Land Data Assimilation System Heritage

North American LDAS

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

Global LDAS

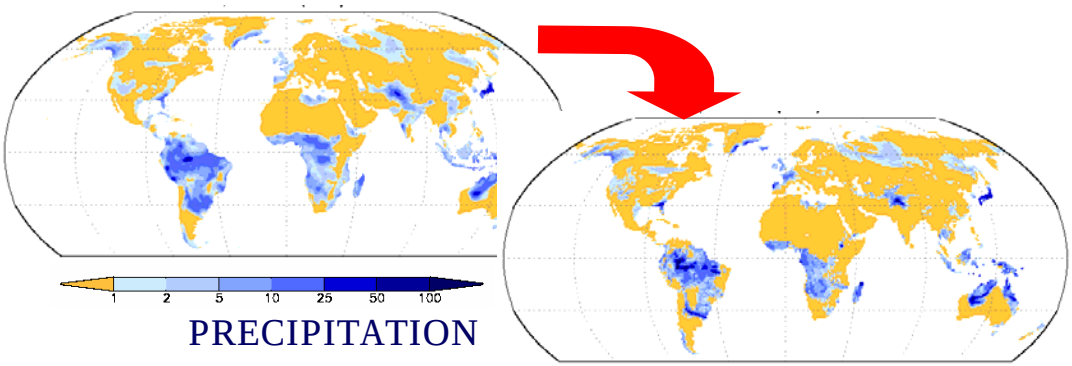
- NASA/IDS Project began in 2000; now supported by NASA/NEWS
- GSFC/HSB and NOAA/NCEP partnership
- Global domain (60°S-90°N), 1/4° and 1° resolutions
- Spin-offs: LIS, South American LDAS
- Ref: Rodell et al., *Bull. Amer. Meteor. Soc.,* 2004

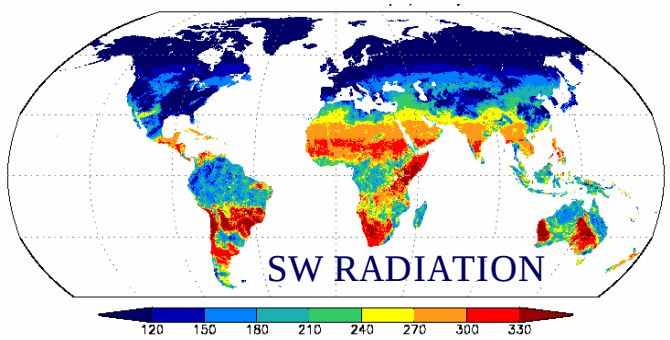
Land Information System (LIS)

- NASA/HPCC project began in 2002; multiple partners
- Global domain (60°S-90°N), resolutions as fine as 1 km
- Software adopted by all other NASA LDAS projects
- Ref: Kumar, Peters-Lidard, et al., *Environ. Model. Soft.,* 2005

Data Integration in GLDAS

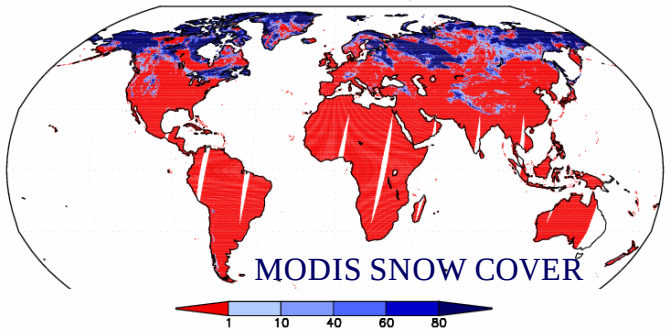
INTERCOMPARISON and OPTIMAL MERGING of global data fields

