

# WESP-GLDAS

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# Land Data Assimilation System Heritage



## North American LDAS

- NOAA/NCEP, GSFC/HSB, and 6 other institutions
- Central North American domain,  $1/8^\circ$  resolution
- Spin-offs: GLDAS, NLDAS-E
- Ref: Mitchell et al., *J. Geophys. Res.*, 2004

## Global LDAS

- NASA/IDS Project began in 2000; now supported by NASA/NEWS
- GSFC/HSB and NOAA/NCEP partnership
- Global domain ( $60^\circ\text{S}$ - $90^\circ\text{N}$ ),  $1/4^\circ$  and  $1^\circ$  resolutions
- Spin-offs: LIS, South American LDAS
- Ref: Rodell et al., *Bull. Amer. Meteor. Soc.*, 2004

## Land Information System (LIS)

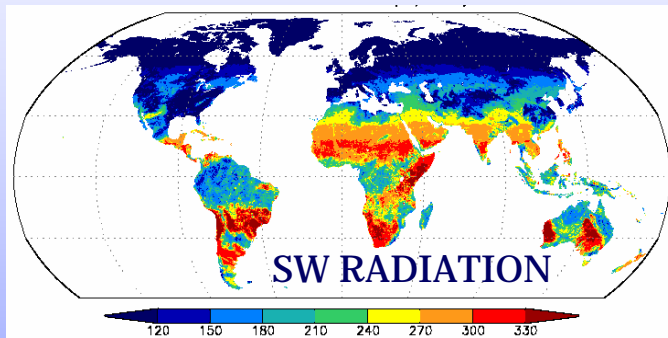
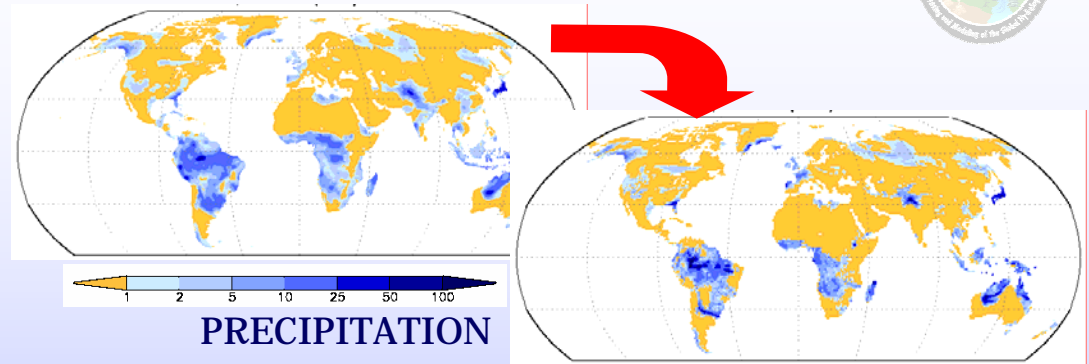
- NASA/HPCC project began in 2002; multiple partners
- Global domain ( $60^\circ\text{S}$ - $90^\circ\text{N}$ ), resolutions as fine as 1 km
- Software adopted by all other NASA LDAS projects
- Ref: Kumar, Peters-Lidard, et al., *Environ. Model. Soft.*, 2006



# Data Integration in GLDAS

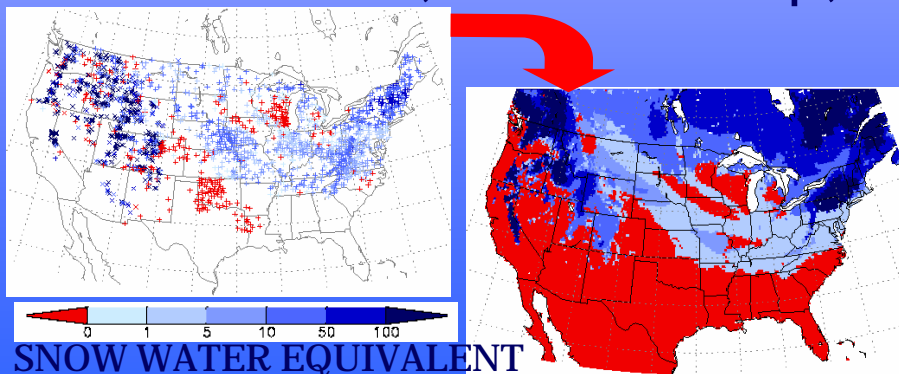
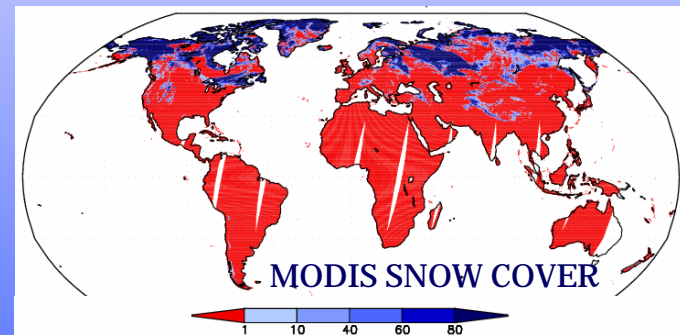


