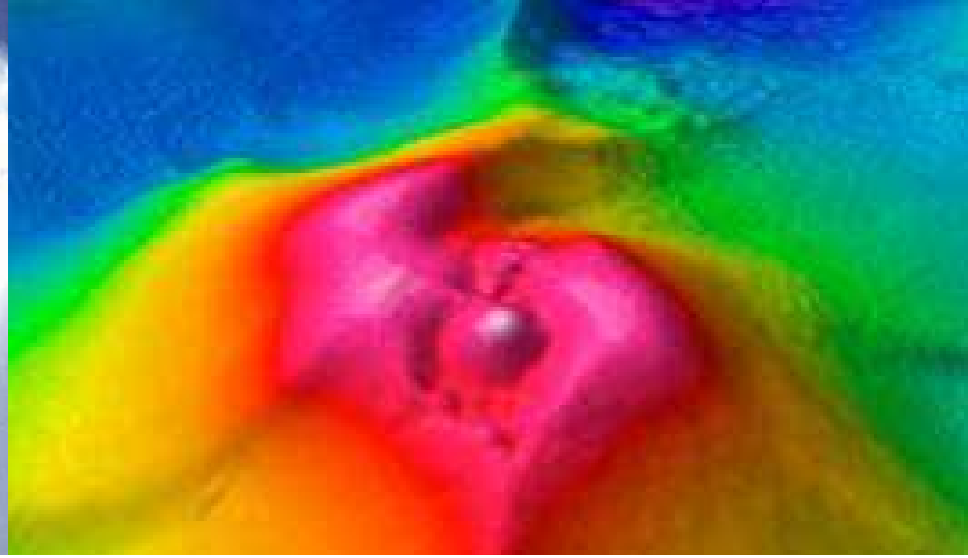


NOAA's Drought Task Force

Annarita Mariotti

NOAA Climate Program Office

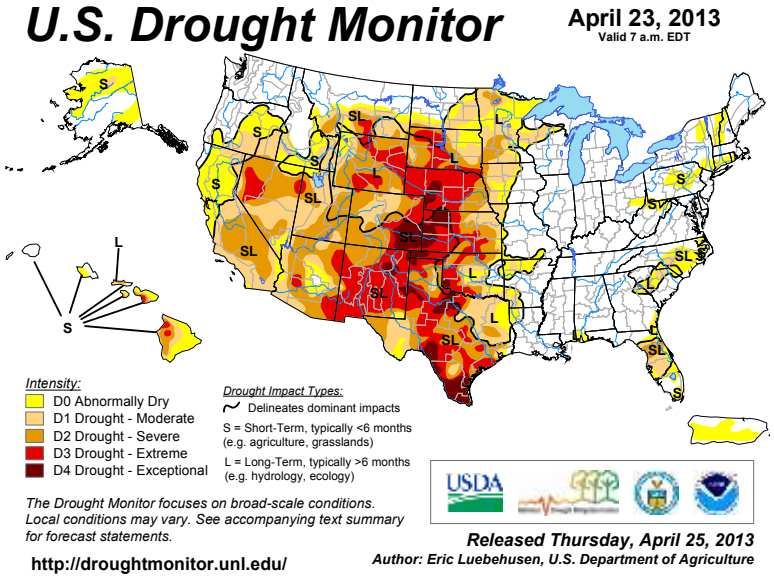
Modeling, Analysis, Predictions and Projections (MAPP) Program

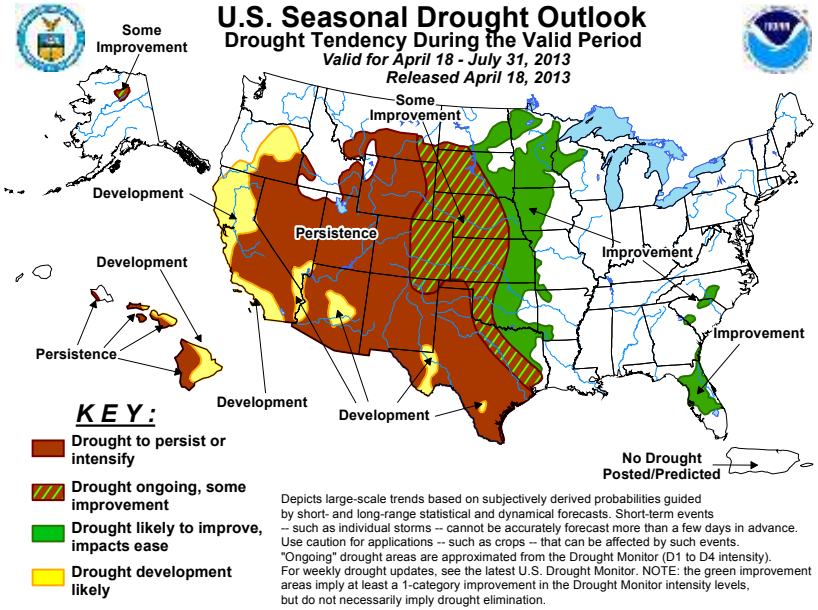
Motivation

- *Despite much progress on drought information spearheaded by NIDIS, current drought monitoring and forecasting capabilities still fall short of users' needs (e.g. accurate and reliable high resolution drought information at lead times appropriate for planning purposes).*

- *The Drought Task Force is on the research-side of the drought challenge, to improve upon current capabilities*

Research to improve official products





- The official USDM and USDO are fundamental contributions to NIDIS
- Many (!!) inputs go into generating these products
- Research advances can improve those inputs and lead to improved USDO and USDM.
- Drought monitoring improvements can be obtained by research providing better data and improved technologies to exploit them
- For drought prediction research is needed to 1) better understand when/where there is predictability 2) improve the forecast systems. E.g. a forecast bust can be due to limitations in either or both.

The Drought Task Force

*Goal: "**Achieving significant new advances in the ability to understand, monitor and predict drought over North America**" (est. in Oct 2011)*

- *A research group organized the MAPP Program*
- *Scientists from NOAA, NASA, USDA, NCAR and several leading universities*
- *Mostly MAPP-funded based on competitive calls, but much leveraging of investments (other Federal grants, home institutions base funding, etc.)*
- *The group is providing focus and leadership to the drought research community*

Siegfried Schubert NASA/GSFC
Christa Peters-Lidard NASA GSFS
Kingtse Mo NOAA/CPC
Andy Wood NOAA/CBR
Amir AghaKouchak UC
Martha Anderson USDA
Rajagopalan Balaji University of Colorado
Hugo Berbery UMD/ESSIC
Allen Bradley University of Iowa
Martyn Clark NCAR
Brian Cosgrove NOAA/OHD
Lisa Darby NIDIS and NOAA/ESRL
JiaRui Dong NOAA/EMC
Chen Fei NCAR
Mike Ek NOAA/EMC

Rong Fu University of Texas at Austin
Chris Hain NOAA/NESDIS
Marty Hoerling NOAA/ESRL/PSD

