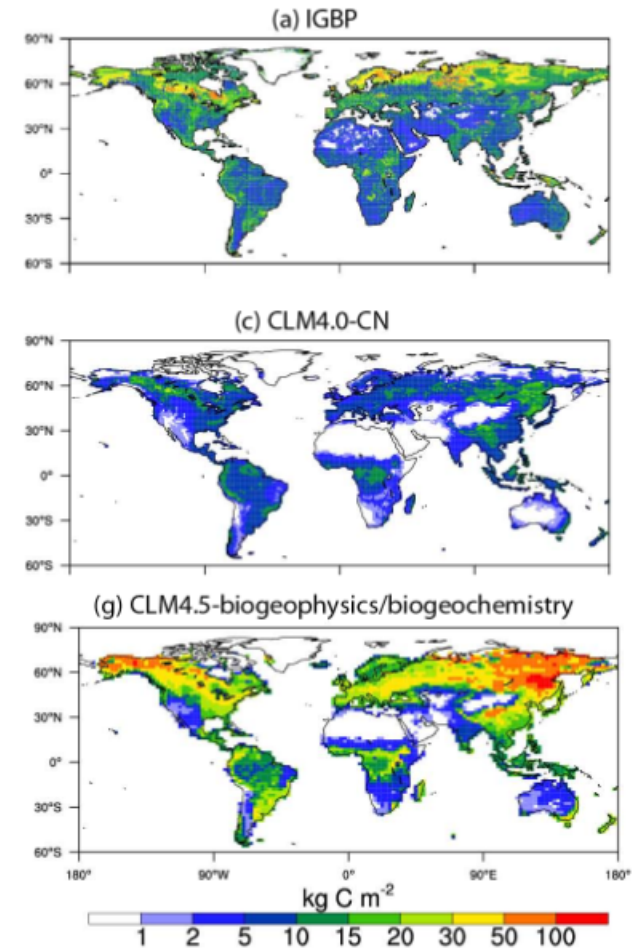


CLM4 versus CLM4.5 Current Day Gross Primary Production and Soil Carbon Simulations

Bonan et al. 2011 using Fluxnet derived GPP estimates from Jung et al. 2009



Koven et al. 2013



CLM4 vs CLM4.5 Land Cover Change Climate Experiments

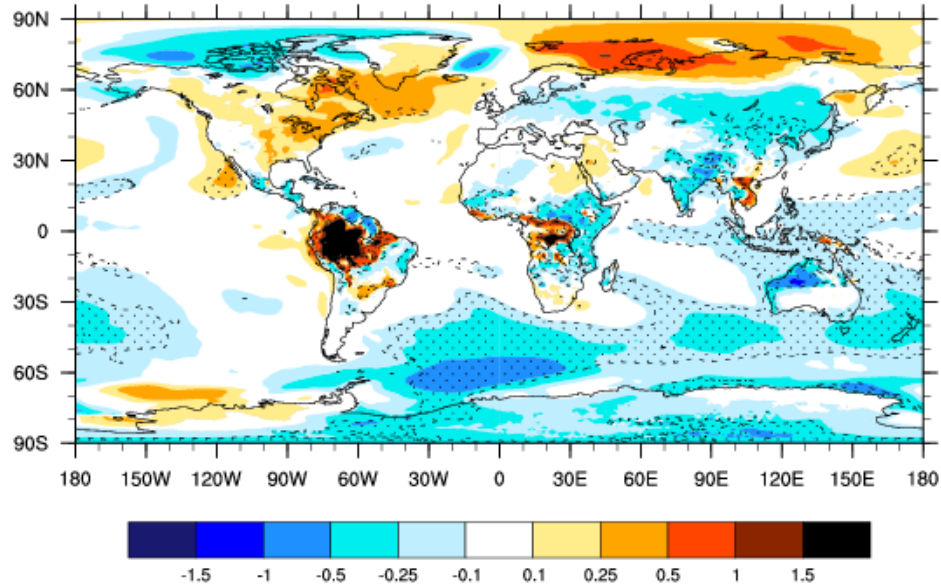
1. Given the large changes in Photosynthesis/GPP and carbon cycle representation between CLM4 and CLM4.5 we have an opportunity to assess the impacts of land model developments on Land Cover Change experiments in CESM
2. Time Slice Fully Coupled Deforestation Experiments of the Tropics, Temperate and Boreal regions.
3. Each simulation run with CESM 1.2 with CAM4 for 50 years of present day climate with year 2000 forcings compared to same simulation with current day vegetation

	CLM4	CLM4.5
Tropical Deforestation	50 yrs	50 yrs
Temperate Deforestation	50 yrs	50 yrs
Boreal Deforestation	50 yrs	50 yrs
Global Deforestation	50 yrs	50 yrs

