

# Genesee/Finger Lakes Severe Weather and Climate Change Impacts

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Building a Weather-Ready Nation

## MISSION

Provide weather, water, and climate data, forecasts and warnings to protect life and property and enhance the national economy

## VISION

A Weather-Ready Nation:  
Society is Prepared for and  
Responds to Weather-  
Dependent Events



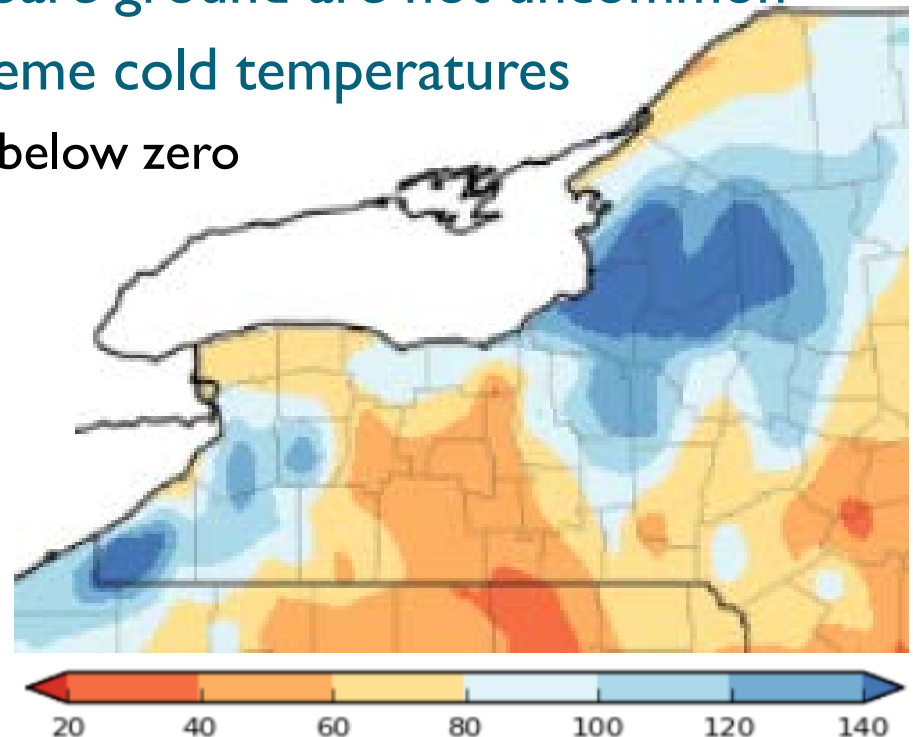


# Seasonal Conditions

# Winter

- ▶ Generally cloudy, cold and snowy
  - ▶ May include frequent thaws and rains
  - ▶ Snow mainly covers the ground from Christmas through early March however periods of bare ground are not uncommon
  - ▶ Lake Ontario modifies extreme cold temperatures
    - ▶ On average about ten nights below zero

Average Annual  
Seasonal Snowfall



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**ACIS**  
Regional Climate Centers



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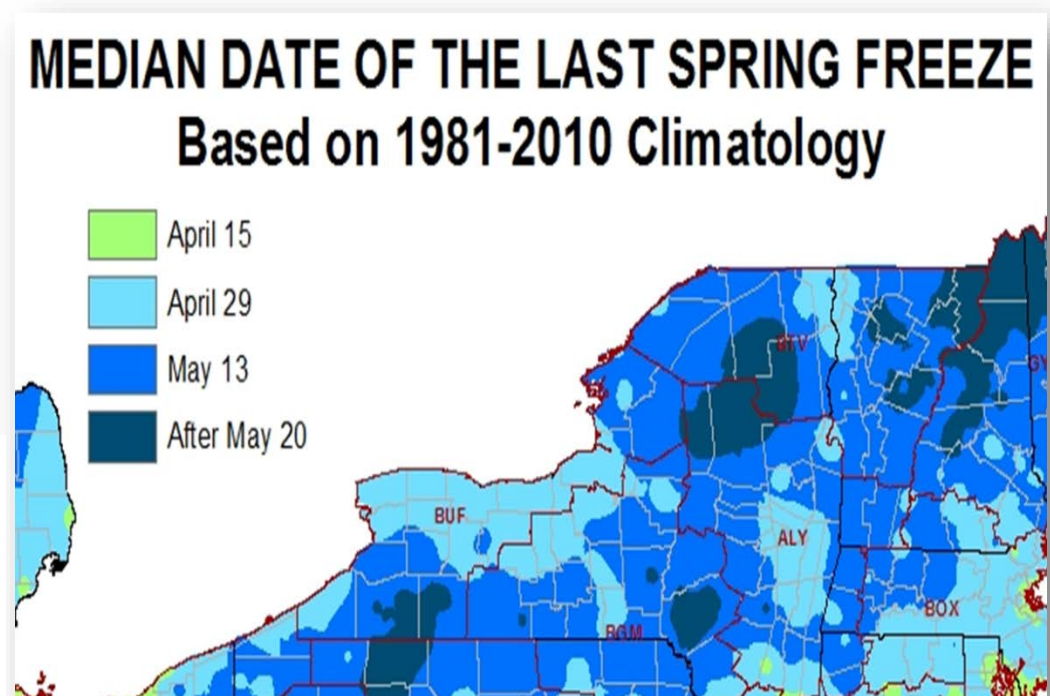
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# Spring

- ▶ Spring comes slowly to the region
- ▶ Last frost usually late April/early May
- ▶ Spring months are the driest statistically
  - ▶ Due in part to the stabilizing effects of Lake Ontario
- ▶ Sunshine increases markedly in May



