A decorative border at the top of the slide consisting of a grid of small squares in various colors including blue, green, yellow, orange, and brown.

# Subgrid approach to understanding biophysical effects of LULCC

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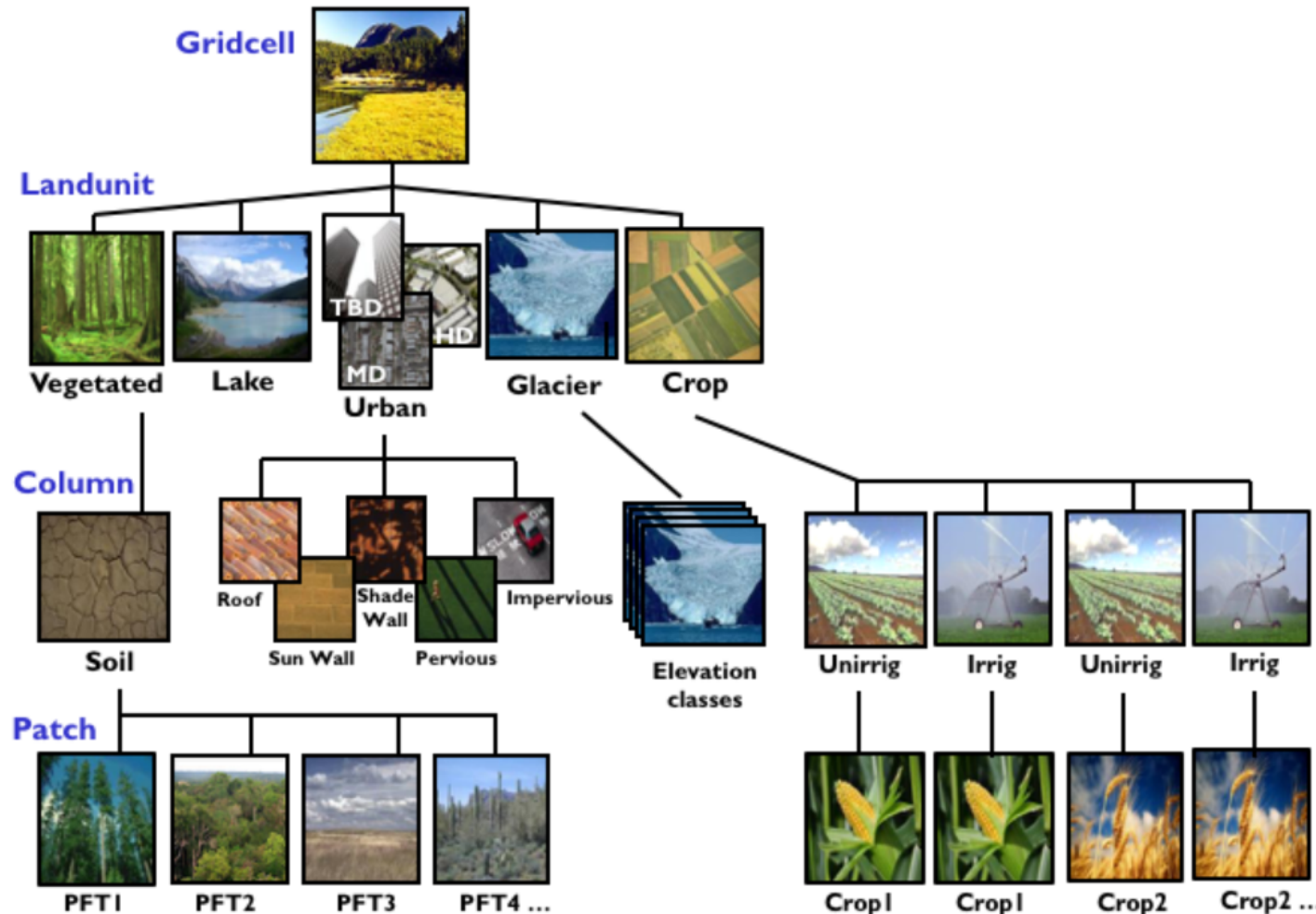
AGCI LUMIP Workshop

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# Biophysical effects of LULCC in climate models

- LULCC modeling experiments:
  - Pre-industrial or potential land cover distributions
  - Present-day or prescribed future land cover map
- Challenges:
  - Properly disentangle LULCC climate signal from unforced model variability and nonlocal feedback effects via changes to atmospheric and ocean circulations
- Some key features are consistent, but substantial disagreement in the simulated response to LULCC exists across models.

