Recent Progress in Land Modeling at the University of Arizona

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Progress

Progress presented in LMWG (March 2009)

a) Evaluation of CLM3.5, CLM3.5+DZ, and CLM4.0 using new data (Decker)

b) Comparison of numerical solutions of Richards equation (Decker)

c) Intercomparison of snow fraction and albedo in four land models (Wang)

d) Amazon-MIP (Christoffersen)

Progress since March 2009

(1) CLM sensitivity to drought over the Amazon (Sakaguchi)

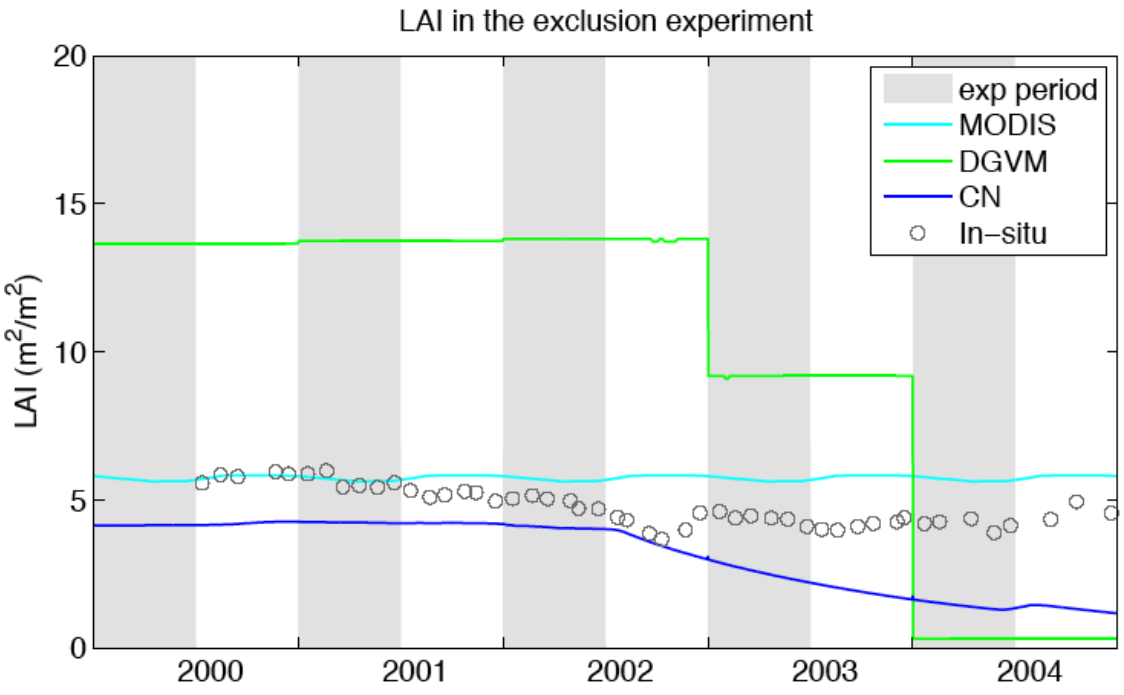
(2) Amazon-MIP (Christoffersen)

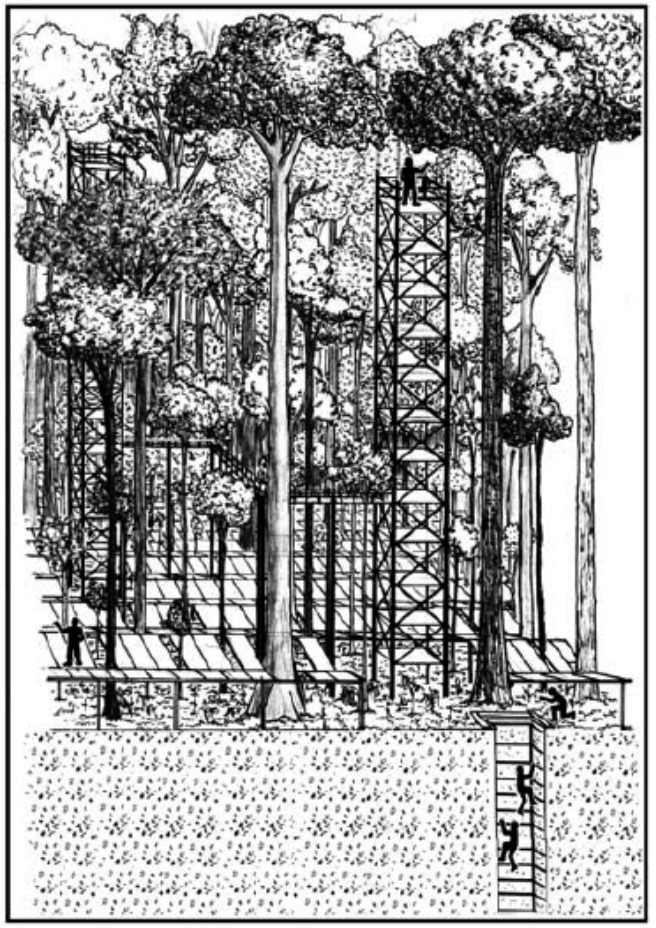
(3) SiB3 sensitivity to drought in the Biosphere 2 (Rosolem)

(4) Comparison of the numerical solutions of the soil moisture-based versus matric potential-based Richards equation (Decker)

(5) Evaluation of Noah versus CLM over snow-covered forest (Wang)