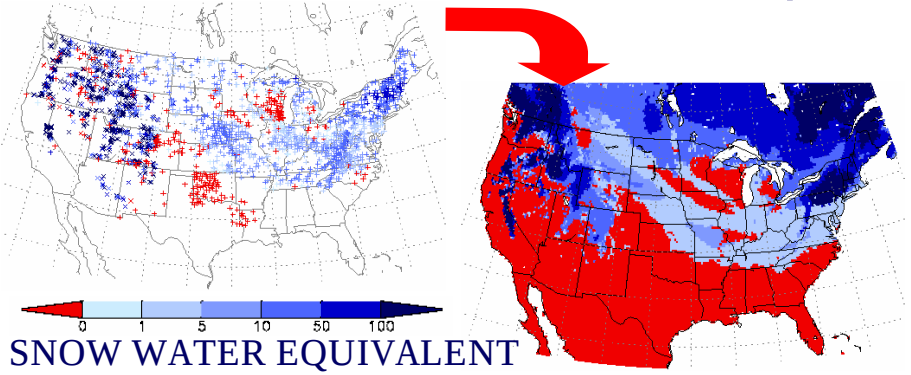




Satellite data products used to PARAMETERIZE and FORCE sophisticated land surface models

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





Ground-based observations used to EVALUATE model output

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Global Land Data Assimilation System

Parameters	U. Maryland and Boston U. vegetation – class/albedo/LAI, 1 km global GTOPO30 digital elevation model, 30" global Reynolds, Jackson, and Rawls [1999] soils, 5' global
Modeled Forcing	NOAA Global Data Assimilation System (GDAS), real time & forecast, ~0.7º NASA Goddard Earth Observing System (GEOS 3.24), near-real time, 1.0º g AFWA AGRMET surface analysis, near-real time, 48 km global ECMWF surface analysis, near-real time, T512
Observation-based fields to replace modeled forcing fields	SW & LW radiation derived from AFWA cloud analyses Precipitation derived from gage, satellite IR, TRMM & SSM/I microwave
Data for assimilation, calibration, and validation	Precipitation - GTS and merged products (e.g., CMAP) Surface temperature from several satellite platforms Soil moisture from AMSR, SMOS, and in-situ networks Snow depth/water from microwave Snow cover from satellite (e.g., MODIS), SNOTEL, GTS Total water storage changes from GRACE Streamflow from satellite altimeter, USGS

Land *Data Assimilation*

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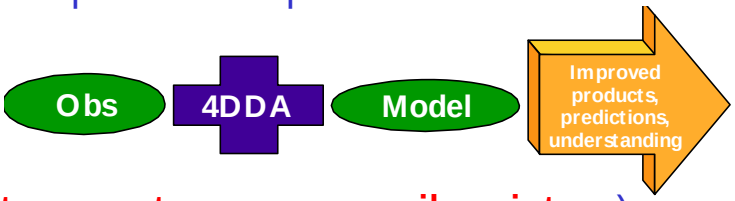
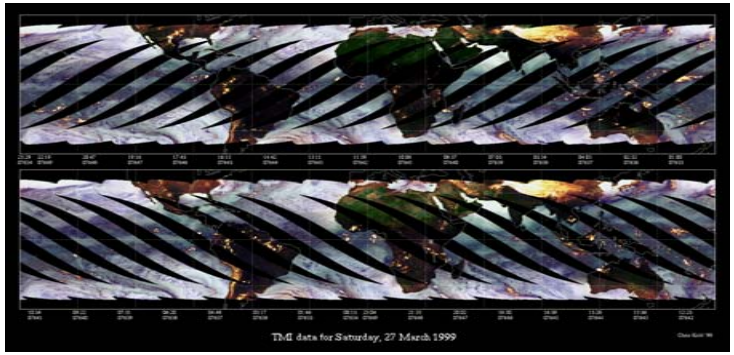
Data Assimilation merges observations & model predictions to provide a superior state estimate.

