# The Use of Earth Observations in NLDAS for Drought Monitoring and Prediction

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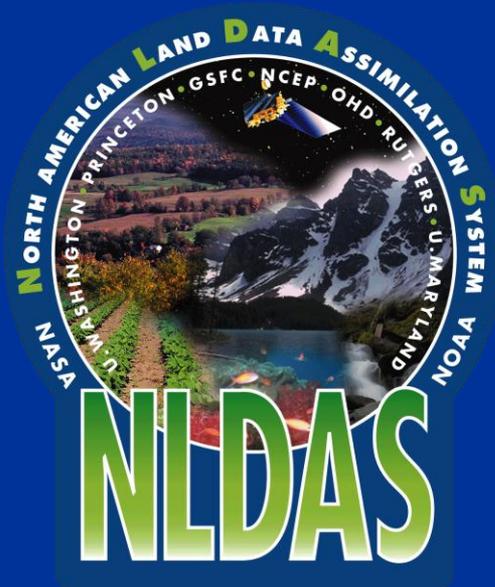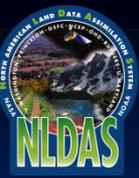
Outline and Attributions

- Use of Earth Observations in the generation of the hourly NLDAS Phase 2 forcing dataset

  - Brian Cosgrove, Charles Alonge, Youlong Xia, Michael Ek, Kenneth Mitchell, Kingtse Mo, Yun Fan, and the NLDAS team

- NLDAS dataset availability and services provided by the NASA Goddard Earth Sciences Data and Information Services Center (GES DISC)

  - Hualan Rui, Bill Teng, Guang-Dih Lei, Bruce Vollmer, David Toll, Joseph Nigro, Henry Fang, and David Mocko

  - Collaborations with AquaTerra and CUAHSI

- The future development of NLDAS including the use of Earth Observations in data assimilation

  - Christa Peters-Lidard, David Mocko, Sujay Kumar, Youlong Xia, Michael Ek, and Jiarui Dong

Earth Observations in NLDAS-2
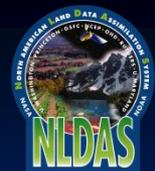
- Forcing is hourly, 1/8th degree, on the same grid as NLDAS Phase 1 data over CONUS and parts of Canada/Mexico (25-53N; 125-67W)
  - NARR model surface data used as base (3 hourly, 32km, Jan 1979 – Present)
  - NARR SWdown at surface is bias-corrected using GOES UMD SRB SW data
  - Hourly NLDAS precipitation based on CPC daily PRISM-corrected gauge data, hourly Stage II Doppler radar data, half-hourly CMORPH, hourly HPD data, and 3-hourly NARR model data (depending on location and data availability)
  - Elevation correction for temperature, pressure, humidity, and longwave
  - Includes 21 standard surface/2m/10m and lowest model layer forcing fields
- List of Earth Observations in the NLDAS-2 forcing along with coverage dates and temporal and spatial resolutions of the data:

Forcing	Coverage	Temporal Resolution	Spatial Resolution	Notes
NARR Model	1979-2003	3 Hourly	32km	
R-CDAS Model	2003-Present	3 Hourly	32km	Realtime version of NARR
GOES Radiation	1996-2000	Hourly	1/8th degree	Used to bias correct NARR
CPC PRISM Gauge	1979-Present	Daily	1/8th degree	Used over CONUS, Mexico
CPC Gauge	1979-Present	Hourly	2 X 2.5 degree	Used over CONUS
CMORPH Precip	2002-Present	1/2 Hourly	8km	Used over CONUS, Mexico
Stage II Precip	1996-Present	Hourly	4km	Used over CONUS

NARR sample plots over NLDAS
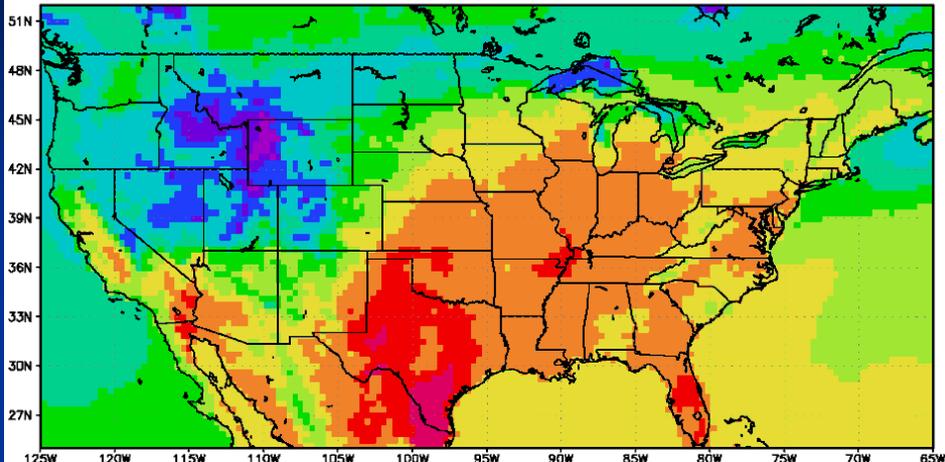
SW bias-correction using GOES SRB

