

# **An Integrated Terrestrial Water Analysis System for the NCA (NCA-LDAS)**

*PI: Christa Peters-Lidard, Chief, Hydrological Sciences  
Laboratory, NASA GSFC Code 617*

*Co-Is: John Bolten, James Foster, Dorothy Hall,  
Michael Jasinski, Matthew Rodell, Jordan Borak,  
Sujay Kumar, Bailing Li, David Mocko, George Riggs*

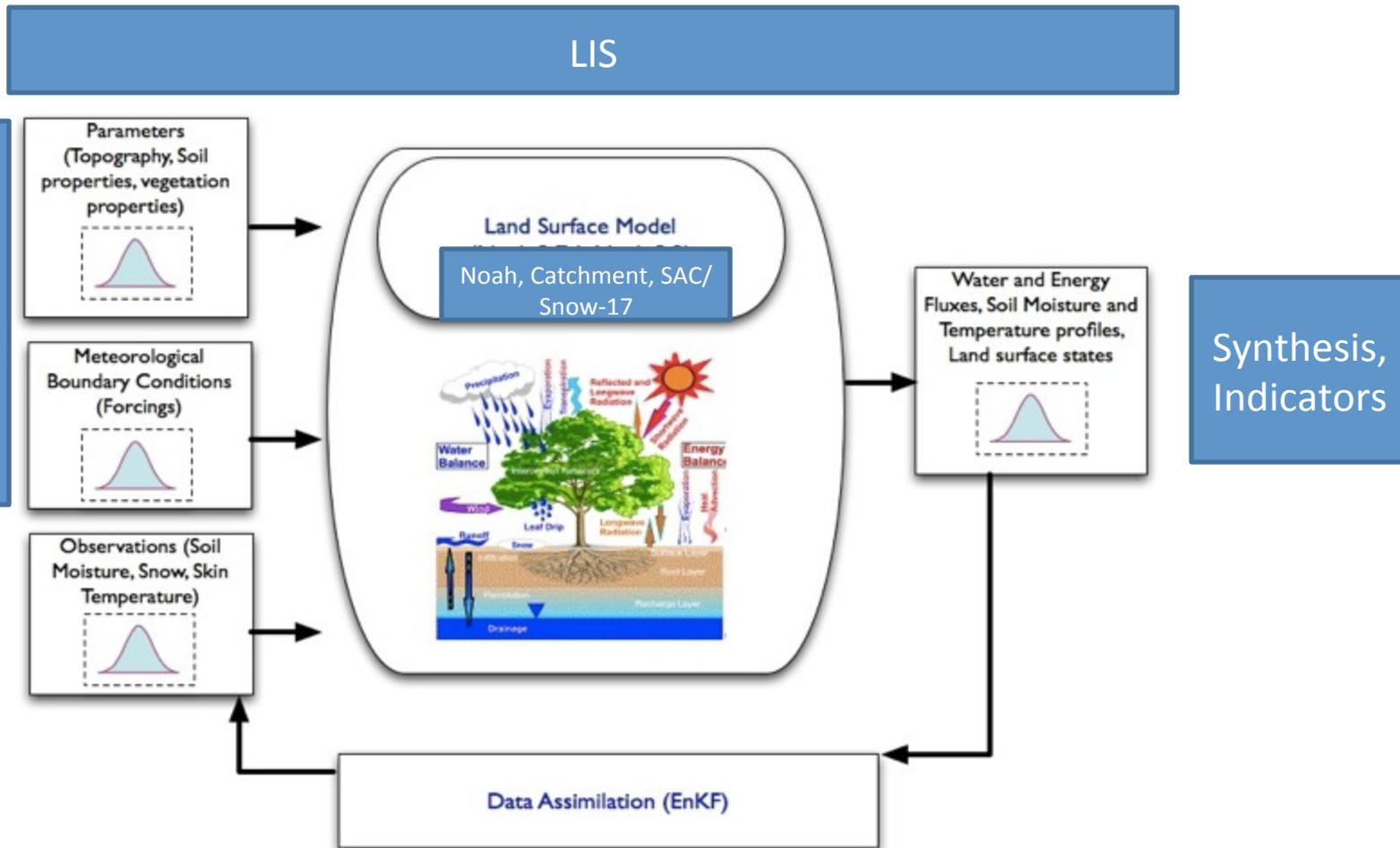
# NCA-LDAS Science

The hypothesis to be tested in this project is that *assimilating NASA's satellite soil moisture, SWE, SCA, TWS and irrigation products into an NCA-LDAS will produce improved characterization of the continental scale water budget, which will directly improve the monitoring and prediction of climate-relevant water availability indicators, including droughts and floods.*

