User Needs:
The US Department of Agriculture

Mark D. Brusberg
Chief Meteorologist
USDA Office of the Chief Economist / World Agricultural Outlook Board

Presented To

Workshop on Building an Interannual to Decadal (2-30 year) Prediction/Projection Capability for Decision Support

June 5, 2019

College Park, MD

How is the agricultural sector affected by seasonal variations in weather?

Types of Weather Affecting Agriculture

Precipitation – things to consider:

- Seasonal accumulation (Excess / Deficit)
- Frequency
- Timeliness

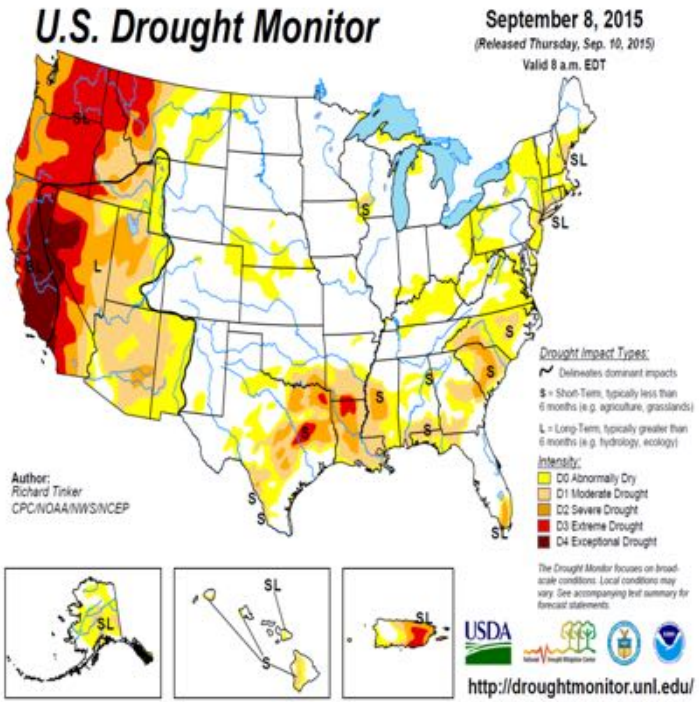
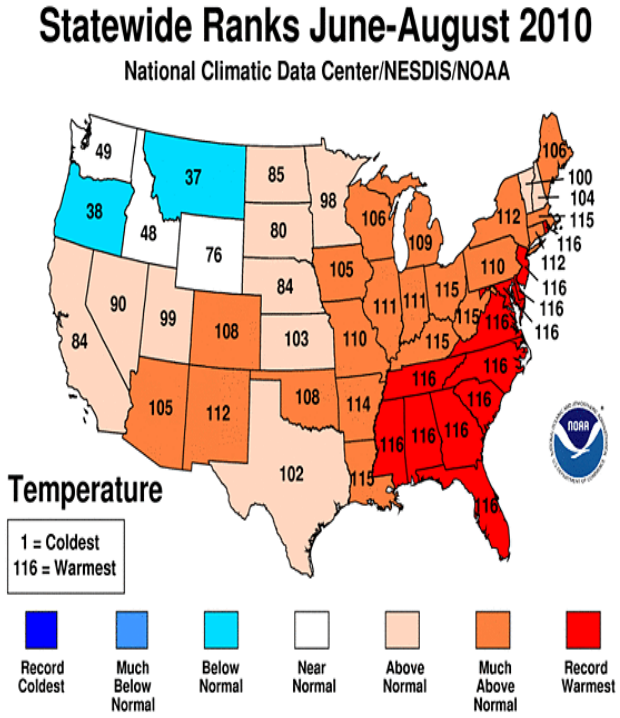


Photo: Getty

Types of Weather Affecting Agriculture

Temperature – things to consider:

- Accumulated heating units
- Heat stress
- Freezes
- Season Length (time between last spring freeze / first of autumn)



Types of Weather Affecting Agriculture

Potentially Damaging Extreme Events:

- Flash Flooding
- Hail
- High winds
- Lightning (forest fires)

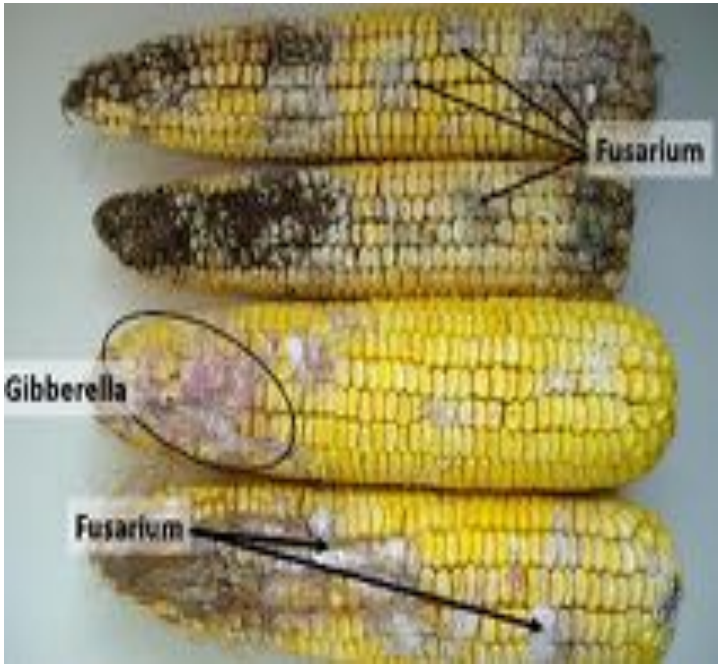
Hail-damaged corn in central Nebraska may be sprouting due to a disruption of normal growth hormones. (*Photos by Jenny Rees*)

Todd Shea, La Crosse National Weather Service Office (NOAA)

Types of Weather Affecting Agriculture

Potential Hazards Resulting from Weather:

- Disease
- Insects
- Longer-term: overwintering, migration

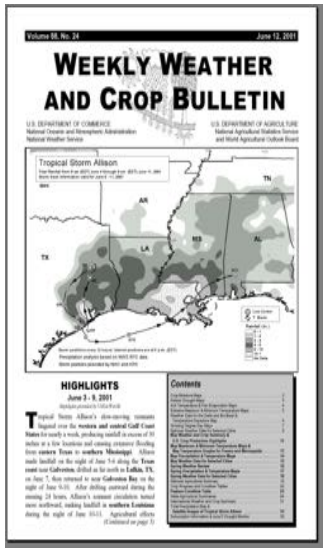


Gibberella and Fusarium ear rot on hail-damaged corn (IA State Extension)

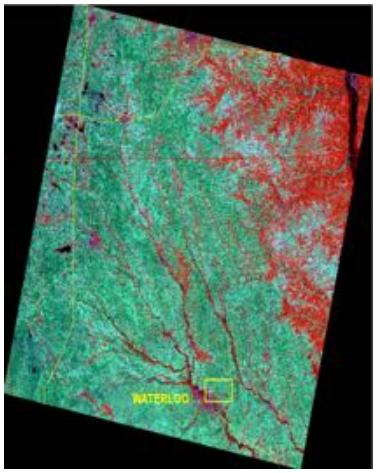
Trees killed by pine beetles (Colorado State Forest Service)

Possible USDA Weather Applications

Fire Weather



Global Monitoring and Assessment



Ground Truth for Remote Sensing

Western Water Supply Forecasting

Research

Crop Insurance Programs

Fire Weather (U.S. Forest Service)

National Significant Wildland Fire Potential Outlook

Predictive Services
National Interagency Fire Center

Issued: September 1, 2015
Next Issuance: October 1, 2015

Outlook Period – September, October & November through December 2015

Executive Summary

The September, October, and November through December 2015 significant wildland fire potential forecasts included in this outlook represent the cumulative forecasts of the ten Geographic Area Predictive Services Units and the National Predictive Services Unit.