NARR Instantaneous SW Radiation (W/m2), 18Z 6/13/01
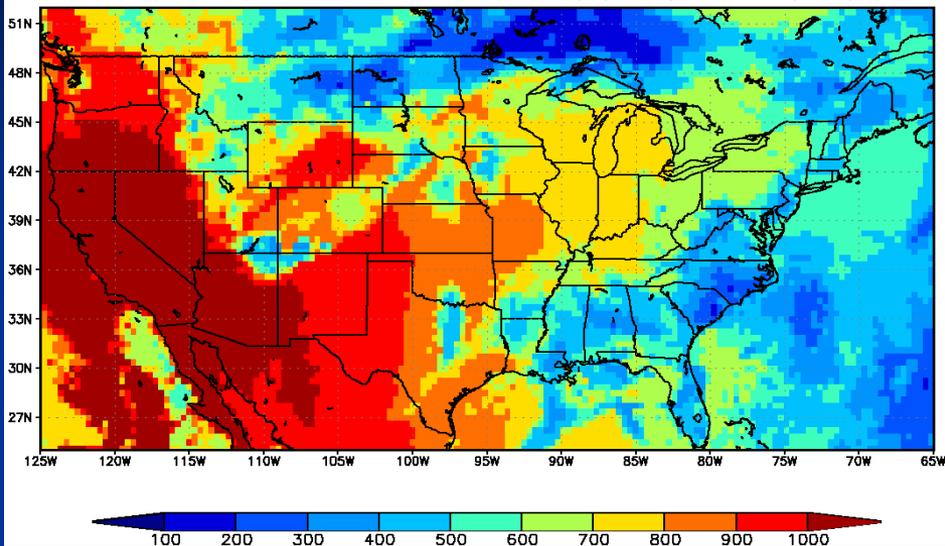
GOES Hourly SW Radiation (W/m2), 18Z 6/13/01
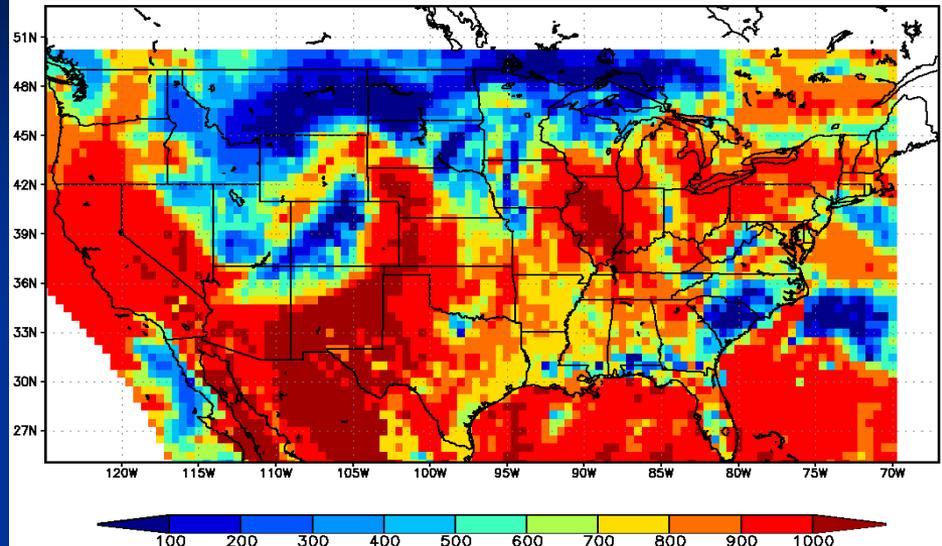
Apply the ratio-based correction:

$$S \downarrow NLDAS_i = \frac{S \downarrow (GOES)}{S \downarrow (NARR)} \times S \downarrow NARR_i$$

$S \downarrow (GOES)$ and $S \downarrow (NARR)$ are the monthly mean downward shortwave radiation from the UMD SRB and NARR data sets respectively (W m^{-2}) at hour i

$S \downarrow NARR_i$ is the instantaneous downward shortwave radiation at hour i from NARR (W m^{-2}) and $S \downarrow NLDAS_i$ is the resulting bias corrected field in the NLDAS forcing.

