

# NCA-LDAS: An Integrated Terrestrial Water Analysis System for the National Climate Assessment

## “Evaluation and Dissemination”



### NCA-LDAS TEAM

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Collaborators: James Foster, Dorothy Hall, George Riggs

**NASA NCA Center Call  
and Indicators Team Meeting  
NASA Hq, Washington DC  
April 8-9 2014**

# NCA-LDAS Science

## **Hypothesis:**

Assimilating satellite SM, SWE, SCA, TWS and irrigation products into an NCA-LDAS will improve i) characterization of continental scale water budgets, and ii) monitoring of climate change indicators relevant water availability, including droughts and floods.

## **Specific Science Questions:**

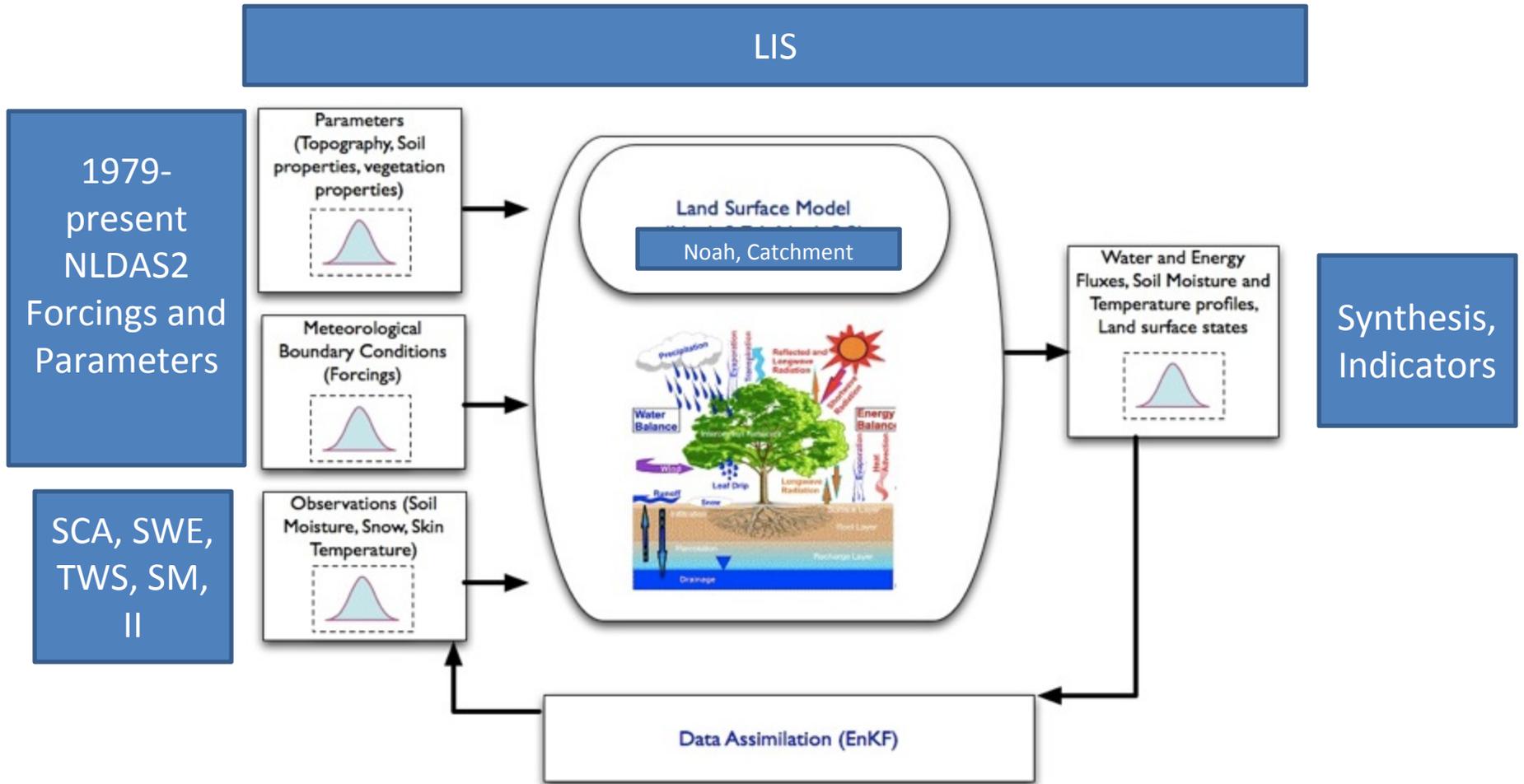
- i) How have North American water storages and fluxes evolved during the satellite era, e.g. 1979-present?
- ii) Have relationships among hydrologic fluxes and states changed?
  - Precipitation-Snowpack-runoff?
  - Groundwater-SM- ET-drought anomalies?
- iii) How well do NCA-LDAS indicators represent U.S. climate change?