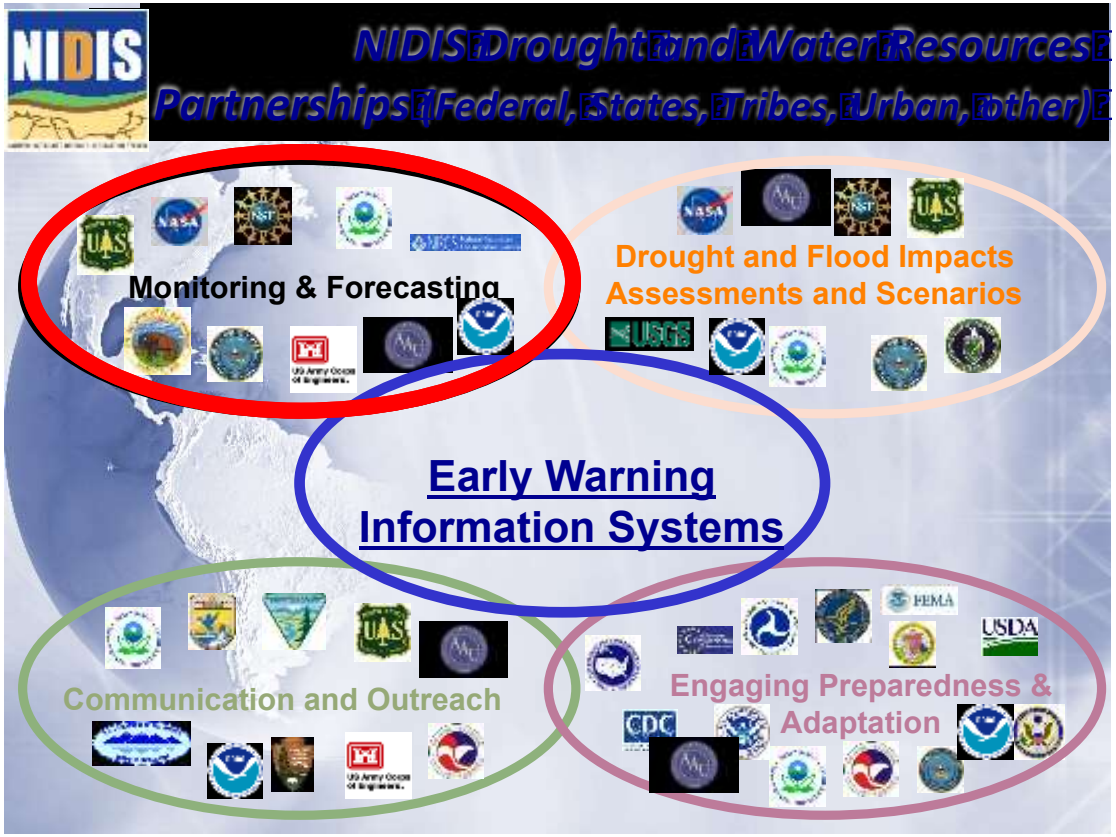
A LOT OF GOOD PEOPLE INVOLVED!

Mark Svoboda University of Nebraska/NDMC
James Verdin NIDIS and USGS
Hailan Wang GSFC
Robert S. Webb NIDIS and ESRL/PSD
Eric Wood Princeton University
Youlong Xia NOAA/EMC
Ning Zeng University of Maryland
Justin Sheffield Princeton University
Soroosh Soroshian UC Irvine

Arun Kumar NOAA/CPC
Venkat Lakshmi University of South Carolina
Dennis Lettenmaier University of Washington
Ruby Leung DOE PNNL
California, Irvine
rsity of Maryland
ate University
Brad Lyon IRI
Chad McNutt NIDIS
Jessi Meng NOAA/EMC
David Mocko NASA GSFC
Hamid Mordakhani University of Portland
Jason Otkin University of Wisconsin–Madison
Roger Pulwarti NIDIS
Pedro Restrepo North Central RFC
Richard Seager LDEO of Columbia University

Partnerships

Drought Task Force Partnership with NIDIS on research



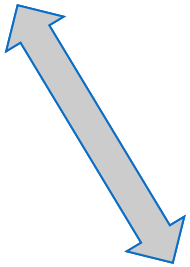
Partnerships with:

- NCEP Climate Test Bed for research to improve operational systems
- Other agencies as part of USGCRP and WCRP research programs

Goal and Approach

Underpinning Science
Basic scientific advances that support progress

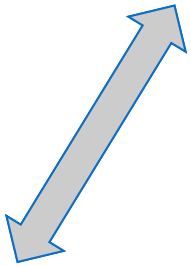
Retrospective Drought Analyses
Assessments to improve understanding of U.S. drought
Narrative Team led by Marty Hoerling, ESRL



Drought Task Force

To advance drought understanding, monitoring and prediction

Lead by Siegfried Schubert (NASA), Kingtse Mo (NCEP), Christa Peters-Lidard (NASA) and Andy Wood (NWRFC)



Assessing and Improving Drought Capabilities
A testbed framework to advance drought systems

Research-to-Capability Team led by Jin Huang, NCEP

- *Activities are interconnected and build on individual MAPP projects*
- *A spectrum of activities from more basic research to improving systems*
- *Focus on U.S. drought but in connection with global efforts on drought*

Advancing basic drought science and understanding

Scientific Advances

Special Collection in J of Hydrometeorology: *Advancing Drought Understanding, Monitoring and Prediction*

Many peered-reviewed papers demonstrating advances in many aspects of drought science as part of the Special Collection and other journals.

Understanding U.S. drought

Need to answer questions such as:

Why do droughts occur? Which drought precursors can be leveraged to improve prediction?

Which processes regulate drought development?

Which past droughts were more predictable and why?

Were they well predicted and if not, why?

Research is exploring:

- Role of initial conditions (soil moisture, snow cover, ground water, vegetation) and land-atmospheric interactions in drought initiation and evolution
- Role of remote SSTs in drought initiation and evolution
- Sub-seasonal to seasonal drought predictability and prediction

DTF Narrative Team focusing on retrospective drought analyses

Retrospective drought analyses

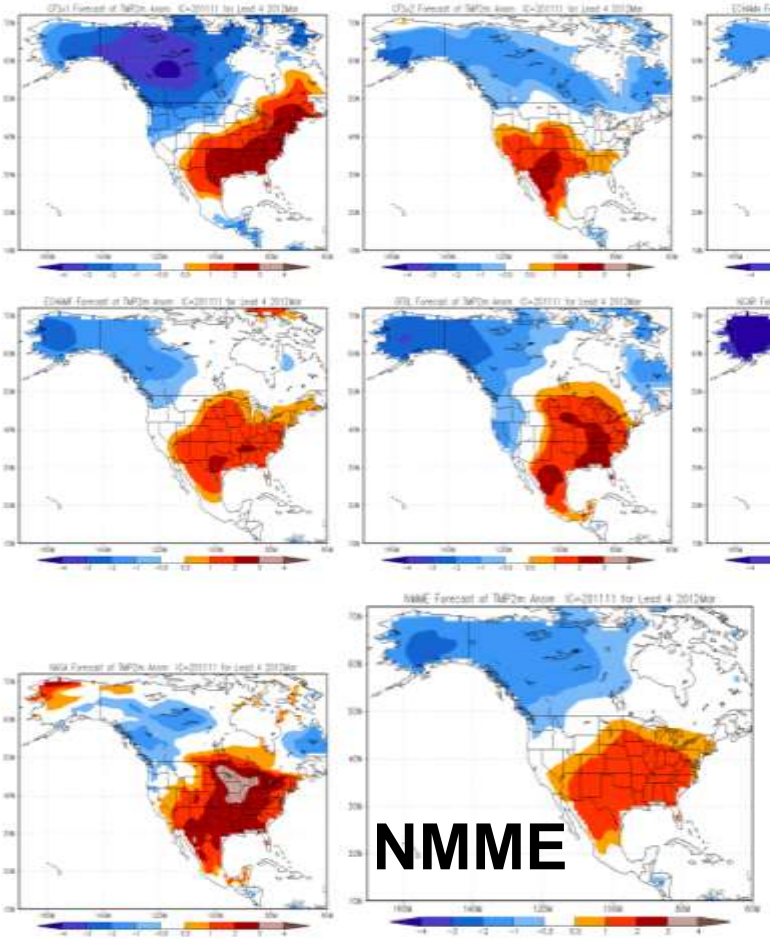
Investigated Cases

- The 2010/2011 Tex-Mex Drought
- The Summer 2012 Central Great Plains "Flash Drought"

Many studies, a couple of examples..

2010/2011 Tex-Mex Drought

A Modeling Study of the 2010/11 Droughts and Heat Waves Over the United States
By Schubert et al.



