Augmenting Drought Early Warning efforts in the U.S.: from Grids to GAC and Beyond

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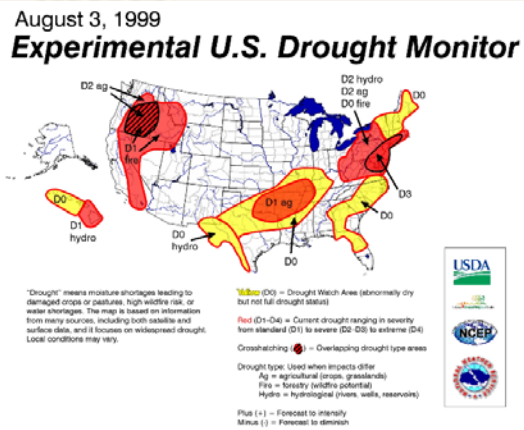
Monitoring Program Area Leader
National Drought Mitigation Center
School of Natural Resources
University of Nebraska-Lincoln

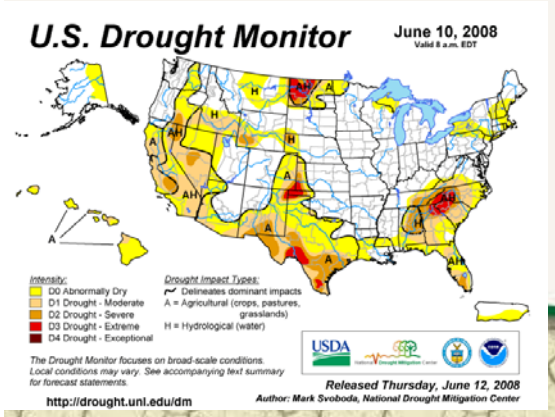
Webinar for NASA Applied Sciences Program, Water Resources Meeting, Sept. 5, 2012

The U.S. Drought Monitor

Since 1999, NOAA (CPC, NCDC, WRCC), USDA, and the NDMC have produced a weekly composite drought map -- the U.S. Drought Monitor -- with input from numerous federal and non-federal agencies

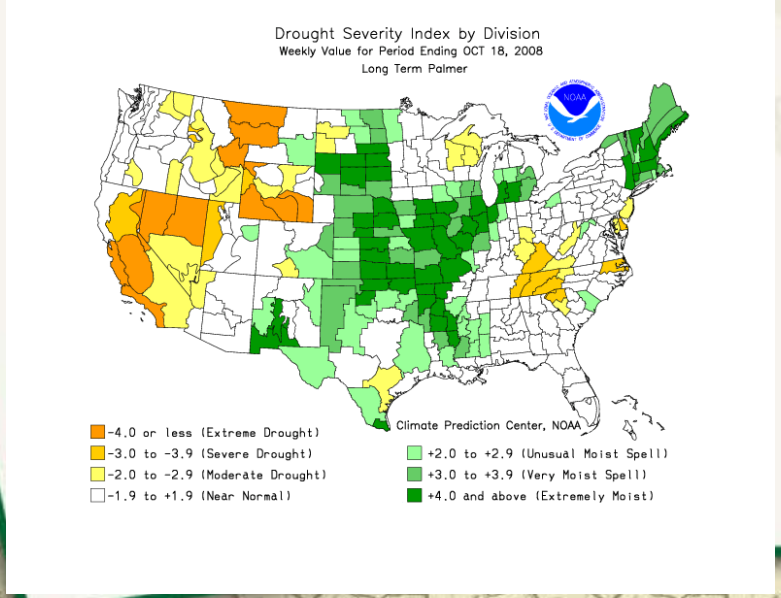
- **Western Region Climate Center on board 2008**
- **11 authors in all**
- **Incorporate relevant information and products from all entities (and levels of government) dealing with drought (RCC's, SC's, federal/state agencies, etc.) *(~350 experts)***

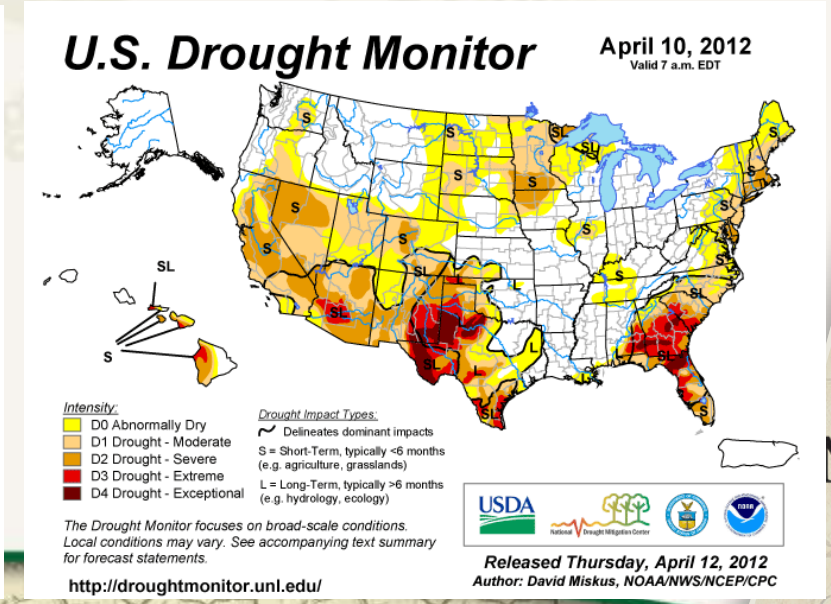




Approaches to Drought Assessment

- Single index or indicator (parameter)
- Multiple indices or indicators
- *Composite (or "hybrid") Indicator*





U.S. Drought Monitor Map

Drought Intensity Categories

D0 **Abnormally Dry** **(30%tile)**

D1 Drought – **Moderate** **(20%tile)**

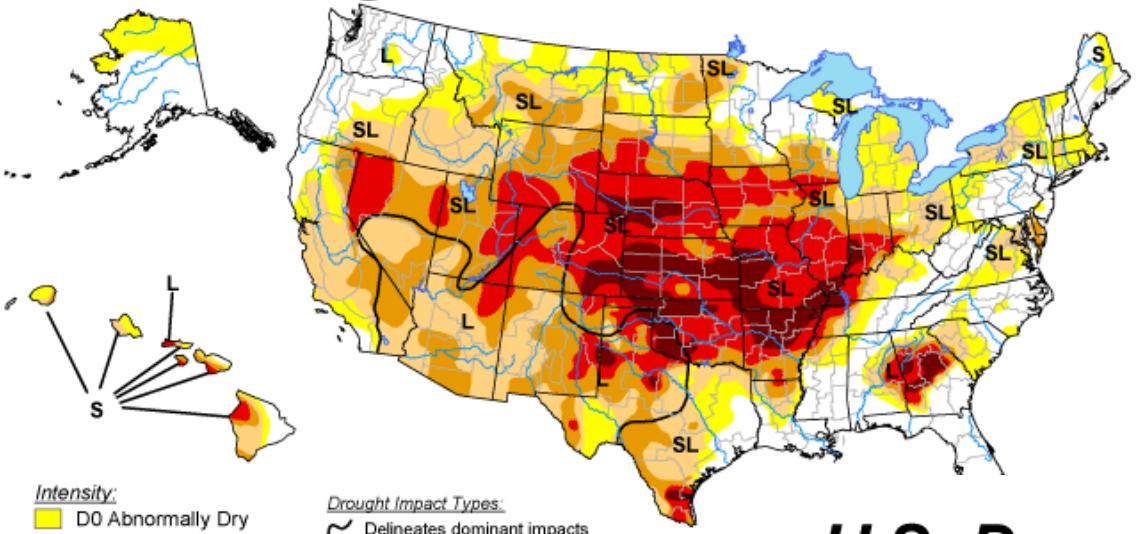
D2 Drought – **Severe** **(10%tile)**

D3 Drought – **Extreme** **(5%tile)**

D4 Drought – **Exceptional** **(2%tile)**

U.S. Drought Monitor

August 28, 2012
Valid 7 a.m. EDT



Intensity:
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:
Delineates dominant impacts
S = Short-Term, typically <6 months (e.g. agriculture, grasslands)
L = Long-Term, typically >6 months (e.g. hydrology, ecology)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

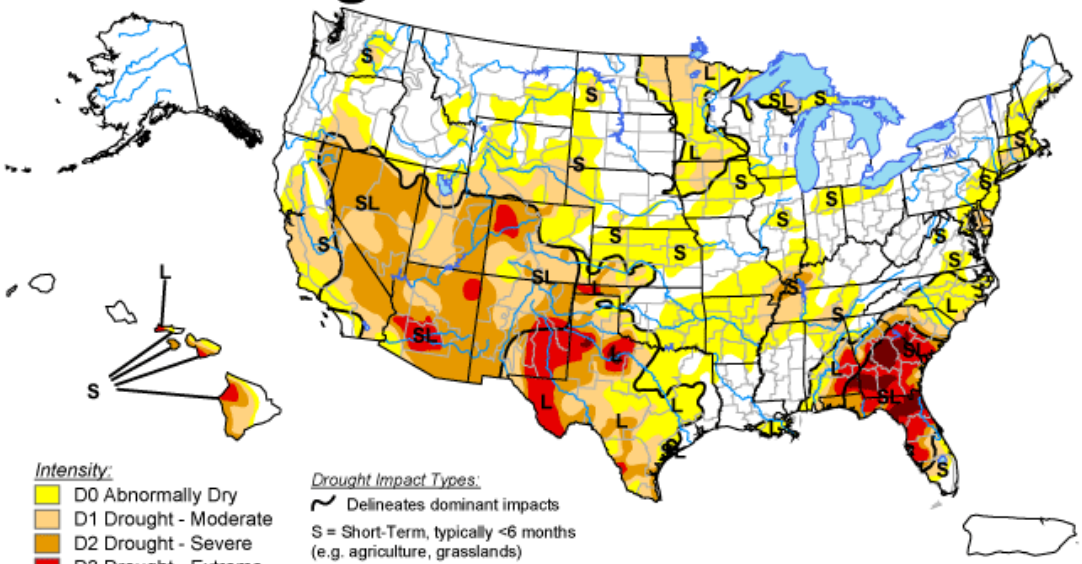
USDA

Released
Author: Brian Fuchs,

http://droughtmonitor.unl.edu/

U.S. Drought Monitor

May 22, 2012
Valid 7 a.m. EDT



Intensity:
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

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The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

USDA

Released Thursday, May 24, 2012
Author: Brad Rippey, U.S.Department of Agriculture

http://droughtmonitor.unl.edu/

U.S. Drought Monitor

Integrates Key Drought Indicators:

- Palmer Drought Index
- SPI
- KBDI
- Modeled Soil Moisture
  - NLDAS
- 7-Day Avg. Streamflow
- Precipitation Anomalies

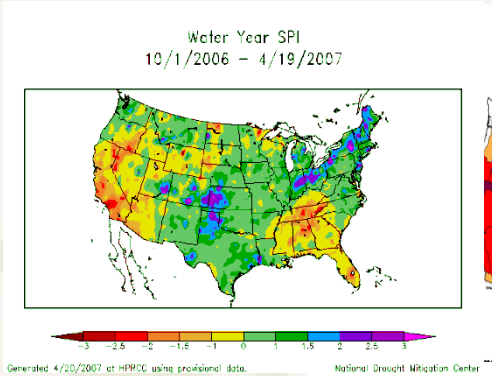
Growing Season:

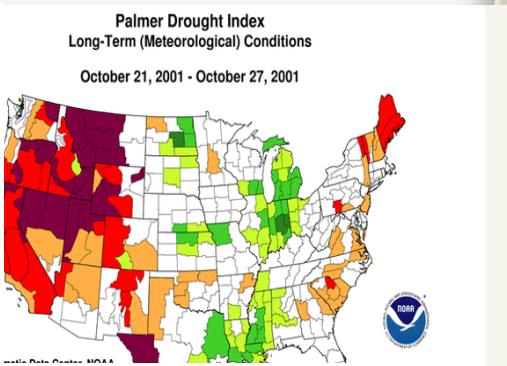
- Crop Moisture Index
- Sat. Veg. Health Index
- VegDRI/ESI/etc.
- Soil Moisture
- Mesonets
  - State/Regional

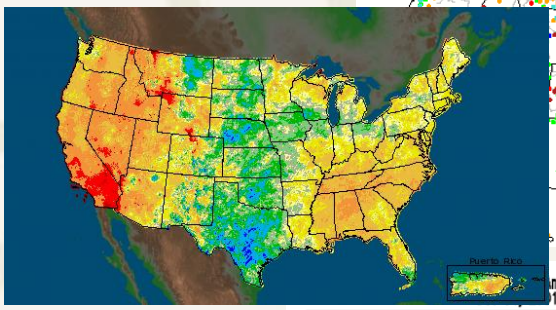
In The West:

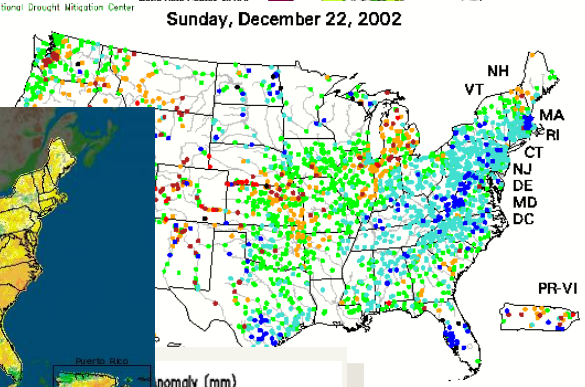
- SWSI
- Reservoir levels
- Snowpack (SNOTEL)
- SWE
- Streamflow

