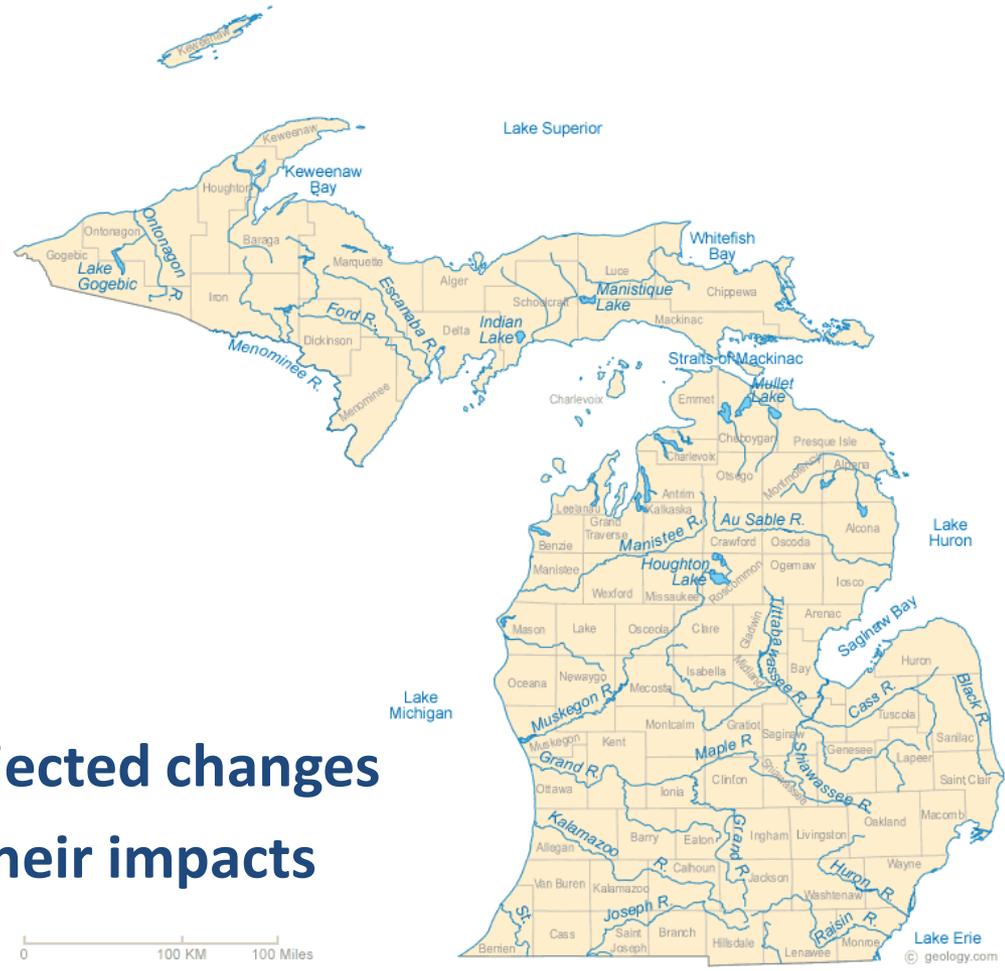


# How will global warming of 2°C affect Michigan?



**Observed and projected changes  
in climate and their impacts**

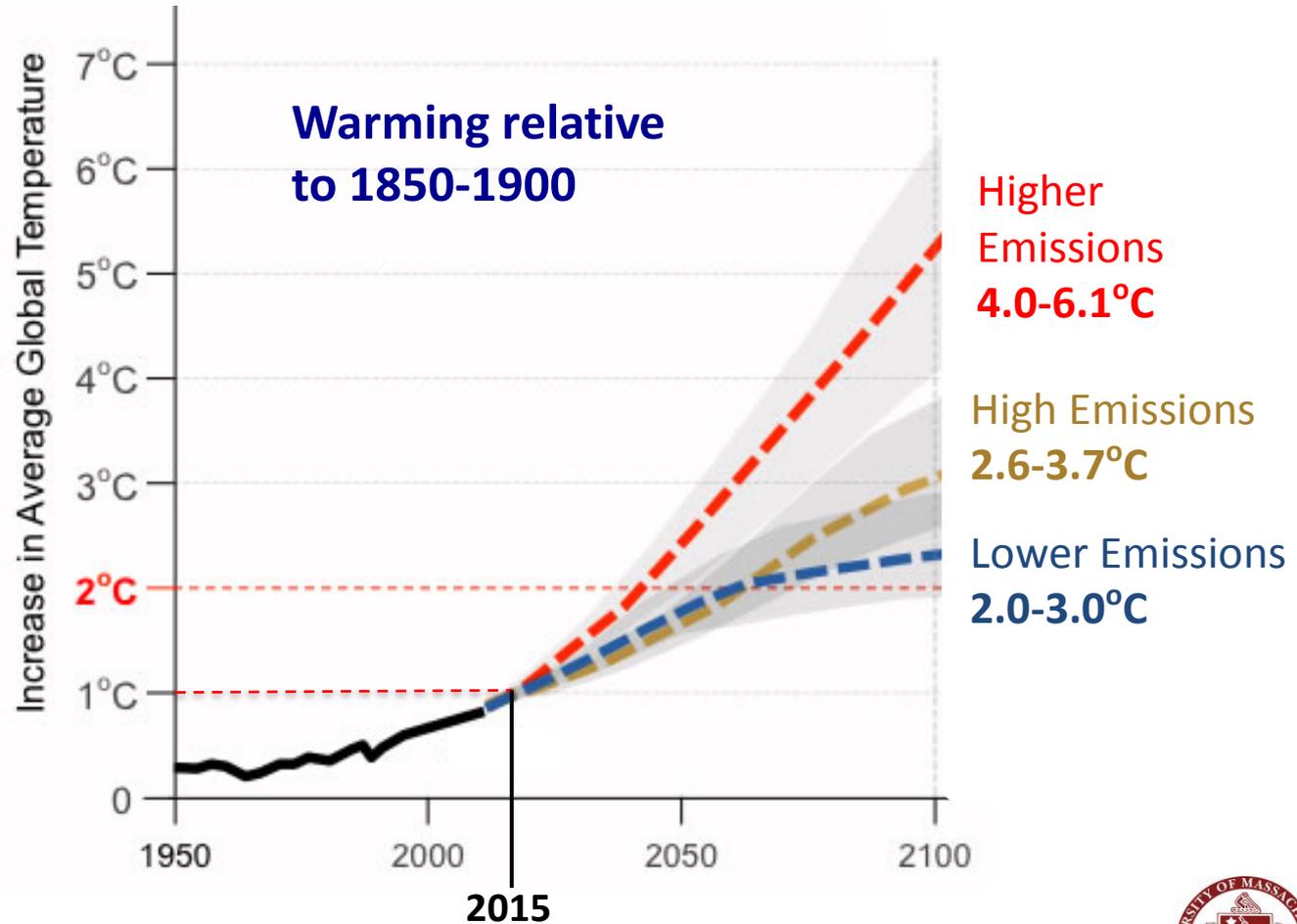
***“To prevent dangerous interference with the climate system, the scientific view is that the increase in global temperature should be below 2°C [relative to pre-industrial levels]”.***

