Evaluation of streamflow and snowpack simulations in the land surface models of the Land Data Assimilation (LDAS) Project (J1.4)

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N-LDAS Collaborators

NCEP/EMC

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NESDIS/ORA

Univ. Oklahoma

Univ. Washington

NCEP/CPC

NOAA/ARL

Univ. Maryland

NOAA **NASA** **Universities**

http://ldas.gsfc.nasa.gov

Major Initiative: LDAS

Goal: provide soil moisture / temperature initial conditions superior to current coupled Eta-based EDAS in realtime

Method: drive land-surface model "off-line" with gage/radar precipitation and satellite-derived solar radiation

Main Contribution: improve coupled-model forecast skill (temperature, precipitation) via improved initial land states

Other Contributions: land states and land surface energy and water fluxes for water cycle research and applications such as agriculture

Future Additions: assimilate satellite-derived skin temperature, soil moisture, snowpack, and vegetation state

LDAS Implementation

Models: Mosaic (GSFC), VIC (Princeton, Washington), NOAH (NCEP/EMC), Sacramento (NWS-OH)

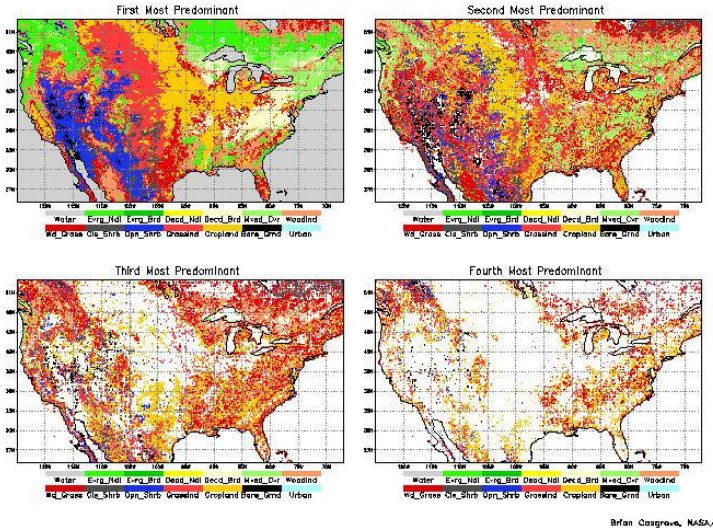
- 1/8 degree resolution
- Runoff routing: calibration, validation

Parameters:

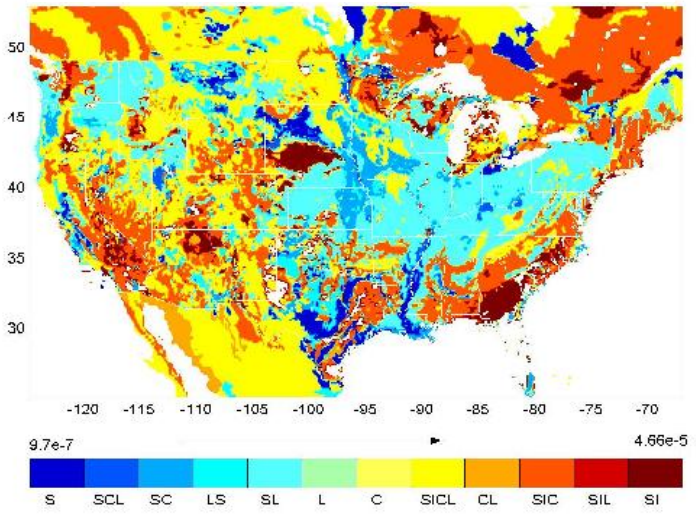
Vegetation: EROS IGBP, UMD, NESDIS greenness, EOS products

Soils: IGBP, STATSGO; Topography: Digital Elevation Models

LDAS predominant vegetation from 1km EROS data



Soil type on LDAS grid

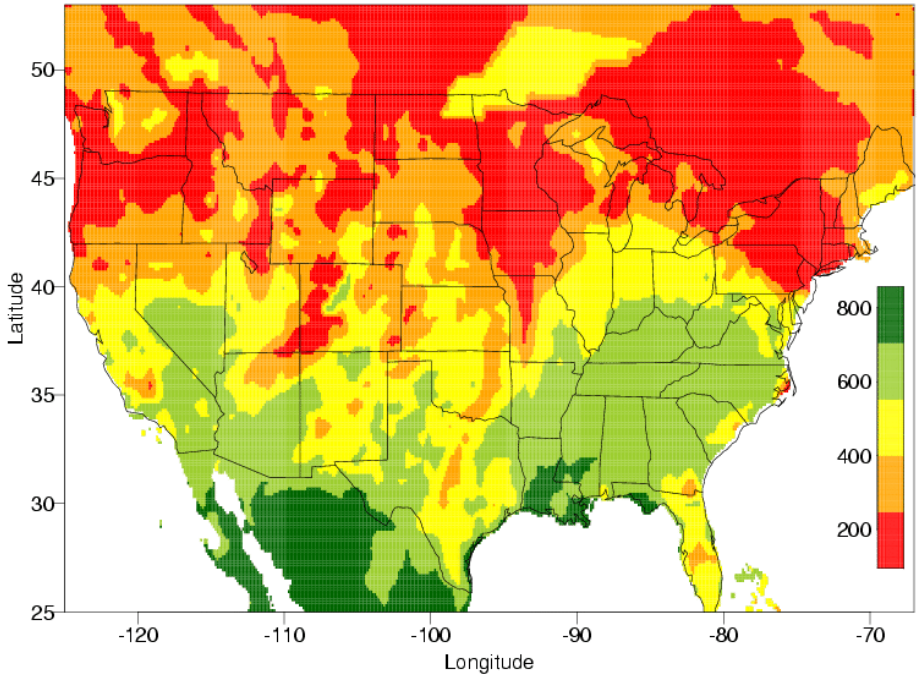


LDAS Implementation cont.

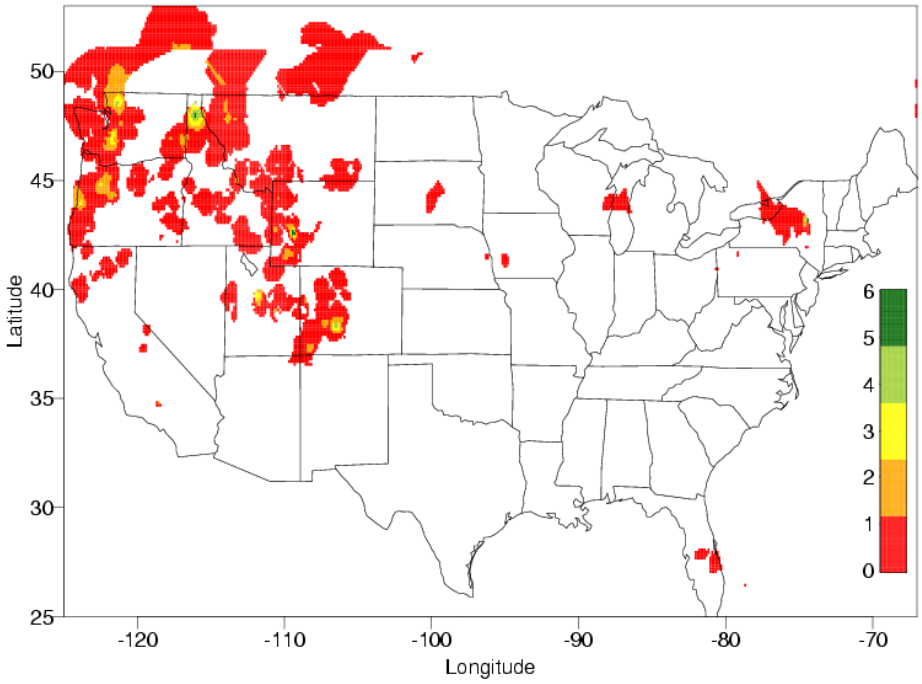
Forcing:

Precipitation: 24 hour gauges, NCEP Stage IV gage/radar precipitation
Radiation: NESDIS 0.5 degrees hourly GOES solar insolation
Meteorology: NOAA/NCEP EDAS analysis (wind, temperature, pressure, humidity, longwave downward, and backup)