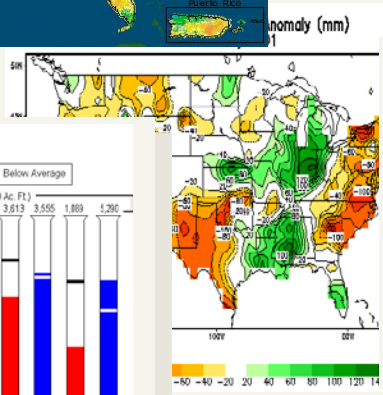
Created in ArcGIS

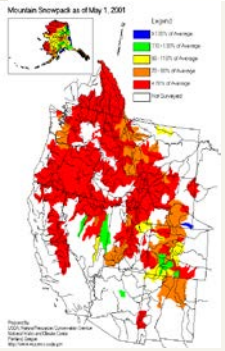


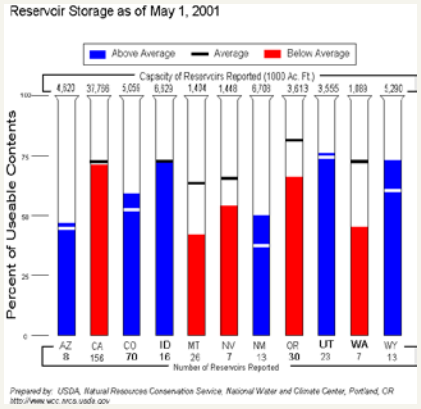








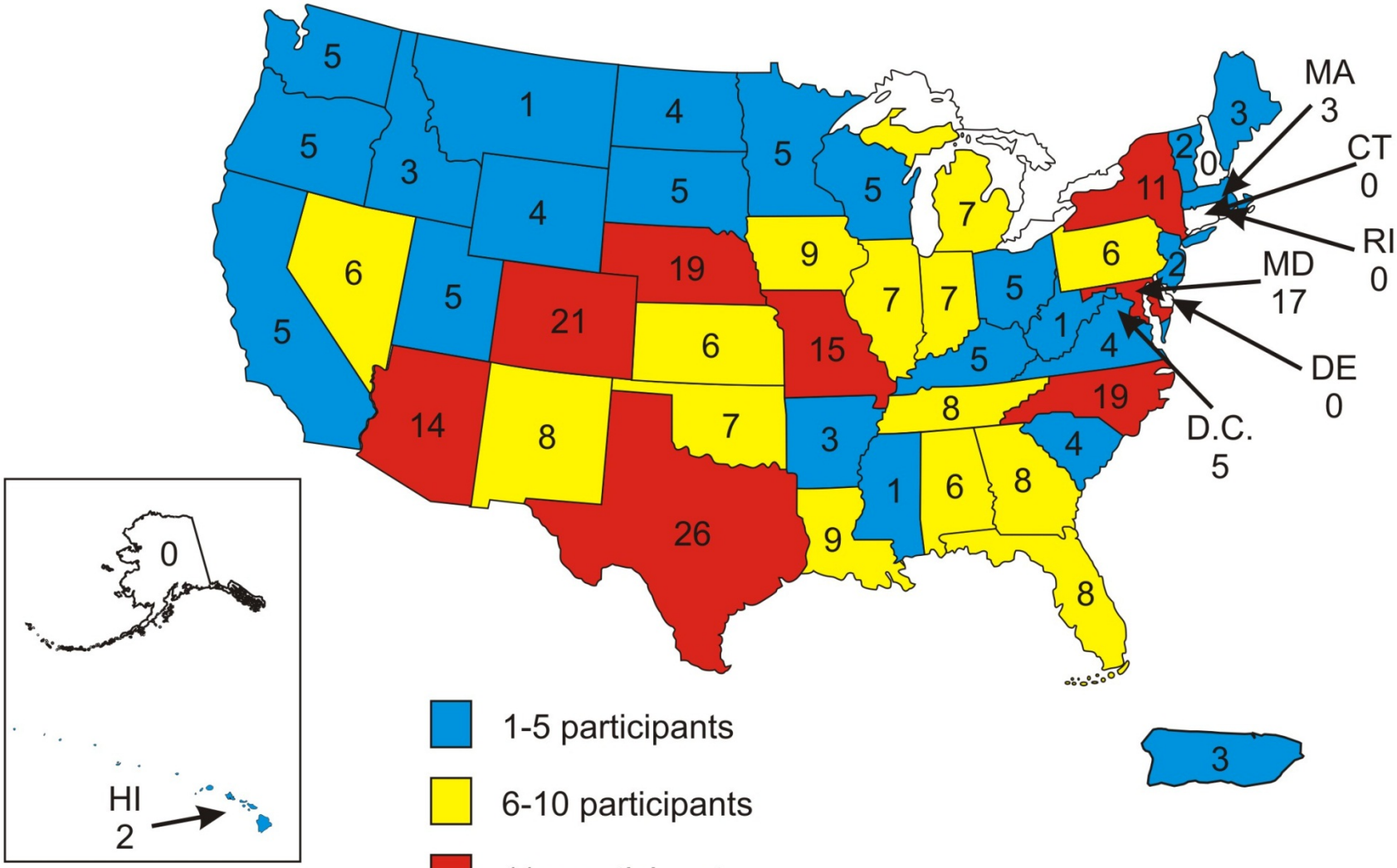




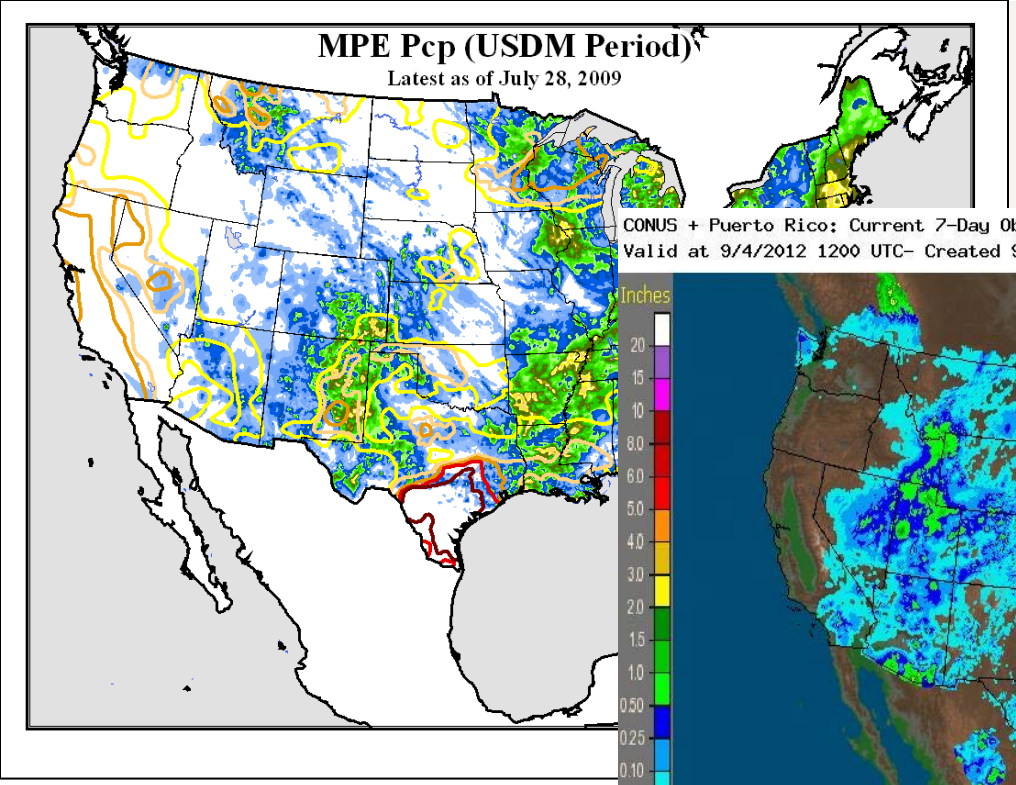
National Drought Mitigation Center

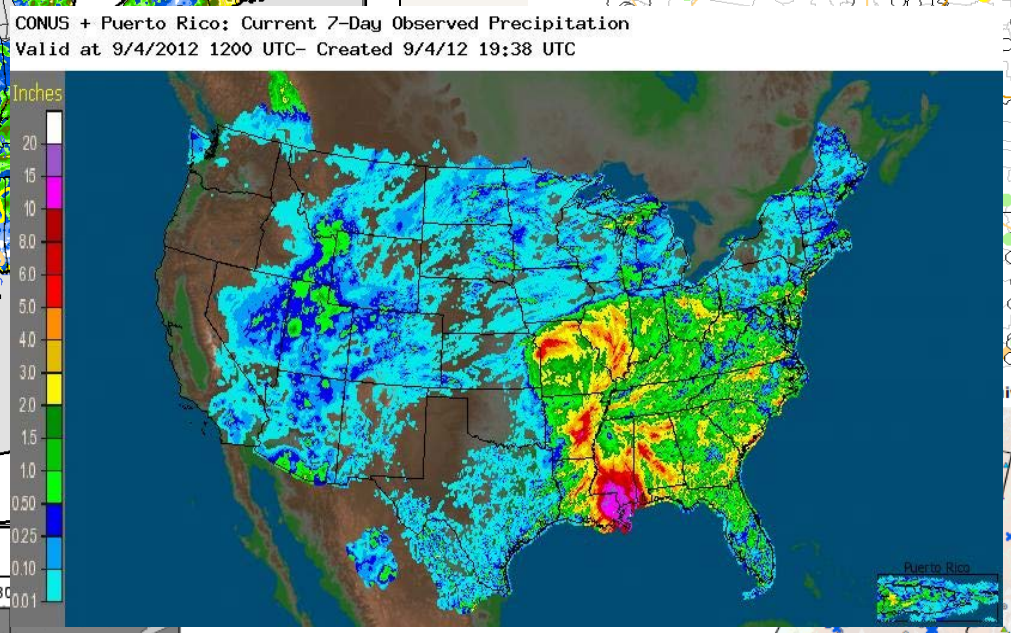
USDM Listserve Subscribers

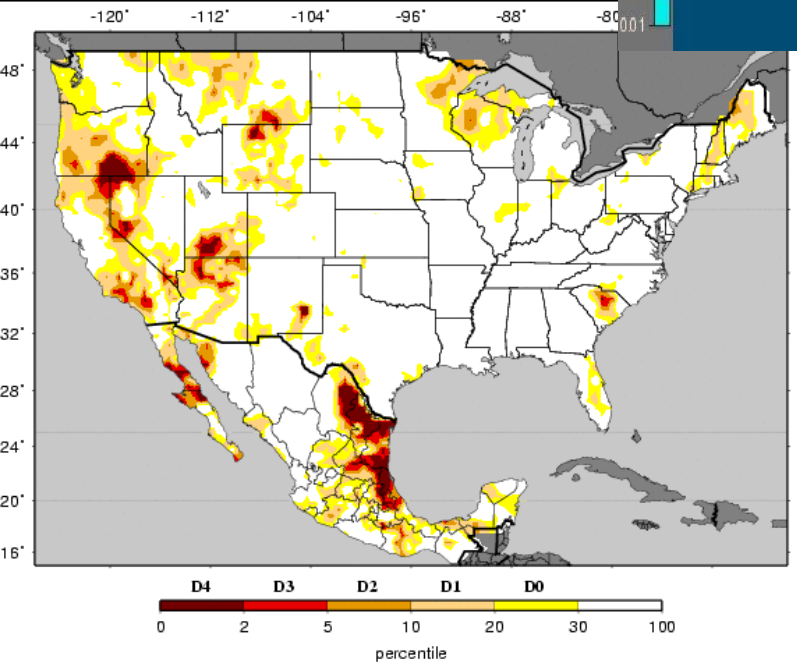
(as of August 10, 2012)

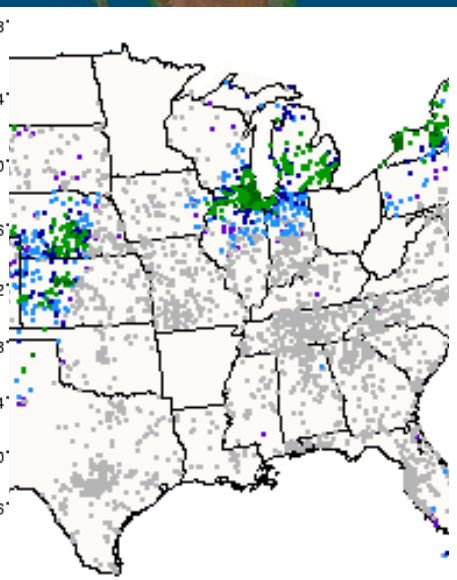


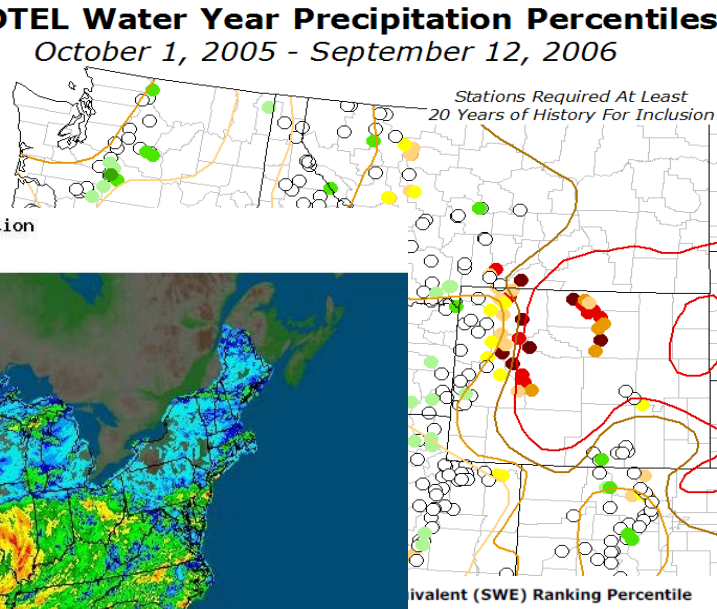
Total: 335 (does not include 1 participant from Canada)

