A Near Real Time Drought Monitoring Capability

Kingtse Mo , Muthuvel Chelliah, Wayne Higgins
and
The NCEP Drought Monitoring Team
Climate Prediction Center
NCEP/NWS/NOAA

An Experimental Drought Early Warning System (DEWS)

An integrated component of a National Policy to monitor and predict drought in support of NIDIS

- 1. A drought early warning system will mitigate the impact of drought over the United States and an improved operational drought monitoring system will contribute to the National Integrated Drought Information System (NIDIS);
- 2. The NCEP regional reanalysis (RR) and the NLDAS allow us to build a consistent mesoscale drought monitoring system;
- 3. The NCEP CFS/GFS forecasts allow enhancement of the DEWS based on dynamical forecasts and regional analysis/NLDAS.

Let us talk

We know:

a) Products available;

b) Strength and weakness of Products

We need your advice:

- List of products that you need;
- Temporal and spatial scales;
- Error margins allowed and form of products
- How to deliver the products

Drought monitoring Team

CPC: Kingtse Mo, Muthuvel Chelliah,
Wayne Higgins and Wanru Wu

EMC: Kenneth Mitchell, Jesse Ming
and Helin Wei

NASA: Brian Cosgrove and Chuck Alonge

Link to: University of Washington: Dennis Lettenmaier
Princeton University: Eric Wood

Supported by NCPO/GAPP Core and CPPA

Monitoring Drought

More than one index or variable is needed to give a complete picture

A) Indices:

(i) Standard Precipitation Index(SPI):

- **Based on precipitation (P) alone;**
- **Easy to extend to forecasts;**
- **Does not include soil/hydrological conditions.**

(ii) Palmer Drought Severity Index (PDSI);

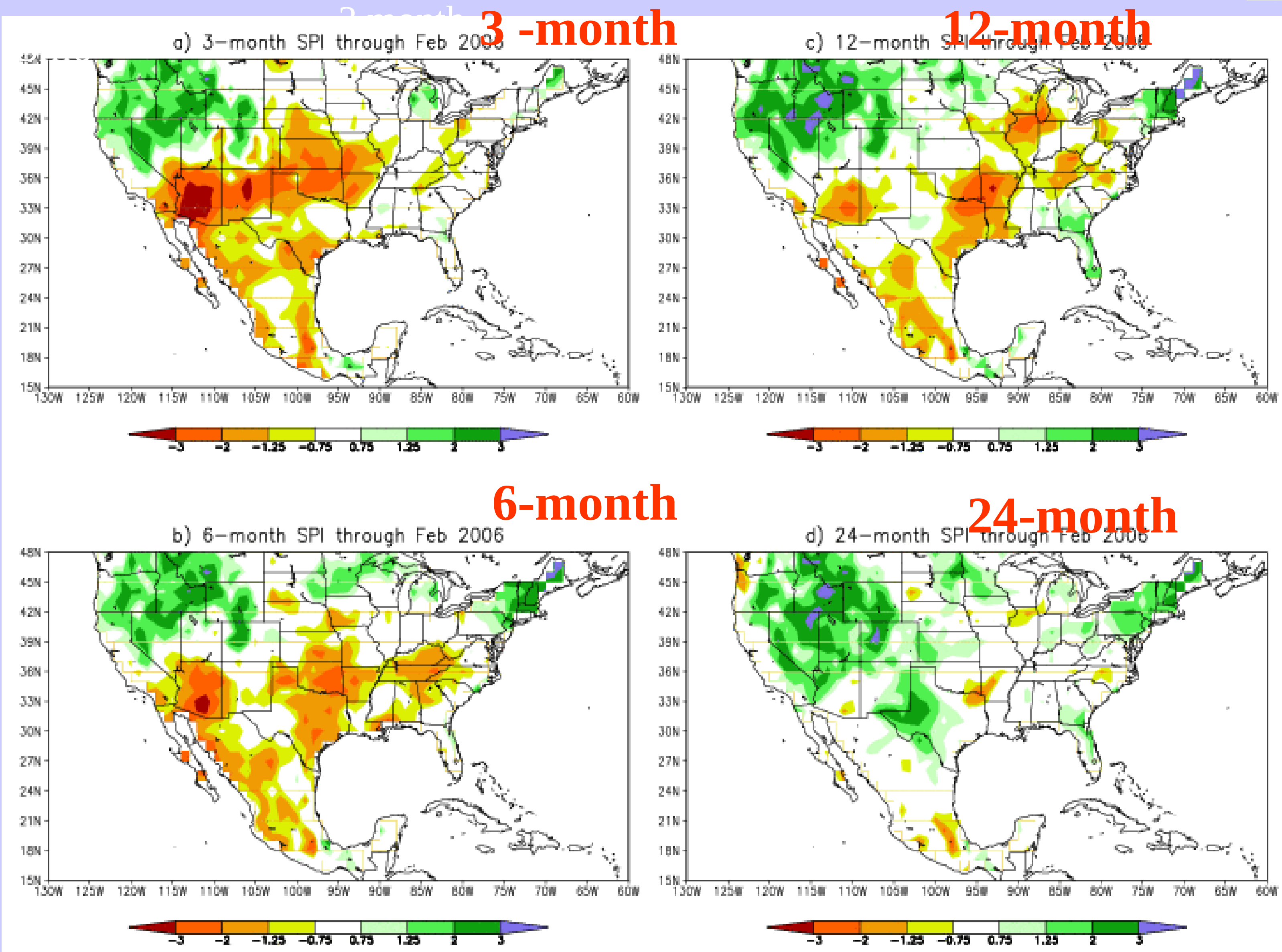
- **Based on the water balance equation;**
- **Difficult to extend to forecasts;**

