Precipitation and temperature effects on corn and soybean basis in the presence of climate change

Teo Skevas, Ben Brown, Wyatt Thompson, and Mohammad Mobarok

Acknowledgments

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Any errors here are our own, but we thank Vince Breneman (OCE, USDA) for assistance with data and communication and Seon Yong Kim and Emily Scully (University of Missouri) for assistance with data analysis and collection.

University of Missouri

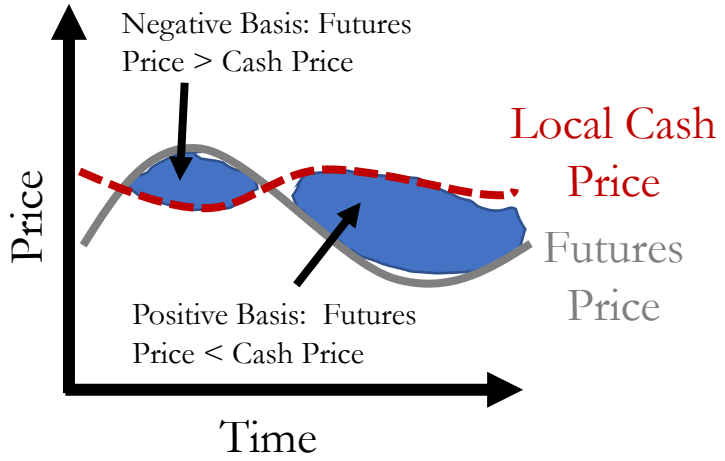
Photo Credit- Mary Griffith

Introduction: What is Market Basis Spread??

Basis and Spreads is the difference between prices usually between 2 different attributes. Basis becomes newsworthy when it is historically wide (is someone taking advantage of an event or trend by manipulating prices).

1. Quality Spread: difference between 2 different qualities of a product. (example: high protein wheat minus Grade 2 cash wheat) Influenced by supply and demand of products.

2. Temporal Basis: difference between prices of same product at 2 different times. (example: delivery point cash corn price minus Chicago September Corn Futures Price) Influenced by interest rates and storage costs. Example: Storage cost increases lead to weaker basis.



3. Spatial Spread: difference between prices of same product at 2 different locations. (example: #2 yellow corn in St. Joseph, MO minus #2 yellow corn in Sikeston, MO) Influenced by transportation costs.

Our study primarily looks at **Spatial Spread (between the Port of New Orleans and Local Cash Prices)** although quality spread and temporal basis are likely implicitly included.

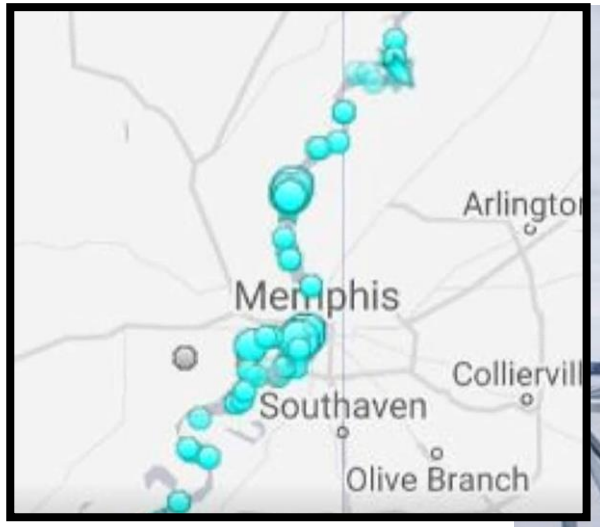
Introduction: What is Market Basis??

Figure 1. Satellite Images of the Mississippi River Near Eudora, Arkansas, October 2021 and October 2022

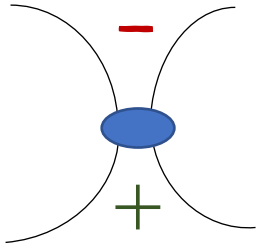
Image credit- farmdoc team: Ivan Flores and Joe Janzen April 3, 2023

Introduction: What is Market Basis??

Caution: it is difficult to capture and explain everything that impacts basis.

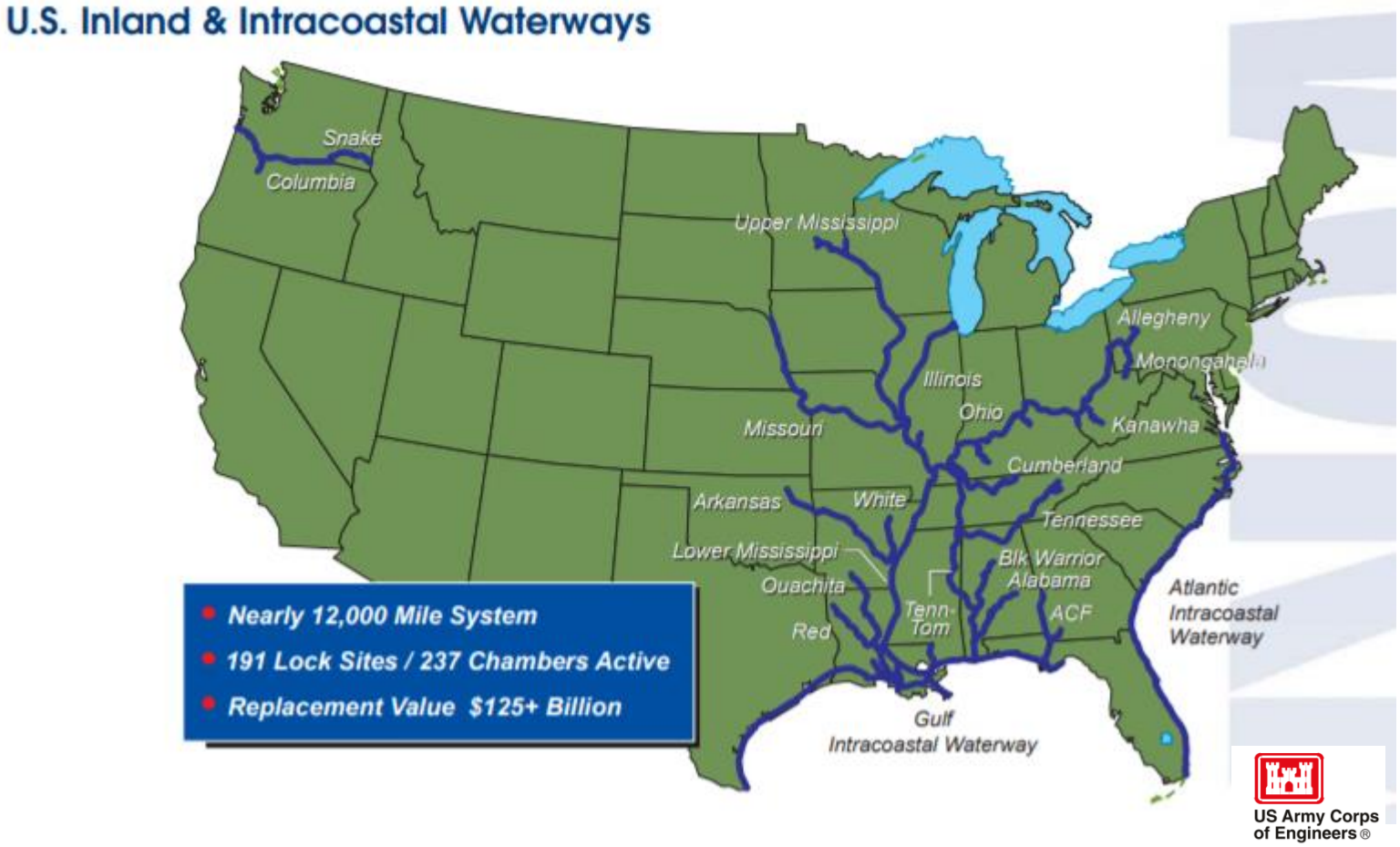


Grain can't go anywhere and floods the market basis weakens.



Can't get grain so end users bid up grain- basis strengthens

Introduction: Hypothesis and Objectives



JT Myers Lock (OR 846)

Lock 20 (UM 343)

Research Question: Does projected rainfall increases stress the current infrastructure to a point that affects the basis between local price and Gulf port price. *Temperature was added in an extension to the original study.*

Introduction: Why New Orleans

RELEVANCE

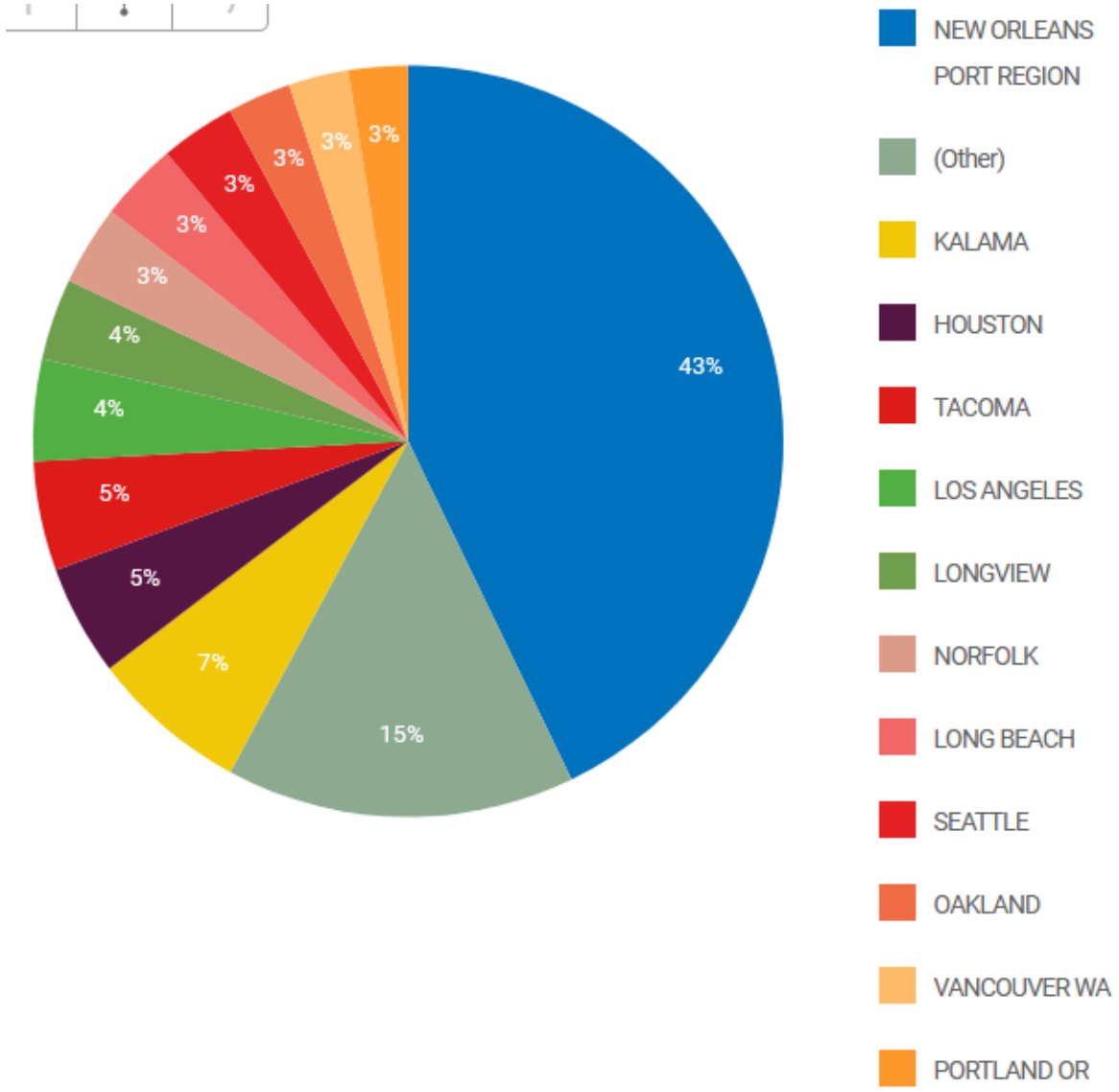
An important port- 43% of ag exports through New Orleans

Local-to port price gaps matter

Higher gap

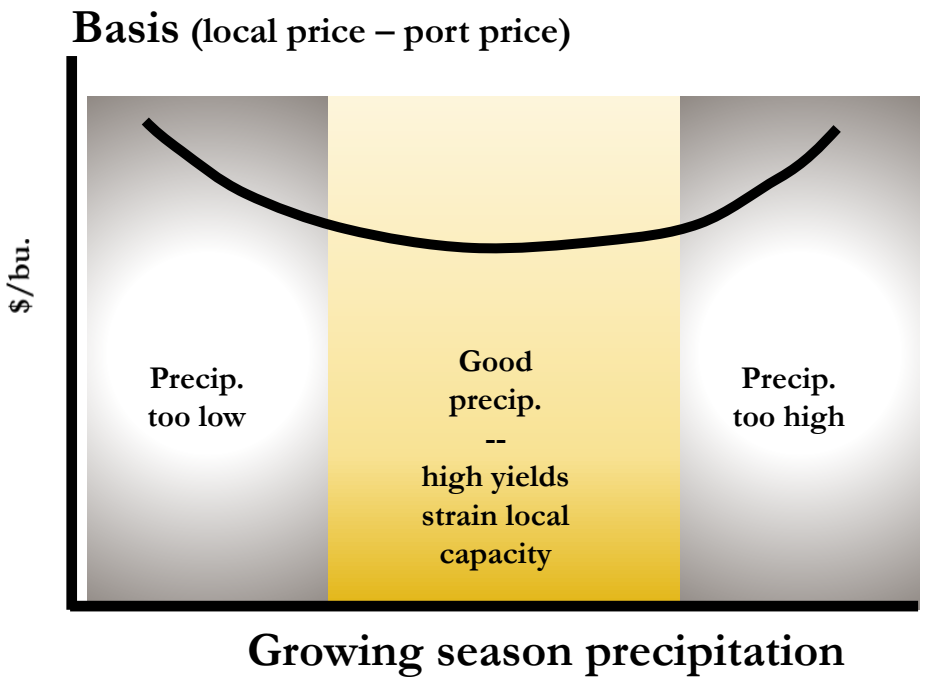
→higher buyer prices and costs

→lower producer prices and receipts



Introduction: Including rainfall and temperature

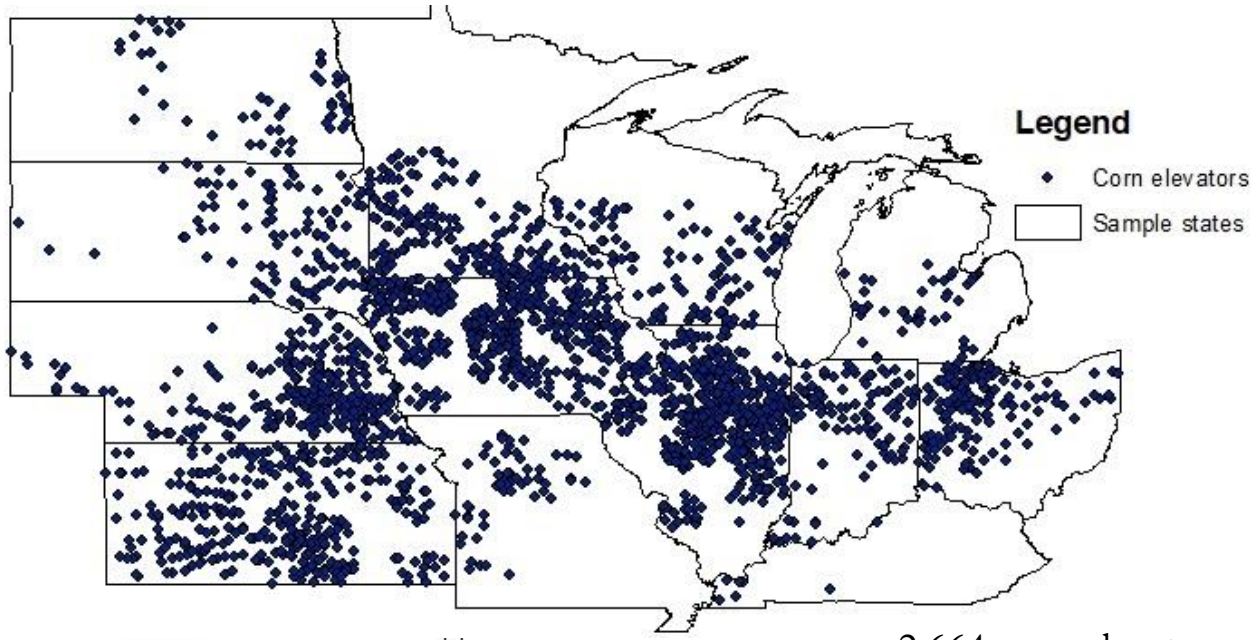
1. Local Conditions- increased precipitation and temperature could cause receiving disruptions and impact crop development. Example: delayed planting due to increased spring precipitation or earlier planting due to high soil temperature.