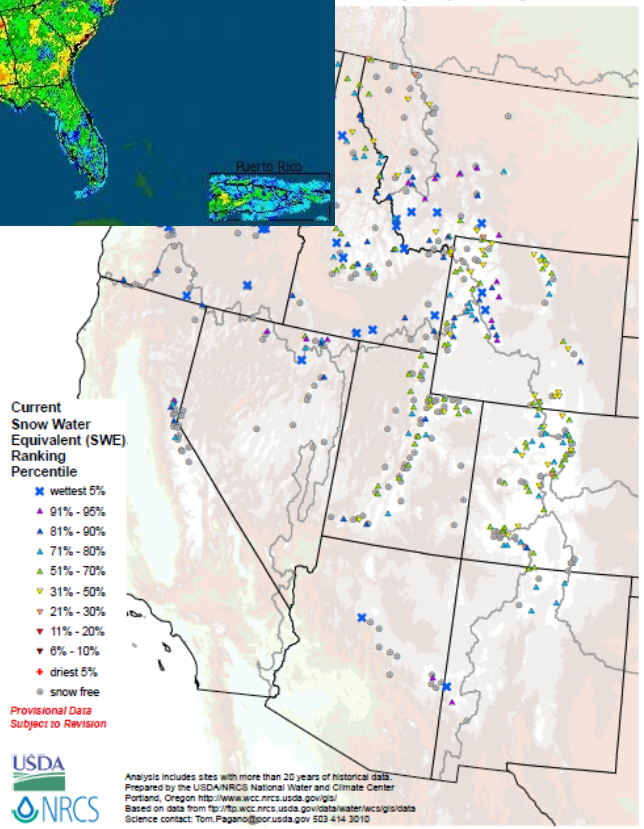

MPE Pcp (USDM Period)
Latest as of July 28, 2009


CONUS + Puerto Rico: Current 7-Day Observed Precipitation
Valid at 9/4/2012 1200 UTC- Created 9/4/12 19:38 UTC
Inches
20
15
10
8.0
6.0
5.0
4.0
3.0
2.0
1.5
1.0
0.50
0.25
0.10
0.01
Puerto Rico


-120°
-112°
-104°
-96°
-88°
48°
44°
40°
36°
32°
28°
24°
20°
16°
D4
D3
D2
D1
D0
0
2
5
10
20
30
100
percentile

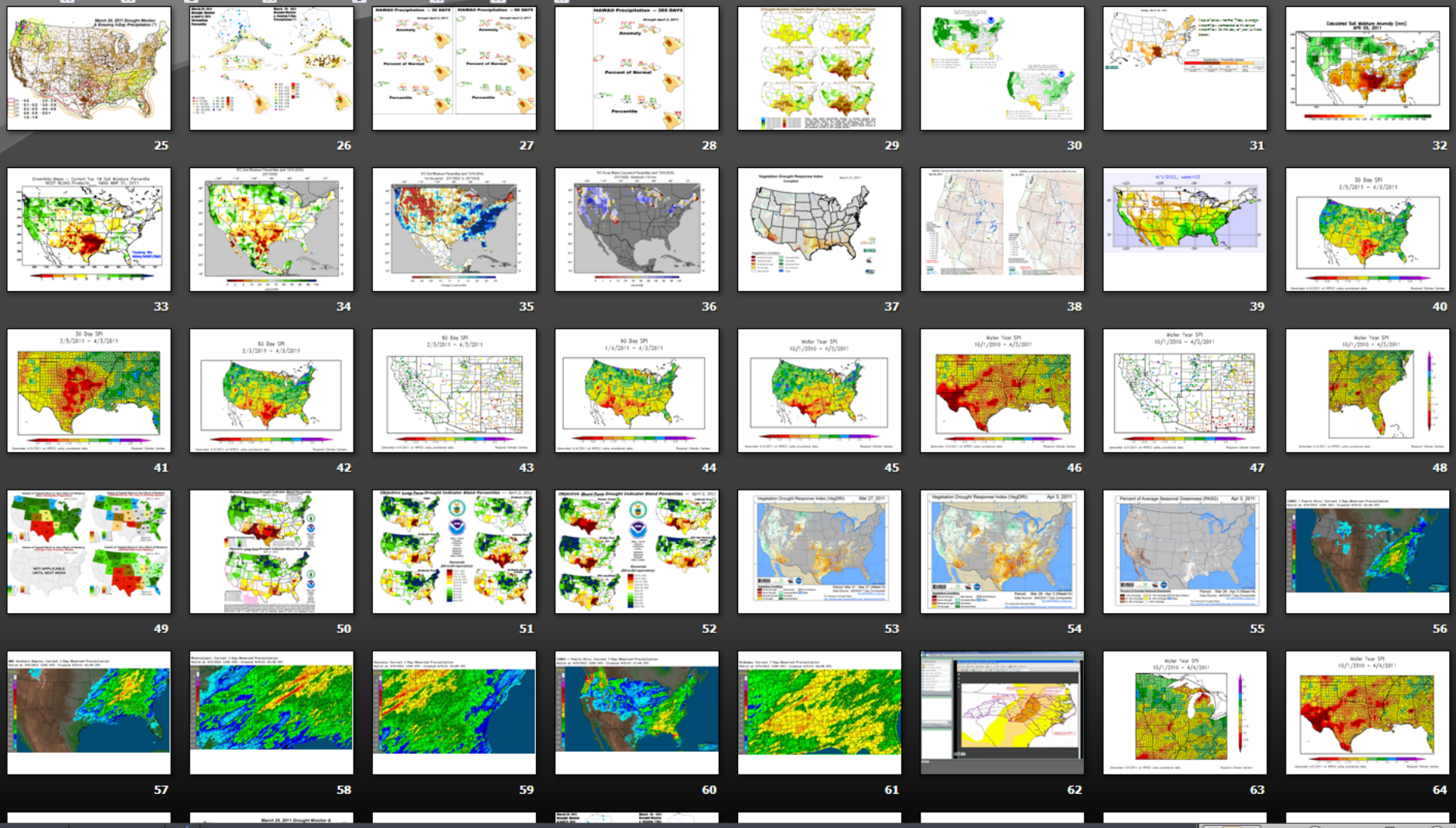

48°
44°
40°
36°
32°
28°
24°
20°
16°


SNOTEL Water Year Precipitation Percentiles
October 1, 2005 - September 12, 2006
Stations Required At Least
20 Years of History For Inclusion


ivalent (SWE) Ranking Percentile
Current
Snow Water
Equivalent (SWE)
Ranking
Percentile
wettest 5%
91% - 95%
81% - 90%
71% - 80%
51% - 70%
31% - 50%
21% - 30%
11% - 20%
6% - 10%
driest 5%
snow free
Provisional Data
Subject to Revision
USDA
NRCS
Analysis includes sites with more than 20 years of historical data.
Prepared by the USDA/NRCS National Water and Climate Center
Portland, Oregon http://www.wcc.nrcs.usda.gov/gis/
Based on data from ftp://ftp.wcc.nrcs.usda.gov/data/water/wcs/gis/data
Science contact: Tom.Pagano@por.usda.gov 503 414 3010

USDM prep inputs 110405 - Microsoft PowerPoint

Home Insert Design Animations Slide Show Review View Add-Ins



Slide Sorter "Office Theme" 66%

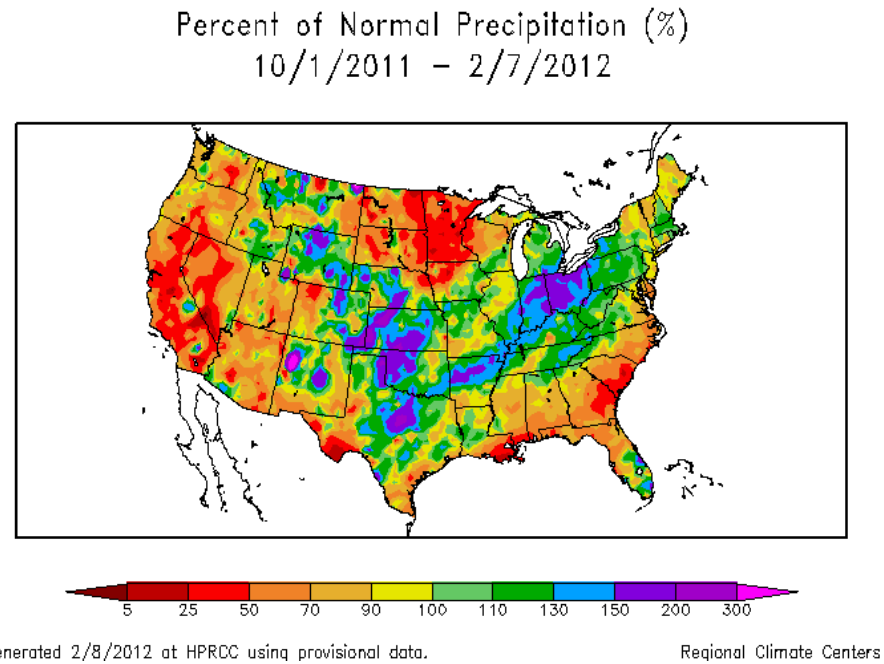
University of Nebraska Lincoln

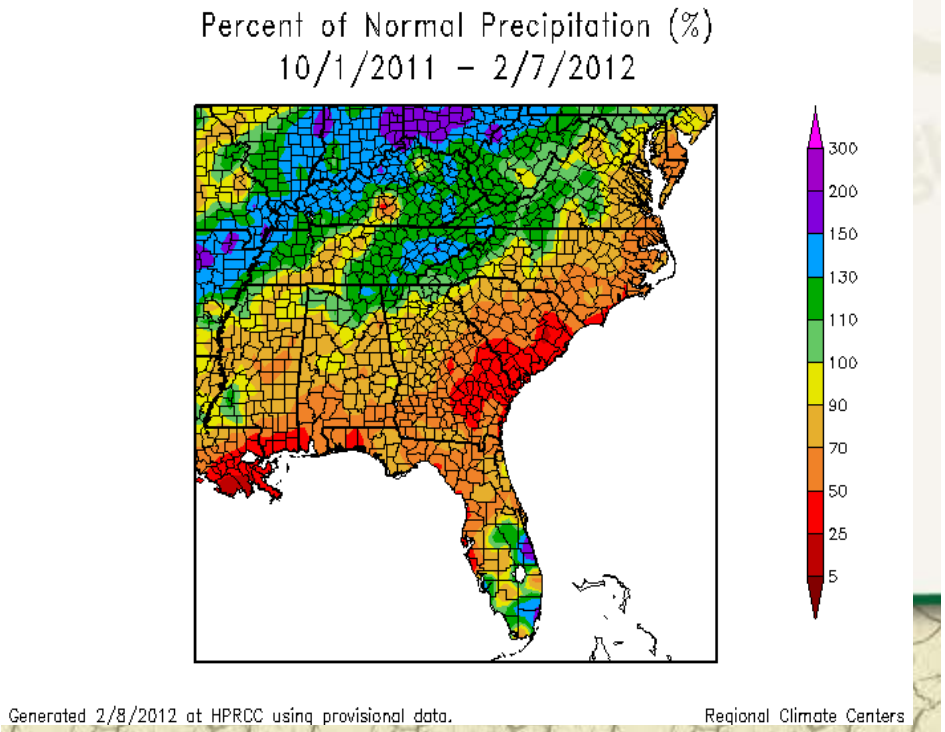
National Drought Mitigation Center

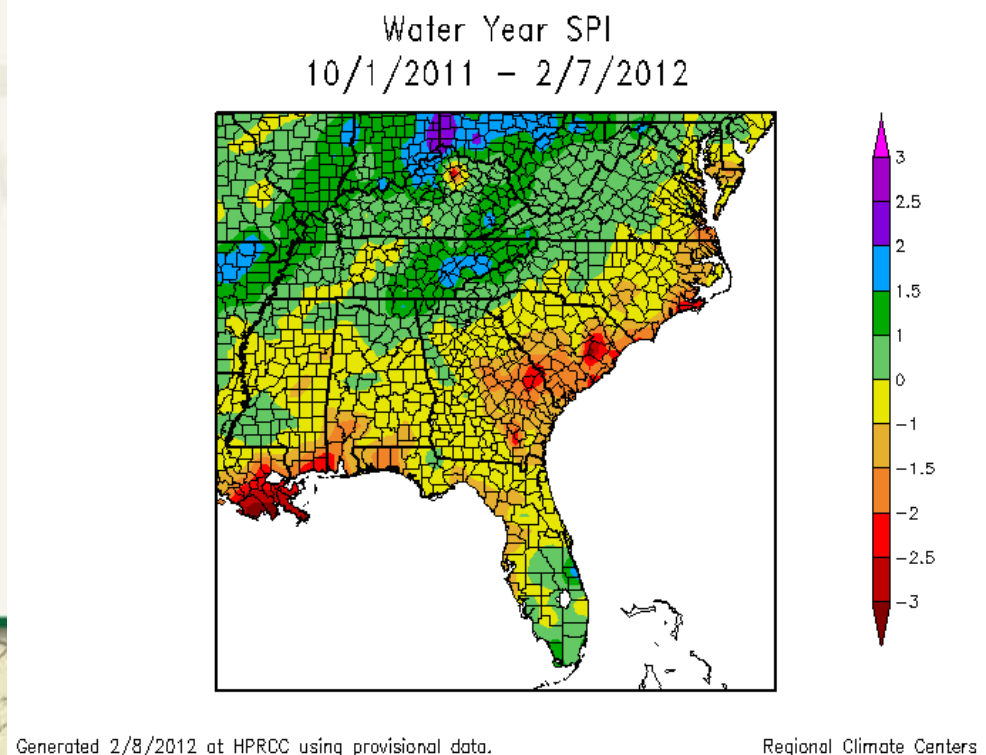
Precipitation, Streamflow and Other Indicators

