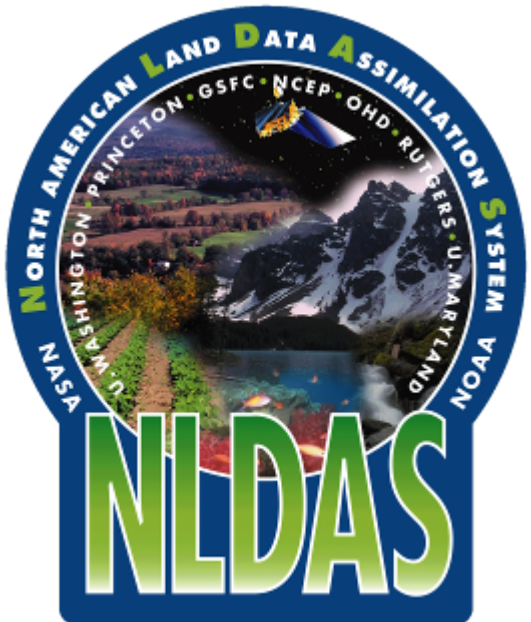
The North American Land Data Assimilation System: NLDAS

Configuration and Application to CONUS Drought Monitoring & Prediction

for the National Drought Information System (NIDIS)



Ken Mitchell

Youlong Xia, Helin Wei

NCEP/EMC

See Next Frame for Key Partners

NCEP Production Suite Review: 11-13 Dec 2007

EMC: Drought Monitoring & Prediction Partners

Funded by NOAA Climate Program Office

- **CPC (Kingtse Mo, Huug van den Dool)**
  - http://www.cpc.ncep.noaa.gov/products/Drought
- **NASA/HSB (Brian Cosgrove, Chuck Alonge)**
  - http://ldas.gsfc.nasa.gov/monitor/
- **NWS/OHD (Pedro Restrepo, John Schaake)**
  - http://www.weather.gov/ahps/index.php?ahps=1
- **Princeton U. (Eric Wood, Lifeng Luo)**
  - http://hydrology.princeton.edu/forecast
- **U. Washington (D. Lettenmaier, Andy Wood)**
  - http://www.hydro.washington.edu/forecast/westwide/

New CPC North American Drought Briefing:

Monthly: Every 2nd Thursday

Next: 13 Dec 07, 1130

Telecon: 888-590-4933, PIN: 3994107

Climate Prediction Center/NCEP/NOAA

Kingtse Mo, Wanru Wu

http://www.cpc.ncep.noaa.gov/products/Drought

Drought Variables to Monitor and Predict

On several time scales: weeks to seasonal

(energy demand, agriculture, fire risk, water resource, river commerce)

- **Precipitation** anomalies
  - weeks, months, seasonal, annual
- **Temperature** anomalies
  - weeks, months, seasonal
- **Humidity** anomalies
  - weeks, months, seasonal
- **Surface evaporation** anomalies
  - weeks, months, seasonal
- **Soil Moisture** anomalies
  - months, seasonal, interannual
  - vertical profiles
- **Snowpack** anomalies
  - months, seasonal, interannual
- **Runoff and stream/river discharge** anomalies
  - months, seasonal, interannual
  - OHD emphasis

Shorter Time Scales

Longer Time Scales

NLDAS Design
(An Uncoupled Multiple Land Model Approach)

1. Force multiple land models with mesoscale analyses of near-surface meteorology (e.g. from NAM NDAS or NARR) and analyses of observed precipitation (not model precipitation)

2. Use 4 different land surface models: (common specifications of forcing, grid, terrain, land mask, vegetation type, soil type)

- **NOAH** (NOAA/NWS/NCEP)
- **MOSAIC** (NASA/GSFC)
- **VIC** (Princeton U./ U. Washington)
- **SAC** (NOAA/OHD Sacramento Model)

Advantages of uncoupled approach (i.e. execute land model only):

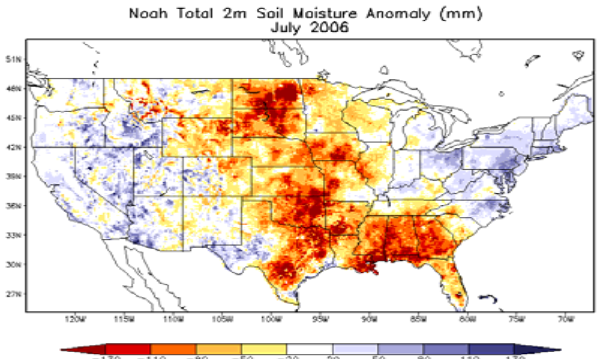
-- easy to utilize multiple land models
-- much improved precipitation forcing
-- **much easier to execute long-term reanalysis**

Monthly Total Column Soil Moisture Anomaly (mm)

