The Water Cycle of the Great Lakes

An Interactive Web Tool
by Dr. Becky Bolinger

The Water Cycle Tool

- Learn how precipitation adds water to the lakes
- Learn how runoff from the land adds water to the lakes
- Learn how evaporation takes water away from the lakes
- Learn how all of them together change water levels
- Learn how each component behaves throughout the year for the different lakes
- Learn how changes in climate can increase or decrease each component

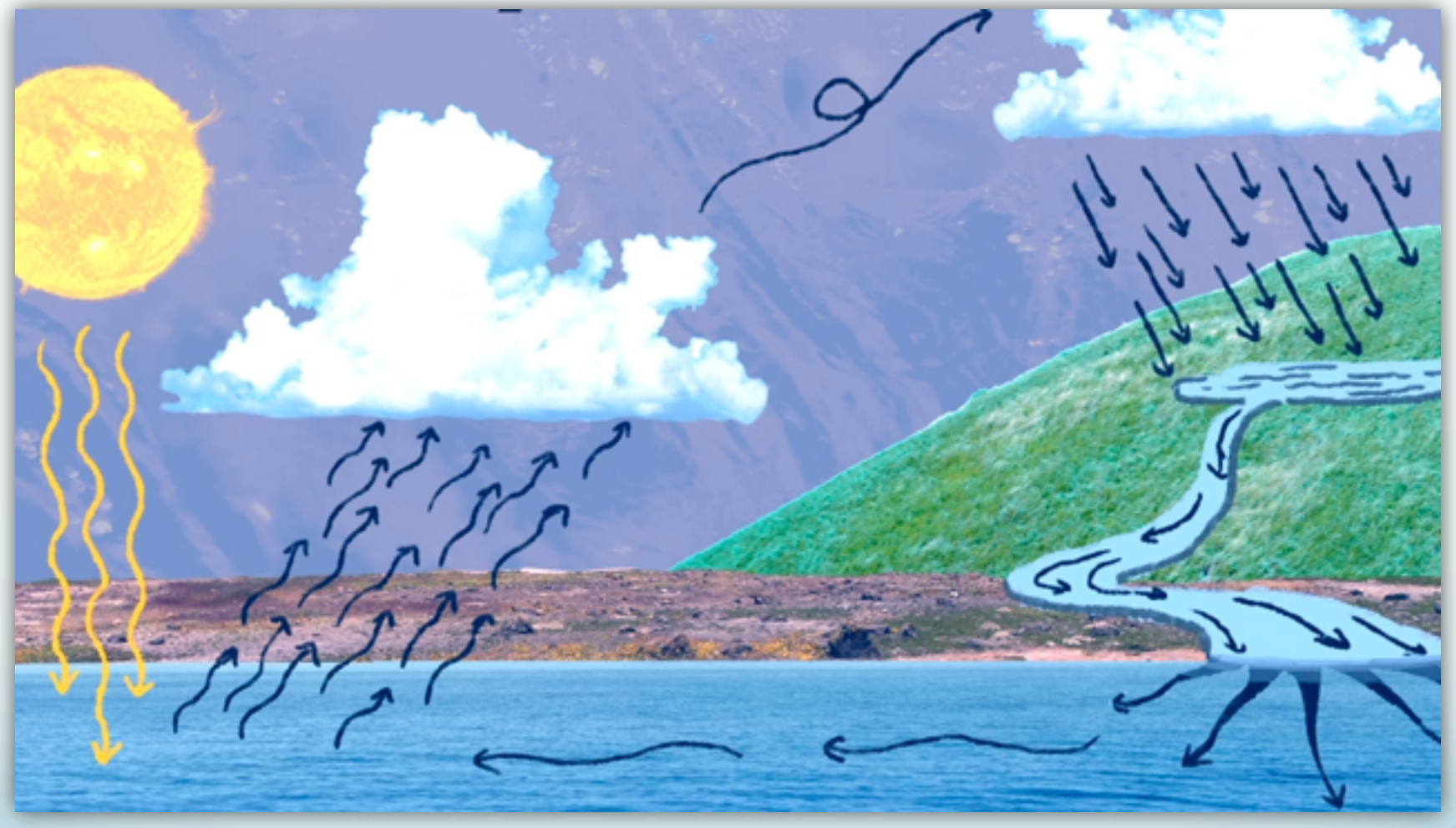
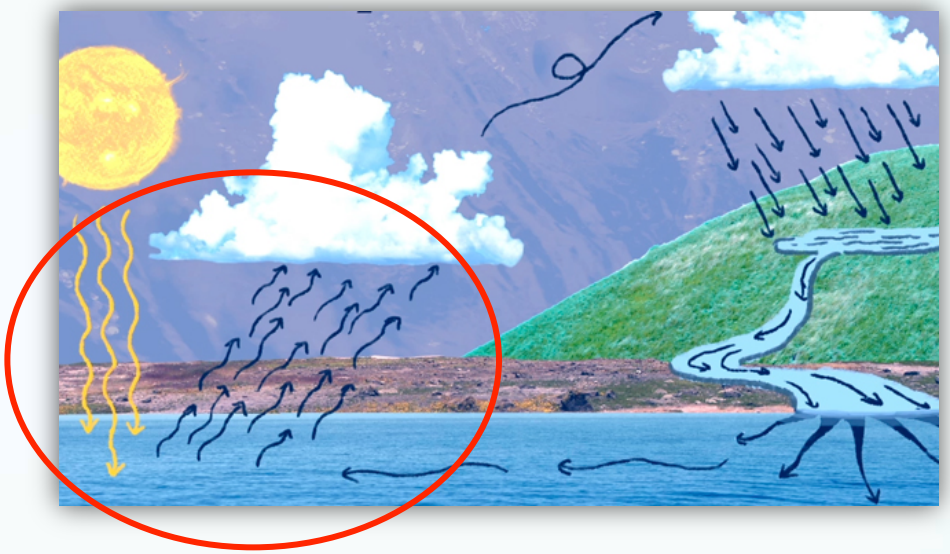


