ED-JULES progress.

JULES Science Meeting. Jan 2008.

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Acknowledgements

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Content

- Introduction to ED model (brief)
- Integration of ecological data into ED
  - 1. Phenology scheme
  - 2. Fire driving data
  - 3. Nitrogen scaling in canopy
  - 4. Leaf property database information.
- Results of simulations.
- Coming Soon
  - Nitrogen Cycle
  - Plastic PFTs

Ecosystem Demography Model

Moorcroft et al. 2001

- ED is a Dynamic Vegetation Model which, uniquely, allows the explicit modelling of :
  - Vertical competition for light
  - Spatial heterogeneity of light environment
  - Modelling of succession and vegetation replacement/recovery from disturbance (fire)
  - Model specification using observable tree scale quantities.
  - For more info, see the last JULES meeting talk.

Integration of ecological data into ED : globalisation

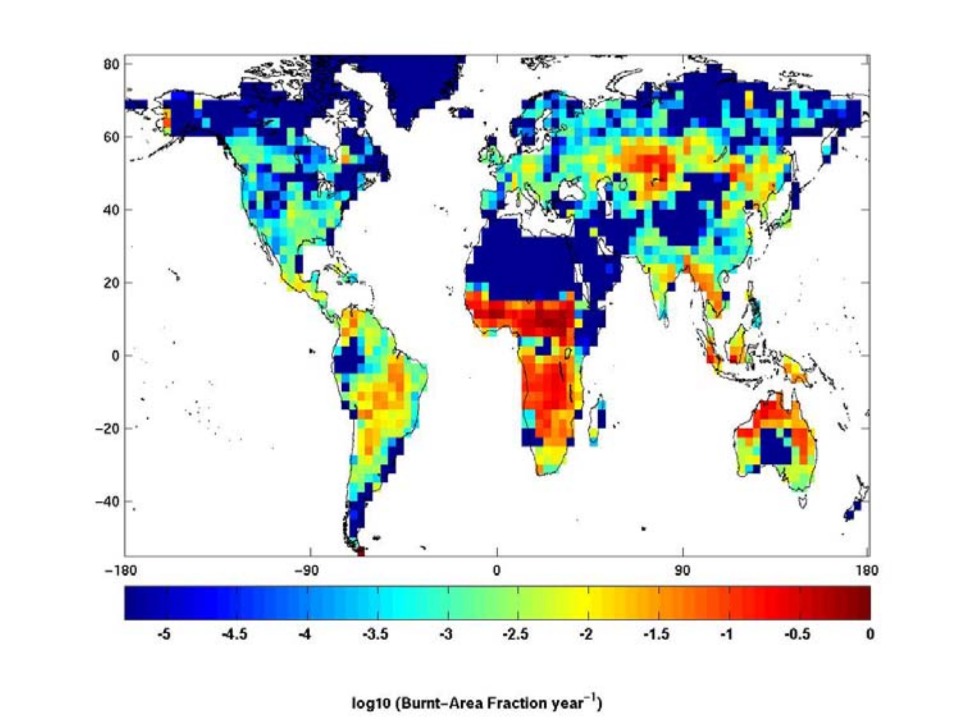
- 1. Phenology scheme
- 2. Fire driving data
- 3. Nitrogen scaling in canopy
- 4. Leaf property database information.

Phenology

- Botta et al. (2000) phenology for cold deciduous trees leaf-on
  - Growing degree days & Chilling requirement.
- Used SDGVM phenology for cold deciduous leaf-off.
  - 5 out of last 10 days below T_{crit}
- No drought-deciduous phenology as-yet.
  - This will be done soon for fire modelling.

Fire

- The existing ED fire model did not perform well in JULES.
- Annual burnt area was estimated from satellite products (van de Werf)



- These data were used to replace the ED fire model
- A replacement fire model is in development (SPITFIRE-ED).