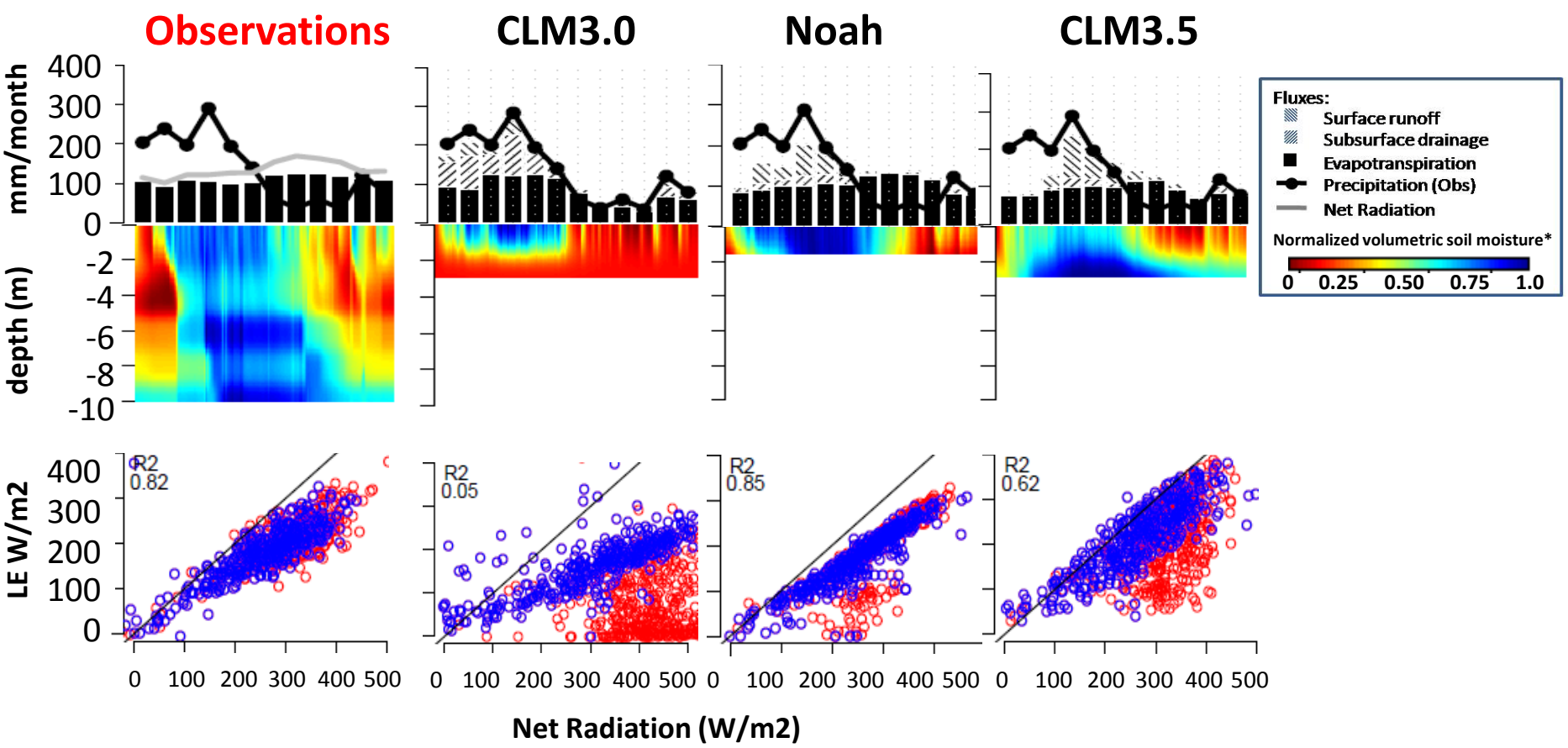
CLM3.5-DGVM and CLM3.5-CN Sensitivity to Drought in the Amazon





Nepstad et al. 2002 and others

LBA-MIP K83 Site



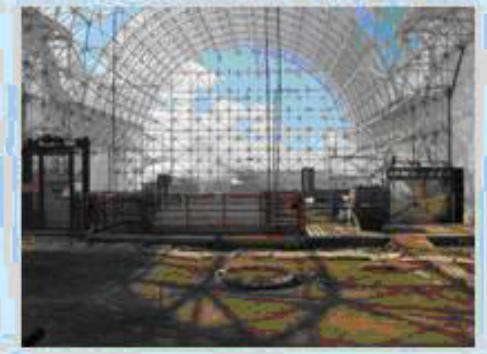
B2 Earthscience

http://www.b2science.org

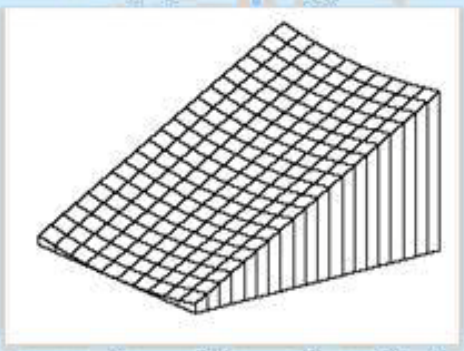
B2 Earthscience institutional experiment

How does rain get to the river and how is it modified by life?