CLM4.5 vs CLM4 Tropical Deforestation

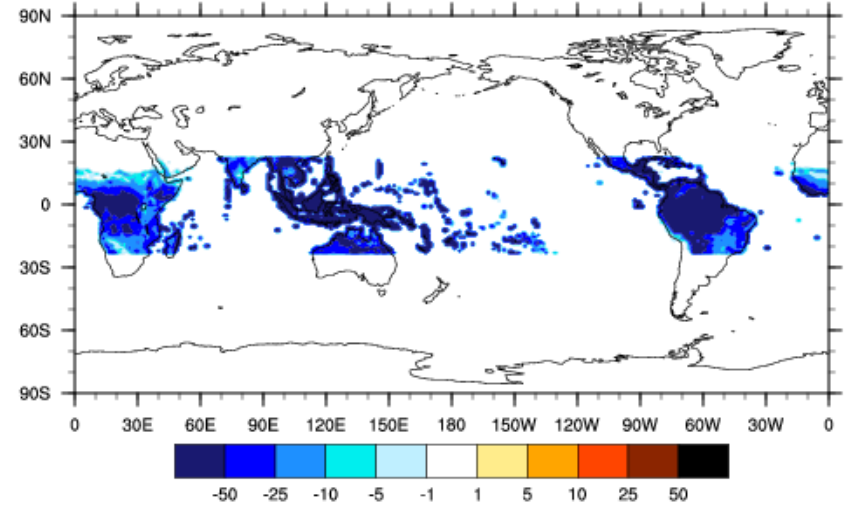
CLM4.5 Tropical Deforest - Current Day Annual Ref Temp

Degrees C



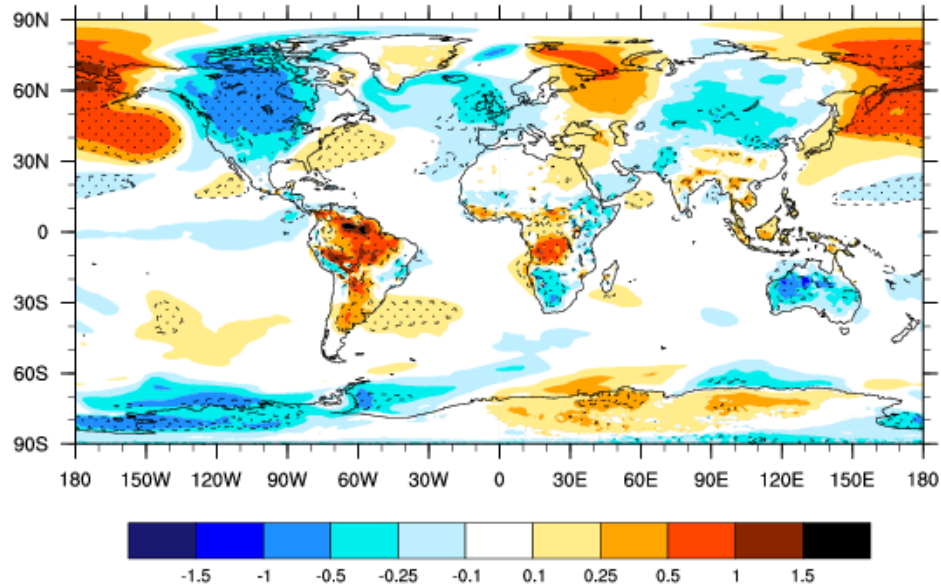
Topical Def. - Current Tree

%



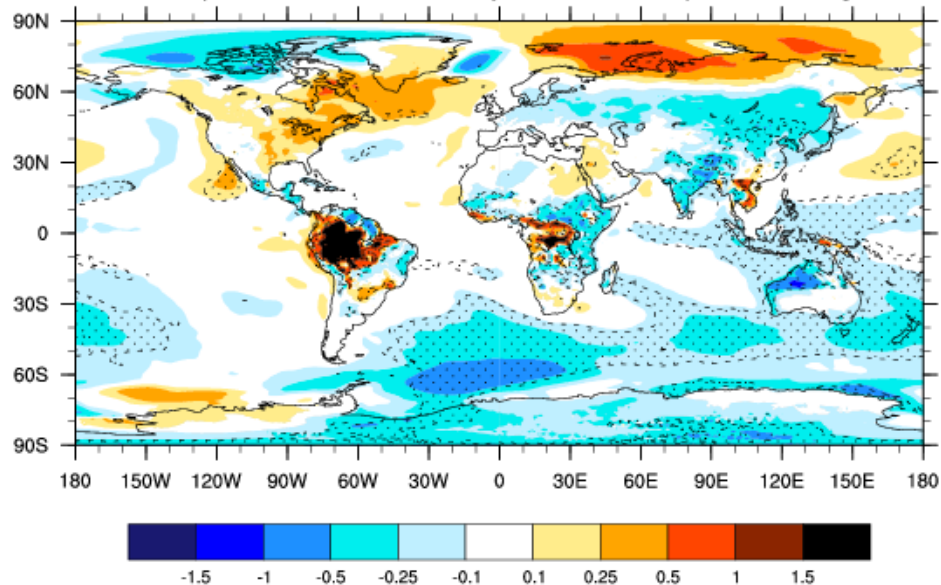
CLM4.0 Tropical Deforest - Current Day Annual Ref Temp

