

Noah-MP Land Surface Model Developments in WRFv3.9 and Beyond

Michael Barlage (NCAR)

Fei Chen (NCAR)

Xing Liu, Dev Niyogi (Purdue University)

Francisco Salamanca (Arizona State Univ.)

Shiguang Miao, Yizhou Zhang (IUM)

WRF v3.9 release cycle: Noah-MP modifications

Noah-MP capabilities/enhancements

- This cycle focused primarily on providing necessary datasets to run crop and groundwater functions in Noah-MP and integrating single- and multi-layer urban models with Noah-MP
 - Added single-layer and multi-layer urban capability to Noah-MP:
 - `sf_urban_physics = 1` -> single-layer urban model
 - `sf_urban_physics = 2` -> multi-layer BEP urban model
 - `sf_urban_physics = 3` -> multi-layer BEP/BEM urban model
- See additional talk tomorrow by Salamanca
- Soil water transport & snow ablation mods in support of NWM
 - SOILPARM.TBL was modified to make table fully consistent with Cosby

WRF v3.9 release cycle: Noah-MP modifications

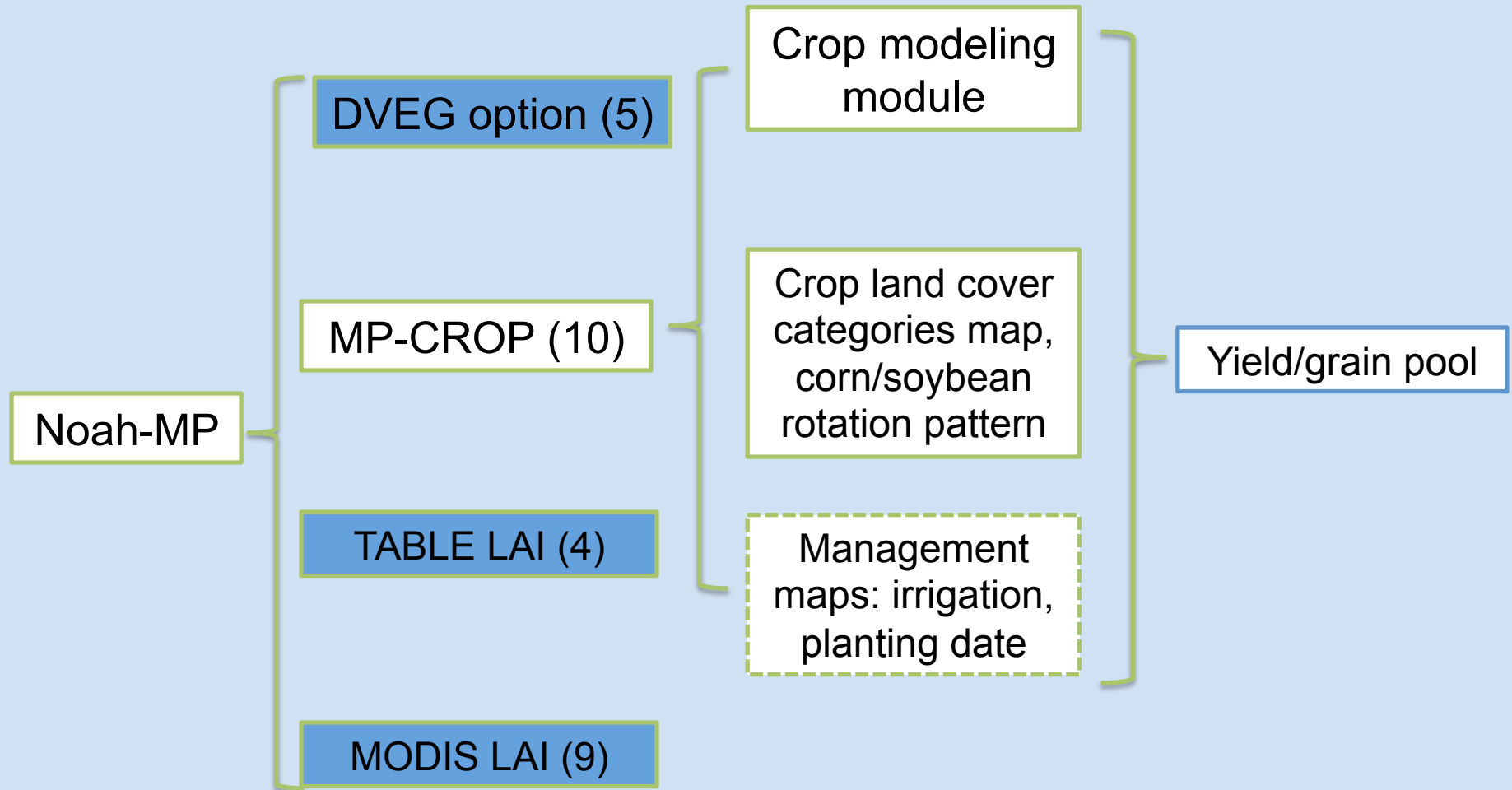
Noah-MP capabilities/enhancements

- Improved upon initial commit of crop model
 - added crop-specific parameters for corn and soybean to run crop model
 - added planting and harvest dates by state
 - added seasonal growing degree day map
 - added crop fraction and specific crop frequency
 - **dveg = 10 -> crop model on (use maximum vegetation fraction)**