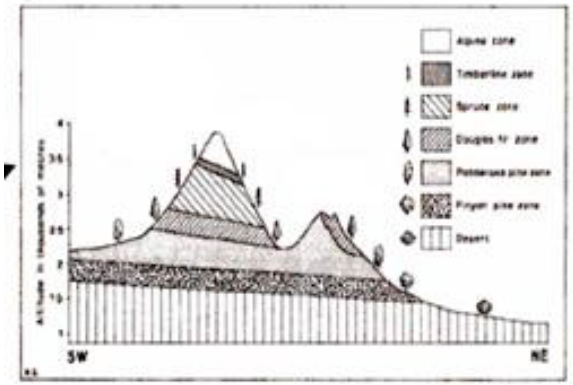
Facility components to renovate



The physical template



A zero order catchment producing variance in soil moisture spatially



Existing Research Programs

SRER, SECA, SAHRA, Modeling, CZO Efforts

Biosphere 2 Macrocosm

Experimental landscape, external-control landscape

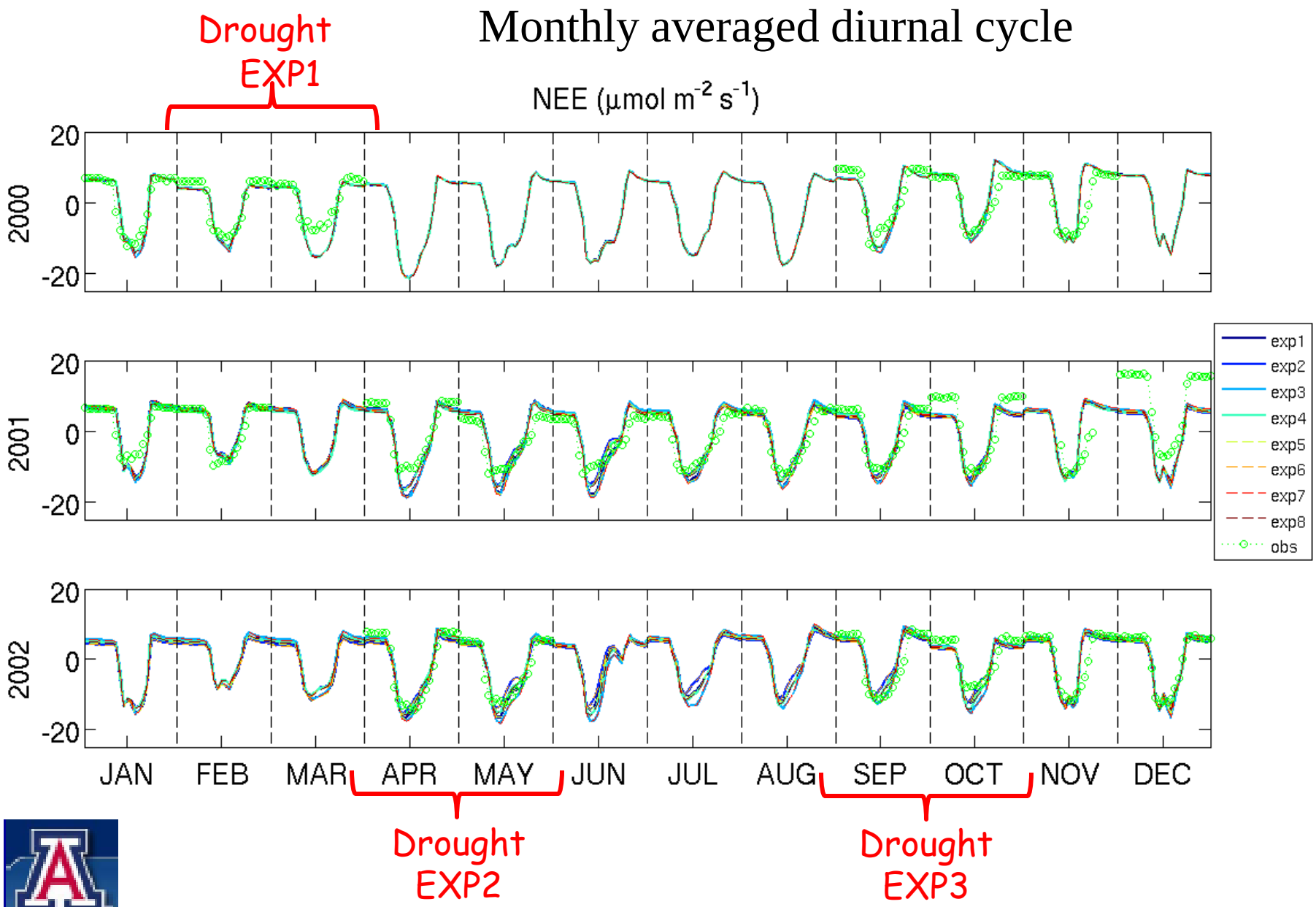
Biosphere 2 Mesocosm