PDSI(RR)

- By in large, the PDSI(RR) averaged over a large area or over a long period is close to the PDSI (Palmer) based on the climate division data. The advantages are:
  - A) The RR has mesoscale (32 km) horizontal resolution;
  - B) More weight is given to soil moisture anomalies;
  - C) More consistent with P (and other fields) because all are taken from the same analysis.

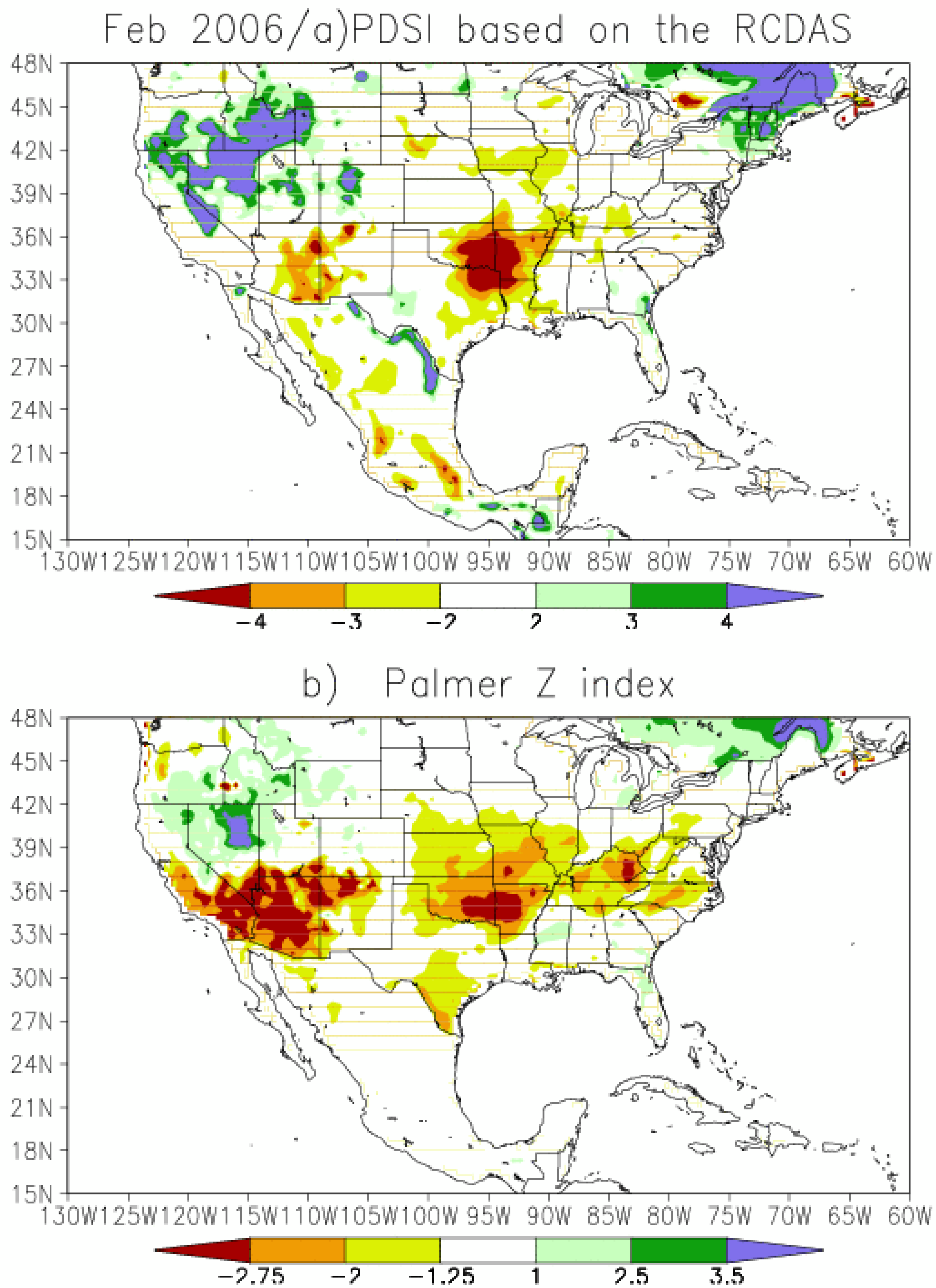
ref: **Mo and Chelliah (2006)**

SPI indices for Feb 2006



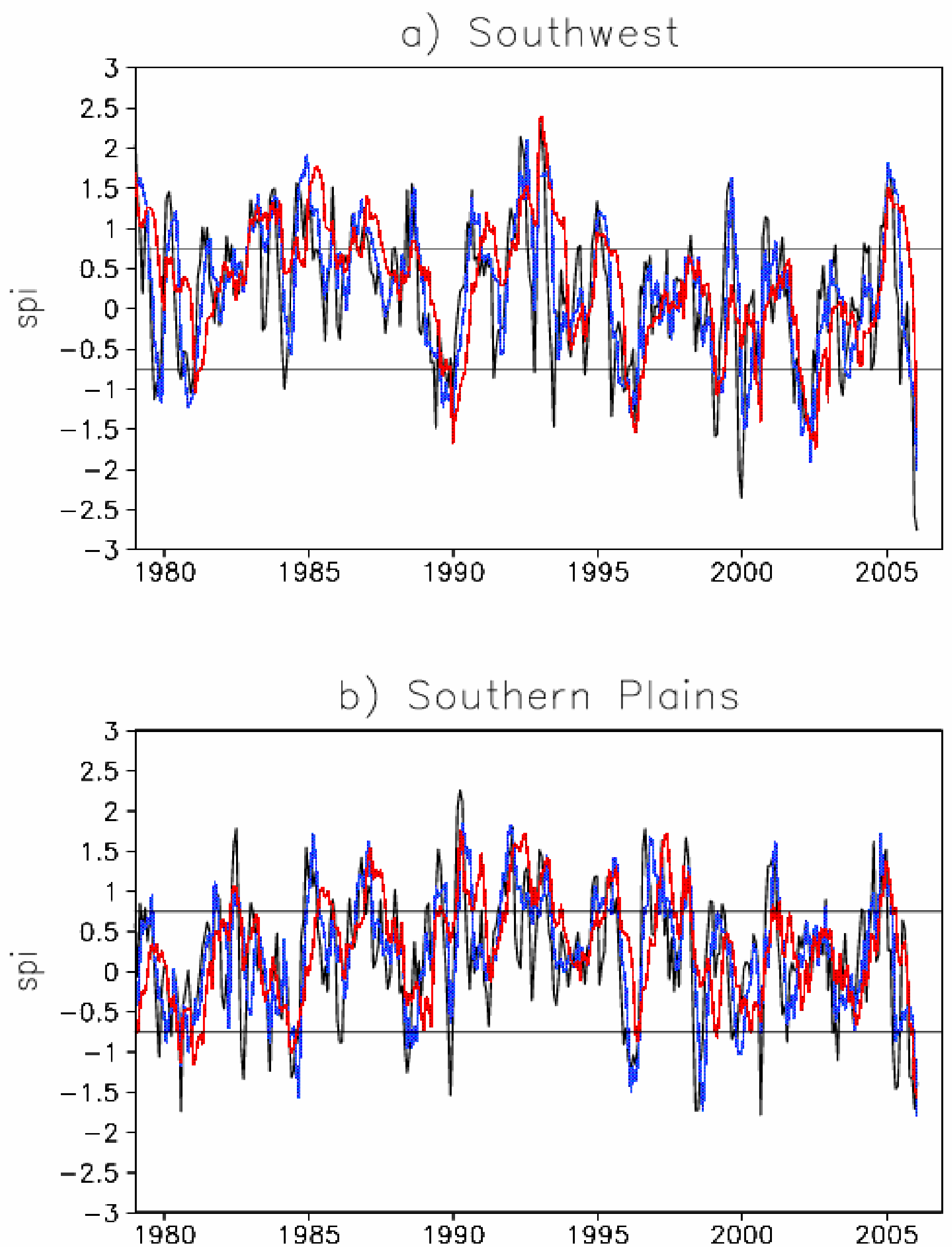
Feb 2006

Modified PDSI



Z Index

Based on the RCDAS


a) Southwest
spi
3
2.5
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2
−2.5
−3
1980
1985
1990
1995
2000
2005
b) Southern Plains
spi
3
2.5
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2
−2.5
−3
1980
1985
1990
1995
2000
2005

RCDAS Monitoring

NOAA's Climate Prediction Center (CPC) is monitoring the components of the hydrological cycle over North America using the Regional Climate Data Assimilation System (R-CDAS) which is the real-time continuation of the NCEP North American Regional Reanalysis (NARR). Details on the NARR can be found on the NARR website.