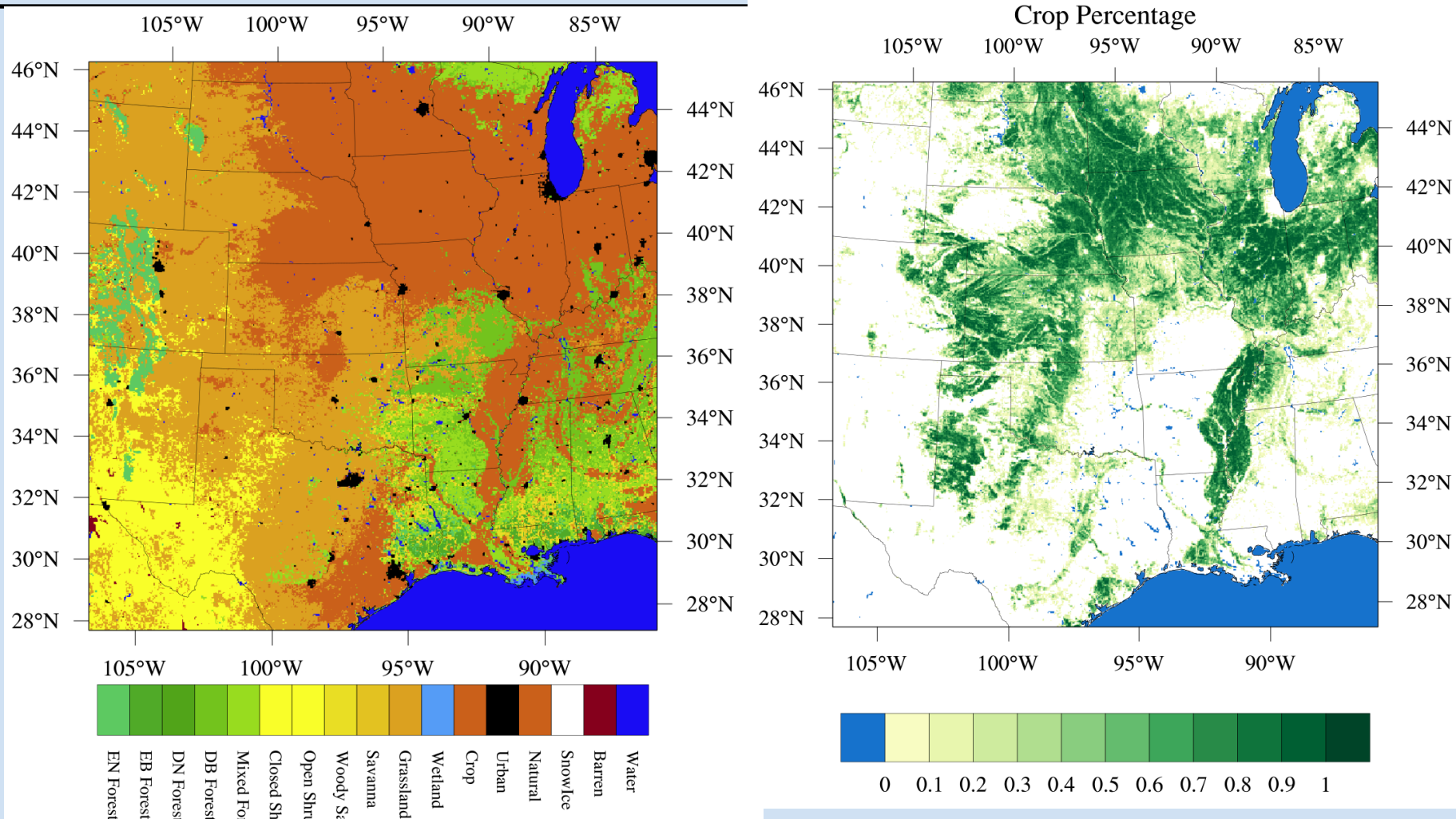
To add new crop and groundwater fields in geogrid, use
GEOGRID.TBL.ARW.noahmp

Many new capabilities also require additional datasets: how do we address this growing issue?

