

Next-Generation Ecosystem Experiments (NGEE Arctic): Connections to CLM

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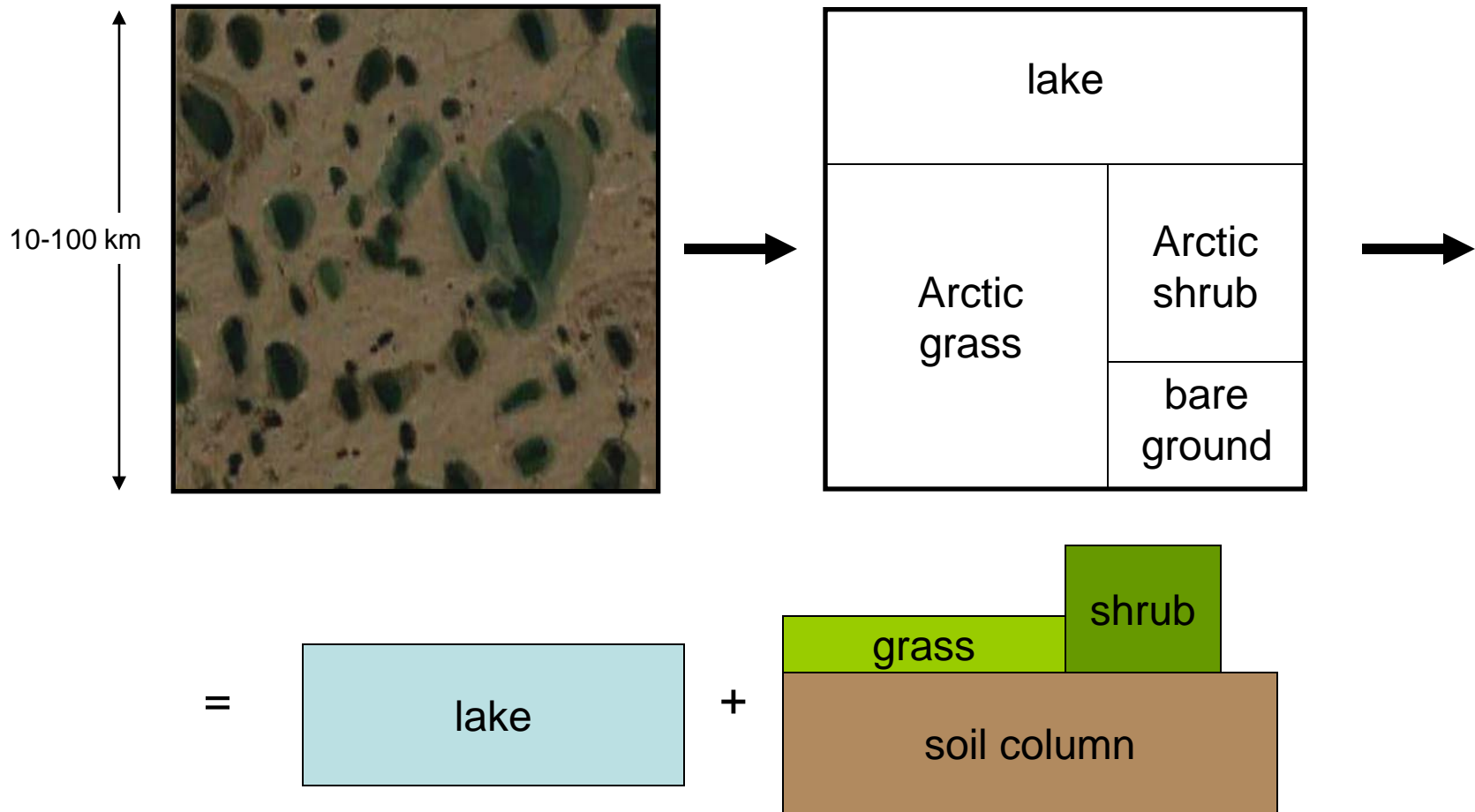
*Land Model Working Group Meeting, Boulder, CO
20 February 2013*





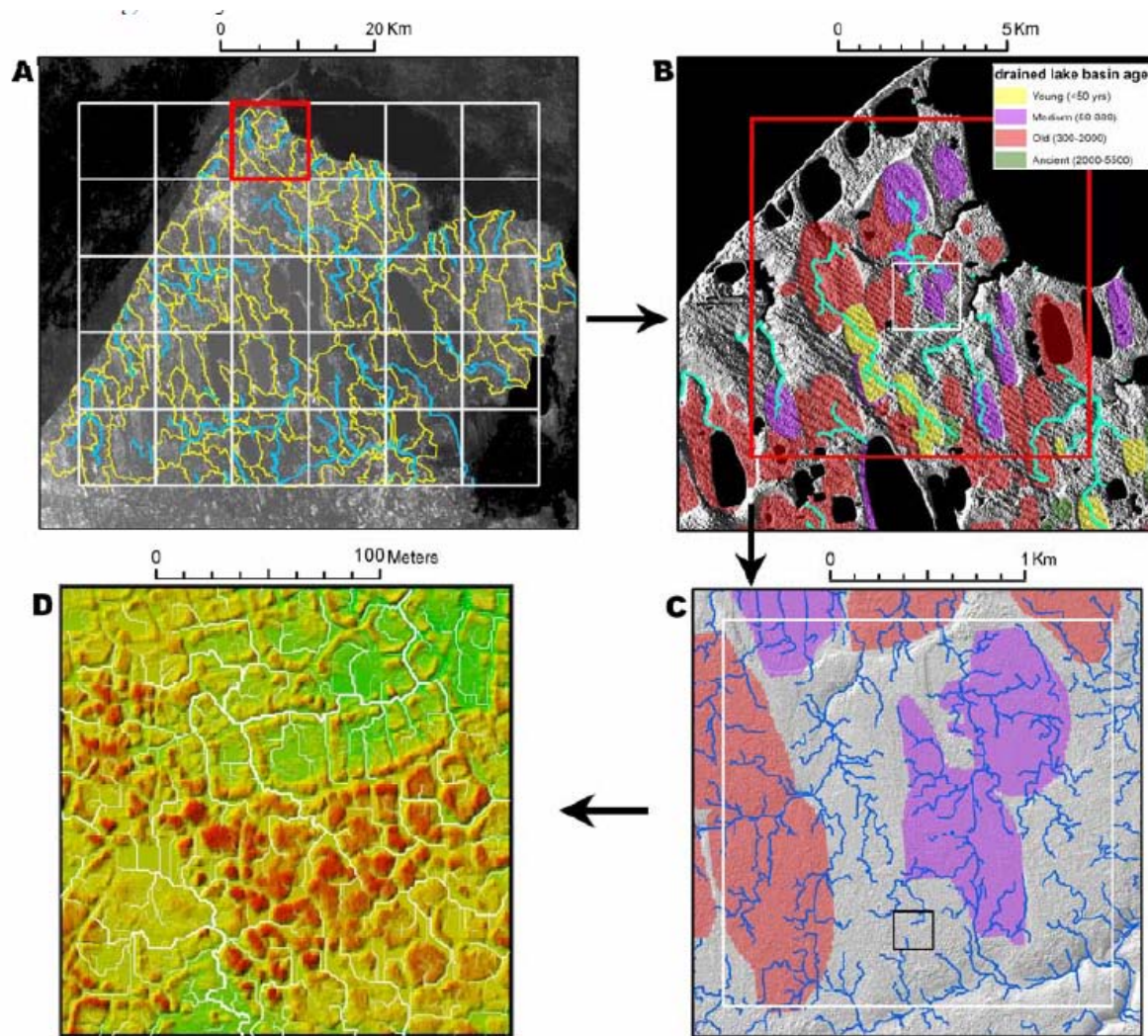
Polygonal tundra on permafrost, near Barrow, Alaska

