



UNIVERSITY OF MINNESOTA

**Driven to Discover<sup>SM</sup>**

# **Institute of Ag Professionals**

Proceedings of the

## **2015 Crop Pest Management Shortcourse &**

### **Minnesota Crop Production Retailers Association Trade Show**

[www.extension.umn.edu/Ag-Professionals](http://www.extension.umn.edu/Ag-Professionals)

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# Climate Change and Variability in the Midwest: Trends and Tools

Dr. Jim Angel, State Climatologist  
Illinois State Water Survey  
Prairie Research Institute



ILLINOIS

[illinois.edu](http://illinois.edu)



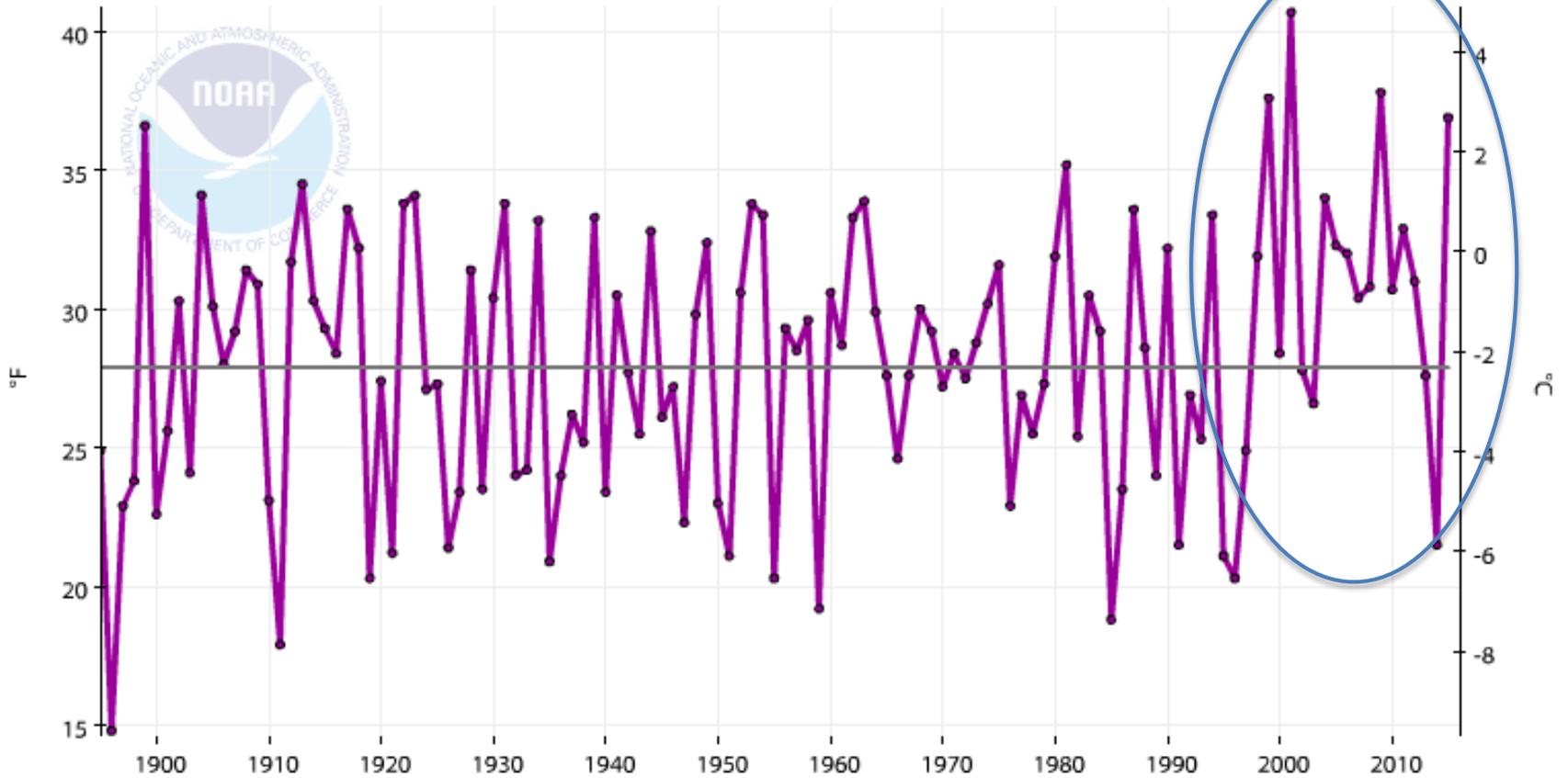




# Minnesota, Average Temperature, November

1901-2000  
Avg: 27.9°F

Avg Temperature



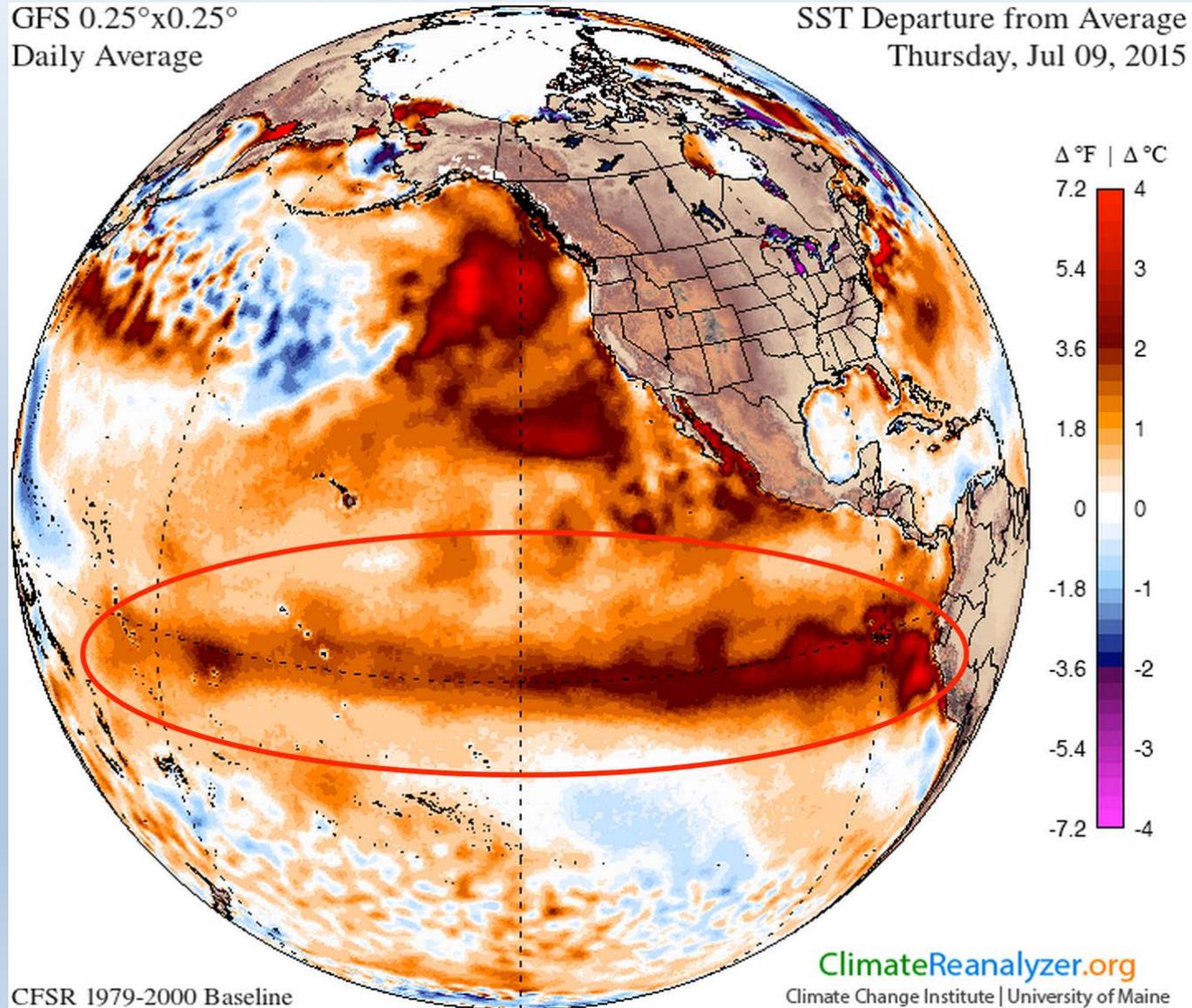
Large year-to-year variability

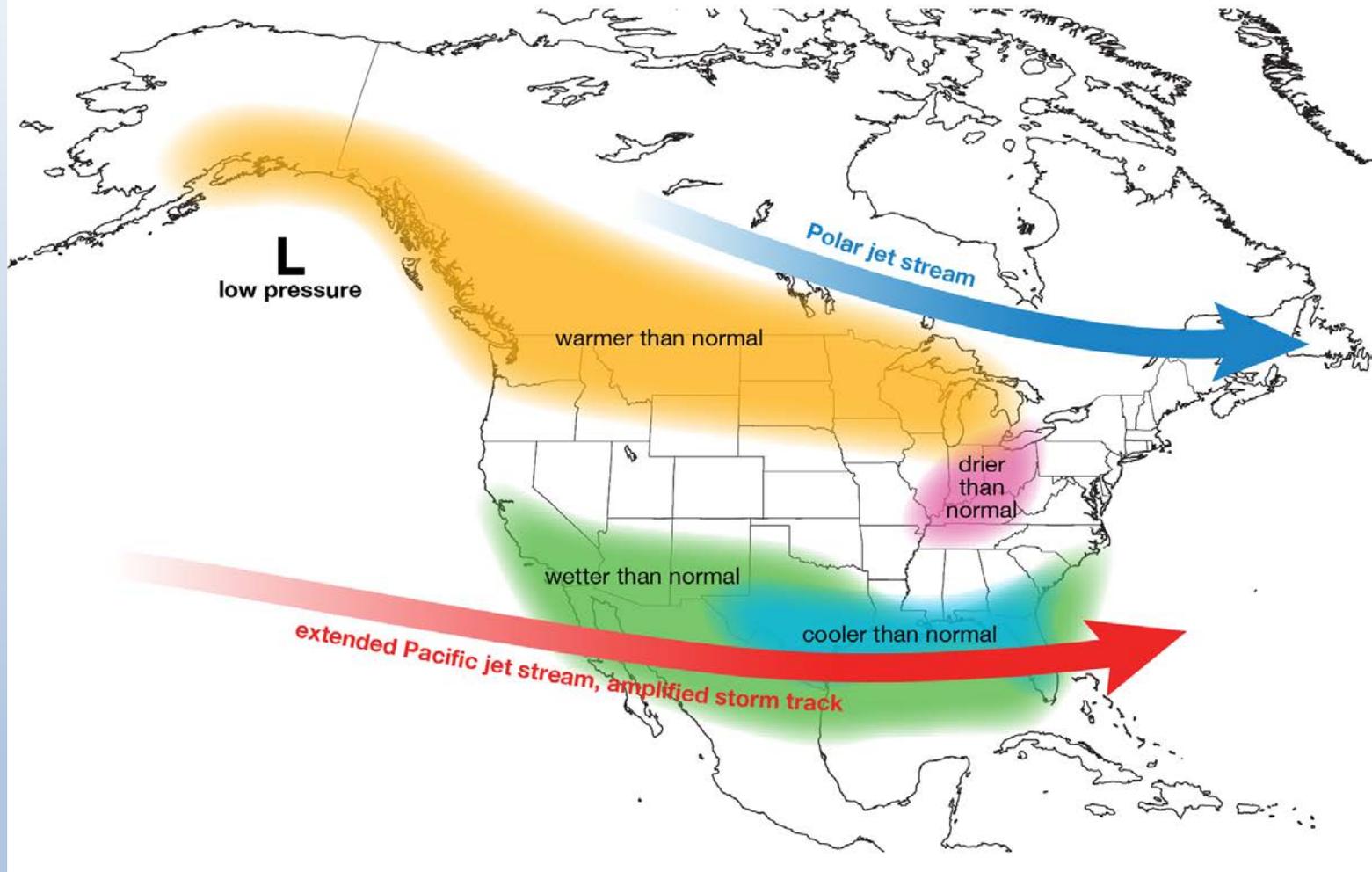
# El Niño

GFS 0.25°x0.25°  
Daily Average

SST Departure from Average  
Thursday, Jul 09, 2015

- Warmer waters in the eastern Pacific Ocean
- Life-cycle:
  - Starts spring/summer
  - Develops fall and winter
  - Fades by next spring/summer

