MICHIGAN SEA GRANT

Climate Variability and Climate Change

WHAT IS THE DIFFERENCE?

The summer of 2009 was one of Michigan's coldest summers on record. In June of the same year, the U.S. Global Change Research Program published a report stating: "Observations show that warming of the climate is unequivocal." How can scientists say climate is changing if a sweatshirt is needed to stay warm on a July afternoon?

The key to making sense of what seems like contradictory evidence is to understand that just as the weather varies naturally, so too does climate. Even though scientists have no doubt that climate is warming, natural climate variability will always occur. We cannot draw conclusions about climate change based on one summer. There will be ups and downs even if we are in the middle of a warming trend. Case in point: while summer 2009 was near-record cold, the summer of 2010 was one of the hottest on record.

Understanding the difference between climate variability and climate change — and how scientists study both — allows us to interpret information on weather and climate and to make sense of our environment.

Climate Variability

Climate varies over seasons and years instead of day-to-day like weather. Some summers are colder than others. Some years have more overall precipitation. Even though people are fairly perceptive of **climate variability,** it is not as noticeable as weather variability because it happens over seasons and years. Evidence includes statements like: "the last few winters have seemed so short," or "there seem to be more heavy downpours in recent years."

Scientists think of **climate variability** as the way climate fluctuates yearly above or below a long-term average value. You can think of it as a story with two parts: **average** and **range**. These parts complement each other; understanding the range gives context to the average and vice versa.

Average – What's Typical

Climate isn't defined by any particular timeframe, however scientists typically use average weather conditions over 30-year time intervals to track climate. These 30-year averages are called **climatological normals**, and are used to determine, monitor or represent the climate – or a specific slice of climate – at a particular location. Thirty years of data is long enough to calculate an average that is not influenced by year-to-year variability.

Normals can be calculated for a variety of weather variables, such as temperature or precipitation based on data from weather stations in the region of interest.

There is significant year-to-year variability around these 30-year averages. For example, in Figure 2 the normal daily maximum temperature for February 15 in South Haven, Michigan is 34.2°F from 1961-1990. But for each year in that range, the daily maximum temperature is not exactly 34.2°F (e.g., in 1967 it was 50°F, in 1979 it was 20°F). This year-to-year fluctuation around the normal is **climate variability**.

Key Terms

- **Climate variability** – The way climate fluctuates yearly above or below a long-term average value.
- **Climate change** – Long-term continuous change (increase or decrease) to average weather conditions or the range of weather.
- **Climatological normal** – 30-year average of a weather variable.

Range – the Variety

Averages only tell half the story of climate variability. The variety around the average — the range of weather — is the other half. When an average is calculated, the variety of the data within is "smoothed." But there is much to gain from understanding this variety, especially the extremes. For example, the average air temperature in Marquette, Michigan was 42.3°F in 2010. But within that year, Marquette residents had to deal with a high of 90°F degrees and a low of -8°F. If you were moving to Marquette and packed only clothes suited for the average temperature, you'd be shivering in January and overheating in August. Studying the frequency and magnitude of extremes — such as heavy downpours, cold snaps and heat waves — is important because these events affect communities the most.

Why Study Variability?

We use these averages and ranges to make important societal decisions. For example, climatologal normals of precipitation and historical records of storm events are used to calculate probabilities of future rain events. Engineers can then use these data to design community stormwater drainage systems.

These data also serve as a baseline against which to compare current weather and climate data. Without a baseline we have no way to understand how current observations fit into the bigger picture.

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What Causes Climate Variability?

Common drivers of climate variability include El Niño and La Niña events, which are shifts of warm, tropical Pacific Ocean currents that can dramatically affect Michigan's winters. El Niños give us milder, less snowy winters (such as the winter of 2009-2010), while La Niñas give us colder, snowier winters (such as the winter of 2007-2008). Other drivers of climate variability include volcanic eruptions and sunspots. Sometimes climate varies in ways that are random or not fully explainable.

For example, let's say you received a B on your latest report card. How do you know if this B is a sign of improvement or if your performance is getting worse? It depends how you did on previous report cards. Without a baseline, it's impossible to tell.

Climate Change

If climate variability is year-to-year variation, what is climate change? Climate change is a long-term continuous change (increase or decrease) to **average** weather conditions (e.g. average temperature) OR the **range** of weather (e.g. more frequent and severe extreme storms). Both can also happen simultaneously. Long-term means at least many decades. Climate change is slow and gradual, and unlike year-to-year variability, is very difficult to perceive without scientific records.

How do scientists detect climate change? They look for long-term continuous changes (trends) in climatological averages and normals and the variety around these averages. Climate in the Great Lakes region is generally highly variable in the short term, which makes it difficult to tease apart natural variability from long-term change. However, looking at data since the late 1800s reveals some significant shifts in temperature, total precipitation, and extreme events in recent decades in the Great Lakes region. Scientists use this evidence to conclude that climate is indeed changing.

Climate change occurs because of changes to Earth's environment, like changes in its orbit around the sun or human modification of the atmosphere. There is nothing inherently wrong with climate change. It has happened in the past and will happen again. The current concern stems from the rate of change – how quickly changes are happening. Scientists have found that the current rate of temperature increase is higher than any previously seen in the last 800,000 years. Evidence strongly indicates that human-driven changes in the atmosphere are contributing to the unprecedented rate of temperature increase.