# Grid cell land surface heterogeneity



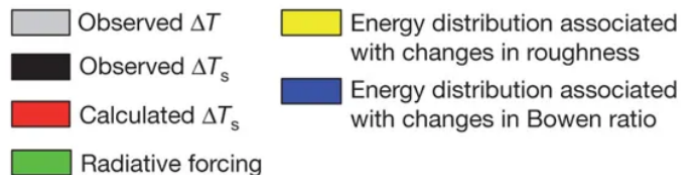
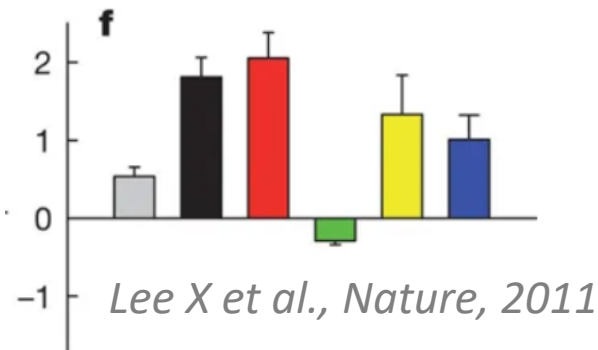
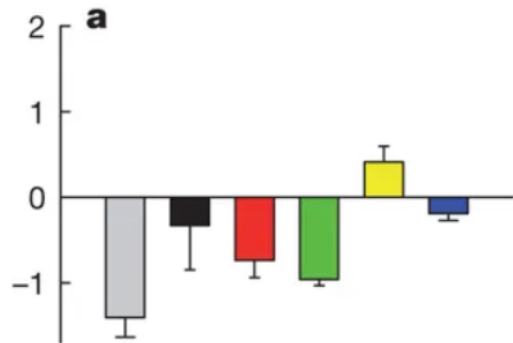
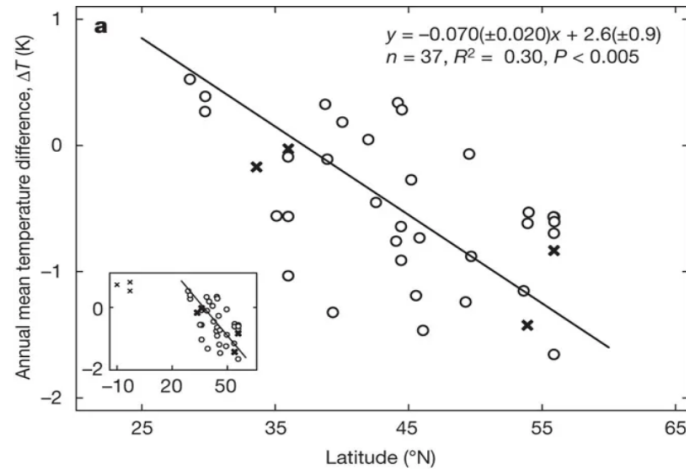
- Mosaic of subgrid tiles
- Subgrid data aggregated to grid means
- Subgrid data not delivered to CMIP
- Missing interesting information at scales at which activities are occurring

# Why subgrid?

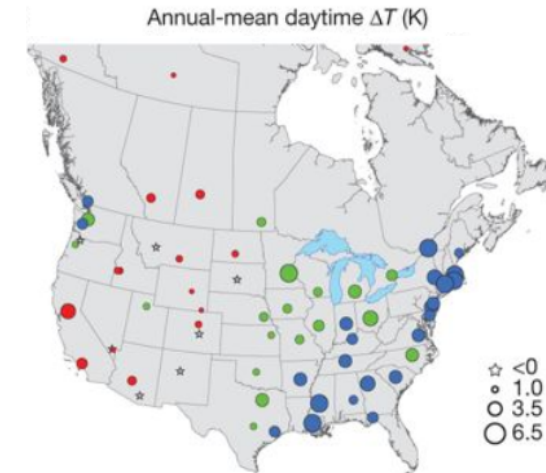
- Same atmospheric forcing is applied to each subgrid tile
  - The differing responses of land cover types can be examined
- “Space-for-time” approach → spatial variations sub for temporal changes
  - Benefit: isolating the biophysical effects of LULCC in models is not limited to regions that have undergone significant land use transitions
  - As long as multiple land cover types exist within a single gridcell, this method can be used to quantify potential impacts of proposed land-use changes virtually anywhere on the globe.
- Allows the isolation of local biophysical drivers associated with LULCC from other large-scale forcings and feedbacks within the simulated climate system.

