OHIO STATE UNIVERSITY EXTENSION

Adapting Agriculture to Extreme Weather

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In Conjunction with SARE
Carbon Energy and Climate Conference

THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

Outline

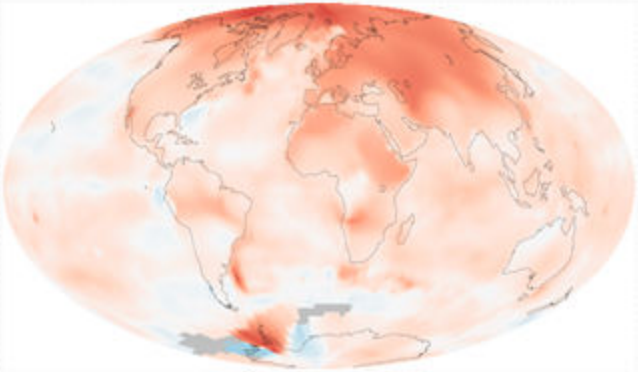
- Definitions and Glacier Data
- Attitudes on Climate Change/Extreme Weather
- Weather changes in USA
- Impacts of extreme weather on agriculture
- Adapting Agriculture to Extreme Weather

Adapted from Dr. Eugene Tackle, Iowa State

Climate vs. Weather

- Both deal with atmospheric conditions, such as temperature, cloud cover and precipitation'
- **Weather**
  - Shorter term such as hourly or daily variations of atmospheric events
  - Example: Today's high temperature was 70ºF
- **Climate**
  - Average "weather" over a longer period of time
  - Example: Last decade was the warmest decade on earth

Global Warming



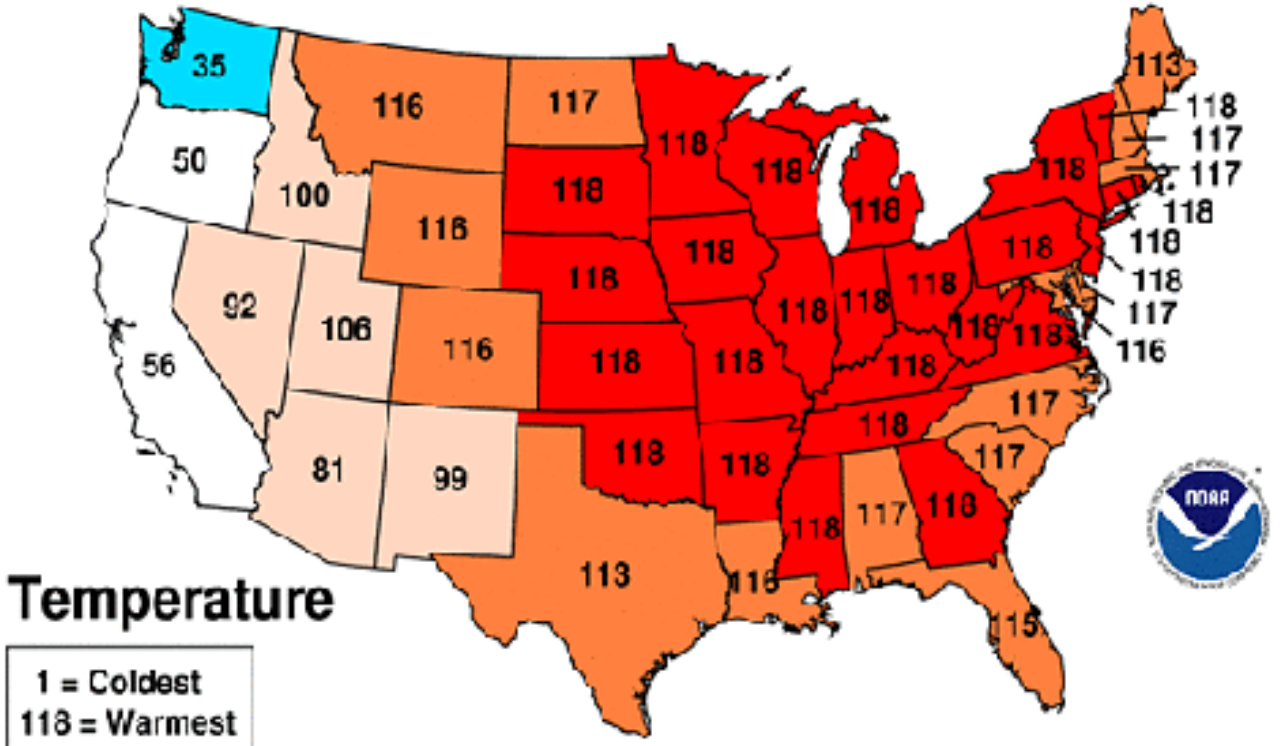
- Increase in the average temperature due to increased concentrations of greenhouse gases in the atmosphere.

Climate Change

- Changes in climate variables such as precipitation, snow, and wind patterns, sea level, extreme events in addition to temperature changes.

