Emissions, Land-Use, and Energy Policies on Climate (Local Equilibrium Temperature Response)

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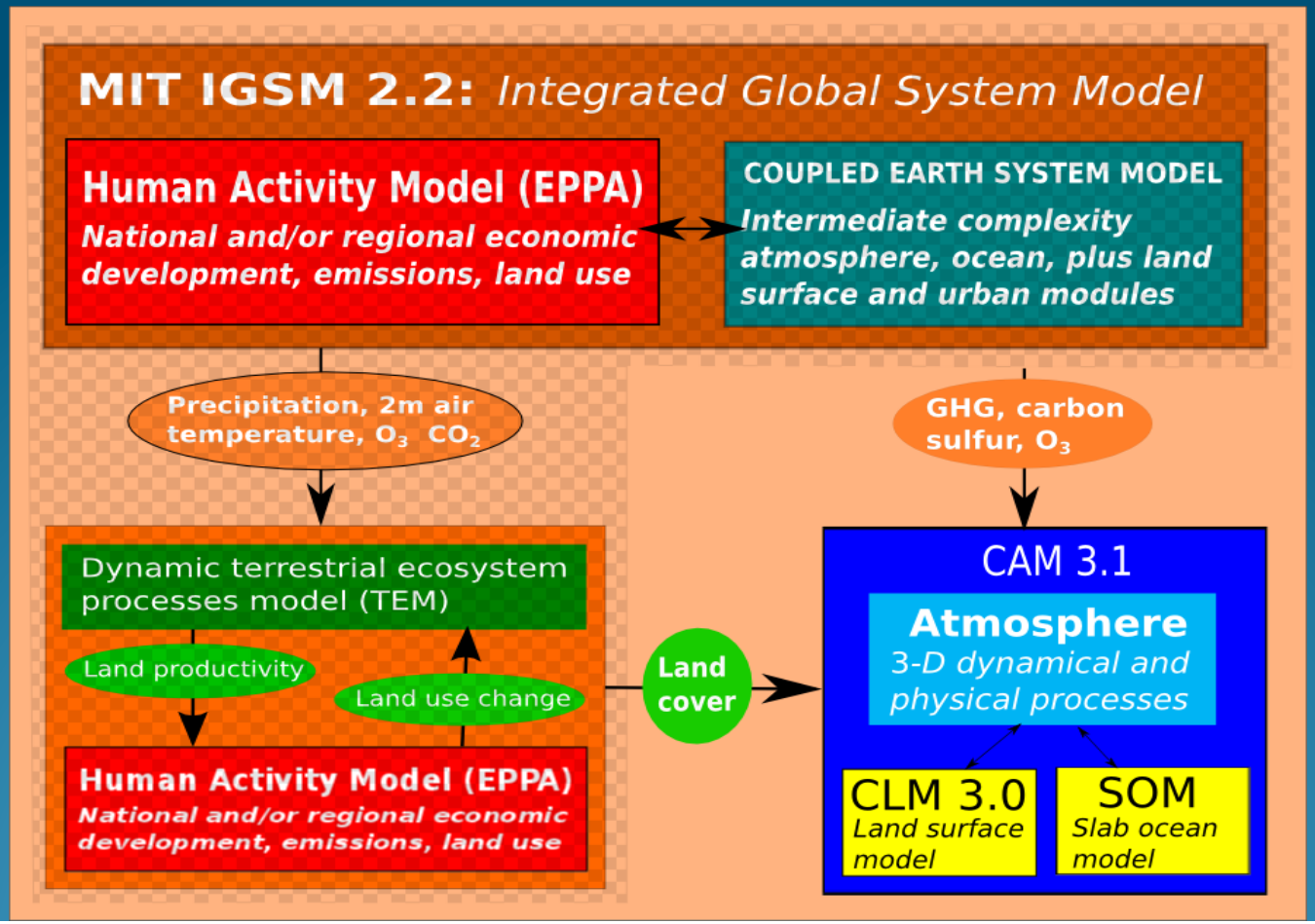
With insights from: Andrei Sokolov, Jerry Melillo, David Kicklighter, John Reilly, Angelo Gurgel, Sergey Paltsev, Ben Felzer, and Yongxia Cai



Background and Experimental Framework

Melillo et al. (2009), based on the IGSM development work of Gurgel et al. (2007), considered future land-use scenarios among economic/energy/emissions policies:

Pure Conversion Cost Response (PCCR): Allows the conversion of natural areas to meet increased demand for land, as long as the conversion is profitable; a.k.a. "Extensification" – involves less constraint in land supply, price is only factor.

