Grand Rapids, MI

Historical and Future Climate Information

GLISA
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WEST MICHIGAN SUSTAINABLE BUSINESS FORUM

Main Points

- Temperatures are rising, but extremes will be moderated (lessened) by Lake Michigan.
- Winter temperatures are becoming less severe.
- Winter precipitation is transitioning to more rain and freezing rain as opposed to snow.
- Intense precipitation events have increased, but the timing of events in the future is not especially predictable.
- Increased drought is possible as more precipitation is projected to fall in shorter, intense events with longer dry periods in between.

Extreme Heat

Hot Days (92˚F) - Days with high temperatures at or above 92˚F are fairly common, and there has not been an increase in the number of days over 92˚F over the last 100 years. Multiple consecutive days experiencing max temperatures above 92˚F occur about once every other year, and the duration of extended hot days has been declining over the record. In 1897 there was a max of 9 consecutive days at or above 92˚F, but since the 1950's these types of events are limited to 3-4 consecutive days on average. By mid-century (2050), models suggest anywhere from one week up to one month more of days over 90˚F per year.

Hot Days (103˚F) - Days with temperatures at or above 103˚F (not taking into account the heat index when temperatures can feel hotter) are rare (only 6 on record, and only one of those was since the 1930's). The record maximum temperature was 108˚F. Geographically, the hottest temperatures are typically in the most urban parts of Grand Rapids (a result of the urban heat island effect) and locations farther away likely do not experience the same intensity of extreme heat. There are also very few (3) instances where multiple consecutive days were greater than or above 97˚F, making this level of prolonged heat rare. By mid-century (2050) models suggest up to two weeks more per year of days over 100˚F, but such hot days will not necessarily occur consecutively.

Heat Waves - Heat waves can result from a combination of different drivers including high humidity, daily high temperatures, high nighttime temperatures, stagnant air movement, etc. In the future, models project an increase in the number of days experiencing high temperatures that could lead to additional heat waves, especially since air stagnation events are projected to increase. There is greater certainty that summer nighttime low temperatures will continue to increase, thereby making it more difficult for people to cool off at night during extended heat events. In addition, periods of future drought will also contribute to extreme heat.

Extreme Cold

Cold Days (-20˚F) - Days with temperatures at or below -20˚F have only been observed 11 times in the 125-year record for Grand Rapids, MI, making it a rare event, and all but three were prior to 1900. In addition, consecutive days at or below -20˚F have not occurred since 1900. In the future there are projected to be even fewer very cold days, so this type of event will be even more rare.

Cold Days (-10˚F) - Days with temperatures at or below -10˚F have been observed very few times in the last 30 years, but were more common during the 1960s-80s. Since 1900, there have only been three instances where a max of three consecutive days were at or below -10˚F, and the majority of cold events of this intensity were only one- or two-day events. In the future there are projected to be even fewer very cold days, so this type of event will be even more rare.

Cold Days (10˚F) - Days with temperatures at or below 10˚F are fairly common and occur on average about 23 times per year. Cold events of three or more consecutive days at or below 10˚F are also more common and occur on average about 2-3 times per year. In the future there are projected to be fewer cold days, so this type of event will likely occur less frequently.

Wind Chill (-15˚F) - Since the mid 1970's, eight years never experienced wind chill values less than -15˚F and 10 years experienced less than 10 hours per year (1994 experienced the most number of hours totaling about 5 days worth). In general, more recent years have been characterized by fewer hours annually below this threshold, but there is great year-to-year variability. The data indicate wind chill values in Grand Rapids are driven more by cold temperatures than high wind speeds. This suggests even fewer wind chill hours in the future below -15˚F as very cold temperatures will become more rare.

Flood Indicators

Floods can occur under a variety of conditions not necessarily caused by heavy or extended periods of rainfall. For example, relatively little rainfall could initiate flooding conditions if the ground is already saturated, or if winter snow pack melts quickly. In the future, flooding associated with winter snow melt and winter rain is more likely. In urban environments, the amount of impervious surfaces and management of runoff also plays a major role in the potential for flooding.

Heavy Rain (1-hour events) - The number of hours per year experiencing heavy rain over 0.3 inches per hour has gradually increased from 16 annual hours to 20 hours on average since 1975 with strong year-to-year variability. The projections do not explicitly provide 1-hour event information, because precipitation is reported at the daily time scale. However, extreme daily precipitation is projected to increase, so it is feasible increases may be in part due to more intense hourly events.

Heavy Rain (35-hour events) - The number of times per year experiencing over 1 inch of rain in 35 hours has increased since 1975 with strong year-to-year variability. Trends are positive but not as strong for 35-hour events receiving over 1.25 and 1.5 inches, and there is very little change in the number of 35-hour events per year receiving over 2 inches of rain. However, by mid-century (2050) up to a week more of days receiving over 2 inches of rain is projected.

Heavy Rain (2-week events) - Periods of 2 weeks receiving

3 or more inches of rain have increased since 1975. The years 2009 and 2013 experienced the largest number of 2-week heavy rain events in the record (since 1975). The projections do not explicitly provide consecutive 2-week event information, but they do suggest fewer days with any amount of rain in the future.