Current scaling approach for land component of climate prediction model (e.g. CLM4)



Best ESMs currently use quasi one dimensional approach, with assumption of linear scaling

A nested scaling framework based on hydrology/geomorphology



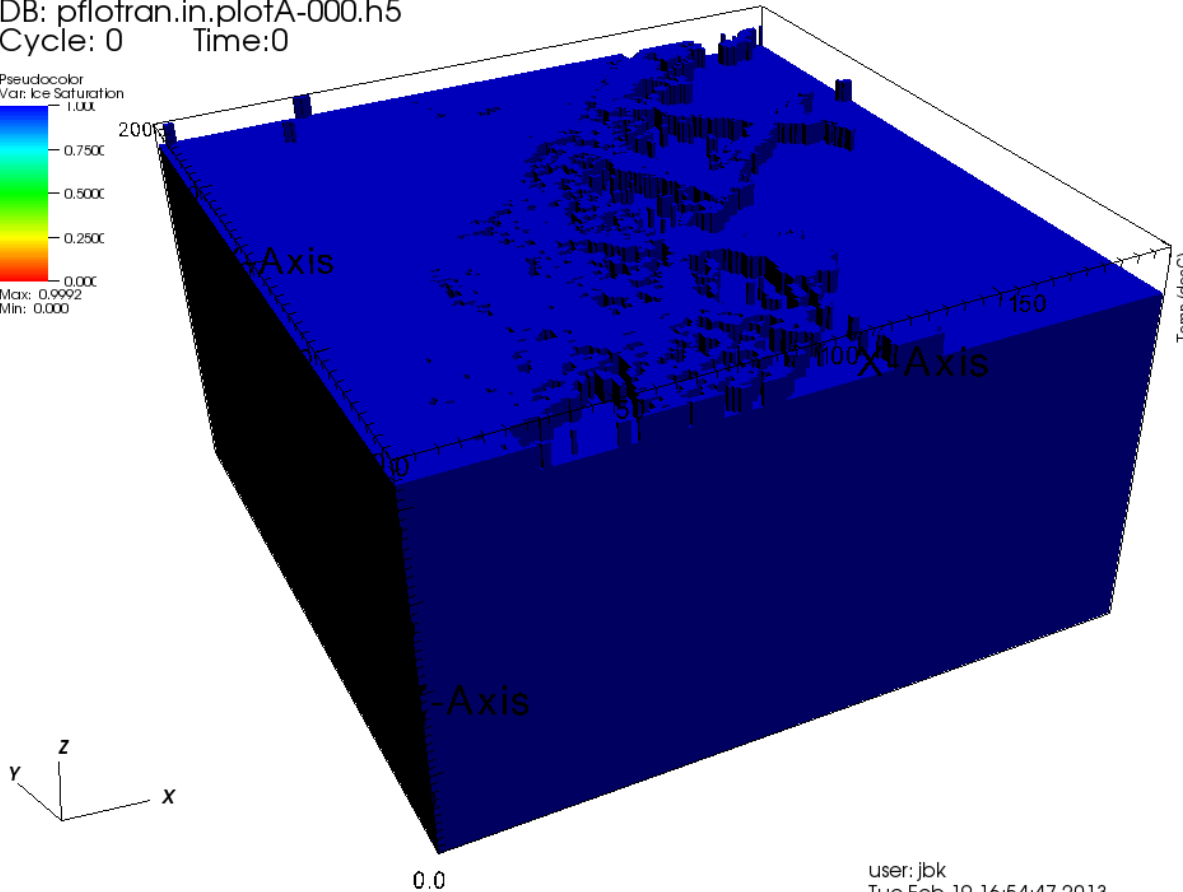
Climate-scale questions:

- What is the fraction of inundated area? and does it have a predictable relationship to carbon content, vegetation community?
- Are active layer thickness and vegetation growth correlated?
- What are the primary controls on vegetation growth and NEE? and on CO₂ vs. CH₄ fluxes?