Using historical weather data from a weather station in South Haven, Michigan, a coastal community on the Lake Michigan shoreline, we can graphically illustrate the climate change and variability concepts using a real life example:

- Figure 1 shows how day-to-day weather data is averaged to become climate data.
- Figure 2 illustrates climatological normal, climate variability, extreme events and range.
- Figure 3 depicts long-term historical mean and climate change.

Constant Variability

There will always be natural climate variability at many scales – decadal, yearly and short-term extreme events. This means that over the long-term record, there will be ups and downs with the yearly and 30-year averages, even if climate is getting warmer. We cannot expect every summer to be warmer than the previous one, but we can expect and plan for variability.

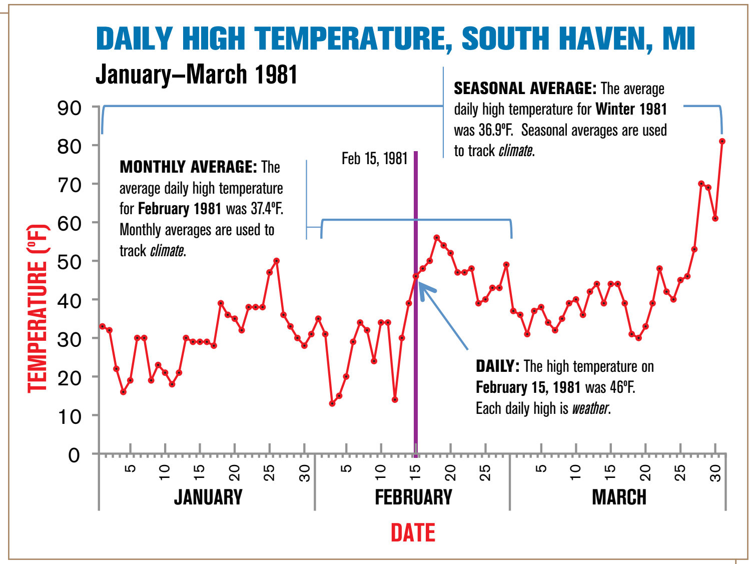

FIGURE 1

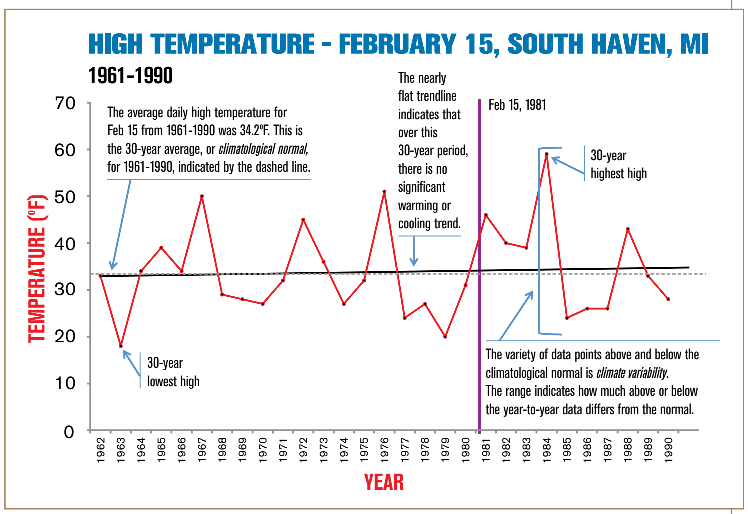

FIGURE 2

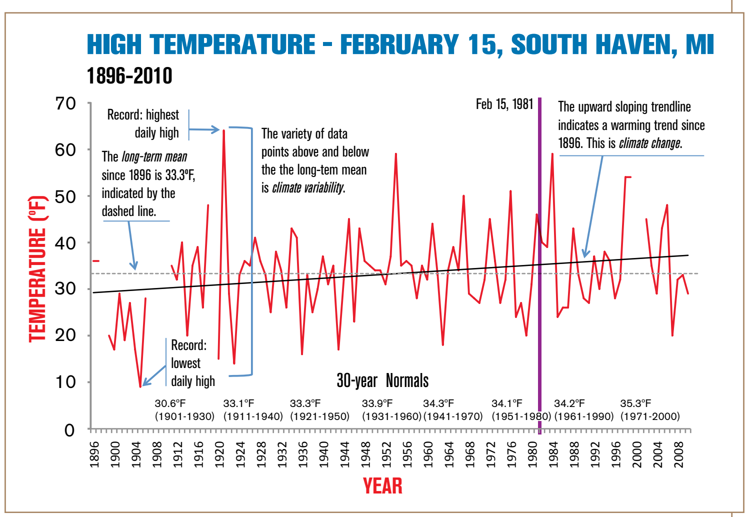

FIGURE 3

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All Michigan-specific data referenced in this factsheet was obtained from the Midwest Regional Climate Center: http://mrcc.isws.illinois.edu

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Michigan Sea Grant enhances the sustainability of Michigan's coastal communities, residents, and businesses through research, outreach and education.

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