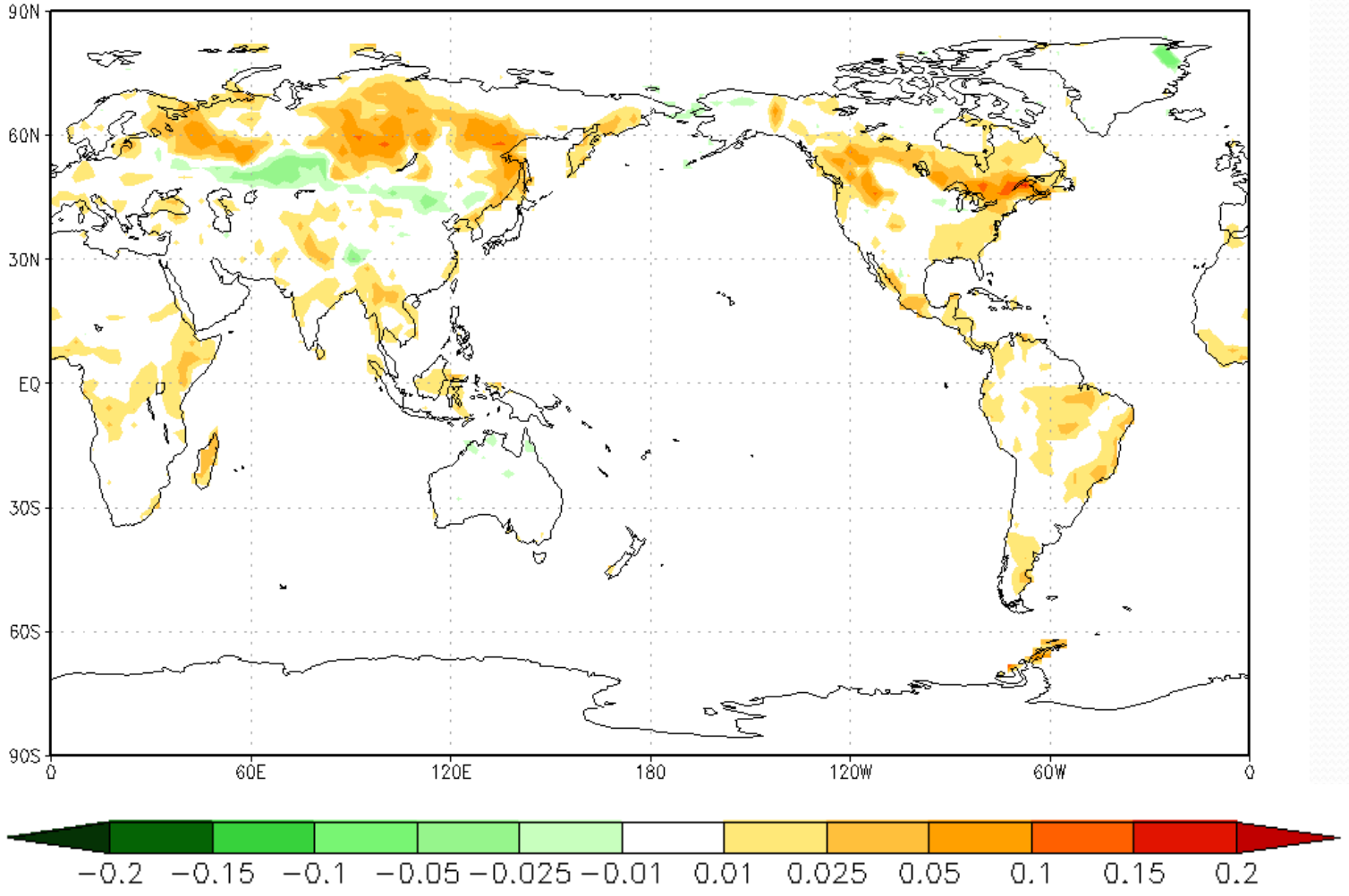
Observed Land Supply Response (OLSR): Driven by more intense use of existing managed land. a.k.a "Intensification" - involves more constraint (legal, environmental to get new land to convert to agricultural production.