# Specific NCA-LDAS Objectives in 2014

## “Evaluation and Dissemination”

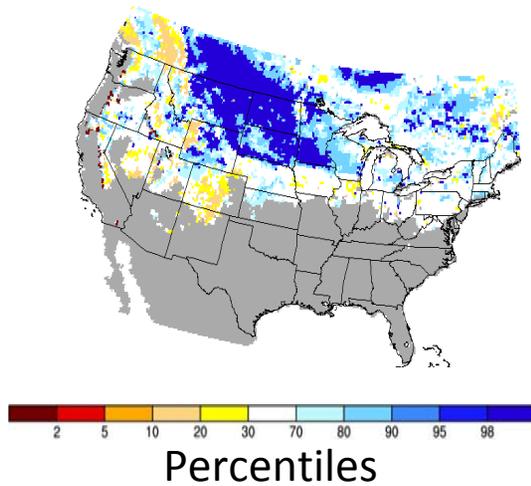
1. Set up LDAS/LIS models at 1/8<sup>th</sup> degree resolution for the continental United States, with and without (open loop) data assimilation.
2. Archive all forcing and validation data, including meteorology, soils, land cover, and satellite imagery on NCCS where NCA-LDAS is currently run.
3. Expand NCA-LDAS to include multi-data assimilation, focusing on *Catchment* and *Noah LSMs*, for satellite era period 1979-present.
4. Extend the Land Verification Toolkit (LVT) for evaluating time series water budget components from the NCA-LDAS output.
5. Evaluate uncertainty of LDAS indicators at NCA regional and basin scales.
6. Provide NCA-LDAS components and results to science community thru GES-DISC.

# NCA-LDAS Schematic

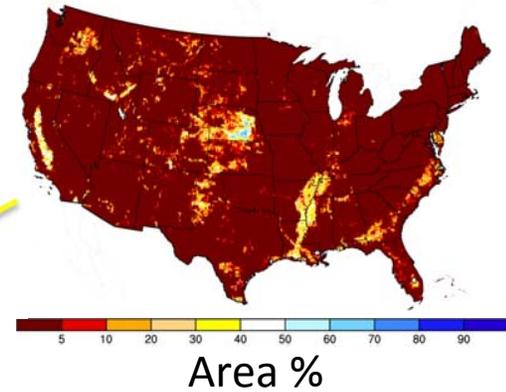
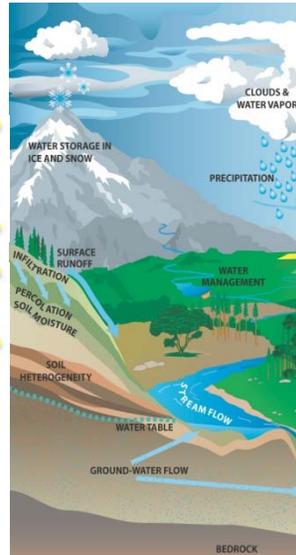


LDAS (Land Data Assimilation System), SCA (Snow Covered Area), SWE (Snow Water Equivalent), TWS (Terrestrial Water Storage), SM (Soil Moisture), II (Irrigation Intensity)

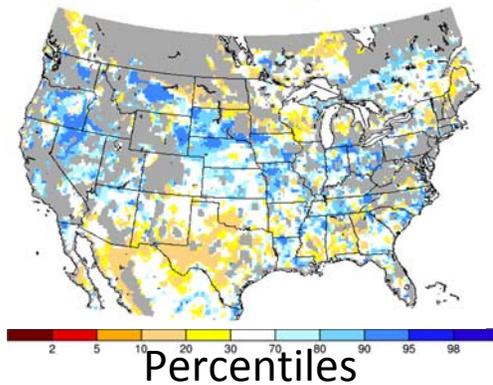
# NCA-LDAS EDRs



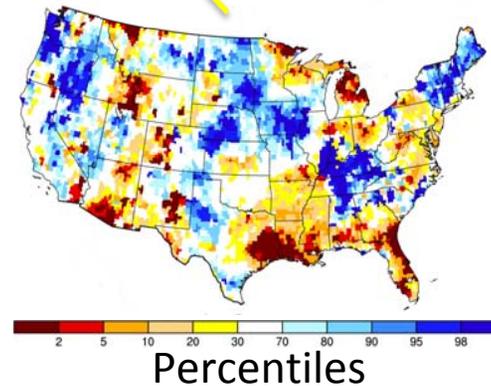
**Figure 1:** March 2011 Snow Water Equivalent (SWE) Mean Percentile from LPRM v5 – NASA Aqua/AMSR-E EDR (2003-2011).



**Figure 2:** Irrigation Intensity (% Area) from MODIS circa 2001 (Ozdogan and Gutman 2008)



**Figure 3:** March 2011 Surface Soil Moisture Percentile from LPRM v5 – NASA Aqua/AMSR-E Aqua EDR (2003-2011)



**Figure 4:** March 2011 GRACE-based Groundwater Percentile from GRACE TWS EDR (2002-present).

# Status of NCA-LDAS Models

## Complete as of 4/2014

- Open Loop Noah (1979 – 2012)
- Open Loop CLSM (1979 – 2012)
- Snow DA Noah (SMMR (1979-1987), SSM/I (1987-2002) , AMSR-E (2002-2011))
- SM DA Noah (ECV (1979-2002), LPRM AMSR-E (2002-2011))
- Irrigation DA Noah (2000 – 2012)

## Ongoing (being tested)

- SM DA CLSM (ECV (1979-2002), LPRM AMSR-E (2002-2011), ASCAT (2007-2012))
- Snow DA CLSM(SMMR (1979-1987), SSM/I (1987-2002) , AMSR-E (2002-2011))
- Irrigation DA CLSM (2000 – 2012)
- TWS DA CLSM (GRACE; 2003-2012)
- Snow cover (IMS (1997-2012) and MODIS (2000-2012))
- Multi-Data DA (snow depth from SMMR, SSM/I, AMSR-E; soil moisture from ECV, AMSR-E and ASCAT; snow cover from IMS, MODIS; terrestrial water storage from GRACE; Irrigation intensity from MODIS)