Specific science questions to be addressed include:

- How have North American water storages and fluxes evolved in the satellite era?
- How have the relationships among hydrologic fluxes and states changed?
  - Snowpack-streamflow-flood anomalies?
  - Groundwater-soil moisture-evapotranspiration-drought anomalies?
  - Irrigation impacts?
- Which global indicators help us understand North American impacts?
- What are key hydrologic indicators that encapsulate these impacts?

# 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)

# NASA Terrestrial Water Products to be Assimilated in NCA-LDAS

<b>Parameters</b>	<b>Spatial Resolution</b>	<b>Satellite Sensors</b>	<b>Reference</b>
Snow covered area (SCA)	500m	AVHRR, Terra/ Aqua MODIS,	(Hall et al., 2002)
Snow water equivalent (SWE)	25-km	SMMR, SSM/I, Aqua AMSR-E	(Kelly et al., 2004)
Terrestrial water storage (TWS)	500-km	GRACE	Swenson and Wahr (2006)
Soil moisture (SM)	25-km	SMMR, SSM/I, Aqua AMSR-E	(de Jeu 2003, Njoku, 2007, Gao et al. 2006, Li et al. 2010)
Irrigation intensity (II)	1km	Terra/Aqua MODIS	(Ozdogan et al., 2010)

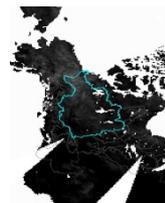
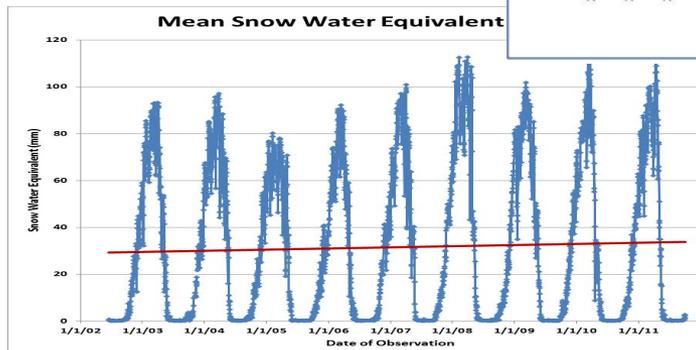
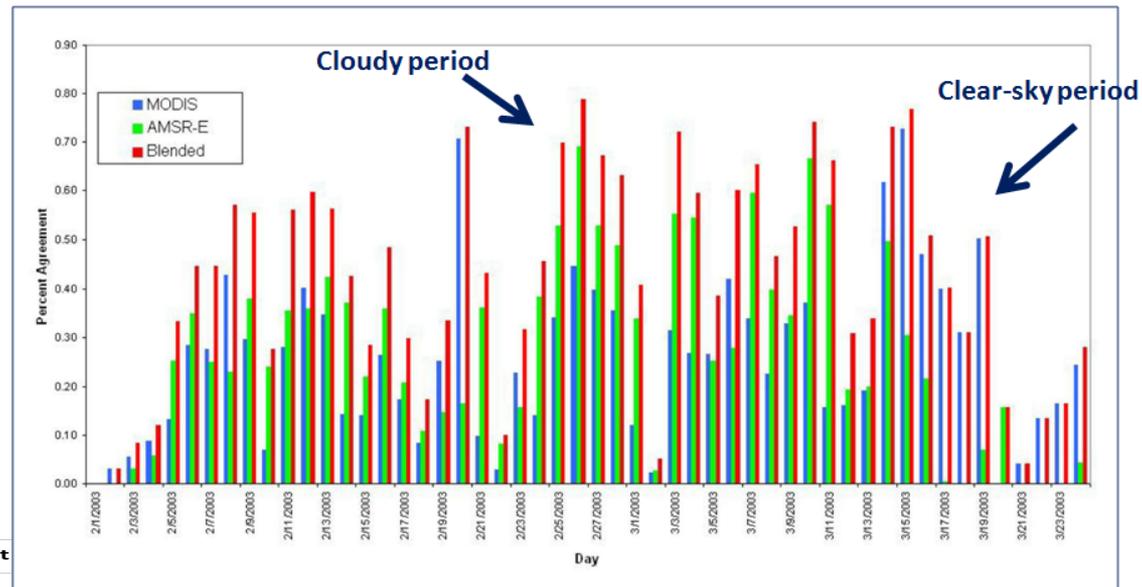
# Snow Products

