LoCo-Relevant Research

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GLASS Panel Meeting
4 October 2016

Issues important to GLASS

* Development of Earth System Models – representation of new processes
* Evaluation of model behavior – comparisons with observations
  * Separating the local from the remote response or the forced signal from interval variability is a challenge
  * Need to have long simulations to look at it statistically
* Historical LULCC scenario studies are a good platform to assess model behavior
* I'll share results from a study using GFDL's ESM2G, comparing simulations with All Historical forcings (AllHist) to ones with land cover kept at Potential natural Vegetation (PotVeg)

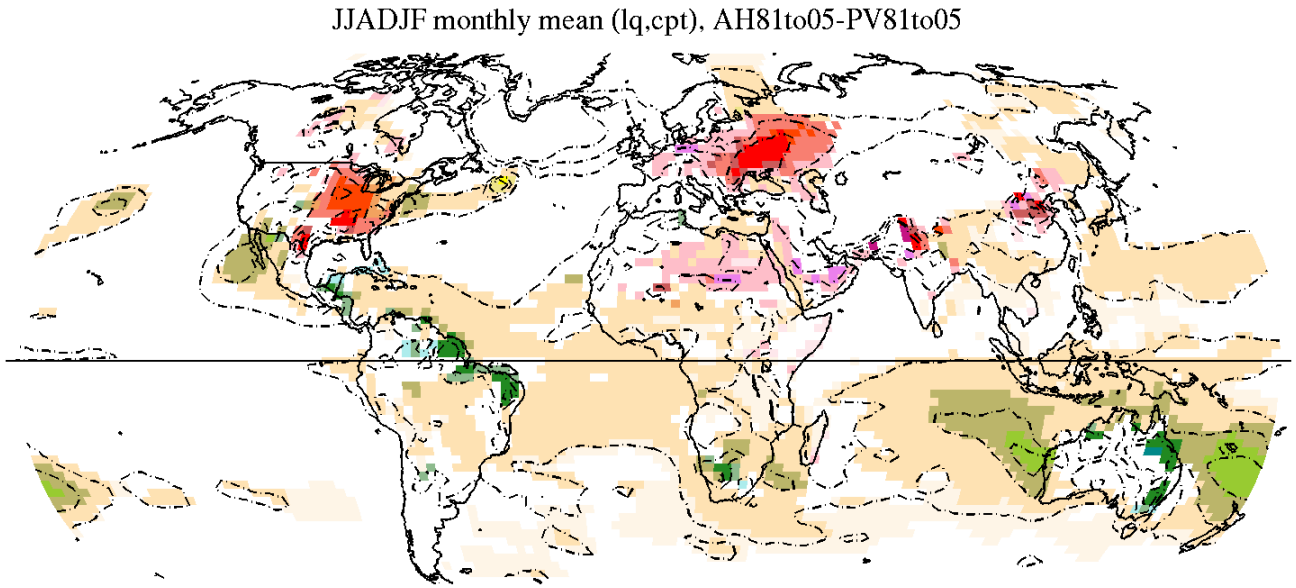
GFDL's ESM: important features

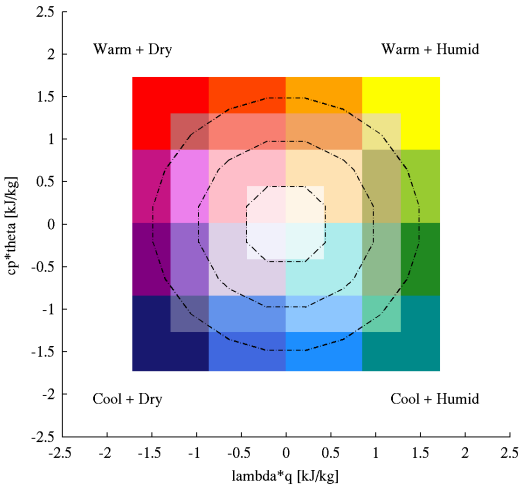
* Transpiration is function of plant stomatal conductance and soil water availability; depends on the vertical distribution of plant roots and soil moisture in each land-use tile.
* Each land-use tile has its own soil water and plant root distribution: thus, ET is not a function of the grid-cell average soil moisture.

GFDL's ESM: important features

* Hurtt et al. (2011) LU history uses transition rates reflecting the paths of changes among different use categories (natural, seconday, crop, pasture)
* Creates more land-cover disturbance than the fraction-based approach (Shevliakova et al., 2013): "gross transitions" between different land-use types, not just the net effect based on changes in fractions.
* Includes shifting cultivation and secondary-to-secondary transitions representing wood harvesting of secondary forests.

