

Global Land Data Assimilation System (GLDAS) and Land Information System (LIS) MOLTS analyses of CEOP-EOP1

Hiroko Kato

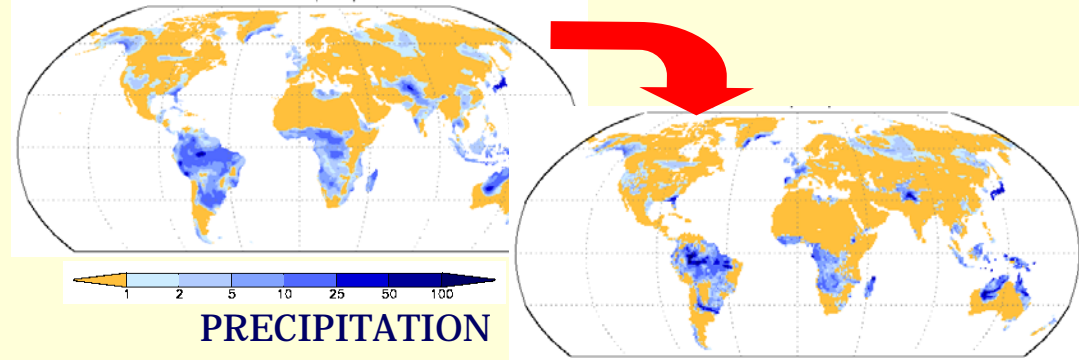
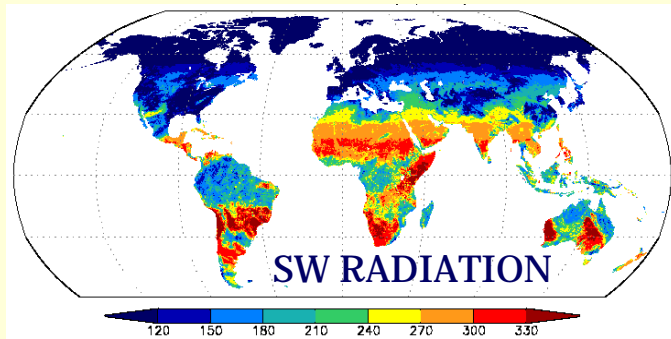
With contributions from

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Houser, Sujay Kumar, and Joseph Santanello



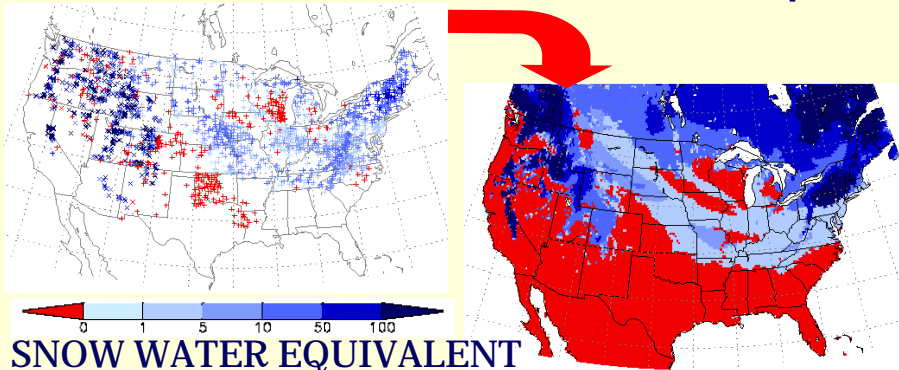
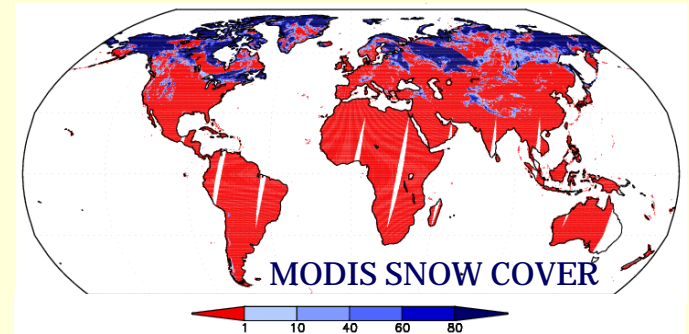
Data Integration in GLDAS/LIS

INTERCOMPARISON and
OPTIMAL MERGING of
global data fields



Satellite derived meteorological
data used as land surface model
FORCING

ASSIMILATION of satellite based
land surface state fields (snow,
soil moisture, surface temp, etc.)



Ground-based observations
used to **VALIDATE** model
output

GLDAS – LIS Relationship

GLDAS = Global Land Data Assimilation System

- NASA IDS project 10/2000 – 9/2003
- Based on North American Land Data Assimilation System
- Highest Resolution: $\frac{1}{4}$ degree, global
- Objectives: Modeling and assimilation innovations; high quality output for research & applications; massive data archive

LIS = Land Information System

- NASA HPCC project 6/2002 – 2/2005
- Based on GLDAS
- Highest Resolution: 1 kilometer, global, regional
- Objective: Delivery of streamlined, parallelized, validated, documented, ESMF/ALMA standard LSM driver software

GLDAS Global simulations

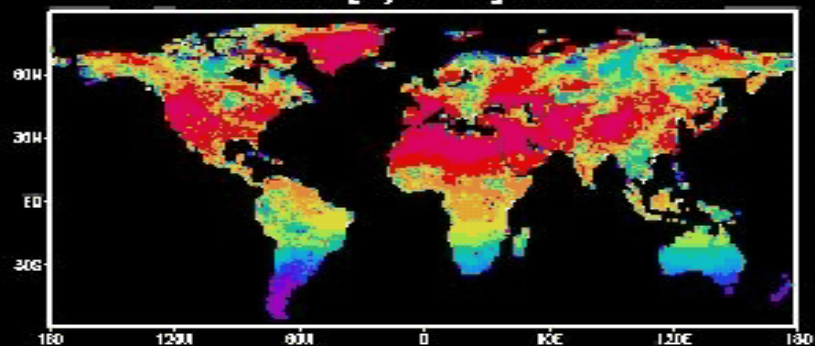
- Specification of runs used in the MOLTS that have been delivered

Model	Res.	Sites	EOP	Forcing	Initialization	Ancillary files
Mosaic	1/4°	38	1	GEOS, HUFFMAN Precipitation & AGRMET Radiation	GEOS land surface states	Vegetation-based tiling, Reynolds soil, AVHRR landcover
Noah	1°	34	1,2,3	GDAS & CMAP	20-yr Noah 1/2 deg simulation	Vegetation-based tiling, Reynolds soil, AVHRR landcover

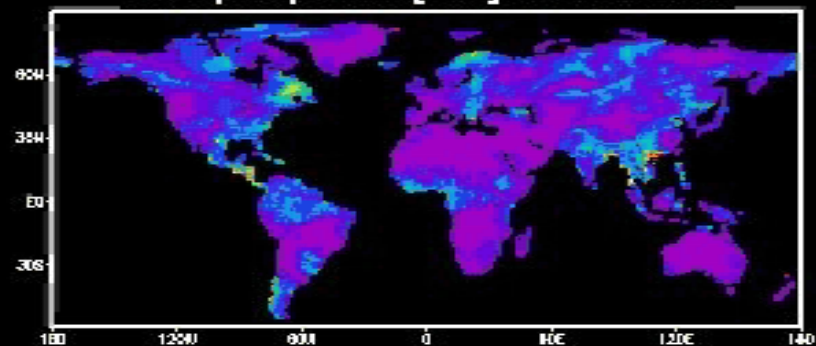
- *Planned future simulations*

- ❖ Long term 1/2 degree with NOAH, CLM, and VIC
- ❖ Global replication of LIS regional runs at 1/4 degree

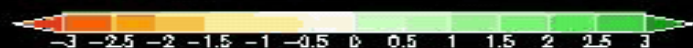
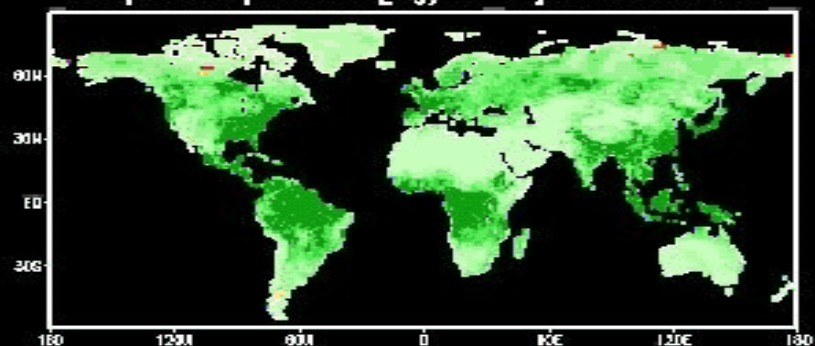
SW down flux [W/m^2] 02 JUL 2001



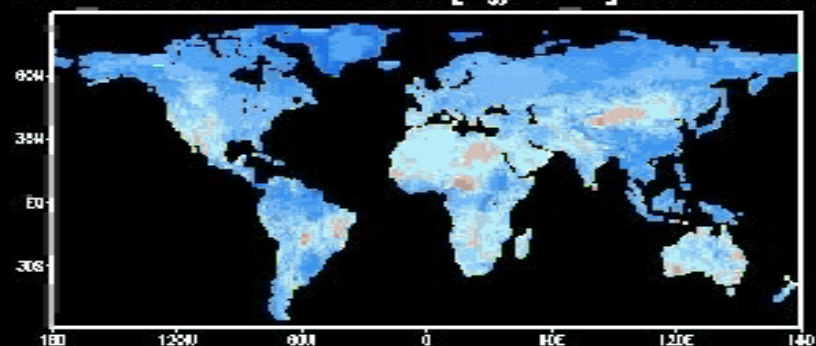
Total precipitation [mm] 02 JUL 2001



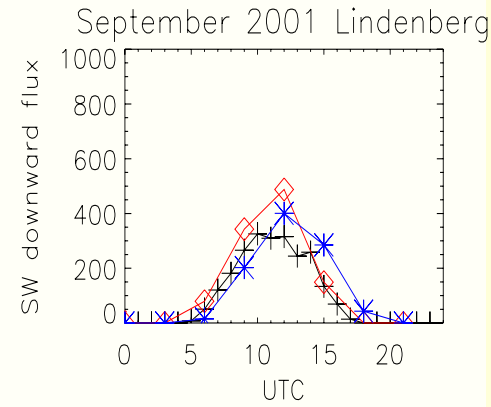
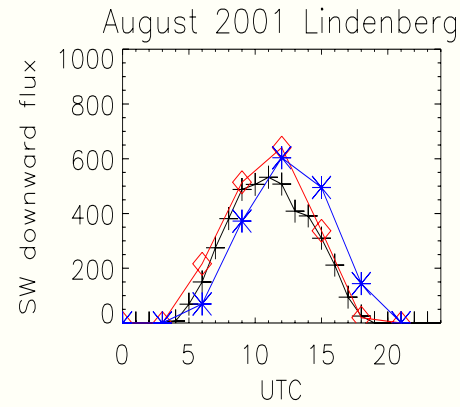
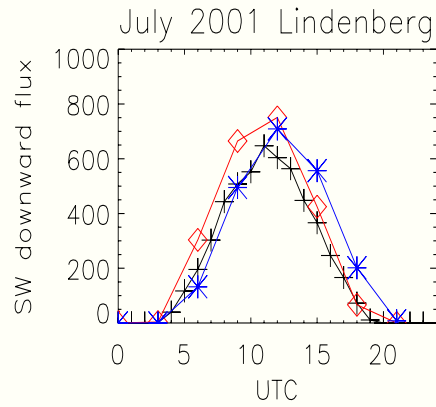
Evapotranspiration [kg/m^2] 02 JUL 2001