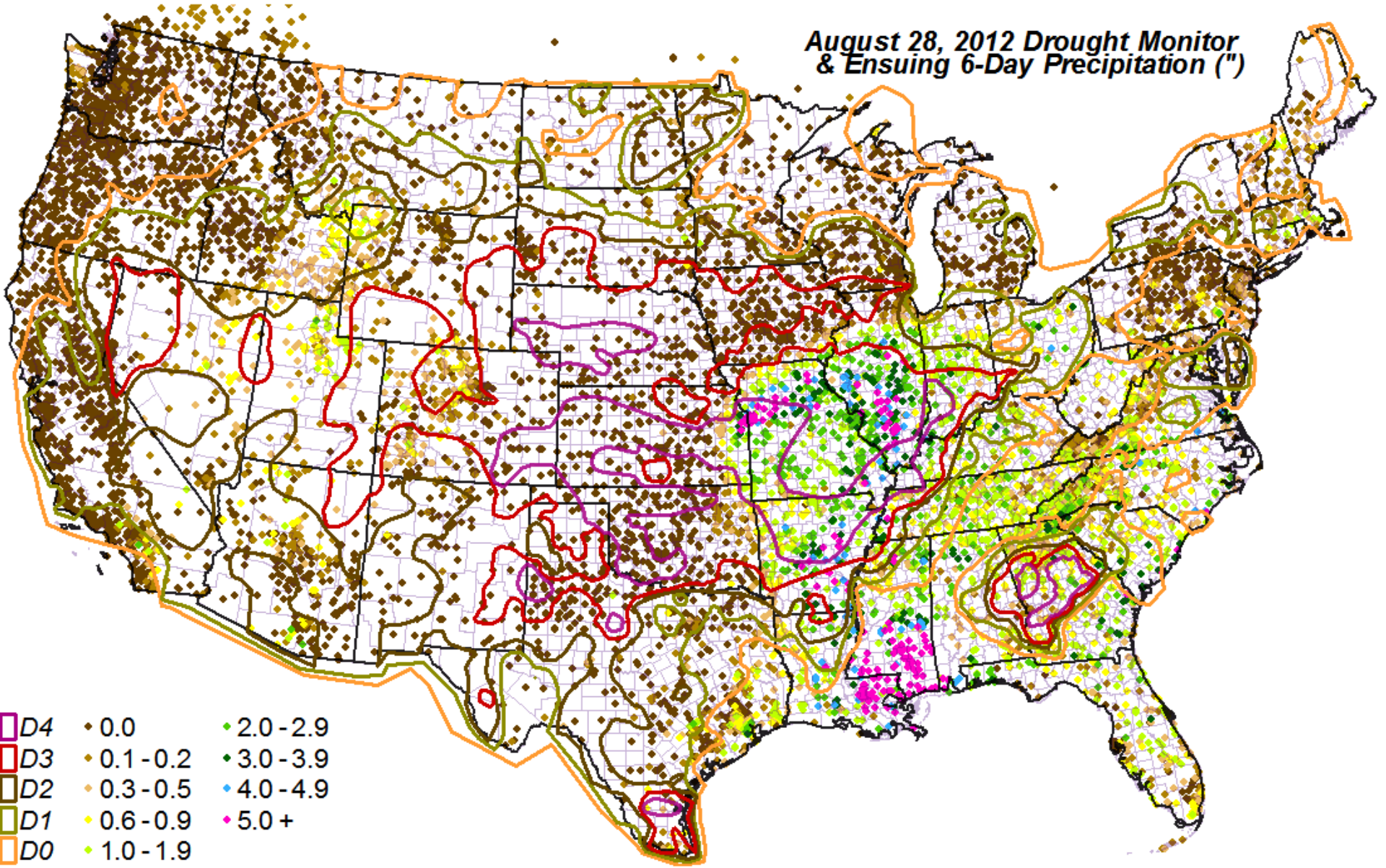
- Typically look at the following suite of products at **30-**, **60-**, and **90-** days, **Year-to-date**, **Water Year-to-date**, **growing season**, **12**-months and **24** months (out to **60** months in the West).

Applied Climate Information System (ACIS) is a key player…..