# Land surface Verification Toolkit (LVT)



Metric Class	Examples
Accuracy metrics	RMSE, Bias, Correlation, Mann-Kendall
Ensemble metrics	Mean, Standard deviation, Likelihood,
Uncertainty metrics	Uncertainty importance
Information theory metrics	Entropy, Complexity
Data assimilation metrics	Mean, variance, lag correlations of innovation distributions
Decision theory metrics	Cost/Loss metrics
Scale decomposition metrics	Discrete wavelet transforms

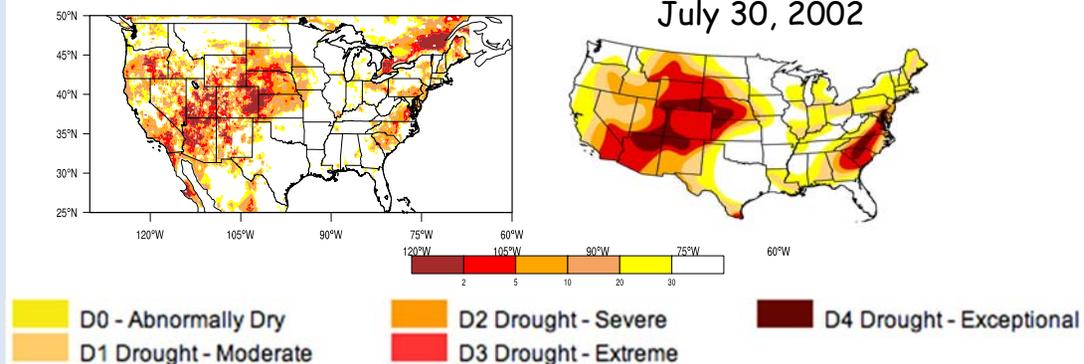
Used for evaluation of NCA model, DA outputs against independent datasets, using a variety of metrics.

LVT includes several features for time series analysis, including the development of normalized indices that are typically used in applications such as droughts (e.g. root zone soil moisture percentiles, standardization).

Root zone soil moisture based drought percentiles generated by LVT from a LIS simulation