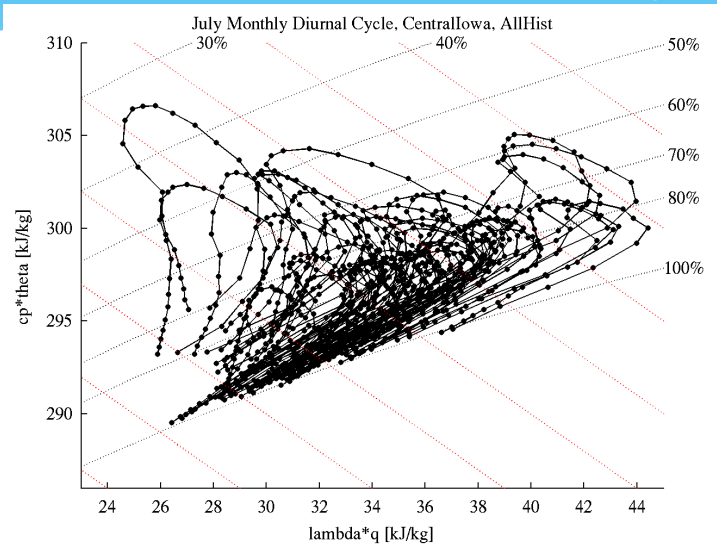
ESM2G response to historical LULCC

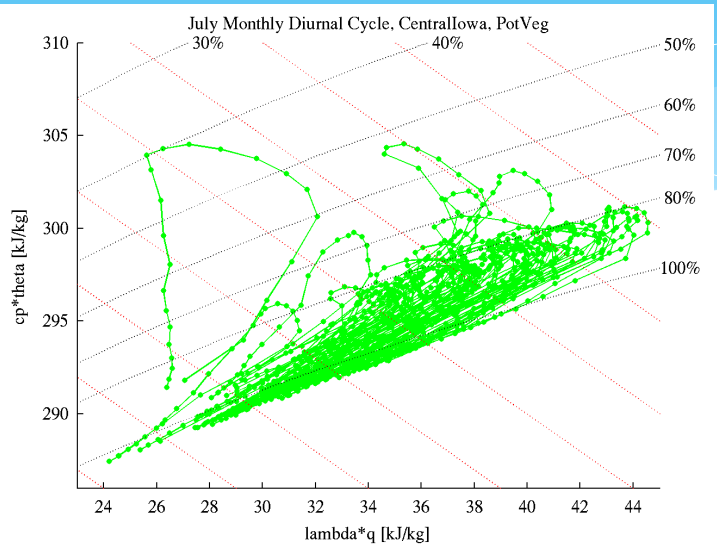


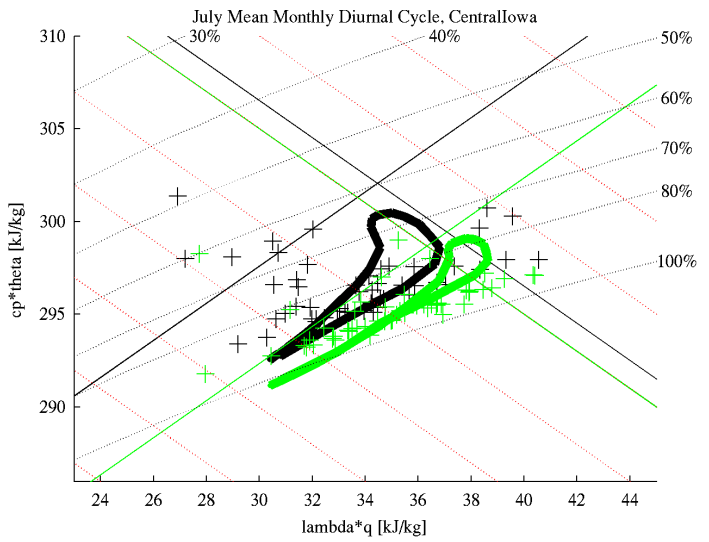


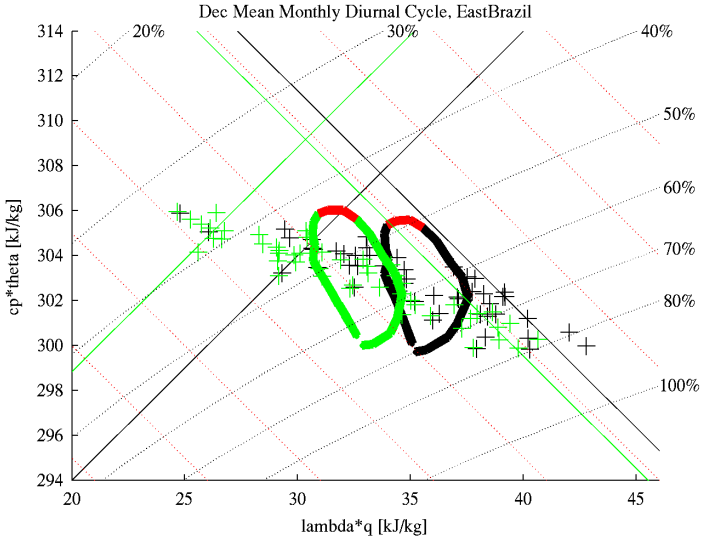
* Warming and drying in the mid-latitudes
* Humidification throughout the tropics

