The University Of Sheffield.

Quantifying and Understanding the Earth System

The Ecosystem Demography model

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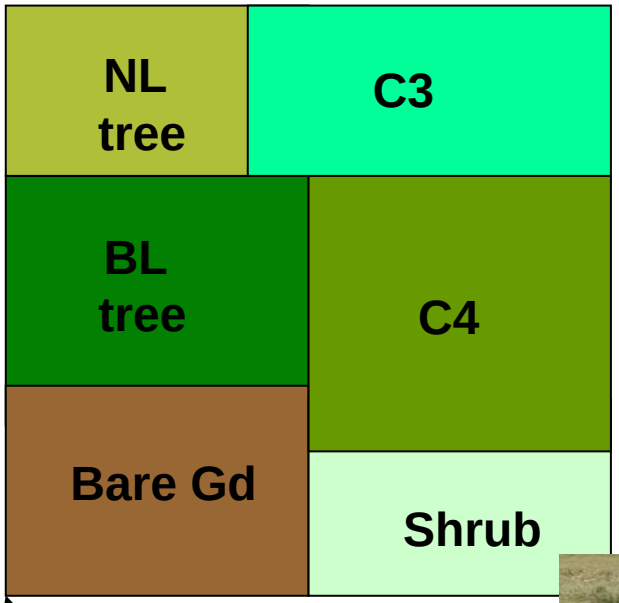
Contents of this talk

- 1. Introduction to ED model
- 2. Implications for physiology
- 3. ED-JULES coupling
- 4. Ongoing model development + testing

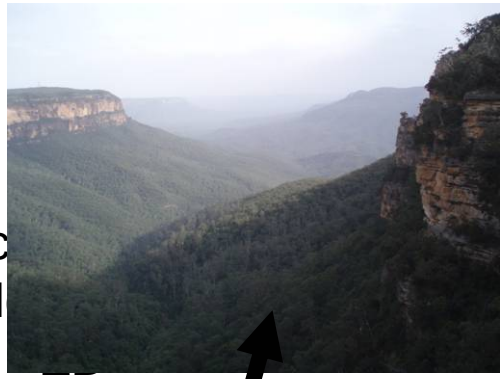
Ecosystem Demography Model

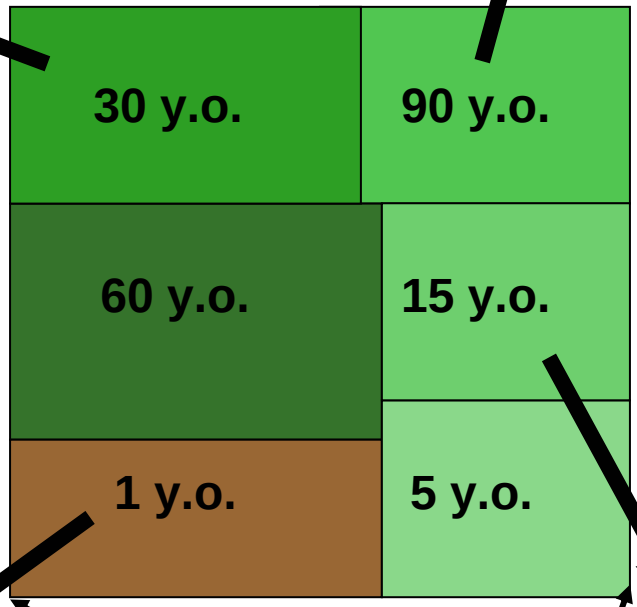
Moorcroft et al. (2001)

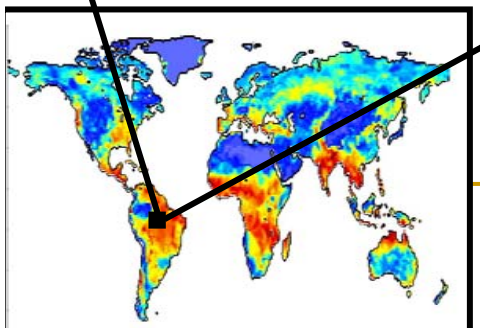
PFT-based tile structure.