- United Nations Framework on  
Climate Change, 2010

# How will global temperatures change in the future?

The global average temperature has already increased by about 1°C (1.8°F) relative to pre-industrial levels.

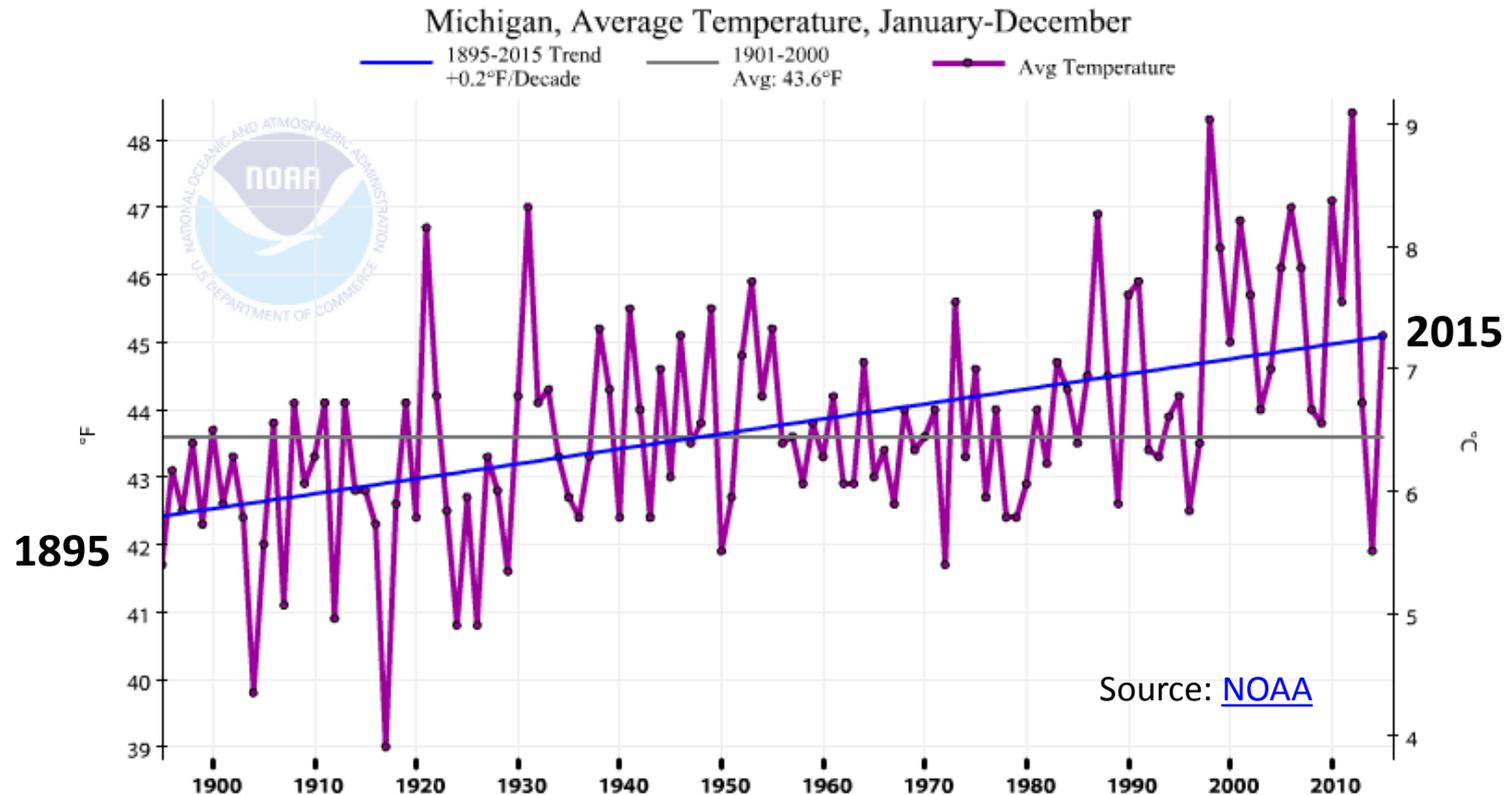
Current CO<sub>2</sub> emissions are tracking the 'higher emissions' scenario; unless emissions are reduced, the 2°C threshold will be crossed before 2050.



# Warming in Michigan



**OBSERVATIONS** The annual mean temperature in MI has increased by about 2.4°F (1.3°C) since 1895 – faster than the rise in global mean temperature.