Both of these land-use trajectories consider two energy-policies: *With and without the inclusion of cellulosic biofuel penetration* into the global energy resource portfolio. These linked ecologic-econometric scenarios were driven by a climate forced 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.**
- **A run was also performed at 2050 trace-gas conditions with no land-use change.**
- **A run was also performed at 1990 trace-gas conditions with default CLM vegetation.**

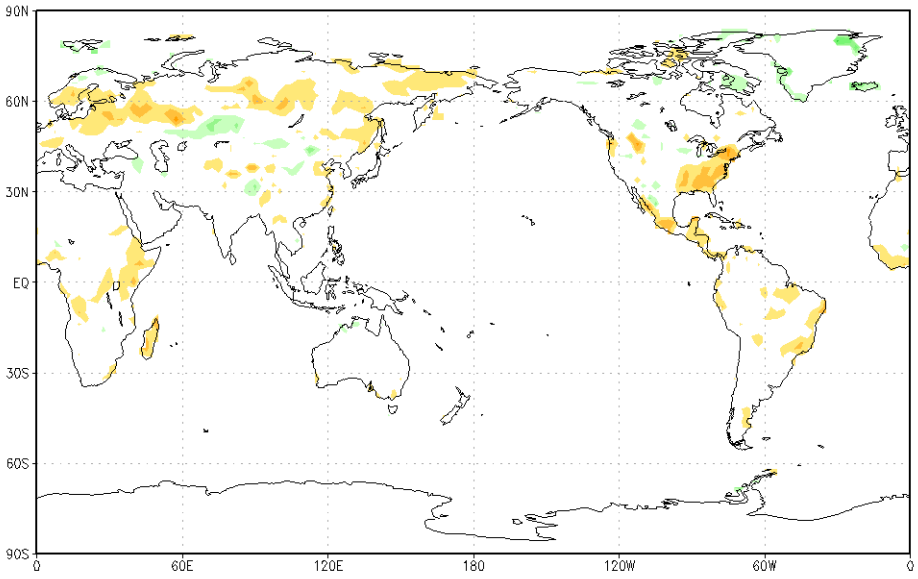
ALBEDO Changes: PCCR Case



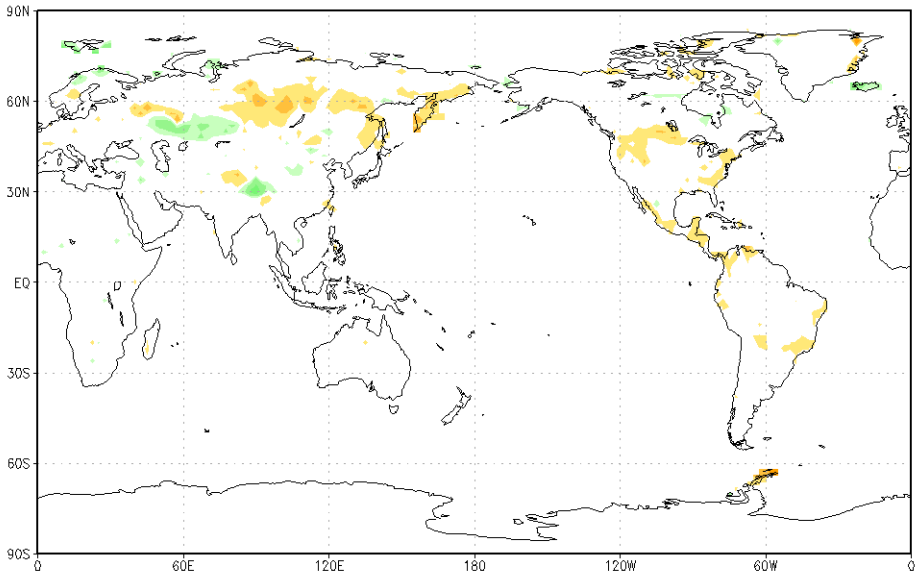
WIDESPREAD EXPANSE OF CLEARED (FORESTED) LAND FOR BIOFUELS SEEN AS INCREASES IN ALBEDO.

