# Land Breakout
# CMMAP Team Meeting
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# Berkeley CA

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# What Topics are we Working on Now?

## (or, How Do I Spend My Time?)

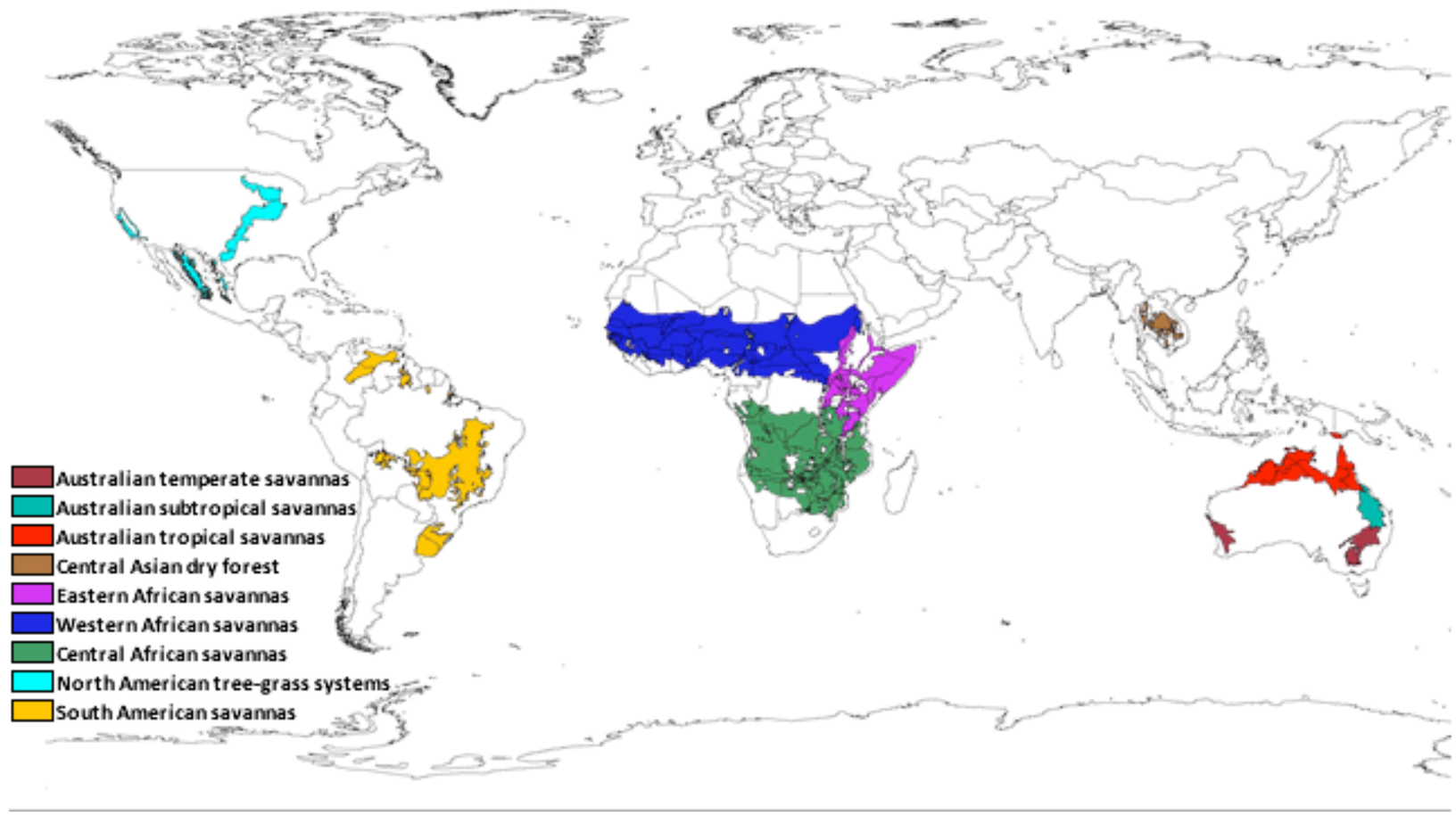
- Biophysics of Land-Atmosphere Interaction
- How Can we Represent our Understanding in MMF?

# Biophysics

- Amazon (see Scott's talk later)
- Savanna
- Radiative transfer at the vegetated (or bare) land surface
- Stomatal regulation of Bowen Ratio
- Long-term source/sink of carbon

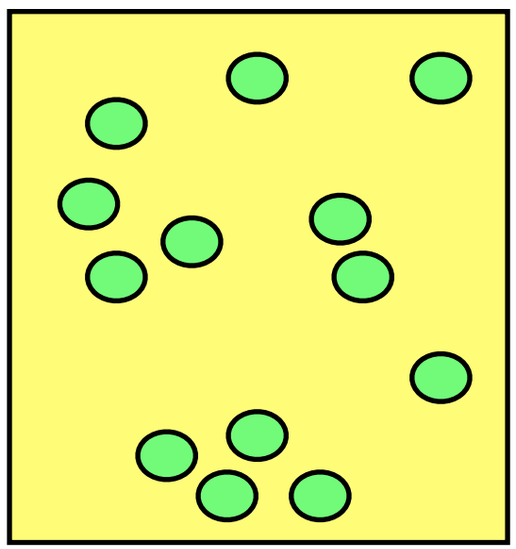
# Savanna

- Essentially unexplored biome, numerically
- Per-area carbon flux low
- large global domain
- important for human activity

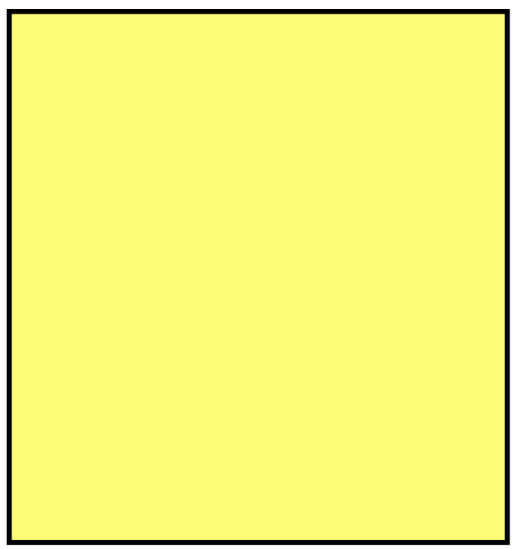


# Savanna: Numerical Representation

Reality

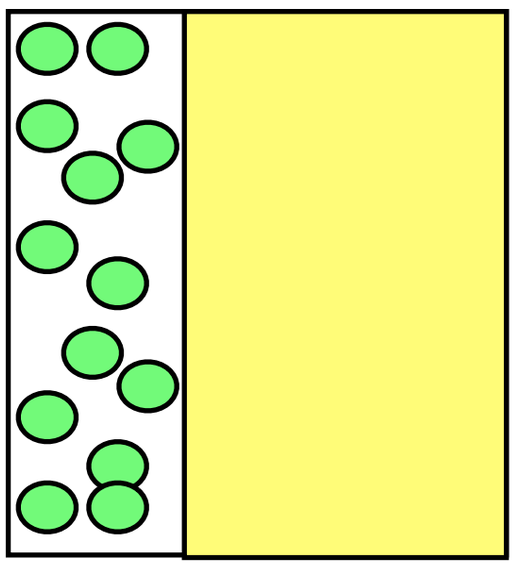


Dominant Vegetation Class



(SiB)

Plant Functional Type



(CLM)

# Community Land Model (CLM)

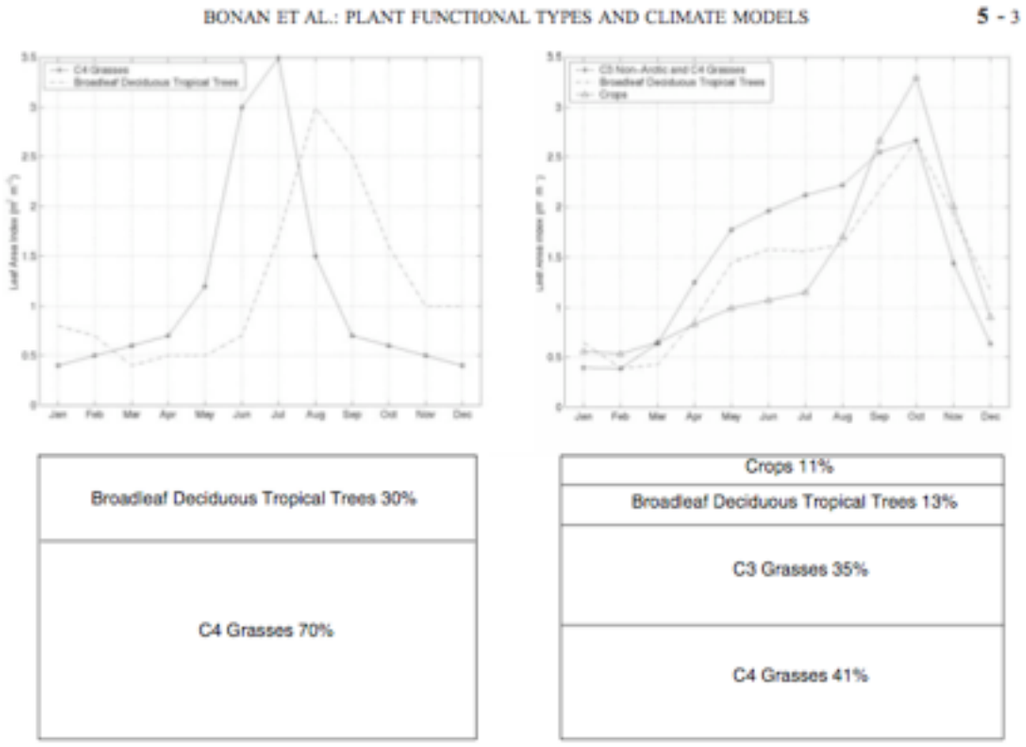
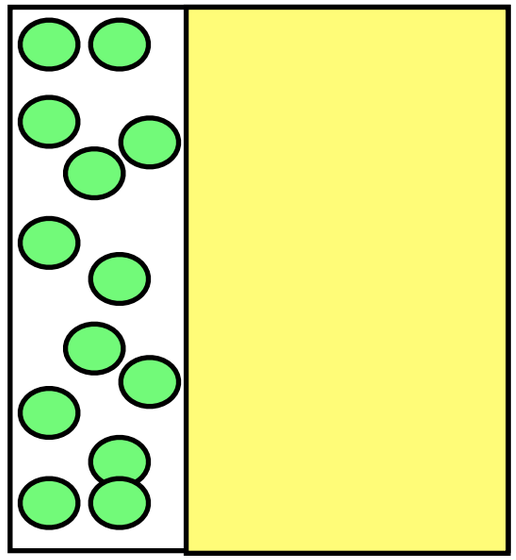



**Figure 1.** Composition and structure of vegetated patches in a grid cell. The figure shows, for a single grid cell centered on latitude 7.5°N and longitude 4.5°W, (top) the monthly leaf area index for each PFT patch and (bottom) the relative abundance of each PFT. The left panels show the fixed PFT LAI and PFT composition used in the biome data set of the standard model. The right panels show the new satellite-derived LAI and PFT composition for the same grid cell.