# Summer

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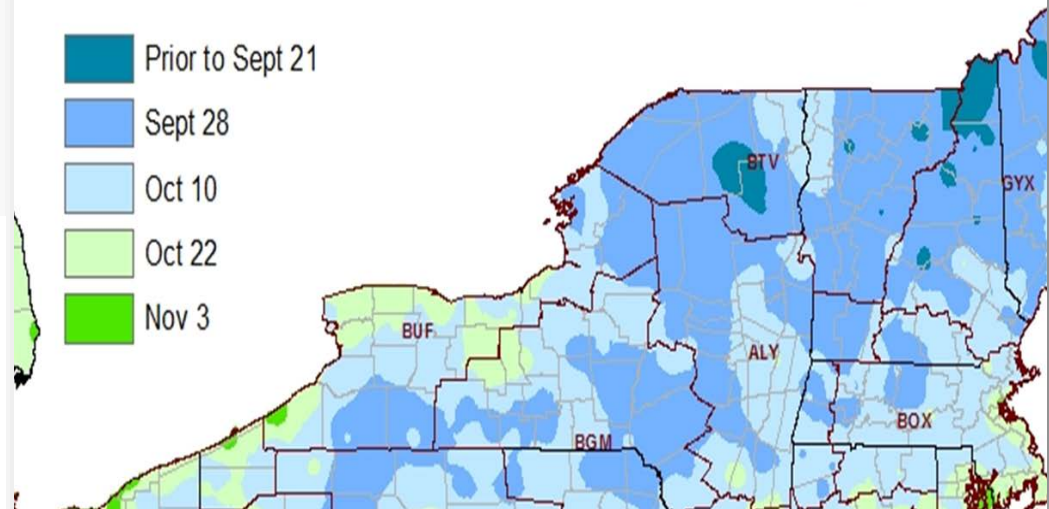
- ▶ Summers are warm and sunny across the region
  - ▶ Average temperature in the 70 to 75 degree range
  - ▶ There usually are several periods of uncomfortably warm and muggy weather
    - ▶ About five days reach the 90 degree mark
- ▶ Rain can be expected every third or fourth day
  - ▶ Mainly in the form of showers and thunderstorms
  - ▶ More common inland than along the lakeshore
- ▶ Completely overcast days are rare



# Autumn

- ▶ Pleasant, mild and dry through October
- ▶ Colder air masses across Lake Ontario brings a dramatic increase in cloud cover and first lake effect snows by mid-November
- ▶ Early snows generally melt off quickly

## MEDIAN DATE OF THE FIRST FALL FREEZE Based on 1981-2010 Climatology





# Severe Weather



# Summer Convective Weather

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- ▶ Thunderstorm Winds – damage producing or  $\geq 50$  knots
  - ▶ About 10 events per year
  - ▶ Estimated \$600,000 damage each year
  
- ▶ Hail
  - ▶ About 5 events per year
  - ▶ Largest Hail reported (since 1950) – 2.00”
    - ▶ Most recently May 2013  
Seneca Castle, Ontario Co
  
- ▶ Lightning
  - ▶ Last 25 years:
    - ▶ 2 deaths (Batavia, Genesee Co. 8/10/2016)
    - ▶ 12 Injuries (Monroe, Livingston, Ontario, Wyoming Cos.)
    - ▶ There have been several lightning-sparked fires



# Summer Convective Weather

## ▶ Derechos

- ▶ Long lived high wind event
- ▶ Occurs about once every 10 to 15 years



## ▶ Tornadoes – 25 since 1950

- ▶ Once every 3 years
- ▶ 2 Deaths
  - ▶ Batavia, Genesee Co 9/3/1993
- ▶ Strongest EF2
  - ▶ Wayne and Wyoming Counties



# Winter Weather

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## ▶ Winter Weather

- ▶ Snow Storms – five to ten per year (areal and lake effect)

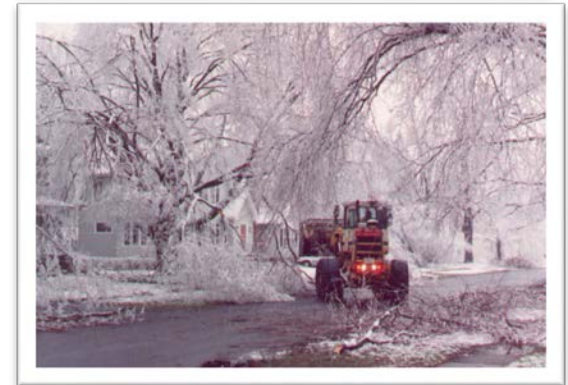
## ▶ Blizzards

- ▶ About once every 10-15 years
  - Most recent – March 2014



## ▶ Ice Storms

- ▶ About once every 5 to 10 years
  - Most recent – December 2013



Photos credit: Rochester D&C



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# Flooding

- ▶ **Floods/Flash Floods**

- ▶ About five events per year
- ▶ Floods can occur any time of year
  - ▶ Winter/Spring – ice jams, snowmelt and/or heavy rain with large storm systems
  - ▶ Spring/Summer - slow moving thunderstorms
  - ▶ Summer/Fall - Tropical Storms





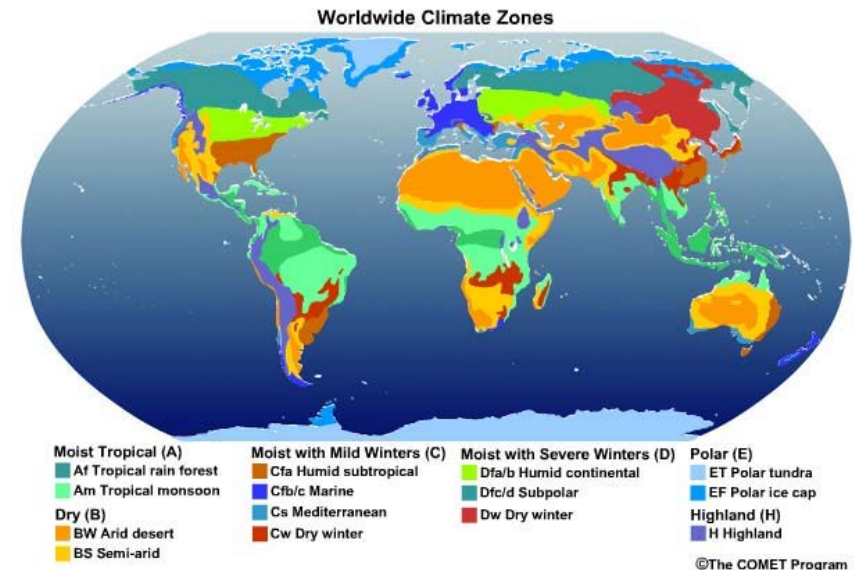
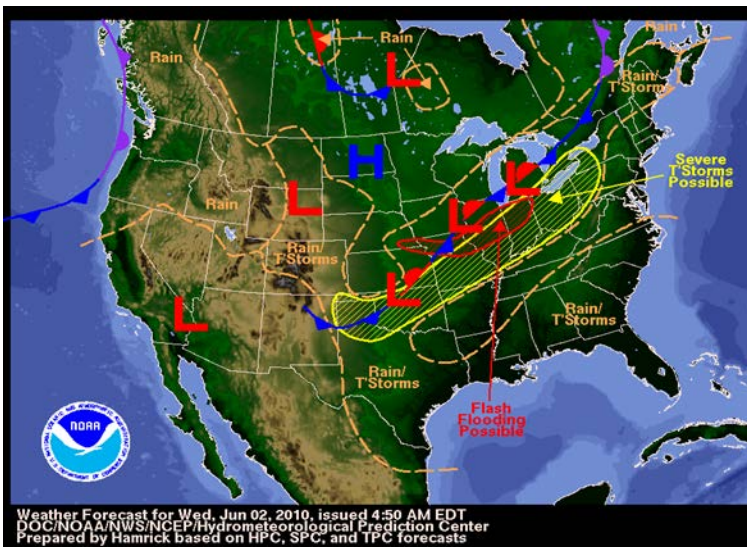
# Climate Change