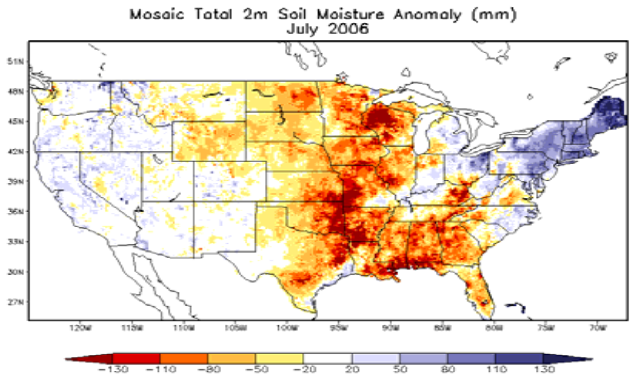
(Model by Model and 4-model Ensemble Mean)

Product of NCEP Realtime NLDAS executed since Oct 1996

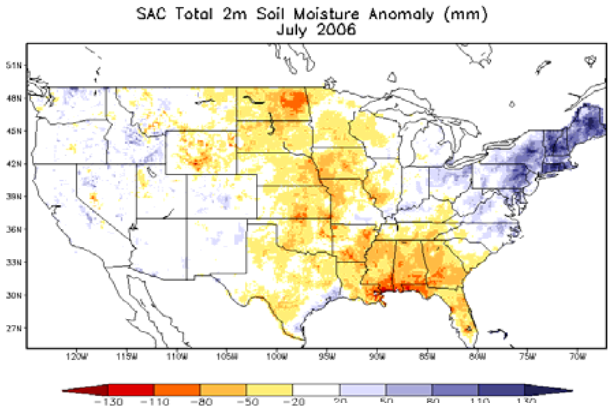
Noah



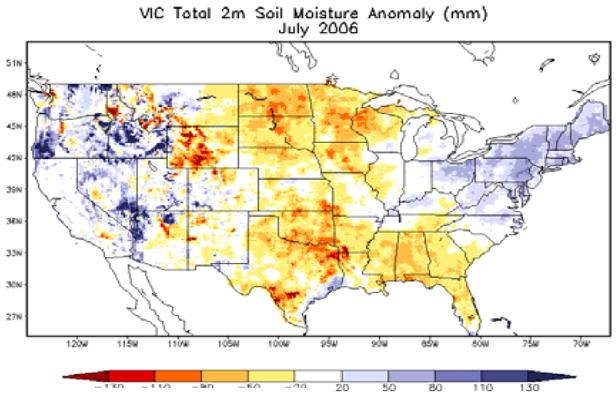
Mosaic



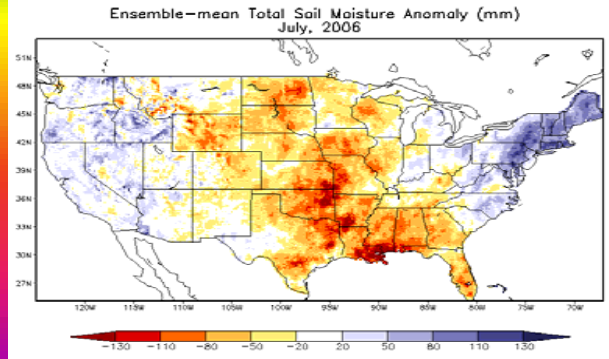
SAC



VIC

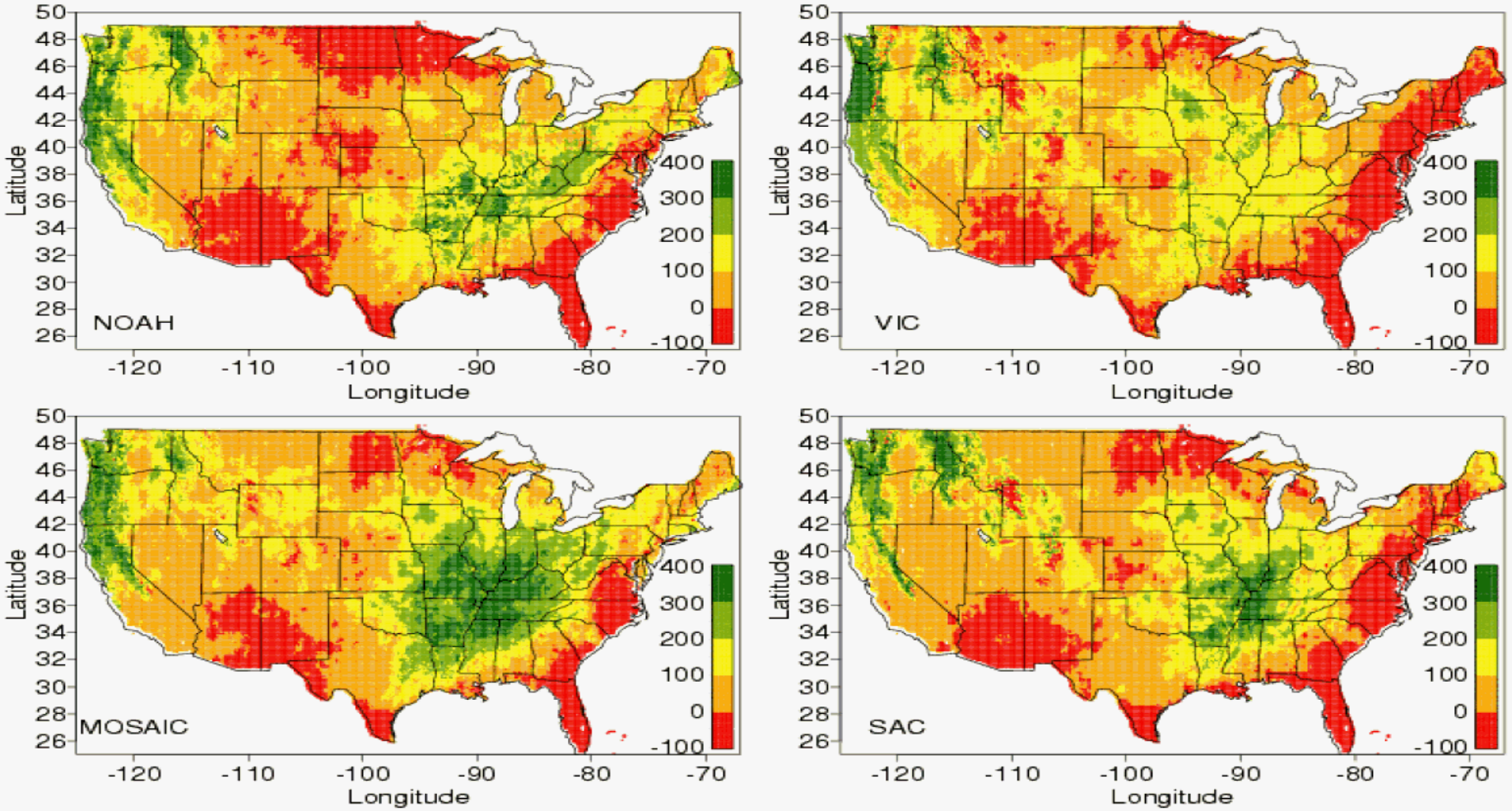


July 2006



Multi-Model Ensemble Mean Anomaly