Bonan et al, 2002



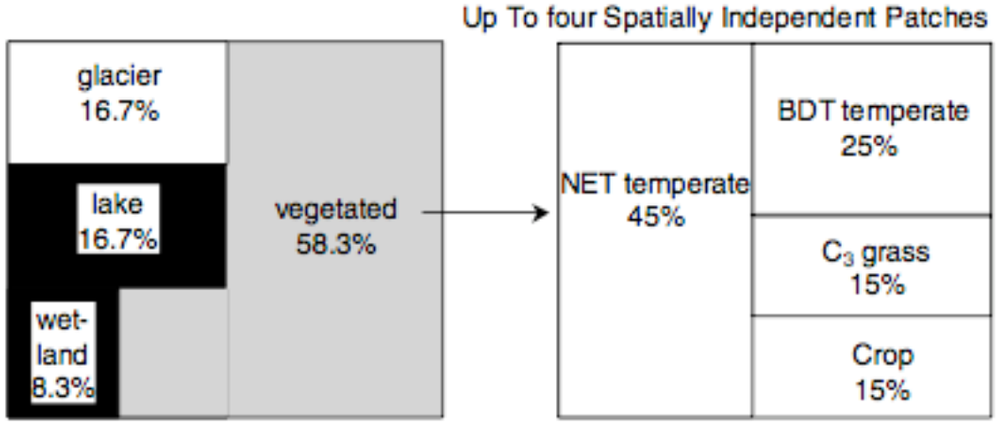
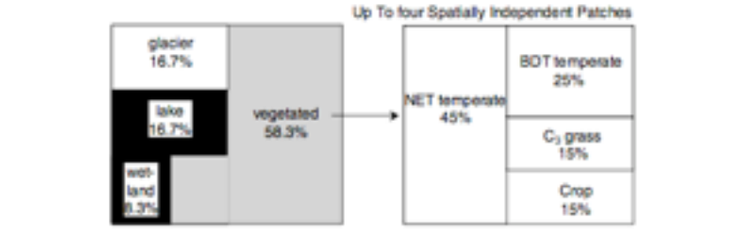



**Figure 2.** Subgrid patches of glacier, lake, wetland, and vegetation in the new version of the NCAR LSM. The vegetated portion of the grid cell is divided into up to four PFTs with unique composition and leaf area.

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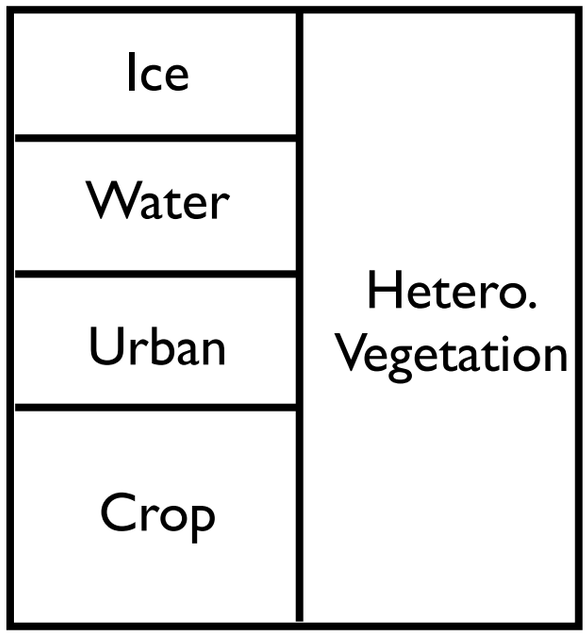
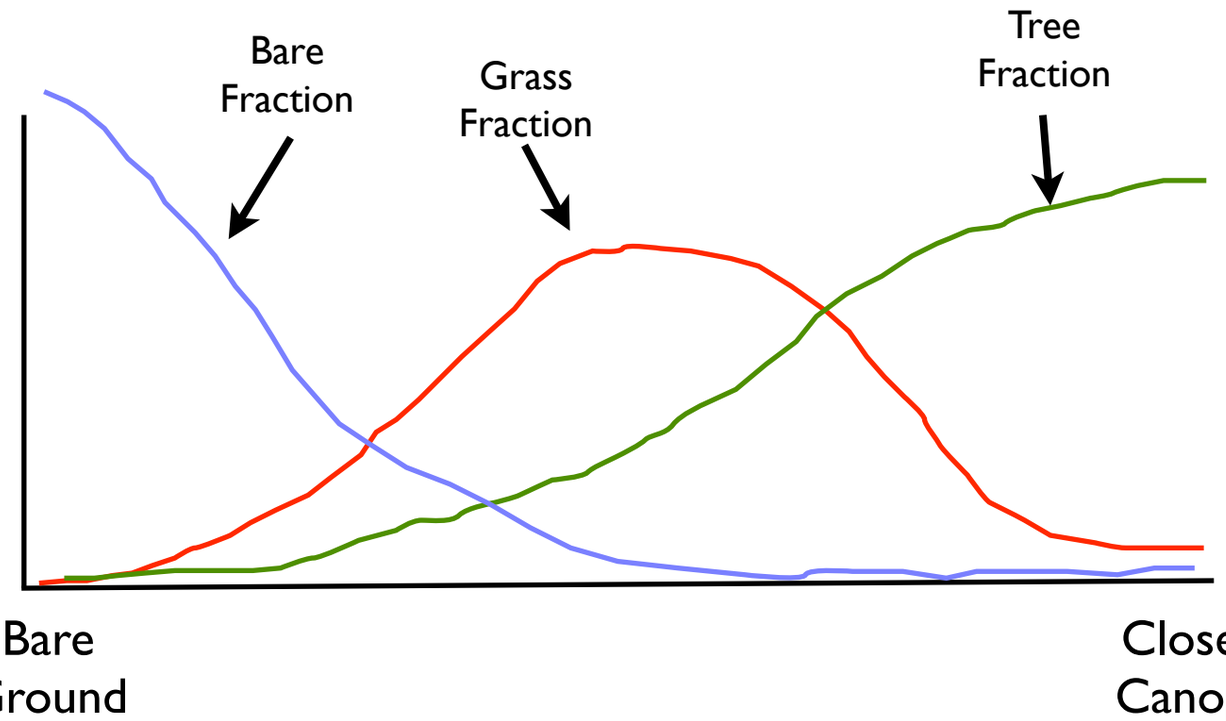
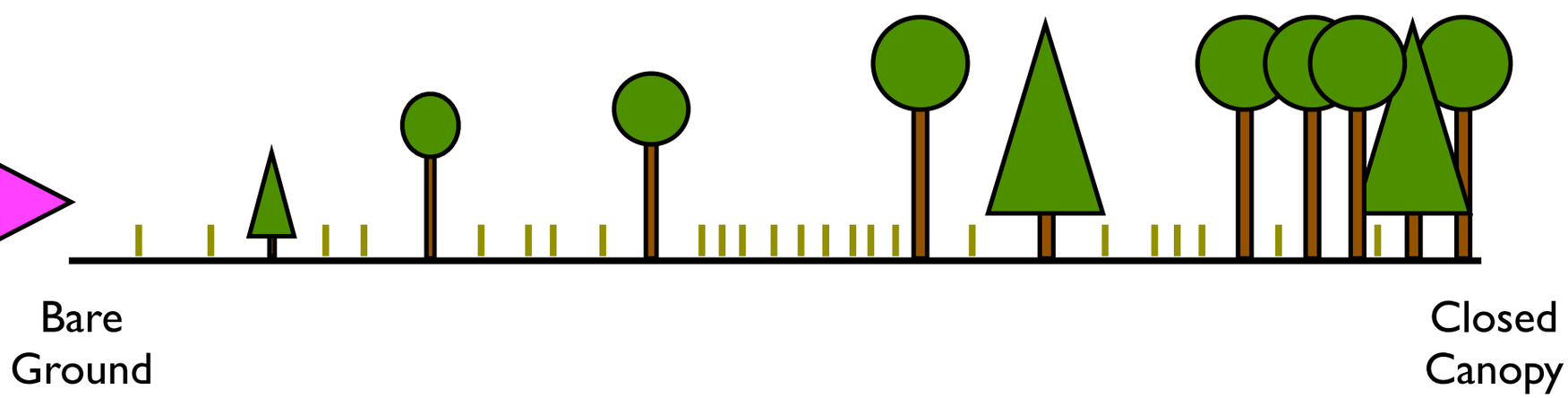
# New Modeling Strategy



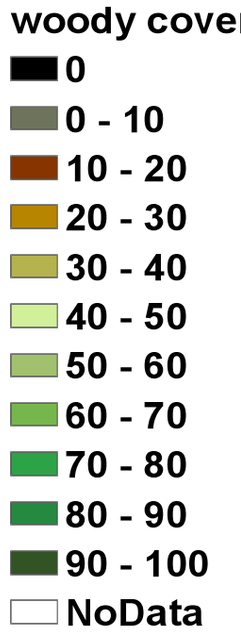



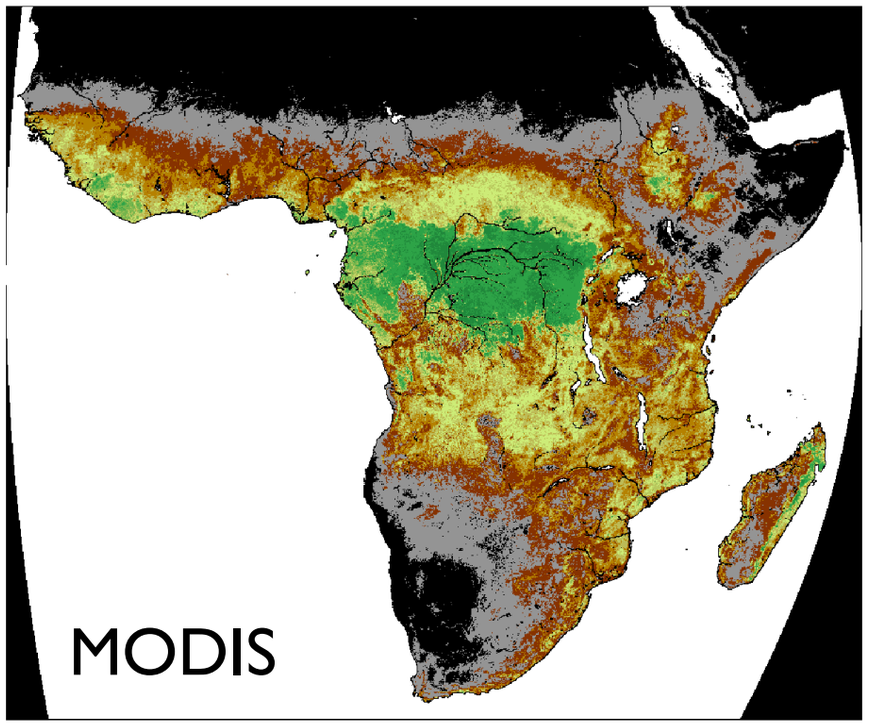

Multiple Physiology!
(Hanan et al 2005)