$$\partial x/\partial t = dynamics + physics + \Delta x$$

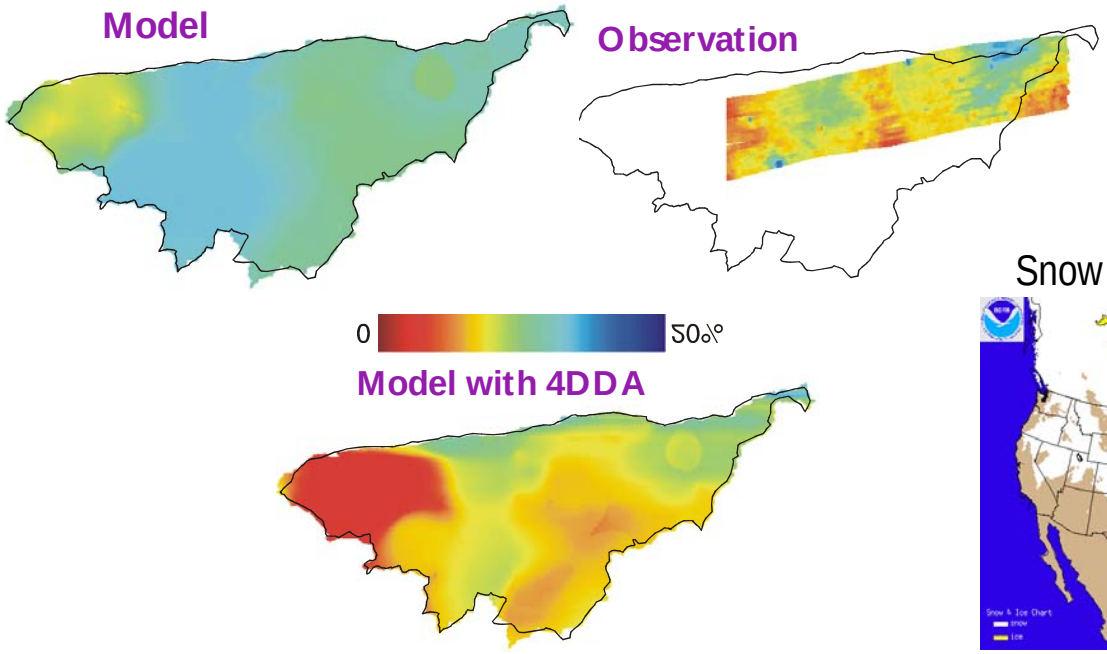


Remotely-sensed hydrologic **state** or storage observations (**temperature, snow, soil moisture**) are integrated into a hydrologic model to improve prediction, produce research-quality data sets, and to enhance understanding of complex hydrologic phenomenon.

