Issues Involving Leaf and Soil Carbon and Nitrogen Cycling in CLM4

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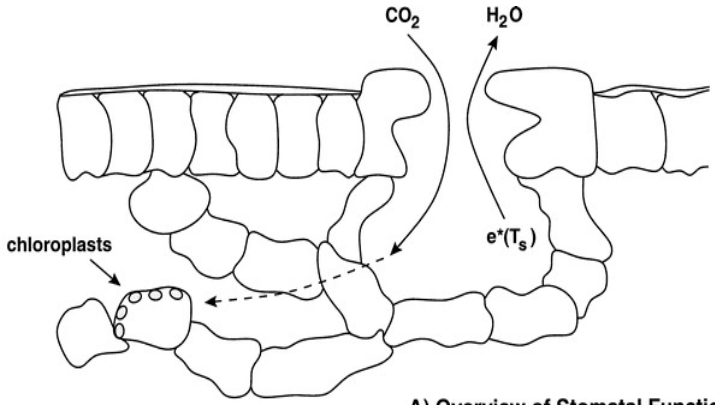
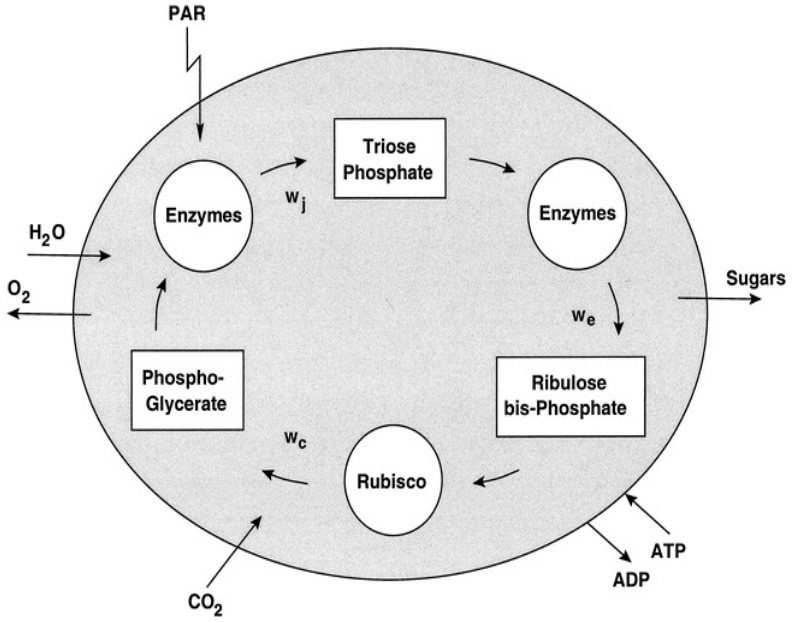
Comments and Discussion (no results)

- Leaf level carbon assimilation and soil carbon and nitrogen cycling in CLM are in need of improvement.
- Calculated numerical values depend on both parameterizations (model structure) and parameter values.
- Much of what in CLM for leaf level processes dates back to Collatz et al, 1991, 1992 papers, highly out of date.
- Bonan et al 2011 (in press) address some of the leaf level issues and make some major changes/improvements, but still a ways to go.



A) Overview of Stomatal Functioning



B) Chloroplast Functioning

Measurements available for determining parameters

- Genomic
- Cellular
- Leaf level
- Fluxnet for CO2 and H2O
- CO2 flask network
- Satellite greenness; LAI; albedo

What is done – should be done?

- Current approach is to take some leaf level measurements from literature, work through how to scale to canopy and evaluate against fluxnet data.
- A statistically optimal approach (once biases have been identified and removed) is to use all data sources for parameter estimation, weighted according to our confidence in them, so perhaps fluxnet data should be made part of parameter estimation strategy.