# What Vegetation Information is Available?

- MODIS Vegetation Cover Fraction (VCF) Maps
- Vegetation Type Maps (Hansen, DeFries, collaborators)

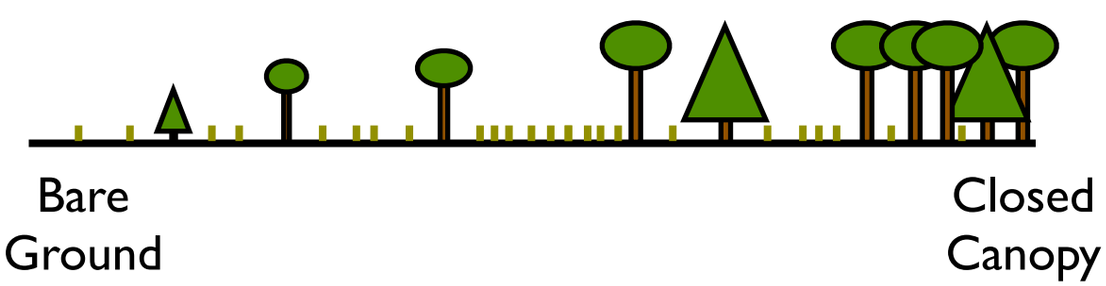




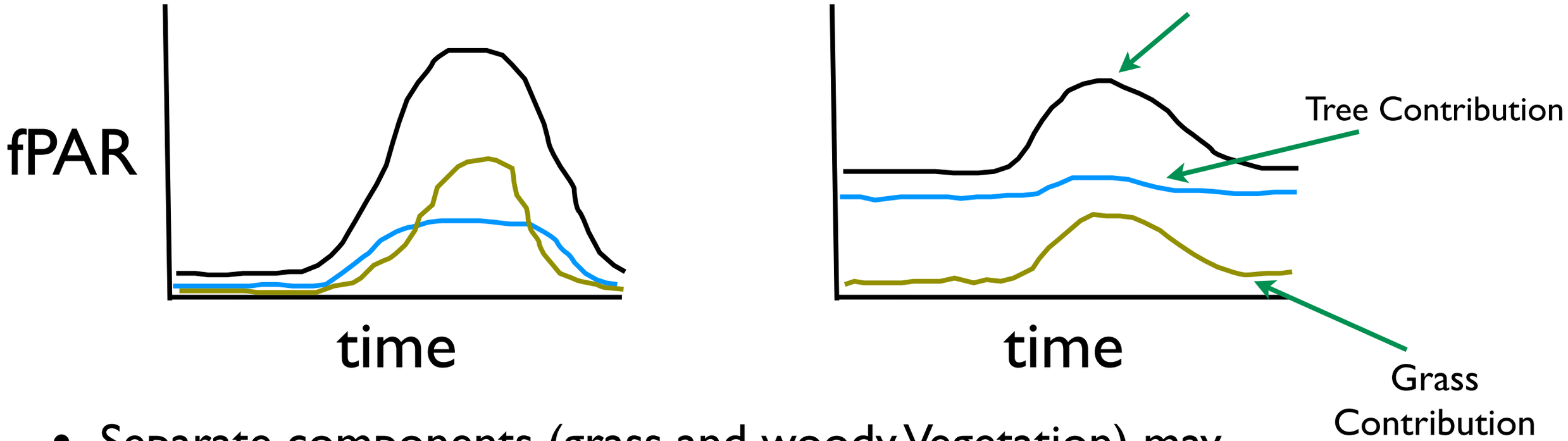


From Bucini et al, FRSES 2010



# The Real Issue:

## How Can We Determine Phenology of Multiple Canopy Components?




- Separate components (grass and woody Vegetation) may respond to different environmental cues

- Spectral vegetation indices may not be able to distinguish between them

# Phenology Partitioning

Archibald & Scholes (2007) were able to separate tree and grass green-up in NDVI data by exploiting differing response to environmental cues

- Trees: respond to photoperiod
- Grass: respond to rainfall (RH, soil moisture)

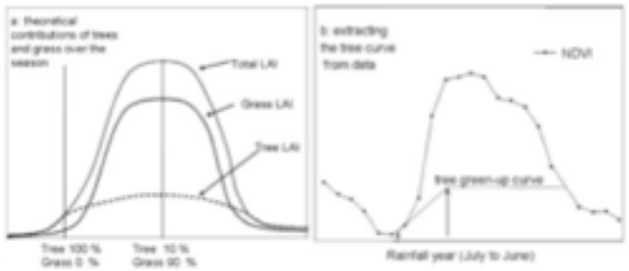



**Fig. 4. a.** Theoretical contributions of trees and grass to total landscape LAI over a growing season. Trees go green earlier, and stay green for longer, but grasses have a higher LAI at the height of the growing season. b. Schematic showing how to extract the tree green-up curve from satellite NDVI data. The parameters required to derive a tree phenology curve are: (1) tree green-up date (the first sign of increased NDVI in spring); (2) the maximum greenness trees can attain in the landscape (calculated from the percentage of tree cover) and (3) the time taken to get from green-up to full leaf (green-up rate – observed from field data).