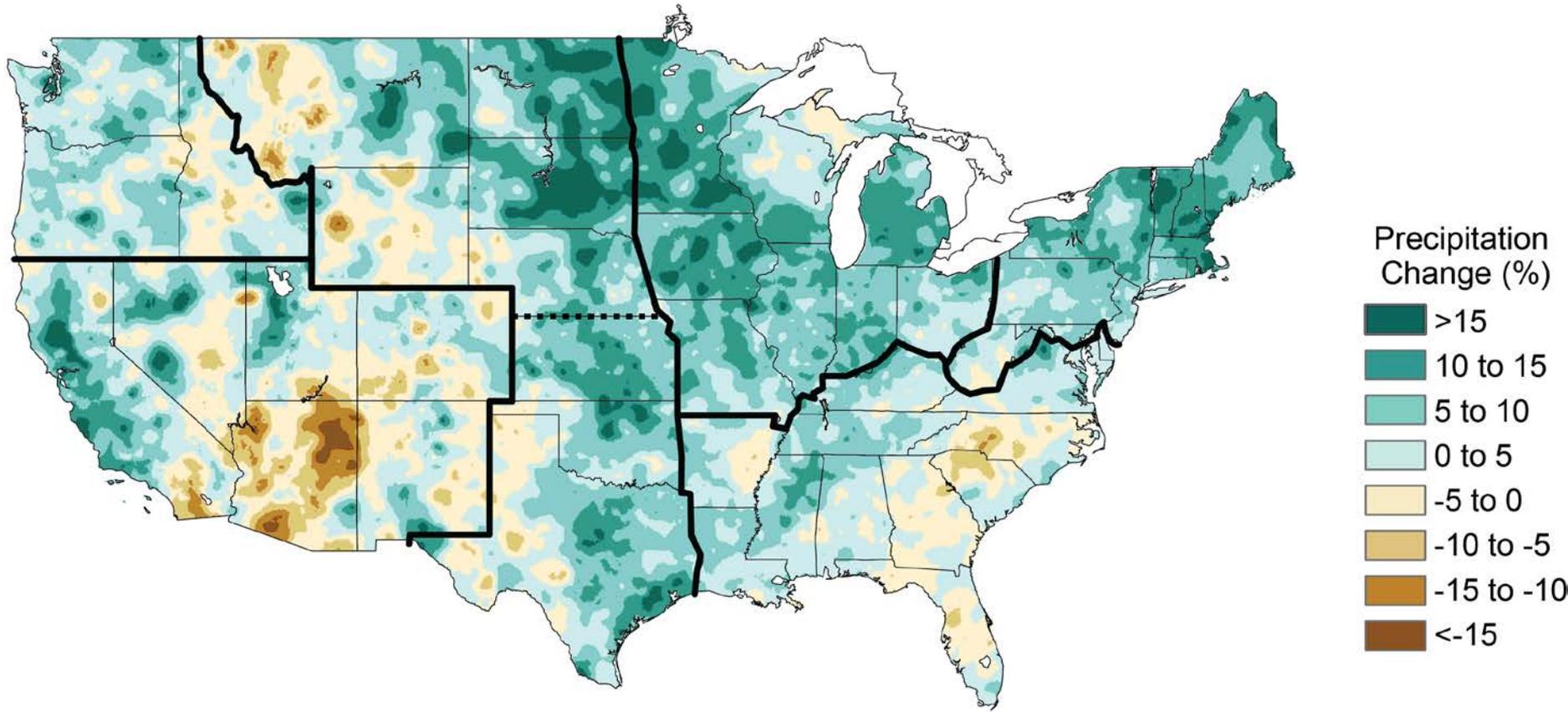




# Back to Climate Change ...

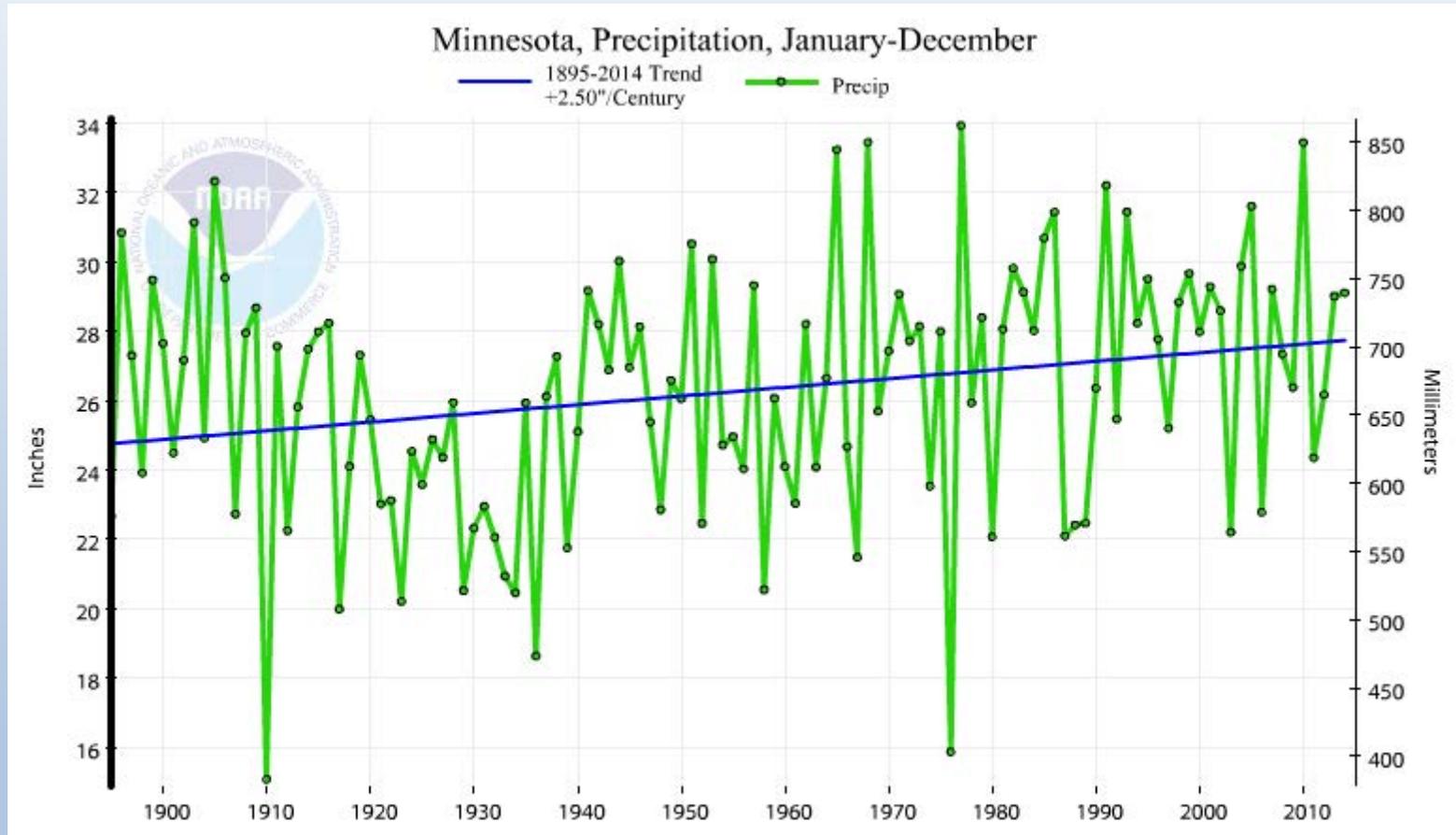
- **Natural Forces**
  - Sun
  - Ocean
  - Volcanoes
- **Human Forces**
  - Greenhouse Gasses
  - Land Use

## Observed U.S. Precipitation Change



The colors on the map show annual total precipitation changes for 1991-2012 compared to the 1901-1960 average, and show wetter conditions in most areas.

# Annual Trend in Precipitation



# Observed Change in Very Heavy Precipitation

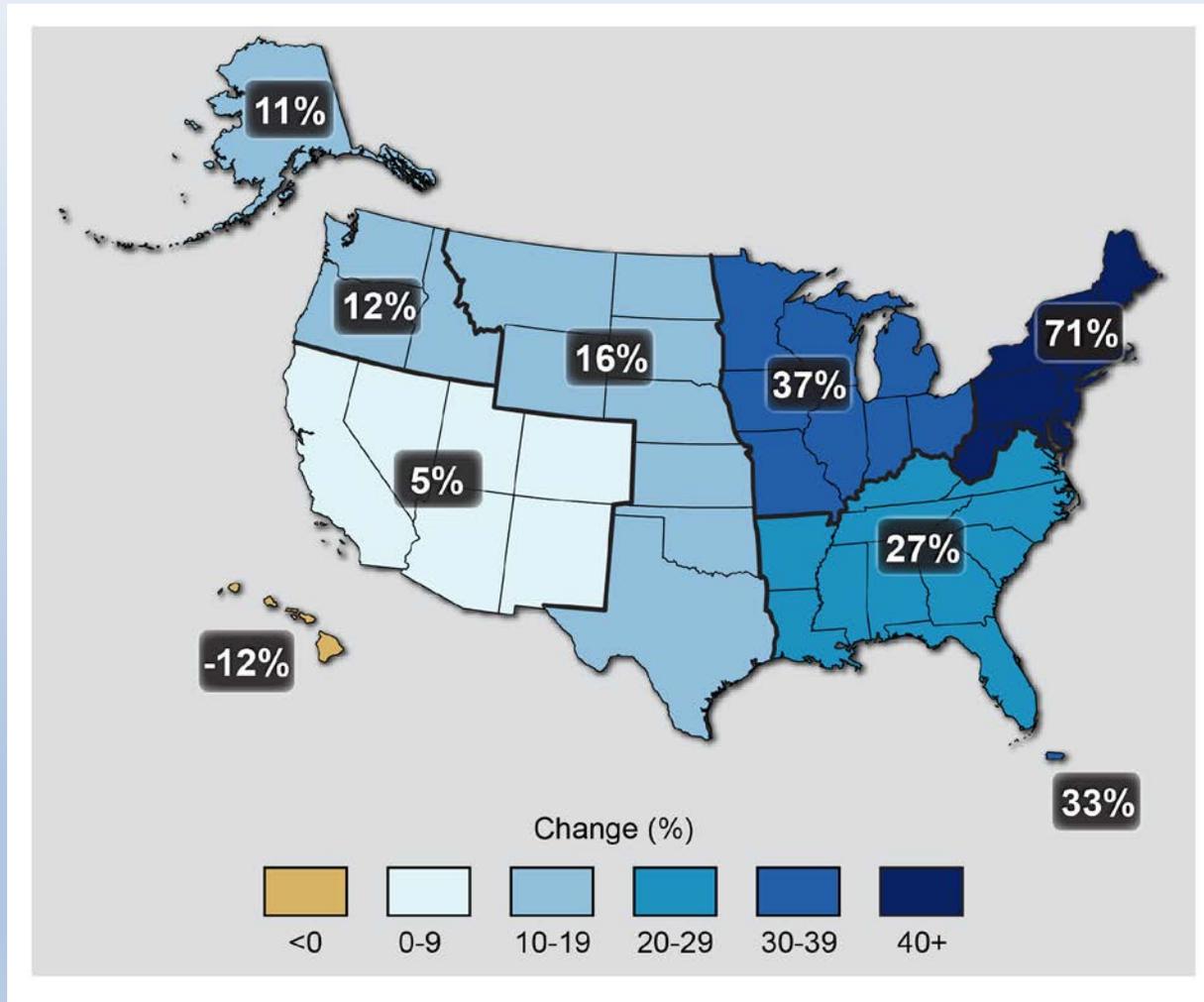
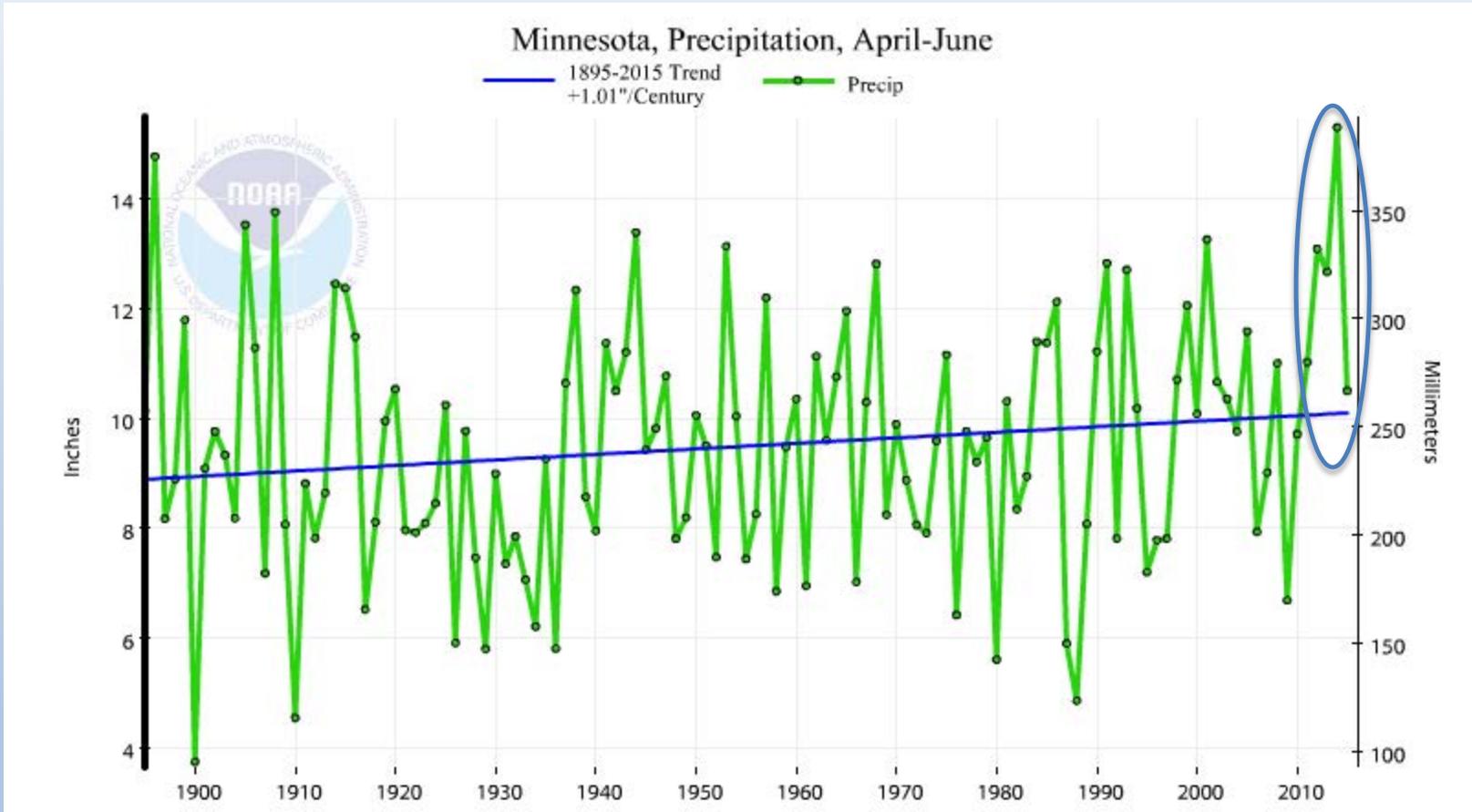
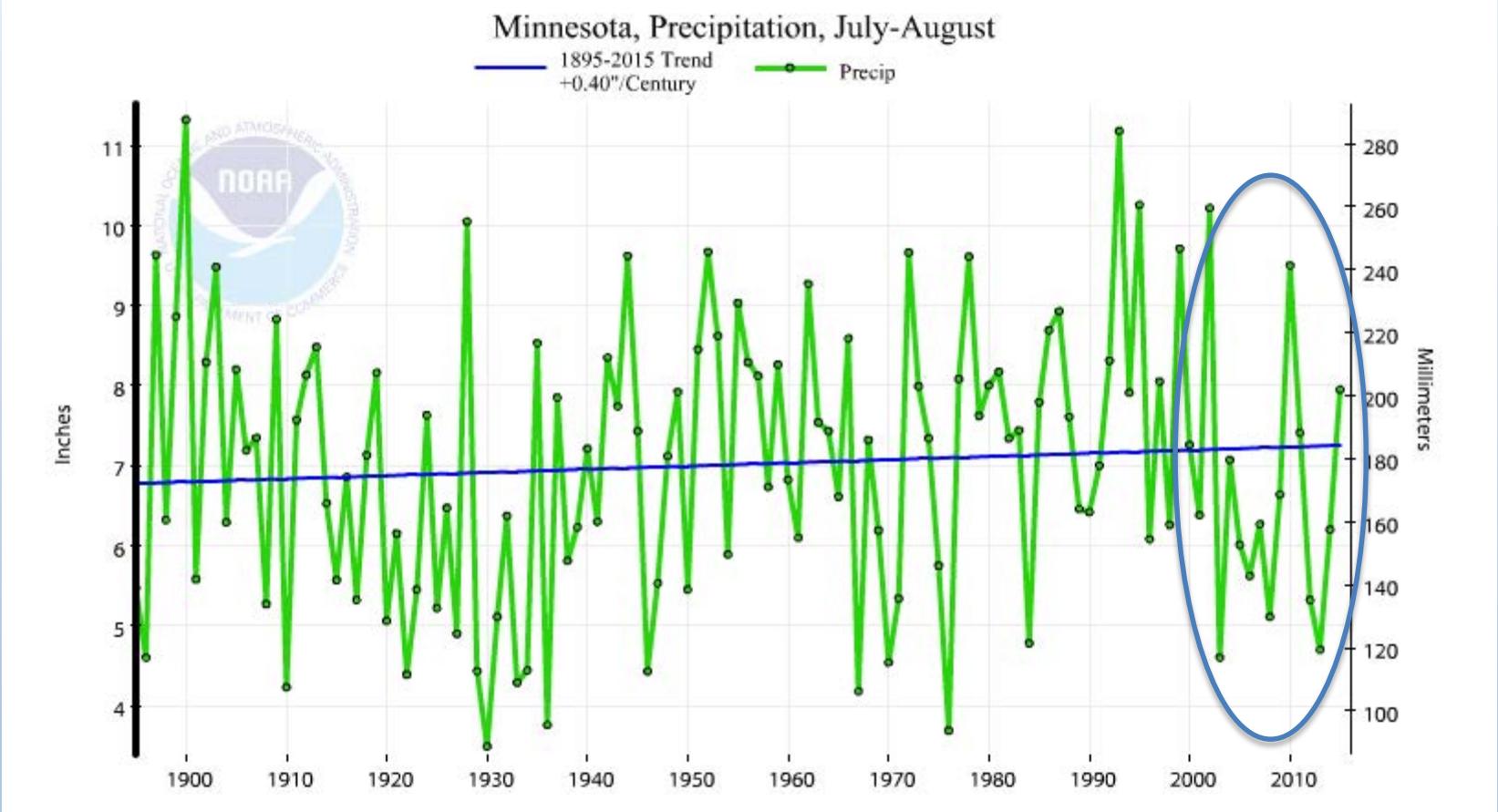