Image Courtesy of Flocabulary (www.flocabulary.com)

Evaporation: Water across the surface of the lakes evaporates, turning into water vapor in the atmosphere.

Evaporation lowers water levels.

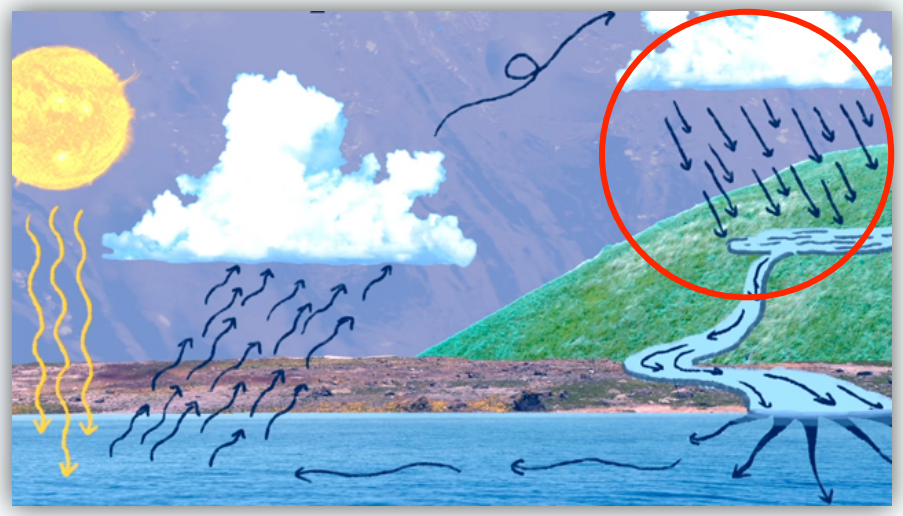


- **Evaporation** increases when the water temperature is warmer than the air temperature.
- **Evaporation** increases under windy conditions.
- **Evaporation** decreases when the water temperature is colder than the air temperature.
- **Evaporation** "shuts off" when the lakes freeze over.

Image Courtesy of Flocabulary (www.flocabulary.com)

Precipitation: Water falls from the sky as rain or snow. It can fall directly on the lake, or on the land near the lake.

Precipitation raises water levels.

