# ASSESSING CLIMATE IMPACTS OF LINKED ECONOMETRIC-BASED LAND-USE PROJECTIONS

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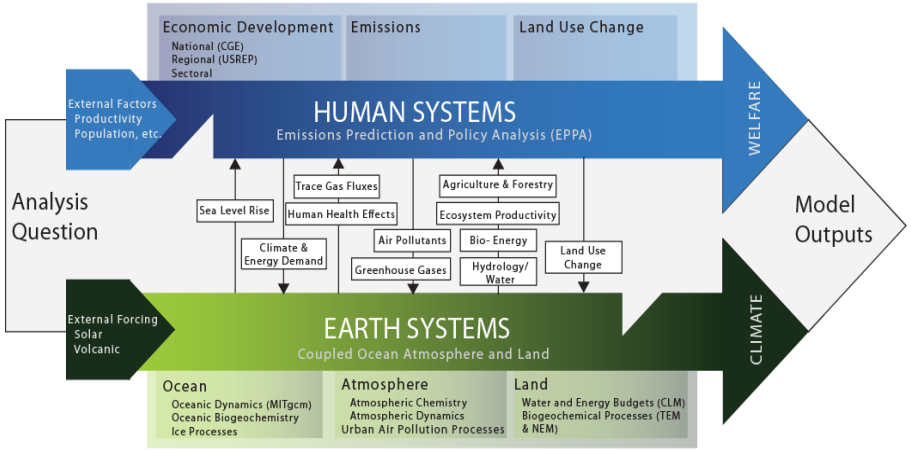
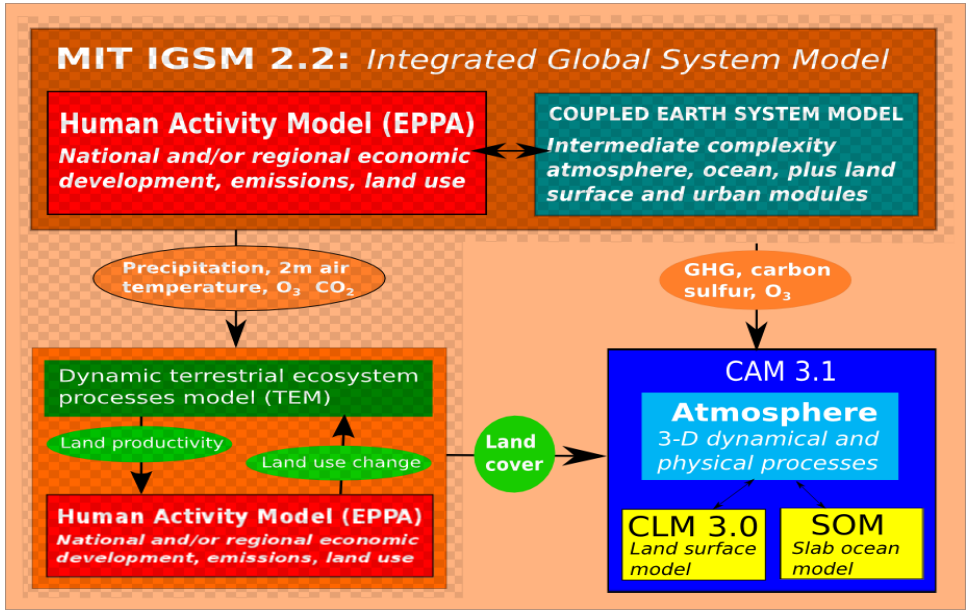



MIT JOINT PROGRAM ON THE
**SCIENCE AND POLICY OF GLOBAL CHANGE**

# Background

Land-used scenarios based on work of Melillo et al. (2009) and Gurgel et al. (2007) across various economic/energy/emissions policies projected within the IGSM framework.

Pure Conversion Cost Response (PCCR): Allows conversion of natural lands to meet demand as long as it's profitable; a.k.a. "Extensification" – less constraint in land use, price only factor.