Figure source: updated from Karl et al. 2009

# Early Growing Season



# June-July



# Increasing Spring Precipitation

- Reduced workable field days
- Planting delays
- Replanting
- Soil compaction
- Drainage
- Nitrogen loss



# Increased Intensity of Rain Events

- Leads to soil erosion
- Need to increase soil conservation

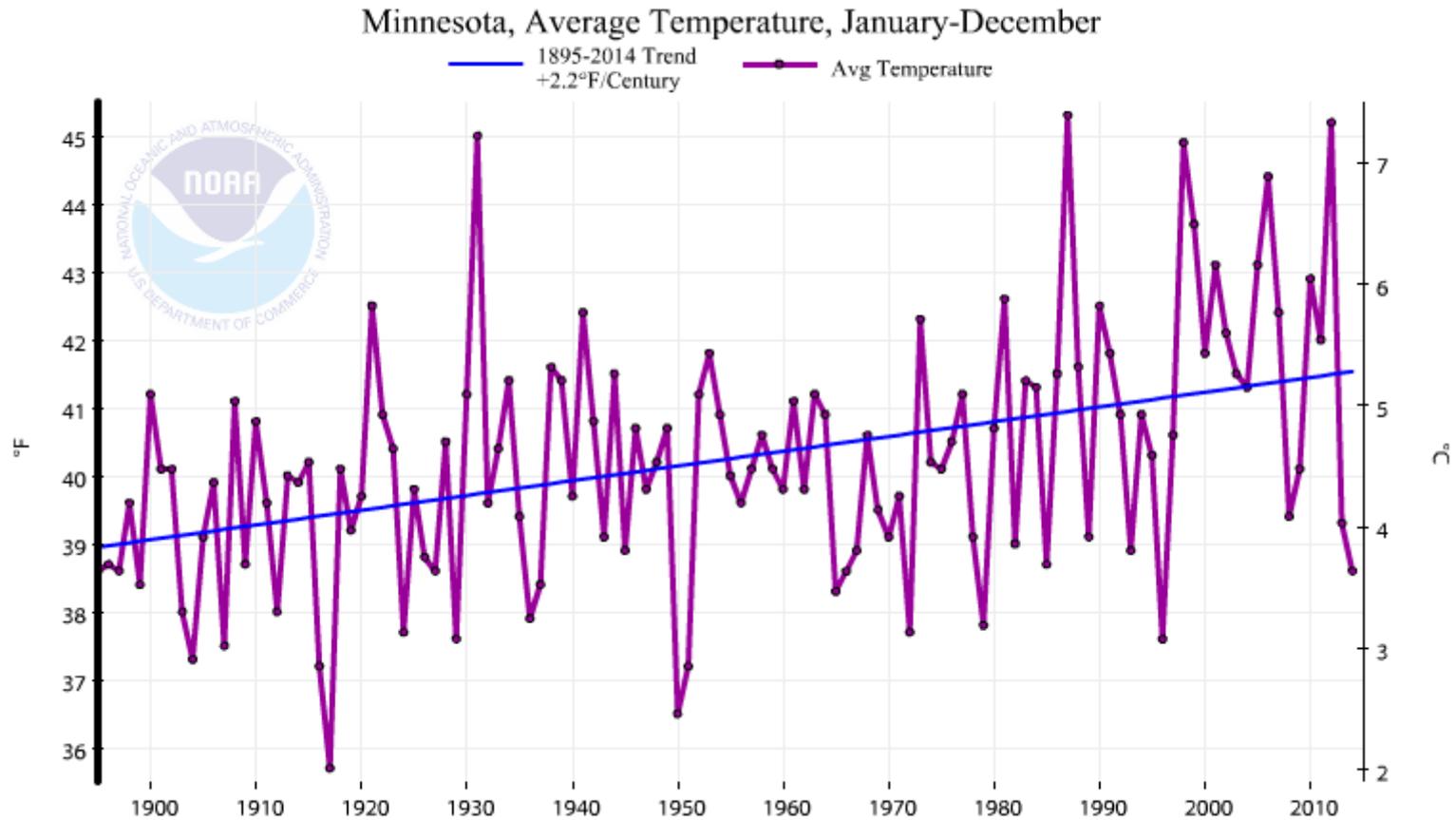


Photo Credit: (Betts, 2011)

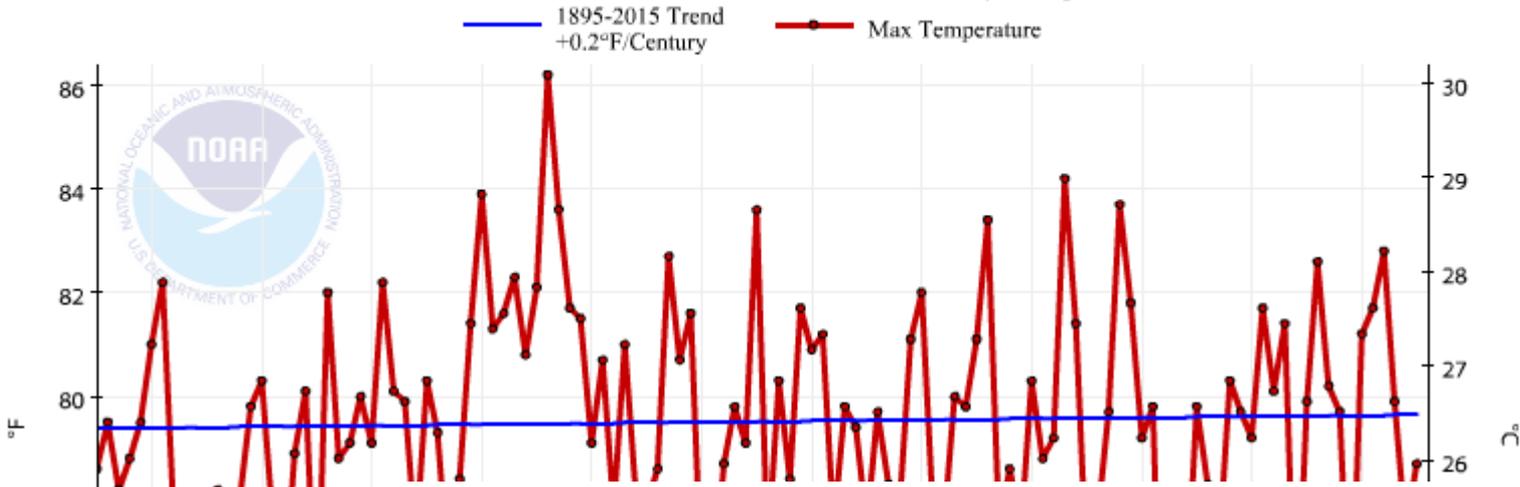
# Mid-Century

- Expect upward trend to continue
  - Winter and spring wetter
  - Fall about the same
  - Summer drier
  - More heavy rain events