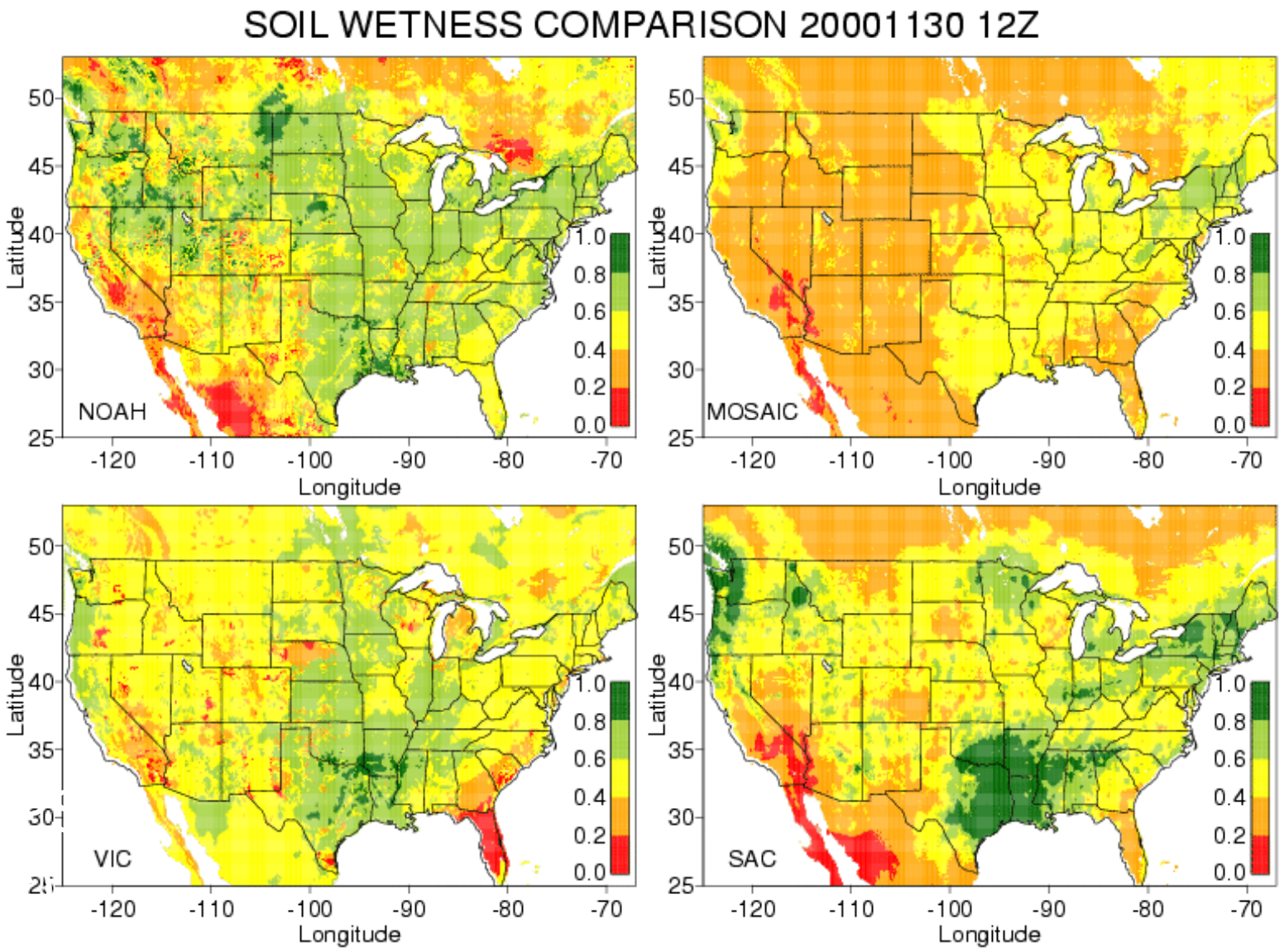
GOES shortwave radiation [W/m^2] 20011101 18Z



Gauge / Stage IV precip [mm] 20011101 18Z



LDAS model output example



LDAS Validation Across Scales

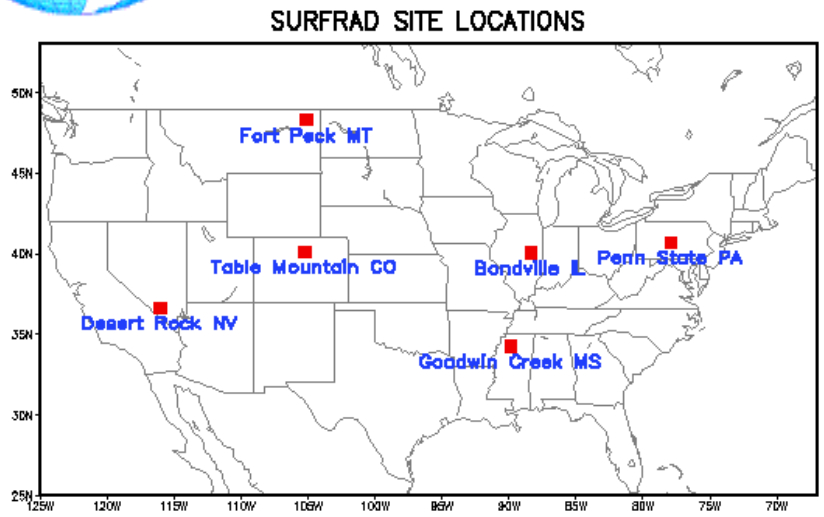
Measured, Estimated		Residual	Resolution
$R_N - G - H - \lambda E$	=	0	Δt = minutes - hours
$P - E - dS/dt$	=	R	Δx = 1–100m (flux tower)
R_N	=	$G - H - \lambda E$	Δt = hours - days
$P - R$	=	$dS/dt + E$	Δx = 10km (catchment)
R_N(Tskin)	=	$(G - H - \lambda E)$(Tskin)	Δt = days – months
$P - R$	=	$dS/dt + E$	Δx = 1000km (continent)
$dW/dt + \Delta^*\underline{Q} + P$	=	E	(atmosphere)

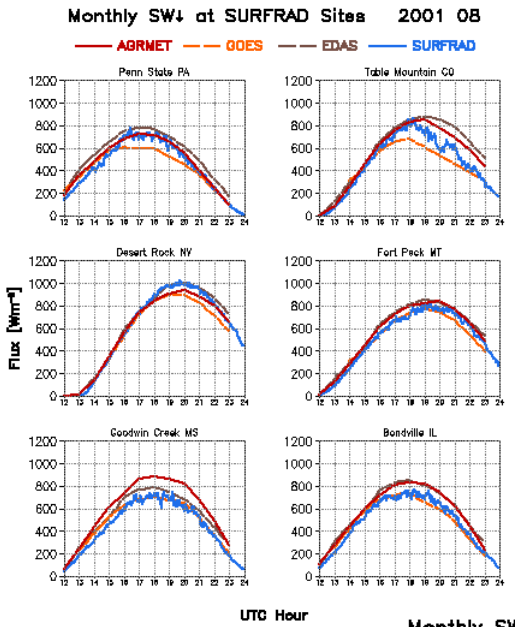
instantaneous: GOES daily: Streamflow, Snow Water Equiv, Mesonet&Surfrad ARM/CART