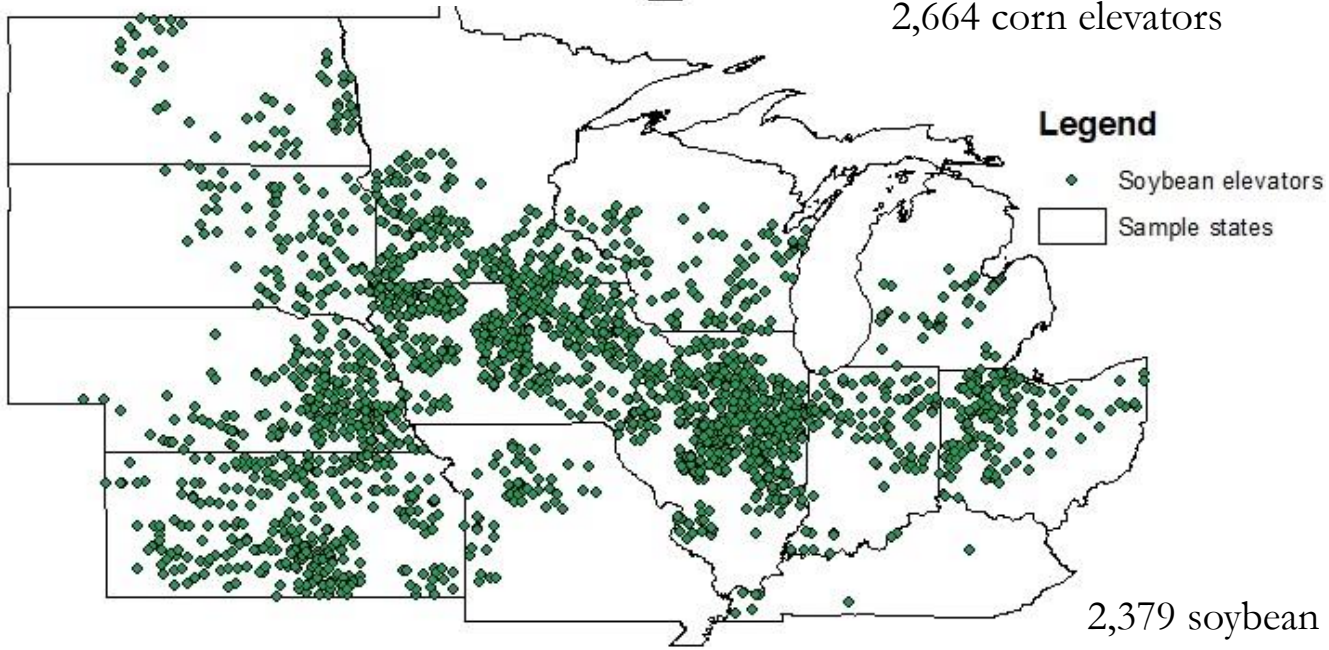
2. Growing Season Conditions- Good growing conditions cause large crop production and strain infrastructure and available storage. Extreme conditions could shrink crop size and lower the burden on infrastructure.

3. Regional Conditions- Extreme precipitation means barges are prohibited from moving (flood conditions) or are filled less than normal (low water)

Introduction: Empirical Study of Current Infrastructure



2,664 corn elevators



2,379 soybean elevators

Detroit News

[Army Corps puts $479M toward construction of new Soo Lock]

That funding is intended to complete engineering and design and start construction on the project to fortify the Brandon Road Lock and Dam...

Jan 19, 2022

Winona Post

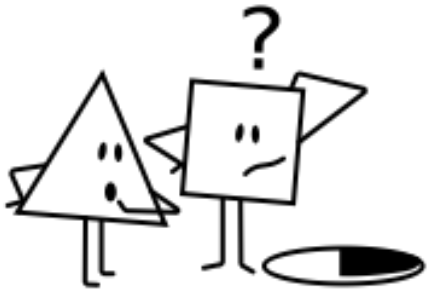
Construction to start at Lock & Dam 6 | Community ...

The construction involves enhancing the auxiliary chambers of the lock and dam. Each auxiliary chamber has only a single set of miter gates that...

1 month ago

It is nearly impossible to estimate the impact a new lock and dam would have on corn & soybean basis throughout the region and when those projects will be completed so we use **actual** prices and rain fall collected through the Midwest.

Introduction: Plan of attack



Part 1. Estimate how _____ impacts _____.

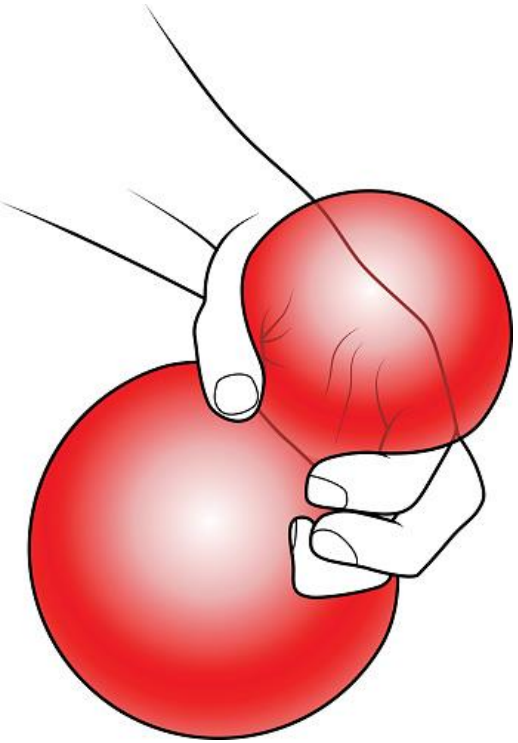
- Regional precipitation → river water levels
- River water level (high or low) → river disruptions
- Temperature and precipitation → planting progress
- Growing season precipitation & temperature → local corn and soybean yields
- Local precipitation, yield changes, river disruptions,… → crop basis

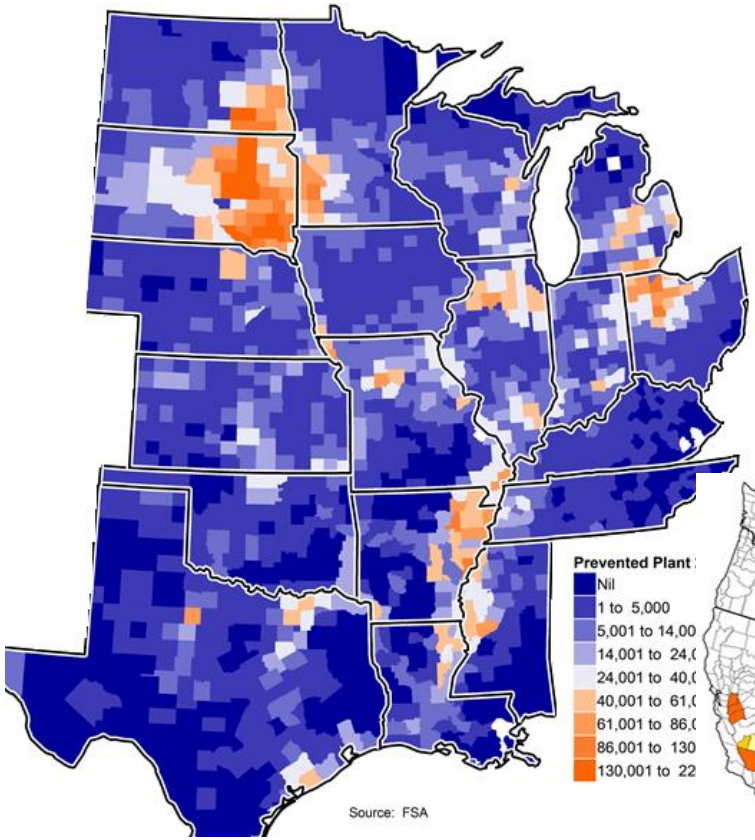
Part 2. Use future climate projections to change historical precipitation and temperature.

Part 3. simulate how river level and disruptions, yield shocks, and basis differ given these weather changes.

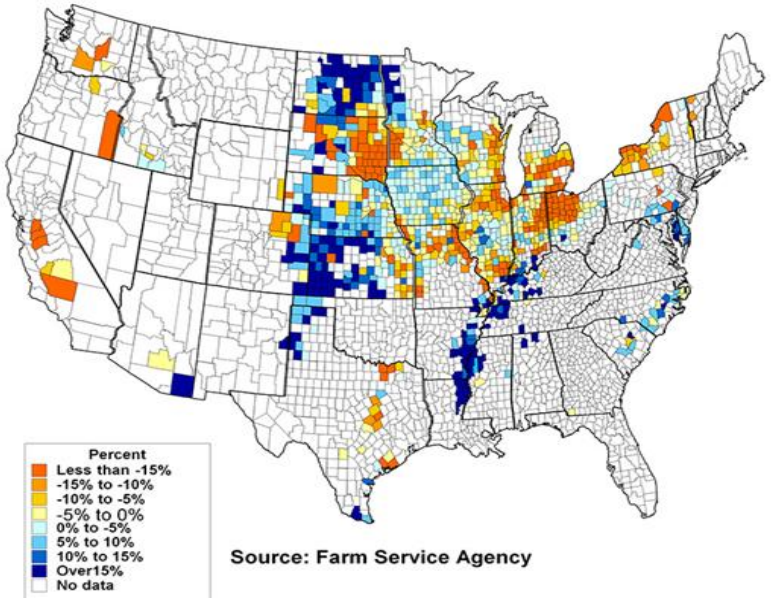
Disclaimer: Aggregate results can hide extremes

Averages are usually wrong for everyone and often a negative impact somewhere else can be a positive result for others.



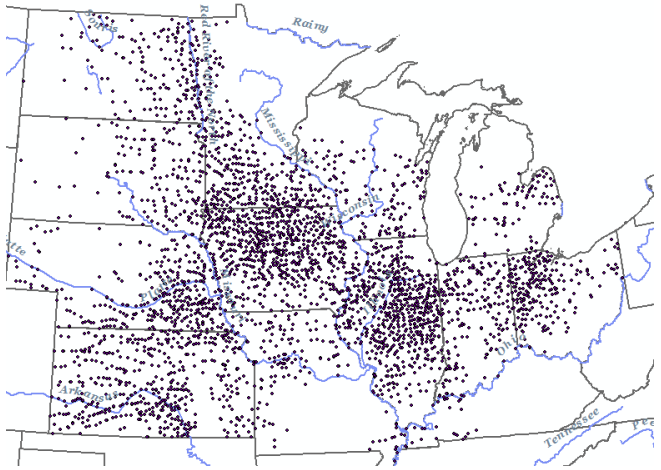


2019 Prevent Plant (left) and change in corn acreage (below)

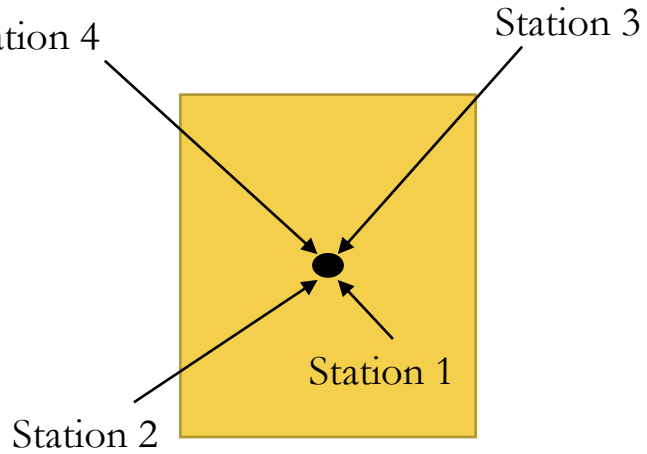


Data: Yields, Price, Historical Weather, River Level

Price data from 2,400 + grain receiving stations across the country for the years 2008-2020 purchased from Refinitiv.

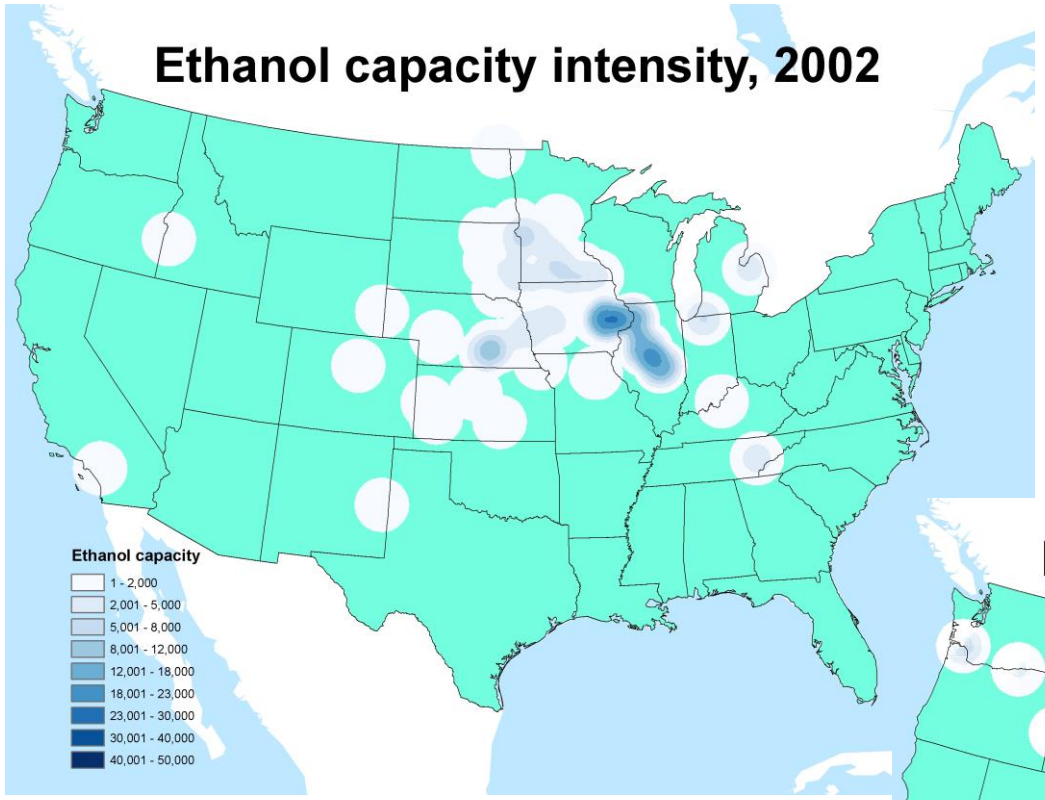


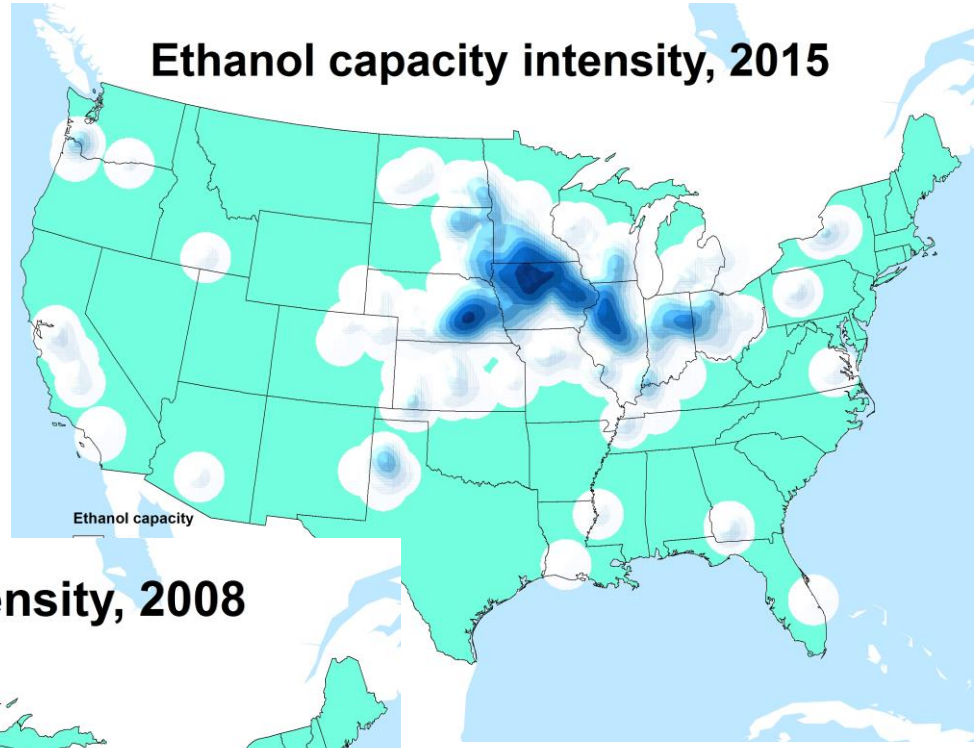
Weekly precipitation and temperature data from National Oceanic and Atmospheric Administration Stations with continuous data and distance weighted to match grain elevator location