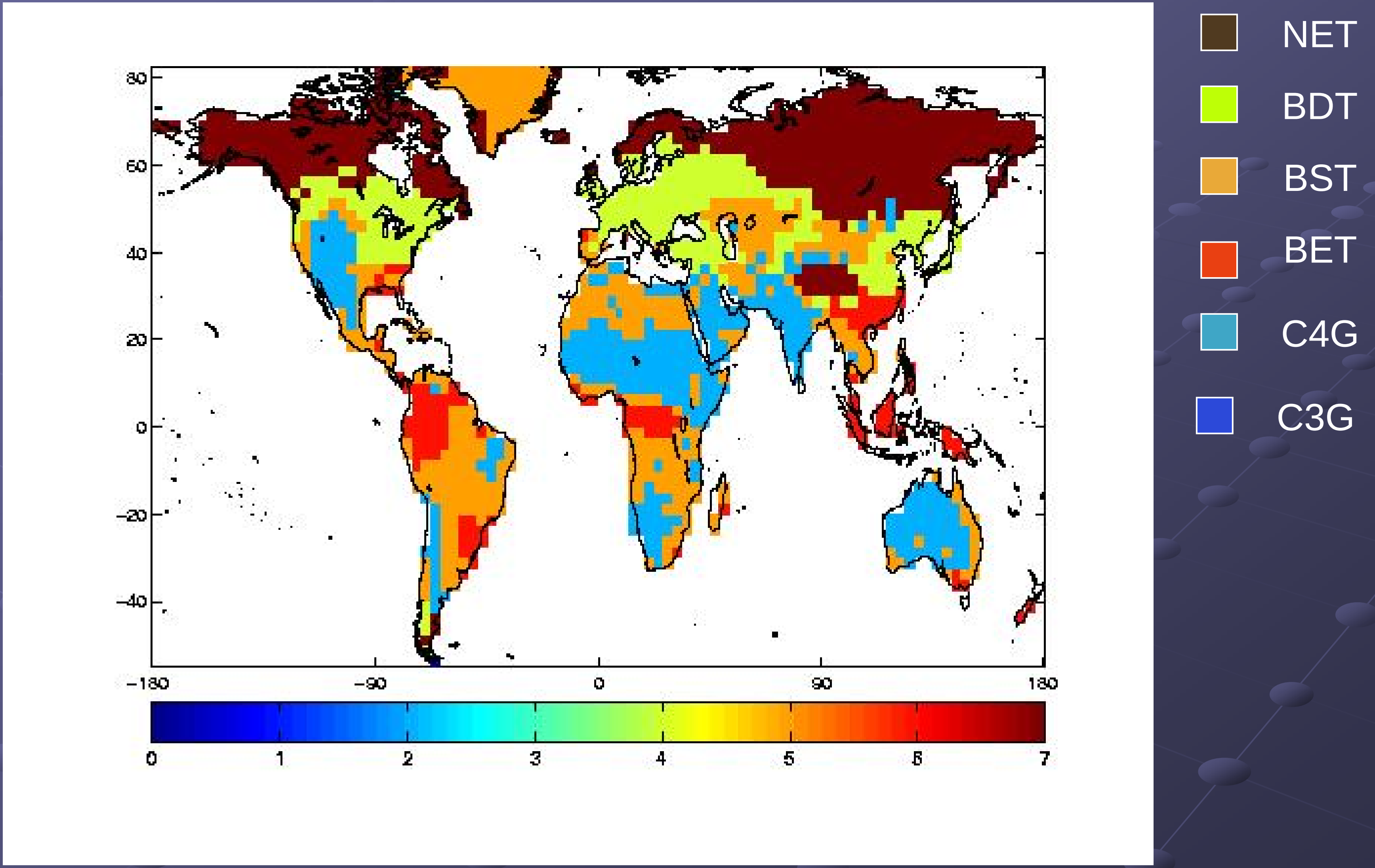
PFT definitions -minimalist approach

- PFTs (NOT fixed)
  - 1. Evergreen broadleaf
  - 2. Deep rooting evergreen broadleaf
  - 3. Deciduous broadleaf
  - 4. Evergreen needleleaf
  - 5. Deciduous needleleaf
  - 6. C3 grass
  - 7. C4 grass