Degrees C

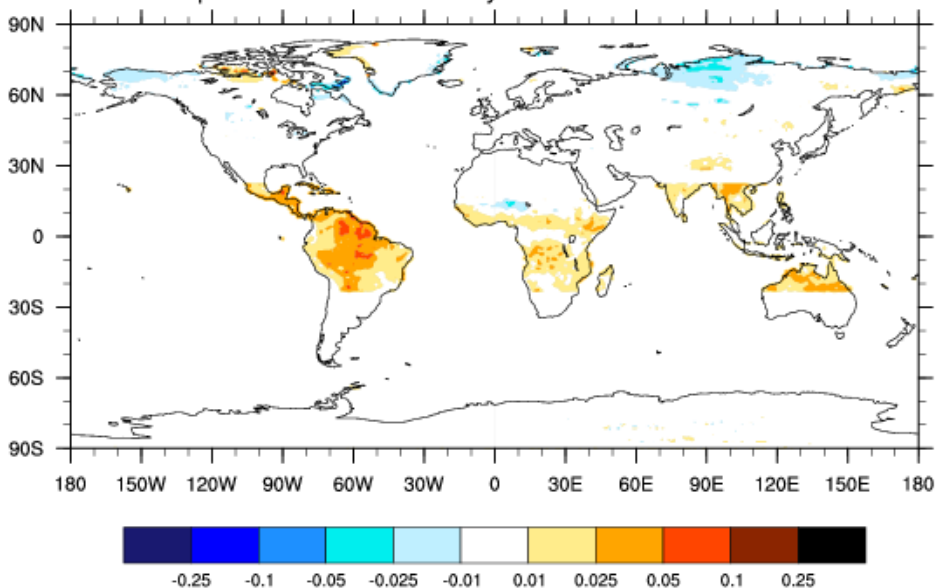


CLM4.5 vs CLM4 Tropical Deforestation

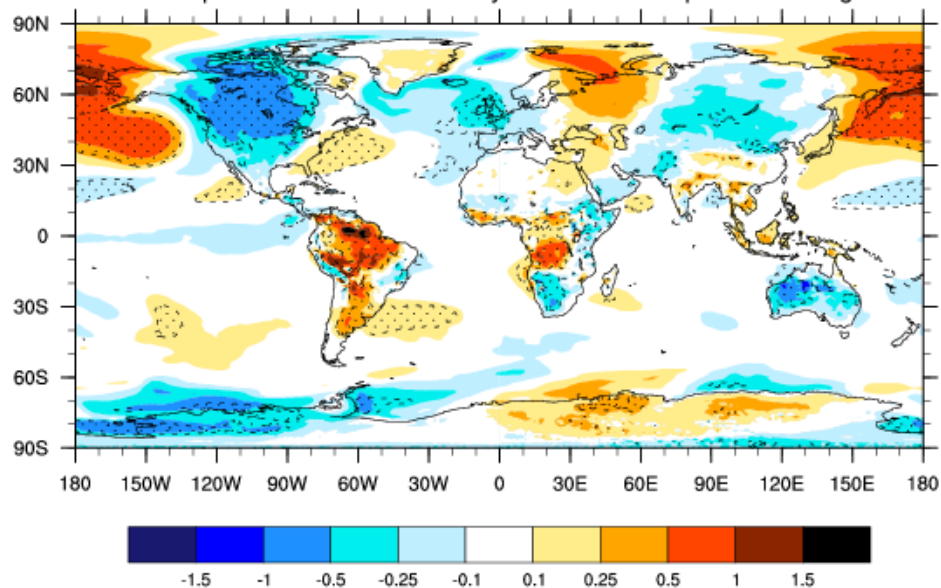
CLM4.5 Tropical Deforest - Current Day Annual Ref Temp Degrees C



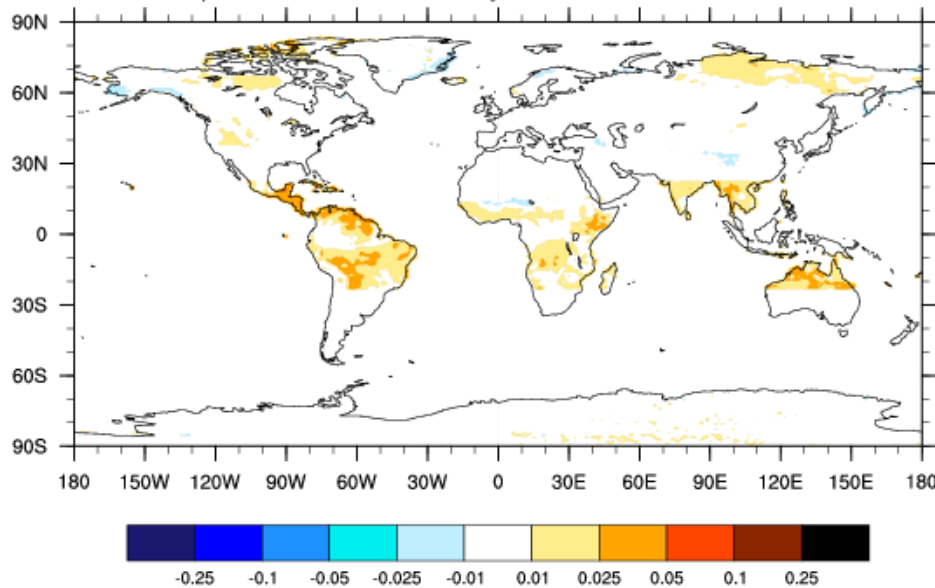
CLM4.5 Tropical Deforest - Current Day Albedo