# Site-pair or “space-for-time” approach

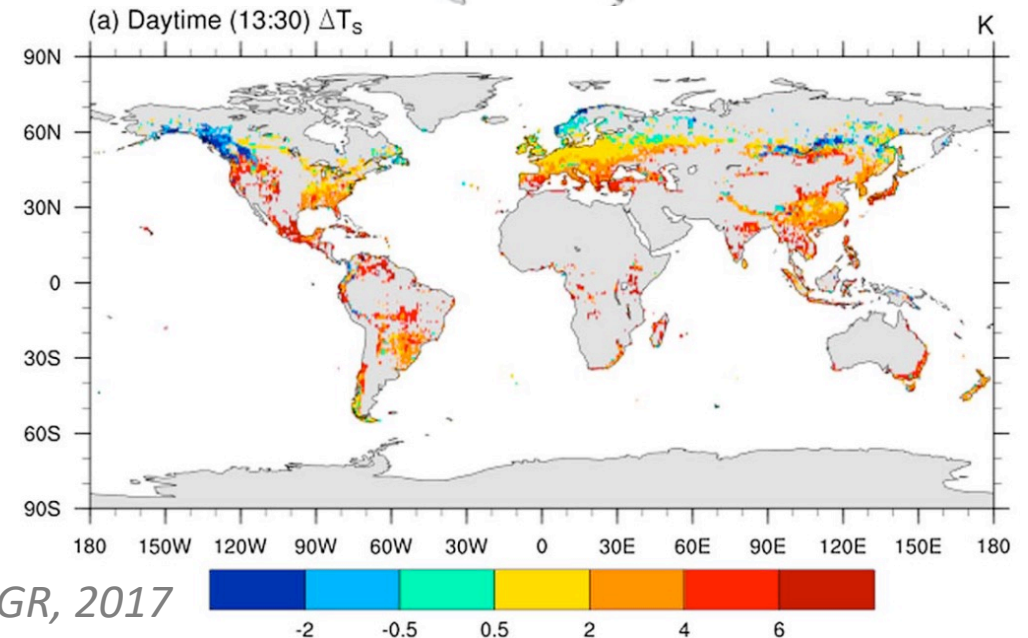
## Ground measurements



## Satellite observations



Zhao L et al.,  
Nature, 2014

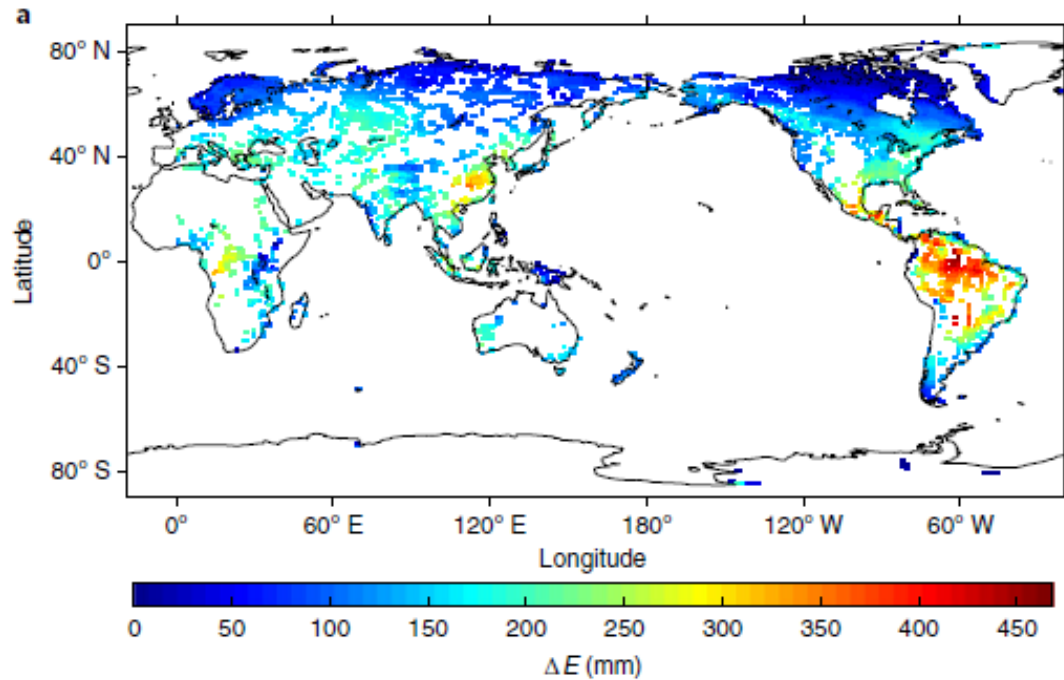


Schultz NM et al., JGR, 2017

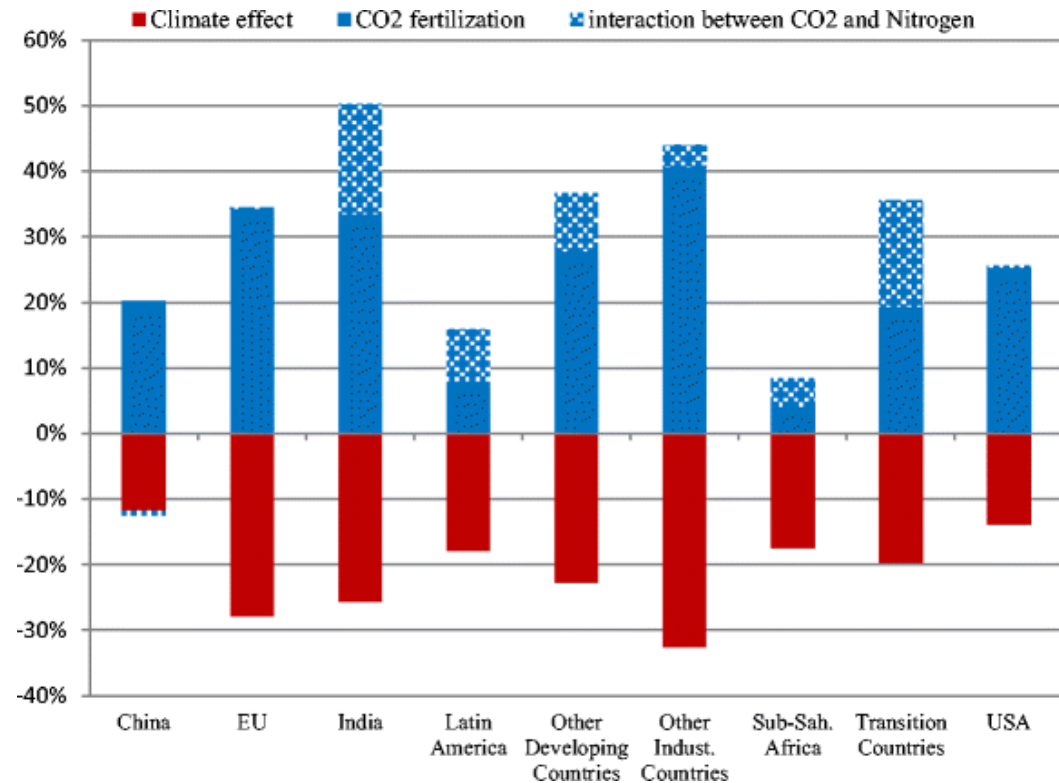
# Subgrid data: climate impacts

- Valuable resource to assess climate impacts + aid adaptation strategies.
- Efforts tied to local issues of much smaller extent than an ESM gridcell

