Development and Application of Land Data Assimilation Systems (LDAS) in NCEP Operations

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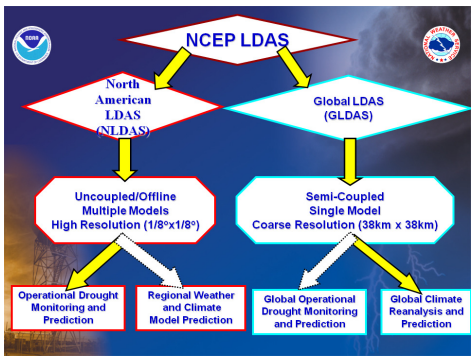
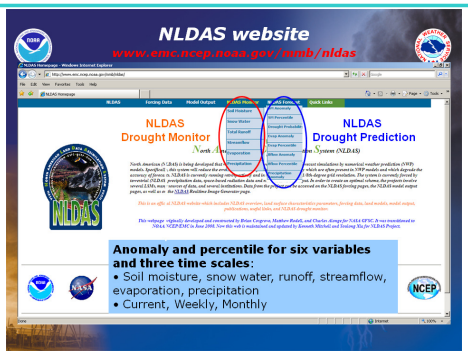
ABSTRACT

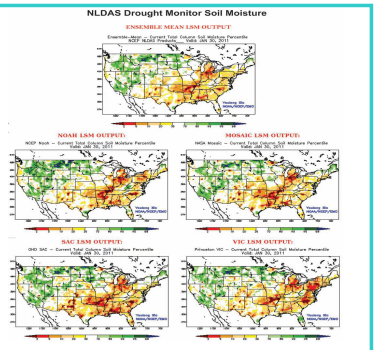
The NCEP/EMC LDAS team has collaborated with its partners in developing two LDAS systems: the North American Land Data Assimilation System (NLDAS, www.emc.ncep.noaa.gov/mmb/nldas) and the Global Land Data Assimilation System (GLDAS). The purpose of NLDAS is to provide initial states to regional numerical models to enhance regional weather and climate prediction skills and to support the U.S. National Integrated Drought Information System (NIDIS) such as U.S. drought monitor (drought.gov), the NCEP monthly drought briefing (www.cpc.noaa.gov/products/Drought), and NCEP seasonal drought outlook (www.cpc.noaa.gov/products/expert_assessment /seasonal_drought.html). NLDAS, an uncoupled system, uses the NCEP North American Regional Reanalysis (NARR) and observed gauge precipitation as surface forcing to drive four land surface models, including the NCEP Noah land surface model, to produce a 29-year (1979-2007) retrospective and more than 3-year (2008-present) real-time hydrometeorological products to support the NIDIS and other users. We suggest development directions of the next generation NLDAS at NCEP. The purpose of GLDAS is to provide optimal initial states to the NCEP Climate Forecast System (CFS) to improve global climate simulation and prediction and generate new hydrometeorological reanalysis products to support users. GLDAS, a semi-coupled system, uses the NCEP CFS global reanalysis products and hybrid precipitation (i.e., gauge, satellite, model) as surface forcing to run the NCEP Noah land surface model in the operational CFS. GLDAS is included as a part of the recent CFS reanalysis (1979-present, cfs.ncep.noaa.gov/cfsr).



Left Figure shows NCEP LDAS flow chart, which includes North-American LDAS and Global LDAS. The yellow arrow indicates that the task has been and/or is being done, and the white arrow indicates that the task will be done in future.



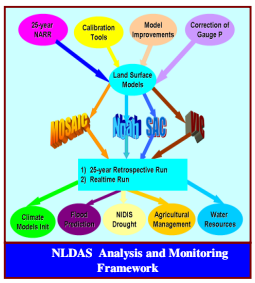
Middle Figure shows NLDAS website, which includes NLDAS drought monitor and NLDAS drought prediction. An example for NLDAS drought monitor is shown in the right. NLDAS development and application is detailed in Ek et al. (2011).



Ek et al., 2011, North American Land Data Assimilation System Phase 2 (NLDAS-2): Development and Applications, *GEWEX NEWS*, 21, 6-7.

1. North American Land Data Assimilation System (NLDAS)

1a. NLDAS Configuration

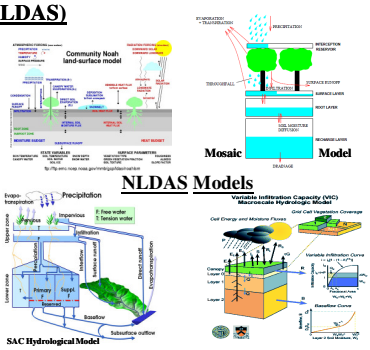


NLDAS Design

NLDAS Drought Monitoring and Prediction Configuration

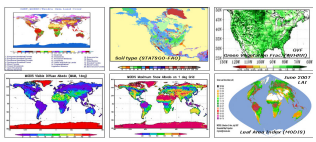
N. American Land Data Assimilation System

- Uncoupled land model simulations
  - four land models: Noah, VIC, Mosaic, SAC
- CONUS domain
  - 1/8th degree resolution (daily gauge precipitation)
- Common land surface forcing
  - hourly and 1/8th degree
  - Jan 1979 to present realtime
- Retrospective mode
  - 30-year: 1979-2008
  - 15-year spin-up
  - 28-year climatology for each land model (1979-2007)



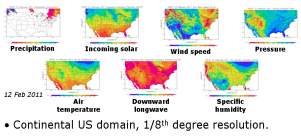
1b. NLDAS Datasets and Setup

NLDAS Configuration: Land data sets



- fixed climatologies or near real-time obs.
- Some quantities may be assimilated (e.g. soil moisture, snow).