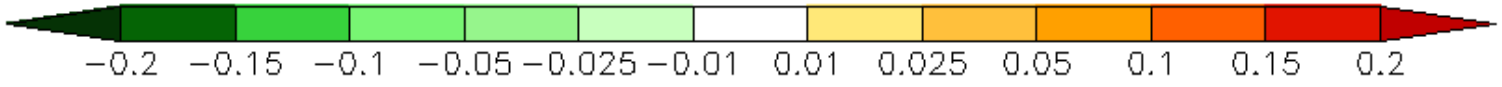
ALBEDO Changes: OLSR Case

WITH BIOFUELS



WITHOUT BIOFUELS



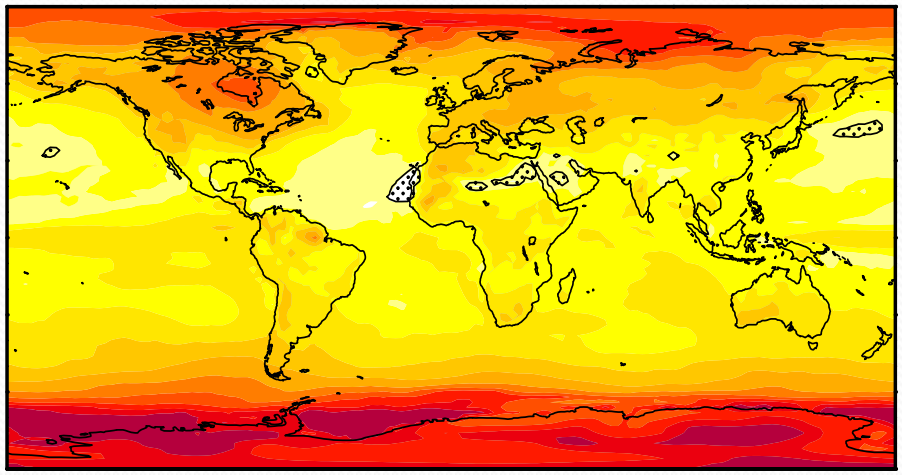


NOTABLE AREAS OF INCREASED ALBEDO ARE BUFFERED OR REMOVED IN THE ABSENCE OF BIOFUEL PENETRATION.