September
- Significant fire potential will remain above normal across much of Washington, northeastern Oregon, northern Idaho and northwestern Montana.

- Above normal significant fire potential will continue across the mountains of southern California.

- Below normal fire potential will occur over the Mid-Mississippi and Ohio Valleys and most of Florida.

October
- The southern California coastal region will remain in above normal fire potential while the central coast and the Sierras return to normal fire potential.

- Below normal fire potential will spread across the Ohio, Tennessee and Mid-Mississippi Valleys.

November through December
- Southern California will return to normal in November.

- Below normal fire potential will spread over the coastal states from Texas to North Carolina.

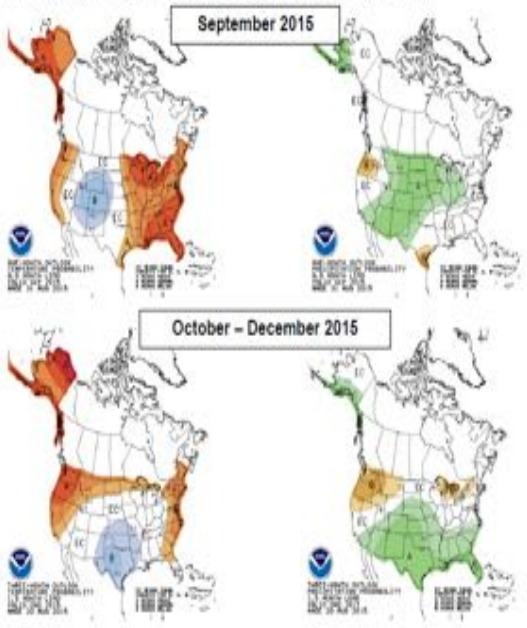
Weather and Climate Outlooks

El Niño conditions continued through August. Positive sea surface temperature (SST) anomalies increased along equatorial Pacific. According to NOAA's Climate Prediction Center (CPC), there is a high probability that El Niño conditions will continue early Spring 2016. These conditions typically result in more precipitation across the southern U.S. and warmer than normal conditions to the northern U.S.

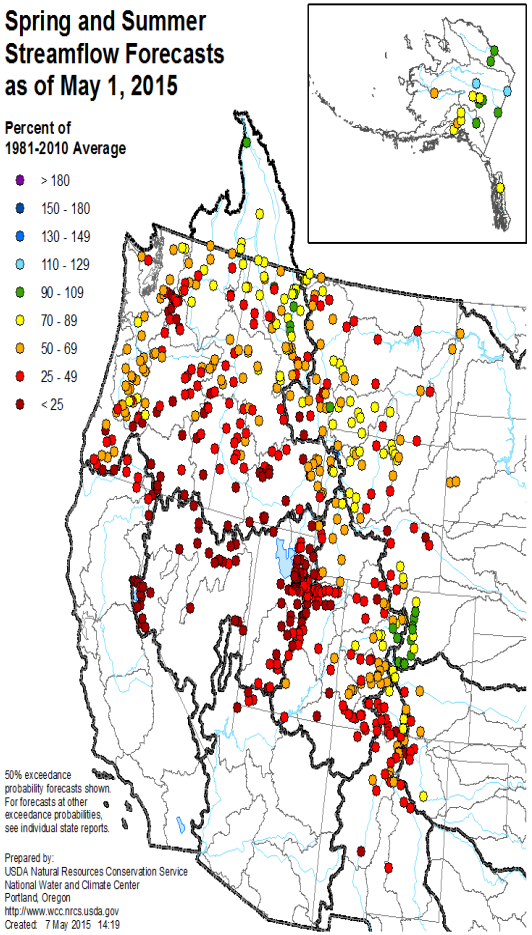
For September, warmer-than-normal conditions are expected in Alaska, the eastern U.S. and most of the Pacific coast, with a continuation of above normal temperatures in these areas as well as along the Canadian border and down the Atlantic coast for the period October through December. Below normal temperatures are expected from the southwestern U.S. through the central in September, shifting into the Southern Plains and Lower Mississippi Valley through December.

Precipitation in September is likely to be above median in the southwestern U.S., the central Rockies, the central Plains and southern Alaska. The Gulf and Southeast coasts are expected to have below normal precipitation. The entire southern half of the U.S. is expected to receive above normal precipitation for the period October through December. Below normal precipitation for this period is likely across the northwestern and northeastern quarters of the U.S.

Top row: One-month (September) outlook for temperature (left) and precipitation (right). Bottom row: Three month (October-December) outlook for temperatures (left) and precipitation (right). (from Climate Prediction Center/NOAA)



Western Water Supply Forecasting (Natural Resources Conservation Service)



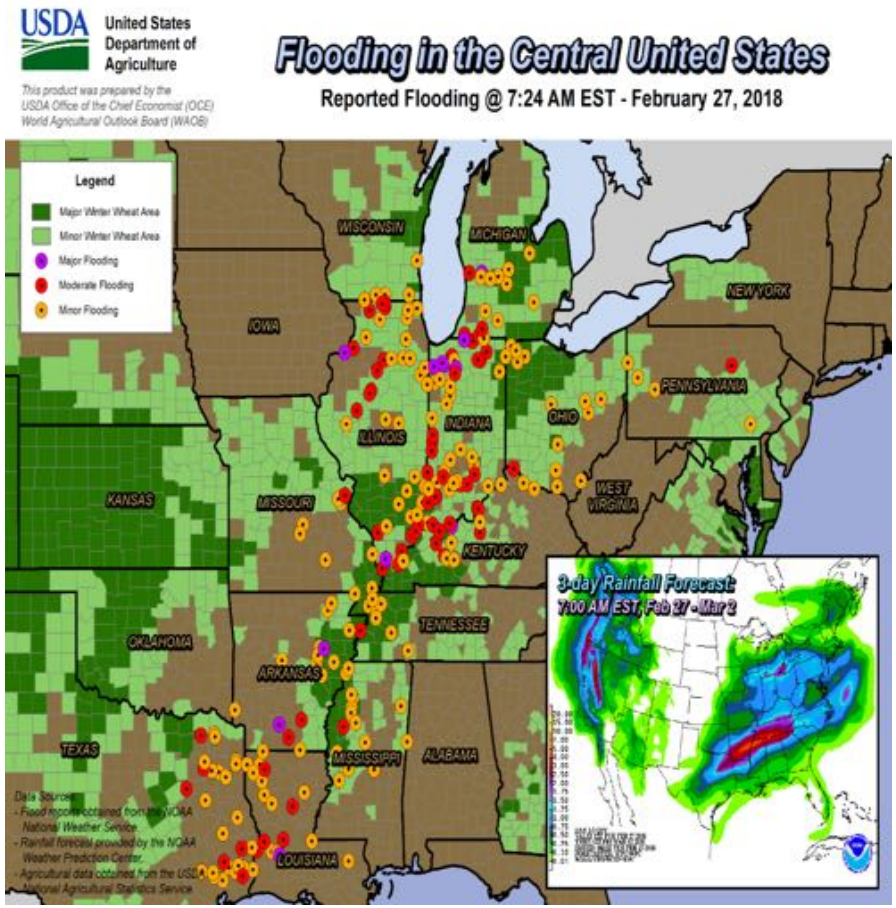
Most water supply forecasts are made using statistical models. These are equations that express a mathematical relationship between the predictor variables (snowpack, precipitation, antecedent streamflow, etc.) and the seasonal streamflow volume of interest. Statistical models have the advantage that they are relatively simple and straightforward to calibrate and use, and they are usually acceptably accurate. The disadvantages are that they require long historical records (preferably greater than 20 years), and they do not represent all known physical processes that affect streamflow.