**Goal: To develop a blended-snow product that includes snow extent and snow water equivalent for NCA.**

Data:

- 1) The blended-snow product is an all-weather product with snow mapped using visible and near-IR data (MODIS, onboard the Aqua and Terra satellites) and microwave data (AMSR-E, onboard Aqua).
- 2) Open-loop (OL) runs using LIS with NLDAS2 forcing without snow data assimilation
- 3) Output products including SNOW-DA including SWE, snow cover, streamflow suitable for trend analysis.

## Mapping Snow-Cover Extent



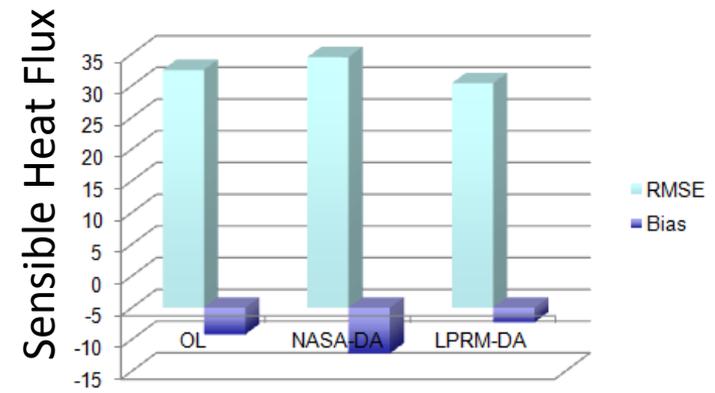
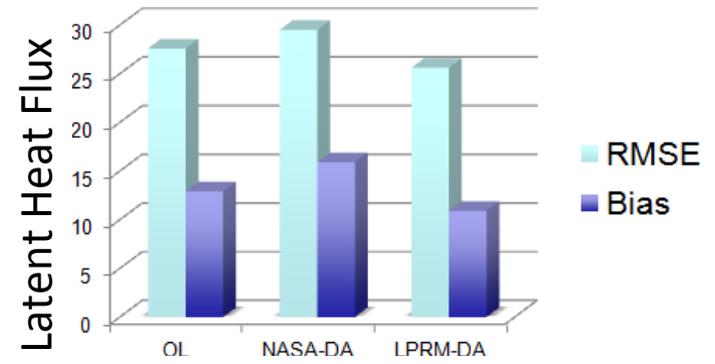
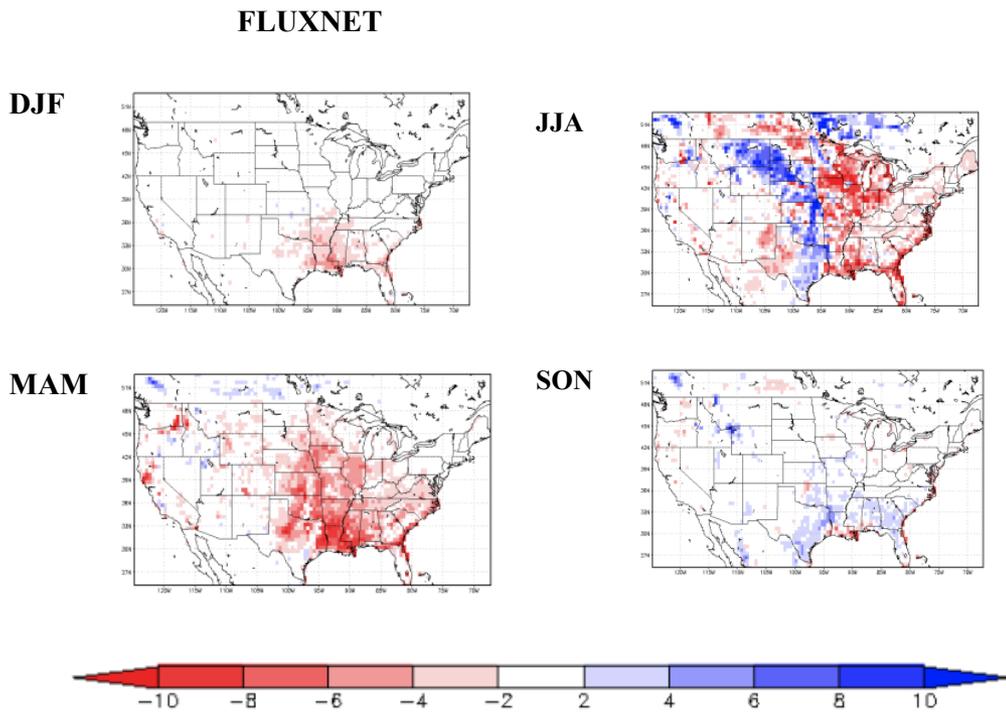
# Soil Moisture