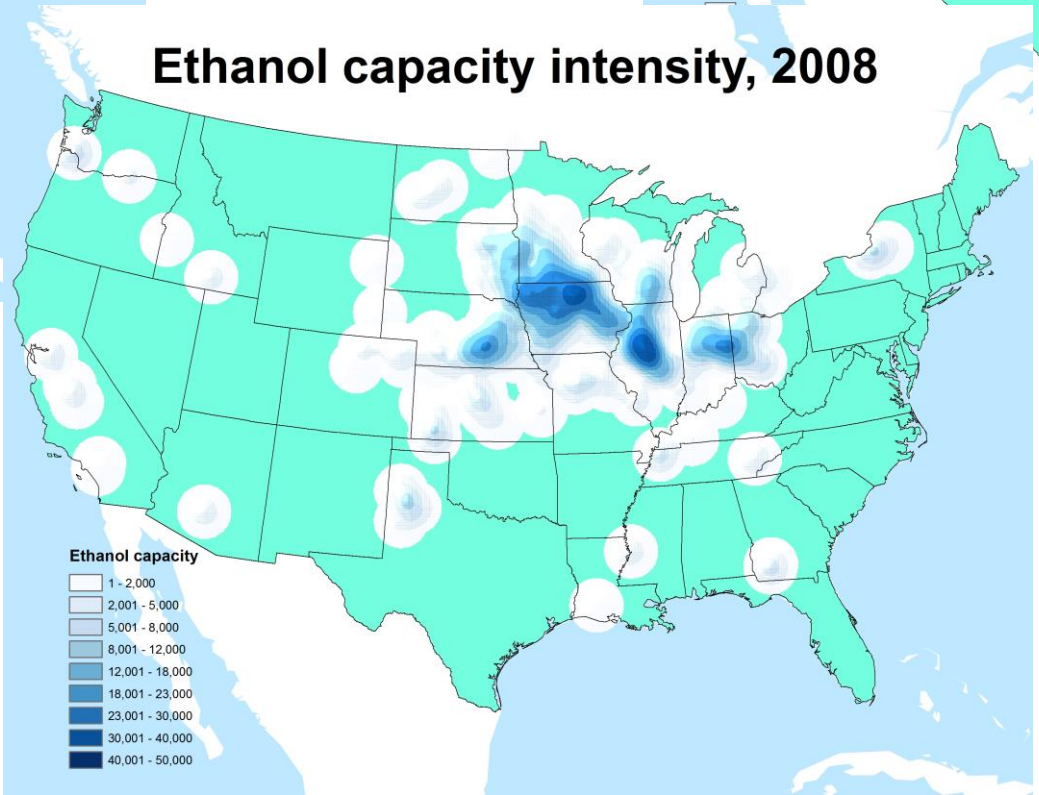


		Corn		Soybeans	
Variables	Unit	Mean	St.dev	Mean	St.dev
Basis	$	-0.8	0.24	-1.15	1.03
Local precipitation	mm	0.52	0.74	0.53	0.75
Growing season precipitation	mm	0.97	0.37	0.97	0.37
Corn belt precipitation	mm	2.61	1.08	2.6	1.08
Distance to NOLA	1,000 km	1.27	0.25	1.27	0.25
Diesel price (Midwest)	$	3.08	0.63	3.08	0.63
Ethanol intensity	mil gallons/sq. km	0.02	0.01	0.02	0.01

Data: Ethanol Intensity







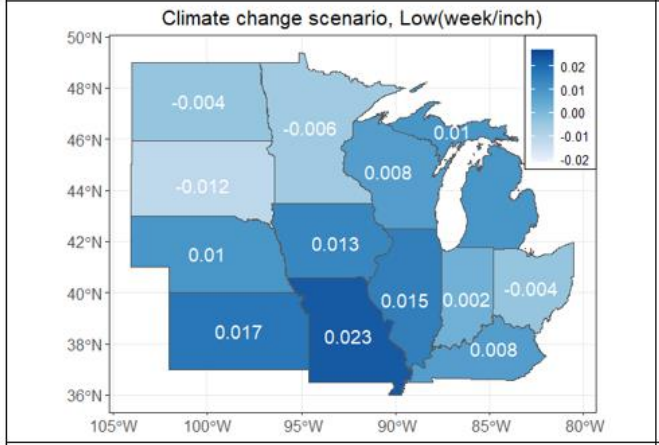
Thanks to Vince Breneman's geospatial work on ethanol intensity we were able to cancel out a local demand driver from ethanol and use more years of data.

Data: Climate Scenarios

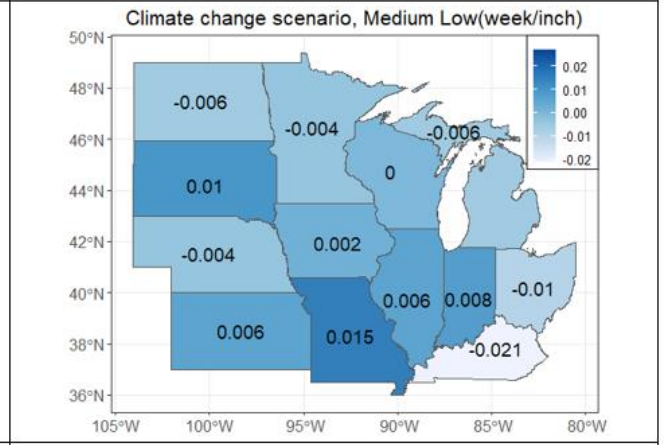
We did not model weather changes. Four different scenarios for precipitation and temperature changes between 2006-2025 and 2025-2044 provided by the National Oceanic and Atmospheric Administration.

Precipitation Change

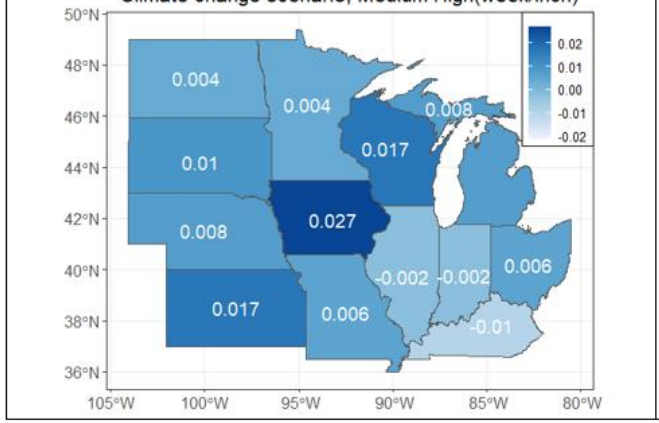
Low



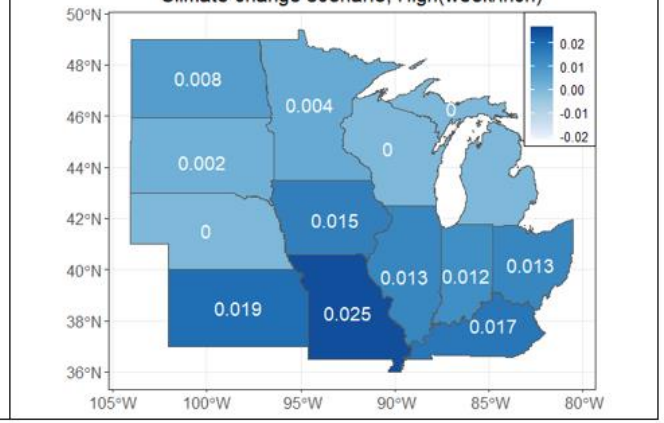
Medium Low



Medium High

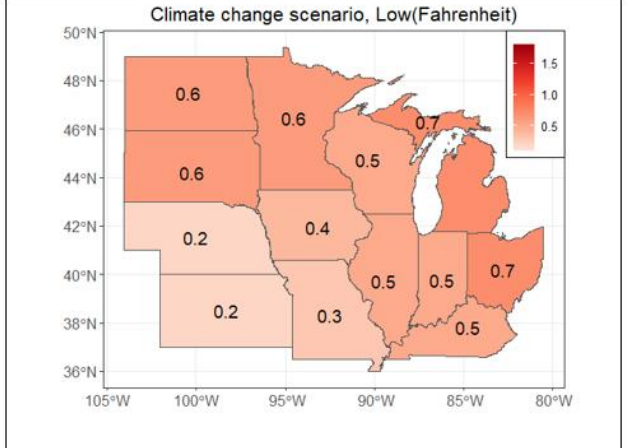


High

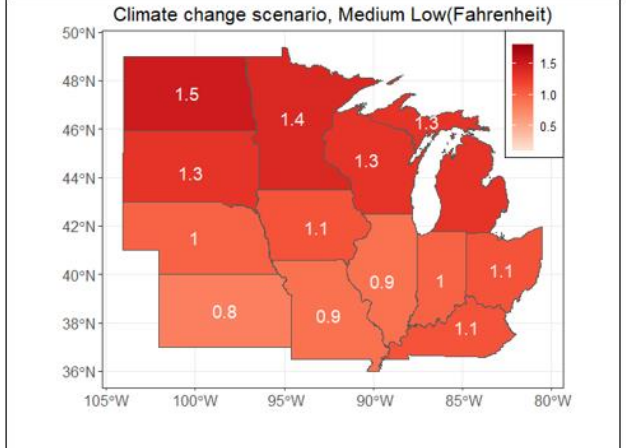


Temperature Change

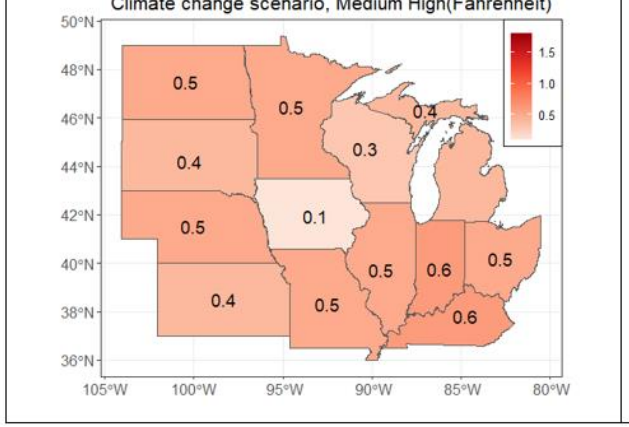
Low



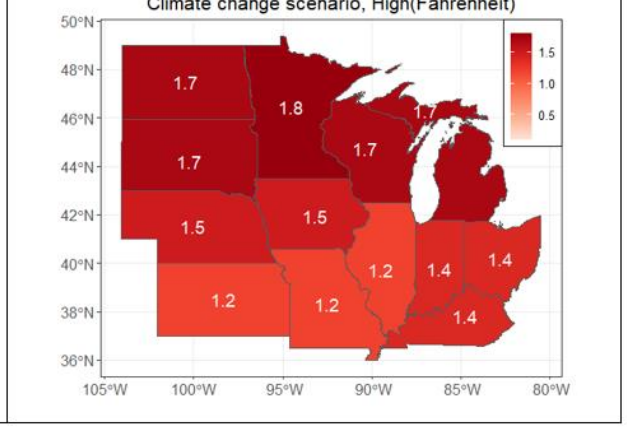
Medium Low



Medium High



High



Step 1: Estimate water level

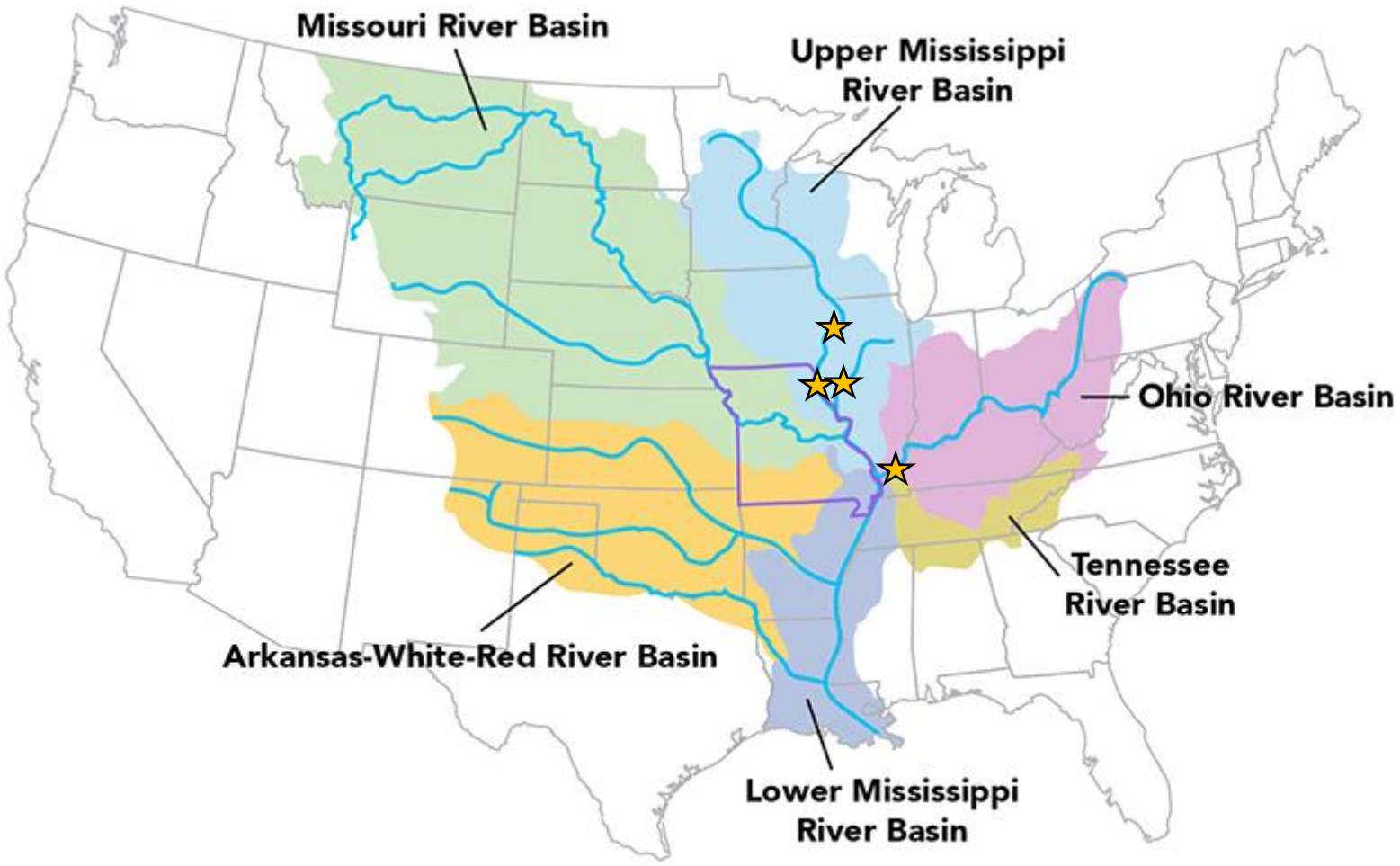


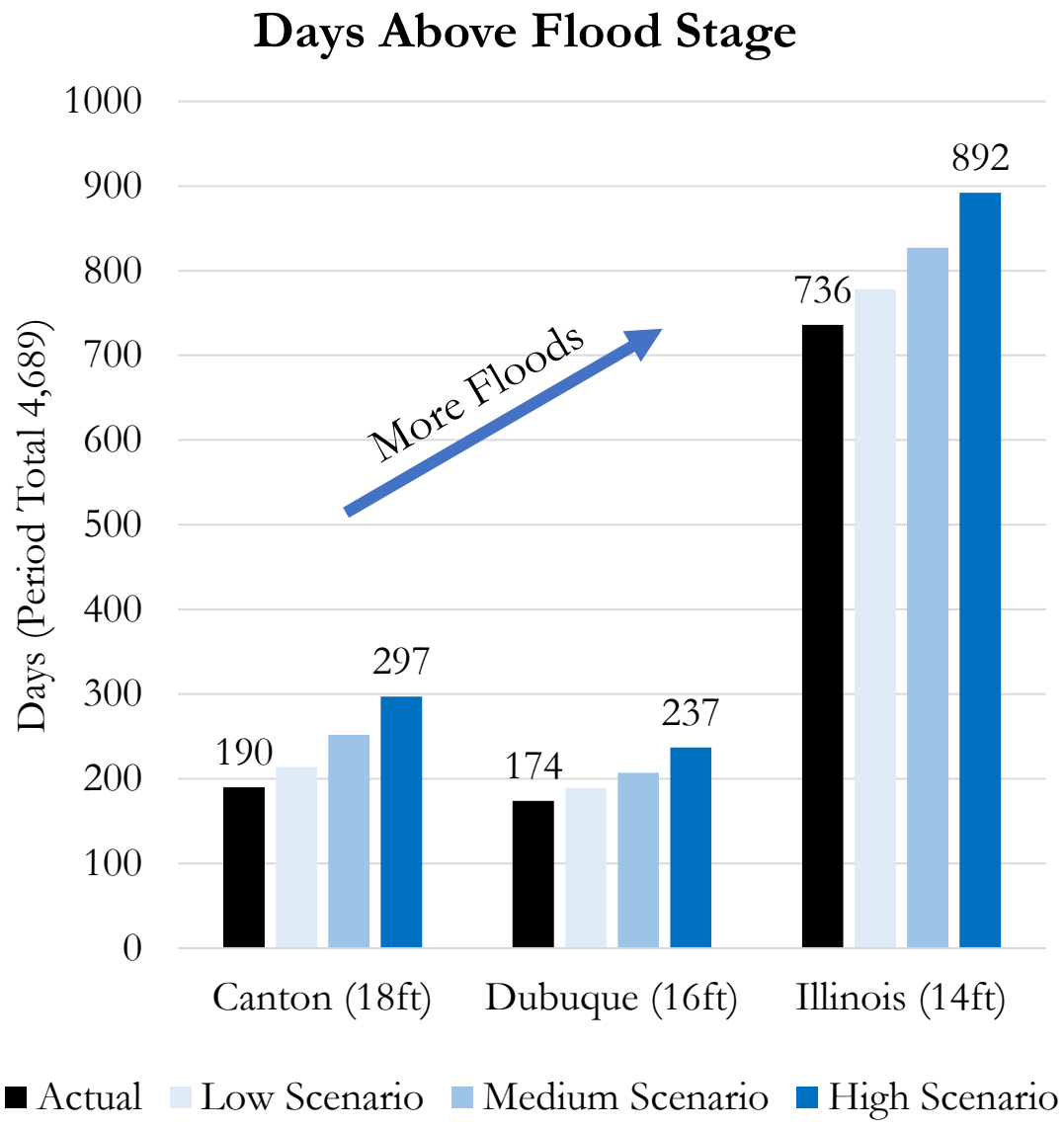
Image Credit- Missouri Department of Natural Resources