*The annual mean temperature in MI has exceeded the 20th-century average almost every year since 1998.*

# Warming in Michigan

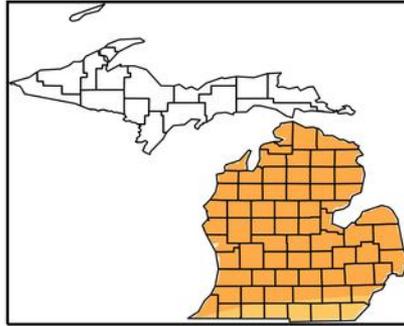


## PROJECTIONS

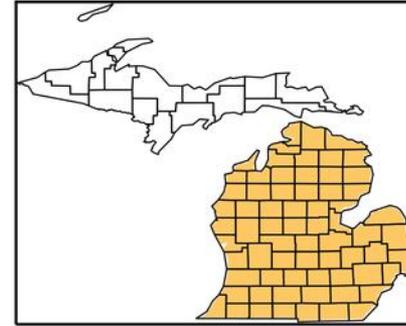
In the next 50-60 years, when global warming crosses the 2°C threshold, MI average summer and winter temperatures are projected to increase by over 5°F (2.8°C) relative to pre-industrial levels.

Lower Emissions

Winter

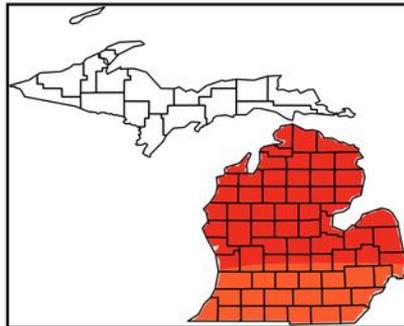


Summer

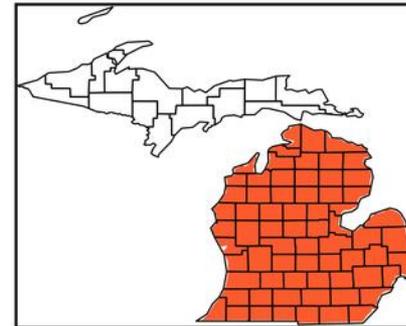


Higher Emissions

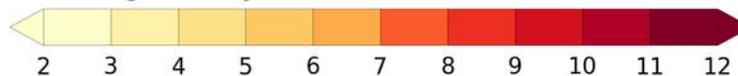
Winter



Summer



Warming in °F by 2070 relative to 1961-1990 mean



Source: produced by CSRC, UMass Amherst

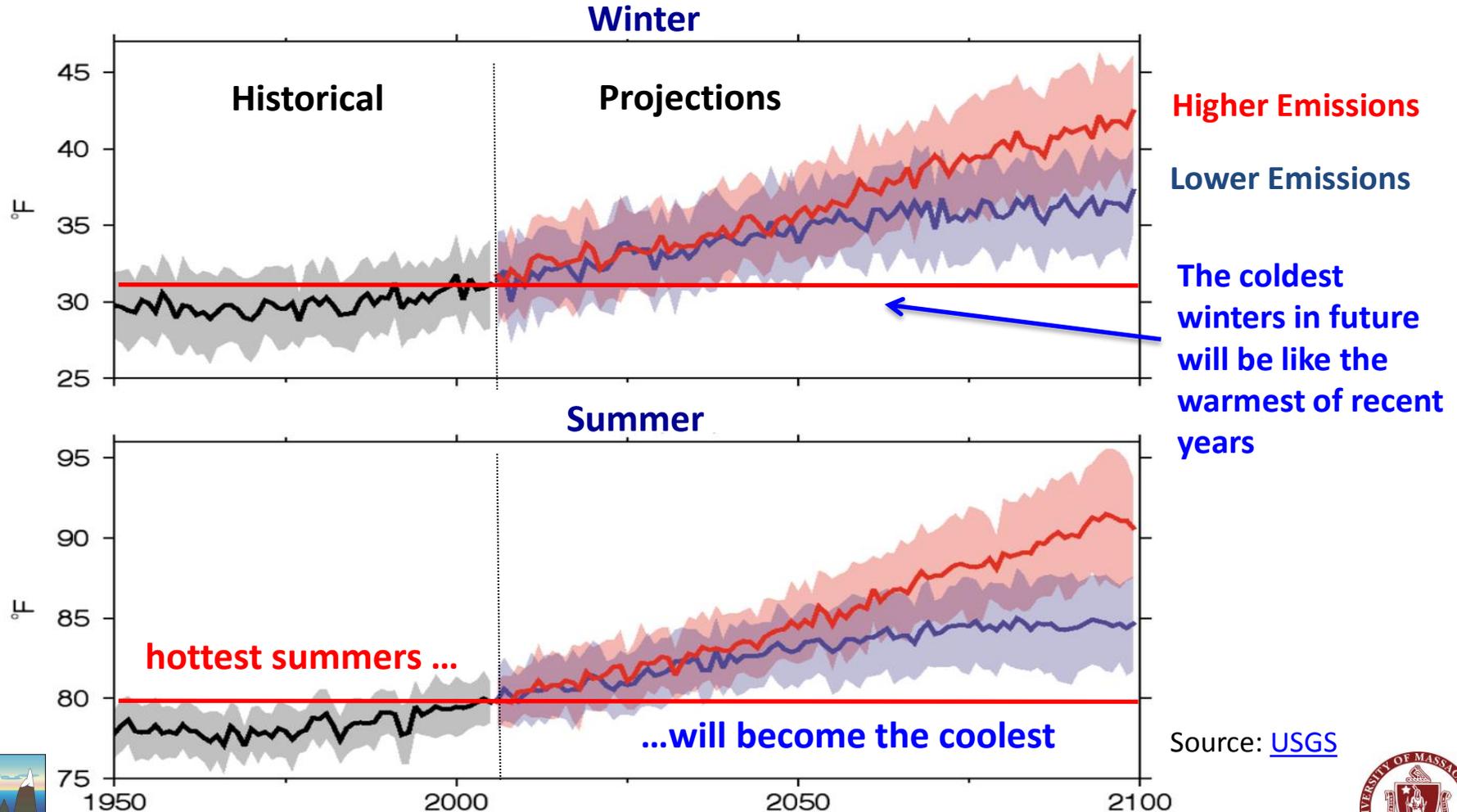
(Upper Michigan projections coming soon)