## Goal: To develop a climatology of remotely-sensed soil moisture for NCA

Data:

- 1) Soil moisture products from AMSR-E (NASA-DA and LPRM-DA)
- 2) Open-loop (OL) runs using LIS with NLDAS2 forcing without soil moisture data assimilation
- 3) Output products including LPRM-DA including Latent and Sensible Heat flux (below), streamflow

### Flux Improvements due to Assimilation of AMSR-E soil moisture products



# Terrestrial Water Storage

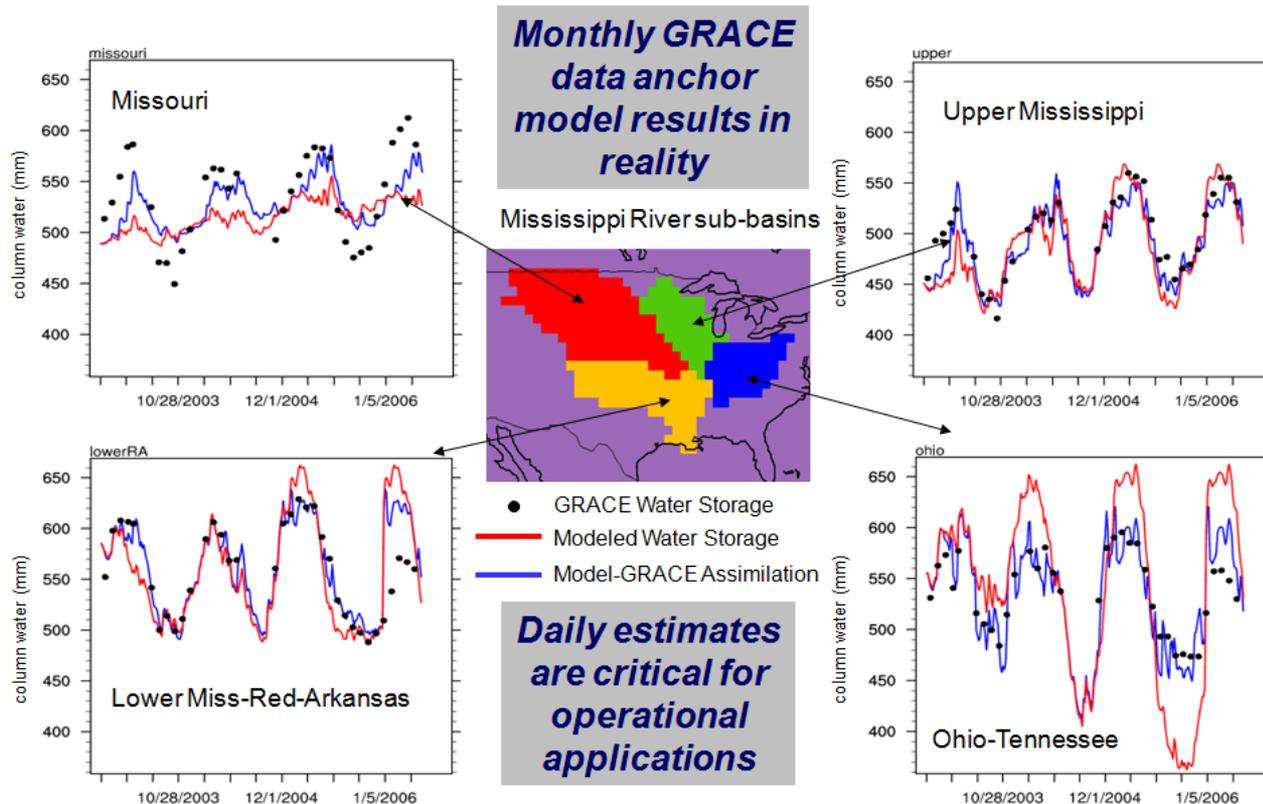
**Goal: To develop a climatology of terrestrial water storage/groundwater for NCA**