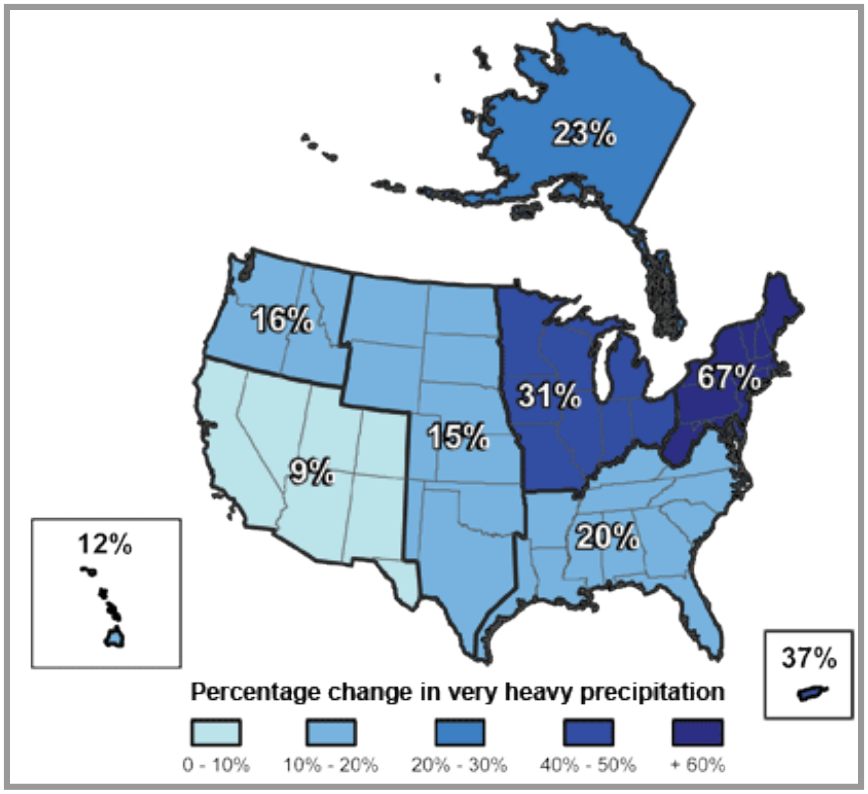
March 2012 Statewide Ranks

National Climatic Data Center/NESDIS/NOAA



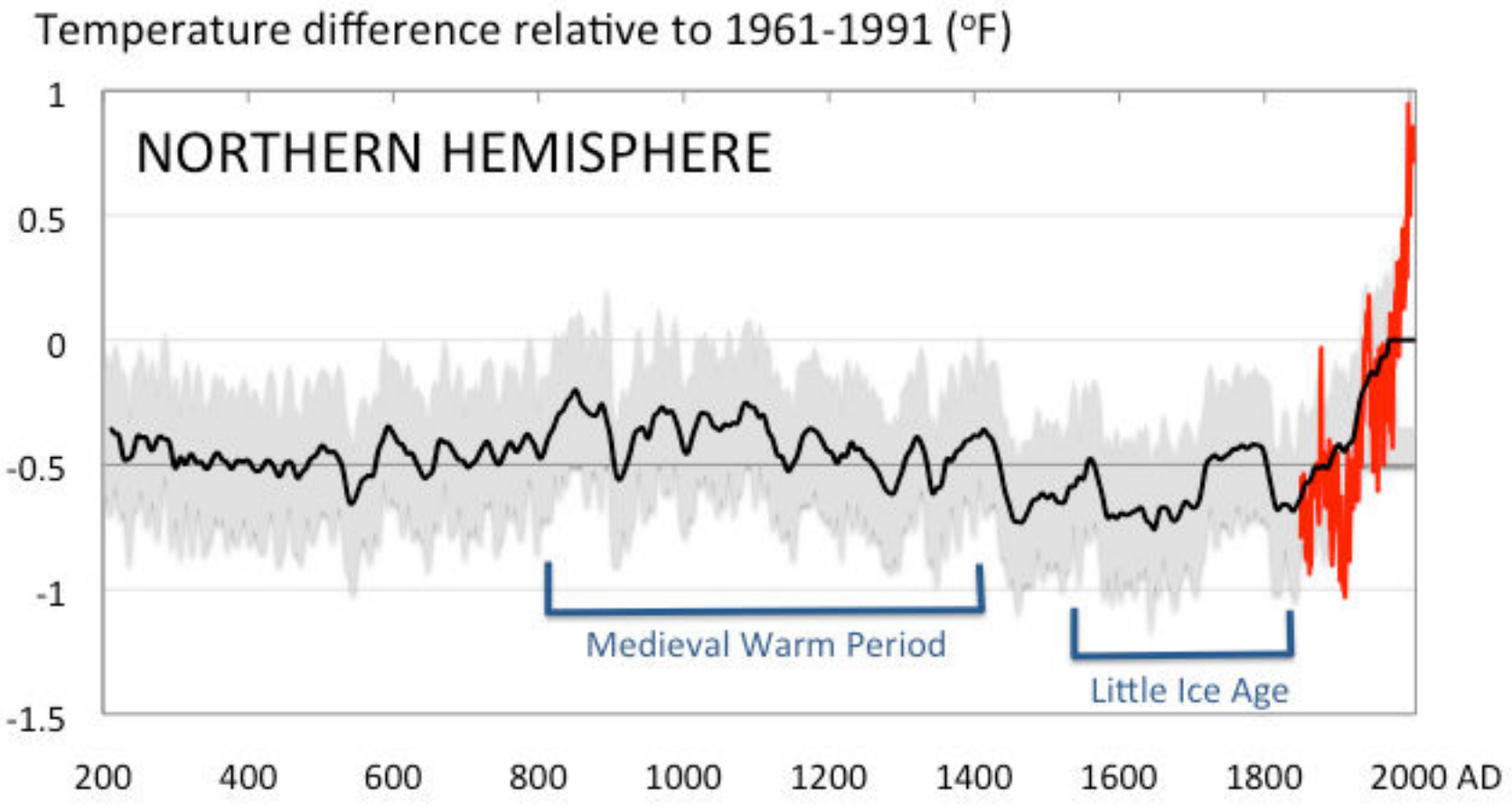
Extreme weather changes are underway in the U.S. and are projected to grow

- Temperature rise
- Increase in heavy downpours
- Rapidly retreating glaciers
- Lengthening growing season
- Lengthening ice-free season in the ocean and on lakes and rivers
- Earlier snowmelt
- Changes in river flows
- Plants blooming earlier;
  animals, birds and fish moving northward



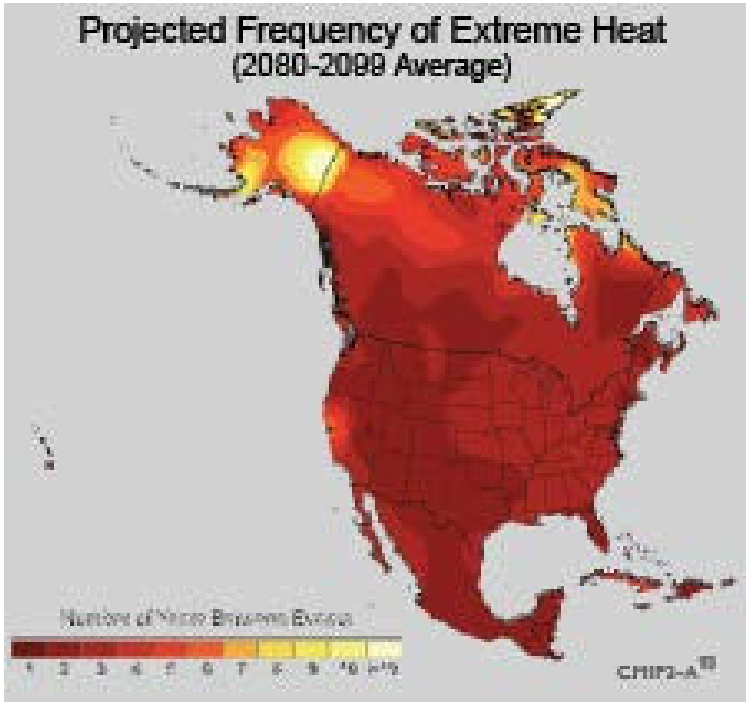
Don Wuebbles

Conditions today are unusual in the context of the last 2,000 years …



Extreme weather events become more common

- Events now considered rare will become commonplace.
- Heat waves will likely become longer and more severe
- Droughts are likely to become more frequent and severe in some regions
- Likely increase in severe thunderstorms & tornadoes.
- Winter storm tracks are shifting northward and the strongest storms are likely to become stronger and more frequent.