March 2012 T2m Forecasts Initialized November 2011 (NMME system)

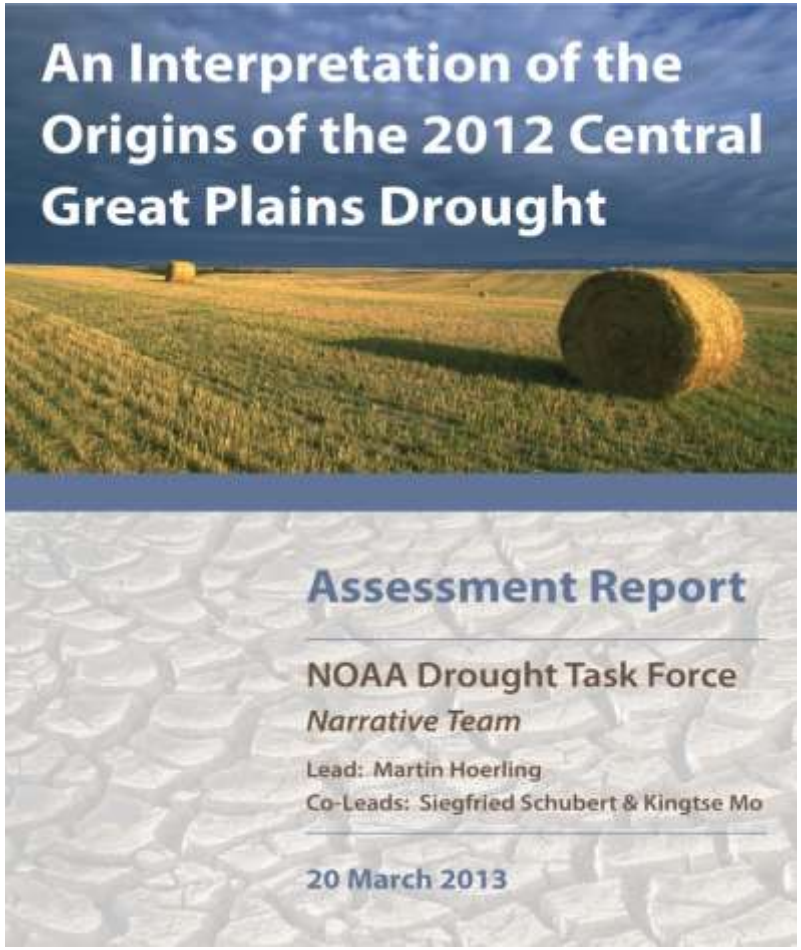
- Differences between 2010 and 2011
- Impacts of the various ocean basins
- Predictability (forced versus unforced variability)

- ***2011 reflected the "typical" La Nina response to cold Pacific SST over the US with hot conditions confined to the southern US***
- ***2011 was highly predictable***

2012 Central Great Plains Drought

A Report to explain causes of the drought with the particular goal to better understand the event's predictability.

Who was involved?
Prepared by the **Narrative Team** of NOAA's Drought Task Force in partnership with NIDIS



What caused the 2012 Central Great Plains Drought?

Mostly natural weather variations.

- Moist Gulf of Mexico air failed to stream northward in late spring as cyclone and frontal activity were shunted unusually northward.
- Summertime thunderstorms were infrequent and when they did occur produced little rainfall.

Was it Predictable?

Neither ocean states nor human-induced climate change appeared to play significant roles in severe rainfall deficits, **hence little predictability** (at least in rainfall)

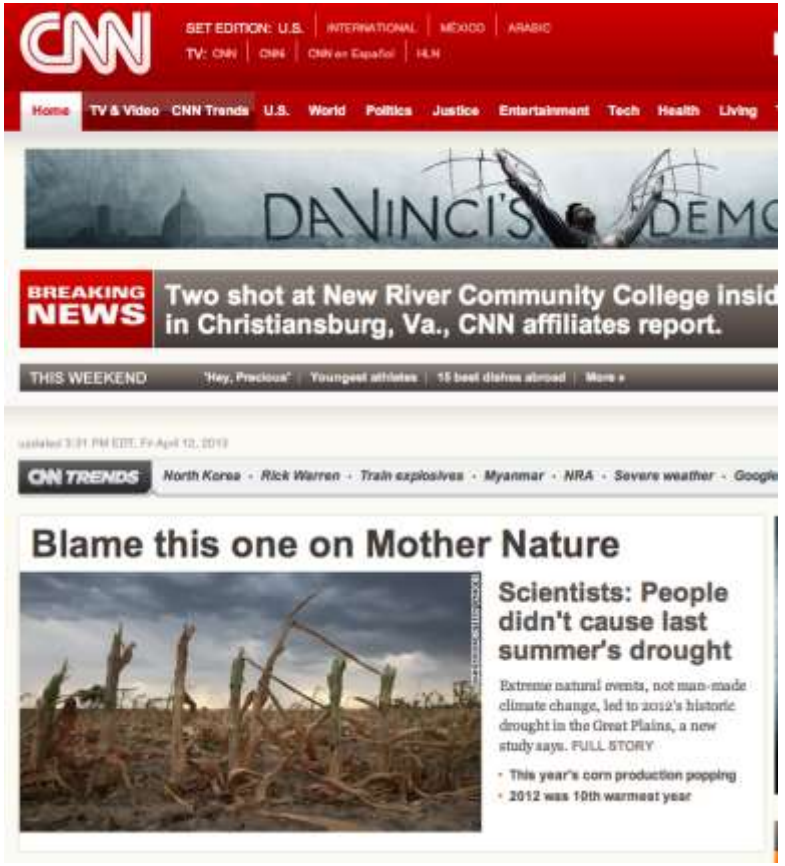
Good News (and other news..)

- A lot of interest, broad press coverage
- Some misinterpretation of results..

FAQ ..

- *Is there contradiction between the Report's finding that the 2012 drought was mostly unrelated to human-induced climate change, and the overwhelming body of scientific evidence that global warming is real?* ***NO..***
- *Did the warm temperatures cause the drought?*
- *How did diminished Arctic sea ice affect the drought?*
- *How did the reduced snow cover in Spring 2012 affect the drought?*

See FAQ on the MAPP Drought TF website



This report is not the final analysis of the 2012 Great Plains Drought..

Advancing Drought Monitoring and Prediction Systems

Assessing and improving systems

Need to answer questions such as:

What is the current state of drought monitoring and predictive capabilities? Which research advances can lead improved drought monitoring and predictions? Are we seeing improvements?

Research is exploring:

- Advanced land and hydrologic models
- Soil moisture and snow depictions (exploiting different data, data assimilation systems)
- Advanced meteorogical prediction systems for monthly-seasonal drought prediction
- Advanced hydrological prediction systems

A **Research to Capability Team** applying a test-bed framework (including cases, metrics, benchmarks) to assess status and progress

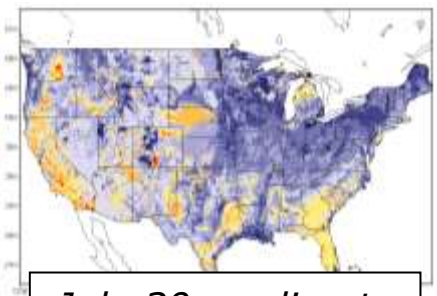
Experimental Monitoring Systems

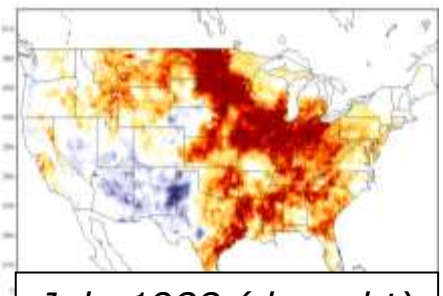
North American Land Data Assim. System (NLDAS)

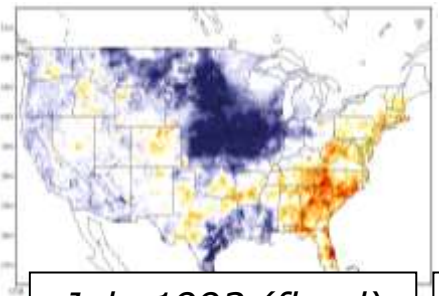
- Uses 4 Land models: Noah, SAC, VIC, Mosaic run in “uncoupled” mode.
- Forcing: CPC observed precipitation, and atmospheric forcing from NCEP NARR.
- Climatology from land model assimilation runs for 30-years.
- Output: 1/8-deg. land & soil states, surface fluxes, runoff/streamflow; operational ‘13.