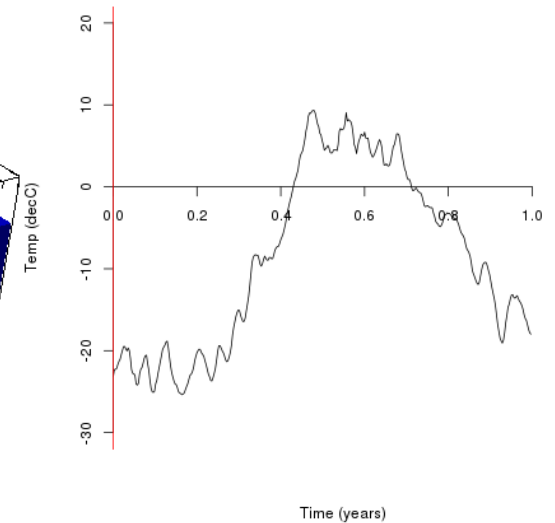
Fine-scale freeze-thaw with PFLOTRAN

DB: pflotran.in.plotA-000.h5
Cycle: 0 Time:0

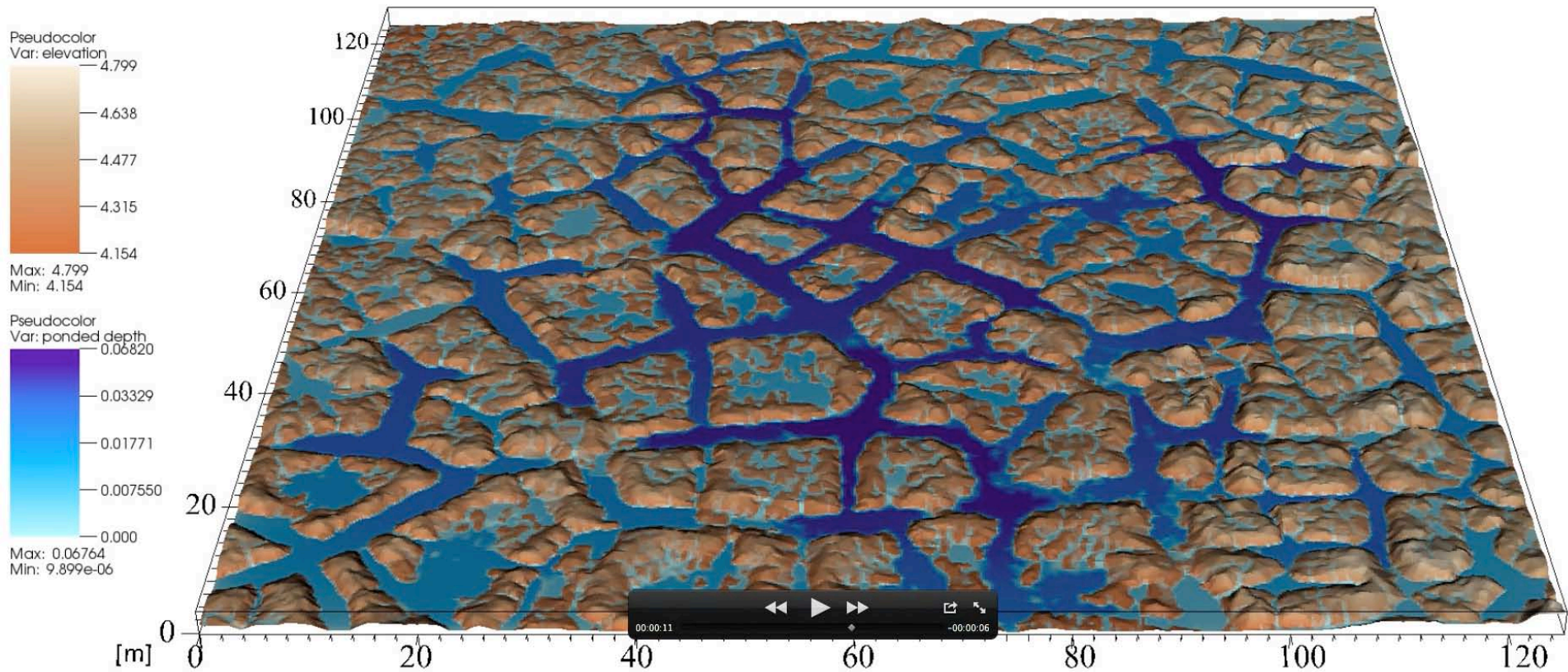
Pseudocolor
Var: Ice Saturation
1.000
0.7500
0.5000
0.2500
0.000
Max: 0.9992
Min: 0.000



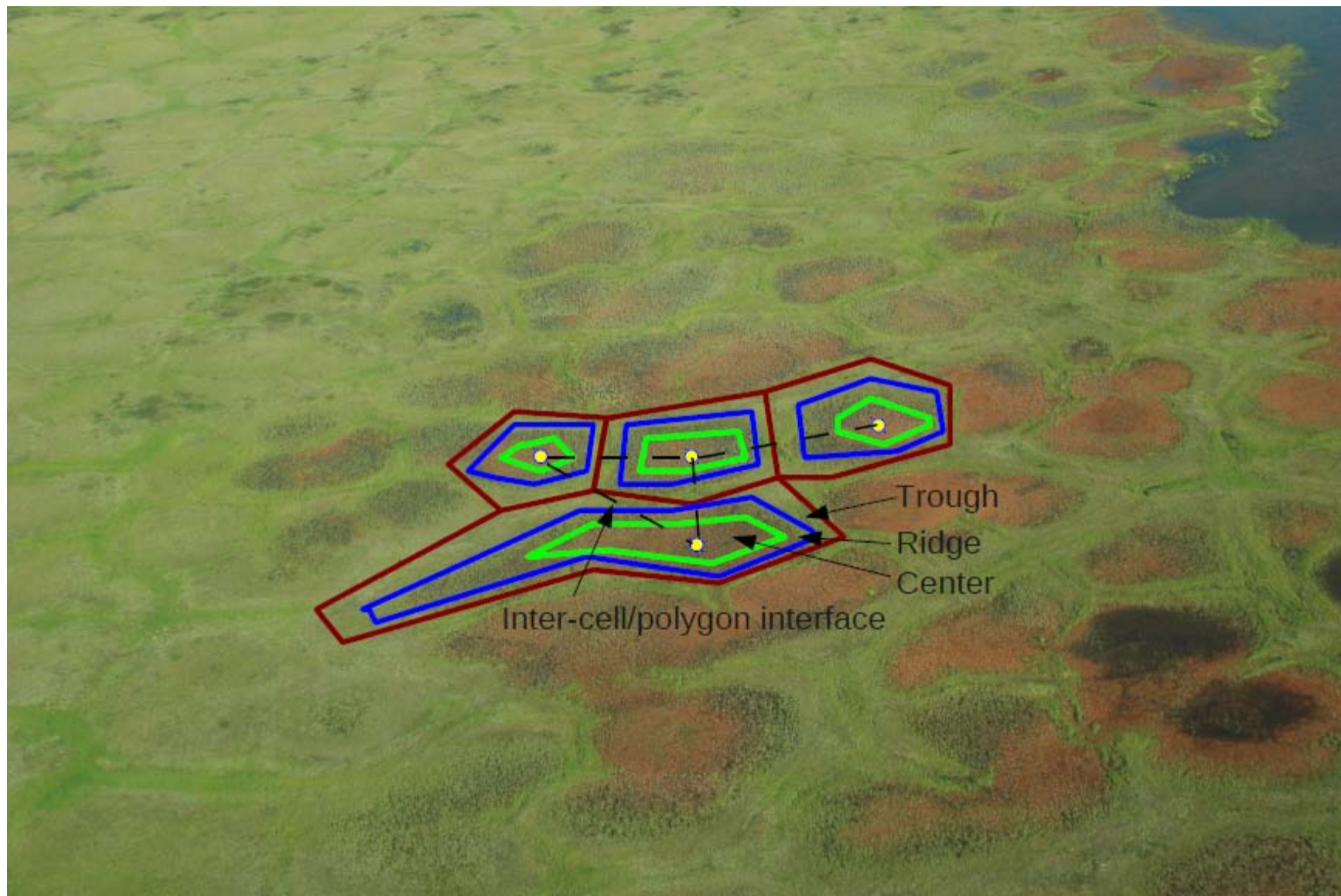
Ground Surface Temperature T=0.000000 yr