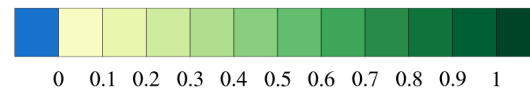
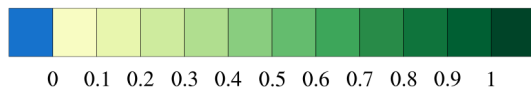
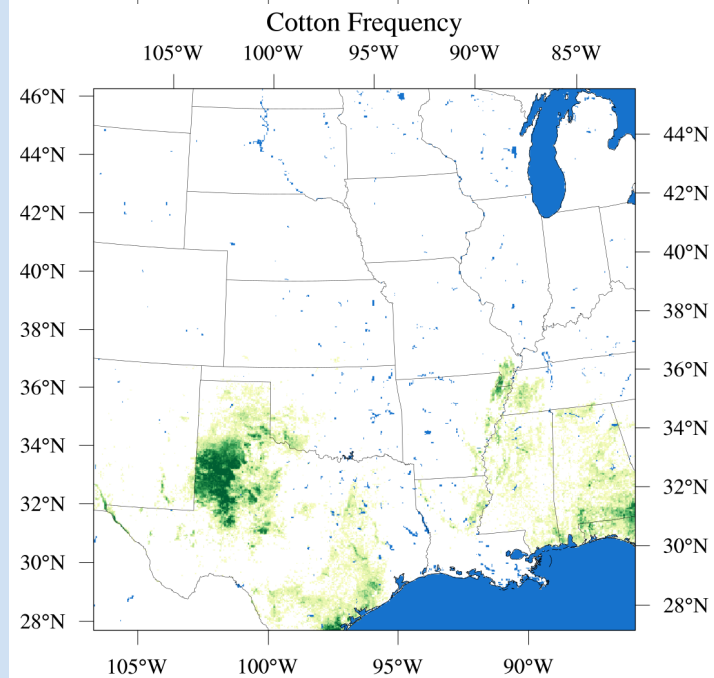
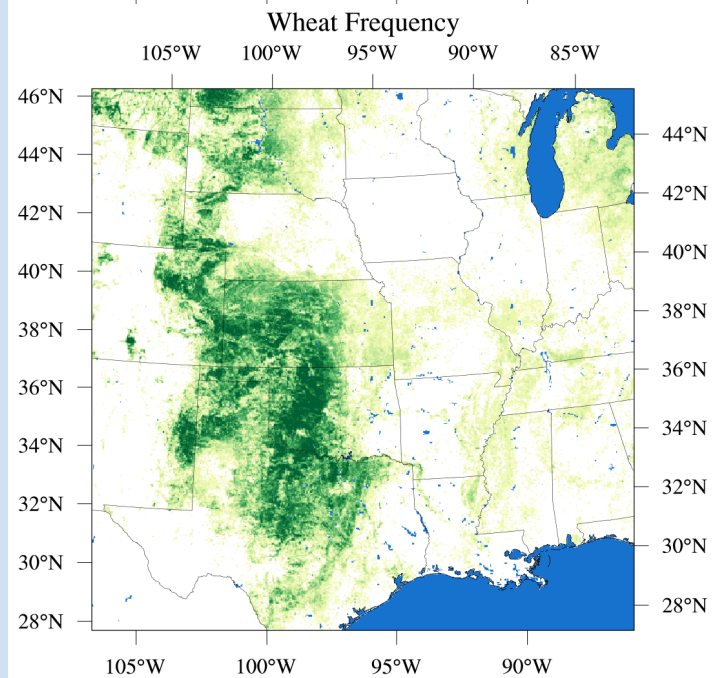
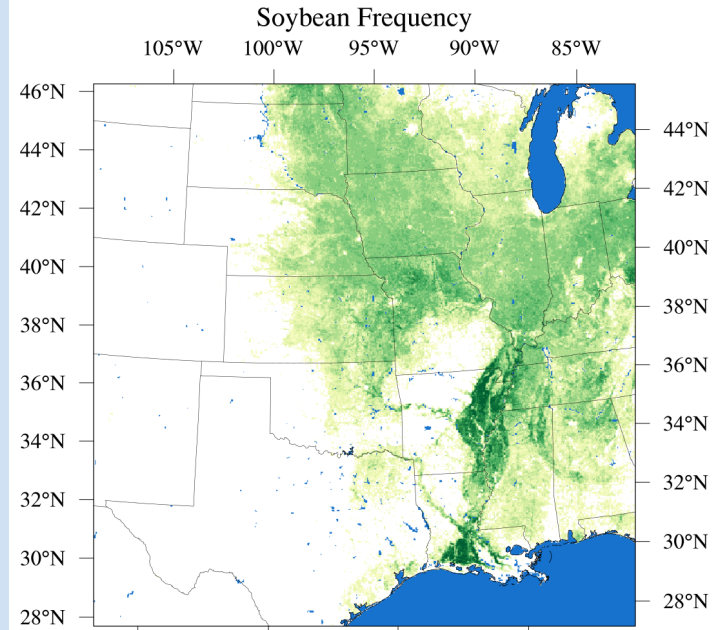
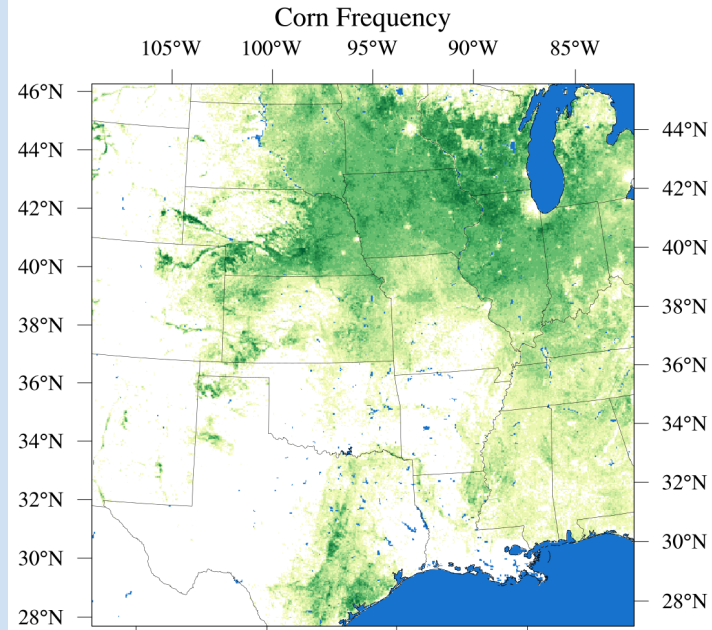
Noah-MP-Crop – expanded capability



WRF v3.9 release cycle: Noah-MP modifications



- Crop data based on Cropscape, a 30 meter US crop dataset by USDA/GMU
- Contains 5 layers: corn crop frequency, soybean, wheat, cotton, crop planting frequency; plus season_gdd (NLDAS), planting and harvest dates