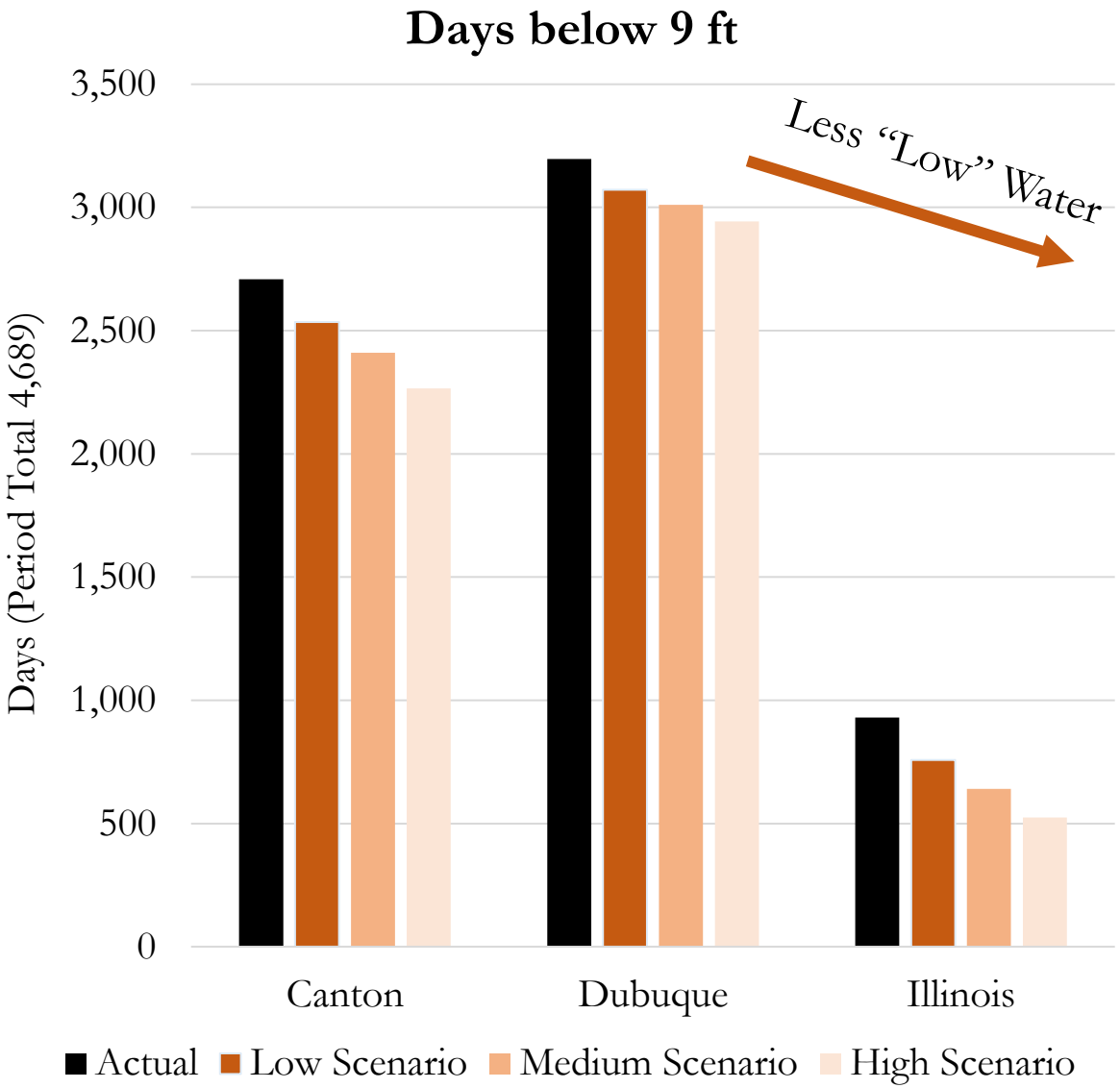
Four locks and dams were used in this study because we could get historical water level data.

1. Mississippi River- Dubuque *16ft Flood Stage*
2. Mississippi River- Canton *18ft Flood Stage*
3. Illinois River- Beardstown *14ft Flood Stage*
4. Ohio River at Smithland Upper. *40ft Flood Stage*

Precipitation for the different basins was average over a moving period of time (4 months) and matched with historical water level through each lock and dam.

Step 2 & 3: Re-estimate water level



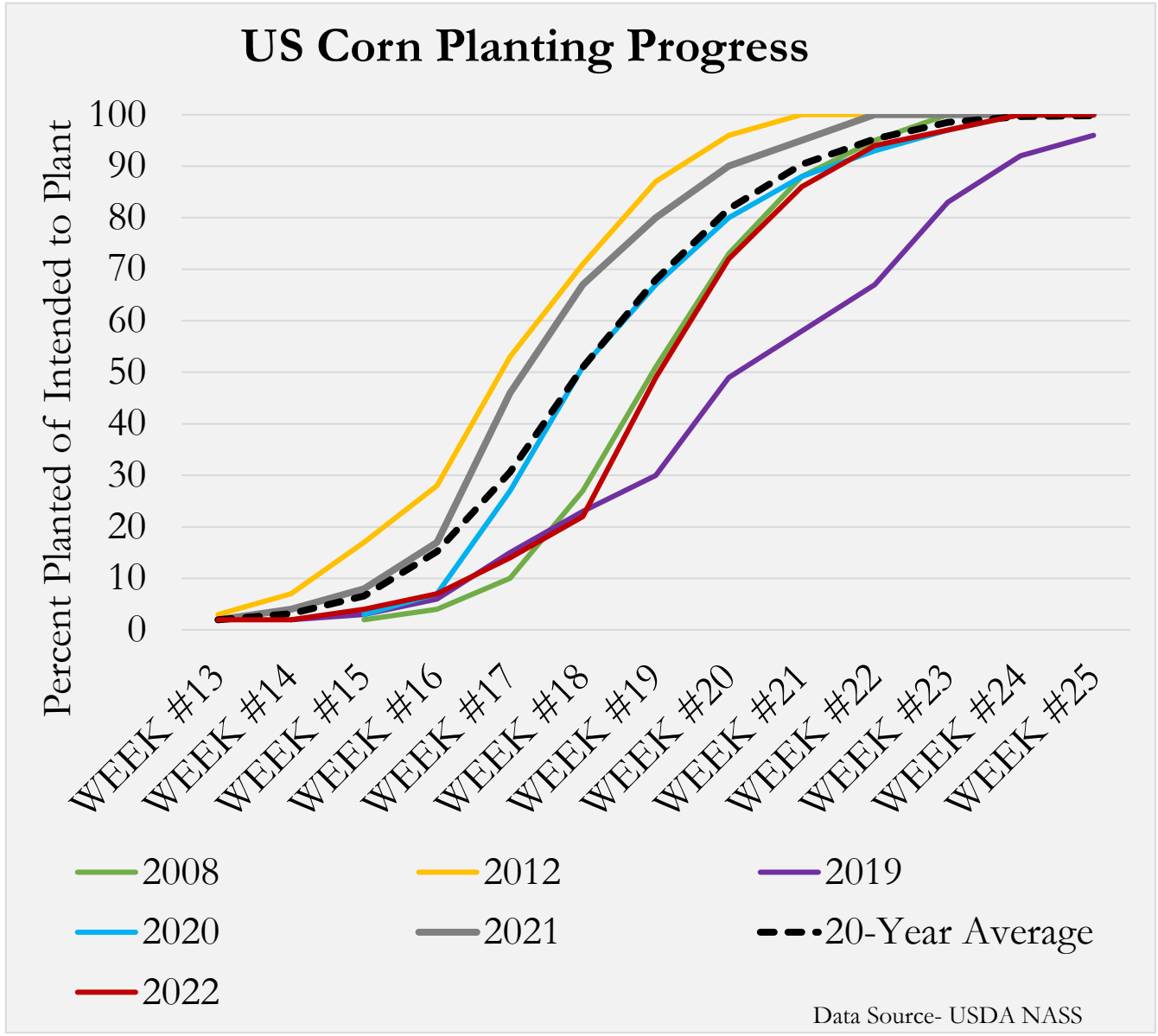


Step 1: Estimating Planting Progress

Did we have an average planting season??

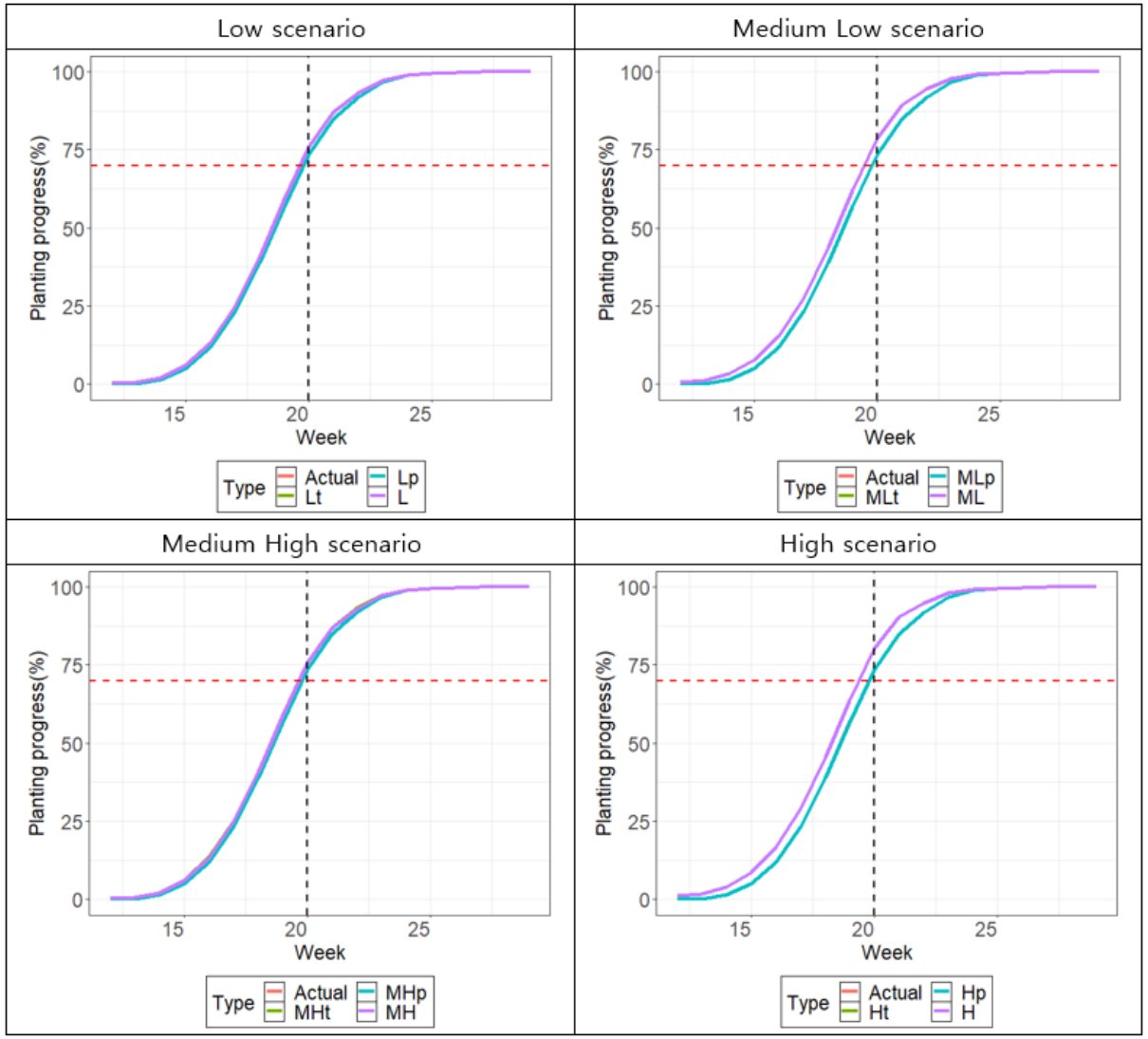
Field Conditions in April & May

Field Conditions in Late June



Step 2 & 3: Re-estimate Planting Progress

Predicted Corn Planting Progress



'L' represents the predicted progress with low scenario, and 'M' and 'H' represent the predicted progress with medium and high scenario, respectively.

Corn Planting Progress- 0.XY= XY%

	15th week	18th week	22nd week
Actual	0.051	0.389	0.919
Low Temp.	0.061	0.410	0.932
Low Prec.	0.051	0.389	0.919
Low	0.061	0.410	0.932

	15th week	18th week	22nd week
Actual	0.051	0.389	0.919
ML- Temp.	0.078	0.440	0.944
ML- Prec.	0.051	0.389	0.919
Medium Low	0.078	0.440	0.944

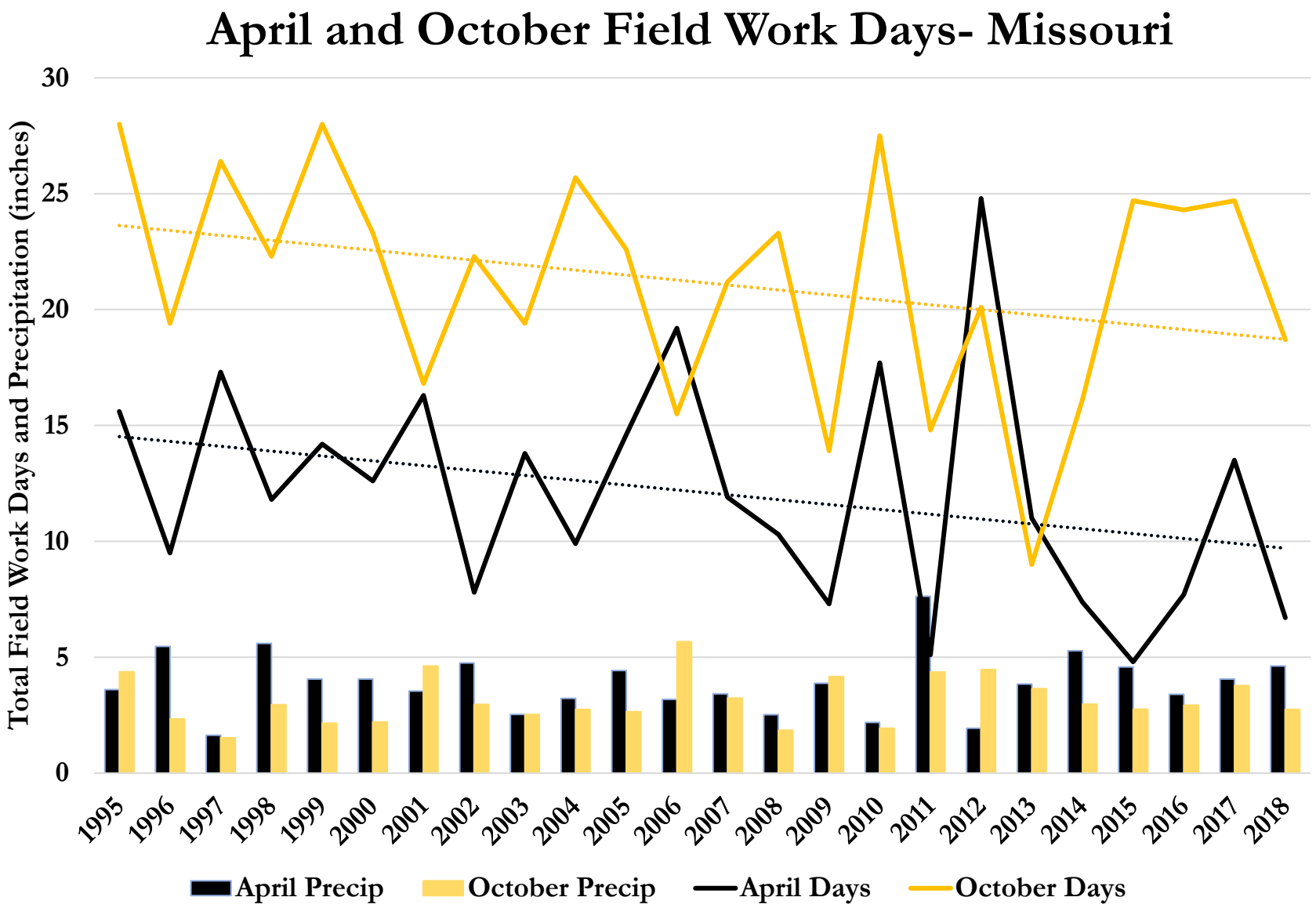
	15th week	18th week	22nd week
Actual	0.051	0.389	0.919
MH- Temp.	0.062	0.409	0.931
MH- Prec.	0.051	0.389	0.919
Medium High	0.062	0.409	0.930