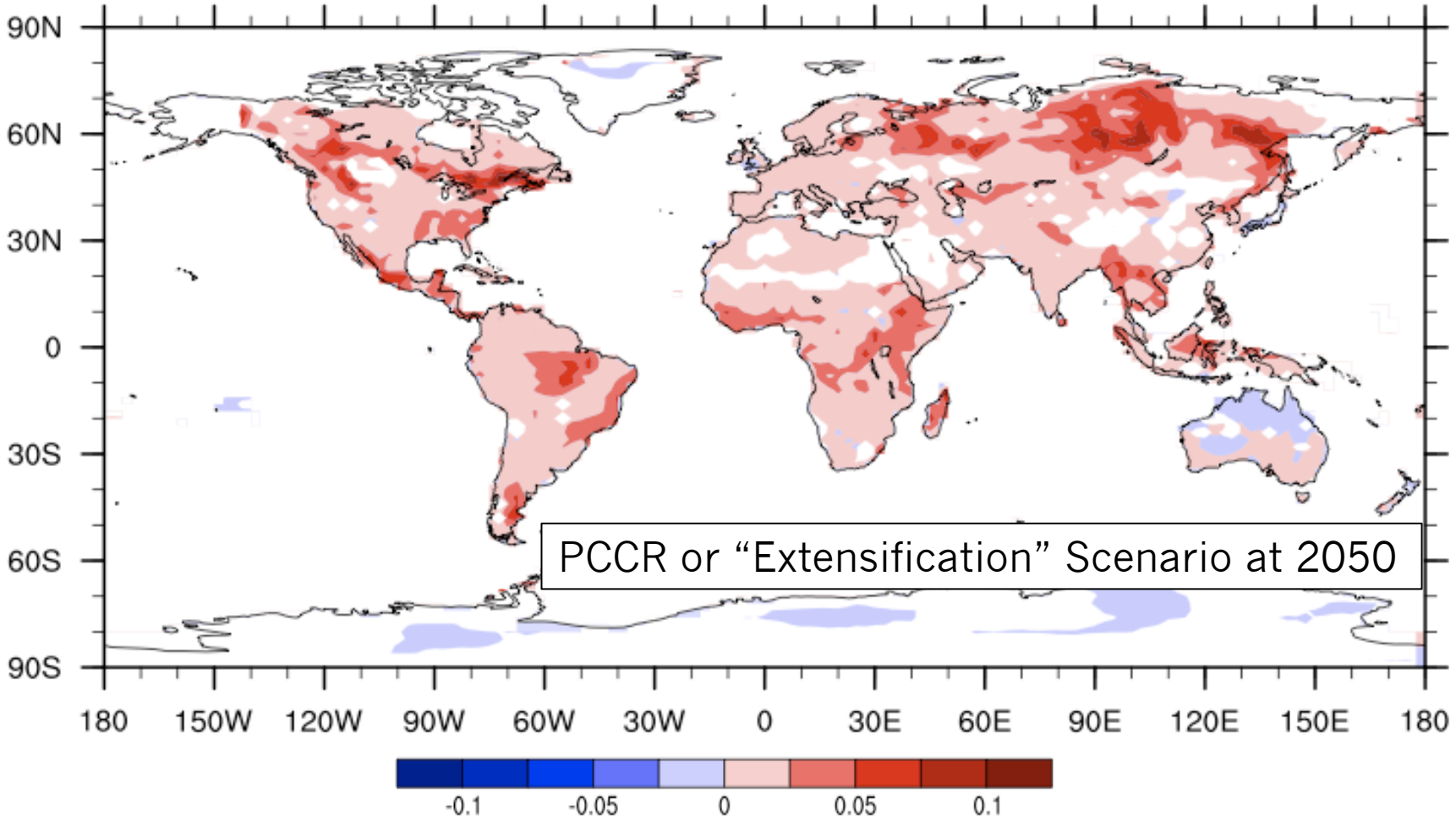
Observed Land Supply Response (OLSR): Driven by more intense use of existing managed land. a.k.a "Intensification" - involves more constraint (legal, environmental) to convert to agricultural land.