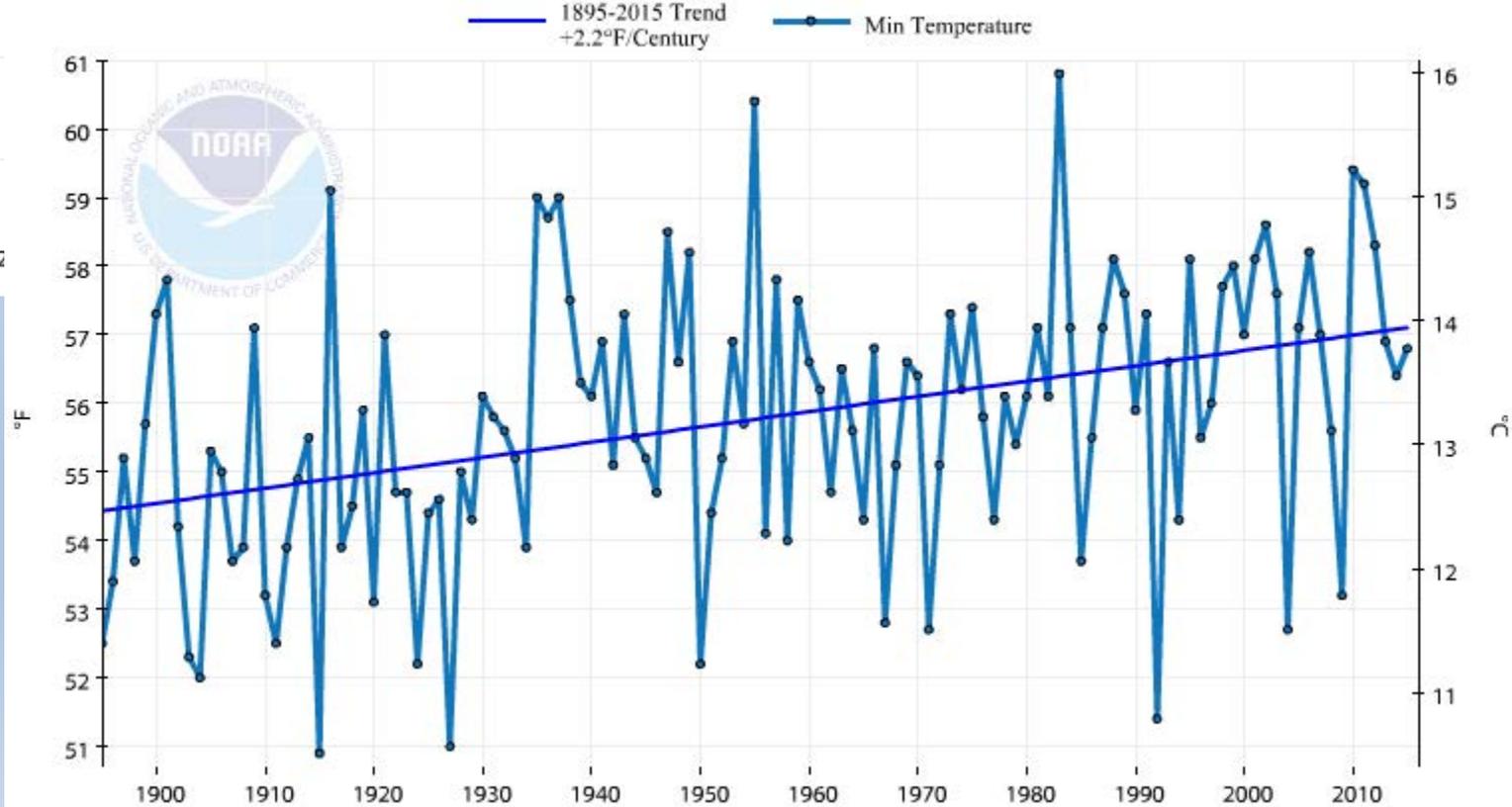
# Annual Temperature



# Minnesota, Maximum Temperature, July-August



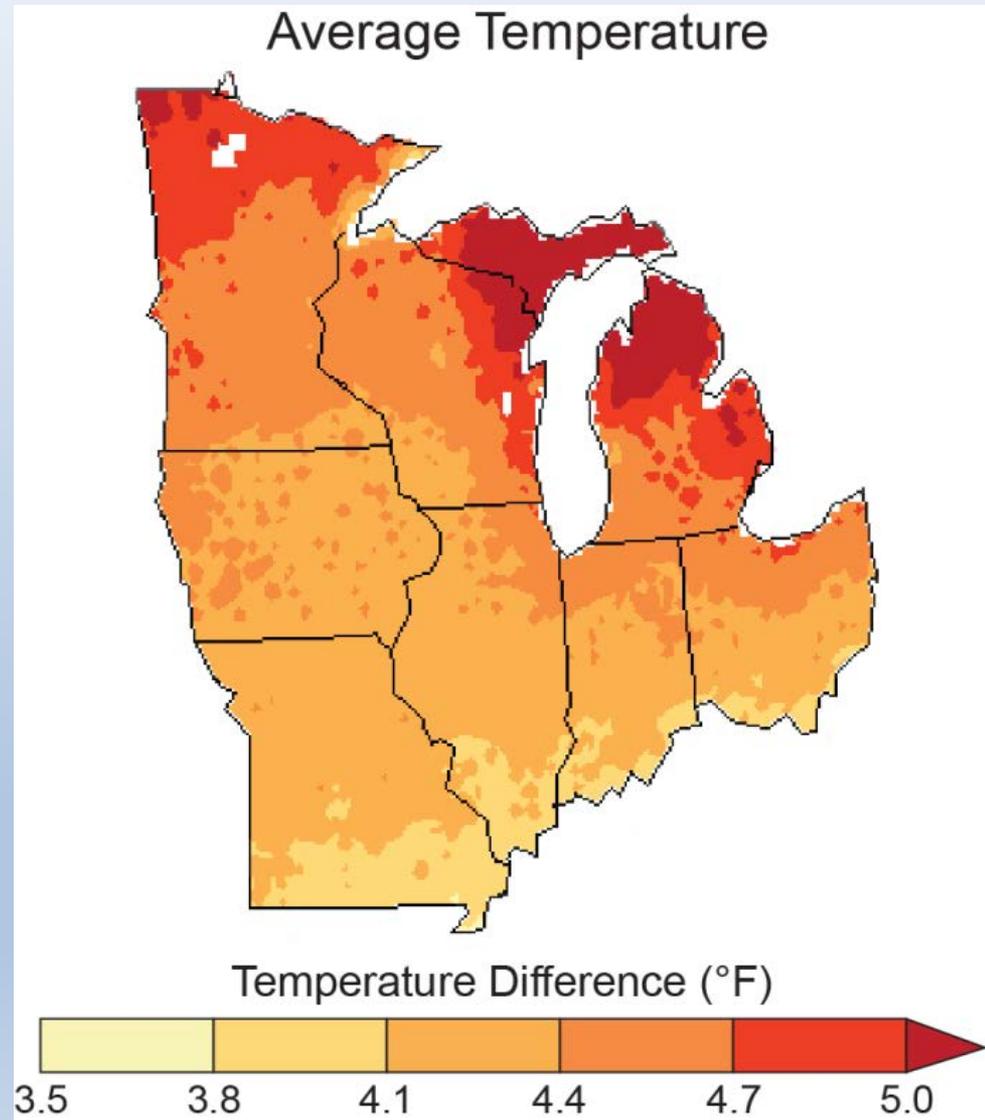
# Minnesota, Minimum Temperature, July-August



# Annual Temperature: Future

- Midwest  
3.5 to 5 degrees F warmer  
by mid-century

Projected increase by mid-century (2041-2070), compared to 1971-2000 period (2014 NCA)



# Climate of Minnesota

Minnesota's natural resources are profoundly impacted by weather and climate. The very existence of many of these resources was, and is, largely determined by Minnesota's climate, the composite of day-to-day weather over a long period of time.



- [Latest Developments](#)
  - [Present Climate Conditions](#)
  - [Retrieve Past Climate Data](#)
  - [Summaries & Publications](#)
  - [Agricultural Climate Data](#)
  - [Related Web Sites](#)
  
  - [Climate Change](#)
  
  - [Mark Seeley's WeatherTalk](#)
  - [Kuehnast Lecture Series](#)
  - [Islands in the Sun](#)
- [Twin Cities Climate Data](#)
  - [Climate Journal](#)
  - [MNGage](#)
  - [CoCoRaHS](#)
  - [Daily NWS Climate Data](#)
  - [Data Summary Tables](#)
  - [Latest Rainfall Reports](#)
  
  - [Frequently Asked Questions](#)
  - [Current Weather Conditions](#)
  - [Drought](#)
  - [Floods](#)
  - [Water Levels](#)

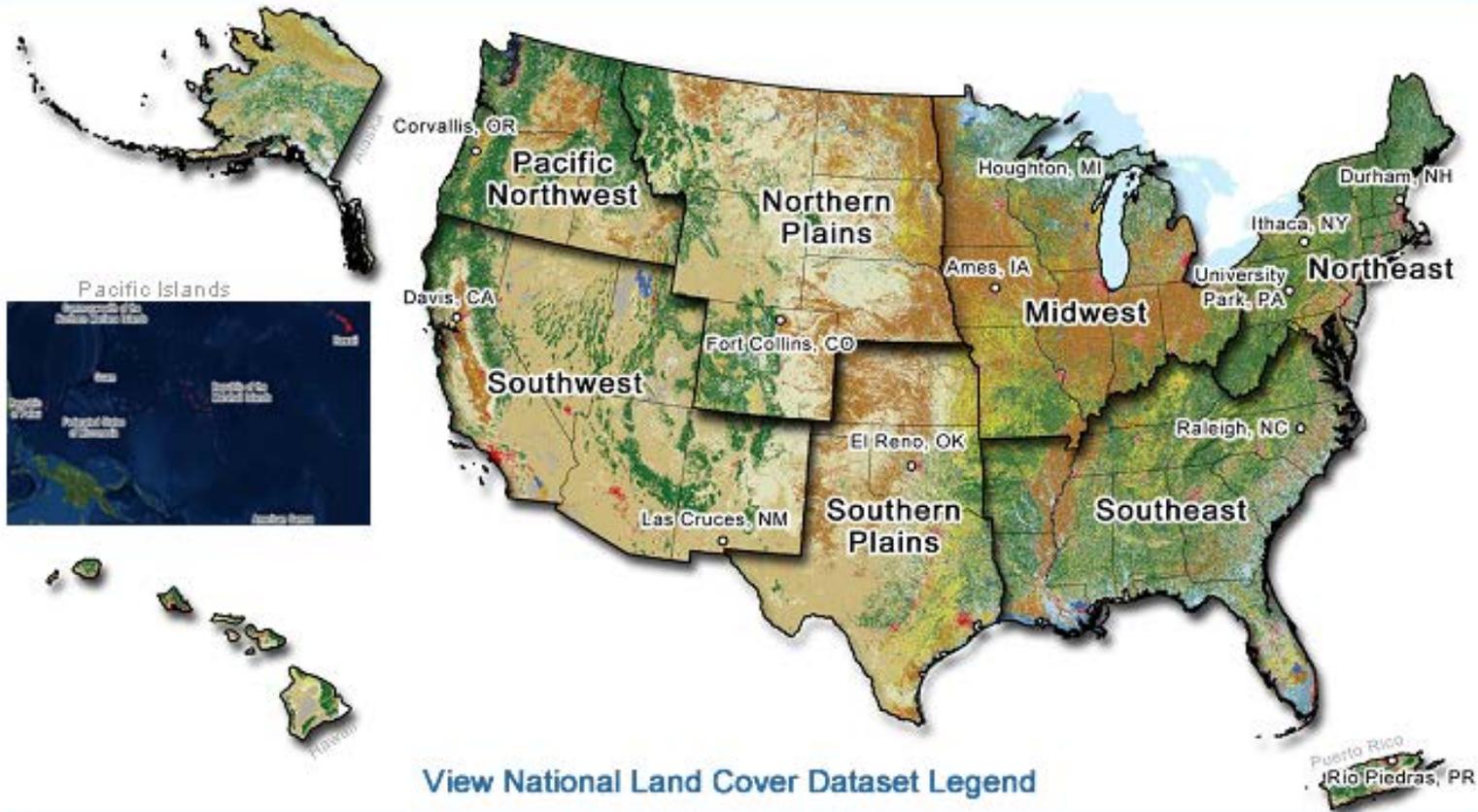
**The DNR State Climatology Office** exists to manage, analyze, and disseminate climate information in service to the citizens of Minnesota. The office is part of the Minnesota Department of Natural Resources - Division of Ecological and Water Resources, and housed at the University of Minnesota - Department of Soil, Water, and Climate.

The office assists its customers in their investigations of the climate's impact on various components of the natural environment, and on socioeconomic activities. We use our climate monitoring resources to quantify weather conditions and to place these conditions within historical and geographical context. We also provide statistical summaries of historical climate conditions, allowing users to make informed decisions about future activities.

**contact:** [☎ 651-296-4214](tel:651-296-4214), [climate@umn.edu](mailto:climate@umn.edu)

# USDA Climate Hubs

## Climate Hub Regions



# www.AgClimate4U.org



Transforming Climate Variability and  
Change Information for Cereal Crop Producers



DECISION DASHBOARD

MEDIA CENTER

NEWSLETTER

ABOUT US



## AgriClimate CONNECTION blog

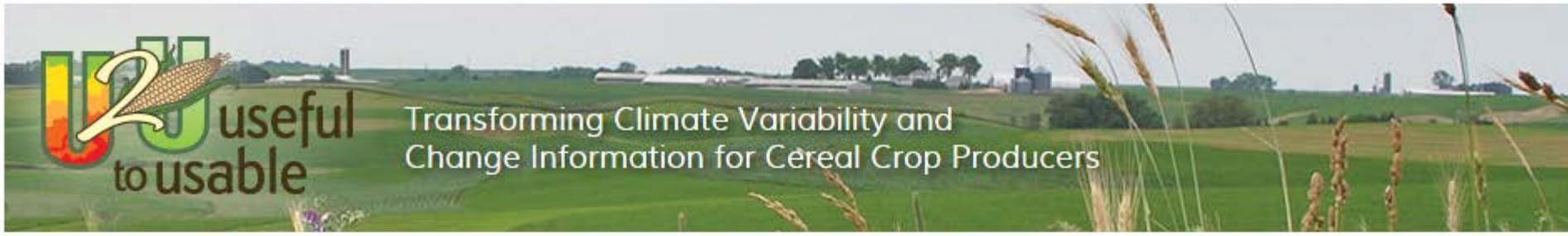
News and views on climate in the Corn Belt ▶



Helping producers make better long-term plans

AgriClimate Connection

# Decision Dashboard



-  [DECISION DASHBOARD](#)
- [MEDIA CENTER](#)
- [NEWSLETTER](#)
- [ABOUT US](#)

## Decision Dashboard

- [U2U<sub>DST</sub> Suite](#)**
- [Other Decision Resources](#)
- [Agro-Climate Reports](#)
- [Weather/Climate Maps](#)
- [Drought Info](#)
- [Climate Outlooks](#)
- [Helpful Links](#)

### U2U<sub>DST</sub> SUITE



#### AgClimate View<sub>DST</sub>

A convenient way to access customized historical climate and crop yield data for the U.S. Corn Belt. View graphs of monthly temperature and precipitation,



#### Corn GDD<sub>DST</sub>

Track real-time and historical GDD accumulations, assess spring and fall frost risk, and guide decisions related to planting, harvest, and seed selection.

# Decision Support Tools

## U2U<sub>DST</sub> SUITE



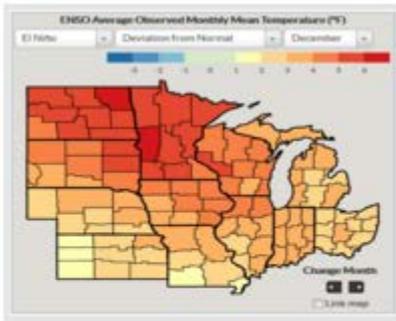
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Determine the feasibility and profitability of using post-planting nitrogen application for corn production. This product combines historical data on crop growth and fieldwork conditions with economic considerations to determine best/worst/average scenarios of successfully completing nitrogen applications within a user-specified time period. Now available for 12 states in the north central US.



Select a Station

Climate Data

Climate Average

Yield Trend

Comparison

Custom Chart

This tab allows you to plot countywide annual yield data with up to two climate variables.