	15th week	18th week	22nd week
Actual	0.051	0.389	0.919
H- Temp.	0.087	0.456	0.950
H- Prec.	0.051	0.389	0.919
High	0.087	0.456	0.949

Data: Days Suitable for Planting and Harvest

~5 fewer days on average in April and October

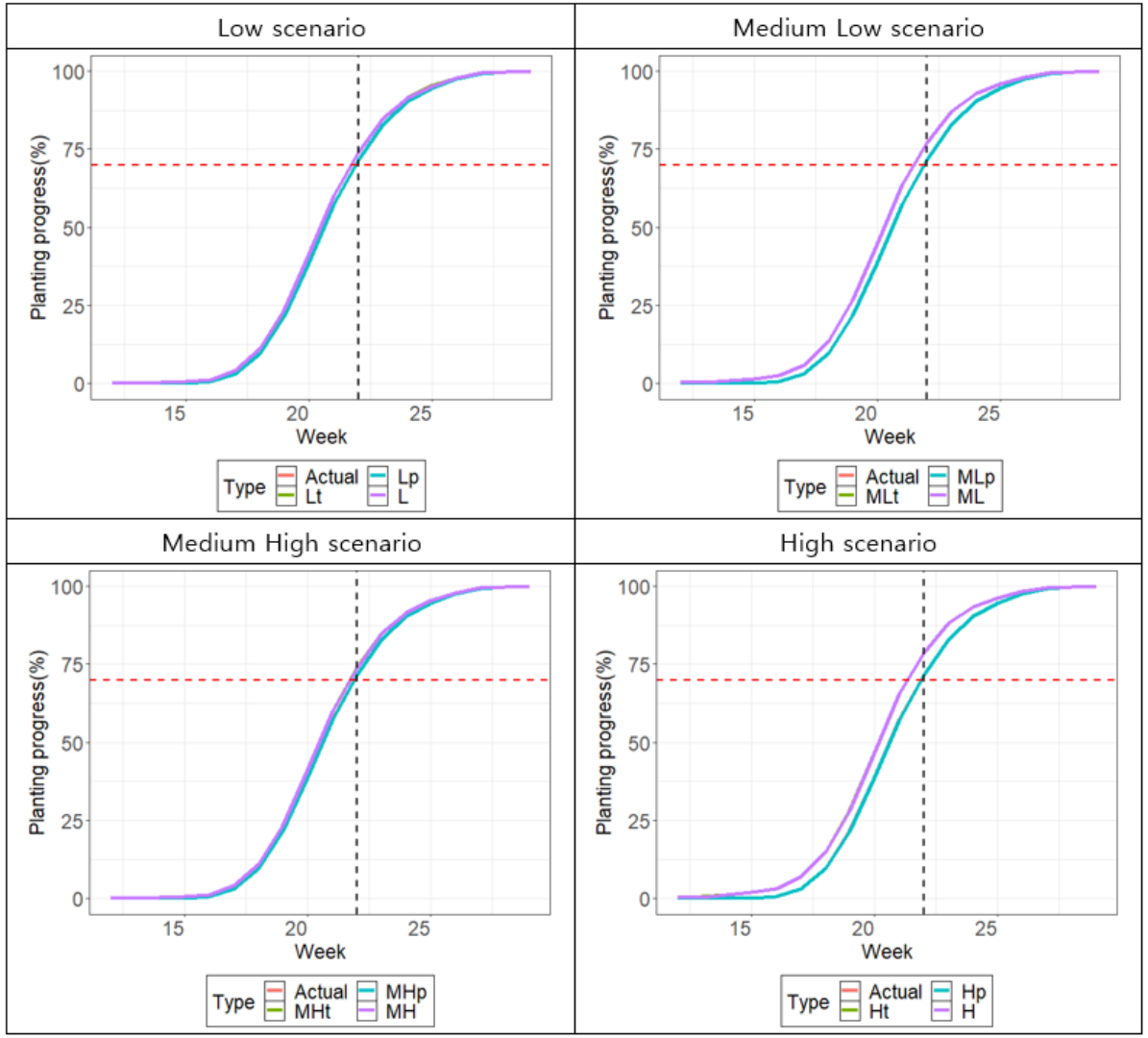
We've largely substituted less people farming for larger equipment. However, less days will make it harder to get the crop in.



Data Source: USDA NASS

Step 2 & 3: Re-estimate Planting Progress

Predicted Soybean Planting Progress



'L' represents the predicted progress with low scenario, and 'M' and 'H' represent the predicted progress with medium and high scenario, respectively.

Soybean Planting Progress- 0.XY= XY%

	15th week	18th week	22nd week
Actual	0.000	0.097	0.715
Low Temp.	0.006	0.112	0.741
Low Prec.	0.000	0.096	0.715
Low	0.006	0.112	0.740

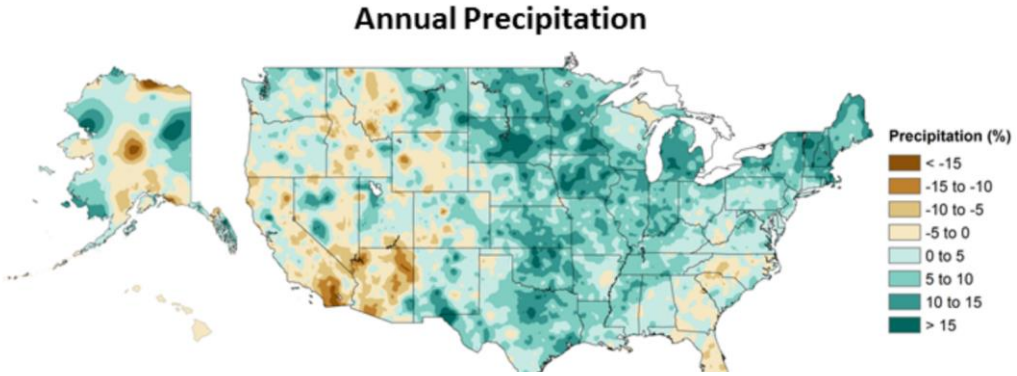
	15th week	18th week	22nd week
Actual	0.000	0.097	0.715
ML Temp.	0.015	0.135	0.771
ML Prec.	0.000	0.097	0.715
Medium Low	0.015	0.135	0.771

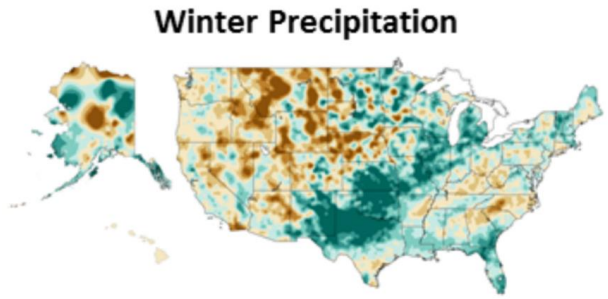
	15th week	18th week	22nd week
Actual	0.000	0.097	0.715
MH Temp.	0.006	0.111	0.739
MH Prec.	0.000	0.096	0.715
Medium High	0.006	0.111	0.738

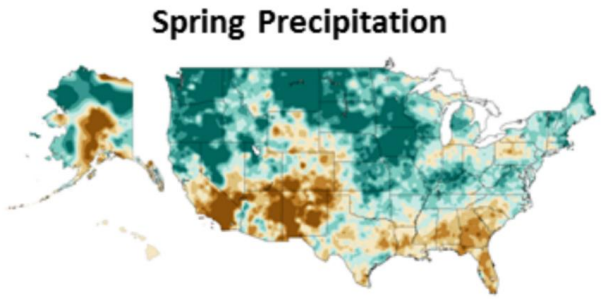
	15th week	18th week	22nd week
Actual	0.000	0.097	0.715
H Temp	0.021	0.148	0.786
H Prec.	0.000	0.096	0.715
High	0.021	0.148	0.786

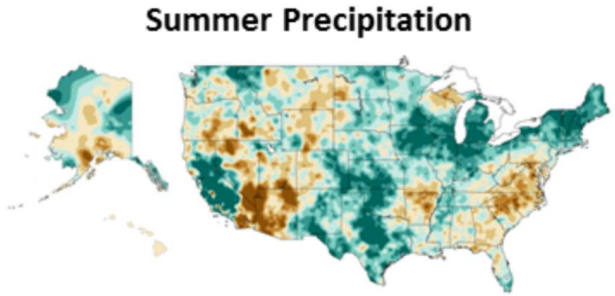
Step 1: Estimate Weather Impact on Yield

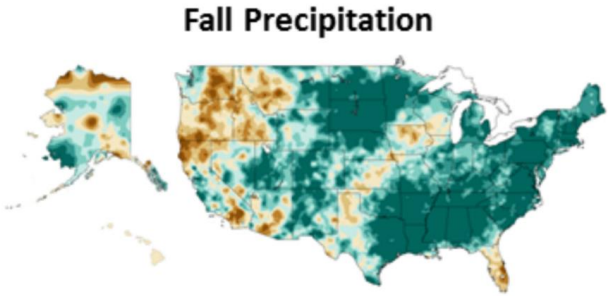
We use planting progress and local precipitation & temperature to signal when the crops are reaching key maturity dates. The yield value used is departure from trend to account for technology advancements in seed and management.

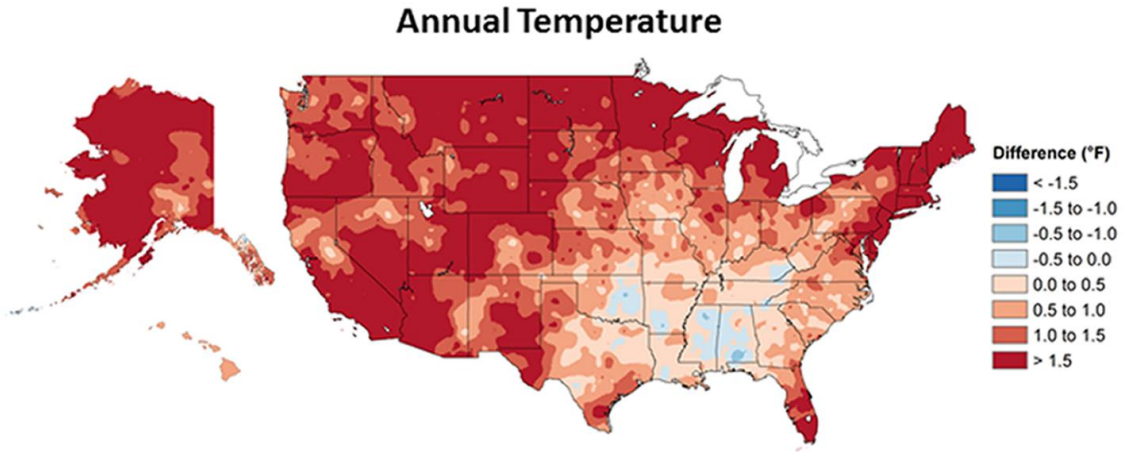


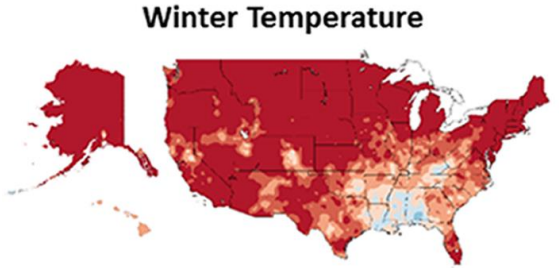


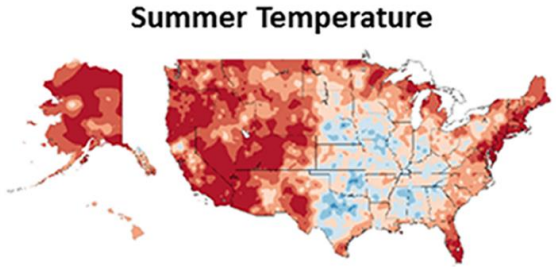






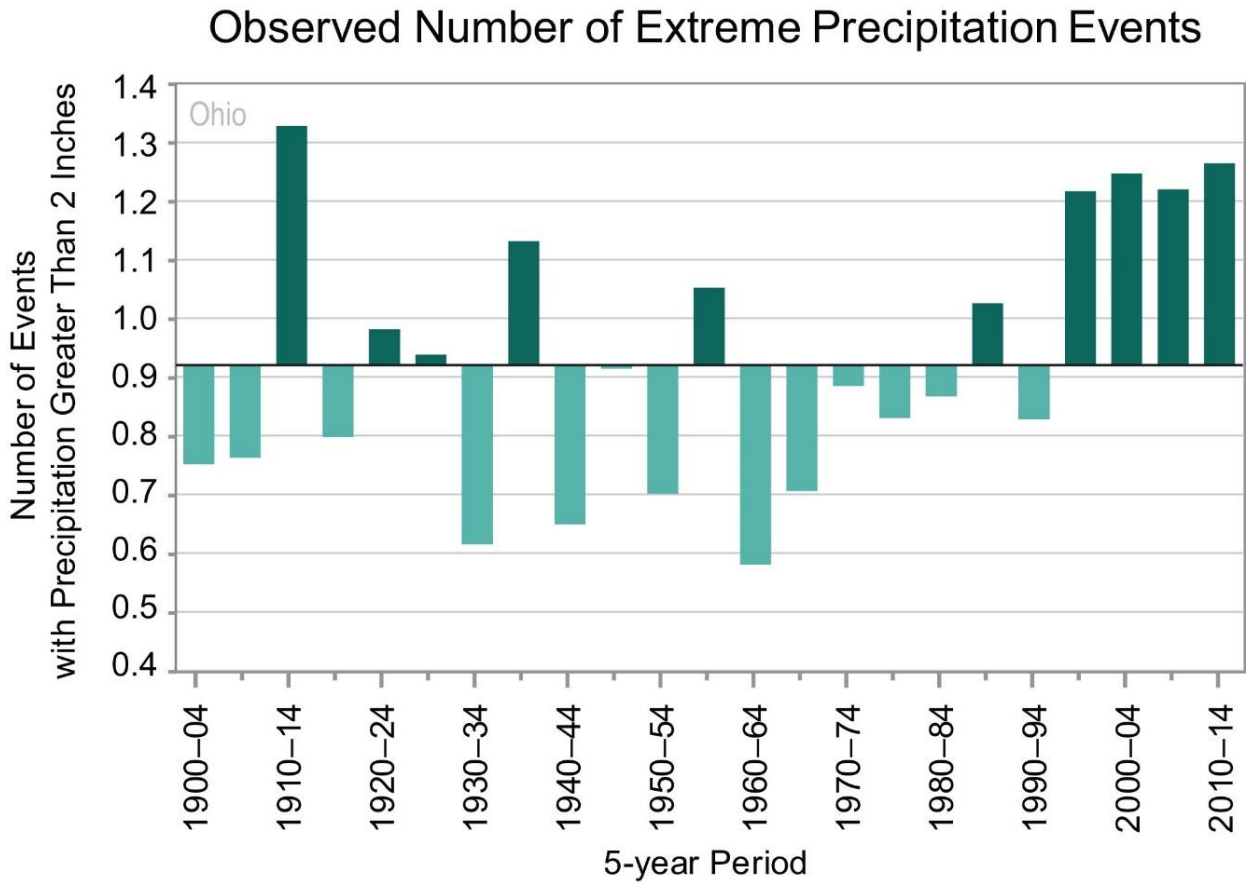






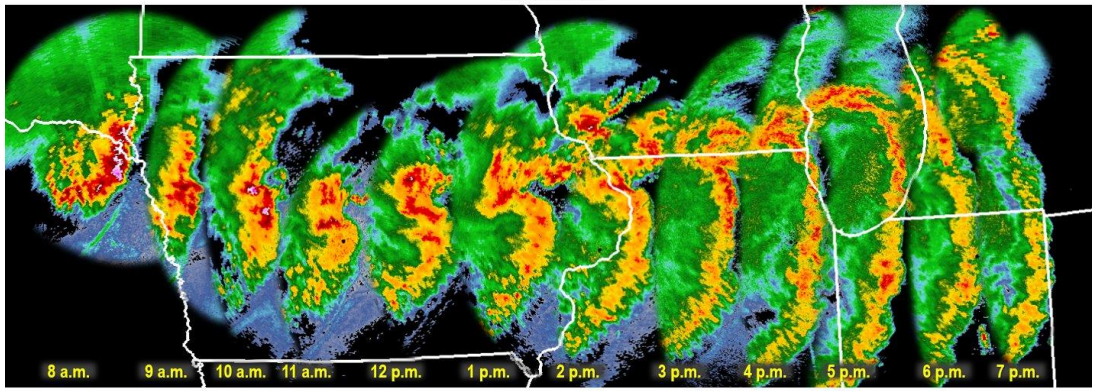
National Climate Assessment CCSR:
https://science2017.globalchange.gov/