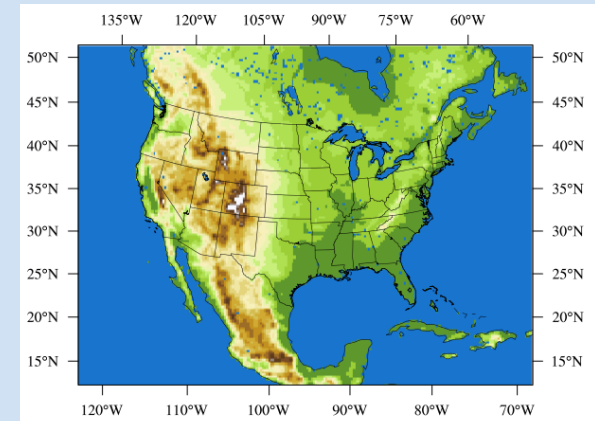


Fan et al, JGR 2007
Miguez-Macho et al., JGR
2007

Miguez-Macho & Fan water table dynamics in Noah-MP

Noah-MP vs. NoahMP w/groundwater Surface Verification

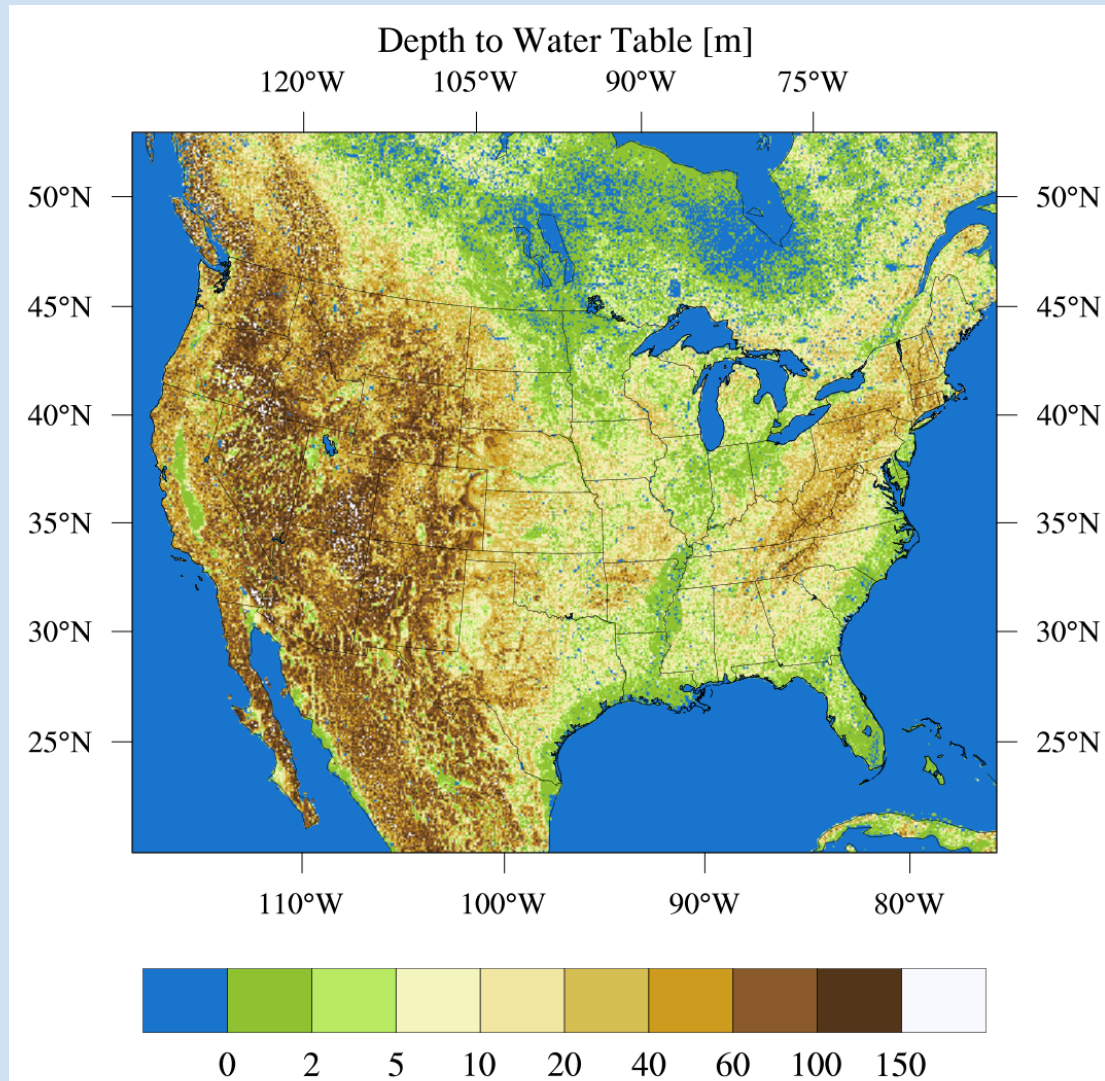
- Six-month 30km WRF simulations - 2010
- Spin-up soil for one year using offline HRLDAS
- IC/BC from NARR
- Verification against ~2600 surface stations



Model	Season	Output field	Day bias	Day RMSE	Night bias	Night RMSE
Noah-MP	MAM	T_{2m}	0.5	1.0	0.2	0.8
w/GW	MAM	T_{2m}	0.4	1.0	0.2	0.8
Noah-MP	JJA	T_{2m}	1.7	1.9	0.5	1.0
w/GW	JJA	T_{2m}	1.1	1.6	0.1	0.9

Green: Noah-MP w/GW improves Red: Noah-MP w/GW degrades

WRF v3.9 release cycle: Noah-MP modifications



- Groundwater information based on Miguez-Macho and Fan
- Contains 6 layers: depth to water table, climatological recharge, rivermask, K e-fold, and terrain of river and non-river.