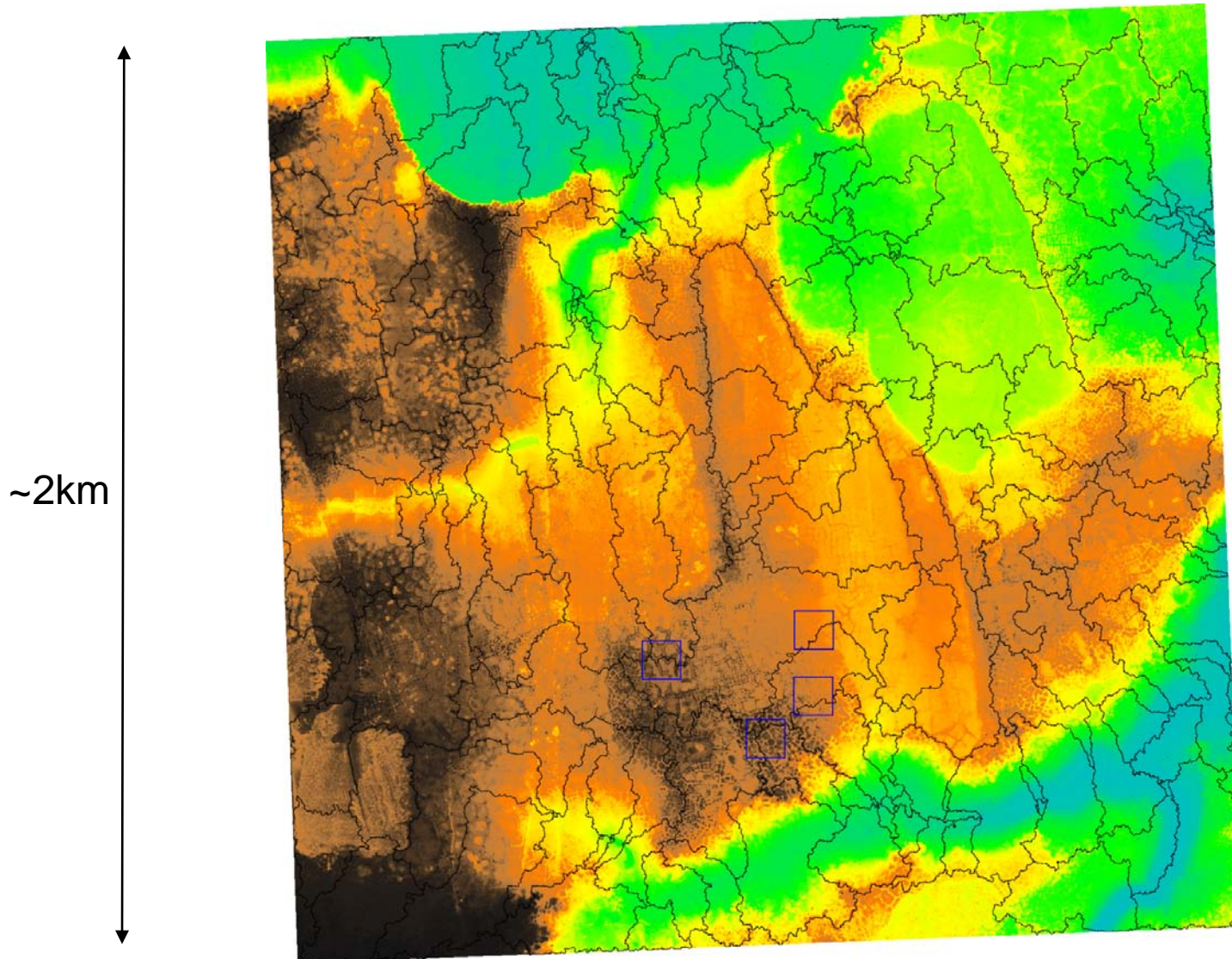
Overland Flow with Amanzi-ATS



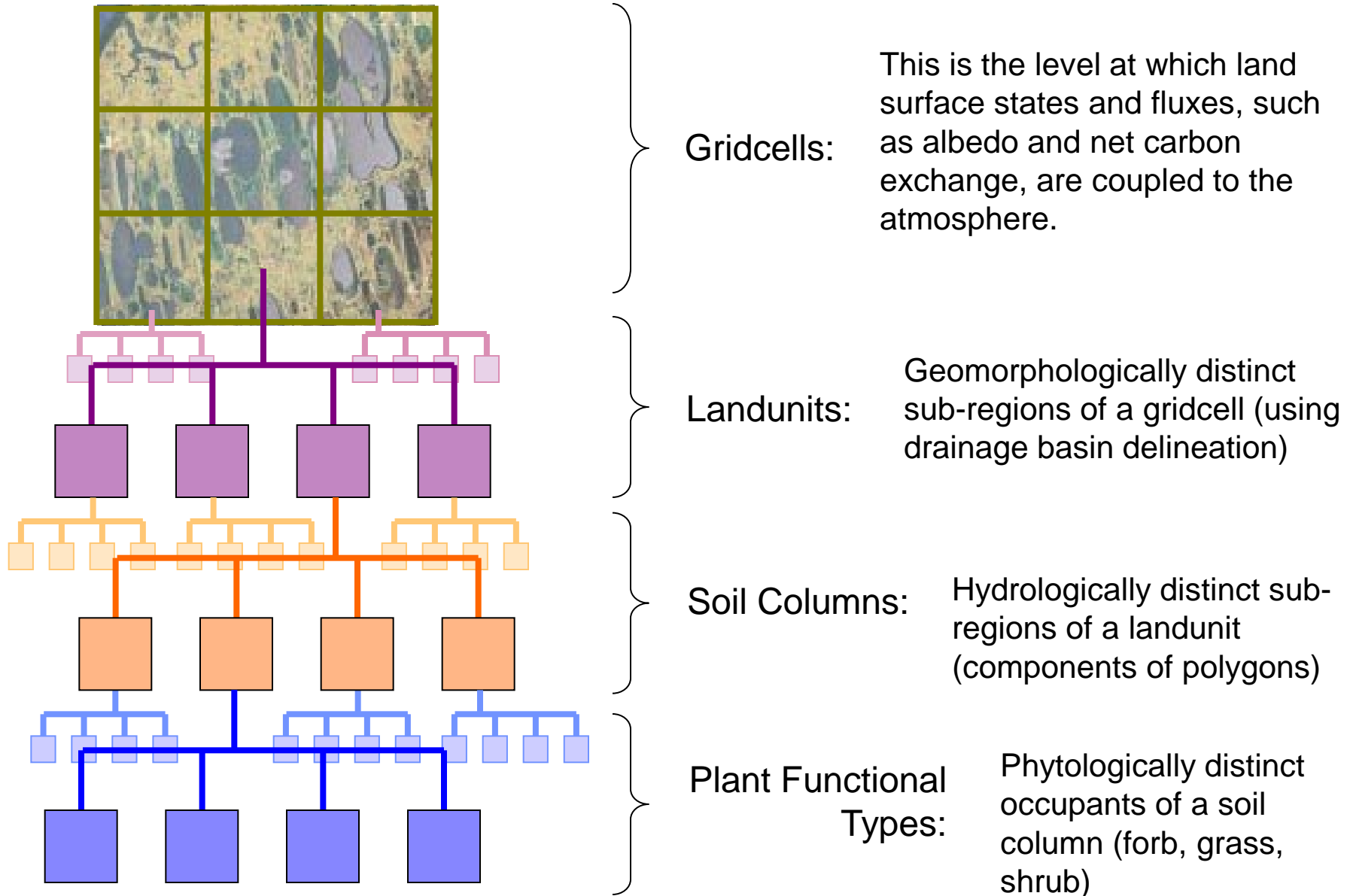
Geomorphic units based approach for intermediate scale model mesh



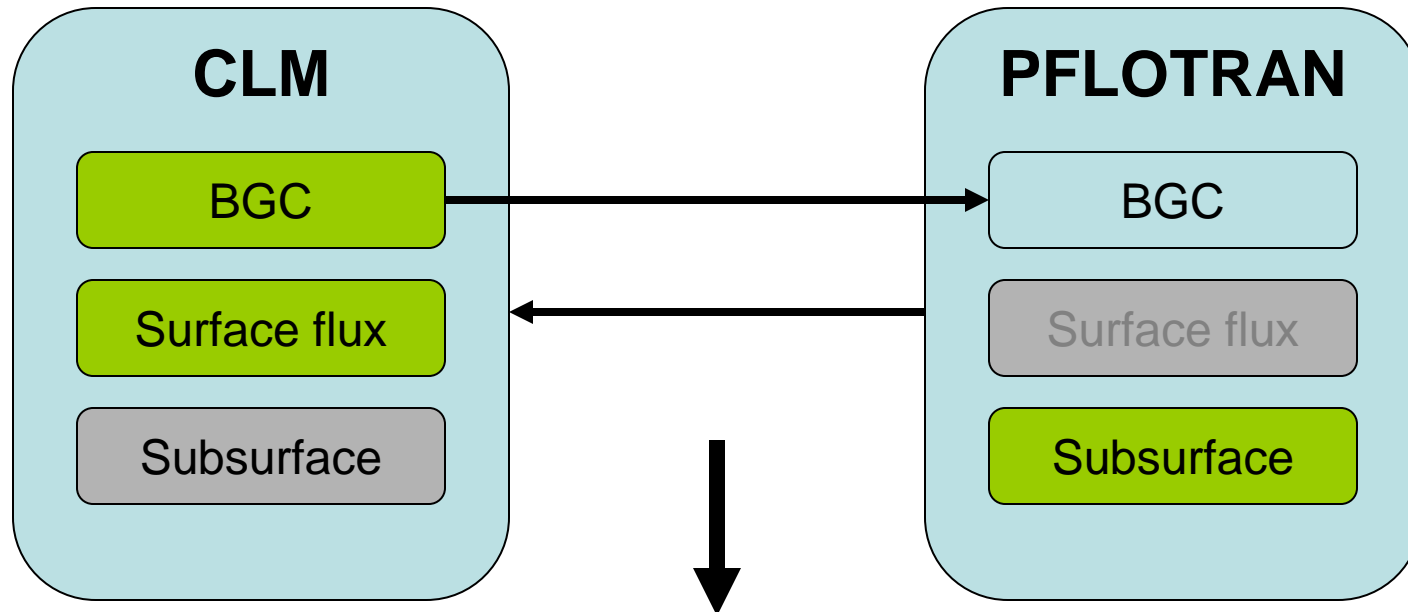
Delineation of watersheds and streams at CLM climate grid-cell scale using 0.5m resolution LIDAR DEM



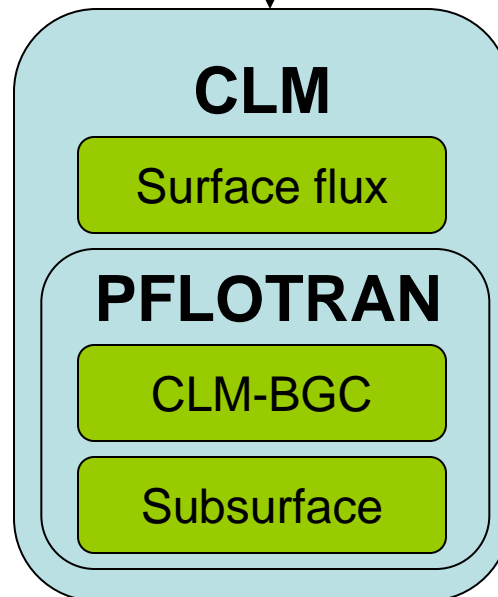
Land model scaling framework: subgrid hierarchy



Prototype model integration



This diagram illustrates how the interoperability of CLM and PFLOTRAN is being addressed. The Amanzi group is tasked with assessing a similar interoperability approach with CLM.



