Effects of Climate Change on the Great Lakes Region

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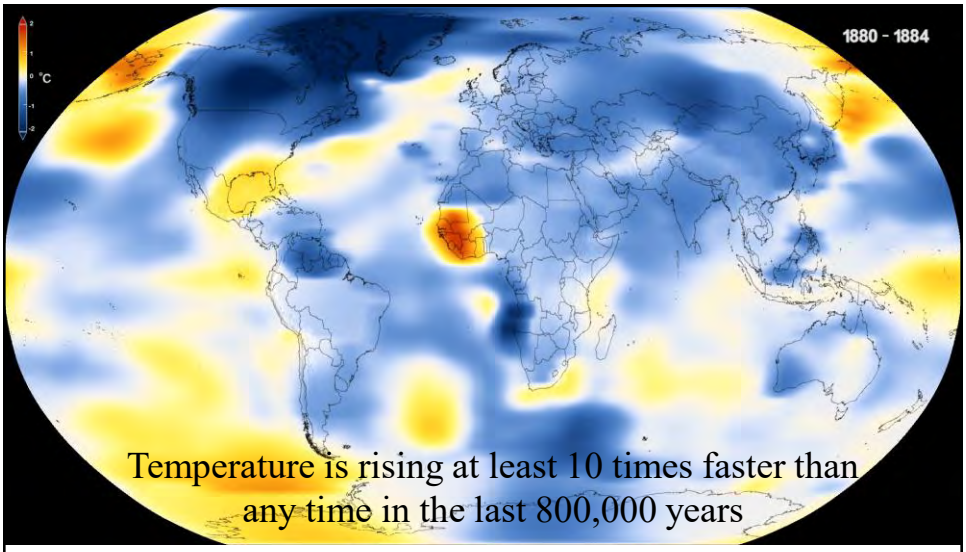
The Paw Paw and Black River watersheds are environmental treasures of southwest Michigan

This evening, we'll address four questions:

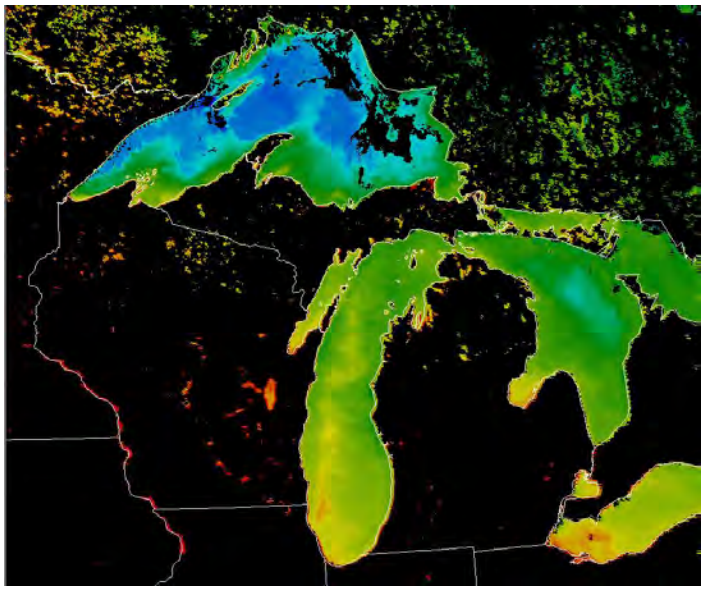
1. Is climate change happening?
2. Are we causing it?
3. Will climate change have adverse impacts on aquatic ecosystems in the Great Lakes Region, including the Paw Paw and Black Rivers?
4. How can we reduce those adverse impacts?



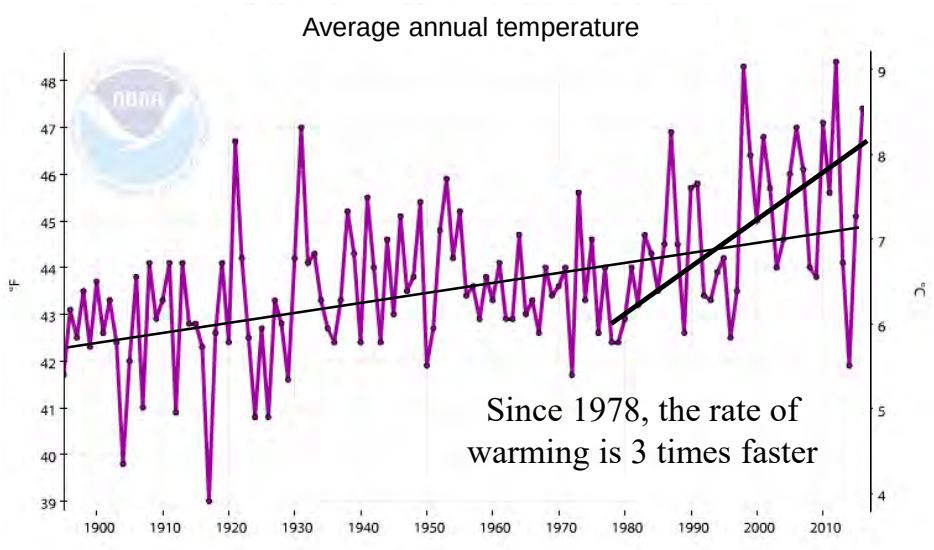
Temperature difference relative to 1950-1980

https://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=4609&button=recent

How has climate been changing in the Great Lakes Region?

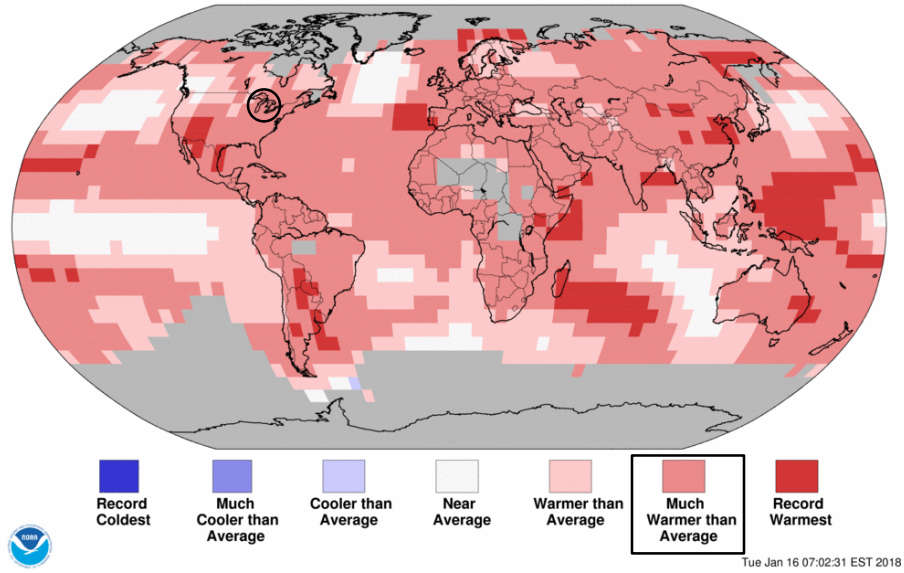


Since 1900, the Great Lakes Region (GLR) has warmed by ~ 1.0° C

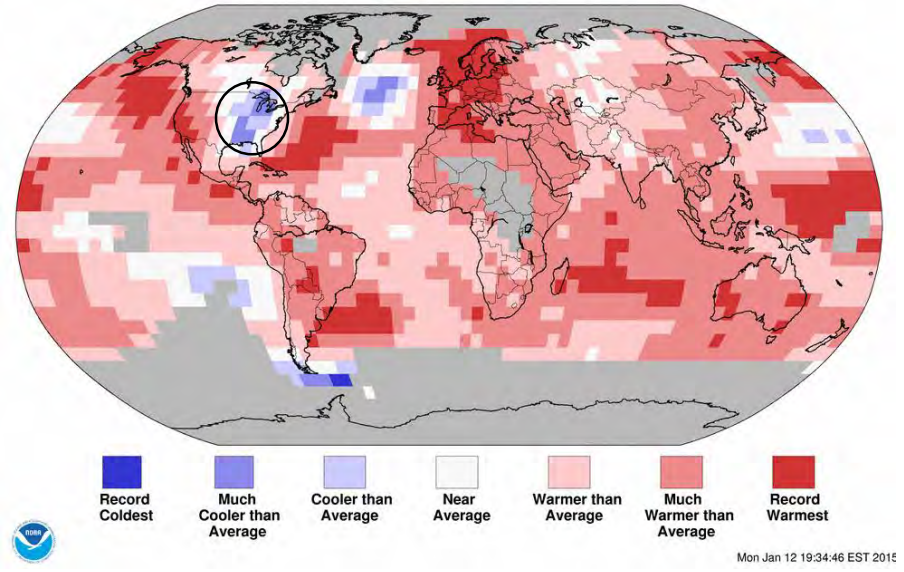


Globally, 2017 was the 2nd hottest year on record

(11th hottest for Michigan)