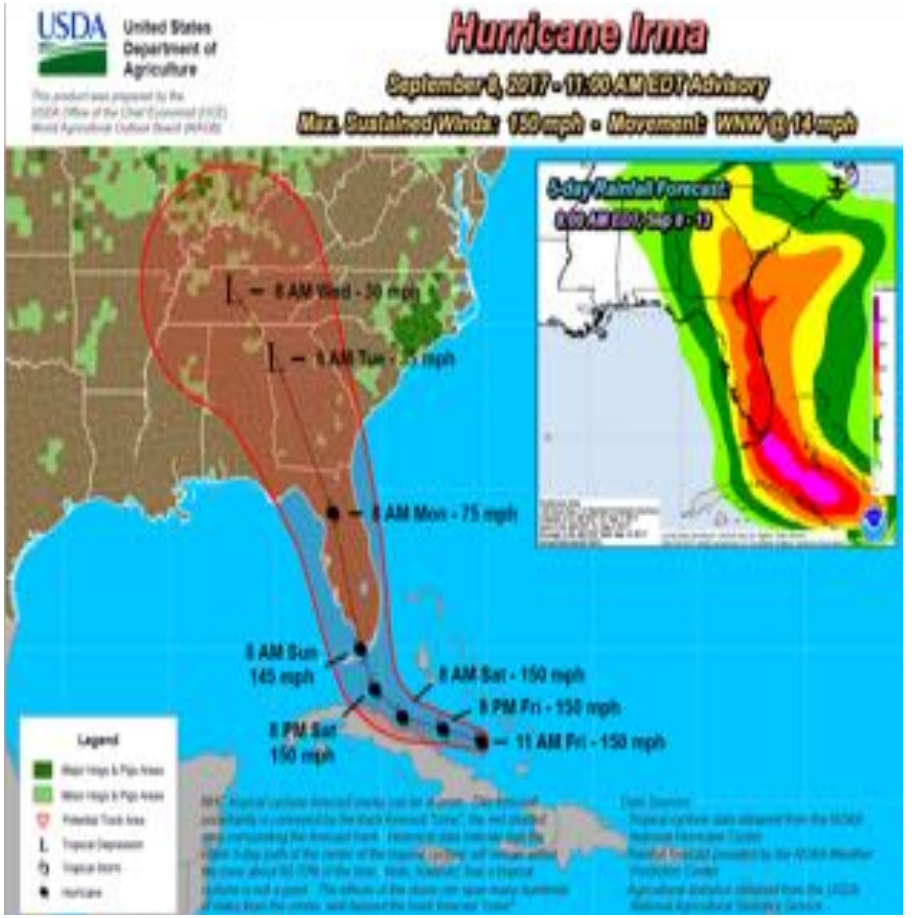
An alternative to statistical models is simulation models. These models attempt to represent, to a greater or lesser extent, all of the main physical processes affecting the movement of water within a watershed and the generation of streamflow. They operate on a continuous basis using a daily or shorter time step. The main advantage of simulation models is that, by explicitly accounting for physical processes, they have a more complete description of what is happening in the watershed and can potentially make more accurate streamflow predictions, especially under unusual circumstances. Other advantages of simulation models are that they can be run year-around and can produce other outputs besides seasonal streamflow volumes, such as full hydrographs and other hydrograph-based quantities. The disadvantages of simulation models are that they require significantly more input data than statistical models, are more difficult and time consuming to calibrate, require more complex output interpretation, and require more database and software infrastructure. Although the use of simulation models is limited at present, they nevertheless have much potential, and their use will increase in the future.

From “Water Supply Forecasting -- A Short Primer”

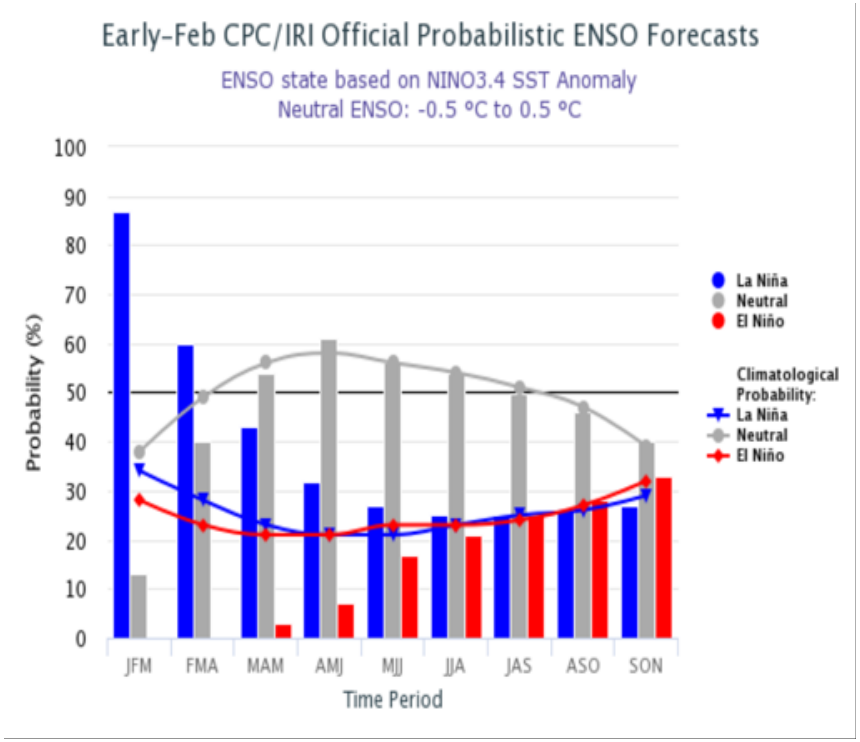
http://www.wcc.nrcs.usda.gov/factpub/wsf_primer.html