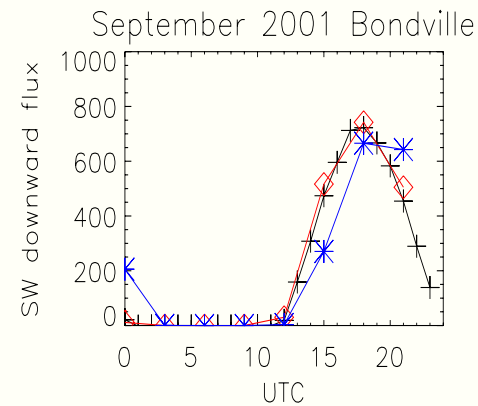
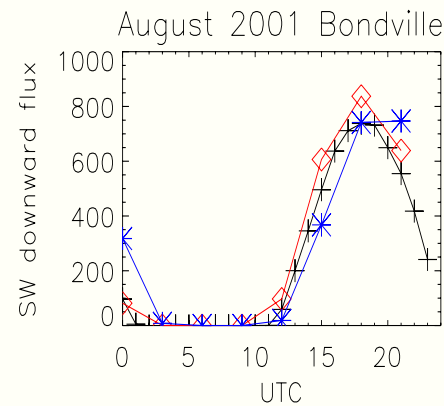
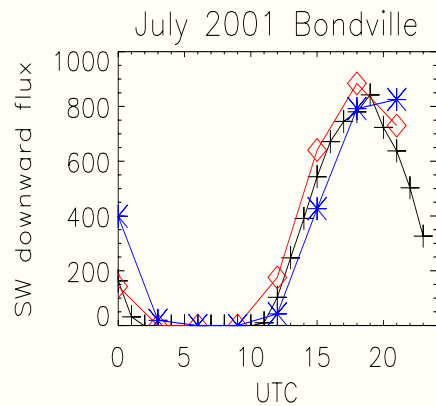
Total column soil moisture [kg/m^2] 02 JUL 2001



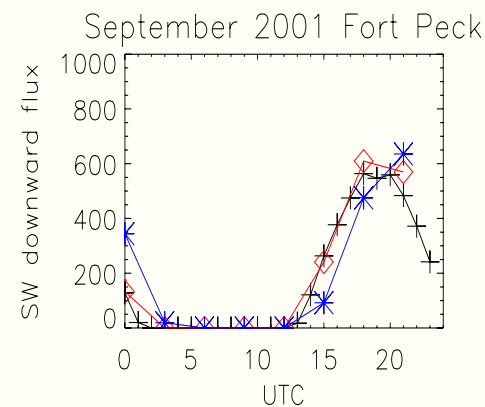
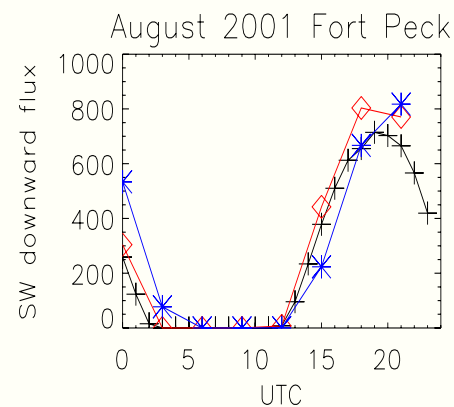
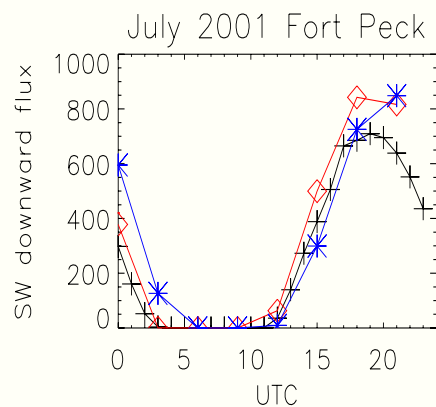
GLDAS Forcing Evaluation -SW↓



Lindenberg
RMSE: 71.13
RMSE: 87.26



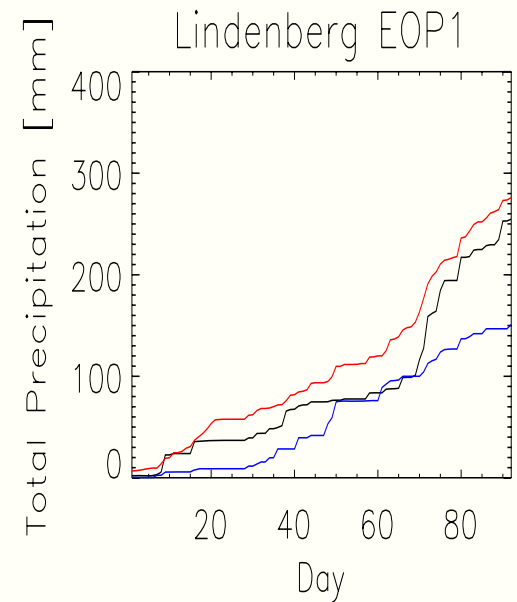
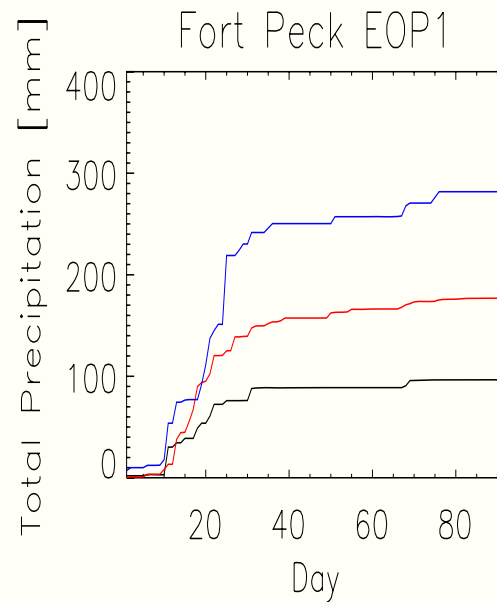
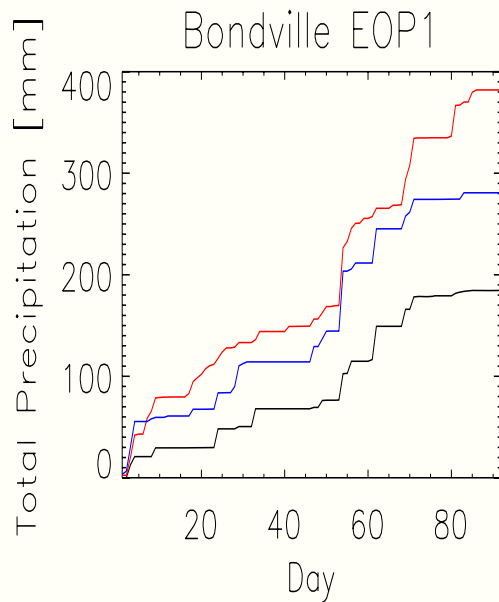
Bondville
RMSE: 54.17
RMSE: 116.71



Fort Peck
RMSE: 72.19
RMSE: 128.08

CEOP
GDAS (NOAH)
GEOS-3 (MOS)

GLDAS Forcing evaluation -Precipitation

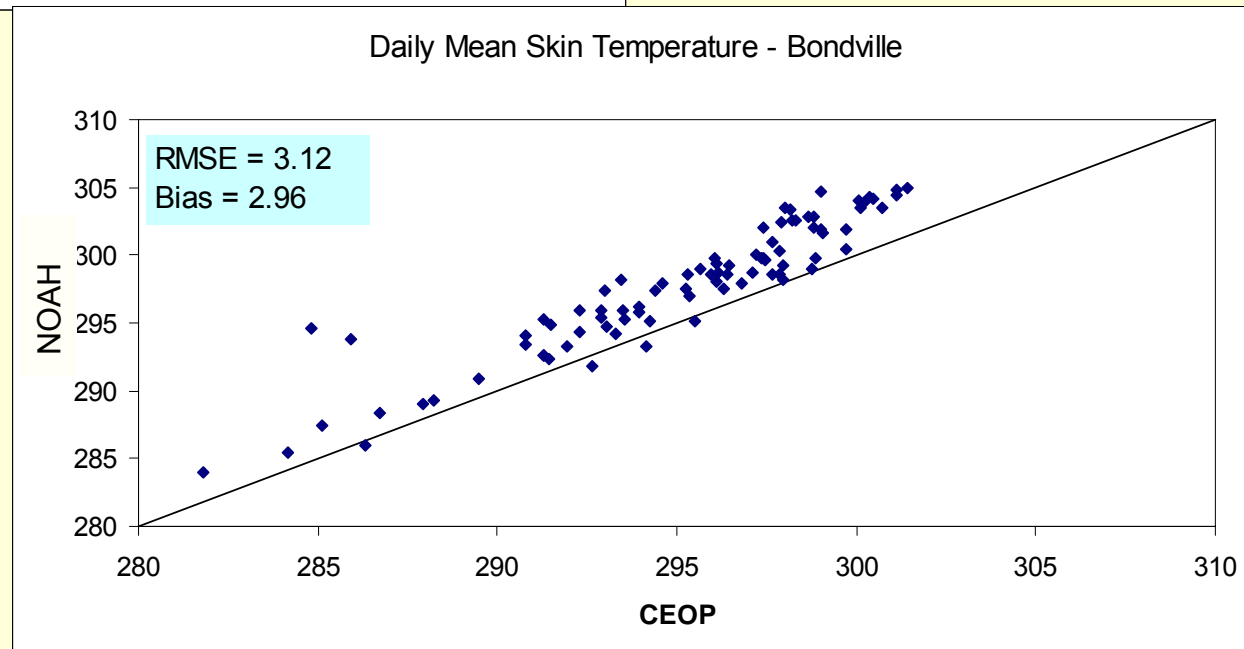
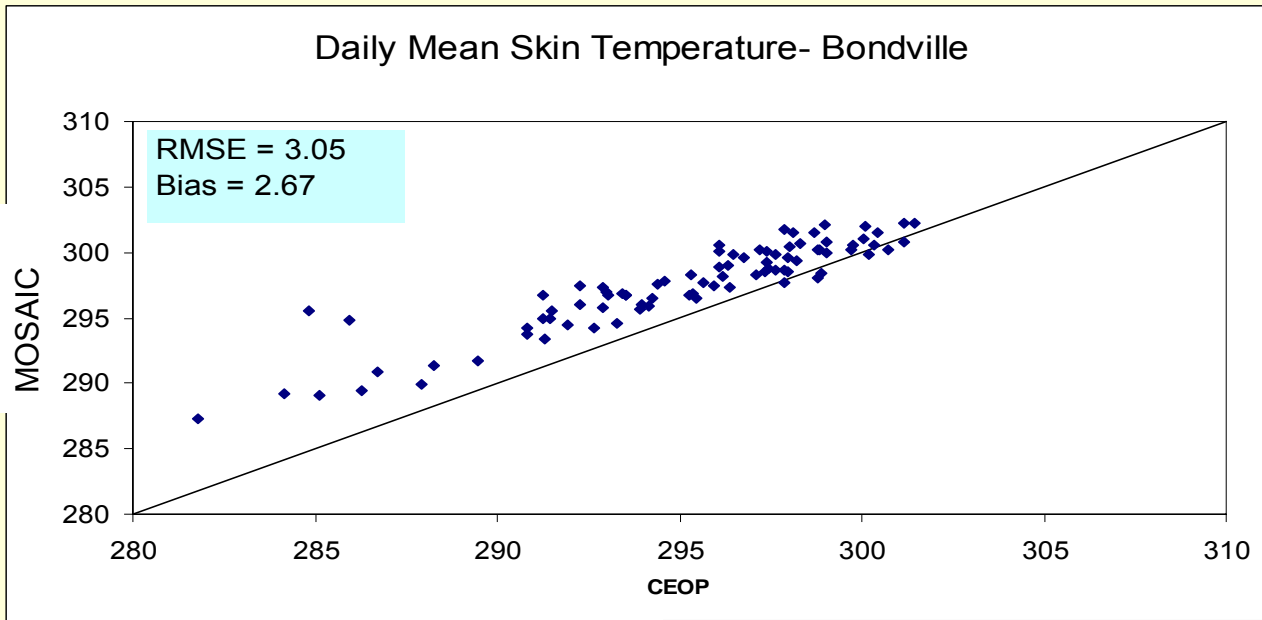