U.S. Drought monitor estimate

July 30, 2002

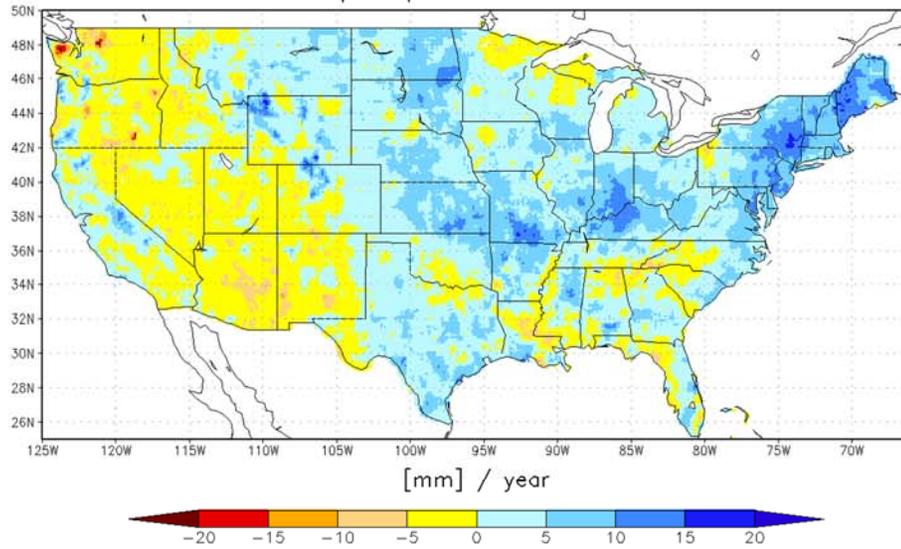


# **Preliminary Evaluation of NCA-LDAS**

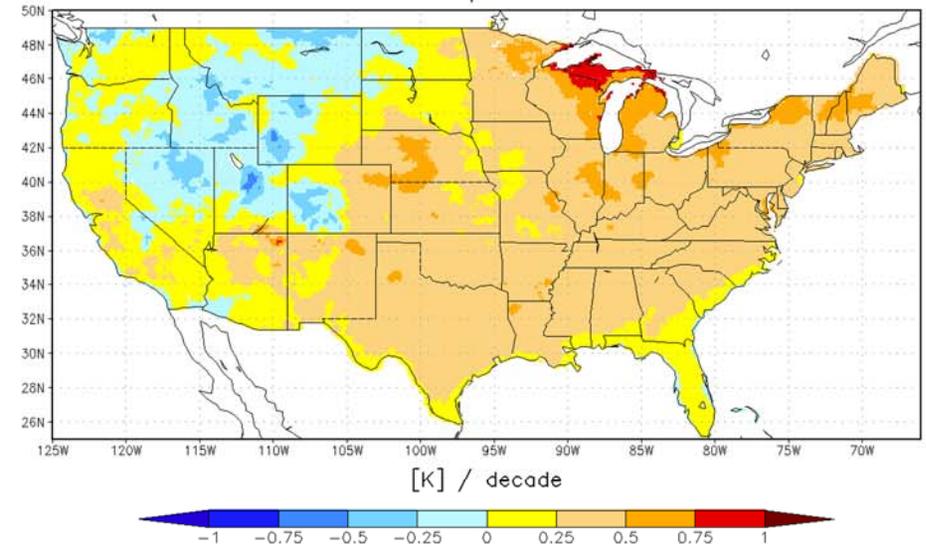
# NCA-LDAS surface forcing from NLDAS-2

David Mocko

NCA-LDAS precipitation trend 1979–2012

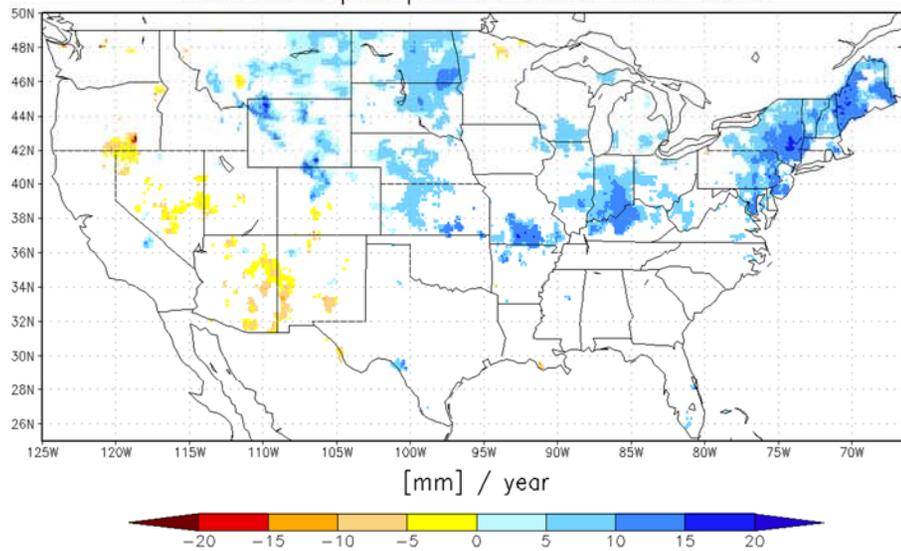


NCA-LDAS 2-m air temperature trend 1979–2012

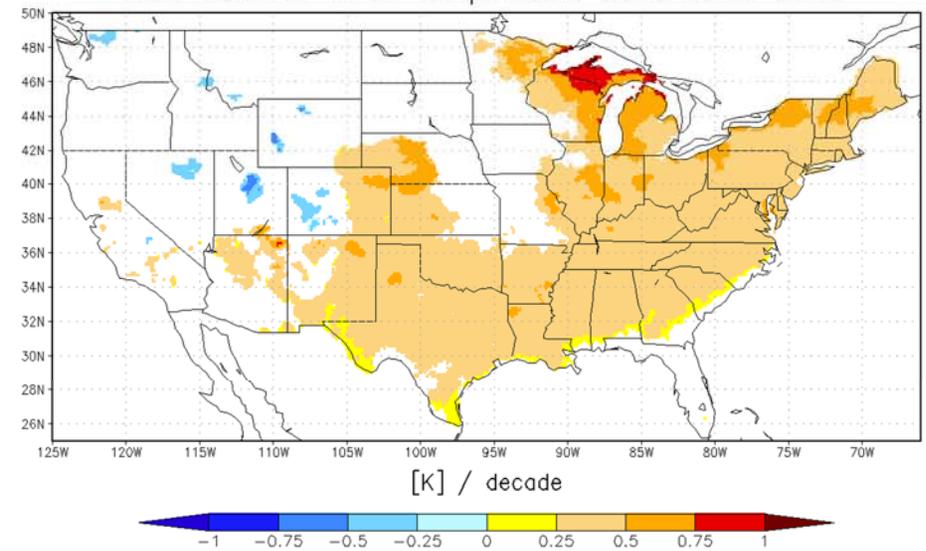


(Top) all points – (Bottom) Mann-Kendall significance test with 10% confidence interval