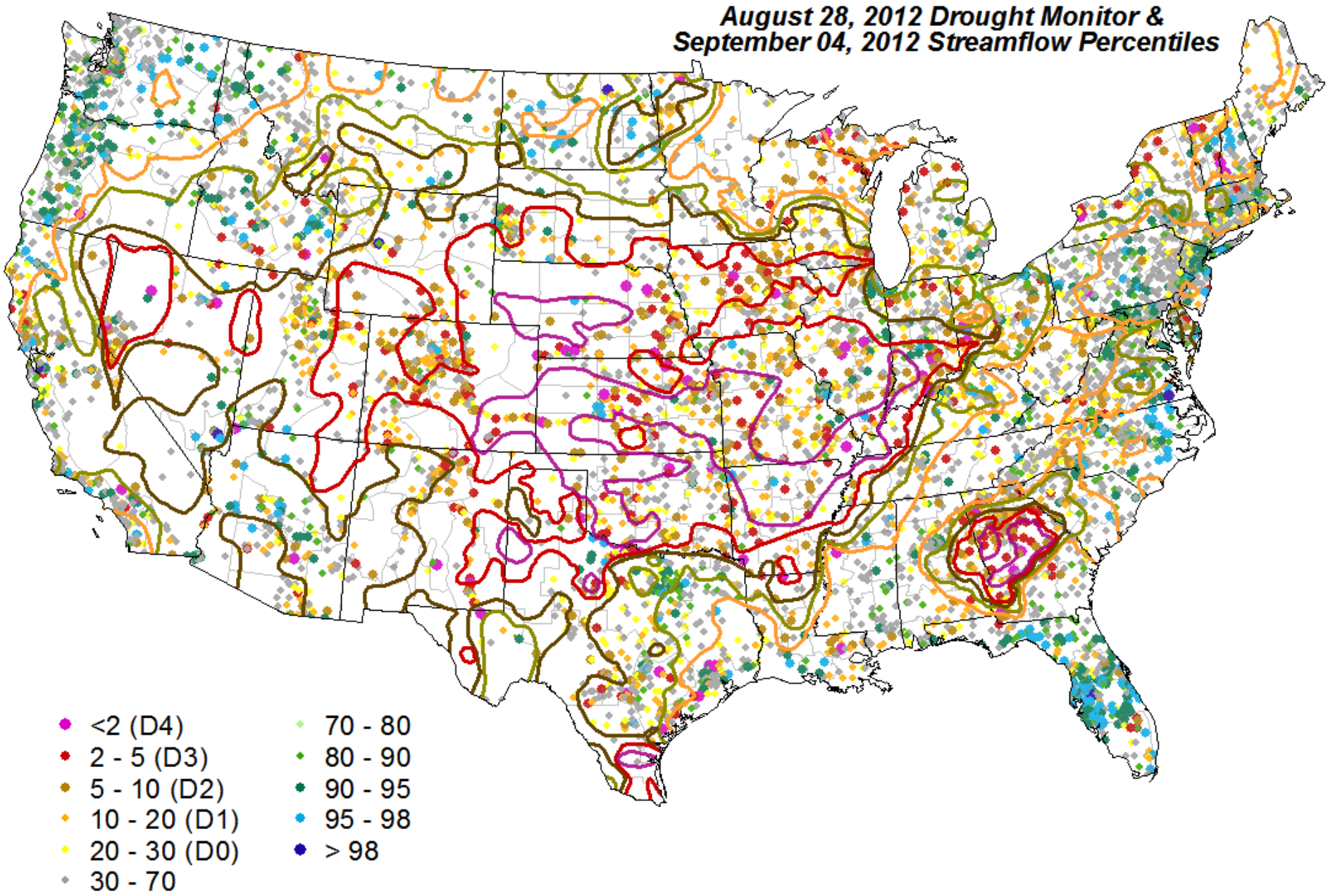




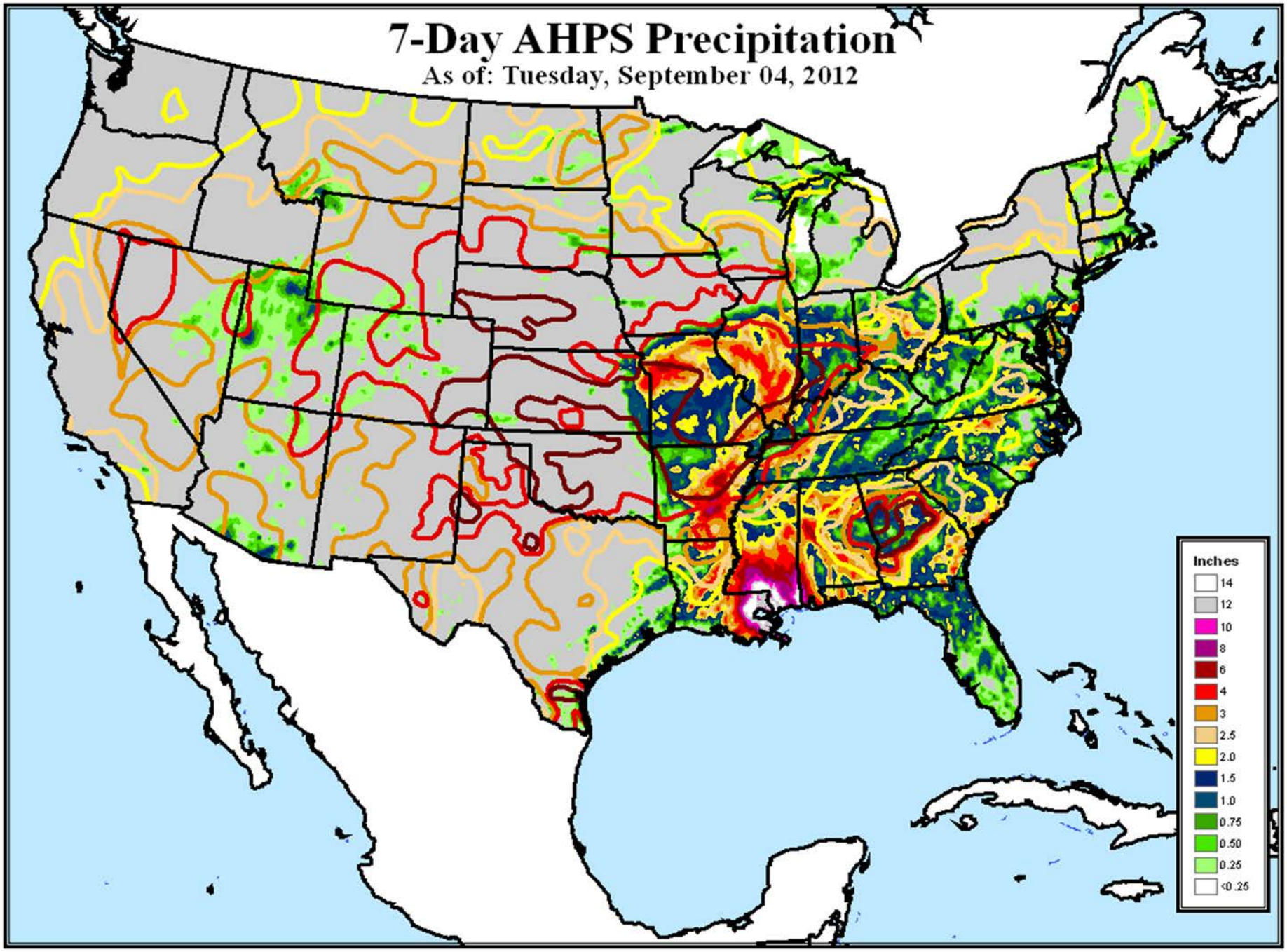


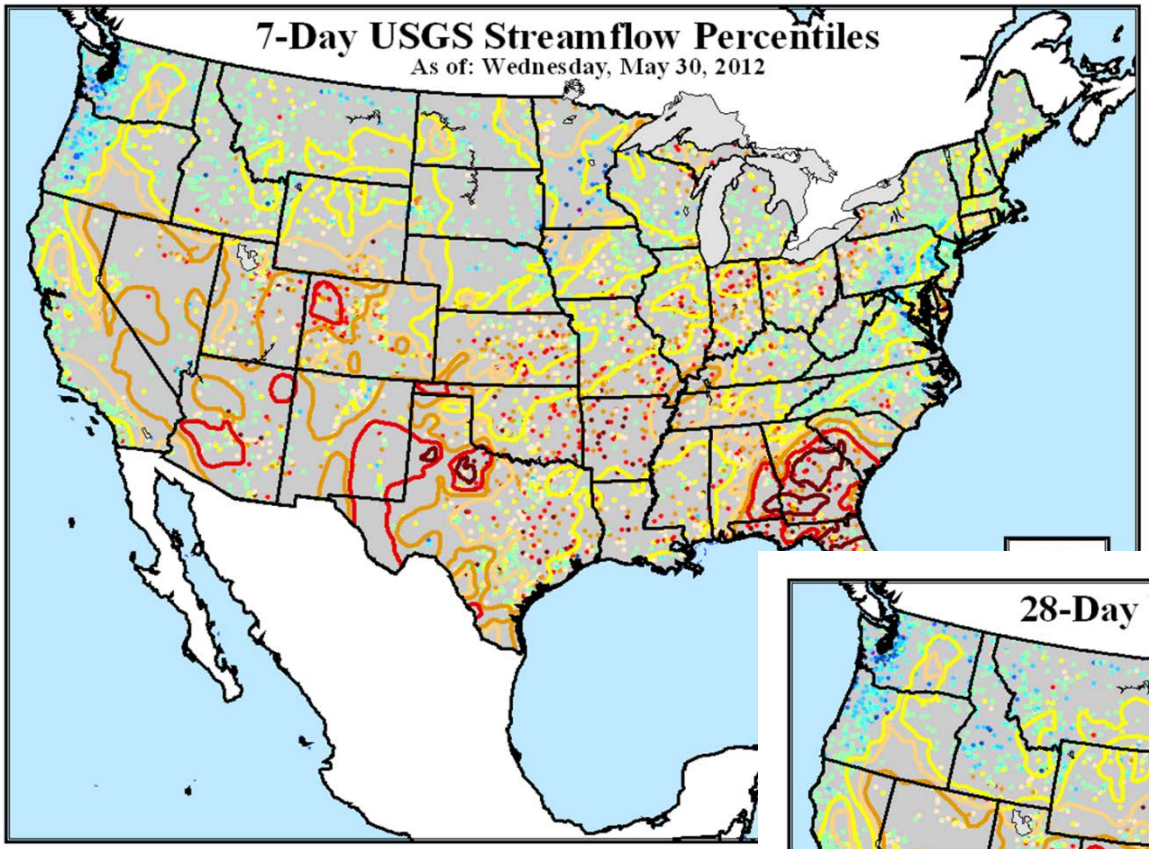


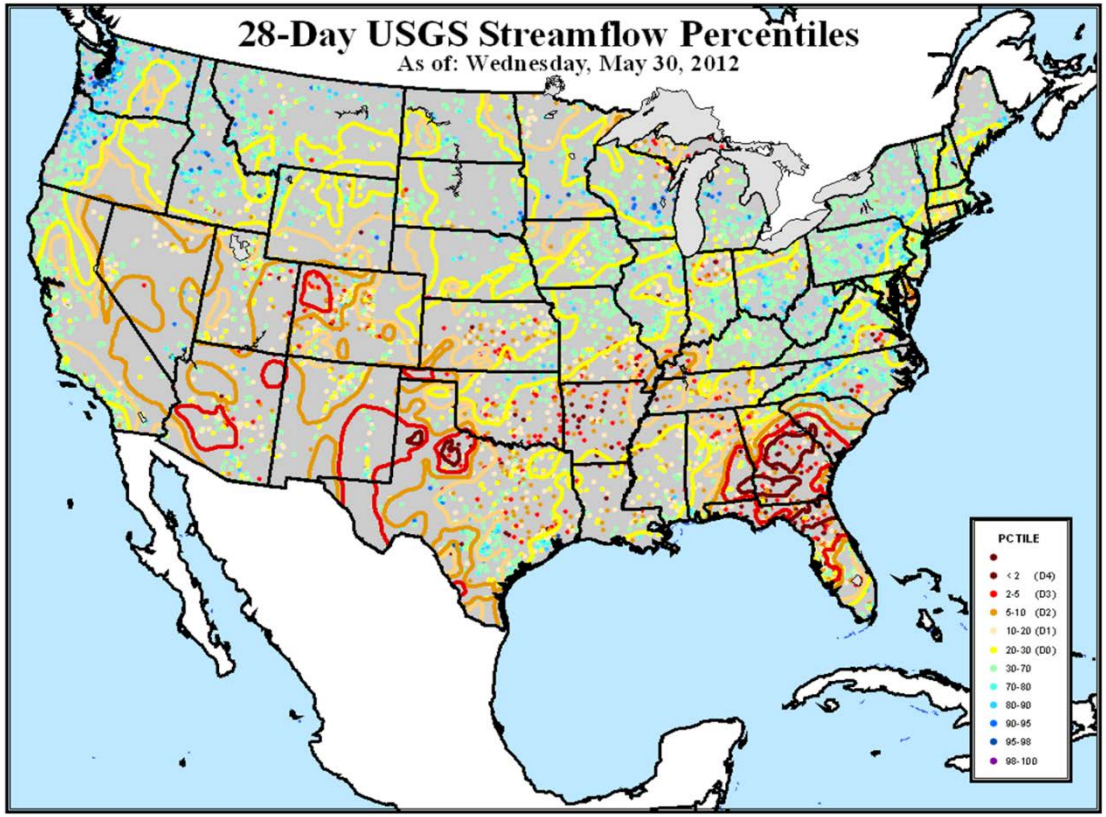
National Drought Mitigation Center

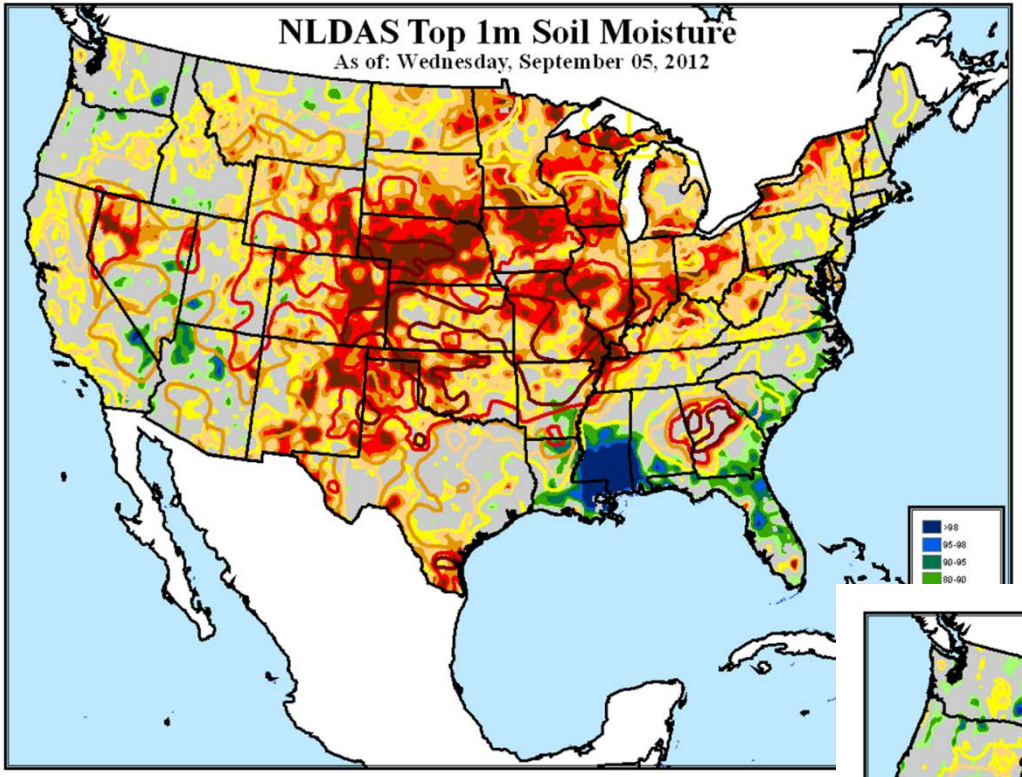


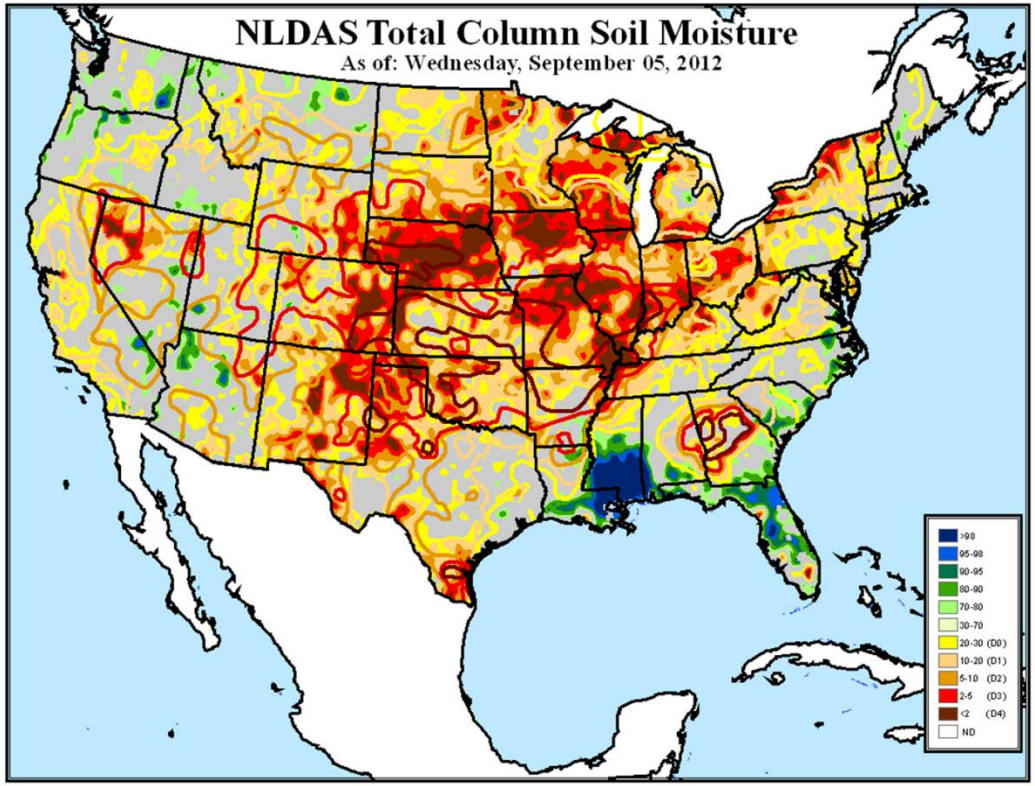
National Drought Mitigation Center

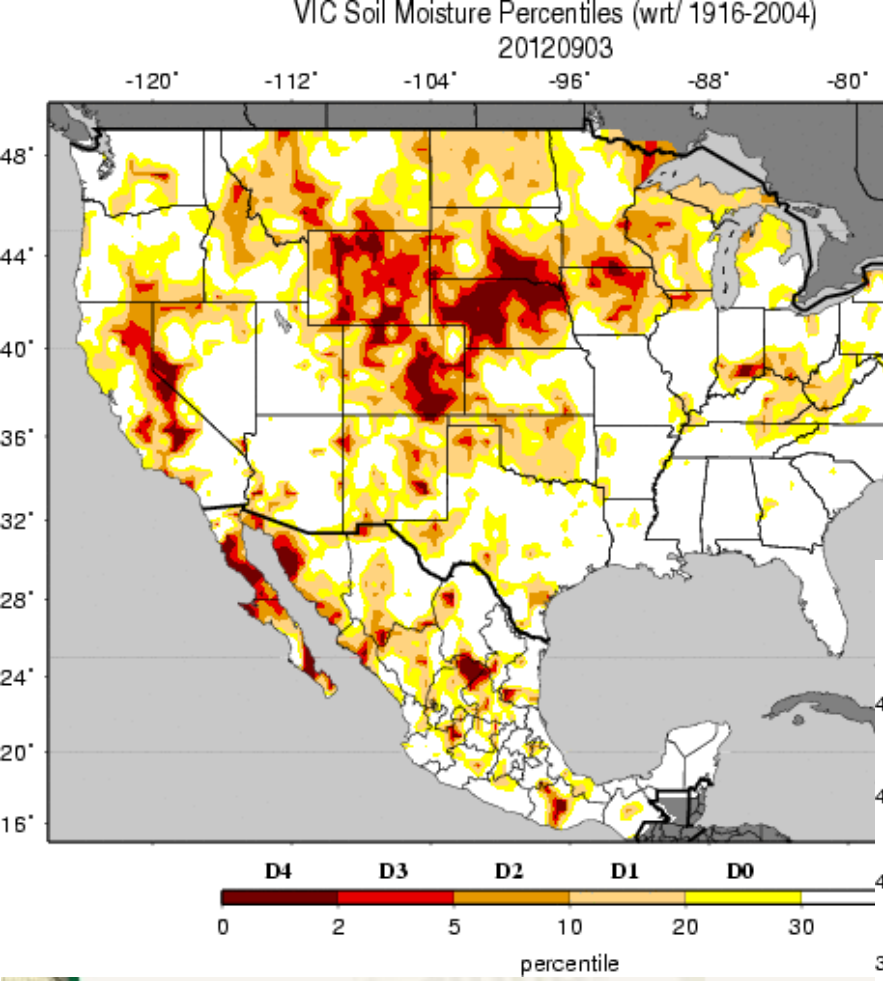

7-Day AHPS Precipitation
As of: Tuesday, September 04, 2012
Inches
14
12
10
8
6
4
3
2.5
2.0
1.5
1.0
0.75
0.50
0.25
<0.25