Coupled Terrestrial – Atmospheric Water Budget

$$dS/dt + R = - dW/dt - \Delta^*\underline{Q}$$

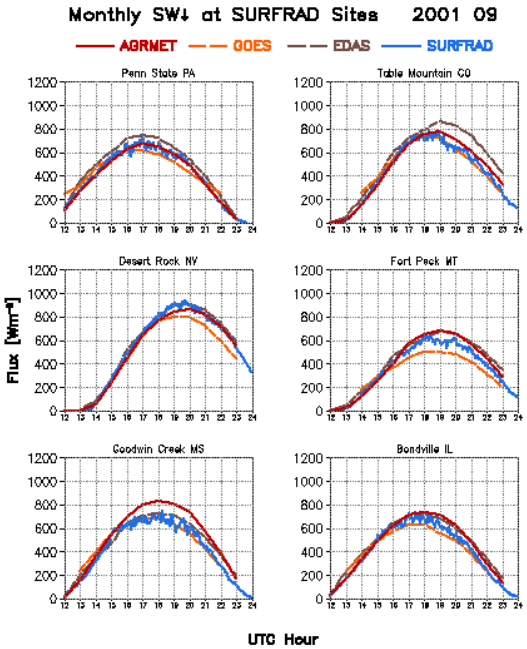
LDAS Forcing Validation 2001 08-11

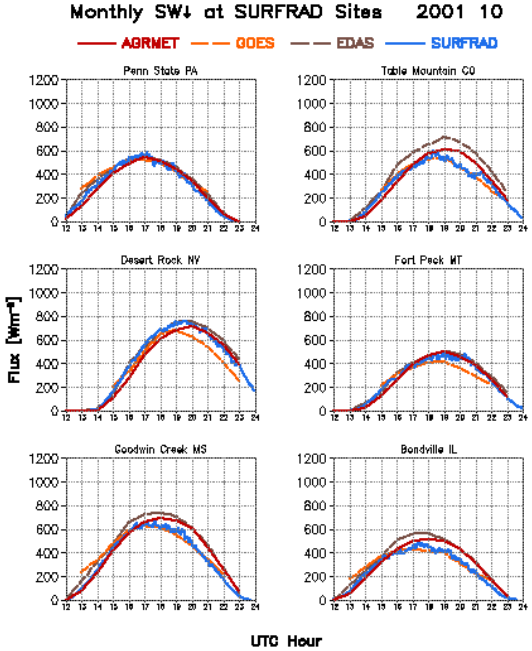


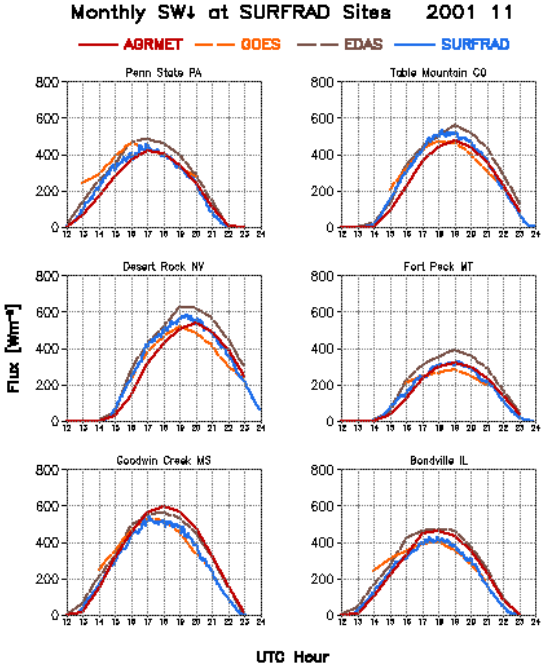


Monthly mean shortwave radiation intercomparison

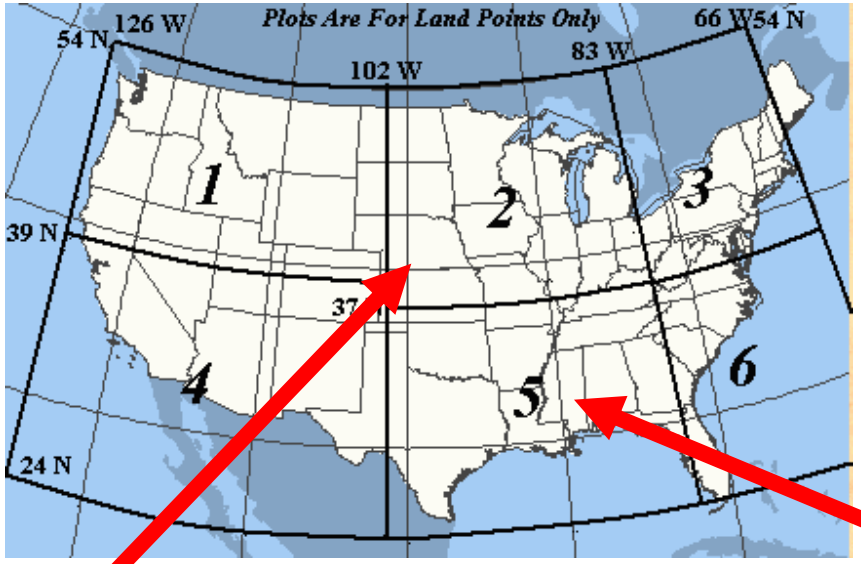
AGROMET
GOES
EDAS
SURFRAD



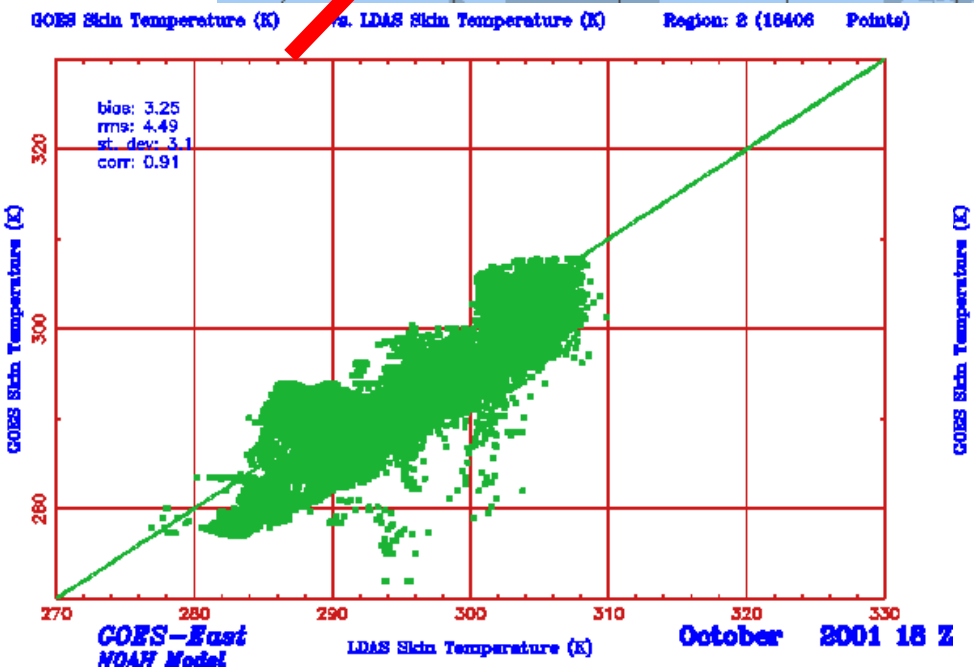


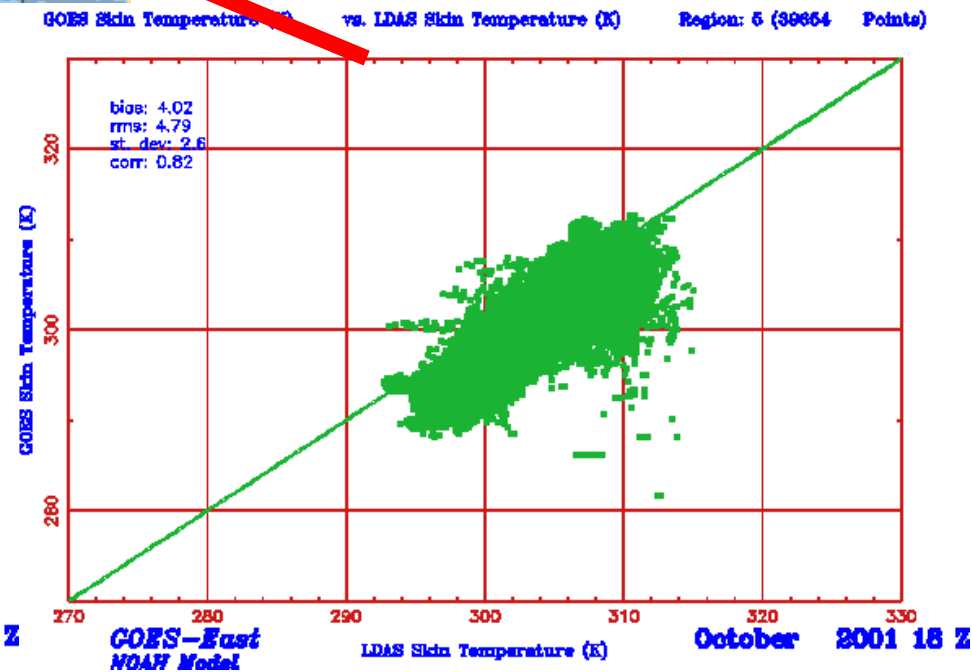


LDAS-NOAH Skin Temperature Validation with GOES October 2001



NOAH model (x-axis)
GOES-East (y-axis)
18Z, all grid points in area 2 and 5



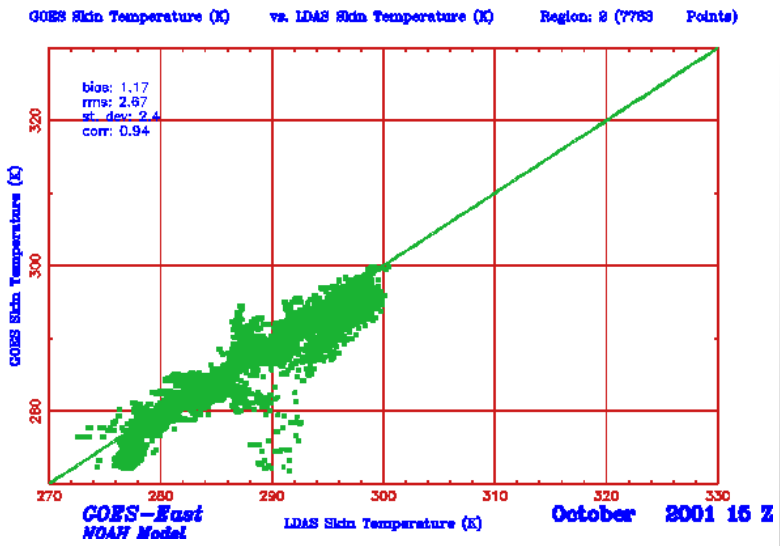


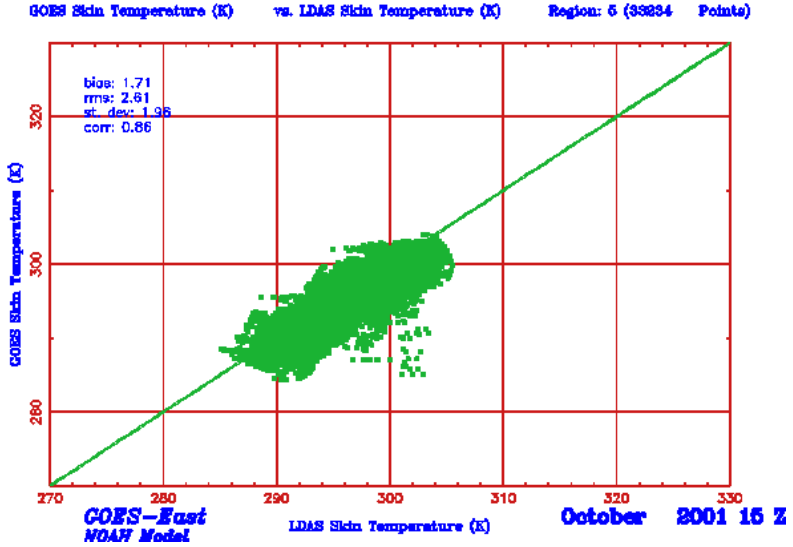
LDAS-NOAH Skin Temperature October 2001 Validation cont.