NCA-LDAS precipitation trend 1979–2012

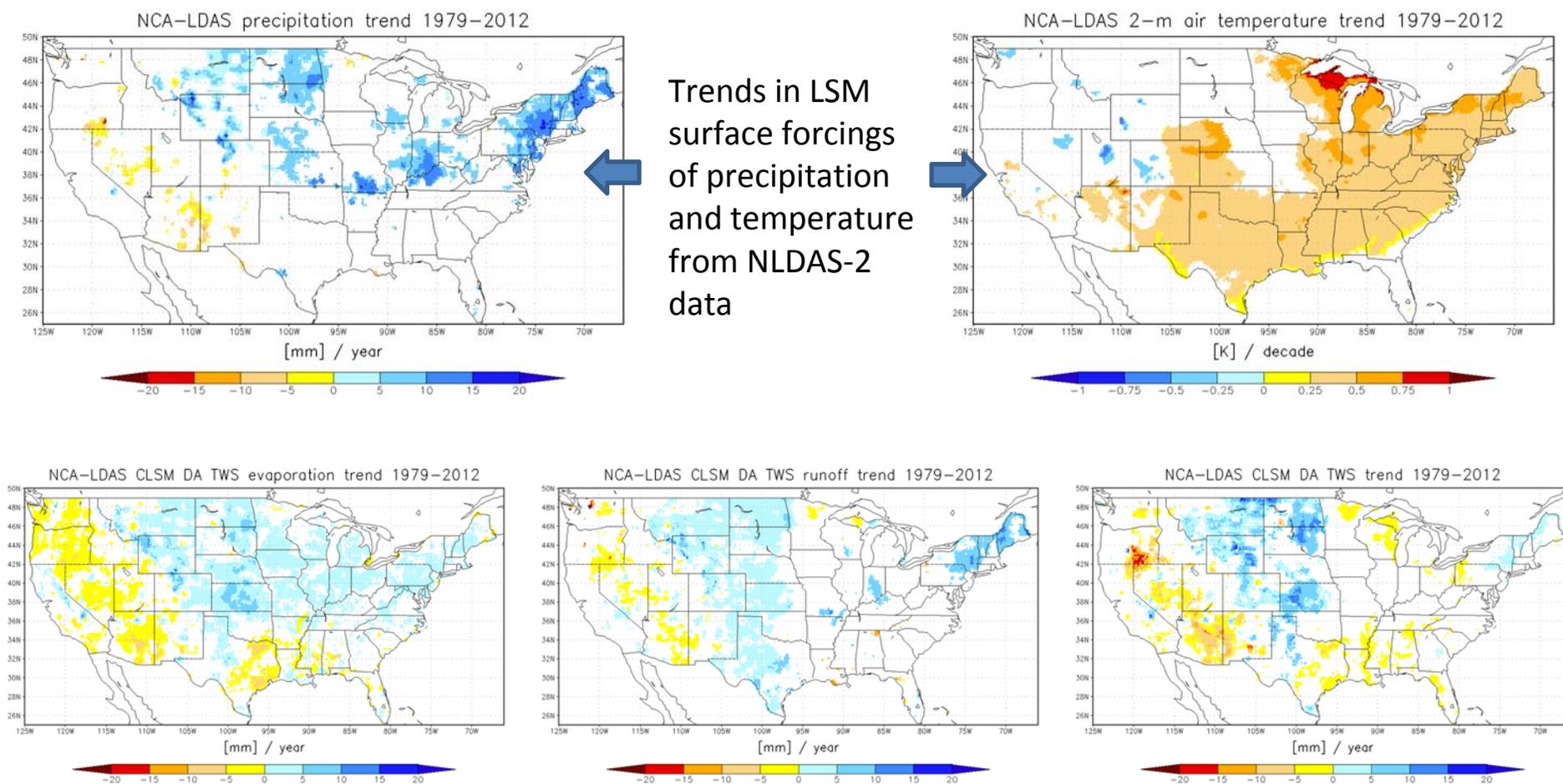


NCA-LDAS 2-m air temperature trend 1979–2012



# Integrated Water Trend Analysis with NCA-LDAS

David Mocko



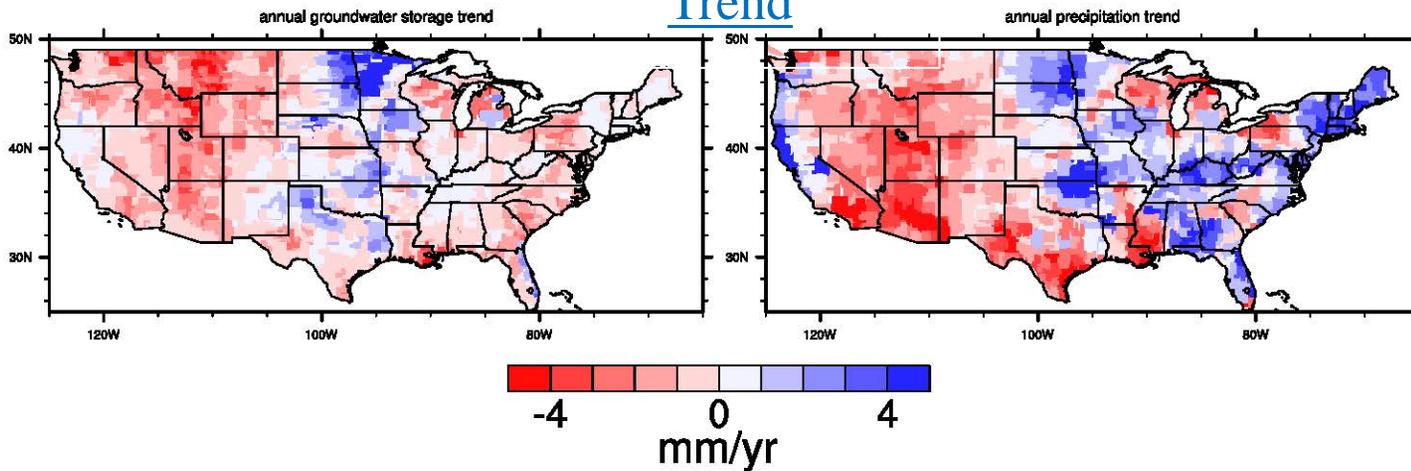
Above: Example trend analysis from CLSM with assimilation of GRACE terrestrial water storage (TWS) anomalies. (Left) Evaporation (Middle) Total runoff (Right) TWS – all units in mm/year. Trends calculated using Mann-Kendall trend test. Only areas with 10% confidence interval plotted. Noted are higher ET in the Great Plains, and higher runoff in the Northeast regions. The TWS also has a higher trend in the upper Great Plains, and a lower trend in the West region.