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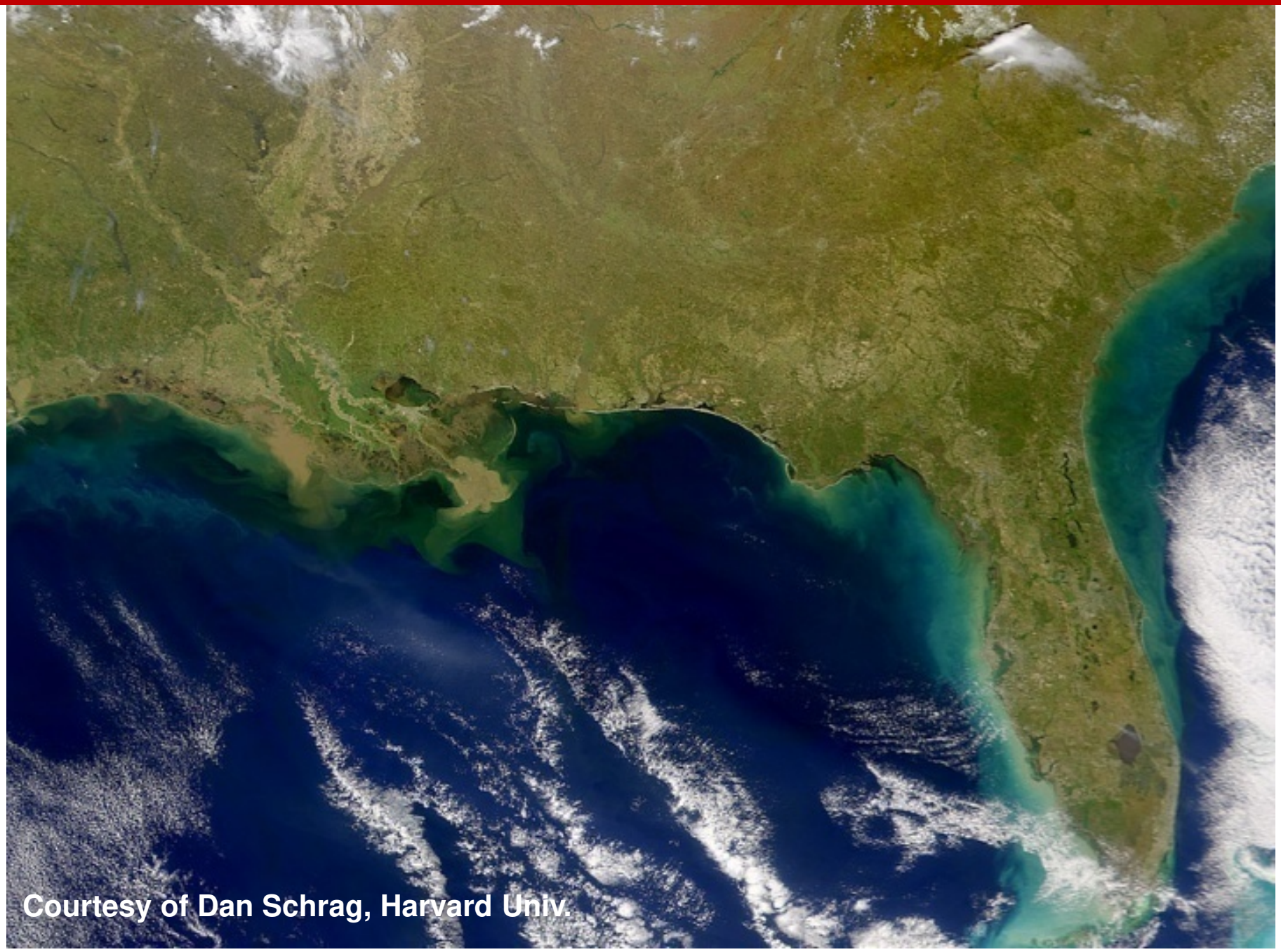
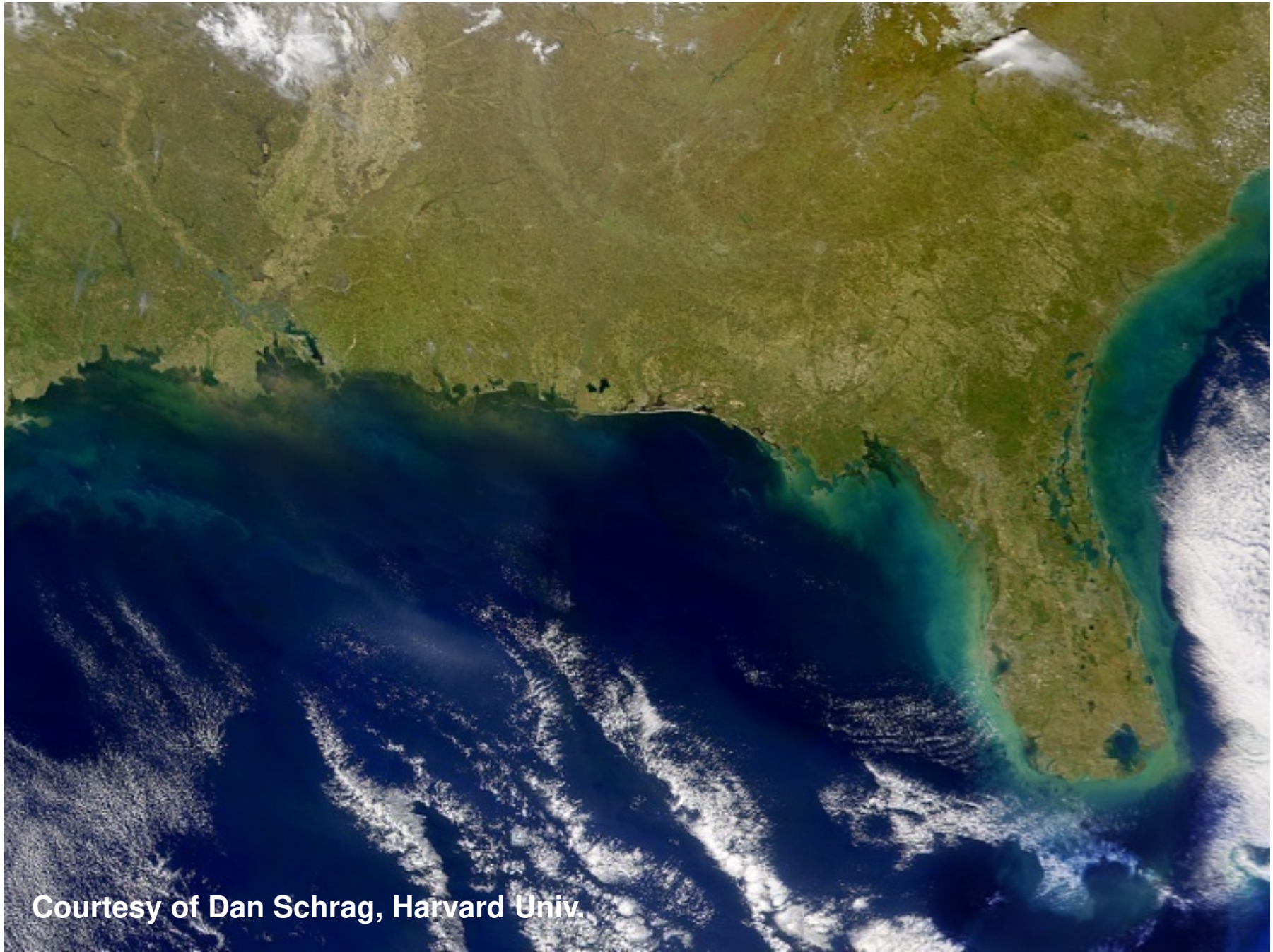
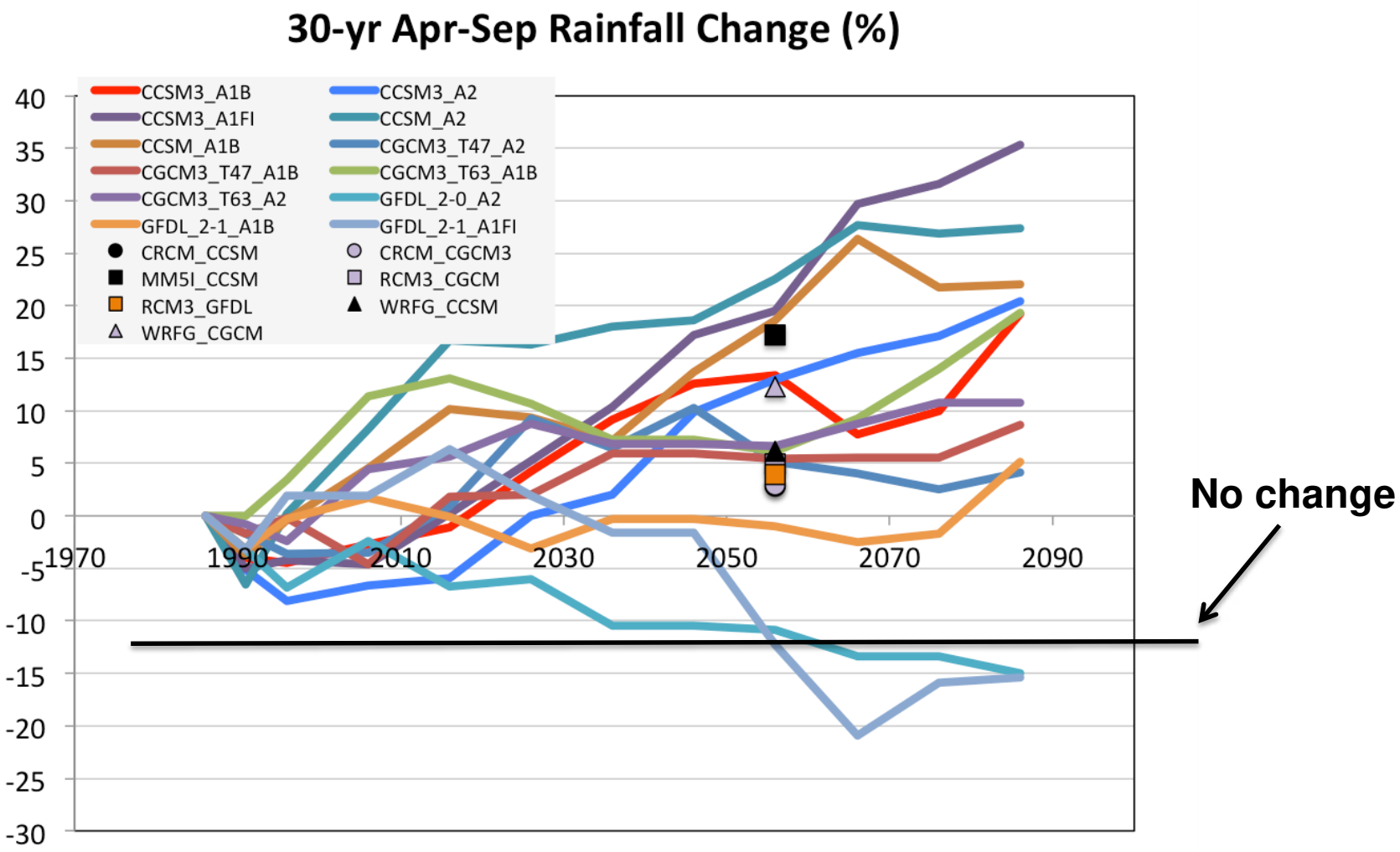

Courtesy of Dan Schrag, Harvard Univ.