# Warming in Michigan



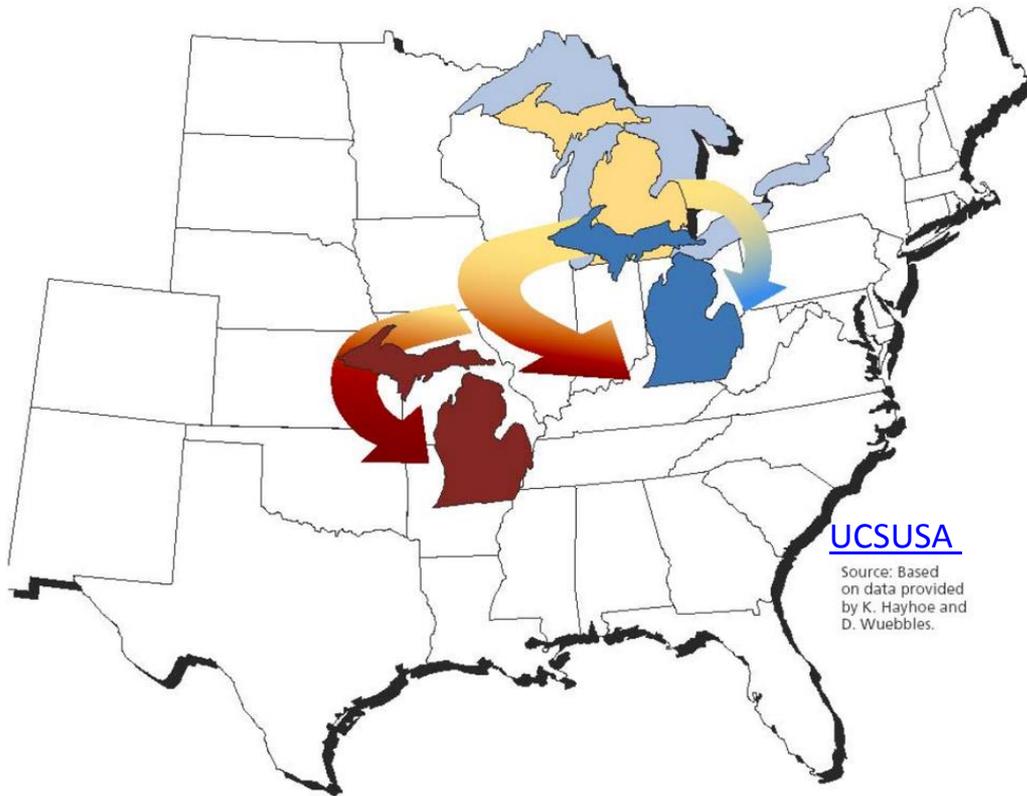
## PROJECTIONS

How warm will Winter and Summer temperatures become?



Source: [USGS](https://www.usgs.gov/)

# Migrating Michigan Climate



[UCSUSA](#)

Source: Based on data provided by K. Hayhoe and D. Wuebbles.



## PROJECTIONS

Summer in Michigan by the end of this century could feel like a present-day typical summer in Missouri or Arkansas.

## *Consequences:*

*Negative impacts on human health, ecosystems, and the economy.*

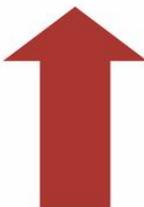
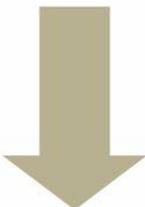
Analysis is based on changes in average summer heat index (a measure of how it actually feels for a given temperature and humidity).

# Extreme Heat



**OBSERVATIONS** The number of hot, dry days has increased, while the number of cool, dry days has decreased significantly in Detroit, MI in the last 50 years.

## 52 Years of Weather Trends: Detroit, MI (1959–2011)

DAILY SUMMER WEATHER TRENDS			NIGHTTIME SUMMER WEATHER TRENDS			
Very hot, humid days and hot, dry days are both dangerous to human health, while cool, dry days bring relief from the summer heat and humidity.			High nighttime temperatures and high relative humidity bring no relief from the heat, putting people at risk for heat-related illness and death.			
Very Hot, Humid Days	Hot, Dry Days	Cool, Dry Days	Temperature and Humidity Changes in Very Hot, Humid Nights		Temperature and Humidity Changes in Hot, Dry Nights	
			Temperature	Dew Point	Temperature	Dew Point
 <b>Increased<sup>^</sup></b> <b>172%</b> 3.5 Days	 <b>Increased<sup>^</sup></b> <b>338%</b> 3 Days	 <b>Decreased*</b> <b>70%</b> 10.5 Days	 <b>Increased*</b> <b>2.1°F</b>	 <b>Increased*</b> <b>2.5°F</b>	 <b>Increased*</b> <b>4.3°F</b>	 <b>Increased</b> <b>1°F</b>
<span style="color: orange;">■</span> +100–199% <span style="color: red;">■</span> + > 200% <span style="color: grey;">■</span> Decrease in Cool Days			<span style="color: orange;">■</span> + 1°–2.9°F <span style="color: red;">■</span> + > 3°F			