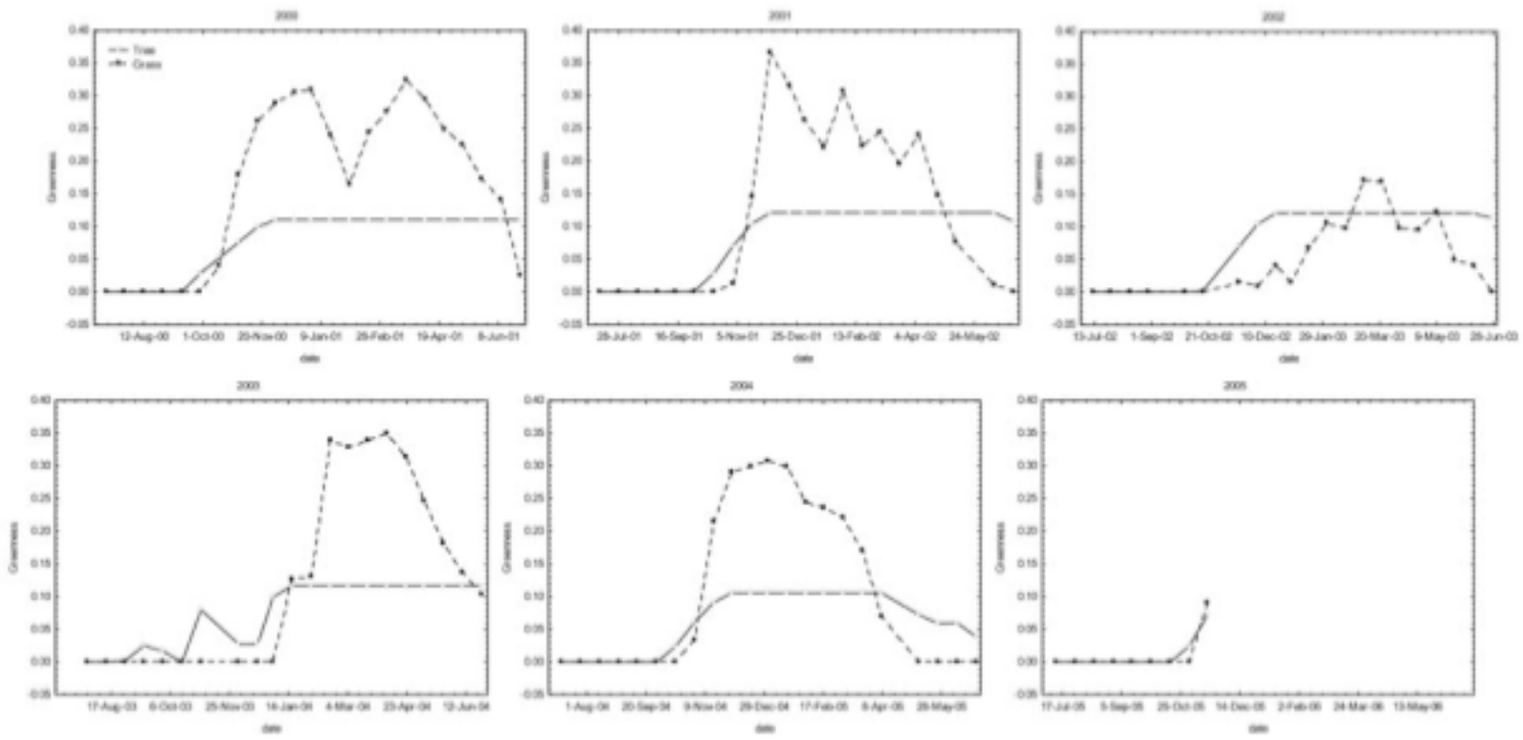
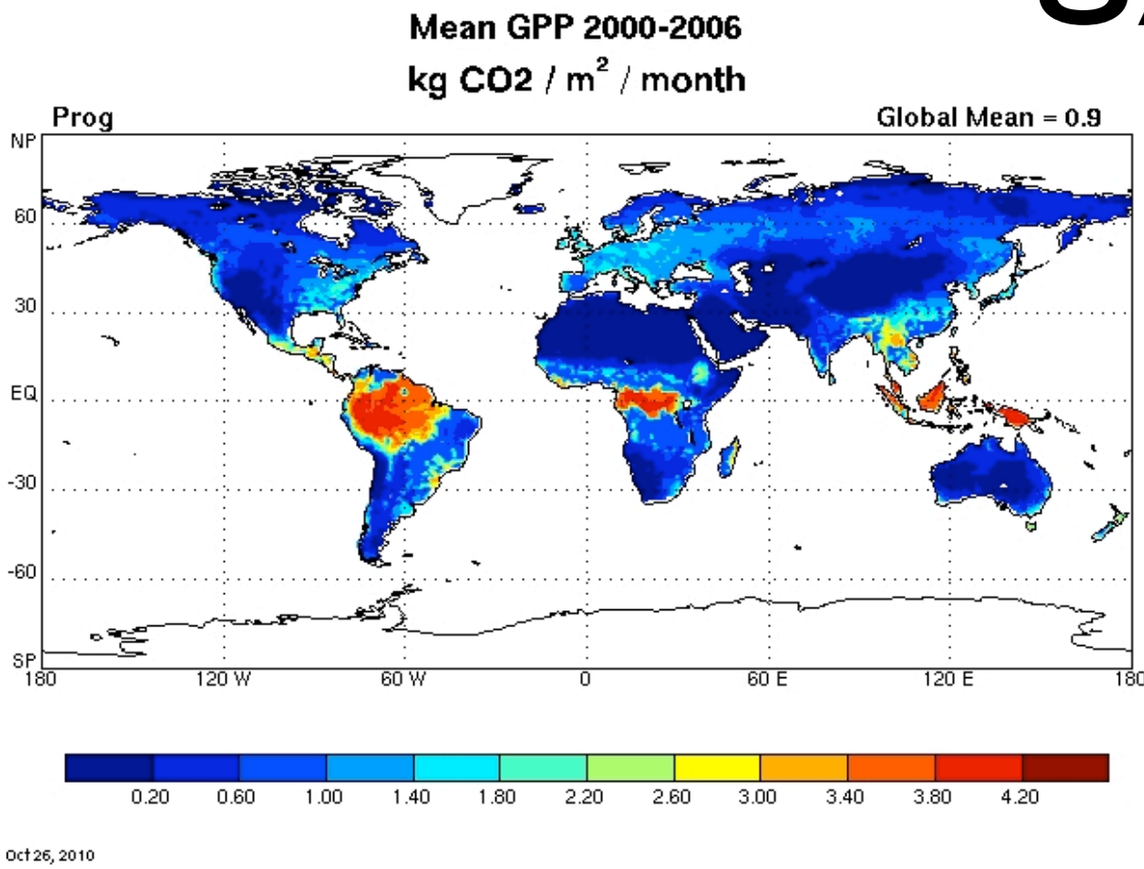
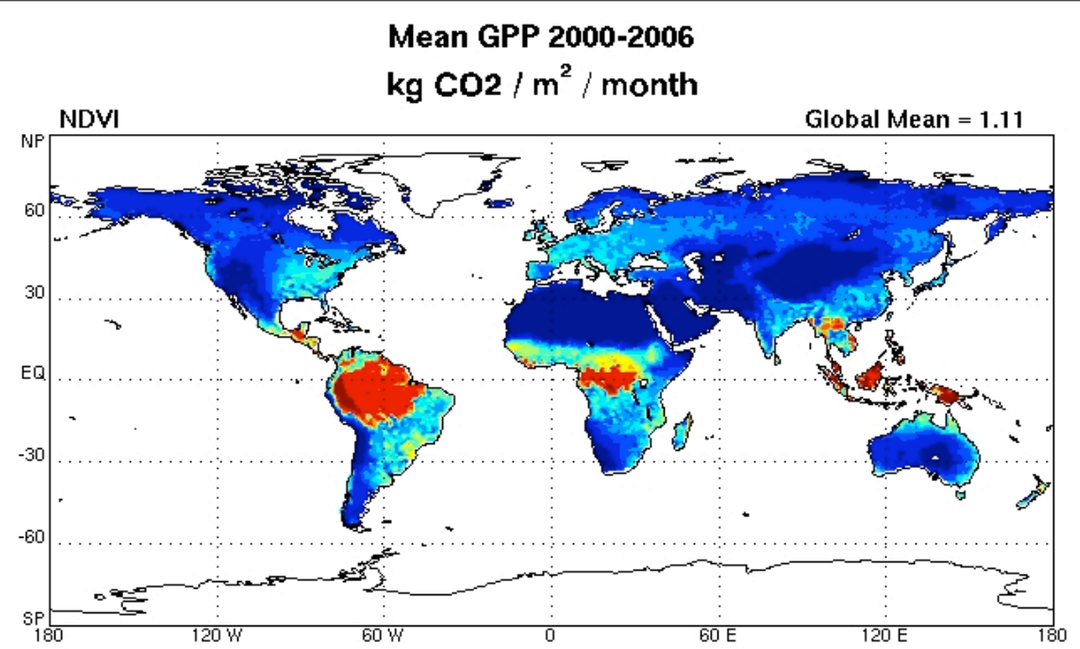
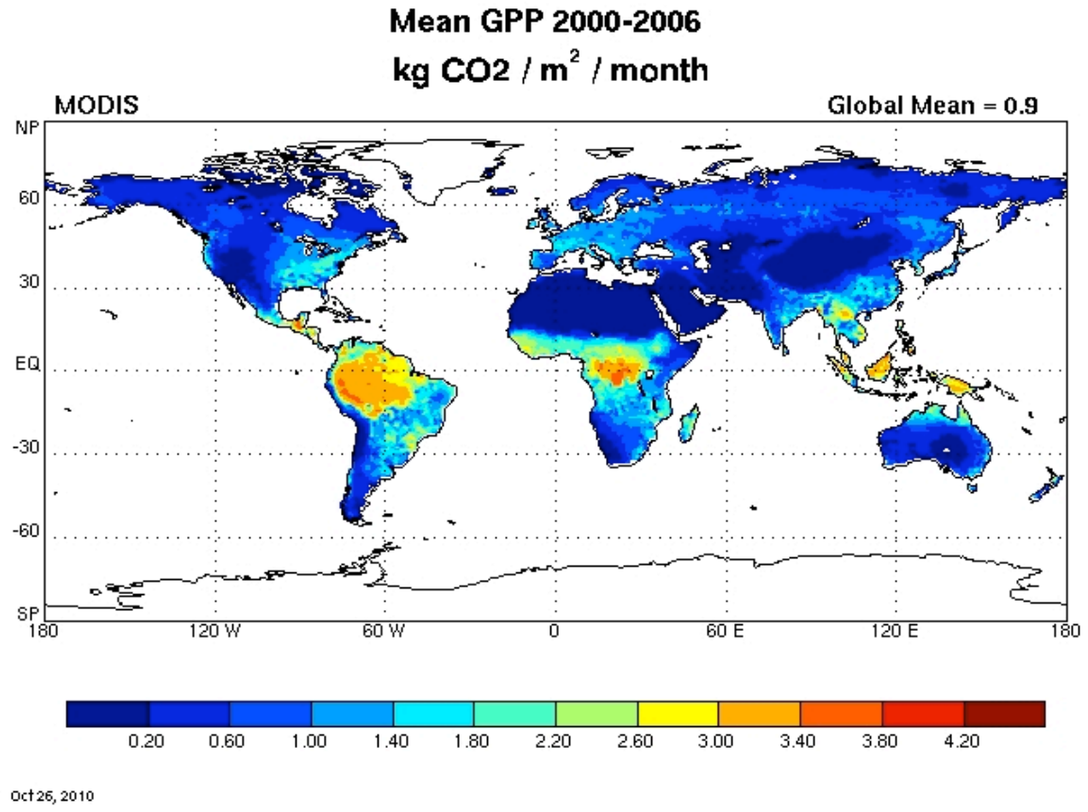



**Fig. 6.** Tree and Grass green-up curves for each year of the MODIS NDVI dataset. The tree green-up curve was extracted from the raw data using field observations of green-up rates and theoretical computation of maximum greenness values for trees in the landscape. This was then subtracted from the total landscape NDVI to obtain the grass curve. In 2002 there was a drought, and very little grass growth occurred.

# Prognostic Phenology



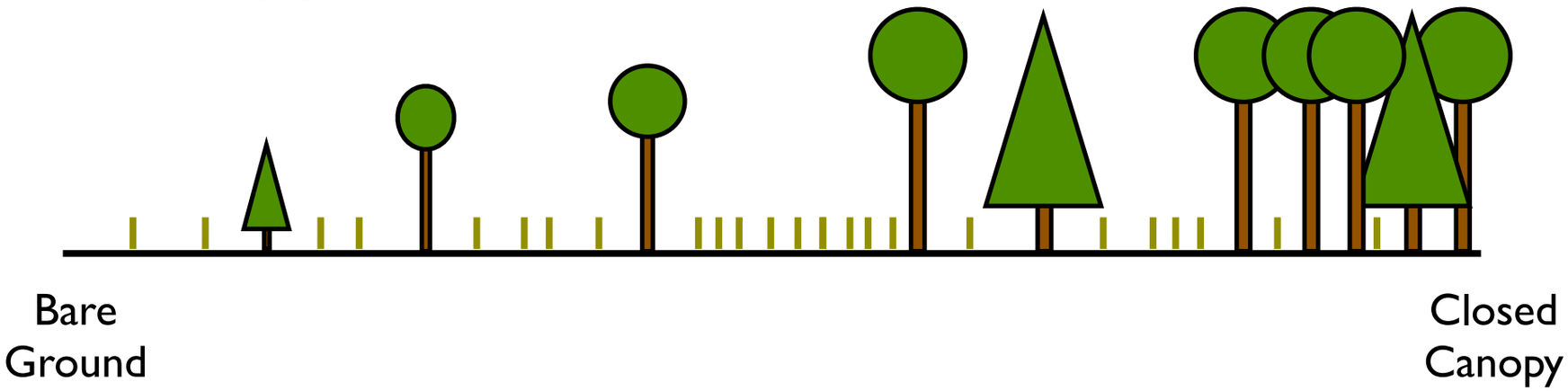




- Prognostic Phenology still has trouble in savanna
- otherwise, a reasonable result