Data:

- 1) Terrestrial water storage anomalies derived from GRACE
- 2) Modeled terrestrial water storage to fill period before GRACE, which began delivering data in April, 2002
- 3) Groundwater, soil moisture, and snow water equivalent output from a GRACE data assimilating instance of LIS/Catchment

## Assimilation of GRACE TWS Data

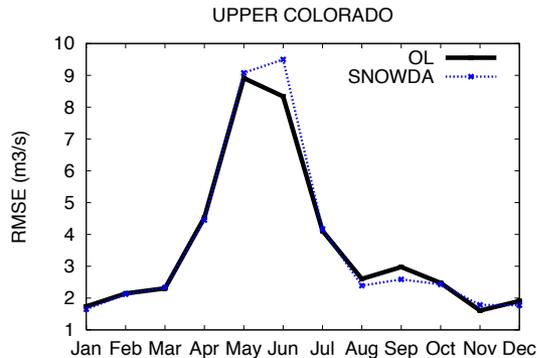
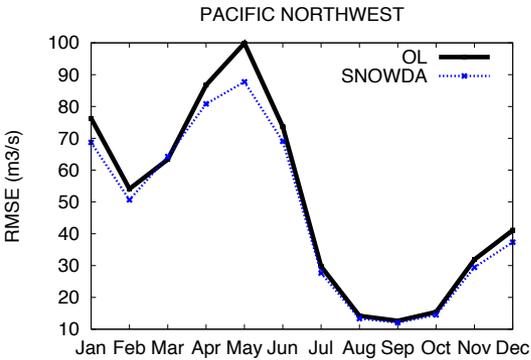
Models produce continuous time series.



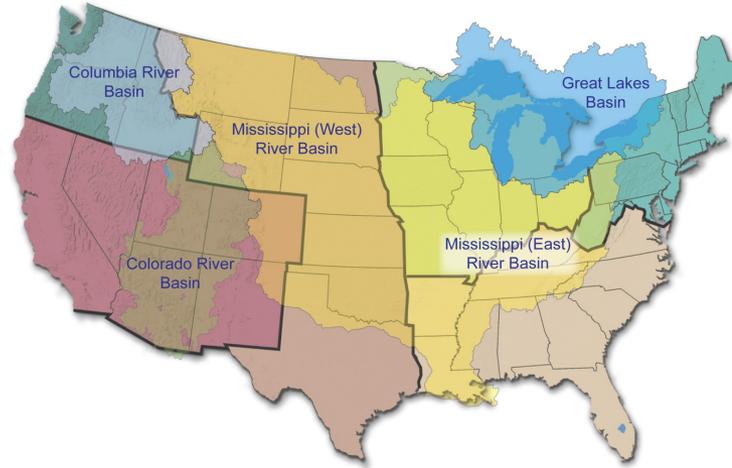
# Connections to NCA

- Author for NCA Water Resources Sector Writing Team: Peters-Lidard
- Contacted various NCA Watershed/Regional Analysis team leads: Great Lakes, Colorado, Columbia, Southeast