INTERCOMPARISON and OPTIMAL MERGING of global data fields



Satellite data products used to PARAMETERIZE and FORCE sophisticated land surface models

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



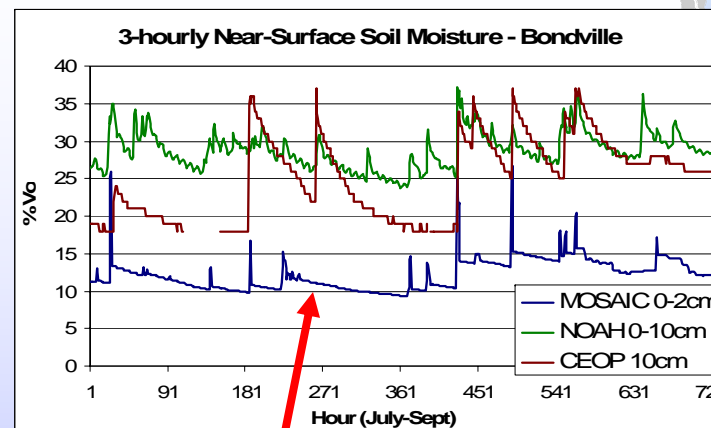
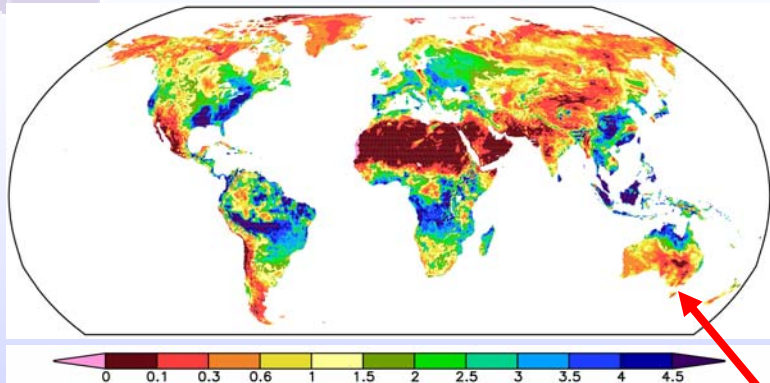
Ground-based observations used to EVALUATE model output