Monthly-mean GOES UMD SRB datasets (Pinker et al., 2003) are used to bias-correct the NARR SW radiation. A ratio-based correction (Berg et al., 2003) was applied using monthly means for the common 5-year period of 1996-2000.
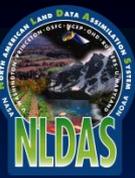
Generation of NLDAS-2 precipitation

NARR 3–Hourly Precipitation ending 18Z 6/13/01
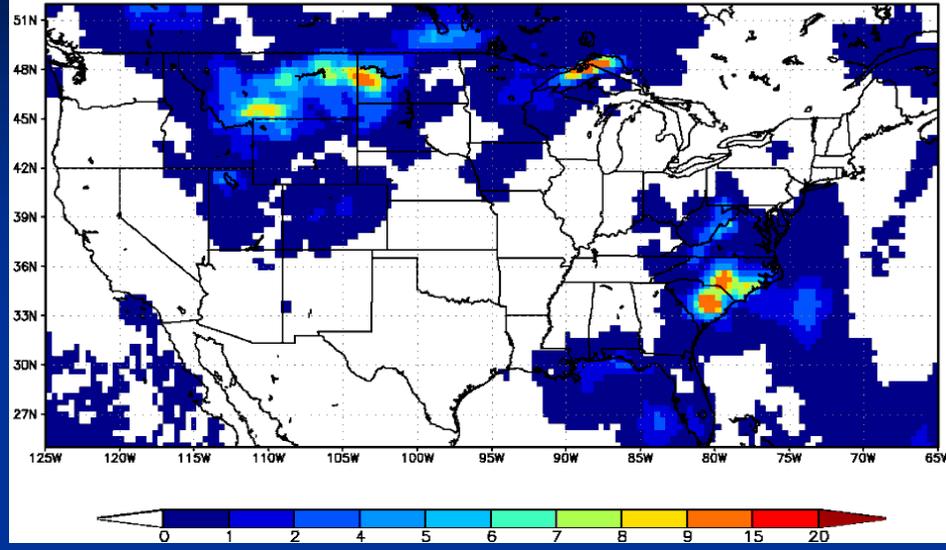
PRISM Daily Precipitation (mm), 6/14/01
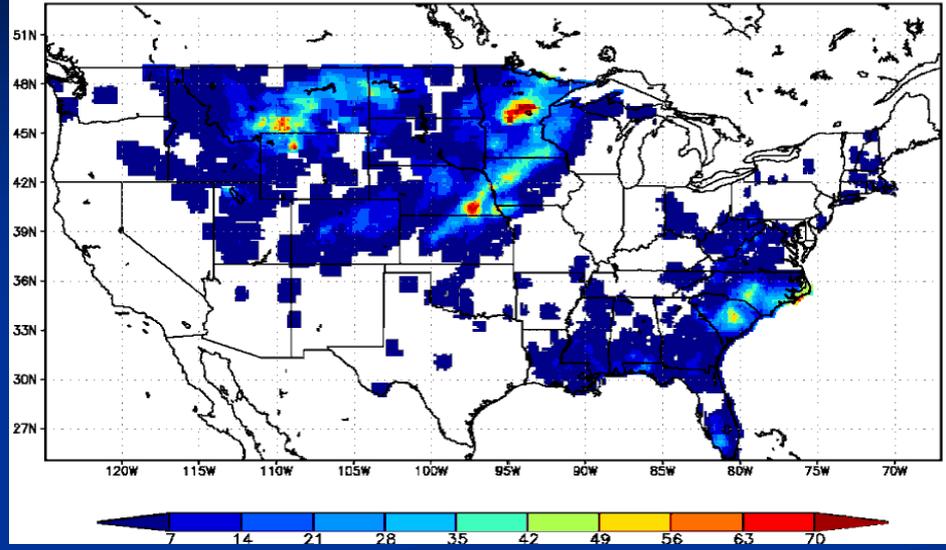
HPD Hourly Precipitation (mm), 18Z 6/13/01
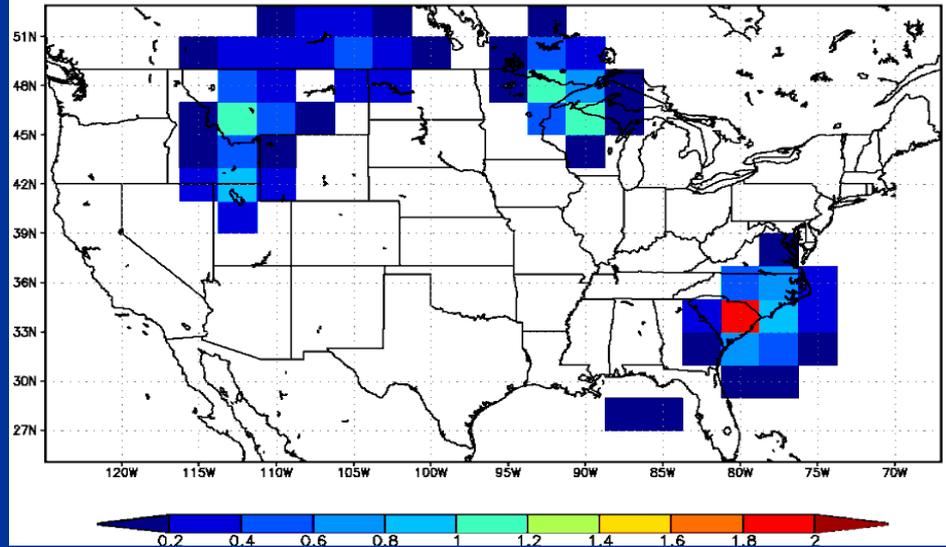
Over CONUS, CPC PRISM-adjusted daily gauge analyses are temporally disaggregated to hourly, primarily using Stage II Doppler radar data. If the radar data is unavailable, the following datasets are used instead, in order of availability: CMORPH analyses, CPC HPD hourly analysis, and then NARR model-simulated precipitation. Different data/methods used over Canada/Mexico.
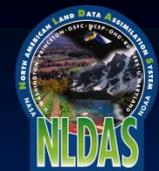
Generation of NLDAS-2 precipitation