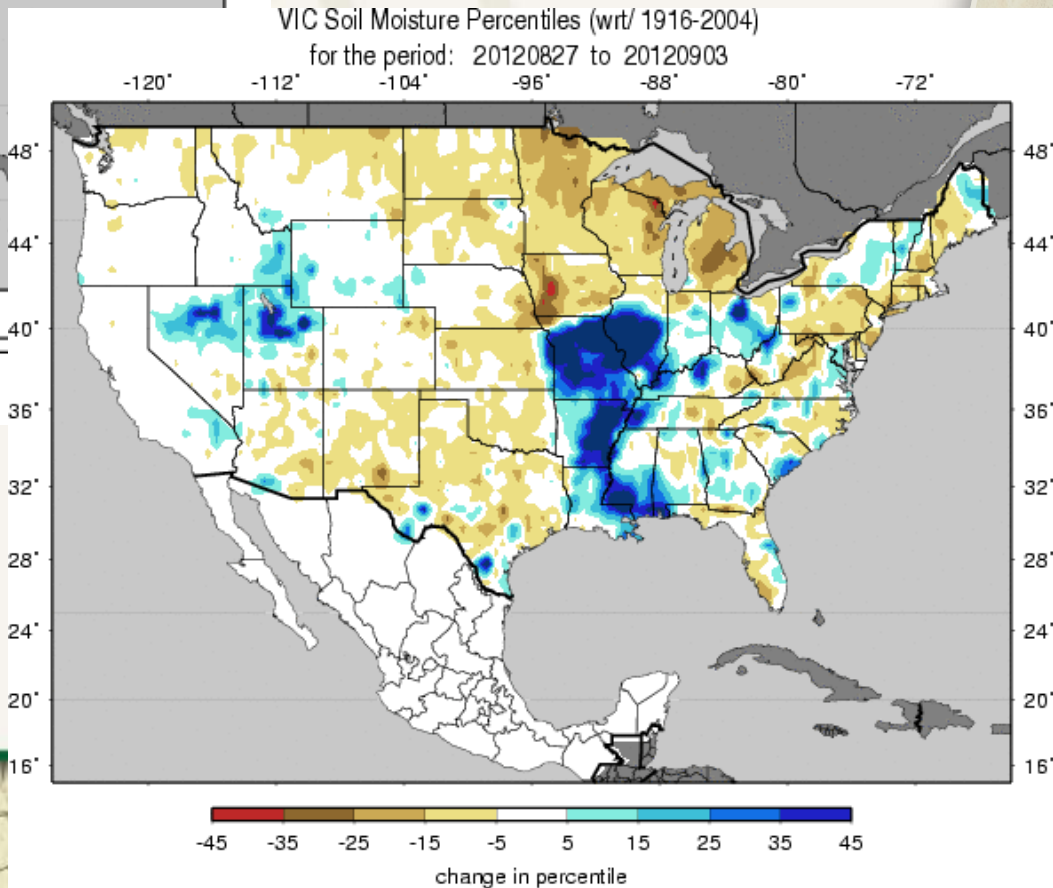

7-Day USGS Streamflow Percentiles
As of: Wednesday, May 30, 2012

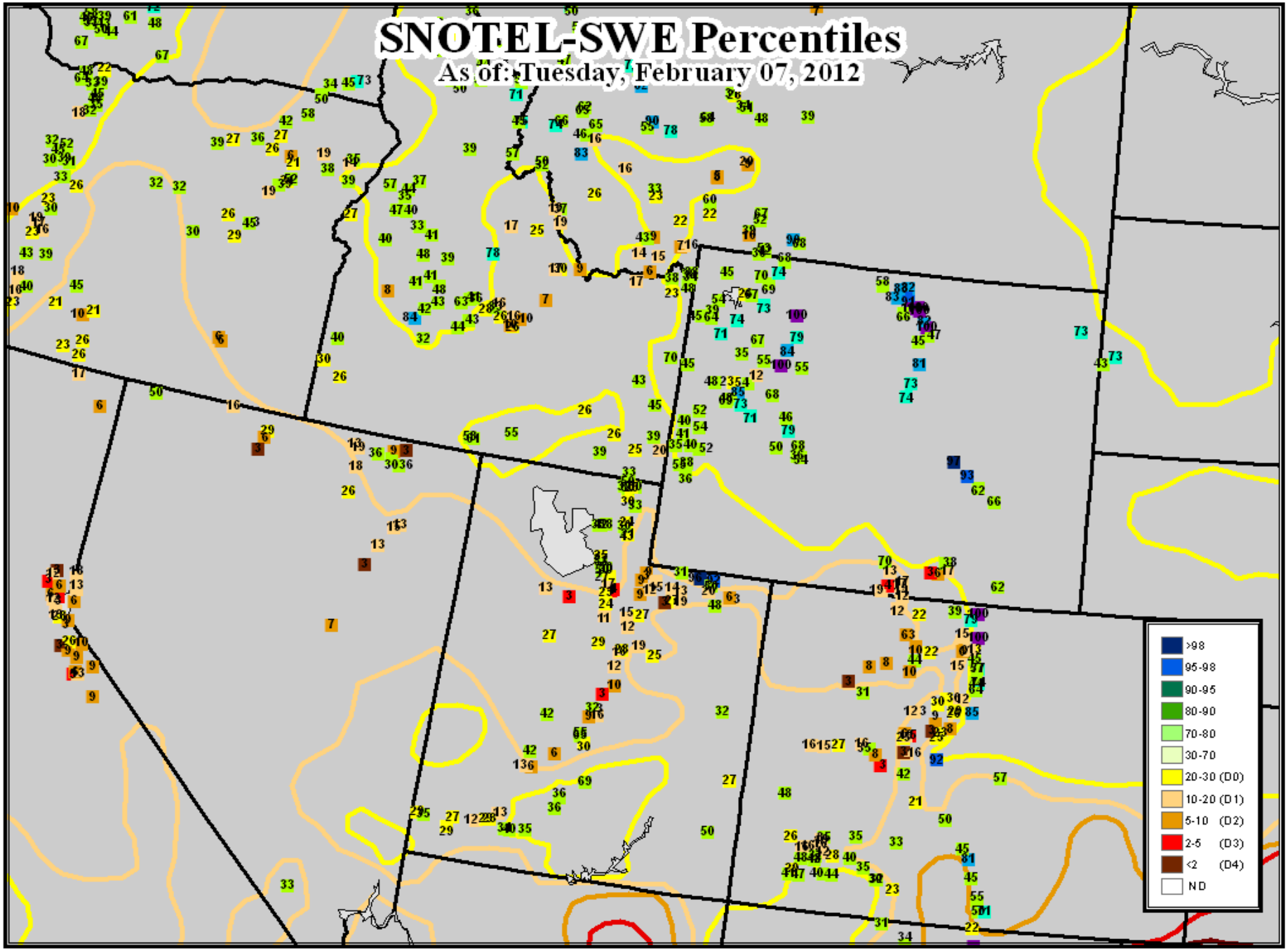

28-Day USGS Streamflow Percentiles
As of: Wednesday, May 30, 2012
PCTILE
< 2 (D4)
2-5 (D3)
5-10 (D2)
10-20 (D1)
20-30 (D0)
30-70
70-80
80-90
90-95
95-98
98-100


NLDAS Top 1m Soil Moisture
As of: Wednesday, September 05, 2012
>98
95-98
90-95
80-90


NLDAS Total Column Soil Moisture
As of: Wednesday, September 05, 2012
>98
95-98
90-95
80-90
70-80
30-70
20-30 (D0)
10-20 (D1)
5-10 (D2)
2-5 (D3)
<2 (D4)
ND


VIC Soil Moisture Percentiles (wrt/ 1916-2004)
20120903
-120˚ -112˚ -104˚ -96˚ -88˚ -80˚ -72˚
48˚ 44˚ 40˚ 36˚ 32˚ 28˚ 24˚ 20˚ 16˚
D4 D3 D2 D1 D0
0 2 5 10 20 30
percentile

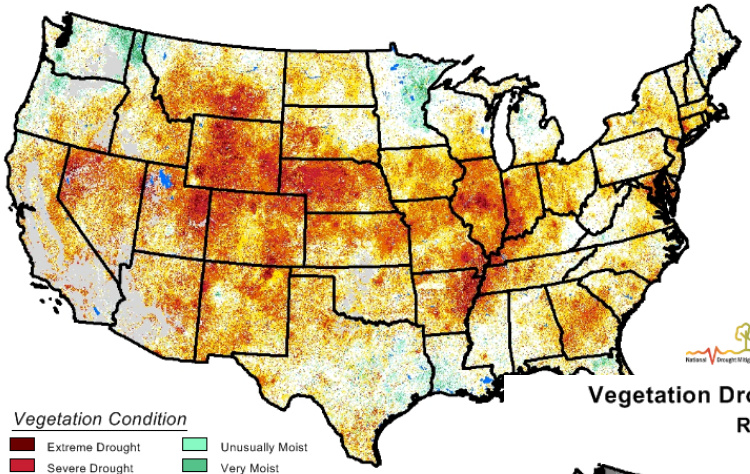

VIC Soil Moisture Percentiles (wrt/ 1916-2004)
for the period: 20120827 to 20120903
-120˚ -112˚ -104˚ -96˚ -88˚ -80˚ -72˚
48˚ 44˚ 40˚ 36˚ 32˚ 28˚ 24˚ 20˚ 16˚
-45 -35 -25 -15 -5 5 15 25 35 45
change in percentile


SNOTEL-SWE Percentiles
As of: Tuesday, February 07, 2012
>98
95-98
90-95
80-90
70-80
30-70
20-30 (D0)
10-20 (D1)
5-10 (D2)
2-5 (D3)
<2 (D4)
ND

Remote Sensing / Vegetation Health

Vegetation Drought Response Index
Complete

August 20, 2012

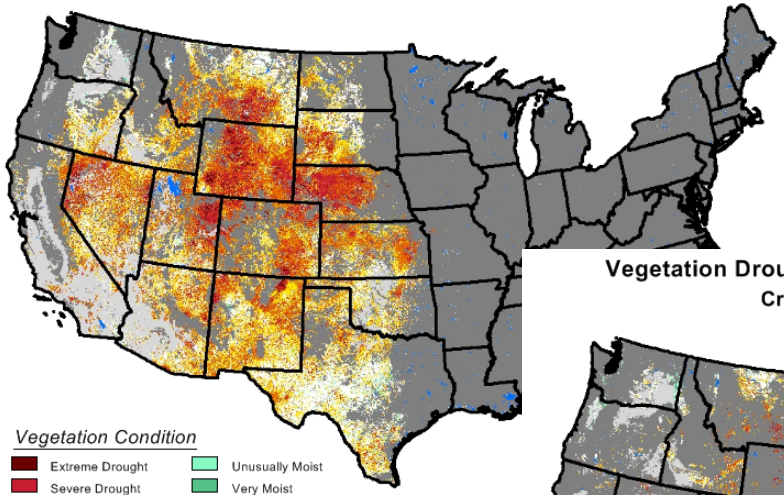


Vegetation Condition

- Extreme Drought
- Severe Drought
- Moderate Drought
- Pre-Drought
- Near Normal
- Unusually Moist
- Very Moist
- Extremely Moist
- Out of Season
- Water

Vegetation Drought Response Index
Rangelands

August 20, 2012

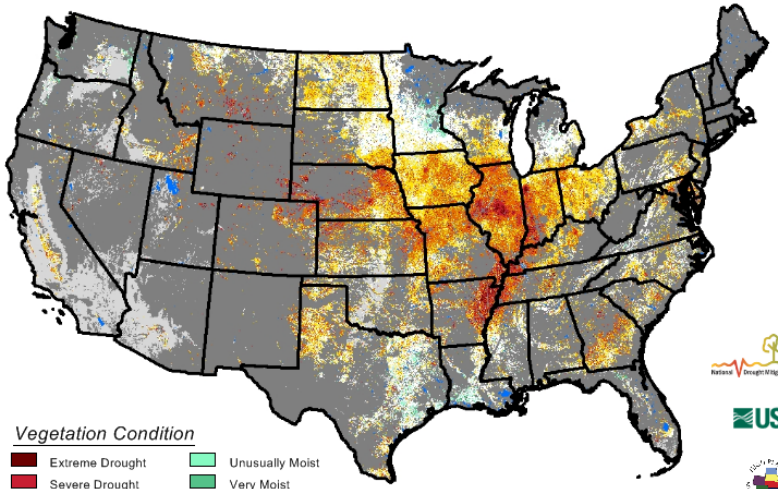


Vegetation Condition

- Extreme Drought
- Severe Drought
- Moderate Drought
- Pre-Drought
- Near Normal
- Unusually Moist
- Very Moist
- Extremely Moist
- Other landcover
- Out of Season
- Water

Vegetation Drought Response Index
Croplands

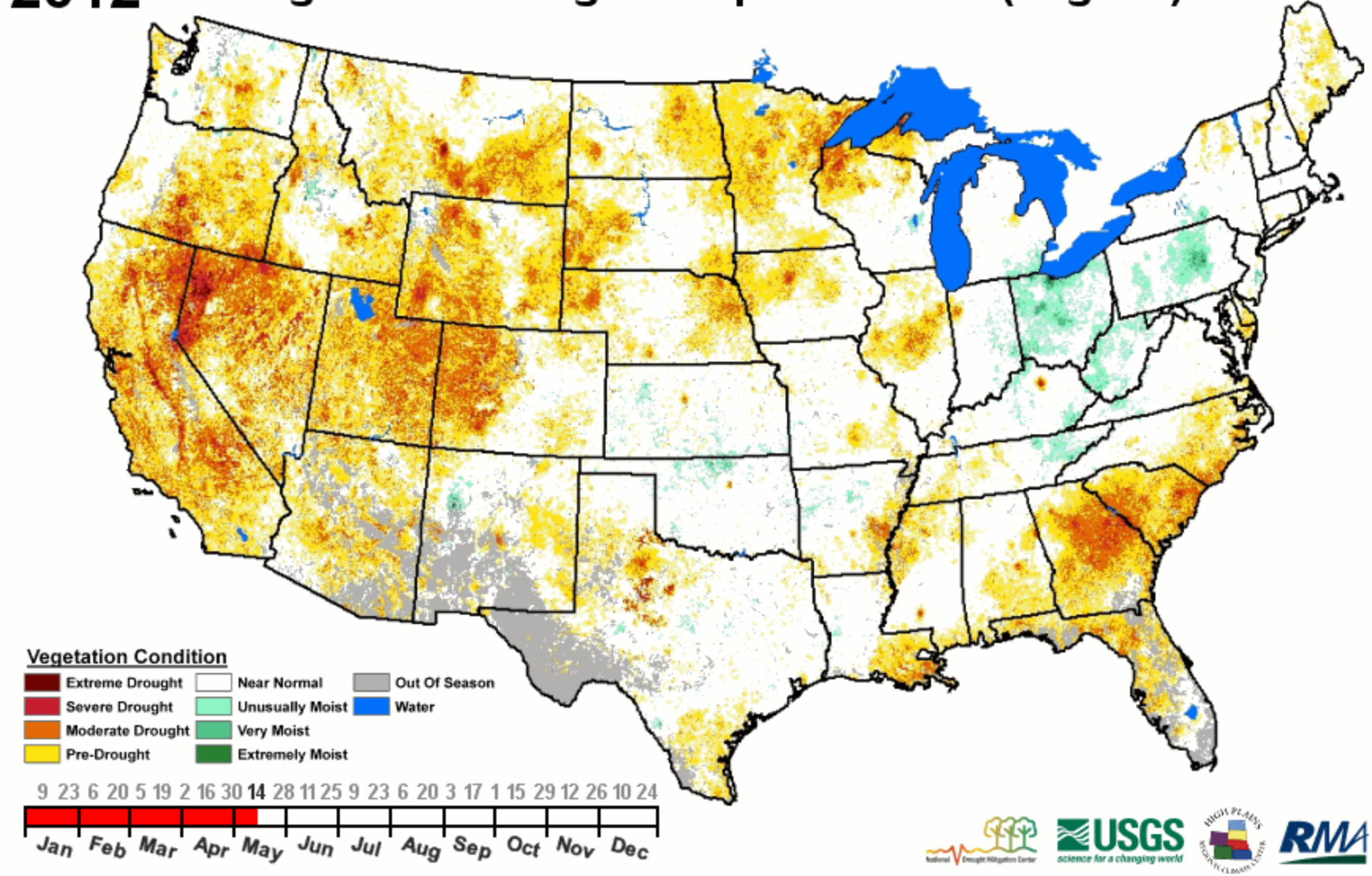
August 20, 2012



Vegetation Condition

- Extreme Drought
- Severe Drought
- Moderate Drought
- Pre-Drought
- Near Normal
- Unusually Moist
- Very Moist
- Extremely Moist
- Other landcover
- Out of Season
- Water