# GLDAS Output for CEOP



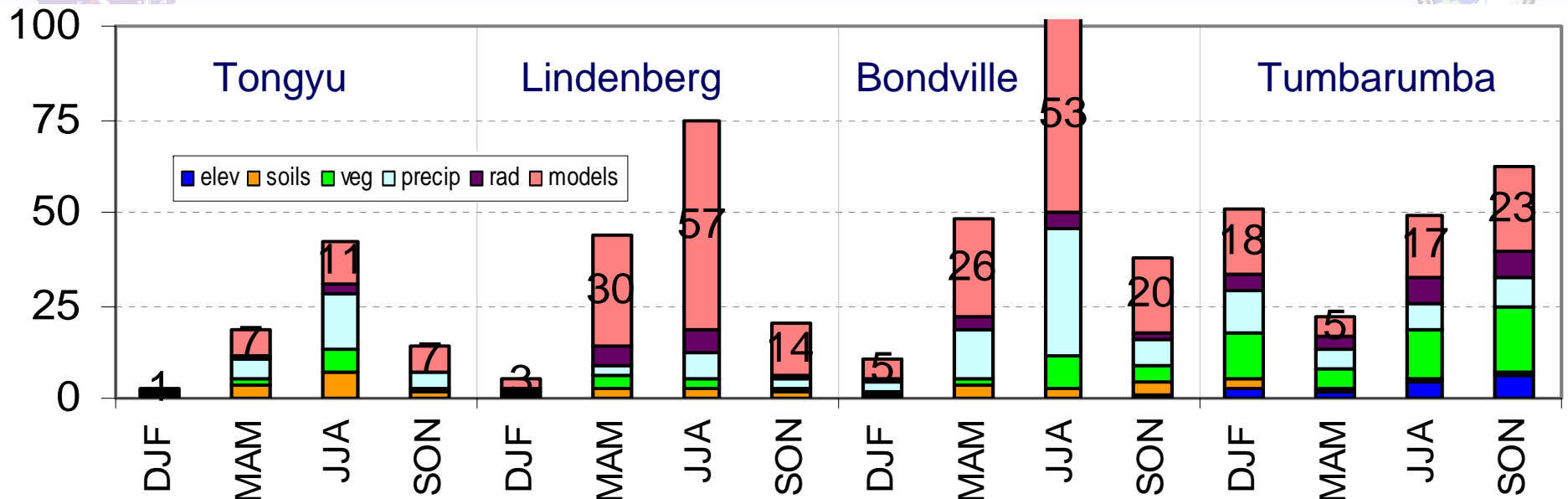
Evapotranspiration [mm/day], 1 May 2006



Land Surface Model	Earth Observation Period	Resolution	Grids	MOLTS	MODIS snow cover assimilation
Noah 2.7.1	1-4	0.25°	✓	✓	
Noah 2.7.1	1-4	0.25°	✓	✓	✓
Noah 2.7.1	1-4	1°		✓	
CLM2	1-4	1°		✓	
Mosaic	1-4	1°		✓	

**GLDAS water and energy budget output fields provided to CEOP data center at MPI**

# GLDAS Sensitivity Study Based on CEOP Data

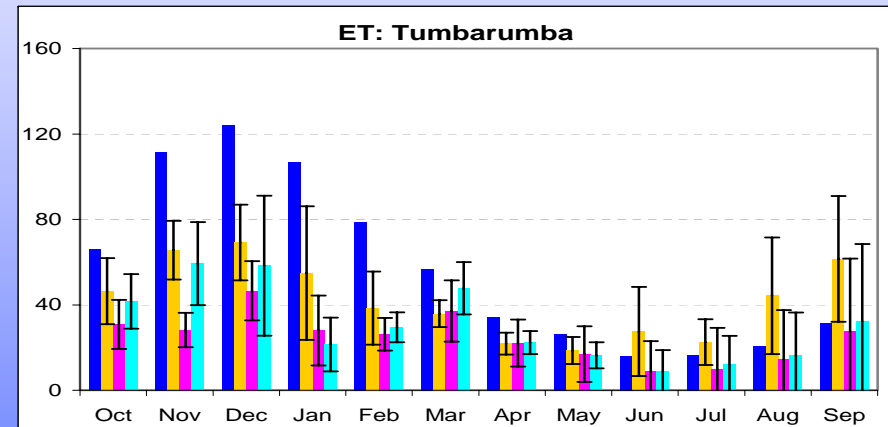
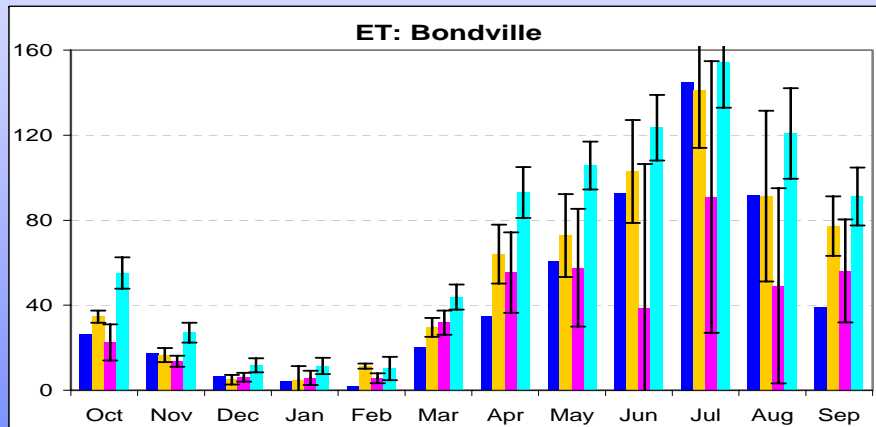
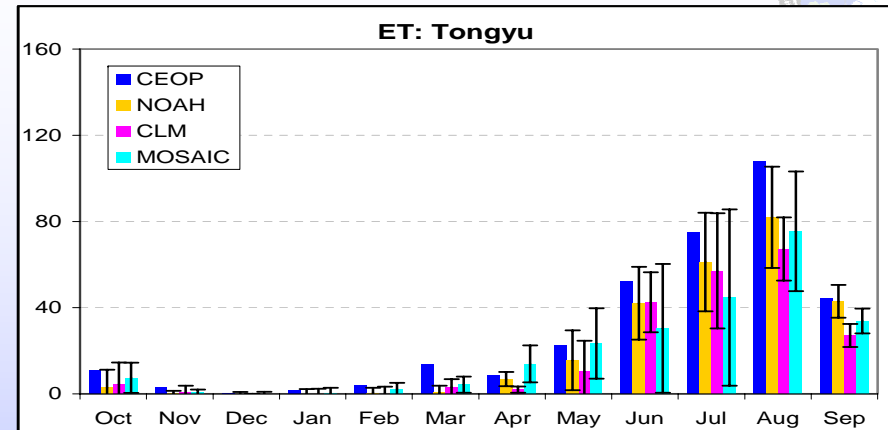
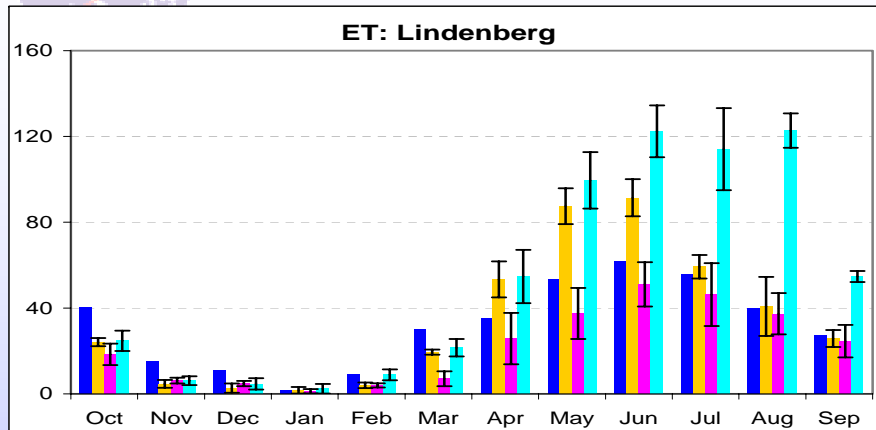