Drought Indicators

There are several different types of drought depending on the impacts being considered, but all depend to a certain degree on the amount of precipitation falling in a given time period.

Rain-Free Periods - Periods of 3 weeks with less than 0.45 inches of rainfall have been highly variable year-to-year. Occurrences of these dry periods decreased after peaking in the 1980s. Summer of 2011 saw the most recent peak in 3-week drought events. In the future, even though more annual precipitation is projected overall, more is anticipated to fall in shorter, extreme events leaving longer periods of time that experience no rainfall, increasing the potential for drought. Models suggest there will be up to two weeks more per year of dry days (days with less than 1mm precipitation), however those days will not necessarily occur consecutively.

Winter Storms

Heavy Snowfall - The number of times per year experiencing over 1 inch of snowfall per hour has increased since 1975, while the number of times per year experiencing over 2 inches of snowfall per hour has seen no change and remained low. The increase in 1-inch hourly snowfall is in part due to an increase in lake-effect snowfall, which in the near term may continue to increase but over the next few decades is more likely to transition to winter rain. Annual snowfall is projected to decrease 36-72 cm by mid-century.

Blizzards - Blizzards are a combination of falling or blowing snow with high winds, and Grand Rapids, MI is in a small region that has historically experienced more blizzards than other parts of Michigan (including the Lake Michigan lake-effect zone). Blizzards are most common in January for this area. With warming winter temperatures, blizzards may be replaced by high winds and rain/freezing rain/sleet events.

Freezing Rain Events - Grand Rapids, MI is in a small pocket that has historically experienced more freezing rain events than the rest of the State. Freezing rain events are most common during January and have typically occurred between 5am and noon, which can cause daily commute challenges among other impacts. There is no significant historical trend to suggest an increase in events, however there may be greater potential for freezing rain in the future (if atmospheric and surface conditions are favorable) as more winter precipitation is expected to fall as rain as opposed to snow.

Wind Storms

High Winds - Wind events show a large amount of variability from year-to-year and at different thresholds (>26mph vs >32 mph) with no consistent historic trend (>26 mph showed a slight increase, >32 mph showed a slight decrease). The future projections used do not provide information about high wind events.

Tornadoes - Tornado counts have stayed fairly constant over the last 60 years with spikes in events roughly every 10 years and less activity in between (it is unclear why this 10-year cycle exists). Tornadoes remain low probability, high impact events.

Freeze-Thaw Cycles

Freeze-thaw cycles can be defined in many ways depending on the application of the information. For general purposes, we define freeze-thaw cycles as the number of times the daily average temperature crosses (dips below and rebounds above) the 28°F and 32°F thresholds. Both thresholds have experienced a slight decreasing trend where recent years experience about two fewer cycles per year compared to the 1960s. However, there is a decent amount of variability from year to year. For example, in 1989 there were 10 freeze-thaw cycles (32°F), but in 1990 there were 22 cycles. The most number of cycles per year on record was 22 (32°F) and 19 (28°F), while the least number of cycles per year on record was 7 (32°F) and 6 (28°F). In the future we anticipate fewer freeze-thaw cycles especially at the lower temperature thresholds as cold temperatures become less common.

Low Visibility Events

Visibility data for Grand Rapids, MI are available for events related to fog and blizzards but, to our knowledge, do not include visibility impacts from extreme precipitation events that also impact visibility conditions. The annual number of hours where visibility conditions were poorer than the critical threshold classified by The Federal Highway Administration (300m) declined in Grand Rapids, MI since 1973 - in other words, visibility conditions have improved. There are not specific projections of fog conditions for the future, but more fog may be anticipated as winters become warmer and the air can hold more moisture. By mid-century, snowfall is projected to decline, so visibility may primarily be impacted by fog and heavy rain events.

About the Data

All **future projections** are based on a dynamically downscaled data set for the Great Lakes region developed by experts at the University of Wisconsin-Madison. There are a total of six downscaled models that represent how a variety of different variables are projected to change (mid-century, 2040-2059, compared to the recent past, 1980-1999). The projections in this summary are applicable to the greater Grand Rapids area. The regional data (and maps) are available for download at: http://nelson.wisc.edu/ccr/resources/dynamical-downscaling/index.php.

Historical trends for Grand Rapids, MI were derived from the following data sets:

ThreadEx daily temperature observations for the Grand Rapids Area from 1892-present. (Wind chill analysis used HadISD data).

TopoWx gridded observations from 1963-2015.

HadISD quality controlled weather station found in Grand Rapids, MI (airport) that provides hourly data from 1973-2015.

ISH weather station data for Grand Rapids, MI (airport) that provides hourly data from 1973-2015.

NCEI Integrated Surface Database data from 1976-2014.

Wind - HadISD weather station found in Grand Rapids, MI that provides hourly data from 1973-2015. Tornado - NCEI Storm Events Database from 1952-2014.