Both land-use trajectories consider two energy-policies: *With and without inclusion of cellulosic biofuel penetration* into the global energy resource portfolio. These linked ecologic-econometric scenarios were driven by a climate under a modest stabilization policy (~650 ppm $CO_2$-eq stabilization by 2100).

Equilibrium Simulations with CAM3.1 coupled to a slab ocean model:

- Ran CAM-SOM-CLM for 50 years (after spin-up) for both 1990 and 2050 trace-gas concentrations (taken from the Melillo et al. results) with corresponding land conditions (@ 1990 or 2050) taken from the above land-use scenarios.
- 2050 trace-gas conditions with no land-use change.
- 2050 trace-gas conditions modified with Melillo et al. (2009) net carbon/$CO_2$ exchange from PCCR/OLSR biofuel plantations.

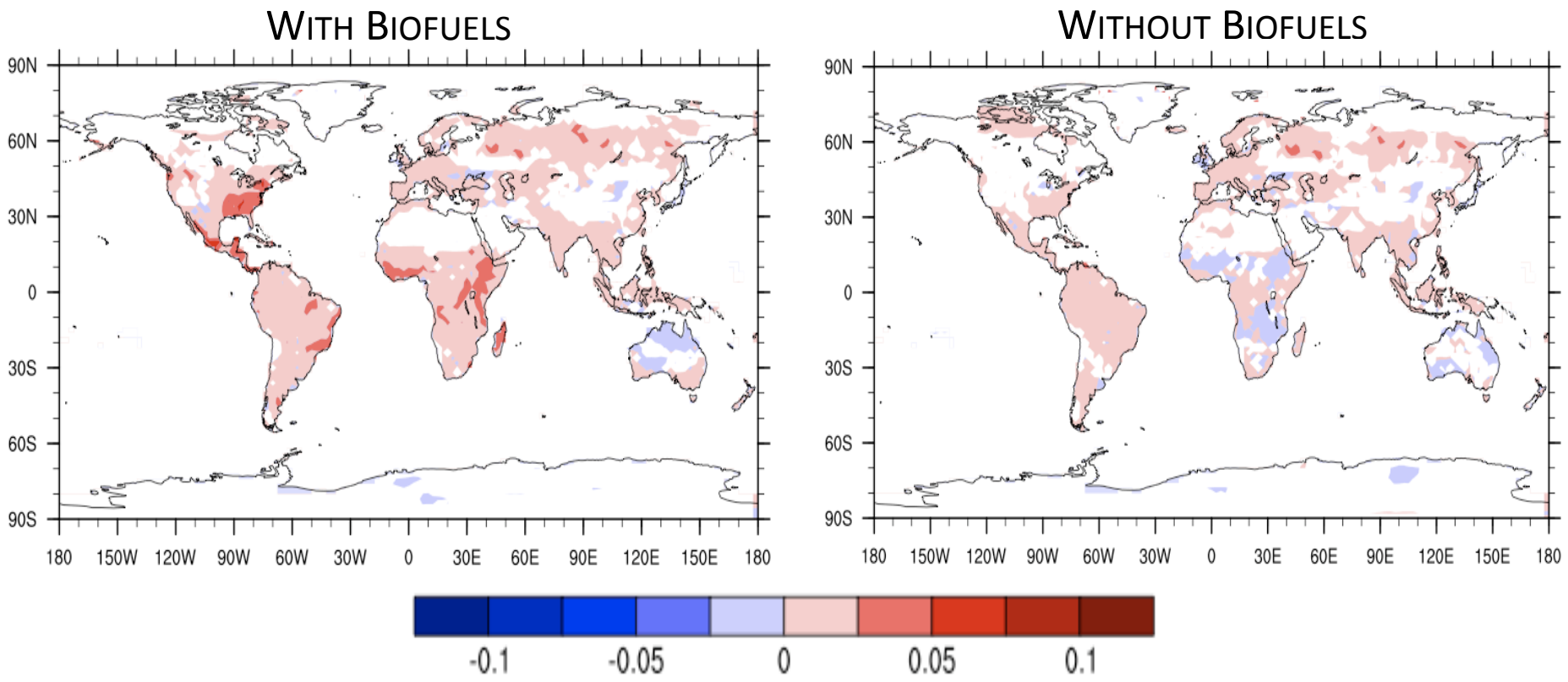
# Land-use associated with climate/energy policy




WIDESPREAD EXPANSE OF CLEARED (FORESTED) LAND FOR BIOFUELS SEEN AS INCREASES IN ALBEDO.