Dataset	Years	CONUS	Mexico	Canada
CPC daily gauge analysis	1979 – present	**1/8th-degree PRISM-adjusted analysis**	**1/4th-degree (before 2001, 1-degree) analysis**	Not used
Stage II Doppler hourly 4-km radar data	1996 – present	**1st choice** to temporally disaggregate	Not used	Not used
CMORPH satellite-retrieved half-hourly 8-km analysis	2002 – present	**2nd choice** to temporally disaggregate	**1st choice** to temporally disaggregate	Not used
CPC HPD 2x2.5-degree hourly analysis	1979 – present	**3rd choice** to temporally disaggregate	**2nd choice** to temporally disaggregate	Not used
NARR/R-CDAS 3-hourly 32km model-simulated precipitation	1979 – present	**4th choice** to temporally disaggregate	**3rd choice** to temporally disaggregate	**Used for all precip over Canada areas; a 1-degree blend near U.S.-Canada border is done.**

NLDAS-2 precipitation diurnal cycle
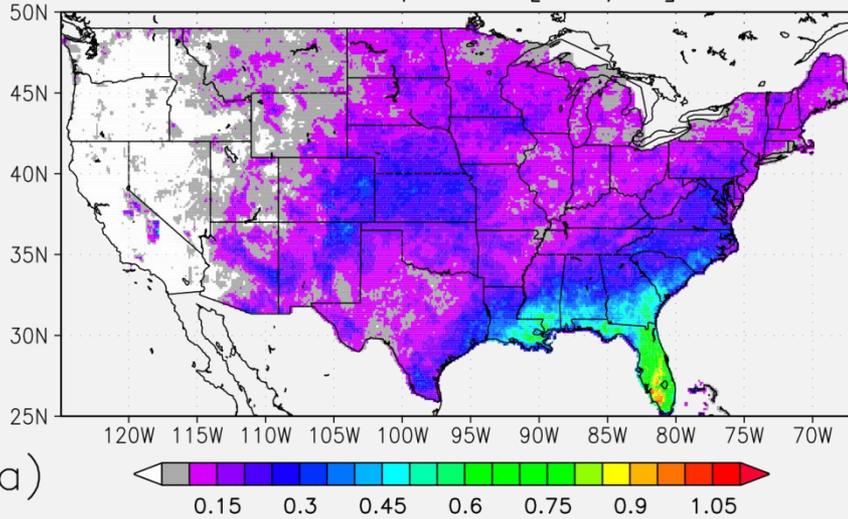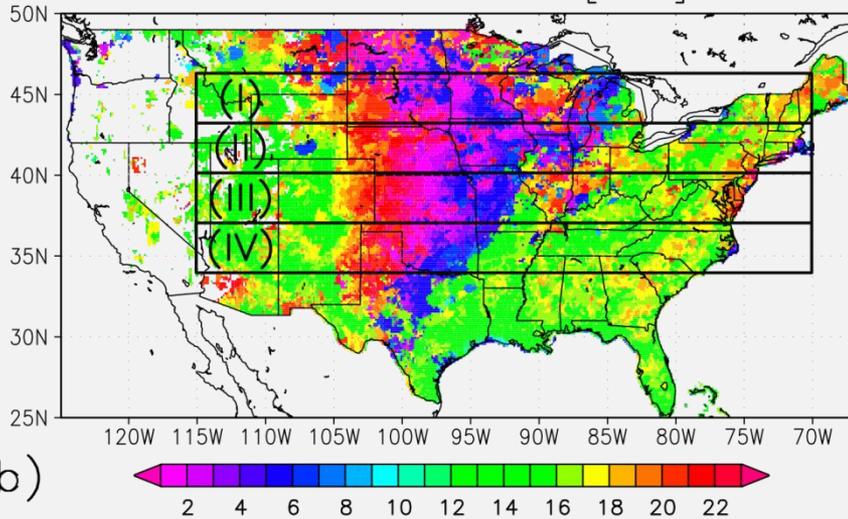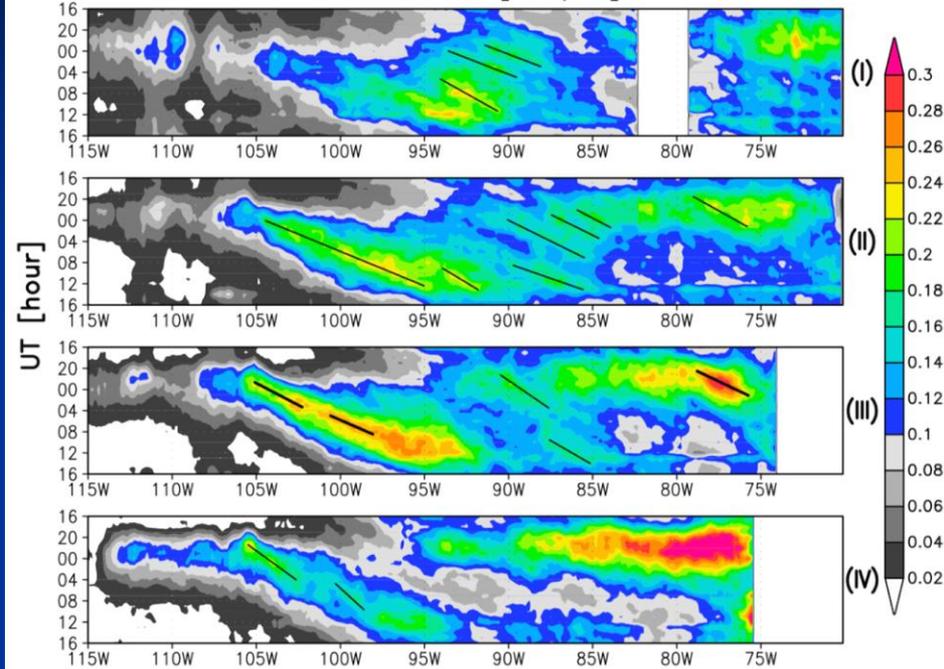
Matsui et al. (2010) examined the diurnal cycle of summertime precipitation in NLDAS over CONUS. Zonal phase speeds of the precipitation were estimated and compared to background zonal wind speeds from the MERRA reanalysis.