Region 2

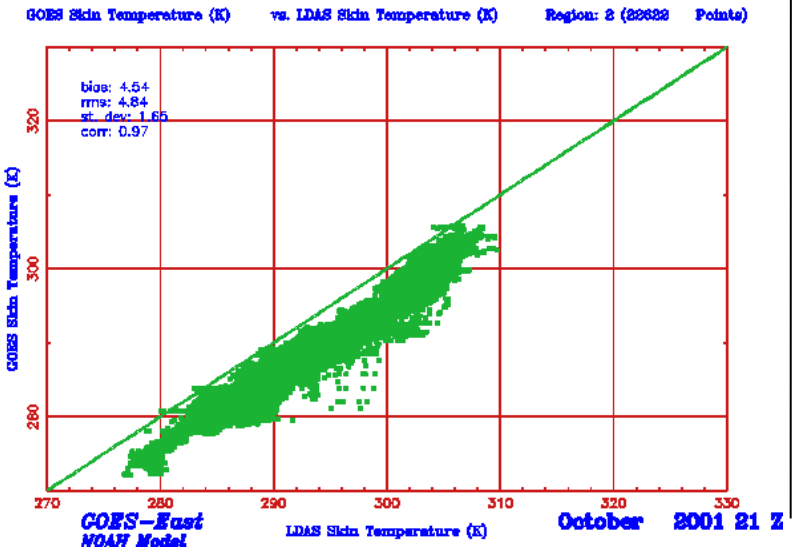
Region 5

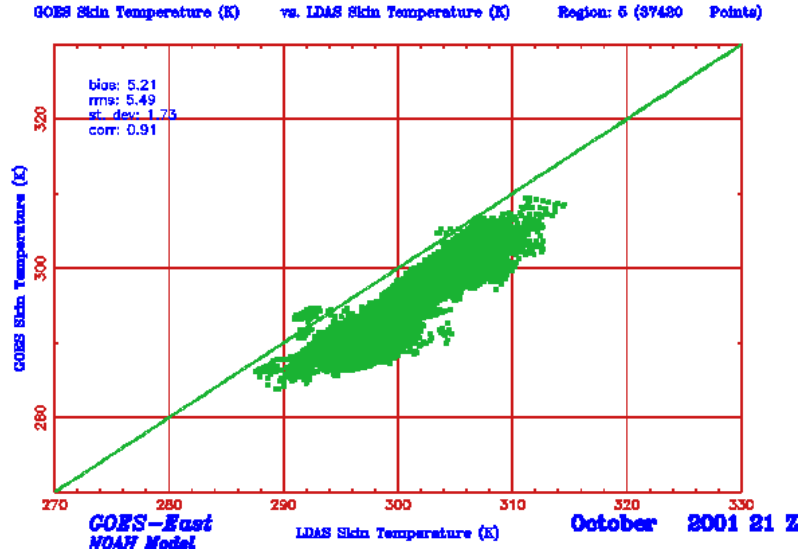
15 Z





21 Z





Snowpack Simulation Comparison

Snow depth from USAF, cover: global 1/8 bedient, unit [in], daily

Snow cover product from NESDIS daily, cover: 1/16 bedient N.Hemisphere grid, flag

= estimated

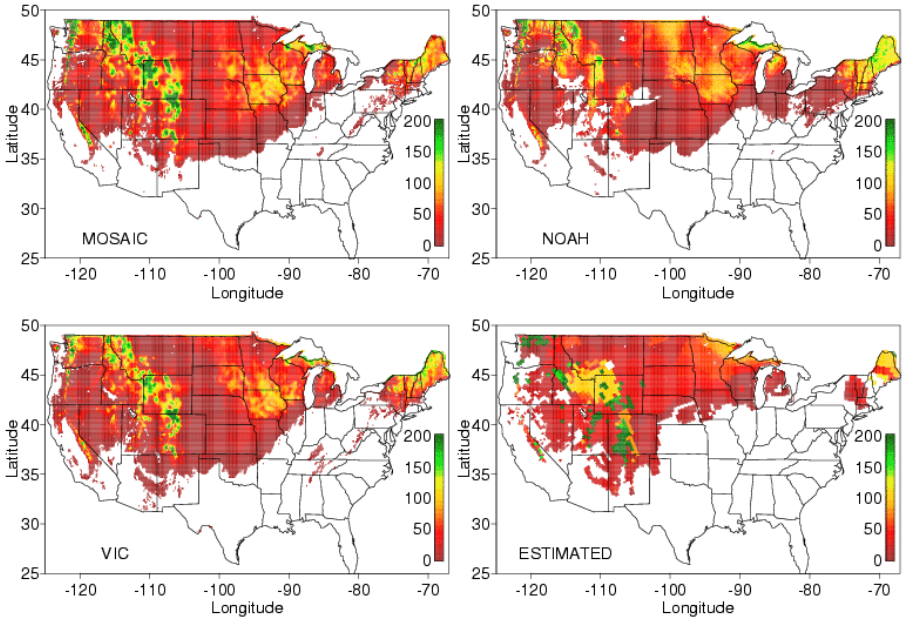
NOHRSC snow water equivalent,

cover: NW USA, 0.075 degrees, unit [2cm], 5days per week

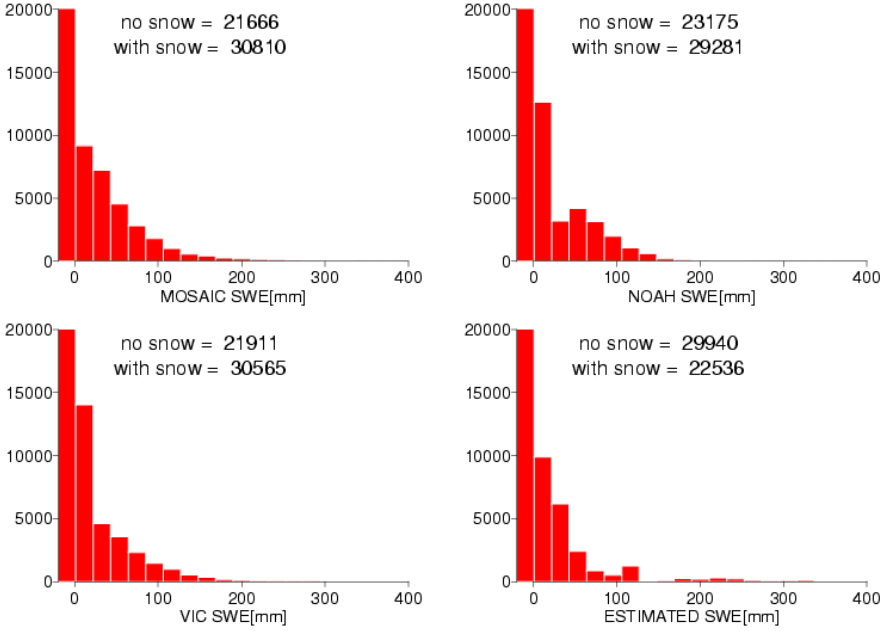
NOHRSC cloud and snow cover, cover: USA, 0.067 degrees, flag

= future

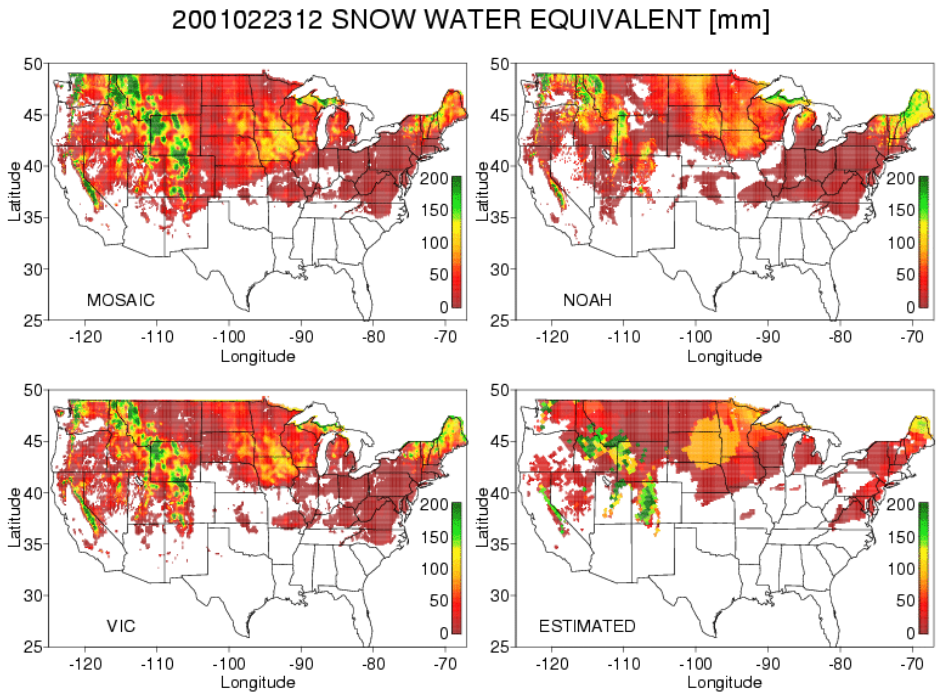
2001021012 SNOW WATER EQUIVALENT [mm]