Courtesy of Dan Schrag, Harvard Univ.

First ever F-5 tornado (winds > 261 mph) in Canada

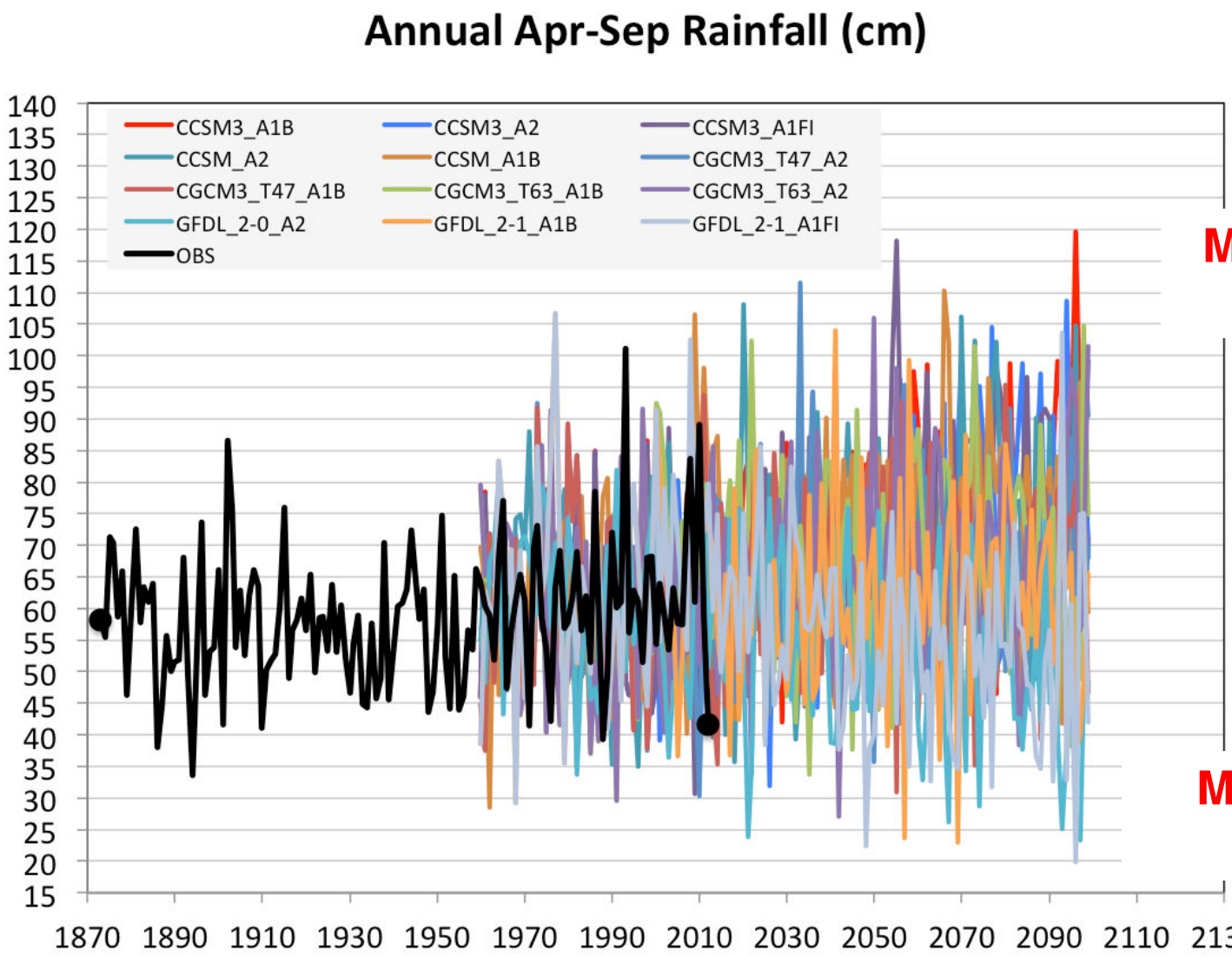
Elie, Manitoba, June 22, 2007

Change in Growing Season Precipitation



CJ Anderson, ISU

Future Variability in Growing Season Precipitation

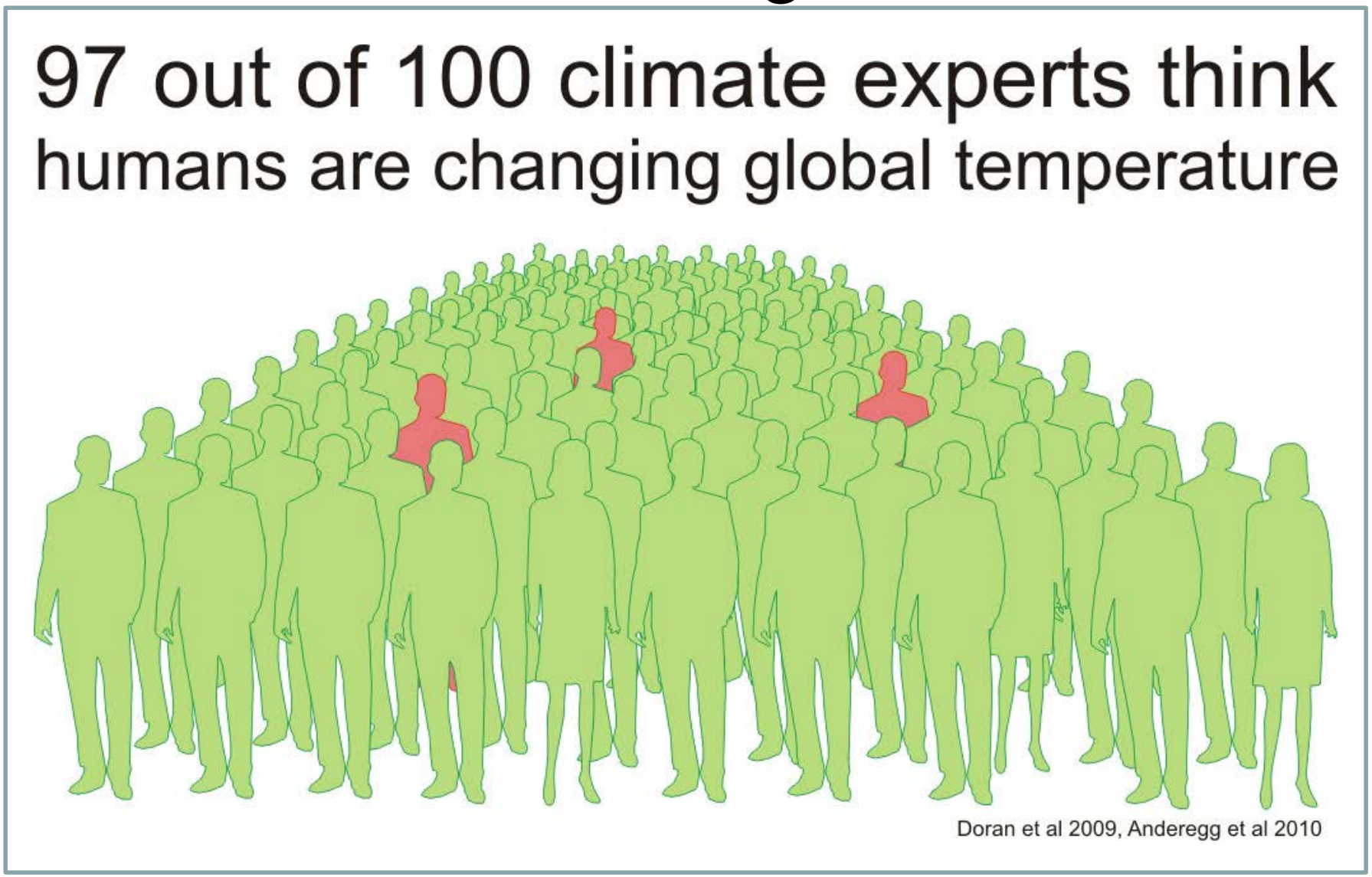


More extreme floods

More extreme droughts

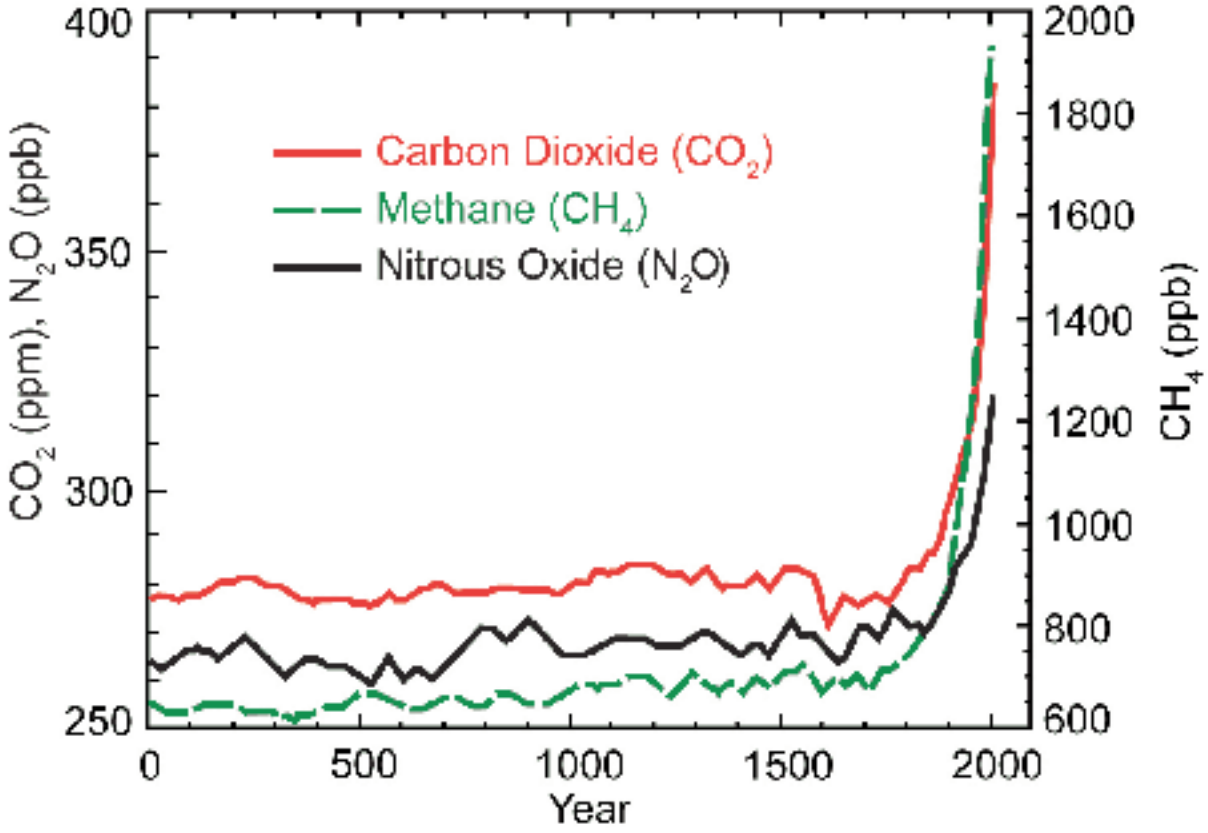
CJ Anderson, ISU

Climate Change is Real



http://www.cooldavis.org/about/science-of-climate-change/

Carbon Dioxide Increases



GWP = 1
GWP = 72
GWP = 310

Look at Past History

- Ice ages with Glaciers 3-5 miles high in North America, CO_2 = 180 PPM.
- Tropical Period when there were Palm Trees in Artic Circle, CO_2 = 280 PPM
- What is the CO_2 levels today?

  390 PPM CO_2 in Atmosphere

PBS Show on Climate Change

C3 versus C4 plants

Corn is a C4 plant-Expect little to no change in yield.

Soybeans and wheat are C3 plants. Expect about a 14% increase in soybean yields.

C3 plants are likely to respond better to higher CO_2 levels than C4 plants.

Climate Change and Ag. Productivity:
Direct Impacts, Midwest Region

- Primary historical climate yield determinant has been the magnitude and timing of plant available moisture
- Recent research suggests increasing temperatures (esp. nighttime) will play an increasingly important role
- CO_2 enrichment
- Occurrence of extremes

Adapting to Extreme Weather

Longer growing season: plant earlier, plant longer season hybrids, harvest later

OR

Plant the same or early to medium maturity hybrids and add a cover crop to increase carbon in the soil. Yield is related to moisture more than crop maturity.