Meter-squared biology and physical sciences

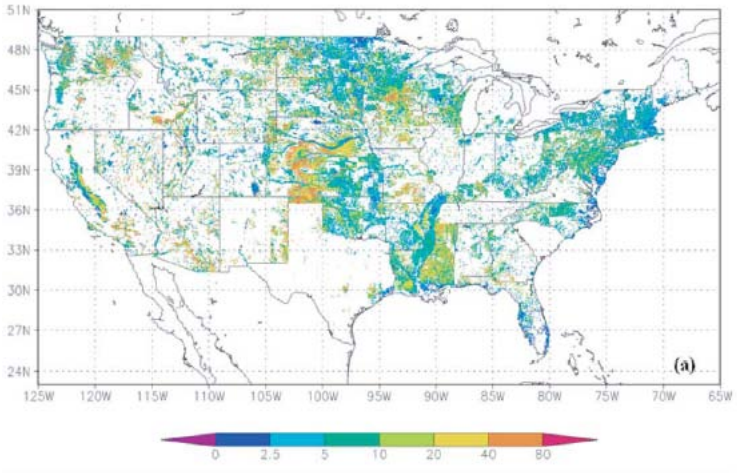
Scale

Degree of Control

SiB3 Sensitivity to Drought in Biosphere 2

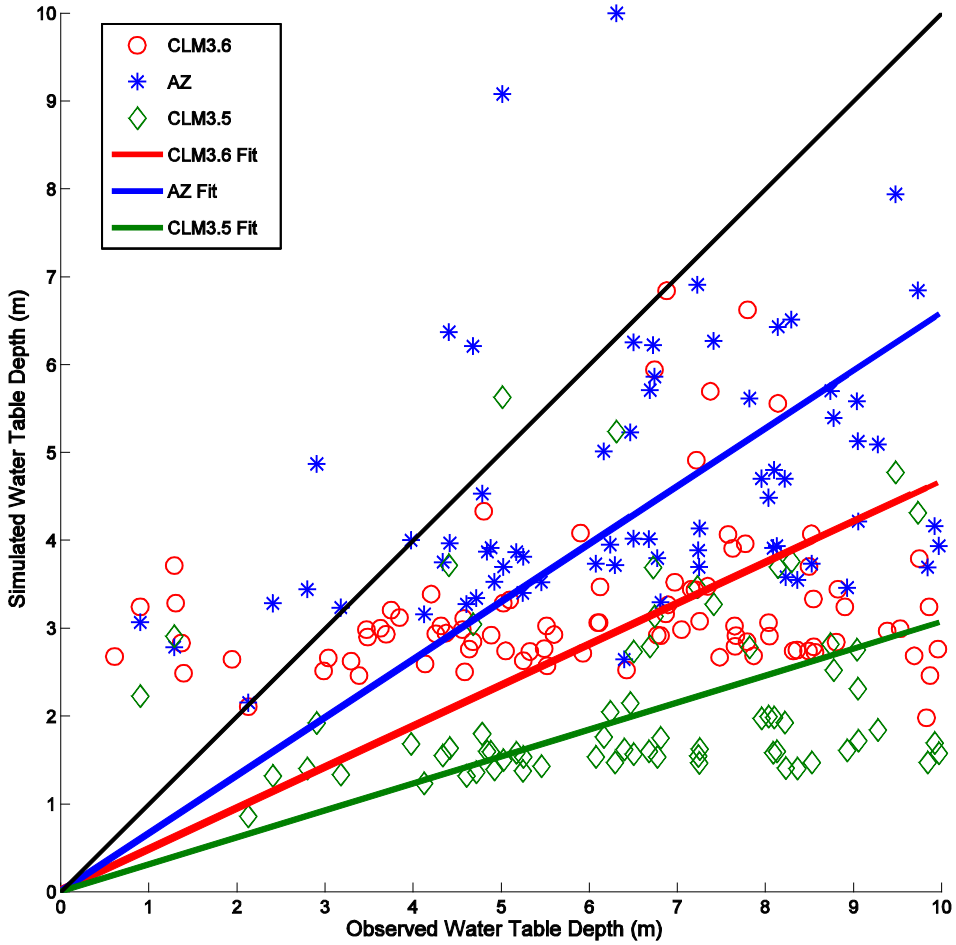


Comparison of Water Table Depth



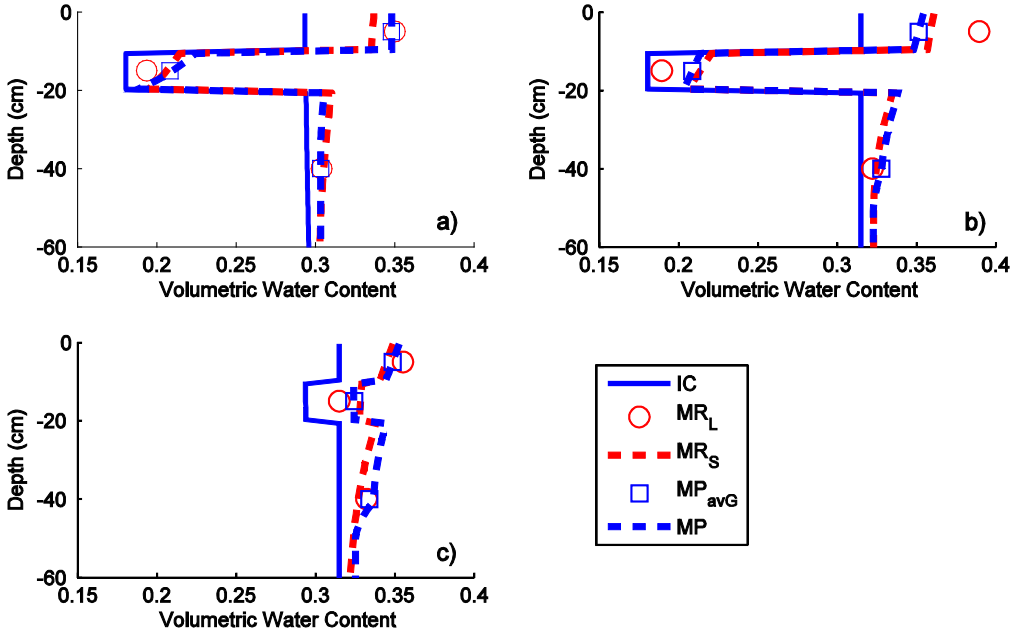
Miguez-Macho et al. (2008)

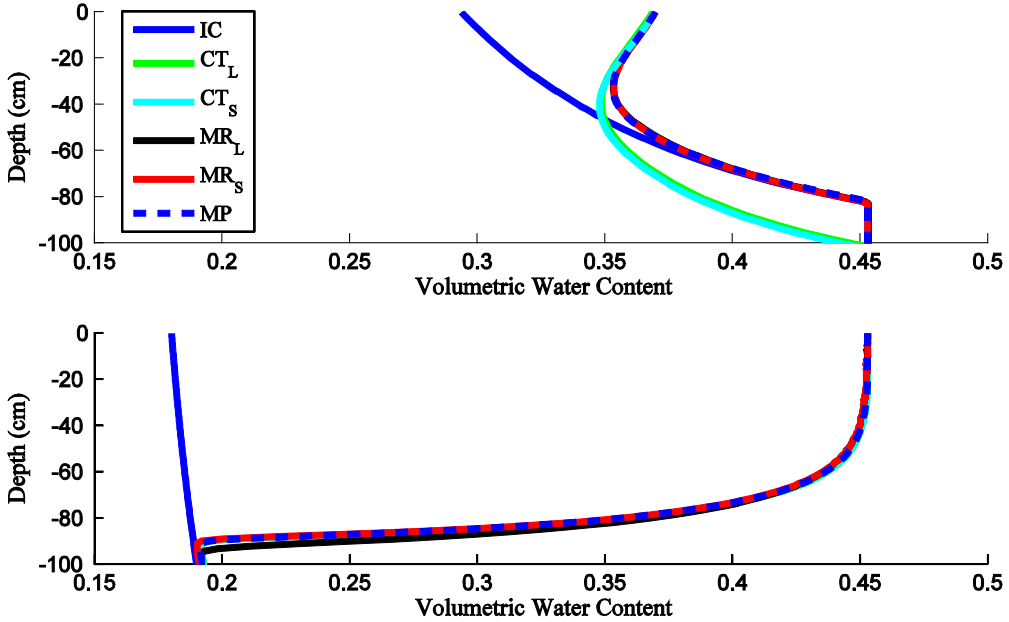
USGS in situ climatological water table observations (~ 550,000)