**Sensitivity of simulated seasonal evapotranspiration (mm/month) to choice of LSM, precipitation and radiation forcings, vegetation, soils, and elevation parameter maps, at four CEOP sites**

- Land surface model itself is dominant factor governing output
- Emphasizes importance of model physics improvements and calibration, not just improvement of input datasets

*Kato, Rodell, et al., J. Meteor. Soc. Japan, in revision.*

# GLDAS Sensitivity Study Based on CEOP Data



**Likely potential ranges of simulated monthly ET (mm/month) at four CEOP sites compared with observed values**

- Often, given a reasonable set of input dataset alternatives, it is not possible for a land surface model to match observed states and fluxes

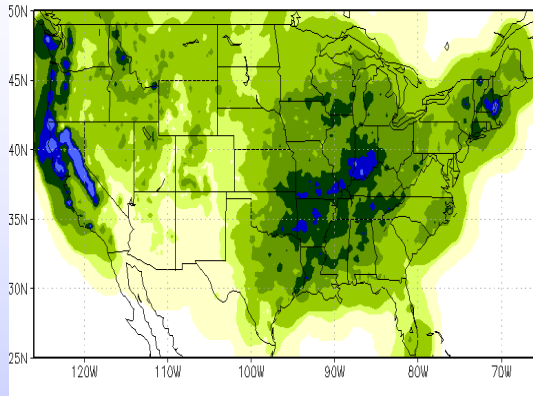
*Kato, Rodell, et al., J. Meteor. Soc. Japan, in revision.*



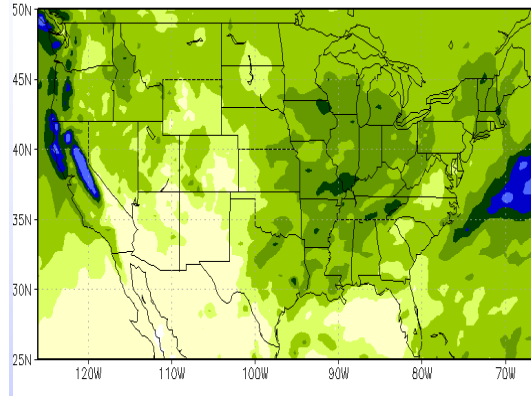
# Intercomparison of Forcing Fields: Precipitation