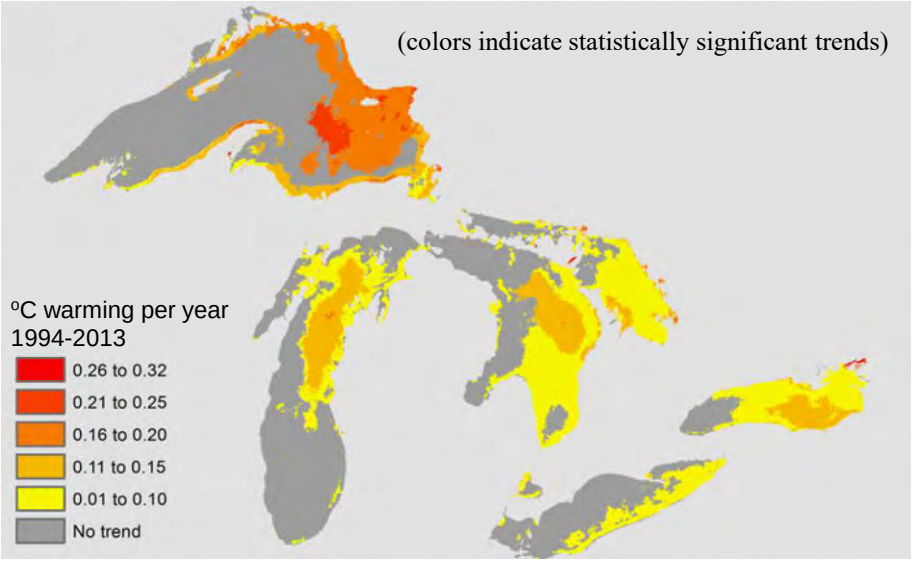


Globally, 2014 is now the 4th hottest year on record

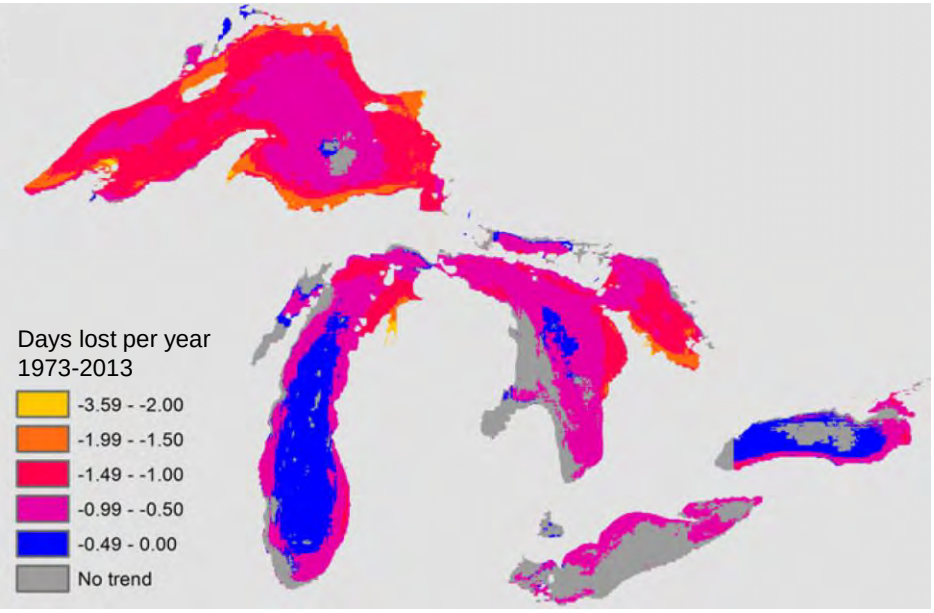


- but 10th coolest for Michigan

The Great Lakes have been warming rapidly

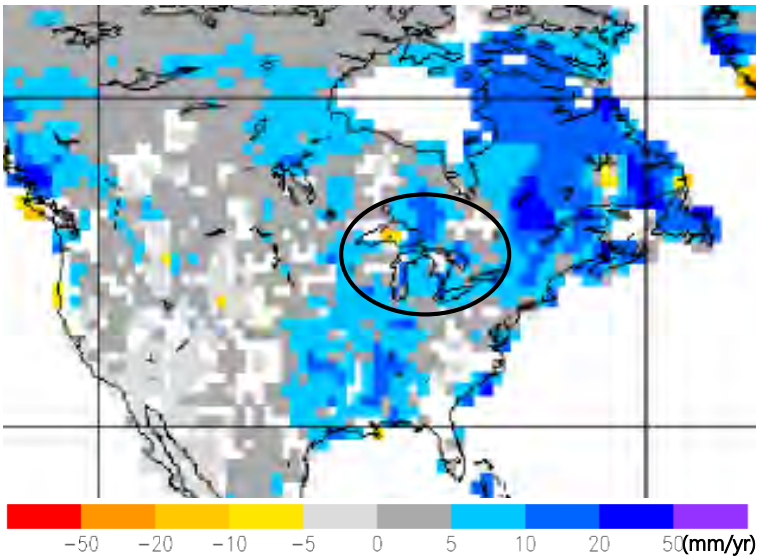


Consequently, ice cover has decreased by 71% since 1973

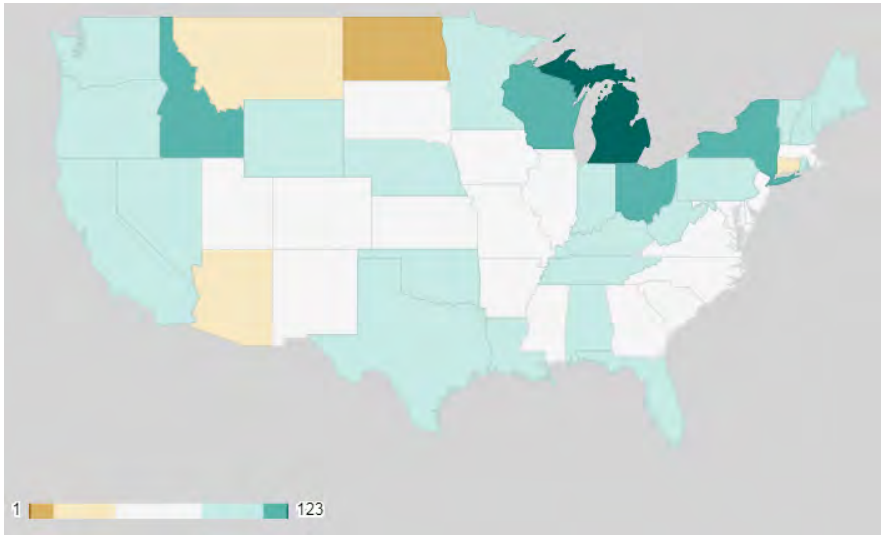


Reduced ice cover results in more lake effect snow, which can result in an extreme precipitation event

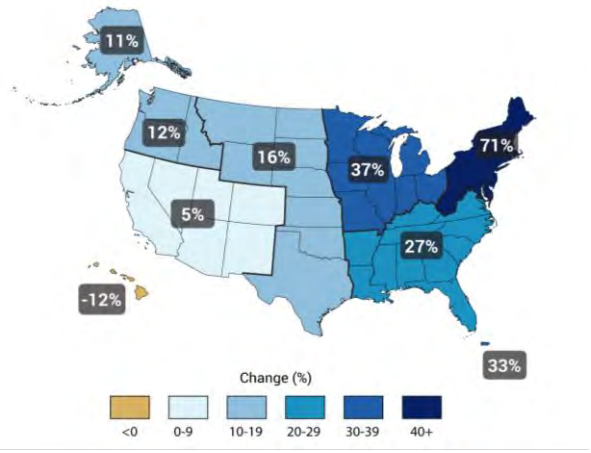
Over the past 110 years, total annual precipitation has been increasing in the GLR



For Michigan, 2017 was the wettest year on record



Most of the increase in the last 60 years has been in the form of extreme precipitation events

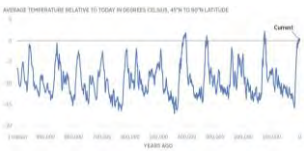
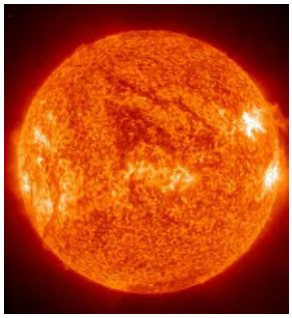
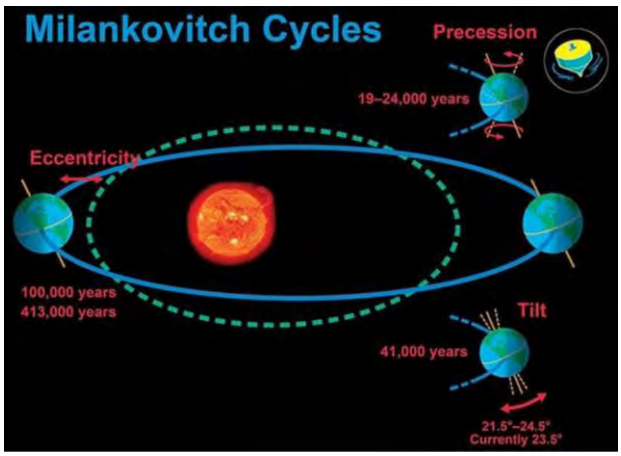


As a result, the GLR experienced extensive flooding



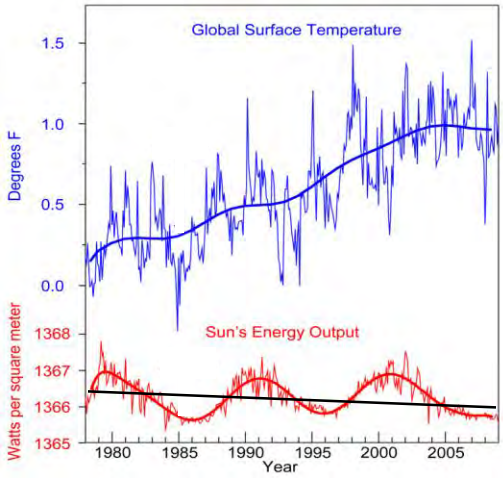
How do we know that today's climate change is **NOT** due to "natural factors"?