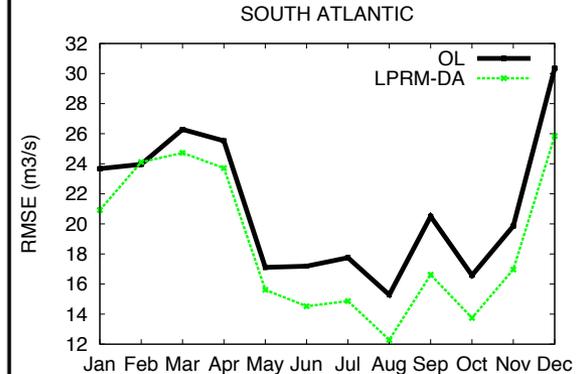
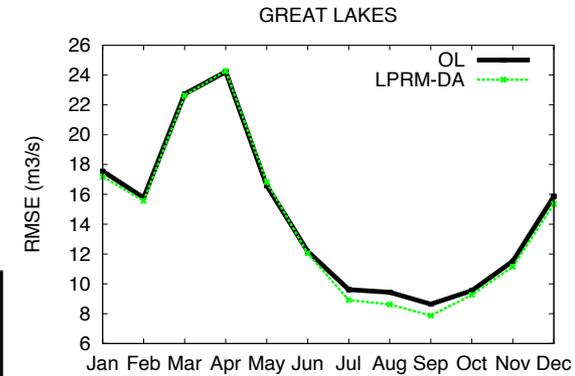
Bias-corrected AMSR-E SWE  
Assimilation Reduces  
Seasonal Streamflow Errors  
In Pacific Northwest  
but not Upper Colorado



## NCA-LDAS Initial Results



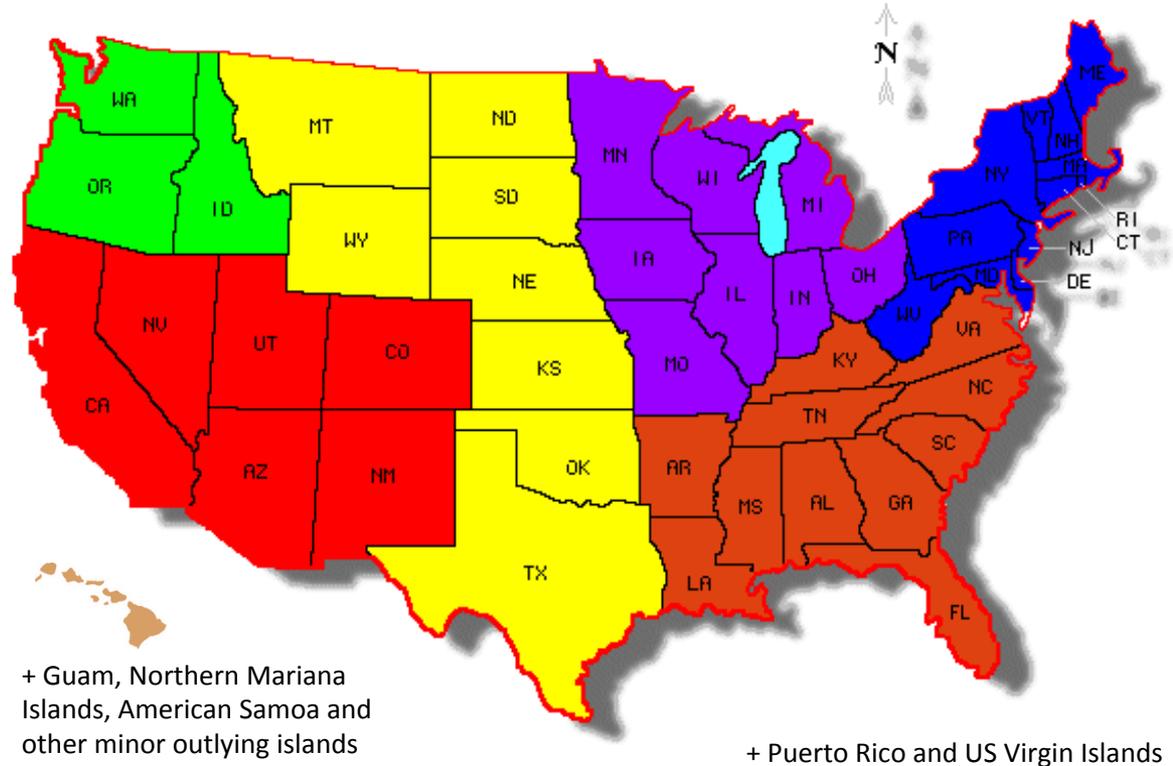
AMSR-E Soil Moisture  
Assimilation Reduces  
Seasonal Streamflow Errors  
Somewhat In Great Lakes and  
especially in South Atlantic