PFT definitions - minimalist approach

Leaf lifespan	Defines: Leaf N (vcmax, respn), SLA, SA/LA ratio.
Max Height	(grass (0.7m) or tree(35m)
Wood density	(grass (0.53 gcm^{-3}) or tree(0.7 gcm^{-3})
Phenology	(Evergreen or Deciduous)
Reflectance	(Parameters from TRIFFID)

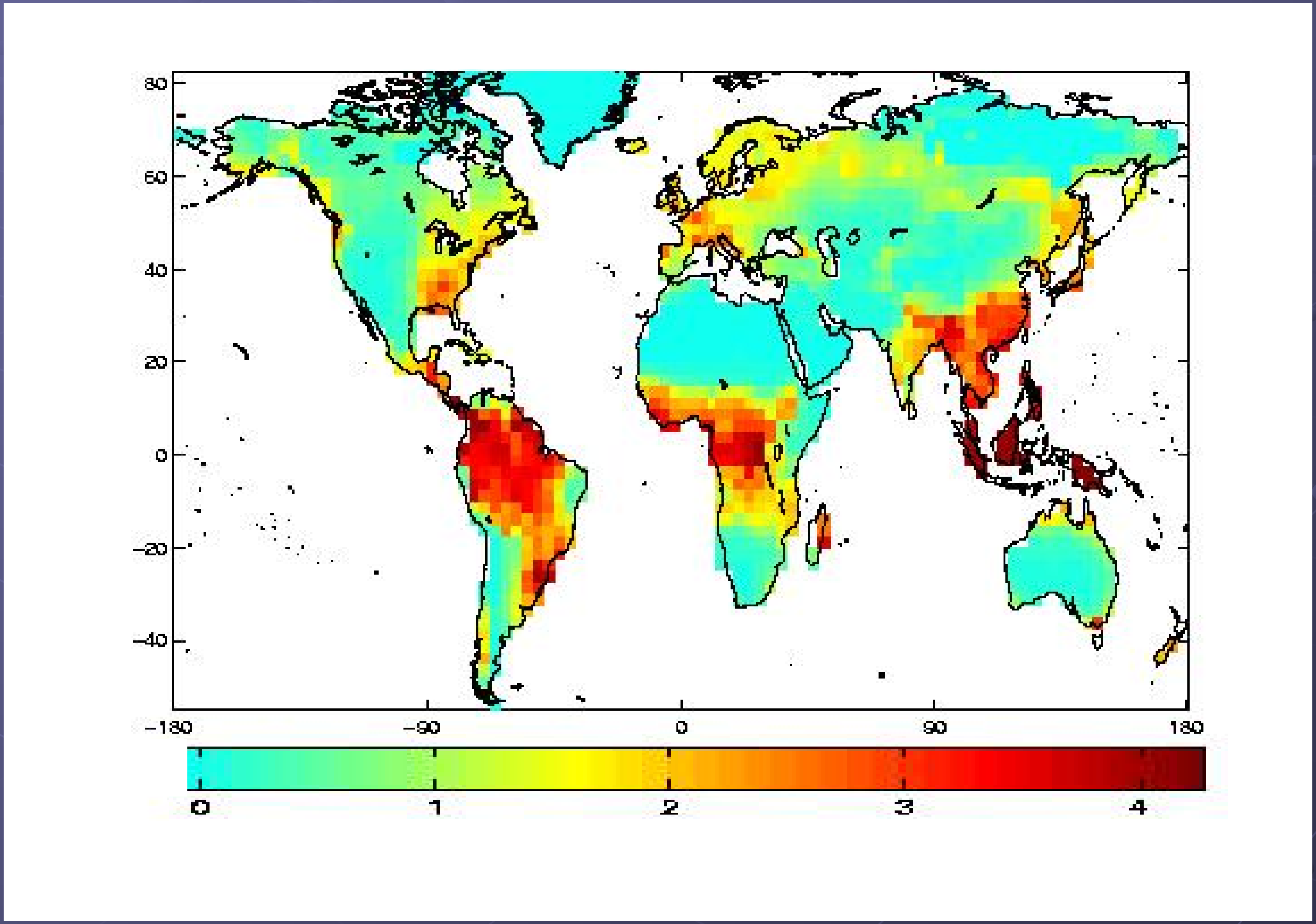
PFT distribution: dominant PFT