Until ~1900, all climate change was due to natural factors

Have we been getting more energy from the sun?

For the past 40 years, while Earth has been warming fastest, energy from the sun has been <u>decreasing</u>



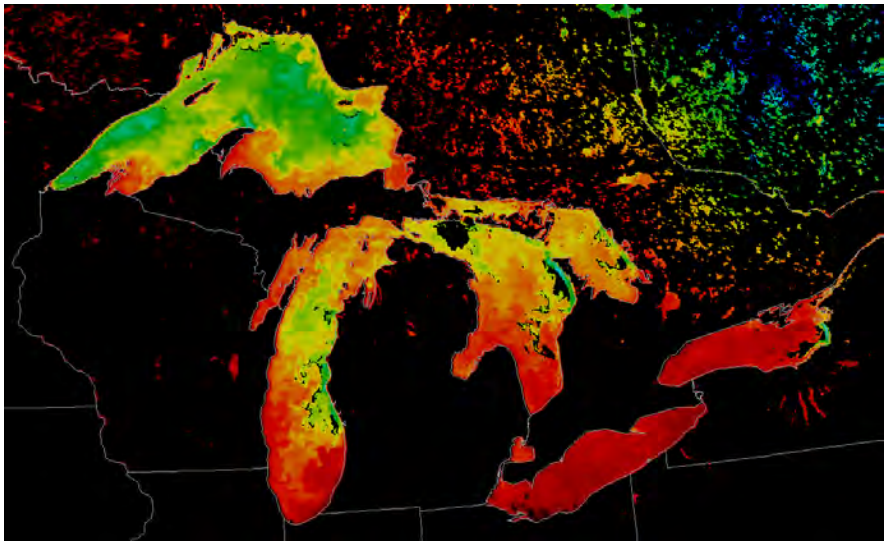
Over the past century, "natural factors" would have caused a slight cooling of Earth

Best estimate: 100% of current warming is due to human activities

Fossil fuel burning (CO_2)

Deforestation

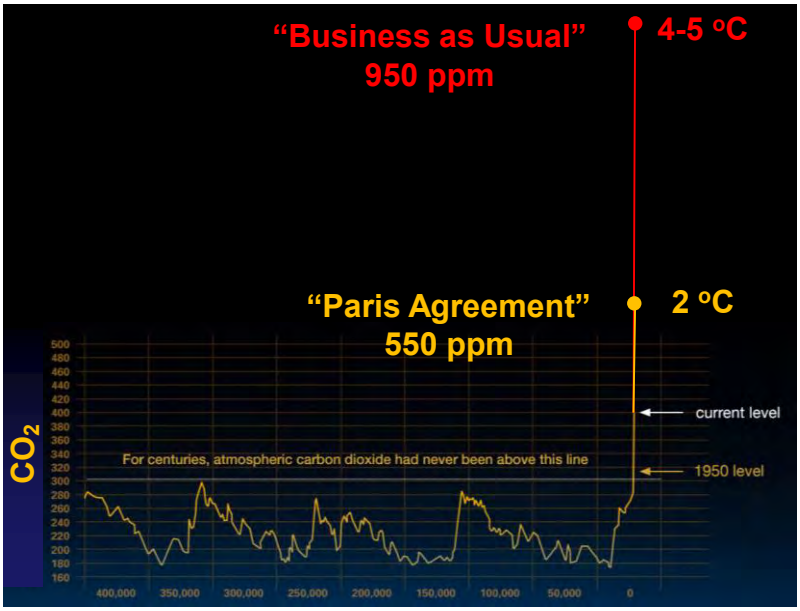
How will future climate change affect the Great Lakes Region?



The future depends on our choices

With the Paris Agreement, 195 countries pledged to limit warming to 2° C, and try for 1.5° C

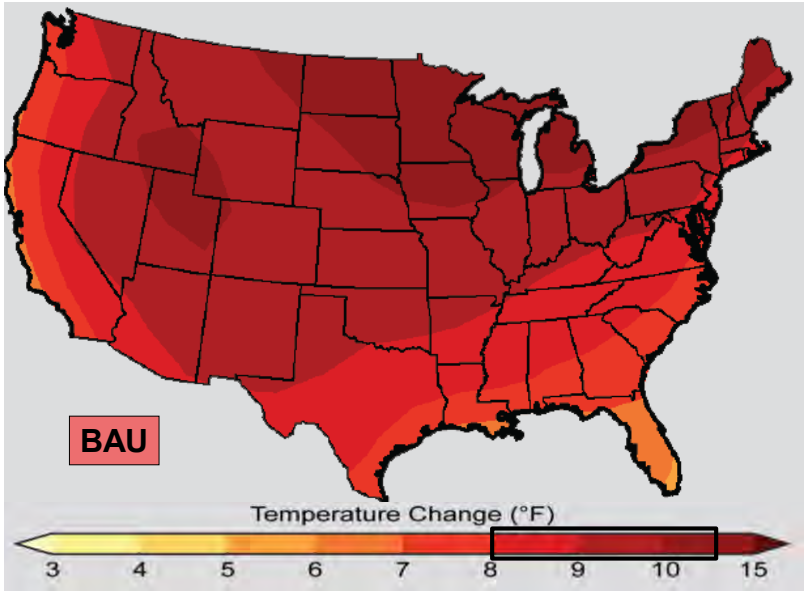
The magnitude of future warming in the GLR depends on our choices



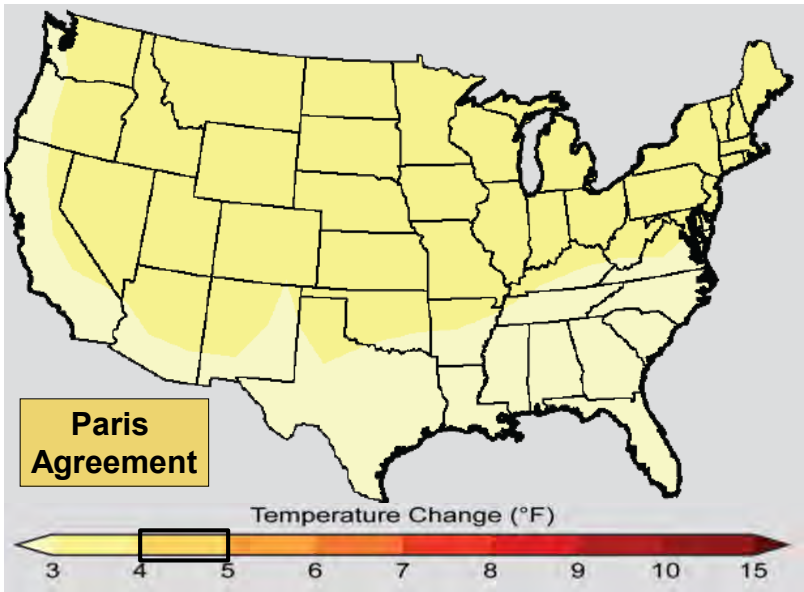
Would a 5° C temperature rise matter?