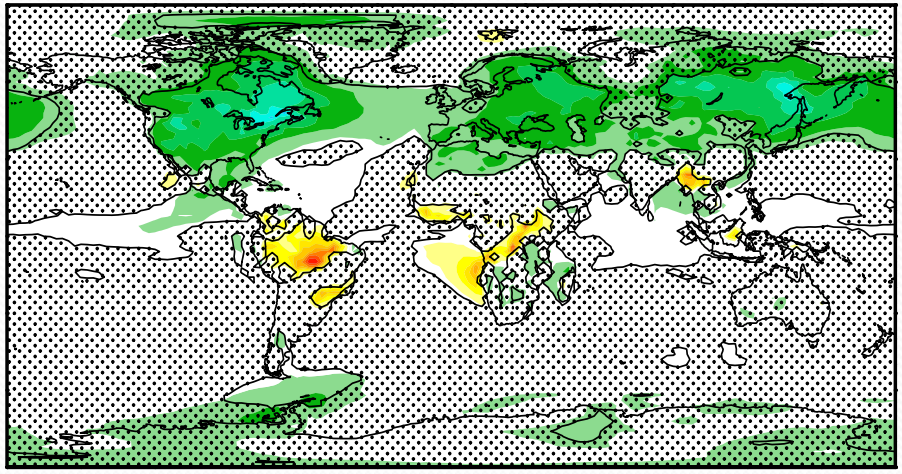
PCCR Case

Surface-Air Temperature Changes

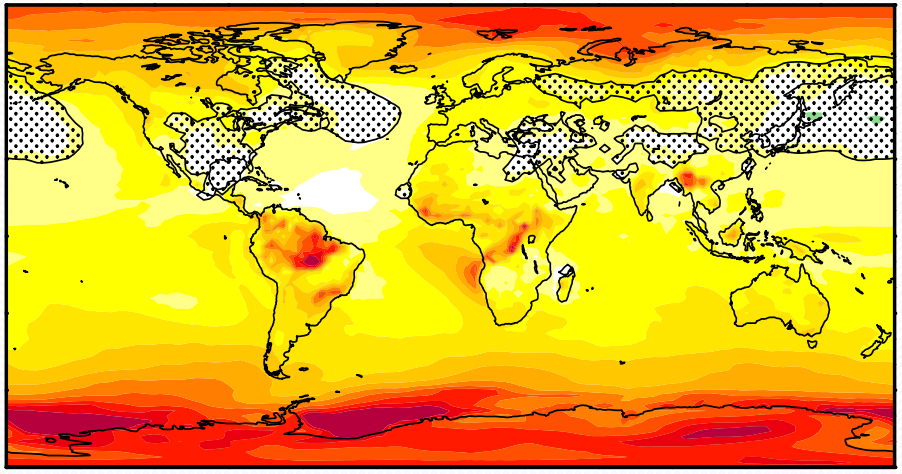
Climate Change only

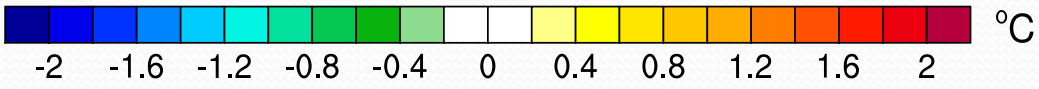


Land Cover Change only



Climate Change + Land Cover Change

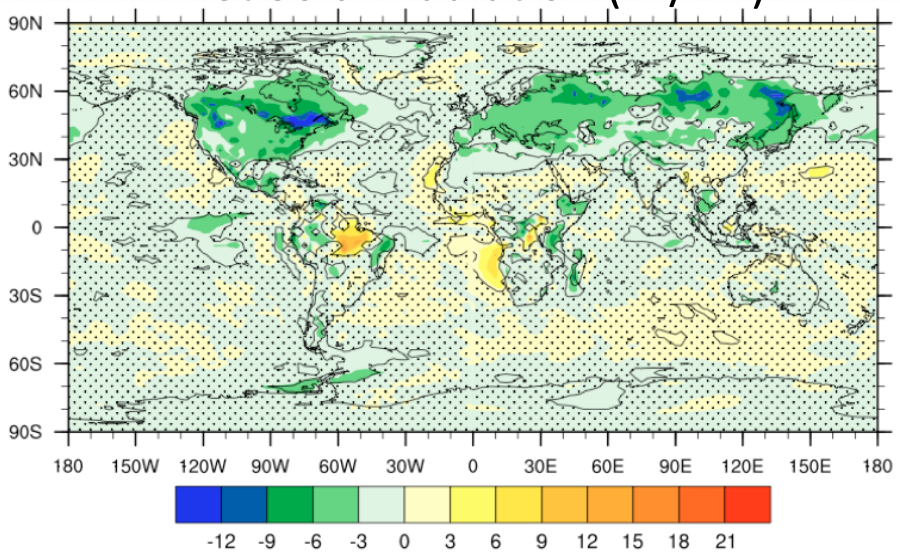




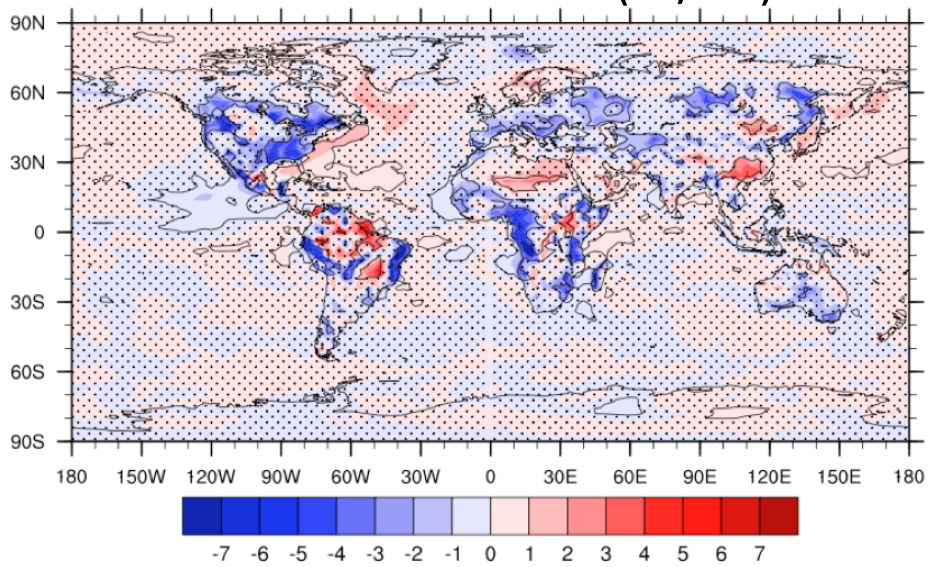