Seasonal Change of Total Column Soil Moisture [mm]
30 Apr. minus 30 Sep., 99, at 23Z

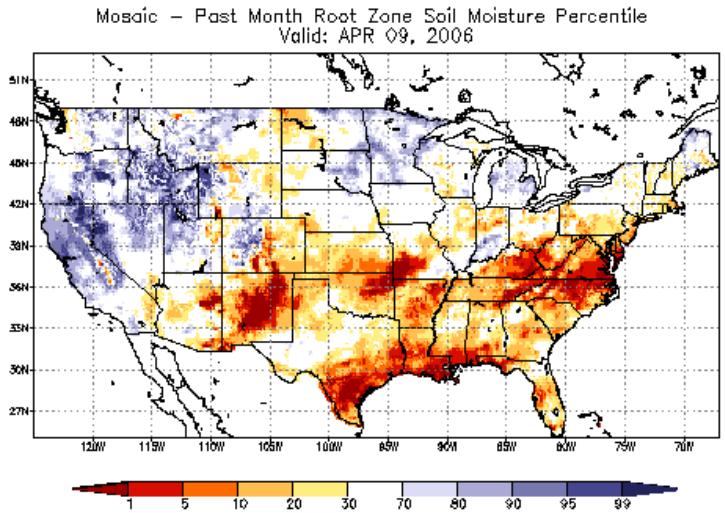


NLDAS Land Model intercomparison: Model results have a wide spread, as for example in total surface evaporation, which leads to above example of wide differences in seasonal change in soil moisture.

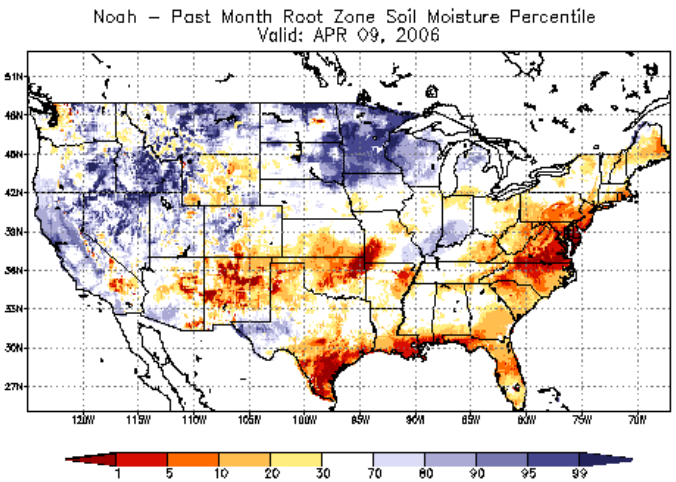
An overview paper can be seen in Mitchell et al., 2004. JGR.