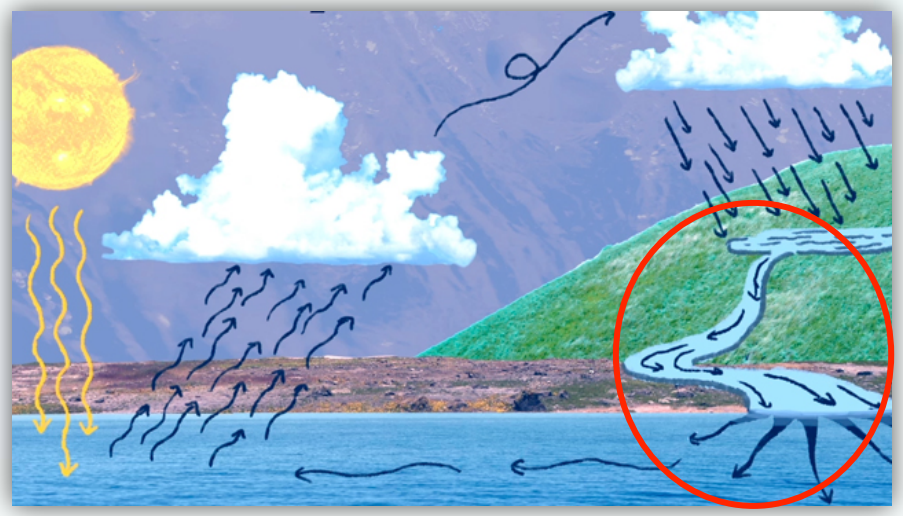


- **Precipitation** has the strongest link to changing water levels.
- Higher **precipitation** amounts are generally related to higher runoff amounts, and vice-versa.
- Even though it doesn't rain every day, **precipitation** occurs every month of the year.
- It's possible that **precipitation** across the Great Lakes region will increase as a result of climate change.

Image Courtesy of Flocabulary (www.flocabulary.com)

Runoff: water that collects on the ground flows to nearby streams and ultimately to the lakes.

Runoff raises water levels.



- **Runoff** occurs immediately when precipitation is in the form of rain.
- **Runoff** can be delayed for months when water is stored on the ground as snow. **Runoff** begins to occur when the temperatures are warm enough to melt the snow.
- **Runoff** increases when there is an increase in rainfall or snowfall.

Image Courtesy of Flocabulary (www.flocabulary.com)