CLM4.0 Tropical Deforest - Current Day Annual Ref Temp Degrees C

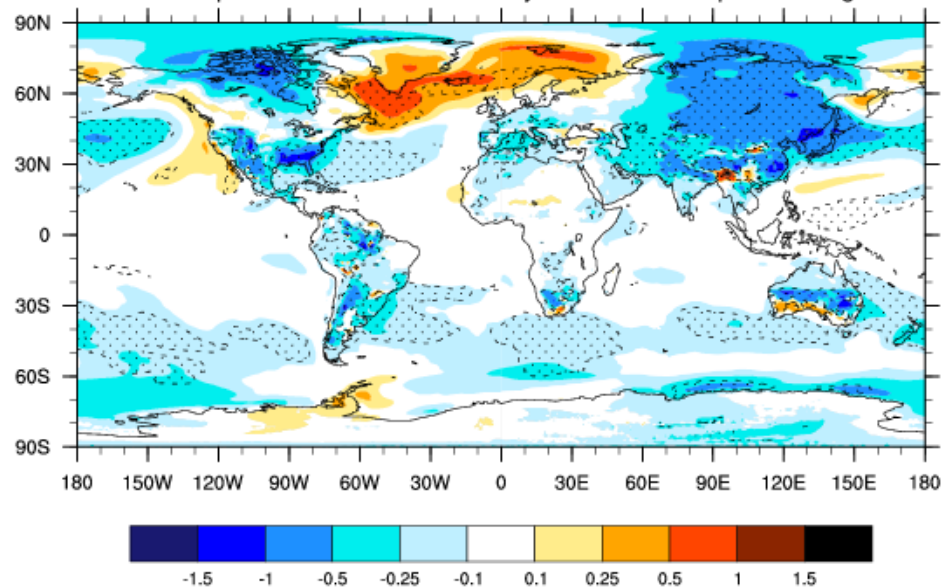


CLM4.0 Tropical Deforest - Current Day Albedo

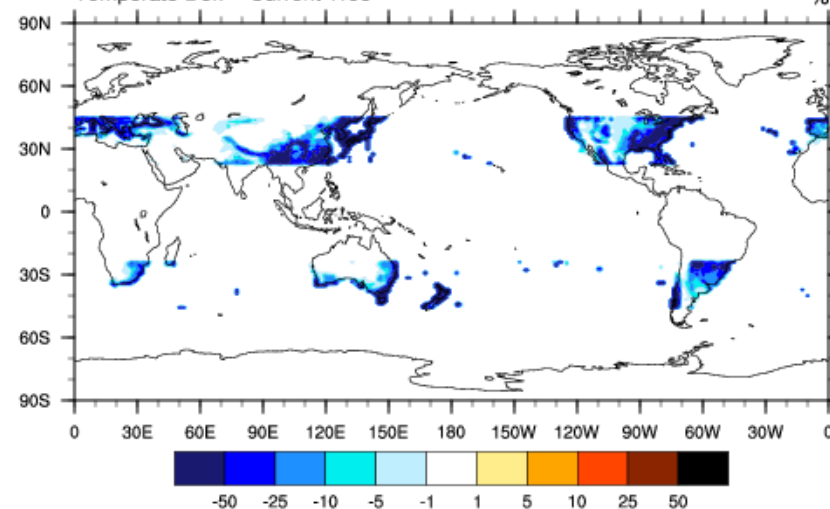


CLM4.5 vs CLM4 Temperate Deforestation

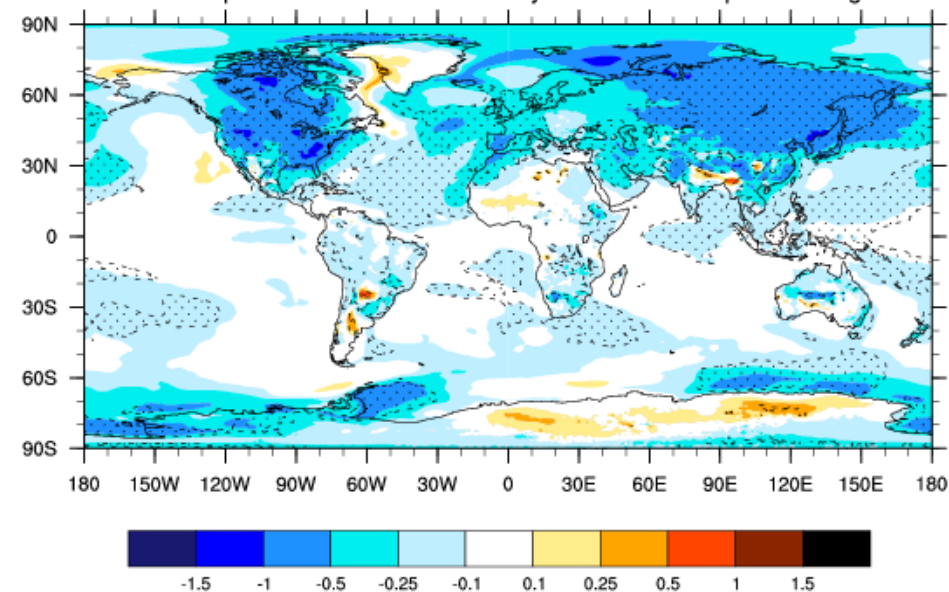
CLM4.5 Temperate Deforest - Current Day Annual Ref Temp Degrees C