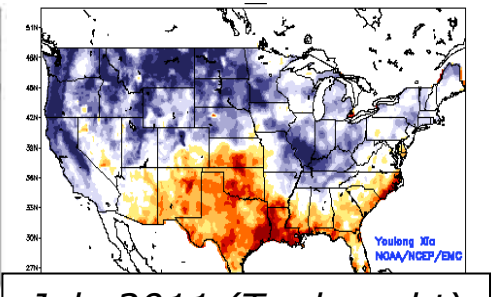
- **Objective anomalies used for drought monitoring as input to USDM.**
- **Current research: higher resolution, land model upgrades, improved forcing, snow and soil moisture assimilation, converting to USDM drought categories.**

Courtesy of Mike Ek, info at www.emc.ncep.noaa.gov/mmb/nldas


July 30-yr climate


July 1988 (drought)


July 1993 (flood)



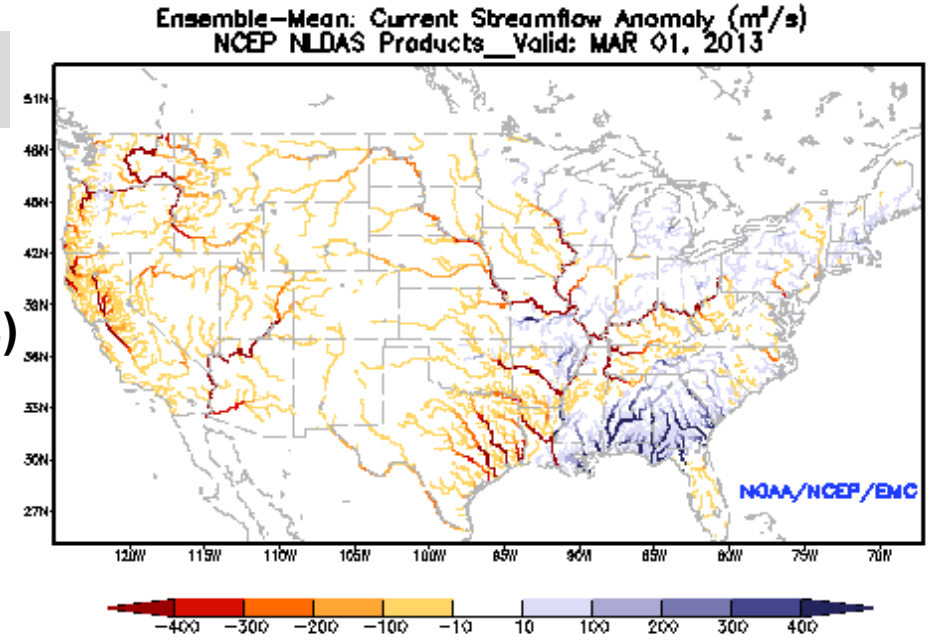
July 2011 (Tx drought)

NLDAS four-model ensemble monthly soil moisture anomaly

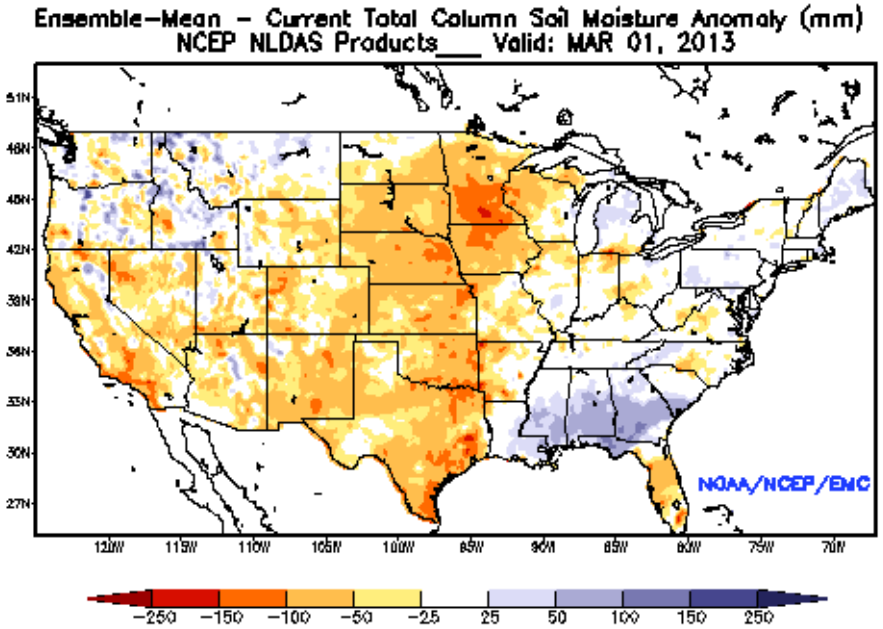
Example of NLDAS output

March 1 - April 21, 2013

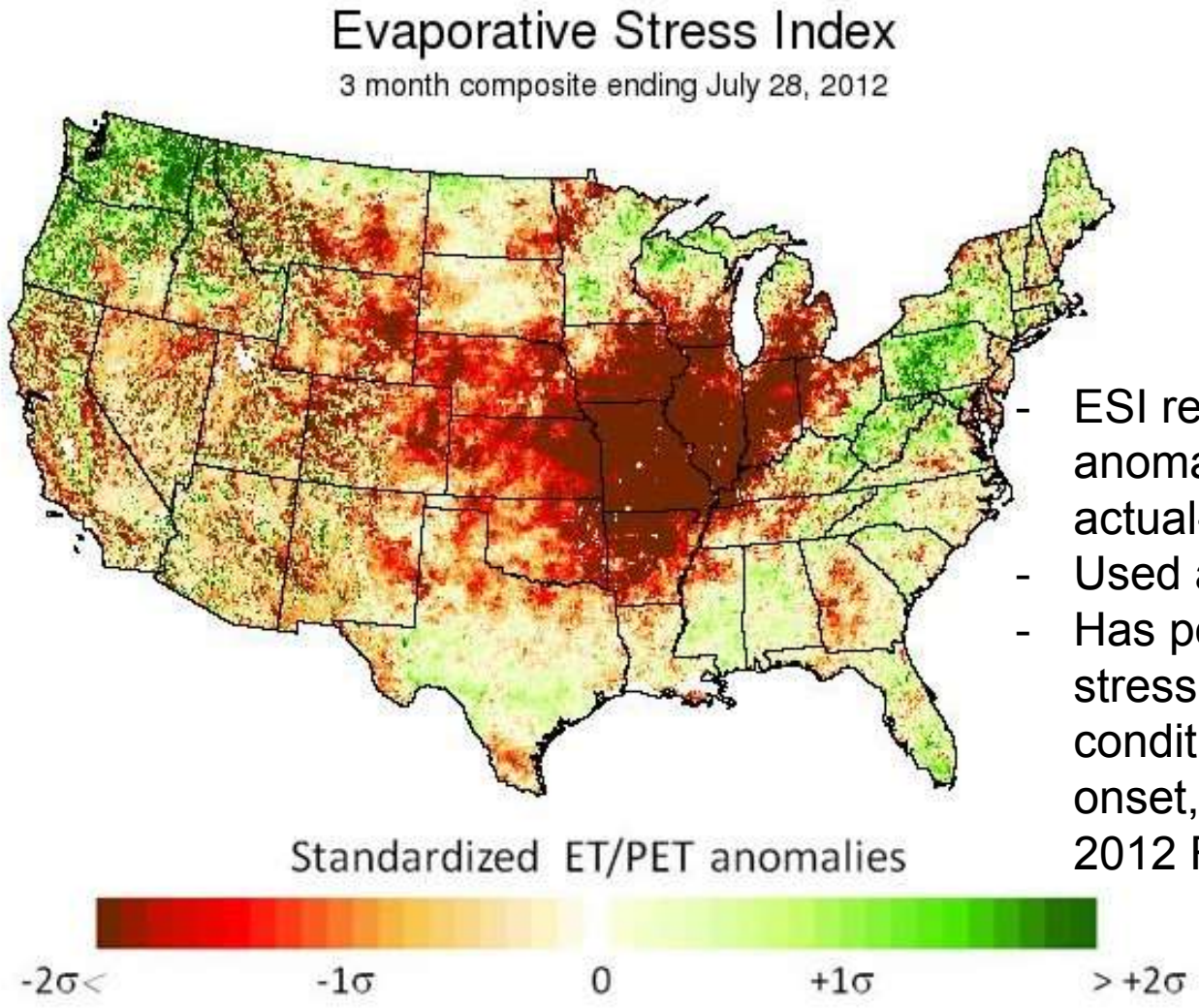
Daily streamflow anomalies (m^3/s)