Adapting to Extreme Weather
Wetter Springs

Wetter springs: larger machinery enables planting in smaller weather windows. More equipment and hired help to plant in a shorter time period.

OR

Use cover crops and controlled traffic to dry the soil through evapotranspiration with firmer soils and timely planting due to controlled traffic.

Wetter Springs

Futurist are already experimenting with GPS and auto-steer and robots.

We may possibly see smaller lighter equipment (3-4 rows) operated remotely using robotics which decreases the weight and compaction factor and may operate 24 hours per day.

Adapting to Extreme Weather

- Higher humidity: more spraying for pathogens favored by moist conditions. more problems with fall crop dry-down, wider bean heads for faster harvest due to shorter harvest period during the daytime.
- OR More robotic harvesters with smaller grain heads that operate continuously. Controlled traffic and cover crops could increase time for harvesting crops if soil conditions improve.

Why Small Changes in Rainfall Produce Much More Flooding

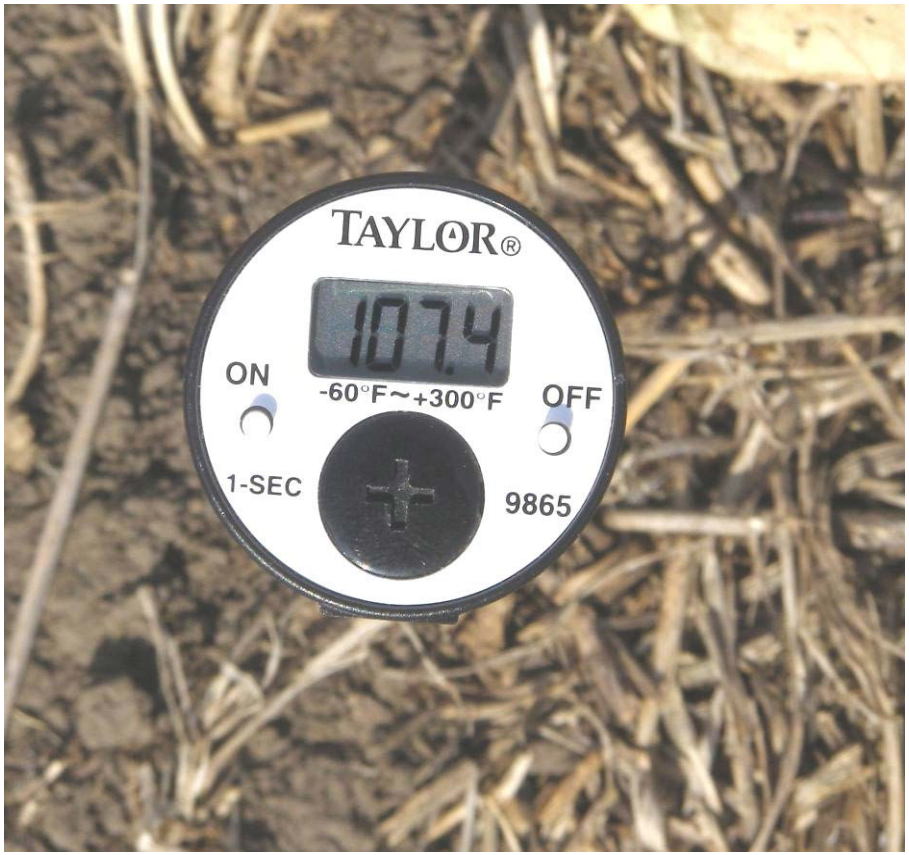
- 13% increase in atmospheric moisture in June-July-August
- ~10% increase in average precipitation in Midwest
- ~5-fold increase in high-precipitation events, mostly in June-July-August, that lead to runoff
- More frequent floods are the result of :
  - **More rain**
  - **More intense rain events**
  - **More rain in the summer**
  - **Streams amplify changes in precipitation by a factor of 2-4**