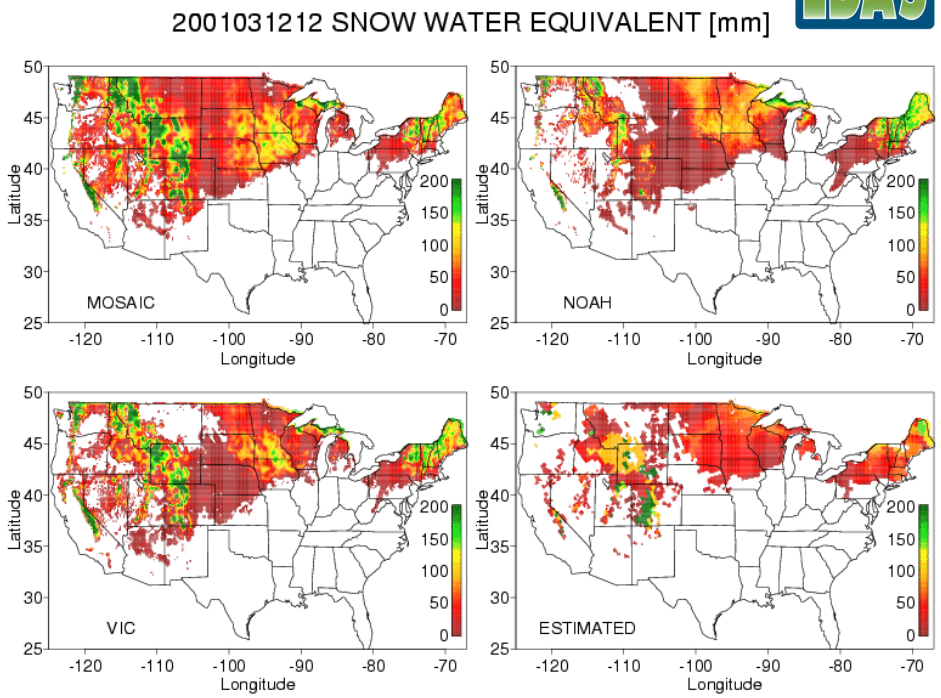


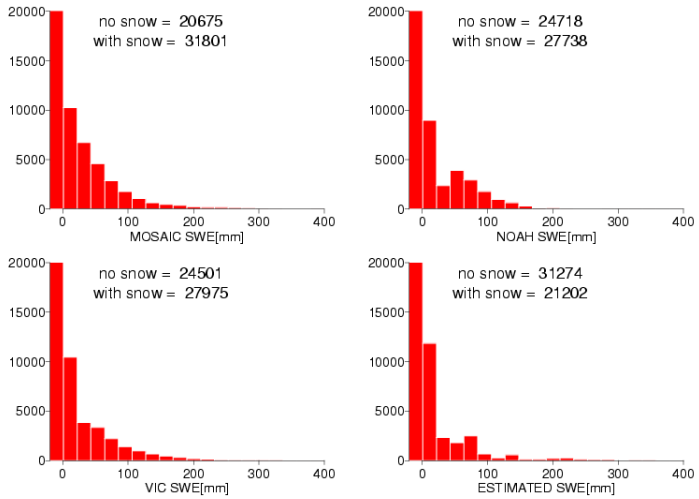
2001021012 Histogram SNOW WATER EQUIVALENT [mm]

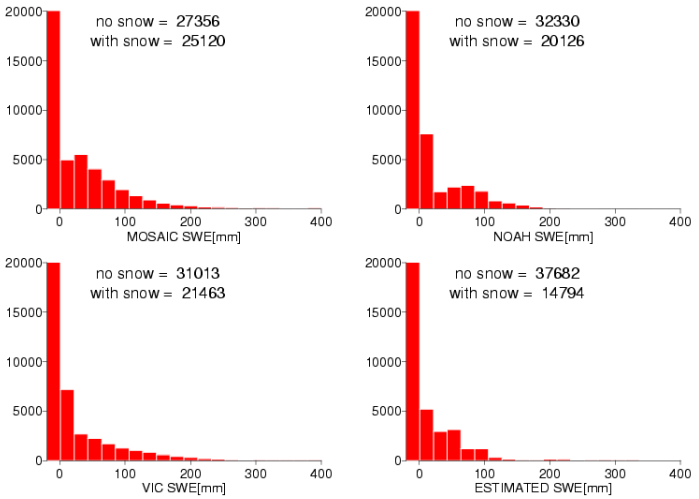


Snowpack Simulation Comparison cont.

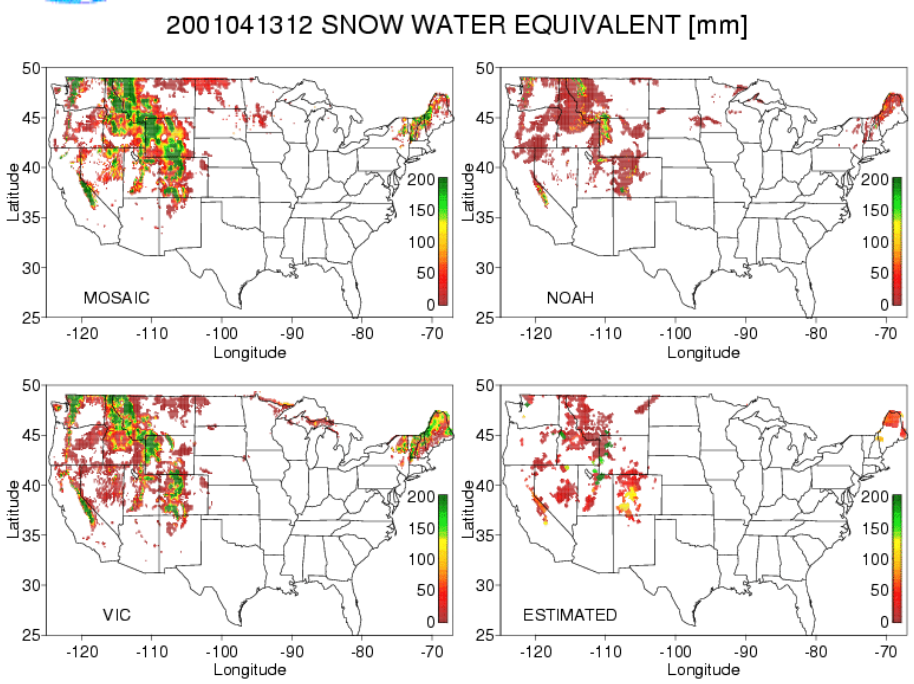


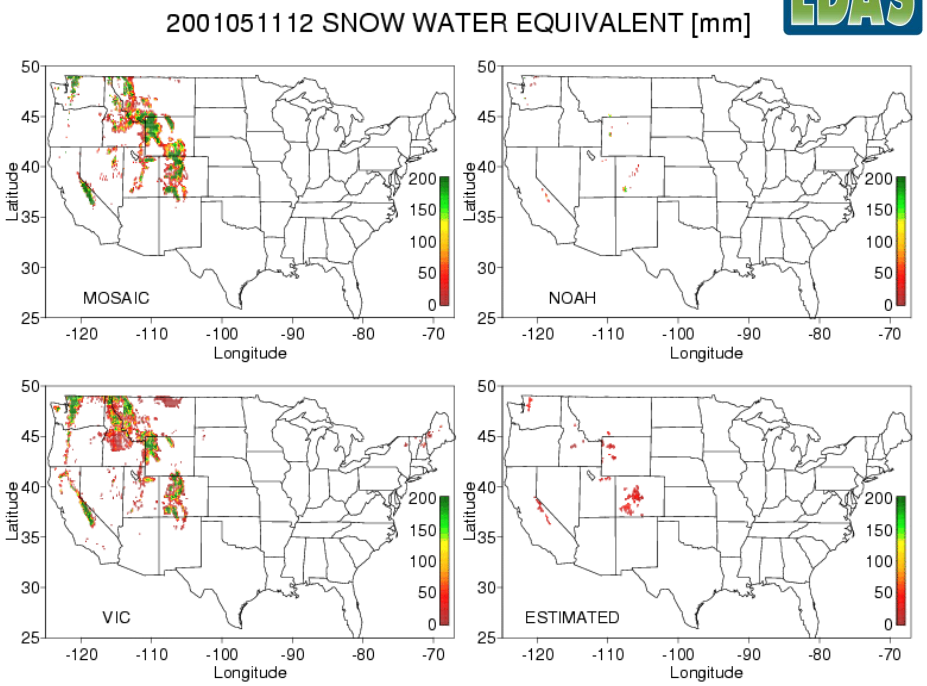


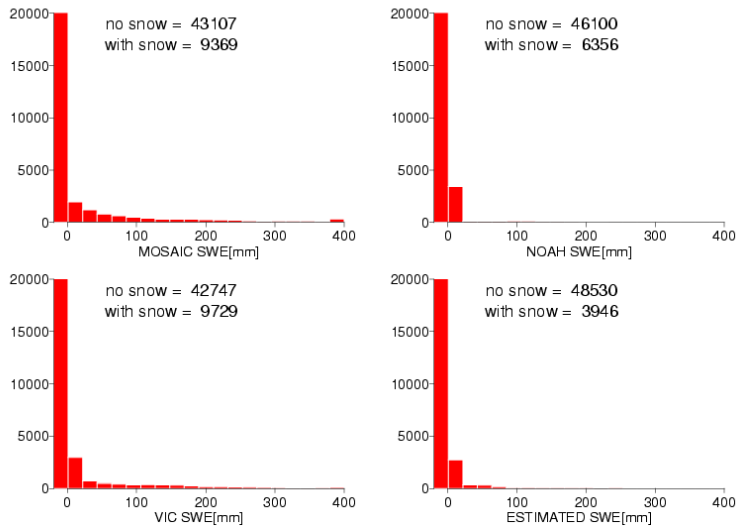


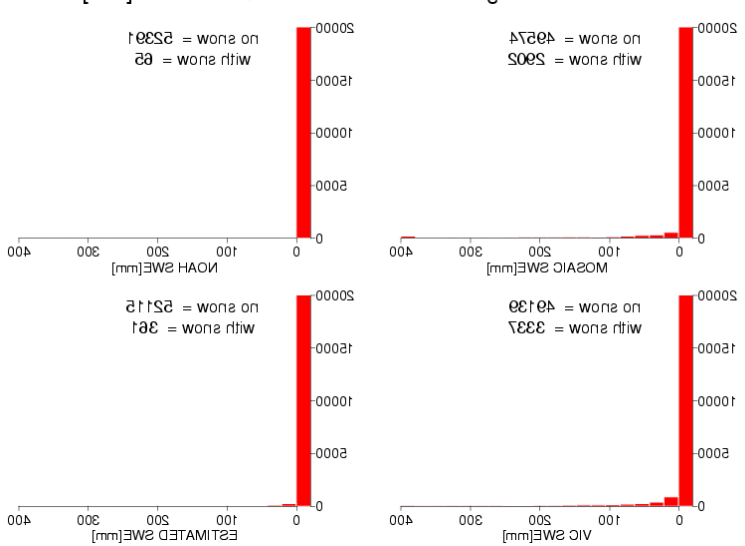


Snowpack Simulation Comparison cont.

