Michigan Extreme Precipitation

Summary

Intensity

The intensity of severe storms across the Great Lakes region has increased (Figure 1). In the State of Michigan, intensification of extreme precipitation events has been more pronounced over the Lower Peninsula (LP) compared to the Upper Peninsula (UP). Intensification of extreme precipitation events will likely continue in the future as the effects of climate change become more pronounced.

The amount of precipitation falling in the heaviest 1% of daily storms increased by 24% in the Great Lakes region from 1950-2010.

The amount of precipitation falling during multi-day events has increased dramatically over Michigan's LP.

Frequency

The frequency of severe storms across the Great Lakes region has increased. In the future, the frequency of heavier storms is projected to increase at a faster rate than storms that are less intense.

In the future, there may be a greater chance of both increased extreme precipitation events and prolonged dry periods.

Seasonality

Precipitation totals over Michigan's LP during the fall and spring have increased in most locations, while summer and winter precipitation totals have remained relatively stable. In Michigan's UP, fall precipitation has increased while all other seasons have experienced a decrease in precipitation.

Form

Annual lake effect snow has increased downwind of Lakes Superior and Michigan, and in the future lake effect precipitation is projected to increase although the LP may experience more rain than snow.

Historical data are based on NOAA's climate division data, US/Canadian weather station observations, and Kunkel, K.E., K. Andsager, and D.R. Easterling, 1999: Long-Term Trends in Extreme Precipitation Events over the Conterminous United States and Canada. J. Climate, 12, 2515–2527.

Historical Extreme Precipitation

Precipitation—especially extreme precipitation—observations can vary greatly over very short distances from one another making it difficult to collect a continuous record in space and time. In the map below, the circles represent locations of weather stations where the data records pass GLISA's quality control standards. The color of the circle indicates whether extreme precipitation events have become more (red) or less (blue) intense. The size of the cirlce indicates the magnitude of that change (bigger = greater change). Most stations across the LP indicate small to moderate increases in the amount of precipitation falling during the most extreme events. A few stations across central and in southwest MI observed larger increases, and the UP stations report very small decreases.

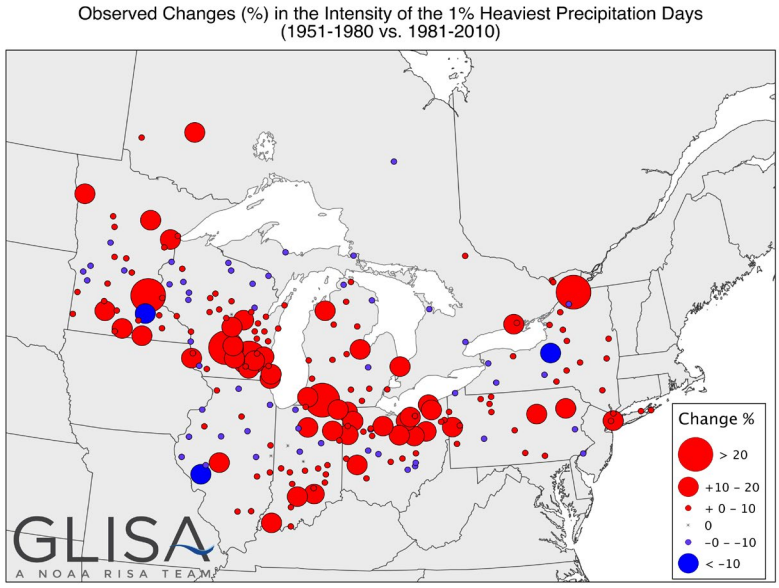

Figure 1: The change (%) in precipitation intensity (defined here as the amount of precipitation falling in one day) of the top 1% of heaviest precipitation days is mapped for the eight Great Lake states and Ontario at select weather station locations. Positive (negative) changes indicate daily extreme precipitation events have become even more extreme.