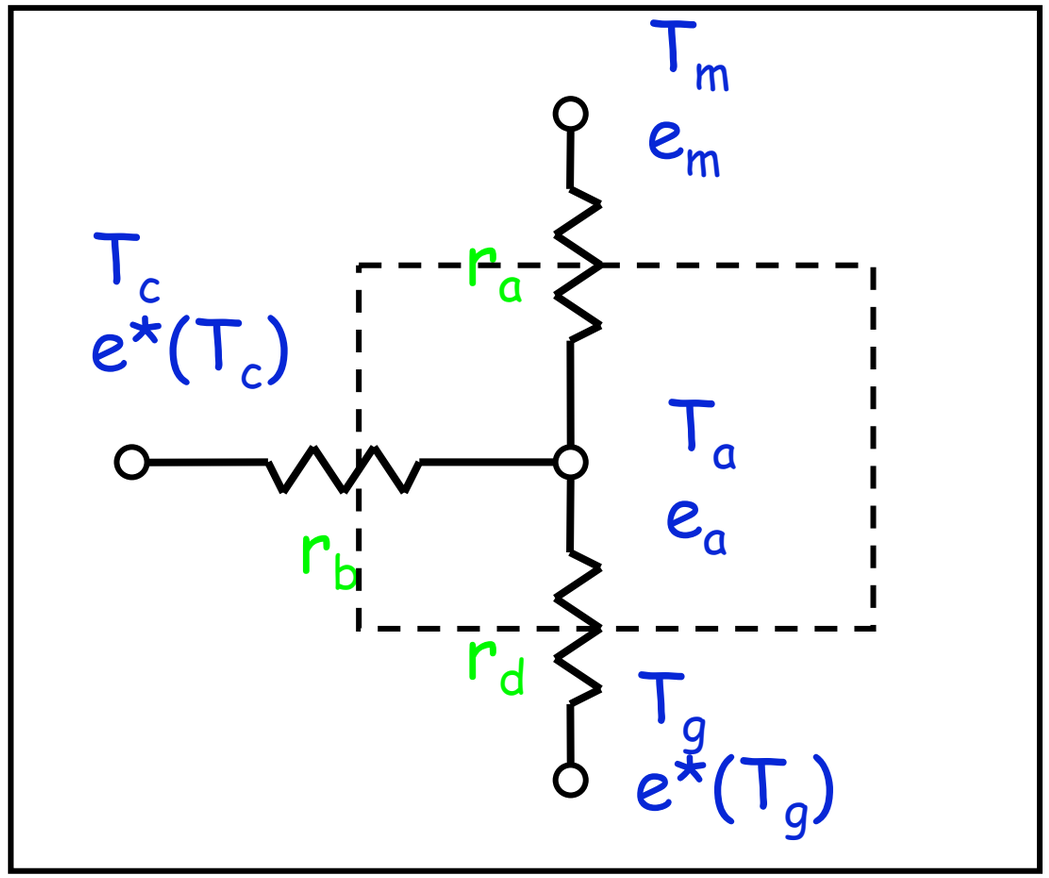
# So now we have options...

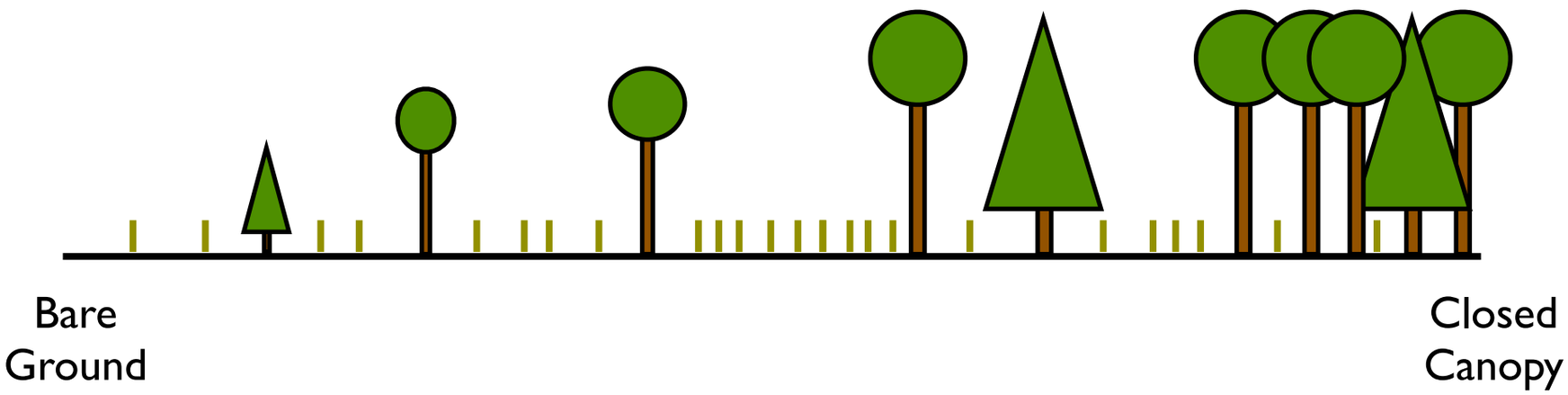
1. Develop code that integrates multiple physiology types sharing soil and airspace (DONE!)
2. Obtain vegetation distribution from MODIS (Available!)
3. Choose phenology determination
    - partition from NDVI (Archibald & Scholes: Hybrid of NDVI and observed phenology)
    - Prognostic Phenology Model (Stockli et al); use MODIS for validation