**Lake evaporation**

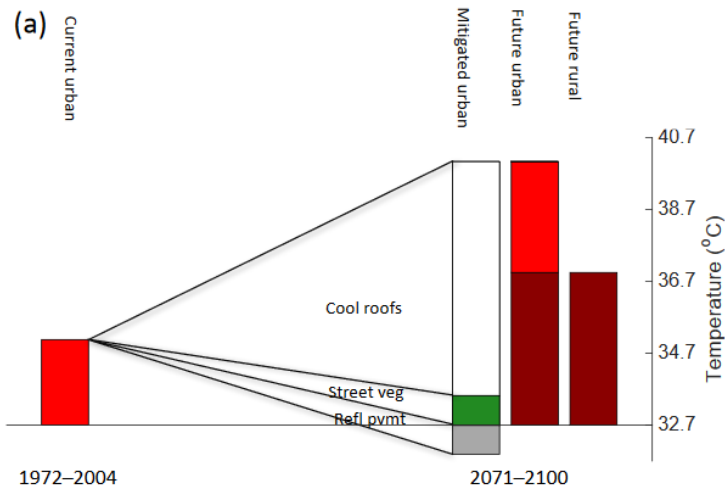
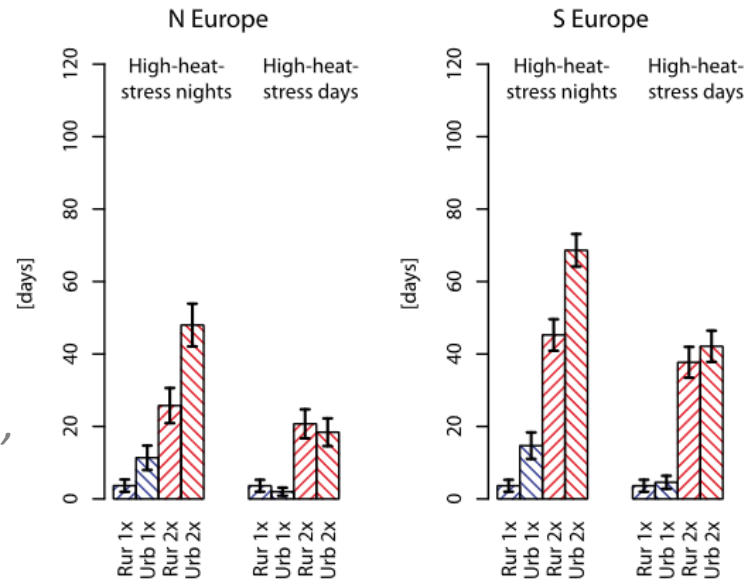