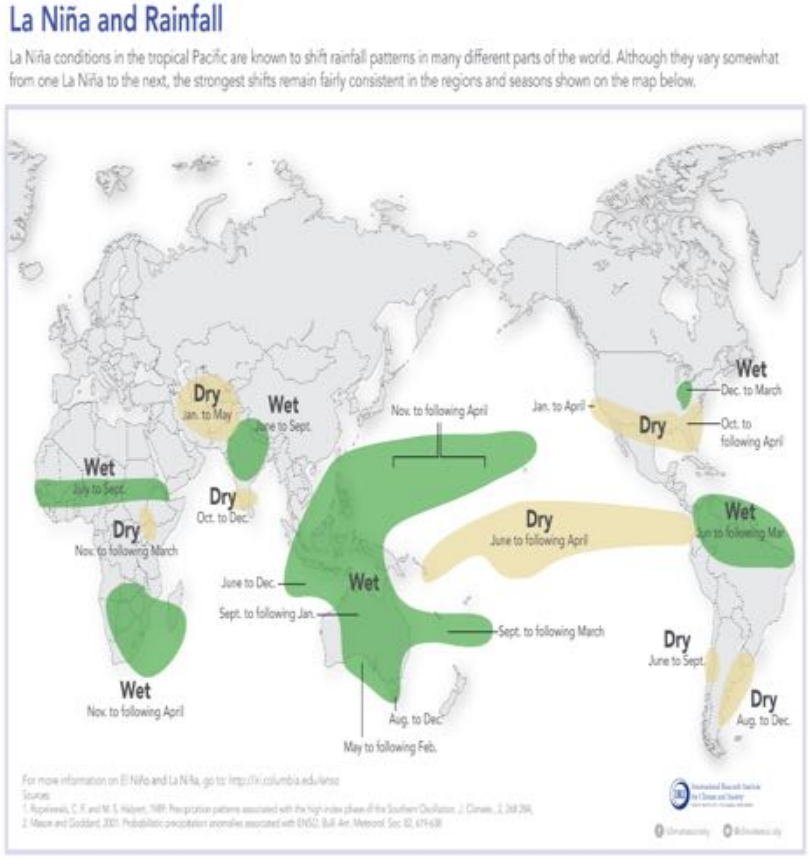
Global Monitoring and Assessment

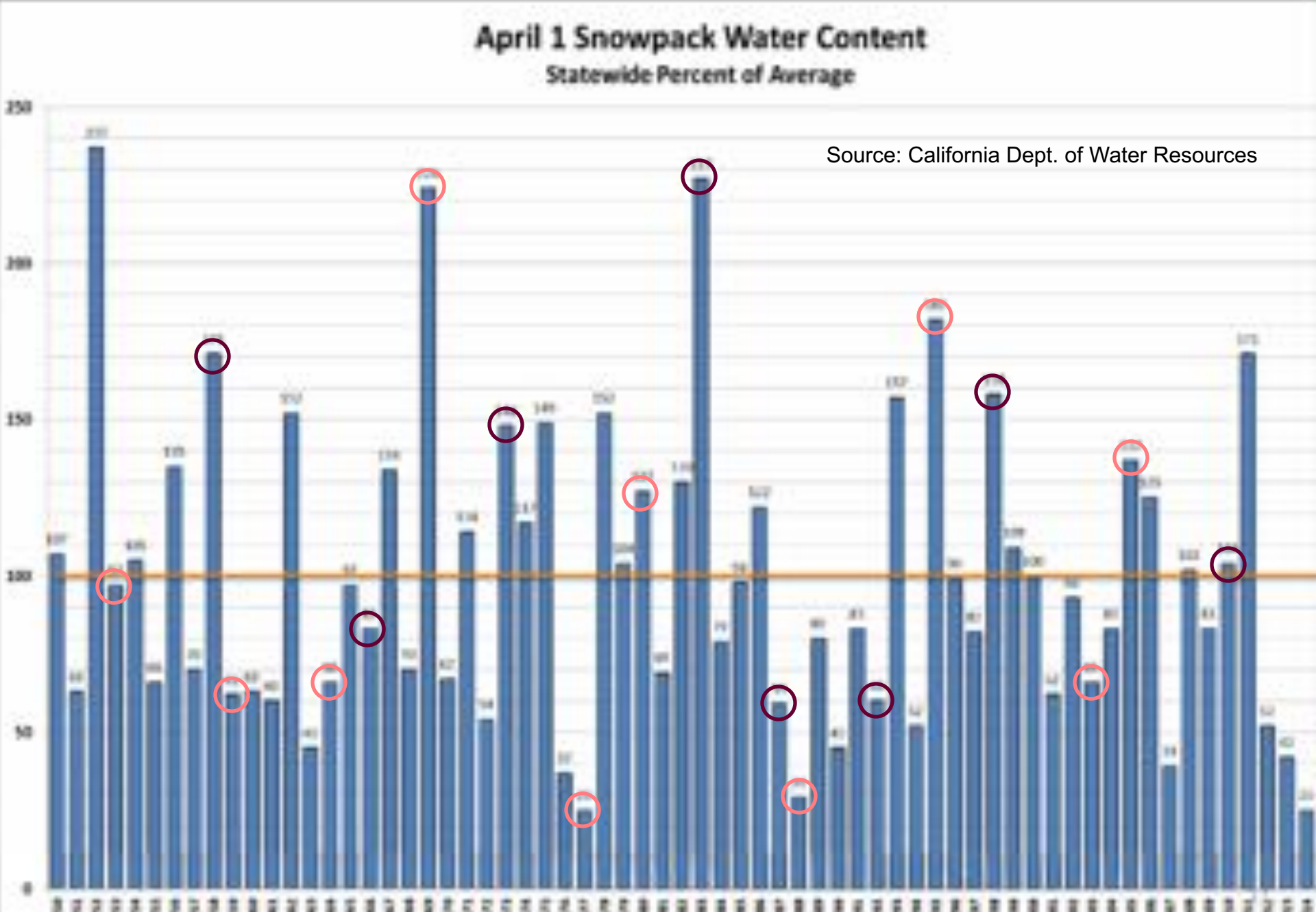




Global Monitoring and Assessment

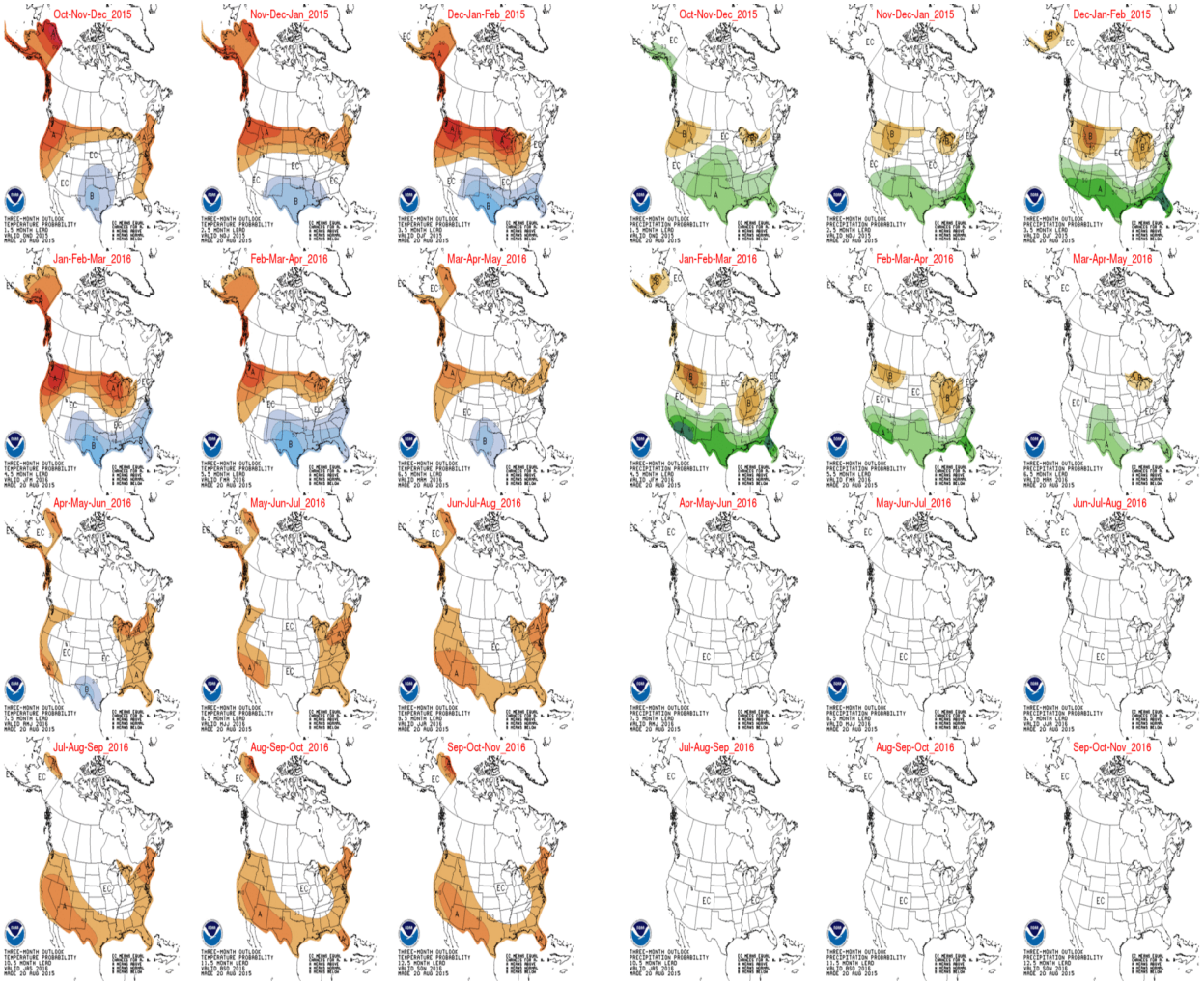






USDA Agricultural Weather Assessments
World Agricultural Outlook Board

What would be the benefits of improved prediction capabilities to USDA and the agricultural sector?



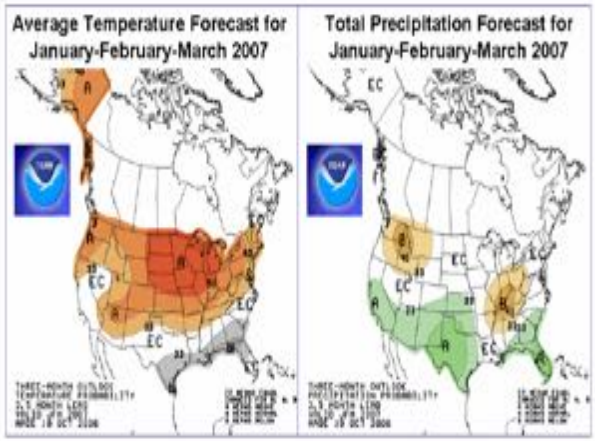
ARS: Where are the best opportunities?

USDA United States Department of Agriculture
Agricultural Research Service

Climate and Watershed Science Fact Sheet
Grazinglands Research Laboratory, El Reno, Oklahoma — November 2006

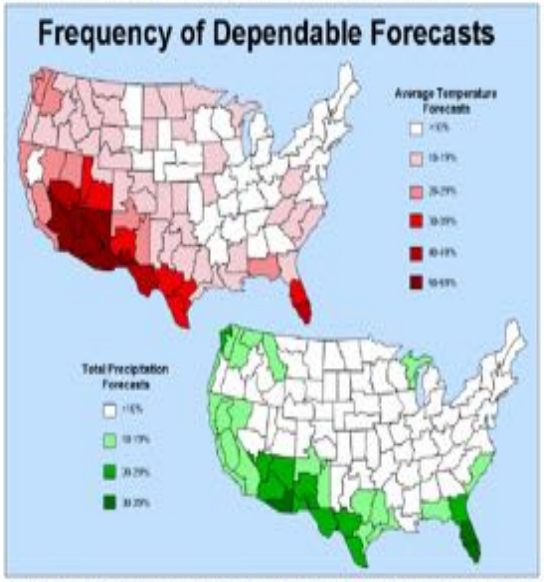
Seasonal Climate Forecasts in Agricultural Applications – Where are the Best Opportunities Right Now?

Variability in weather and climate leads to large natural risks in agricultural production and management of natural resources. Any reliable forecast of weather and climate has the potential to reduce weather and climate related risks for producers and managers. The National Oceanic and Atmospheric Administration (NOAA) has been issuing seasonal climate forecasts (average air temperature and total precipitation) for 3-month periods out to a full year ahead for more than 10 years. The forecasts are probabilistic – they state the odds for specific average air temperature or total precipitation values to occur, rather than making a prediction that a specific value of average air temperature or total precipitation will occur.



The forecasts have been reported to have some skill. However, it is not clear where or when the forecasts are dependable, or if the dependable forecasts have any utility in real-world management decisions. Research is being conducted at the ARS Grazinglands Research Laboratory at Fort Reno, Oklahoma, to determine the potential utility of the NOAA climate forecasts for agricultural producers or water resource managers.

Potential utility for practical applications will depend on several forecast properties. First, forecasts need to be significantly different from average for managers to consider adjusting their current management practices to include climate forecast information. Second, forecasts need to be offered frequently enough to justify their use. Third, forecasts need to correctly predict the shift in odds for specific average air temperature and total precipitation to occur. Researchers at the ARS Grazinglands Research Laboratory developed measures for these forecast properties, and examined 8 years of three month climate forecasts issued for 1997 through early 2005 for the contiguous United States. The results are shown in the figures below, where the percentages are the frequency of forecasts that provided dependable information beyond standard climatology.