# SiB: perfectly suited...

- Prognostic Canopy Air Space
- Multiple Physiology Capability

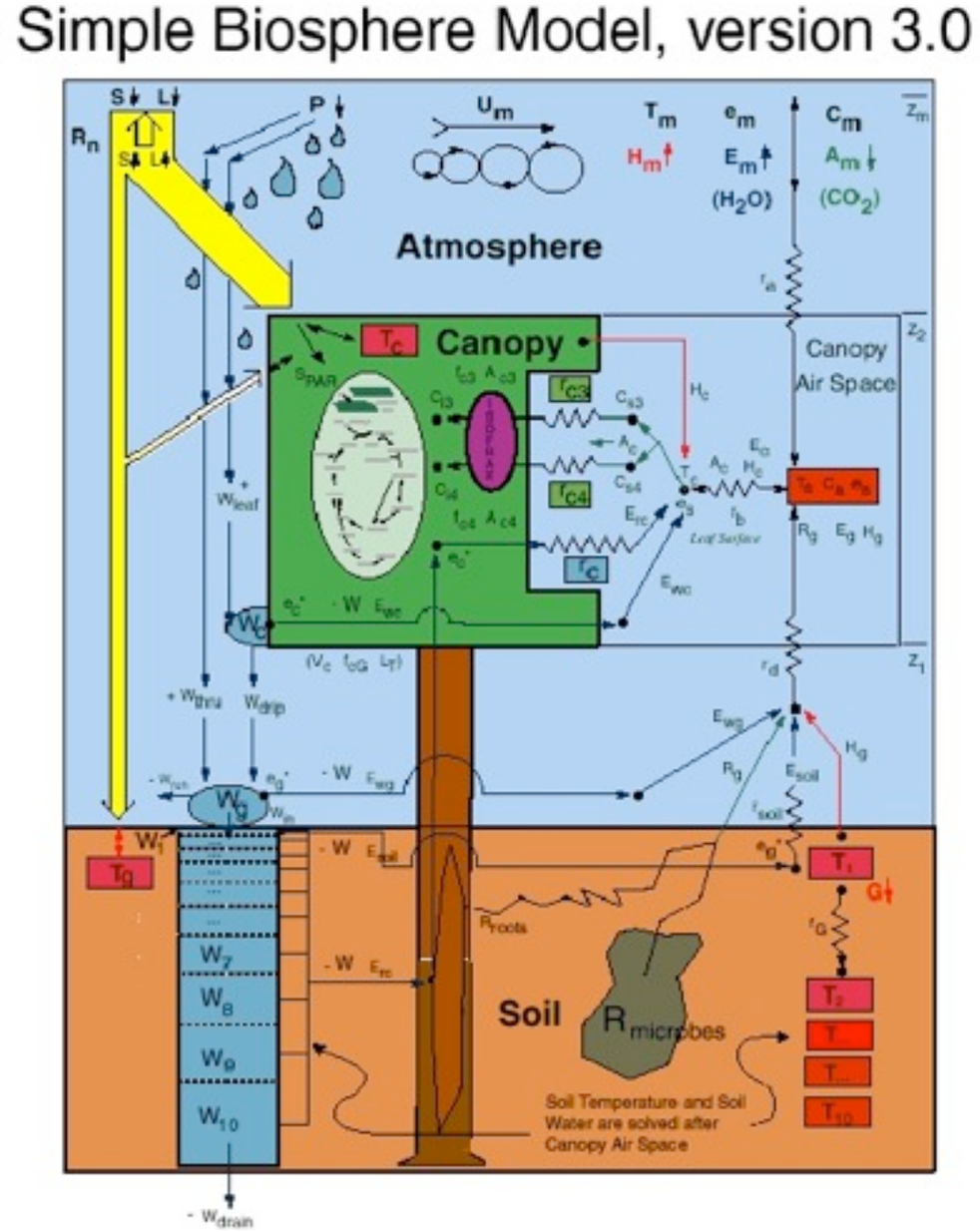


# Radiative Transfer

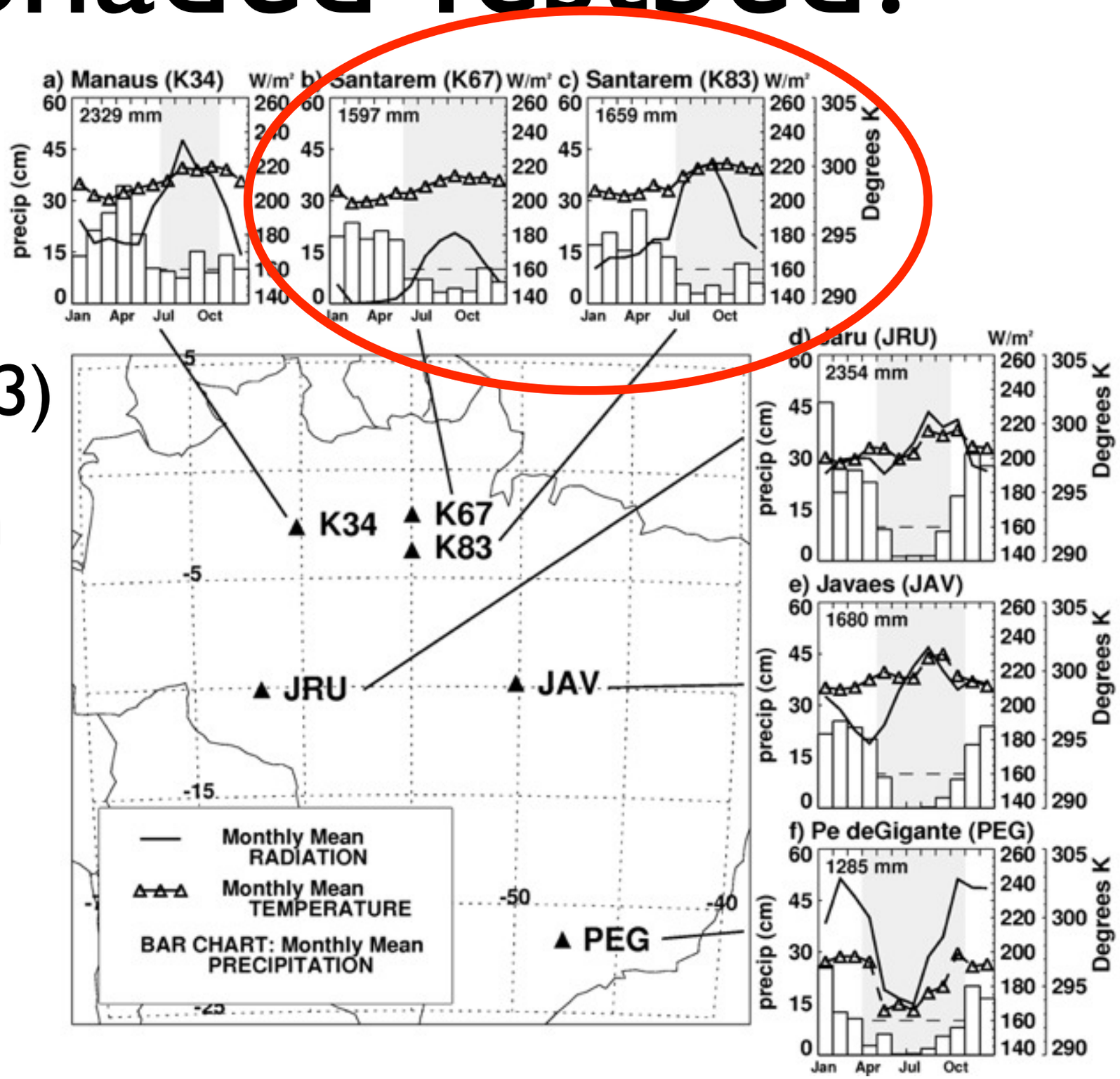
(and now for something completely different)

- SiB: Calculates Sun-Leaf behavior, integrates for canopy-level (Sellers 1985)
- Bowen Ratio bias in dense canopies
- Sunlit/Shaded Canopy (de Pury & Farquhar 1997, Wang & Leuning 2008, Dai, Dickinson & Wang 2004)



# Sunlit Shaded Testbed?

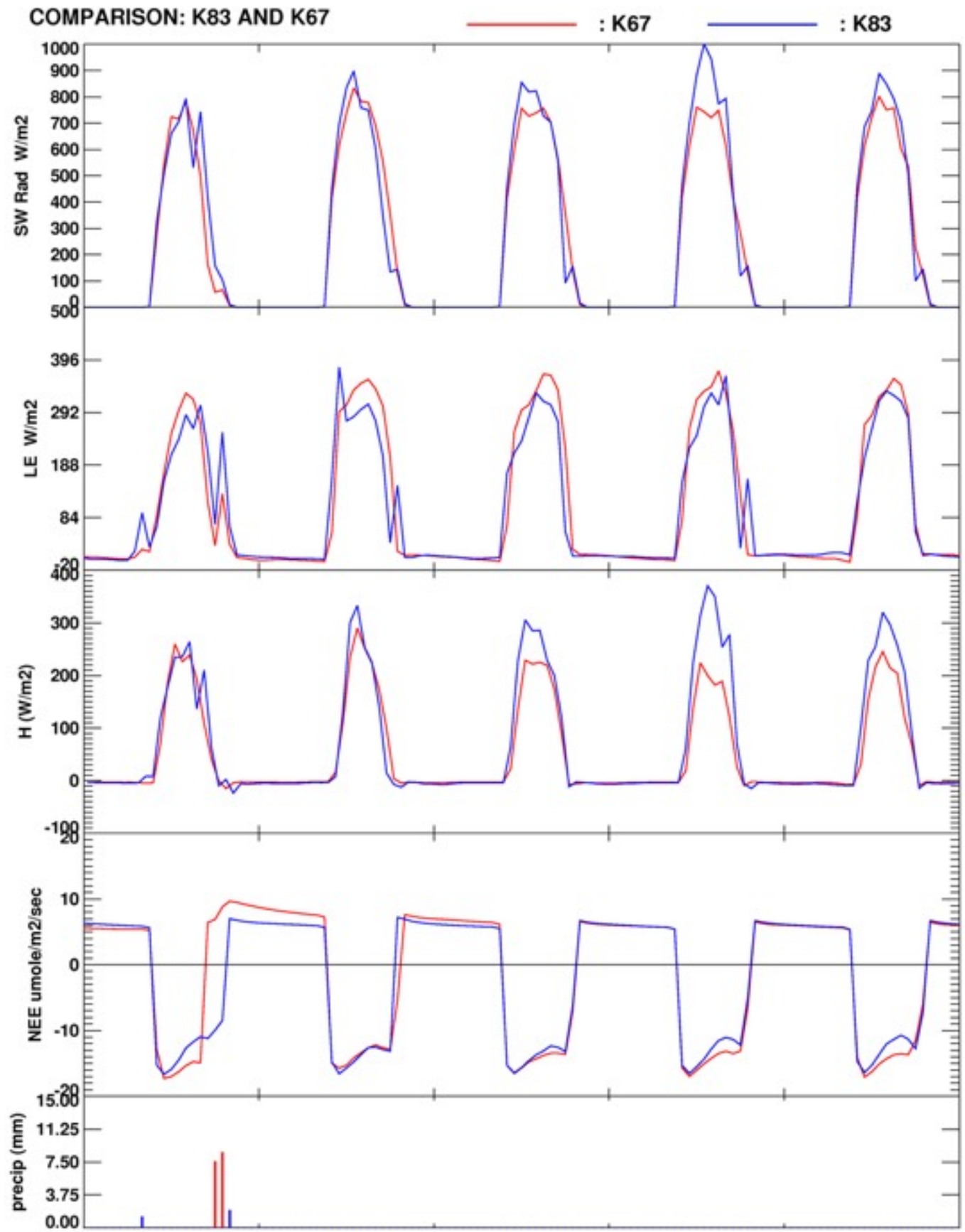
- Tapajos River National Forest, Brazil (KM67/KM83)
- Sites are near each other
- Virtually identical- but look at radiation!



# Sunlit/ Shaded: Tapajos K67/K83

- Is it instrument bias?

  No.



# So What's going on?

- River Breeze (Silva Dias et al. 2004)
- Convergence line (Lu et al. 2005)