NLDAS data/services at the GES DISC

- ## Hydrology DISC (HDISC)
  http://disc.gsfc.nasa.gov/hydrology/
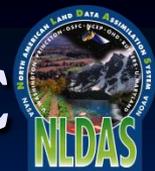
- ## GrADS Data Server (GDS)
  http://hydro1.sci.gsfc.nasa.gov/dods/

32+ years of hourly NLDAS datasets available at the NASA Goddard Earth Sciences Data and Information Services Center (GES DISC)

| Data Type (Short Name)	Description	FTP	GDS	Mirador Navigation	Mirador Search
NLDAS-1, 0.125 degree, North America					
NLDAS_FOA0125_H.001	Hourly forcing	✔	✔	✔	✔
NLDAS-2, 0.125 degree, North America					
NLDAS_FORA0125_H.002	Hourly primary forcing	✔	✔	✔	✔
NLDAS_FORB0125_H.002	Hourly secondary forcing	✔	✔	✔	✔
NLDAS_MOS0125_H.002	Hourly Mosaic	✔	✔	✔	✔
GLDAS-2, 1.0 degree. Global					
GLDAS_NOAH10_3H_E1.002	3 hourly Noah experiment 1	✔	✔	✔	✔
GLDAS_NOAH10_M_E1.002	Monthly Noah experiment 1	✔	✔	✔	✔
GLDAS-1, 0.25 degree, Global					
GLDAS_NOAH025SUBP_3H	3 hourly Noah	✔	✔	✔	✔
GLDAS_NOAH025_M	Monthly Noah	✔	✔	✔	✔
GLDAS-1, 1.0 degree, Global					
GLDAS_CLM10SUBP_3H	3 hourly CLM	✔	✔	✔	✔
GLDAS_CLM10_M	Monthly CLM	✔	✔	✔	✔
GLDAS_MOS10SUBP_3H	3 hourly Mosaic	✔	✔	✔	✔
GLDAS_MOS10_M	Monthly Mosaic	✔	✔	✔	✔
GLDAS_NOAH10SUBP_3H	3 hourly Noah	✔	✔	✔	✔
GLDAS_NOAH10_M	Monthly Noah	✔	✔	✔	✔
GLDAS_VIC10_3H	3 hourly VIC	✔	✔	✔	✔
GLDAS_VIC10_M	Monthly VIC	✔	✔	✔	✔

GES DISC GrADS Data Server - NLDAS products - directory for / - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://hydro1.sci.gsfc.nasa.gov/dods/

GES DISC GrADS Data S...