CEOP

CMAP (NOAH)

HUFFMAN (MOS)

GLDAS MOLTS Evaluation-Skin temperature

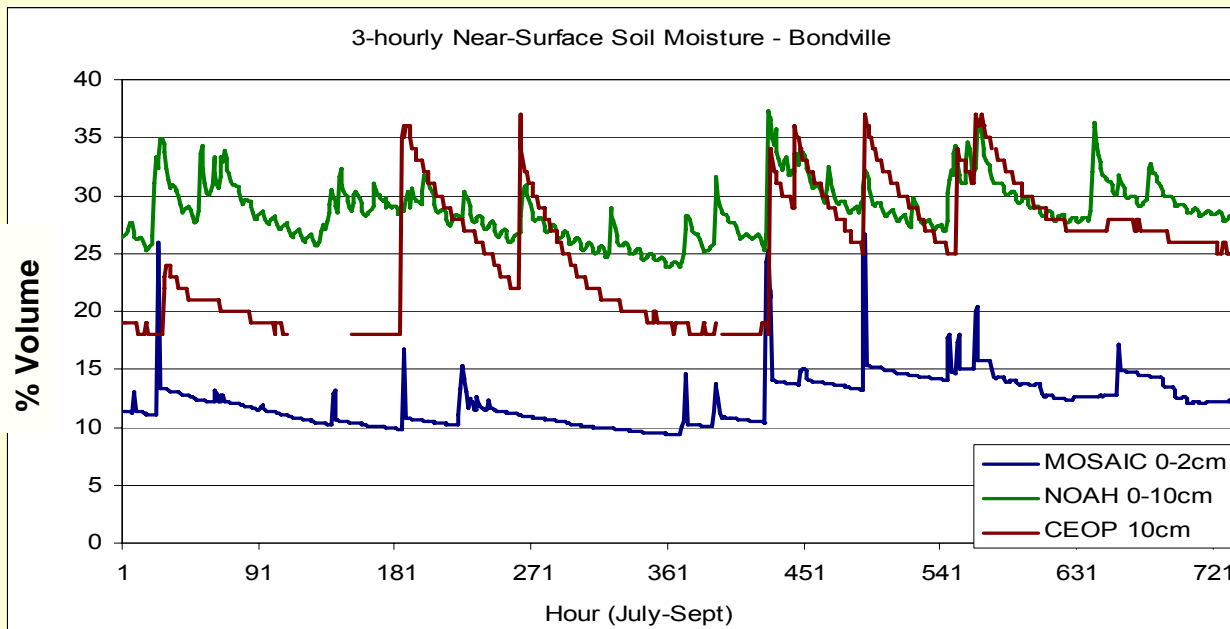
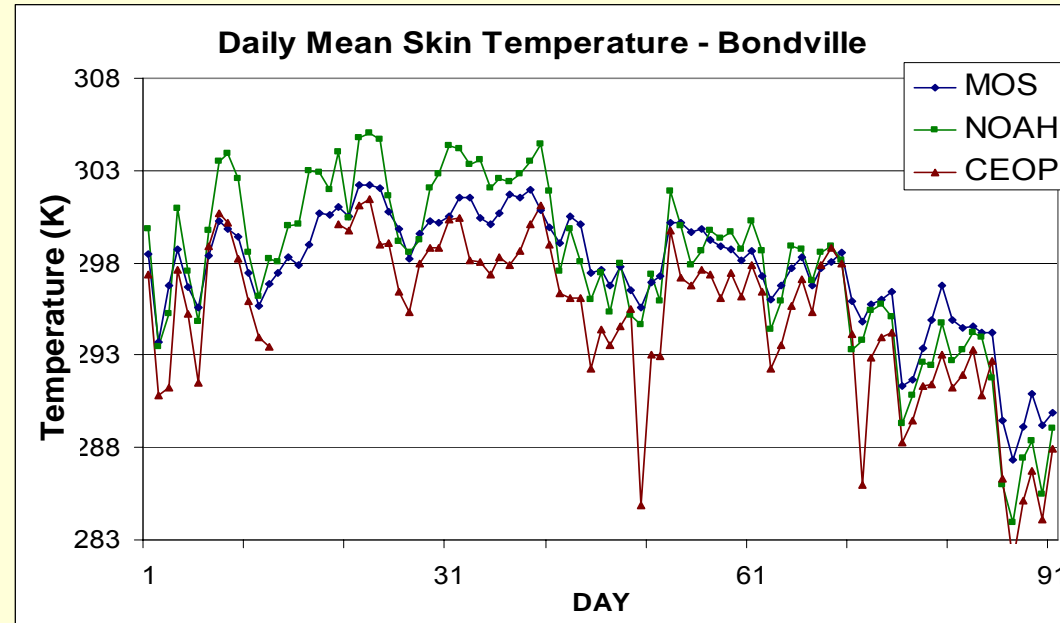


GLDAS MOLTS Evaluation-Soil Moisture

-Day-day trends in daily skin temperature are captured well by both models

-NOAH is 2-5 K warmer than observations

-Treatment of soil water and surface fluxes in NOAH are highly dependent on soil and land cover characteristics



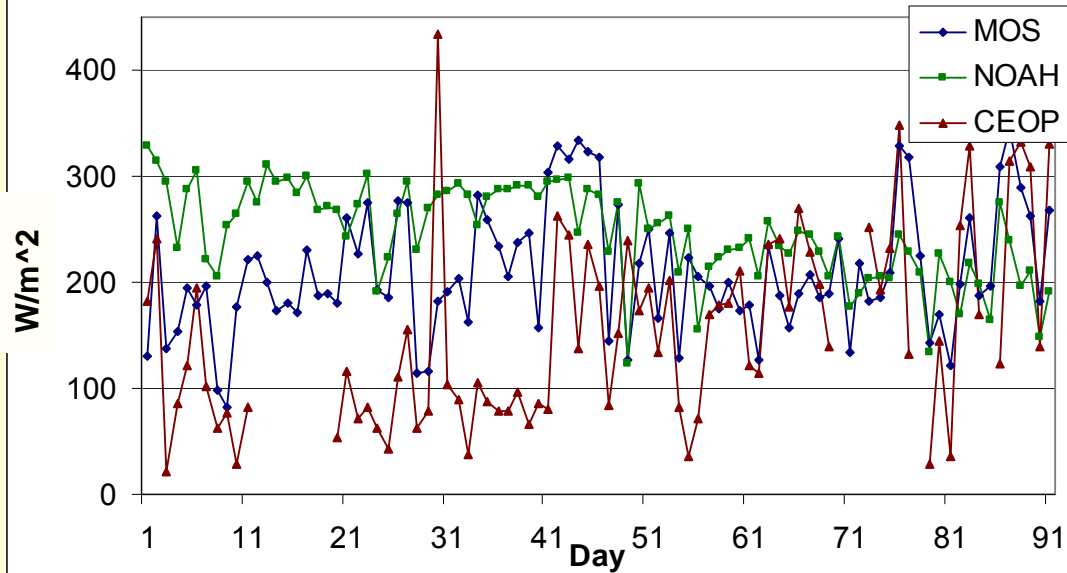
-Overall trends in wetting and drying events are captured well by the models

-MOSAIC is for the upper 2cm which is consistently drier than deeper (10cm) layers

-Specification of soil properties at 1-degree resolution are difficult to match with actual site conditions

GLDAS MOLTS Evaluation –Surface Fluxes

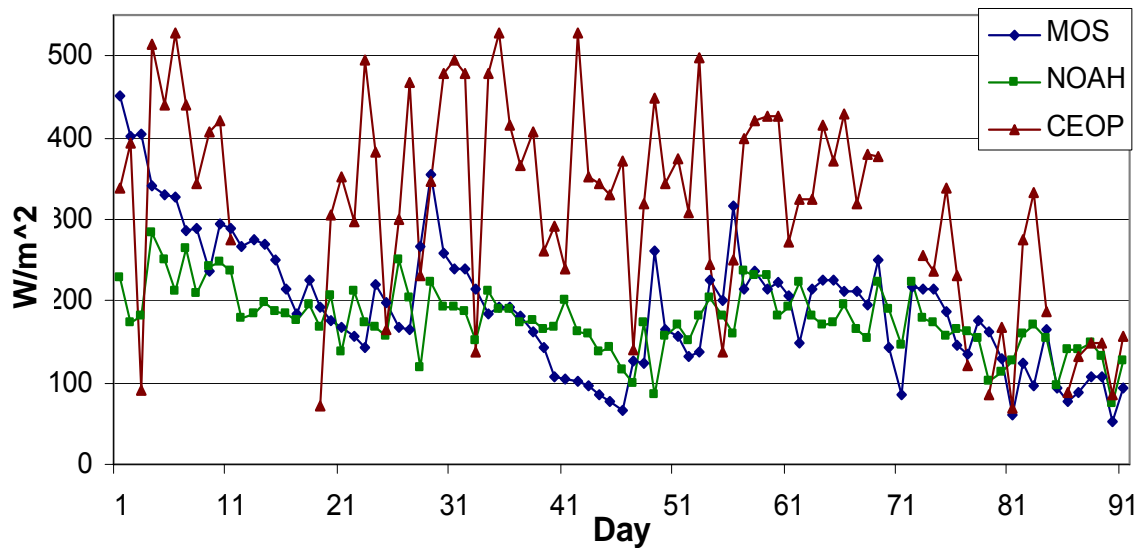
Daily Maximum Qh - Bondville



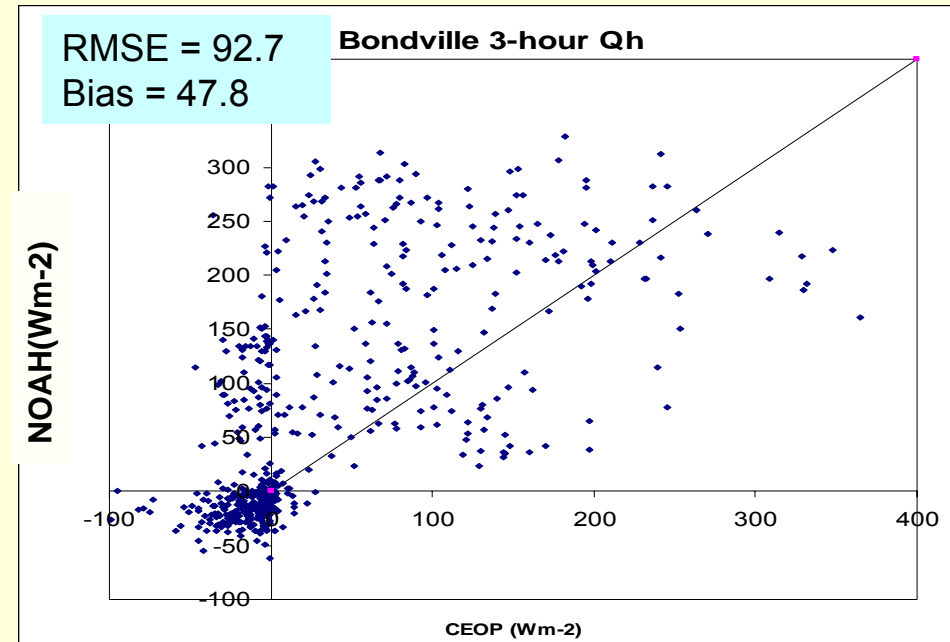
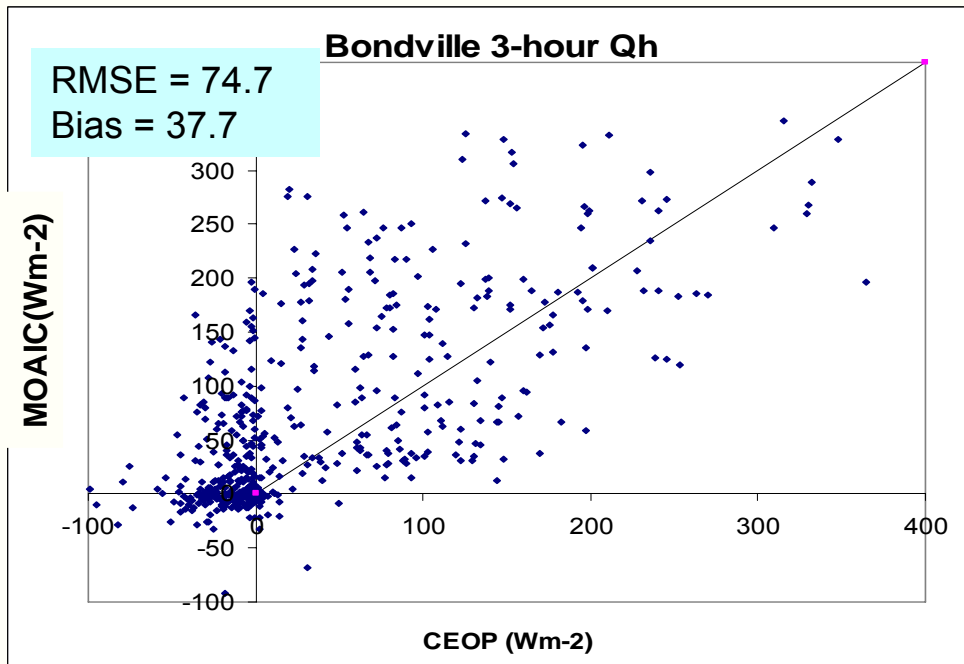
-Modeled Q_h is much higher than that observed especially in July and August.