WRF v3.9 release cycle: Noah-MP results

- Focus on 2-meter temperature forecast in regional climate runs
- Three-month simulations (May – July 2014) with different LSMs
 - LA2DVX: Noah
 - LA4DV4: Noah-MP with table LAI (dveg = 4)
 - LA4DV9: Noah-MP with satellite LAI (dveg = 9)
 - LA4DV5: Noah-MP with dynamic LAI (dveg = 5)
 - LA4DV0: Noah-MP with crop model (dveg = 10)
 - LA4DVG: Noah-MP with groundwater model (opt_run = 5)

Results are presented as relative improvement in bias:

Negative/blue mean an improvement in bias compared to Noah

Positive/red means a degradation in bias compared to Noah

WRF v3.9 release cycle: Noah-MP results

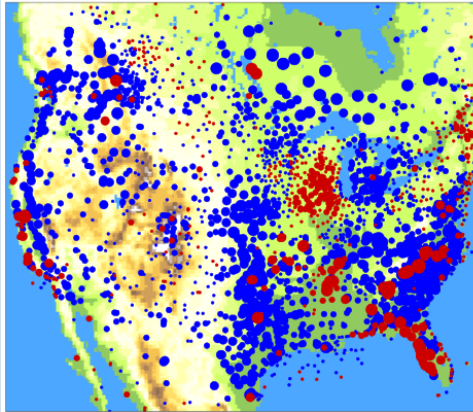
2014-05 00Z T2 bias improvement(-) over LA2DVX

LA4DV4 (mean: -0.445)

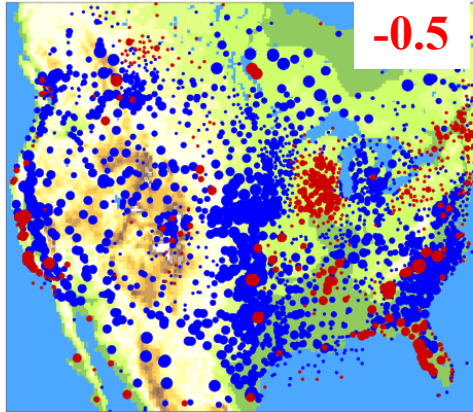
LA4DV9 (mean: -0.456)

LA4DV5 (mean: -0.168)

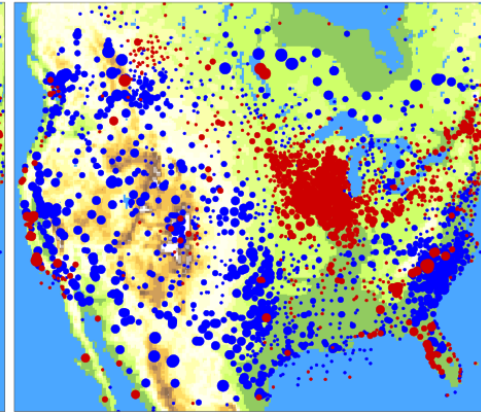
-0.4



-0.5



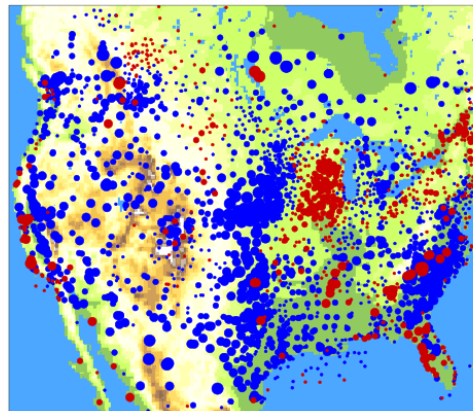
-0.2



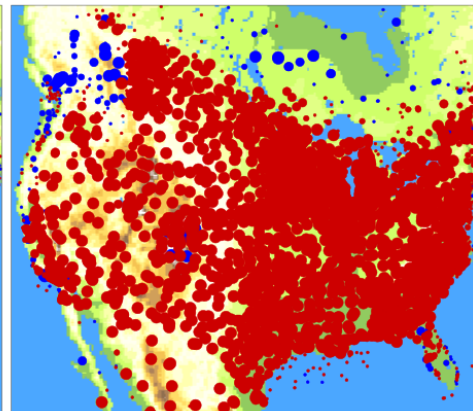
LA4DV0 (mean: -0.355)

LA4DVG (mean: 2.421)

-0.4



2.4



WRF v3.9 release cycle: Noah-MP results

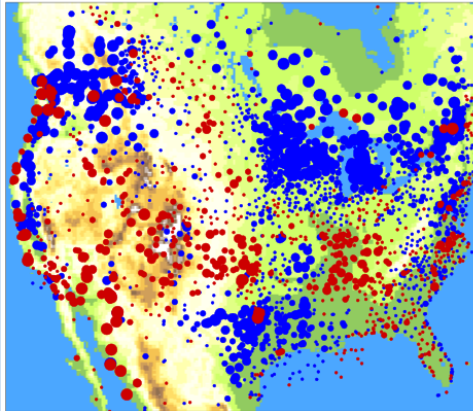
2014-07 00Z T2 bias improvement(-) over LA2DVX