Mixing diagrams reveal differences in diurnal cycle behavior

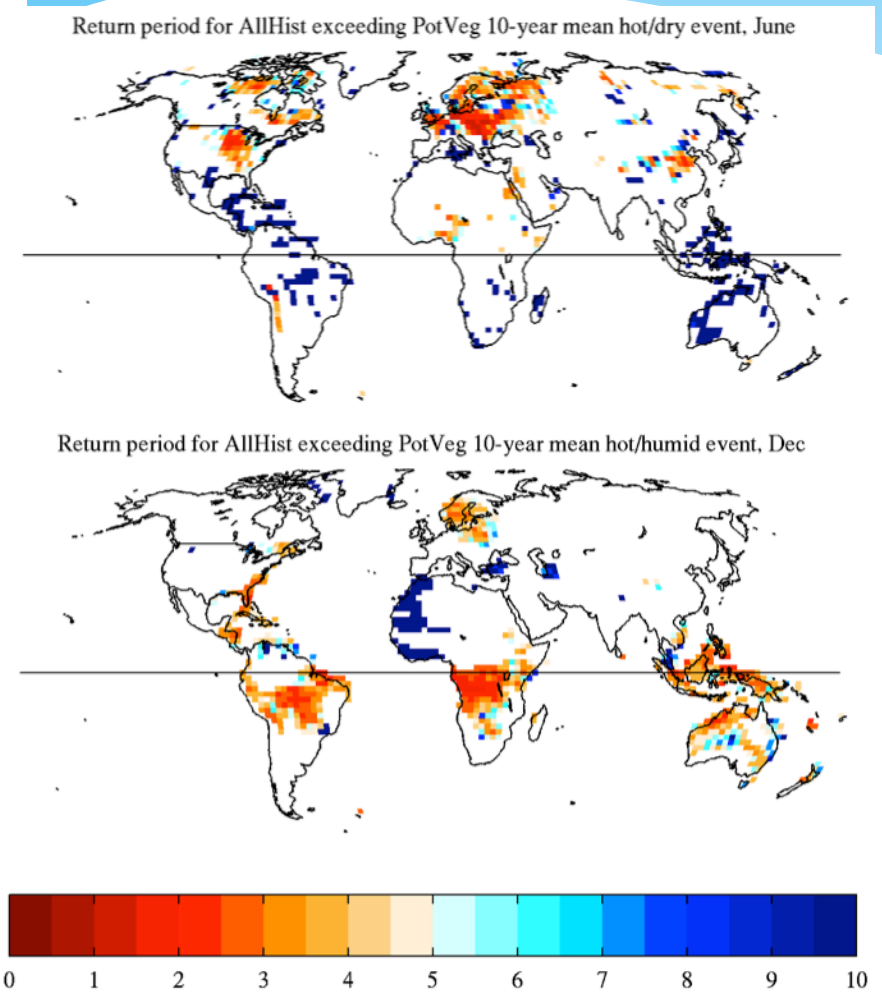








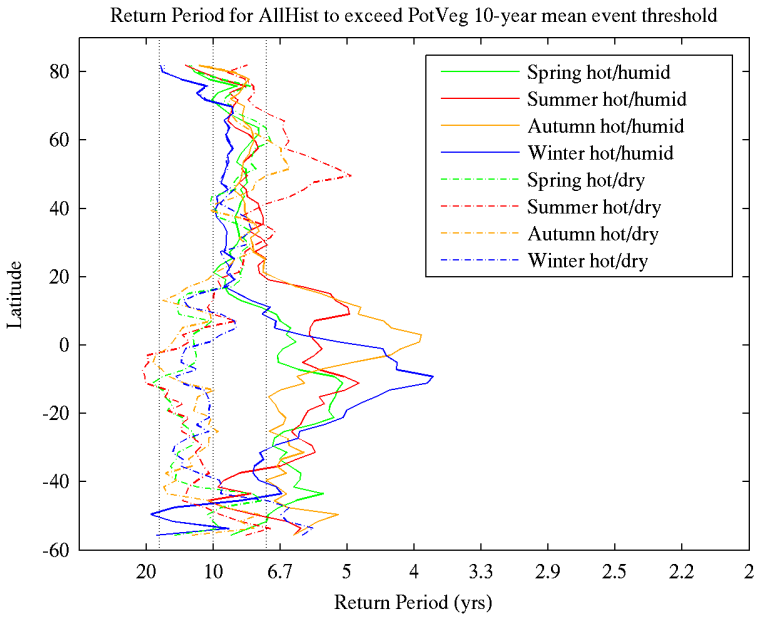
Impact on extremes



* Midlatitudes: What was a once-in-a-decade hot/dry summer in the PotVeg simulation occurs every 2-3 years with historical LULCC
* Tropics: High humidity months occur 2-3 times more frequently

Impact on extremes

* Extreme hot/dry summers in the midlatitudes are 2-3 times more likely as a result of historical LULCC
* Tropics are more humid throughout the year than they would be without shifting cultivation and secondary vegetation – These are important processes to represent in ESMs



Ongoing work

* Looking at fertilization effect in another series of simulations
* The model response to CO_2 fertilization and to LULCC impacts the diurnal cycle of T and q in ways that are in competition in some places, in concert in others
  * These behaviors need to be considered when exploring future scenarios with uncertain LULCC trajectories.