Monthly Circulation

VARIABLES	Mean and Anomaly
Sea-Level Pressure (SLP)	SLP
500-hPa Height	500-hPa Height
200-hPa Height	200-hPa Height
Moisture flux (vertically integrated)	Qx;Qy
Precipitable Water	Precipitable Water

Surface Hydrological Variables

VARIABLES	Mean and Anomaly
2-m Temperature	2-meter Temperature
Precipitation	Precipitation
Evaporation	Evaporation
2 meter Specific Humidity	2-meter Specific Humidity
Evaporation-Precipitation (E-P)	E-P
Atmospheric Column Water Vapor Flux	

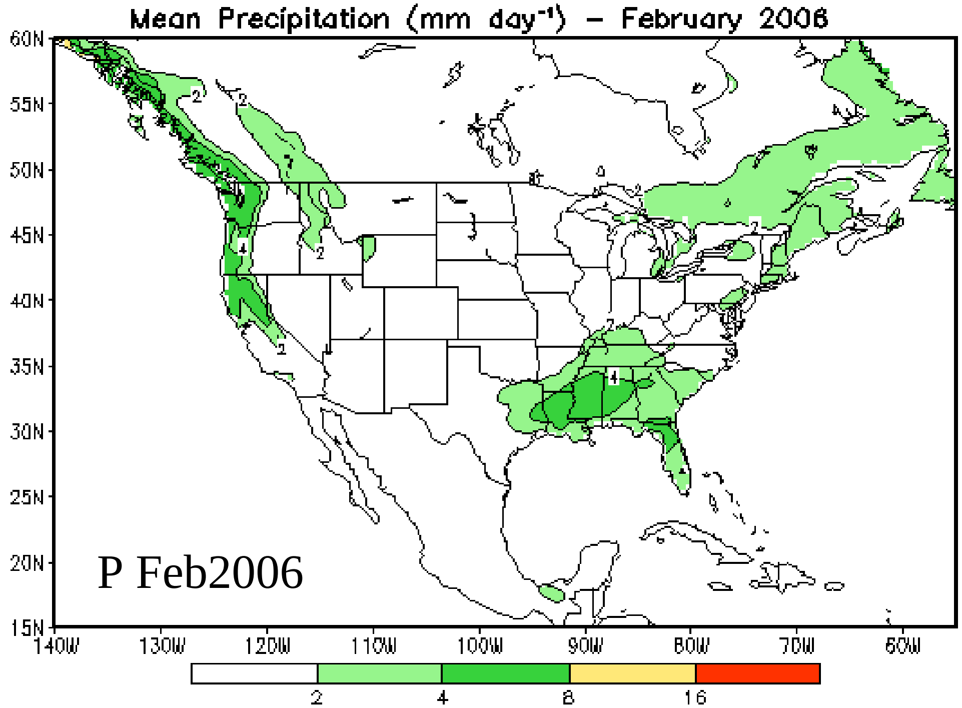
Monitoring drought seasonal, monthly & weekly Mean and anomaly (RR based)