LA4DV4 (mean: -0.245)

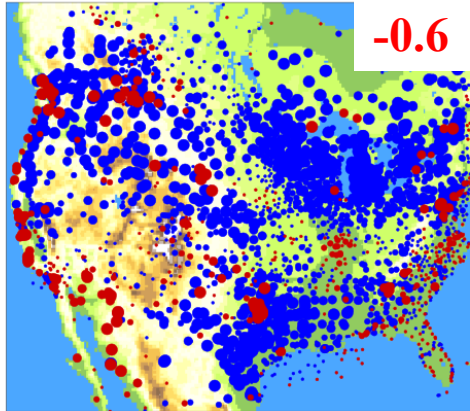
LA4DV9 (mean: -0.616)

LA4DV5 (mean: -0.268)

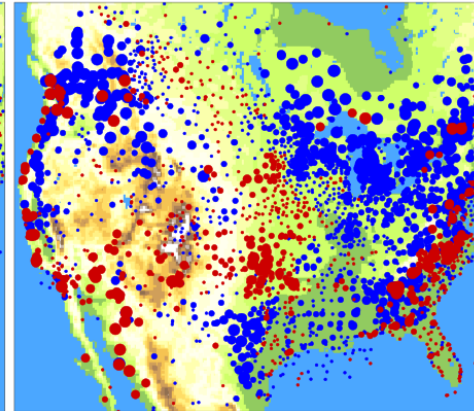
-0.2



-0.6



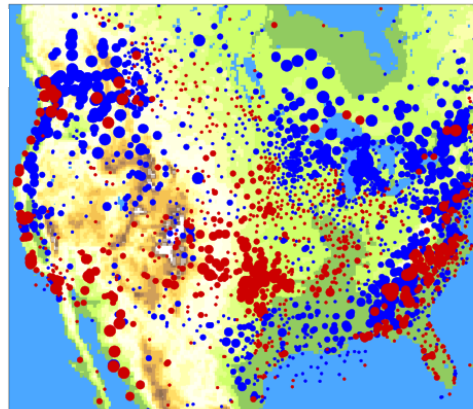
-0.3



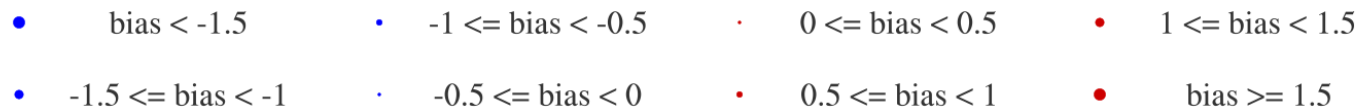
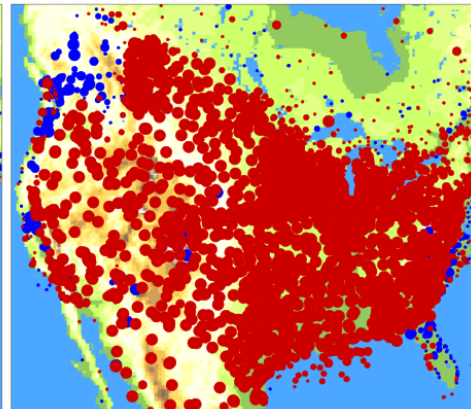
LA4DV0 (mean: -0.176)

LA4DVG (mean: 2.182)