Surface Flux Changes

PCCR Case: Land Cover Change Only

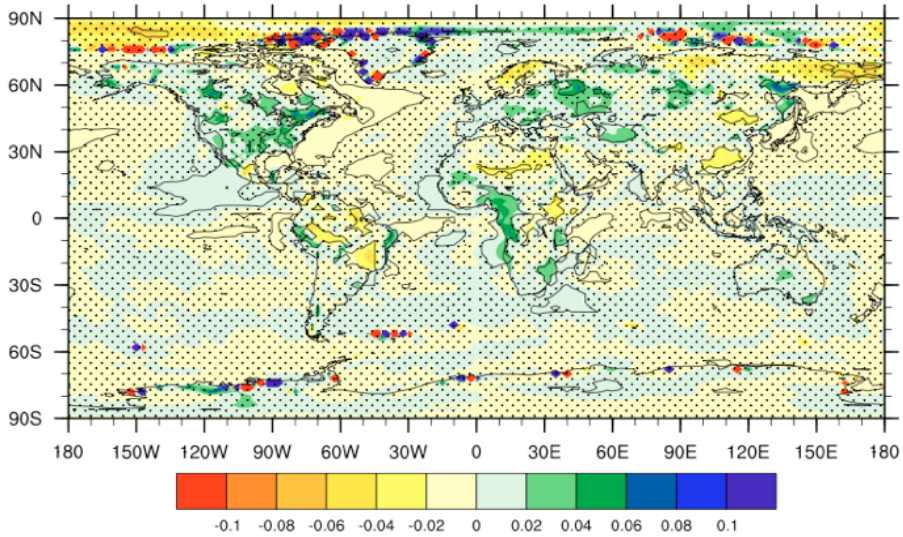
Net Solar Radiation (W/m^2)



Sensible Heat Flux (W/m^2)

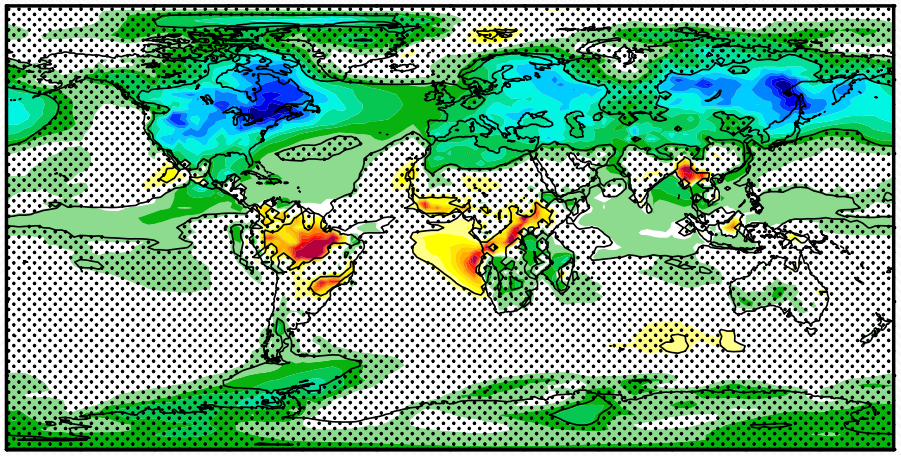


Evaporative Fraction

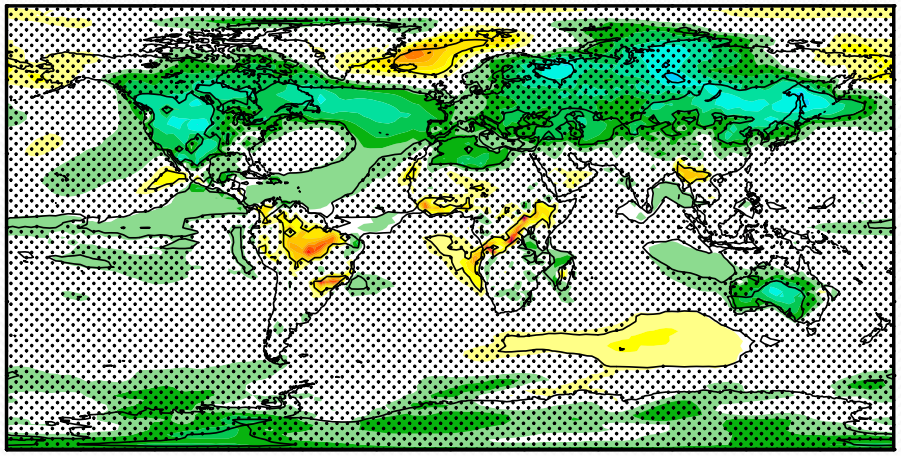


Surface-Air Temperature Changes (˚K)