# Weather vs. Climate

**Weather** is the state of the atmosphere at any given time and place (temperature, humidity, precipitation, cloudiness, wind, etc.).

**Climate** is the set of meteorological conditions that prevail in a particular place or region over a long period of time.



# Climate Change: The Fundamentals

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## Climate

- **Climate** describes how *Weather* varies at a particular location over a longer period of time.



## Climate Variability

- **Climate Variability** describes fluctuations in the *Climate* itself over time. These changes are usually natural and brief.



## Climate Change

- **Climate Change** describes long-term (decades or longer) and persistent changes in Earth's *Climate*.



# Global Climate Change: The Observations

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- ▶ Carbon dioxide in the atmosphere is increasing
- ▶ There has been a significant increase in globally-averaged surface temperatures over the last century.
- ▶ Global sea level has risen 4–8 inches over the past century.
- ▶ Arctic sea ice has decreased
- ▶ Climatologists have observed increases in northern latitude precipitation and decreases in southern and subtropical regions.





# Climate Models

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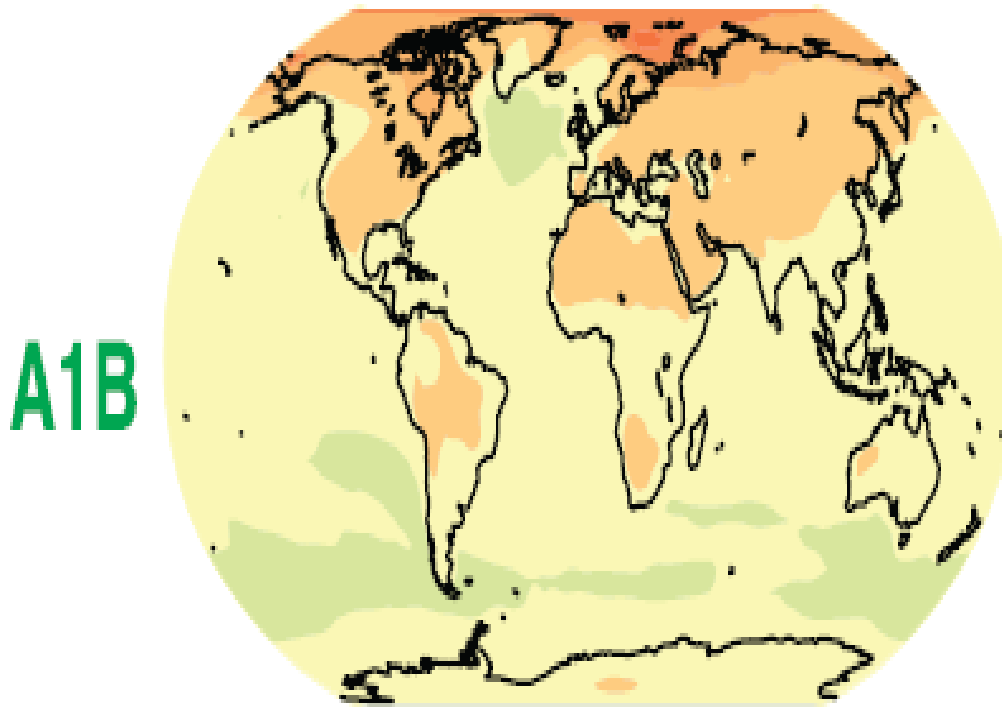
- Computer models are essential for understanding the complexities of climate change.
- Confidence in the ability of models to project future climate is growing.



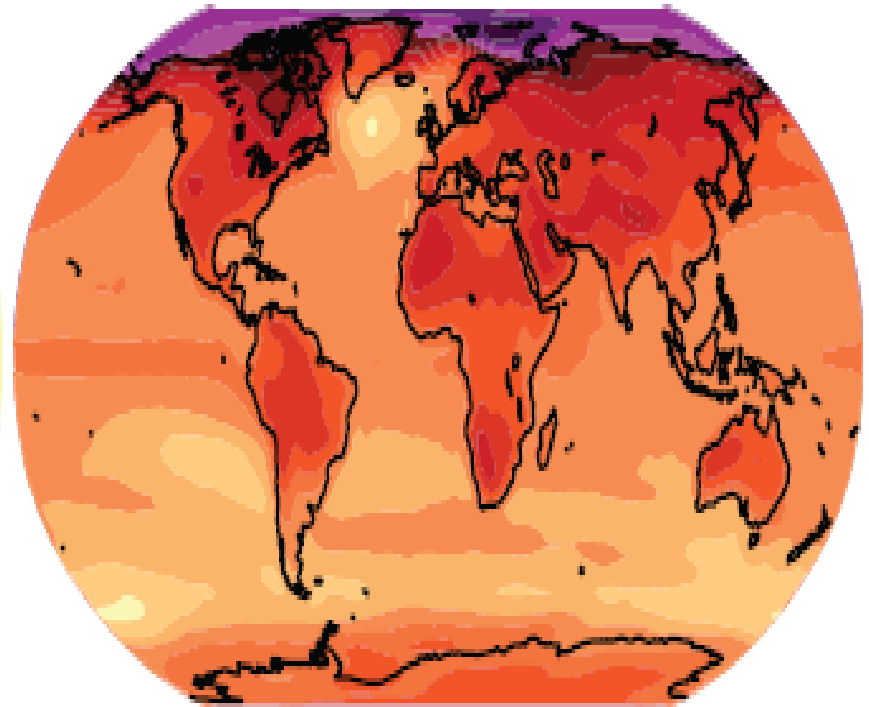
# Global Climate Change: Likely Projections