Glossary of Terms

Ensemble - A set of several climate model projections

Ensemble Mean - The average of several climate models

Precipitation Intensity - Rainfall rate measuring amount of rainfall over a given time period

Projection - Data representative of the future climate from a climate model simulation

Very Heavy Precipitation - The heaviest 1% of all daily precipitation events

Future Extreme Precipitation

In the future, more extreme precipitation events are anticipated. The change in days receiving one, two, and three-inches of precipitation by the mid-21st century are presented here. Since extreme events are, by definition, uncommon the numbers reported are in units of days per decade to avoid reporting fractions of a day.

The maps (Figure 2) of future projections are based on the average of an ensemble of six regional climate models.[1] The lower and upper range of the ensemble, which characterizes the difference between models, is reported in Table 1 for Michigan.

Table 1: Future change in number of days (per decade) with over 1, 2, and 3 inches of precipitation by mid-century for MI sub-regions. The reported range spans the lower to upper bound of projections in the ensemble. In every region at least one model projected a decrease in the number of days.

	1+ Inches	2+ Inches	3+ Inches
Western UP	-8 to 32 (days/decade)	-8 to 16	-8 to 8
Eastern UP	-8 to 24	-8 to 8 (up to 16 in far east)	-8 to 8
Northern LP	-8 to 24	-8 to 8	-8 to 8
Southern LP	-8 to 24 (up to 40 in southeast)	-8 to 16	-8 to 8

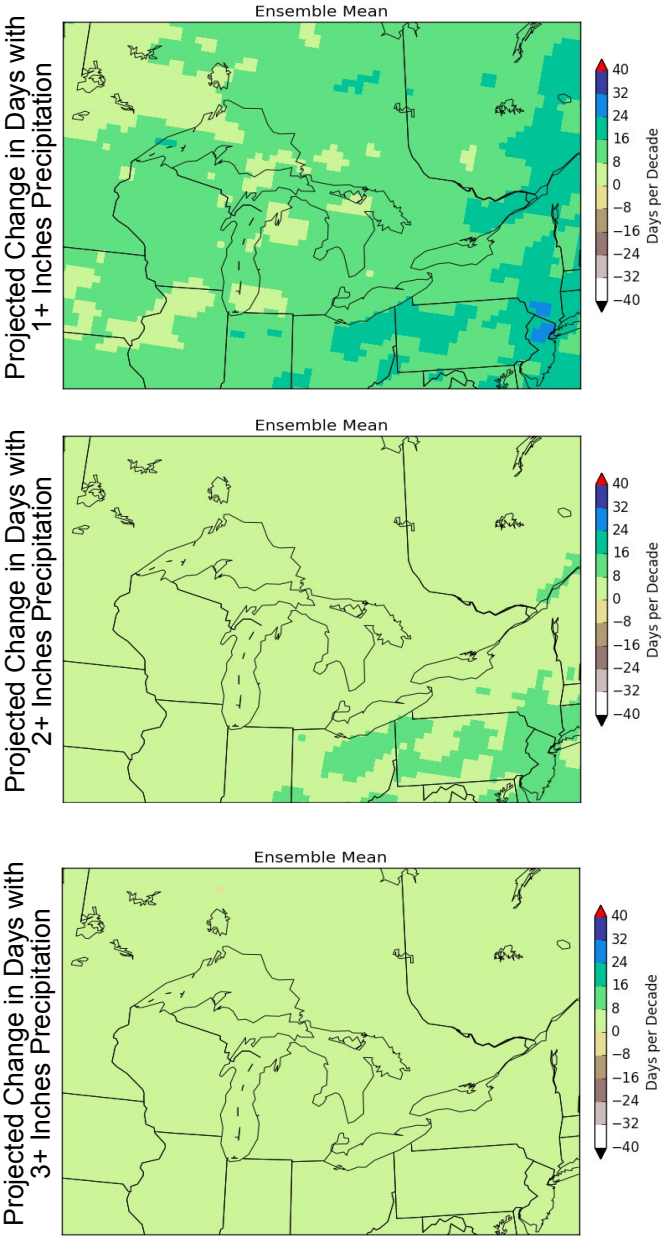

Figure 2: Maps of the projected change in days with 1+, 2+, and 3+ inches of precipitation by the mid-21st century (2040-2059 compared to 1980-1999). The Ensemble mean (average of 6 high-resolution regional climate models) is mapped.