-Corn harvest results in increased Bowen ratio in September and better match of models with observations.

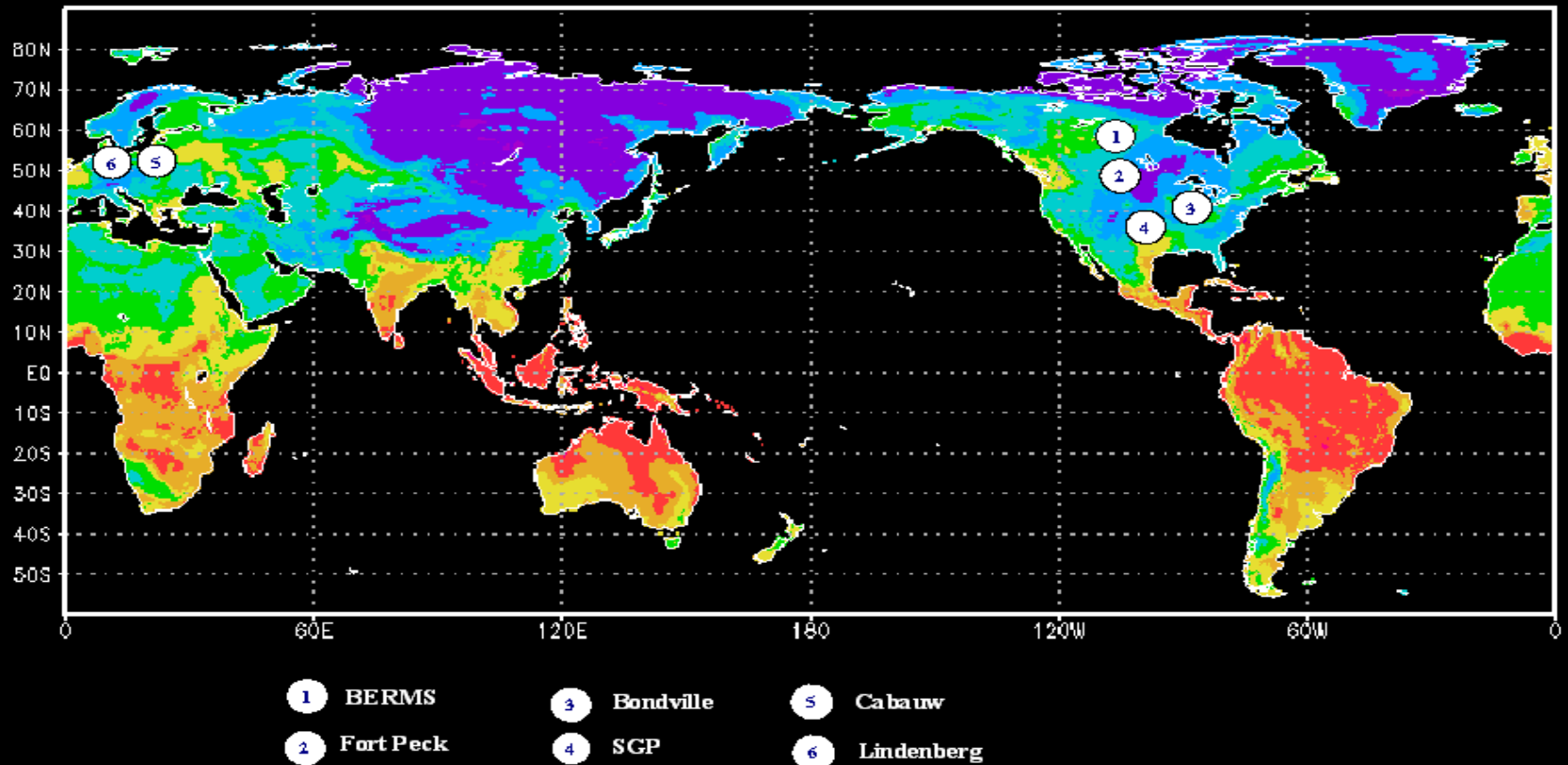
Daily Maximum Qle - Bondville



GLDAS Evaluation –Sensible heat Flux



LIS Regional Simulations



LIS Regional Simulations

Initialization,
Meteorological input

15 year spinup, GDAS+CMAP forcing

Land surface
models

CLM

Noah

Spatial Resolution

1KM

$\frac{1}{4}$ degree

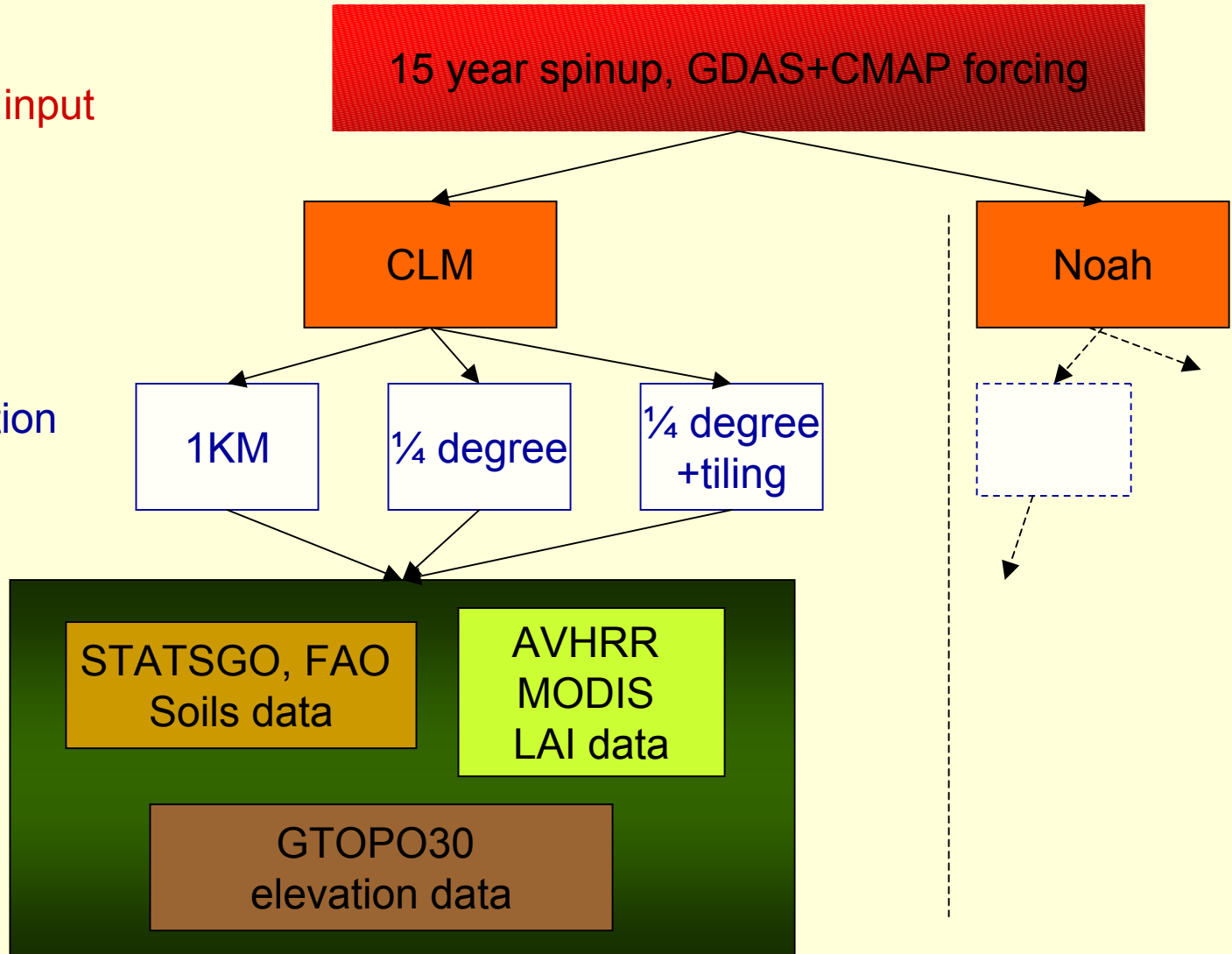
$\frac{1}{4}$ degree
+tiling

Land surface
parameters

STATSGO, FAO
Soils data

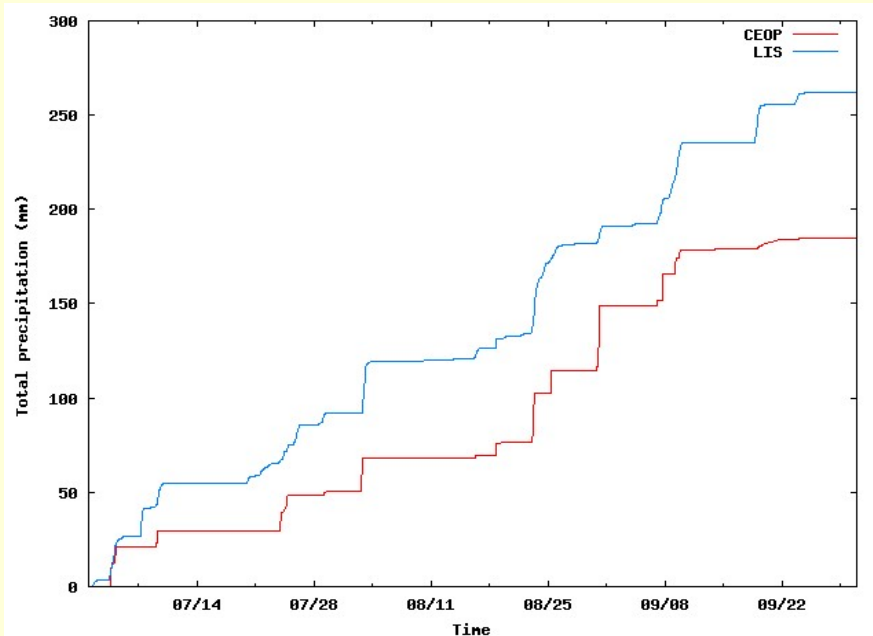
AVHRR
MODIS
LAI data

GTOPO30