NLDAS Configuration: Forcing data



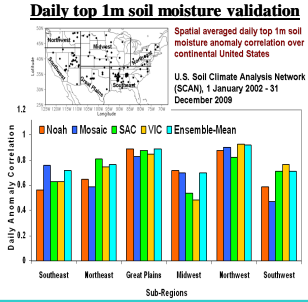
- Continental US domain, 1/8th degree resolution.
- Common land surface forcing from North American Regional Reanalysis real-time extension (gauge-based observed precipitation, temporally disaggregated with radar/sat. data).
- hourly, 1/8-deg, Jan 1979 to present, near real-time.

NLDAS Configuration: Simulations

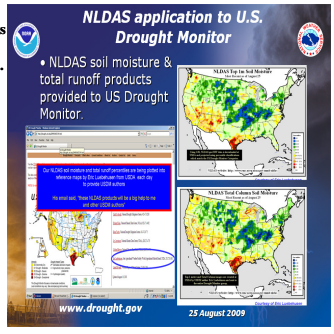
- Retrospective mode (*to provide climatologies*)
  - 30-year runs: Oct 1979-Sep 2008
  - 15-year spin-up
  - 30-year climatology for each land model (1979-2008)
- Near real-time mode (*quasi-operational*)
  - depict conditions as anomalies and percentiles from climatology

1c. NLDAS Validation and Application

Daily top 1m soil moisture validation



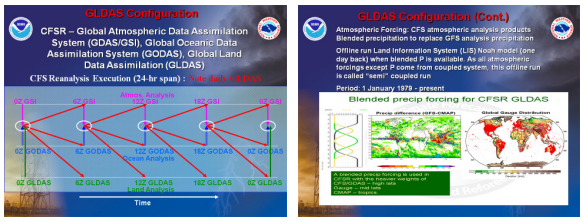
Daily anomaly correlation (AC) shows that AC is depended on models and regions. However, overall performance displays ensemble-mean is more reliable approach for all regions as its AC is either highest or second highest when compared with individual model. NLDAS soil moisture products capture variation of observed soil moisture quite well.



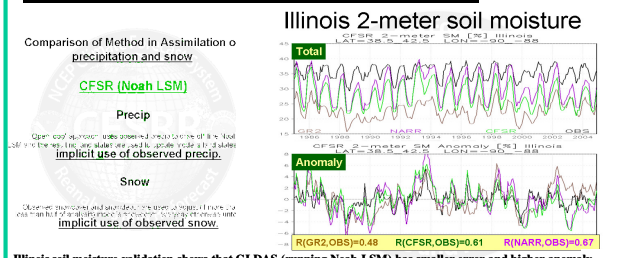
directly used in U.S. operational drought and prediction such as U.S. drought monitor (left), Climate Prediction Center (CPC) monthly drought briefing and seasonal drought outlook. These products also support the other public users from different institutions.

2. Global Land Data Assimilation System (GLDAS)

2a. GLDAS Configuration

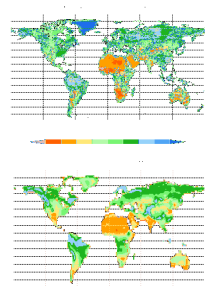


2b. GLDAS Assimilation Method and Validation

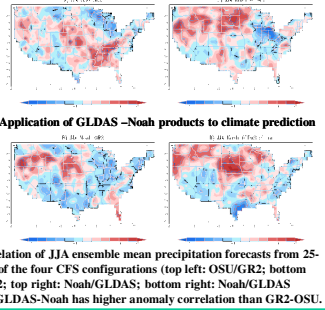


Illinois soil moisture validation shows that GLDAS (running Noah LSM) has smaller error and higher anomaly correlation than previous NCEP reanalysis GR2 (running OSU LSM). GLDAS soil moisture is comparable with NARR soil moisture.

2c. GLDAS Analysis and Application



Left Figure shows a comparison between May GLDAS-Noah and GR2-OSU soil moisture during the period 1980 and 2008. The results display significant differences in some regions such as Australia, south Africa etc.



Application of GLDAS –Noah products to climate prediction

Anomaly correlation of JJA ensemble mean precipitation forecasts from 25-yr reforecasts of the four CFS configurations (top left: OSU/GR2; bottom left: Noah/GR2; top right: Noah/GLDAS; bottom right: Noah/GLDAS climatology). GLDAS-Noah has higher anomaly correlation than GR2-OSU.

3. Summary and Future Work

NLDAS will be implemented in NCEP operation in 2012. NLDAS runs in quasi-operational mode at NCEP Environmental Modeling Center to support National Integrated Drought Information System (NIDIS, drought.gov) activities and U.S. operational drought monitor and prediction task. NLDAS will be expanded to whole North American domain to support North American Drought Monitor and to fine scale resolution (~4km), to support National Weather Service hydrological research and operational monitoring and prediction. NLDAS will be coupled with Land Information System to assimilate observed soil moisture, snowpack and streamflow. GLDAS has been implemented in NCEP operation since January 2011. GLDAS will be expanded to multiple models to support global drought monitor activity.