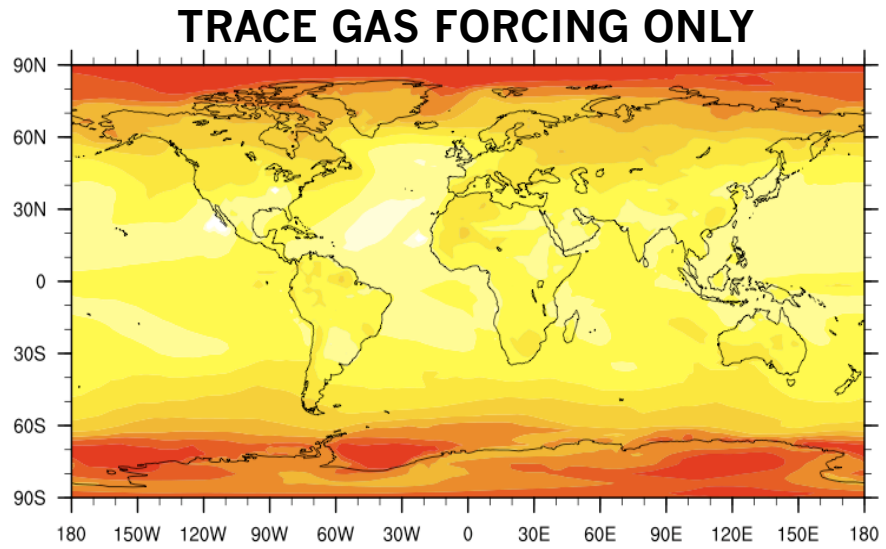
# Land-use associated with climate/energy policy

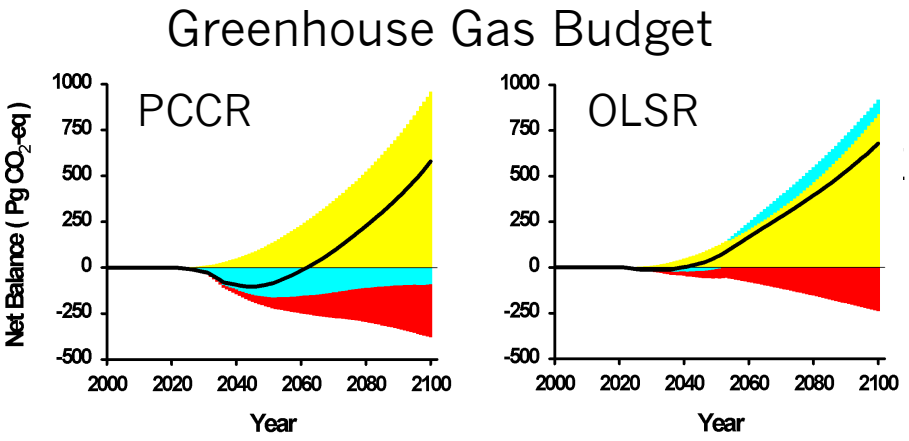
**OLSR or "Intensification" Scenario at 2050**