elevation data

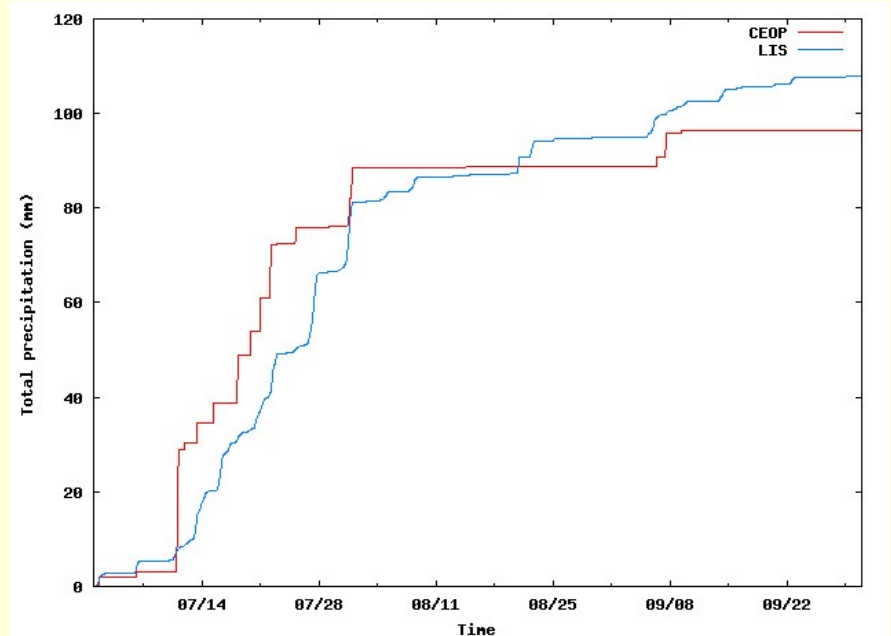


LIS Forcing Evaluation-Precipitation

Bondville



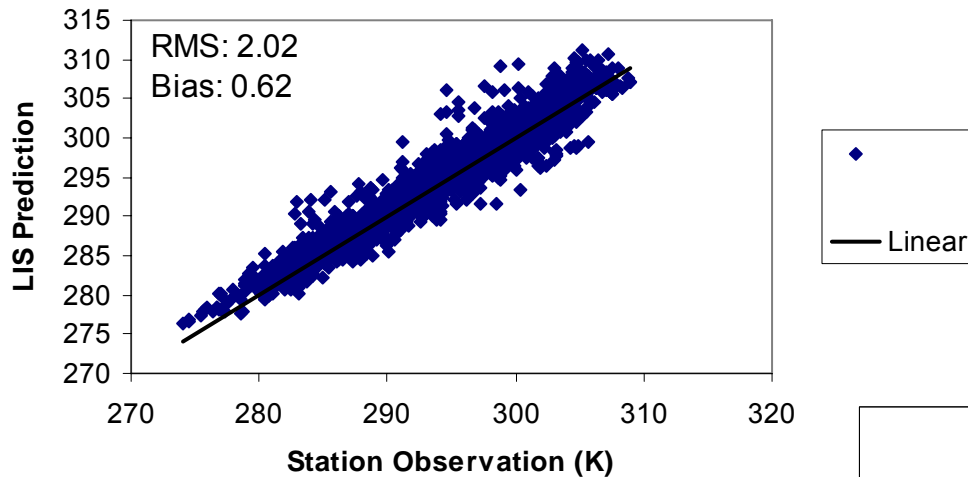
Fort Peck



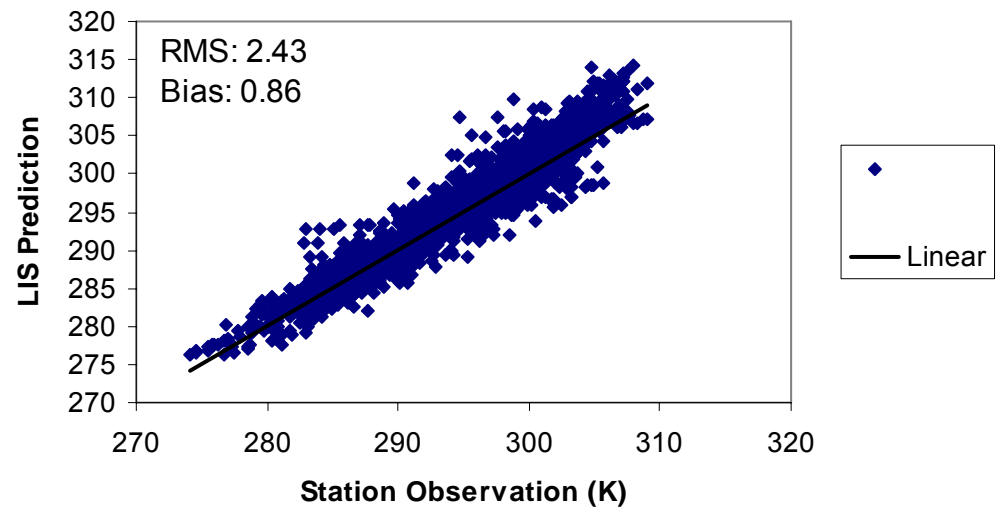
Improvement in agreement due to resolution downscaling

LIS MOLTS Evaluation –Skin temperature

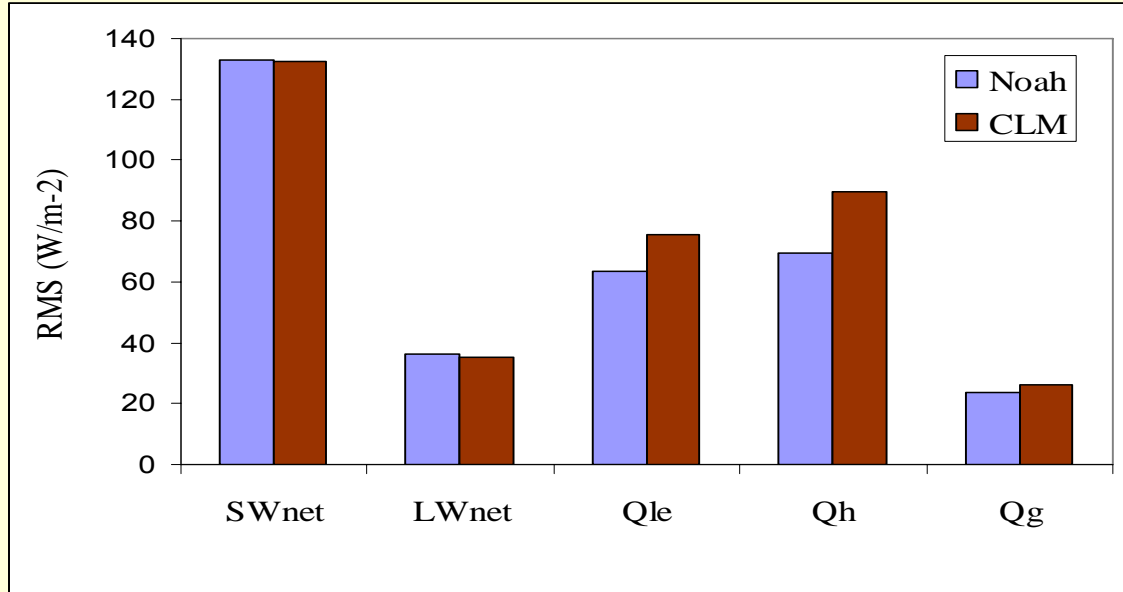
**Bondville, Noah
1KM, Skin Temperature (K)**



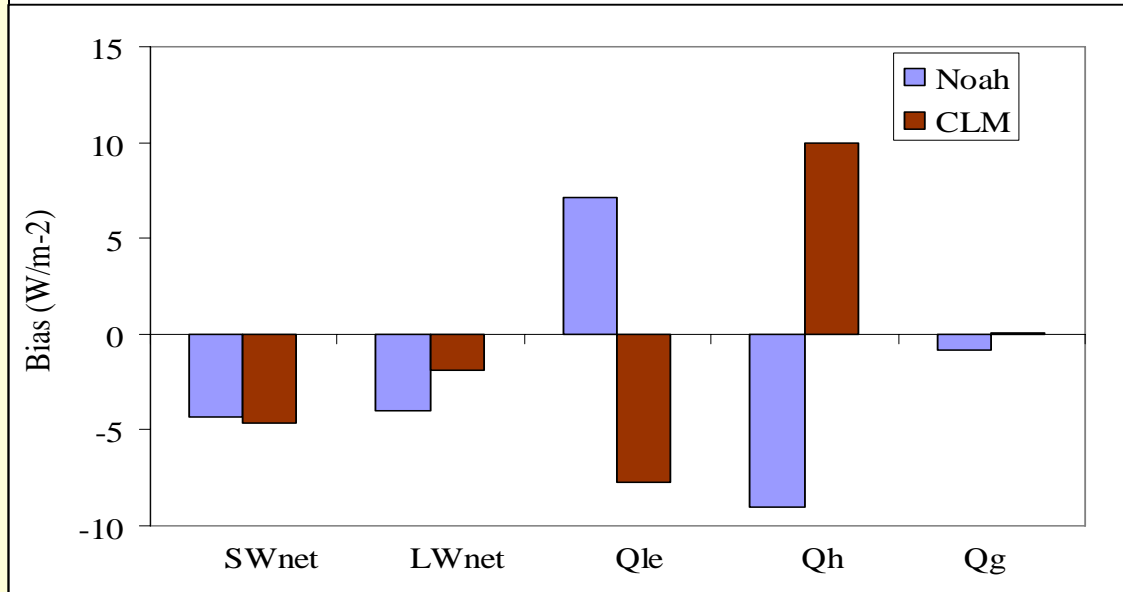
**Bondville, CLM
Skin Temperature (K)**



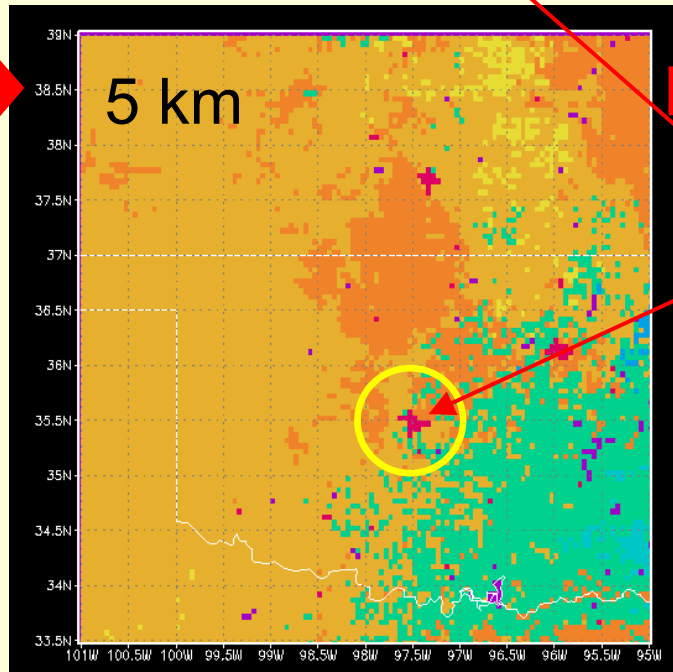
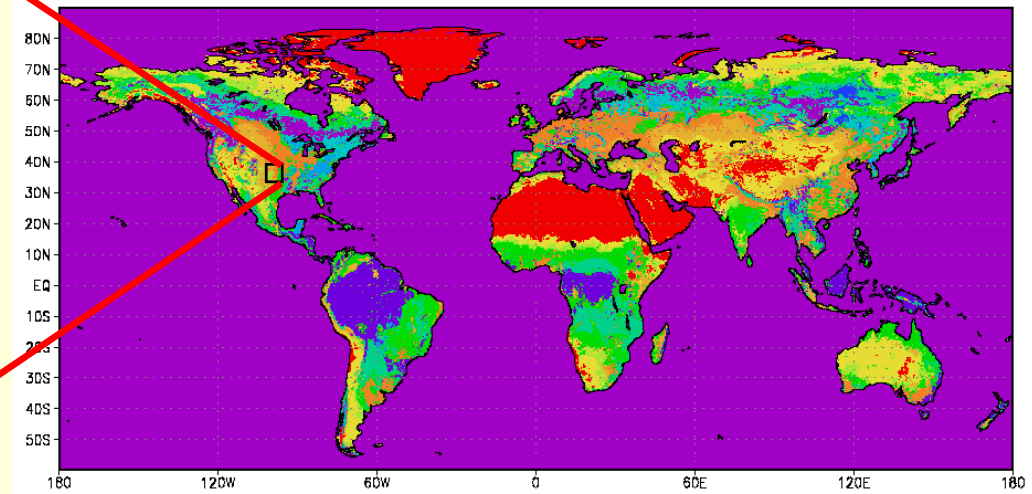
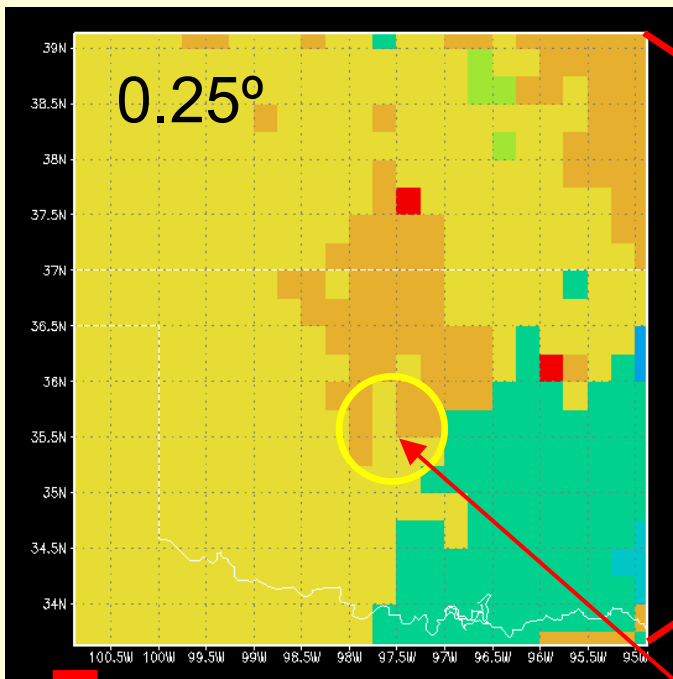
LIS 1km Energy budget evaluation