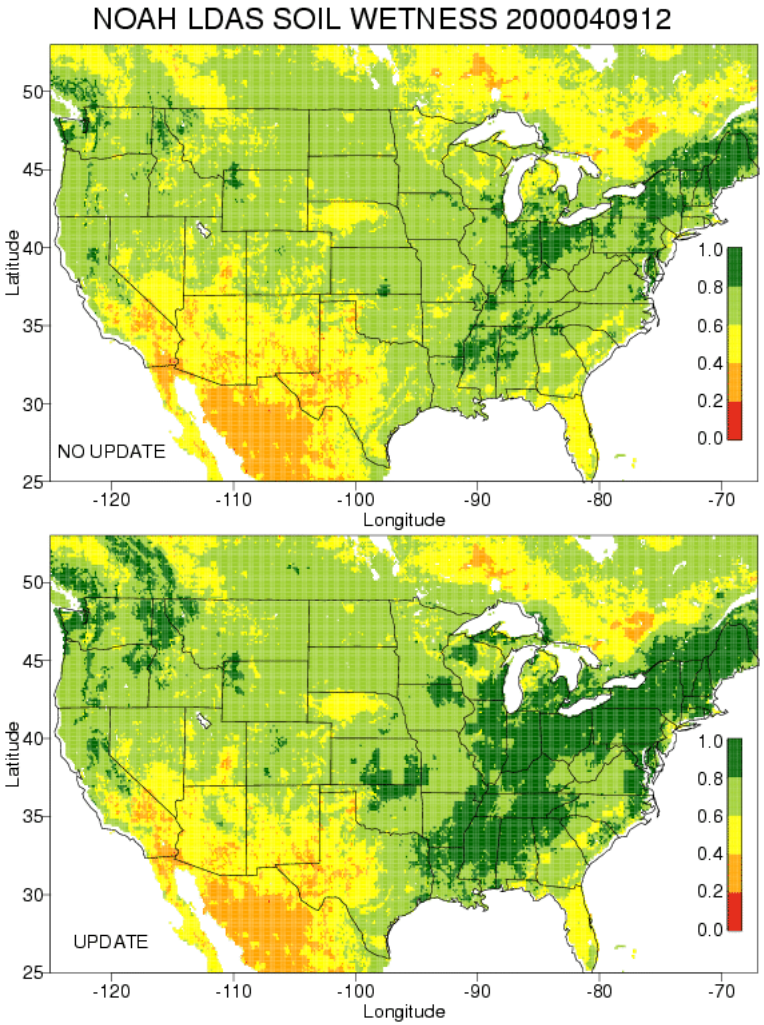








NOAH LDAS Soil Wetness With / Without Snow Update

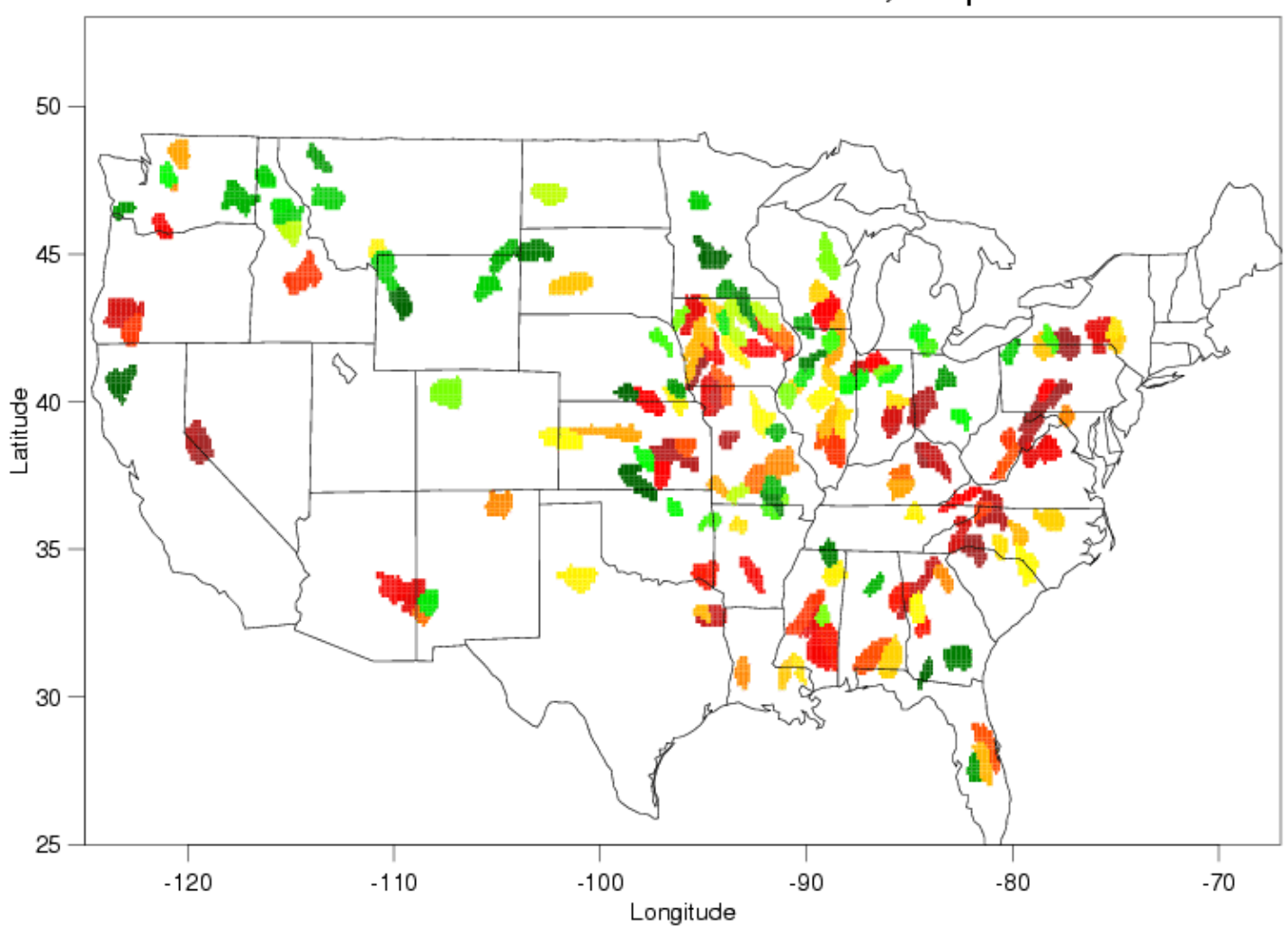


Control run starting 1999 04 15 12Z, no update on any state variable, soil wetness on 2000 04 09

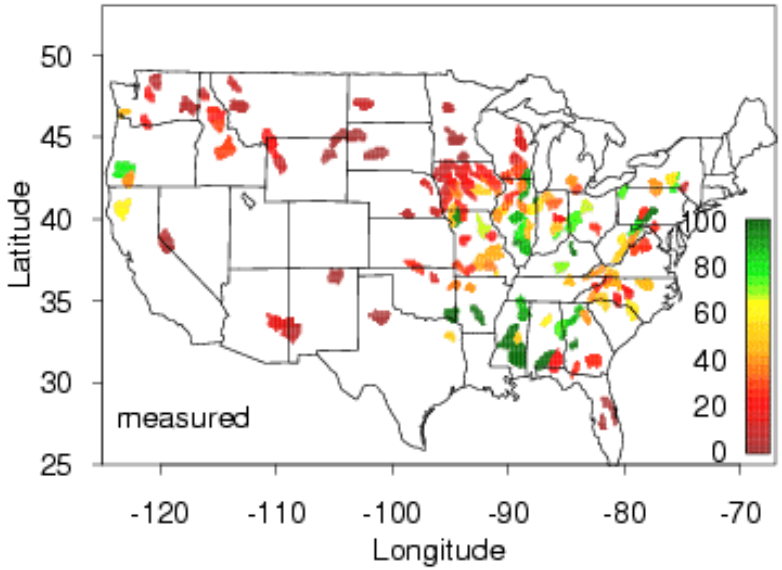
NOAH model snow water equivalent was updated daily with blended NESDIS / USAF snow cover and snow depth