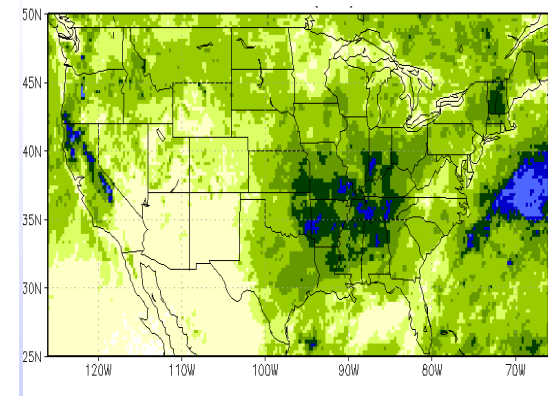
Higgins Gauge Based



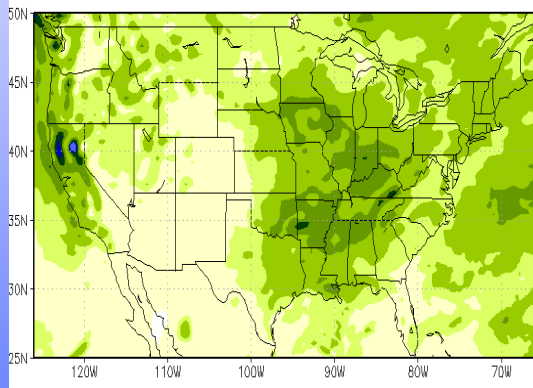
ECMWF Analysis Model



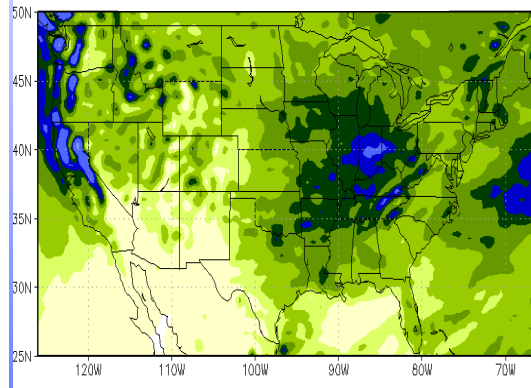
GSFC 3B42 v.6



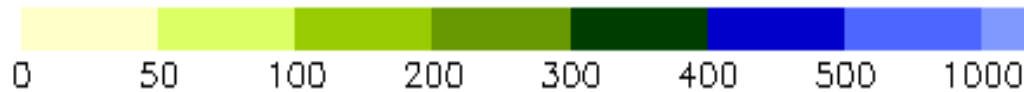
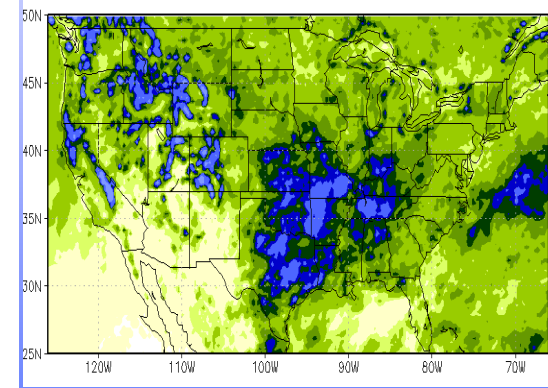
CMAP