Age–sinc
based til



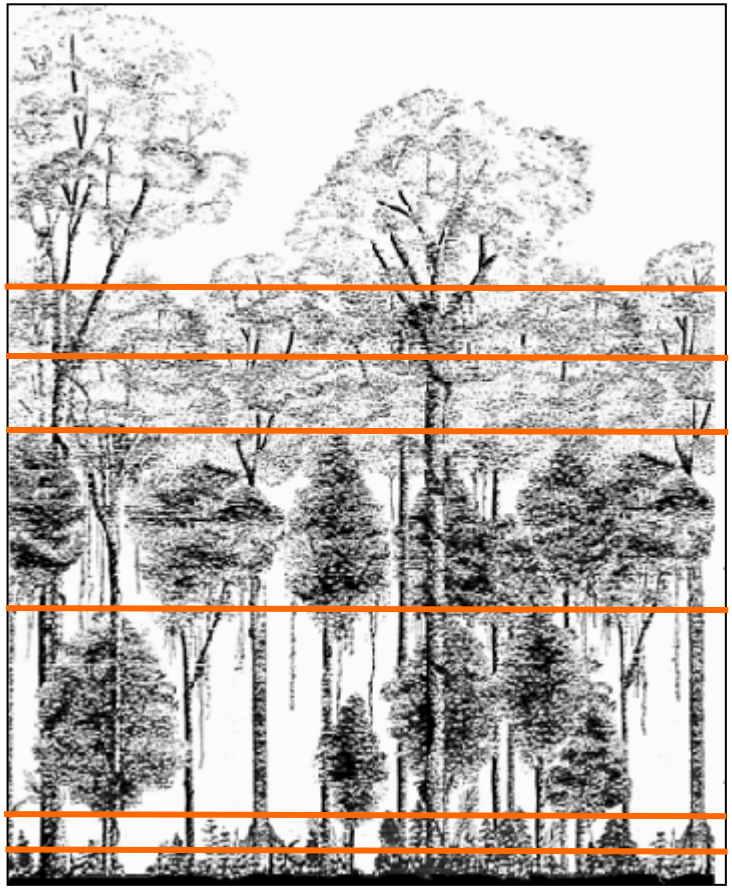




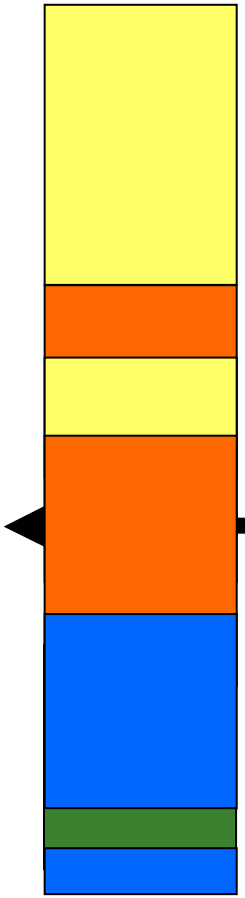
ED model structure

- In ED, tiles are defined by common ‘age since disturbance’.
- Tiles are characterised by 1D canopy structure
- Within tiles are of ‘**cohorts**’, of trees
- **Cohorts** are groups of trees with similar characteristics
  - (PFT, height)
- In JULES, each cohort = a layer of leaf area of given PFT
- Different PFTs can exist in the same canopy…