Numerical Solutions of Richards Equation

- CLM3.5
- CLM3.5+revised Richards equation
- Matric potential-based Richards equation



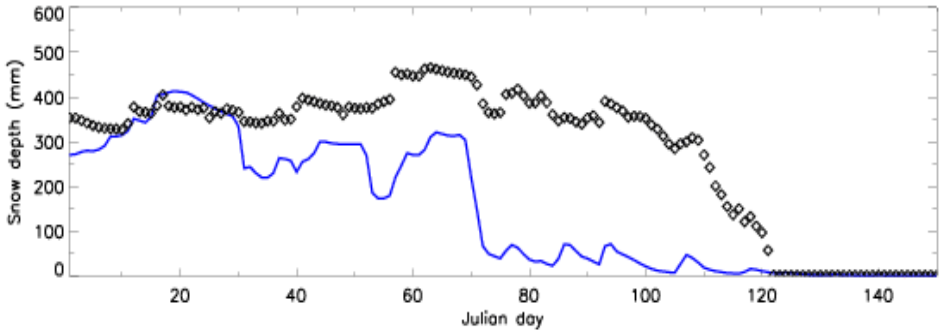


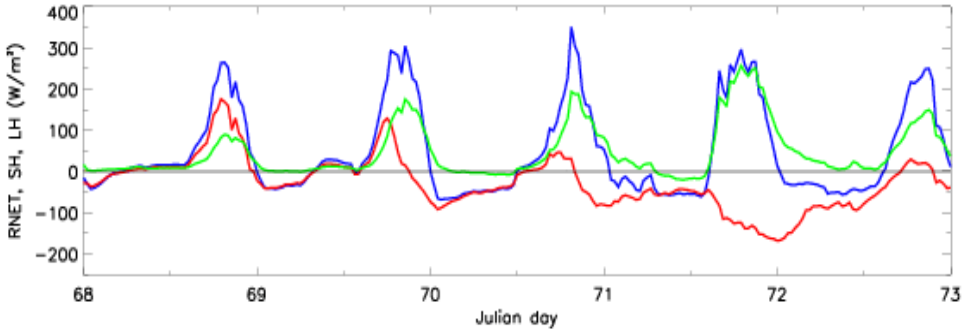
Main Difference:
Linearization vs iterations

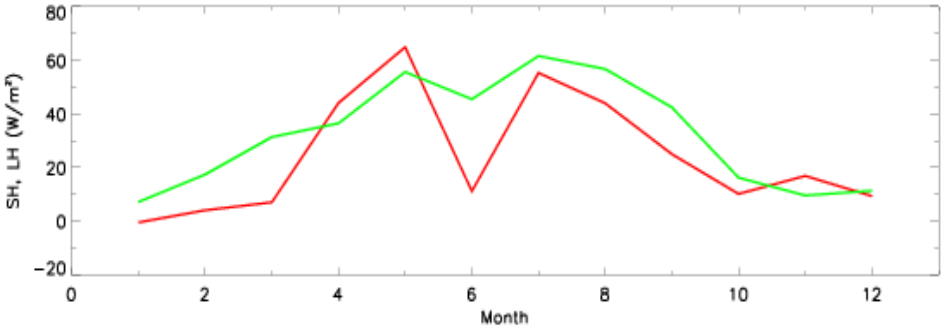
Revised Richards equation method is 2-3 orders of magnitude as fast

Major snow deficiencies of Noah over forest areas

- Snowmelt too early
- Abrupt drop in snow depth
- Small fraction of snow difficult to melt in spring
- Downward SH too large for some days in mid-winter
- Later winter-early spring LH (primarily sublimation) too large







Top panel (snow depth):

Noah

Middle panel:

Rnet LH SH

Bottom panel:

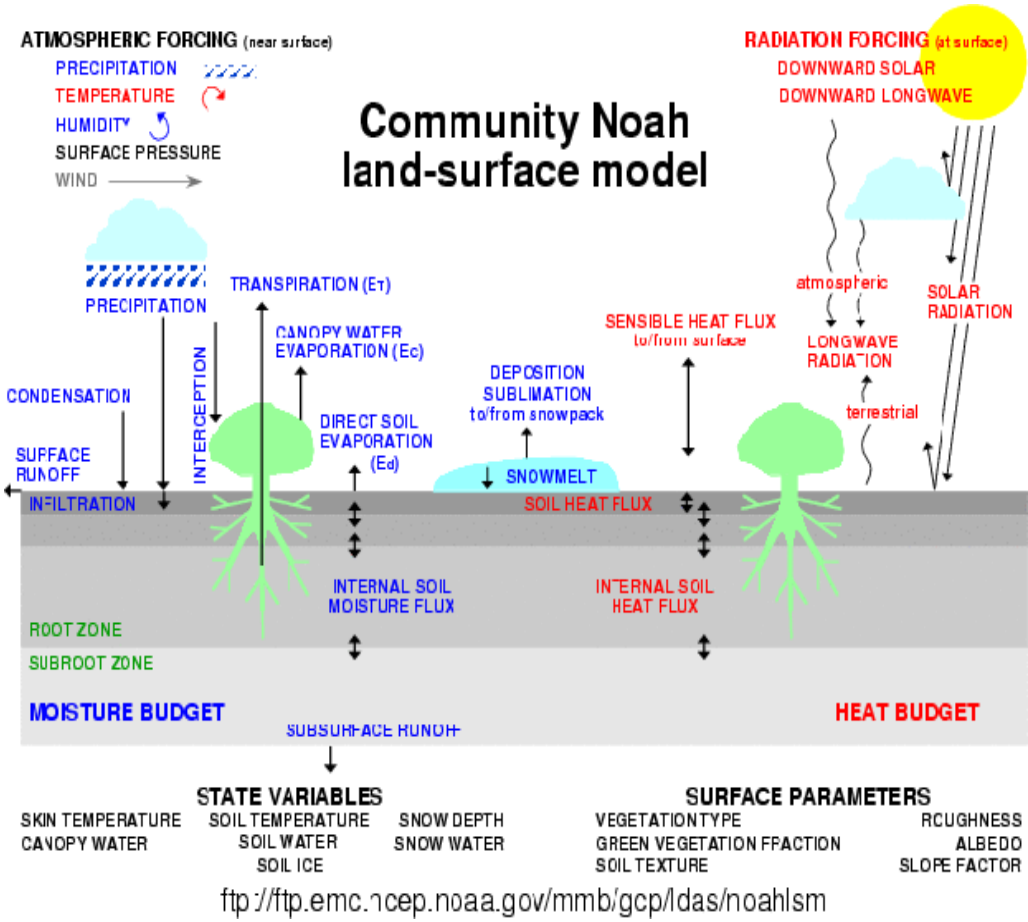
LH SH

Overall reasons:

-----Structure
single combined temperature of ground, vegetation, & snow

----Physics
vegetation shading effect on underlying snow sublimation & melt not considered (while effect on albedo considered)

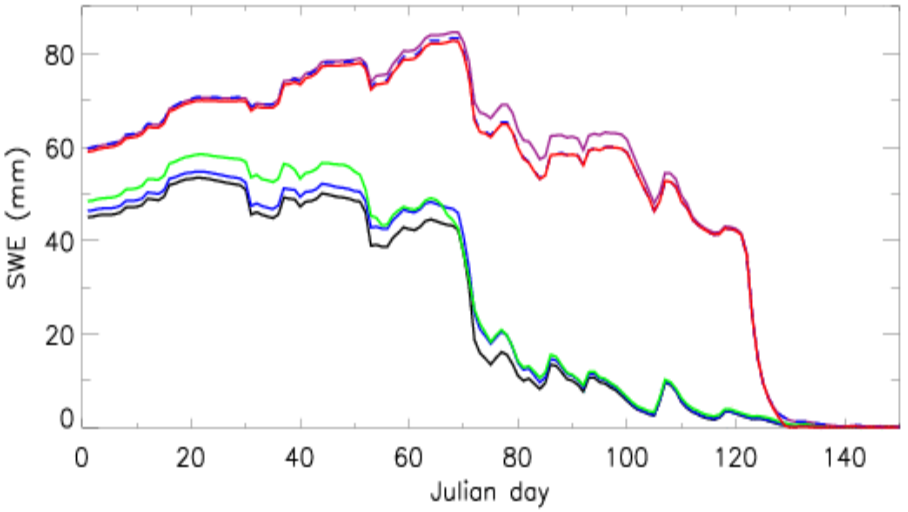
various approaches have been tested by different groups, but problems remain

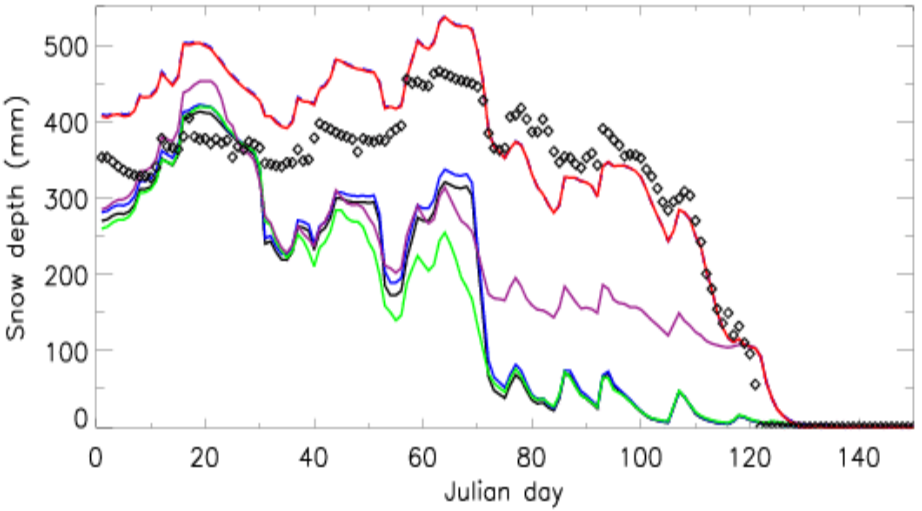


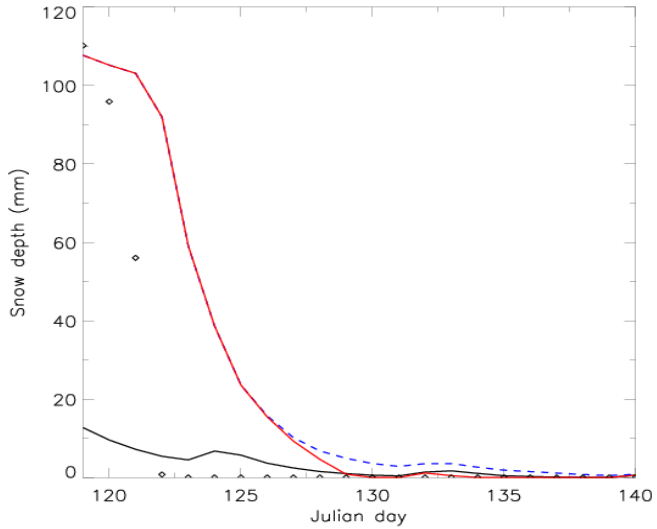
Our revisions

- Control
- + turbulence convergence
- + Zo convergence

  Zo = f(Zo,sn, Zo,v, non-buried GVF)
- + shading effect on snow melt and sublimation (Primary reason)
- + snow density near 0ºC using T_1 and T_{soil}
- + sublimation at small f_{sn} using max(0.3,f_{sn})