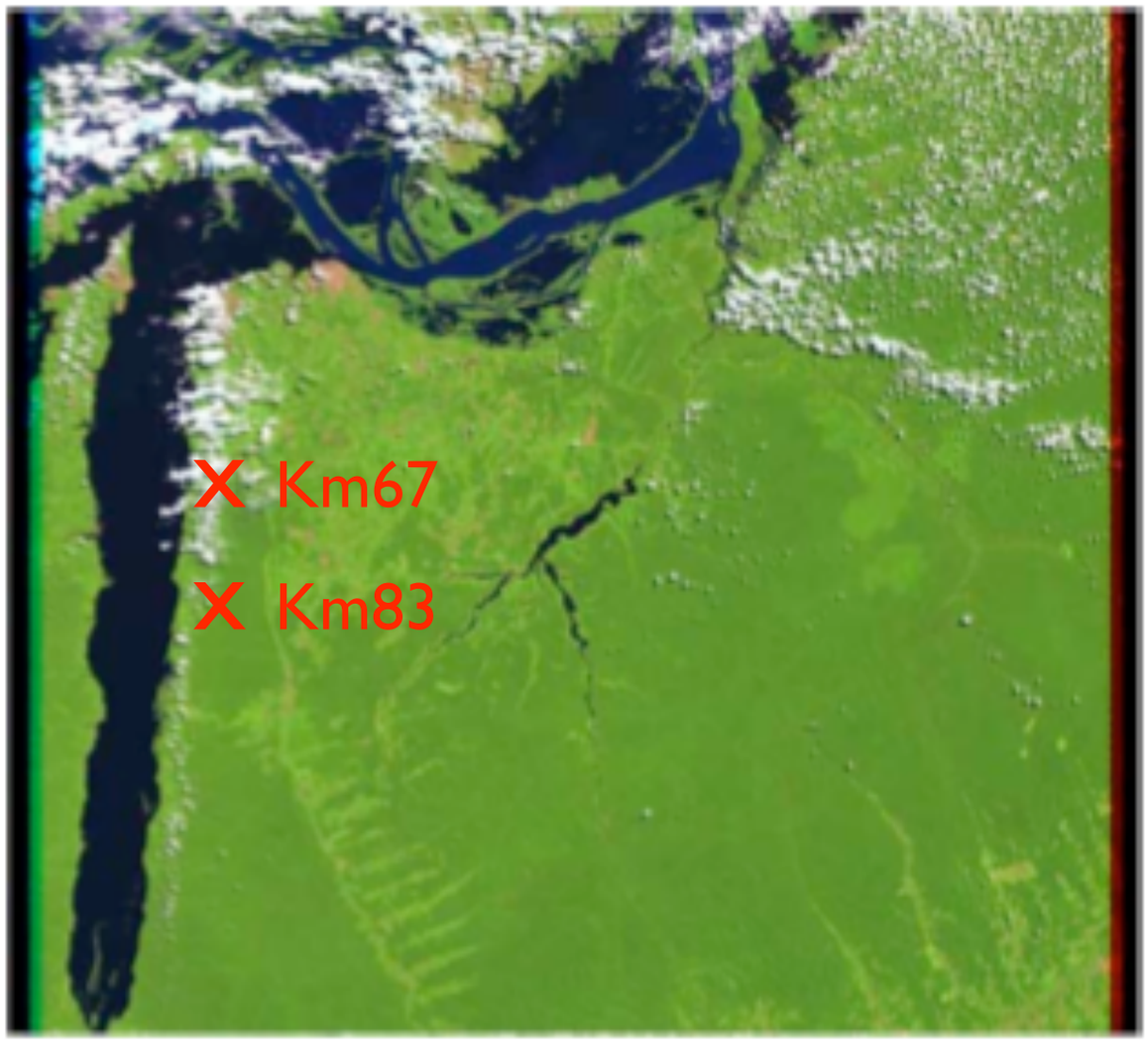
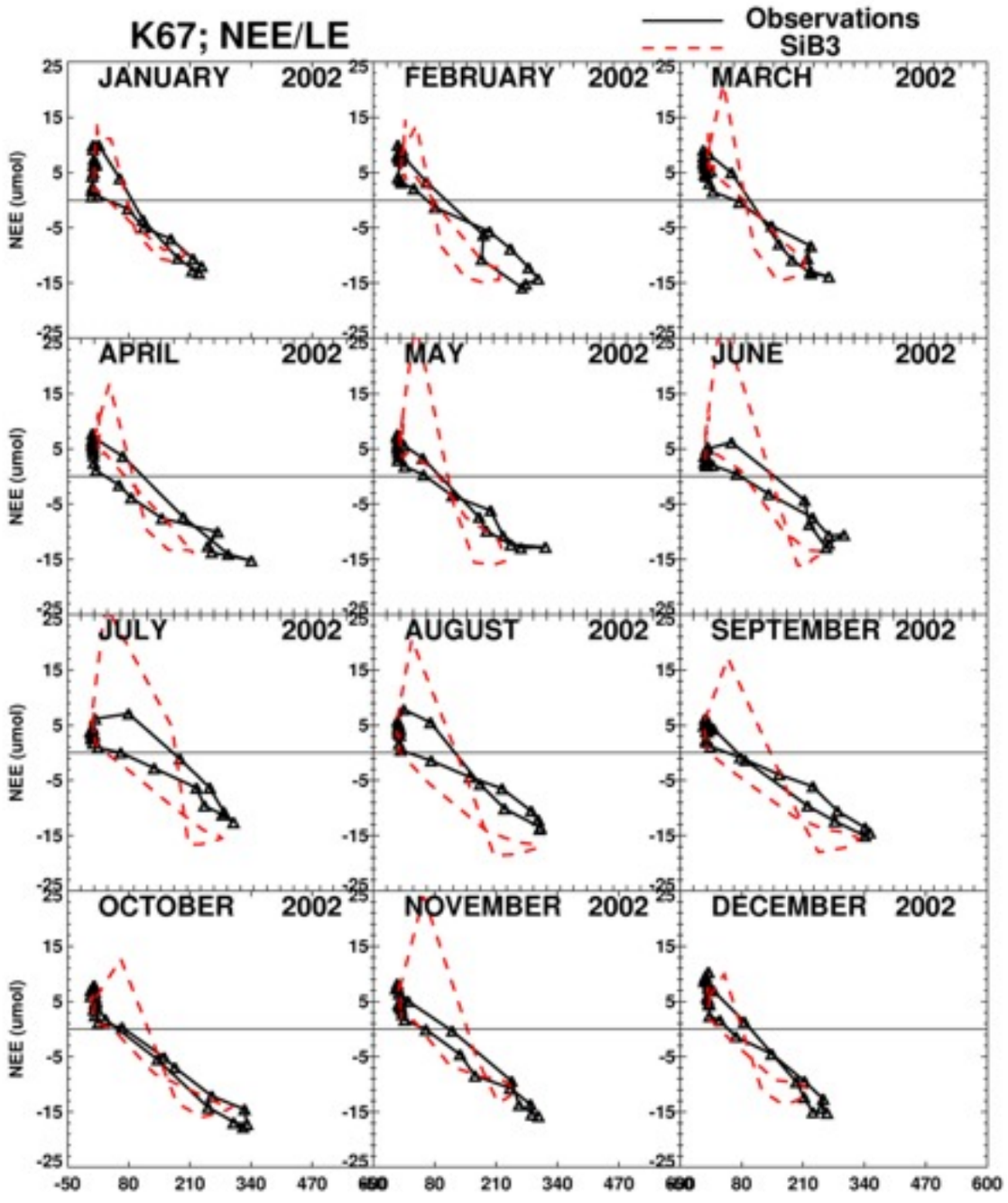
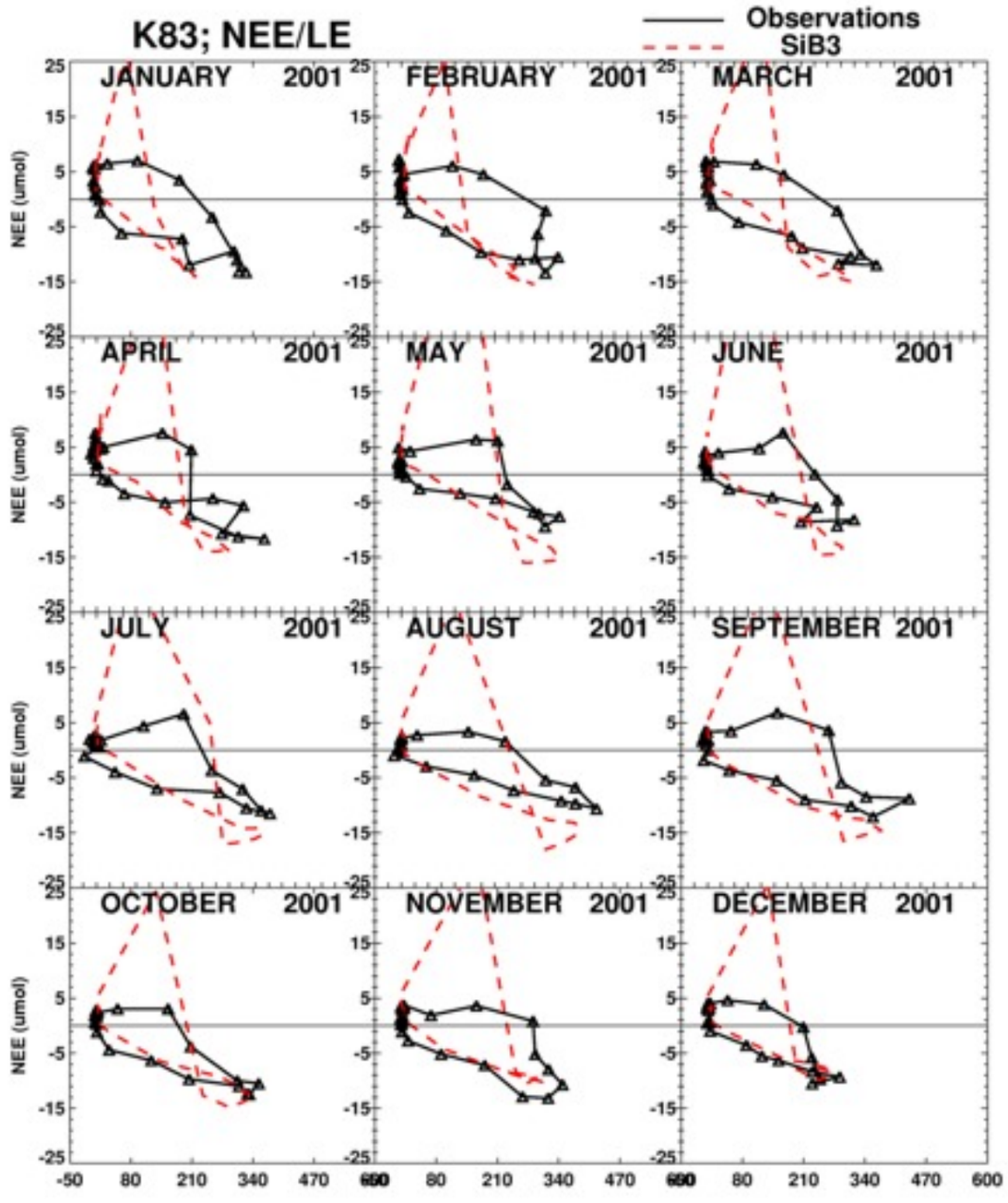



**Figure 9.** Satellite image obtained from LandSat 7 ETM+ scene for path 227 and row 62, on 31 July 2001. It shows that during a clear day, the low-level cumulus clouds favor the east bank of Tapajós River. The image is located at the Web site of Tropical Rain Forest Information Center (TRFIC), which is jointly hosted by LBA-ECO and Michigan State University.

# What do the Obs Show?



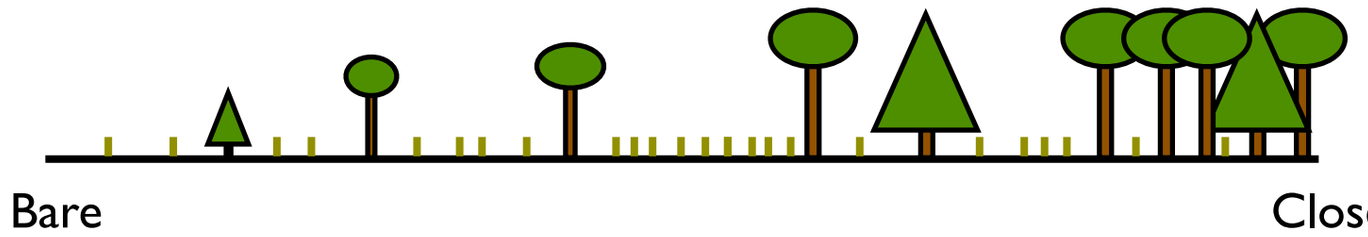

Differential Response: K67 is more ‘linear’

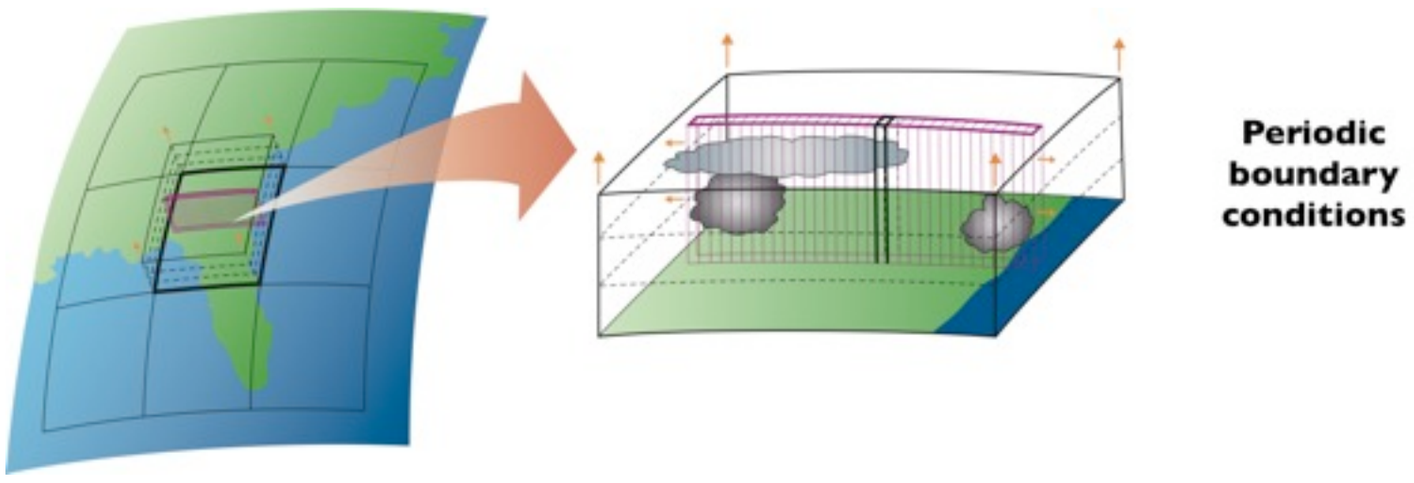
# So What?