In summary, the best opportunities for use of the NOAA seasonal climate forecasts are in regions with high percentage of dependable forecasts. Even for high dependability in a particular region, investigations must be conducted to determine if the forecast information is actually offered during the right seasons for a particular crop or water resource management decision, and whether the forecast shifts in odds are large enough to make a financial difference in the outcome. This research is ongoing at the ARS Grazinglands Research Laboratory. Additional information pertaining to this research is available at: http://ars.usda.gov/Main/docs.htm?docid=11617

ARS: How can these be improved?

Downscaling Seasonal Climate Forecasts for Agricultural or Hydrologic Applications

A. What is this research project?

Variations in weather from month to month or year to year are critically important in agriculture and water resource management. As an example, droughts lasting more than a few months are a particularly expensive hazard, sometimes with prolonged and pervasive fiscal, environmental, and ecological impacts. If our decision support tools could be made climate-sensitive, incorporating skillful seasonal forecasts of precipitation or air temperature out to a year ahead, losses could be minimized and opportunities maximized. This project is part of an over-arching effort to transform freely available official NOAA seasonal climate forecasts into decision support information.

B. What problem does it address?

NOAA has been offering seasonal climate forecasts for more than a decade, but the forecasts are offered for very large areas and three month periods. Crop and hydrologic models operate at daily scales for specific locations or watersheds. This mismatch between space and time scales makes it impossible to use the forecasts directly in decision support. A bridging method has been developed to address this problem. The first step is to downscale the seasonal climate forecasts to the location of area of interest; the second is to downscale them in time, from three months to single months so they can be used to drive a weather generator (see companion poster by Jurgen Garbrecht).

C. How is the project different from or how does it enhance other projects?

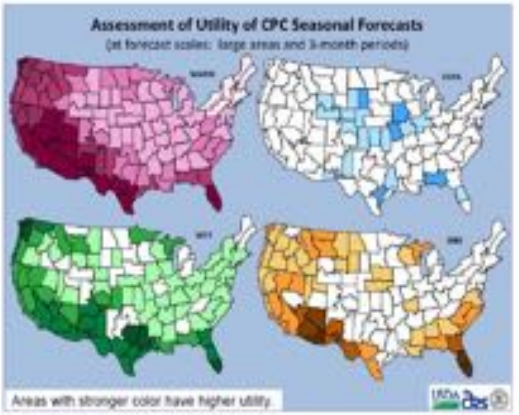
This project is unique in both subject and approach, and enhances other decision support projects by offering the possibility of incorporating seasonal climate forecast information. As part of this effort, the NOAA seasonal climate forecasts were evaluated for skill on a regional, seasonal, and situational basis, producing information that is still not offered with the forecasts.