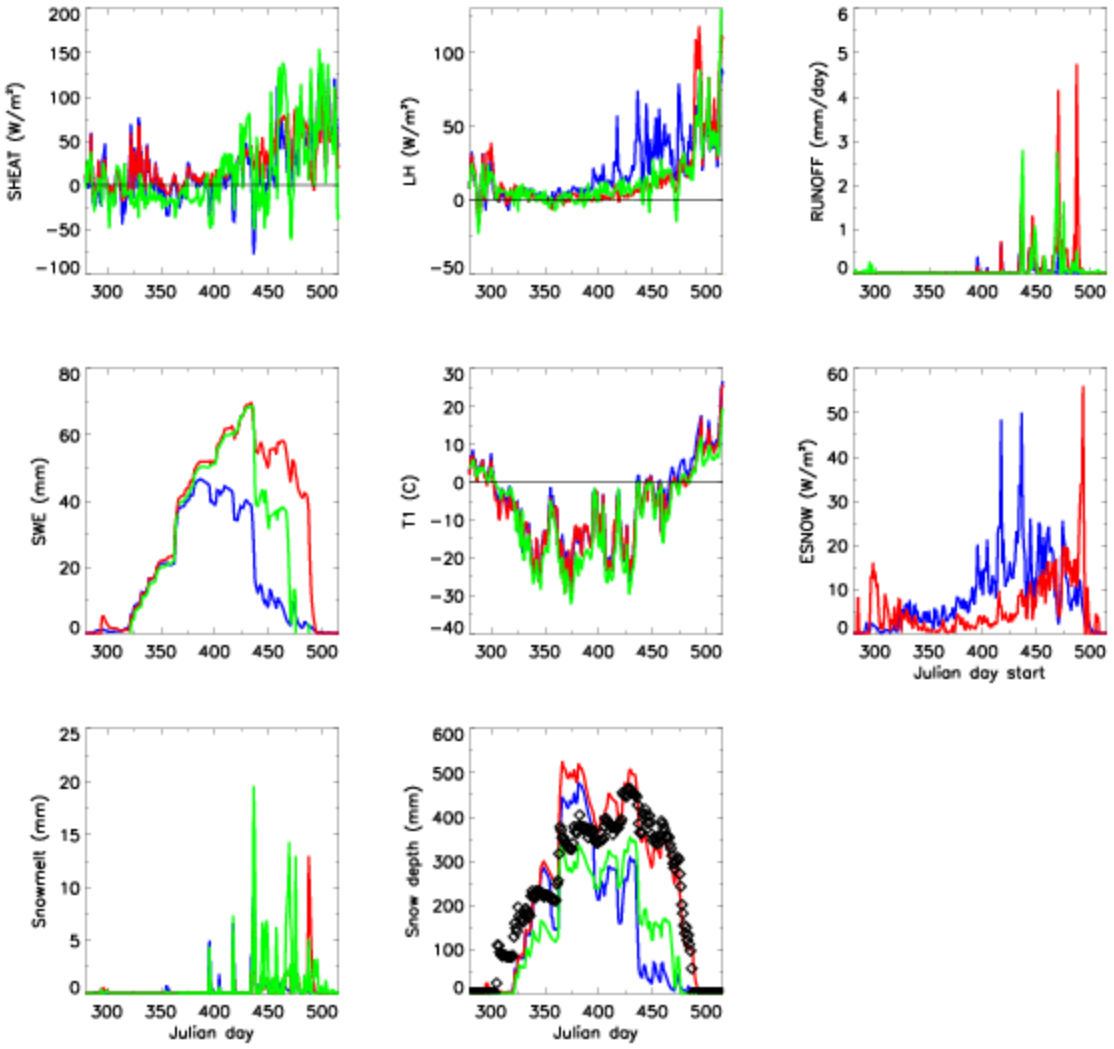


Boreal Forest Site, Canada

Noah

Noah_new

CLM3.5

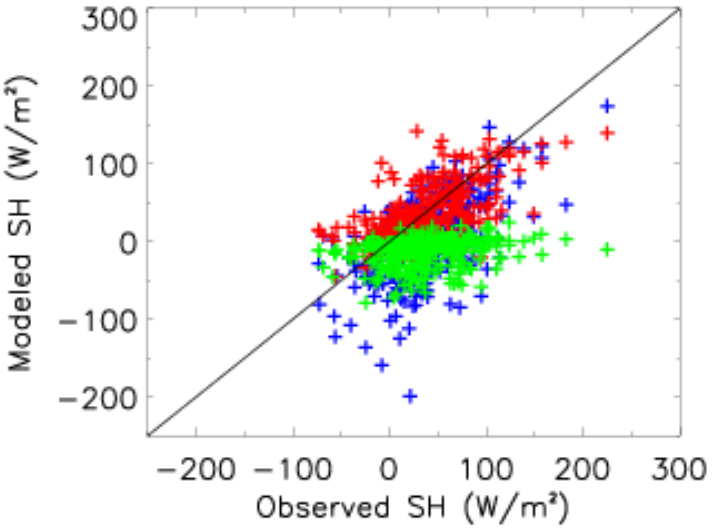


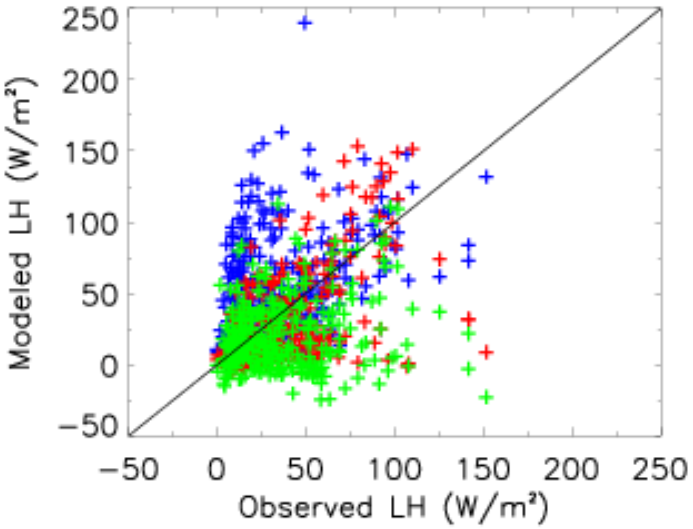
Niwot Ridge Forest Site, Colorado

Noah

Noah_new

CLM3.5





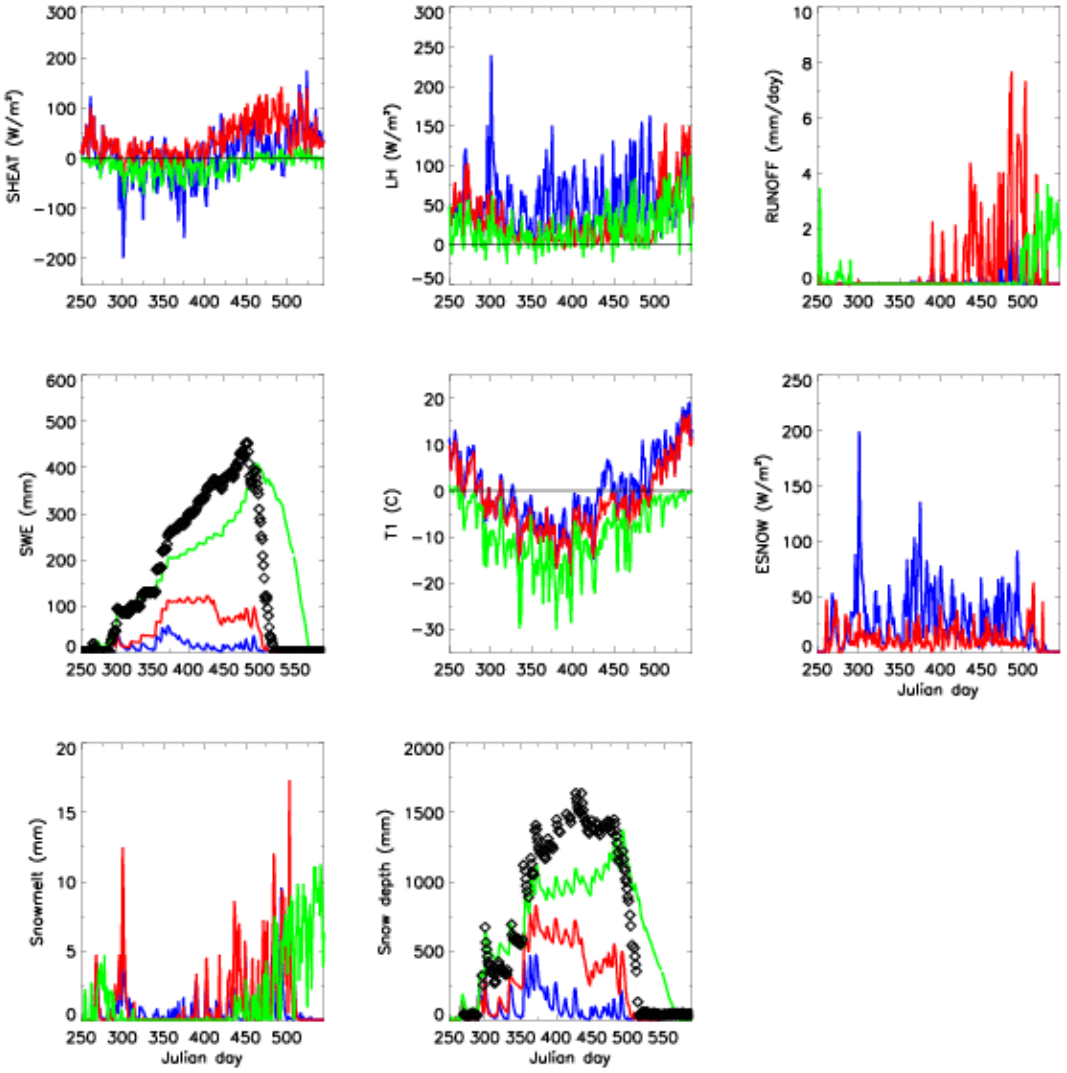
	Correlation coeff	Absolute deviation
Noah	0.56	40.8
Noah_new	0.61	27.5
CLM3.5	0.22	56.2
Noah	0.35	30.5
Noah_new	0.56	21.1
CLM3.5	0.19	26.9

Niwot Ridge Forest Site, Colorado

Noah

Noah_new

CLM3.5



Summary

Good testbeds for future CLM4.0 testing:

- drought experiment over the Amazon
- drought experiment in the Biosphere 2
- Amazon-MIP
- USGS groundwater table data

Numerical scheme of CLM plus the revised Richards equation provide an efficient solution of soil moisture in the unsaturated and saturated zones

Proposed preliminary ideas to improve the Noah snow modeling

CLM3.5 still needs to be further improved in snow simulation