Daily total column soil moisture anomalies (mm)



Courtesy of Yulong Xia



- ESI represents std anomalies in the ratio of actual-to-potential ET.
- Used as input USDM
- Has potential for early stress detection under conditions of rapid drought onset, as shown during the 2012 Flash Drought

Atmosphere-Land Exchange Inverse Model (ALEXI)

(Anderson et al., 1997, 2007)

ESI at higher resolution

GOES Evaporative Stress Index JUNE 2002

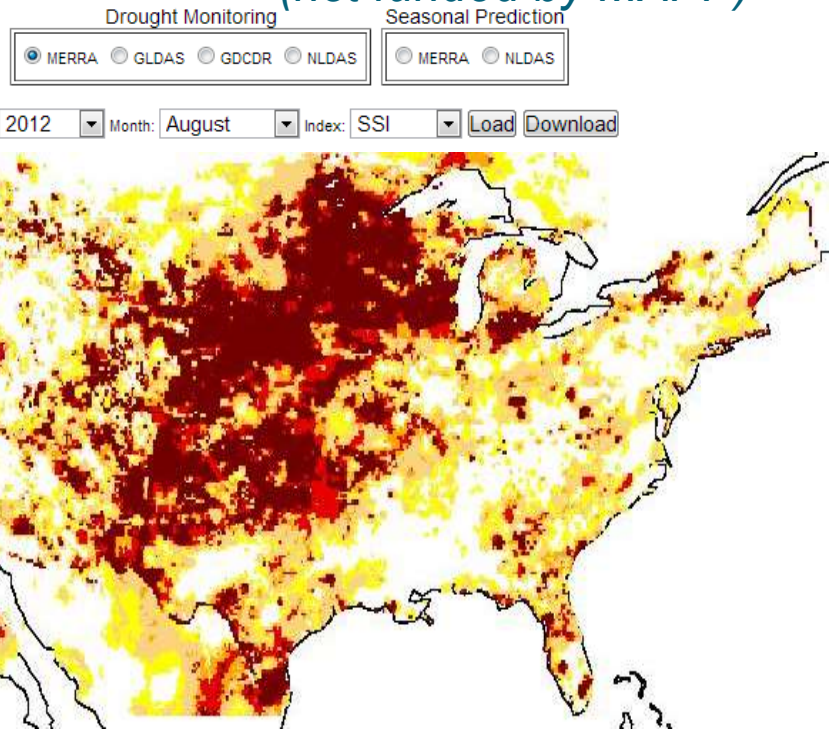
With higher resolution thermal IR imagery from e.g. MODIS and Landsat, we can potentially determine how the GOES-scale stress signal is distributed over subpixel landclasses.

Courtesy of M. Anderson

An Experimental Integrated System

GIDMaPS: Global Integrated Drought Monitoring and Prediction System

(not funded by MAPP)



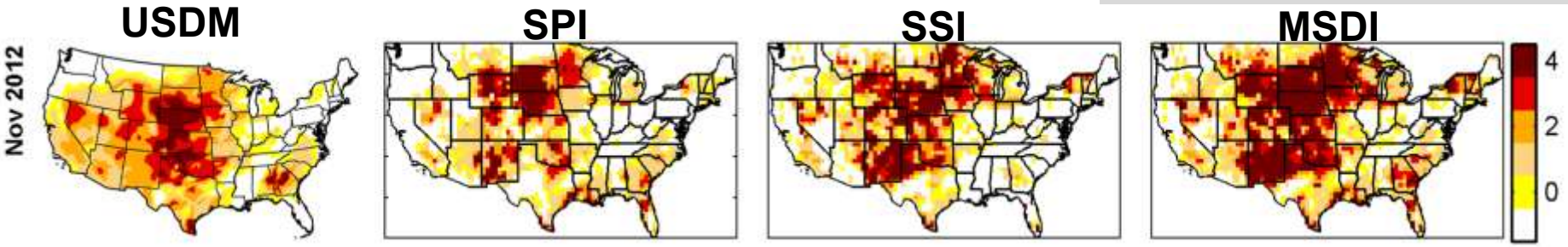
Feb, 2013

GIDMaPS provides:

1- Drought monitoring using NASA MERRA, NLDAS and GLDAS, and satellite precipitation data based on SPI, Standardized Soil Moisture Index (SSI) and Multivariate Standardized Drought Index (MSDI).

2- Seasonal (1-6 months) drought prediction using a persistence model and the SSI and MSDI indices.

Courtesy of Amir Aghacouchak
http://drought.eng.uci.edu



Experimental Drought Prediction Systems

NMME system for Climate and Drought Prediction

The National Multi-Model Ensemble (NMME)

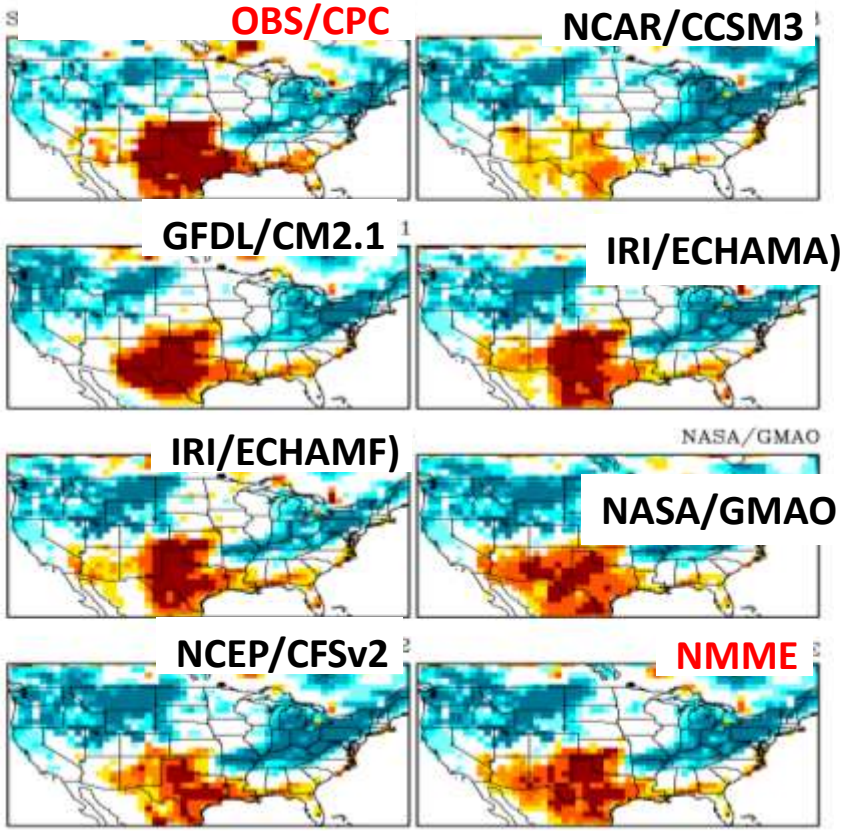
A broad NOAA-led multi-institutional interagency-funded research project

- 2 year research project involving U Miami, GFDL, NCEP, ESRL, NCAR, NASA, IRI, U of Princeton, COLA; PI Kirtman
- MAPP-CTB partnership; NOAA/NSF/DOE/NASA support.