Canopy Structure



Jules canopy layers

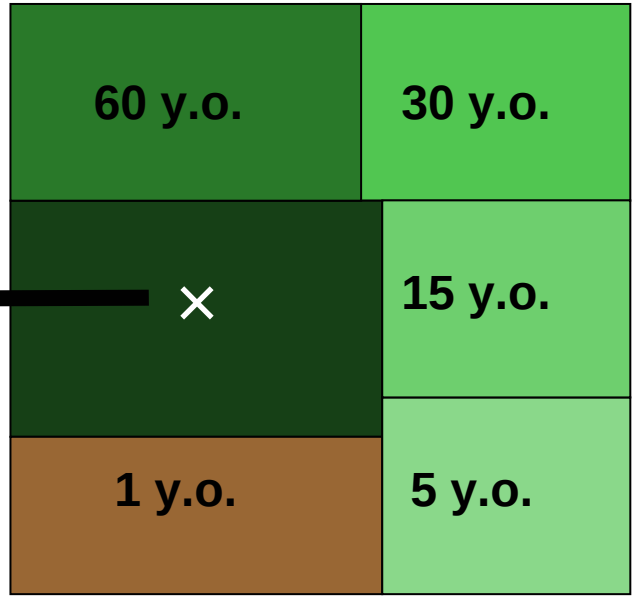


Grass

Shrub

BL Tree

NL Tree



Pros and cons of ED model

- Advantages (compared to existing DGVM's)
  - Vertical competition for light among PFTs
  - Regeneration after disturbance (succession)
  - 'Tree scale' parameters – constrain with observations
  - Age structure: good for fire, grazing and soil CNP cycling models.

- Disadvantages
  - Increased complexity of output/analysis
  - Untested at global scale

Implications for physiology

- Previously modelled by TRIFFID, now by ED:
  - 1. Plant functional type description
    - QUERCC (Lloyd) developing new empirical PFT description.
    - Derived from ordination analysis of largest existing vegetation datasets (RAINFOR, GLOPNET, TROBIT)
    - Completed for Amazonia, ongoing for Boreal + Savanna
    - No. PFTs will increase. Extent depends on model speed.
  - 2. Phenology
    - Simplistic phenology currently implemented.
    - Requires updating

Implications for physiology

- 3. Disturbance (fire and tree fall)
  - Fire model development funded to begin soon (Reading)
  - Derivation of mortality parameters from permanent sample plot data (RAINFOR, etc.). Modelling of intrinsic and extrinsic mortality will be implemented.
  - Tiling structure defined by disturbance models.
- 4. Growth and Allocation
  - Allometric relationships defined empirically within the PFT definitions.
- 5. Nutrients
  - New CN cycling model under development in QUERCC (Oxford, Aberdeen etc…)
  - Nutrient conditions will affect growth and competitive interactions.