Water Supply

Water Supply =

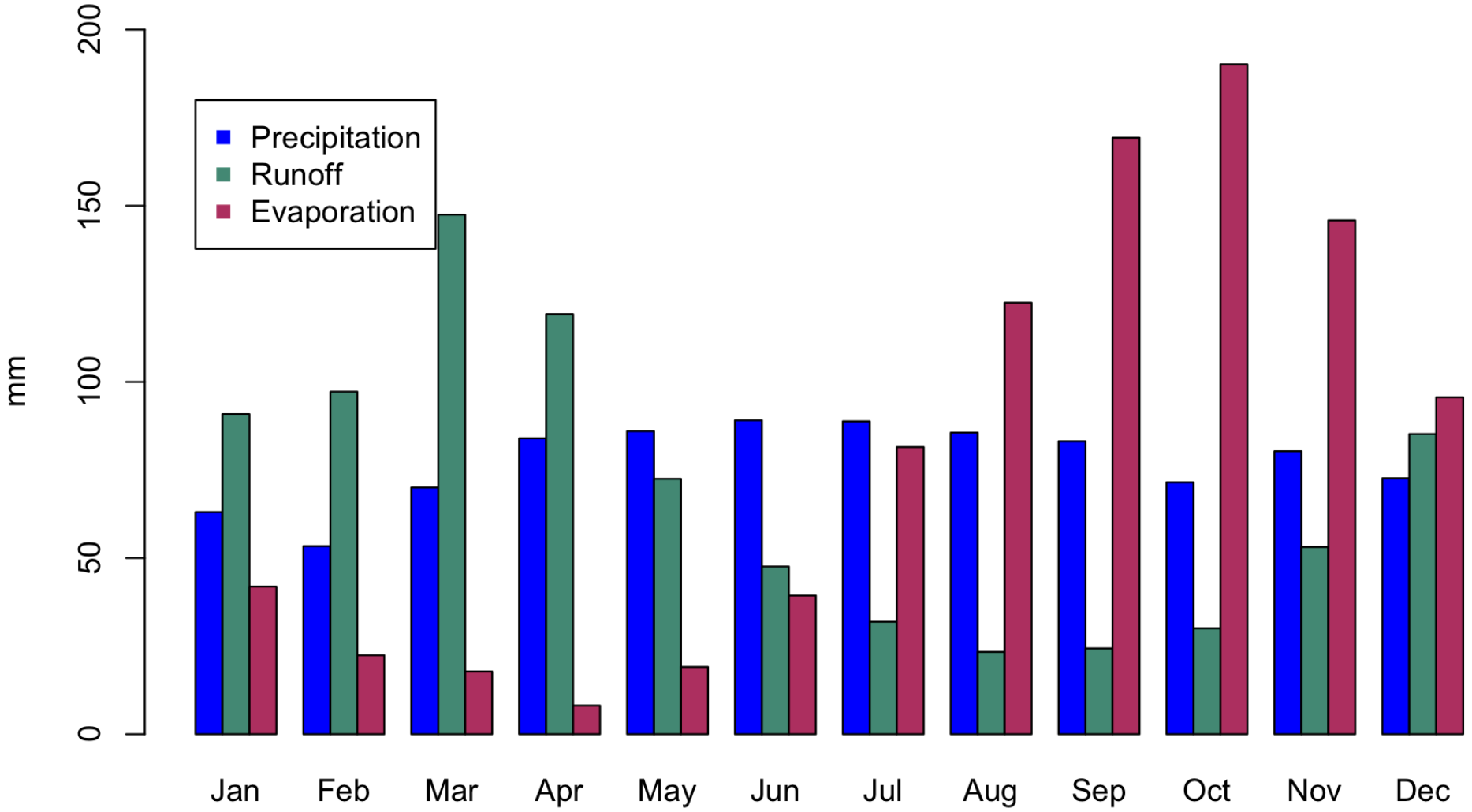
Precipitation + Runoff − Evaporation

$$WS = P + R - E$$

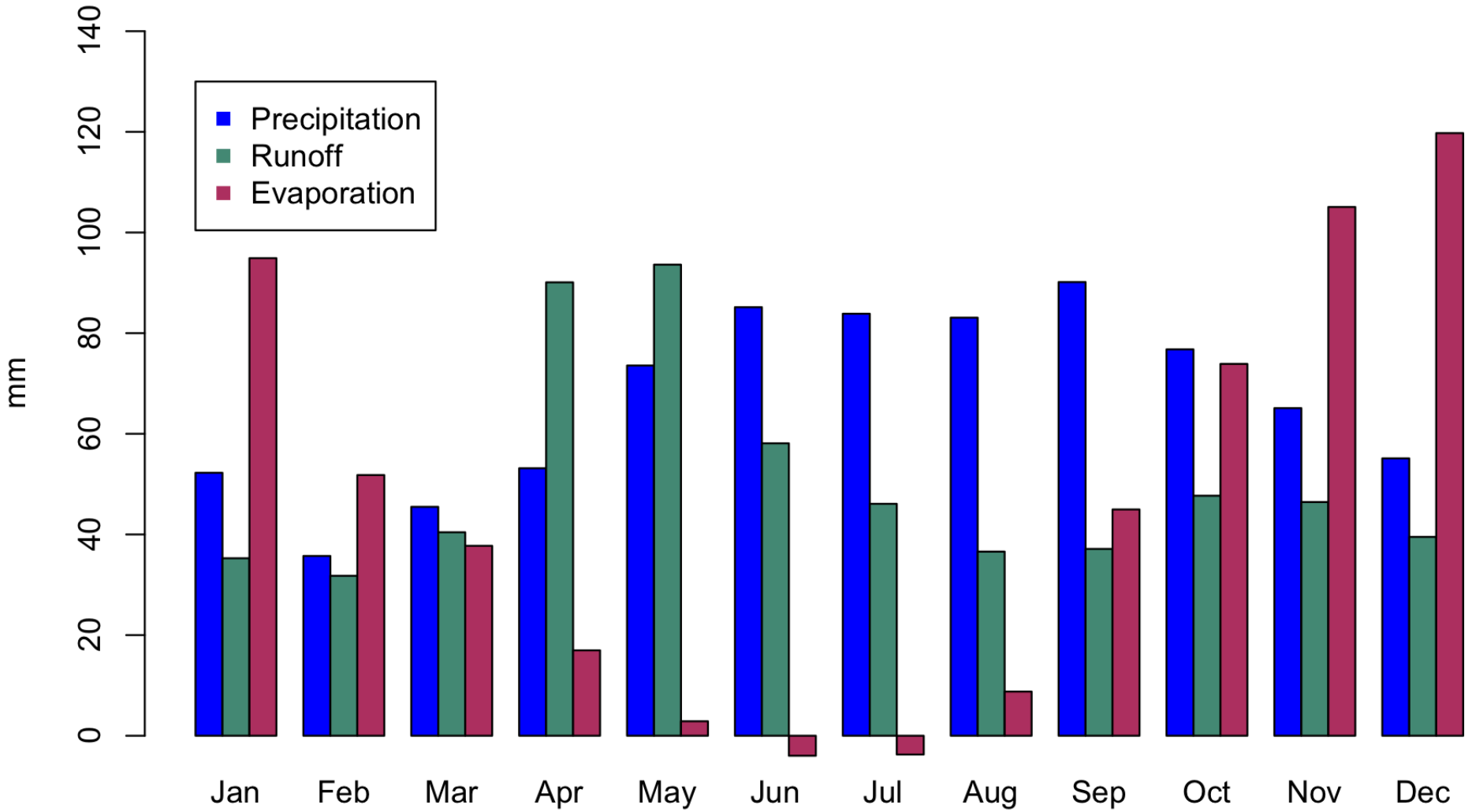
Water Levels

- The water levels of the Great Lakes is closely related to the water supply.
- Water levels can also change with inflows and outflows from major rivers and channels.
- Inflows and outflows are only partially controlled by climate and nature.
- Flows into and out of the Great Lakes are also regulated by humans
  - U.S. Army Corps of Engineers
  - Niagara River Control Center