- K67 has slightly less total incoming radiation, and (we expect) a larger fraction of diffuse light
- This is a perfect testbed to evaluate sunlit/shaded radiative transfer parameterizations
- sunlit/shaded is critical to the heterogeneous configuration for savannas, shown earlier

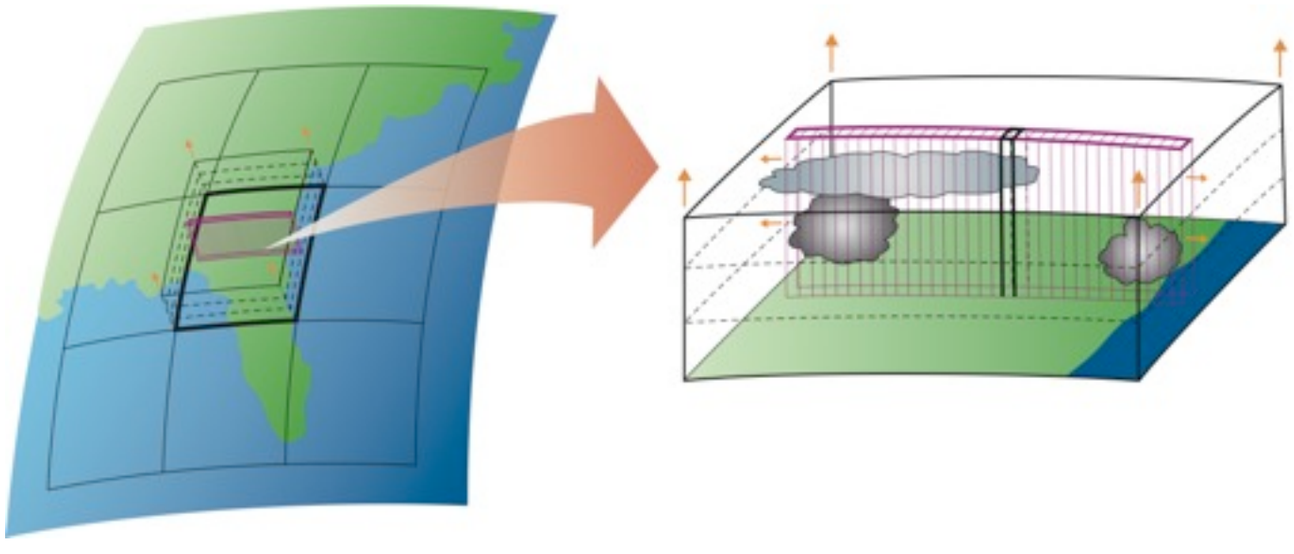
# Back to Savannas?

- Actually, I'm thinking that this heterogeneous setup might be the 'way in' to put realistic land surface into MMF



# Yeah? How So?

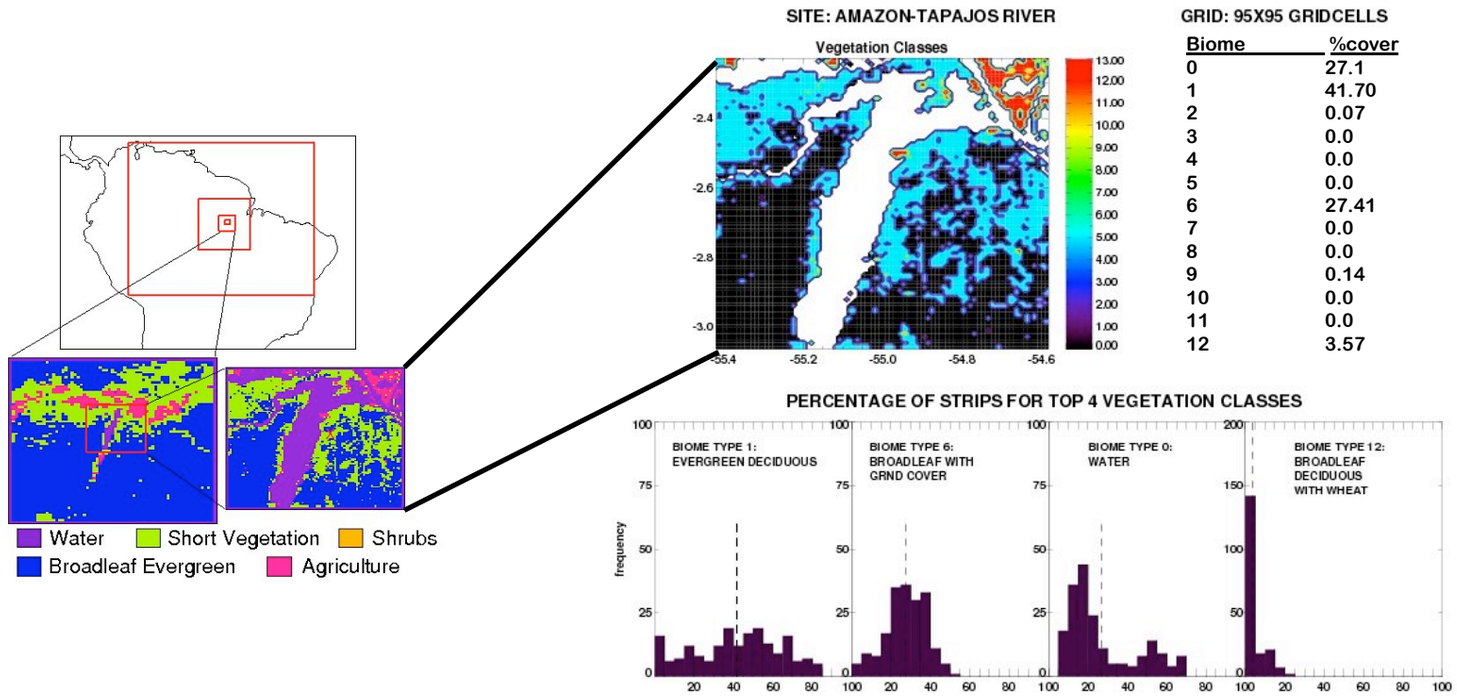


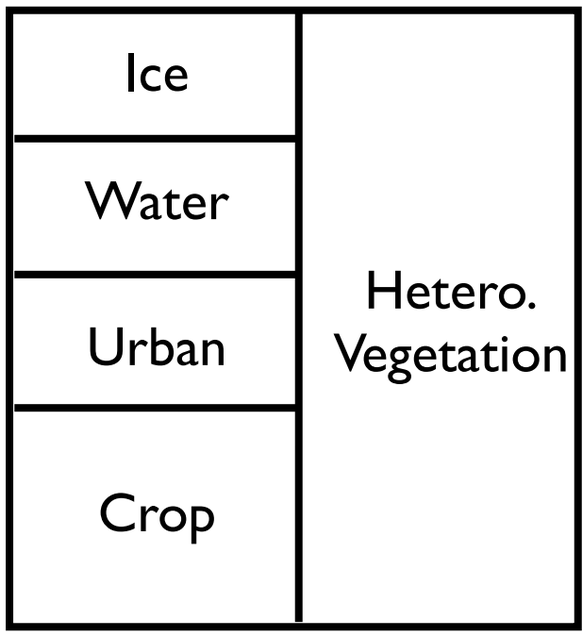
**Periodic boundary conditions**

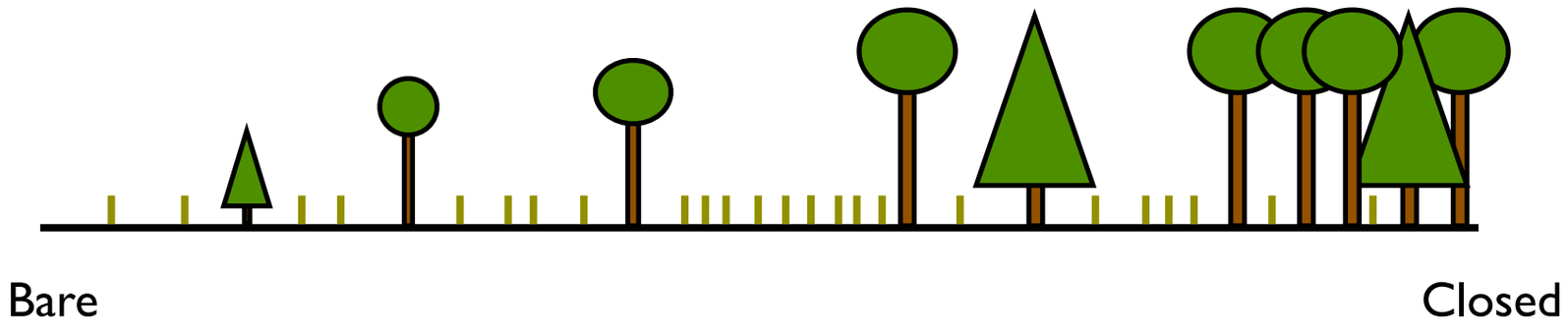
- We've been contemplating how to install a realistic land cover into a 'strip' of explicit land cells in an MMF configuration
- If we're using satellite landcover with prognostic phenology, we may be able to subsample a GCM gridcell in a statistical manner to create a representative surface characterization

# Anticipated Problems?

- Can the CRMs handle Tiles?



# Summary

- Almost all of the pieces of the new heterogeneous formulation exist: They just haven't all been put together
- Explicit full CRM/MMF simulations may be the perfect testbed to try it out