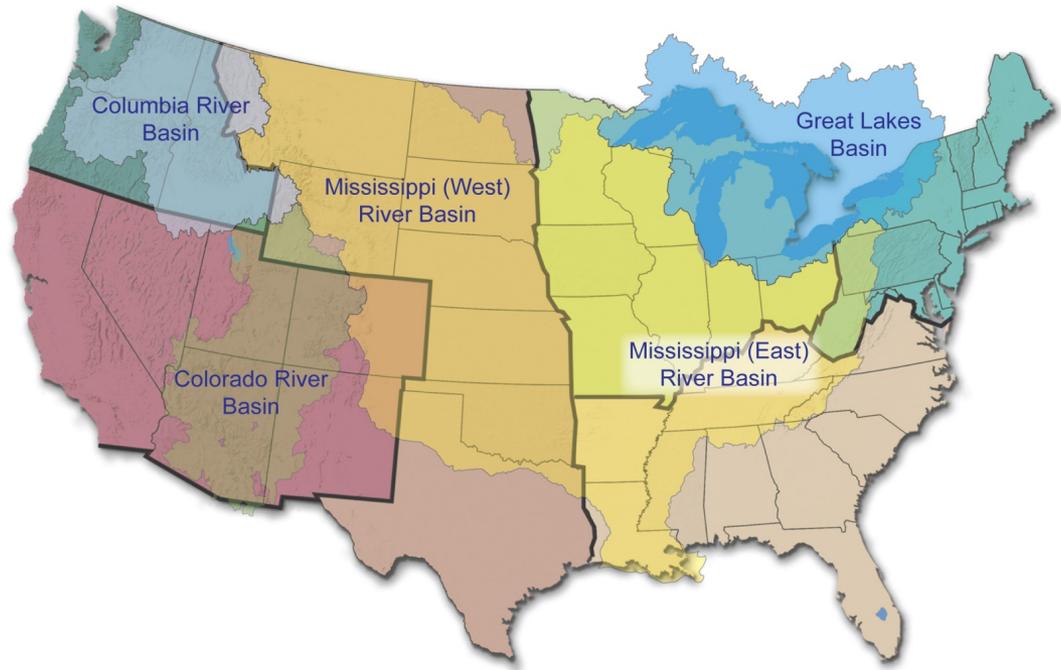
# NCA Regions

- Northeast
- Southeast and Caribbean
- Midwest
- Great Plains
- Northwest
- Southwest
- Alaska and Arctic
- Hawaii and Pacific Islands



# NCA Biogeographical Cross-Cuts

- Oceans and marine resources
- Coastal zone, development, and ecosystems, e.g.,
  - SF Bay Delta
  - Chesapeake Bay
  - Gulf Coast
- Watersheds, e.g.
  - Great Lakes
  - Colorado River
  - Columbia River
  - Mississippi River



# References

- Hydrology DISC (HDISC)  
<http://disc.gsfc.nasa.gov/hydrology/>
- NASA/GSFC NLDAS website:  
<http://ldas.gsfc.nasa.gov/nldas/>
- NASA/GSFC LIS website:  
<http://lis.gsfc.nasa.gov/>