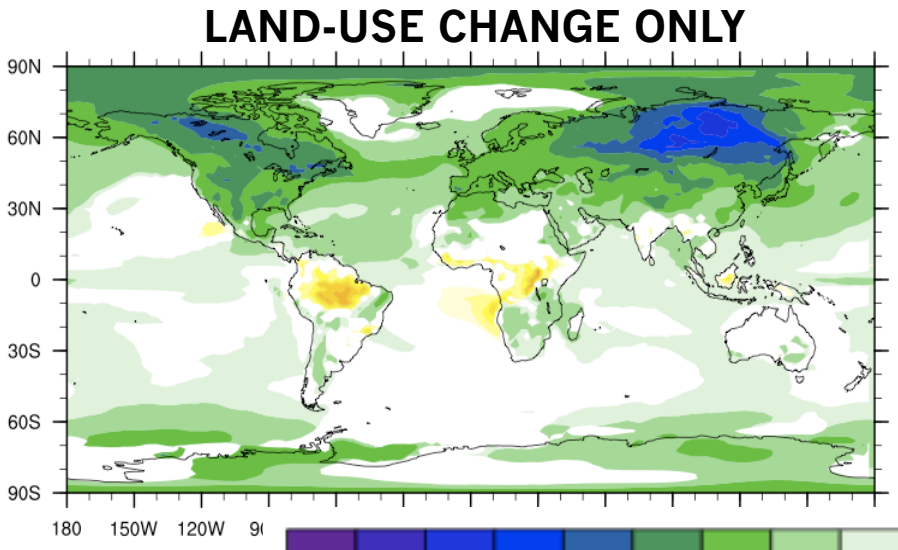


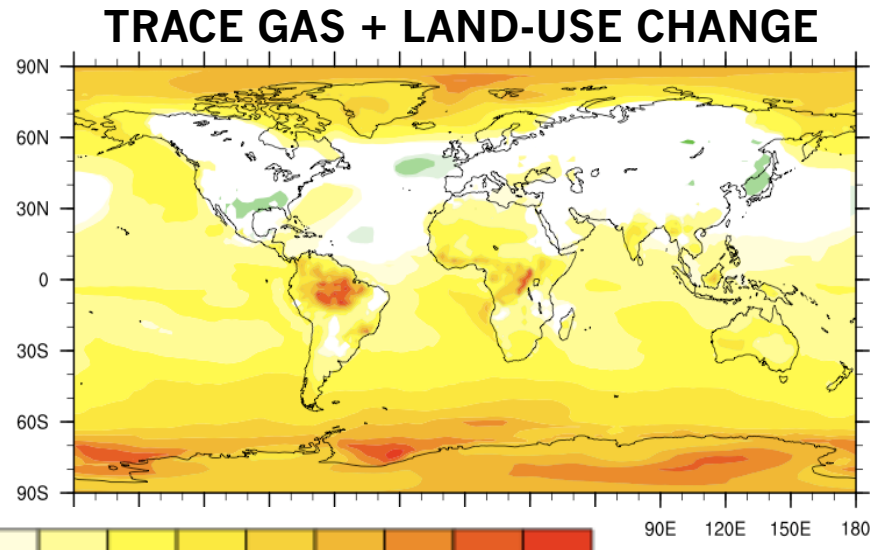

Notable areas of increased albedo are buffered or removed in the absence of biofuel penetration.

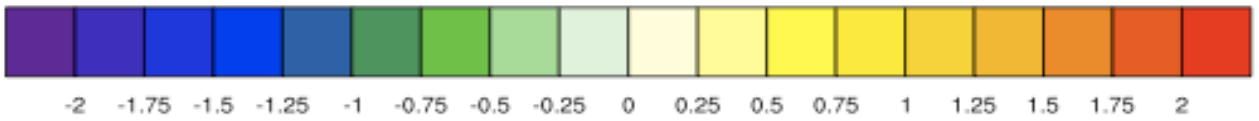
# Surface-Air Temperature Changes: Land-Use Vs. GHG