D. What are the potential benefits of partnering with ARS on this research?

Our team has conducted analyses of forecast skill, has developed the necessary methods, has access to the climatological data required, and experience with the downscaling techniques.

E. Who are the potential customers?

Everyone who desires to develop climate-sensitive decision support in a region where the NOAA seasonal climate forecasts have demonstrated predictive skill.



Stage of Development

This approach to downscaling seasonal climate forecasts has been developed and reported at meetings and in journal articles. To date, the method has been applied in two very different applications to evaluate possible utility for hydrologic and agricultural decision support in Oklahoma: forecasting monthly runoff for a small watershed, and forecasting grain and beef production in a wheat grazing model.

Moving Forward

This method for downscaling seasonal climate forecasts needs to be applied and evaluated for specific agricultural or hydrologic applications and locations. The skill of the seasonal climate forecasts varies with region, season, and the state of the oceans (for example, whether an El Niño event is occurring). This is especially true for precipitation forecasts, so each possible application of climate-informed decision support needs to be examined separately. Anyone interested in exploring the possible use of seasonal climate forecasts as part of a decision support tool is encouraged to review the associated papers and to contact the authors.

Researchers

Jeanne M. Schneider, Research Meteorologist
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USDA ARS Water Quality

High Quality Water Benefits Everyone

www.mwa.ars.usda.gov

Outreach to the Ag Community

Dan Barker, Iowa State University, discusses research findings with area farmers at a field-based meeting

Major Cold and Wet Spring Event: Potential Impacts in the North Central U.S. April 26-May 9, 2017

Prepared By:
Barb Mayes Boustead, Ph.D.
Meteorologist and Climatologist, National Weather Service

Dr. Dennis Todey
Director – USDA Midwest Climate Hub

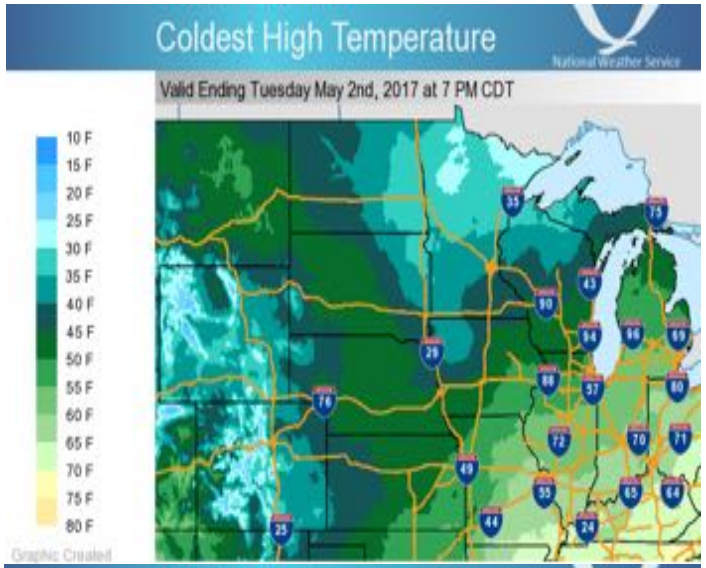
In Partnership With:
Doug Kluck (NOAA/National Centers for Environmental Information), Dannele Peck (USDA Northern Plains Climate Hub), Crystal Stiles (High Plains Regional Climate Center), Mike Timlin (Midwestern Regional Climate Center), Ray Wolf (National Weather Service)

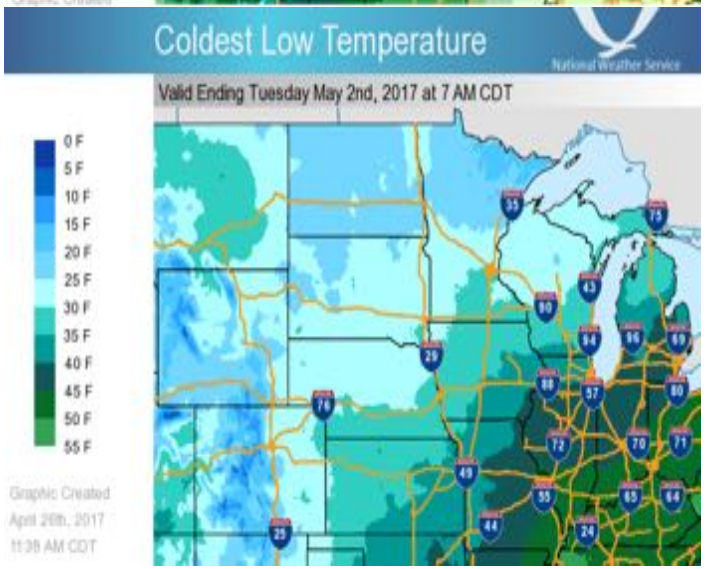
Temperatures: April 26-May 1

- *Top right*: Coldest high temperatures on any day between April 27 and May 2
- *Bottom right*: Coldest low temperatures on any day between April 27 and May 2

- **Freezing temperatures** possible from the central and northern Plains to the Great Lakes
- **Much below-normal high temperatures** possible across the area
- Conditions may occur on **several days** through the period

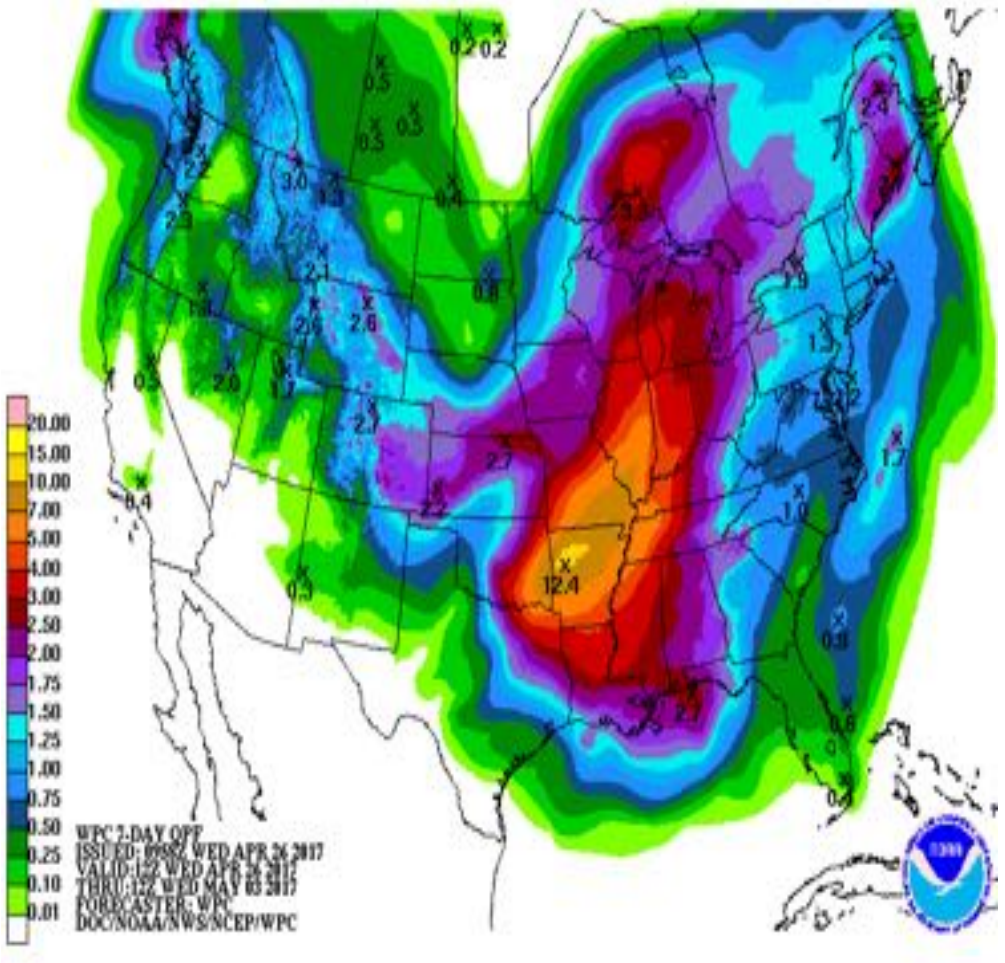
- For local weather updates now through 7 days: http://www.weather.gov/