When Earth was 5° C cooler:

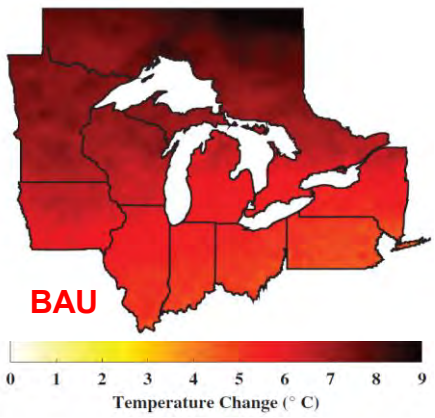
By 2100 under "Business as Usual" (BAU), most of the GLR is predicted to warm by 8-12° F

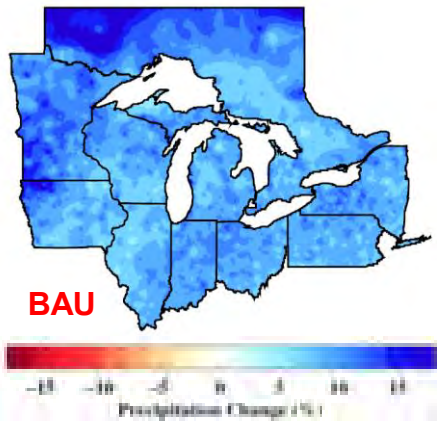


But under the Paris Agreement, most of the GLR is predicted to warm by only 4-5° F

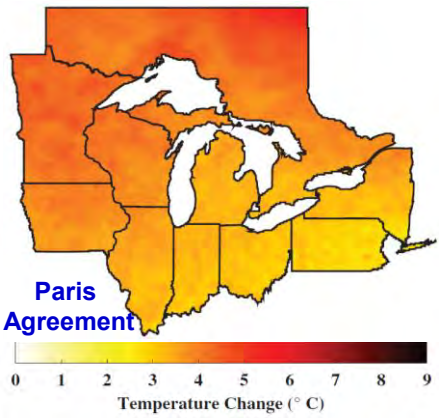


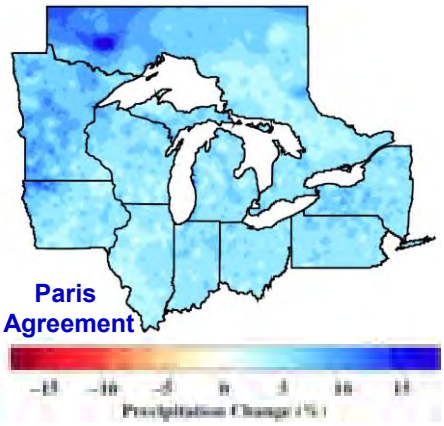
By 2100 under Business as Usual, winter temperature would increase by ~14° F
and winter precipitation would increase by ~10%





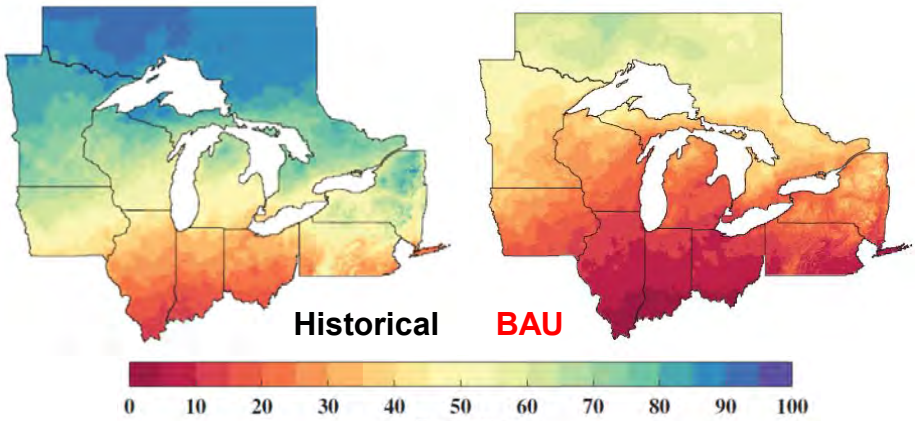
But under the Paris Agreement, winter temperature would increase by only ~7° F
and winter precipitation would increase by only ~5%





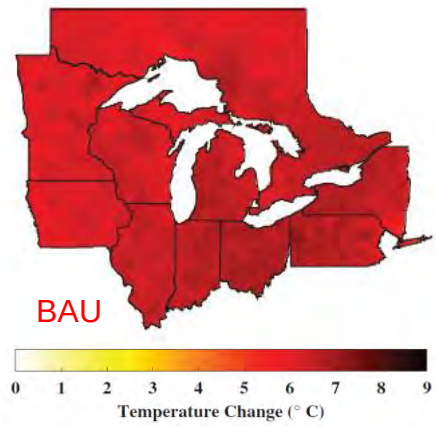
- and more winter precipitation would remain as snow

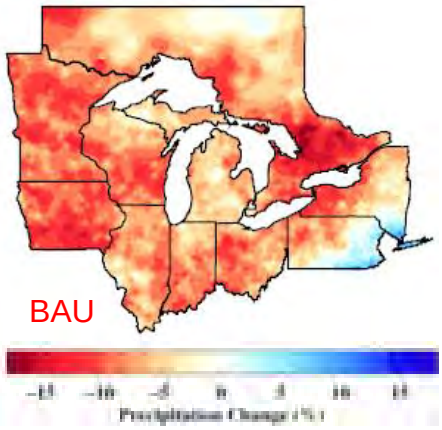
Under Business as Usual, much more winter precipitation will occur as rain rather than snow



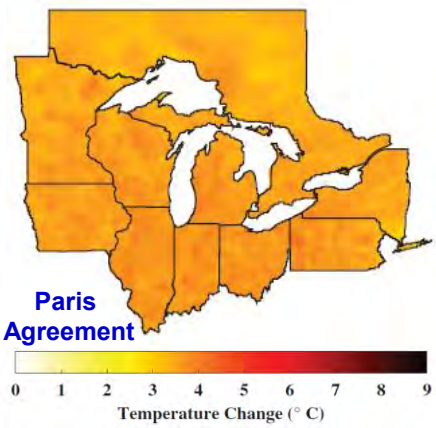
- peak streamflow will occur earlier
- spring flooding will increase

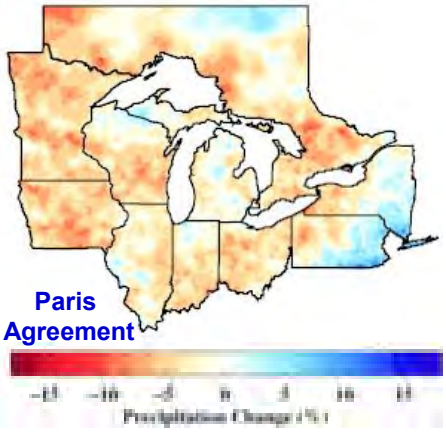
By 2100 under Business as Usual, summer temperature would increase by ~ 12° F
and summer precipitation would decrease by ~10%





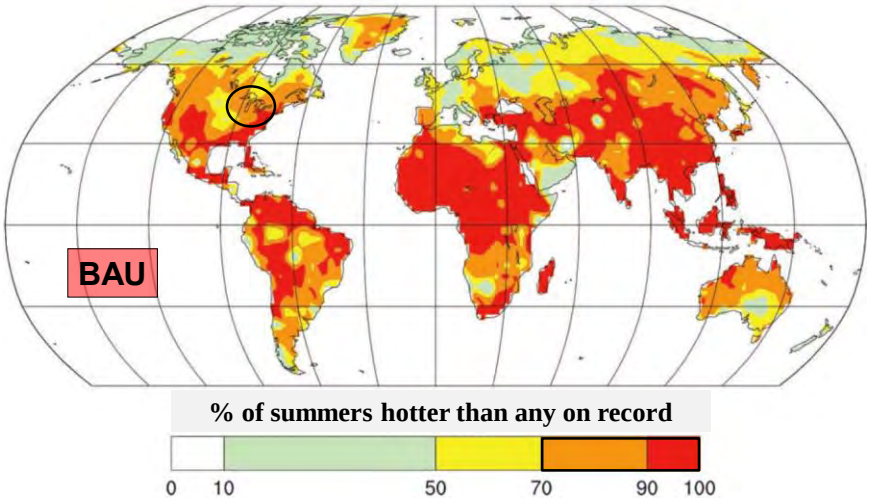
But under the Paris Agreement, summer temperature would increase by only ~6° F
and summer precipitation would decrease by only ~5%



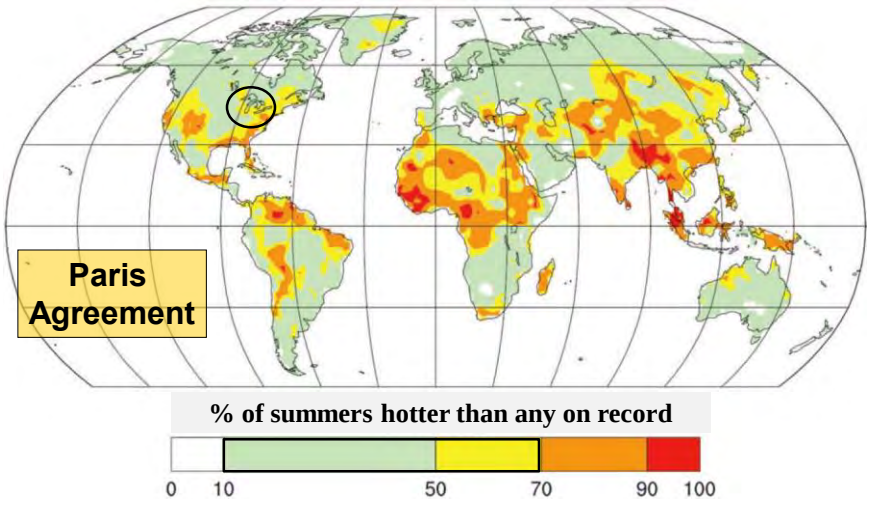


- much less stressful for species and ecosystems

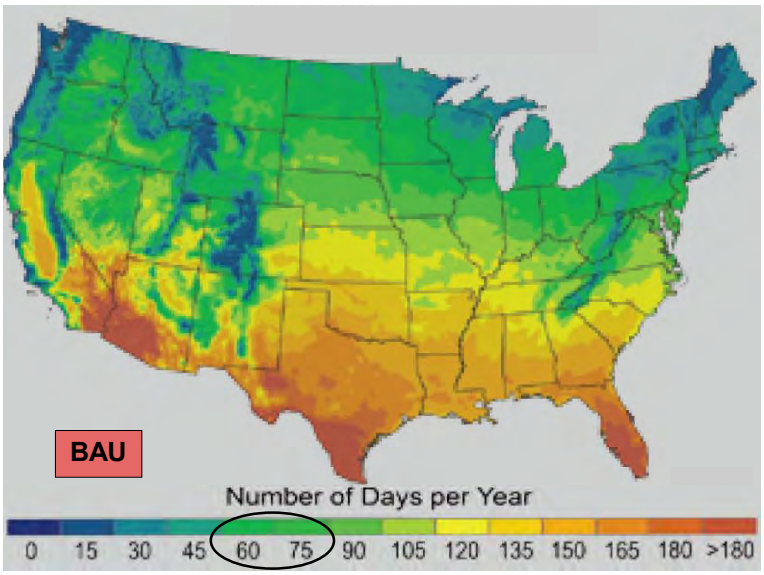
By 2100 under Business as Usual, 70-100% of GLR summers will be hotter than today's record hot summer