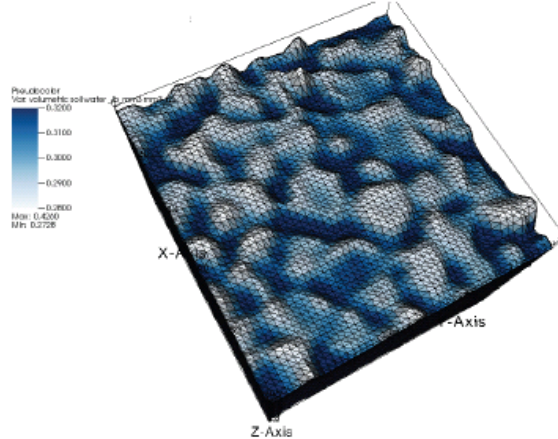
Summary:
CLM's BGC algorithms are being implemented in PFLOTRAN's BGC infrastructure. CLM's subsurface routines are being replaced by PFLOTRAN, and CLM's surface flux algorithms and implementation are being retained. Current prototype interface between CLM and PFLOTRAN is being refined

CLM-PFLOTRAN water/energy coupling

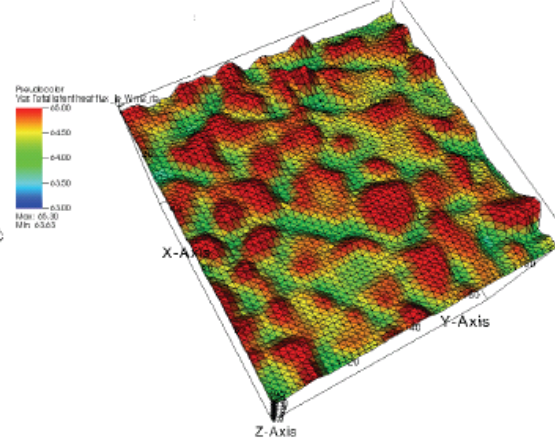
Gautam Bisht, LBNL

Time = 194 [hrs]

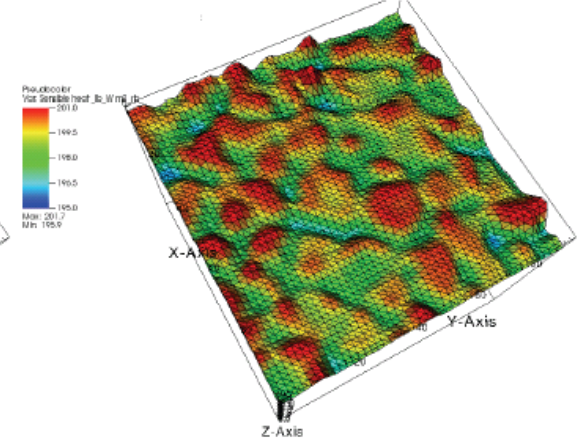
Soil Moisture



Latent Heat flux

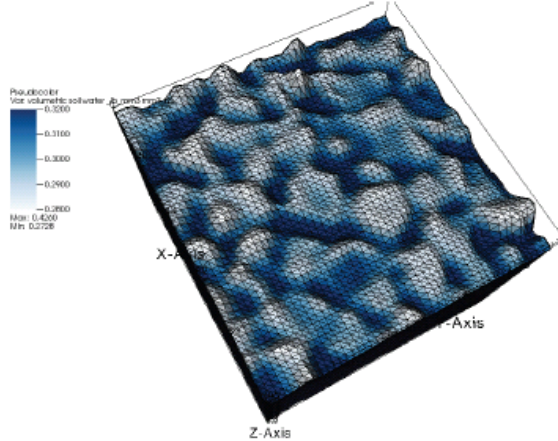


Sensible Heat flux

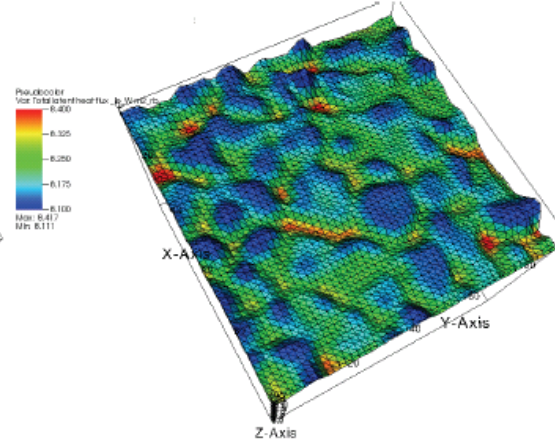


Time = 208 [hrs]