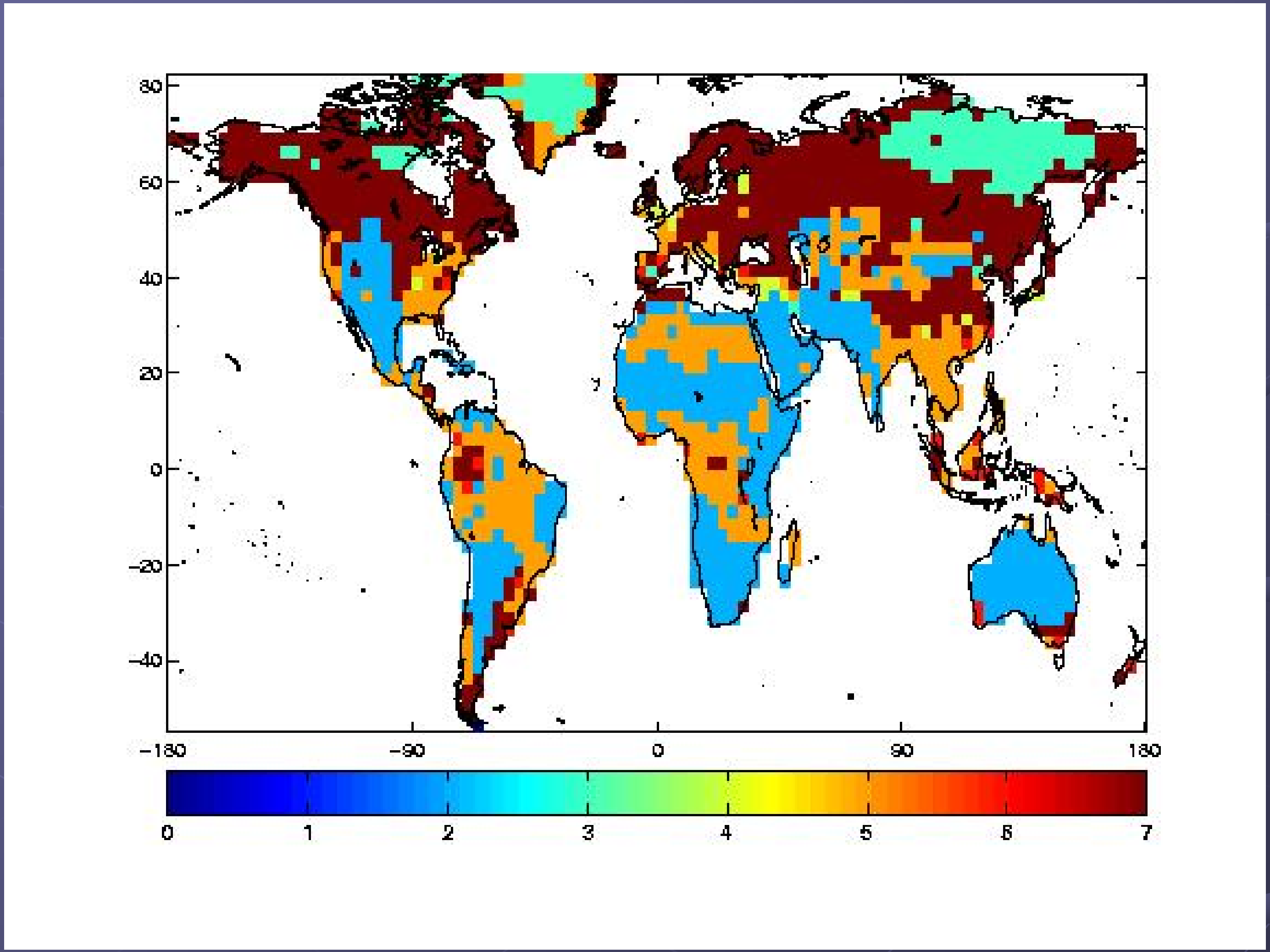
Nitrogen Profile

- NPP too high due to the multi-layer model
- Implemented Nitrogen scaled to position in canopy and total canopy LAI from Mercado et al. (derived from canopy N data).
- How does N scale with height in incomplete canopies?
- $N=NL_0*\exp[\,L/L_{max} * L_{shade}/L * (-0.78)]$