Step 1: Estimate Weather Impact on Yield



August 10, 2020 Derecho: Lowest Angle NWS Radar Reflectivity at One-Hour Time Steps

All times in CDT

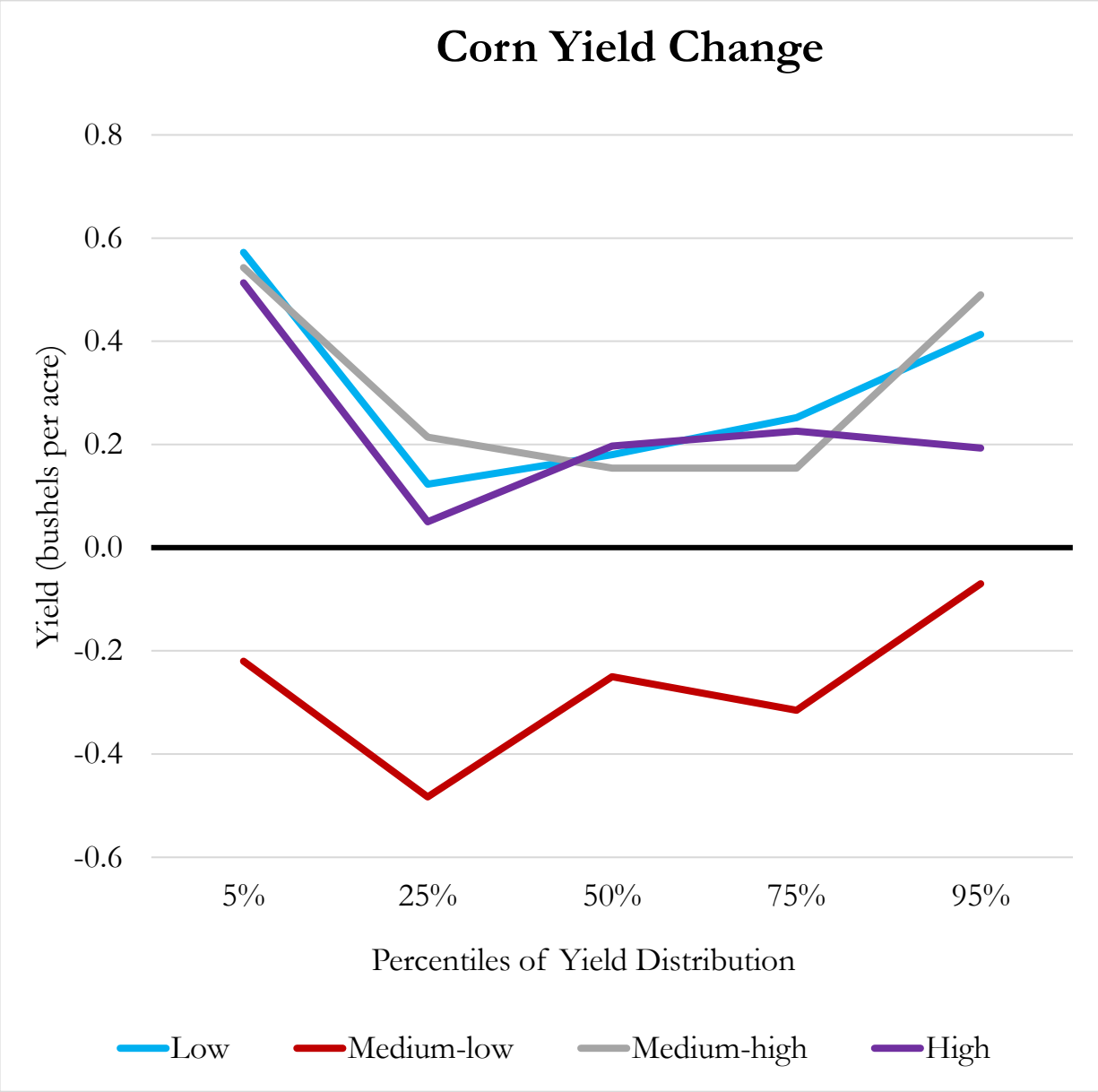


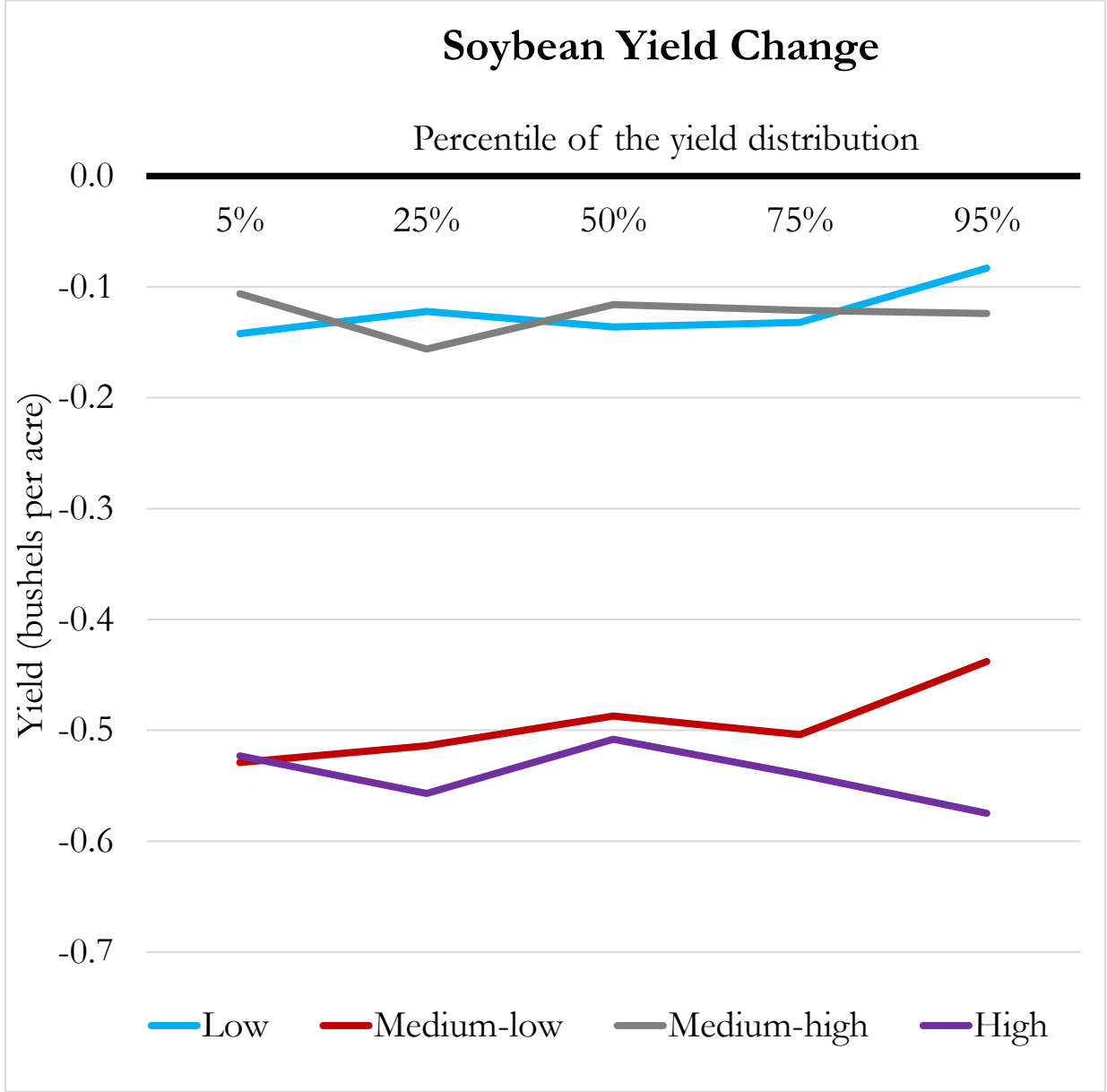
This long-lasting, severe wind thunderstorm complex (known as a derecho) produced hundreds of reports of damage along with likely a few tornadoes.

NWS Chicago | weather.gov

Aug 11, 2020

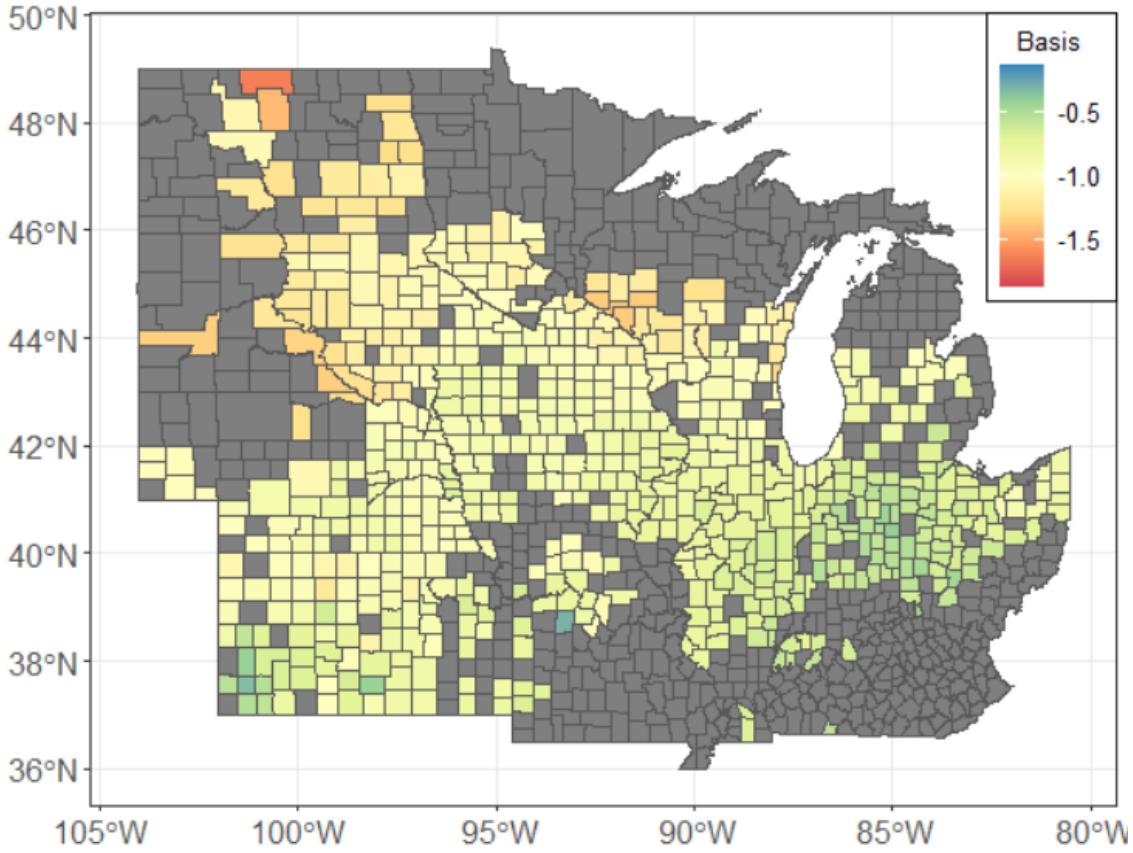
Step 2 & 3: Re-estimate Weather Impact on Yield



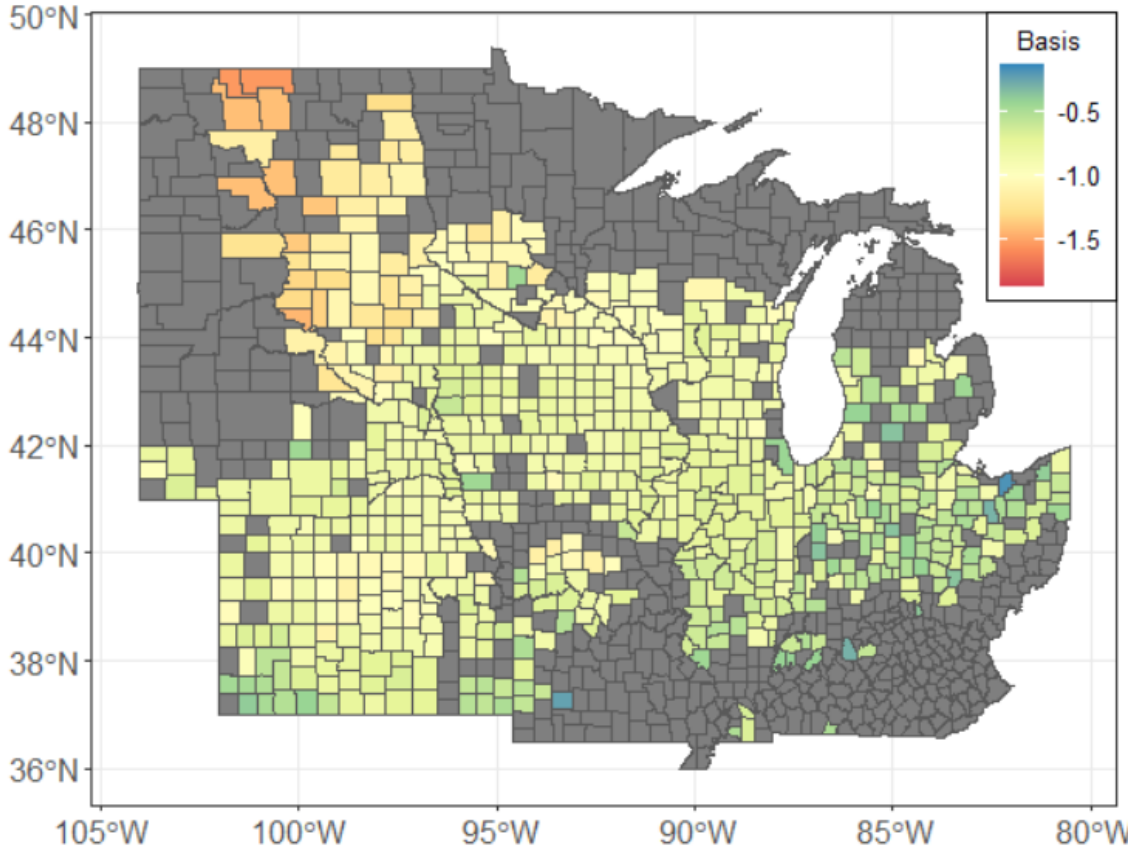


Step 1: Use Yield, Water Level, Ethanol.. To estimate Basis

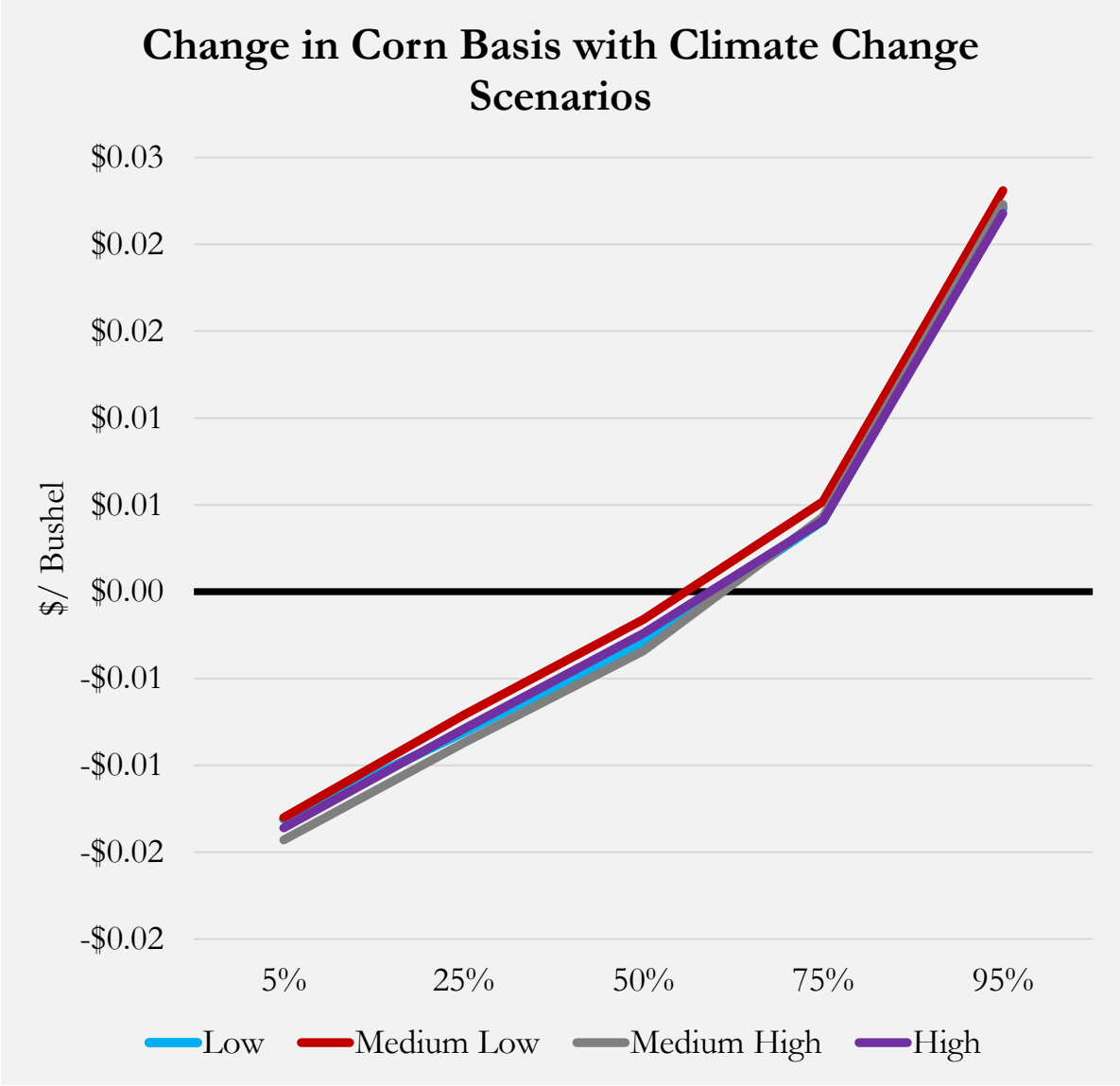
Historical Corn Basis (2008-2011)