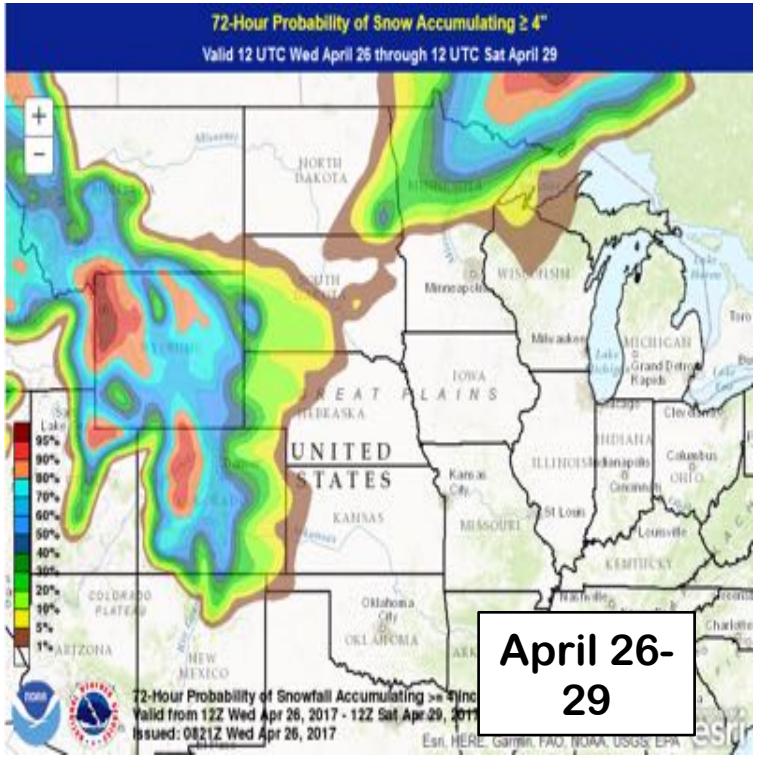


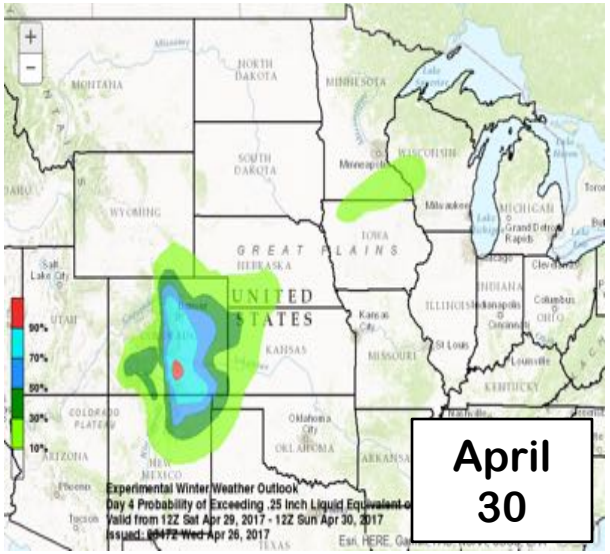
Precipitation: April 26-May 2

- Image: Total forecasted precipitation for the whole week (actual precipitation often is more spotty or varied in coverage)
- **Unusually wet** conditions likely for much of the central U.S. for April 26-May 3
- Combined with cool temperatures



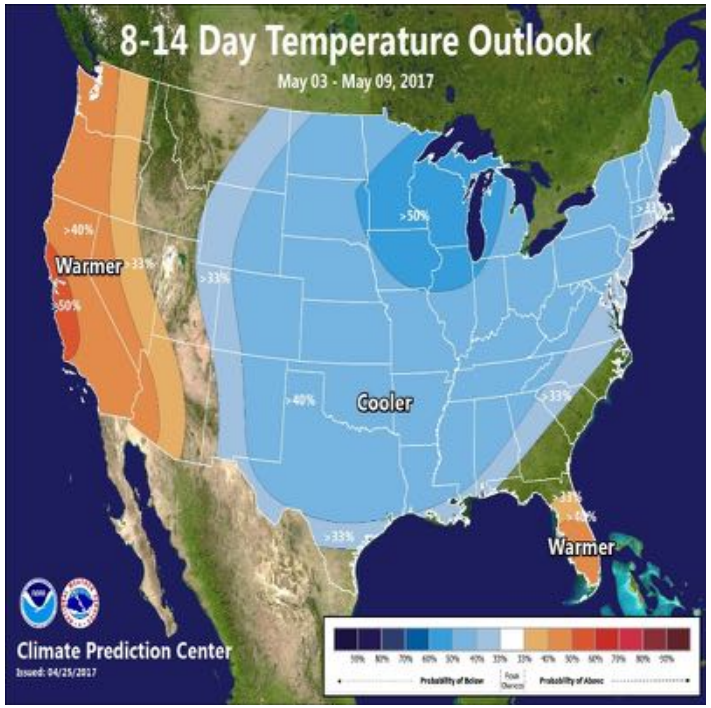
Snowfall: April 26-May 2

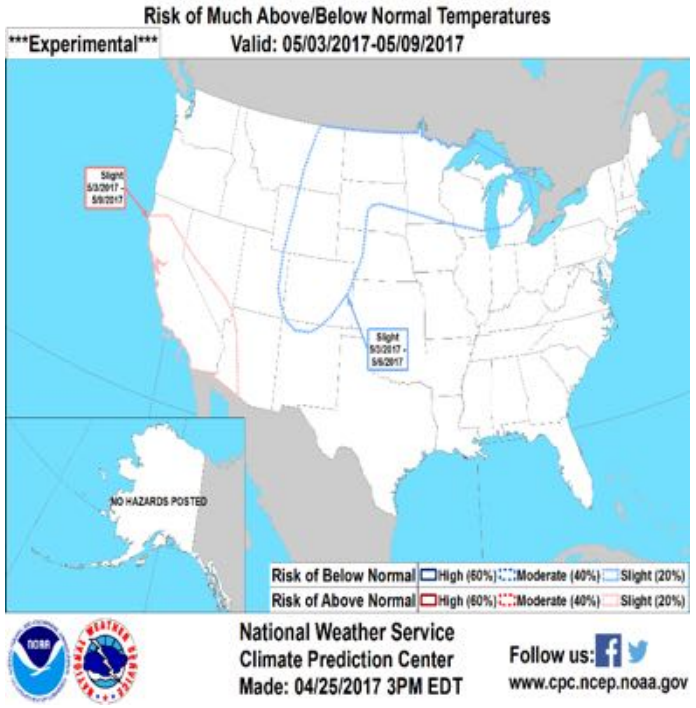




- *Top left*: Chance of snow >4" total for April 26-29
- *Top right*: Chance of snow >0.25" liquid equivalent for April 30
- *Bottom right*: Chance of snow >0.25" liquid equivalent for May 1
- **Significant snowfall possible** in Wyoming, Colorado