**Crop yield**

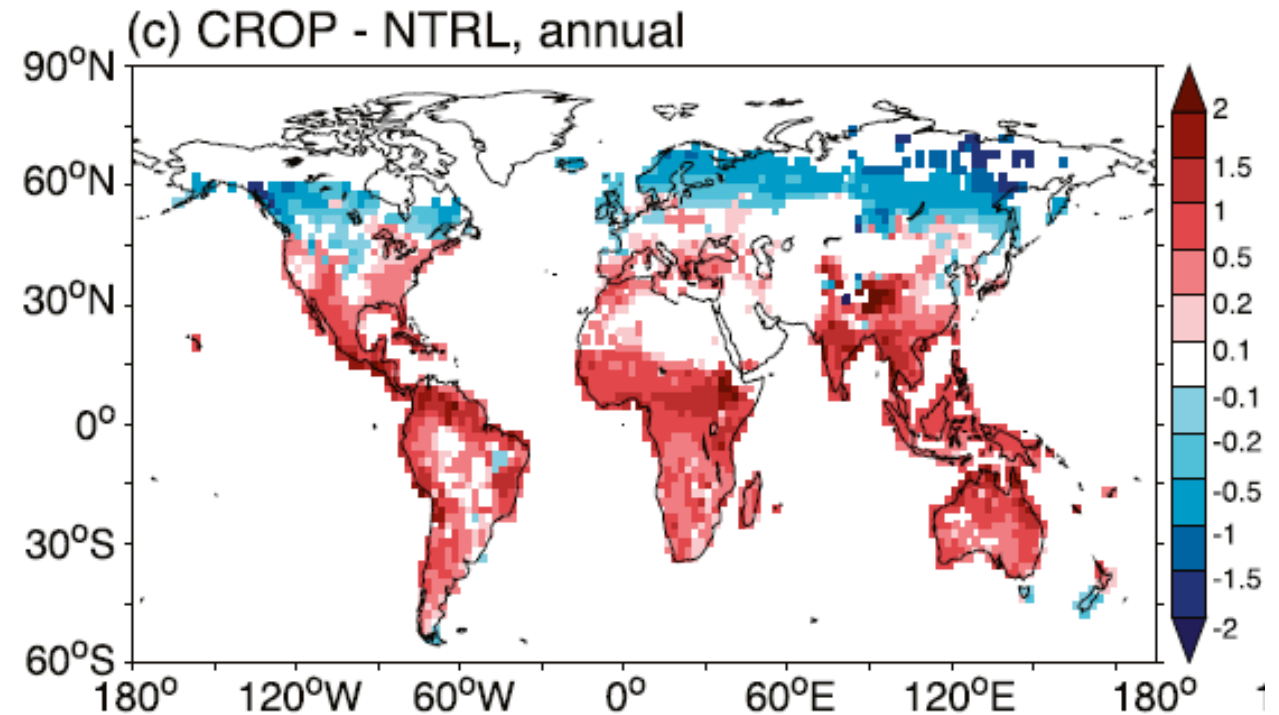


# Subgrid data: examine biophysical effects of LULCC

## Urban heat island



## Crop – Natural Veg



*Fischer et al.,  
GRL, 2012*

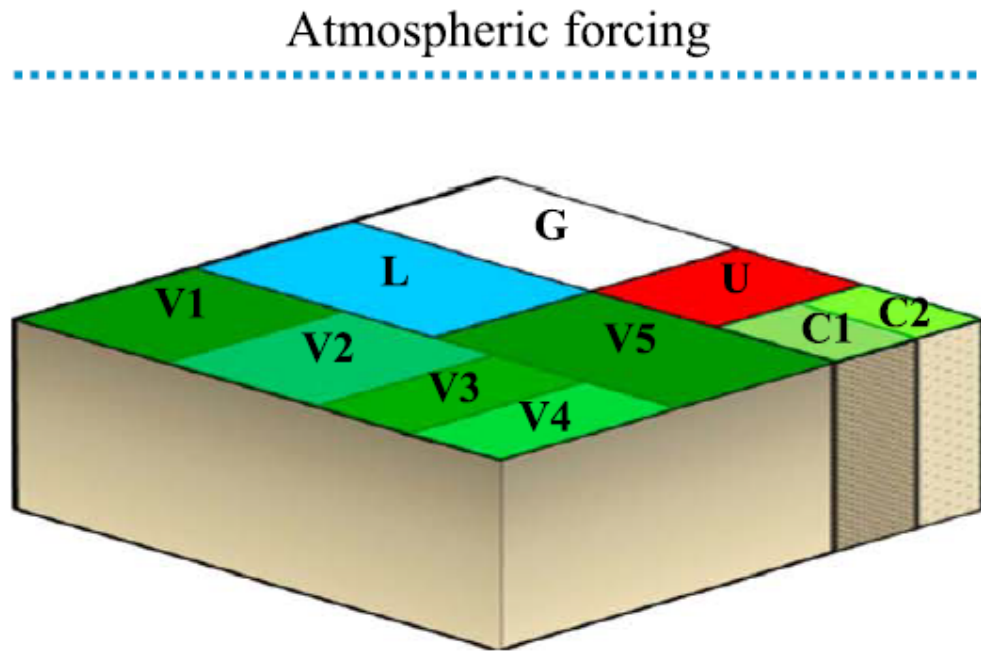