Historical Corn Basis (2016-2020)



Step 2 &3 : Use Yield, Water Level, Ethanol.. To estimate Basis

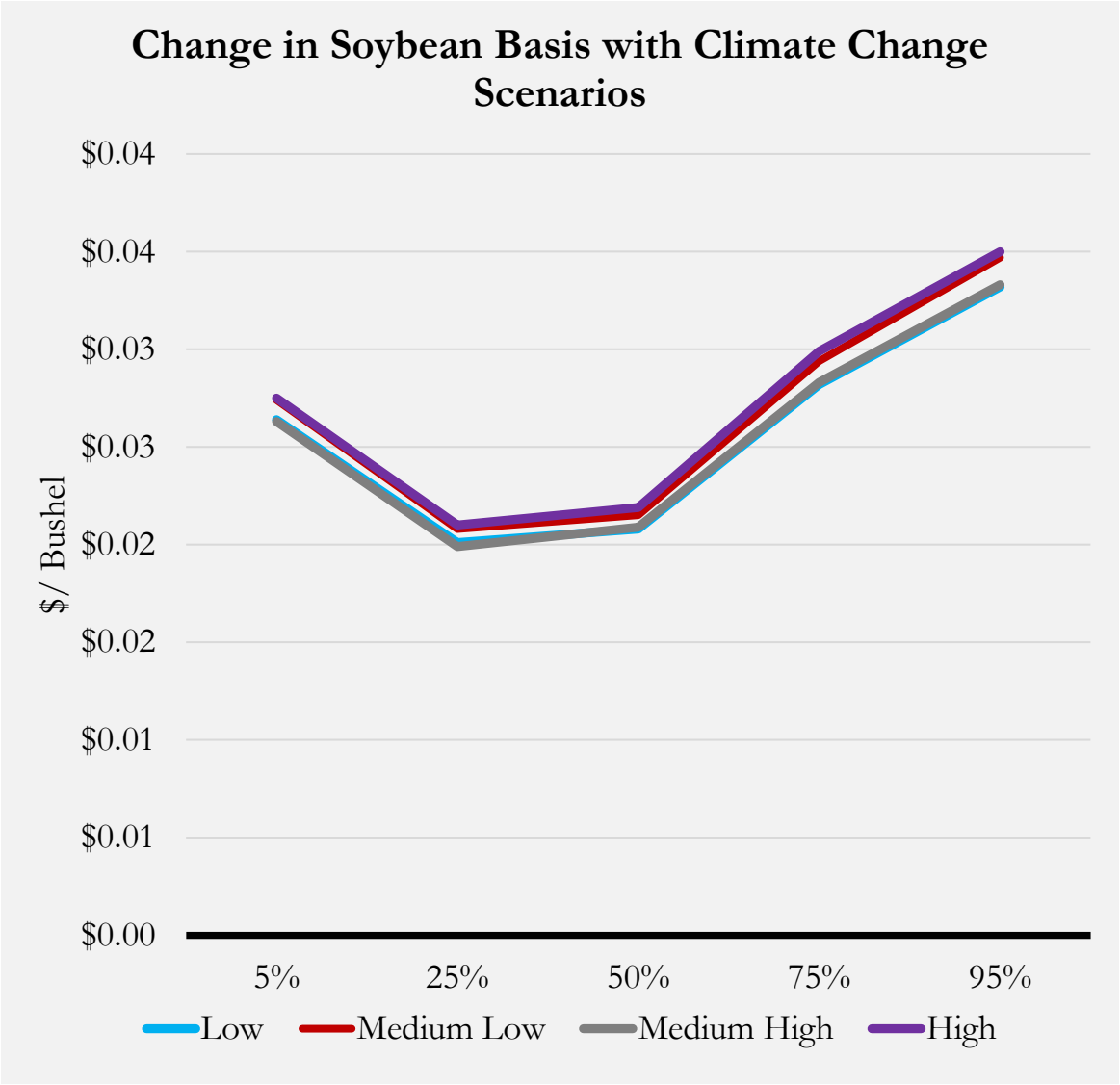


The distribution in basis across all four climate change scenarios gets wider.

Corn Basis	Low	Medium Low	Medium High	High
Temperature	0.00041	0.00061	0.00041	0.00071
Precipitation	-0.00059	0.00021	-0.00099	-0.00089
All	-0.00049	0.00051	-0.00089	-0.00049

Across our entire data set of 740,000 observations, at the median anticipated temperature changes increased corn basis spread while anticipated precipitation changes decreased basis spread.

Step 2 &3 : Use Yield, Water Level, Ethanol.. To estimate Basis

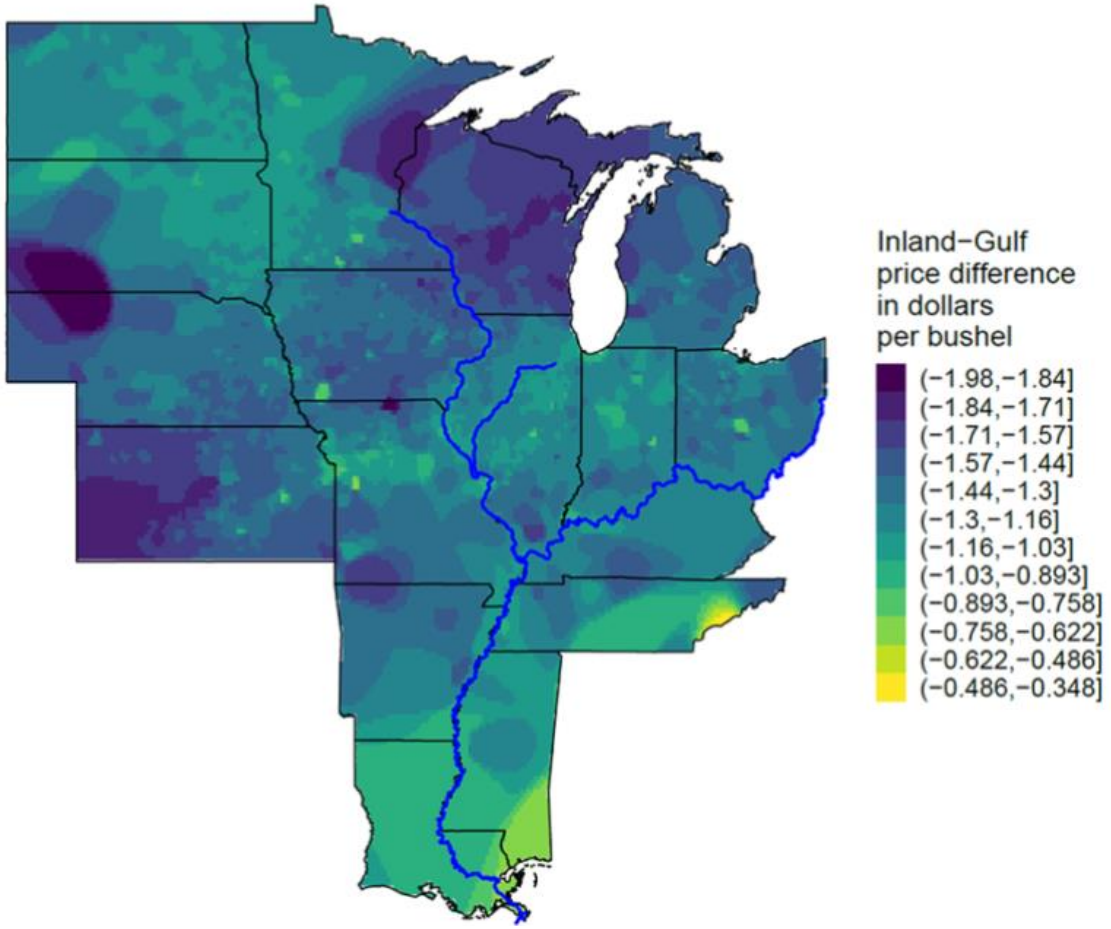


Soybean Basis	Low	Medium Low	Medium High	High
Temperature	0.02473	0.02563	0.02483	0.02623
Precipitation	0.02413	0.02433	0.02413	0.02413
All	0.02463	0.02563	0.02463	0.02593

Case Scenario: 2022 Low Water Level and High Regional Production

Differences Between Spot Prices and Gulf Export Bids by Location

Panel A. October 2021



Panel B. October 2022

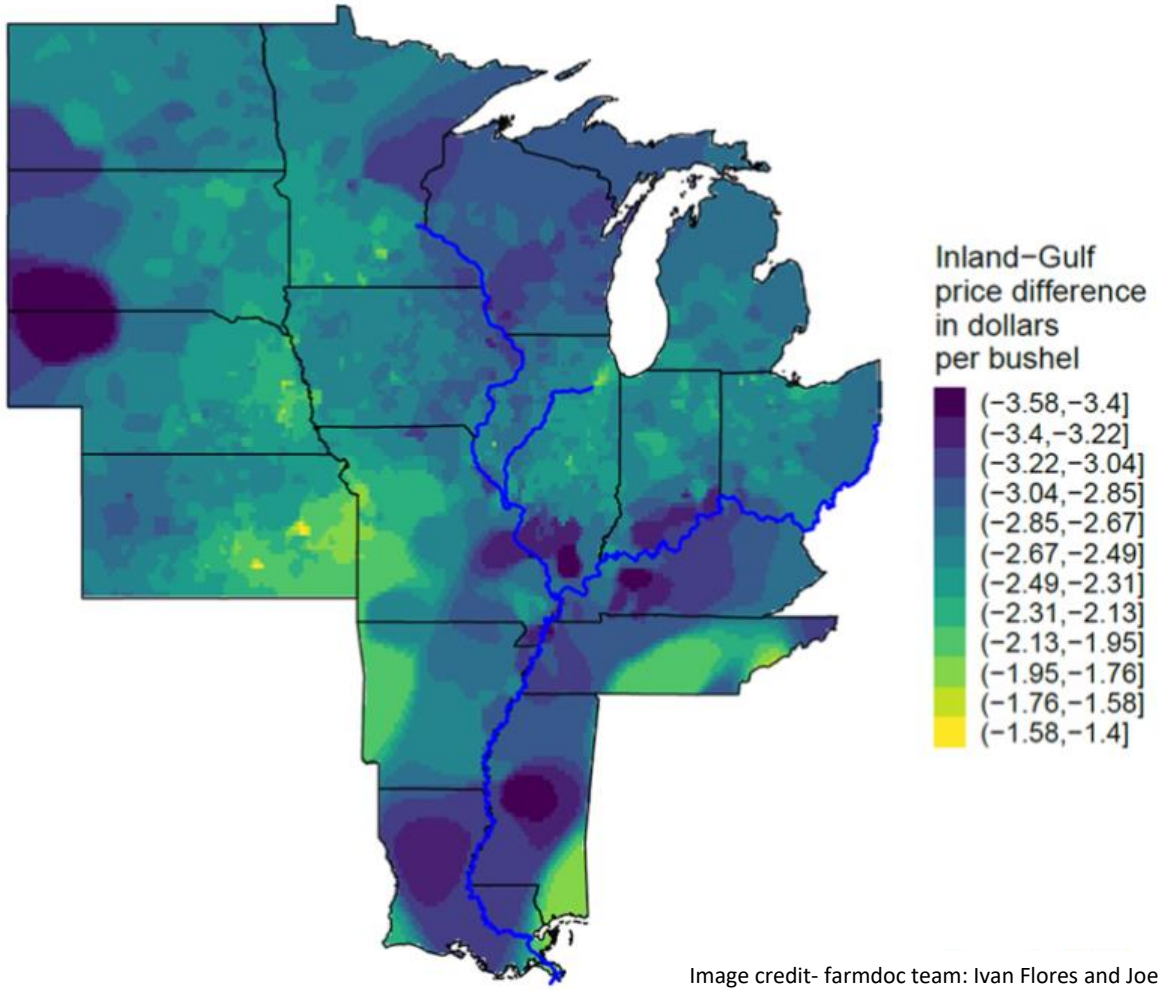


Image credit- farmdoc team: Ivan Flores and Joe Janzen April 3, 2023

Case Scenario: 2022 Low Water Level and High Regional Production

Figure 5. Change in October Spot-Gulf Price Difference by Location, 2022 minus 2021

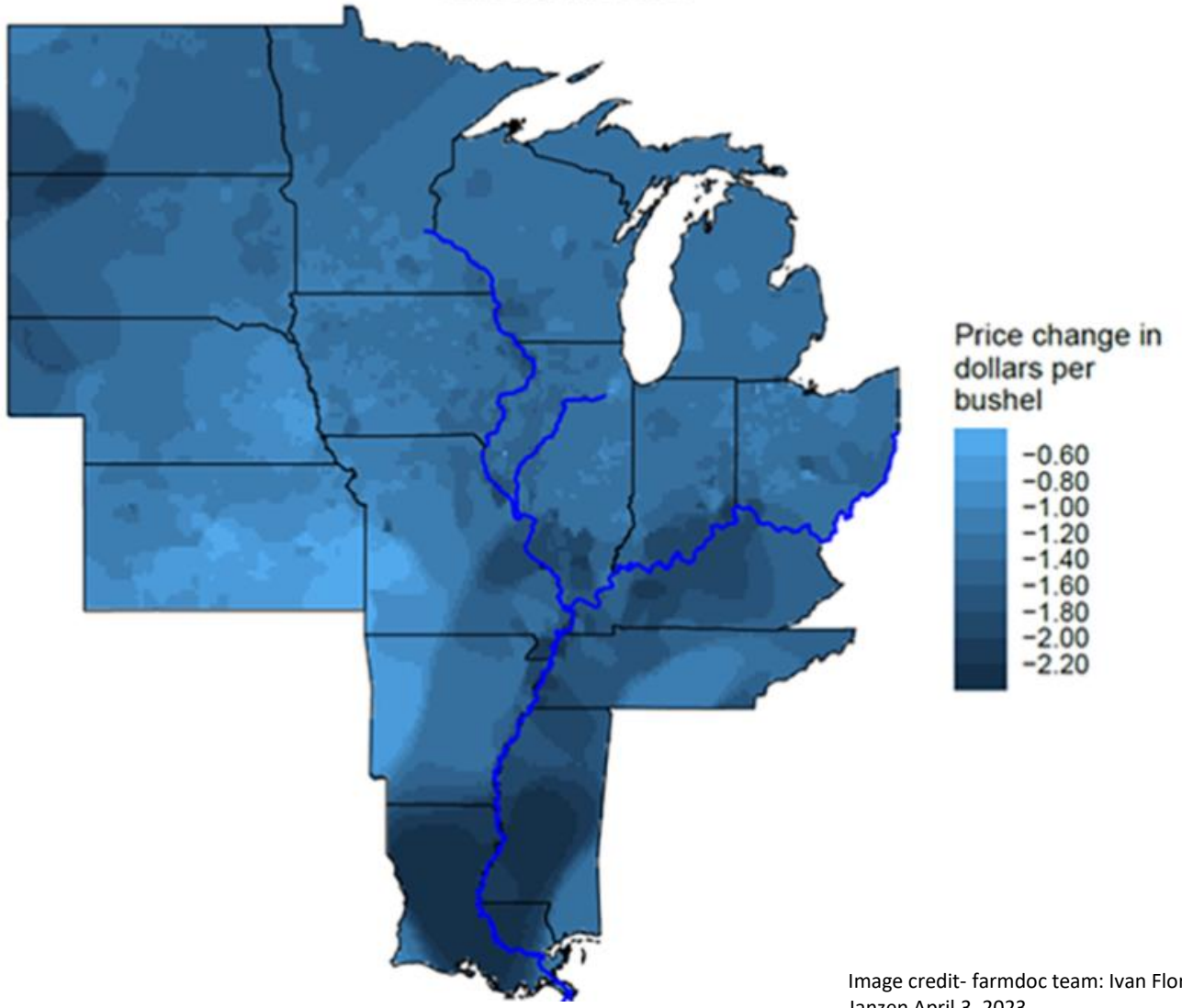


Image credit- farmdoc team: Ivan Flores and Joe Janzen April 3, 2023

Some Concluding Thoughts

Our study shows that increased temperature and precipitation does have an impact on corn and soybean basis across the Midwest.