8- to 14-Day Temperature Outlook: May 3-9, 2017

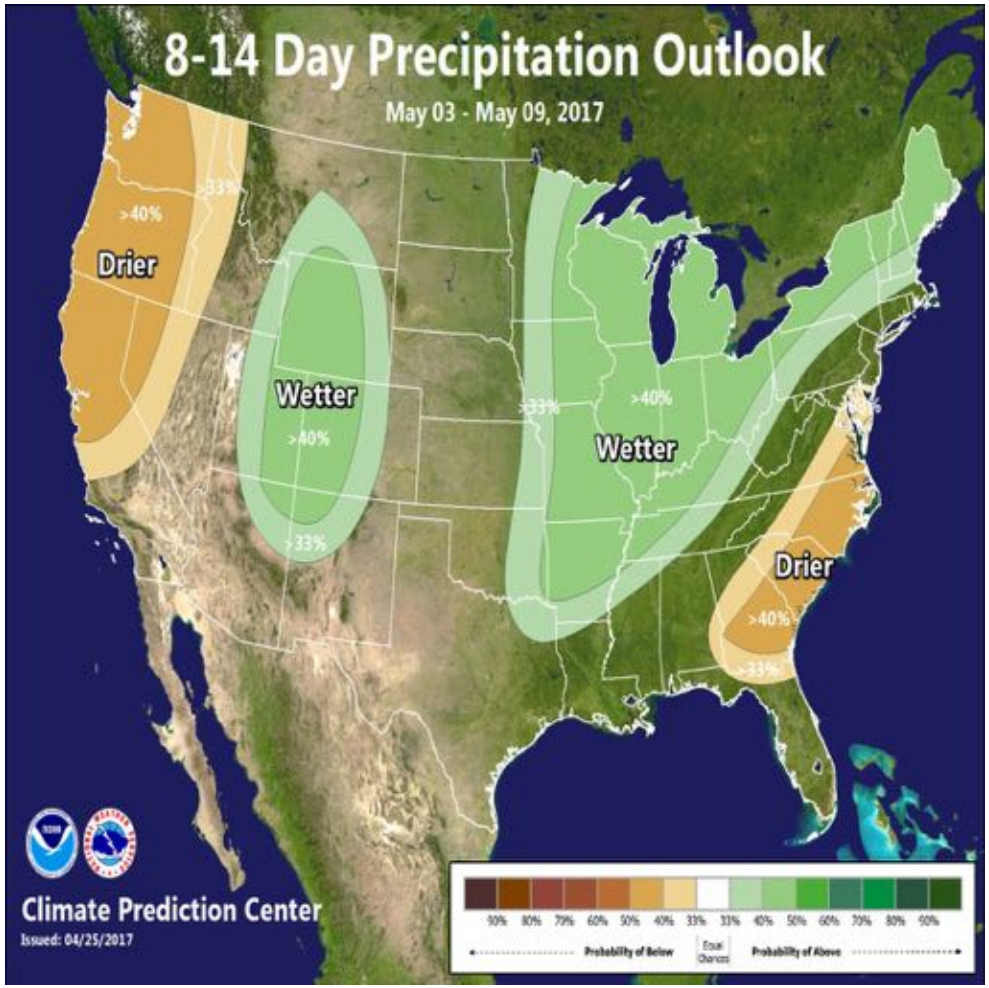




- Odds favor below-normal temperatures
- Odds slightly favor much below-normal temperatures
- Highest chances in the western Great Lakes to upper Midwest

8- to 14-Day Precipitation Outlook: May 3-9, 2017

- Odds favor above-normal precipitation
- Highest chances in the Great Lakes to Mississippi River valley
- Thus… cold and wet conditions remain possible through the next 2 weeks



Impacts

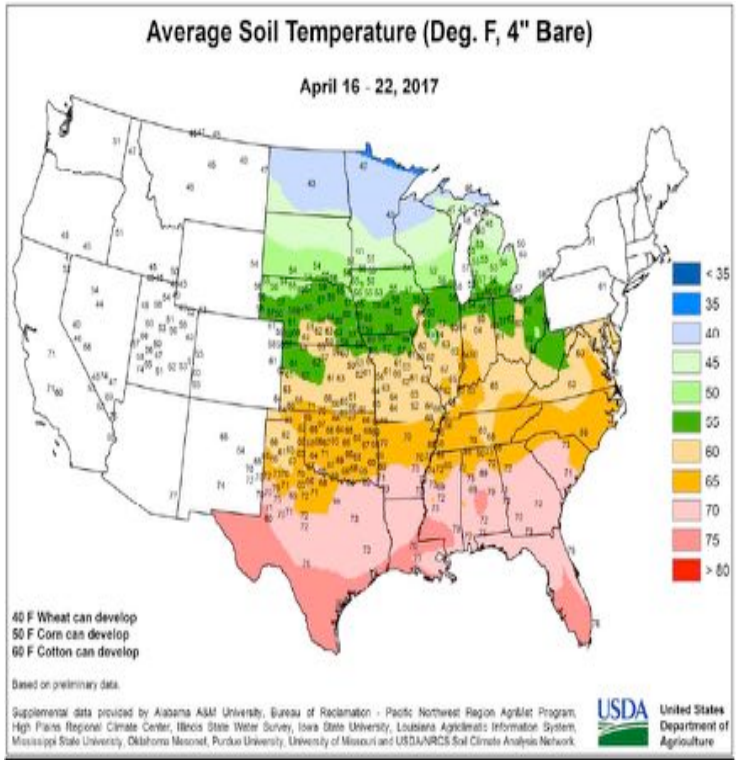
Freeze:

- Wheat growth
- Apple and other fruit tree blooms
- Home gardens and landscaping

Cold and Rain:

- Corn planting and seed germination
- Livestock health, especially calves
- Soil compaction and nutrient loss
- Inaccessible fields

Impacts - Soils



USDA Weekly Weather and Crop Bulletin

Temperature:

- Continuous cold, wet soil and cloud cover will keep soils very cool

Moisture:

- Flooded fields/slow field access
- Contribute to nutrient loss
- Increased crop disease issues
- Impact root growth

Risk:

- Likely delay additional planting
- Heaviest rain expected southern/eastern Corn Belt
- Most plains and Midwest will likely have some wetness

Impacts - Crops

http://crops.extension.iastate.edu/cropnews/2012/05/imbibitional-chilling-and-variable-emergence

Freezing conditions:

- Wheat, horticultural, fruits, perennials most at risk based on development (different risk temperature at different stages: fruits, wheat)
- Freeze risk management very likely
- Exposed home vegetation need to monitor forecasts

Cold conditions:

- Most field crops less risk of freeze, more risk sitting in cold soils
- Slow crop development
- Increased disease risk
- Replant may be necessary

Impacts - Livestock

Cold, Rain, Winds:

- Young livestock should be monitored because of prolonged cold/wet conditions over the 1-2 weeks
- Snow accumulations could add to risk in Plains, northern states

Useful information in Agricultural Planning Over Larger Time Scales

- **Identification of position in decadal cycles**
  - getting wetter / drier?
- **Variations in seasonal norms**
  - “early or wet spring”, etc.
- **Possible regional analogs**
  - “This year will be just like 19xx”
- **Irreversible trends**
  - Early snow melt in western watersheds, longer growing seasons, etc. (what is the new anomaly?)
- **Most importantly …..**

….. Put this guy out of business!

Thanks!

mbrusberg@oce.usda.gov

Getty