Temperate Def. - Current Tree %

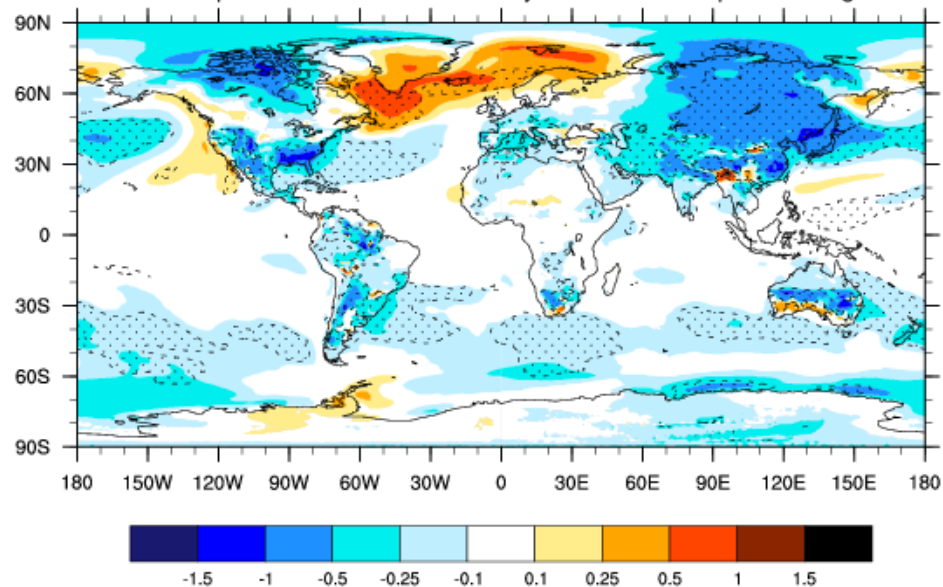


CLM4.0 Temperate Deforest - Current Day Annual Ref Temp Degrees C

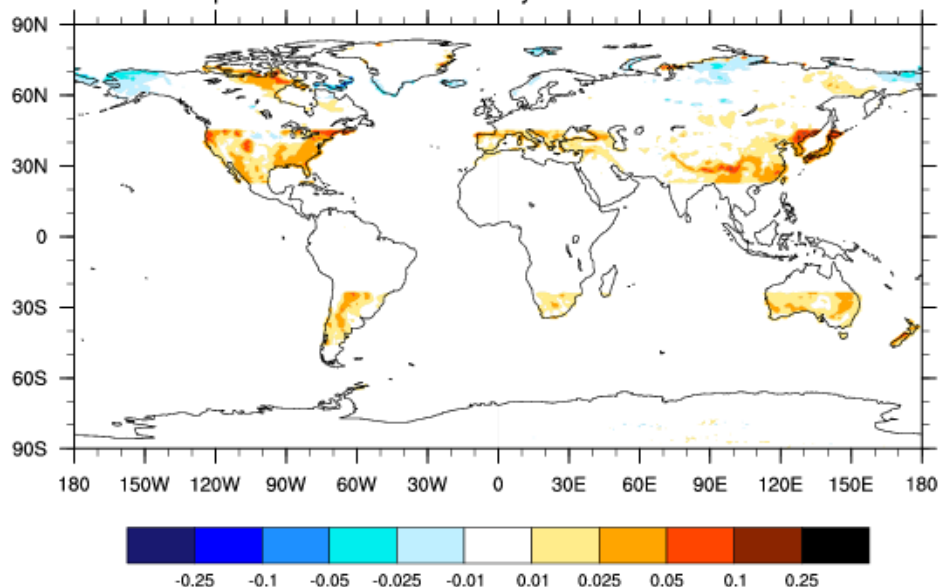


CLM4.5 vs CLM4 Temperate Deforestation

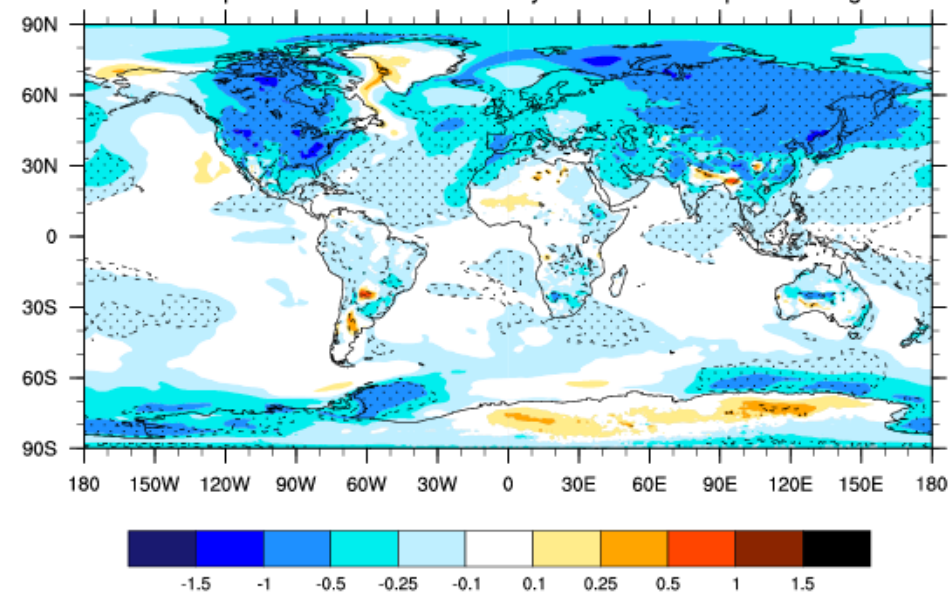
CLM4.5 Temperate Deforest - Current Day Annual Ref Temp Degrees C