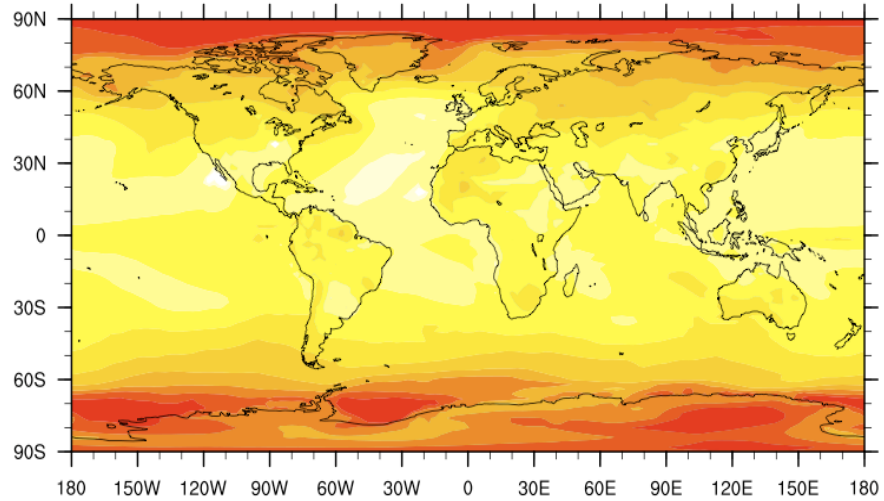



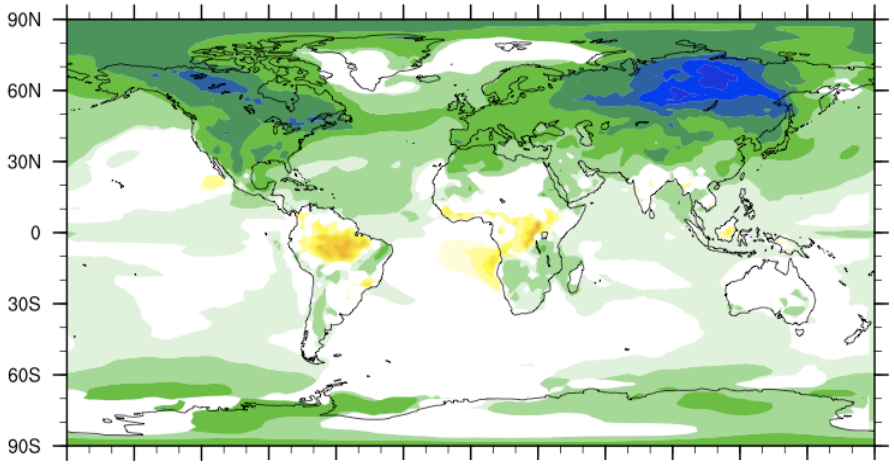
# Surface-Air Temperature Changes: Land-Use Vs. GHG