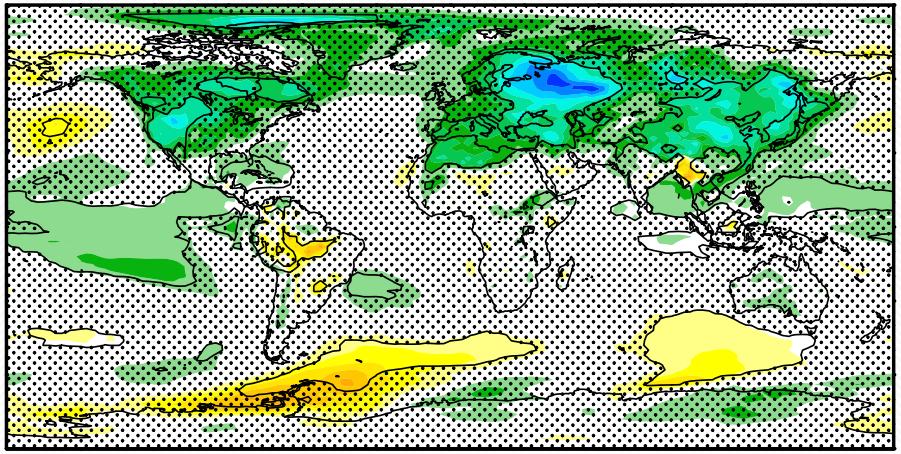
Land Cover Change only: PCCR scenario



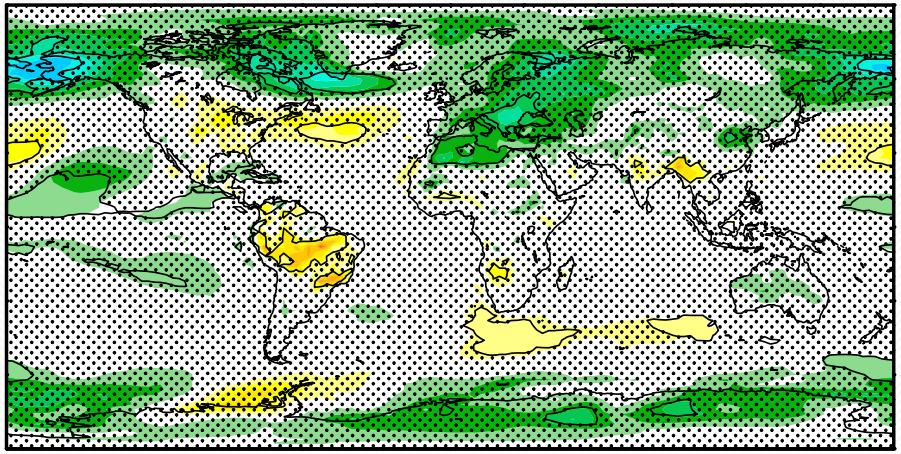
Land Cover Change only: OLSR scenario

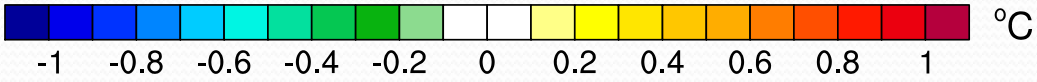


Land Cover Change only: PCCR-NoBiofuel scenario



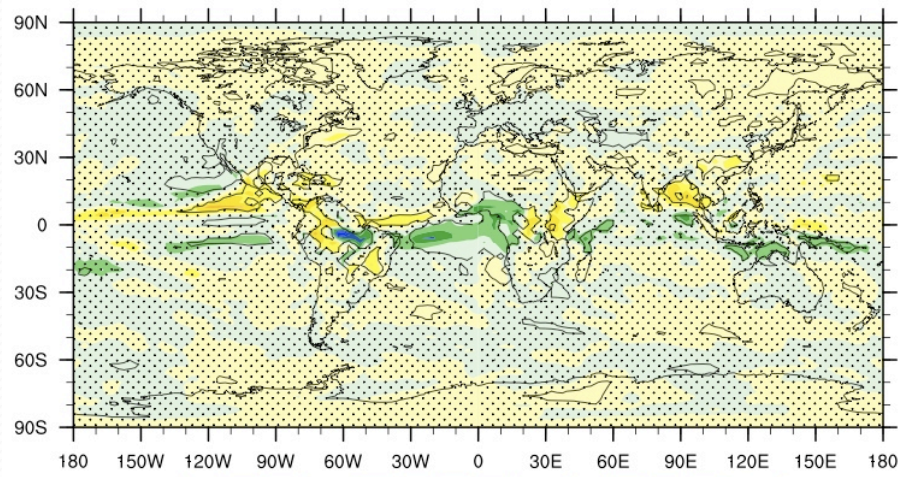
Land Cover Change only: OLSR-NoBiofuel scenario