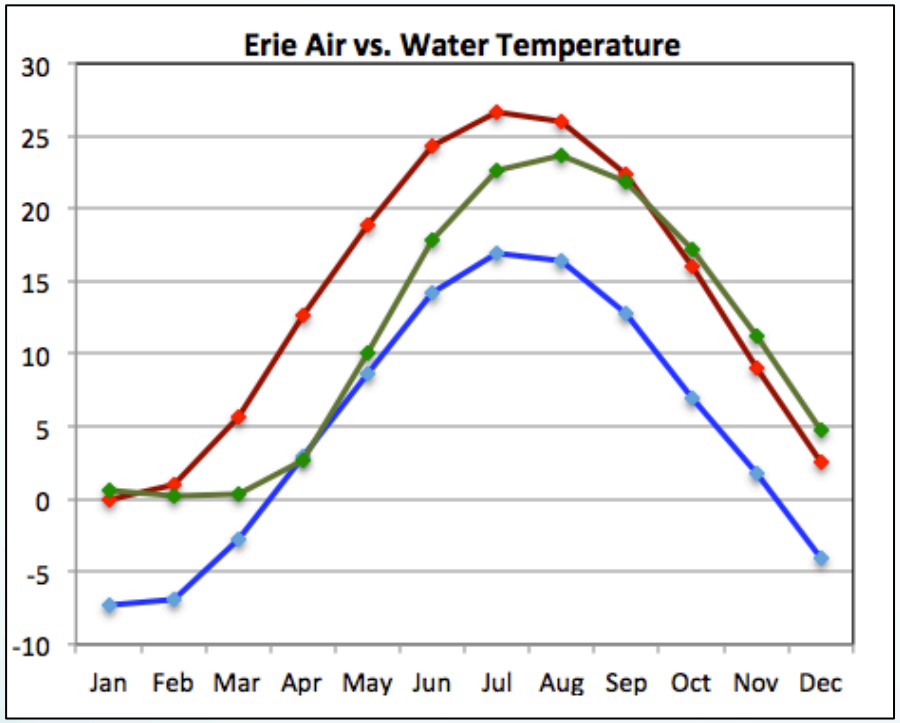
Water Cycle Components of Lake Erie

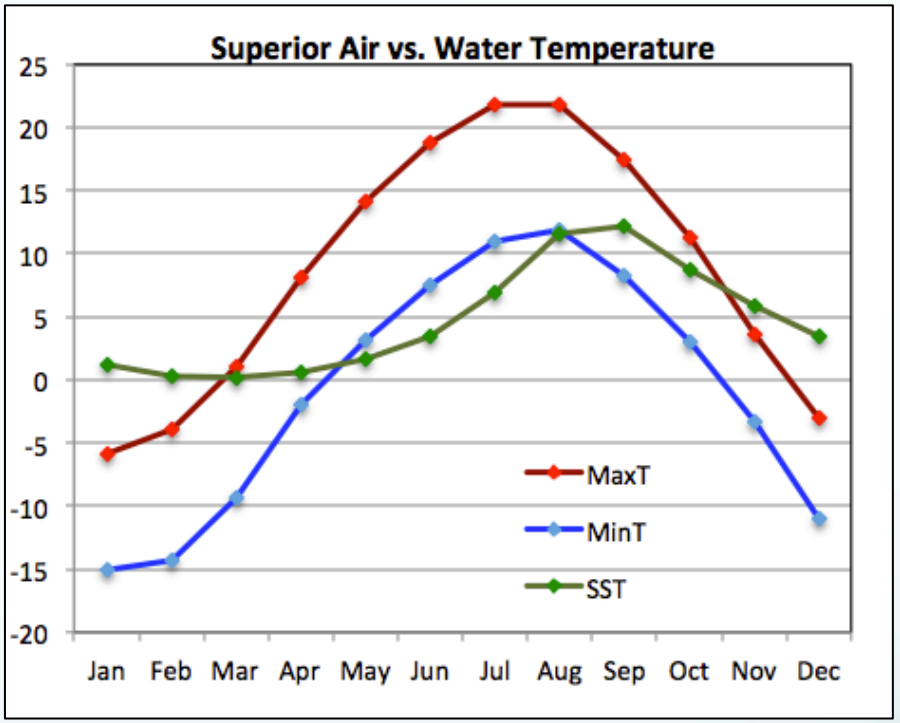


Water Cycle Components of Lake Superior



Water and Air Temperatures





- **MaxT** refers to the monthly average High Temperature.
- **MinT** refers to the monthly average Low Temperature.
- **SST** refers to the water temperature of the lake.

Interactive Web Tool

- Go to the main webpage.
- The sliders on the top left can change the values of each water supply component from 0 to 10 inches.
- Click the Customize Totals button after adjusting the sliders.
- Click on a month button to see typical conditions for that specific month.
- The chart on the top right shows the current selected values for each water supply component.
- The water level in the lower left will raise or lower depending on the different component conditions.
- Water supply calculations are shown in the lower right box.

Sample Exercises

- What months show water level decreases?
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- What is causing these water level decreases?
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- List the two months that show the largest water level increases.
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- Why do you think water level increases so much in those two months?
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Sample Exercises

- What months show water level decreases?
  - August – November
- What is causing these water level decreases?
  - Evaporation is greater than the sum of precipitation and runoff
- List the two months that show the largest water level increases.
  - March and April
- Why do you think water level increases so much in those two months?
  - Because runoff is very high and evaporation is low

Sample Exercises

- Climate change could result in more precipitation amounts throughout the year. How would that affect water levels?
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- What is the difference between May and August evaporation? Why are they different?
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- Temperatures more frequently go above freezing in March and April. How is this related to runoff?
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Sample Exercises

- Climate change could result in more precipitation amounts throughout the year. How would that affect water levels?
  - Adding precipitation raises water levels.
- What is the difference between May and August evaporation? Why are they different?
  - August evaporation is 4 inches greater than May.
  - This difference is mostly due to the water temperatures being much colder in May than in August.
- Temperatures more frequently go above freezing in March and April. How is this related to runoff?
  - Snow is melting and running off when temperatures are above freezing.

Sample Exercises

- In the month of October, imagine that the average air temperature is equal to the water temperature. How would the water level change?
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- Keeping in mind that this tool is loosely based on Lake Erie, describe how Lake Superior levels might behave differently during January. (Note: more of Lake Erie would be covered in ice than Lake Superior)
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Sample Exercises

- In the month of October, imagine that the average air temperature is equal to the water temperature. How would the water level change?
  - Equal air and water temperature would mean the evaporation goes to zero and the water level would increase from the normal October level.
- Keeping in mind that this tool is loosely based on Lake Erie, describe how Lake Superior levels might behave differently during January. (Note: more of Lake Erie would be covered in ice than Lake Superior)
  - With less ice cover, Lake Superior would experience more evaporation. Raising evaporation means the water levels would decrease.

Sample Exercises

- Imagine that March is very cold, all precipitation falls as snow and none of that snow will melt until April. How might that change March and April water levels?
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- Imagine a June with a very high precipitation value of 7 inches. All the extra precipitation increased runoff by 2 inches above average. Because it was so rainy and the sun didn't shine much, in addition to the lake being very cold, there was no evaporation. How much greater is the water supply than normal?
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Sample Exercises

- Imagine that March is very cold, all precipitation falls as snow and none of that snow will melt until April. How might that change March and April water levels?
  - In March, runoff would be lower than average. This would lower the water levels.
  - In April, runoff would be increased because of the melting snow. This would increase the water levels.
- Imagine a June with a very high precipitation value of 7 inches. All the extra precipitation increased runoff by 2 inches above average. Because it was so rainy and the sun didn't shine much, in addition to the lake being very cold, there was no evaporation. How much greater is the water supply than normal?
  - Water Supply = 7in. + 3.9in. – 0in = 10.9in.
  - This is 7 inches greater than the normal of 3.9 inches.