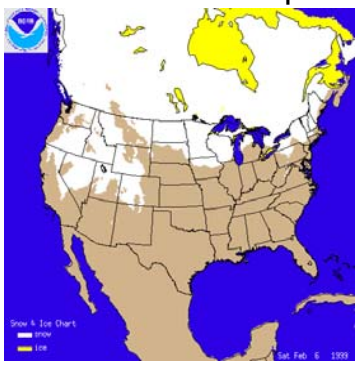
Soil Moisture



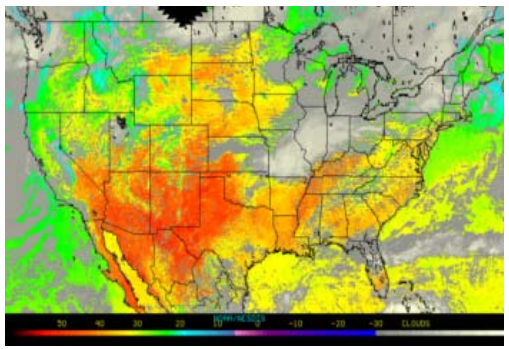
Data Assimilation Example



Snow Cover/Depth

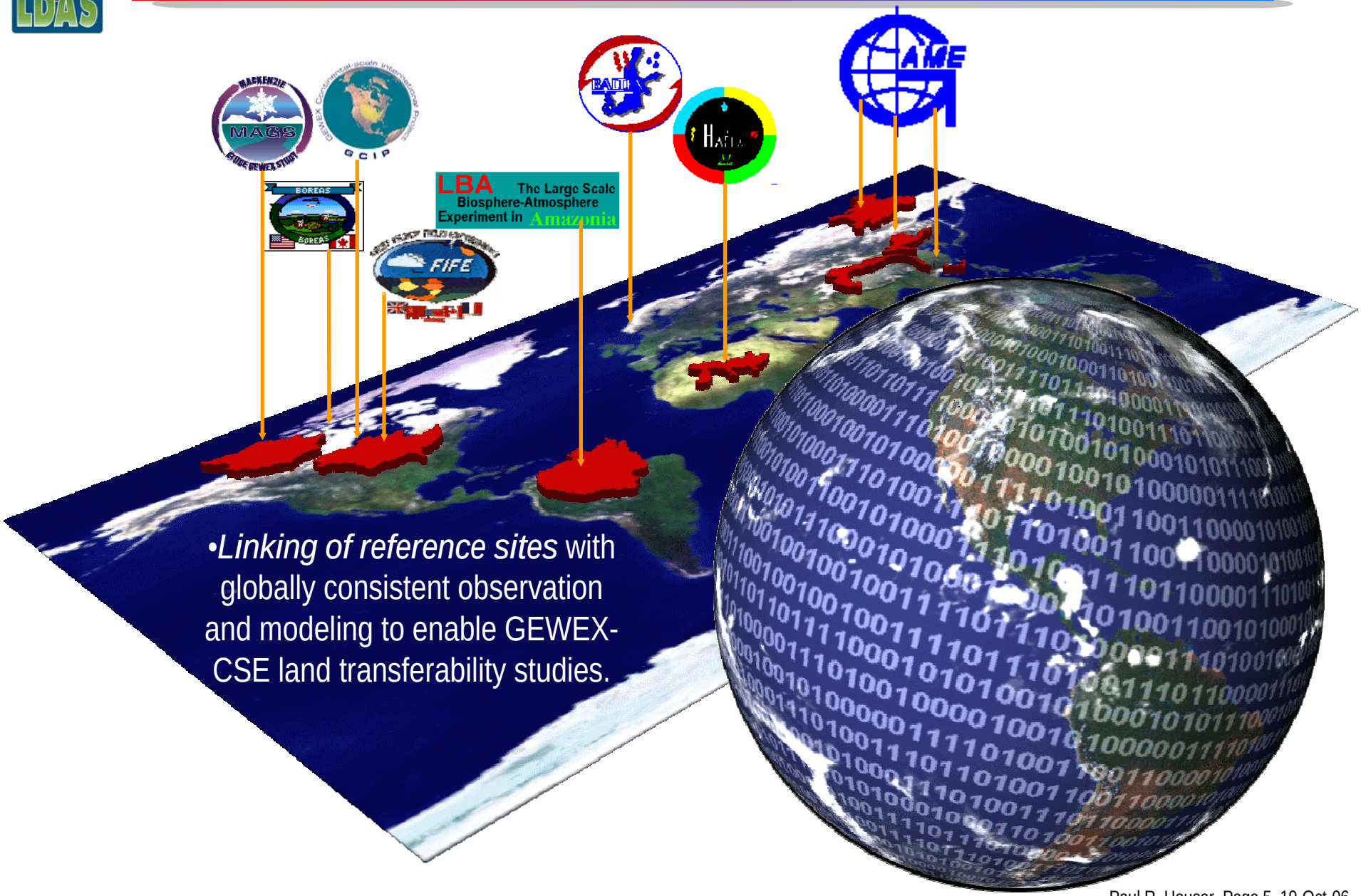


Skin Temperature



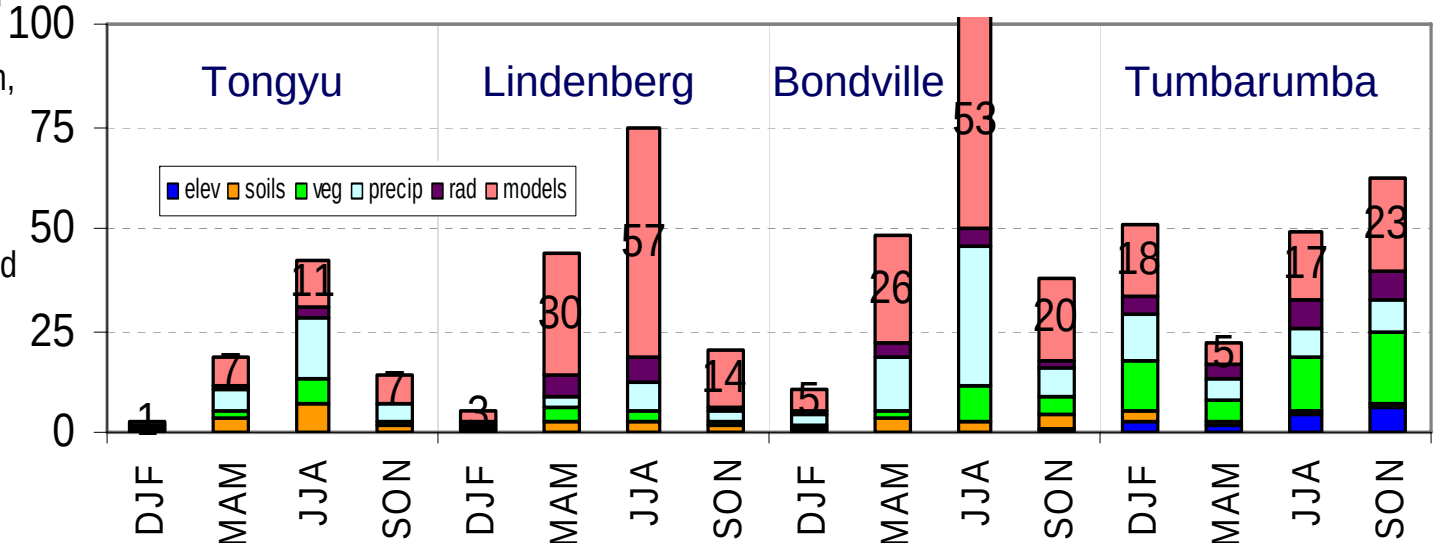