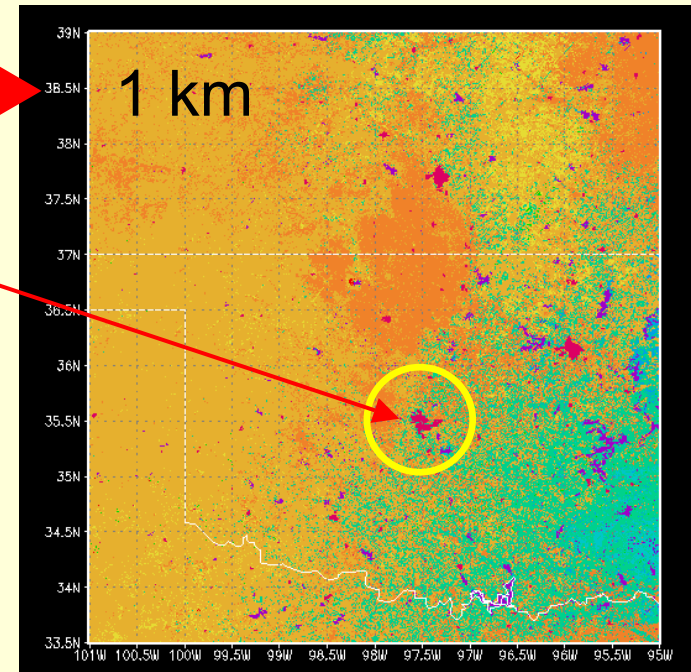
- All 6 regions merged
- EOP1



Scaling Issues: Land Cover

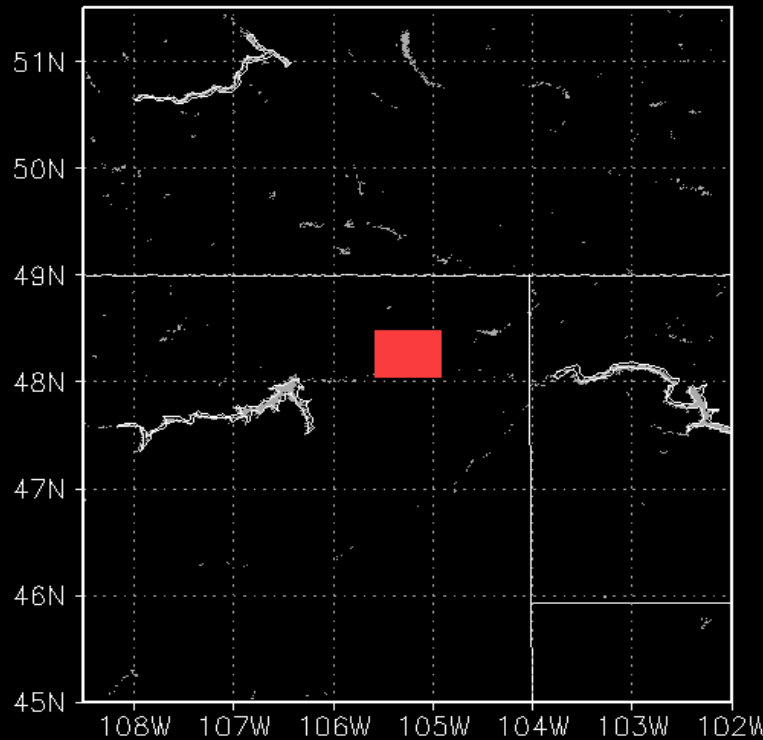


Oklahoma City

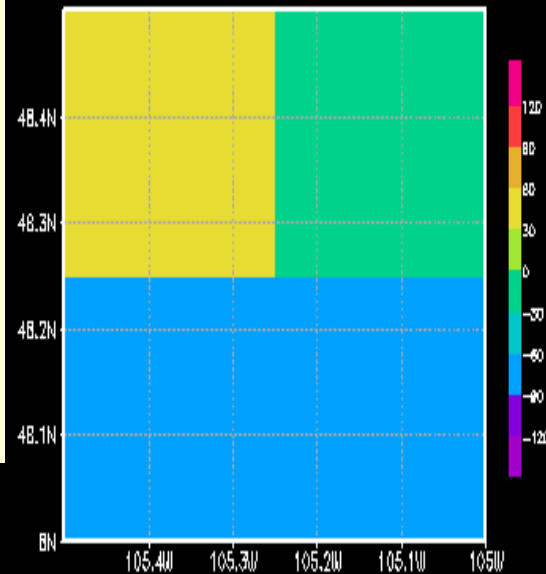


Spatial Heterogeneity (0.25 deg vs 1km)

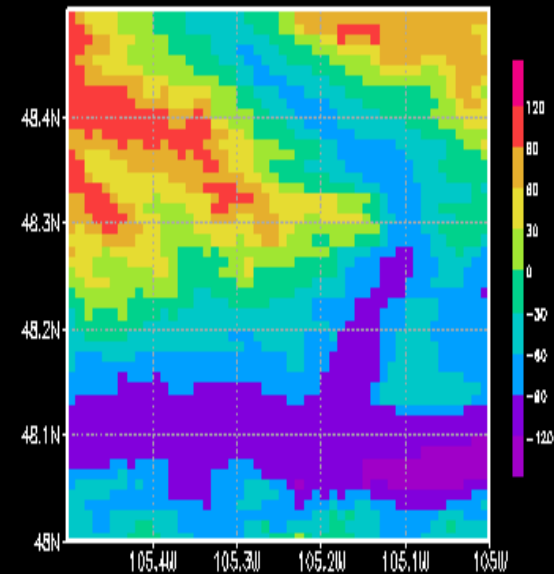
Example:
Fort Peck



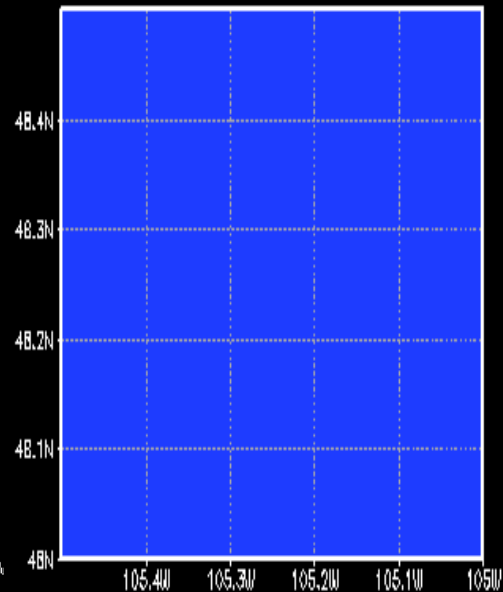
Elev diff for GDAS 0.25 at FPK



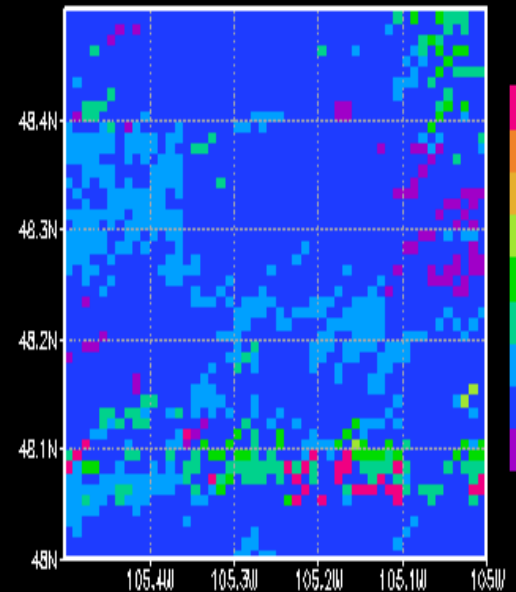
Elev diff for GDAS 1-km at FPK



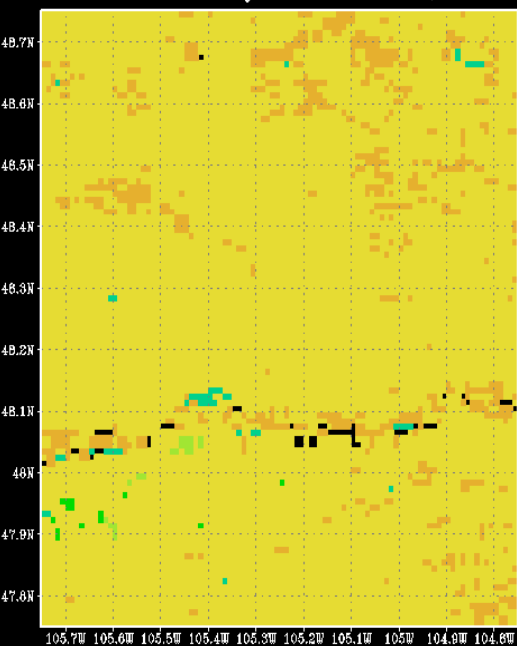
AVHRR 0.25 LAI CLIM at FPK, July



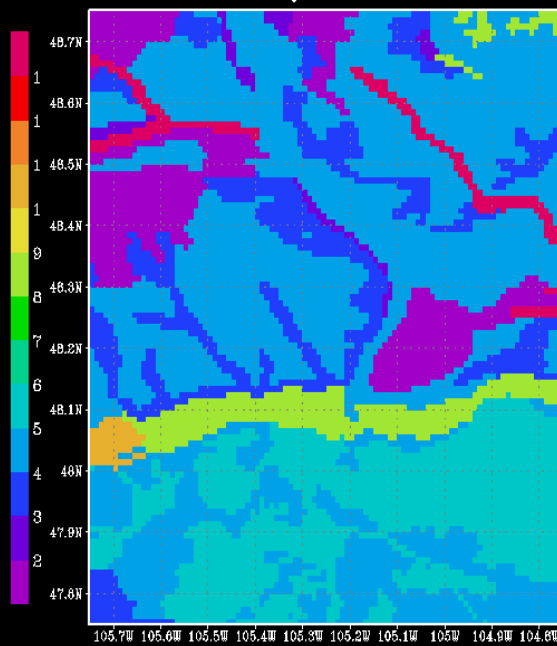
AVHRR 1-km LAI CLIM at FPK, July



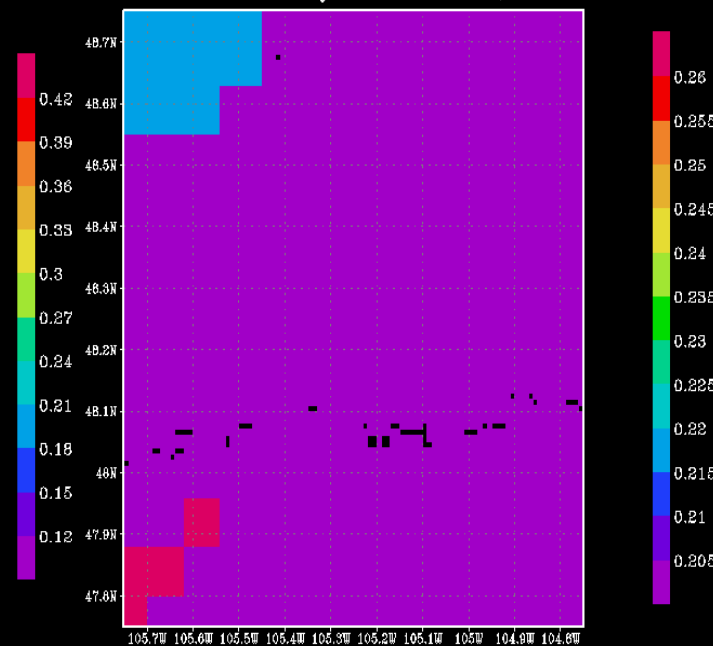
UMd vegetation types
in the vicinity of Fort Peck, MT