GPP with adjusted N Profile



PFT distribution with lower NPP



NET

BDT

BST

BET

C4G

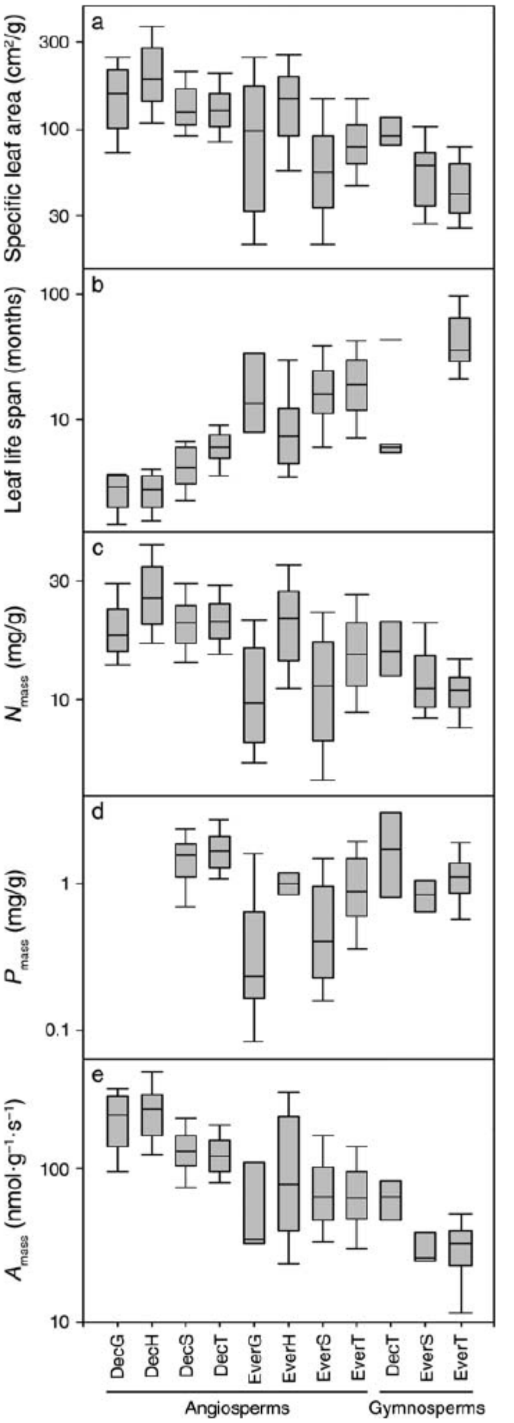
C3G

DNT

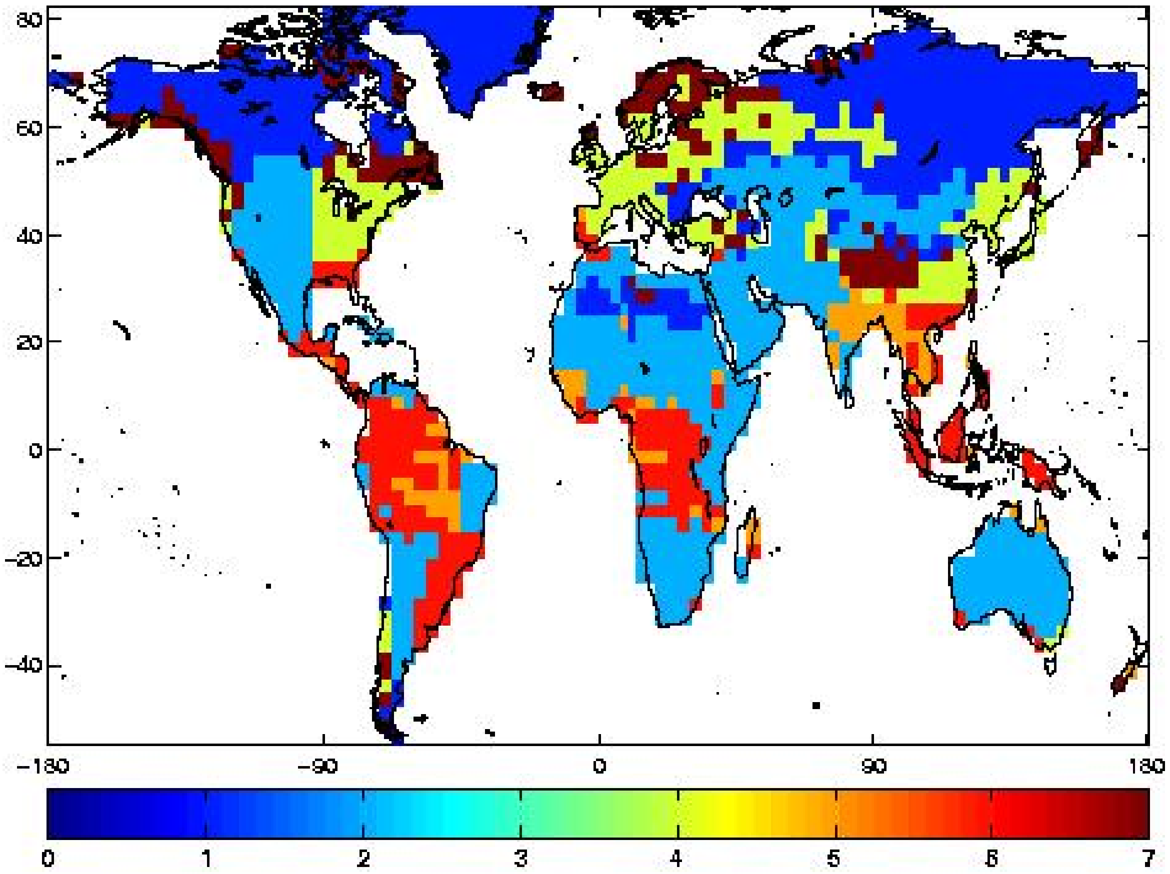
PFT definitions:

Data driven approach.

- Reich et al. (2007)
  - GLOPNET leaf trait database
  - Basic PFT definitions
  - ‘Error’ estimates
  - Leaf Properties Only
    - Lifespan
    - N & P content
    - Assimilation
    - Specific Leaf Area