Skin temperature derived from NOAA/NESDIS GOES.

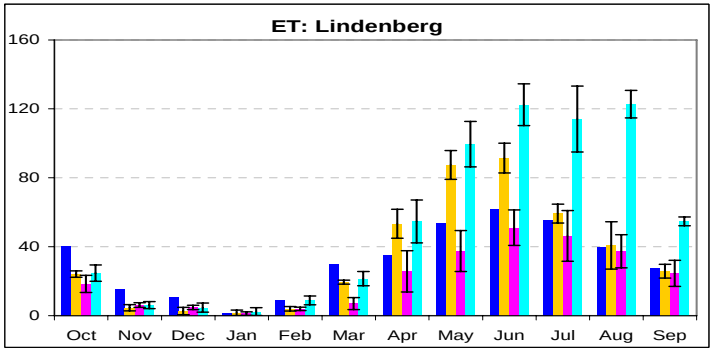
GLDAS-CEOP Synergy

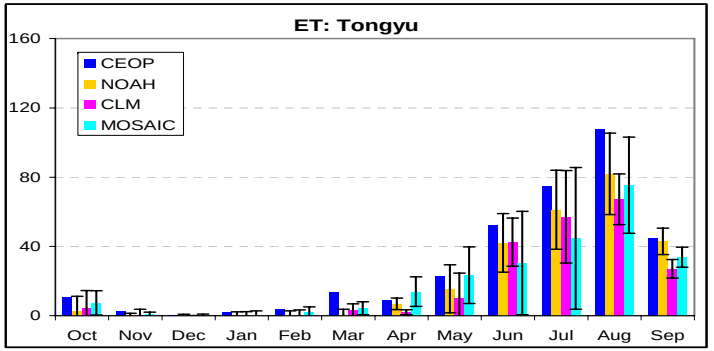


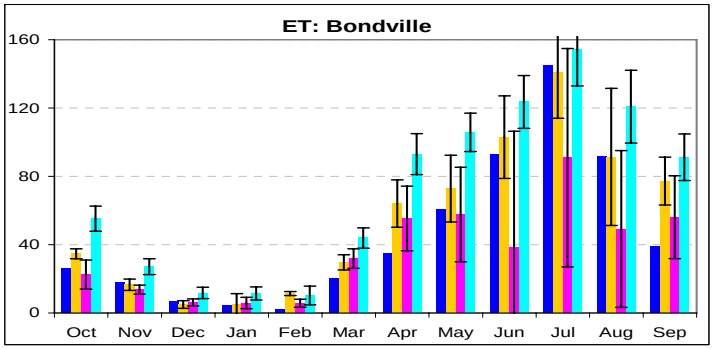
Sensitivity of GLDAS/LIS LSMs to Physics, Land Characteristics, and Forcing