NOAA GDAS



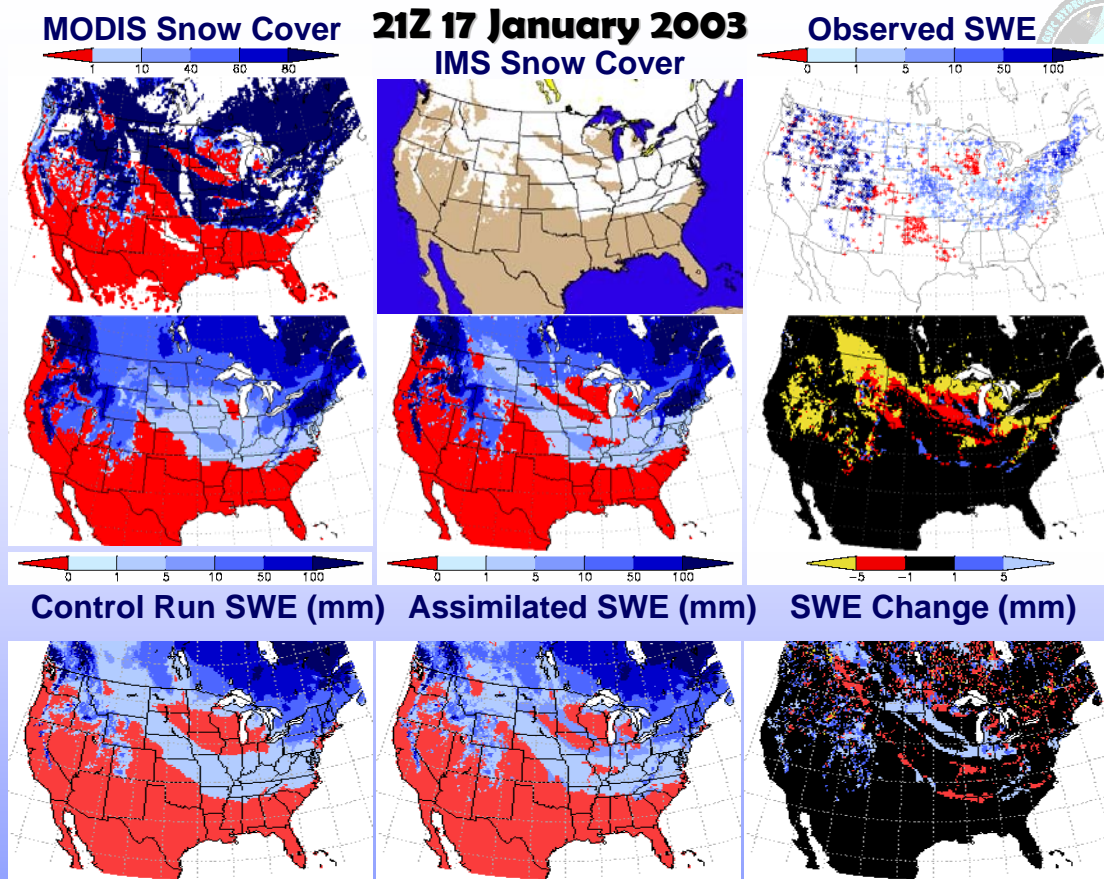
GSFC 3B42 Real-time



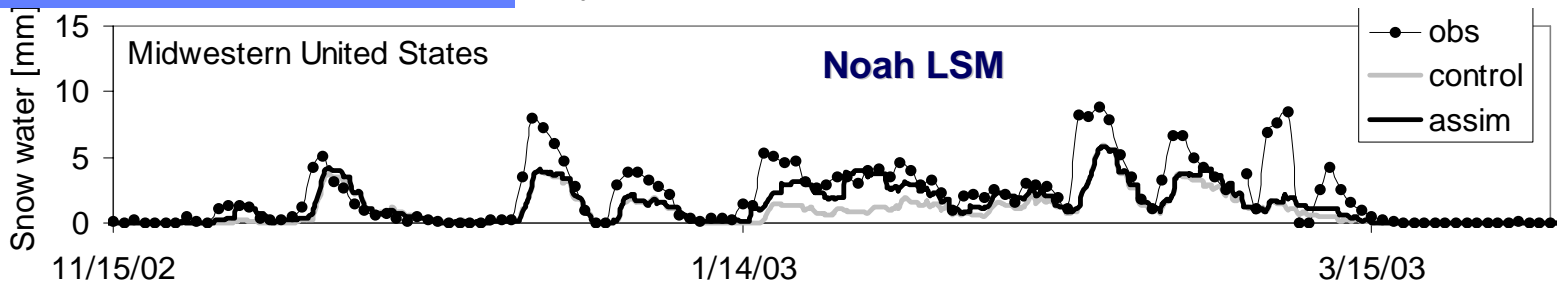
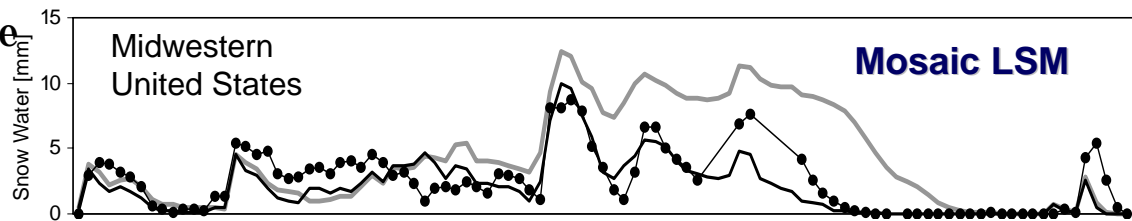
**Mar-Apr-May 2006 total precipitation (mm) from five global products used to force GLDAS, compared with the Higgins gauge based product.**

# GLDAS/LIS MODIS Snow Cover Assimilation Output

- MODIS snow cover assimilation technique of Rodell and Houser (2004) installed in LIS/Noah
- 2001-present, global, 1/4° GLDAS/Noah assimilation output is publicly available
- Assimilated output from Mosaic and Noah are better than control in both cases, though biases remain
- Assimilated output is continuous and contains more information (SWE) than MODIS (snow cover) alone



Observations  
Mosaic LSM  
Noah LSM



Rodell and Kato, CEOP Newsletter, 2006.