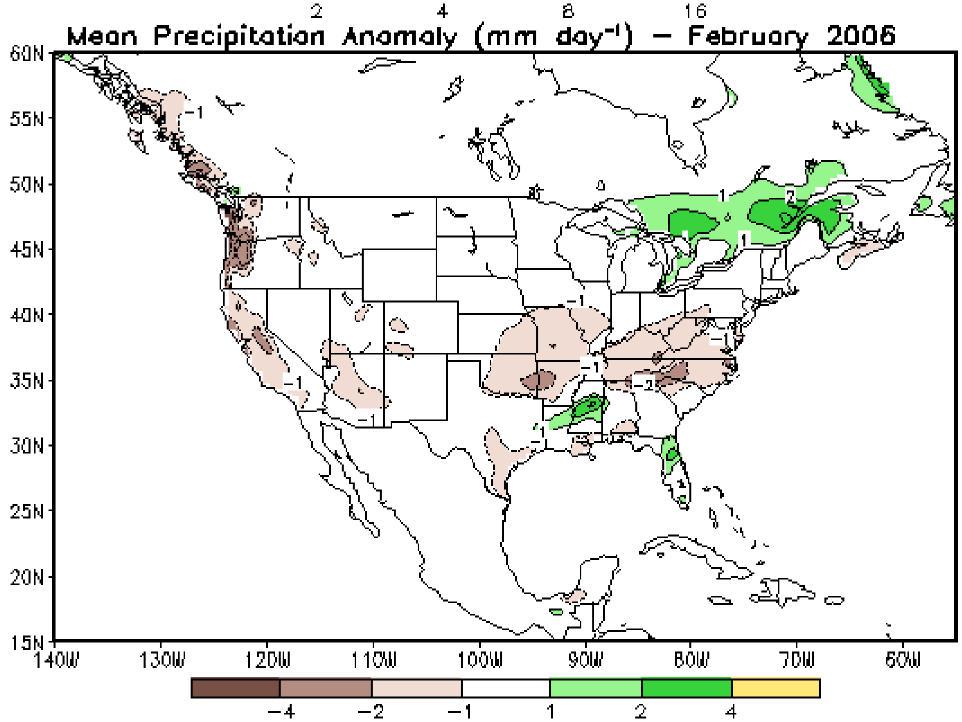
Advantages:

- 32-km based on the RCDAS;
- Atmospheric conditions and surface conditions are consistent;

Disadvantages:

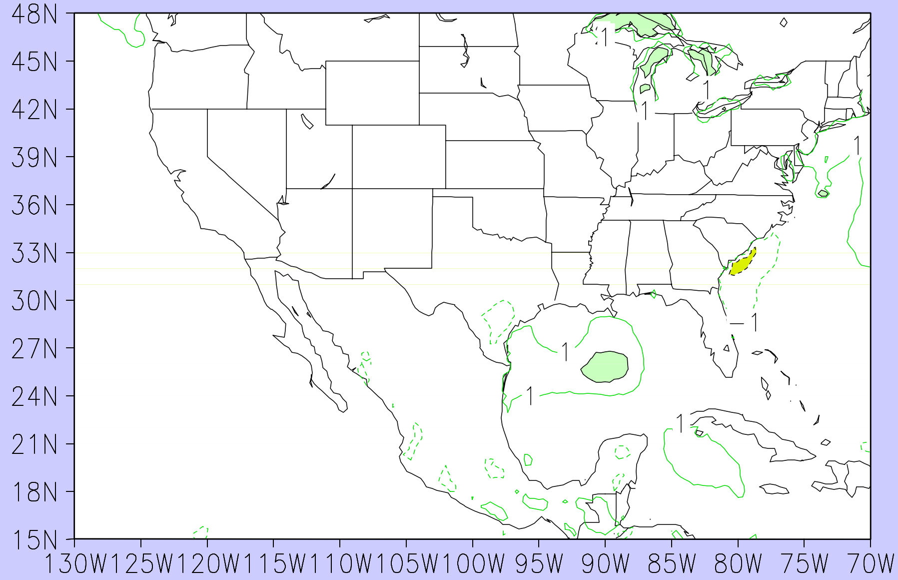
- May be too coarse;
- Model & input data dependent