Left Column: NLDAS root zone soil moisture anomaly for 09Apr06, depicted as percentile with respect to 1997-2006 10-year retrospective
(Aside: 28-year retrospective run is now underway)
Right column: U.S. Drought Monitor & CPC Leaky Bucket Model

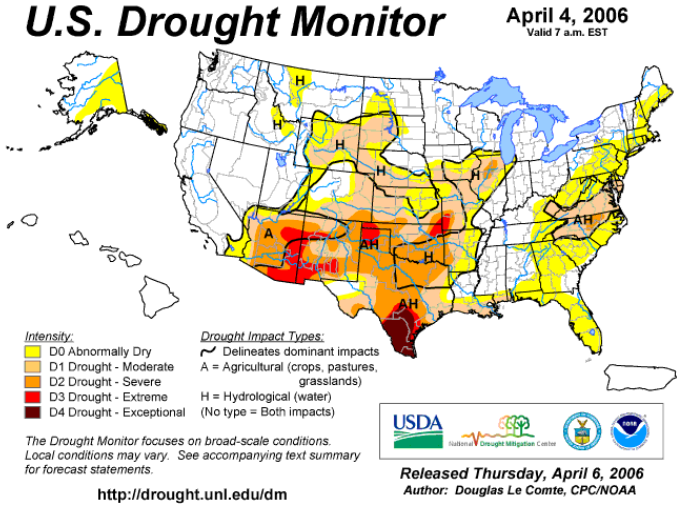
NLDAS – Mosaic LSM Output



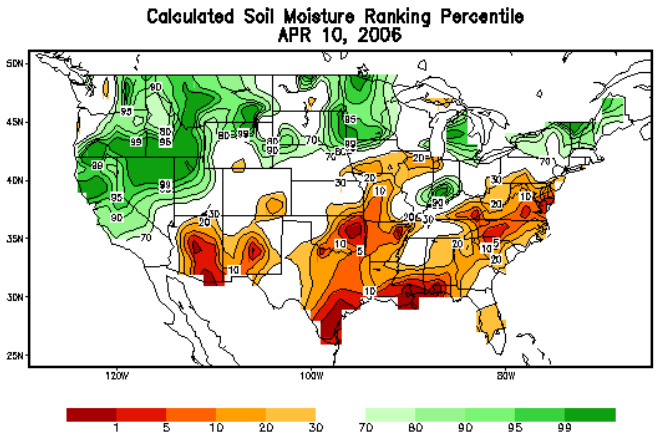
NLDAS – Noah LSM Output



U.S. Drought Monitor



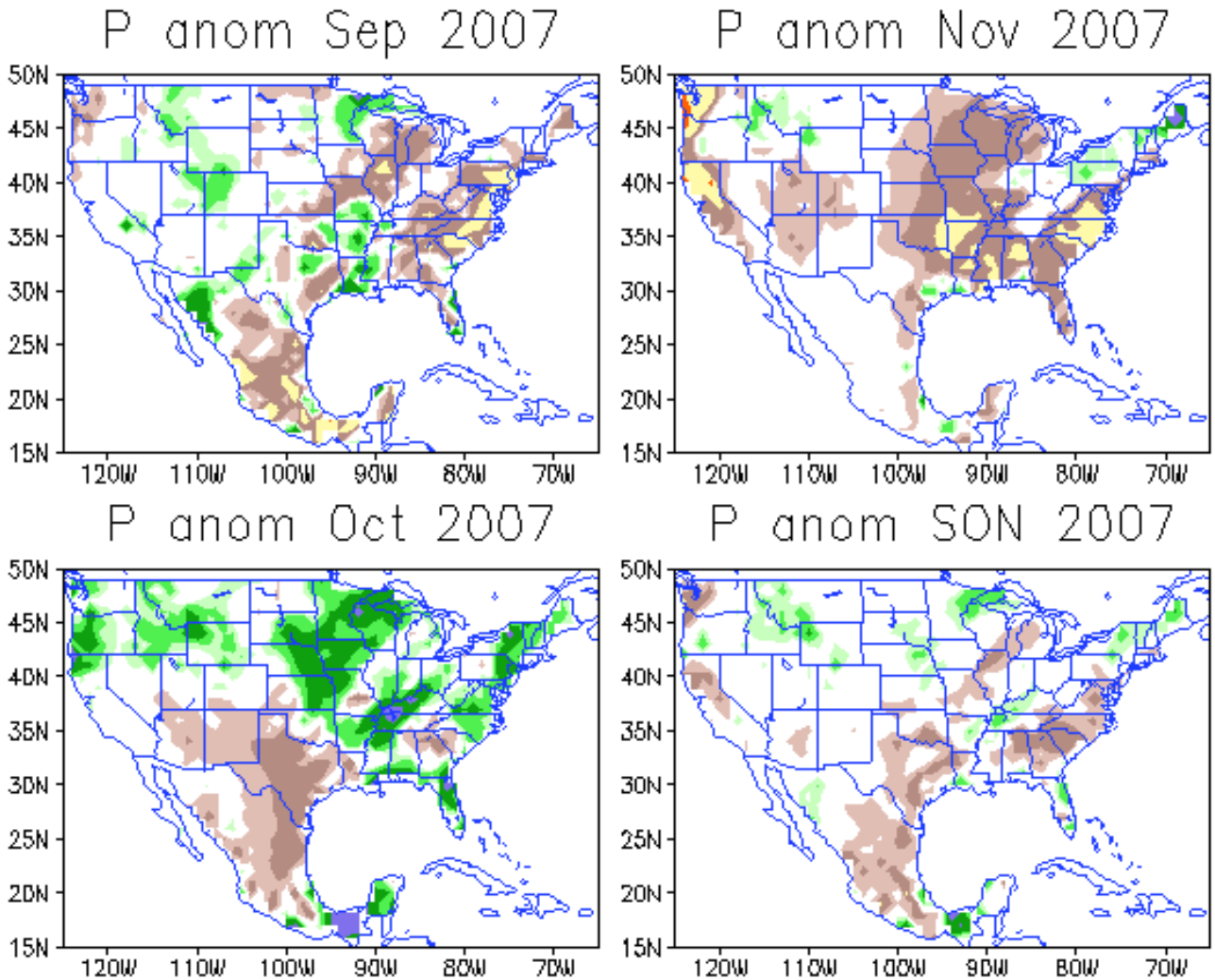
CPC - Leaky Bucket Model



Now for Current Conditions

Precipitation anomaly (mm):