Status:

- NMME system currently running experimentally in an operational mode;
- Used for research, including experimental SPI prediction (right)

SPI6 for 2011 MAMJJA

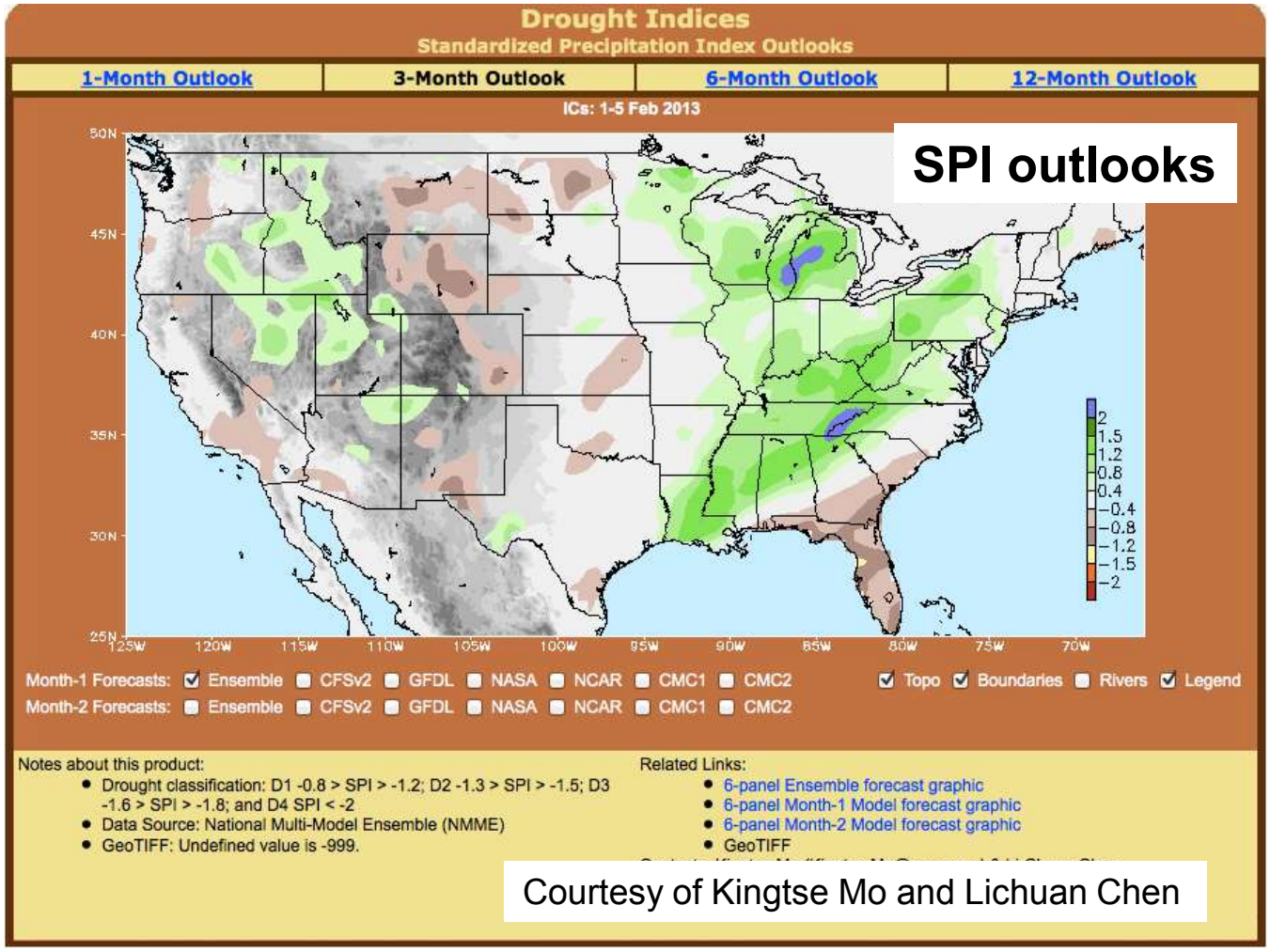


Prior 3-month (MAM) observation with current (JJA) 3-month forecast

Courtesy of E Wood

NMME-based Drought Products at NCEP

- Experimental NMME forecasts already used as part of NCEP's forecasts
- An input for the USDO

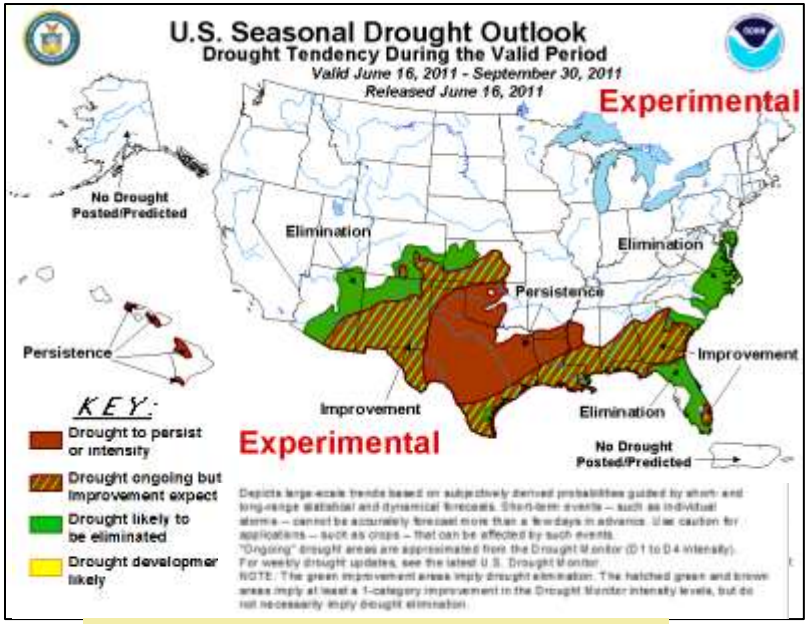


Courtesy of Kingtse Mo and Lichuan Chen

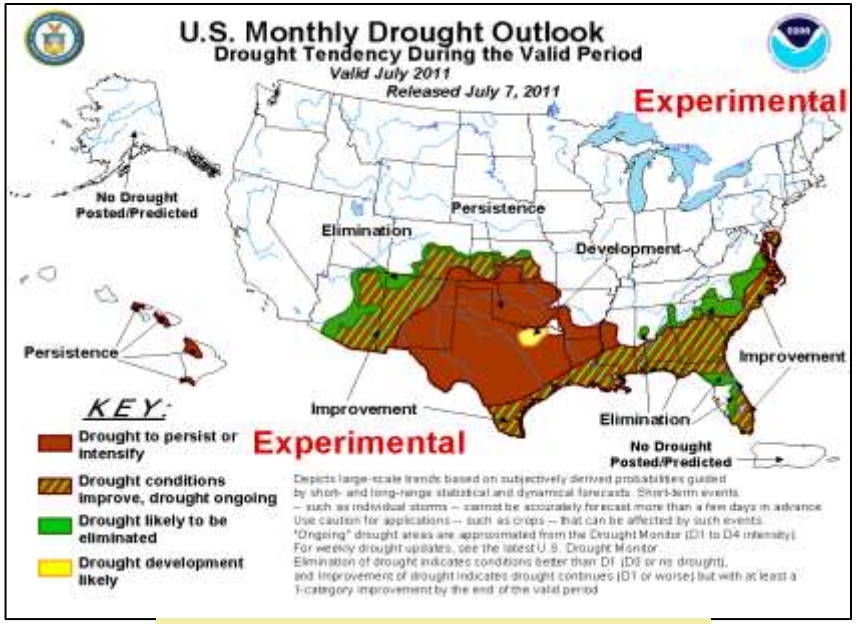
http://www.cpc.ncep.noaa.gov/products/Drought/Monitoring/spi_outlooks.shtml

Proposed Modifications to the U.S. Seasonal Drought Outlooks

By CPC USDO Authors: David Miskus, Brad Pugh, Adam Allgood, Rich Tinker, and Anthony Artusa