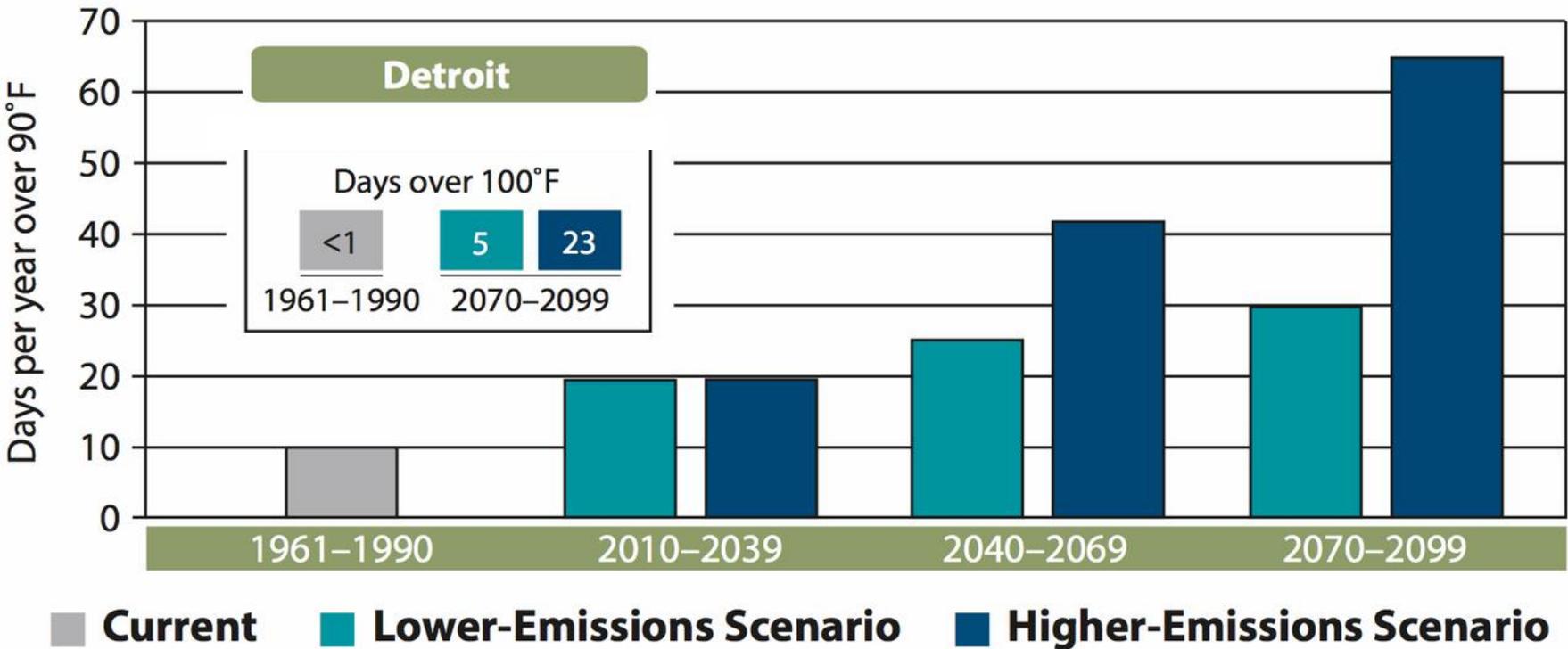
Source: [UCSUSA](http://UCSUSA)



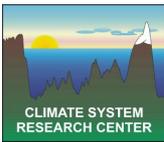
# Extreme Heat



**PROJECTIONS** The number of days with dangerously high temperatures (above 100°F) is projected to increase significantly in the future.



Source: [UCSUSA](https://www.ucsusa.org)

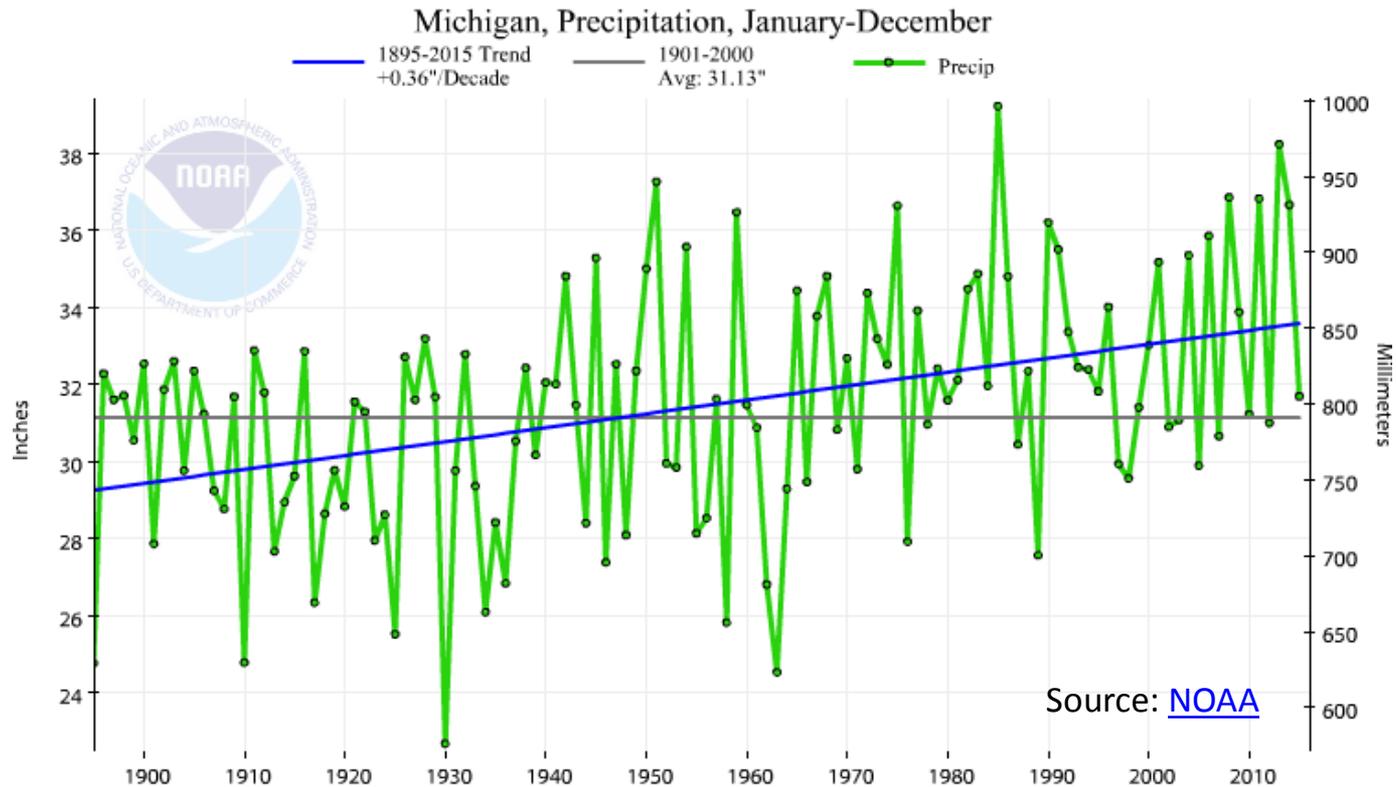


# Rain and Snow in Michigan



## OBSERVATIONS

Annual total precipitation (rain + snow) has increased over the last few decades.