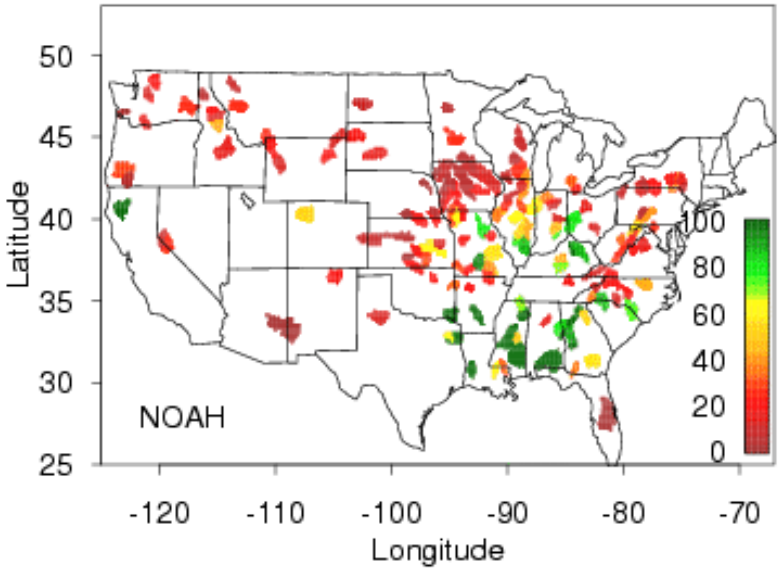
LDAS Streamflow Validation
188 Basins

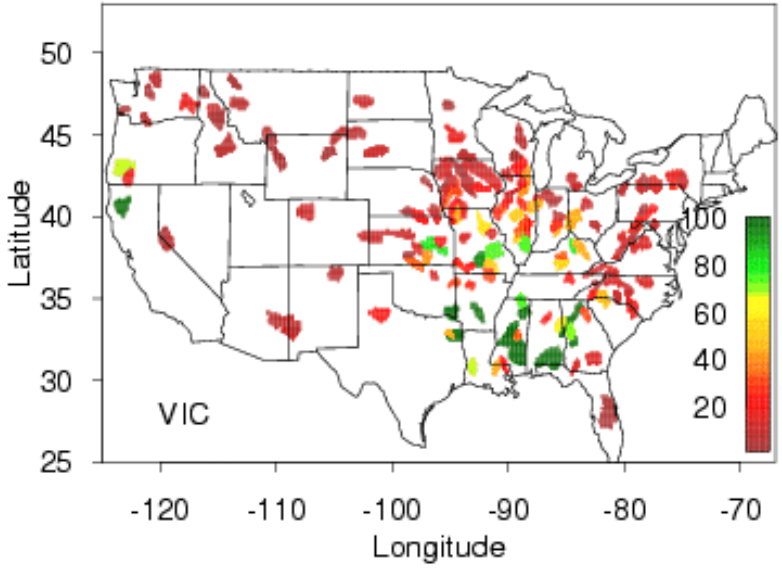
Size between 1000km^3 and 10000km^3, realtime and retrospective data are available