*NCA-LDAS Team, NASA NCA Meeting, Apr 8-9 2014*

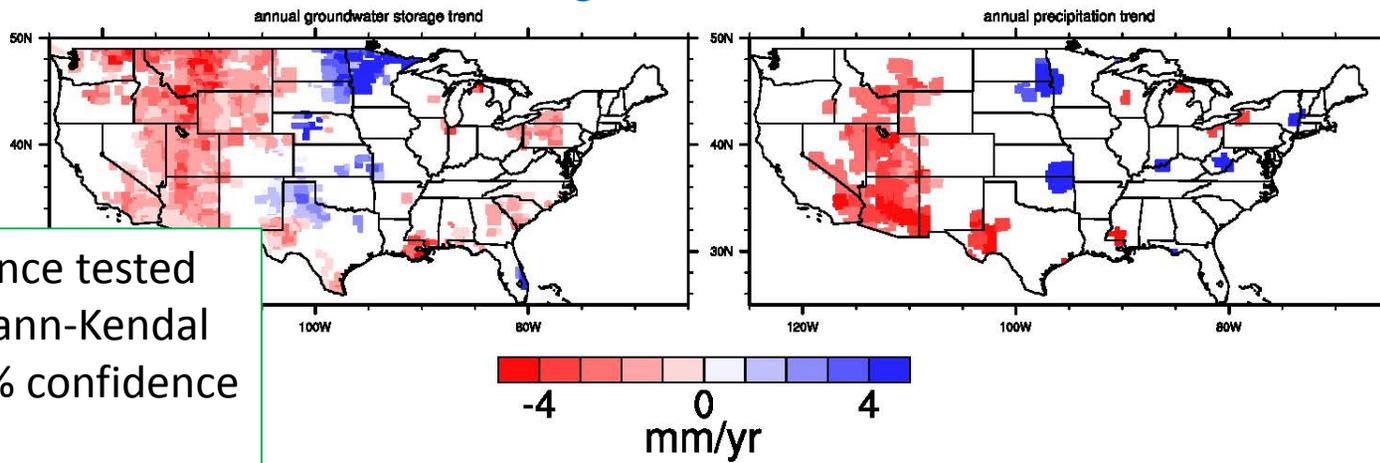
# Modeled Trends in annual mean groundwater storage and annual precipitation