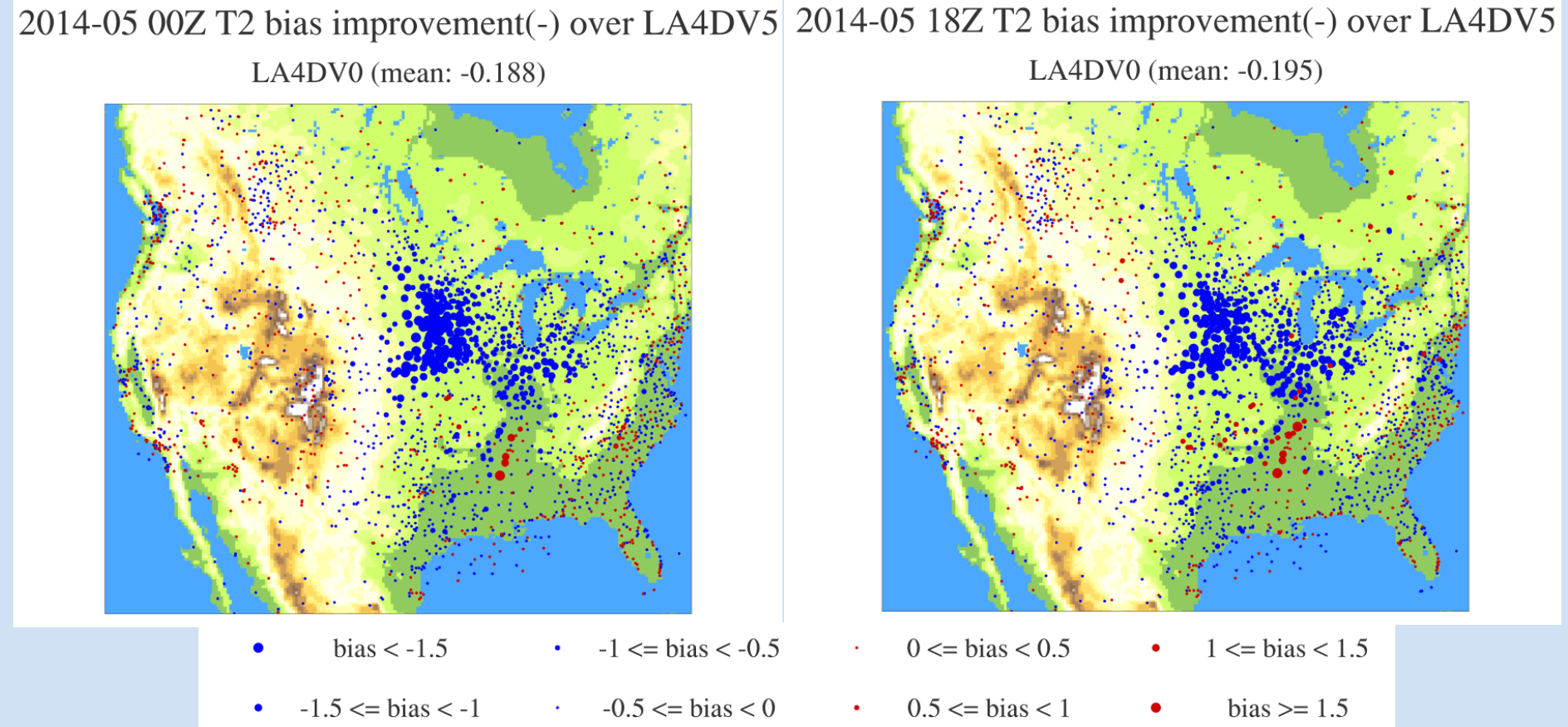
-0.2



2.2



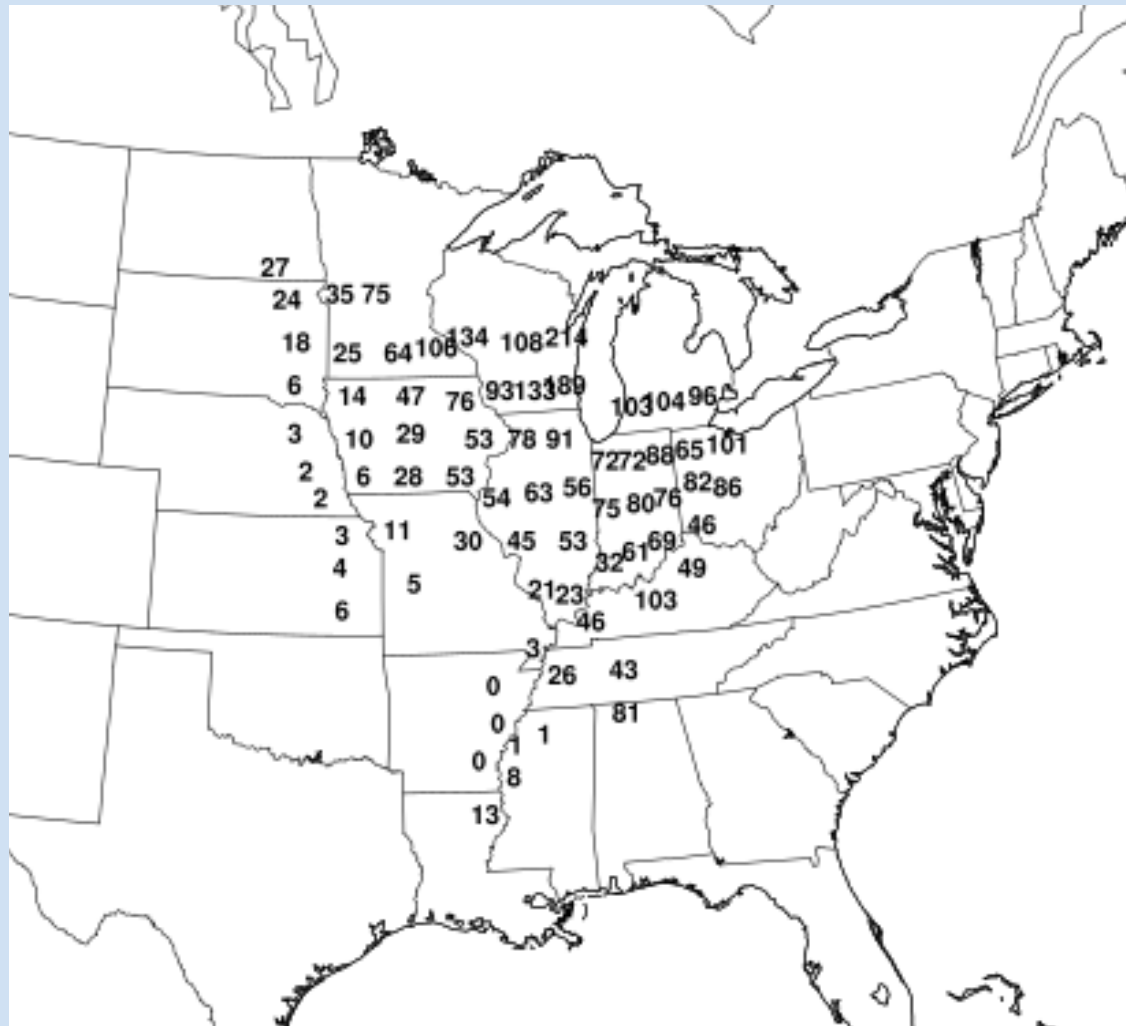
WRF v3.9 release cycle: Noah-MP results



Negative/blue mean an improvement in bias compared to Noah-MP with dynamic vegetation