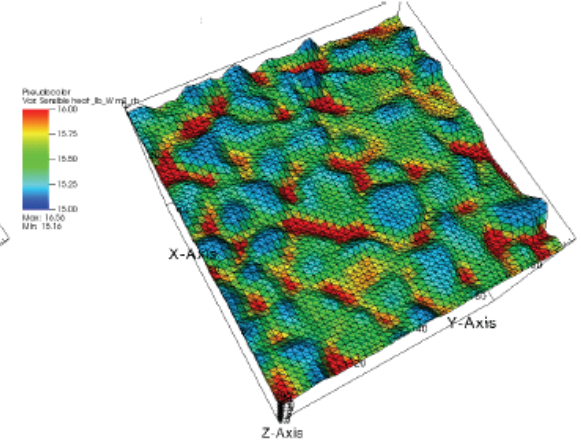
Soil Moisture



Latent Heat flux



Sensible Heat flux



Implementation of CLM-CN BGC within the PFLOTRAN reaction network

Without N-limitation

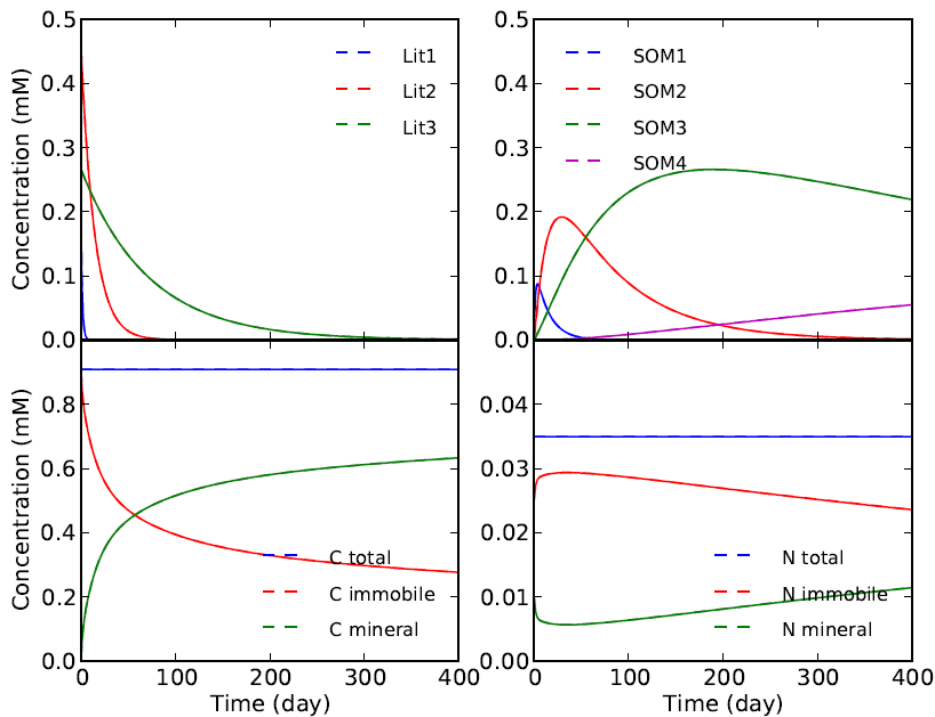


Figure 1: N-nonlimiting case— $N_0 = 10 \mu\text{M}$

With N-limitation

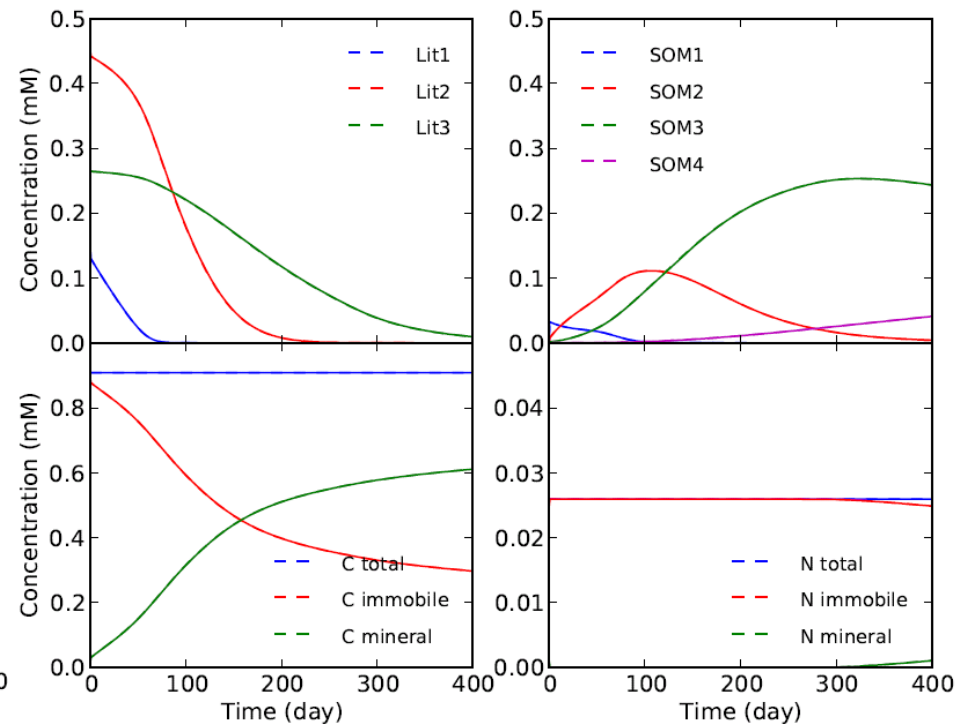


Figure 2: N-limiting case— $N_0 = 1 \mu\text{M}$

New PFTs for Arctic Tundra

- 1 not_vegetated
- 2 needleleaf_evergreen_temperate_tree
- 3 needleleaf_evergreen_boreal_tree
- 4 needleleaf_deciduous_boreal_tree
- 5 broadleaf_evergreen_tropical_tree
- 6 broadleaf_evergreen_temperate_tree
- 7 broadleaf_deciduous_tropical_tree
- 8 broadleaf_deciduous_temperate_tree
- 9 broadleaf_deciduous_boreal_tree
- 10 broadleaf_evergreen_shrub
- 11 broadleaf_deciduous_temperate_shrub
- 12 broadleaf_deciduous_boreal_shrub
- 13 c3_arctic_grass
- 14 c3_non-arctic_grass
- 15 c4_grass
- 16 c3_crop
- 17 c3_irrigated
- 18 corn
- 19 spring_temperate_cereal
- 20 winter_temperate_cereal
- 21 soybean