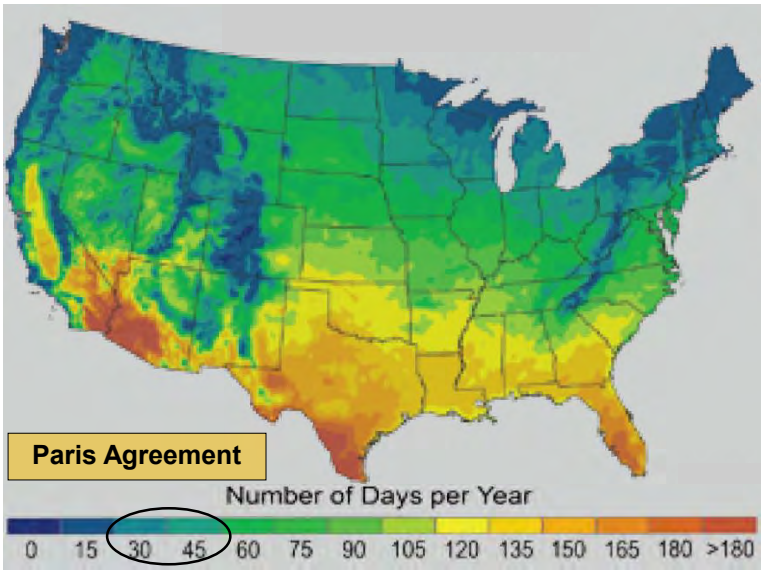
But under the Paris Agreement, only 10-70% would be hotter than today's record hot summer



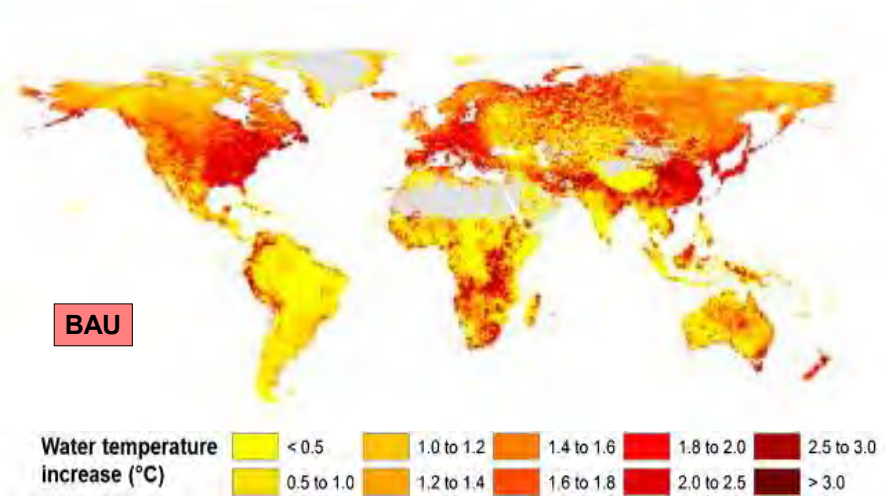
By 2100 under Business as Usual, southwest Michigan is predicted to have 60-75 days per year over 90° F



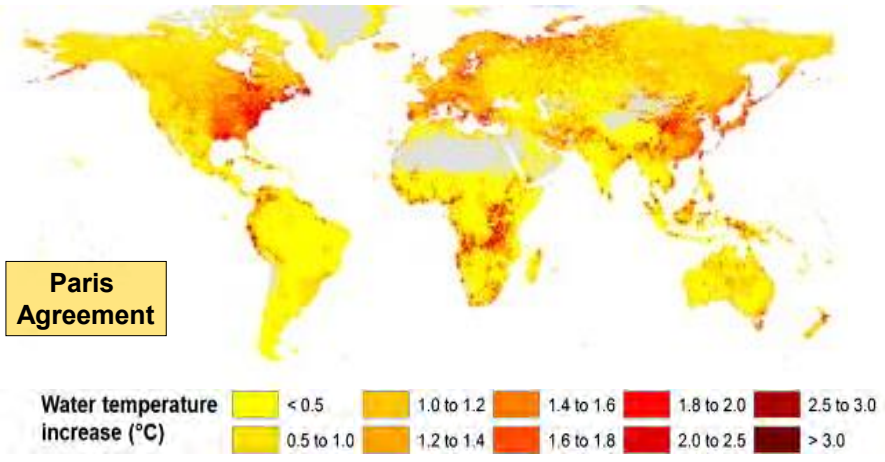
But under the Paris Agreement, southwest Michigan is predicted to have 30-45 days per year over 90° F



Under Business as Usual, GLR lakes and rivers would warm by ~2.5° C



But under the Paris Agreement, GLR lakes and rivers would warm by only ~1.6° C



Warm-water species will be “climate winners”,
but cold- and cool-water species will be “climate losers”

climate winners		climate losers	
	carp	trout	
	bluegill	whitefish	
	catfish	salmon	

Extreme precipitation events are predicted to
become more common in the GLR

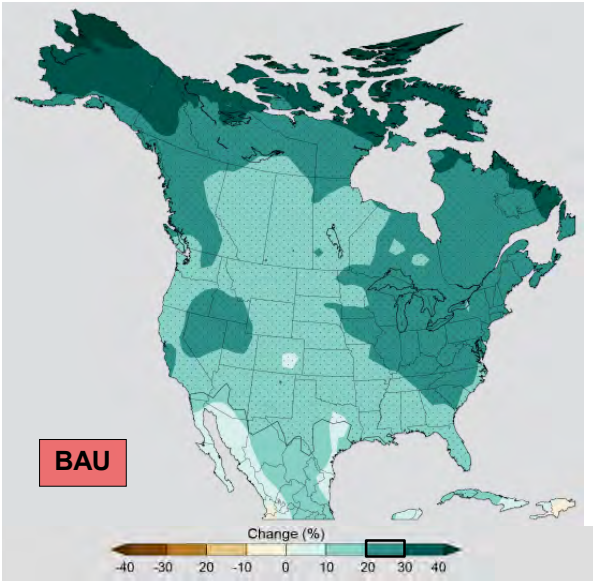


How often will today’s “once every 20 years” rain event
happen in the future?

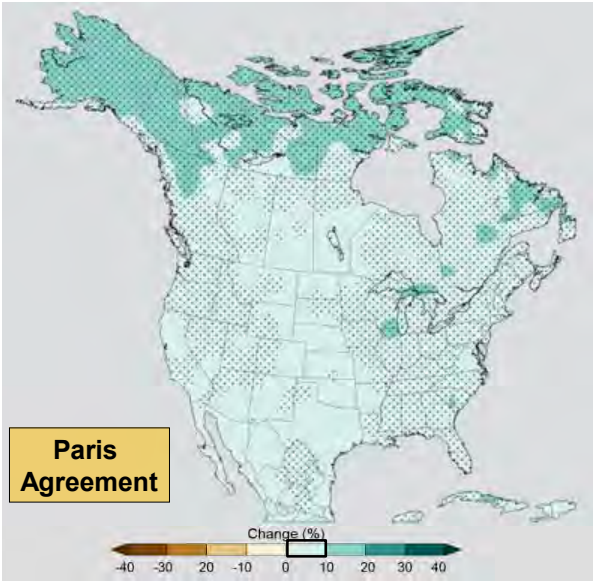
Business as Usual: once every 5 years

Paris Agreement: once every 9 years

By 2100 under Business as Usual, extreme precipitation events in the GLR would also be ~25% stronger



But under the Paris Agreement, extreme precipitation events in the GLR would be only ~5% stronger



Climate change will make river flow more variable throughout the Great Lakes Region

High flow days
(winter and spring)

BAU: +85%

Paris: +55%

Low flow days
(summer)