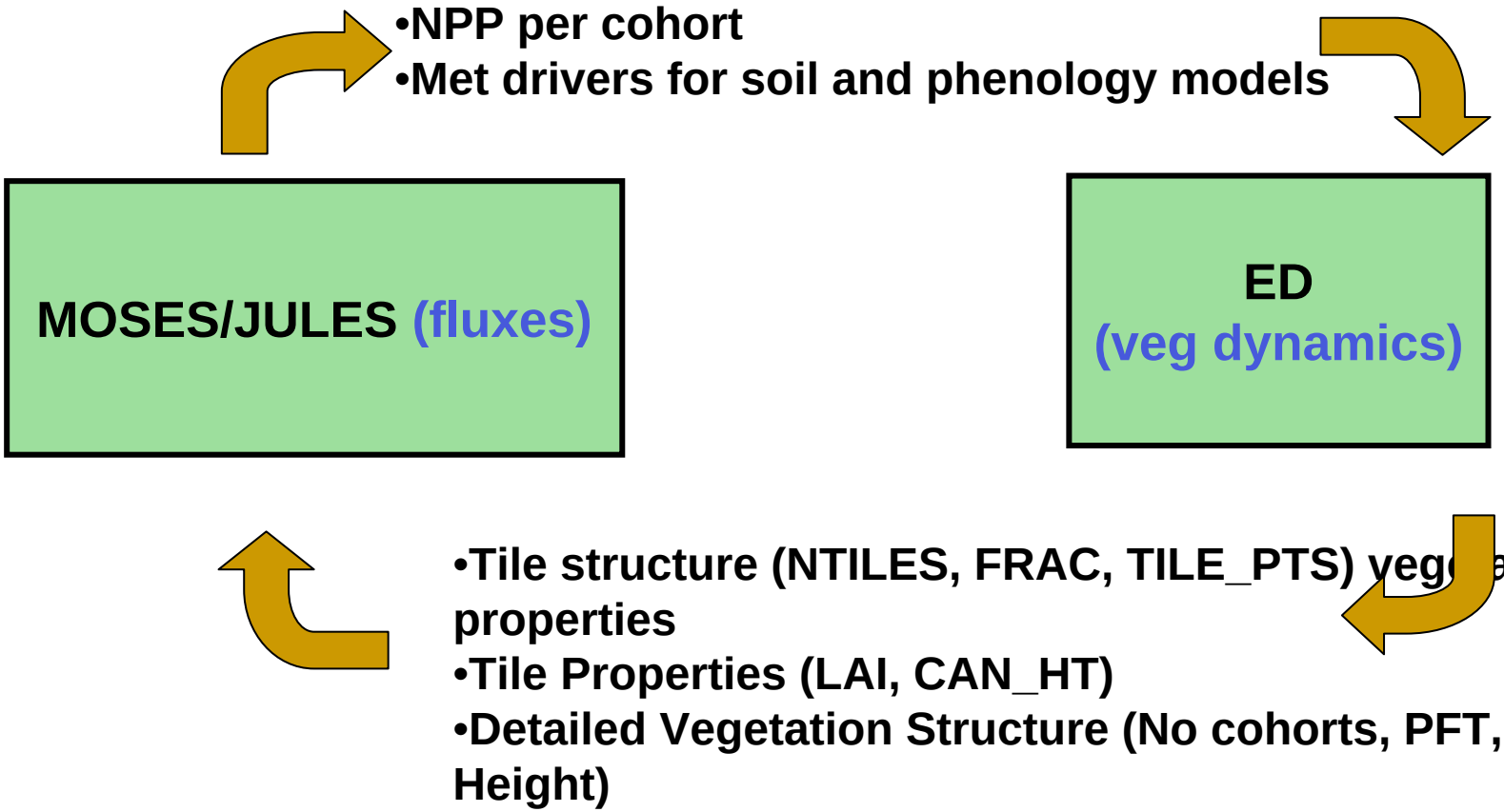
No alterations required.

- 1. Canopy gas exchange
- 2. Hydrology
- 3. Stomatal Conductance
- 4. Energy Balance.