1. Increased precipitation in the river basins does indeed increase the number of floods on the river given current infrastructure and decreases the number of days with "low" water.

2. Temperature has a larger impact on planting progress compared to precipitation.

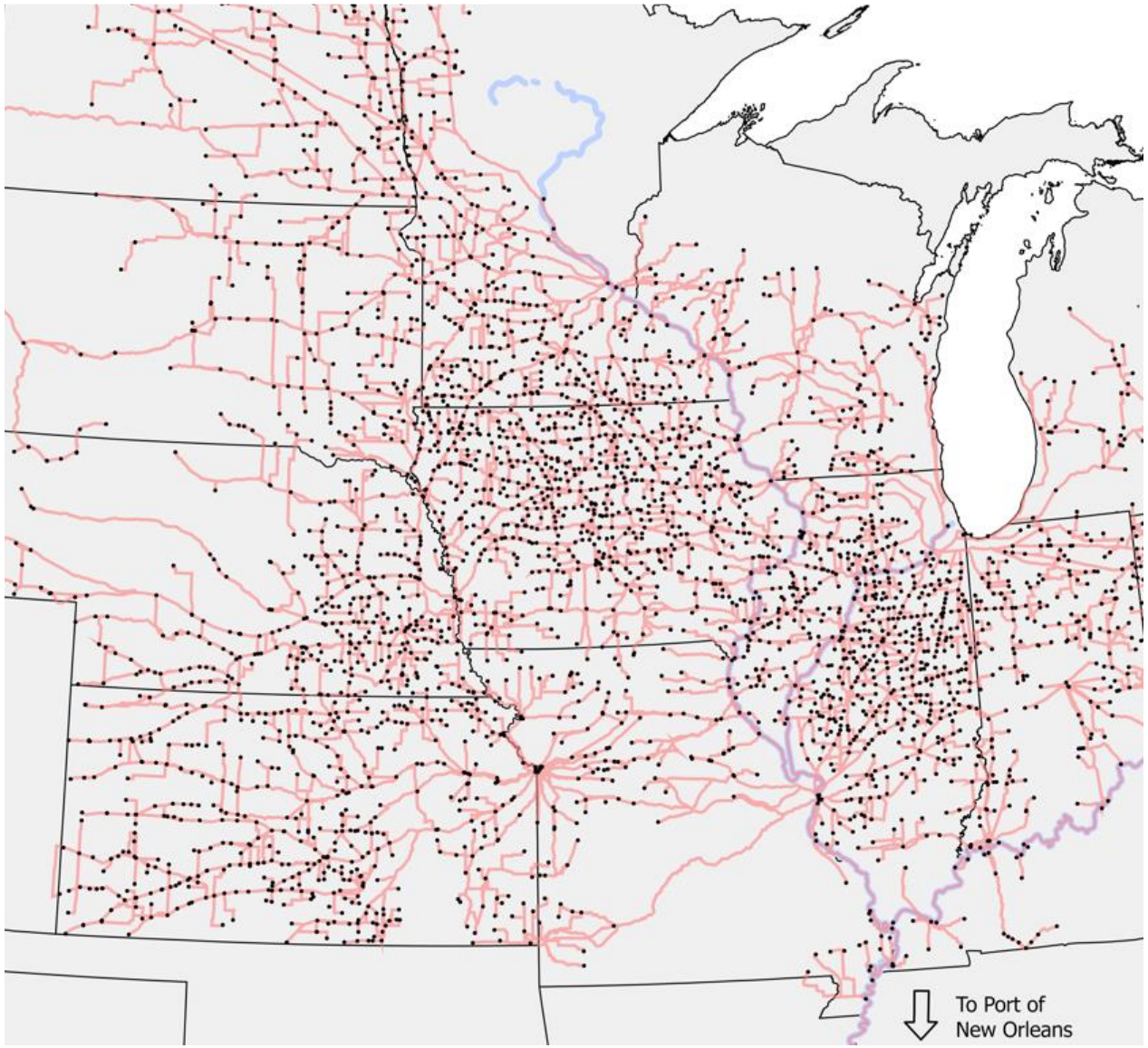
3. Climate change scenarios are estimated to increase corn yields (except the medium low scenario) at the median across the region while decreasing soybean yields.

4. Both corn and soybean basis distributions widen across the region. Local yields having the largest impact.

New Work: Disaster Disruptions

- Do disasters (storms, floods, other) disrupt flow of grains, increase system costs, and reduce local prices?

New Work: Hypothetical least-cost routes to New Orleans



- Road, rail, river routes

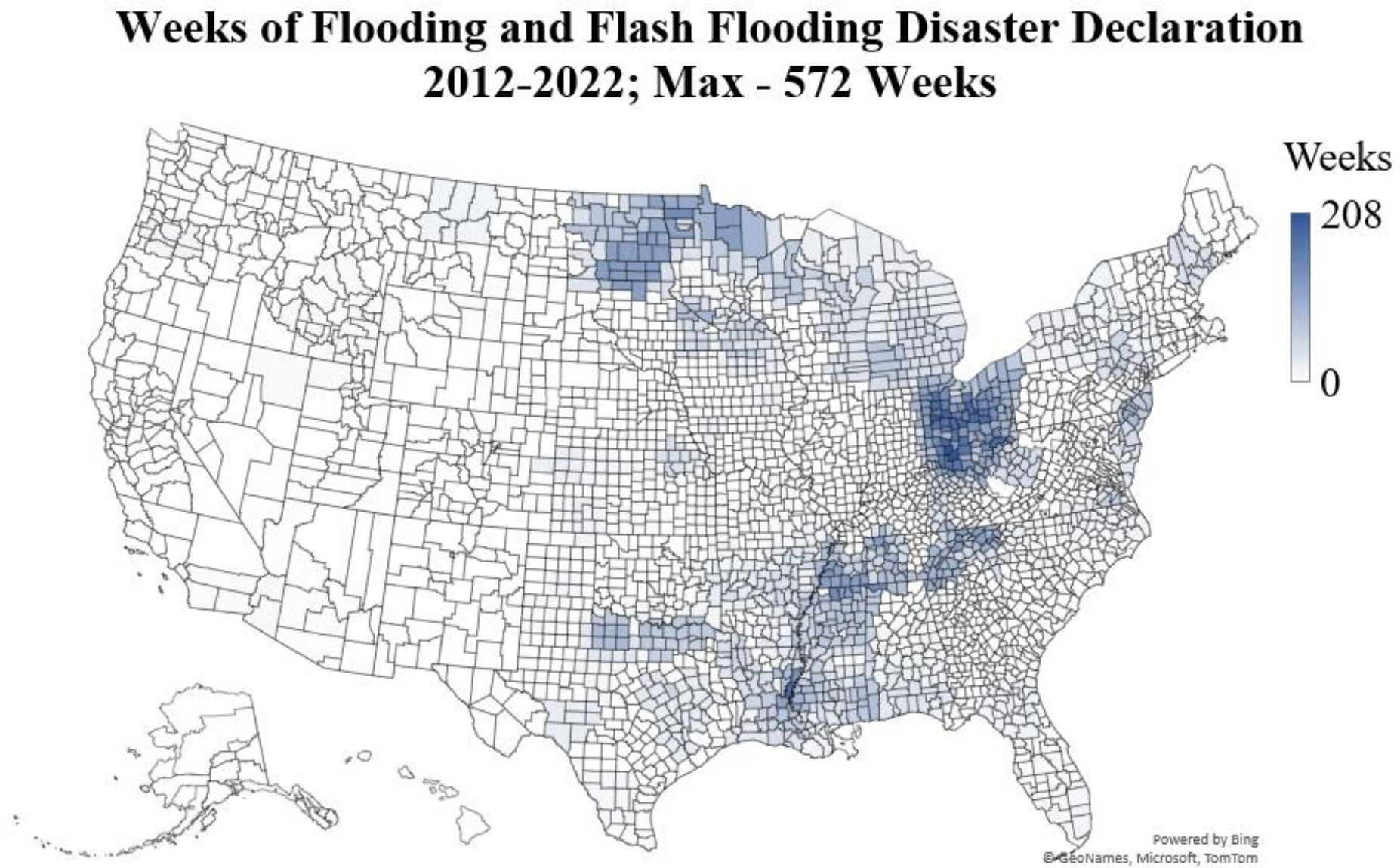
Notes:

Only to New Orleans

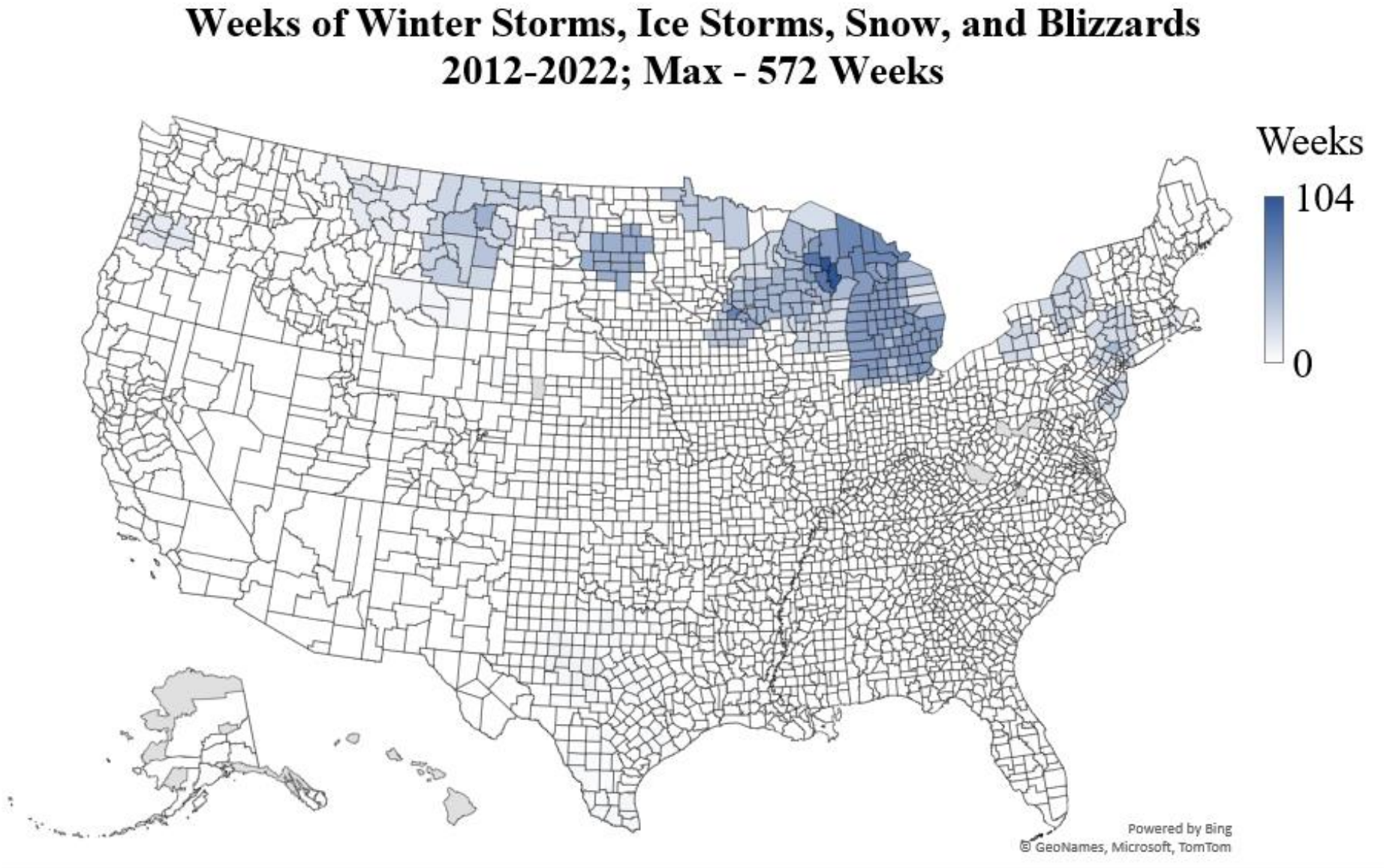
Hypothetical least-cost route

….

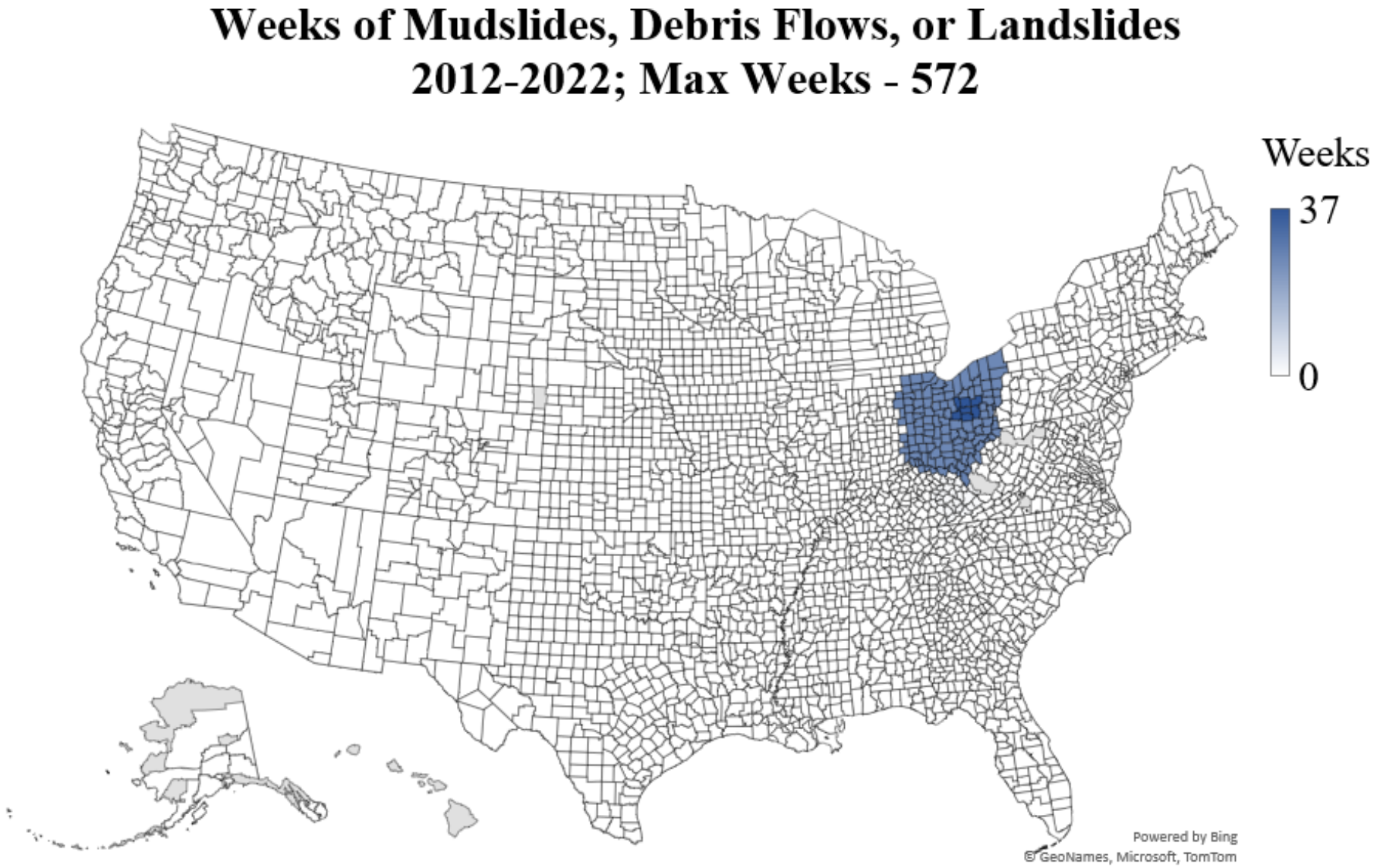
New Work: Disaster Disruptions- Floods



New Work: Disaster Disruptions- Winter Storms



New Work: Disaster Disruptions- Mudslides/ landslides



Thank you! Are there any questions??

Mizzou/Brownfield Market Information

- **Weekly Crop Markets-** Tuesday Afternoons
- **Weekly Livestock Markets-** Saturday Mornings

Ben Brown- University of Missouri
660-492-7574; bpbrown@missouri.edu @BenBrownMU