New PFT map



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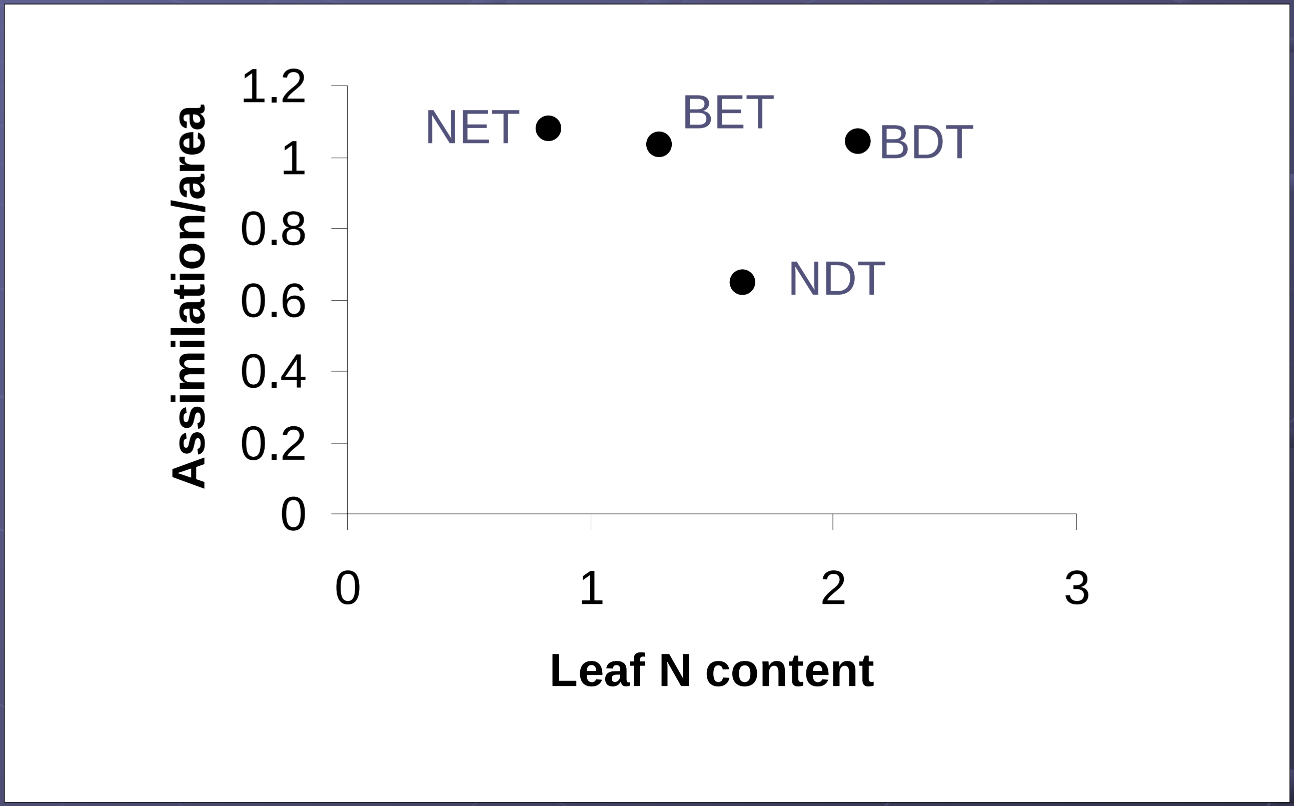
Current status