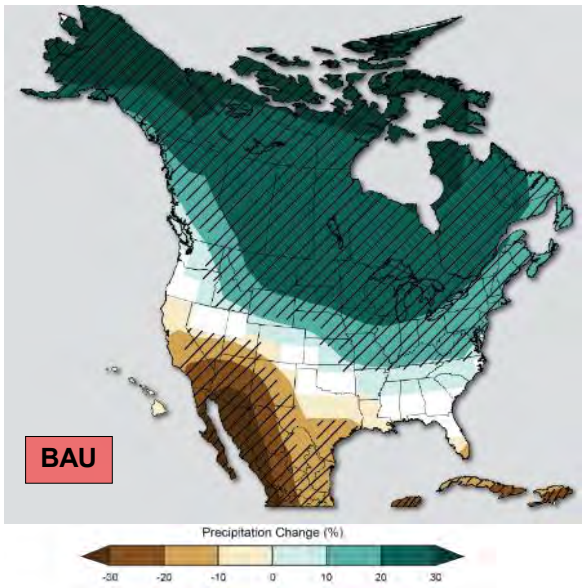
BAU: +50%

Paris: +3%

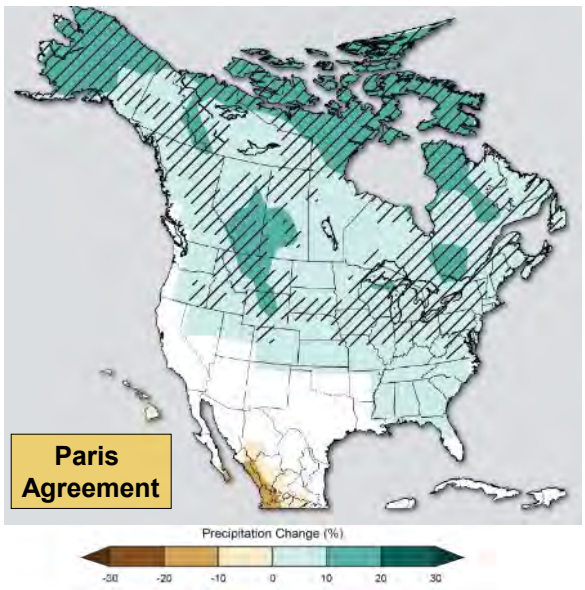
- much less stressful for aquatic species and ecosystems

Increased frequency and severity of extreme precipitation events will increase stormwater problems

By 2100 under Business as Usual, spring precipitation in the GLR would increase by ~25%

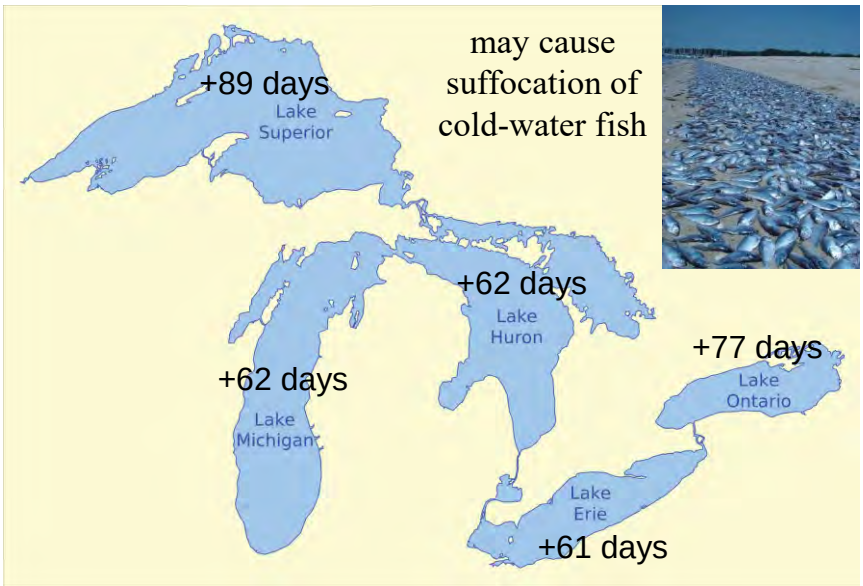


But under the Paris Agreement, spring precipitation in the GLR would increase by only ~5%



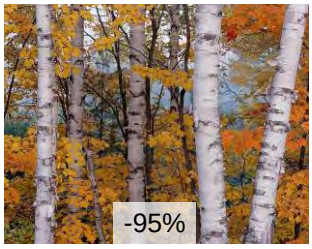
More runoff and higher temperatures will increase harmful algal blooms

Under Business as Usual, summer stratification period is predicted to increase dramatically for all Great Lakes



may cause suffocation of cold-water fish

In Michigan, under BAU, 13 of the 20 most abundant tree species are predicted to decline by at least 50%

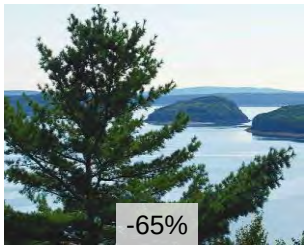


paper birch

both aspen species

balsam fir

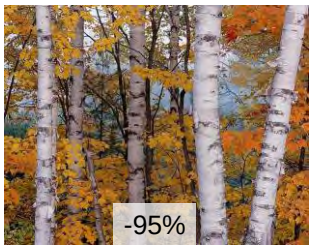
white cedar



white pine

sugar maple

Under the Paris Agreement, 9 of the 20 most abundant tree species are predicted to decline by at least 50%