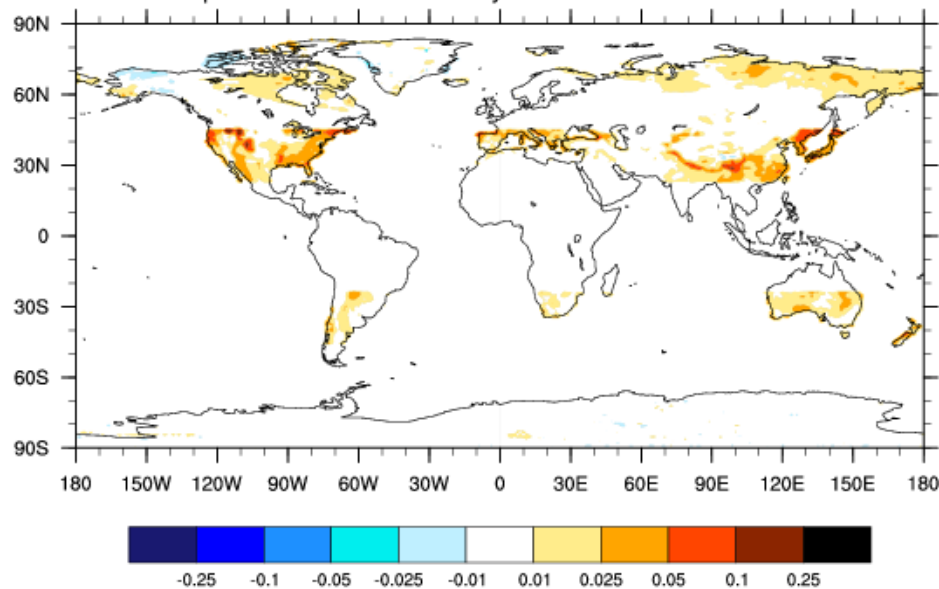
CLM4.5 Temperate Deforest - Current Day Albedo



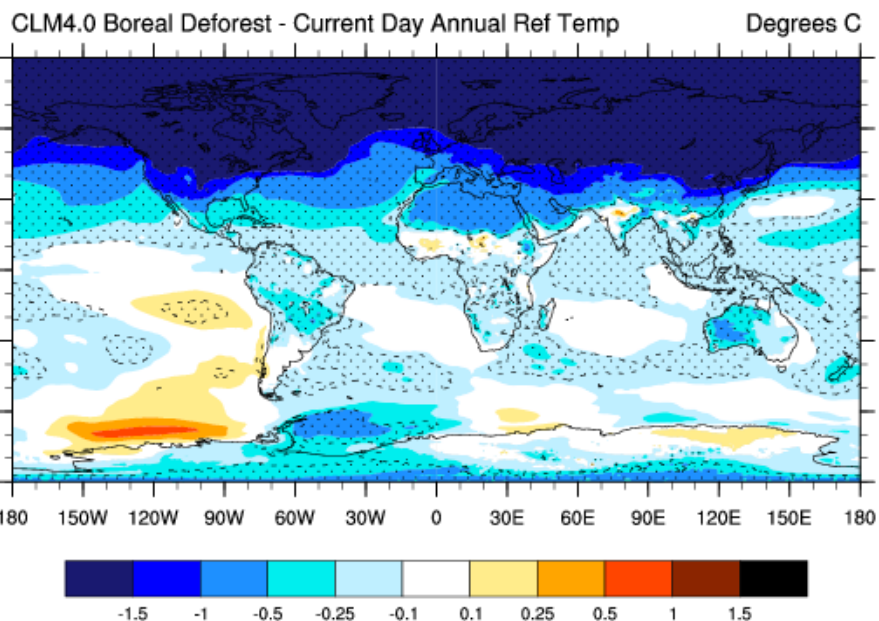
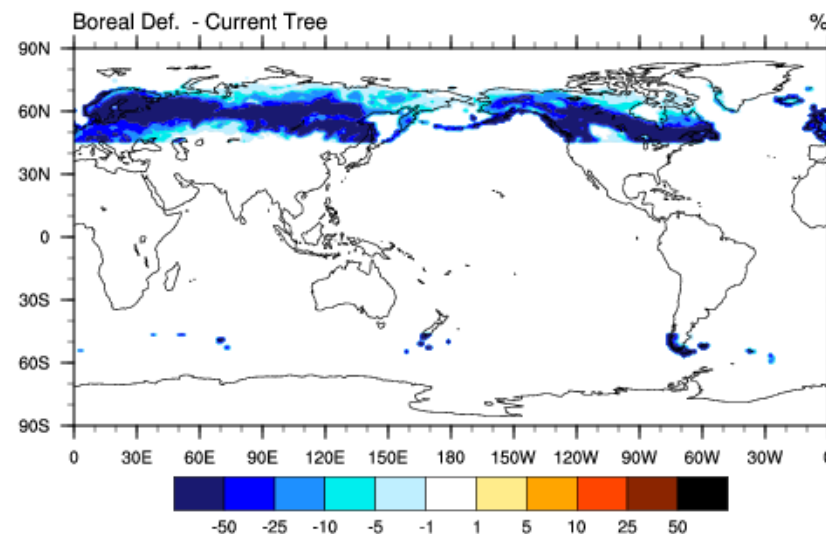
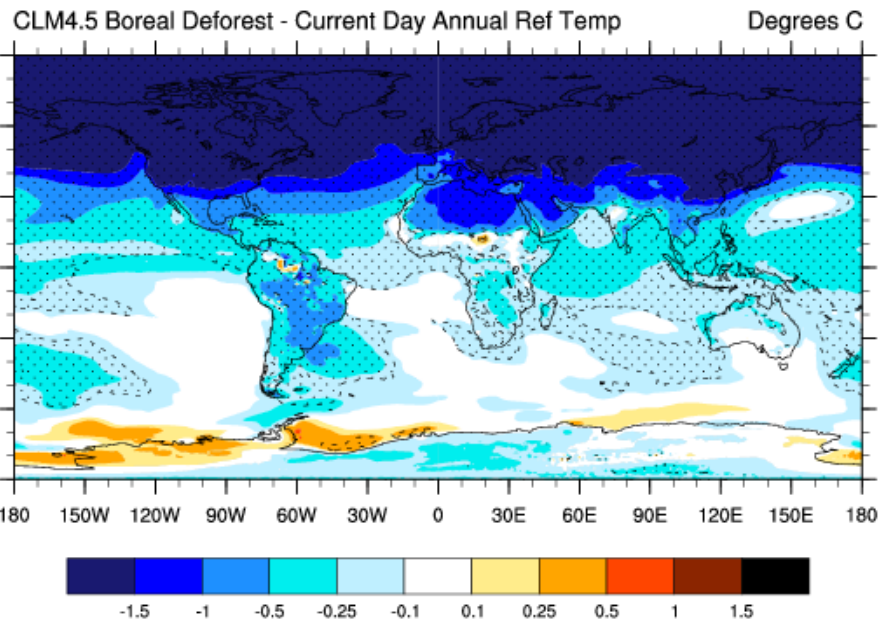
CLM4.0 Temperate Deforest - Current Day Annual Ref Temp Degrees C