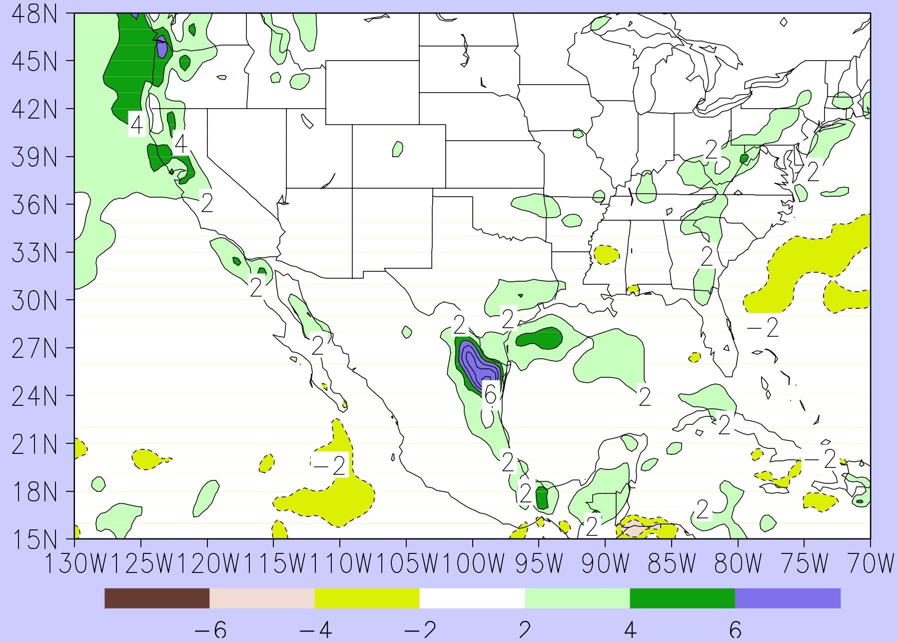


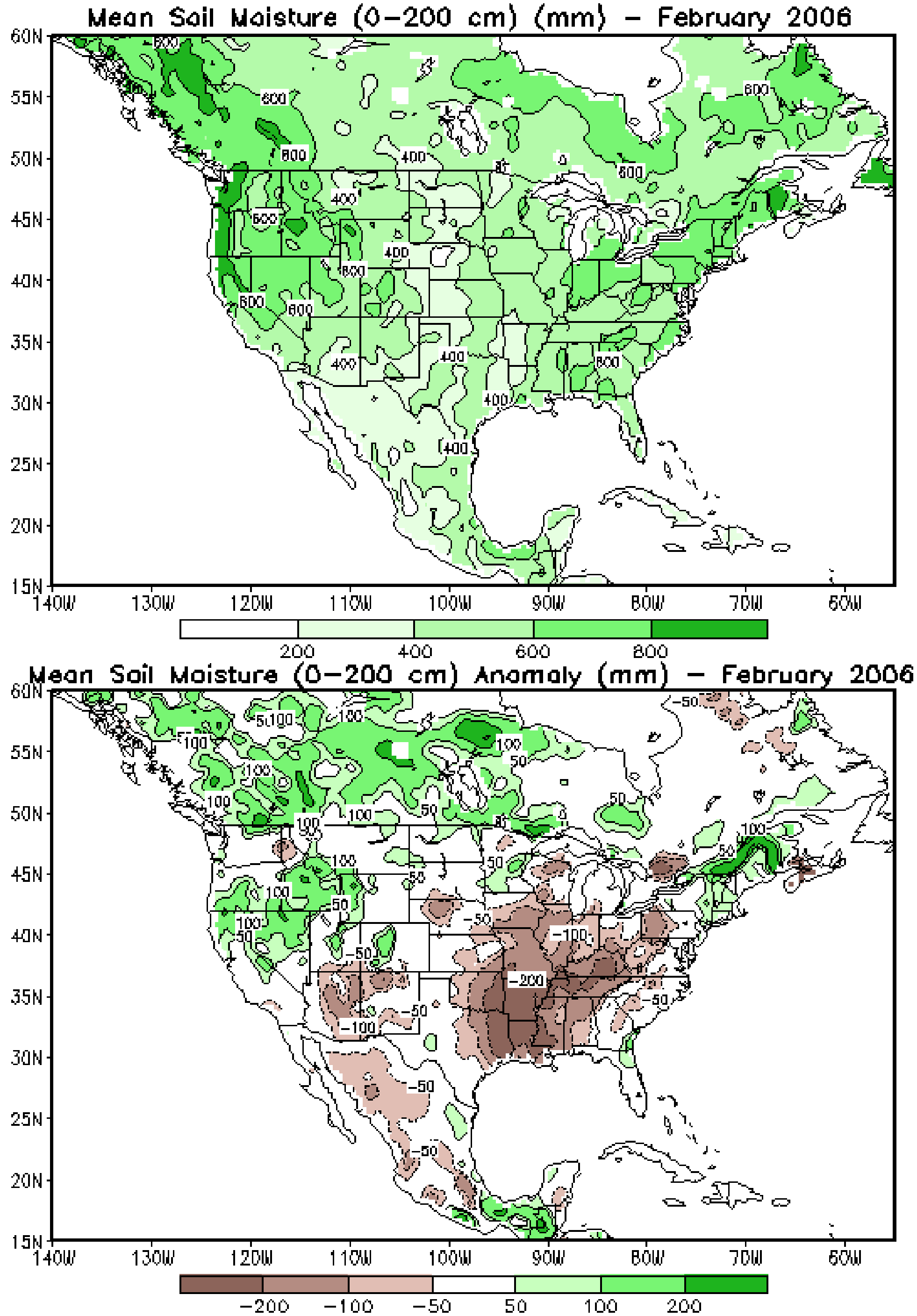
- **Atmospheric conditions:**
  850 & 200 hPa winds,
  T2m, Rh850,10m Winds , total precipitable water & Q2m;
- **Moisture budget terms;**
- **Surface conditions**
  Streamflow and runoff
  Soil conditions
  Soil moisture and soil temperature at 4 layers

a) E anom Feb 2006



b) D(Q)