Sep, Oct, Nov, SON 2007

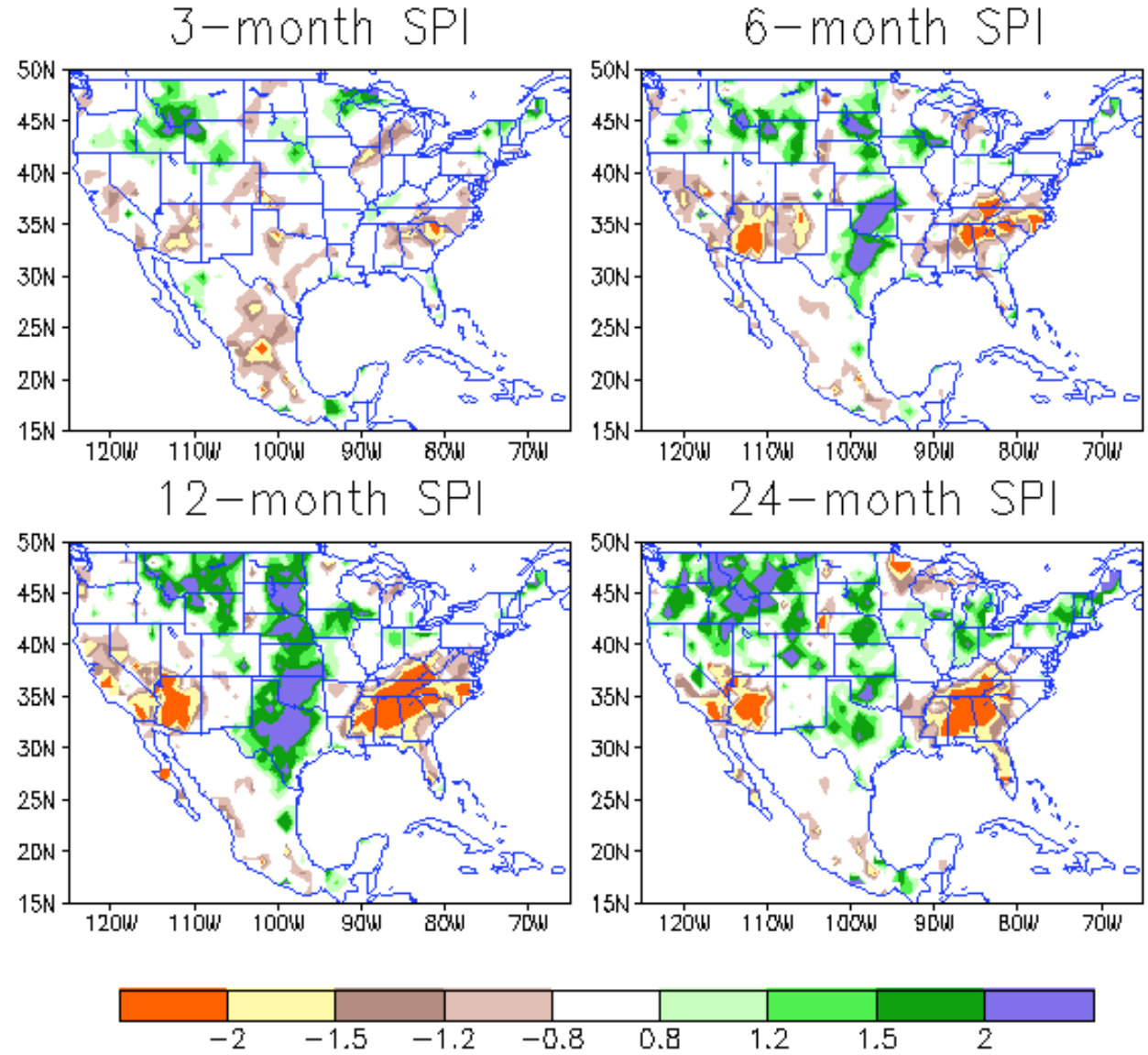


Over the Northern Plains, the lack of rain in Nov off set the positive anomaly in Oct.

Low anomaly persists in Southeast and mid-Atlantic states.

SPI: Standard Precipitation Index

As of end of Nov 07



SPI is a relatively new drought index defined with respect to the historical frequency of precipitation over a specified time period at a given location.

The SPI was formulated by the Colorado Climate Center in 1993. The purpose of SPI is to assign a single numeric value to the precipitation that can be compared across regions with markedly different climates. The standardization of the SPI allows the index to determine the rarity of a current drought.

The SPI was designed to show that it is possible to simultaneously experience wet conditions on one time Scale and dry conditions at a different time scale.

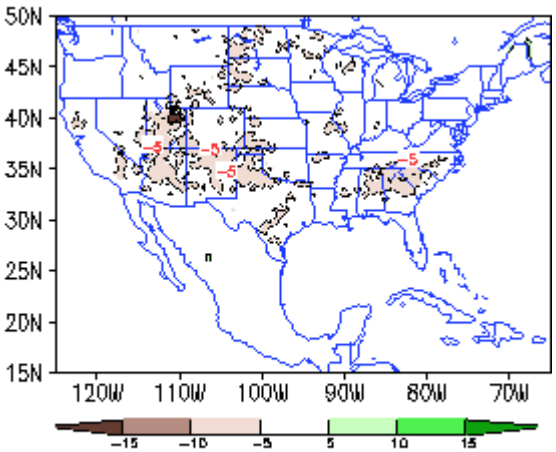
Ensemble Mean Soil Moisture anomaly (mm):

(NLDAS multi-model mean: Noah, Mosaic, VIC)

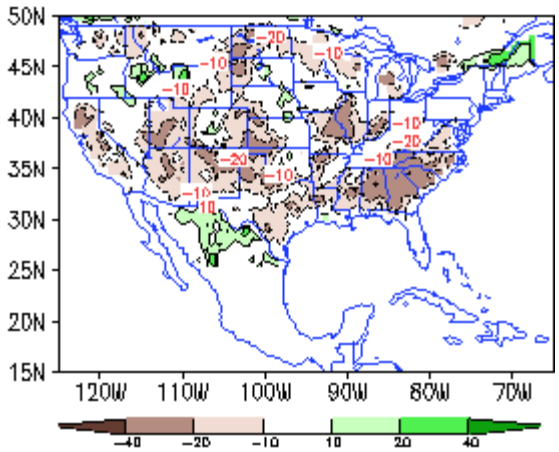
For Nov 07 by soil depth and SON 07 for total soil column