8” Rain in Iowa (2012)

Photo courtesy of RM Cruse

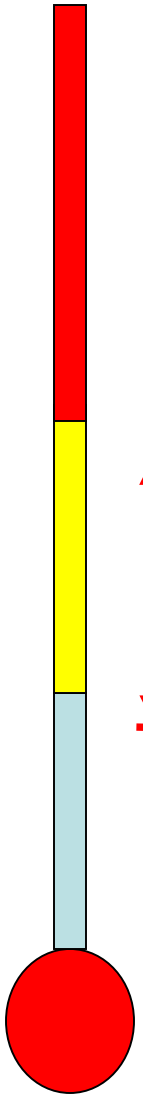
Soil Temperature Differences

Conventional /No-till??



No-till + Cover Crops & Live Plants

When soil temperature Reaches...



140 F — Soil bacteria die

130 F — 100% moisture is lost through evaporation and transpiration

113 F — Some bacteria species start dying

100 F — 15% of moisture is used for growth
85% moisture lost through evaporation and transpiration

95 F

70 F — 100% moisture is used for growth

J.J. McEntire, WUC, USDA SCS, Kernville TX, 3-58 4-R-12198. 1956

For Hot Dry Summers??

For Corn Production:

75 degrees Fahrenheit – 1 Inch water/week

85 degrees Fahrenheit – 2 inch water/week

95 degrees Fahrenheit – 4 inch water/week

2X Water requirements for every 10F increase

1” Rain = 8 bu. corn, 22” needed for 200 bu. Corn

Rain = 19-23 inch/year in growing season

Heat and drought quickly increase yield losses!

By Elwynn Taylor, Iowa Ag. Climatologist

Adapting to Extreme Weather

- Expect more variability in moisture from year/year.
- More summer precipitation: higher planting densities for higher yields.
- Wetter springs and summers: more subsurface drainage tile is being installed, closer spacing.
- May use sub-irrigation and controlled drainage to control and manage water efficiently, to save water.
- If water is short, may increase need for irrigation during drought or dry periods.

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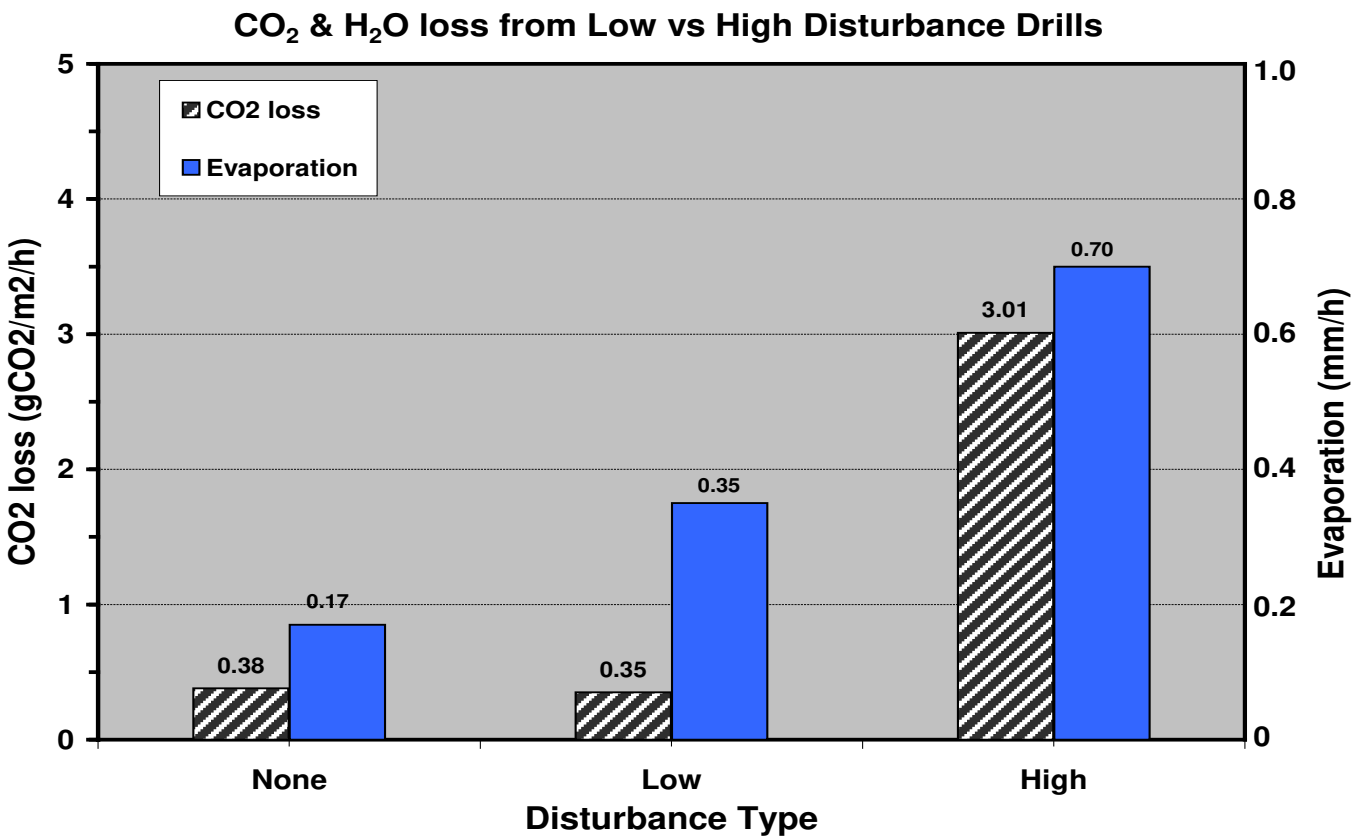
Intense Tillage



How do we manage tillage?

- Need to reduce tillage to avoid soil drying
- The more variable precipitation the more critical tillage management will become in order to maximize the soil water for the crop
- Water is the most limiting nutrient for crop yields. What is the best way to increase water holding capacity? ADD Soil organic matter or increase carbon content.