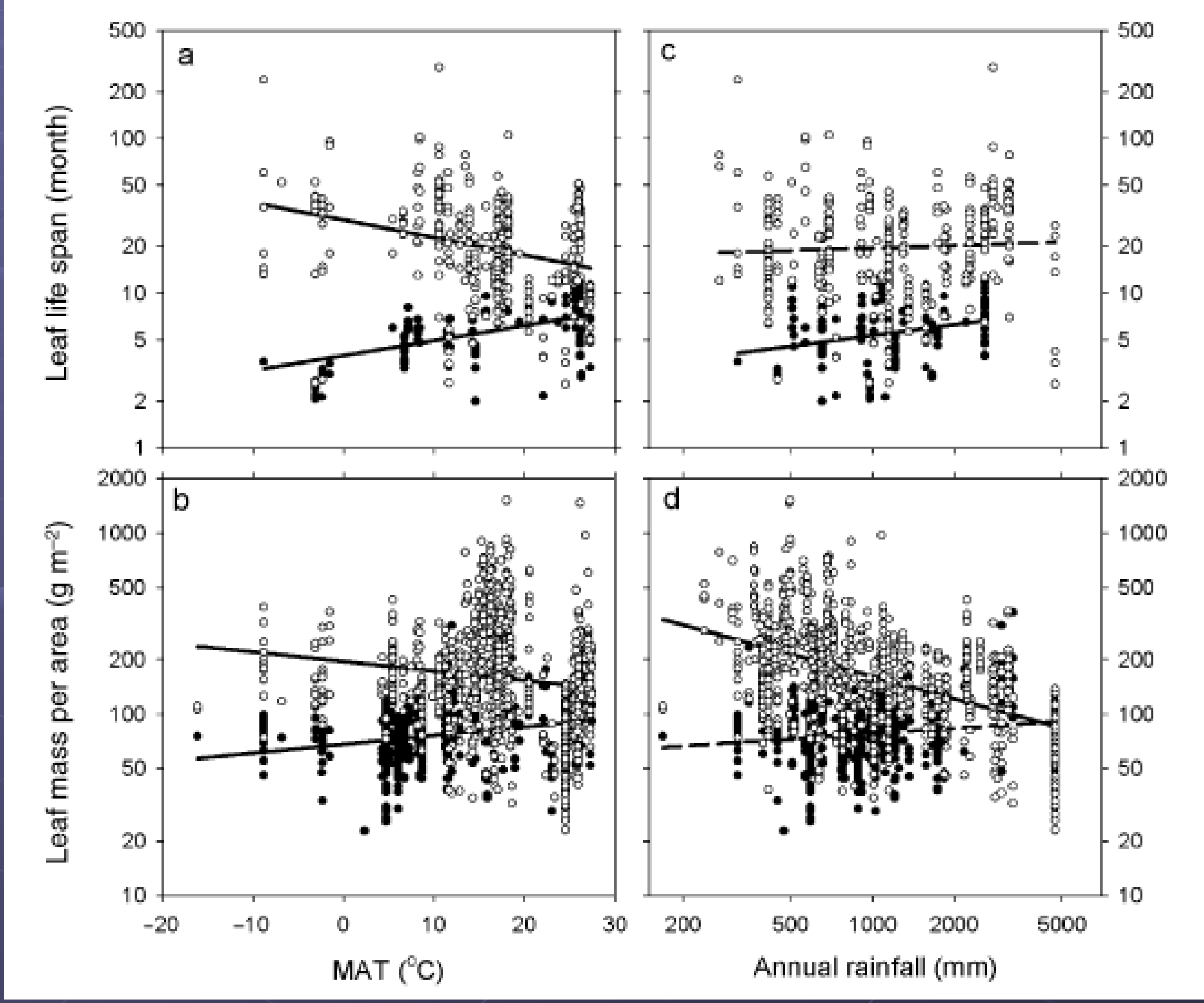
- Making the model more realistic in terms of leaf economy creates large errors in the PFT distribution.
- Do we need the N cycle to explain the existence of needleleaf trees?
- Does N scale directly to Vcmax across life forms?
- OR do we need a more spatially complex representation of leaf economics?

N vs. assimilation



Plastic plant functional types.

PFT specific equations for the impact of Radiation, rainfall and temperature on SLA and Lifespan. Explain 64% of the variance



Nitrogen Cycle

- Model developed by Josh Fisher, Steve Sitch, me and Chris Huntingford.
- Uses N availability from ECOSSE/SUNDIAL
- Assume C:N ratio of leaves doesn't change
- Calculate N demand from NPP
- Calculate passive N uptake via transpiration
- Is it enough?
- If not, use remaining C to pay for N uptake via fixation or via active N uptake.

Conclusions

- Generating agreement with one data source often reduces agreement with other data sources.
- BUT we MUST predict where vegetation is for the right reasons, or we cannot trust our predictions at all.
- Our approach is to improve the model via the incremental inclusion of verifiable data and processes.
- Hopefully, we will soon get the right result for the right reasons

Mortality Functions

- Moorcroft et al. 2001
  - Mortality = f(NPP/NPP_{max})
  - NPP_{max} = NPP in full sunlight & water.
    - Advantage to low ‘N’ PFTs, which are less affected by shade.
    - Is difficult to implement when NPP_max is negative.

Mortality Functions

- New mortality function
  - Carbon balance = NPP – Turnover
  - If carbon balance is negative, mortality increases sharply.
  - This allows us to replicate the death of slow growing things in cold regions & therefore gives a ‘tree line’ which was previously absent.