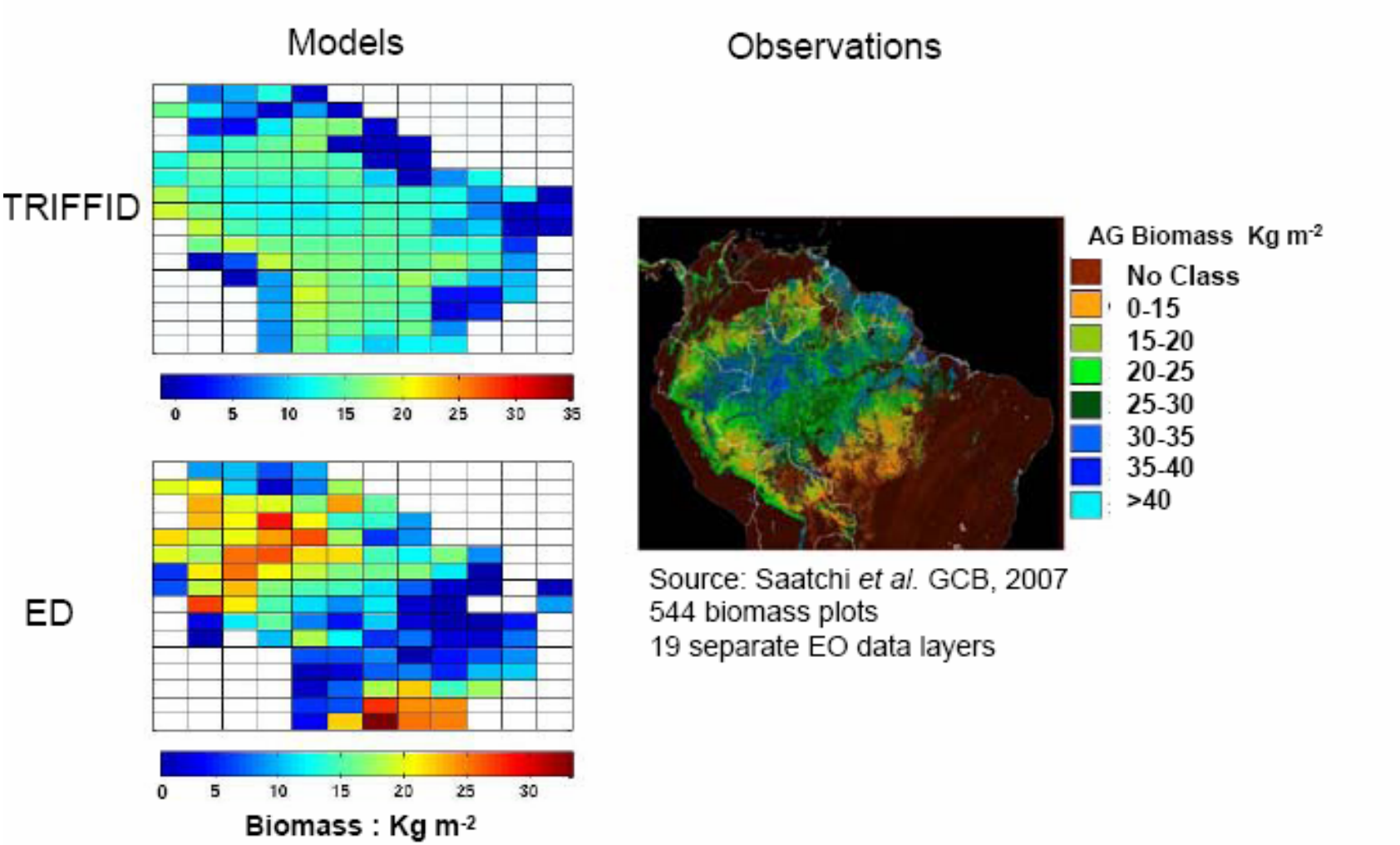
ED-JULES coupling

- ED is written in Fortran 90, and uses pointers and structures, not arrays, for memory efficiency.
- ED is called in the same place/time as TRIFFID
- It passes the **same** data back and forth except…
- …detailed canopy structure, which is only used in photosynthesis routines, not affecting the rest of JULES.