Positive/red means a degradation in bias compared to Noah-MP with dynamic vegetation

WRF-Crop Results



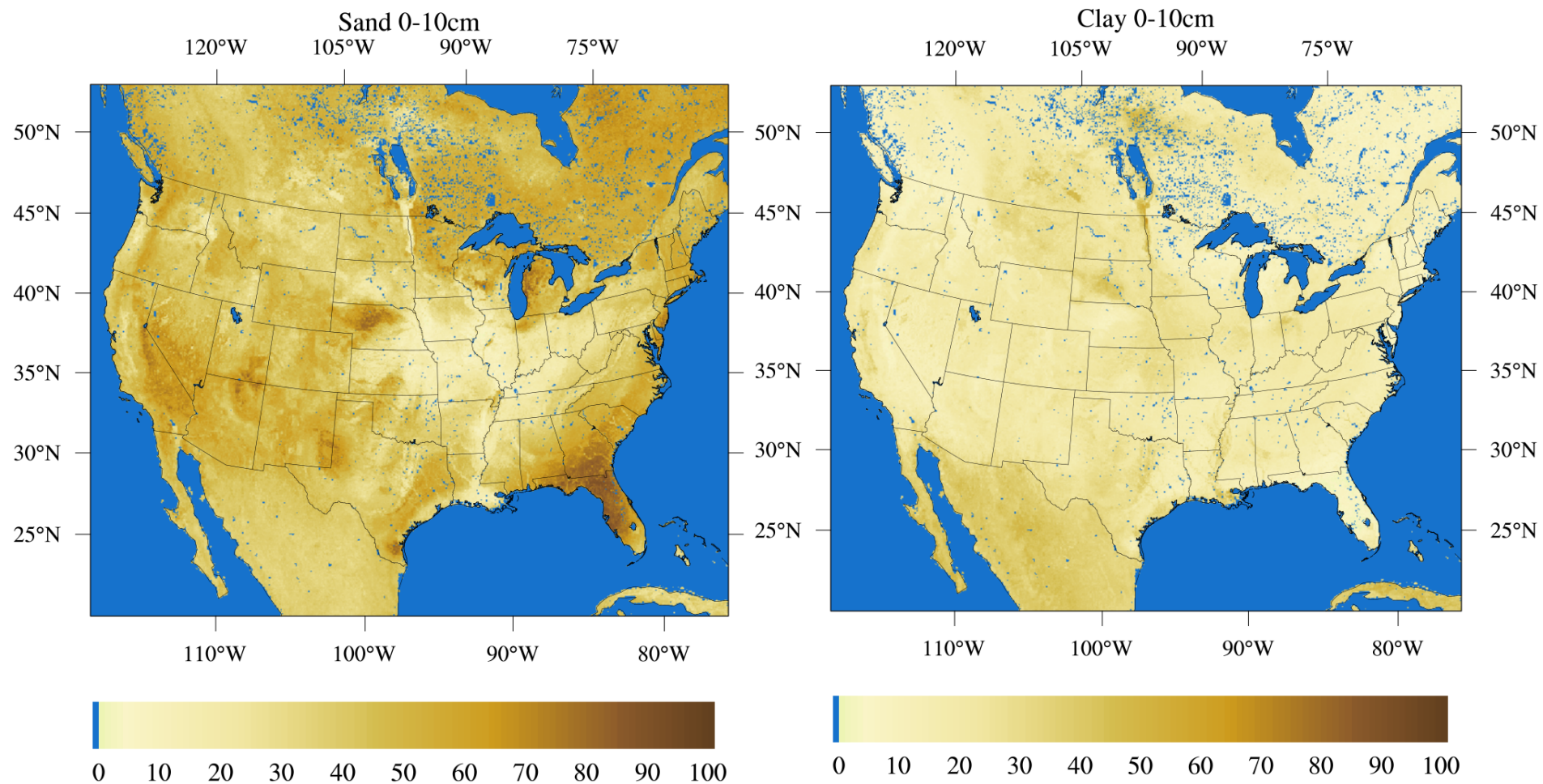
- Spatial variation of yield fraction for the 73 corn/soybean climate zones
- Best performance in the area around Lake Michigan (coincidence?)
- Very poor performance in the irrigated corn regions
- Also poor performance in the south
- Parameter table driven (5 crop types)
- Currently using generic corn – need to incorporate species
- No irrigation
- No dynamic roots
- No pests
- No fertilizers

WRF future release: Noah-MP modifications

Noah-MP capabilities/enhancements

- Added depth dimension to soil parameters and capability to read

Many of these new capabilities are developed through work with WRF-Hydro team.



Summary

Several new datasets were added to Noah-MP v3.9 in coordination with users and their needs and concerns, many utilizing existing or new code.

The more sophisticated urban models have been linked with Noah-MP and show encouraging results.

The future Noah-MP is focused on expanding soil capabilities and hydrology in general including non-standard datasets.

Users are encouraged to integrate the Noah-MP LSM into their studies, test/develop/propose new options, and interact with us on results/concerns.

<http://github.com/NCAR/hrldas-release>