NOVEMBER 2007

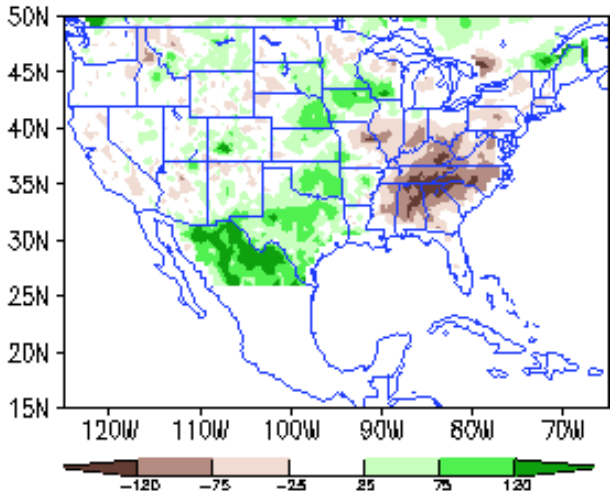
SM top 10cm



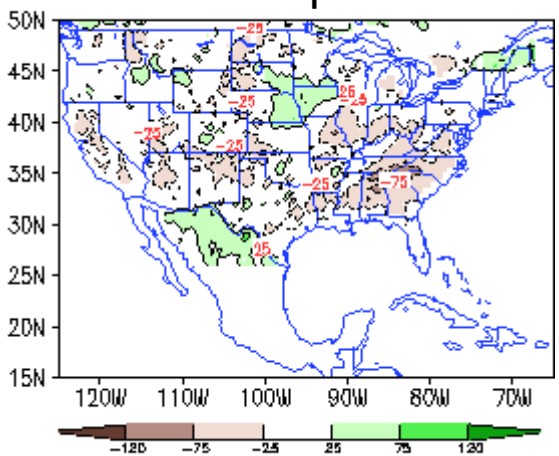
SM top 40cm



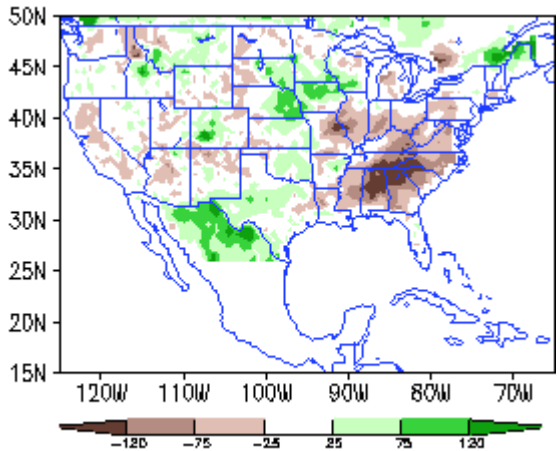
SON 2007 SM total