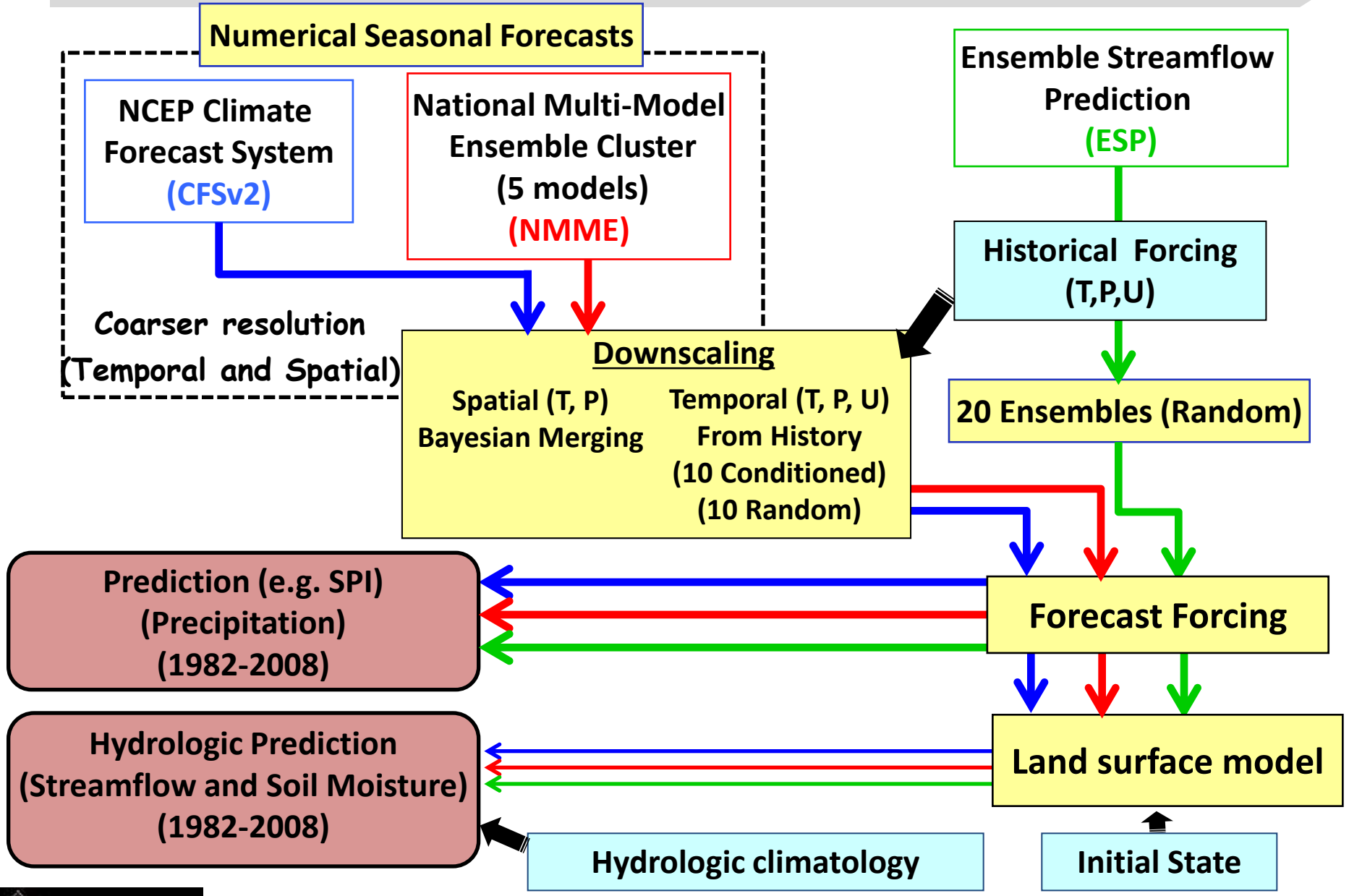
Seasonal Drought Outlook



Monthly Drought Outlook

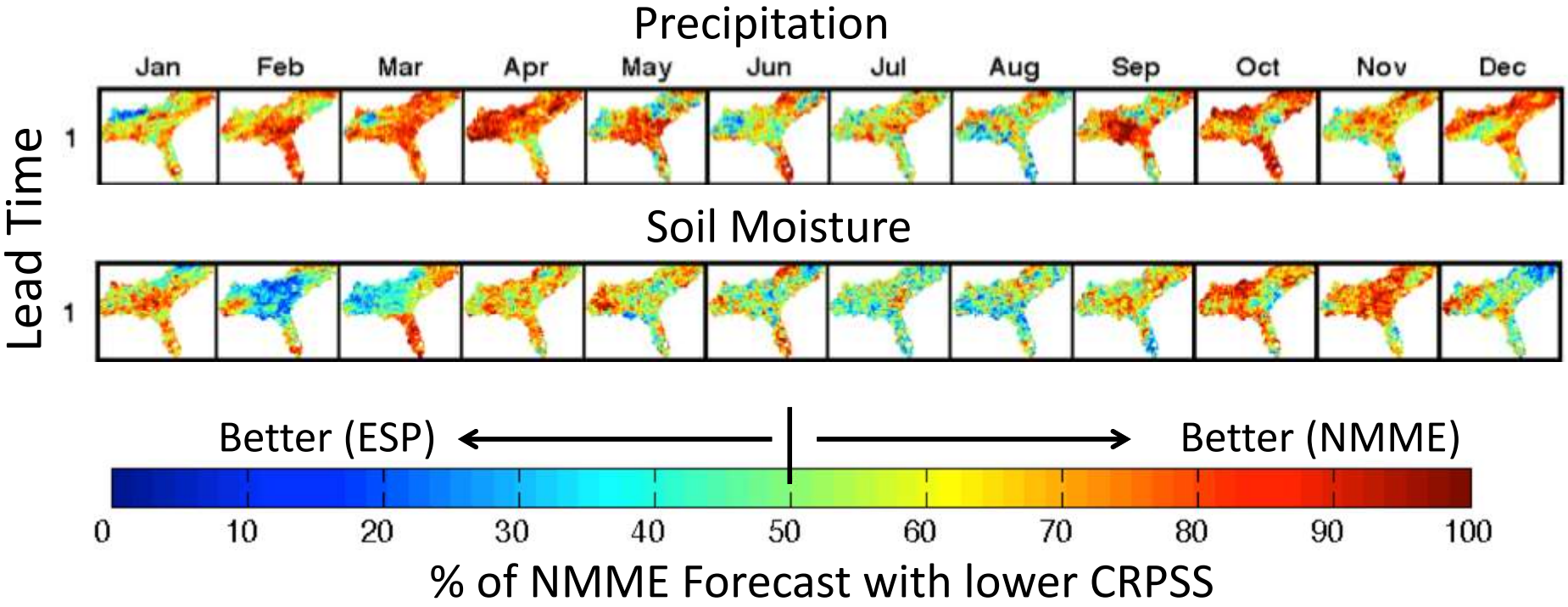
- Taking advantage of improving skills of short-term forecasts (e.g. 6-10 day, 8-14 day, week 3) and dynamical models (NMME, CFSv2, etc.)
- Fulfilling the need for shorter time-scale for drought prediction after the Flash Drought in the Midwest last year – **A Monthly Drought Outlook**
- Clarifying our drought categories, now: **Removal** (if drought goes to D0 or nothing at end of period) & **Improvement** (if drought improves at least 1-category but is still at D1 or worse at end of period), with **Persistence** and **Development** staying the same.

Princeton University's Hydrologic Forecast Methodology



NMME Soil Moisture Skill

- How does the precipitation skill propagate to soil moisture forecast skill?

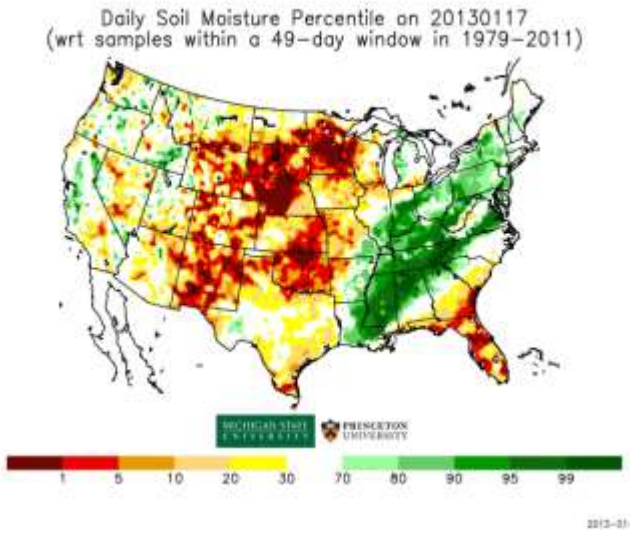


Results show that the NMME has higher precipitation skill (based on CRPSS) than resampling from climatology (ESP), and that this skill gets translated into improved soil moisture skill.