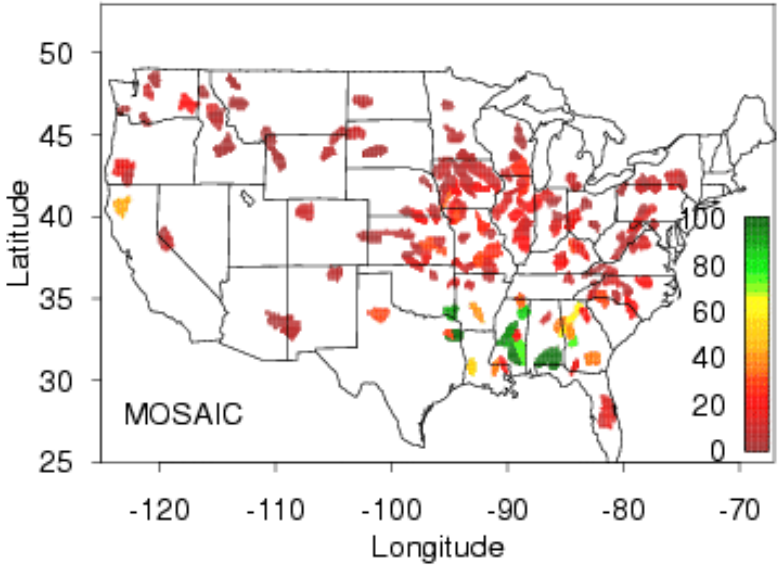


LDAS Models Total Runoff
Nov. 2000 – July 2001

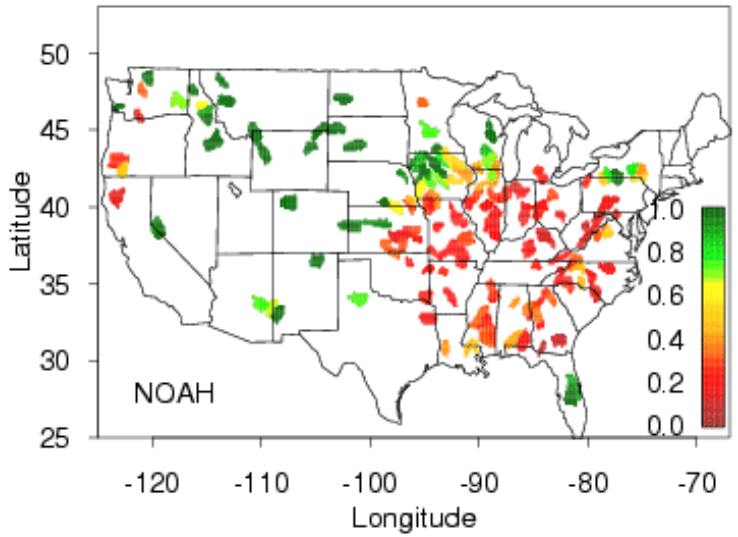


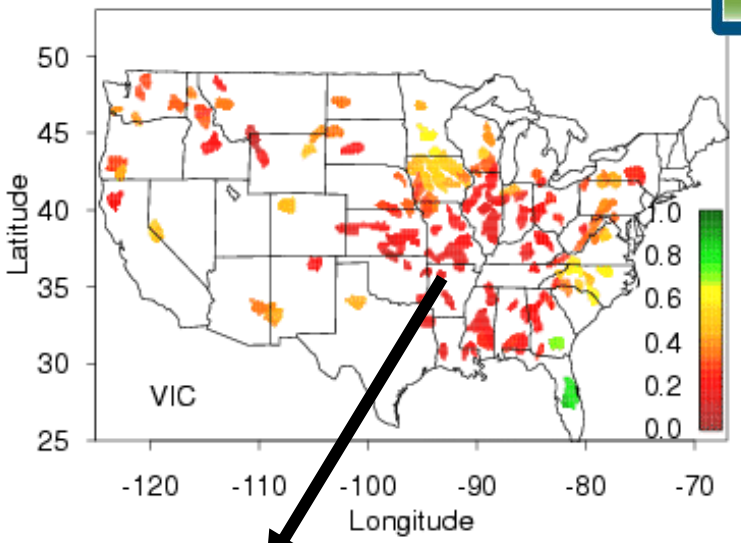




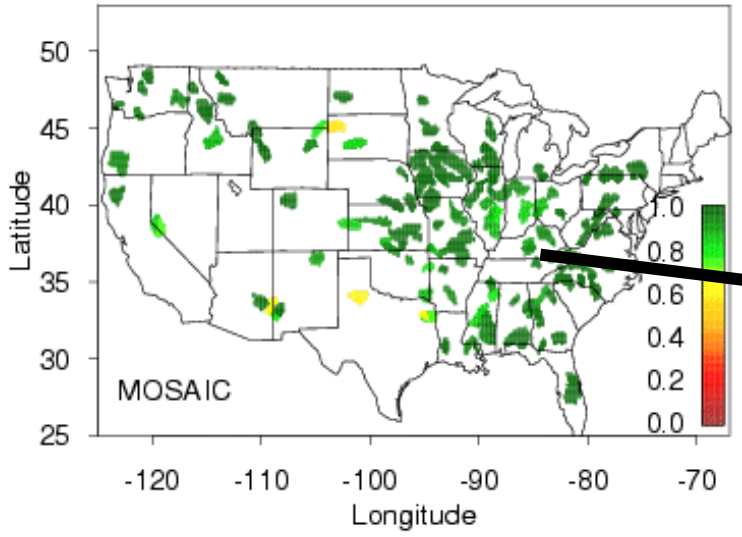


LDAS Models
Surface Runoff / Total Runoff





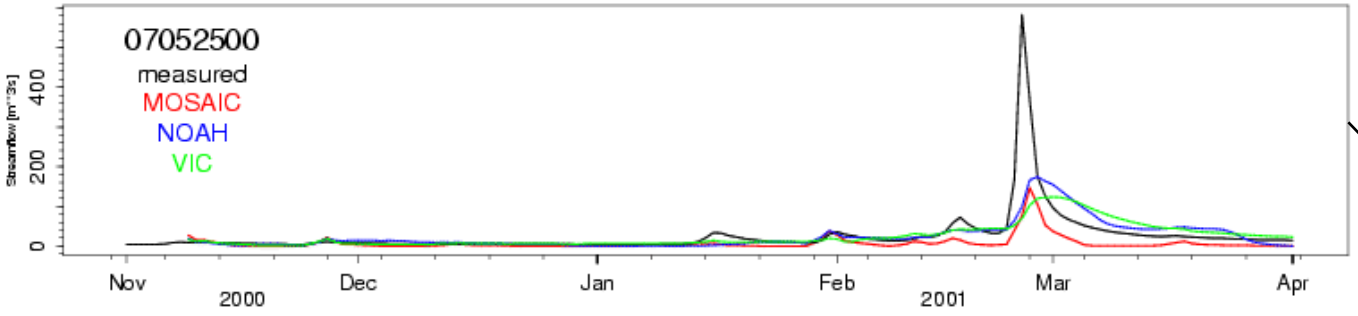
Dominant Sub-Surface Runoff

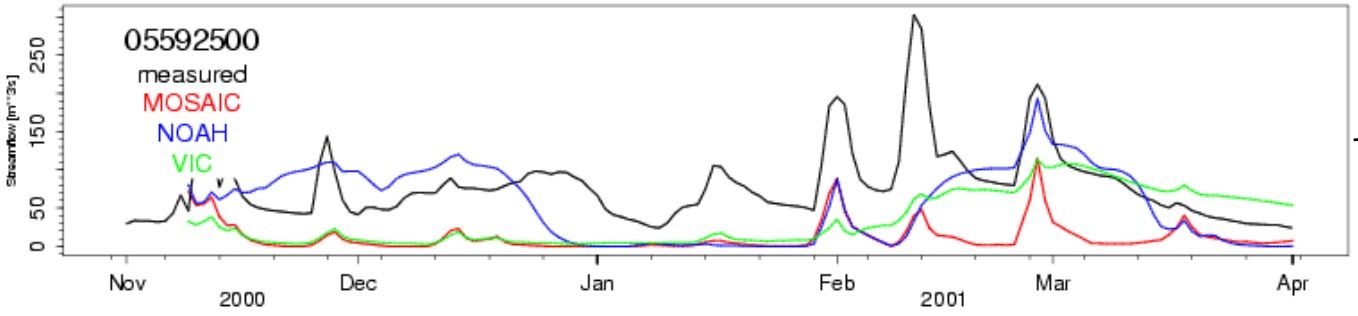


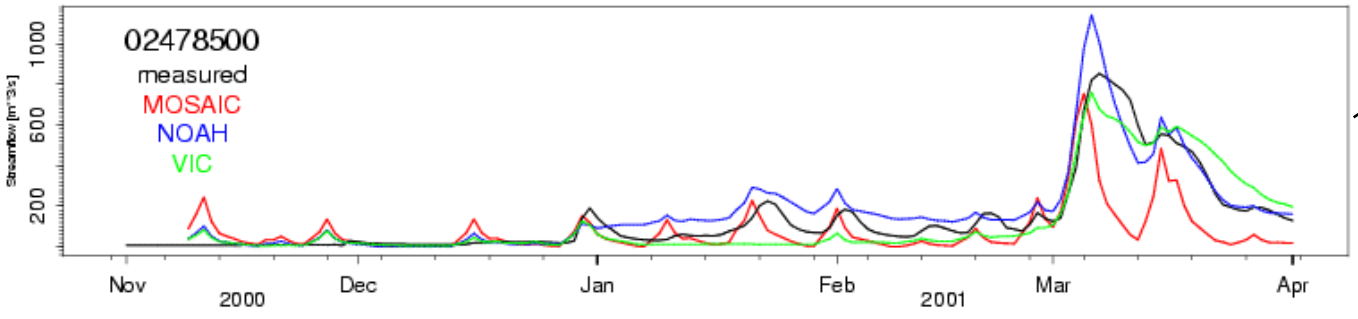
Dominant Surface Runoff

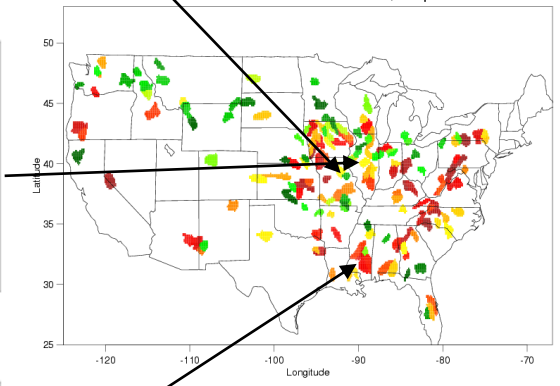
LDAS Models Streamflow [m^3/s]

07052500 = James River, MO, 996 sq.miles
05592500 = Kaskaskia River, IL, 1940 sq. miles
02478500 = Chickasawhay River, MS, 2690 sq. miles



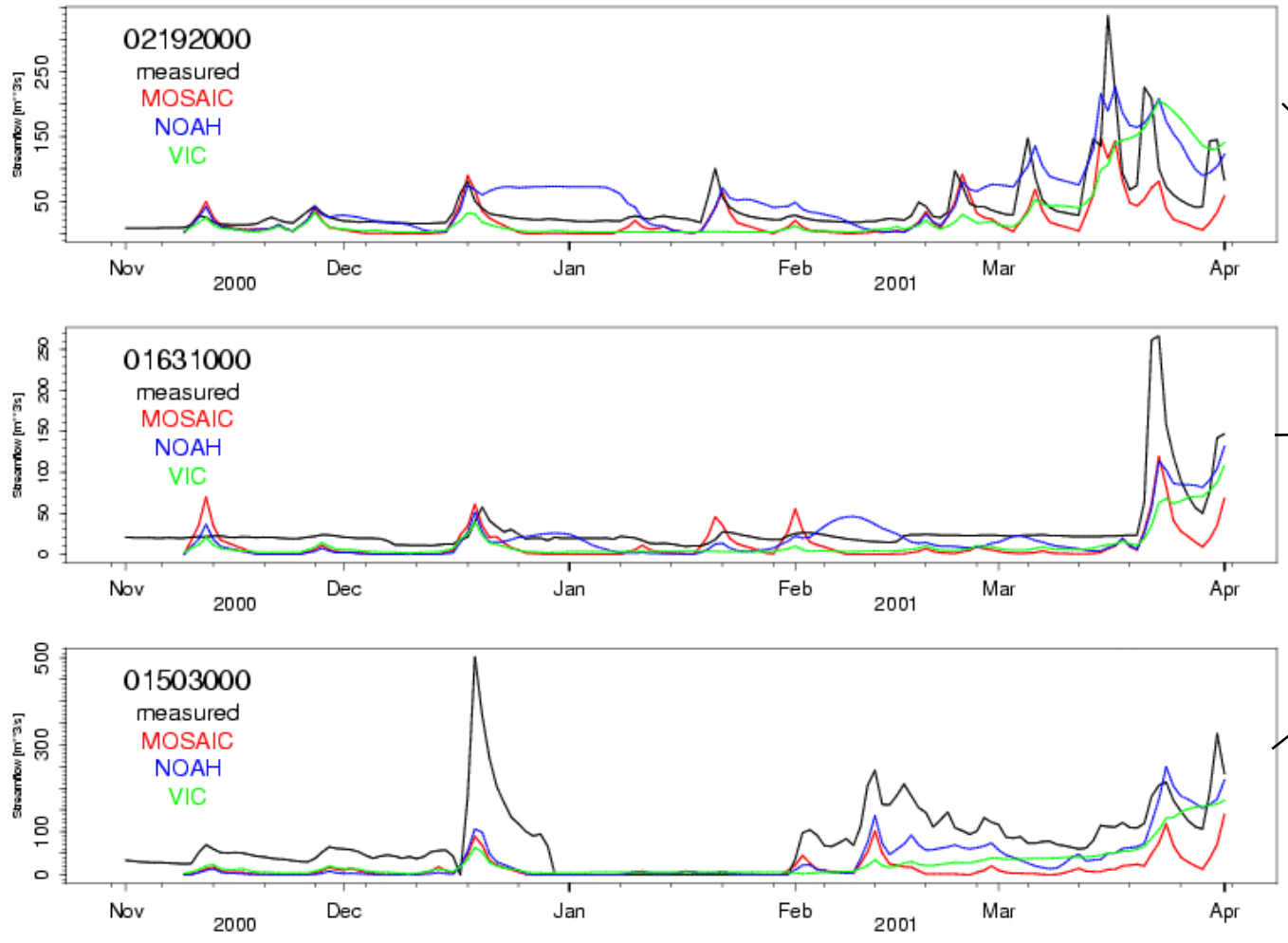


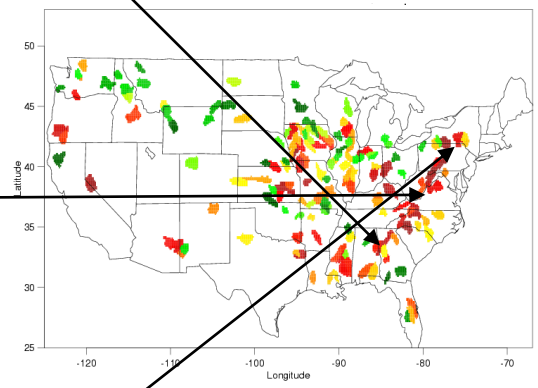




LDAS Models Streamflow cont.

02192000 = Broad River, GA, 1430 sq. miles
01631000 = Shenandoah River, VA, 1642 sq. miles
01503000 = Susquehanna River, NY, 2232 sq. miles





Conclusions & Outlook

- Showed LDAS results (forcing validation, skin temperature validation, snow cover comparison and runoff / streamflow comparison) from realtime runs (started April 15th 1999).
- Monthly mean hourly GOES shortwave radiation is very similar to measurements from 6 SURFRAD sites.
- Skin temperature validation is a useful tool, but needs to be explored more for data assimilation.
- Snow cover seems to be overestimated by the models (possible reason: EDAS cold bias), NOAH melts snow faster than VIC/MOSAIC (see PILPS 2e and Rhone Experiment).
- Streamflow comparison shows large differences between models, mainly due to different runoff production processes.

More detailed analysis with upcoming 3 year retrospective runs