**TRACE GAS FORCING ONLY**

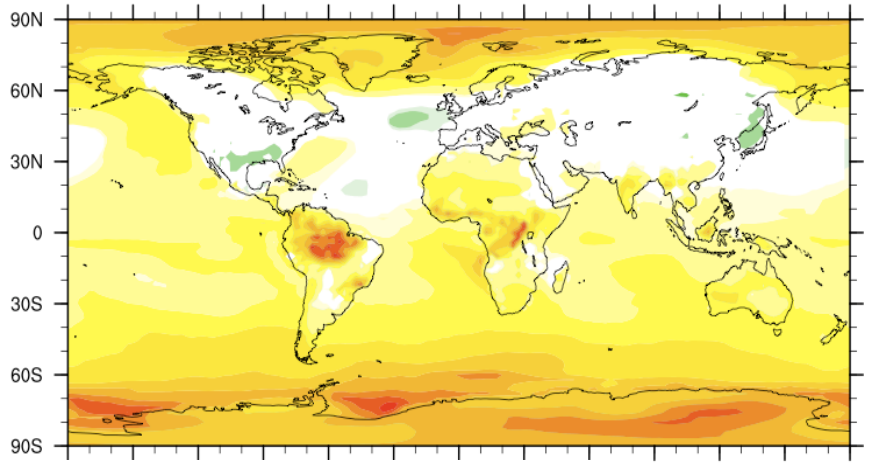


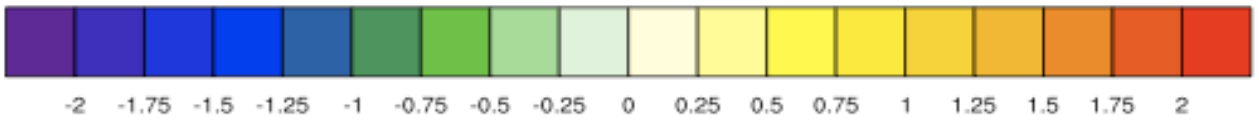

AT 2050 - BIOGEOPHYSICAL LAND-USE IMPACTS ON SURFACE TEMPERATURE CAN BE UP TO *2 TIMES LARGER THAN* THE BIOGEOCHEMICAL/CARBON IMPACT ON GLOBAL TEMPERATURE FROM BIOFUELS, *AND OF THE OPPOSITE SIGN*.

**LAND-USE CHANGE ONLY**




**TRACE GAS + LAND-USE CHANGE**

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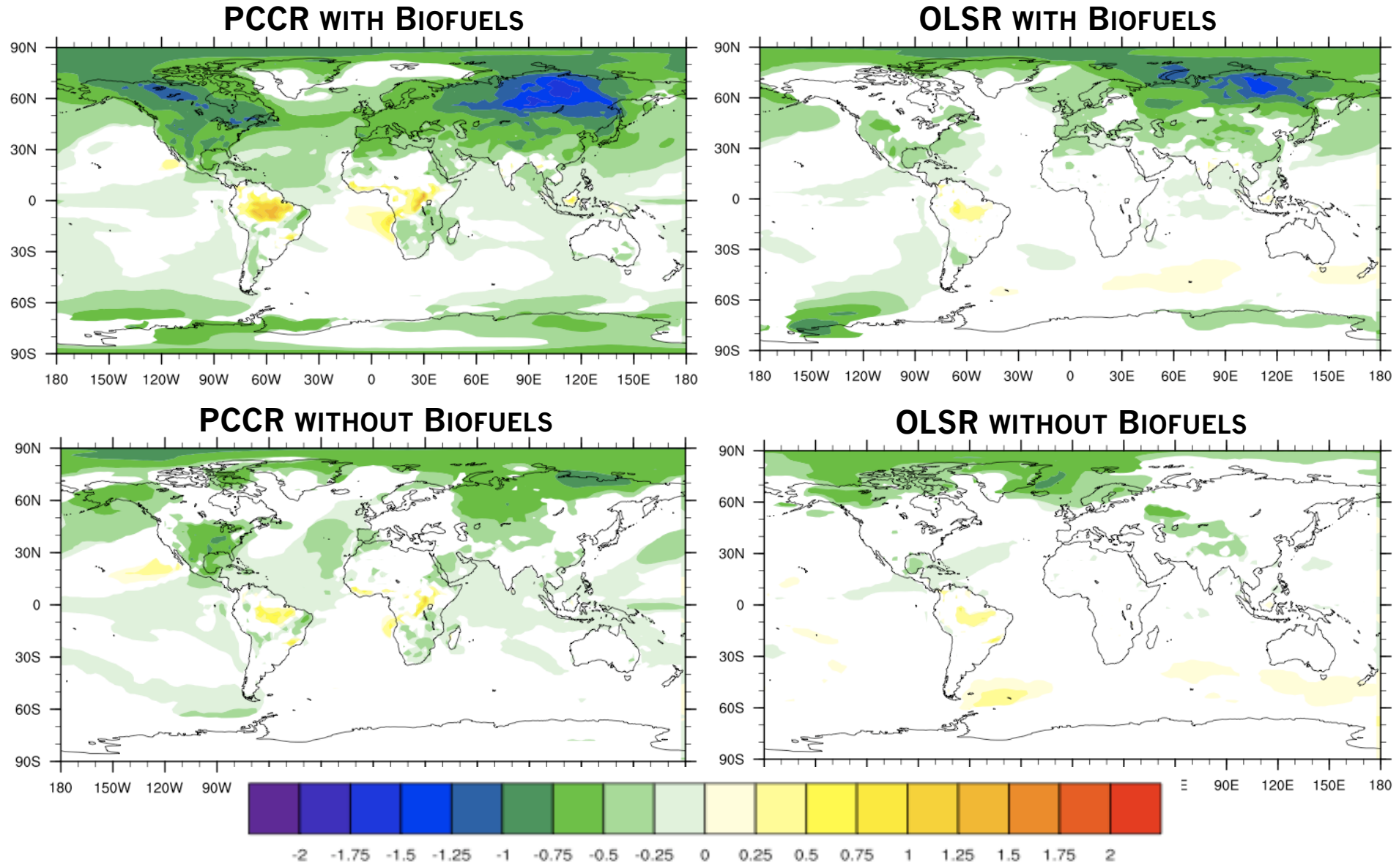
# Surface-air temperature changes due to land use