GES DISC GrADS Data Server - NLDAS products - top level

GES DISC GrADS Data Server - NLDAS products - directory for / : 4 entries

1: NLDAS_FORA0125_H.002: 0.125 Degree Hourly Primary Forcing Data for NLDAS-2   info dds das

2: NLDAS_FORB0125_H.002: 0.125 Degree Hourly Secondary Forcing Data for NLDAS-2   info dds das

3: NLDAS_MOS0125_H.002: 0.125 Degree Hourly Data from the NLDAS-2 Mosaic Model   info dds das

back to parent directory

GrADS Data Server 2.0 (help using this server) . This page last updated 06Z 23 Nov 2009.

Data is available via 3 methods: Mirador searching and downloading, anonymous ftp, and a GDS. Currently, NLDAS-2 forcing and Mosaic model output, and NLDAS-1 forcing datasets are available.

NLDAS-2 precip used in EPA BASINS
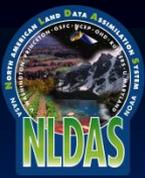
- The **B**etter **A**ssessment **S**cience **I**ntegrating Point & **N**onpoint **S**ources (BASINS) environmental analysis system, created by the EPA, now can use NLDAS-2 hourly precipitation from the GES DISC, via the GDS

- Nigro et al. (2010) showed "dramatic" improvements in water quality model performance when using NLDAS-2 precipitation in BASINS


Left: Screen capture of the BASINS v4.0 interface, showing the availability of NLDAS data. Above: 32-year time series of NLDAS-2 precipitation, generated by BASINS.

LDAS datasets to be added to CUAHSI
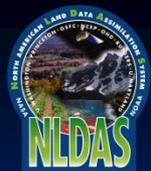
- The GES DISC is working to integrate NLDAS & GLDAS data into the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) Hydrologic Information System (HIS)


NASA Hydrologic Data Access from HydroDesktop (an example)[1]

[1]Courtesy NASA Goddard Earth Sciences Data and Information Services Center and Hydrological Sciences Branch
[2]NLDAS (North American Land Data Assimilation System) is a collaboration among NOAA, NASA, Princeton Univ., Univ. of Washington, and others.
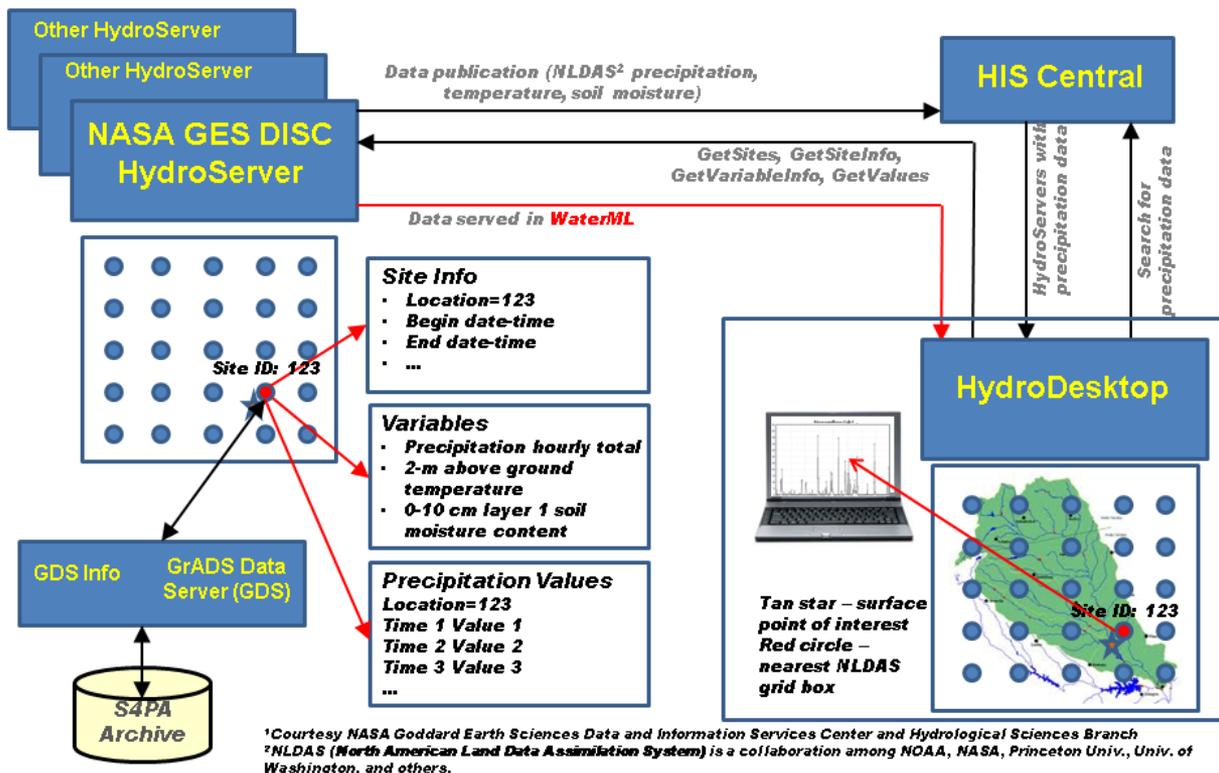
A Web Service to provide the data as a time series along with corresponding metadata in WaterML are in development; this figure shows a schematic of the data access using the CUAHSI HIS client HydroDesktop; the data can be searched, retrieved, and analyzed along with hydrogical data from other sources available via HIS.