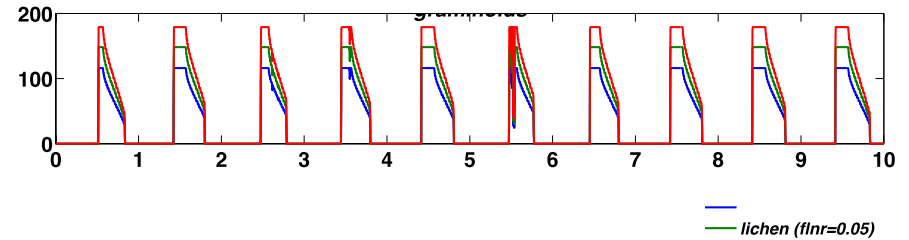
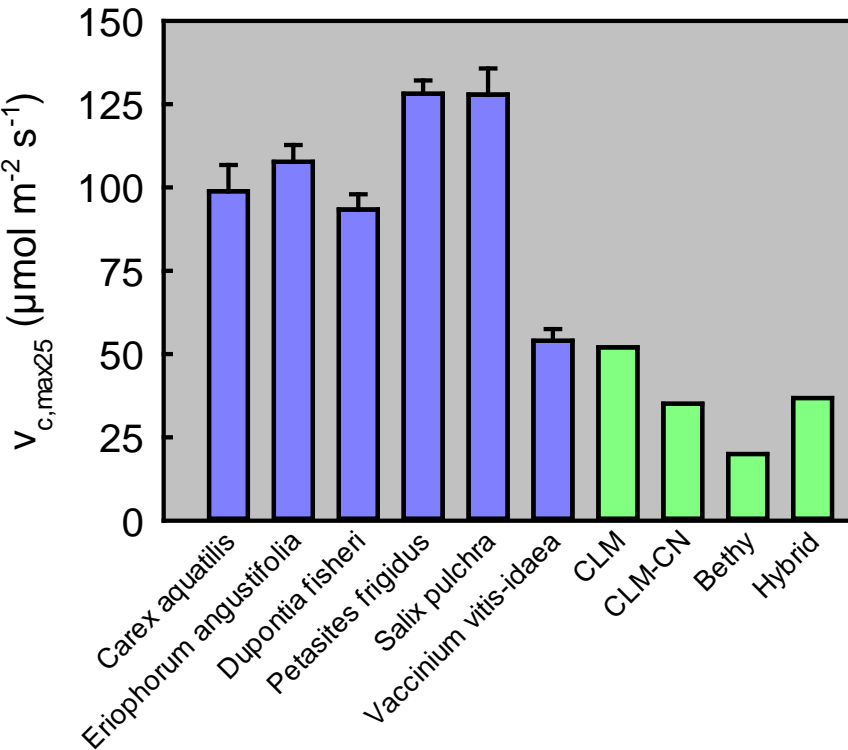
PFT

- 1 not_vegetated
- 2 needleleaf_evergreen_temperate_tree
- 3 needleleaf_evergreen_boreal_tree
- 4 needleleaf_deciduous_boreal_tree
- 5 broadleaf_evergreen_tropical_tree
- 6 broadleaf_evergreen_temperate_tree
- 7 broadleaf_deciduous_tropical_tree
- 8 broadleaf_deciduous_temperate_tree
- 9 broadleaf_deciduous_boreal_tree
- 10 broadleaf_evergreen_shrub
- 11 broadleaf_deciduous_temperate_shrub
- 12 broadleaf_deciduous_boreal_shrub
- 13 arctic_evergreen_shrub
- 14 arctic_deciduous_shrub
- 15 c3_arctic_grass (true grass)
- 16 arctic_sedge
- 17 arctic_forb
- 18 arctic_moss
- 19 arctic_lichen
- 20 c3_non-arctic_grass
- 21 c4_grass
- 22 c3_crop
- 23 c3_irrigated
- 24 corn
- 25 spring_temperate_cereal
- 26 winter_temperate_cereal
- 27 soybean

Most plant physiological parameters, except for 'flnr' and 'fcur', are derived from following publications:

Chapin et al. 1980; 1986; 1988; 1996; Chapin and Shaver 1988; Hobbie, 1996.

Vcmax with New PFTs at Barrow

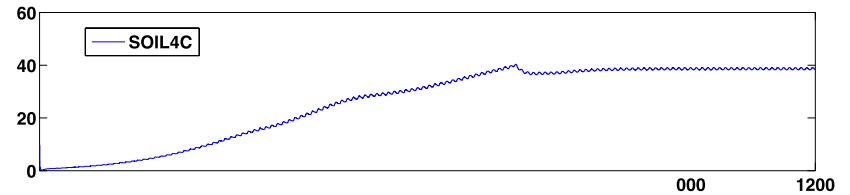
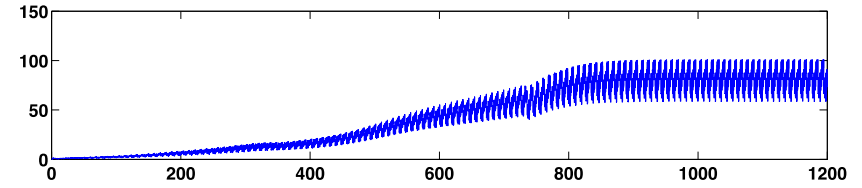
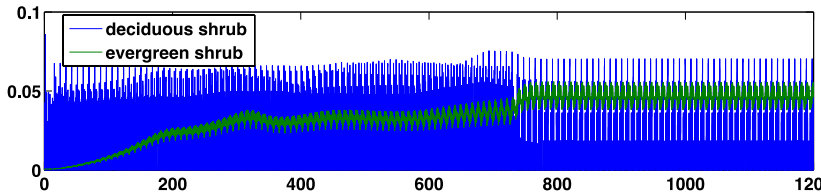


(Alistair Rogers et al. 2013)

(Moss: Williams and Flanagan, 1998. PCE 21: 555-564;
Lichen: Nash et al. 1983. Oecologia 58: 52-56)

Vcmax parameterized via 'flnr'

Accelerated-Spinup with New PFTs at Barrow, AK



Veg. coverage (1972):

- (1) Evergreen shrub 3%, Deciduous shrub 1%;
 - (2) Grass 16%, Sedge 9%, Forb 12%;
 - (3) Moss 44%, Lichen 15%
- (Wielgolask and Webber, 1973; P.J. Webber et al. 1998)

'fcur' adjustment to allow all PFTs not dying out during 1200 year spinup:

- (1) Evergreen shrub 0.50, Deciduous shrub 0.97;
- (2) Grass 0., Sedge 0.30, Forb 0.80;
- (3) Moss 0.17, Lichen 0..60 (both assumed as evergreen plant type)

Modeling experiments indicated 'fcur' is one of very sensitive physiological parameters in CLM-CN

Timeline for initiation and completion of major modeling tasks