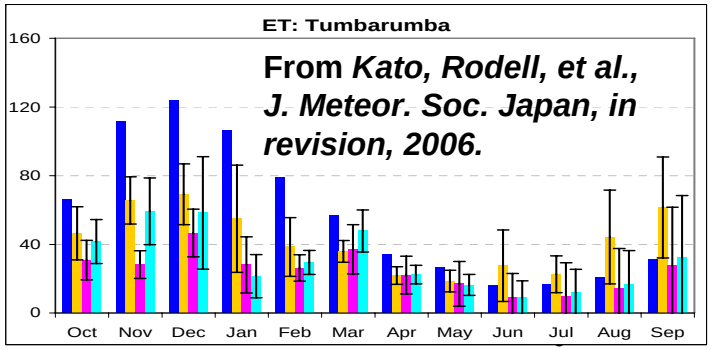
- Control simulations of LIS/Noah, CLM2, and Mosaic forced by CEOP site observations
- Best available global datasets used to test sensitivity of modeled states and fluxes to choice of LSM, precipitation and radiation forcing, elevation, soils, and vegetation
- Choice of LSM has largest impact
- In many cases, observed states and fluxes could not be reproduced no matter which inputs were chosen
- Results emphasize the importance of improving model physics and calibration











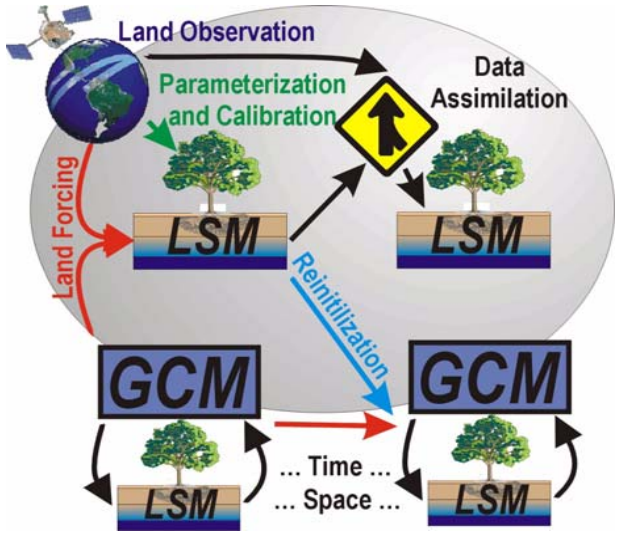
Top: Sensitivity of simulated seasonal ET (mm/month) to 6 runtime options

Below: Likely potential ranges of simulated monthly ET (mm/month) compared with CEOP observations

*L*and *D*ata *A*ssimilation *S*ystems: CEOP Synergy

CEOP and GLDAS have value-added synergy:

- Compile the land data (obs and analyses) including radiance, higher-level satellite, in-situ, and NWP/reanalysis land data.
- *Test and evaluate multiple land surface hydrologic models*
- *Long term* land model baseline experiments and intercomparisons
- *Linking of reference sites* with globally consistent observation and modeling to enable GEWEX-CSE land transferability studies.
- *Initialize land* surface states for seasonal-to-interannual coupled *predictions*.
- Use GLDAS to evaluate NWP and climate predictions for land.
- Integrate remote sensing land observations in land/atmospheric modeling for use in CEOP and higher level understanding.
- GLDAS may serve as a CEOP *data integration center*.
- Data assimilation and modeling may serve as a *quality control check* on observations.
- 4DDA "value-added" GLDAS-CEOP datasets
- GLDAS-MOLTS from multiple land surface models.
- Consistent GLDAS reanalysis for CEOP



"LDAS" concept:

Optimal integration of observation, simulation, and assimilation tools to *operationally* obtain high quality land surface conditions and fluxes continuous in time&space; multiple scales; retrospective, realtime, forecast

GLDAS views CEOP as an opportunity for increased community involvement and coordinated validation through data set development and continuity.