Bailing Li

## Trend



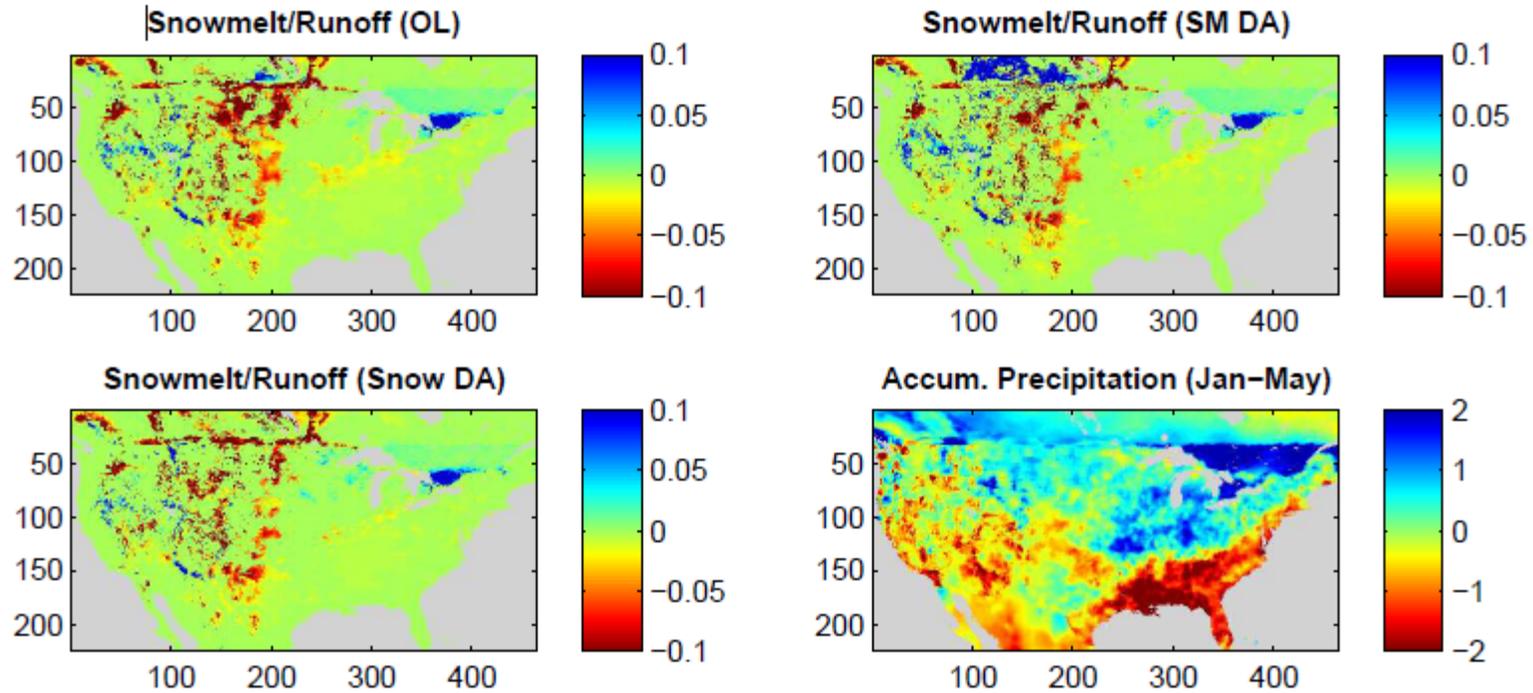
## Significant trend



Significance tested using Mann-Kendal with 10% confidence interval

# Jan-May Snowmelt/Runoff Ratio Trend

*Yuqiong Liu*

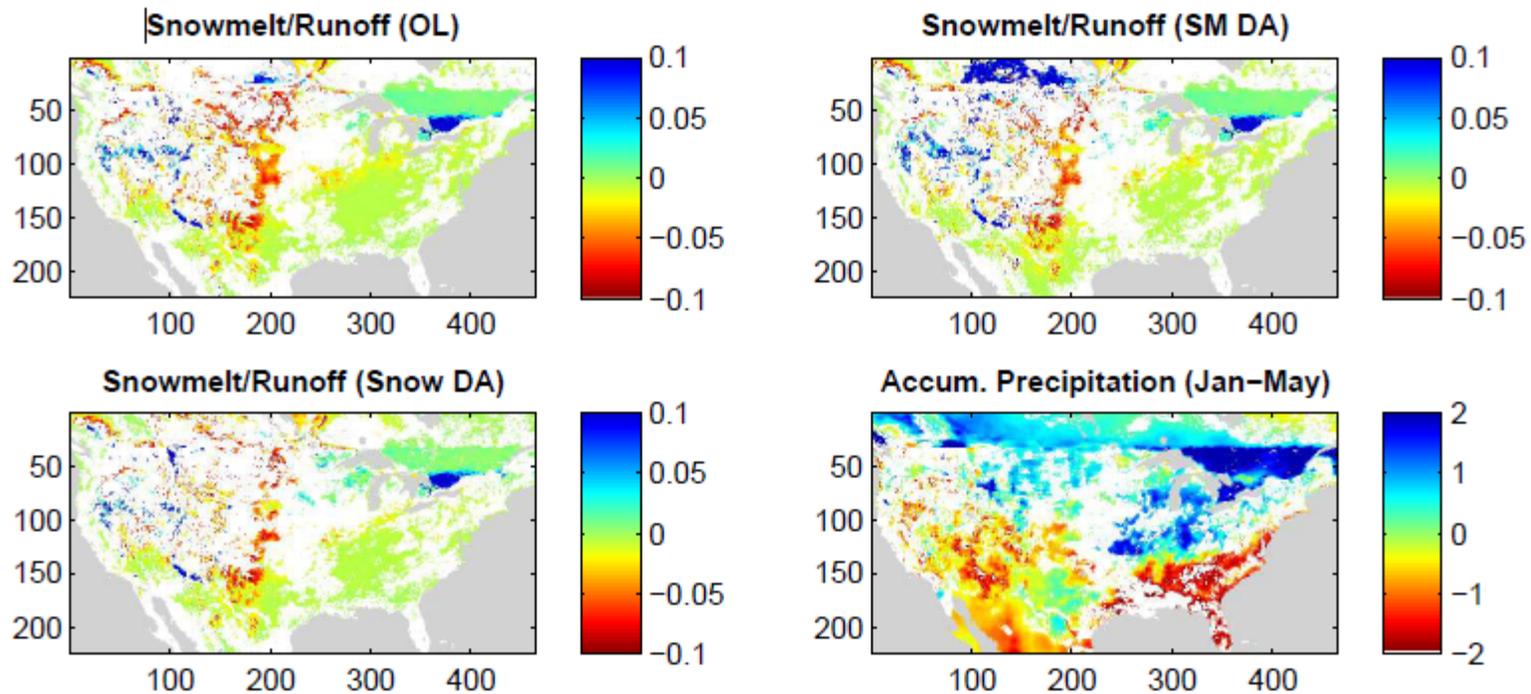


## Notes:

- Data period: 1979-2012 (34 years)
- Trends are in the unit of ratio/decade for snowmelt/runoff and mm/decade for precipitation

# Jan-May Snowmelt/Runoff Ratio Trend (Significant)

*Yuqiong Liu*



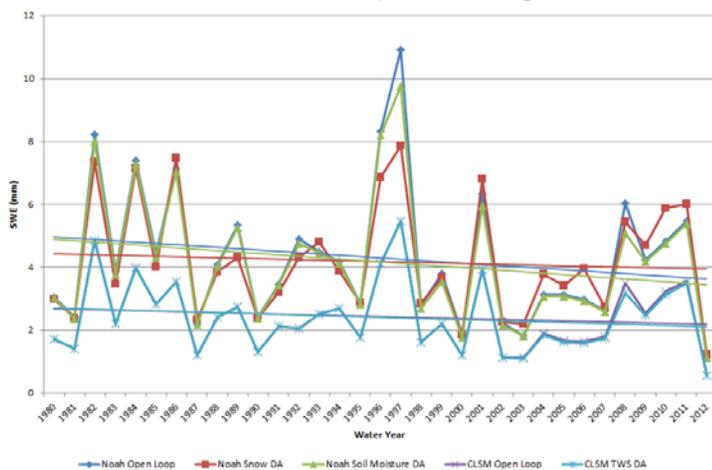
## Notes:

- Significance was tested using Mann-Kendal with 10% confidence interval
- Data period: 1979-2012 (34 years)
- Trends are in the unit of ratio/decade for snowmelt/runoff and mm/decade for precipitation