Matt Rodell  
NASA GSFC



# Incorporation of Satellite Derived Irrigation Data into GLDAS/LIS

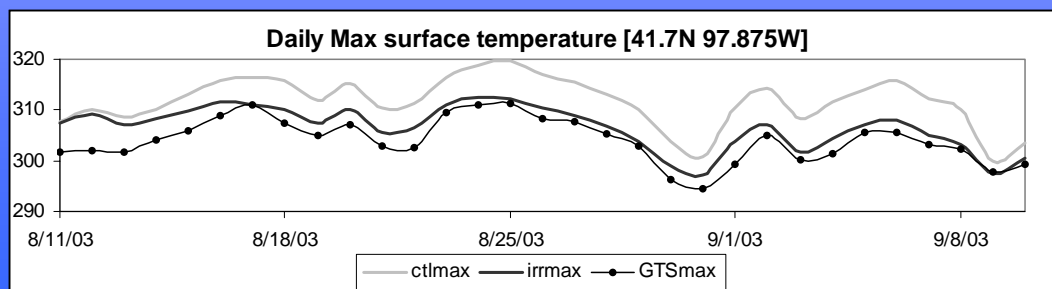
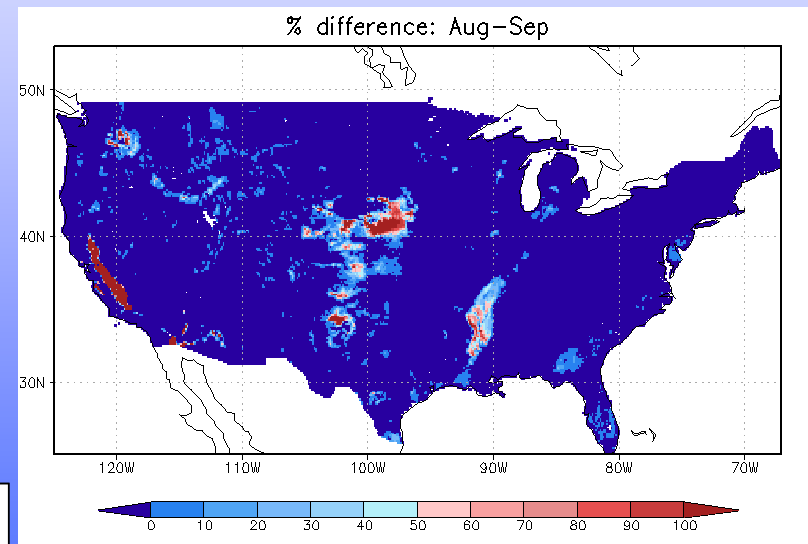
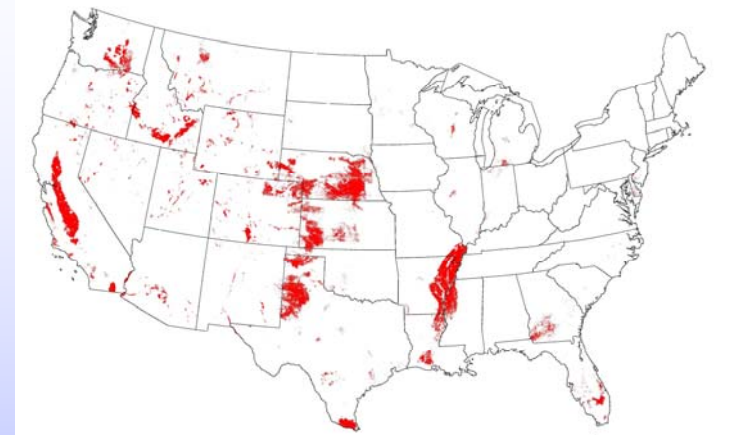


- Extent and intensity of irrigation derived from MODIS satellite observations
- Using a rule based approach with crop type data, irrigation is applied within the Noah land surface model, driven by GLDAS/LIS
- Preliminary results demonstrate that irrigation significantly effects modeled states and fluxes, including soil moisture, surface temperature, and evapotranspiration