2012 Vegetation Drought Response Index (VegDRI)



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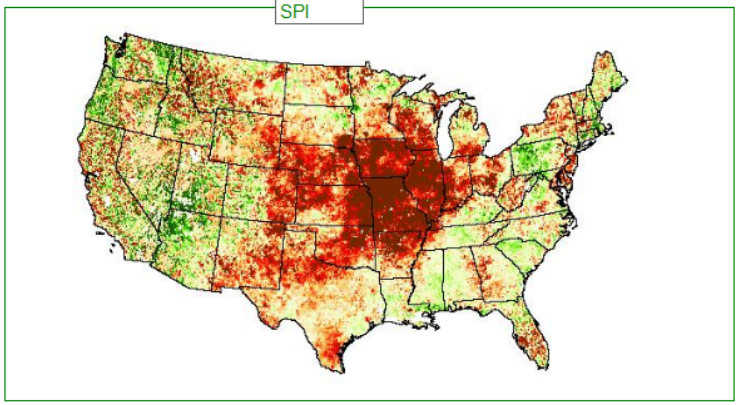
ESI Archive - CONUS

USDA-ARS HRSL
Hydrology & Remote Sensing Lab
Beltsville, Maryland, USA

Index: ESI (ESI, ΔESI, USDM, SPI) | Timescale: 1 Month | 2012

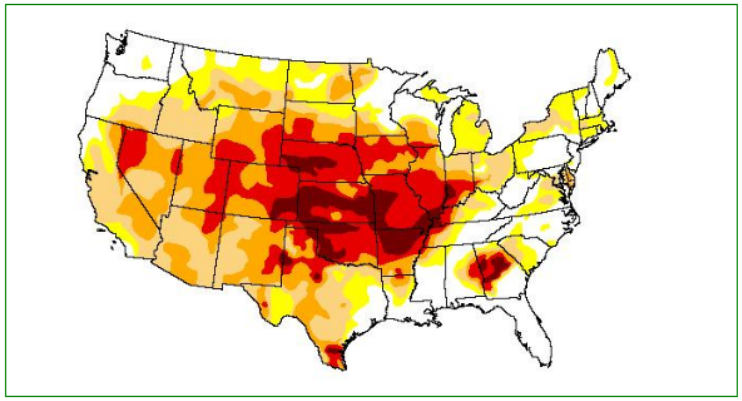


Download | Popup

Standardized ET/PET anomalies

-2σ < | -1σ | 0 | +1σ | > +2σ

Index: USDM | Timescale: Weekly | Aug 25 | 2012



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U.S. Drought Monitor Drought Severity

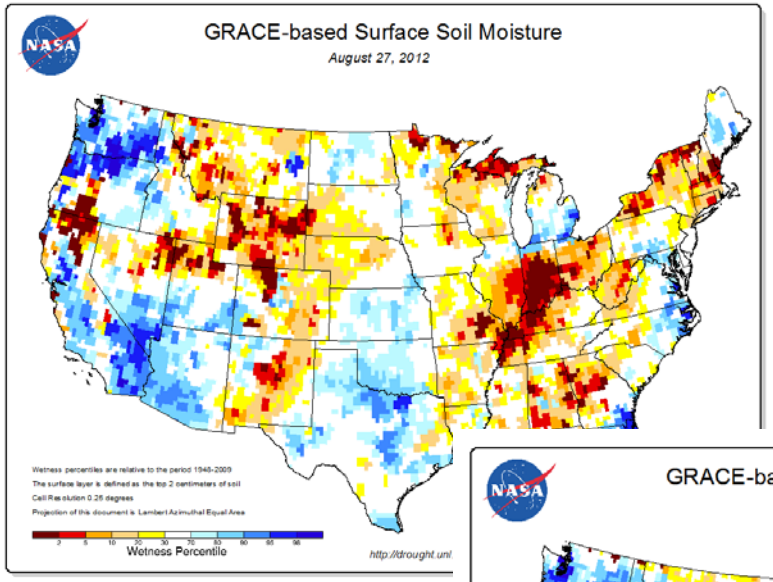
D0 | D1 | D2 | D3 | D4

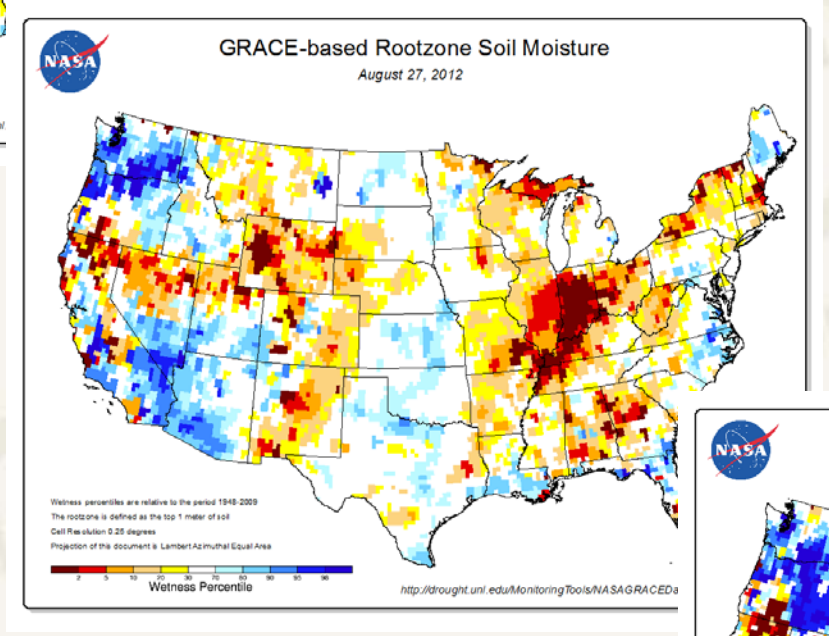
View in Pan and Zoom Mode

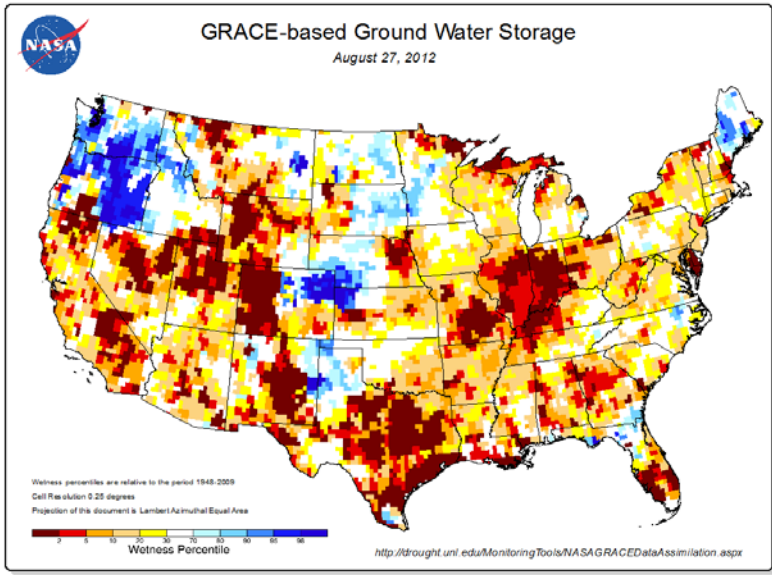
NIDIS

University of Nebraska Lincoln

National Drought Mitigation Center


GRACE-based Surface Soil Moisture
August 27, 2012
Wetness percentiles are relative to the period 1948-2009
The surface layer is defined as the top 2 centimeters of soil
Cell Resolution 0.25 degrees
Projection of this document is Lambert Azimuthal Equal Area
2 5 10 20 30 70 80 90 95 98
Wetness Percentile

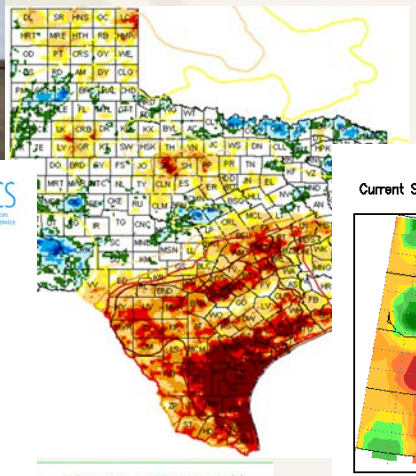

GRACE-based Rootzone Soil Moisture
August 27, 2012
Wetness percentiles are relative to the period 1948-2009
The rootzone is defined as the top 1 meter of soil
Cell Resolution 0.25 degrees
Projection of this document is Lambert Azimuthal Equal Area
2 5 10 20 30 70 80 90 95 98
Wetness Percentile
http://drought.unl.edu/MonitoringTools/NASAGRACEDa

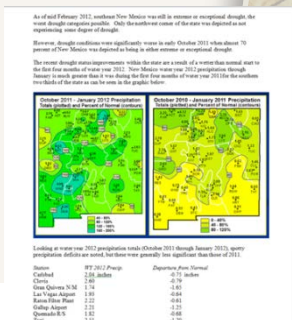

GRACE-based Ground Water Storage
August 27, 2012
Wetness percentiles are relative to the period 1948-2009
Cell Resolution 0.25 degrees
Projection of this document is Lambert Azimuthal Equal Area
2 5 10 20 30 70 80 90 95 98
Wetness Percentile
http://drought.unl.edu/MonitoringTools/NASAGRACEDataAssimilation.aspx

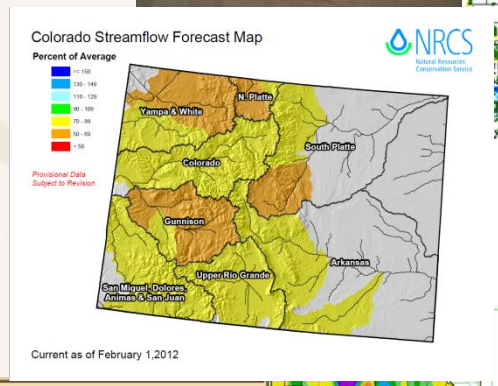
The Importance of Local Expert Input

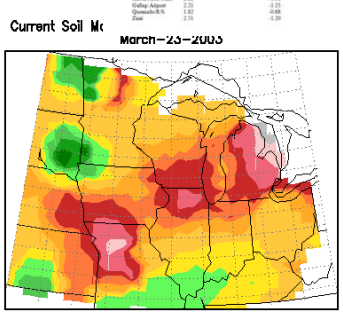
- **The U.S. Drought Monitor Team Relies on Field Observation Feedback from the Local Experts for Impacts Information & "Ground Truth"**
  - ***Listserver (~350 Participants: 2/3 Federal, 1/3 State/Univ.)***

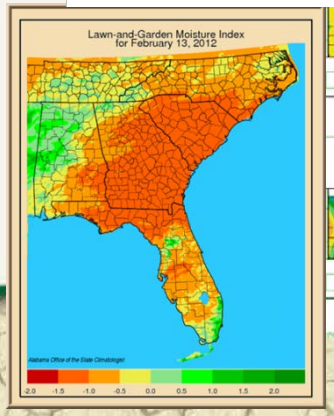
- **Local NWS & USDA/NRCS Offices**
- **State Climate Offices**
- **State Drought Task Forces**
- **Regional Climate Centers**
- **NIDIS Basin Webinars**

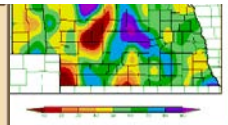


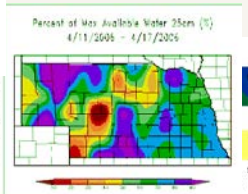


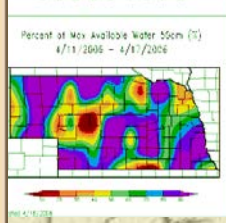


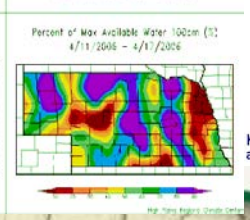


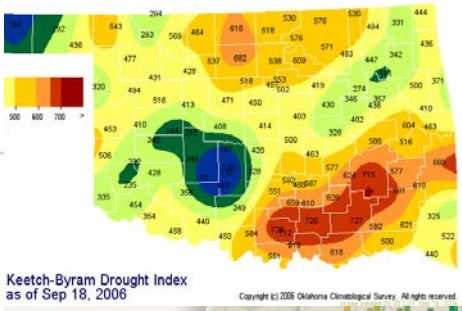










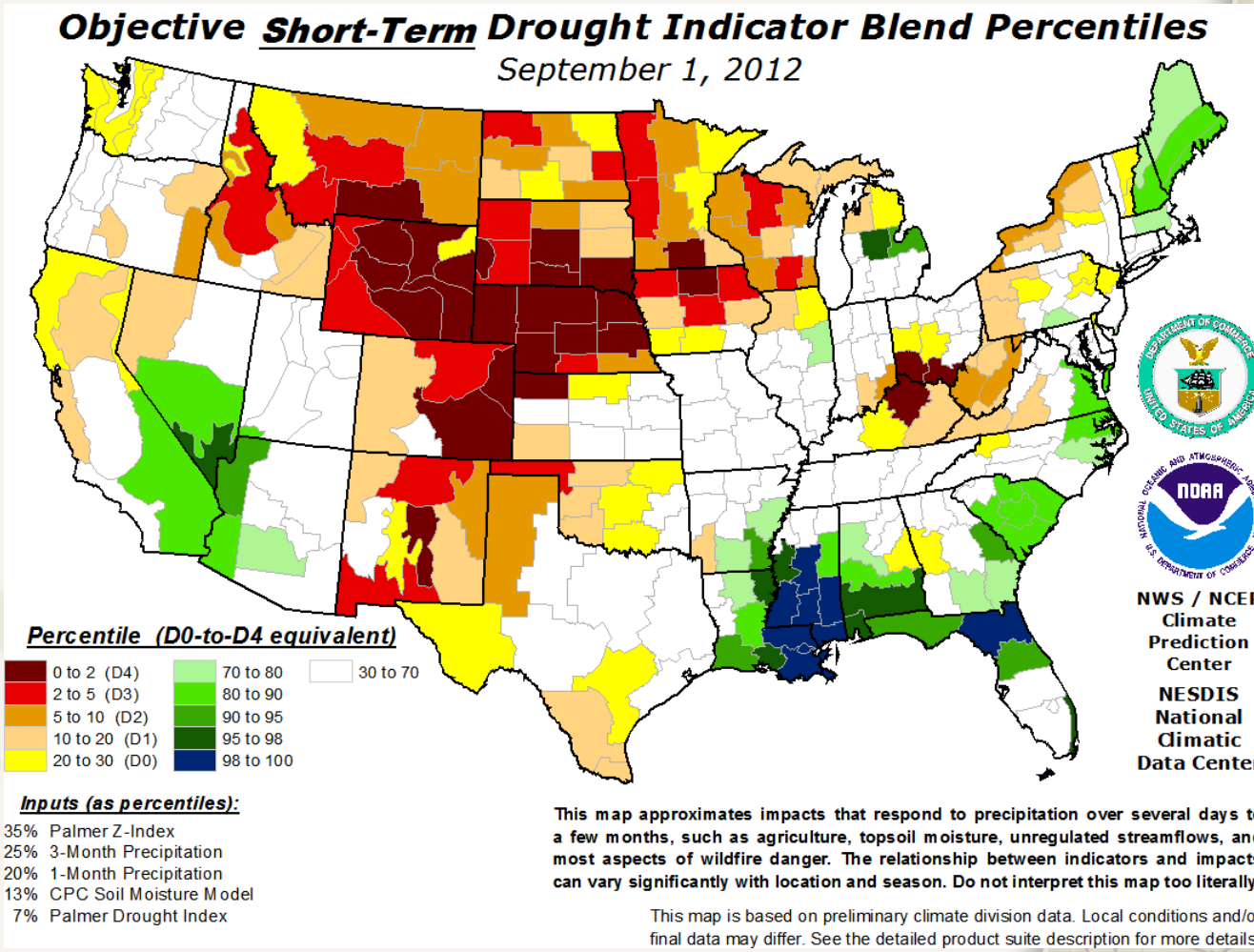


National Drought Mitigation Center

Objective Blends

- **Short-Term Blend**

35% Palmer Z Index
25% 3-Month Precip.
20% 1-Month Precip.
13% CPC Soil Model
7% Palmer Drought Index