The Land Information System (LIS)

- LIS is a flexible land-surface modeling and data assimilation framework developed with the goal of integrating satellite- and ground-based observational data products with land-surface models

- LIS can generate improved estimates of land-surface conditions such as soil moisture, evaporation, runoff, snow pack, and surface fluxes
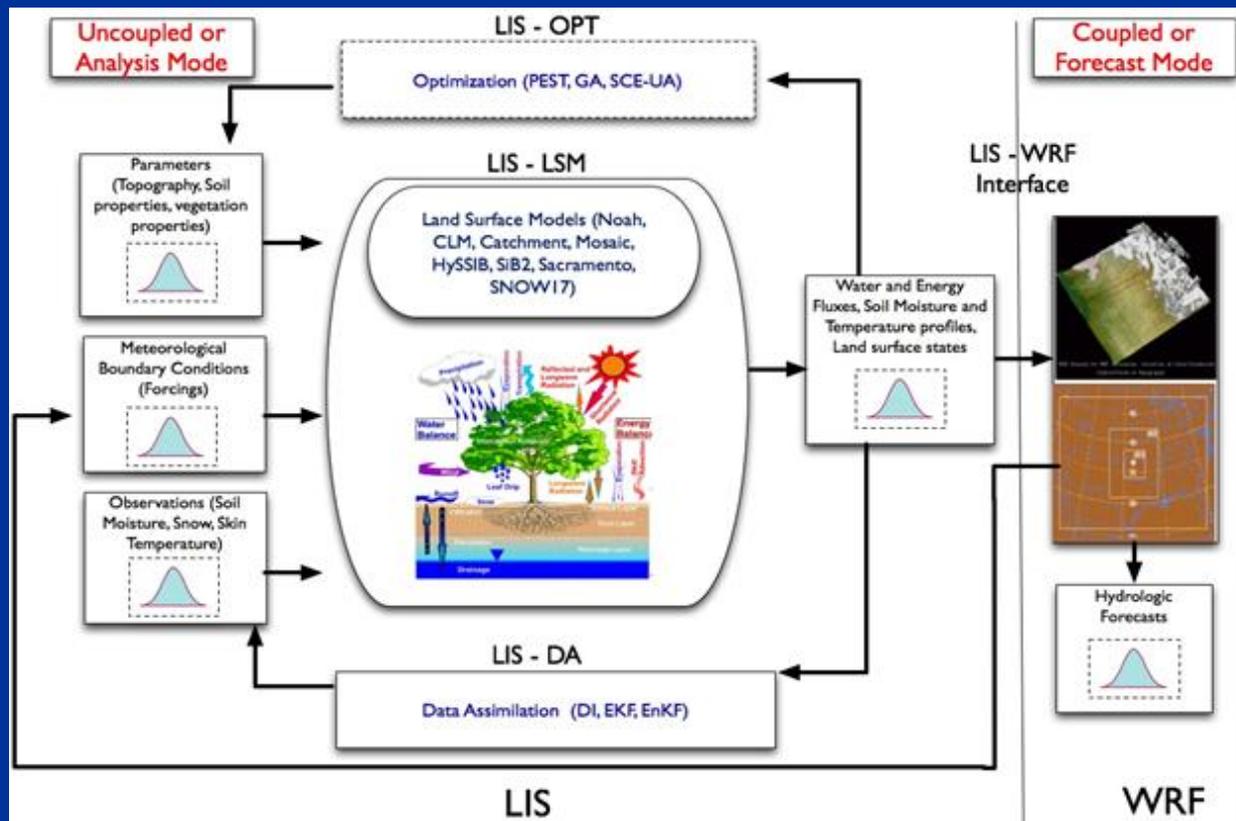
LIS can use many different LSMs, forcings, parameter datasets, observations, and includes modules for data assimilation and parameter optimization techniques.
In addition to being run in an offline/uncoupled mode forced by surface datasets, LIS is also coupled to the WRF forecast model
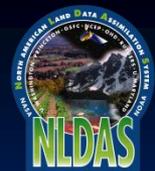
LSM and Data Assimilation in LIS

- NLDAS land-surface models (LSMs) will be benchmarked in LIS and upgraded to latest versions (Noah3.2/3.3, GMAO's Catchment, etc.)