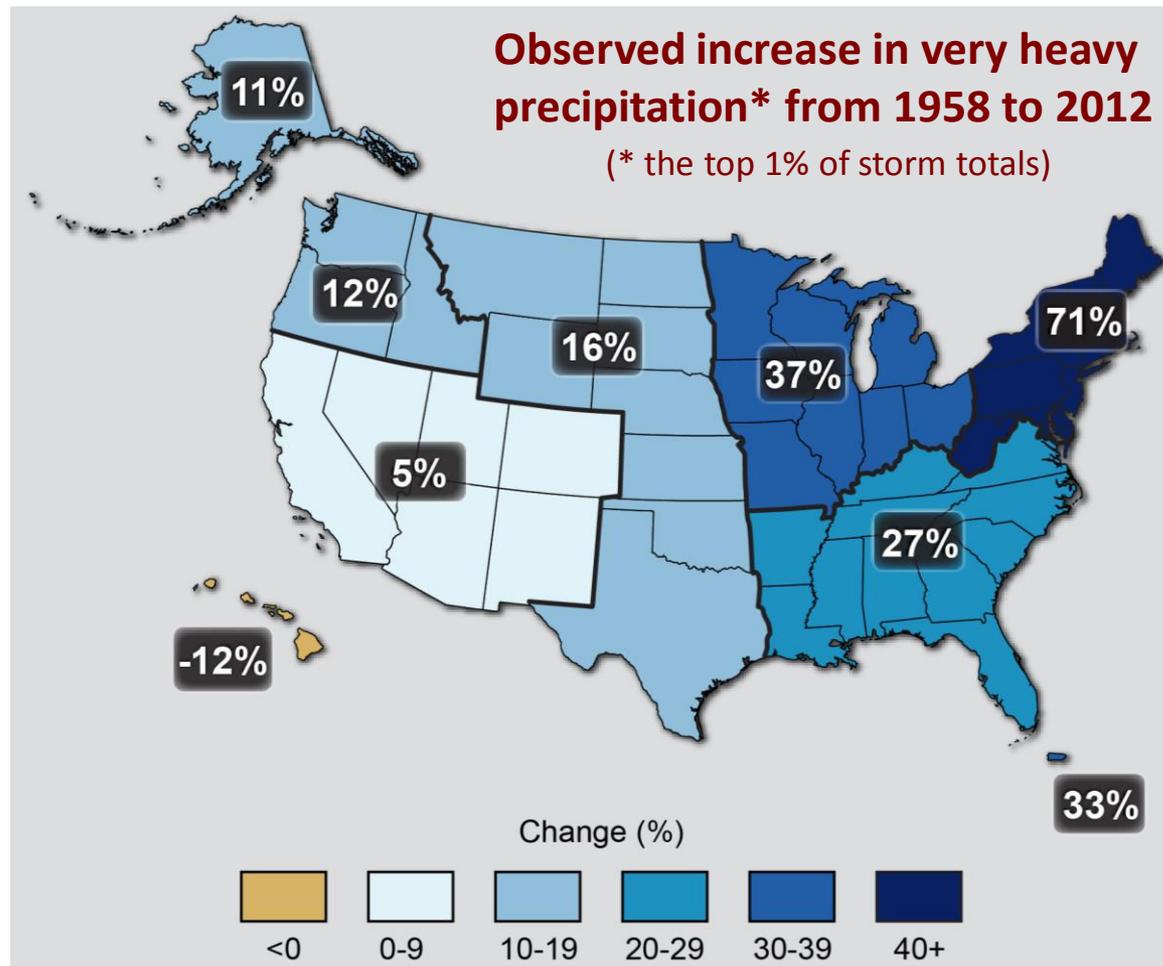
*In 8 out of the last 10 years, Michigan received more precipitation than the 20<sup>th</sup> century average.*

# Very Heavy Rainfall

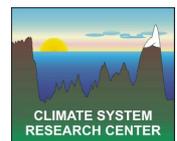


## OBSERVATIONS

The amount of precipitation falling during intense multi-day events has increased significantly in the Midwest US.