Step 1: Select one of the crops

Corn  Soybean  None

Step 3: Select start & end month range to plot

April  October

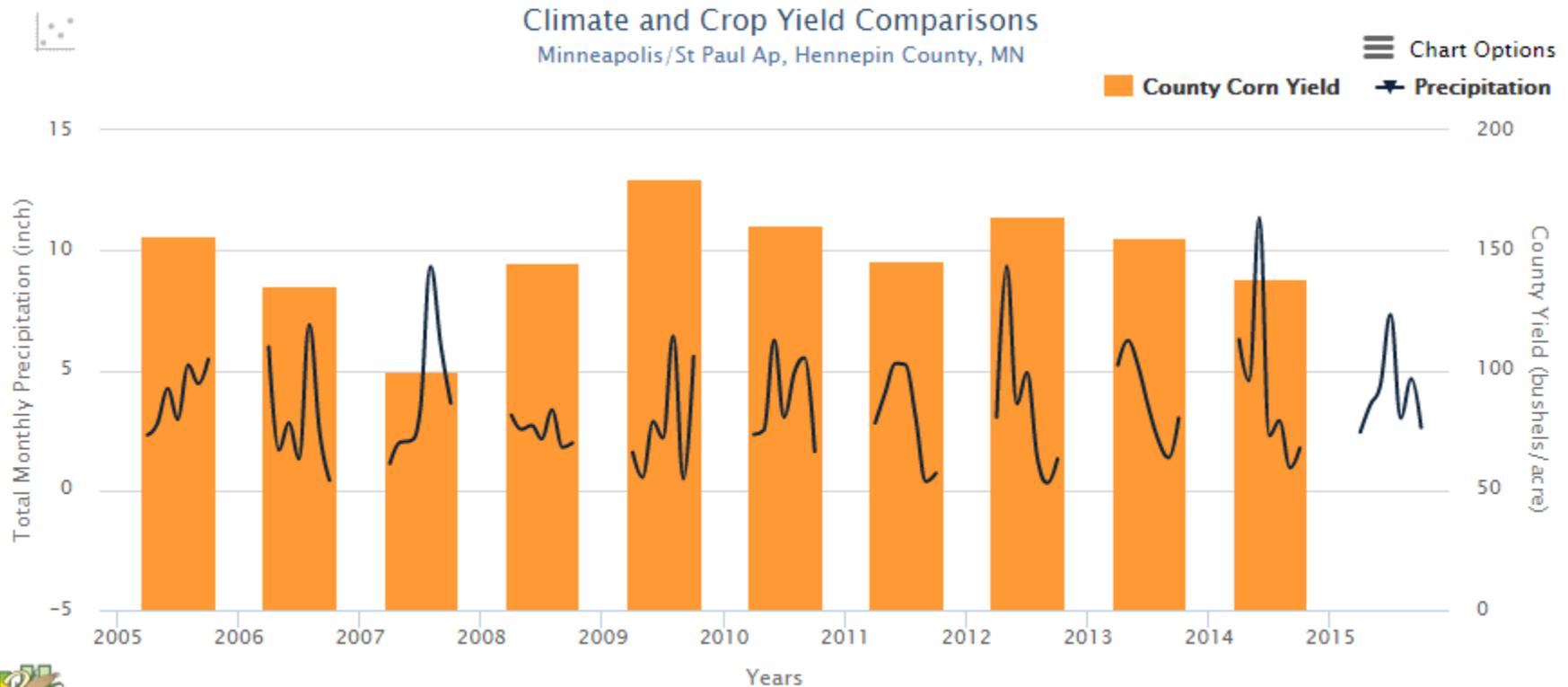
Step 2: Select up to two monthly climate variables

Show Weather Values

Step 4: Select start & end year range to plot

2005  2015

Max Temperature  Min Temperature  Precipitation  GDD50  SDD90



# Decision Support Tools

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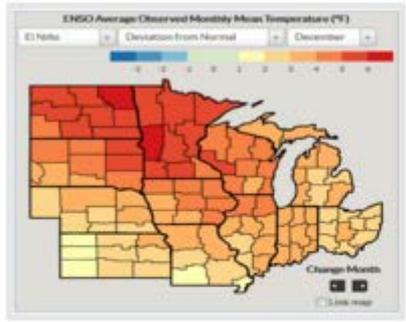
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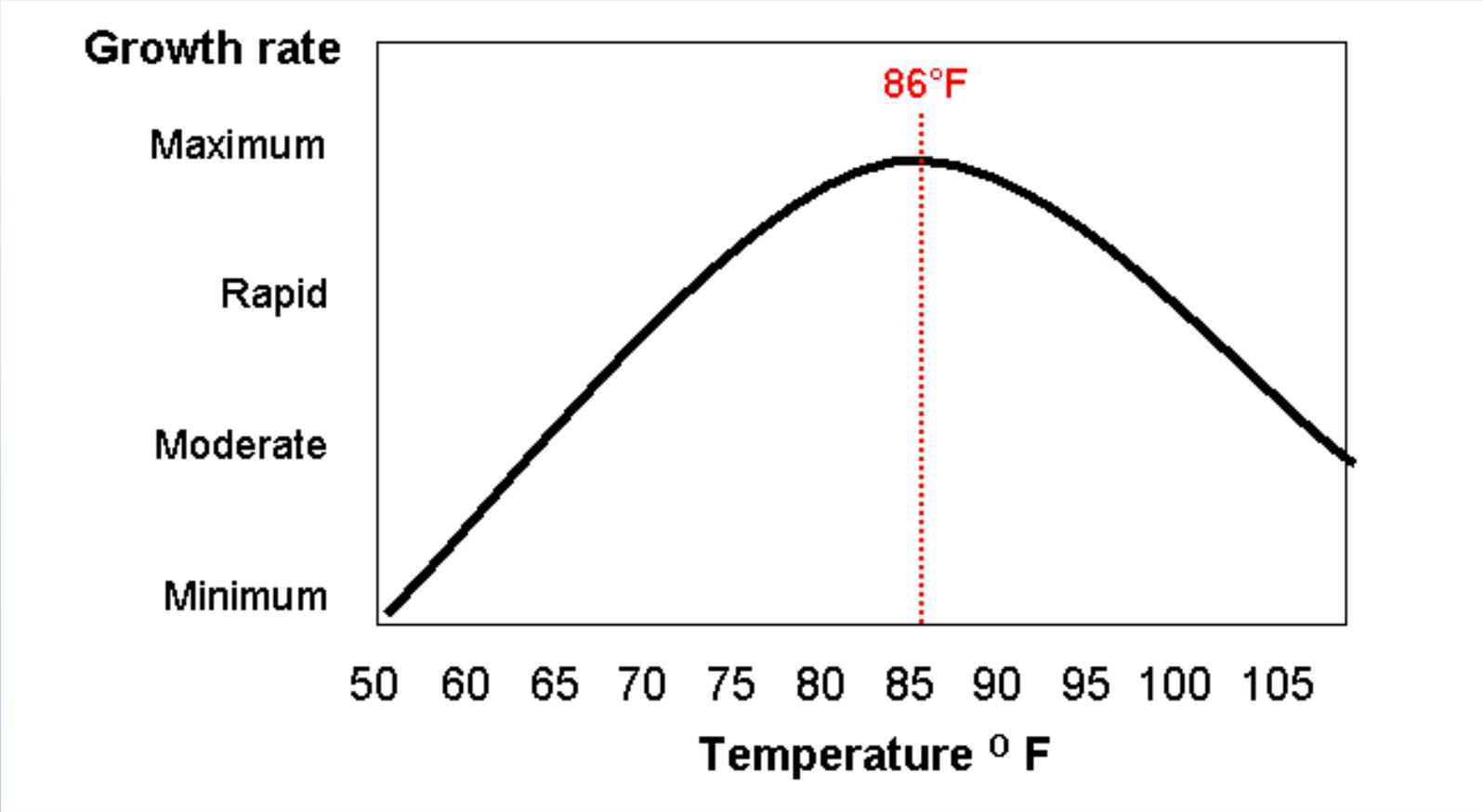
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# GDD TOOL

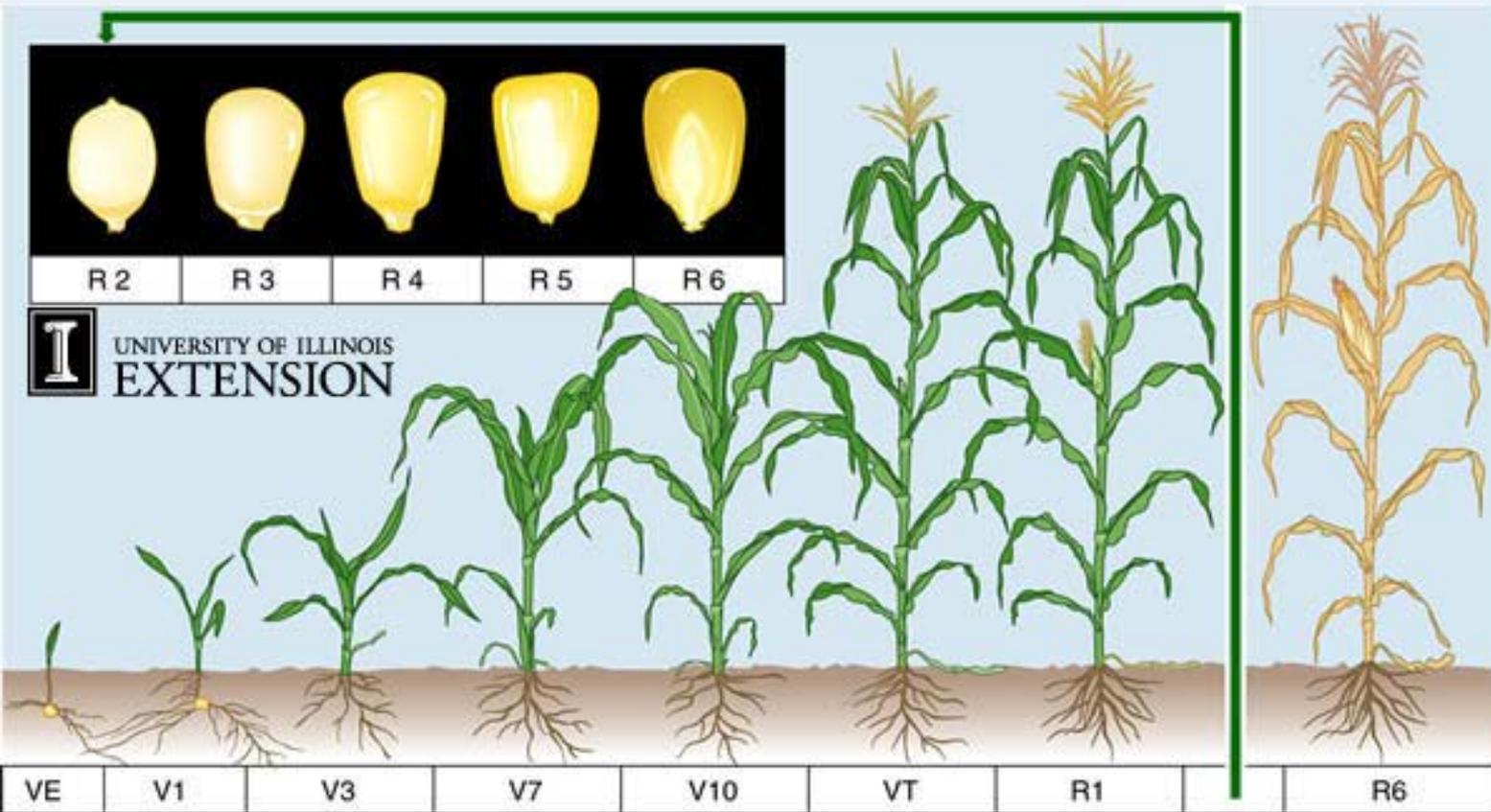
- Climate risks:
  - like spring/fall frost
  - late planting
- Plan activities – based on current and projected GDDs
- Marketing – locally, and across region

# Principle Behind Growing Degree Days



$$GDD = (High + Low)/2 - Base_{50}$$

$$20 = (80 + 60)/2 - 50$$



360 GDD to reach V1 after planting

# For Example:

Map Animations

Feedback? About GDD

To get started, click on any location within the gray area of the map.

Search by Zip / City / County X Q

Hennepin Co., MN  
Lat-Lon: 44.973, -93.273  
**Create GDD Graph**

The image shows a web-based map interface. At the top, there are navigation tabs for 'Map' and 'Animations', and links for 'Feedback?' and 'About GDD'. Below the navigation is a search bar with the placeholder text 'Search by Zip / City / County' and a magnifying glass icon. The main map area displays a satellite view of the United States with a gray grid overlay on the central part of the country, including states like North Dakota, Minnesota, Wisconsin, and Michigan. A tooltip is displayed over Hennepin County, Minnesota, containing the text 'Hennepin Co., MN', the coordinates 'Lat-Lon: 44.973, -93.273', and a blue button labeled 'Create GDD Graph'. The map includes standard navigation controls on the left side, such as a compass and zoom in/out buttons. At the bottom, there is a Google logo and a copyright notice: 'Map data ©2015 Google, INEGI Imagery ©2015 TerraMetrics Terms of Use Report a map error'.