*Zhao L et al.,  
ACP, 2017*

*Malyshev S et al. JCLim, 2015*

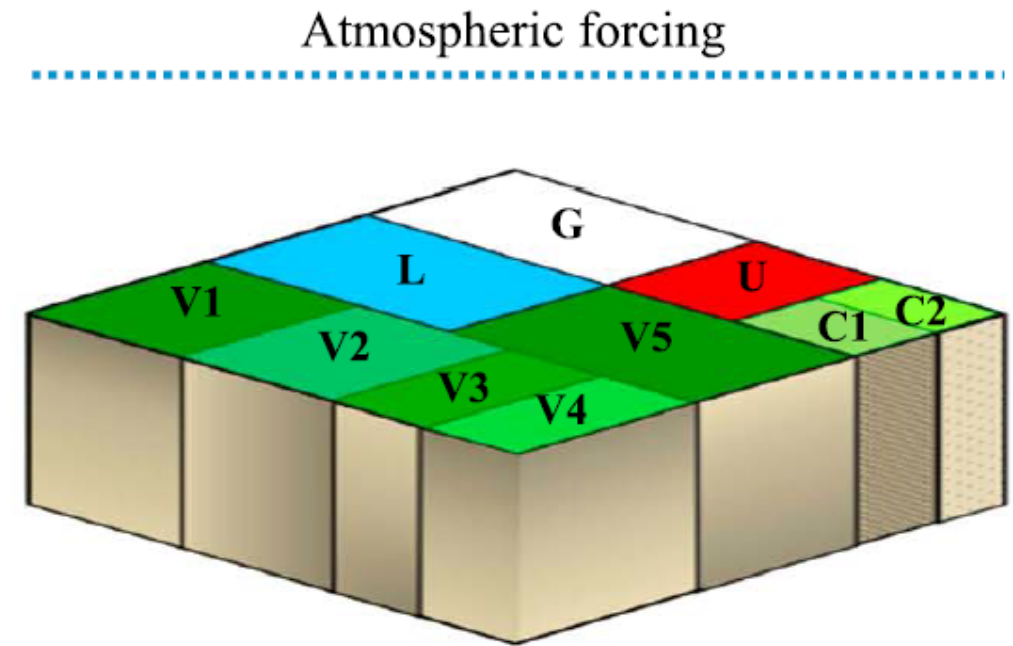


# PFT tiling configuration

**Shared column**

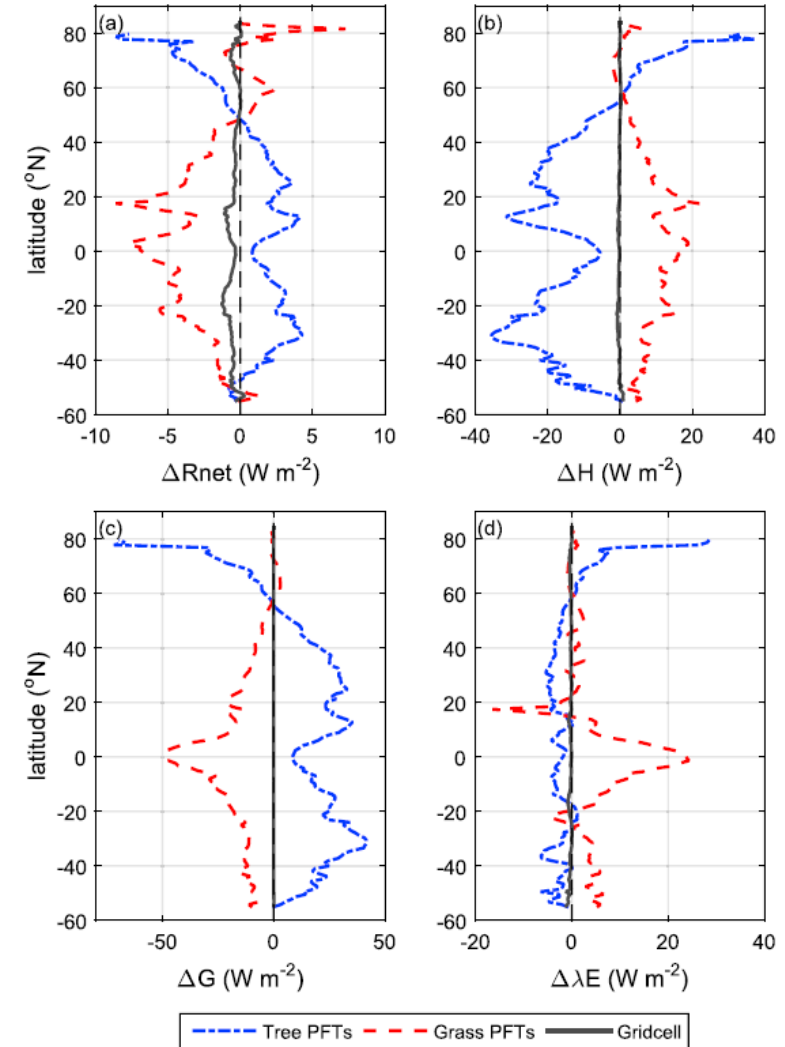
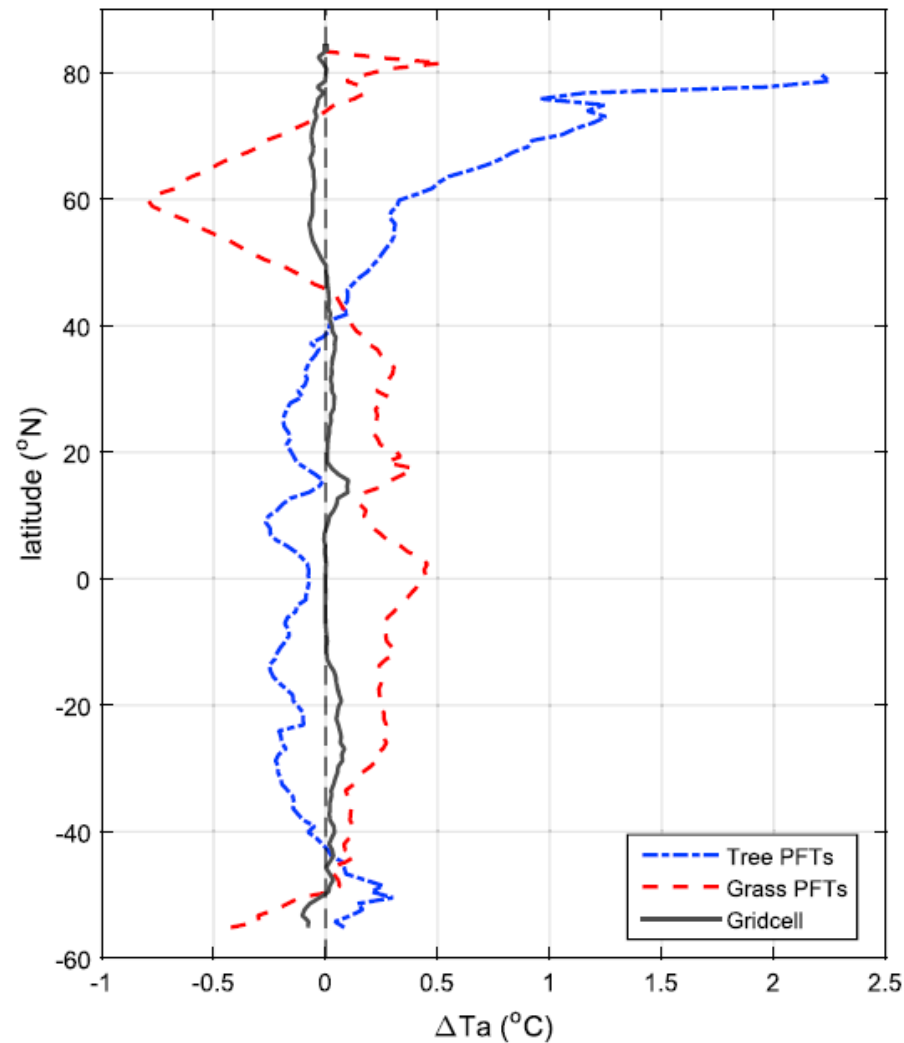