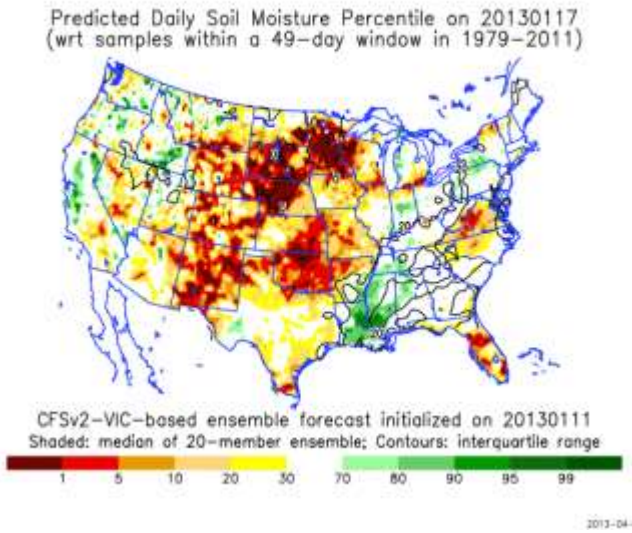
Courtesy of E Wood

CFSv2 Model Based Predictions

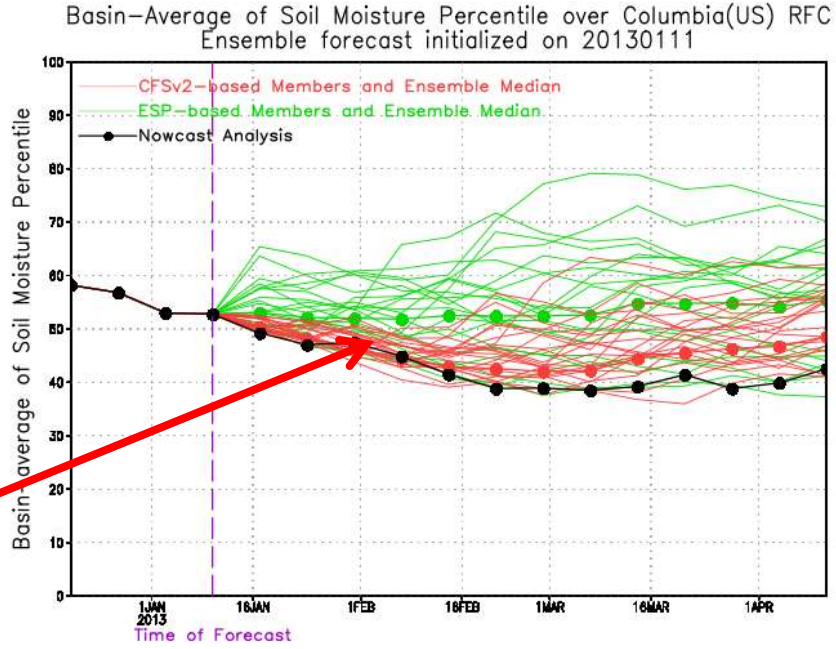
Verification



Prediction



- ✓ CFSv2-based seasonal drought prediction with VIC hydrological model
- ✓ Updated weekly using most recent CFSv2 forecast runs
- ✓ Compared to the traditional forecast method (ESP-based, green), the new forecast has much reduced uncertainties and higher skills (red lines)



http://drought.geo.msu.edu/research/forecast/

Courtesy of Lifeng Luo

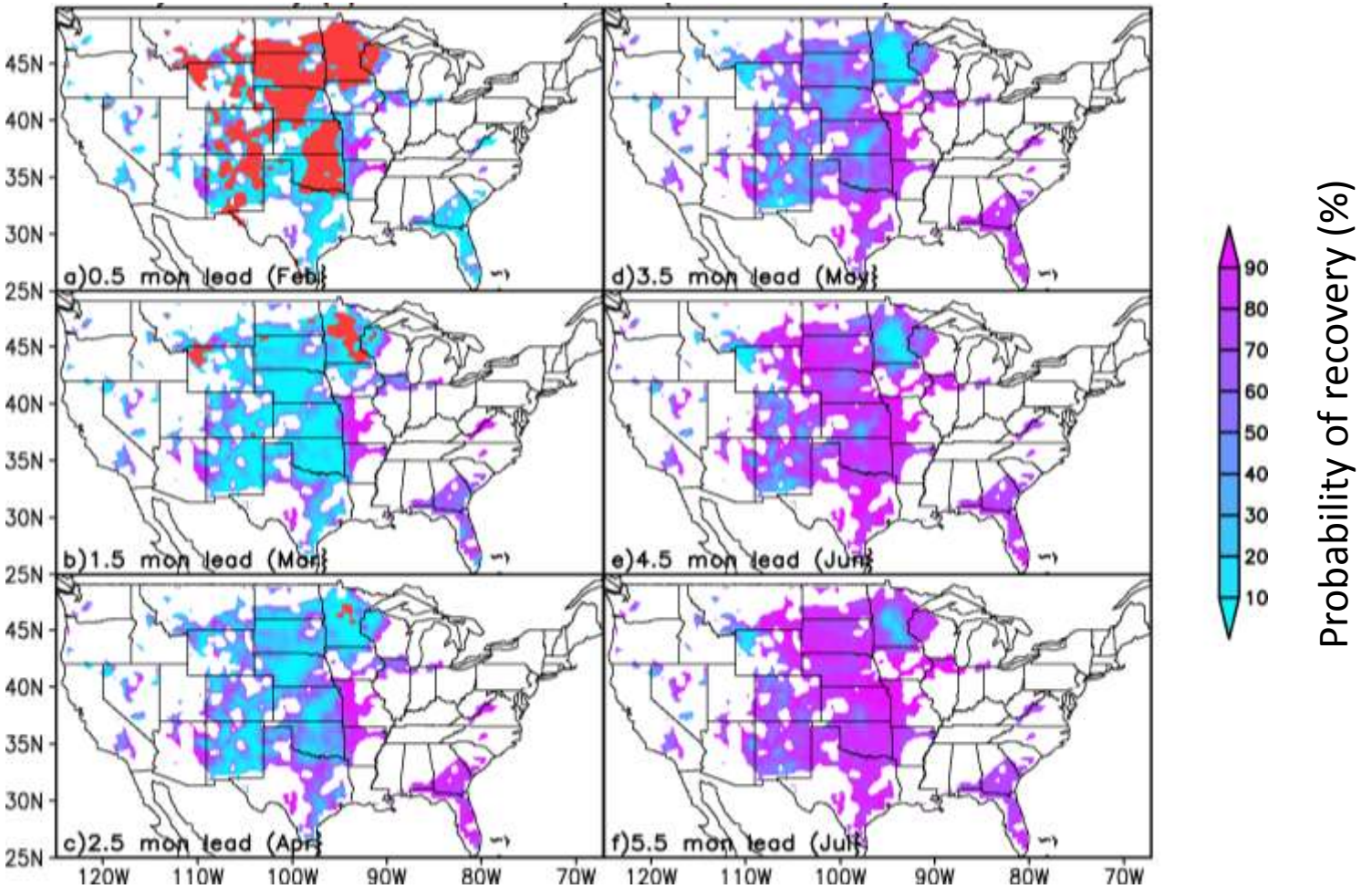
2013-04-26-21:55

A Probabilistic Framework for Assessing Drought Recovery

Ming Pan, Xing Yuan, and Eric F. Wood, Princeton University.

PRINCETON UNIVERSITY

Maps of agricultural drought recovery probabilities (soil moisture greater that 30%) if median (50% chance) precipitation occurs during the forecast period. Red shows zero chance of recovery. Leads from 0.5 months to 5.5 months.



Summary & Opportunities

- The Drought Task Force includes top-notch scientists and projects with great potential; the group is providing focus and leadership to the drought research community
- The challenge is to sustain this effort in the current budget situation

Opportunities for further progress:

- Improved understanding of drought processes and predictability (predictability sources, better identification forecasts of opportunity..)
- Development of objective/probabilistic drought monitoring and prediction (accounting for uncertainties) that better exploit predictability, better representing drought evolution
- Monitoring systems that leverage on assimilation of new/improved data to deliver higher resolution depictions.
- Further data integration leveraging on different methodologies

THANKS!

For more info google:

“MAPP Drought Task Force”

or email: annarita.mariotti@noaa.gov