Changes in Days/Decade with 1+ Inches Precipitation

On average, the State of Michigan is projected to experience more days with 1+ inches of precipitation by mid-century. In most parts of the State, 8 to 16 more days/decade are projected. In the northern LP and south western LP increases may be smaller (0 to 8 more days/decade). The western UP is one particular region where some models diverge - two of the six models project over 24 more days/decade receiving 1+ inches of precipitation, and one model projects a slight decrease (0 to 8 fewer days/decade).

Changes in Days/Decade with 2+ Inches Precipitation

On average, the State of Michigan is projected to experience up to 8 more days/decade of 2+ inches of precipitation by mid-century. Individual models indicate slightly more extreme precipitation in small pockets of the State, particularly southeast MI. Parts of the central LP show decreases and increases depending on the model.

Changes in Days/Decade with 3+ Inches Precipitation

On average, the State of Michigan is projected to experience up to 8 more days/decade of 3+ inches of precipitation by mid-century. There is very little variability among individual models indicating all would suggest a similar future change in extreme precipitation at the 3+ inches/day threshold. Two models suggest slight decreases of 3+ inch precipitation days in the central LP.

[1]The six models are the dynamically downdownscaled projections for the Great Lakes region available from the Center for Climatic Research, Nelson Institute, University of Wisconsin-Madison (http://nelson.wisc.edu/ccr/resources/dynamical-downscaling/index.php)

Extreme Precipitation & Impact Scenarios

GLISA and the Inter-Tribal Council of Michigan developed a set of extreme precipitation events and accompanying environmental conditions, as described in the four scenarios below, as a resource for the Tribes to use when thinking about how extreme precipitation may impact people and the environment at specific locations/regions. A list of general Tribal impacts is provided, and there is space for new impacts to be added to each scenario as specific concerns, issues, systems, etc. are considered.

Scenario 1
Extreme Precipitation Event During Dry Period in Spring/Summer

Event Description
The previous season experienced less than normal precipitation, and the ground is dry when the extreme rain or snow (in Spring) event occurs. The rain event may be an intense 1-day event or multi-day rain event with extremely high rain totals.

Specific Impacts

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Scenario 2
Extreme Precipitation Event During Wet Period in Spring/Summer

Event Description
The previous season experienced more than normal precipitation, and the ground is saturated when the extreme rain event occurs. The rain event may be an intense 1-day event or multi-day rain event with extremely high rain totals.

Specific Impacts

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Scenario 3
Extreme Rain Event Over Bare, Frozen Ground

Event Description
Winter conditions leave the ground frozen but without snowpack at the time of an extreme rain event. The rain event may be an intense 1-day event or multi-day rain event with extremely high rain totals.

Specific Impacts

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Scenario 4
Extreme Rain Event Over Deep Snowpack

Event Description
The ground is covered in moderate to deep snow at the time of an extreme rain event. The rain event may be an intense 1-day event or multi-day rain event with extremely high rain totals.

Specific Impacts

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General Impacts for All Scenarios

- Increased flooding & associated risks with infrastructure, damage to vegetation
- Erosion - major issue with coastal communities & developed areas, water quality, aquatic fish/plants/mussels
- Sedimentation & nutrient loading in surface waters, decrease water quality, cascading impacts on aquatic communities
- Interruption of pollination and food/medicine gathering, destroy gardens & wild gathered foods (depending on timing)
- Damage to budding vegetation, interruption of food/medicine gathering, interruption of pollination, reduced production wild/gathered foods, interruption in wildlife cycles, poor breeding outcomes among wildlife
- Stress on cold water fisheries
- Blockage or washout of main roads, inability to access healthcare (extreme case with dialysis), groceries, childcare/work
- Seiche on Great Lakes degrade shorelines, docks, buildings, parking lots, roads, gathering areas/beaches
- Risk of mold in homes