Source: [NCA](#)  
2014

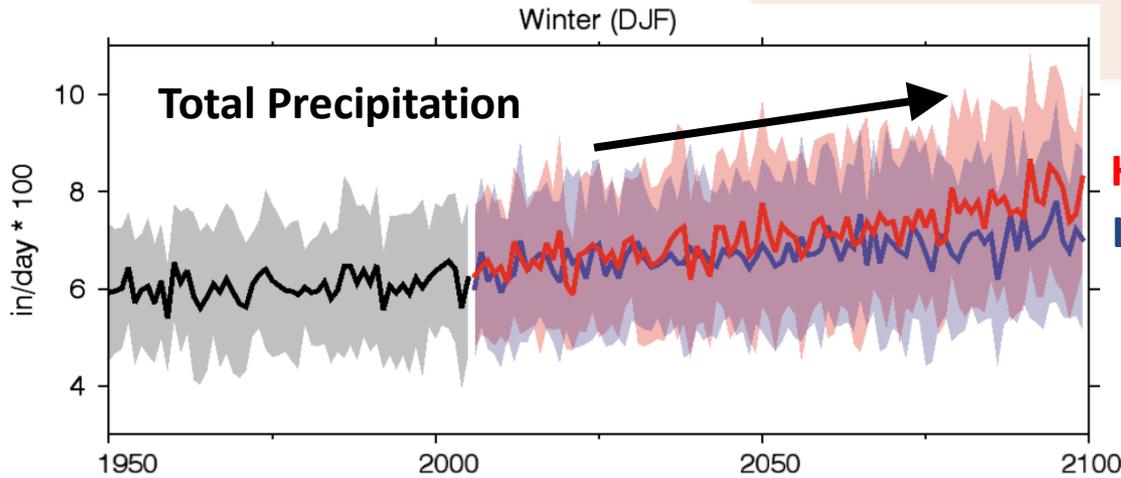


# Rain and Snow in Michigan



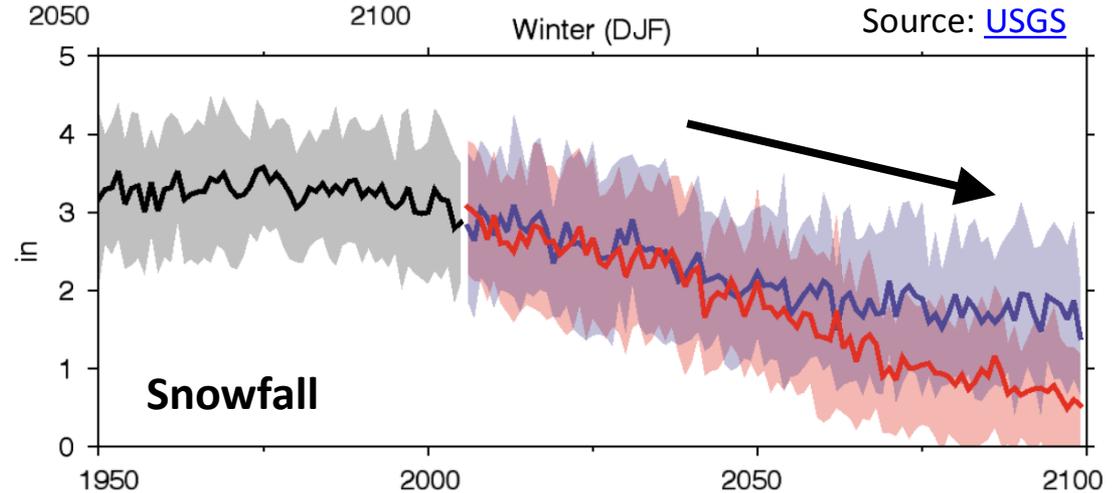
## PROJECTIONS

Winter precipitation is projected to increase through the 21<sup>st</sup> century.



Higher Emissions  
Lower Emissions

Due to increasing temperatures, there will be more rain and less snow.



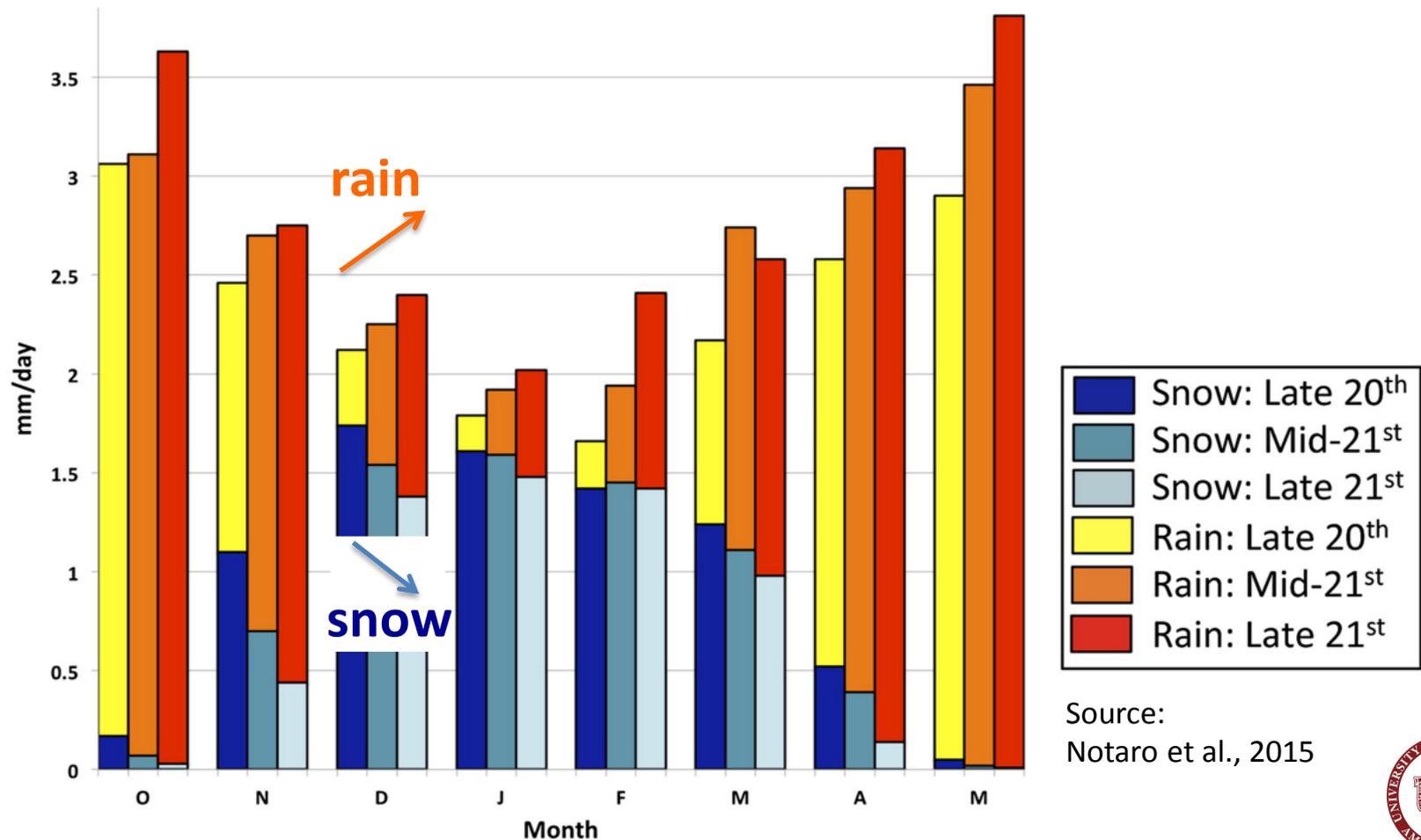
Source: [USGS](https://www.usgs.gov/)

Projected changes in rainfall in summer are uncertain.