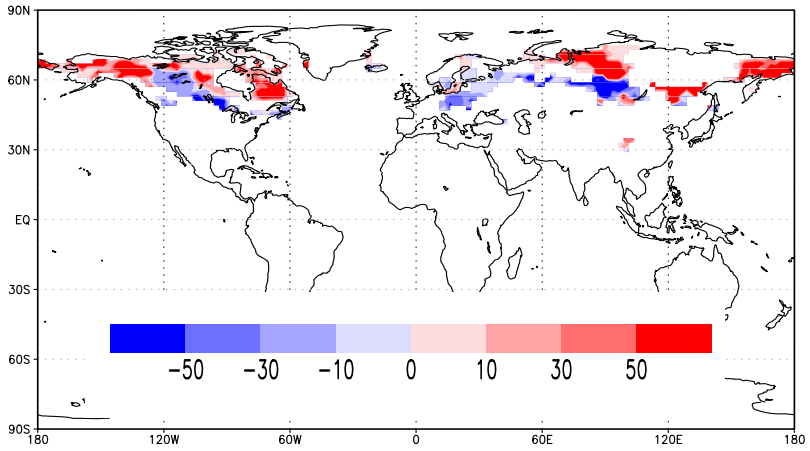


# Closing Remarks

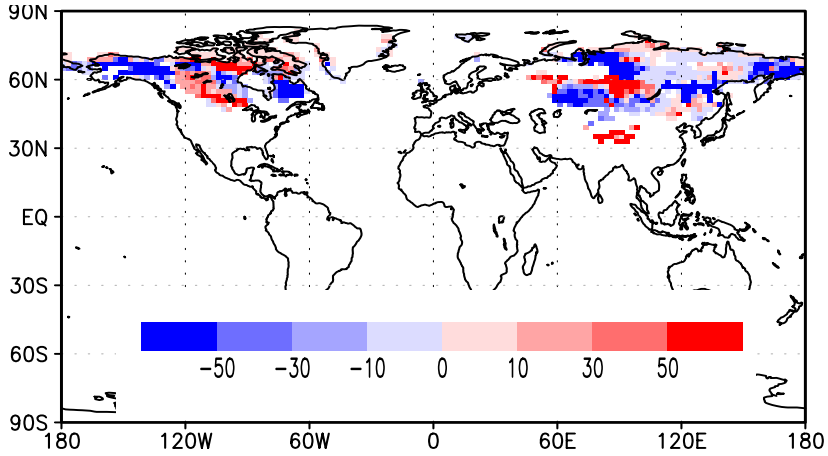
- Land-use and/or bioenergy: Locally, in coming decades – biogeophysics wins over biogeochemistry for climate "benefit".
- Crop representation, Physiology, Phenology, Irrigation
- TEM vs. CLM: NPP control/response in land-use algorithm.
- Quasi-linked framework between IGSM land-use scenarios and CAM-SOM equilibrium runs.
- Uncertainty in regional climate and its feedbacks.
- Precipitation analyses ongoing and performed in light of uncertainty in strength and location of land-climate feedbacks.
- Natural migration by end of century potentially as "climate potent", biogeophysically speaking, as human land use (in 2050).

# Plant Migration of Boreal Vegetation

Change in boreal forest area (%)
early 21st century to the end of 21st century




Change in Arctic grass area (%)
early 21st century to the end of 21st century




Change in albedo
early 21st century to the end of 21st century