SM top 1m



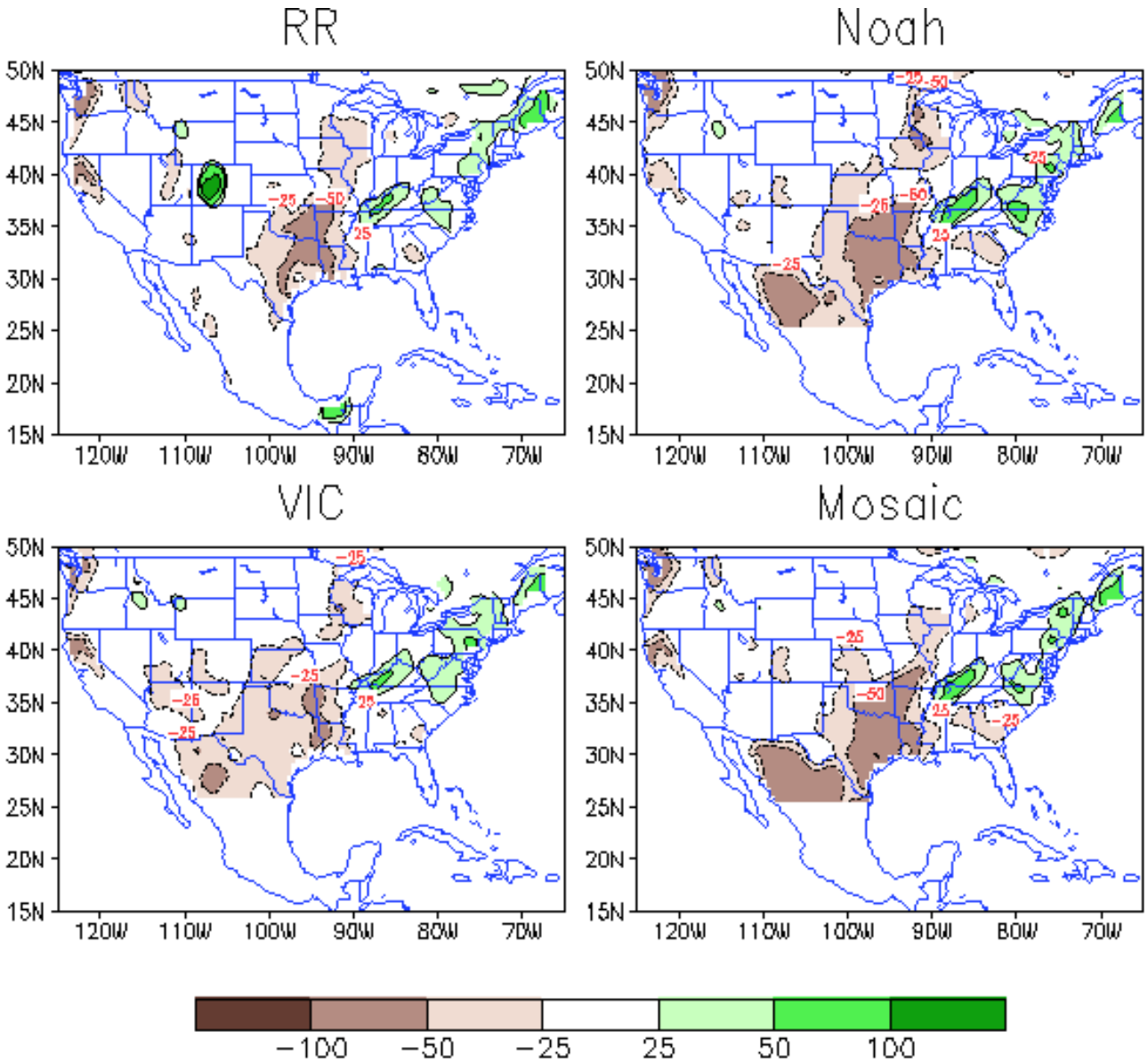
SM total



SM anom was dry for the top 40cm over the entire US in Nov. At the deep soil Level, wetness was from Oct rain.