Top right: MODIS derived intensity of irrigation

Right: Percentage difference in evapotranspiration between irrigation and control runs, August-September 2003

Below: Time series of daily maximum surface temperature (K) at an irrigated location from control run (gray line), irrigation run (black line), and observations (dots)



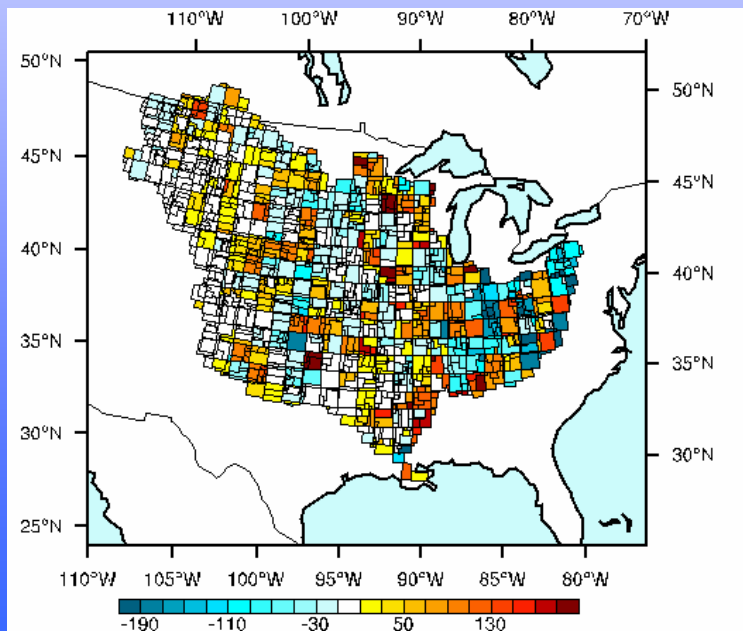
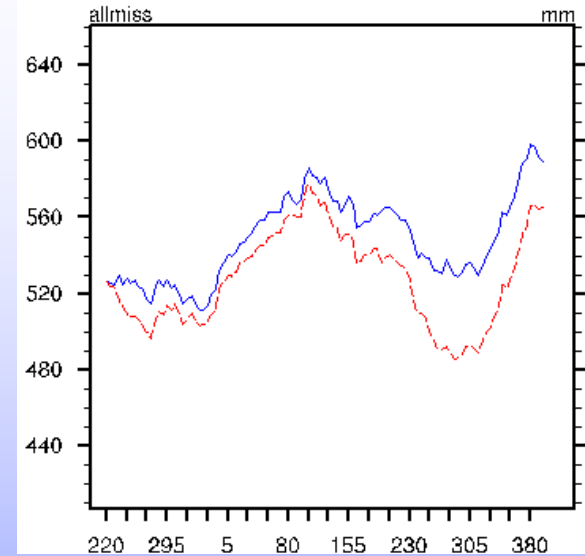
*Ozdogan, Rodell, and Kato,  
in preparation.*



# Assimilation of GRACE Derived Terrestrial Water Storage Variations



- Land surface model is tool for disaggregation of 10-day, basin scale (160,000 – 1,000,000 km<sup>2</sup>), GRACE derived terrestrial water storage variations into high resolution fields of groundwater, soil moisture, and snow water storage
- Ensemble Kalman filter used to estimate model errors and distribute basin scale innovations among catchments
- Preliminary results suggest that the model's response is both reasonable and significant



Left: Difference (column integrated water, mm) between assimilation and control runs of Catchment LSM, November 2003

Above: Daily time series of column integrated water (mm) averaged over the Mississippi River basin, without (red) and with GRACE assimilation (blue), 7/5/2003 - 12/25/2004

*Zaitchik, Rodell, and Reichle, in preparation.*

Project supported by NASA's Terrestrial Hydrology Program

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## Summary



- GLDAS = Global Land Data Assimilation System
- Drives multiple land surface models globally at  $1/4^\circ$  resolution using Land Information System (LIS) software
- Massive archive of land surface and met datasets
- Integrates data from multiple sources as through optimal merging, forcing, parameterization, assimilation, and validation
- Output available to CEOP and international community
- Recent thrusts include assimilation of MODIS snow cover and GRACE water storage data; simulating irrigation; sensitivity studies; precipitation forcing evaluation
- More info: Rodell et al., *BAMS*, 2004; <http://ldas.gsfc.nasa.gov/>