ED-JULES coupling

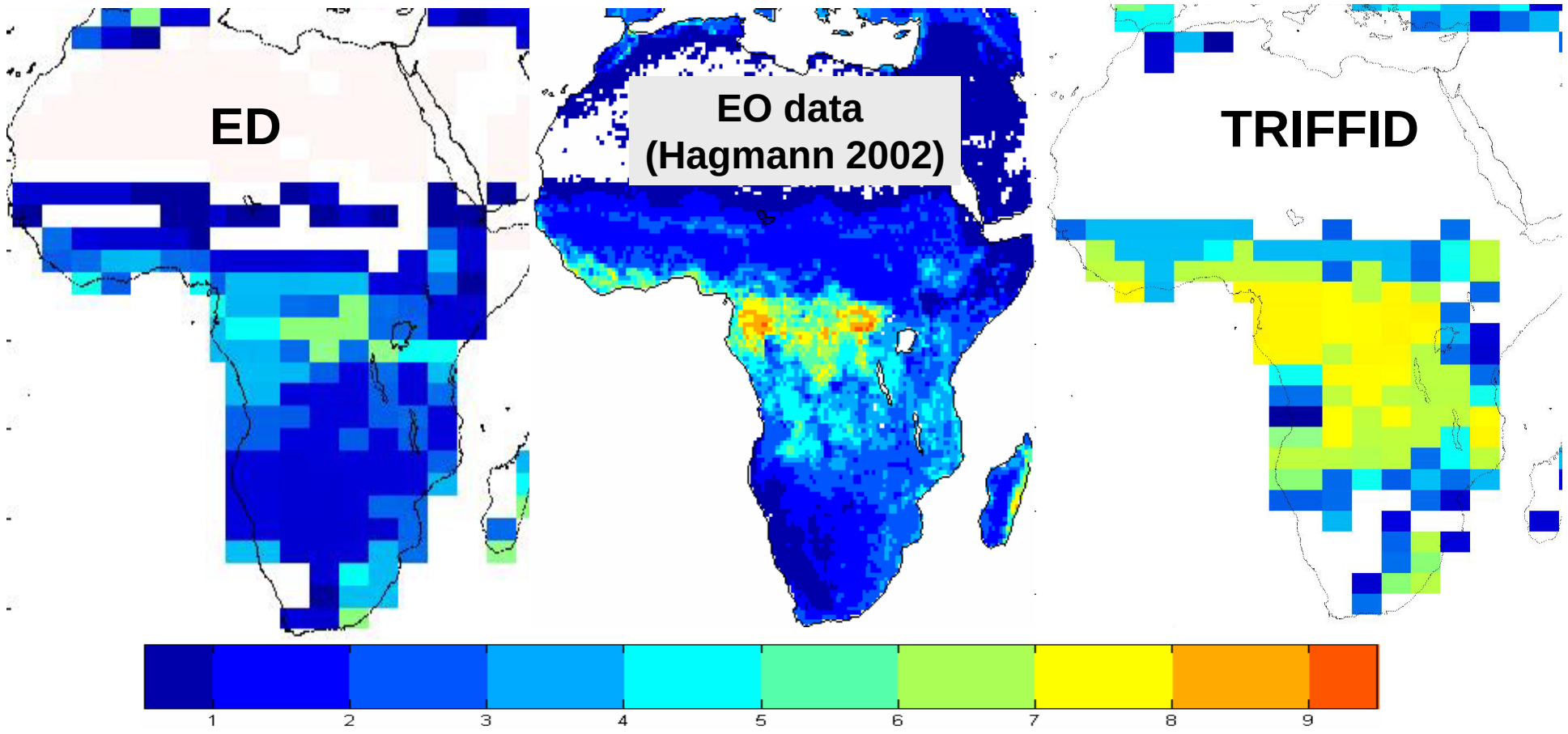


Amazon Biomass Estimates



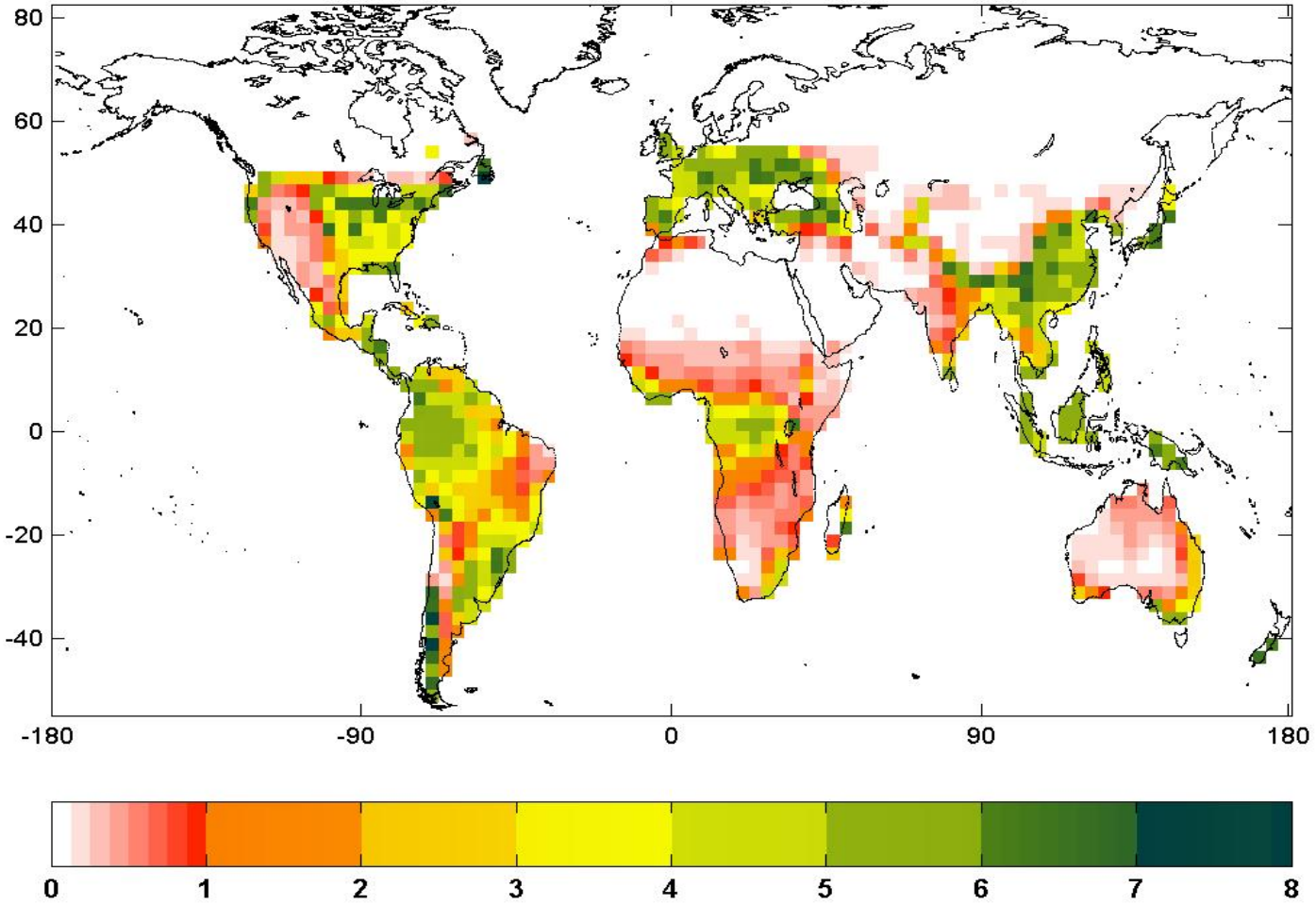
Source: Saatchi *et al.* GCB, 2007
544 biomass plots
19 separate EO data layers

LAI of Africa in y2000



Figures c/o Jiafu Mao.

Global LAI distribution in ED (no needleleaf)



Conclusions

- ED is a radically different format to other DGVMs
- ED is a mechanism for including better ecological scale understanding in a DGVM.
- Un-calibrated ED-IMOGEN represents contemporary forest cover well, so far.
- Biomass estimates are within the observed ranges.