Soil moisture

From 0-200cm

And anomalies for Feb 2006

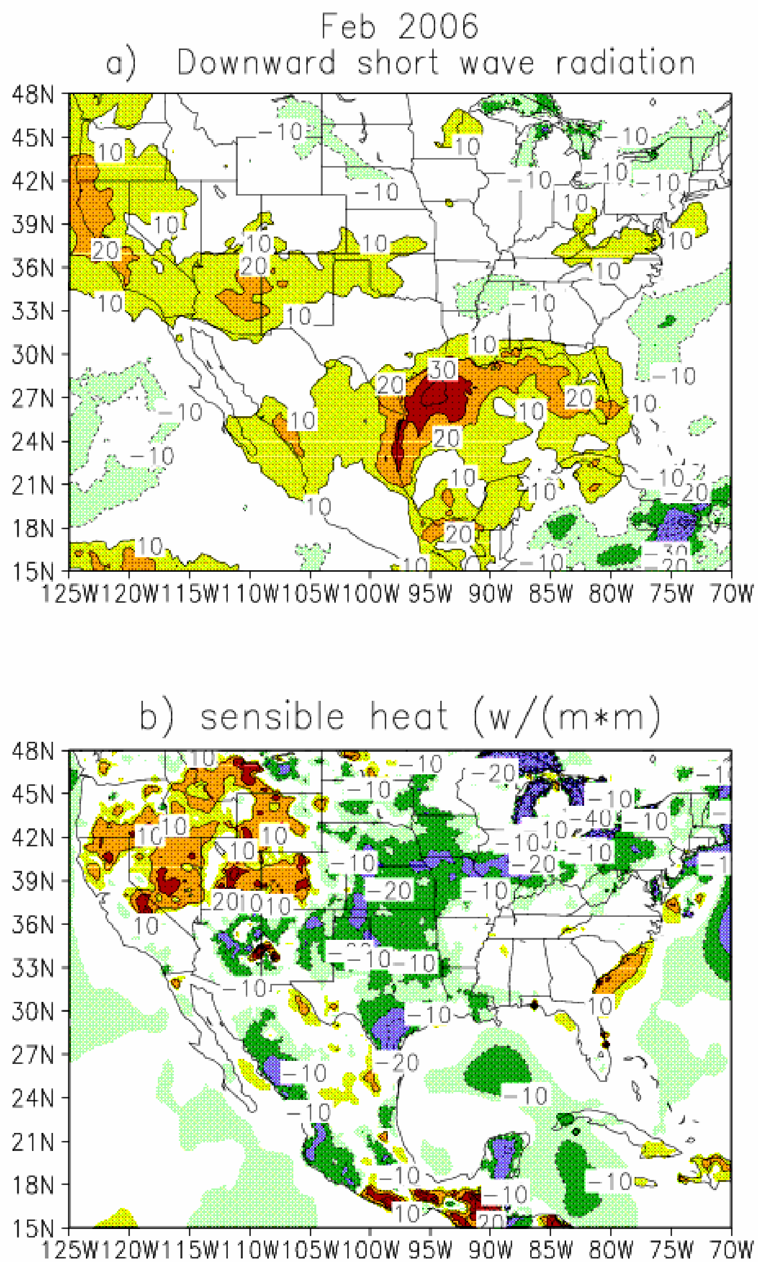
Monitoring drought

- Energy Budget terms

  Seasonal Monthly , weekly means and anomalies: downward and upward short and long wave radiation; latent and sensible heat;