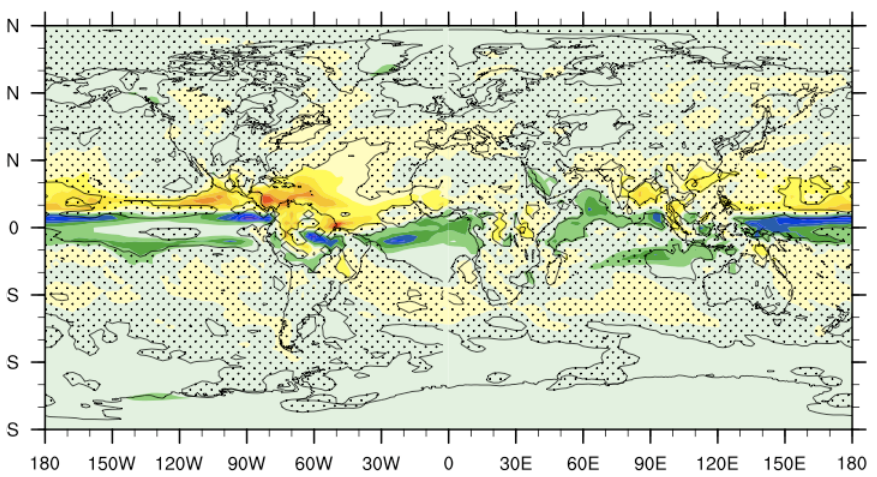


Total Precipitation Changes (mm/day)

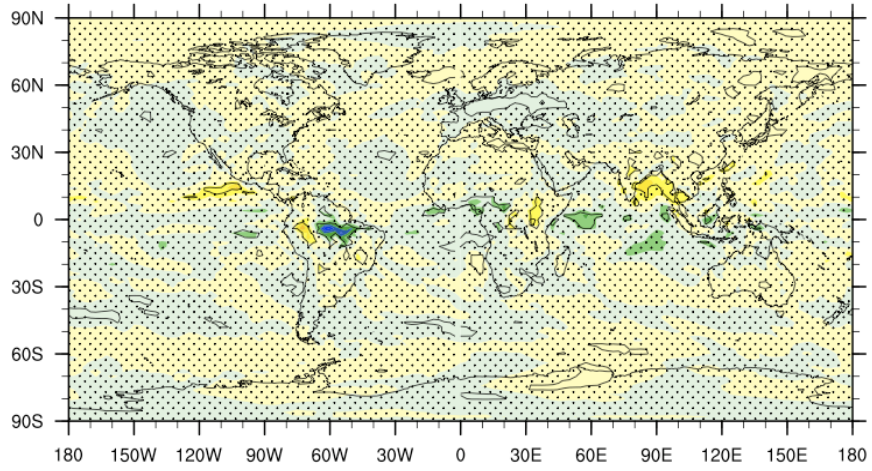
PCCR: Land Cover Change Only



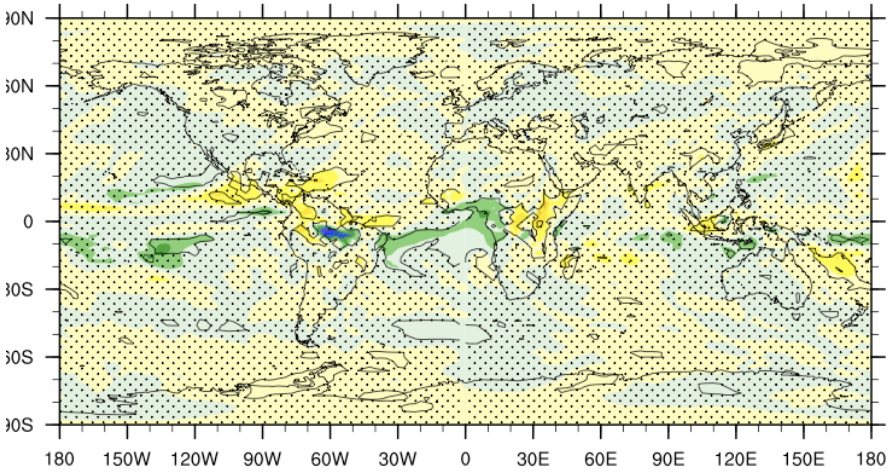
PCCR: Land Cover and Trace-Gas Forcing

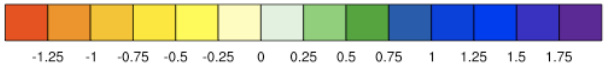


PCCR - OLSR



PCCR - PCCR:No Biofuel





Closing Remarks

- 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.
  - Planned follow-up runs to address more egregious features.
- Uncertainty in regional climate and its feedbacks.
- Precipitation analyses ongoing and performed in light of uncertainty in strength and location of land-climate feedbacks.