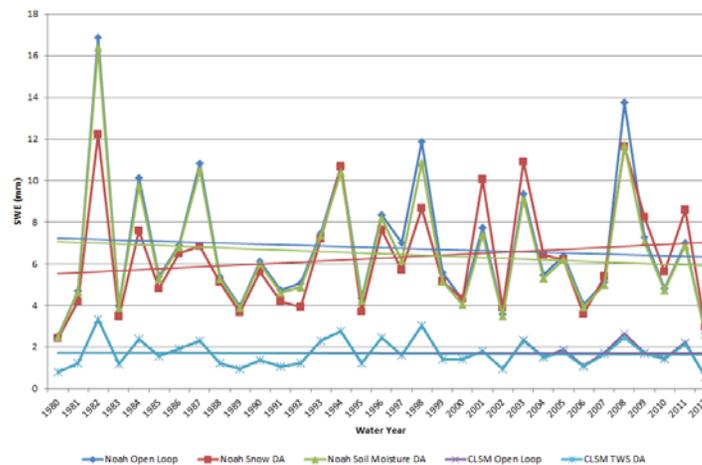
# SWE Analysis

Jordan Borak

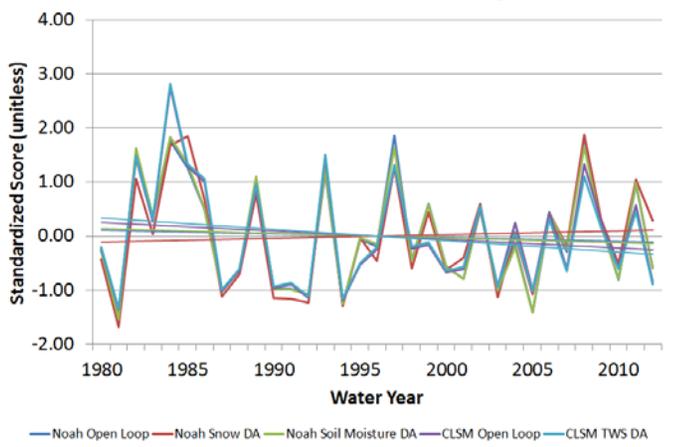
Trends in Annual Mean Snow Water Equivalent, Water Years 1980-2012  
Noah and Catchment LSMs, NCA Midwest Region



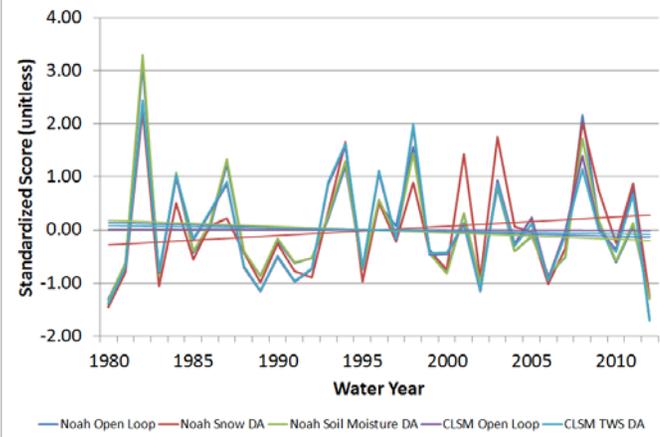
Trends in Annual Mean Snow Water Equivalent, Water Years 1980-2012  
Noah and Catchment LSMs, NCA Northeast Region



Standardized Annual Mean SWE, Water Years 1980-2012  
Noah and Catchment LSMs, NCA Northwest Region



Standardized Annual Mean SWE, Water Years 1980-2012  
Noah and Catchment LSMs, NCA Northwest Region



# Website for NCA-LDAS under Development



## LDAS Land Data Assimilation Systems

[Home](#)[NLDAS](#)[GLDAS](#)[Resources](#)[FAQ](#)[General Information](#)[Parameters](#)[Forcing Data](#)[Assimilated Data](#)[Model Output](#)[Evaluation Data](#)[Indicators](#)[NCA-LDAS Atlas](#)[Presentations](#)[Publications](#)

### NCA-LDAS News

#### **The NCA-LDAS datasets will be made available through the NASA GES DISC**

NCA-LDAS datasets are currently being added to the [NASA Goddard Earth Sciences Data and Information Services Center \(GES DISC\)](#). This page will be updated when the datasets are made available. The current target date for public release of the data is during June 2014.

The [NLDAS](#) Phase 2 datasets used as forcing for NCA-LDAS are currently available from the [NASA Hydrology DISC](#) within the GES DISC.

#### **LDAS Mailing List**

Users interested in the NCA-LDAS datasets are encouraged to join the [LDAS mailing list](#) for updates on new data releases. Be the first to know when the NCA-LDAS datasets are available!

#### **Under construction!**

The NCA-LDAS webpages are currently under construction. All pages should be active, but content is not yet complete and is being added. Thanks for your patience!

NCA-LDAS webpage, with documentation of the project, and (soon) links to the datasets. The website address is not yet released to the public while the webpage information is populated, and the datasets are being added to the NASA GES DISC. The current target for a public release of the webpage and datasets is **June 2014**.

LDAS dataset mailing list: [https://lists.nasa.gov/mailman/listinfo/ldas\\_users](https://lists.nasa.gov/mailman/listinfo/ldas_users) pr 8-9 2014

# Preliminary Conclusions

- Integrated response of NCA-LDAS D/A models are responsive to satellite era forcings, e.g. Precip, Et and runoff trends,
- Significance of trends is more evident at scale of the grid box, not the NCA domain.
- D/A seems to improve the significance of the trend analysis

**Thank You!**