# Lake Effect Snow

**PROJECTIONS** The total lake-effect precipitation is projected to increase in the future in the Great Lakes basin, but with increased rainfall at the expense of snowfall.



Source:  
Notaro et al., 2015



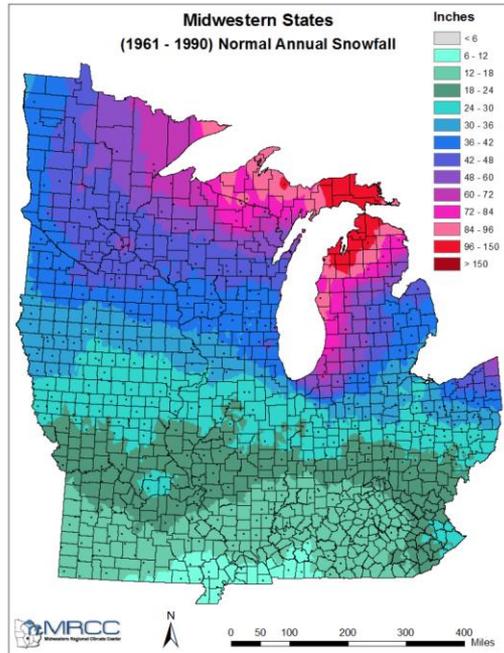


# Lake Effect Snow

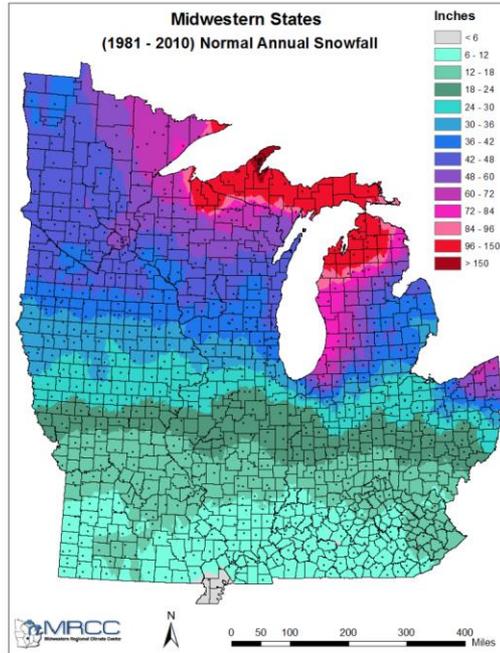
## PROJECTIONS

Some regions in MI may also receive more lake effect snow in the future due to a reduction in lake ice cover.

Snowfall 1961-1990



Snowfall 1981-2010



**Beach in Arcadia, MI covered in snow off of Lake Michigan, 2013**



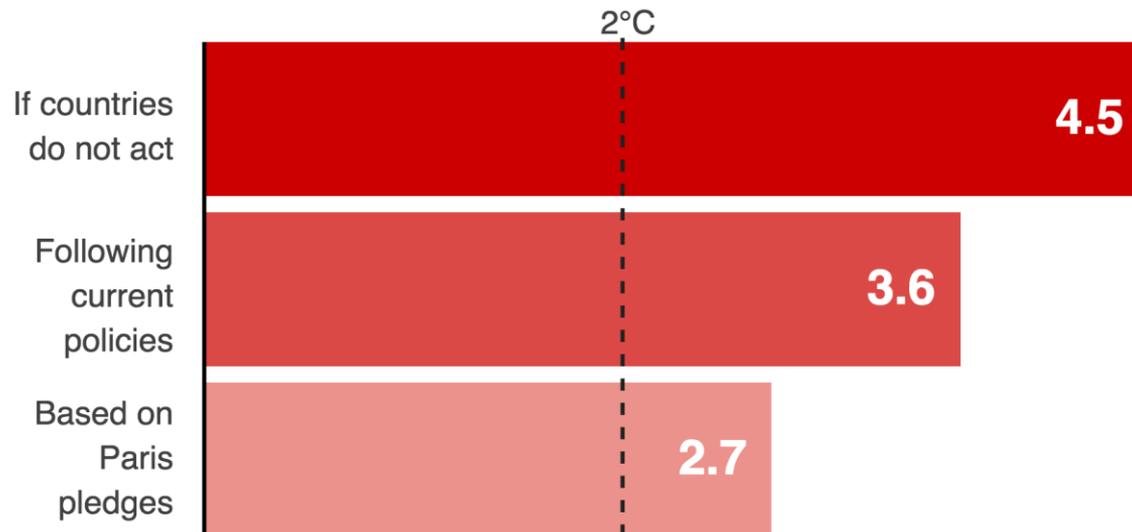
Source: [www.miseagrant.umich.edu](http://www.miseagrant.umich.edu)

Source: [MRCC](http://MRCC)

# Climate Summit in Paris [COP21]

Immediate action on local and global scales is required to limit the global mean temperature increase to 2°C (3.6°F).

Average warming (°C) projected by 2100



Source: Climate Action Tracker, data compiled by Climate Analytics, ECOFYS, New Climate Institute and Potsdam Institute for Climate Impact Research.

# Strategies and Actions

## National Climate Assessment:

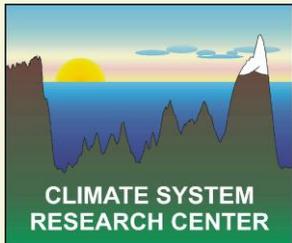
*The National Climate Assessment summarizes the impacts of climate change in the US, now and in the future.*

## Integrating Climate Change into State Wildlife Action Plan (SWAP):

*The goals of SWAP are to generate proactive, comprehensive wildlife conservation strategies that assess the health, challenges, and potential actions each State would like to accomplish during the coming decade and beyond.*

## Climate and Health Assessment:

*This scientific assessment examines how climate change is already affecting human health in the US and the changes that may occur in the future.*



This report was created by Prof. Raymond Bradley,  
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[Climate System Research Center \(CSRC\)](#)  
University of Massachusetts Amherst

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