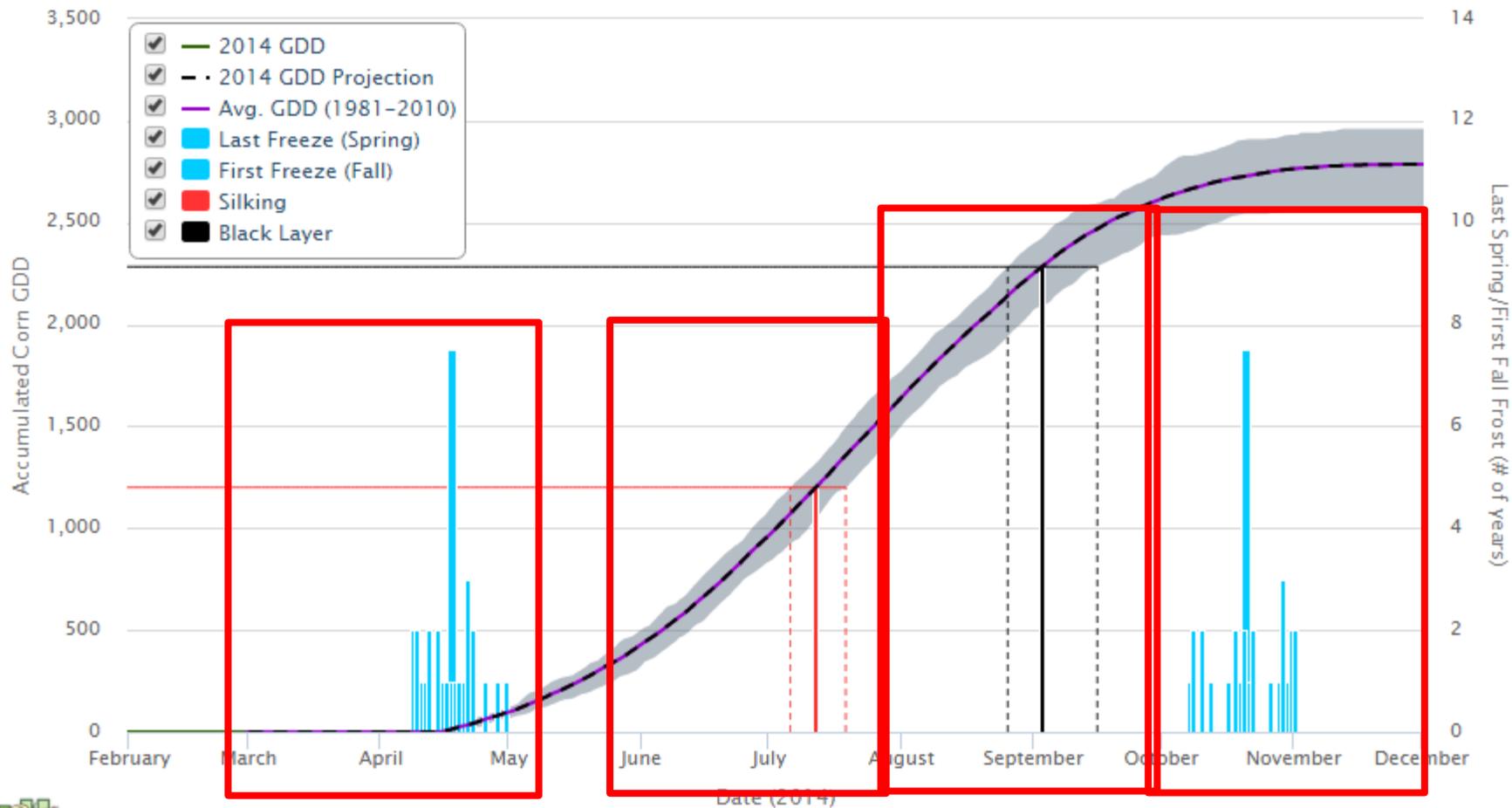
# GDD Graph

GDD Start: April 15 Comparison Years: Choose a Year Corn Maturity Days: 95 Silking GDDs: 1189  
 Freeze Temperature (°F): 28 Variation: Middle 20 Years Current Day: March 1, 2014 Black Layer GDDs: 2280

## Corn Growing Degree Day Tool

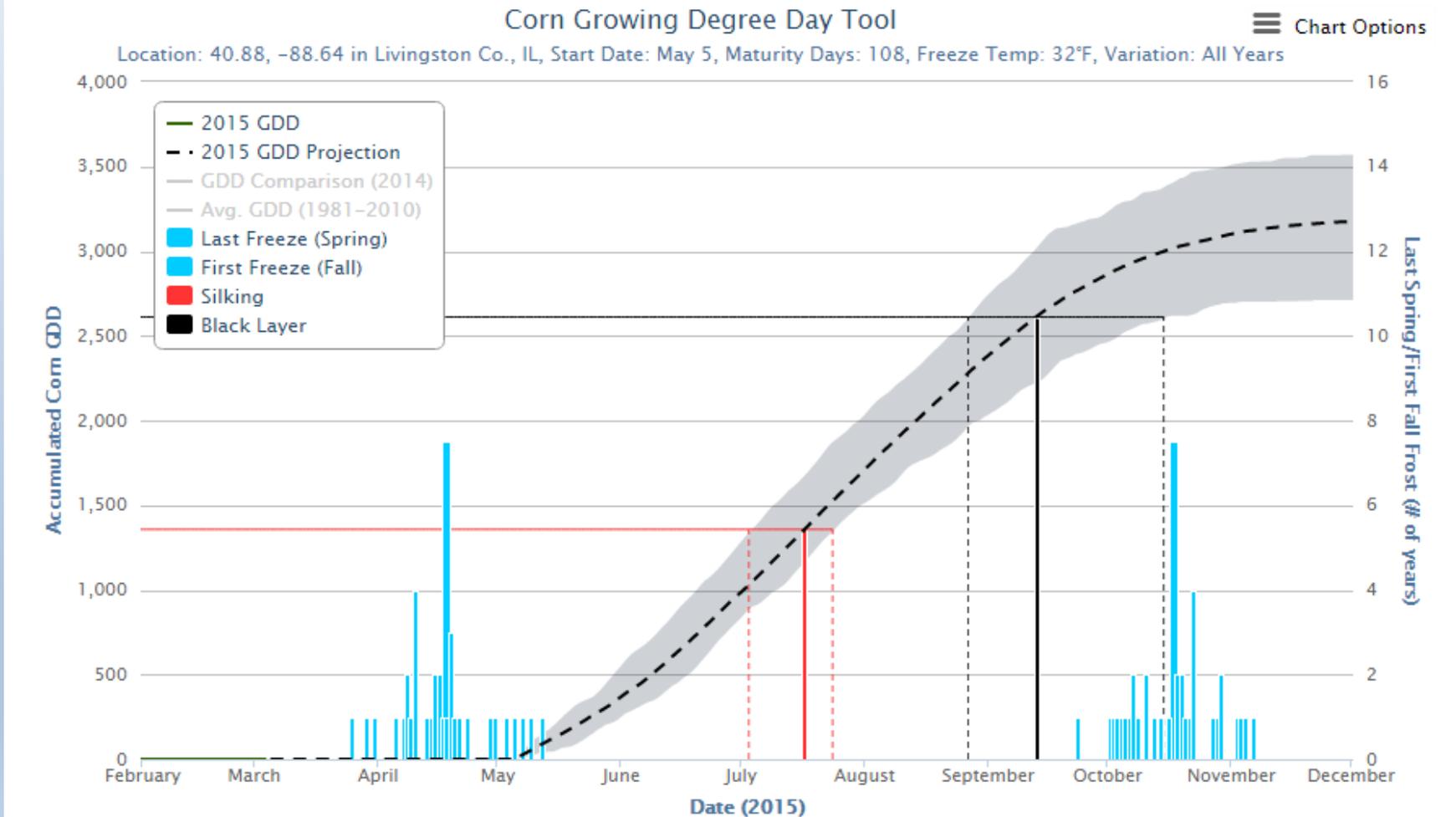
Chart Options

Location: 44.97, -93.27 in Hennepin Co., MN, Start Date: April 15, Maturity Days: 95, Freeze Temp: 28°F, Variation: Middle 20 Years



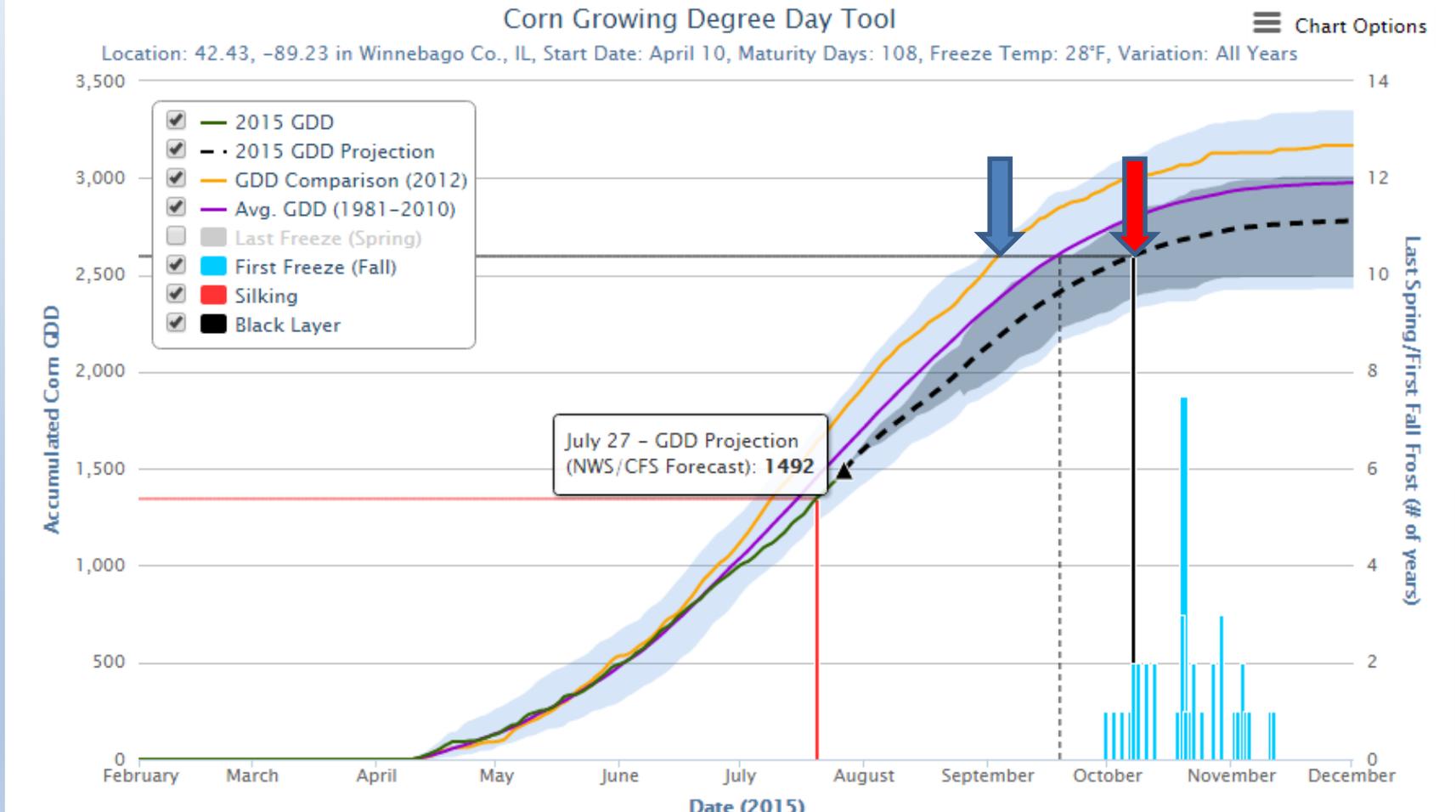
# Adjust for Planting Date & Temperature

GDD Start:   Comparison Years:  Corn Maturity Days:  Silking GDDs:   
Freeze Temperature (°F):  Variation:  Current Day:  Black Layer GDDs:



# Comparison Year - 2012

GDD Start: April 10 Comparison Years: **x2012** Corn Maturity Days: 108 Silking GDDs: 1338  
Freeze Temperature (°F): 28 Variation: All Years Current Day: Today Black Layer GDDs: 2594



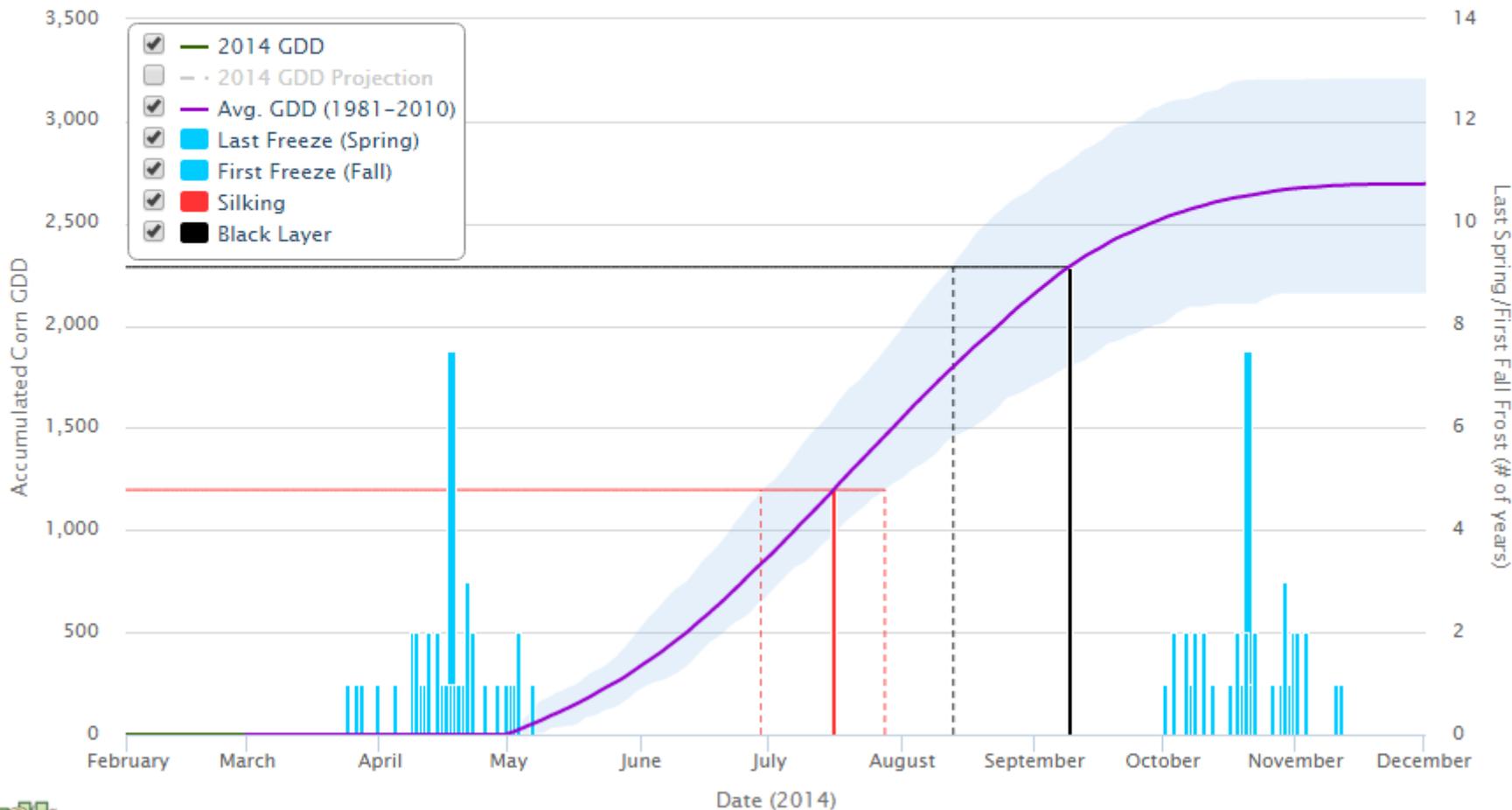
GDD Start:   Comparison Years:  Corn Maturity Days:  Silking GDDs:

Freeze Temperature (°F):  Variation:  Current Day:  Black Layer GDDs:

### Corn Growing Degree Day Tool

Chart Options

Location: 44.97, -93.27 in Hennepin Co., MN, Start Date: April 30, Maturity Days: 95, Freeze Temp: 28°F, Variation: All Years

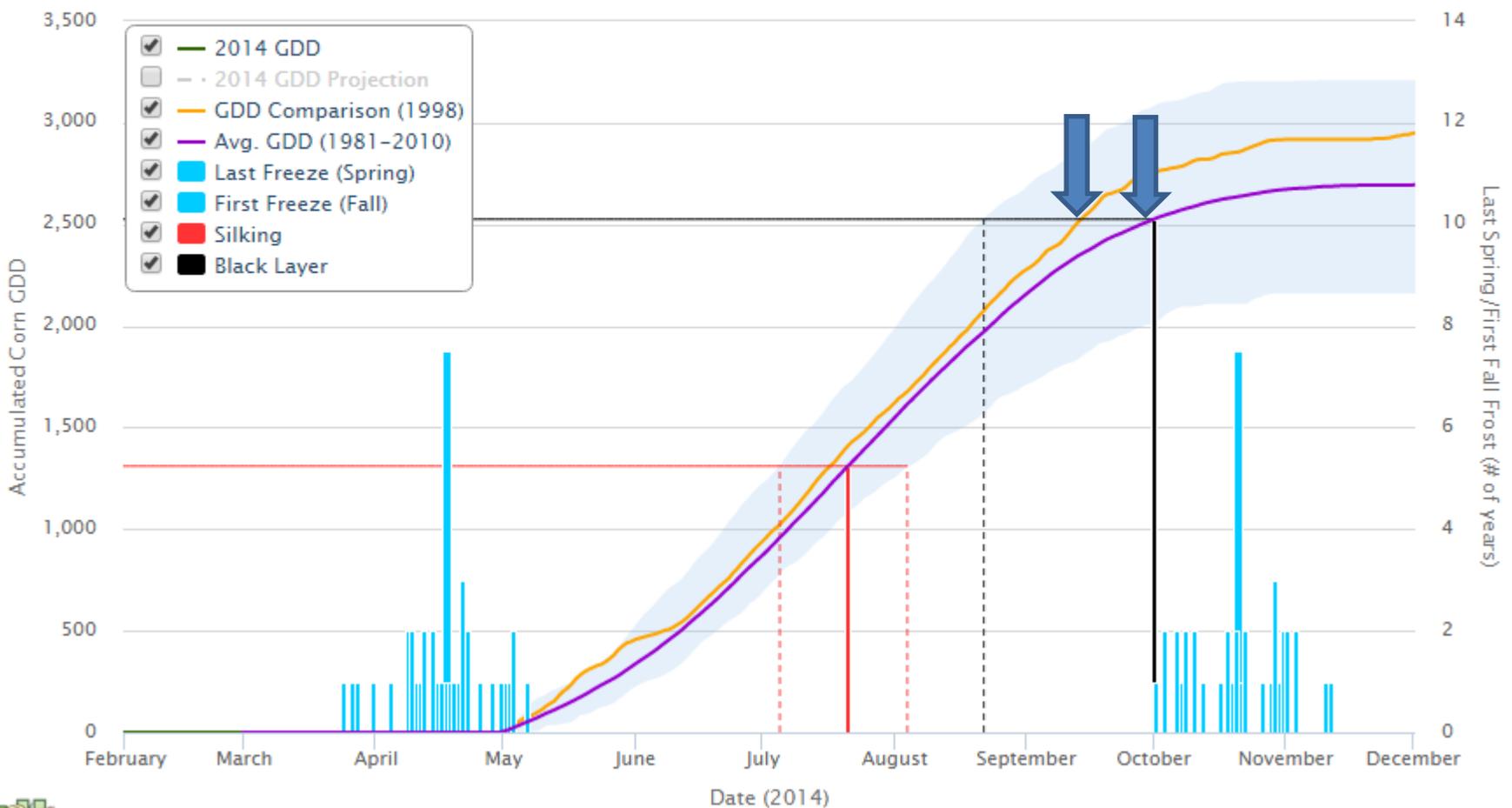


# Crop Maturity Date

GDD Start: April 30 Comparison Years: 1998 **Corn Maturity Days: 105** **Silking GDDs: 1303**  
Freeze Temperature (°F): 28 Variation: All Years Current Day: March 1, 2014 **Black Layer GDDs: 2521**

## Corn Growing Degree Day Tool

Location: 44.97, -93.27 in Hennepin Co., MN, Start Date: April 30, Maturity Days: 105, Freeze Temp: 28°F, Variation: All Years



# Data Details and Download

Map Graph **Data** Animations

This tab provides a text-only view of current and historical Corn (86/50) GDD accumulations, silking and black layer dates, and first/last freeze dates. ?

GDD Start: May 1 GDD Comparison Year: 2009 Corn Maturity Days: 108 Silking GDDs: 1338  
Freeze Temperature (°F): 32 Variation: All Years Current Day: Today Black Layer GDDs: 2594

### User Input Summary

Location (lat, long): 42.036, -93.506  
Location (county, state): Story Co., IA  
GDD Start Date: May 1, 2014  
Today's Date: September 26, 2014  
Latest Data Available: September 25, 2014  
Corn Maturity Days: 108 days  
Growing Degree Days to Silking: 1338  
Growing Degree Days to Black Layer: 2594

### Corn Growing Degree Day (GDD) Results

30-Year History (1981 - 2010)

	This Year (2014)	Average	Occurs within this range for all years
GDD Accumulation (May 1 - September 25)	2459	2631	2296 - 2975
V2 Date	May 31	June 2	May 24 - June 12
V4 Date	June 9	June 11	June 3 - June 19
V6 Date	June 19	June 20	June 12 - June 27
V8 Date	June 26	June 28	June 18 - July 4
V10 Date	July 6	July 5	June 25 - July 12
Silking Date	July 22	July 19	July 10 - July 26
Blacklayer Date (Estimated (Earliest-Latest))	October 8 (October 3 - October 30)	September 22	September 1 - None

### Freeze Results (32°F)

Last Spring Freeze	April 19	April 25	April 4 - May 14
Freeze Probability after May 1	37%		
First Fall Freeze		October 5	September 18 - October 24
Freeze Probability before Black Layer	58%		

**Accumulated GDD Details**

**Tool Tips:**

- Select the blue question mark icon in the top right corner of the tab section for instructions and other information.

**Download Data** **About GDD**

# Decision Support Tools



## U2U<sub>DST</sub> SUITE



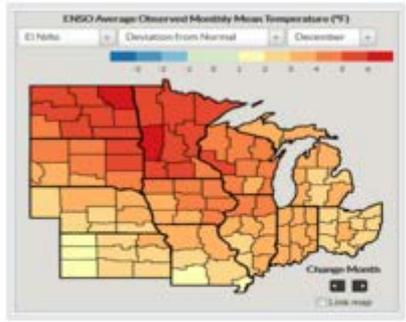
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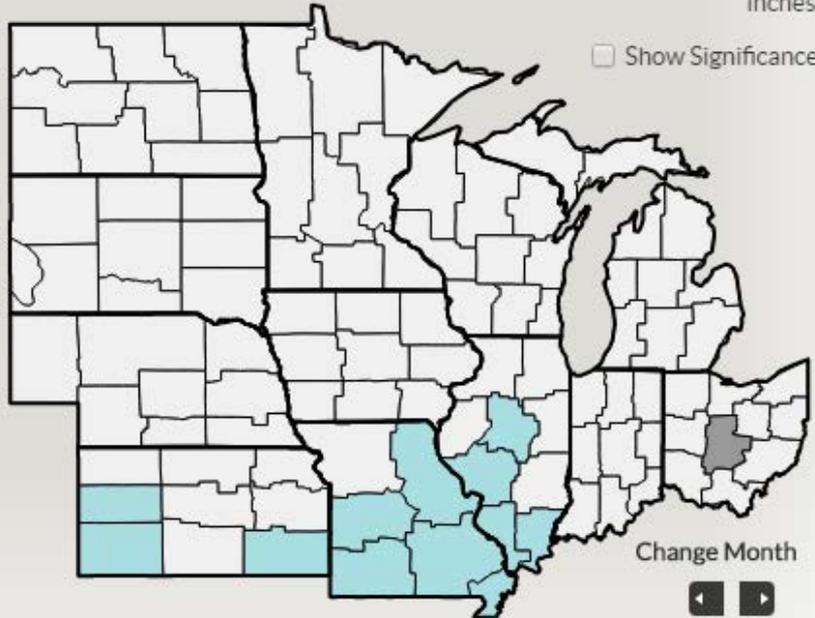
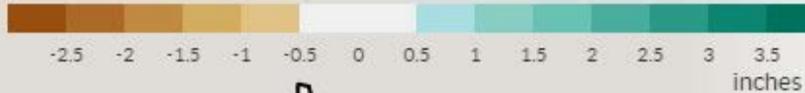
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Click on the map to view a chart of the data for that location; chart will appear below the maps.

Four Maps ?

### ENSO Average Observed Monthly Precipitation (inches)

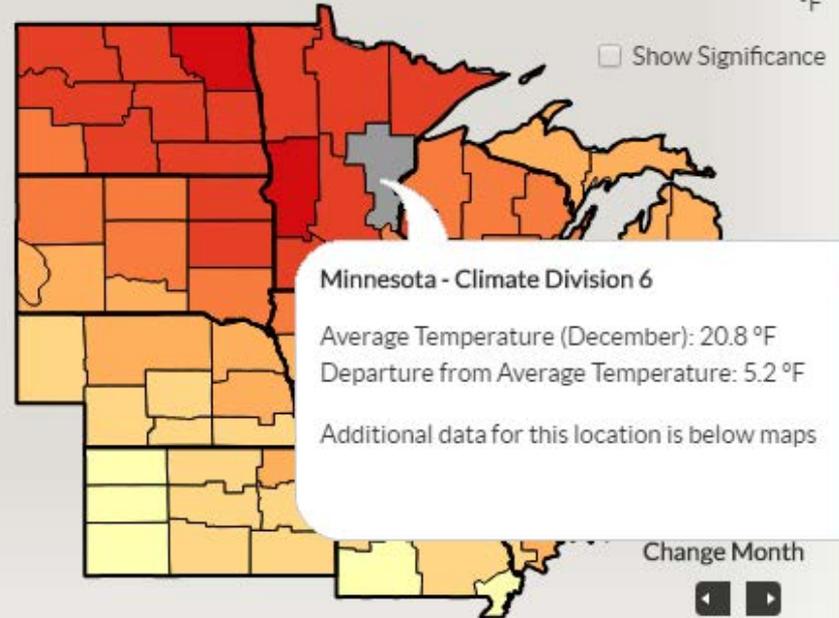
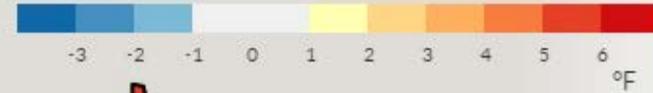
El Niño ▼ Deviation from Normal ▼ December ▼



Link map

### ENSO Average Observed Monthly Mean Temperature (°F)

El Niño ▼ Deviation from Normal ▼ December ▼



Link map

**Minnesota - Climate Division 6**

Average Temperature (December): 20.8 °F

Departure from Average Temperature: 5.2 °F

Additional data for this location is below maps

ENSO ▼ Temperature Deviation from Normal ▼

# Decision Support Tools

## U2U<sub>DST</sub> SUITE



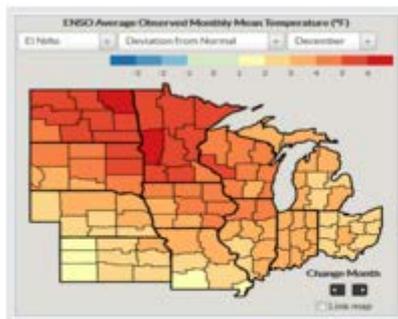
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## U2U Decision Support Tools - Corn Split Nitrogen Application

Map Scenario/Results

Feedback?