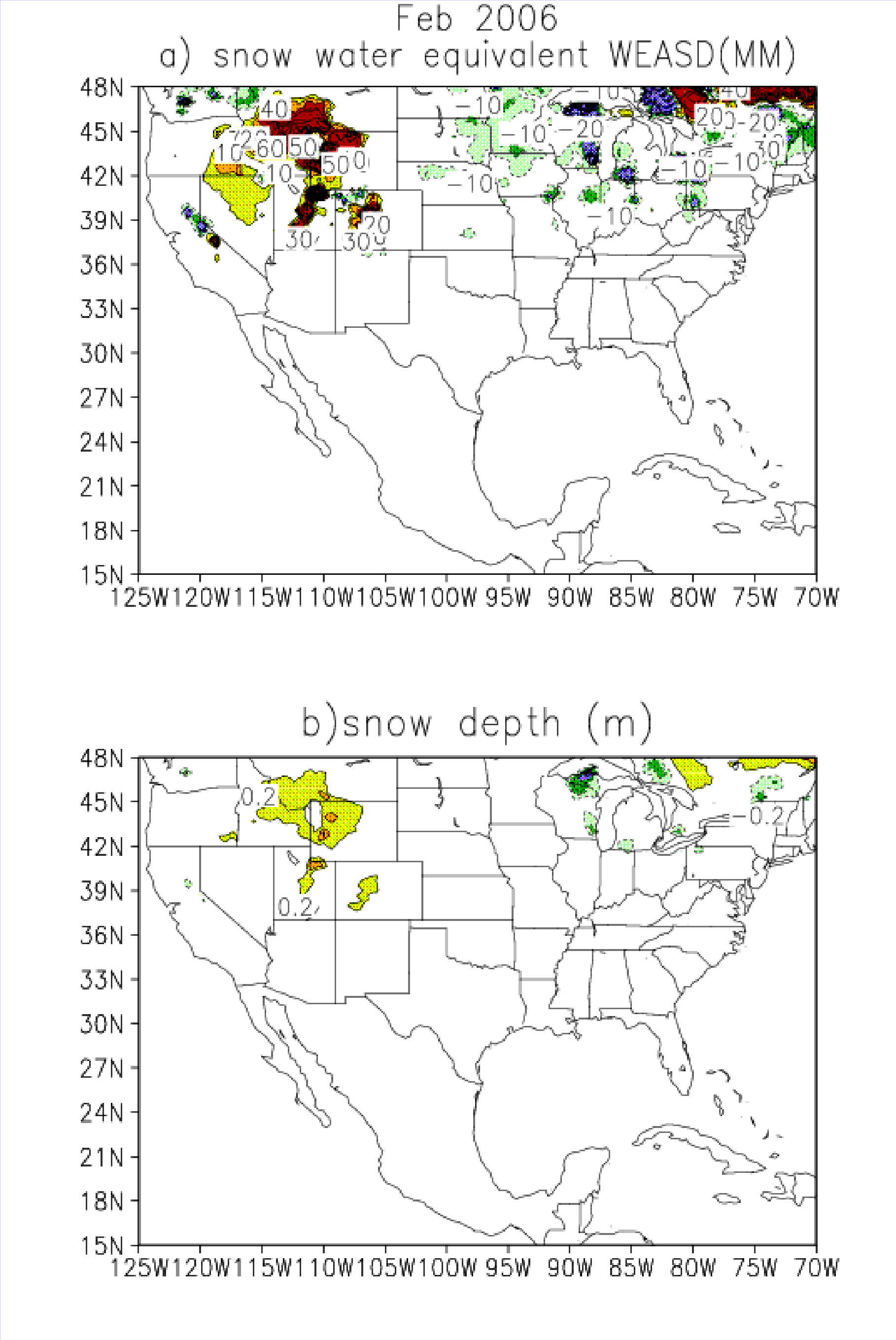
- Snow products

  Snow water equivalent; snow melt total and snow depth



Downward short wave radiation anom

Sensible heat anom



Snow water equivalent anom

Snow depth anom

NLDAS Products

- 4 NLDAS products and combine;
- Noah, Vic, Mosiac and Sac

advantages

- They are 0.125 degrees resolution

Disadvantages

Highly model dependent

Future plans

- 4 NLDAS products from 1979-present;
- Verification;
- Calibration;
- Consolidation based on anomalies
- Need your advice:

A) All products or combined ones;

B) Product list;

C) Indication of spread

Forecast products

- GFS (~ 40 km) weekly (7-day) forecasts (more than T2m, P and Soil conditions);
- Consolidated and CFS forecasts

Your input:

- A) Products;
- B) Margin of error;
- C) form of products

Conclusions

- We are in the processes to develop a dynamically-based DEWS based on the mesoscale regional reanalysis and NLDAS.
- In addition to precipitation, soil moisture from 0-200cm and four layers, we plan to use the PDSI based on RR, SPIs and surface fluxes and energetic to monitor drought near real time
- The advantages are (a) the RR and NLDAS are mesoscale, (b) all fields are consistent.
- More than one index is needed to monitor drought

NOAA Climate Prediction Services Team & CTB

We are working with the Climate Service Division to serve you.

mPDSI from the RR

- The same frame work as Palmer (1965) is adopt:

A) The water balance equation;

B) The difference between P and the expected P from the maximum conditions (CAFEC);

C) The assumption of the first order Markov process;

- The following changes were made:

A. The PE, E, runoff, total soil moisture change were taken from monthly mean RR archive;

B. Potential recharge is defined as PR=Smax-S';where Smax is the maximum total soil moisture for a given calendar month; S' is the total soil moisture at the beginning of the month;

C. Potential precipitation is assumed to be the maximum P for a given calendar month;

D. The AWC and assumption of two soil layers are no longer needed. Normalization is recalibrated

Mo and Chelliah (2006)