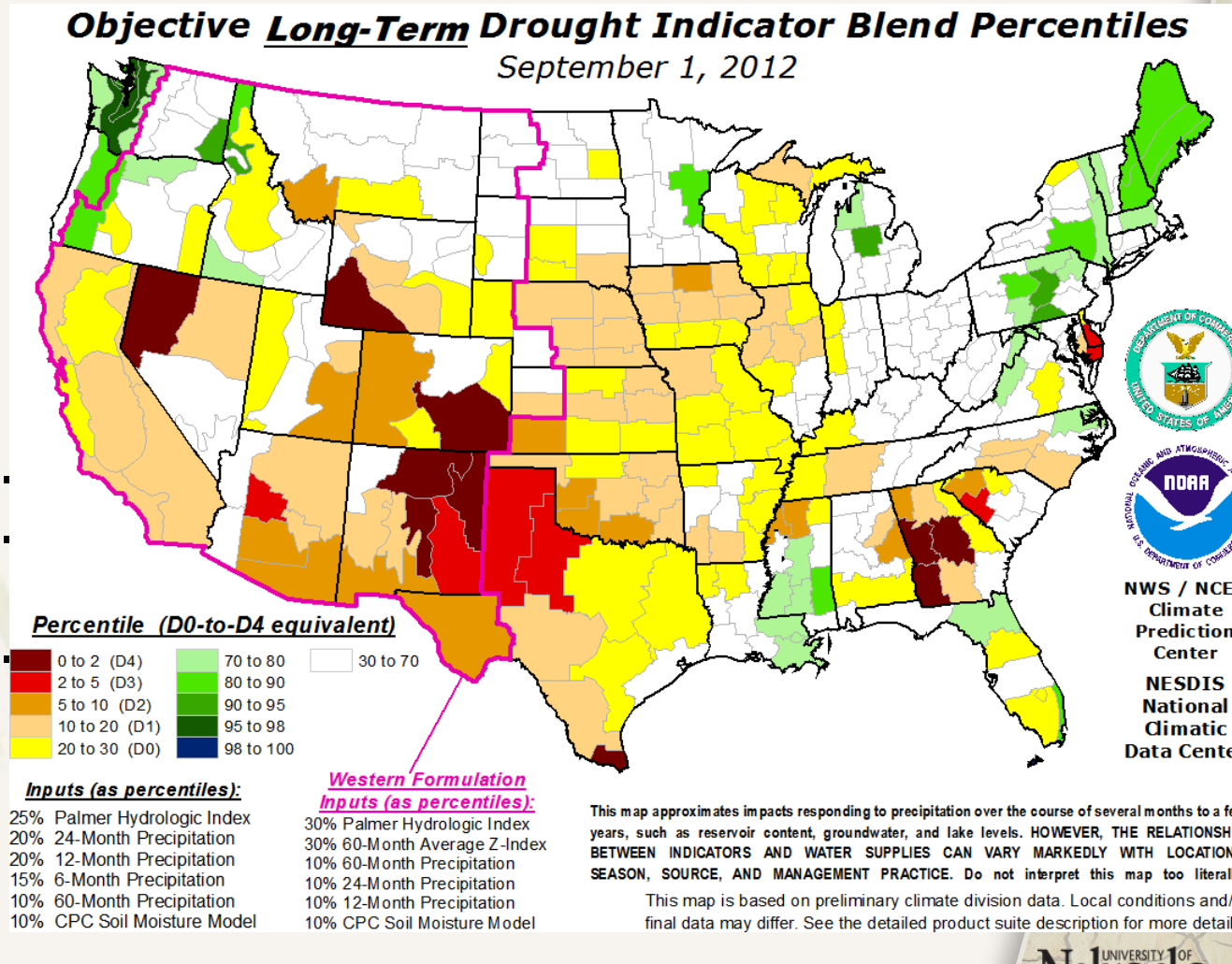


National Drought Mitigation Center

Objective Blends

- **Long-Term Blend**

25% Palmer Hydrological Index
20% 24-Month Precip.
20% 12-Month Precip.
15% 6-Month Precip.
10% 60-Month Precip.
10% CPC Soil Model



DROUGHT INDICATOR BLEND AND COMPONENT PERCENTILES -- *September 10, 2011*

(KEY: **D4**=0-2 [pink fill] **D3**=2-5 [red fill] **D2**=5-10 [brown fill] **D1**=10-20 [tan fill] **D0**=20-30 [yellow fill] WET=70-100 [green text]*)*

Climate Division						Drought Blends		Individual Blend Components										
								Precipitation						Palmer Z-Index	Palmer Drought Index (PDI)	Palmer Hydro. Drought Index (PHDI)	5-Year Average Z-Index	CPC Soil Moisture Model
ID #	U.S. CD #	State #	State CD #	State Name	CD Name	Short Term	Long Term	1-Month	3-Month	6-Month	1-Year	2-Year	5-Year					
0101	1	1	1	Alabama	Northern Valley	94.6	82.4	99.5	89.3	93.4	77.5	76.7	31.9	89.9	77.3	73.0	26.1	98.8
0102	2	1	2	Alabama	Appalachian Mountain	97.8	88.8	99.5	92.3	95.4	71.6	80.5	37.1	98.4	93.5	92.0	17.4	100.0
0103	3	1	3	Alabama	Upper Plains	77.6	54.6	86.3	56.4	60.6	40.7	74.4	54.7	75.7	54.5	27.6	30.4	88.8
0104	4	1	4	Alabama	Eastern Valley	57.9	25.7	72.9	50.5	38.9	20.6	64.0	20.5	61.7	42.2	13.6	3.6	26.3
0105	5	1	5	Alabama	Piedmont Plateau	9.1	11.4	19.2	15.2	7.0	4.3	52.7	21.2	14.3	12.1	7.9	15.9	7.5
0106	6	1	6	Alabama	Prairie	54.3	13.2	70.1	49.3	15.9	9.5	38.2	21.5	62.0	40.3	16.0	20.2	18.8
0107	7	1	7	Alabama	Coastal Plain	19.8	8.2	25.5	26.2	4.6	3.7	35.6	41.3	29.3	4.5	3.2	28.0	12.5
0108	8	1	8	Alabama	Gulf	78.8	19.2	81.5	63.8	10.9	5.1	46.1	43.0	90.4	44.3	19.7	41.8	56.3
0201	9	2	1	Arizona	Northwest	17.1	26.9	16.6	41.7	17.6	49.0	43.3	5.0	10.3	37.9	46.2	15.3	25.0
0202	10	2	2	Arizona	Northeast	28.9	17.6	29.1	53.2	21.7	21.0	49.3	34.5	23.9	16.9	20.2	17.5	21.3
0203	11	2	3	Arizona	North-Central	3.6	0.7	4.0	23.0	2.1	10.2	13.5	1.7	1.3	9.4	9.5	0.5	2.5
0204	12	2	4	Arizona	East-Central	35.2	14.6	17.2	72.1	25.8	17.4	52.9	43.7	38.2	10.3	11.6	22.1	16.3
0205	13	2	5	Arizona	Southwest	55.7	54.7	34.5	91.5	67.2	43.9	68.0	37.9	30.3	65.6	70.5	37.5	53.8
0206	14	2	6	Arizona	South-Central	9.3	1.4	8.9	29.8	9.9	3.7	16.2	9.0	12.7	6.2	8.3	2.3	2.5
0207	15	2	7	Arizona	Southeast	42.5	8.5	47.2	88.2	62.5	7.0	24.4	18.9	8.3	3.8	3.2	9.0	62.5
0301	16	3	1	Arkansas	Northwest	11.7	59.6	50.4	4.5	92.2	76.2	78.0	95.0	7.2	5.5	6.2	89.9	25.0
0302	17	3	2	Arkansas	North-Central	15.5	64.8	35.1	6.4	93.9	70.4	94.9	100.0	18.8	10.6	10.6	100.0	32.5
0303	18	3	3	Arkansas	Northeast	10.2	54.9	16.1	7.3	85.9	53.0	77.5	94.8	12.1	6.2	7.6	82.3	31.3
0304	19	3	4	Arkansas	West-Central	12.5	38.4	47.9	4.2	70.5	29.3	57.8	98.8	10.7	8.1	7.1	92.7	17.5
0305	20	3	5	Arkansas	Central	33.4	55.2	71.5	22.9	79.7	38.6	76.0	100.0	22.8	21.6	14.0	94.3	52.5
0306	21	3	6	Arkansas	East-Central	39.8	54.8	62.4	27.0	82.4	51.1	67.8	75.5	35.7	19.9	18.9	53.9	55.0
0307	22	3	7	Arkansas	Southwest	2.1	14.7	11.5	1.0	27.4	6.7	39.6	64.4	4.7	0.0	0.0	45.4	5.0
0308	23	3	8	Arkansas	South-Central	23.4	15.8	55.6	14.9	25.5	2.3	38.2	75.0	26.8	2.3	2.3	68.4	17.5
0309	24	3	9	Arkansas	Southeast	22.5	8.2	51.3	29.7	13.4	0.9	25.0	48.5	17.1	0.0	0.0	34.3	21.3
0401	25	4	1	California	North Coast Basin	36.9	38.7	8.1	37.2	49.8	60.0	64.7	21.6	40.7	42.0	46.8	19.1	81.3
0402	26	4	2	California	Sacramento Basin	53.3	65.4	21.5	55.6	66.1	81.3	78.3	28.0	48.0	61.3	70.0	33.7	96.3
0403	27	4	3	California	Northeast Interior Basin	34.7	53.7	5.0	63.7	73.9	85.9	78.3	24.7	17.5	32.8	58.1	23.7	85.0
0404	28	4	4	California	Central Coast Basin	66.1	61.0	72.4	93.1	61.6	80.5	85.2	46.8	26.6	23.7	49.6	42.8	91.3
0405	29	4	5	California	San Joaquin Basin	85.7	71.3	100.0	99.5	73.9	94.0	92.0	41.9	56.9	48.6	62.4	39.0	98.8
0406	30	4	6	California	South Coast Basin	40.5	35.1	39.3	29.7	31.2	81.9	79.7	21.0	42.1	34.4	34.4	8.7	73.8
0407	31	4	7	California	Southeast Desert Basins	56.2	35.6	35.4	70.8	22.5	62.4	49.3	5.5	51.1	46.4	53.3	10.8	58.8

Climate Division						Drought Blends		Individual Blend Components										
								Precipitation						Palmer Z-Index	Palmer Drought Index (PDI)	Palmer Hydro. Drought Index (PHDI)	5-Year Average Z-Index	CPC Soil Moisture Model
ID #	U.S. CD #	State #	State CD #	State Name	CD Name	Short Term	Long Term	1-Month	3-Month	6-Month	1-Year	2-Year	5-Year					
0501	32	5	1	Colorado	Arkansas Basin	4.1	8.7	16.0	13.1	11.2	0.5	23.8	38.8	4.1	0.0	0.0	23.3	3.8
0502	33	5	2	Colorado	Colorado Basin	49.6	66.6	46.9	67.8	82.8	76.0	65.4	76.5	29.6	52.2	56.8	51.9	70.0
0503	34	5	3	Colorado	Kansas Basin	9.5	54.7	7.8	18.6	72.5	46.2	67.7	93.5	5.8	28.7	29.4	73.5	41.3

Some Examples of Decision Making Using the DM

- ***Policy***: 2008 (2013?) Farm Bill / IRS / USDA / EPA / NOAA DGT / State drought plan triggers (several)
- ~3.5M+ page views and ~2M+ visitors / year
- ***Media***: The Weather Channel / USA Today and all major newspapers / Internet Media / Network News / CNN / NPR / etc.
- Presidential / Congressional briefings
- NIDIS portal / portlet
- A model of interagency / level collaboration

Next Steps

- ***Revisit and refresh the DM Classification Table***
  - ***inputs/weighting***
- ***IMPACTS*: We have changed the (A)gricultural and (H)ydrological impact labels to (S)hort and (L)ong-term drought**
- **Gridded OBDI blends**
  - **revisit inputs and weightings?**
- **Continue to evaluate and integrate new tools (ET-ALEXI/ESI, GRACE, NLDAS, SM, GW)**
- **Continue to work w/ states and basins on a coordinated DEWIS:**
  - ***NIDIS*: UCRB/ACF/4-Corners/CA**
  - **HI, NC, TX, FL, AL, AZ……Who's Next?!?!**
- **Continue to listen to your needs and do what we can to integrate new tools/products….it is a "living" product**

Thank You

Please contact me at:

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