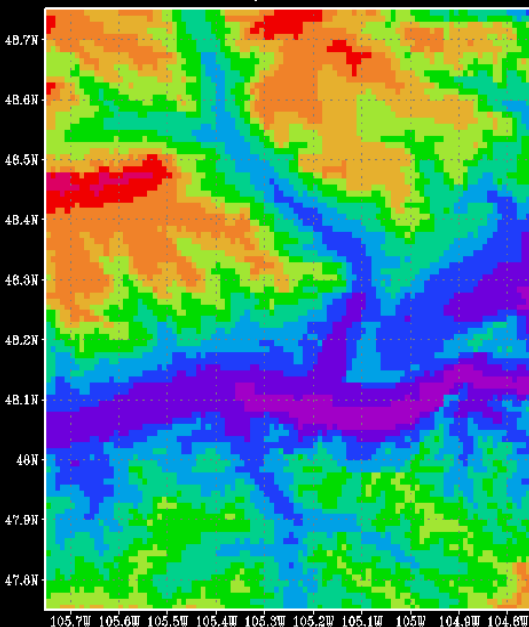
STATSGO clay content
in the vicinity of Fort Peck, MT



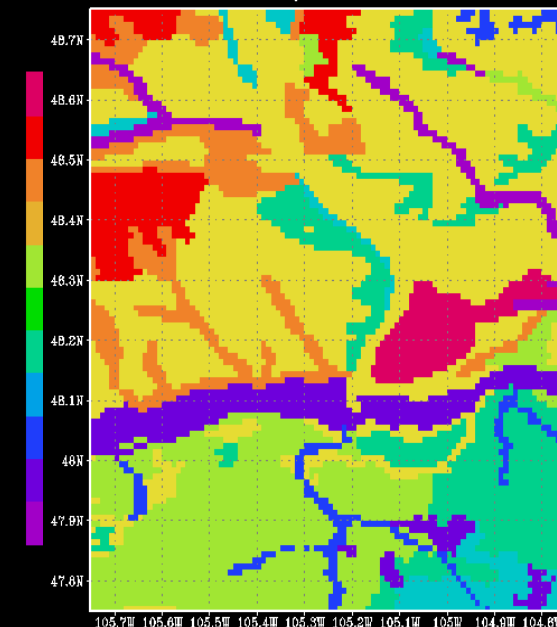
FAO clay content
in the vicinity of Fort Peck, MT



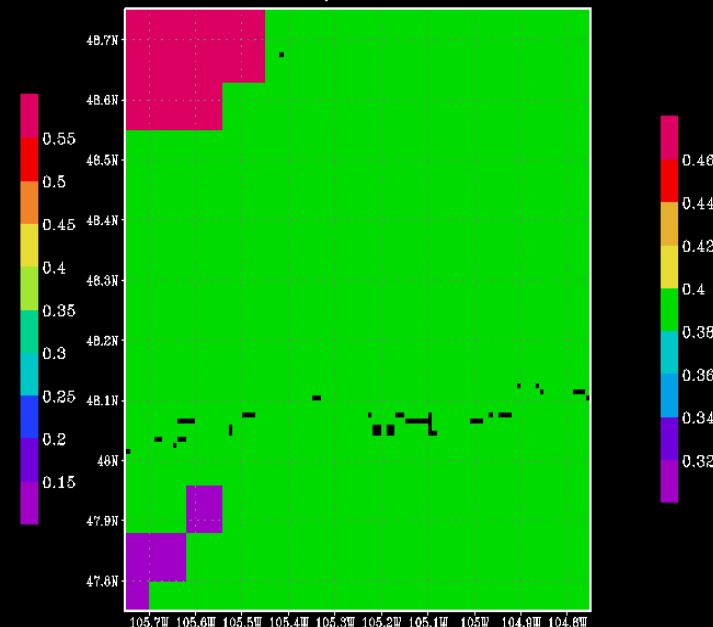
GTOP030 elevation (m)
in the vicinity of Fort Peck, MT



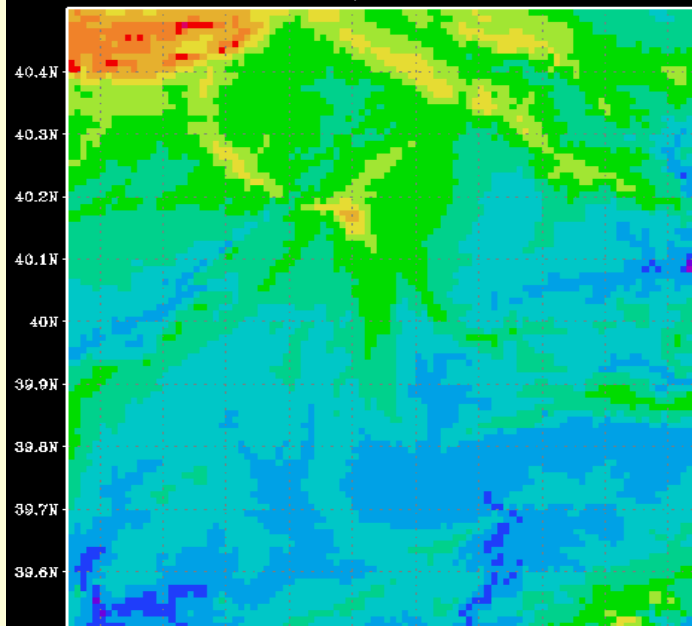
STATSGO sand content
in the vicinity of Fort Peck, MT



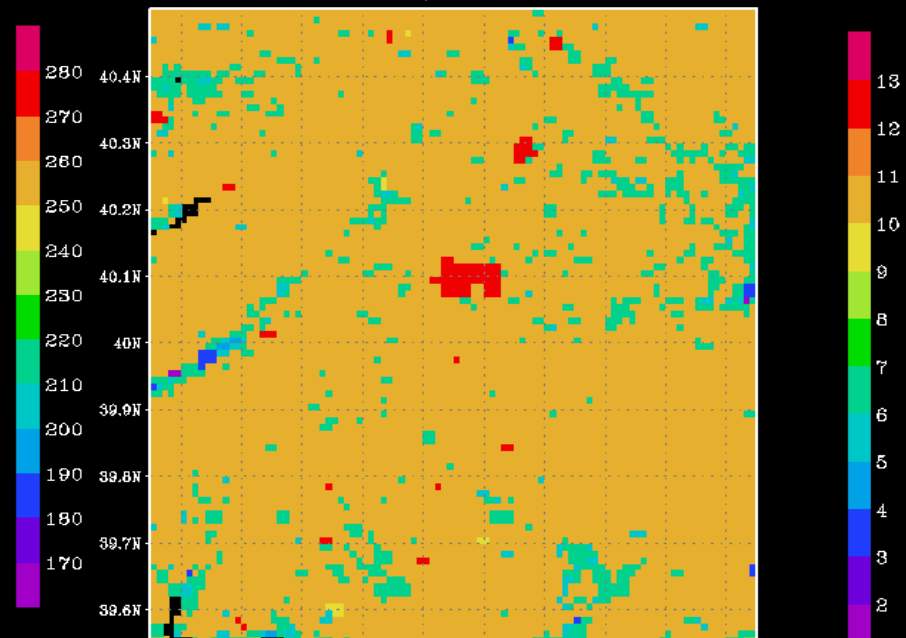
FAO sand content
in the vicinity of Fort Peck, MT



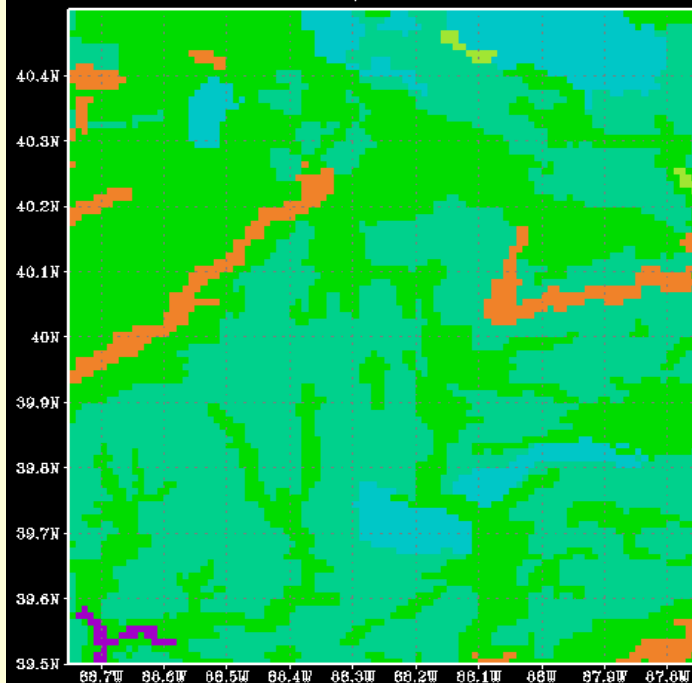
GTOP030 elevation (m)
in the vicinity of Bondville, IL



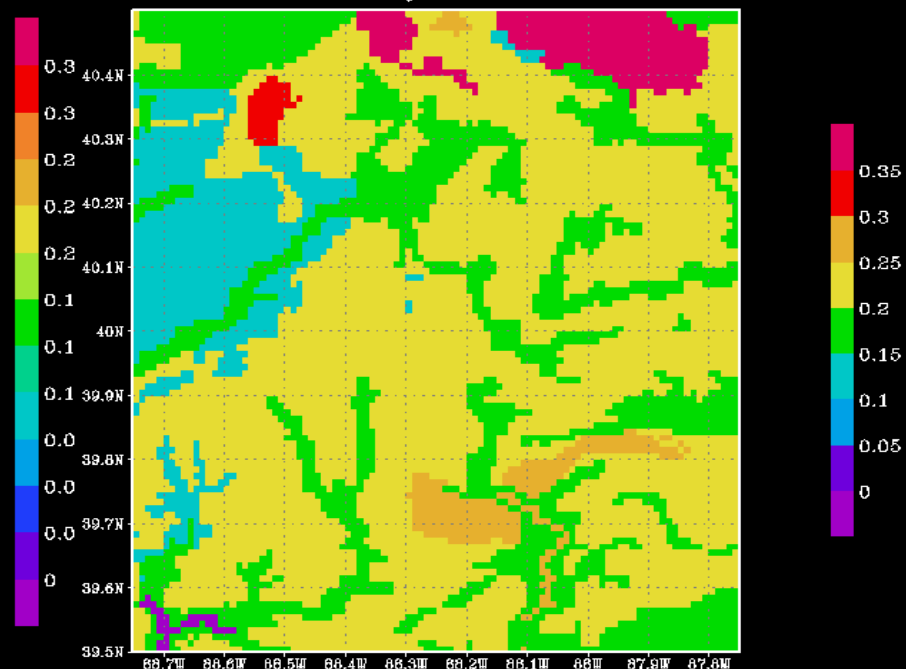
UMd vegetation types
in the vicinity of Bondville, IL