About SplitN

HELP

This tab allows you to customize inputs for your farm and view summarized results.

Location: Hennepin Co, Minnesota; Crop Reporting District: EastCentral (6)

Planting Date:

Yield Goal:  bu/acre

Initial Nitrogen Application:  lbs

Apply N by what stage?  V8 expected by Jul 04

Apply Nitrogen from:   to:

Yield penalty for not getting post-planting N applied:  bu/acre

Yield benefit from post-planting N application:  bu/acre

Reduced N applied due to post-planting N application:  lbs/acre

*Yield penalties/benefits and reduced N usage are critical inputs. The provided default values should be adjusted with help from Univ. Extension specialists or crop consultants to ensure accuracy for your soil and climatic conditions. [More info](#)*

Nitrogen Price (\$/lb):  /lb

Corn Price (\$/bu):  /bu

Sidedress Cost (\$/acre):  /acre

Implement width (ft):

Implement speed (mph):

Field efficiency:

Acres worked per hour:

Acres:

Calculated hours needed:

Hours in field per day:

All daylight hours

Custom hours

Days worked in 7:

Days in selected period:

Average days suitable in period:

Average hours suitable in period:

## Economic Analysis using 28 years of Field Work Days History

Scenarios	Acres	Units/acre	Dollars/unit	Total Dollars
<b>Input Acres Completed</b> (completed 1500 acres post-planting N application 25 years of 28 years, or 89% of years)				
Additional cost of post-planting fertilizer application	1500	1	\$15.00	\$(23,000)
Yield loss due to unfertilized acres	0	12	\$4.50	\$0
Yield gain due to post-planting fertilization	1500	5	\$4.50	\$34,000
Nitrogen saved (lb) due to post-planting fertilization	1500	30	\$0.55	\$25,000
<b>Net Benefit of Post-planting N application on 1500 acres</b>				<b>\$36,000</b>
<b>Average Acres Completed</b> (completed an average of 1500 acres post-planting N application 25 years of 28 years, or 89% of years)				
Additional cost of post-planting fertilizer application	1500	1	\$15.00	\$(23,000)
Yield loss due to unfertilized acres	0	12	\$4.50	\$0
Yield gain due to post-planting fertilization	1500	5	\$4.50	\$34,000
Nitrogen saved (lb) due to post-planting fertilization	1500	30	\$0.55	\$25,000
<b>Average Net Benefit of Post-planting N application on 1500 acres</b>				<b>\$36,000</b>
<b>Worst Case</b> (At least 648 acres of post-planting N application completed in all years)				
Additional cost of post-planting fertilizer application	648	1	\$15.00	\$(10,000)
Yield loss due to unfertilized acres	852	12	\$4.50	\$(46,000)
Yield gain due to post-planting fertilization	648	5	\$4.50	\$15,000
Nitrogen saved (lb) due to post-planting fertilization	1500	30	\$0.55	\$25,000
<b>Worst Case Net Benefit of Post-planting N application on 1500 acres</b>				<b>\$(16,000)</b>
<b>Best/Max Case</b> (could have completed up to 3006 acres 1 year(s) of 28 years, or 4% of years)				
Up to 3006 acres of post-planting N application completed	3006			
<b>Breakeven Number of Acres</b> (Post-planting N revenue equal costs in 27 years of 28 years, or 96% of years)				
Number of acres (out of 1500 acres) requiring post-planting N application to breakeven	915			

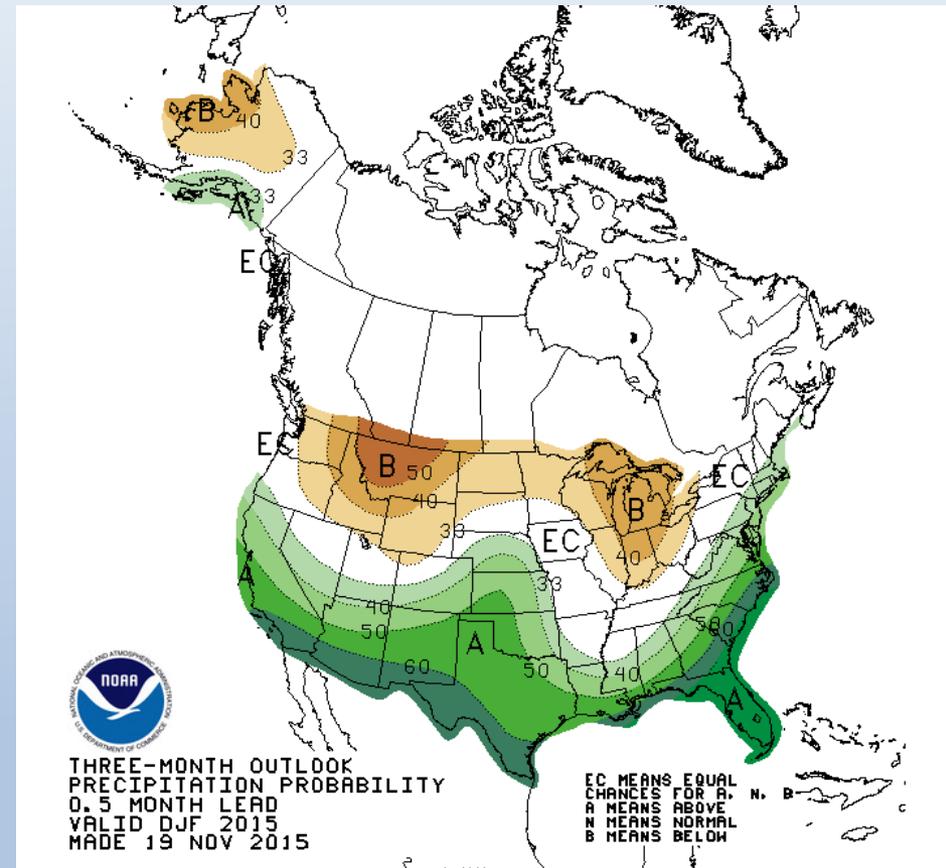
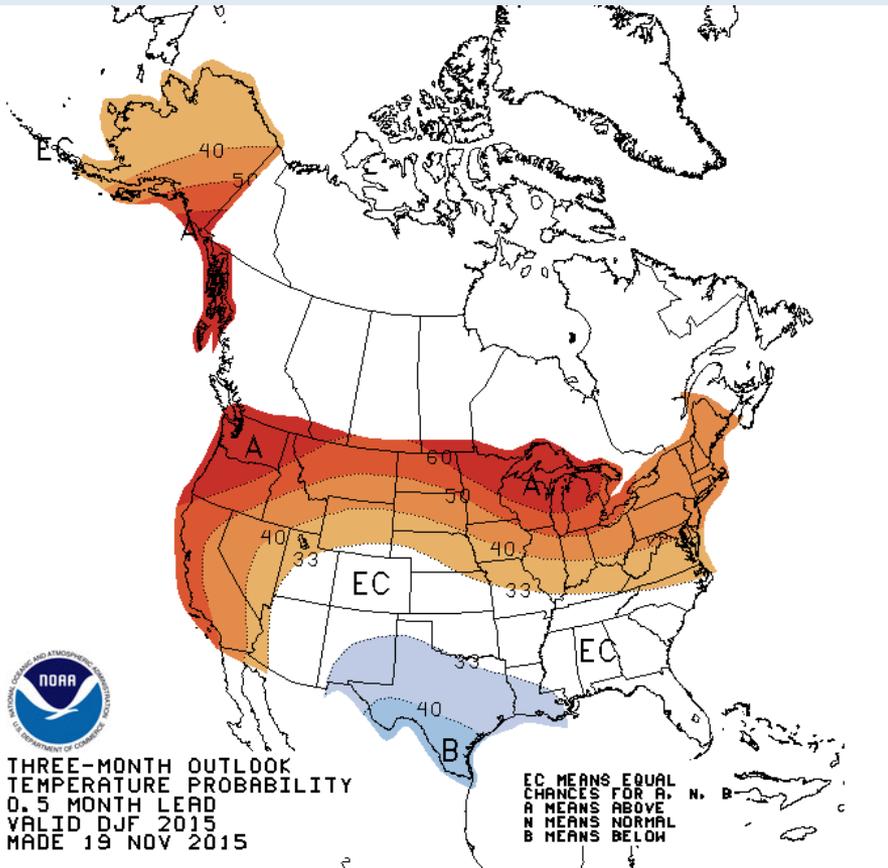
Note: This information is educational and should not be the sole source of information used to make a management decision.

Total Dollars are rounded to nearest thousand.

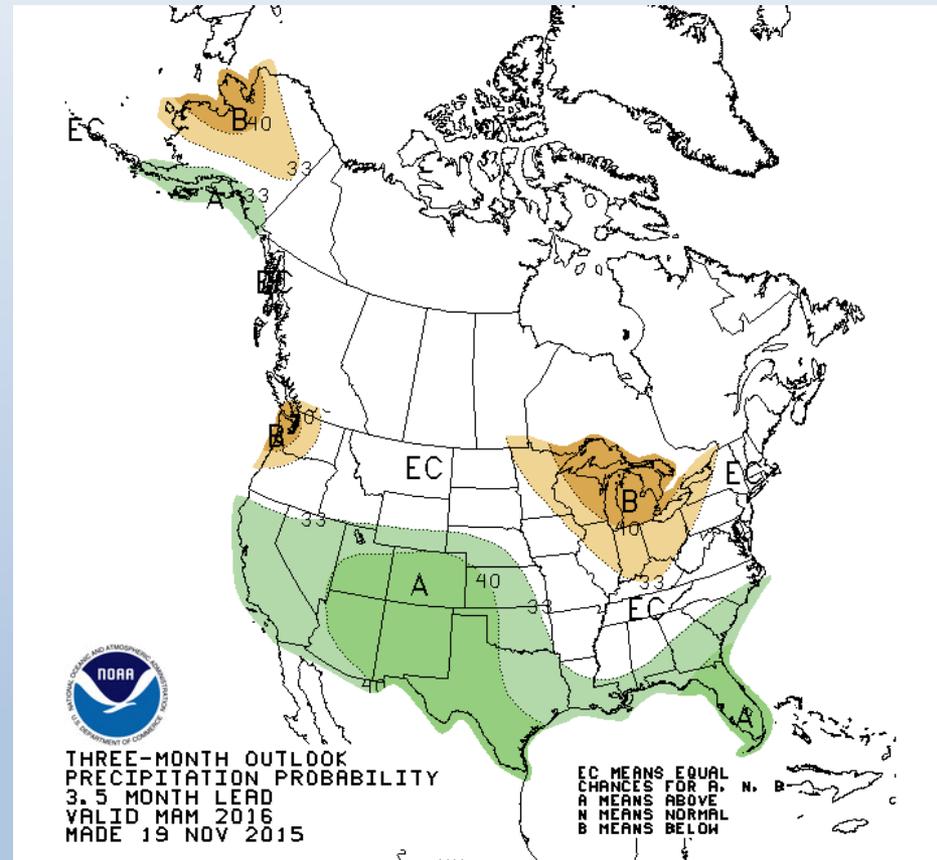
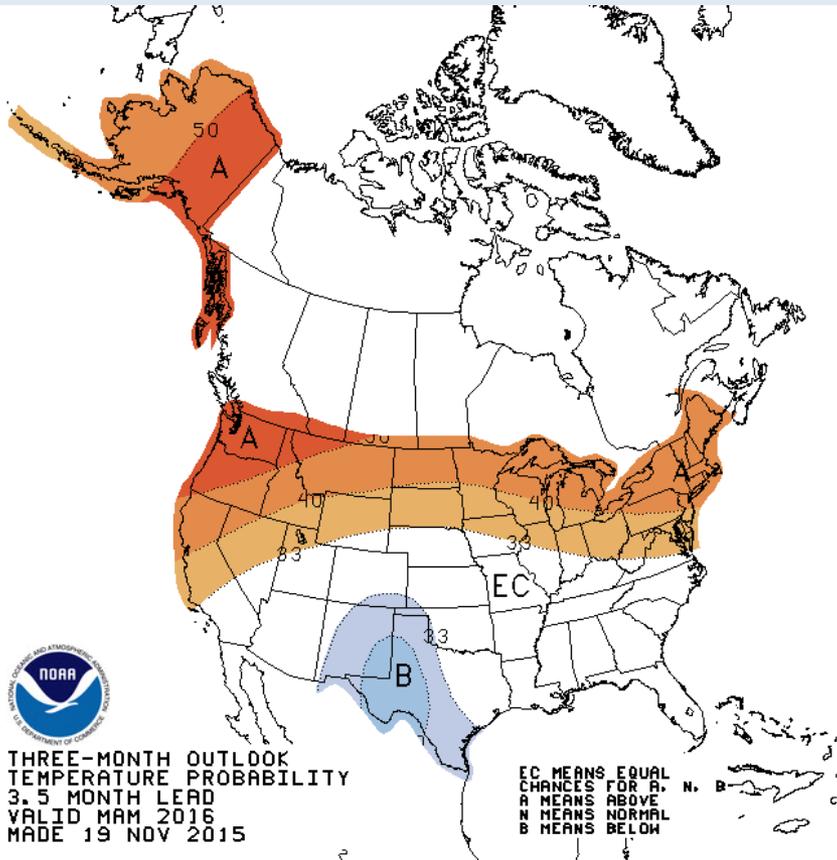
# Forecast

## NOAA Climate Prediction Center

# Winter



# Spring



# Summer 2016

- No clear pattern of rainfall from past strong El Nino events
- 1983 – warmer than average
- 1998 – cooler than average
- Models out to June – warmer than average

# Thank You

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