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**2020-2029**



**2090-2099**



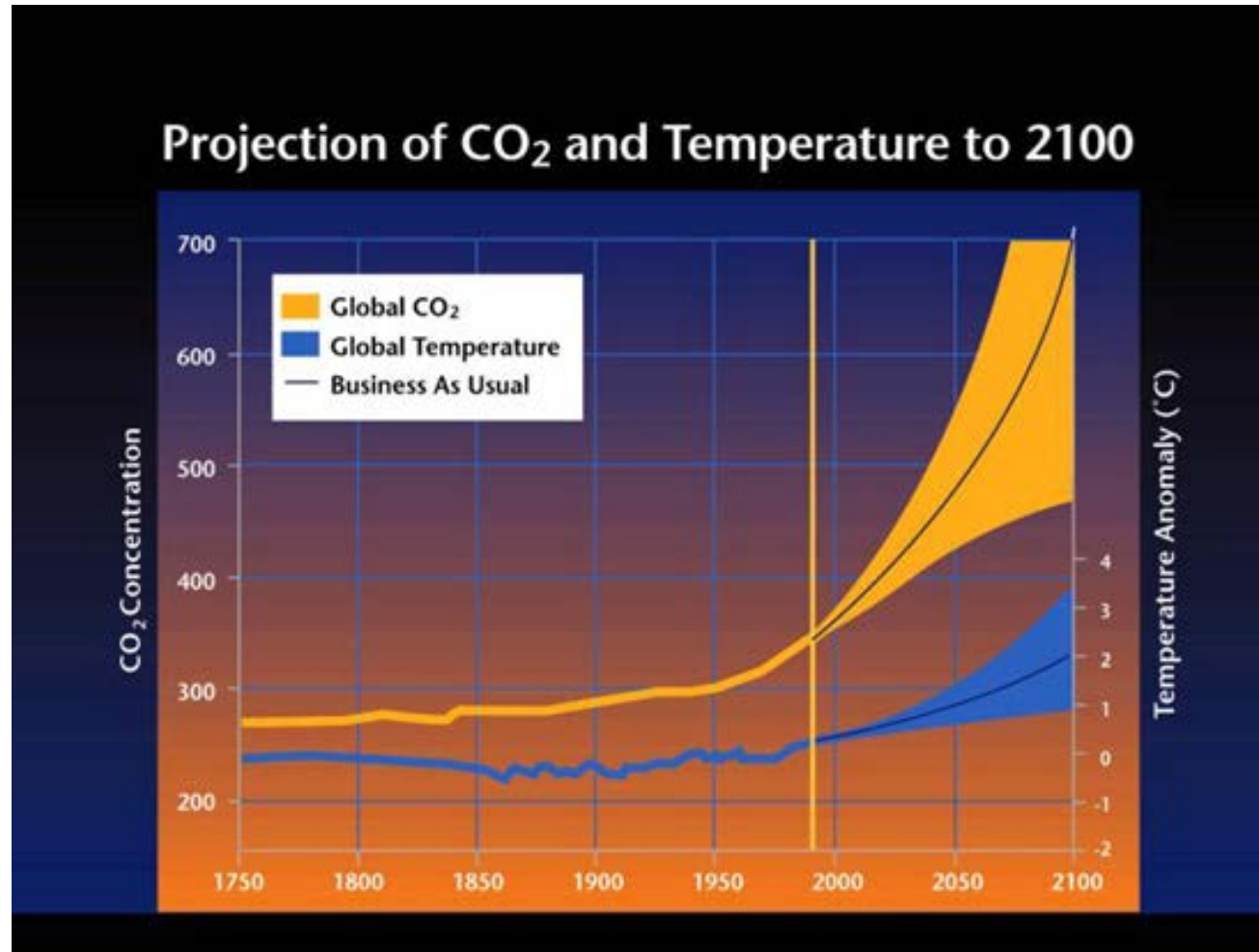
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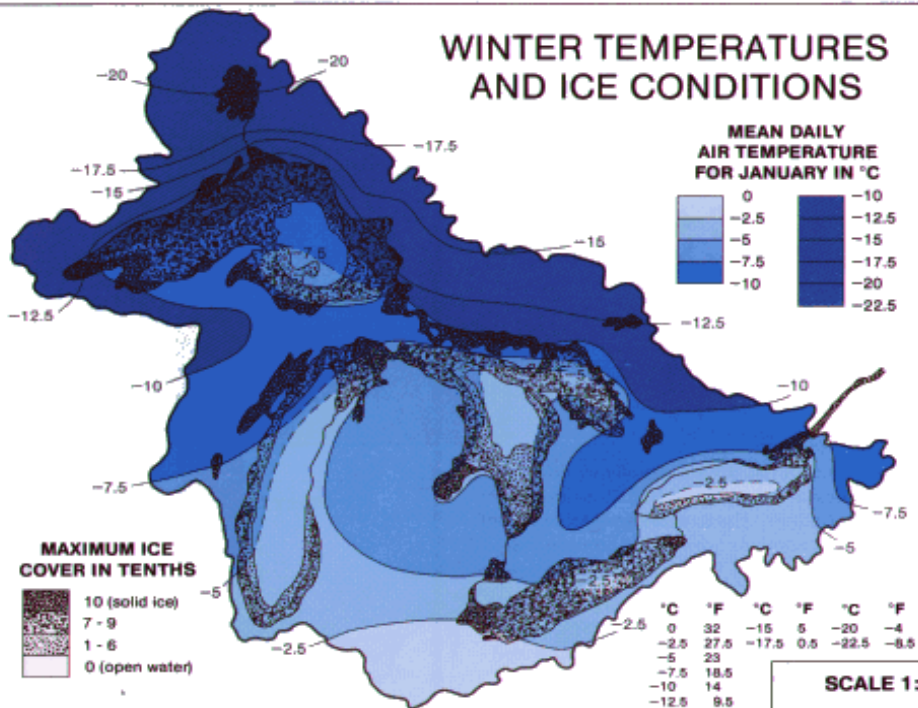
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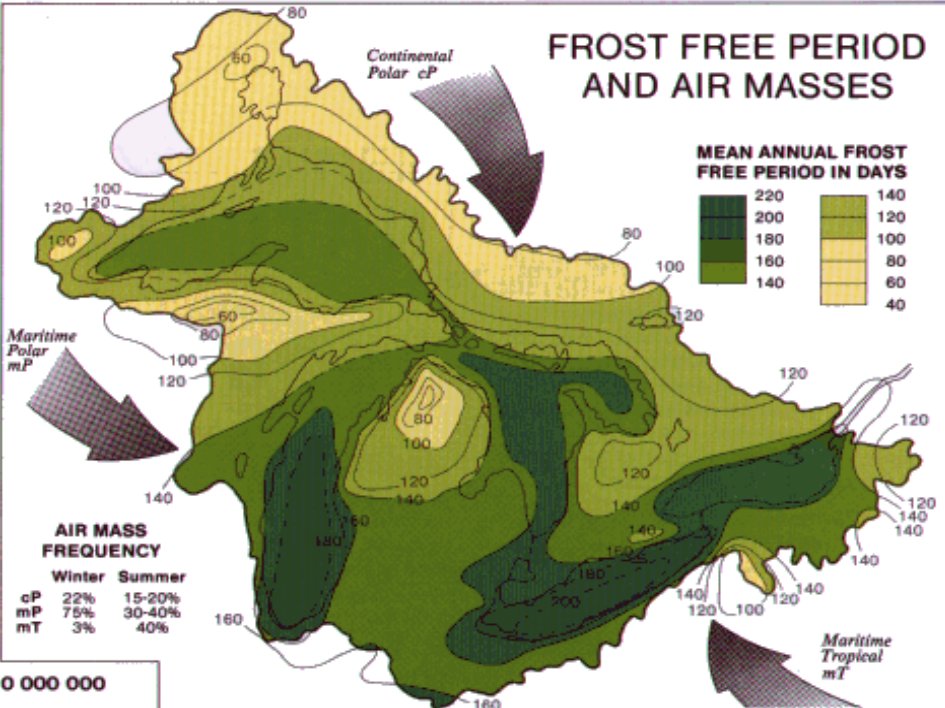
# Global Climate Change: Likely Projections