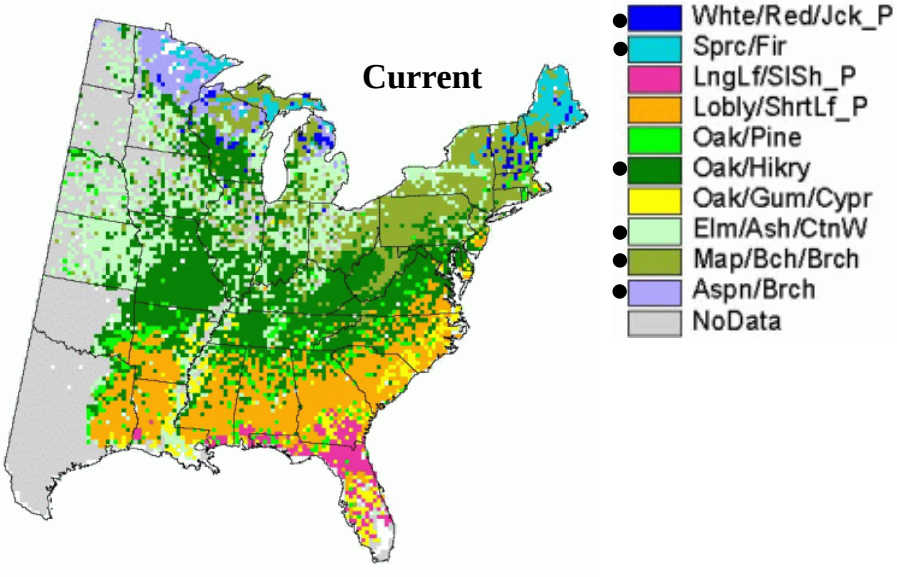
paper birch

both aspen species

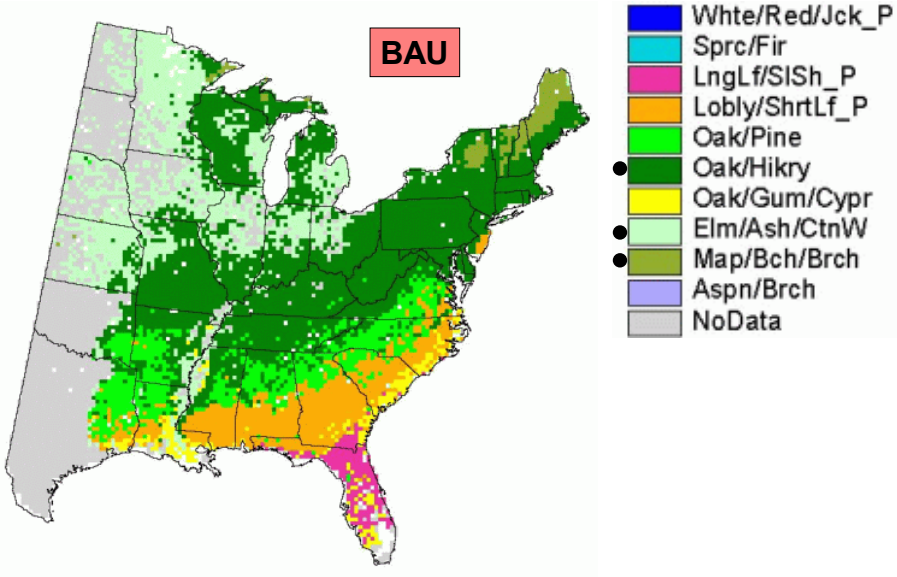
balsam fir

white cedar

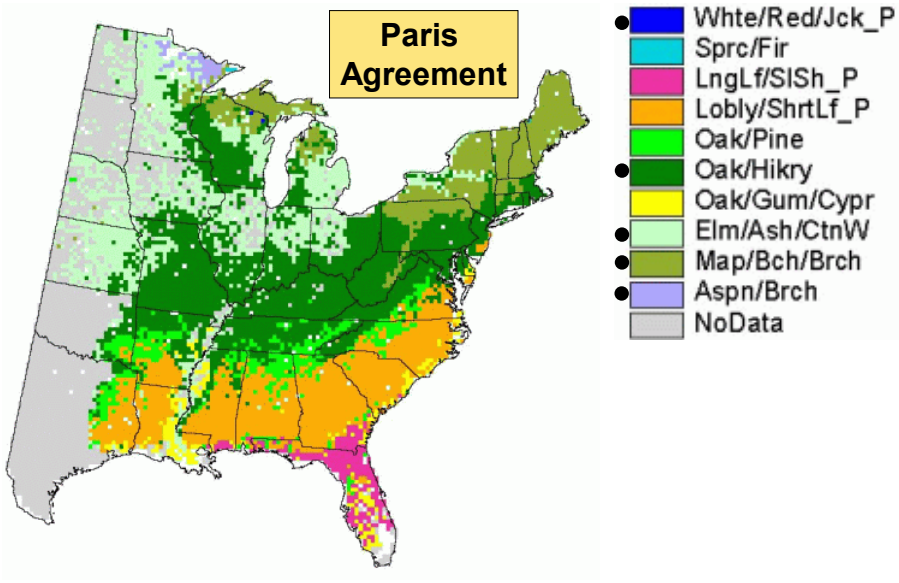
Today, the U.S. Forest Service recognizes six forest types in Michigan



Under Business as Usual, Michigan forest diversity is predicted to decline dramatically



Dut less so under the Paris Agreement



But forests are more than just trees

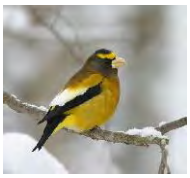
Under BAU, 24 Michigan bird species are predicted to decline by 80-100%


Common loon


White-throated sparrow


Veery


Yellow-bellied sapsucker


Evening grosbeak


Red-breasted nuthatch


Magnolia warbler


Blackburnian warbler

But under the Paris Agreement, only 10 Michigan bird species are predicted to decline by 80-100%


Common loon


White-throated sparrow


Veery

Great Lakes southern small mammal species have been moving northward, replacing northern species

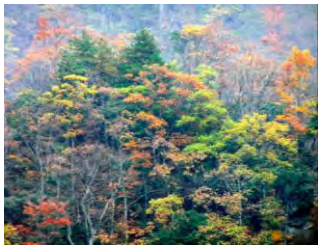
e.g. the white-footed mouse is replacing the deer mouse (and is a major reservoir for Lyme Disease)

All forest species and ecosystems in the GLR will experience more frequent fires

- fire season will be at least 20 days longer

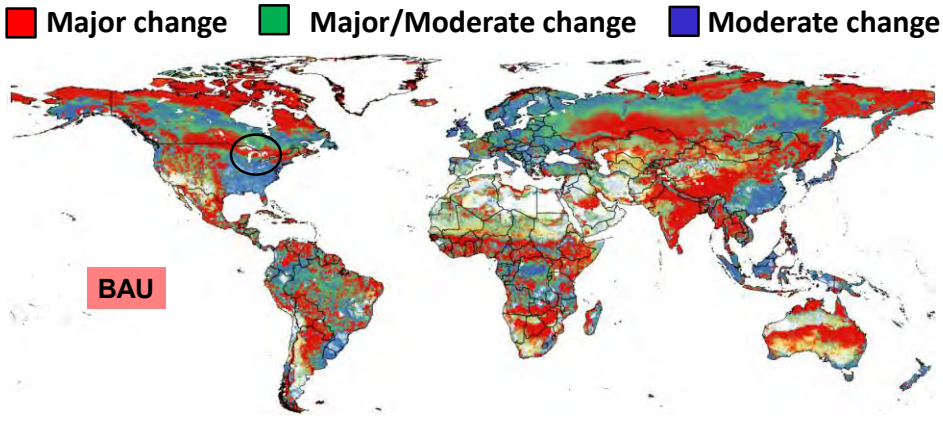
Under Business as Usual, 70% of the Earth's land surface will be at risk of at least moderate biome change

Moderate change *e.g.* boreal forest to temperate deciduous forest

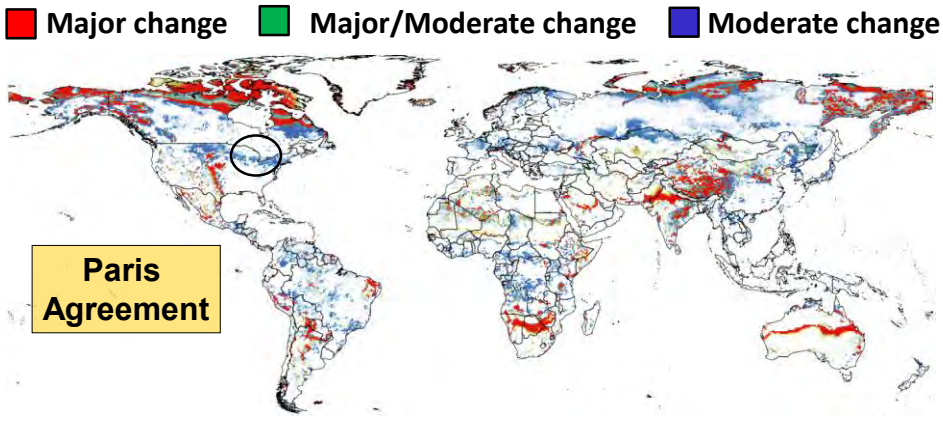


Major change *e.g.* tropical forest to savanna

Under Business as Usual, almost all of the GLR will be at risk of at least moderate biome change



Under the Paris Agreement, much less of the GLR (and only 25% of Earth's land surface) will be at risk of at least moderate biome change

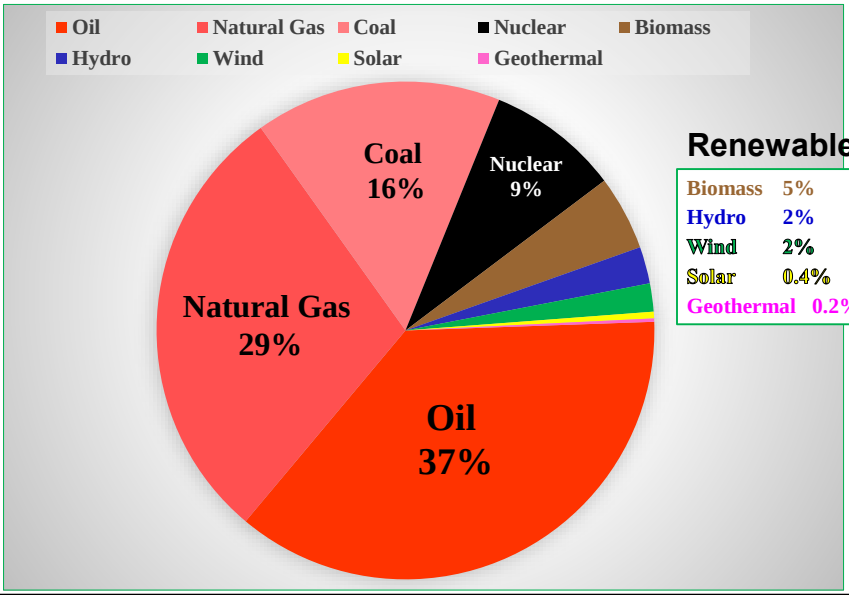


The future depends on our choices

With the Paris Agreement, 195 countries pledged to limit warming to 2° C, and try for 1.5° C

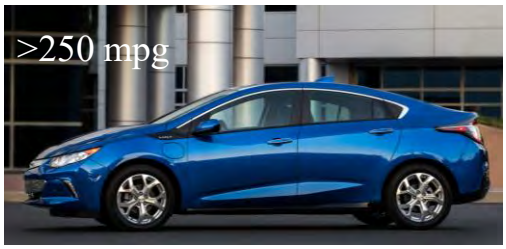
How do we limit warming to 2° C?