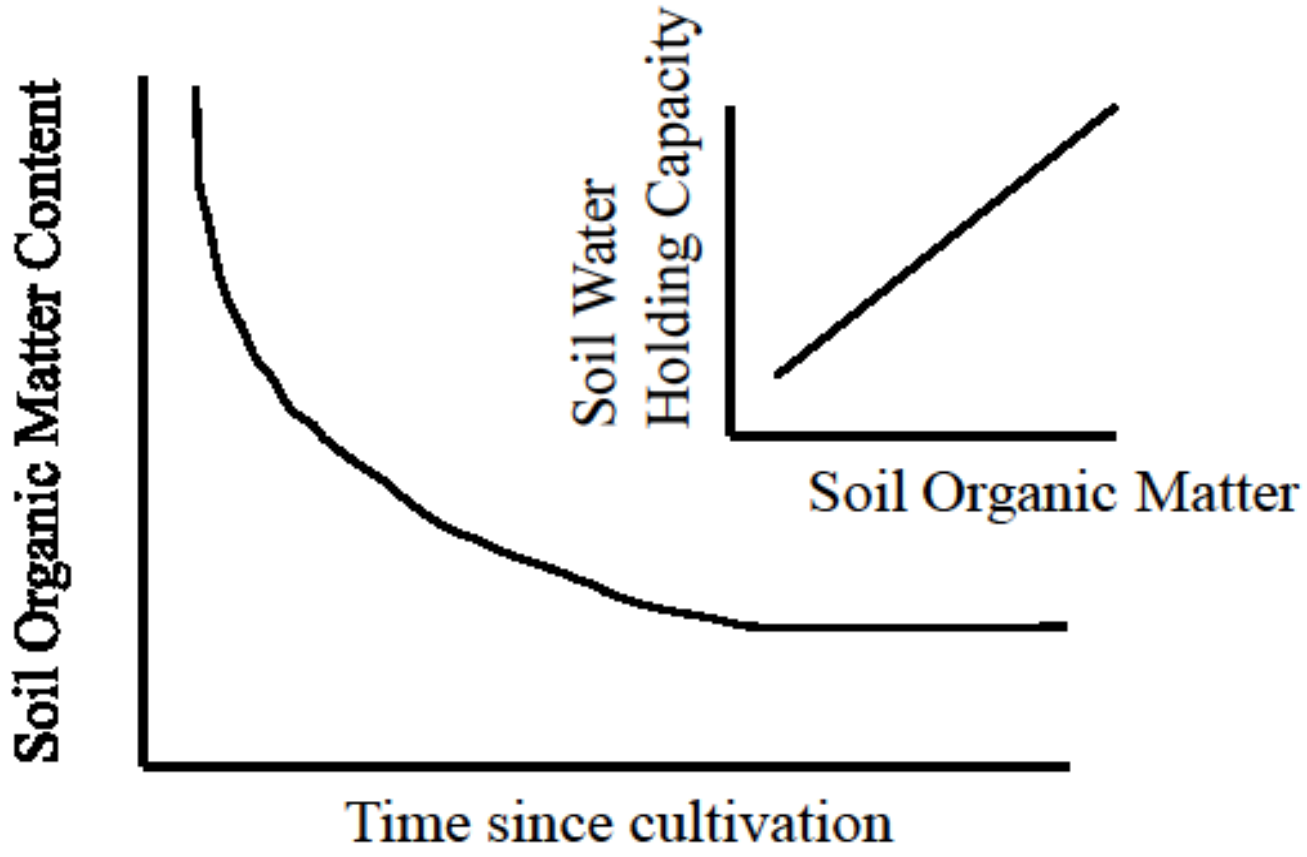
How can you thrive in adverse weather?

- Increase soil water holding capacity through increases in soil organic matter
- Maintain crop residue to moderate the soil microclimate and decrease the evaporation component. Maximize the water moved through the roots into the plant
- Adjust management of the crop, e.g., planting to avoid periods of high stress

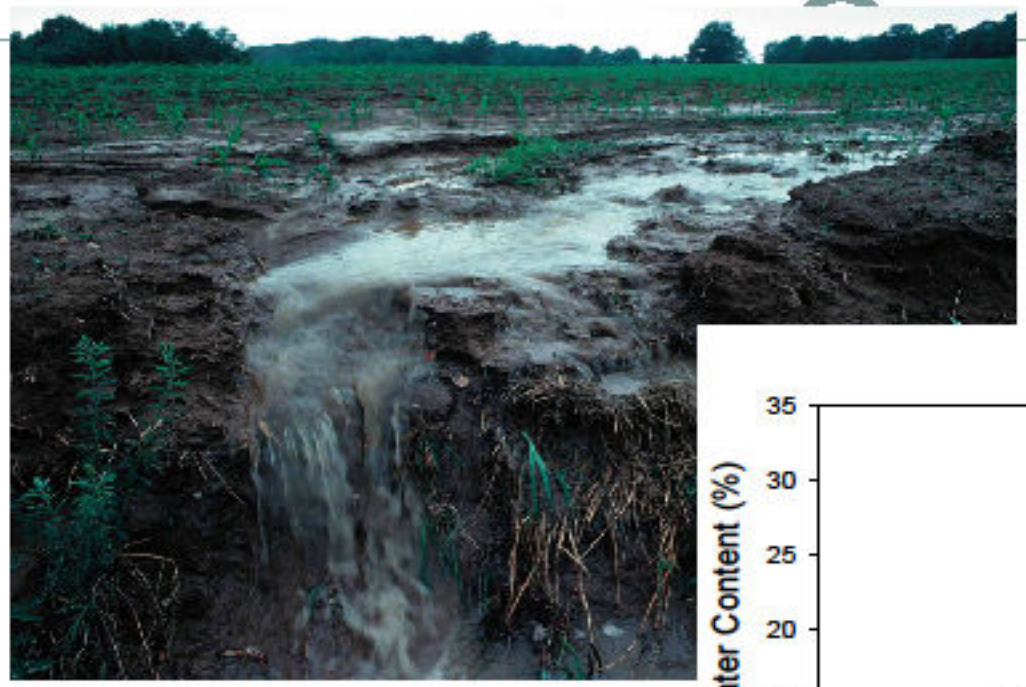
No-Till Enhances Water Use Efficiency

- Short-term
  - Increase and maintain infiltration rates
  - Decrease soil water evaporation rates
- Long-term
  - Increase soil organic matter leading to soil water holding capacity
  - Improved soil environment