CLM4.0 Tropical Deforest - Current Day Albedo

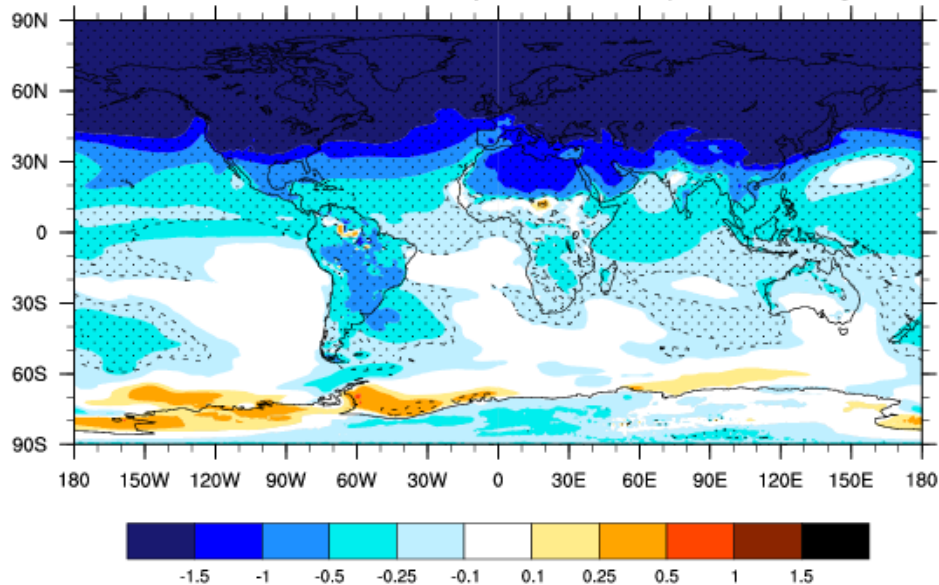


CLM4.5 vs CLM4 Boreal Deforestation

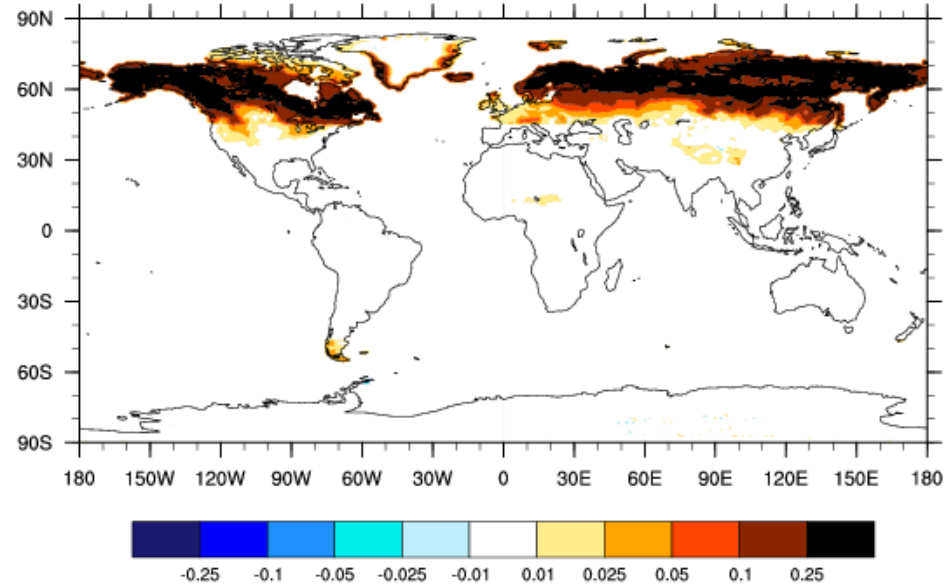


CLM4.5 vs CLM4 Boreal Deforestation

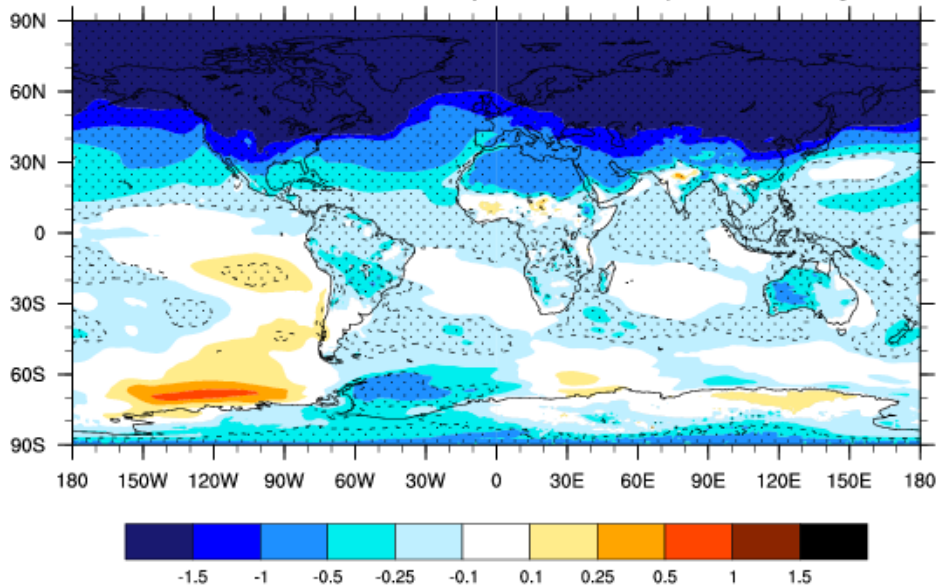
CLM4.5 Boreal Deforest - Current Day Annual Ref Temp Degrees C



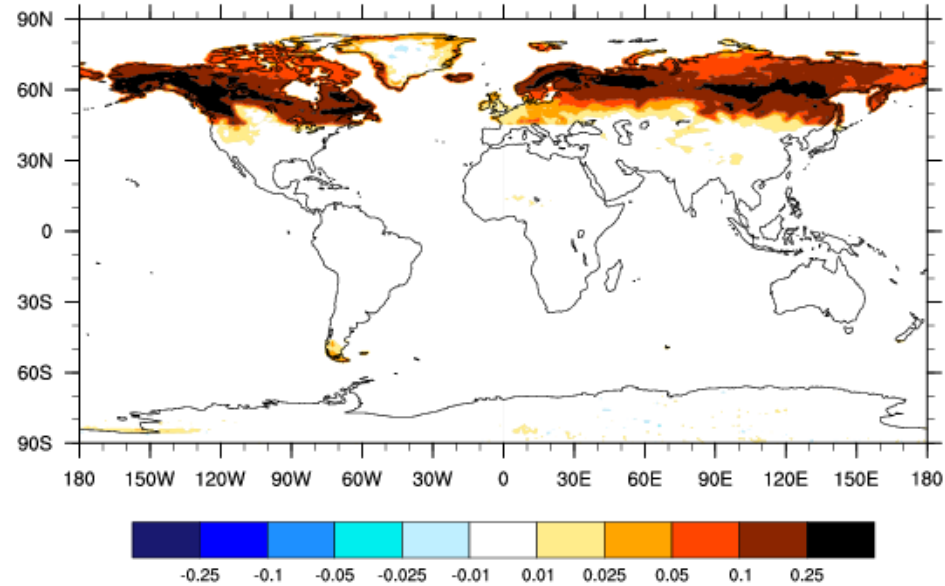
CLM4.5 Boreal Deforest - Current Day Albedo



CLM4.0 Boreal Deforest - Current Day Annual Ref Temp Degrees C



CLM4.0 Boreal Deforest - Current Day Albedo



Need for Land Cover Change

1. Direct Biogeophysical Impacts:

- Albedo – Radiation (Snow Interactions)
- Surface Hydrology (Irrigation)
- Surface Roughness

2. Direct Biogeochemical Impacts:

- Vegetation and Soil Carbon Fluxes from Conversion Natural -> Human systems
- Harvesting from Forestry and Agriculture

3. Indirect Impacts:

- Increased Photosynthesis through higher CO₂, Nitrogen, Phosphorus and Potassium
- Atmospheric Responses in Temperature, Cloud, Precipitation and Larger Scale Circulation
- Fire, Methane, Dust, Volatile Organics, Aerosols

Lawrence et al., [2011], *Lawrence and Chase*, [2010], *Feddema, et al.*, [2005], *Findell, et al.*, [2007], *IPCC*, [2007], *Bonan*, [2008], and *Canadell, et al.*, [2007]