2-Month Change in Total Soil Moisture (mm)

Nov-Oct 2007

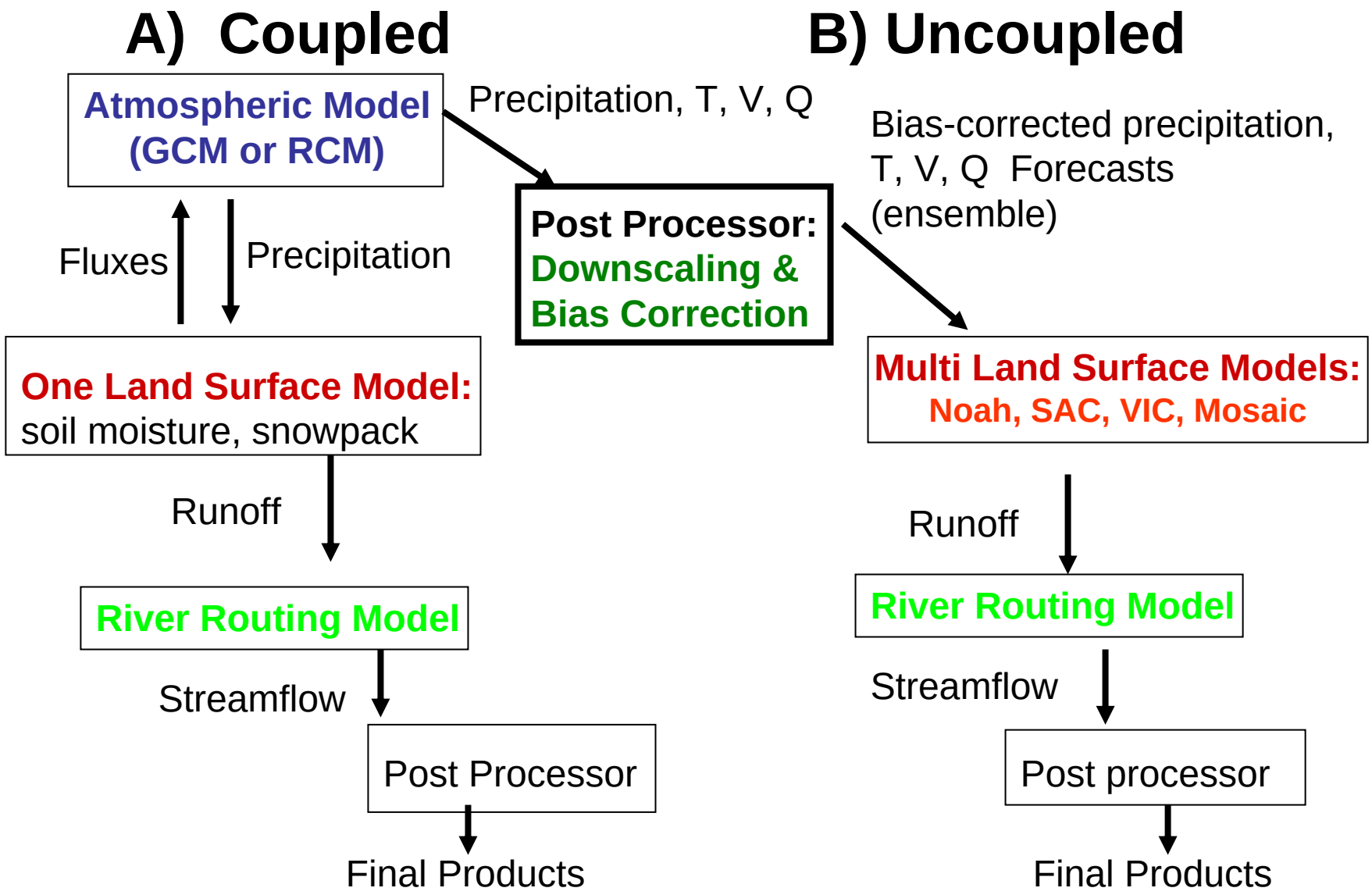


All NLDAS systems give consistent picture of depreciation of soil moisture over the Great Plains and the Southeast

SM increased over the Northeast coast

This field useful for tracking drought recovery or newly emerging drought

Two Dynamical Approaches to Drought, Flood Hydrological Prediction:



Both approaches should be executed in ensemble mode, with companion multi-decade reforecasts for developing bias correction and downscaling.

Example of Approach B (from Princeton U.):

Using bias-corrected ensemble CFS land surface forcing to drive ensemble VIC land model executions over seasonal scales.

Prediction for Jan08 (top) & Mar08 (bottom) from Nov07 initial states