Current State of Agricultural Soils

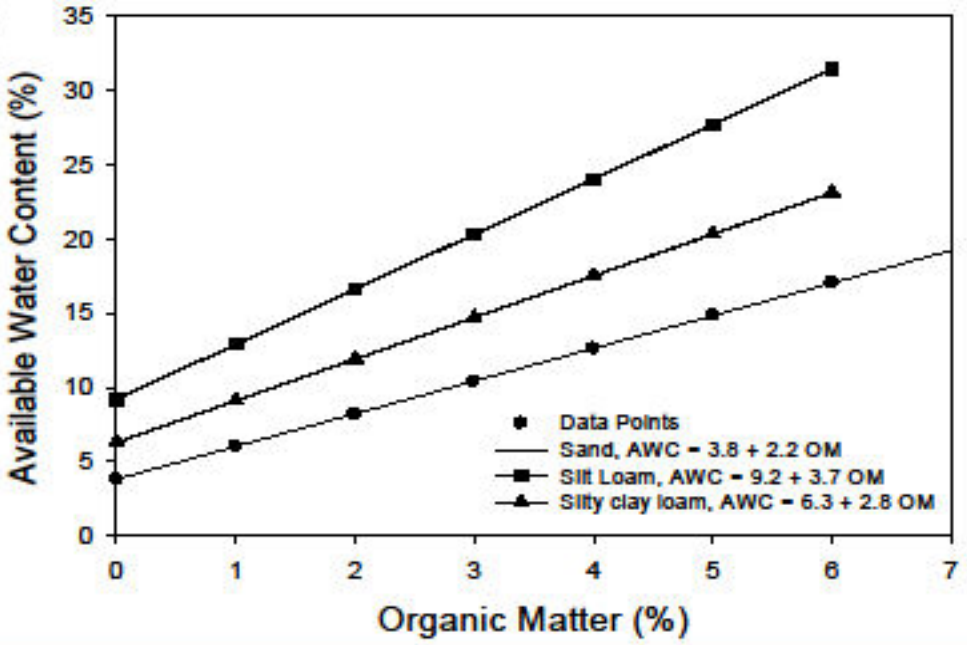


Soil Erosion



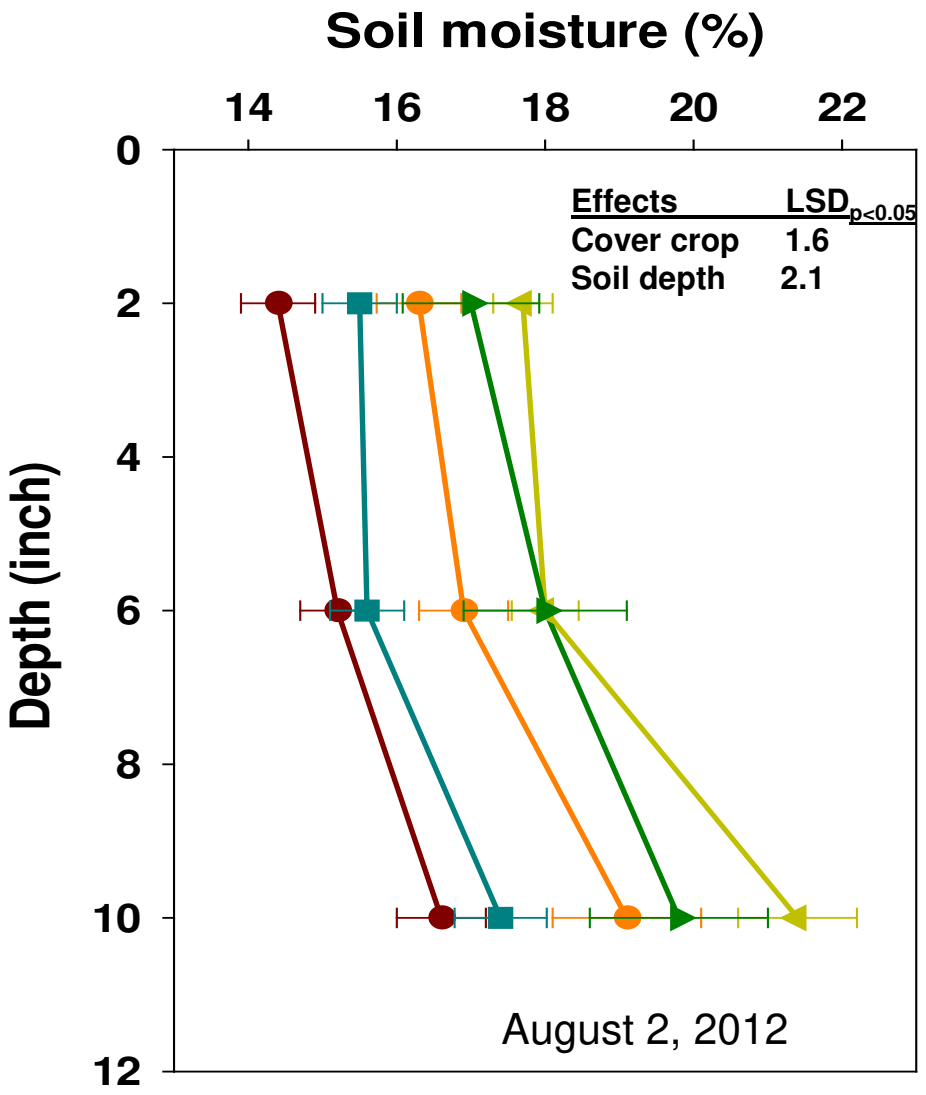
Degrading the soil resource decreases the water holding capacity

Hudson, 1994



Effects of mixed cover crops in continuous no-till on **soil moisture storage** under corn-soybean-wheat rotation (Islam, 2013)

- NT = No-till (control)
- NTcc1 = No-till cover crop mix-1
- NTcc2 = No-till cover crop mix-2
- NTcc3 = No-till cover crop mix-3
- NTcc4 = No-till cover crop mix-4



CC Increases Soil moisture 2-3 inches

1 Inch additional water = 8 bu. Corn, 3.5 bu. Soybean, and 6 bu. Wheat

Adapting to Extreme Weather

- Waterlogged soils in spring: shallow root system more prone to disease, nutrient deficiencies and drought later on; delayed planting
- More frequent rains: delayed fertilizer application
- More intense rain events: more soil erosion
- Solution: Plant cover crops to improve soil structure, water infiltration, and water holding capacity. Cover crops also tie up soluble soil nutrients and carry them forward.

Adapting to Extreme Weather

Water quality issues: loss of nitrate and phosphorus fertilizer, more sediment, runoff from manure application

Solution: use cover crops and no-till to improve soil structure, water infiltration, and nutrient uptake.

Adapting to Extreme Weather

- Will change insect, weeds, diseases, and soil microbes.
- Warmer winters affects grains storage and insect and pest survival, changes populations.
- May change the efficiency and persistence of herbicides (volatility) and fungicides.
- Warmer summers affect algae blooms.
- More stress on workers & livestock in summer if temperatures increase= more air conditioning needed.

Solution: Adapt with new crops, new varieties, new technology.

Our soil resources are being taxed more with the rapidly increasing population, as a result, soil degradation will take place much faster than ever before.

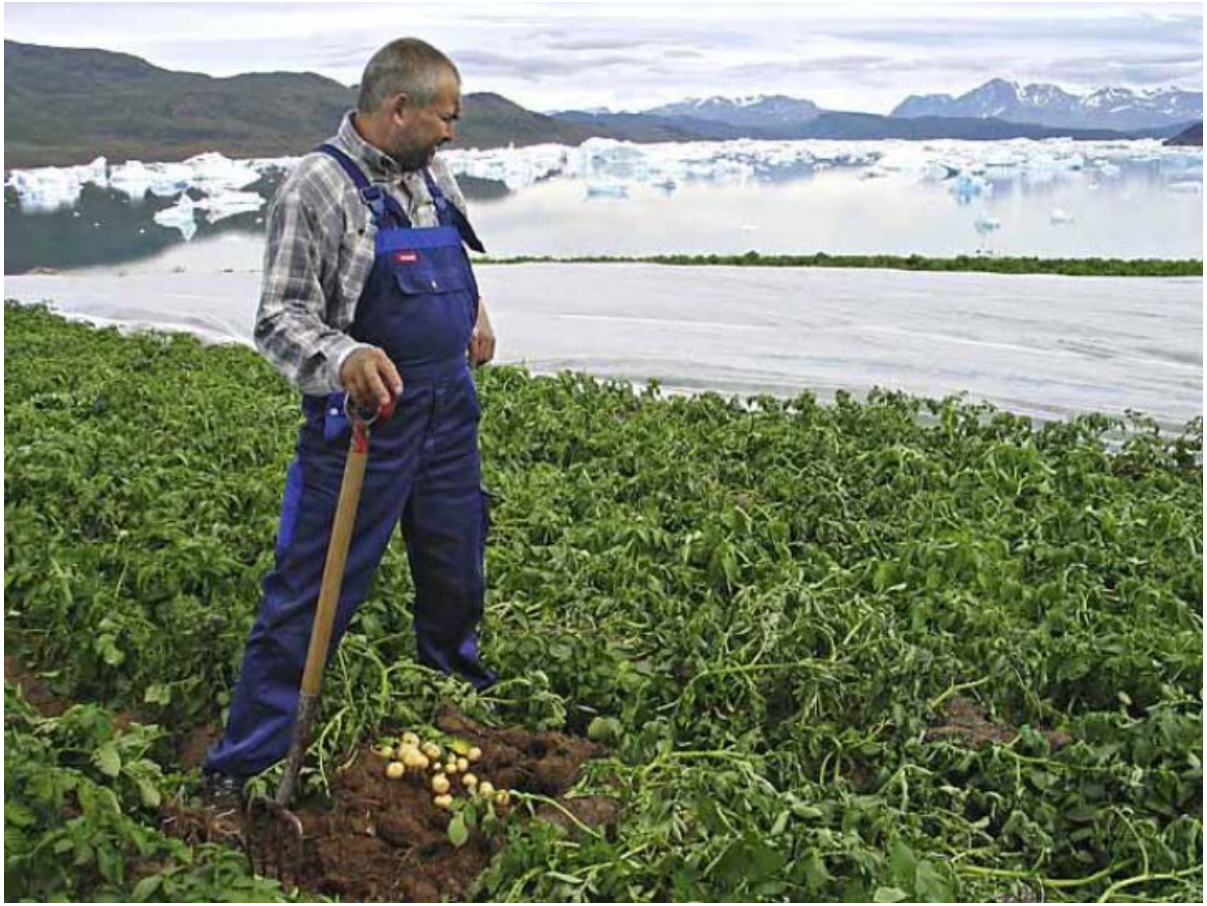
Very thin, fragile atmosphere.

7,018,456,957 people

Very thin, fragile soil.

Carbon is Critical!

New Greenland Potato farmer



Think about how you can grow cotton and rice!

Summary

- Warmers and wetter mean temperatures in Midwest could mean increased crop yields.
- However, warmer weather, droughts, wetter springs could increase crop yield variability.
- Expect higher night temperatures in the summer and more rainfall in the winter.
- Expect a mix of beneficial and adverse weather conditions in the future with much more variability.
- Humans, Animals, Plants, Microbes will need to adjust to extreme weather events.

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YouTube Video
Bacteria at Root

Bacteria at root.mov.wmv