STATSGO sand content
in the vicinity of Bondville, IL

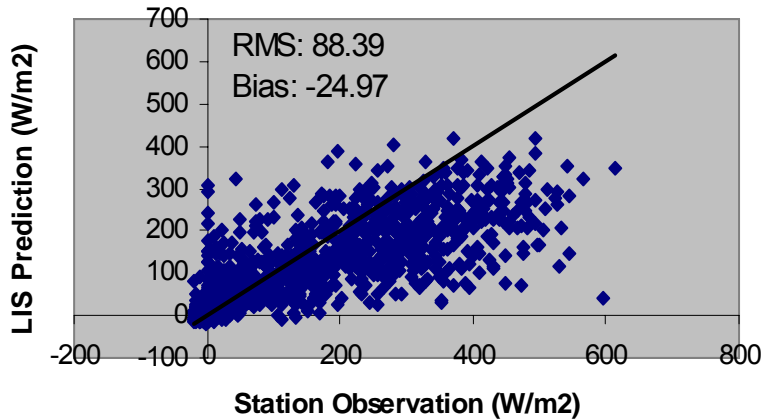


STATSGO clay content
in the vicinity of Bondville, IL

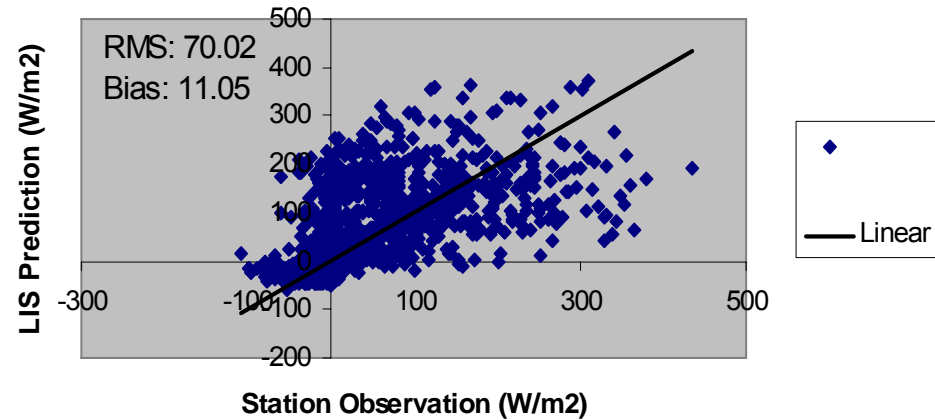


LIS Evaluation –Surface fluxes

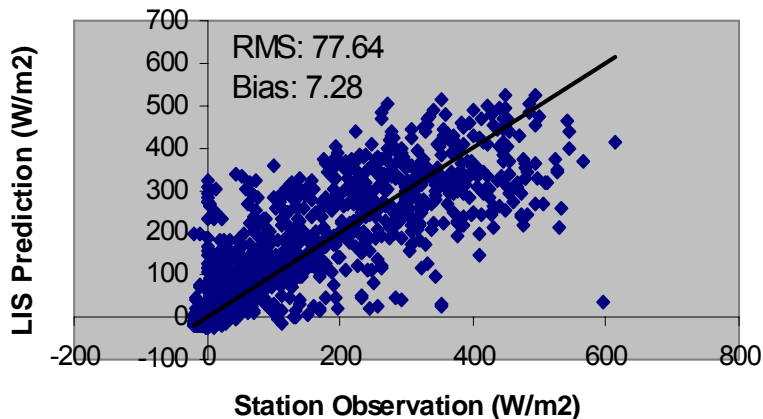
**Bondville
CLM-Qle-1KM-STATSGO**



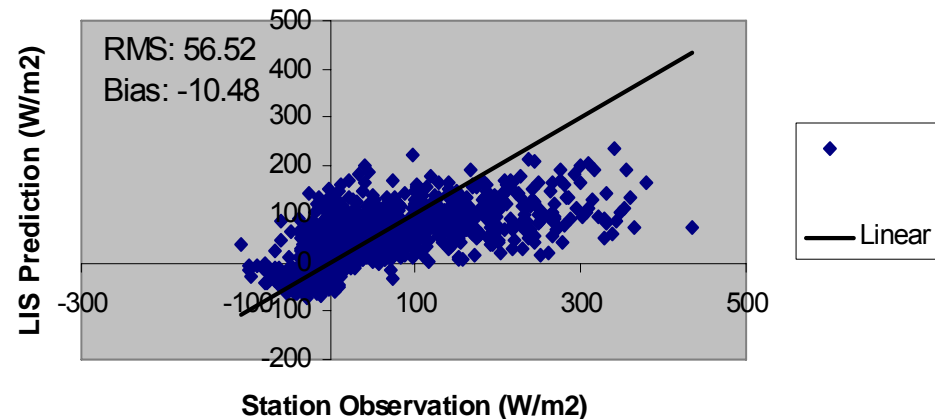
**Bondville
CLM-Qh-1KM-STATSGO**



**Bondville
Noah-Qle-1KM-STATSGO**

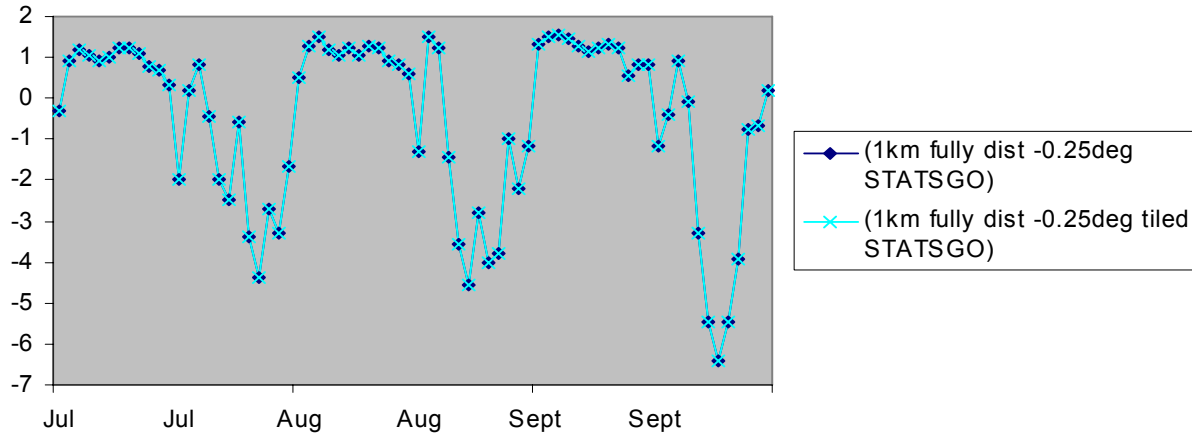


**Bondville
Noah-Qh-1KM-STATSGO**



Resolving spatial heterogeneity

**Bondville
CLM-Qle**

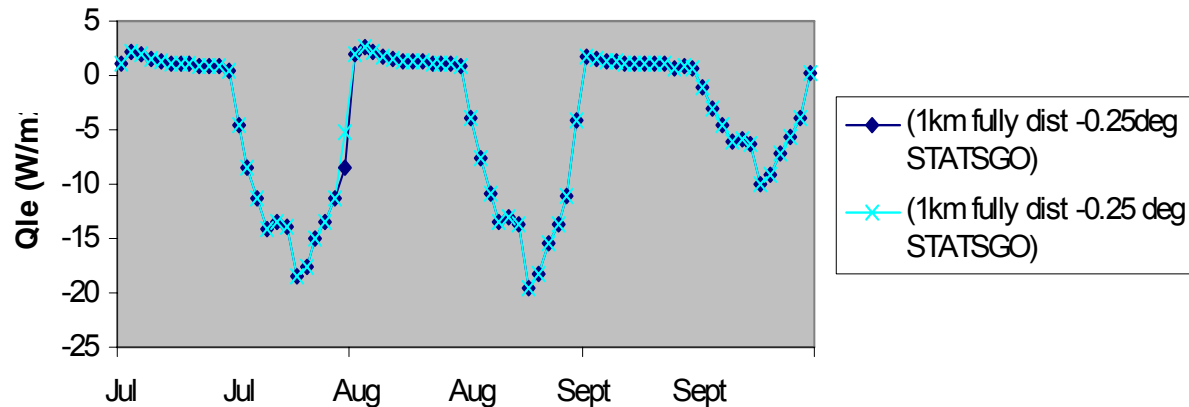


- 1KM fully distributed: 1KM soil, elevation, LAI, and vegetation parameters
- 0.25 deg: uniform vegetation in a grid
- 0.25 deg tiled: dominant vegetation types with 10% cutoff

➤ Vegetation-based tiling is good approximation of 1KM at 0.25 deg.

➤ Heterogeneity in soil, elevation, and LAI at 1KM needs to be represented in a 0.25 deg grid

**Bondville
Noah-Qle**

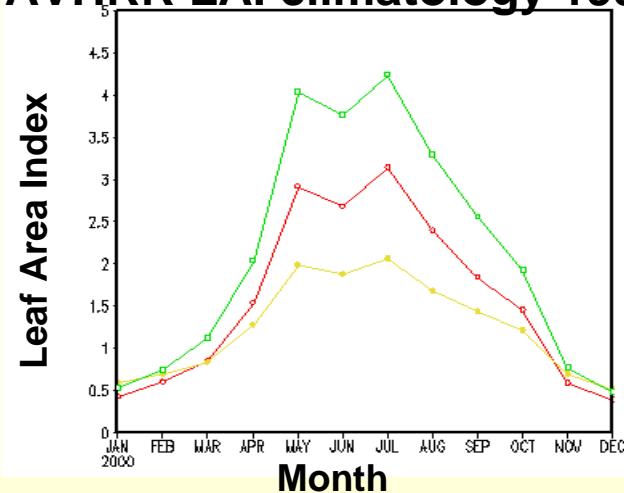


Site characteristics data – Lindenberg example

<http://www.joss.ucar.edu/ghp/ceopdm/insitu/lindenberg>

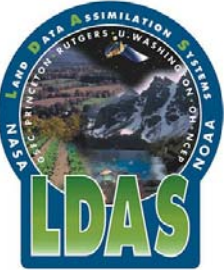


AVHRR LAI climatology 1996-2000



-- Cropland
 -- Wooded grassland
 -- Grassland

	Veg	Elev. (m)	LAI	Sand (%)	Clay (%)	Por. (%)	Silt (%)
Site	Forest (~45%) Agricultural fields (~45%)	40	NEEDED	0.74	0.26	0.37	?
GLDAS/LIS ¼° (AVHRR land cover, Reynolds Soil, GTOPO30)	Cropland (64%) Wooded grassland (21%) Grassland (11%)	56	See fig	0.48	0.20	0.66	0.32



Summary



- GLDAS and LIS produce global, regional, and point scale time series of land surface states and fluxes by integrating data from multiple sources within sophisticated land surface models
- MOLTS have been extracted for CEOP reference sites from $\frac{1}{4}$ degree and 1 degree GLDAS simulations and LIS point simulations at $\frac{1}{4}$ degree (tiled) and 1 km
- Comparisons of CEOP reference site data with GLDAS/LIS forcing data demonstrate the shortcomings of these data
- Comparisons of CEOP reference site data with GLDAS/LIS MOLTS output indicate that output improves at higher model resolutions but is hindered by the forcing and parameter data
- CEOP site parameter information is valuable for improving model simulations and understanding the comparisons