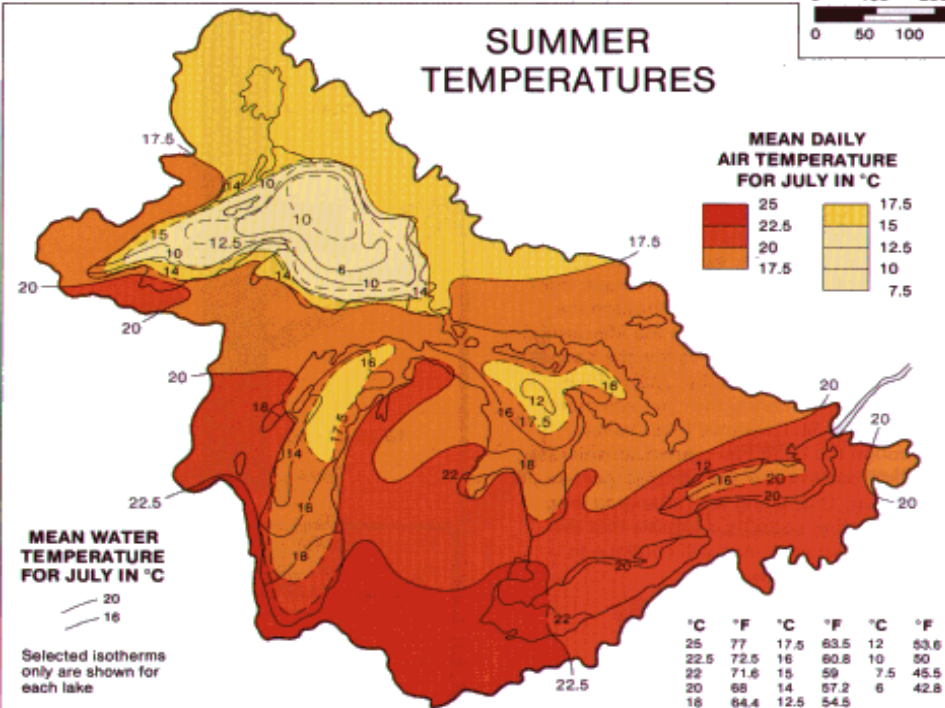
## WINTER TEMPERATURES AND ICE CONDITIONS



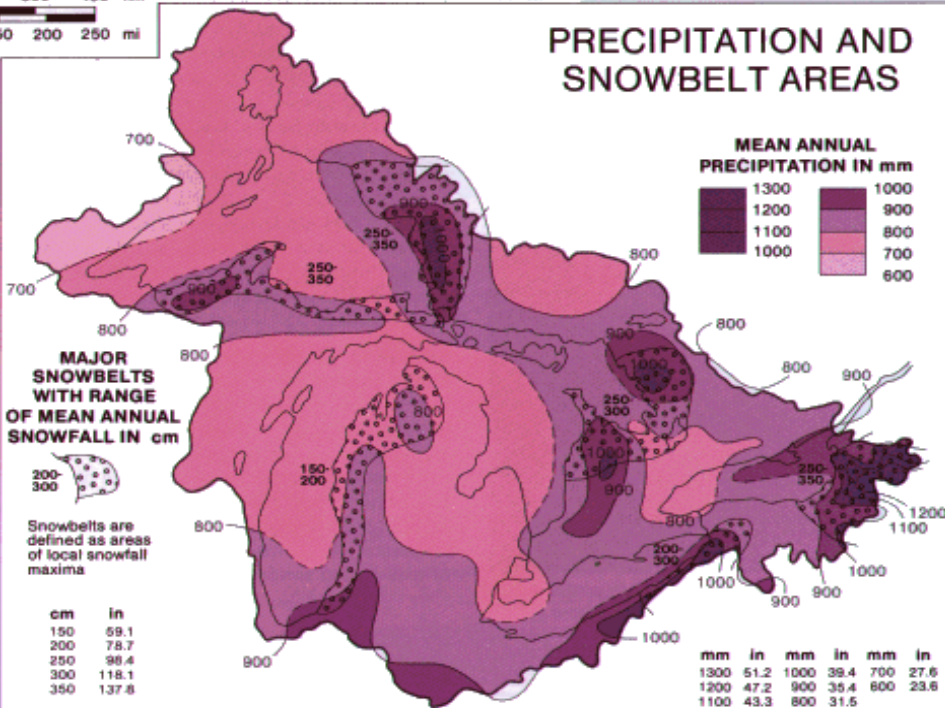
## FROST FREE PERIOD AND AIR MASSES



## SUMMER TEMPERATURES



## PRECIPITATION AND SNOWBELT AREAS





# Climate Changes Are Already Occurring

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## ► Temperatures:

► Winter – warmer and fewer cold days and nights

► Summer – hotter and more frequent hot days/nights and heat waves



# Climate Changes Are Already Occurring

## ► Precipitation:

- Regions that already experience long-duration droughts, such as the Southwestern U.S., will likely see the area affected increase.
- Many areas in the U.S. have seen an increase in the heaviest downpours, and that pattern is very likely to continue in the future.

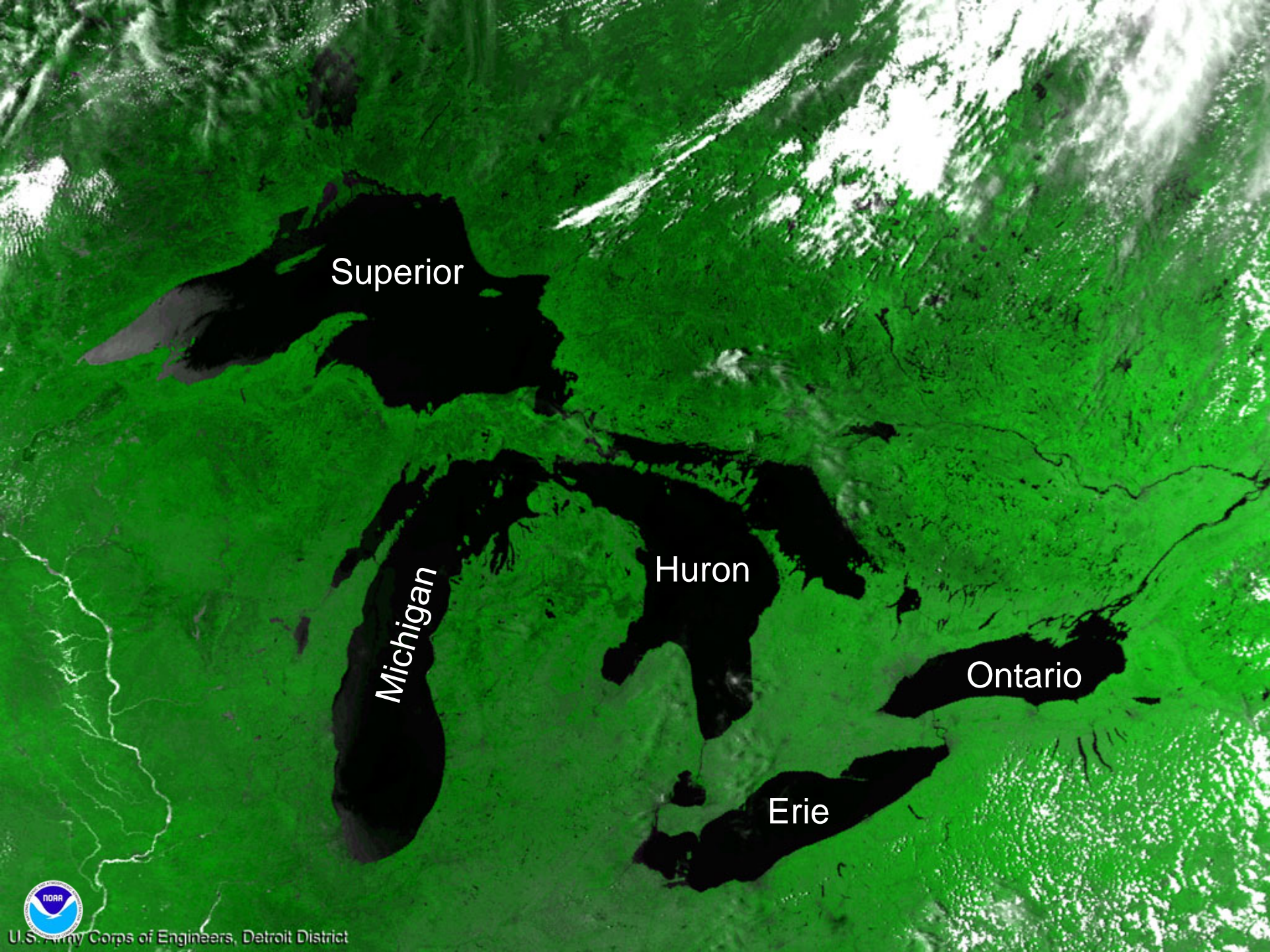


# Climate Changes Are Already Occurring

- ▶ **Hurricanes:** More intense hurricanes
- ▶ Observations indicate an increase in hurricane intensity in the Atlantic and West Pacific







Superior

Michigan

Huron

Erie

Ontario





# Projected Changes in Great Lakes Weather: Temperature

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The following changes are *likely* over the next century:

- Average temperature will continue to increase
  - Projected increases of
    - 1.5 to 3°F in the 2020s, and
    - 3 to 5.5 °F in 2050s
- Number of days with:
  - Low temperatures below 0°F will drop by 50% or more
  - High temperatures above 90°F will more than double



# Projected Changes in Great Lakes Weather: Precipitation

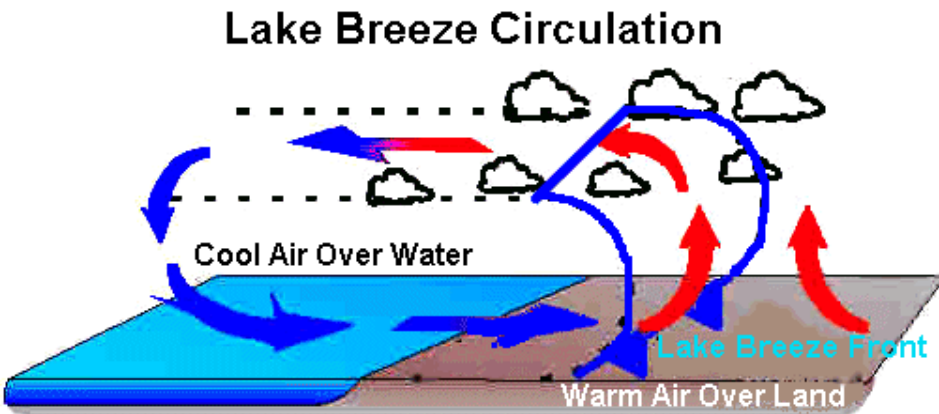
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The following changes are *likely* over the next century:

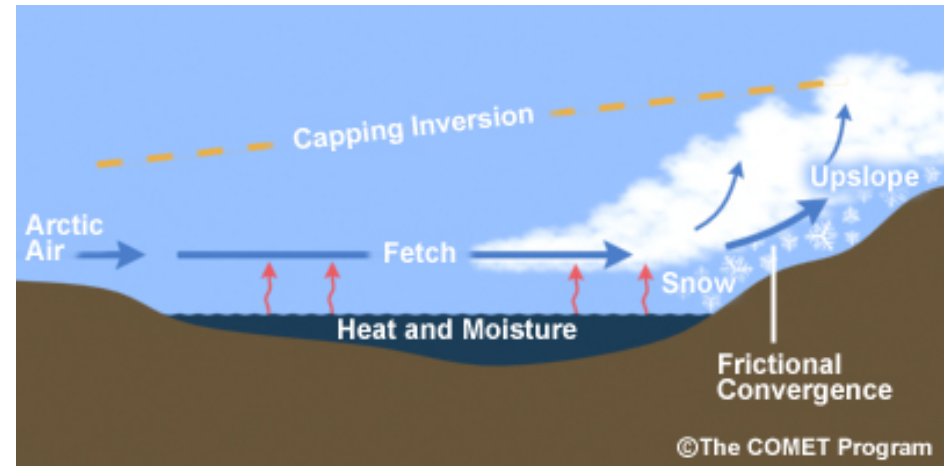
- ▶ Projected small increase in annual precipitation
- ▶ Larger variability
  - ▶ More precipitation in winter
  - ▶ Less precipitation in late summer early fall
- ▶ Intense precipitation events (heavy downpours) are likely to increase
  - ▶ Some projections say 50-100% more frequent



# The Impact of the Great Lakes on Regional Climate and Climate Change



In summer, lake breeze circulation keeps shoreline areas cooler (as compared to surrounding inland areas).



Lake-effect precipitation may become increasingly common in late fall and winter (as cool wintertime air flows over warm lake waters).



# Affects of Climate Change

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- Lake Levels



- Ice Cover



- Severe Weather



- Human Health and Economy



# Lake Levels

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***OR***



An overall downward trend in lake levels is expected



# Ice Cover

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# Severe Weather

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- ▶ The relationship between climate change and localized severe weather events is complex
- ▶ No one event can be directly attributed to climate change however the increased frequency of severe weather events can





# Severe Weather



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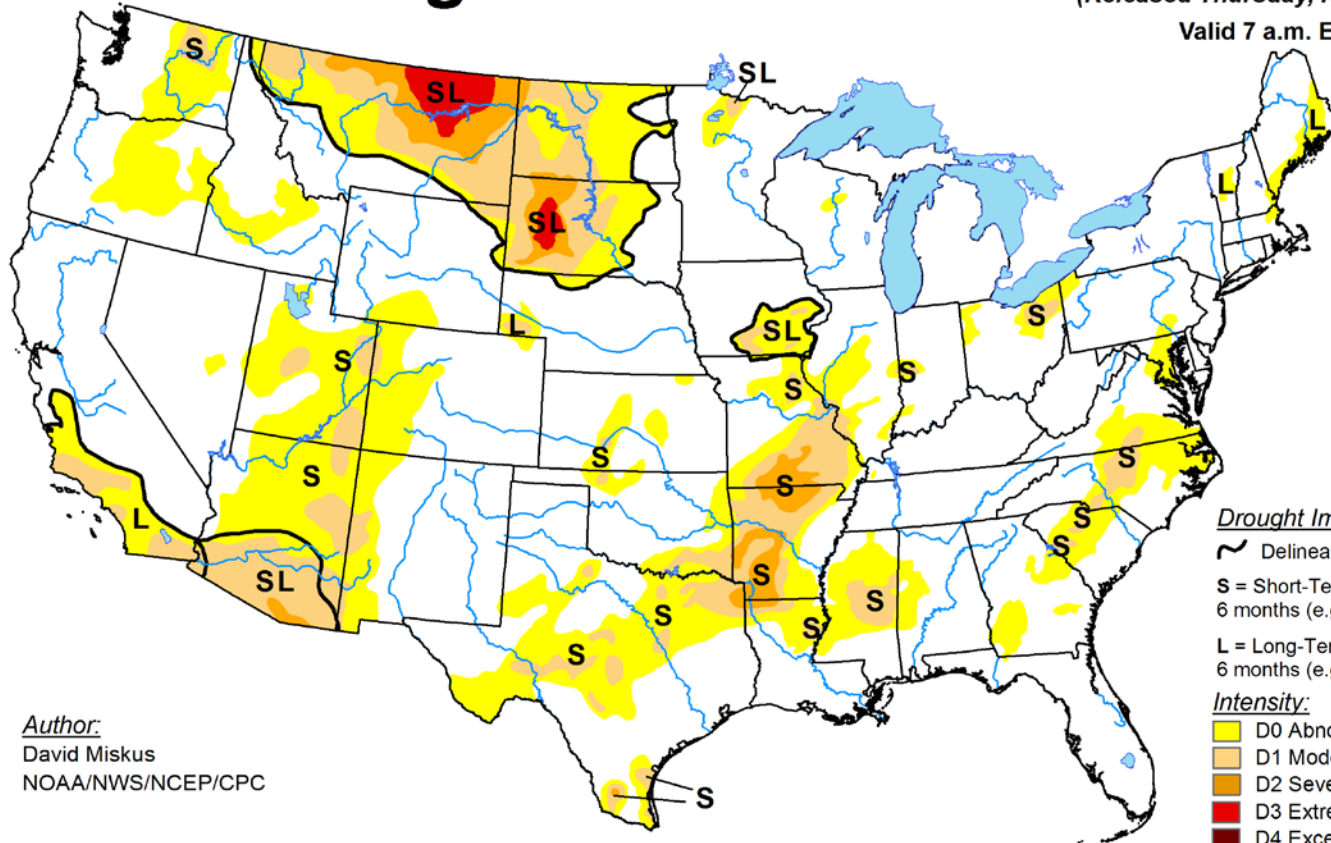
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# U.S. Drought Monitor