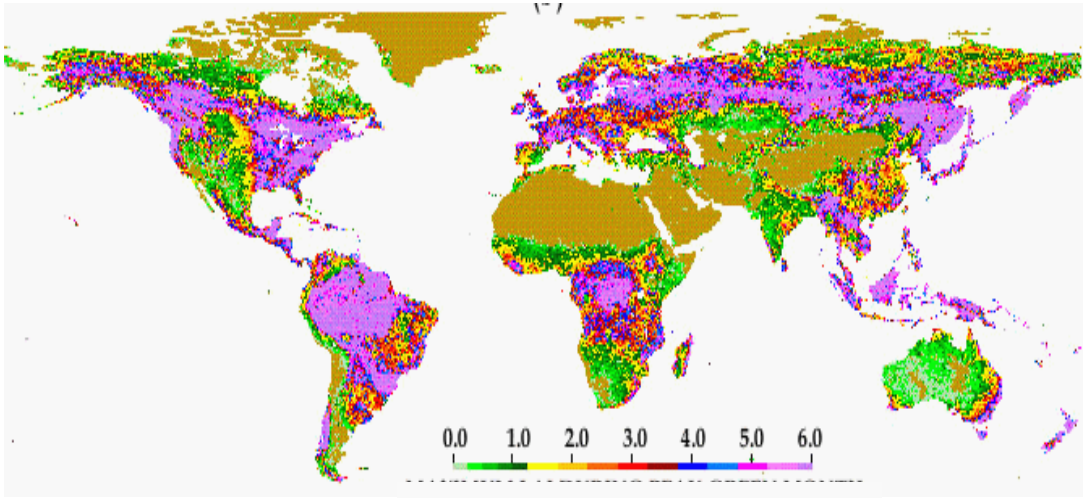
Developments

- Globalisation : Inclusion of ‘interim’ PFT’s
- Phenology modelling
- Preparation for QESM deadline - October

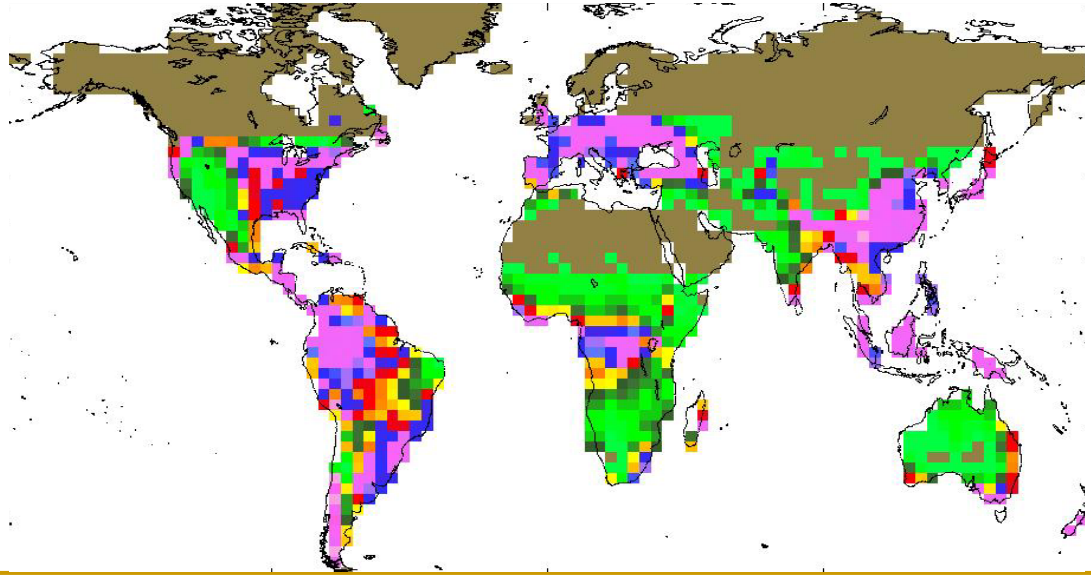
Developments

- ED is a mechanism for including better ecological scale understanding in a DGVM.
- We can construct new hypotheses to explain vegetation distribution.
  - Evergreen vs. Deciduous (Nutrients? Temperature? Light regime?)
  - Tree vs. Grass (Light? Water? Nutrients?)
  - Shrubs vs. Trees (Nutrients? Water logging?)
- If we get this wrong, the responses to climatic forcing will also be wrong.

Global LAI



Myneni et al. 1997



IMOGEN_ED LAI