82% of U.S. energy use comes from fossil fuels



1. Choose to use less fossil fuel energy

- practice energy efficiency and conservation

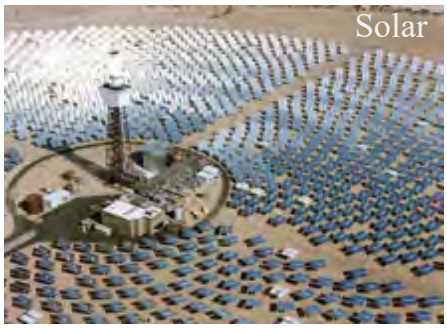


- however, by itself, only delays the outcome

2. Choose to generate some of your own green energy

3. Choose to demand that our policymakers support smarter energy choices

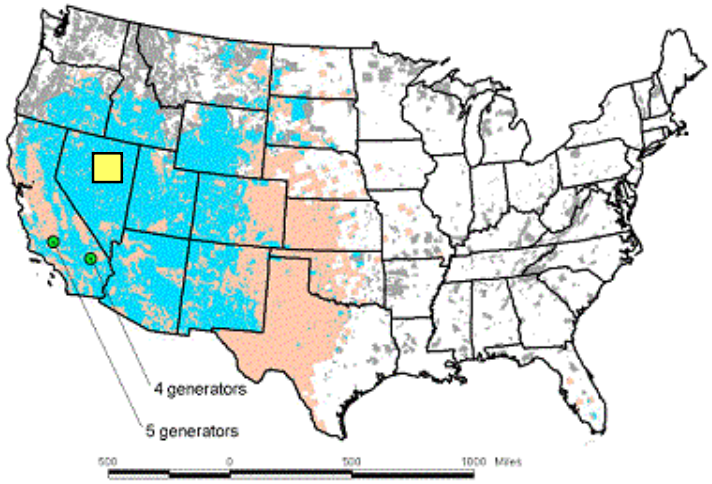
Target: 80% of energy from smarter sources by 2040



Potential: 100 times total global energy use

Potential: 40 times total global energy use

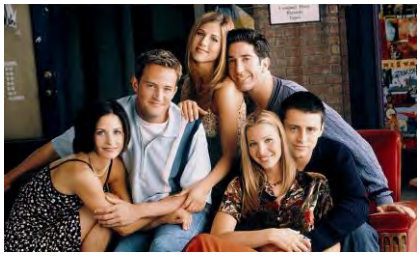
A solar array less than 100 x 100 miles could provide all of U.S. electricity needs today



- excess heat captured during the day is already being stored and used to produce electricity at night

4. Choose to talk about climate change causes, consequences, and solutions

with friends



with ones who think differently

with coworkers

and especially with youth

5. Speak for the moral high ground

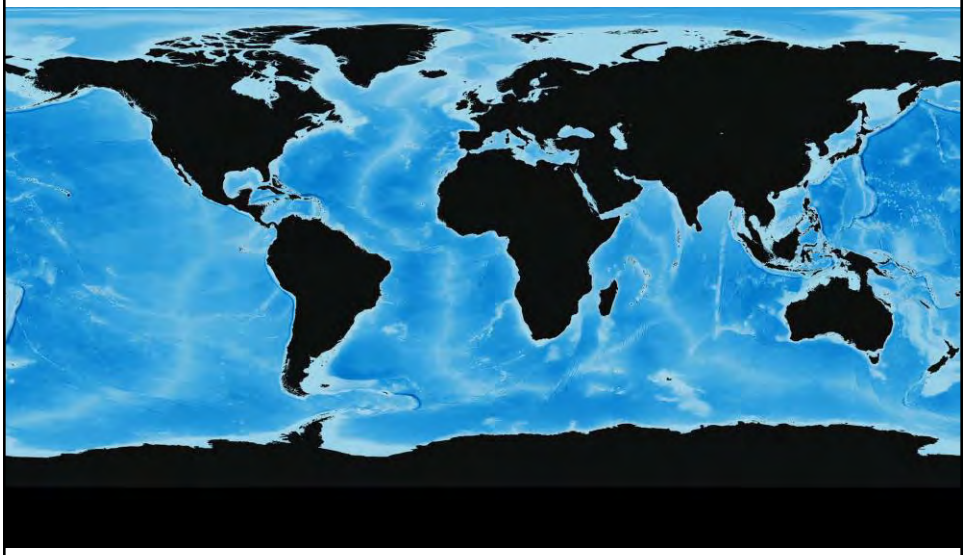
People in developed countries are causing the problem, but people in developing countries will suffer most of the health effects

Countries proportional to CO_2 emissions through 2002:

People in developed countries are causing the problem, but people in developing countries will suffer most of the health effects

Countries proportional to climate-related health effects:

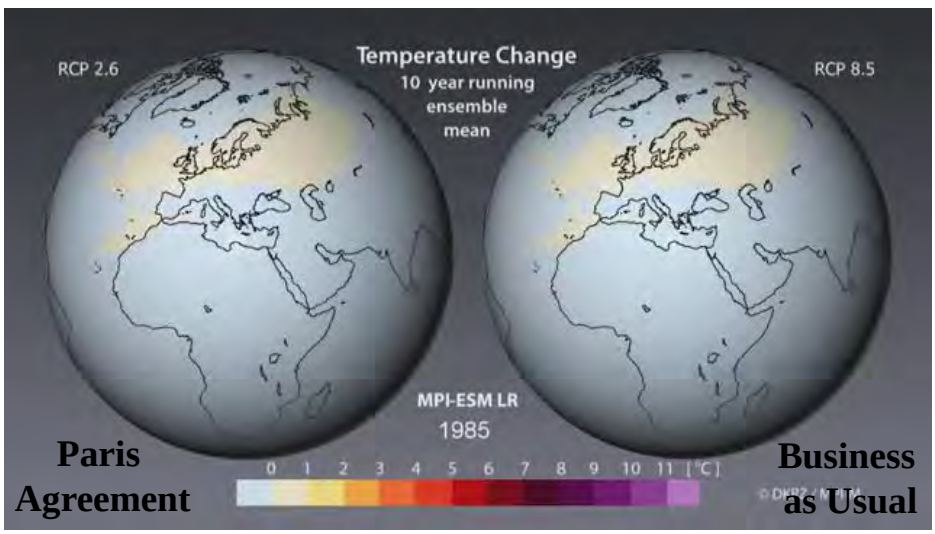
Most CO_2 emissions are from countries in the Northern Hemisphere



https://youtu.be/1rZDJrVcie4

6. Choose to join a climate truth organization

7. Choose to make climate change a major voting issue

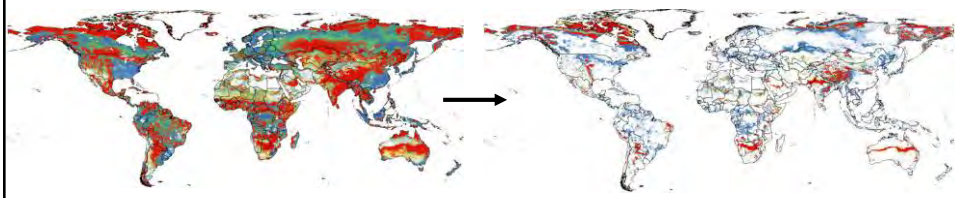


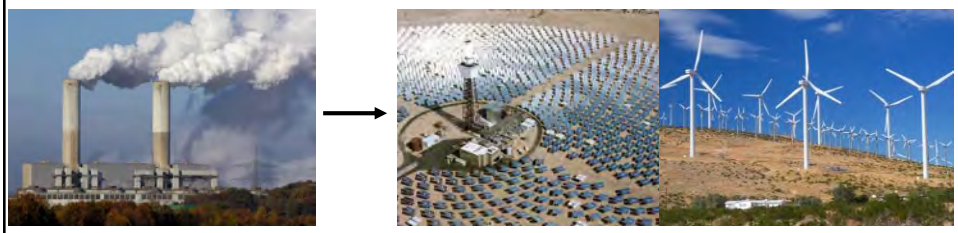
Paris Agreement

Business as Usual

https://www.youtube.com/watch?v=dBHL_7dEpTg&feature=youtu.be

Bottom line: The Great Lakes Region, like the rest of the planet, would benefit tremendously from limiting warming to 2° C. For a short time, it's still an achievable target, and it's worth fighting for.





The future depends on our choices

Let's be the generation that saves the world

Thank you for listening

How Will Climate Change Affect Southwest Michigan?

If we act quickly, we can still choose the type of planet we leave to future generations. Among our choices are to 1) continue along our "Business as Usual" pathway, in which we slowly reduce carbon emissions, or 2) reduce carbon emissions much more rapidly, as pledged in the Paris Agreement, by using already available wind, solar, and other technologies. The comparisons below illustrate how these choices would affect southwest Michigan. (All predictions are for the later decades of this century.)

Business as Usual

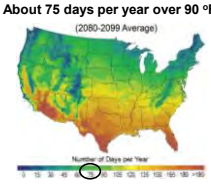
Warming of about 9.5 °F

Paris Agreement

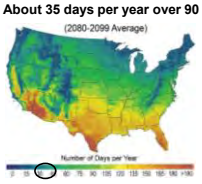
Warming of about 3.5 °F

The difference between today and the last ice age was about 9.5 °F in the other direction.

About 75 days per year over 90 °F

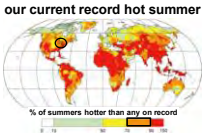


About 35 days per year over 90 °F

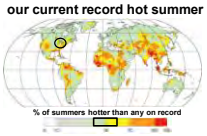


During the 20th century, SW Michigan averaged about 3 days per year over 90 °F.

About 80% of summers hotter than our current record hot summer



About 50% of summers hotter than our current record hot summer



Business as Usual

About 23 Chicago 1995-like heat waves per decade (killed >700 people)

Paris Agreement

About 3 heat waves per decade like the one in Chicago in 1995

Historically, this was a once-in-a-century event.

About 10% less rain in summer, when crops need it most

About 5% less rain in summer

Loss of many plant and animal species

Loss of many fewer species

If you would like more information, please feel free to contact Dr. David Karowe, WMU Professor of Biological Sciences, at david.karowe@wmich.edu or 269-387-5630