November 7, 2017  
(Released Thursday, Nov. 9, 2017)  
Valid 7 a.m. EST



Author:  
David Miskus  
NOAA/NWS/NCEP/CPC

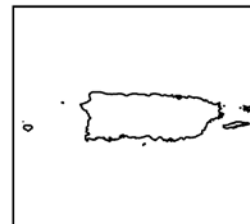
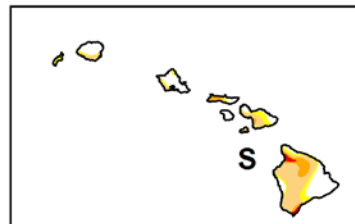
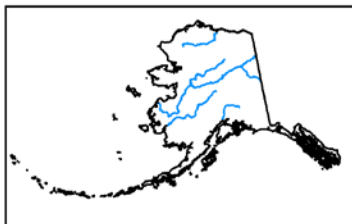
## Drought Impact Types:

- ~ Delineates dominant impacts  
S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)  
L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

## Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.



<http://droughtmonitor.unl.edu/>



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# Human Health Concerns

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- Heat Waves



- Water and Air Quality

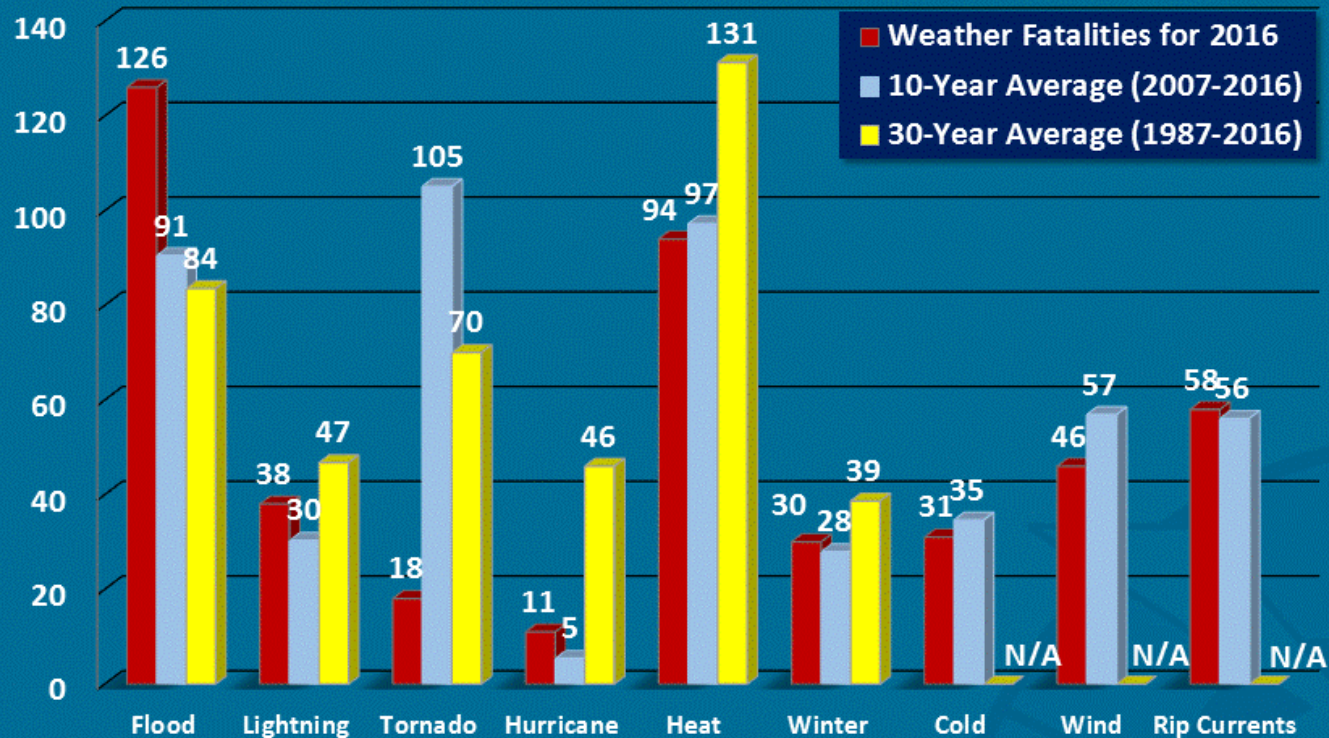


- Agriculture





# Weather Fatalities 2016



More frequent

More Severe

Longer Lasting



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# Air Quality

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- Air Temperature



- Air Stagnancy



- Emissions



# Water Quality



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# Agriculture

Changes in the length of the growing season in the eastern and western U.S. (1900-2002)



Data source: Kunkel, 2009<sup>6</sup>

EPA / <http://www.epa.gov/climatechange/indicators>



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# Economical Impacts

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- Reduced heating demand and lower heating bills in winter
- Shifts in business opportunities
  - Longer summer vacation season (tourism)
  - Longer construction season
- Increased warm weather activities e.g. swimming, boating, golfing
- Less snow and ice will result in fewer shipping disruptions in winter
- City operations shift – lower expenses for snow removal



# Summary

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- ▶ Climate Changes Are Already Occurring
  - ▶ **Temperatures:**
    - ▶ Winter – warmer and fewer cold days and nights
    - ▶ Summer – hotter and more frequent hot days/nights and heat waves
  - ▶ **Precipitation:**
    - ▶ Precipitation totals will show a small increase
    - ▶ Regions that already experience long-duration droughts will likely see the area affected increase.
  - ▶ **More intense hurricanes**
- ▶ Projected Changes to the Great Lakes Weather
  - ▶ **Temperatures will continue to increase**
    - ▶ Fewer cold nights and more hot days
  - ▶ **Precipitation**
    - ▶ Larger variability in winter ( more rain than snow )
    - ▶ Less precipitation late summer, early fall
    - ▶ Increased number of high intensity precipitation events
- ▶ Climate Changes will affect lake levels, ice cover, severe weather, human health and the economy



# QUESTIONS?

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