Leaf level parameter estimation

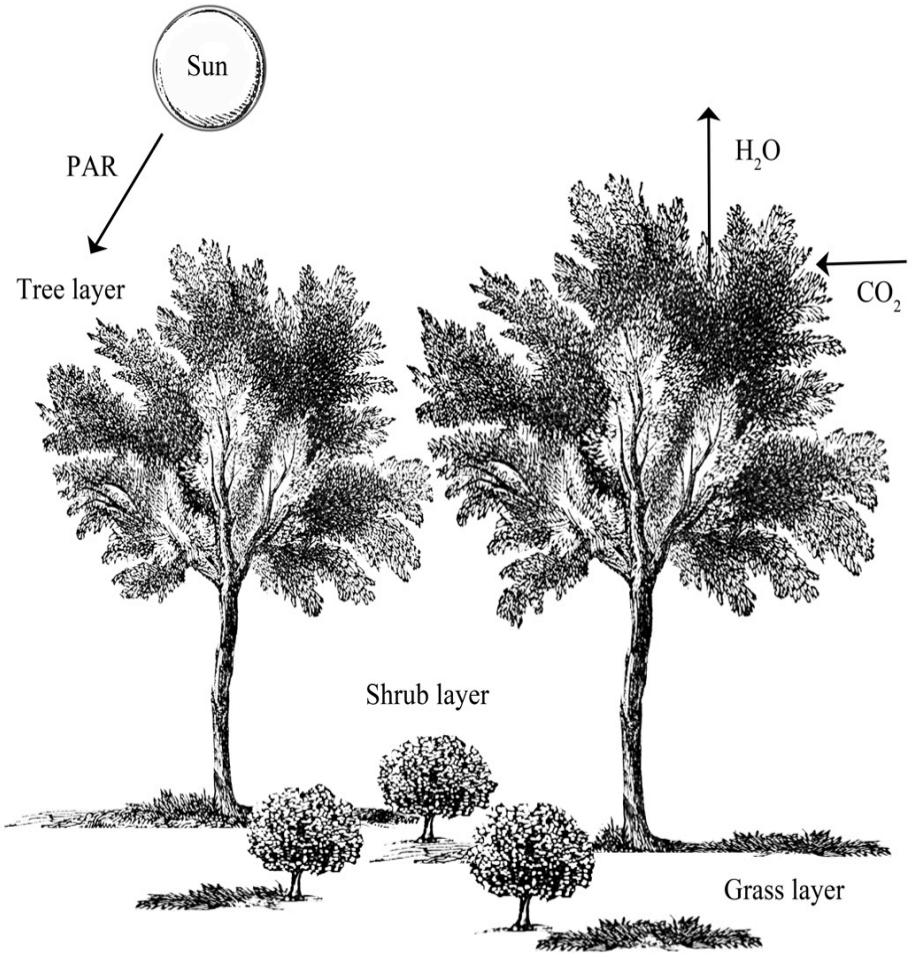
- How to do it: Gu, L., S. G. Pallardy, K. Tu, B. E. Law, and S. D. Wullschleger (2010), Reliable estimation of biochemical parameters from C3 leaf photosynthesis-intercellular carbon dioxide response curves, *Plant, Cell, and Environment*, *33*, 1852-1874 doi:10.111/j.1365-3040.2010.02192.x.
- Lessons learned:
  - Past estimates are unreliable
  - Fitting for the same parameter, e.g. Vmax with different model structures gives different results

CLM issues

- Parameters left out.
  - Jmax; easy to include. Bonan et al 2011 shows important. Should it scale with Vmax?
  - Mesophyllic resistance – established last decade or so at cellular level - comparable in magnitude to stomatal resistance.

Shaky parameters in CLM

- Vmax – varies seasonally, with canopy light levels, with nitrogen limitations – needs to be modeled but with some sensible use of observational constraints at leaf and fluxnet levels.
- TPU – not much data to support. What's in CLM probably too large; Bonan et al suggest a much smaller value. Increasingly important with more CO2


Sun
PAR
Tree layer
H_2O
CO_2
Shrub layer
Grass layer

Other carbon cycling issues

- Box model structure has to go – many modeling issues cannot be addressed seriously without a layer structure; preferable to be same as for water and temperature.
- Need to pay much more attention to the temperature dependence of soil respiration; increasing evidence that it is very different on decadal time scales than on the short time scale of the data that it is derived from.
- Should we worry about the compost bomb effect?

Nitrogen Cycling issues

- Can view as consisting of fast (plant-soil) and slow (soil sources and sinks) cycles.
- Slow cycles are sensitive to feedbacks on sources and sinks;
- Nitrogen fixation depends on T and ammonium ion levels (not in CLM/C-N)
- Several recent papers show the temperature dependence gets rid of tropical nitrogen limitations
- Several recent papers show the ammonium dependence can greatly reduce nitrogen limitations elsewhere
- Leaching/ denitrification losses depend on nitrate ions; low ammonium in soil may suppress nitrification.