**Separate columns**



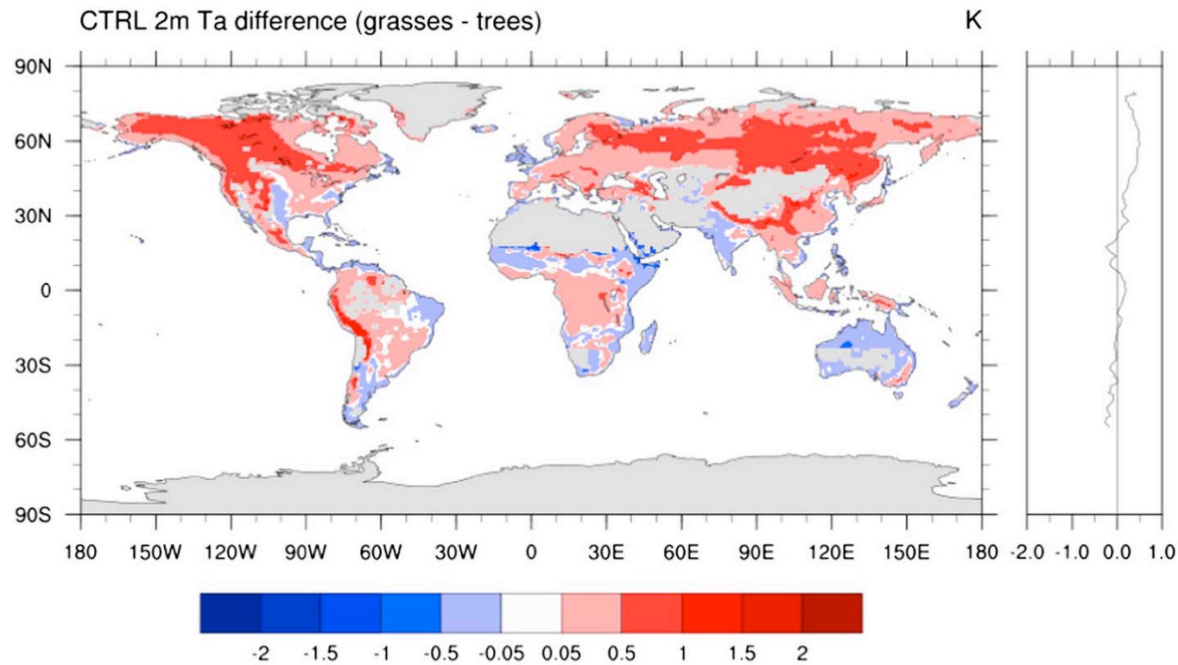


# Sensitivity to PFT tiling configuration

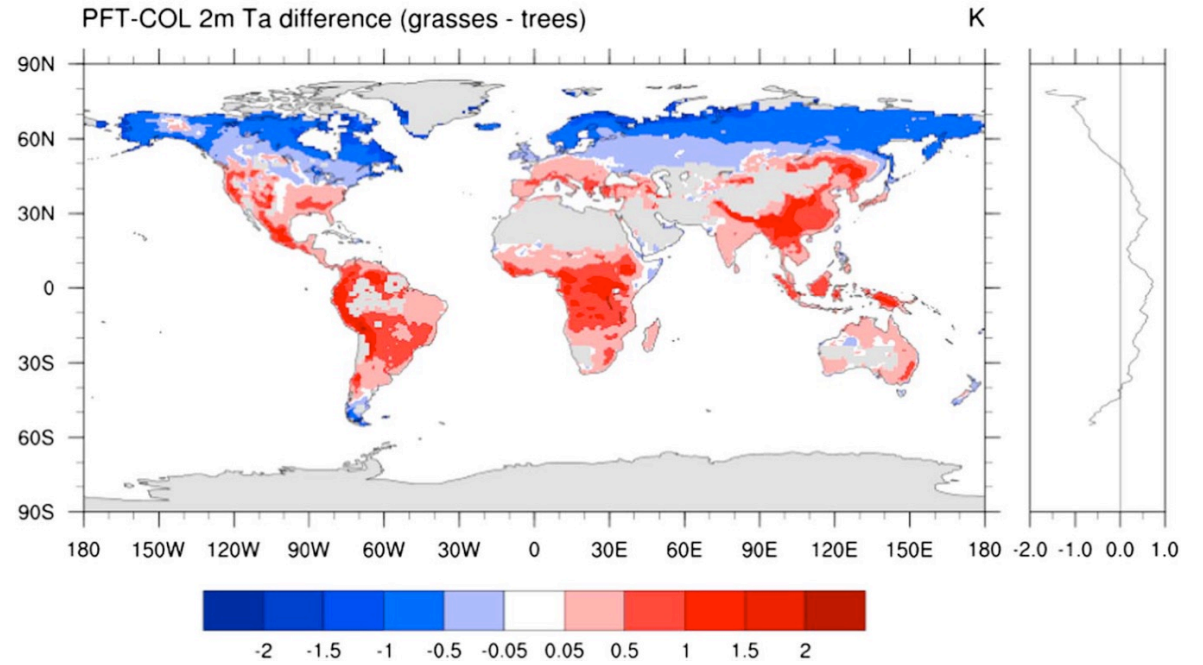


# $\Delta T_a$ sensitivity to PFT tiling configuration

Shared column

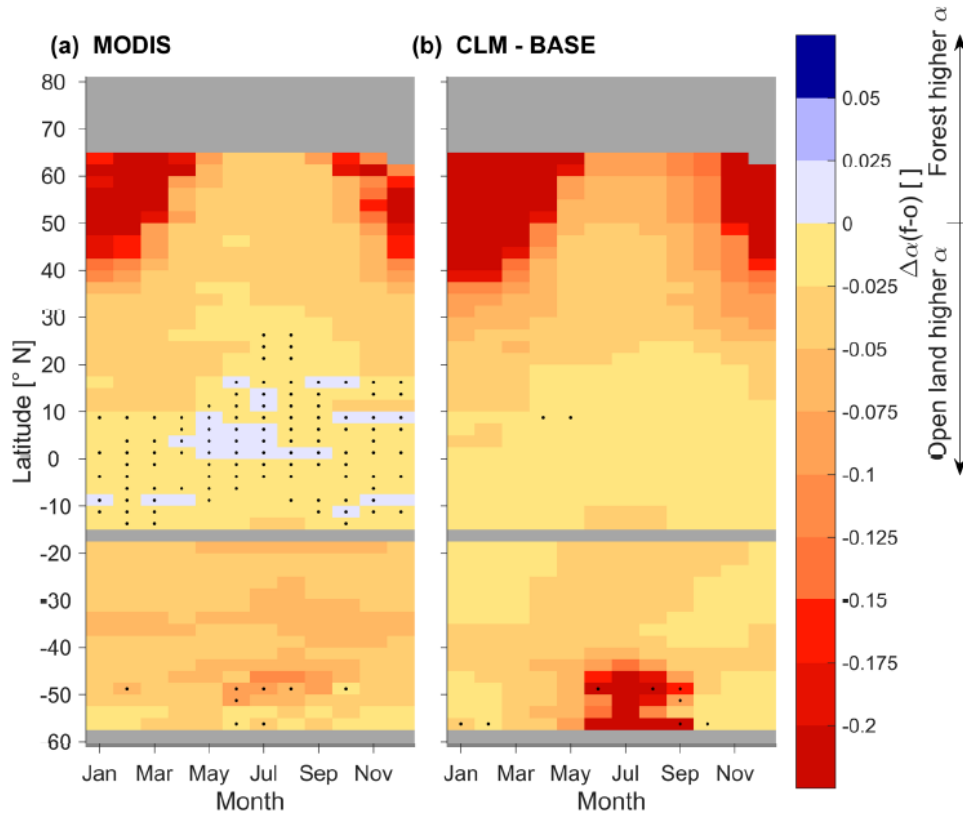


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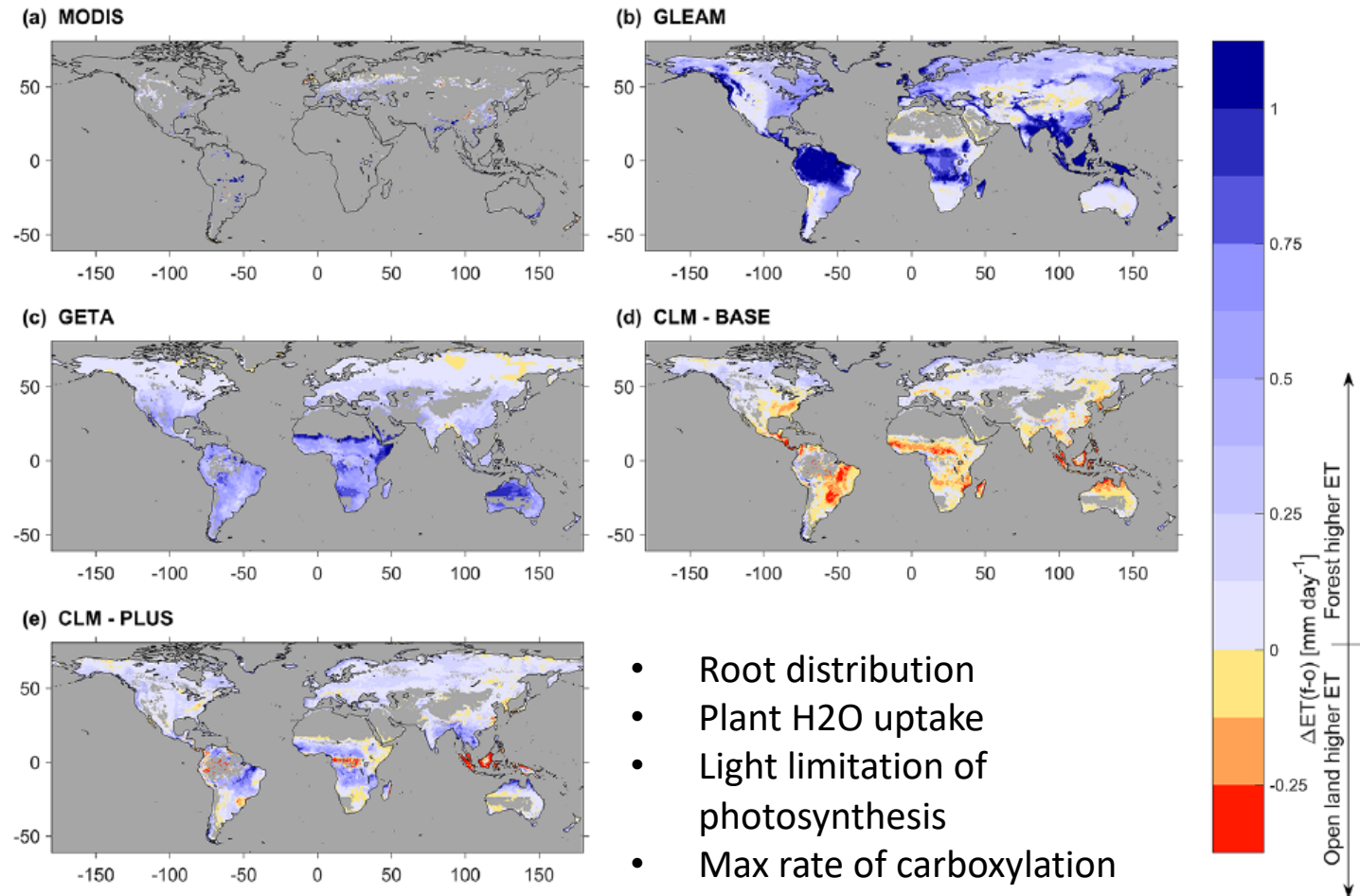


# Improve model parameterizations

## Albedo



## Evapotranspiration



# LUMIP subgrid opportunities

- First multi-model ensemble of subgrid data
- Potential to obtain our best estimate of the climate effects of LULCC, including a range of projected outcomes and the drivers of these outcomes
- Disentanglement of the local biophysical drivers associated with LULCC from other large-scale forcings and feedbacks within the simulated climate system.
- Subgrid data from multiple models can be compared to understand simulated processes and to improve model parameterizations.

Thank you.