- The LIS framework will allow data assimilation of soil moisture and snow products to help improve drought diagnosis using NLDAS

- List of parameters, resolution, and satellite sensors of data to be used:

Parameters	Spatial Resolution	Satellite Sensors
Snow covered area (SCA)	500m	Terra/Aqua MODIS
Snow water equivalent	25-km	Aqua AMSR-E
SCA & SWE	25-km	ANSA
Soil moisture	25-km	Aqua AMSR-E

- Early results of snow simulation from new LSMs and assimilation:
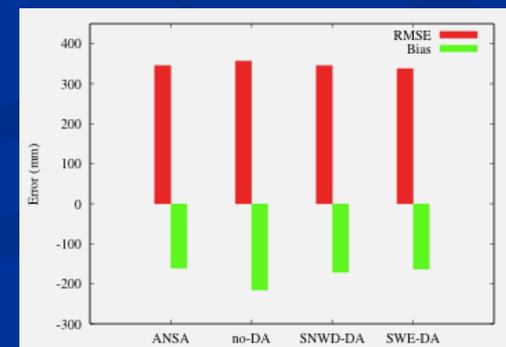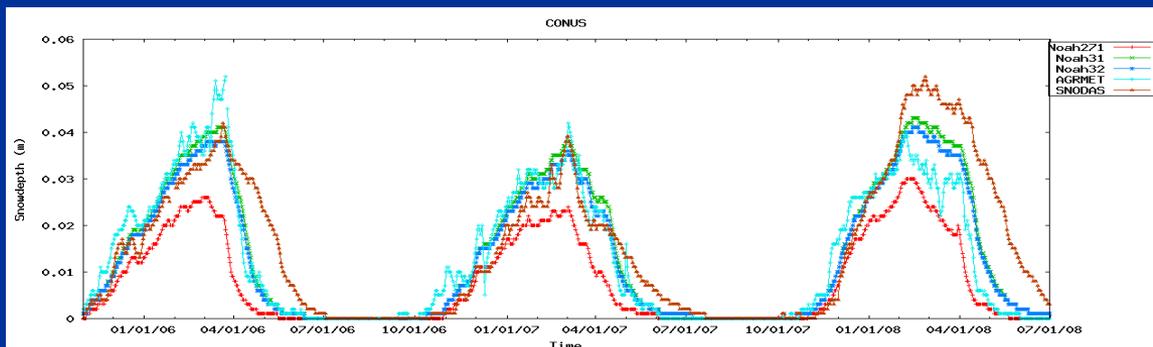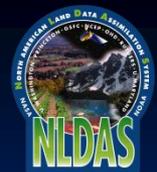
Earth Observations in NLDAS

- Numerous observations (too many to list) used in the generation of the NARR/R-CDAS reanalysis used as backbone of NLDAS forcing
- Precipitation gauge analyses, Stage II Doppler radar, CMORPH
- GOES UMD SRB shortwave radiation data for bias-correction
- Land mask/cover datasets from AVHRR and MODIS (UMD, IGBP)
- Albedo, greenness, and LAI/SAI from AVHRR (soon, MODIS)
- STATSGO (over CONUS) and FAO (outside CONUS) soil info
- GTOPO-30 ~1-km elevation dataset
- LSM-specific observations used as parameter values and evaluation
- Planned: SWE, SCA, and soil moisture from MODIS/AMSR-E
- Planned: GRACE-based terrestrial water storage; MODIS irrigation
- Planned: Transition from NARR to CFSR; CPC daily surface temp
- Future: Soil moisture from SMAP
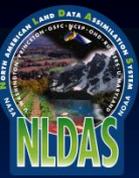
Summary

- NLDAS is a successful collaboration project that's produced over 32 years of hourly 1/8th-degree surface forcing and land-surface model output over CONUS and parts of Canada/Mexico

- NLDAS integrates many different Earth Observations in the creation of the surface forcing as well as in the LSMs to produce model output of soil moisture, evaporation, snow pack, runoff, and surface fluxes

- The NASA GES DISC provides many NLDAS datasets/services; NLDAS precipitation available in EPA BASINS & NLDAS/GLDAS datasets being added to CUAHSI HIS

- The next-generation of NLDAS will include upgraded LSMs as well as data assimilation of soil moisture and snow products towards improved diagnosis of drought and initial conditions for forecasts

NLDAS & LIS websites

- NLDAS at NASA:
  http://ldas.gsfc.nasa.gov/nldas/
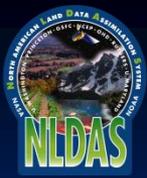
- NLDAS datasets at the NASA GES DISC:
  http://disc.gsfc.nasa.gov/hydrology/

- NLDAS at NOAA/NCEP/EMC:
  http://www.emc.ncep.noaa.gov/mmb/nldas/

- LIS website at NASA:
  http://lis.gsfc.nasa.gov/