Understanding Temperature Patterns in Our Watersheds

Overview

In this lab we will use data from Mayfly Data Logger Board™ Sensor Stations installed in rivers and streams to learn more about the patterns of temperature in nature. These Sensor Stations measure and transmit important data to the Monitor My Watershed® web portal that can be accessed by scientists, educators, students, and various organizations interested in understanding and monitoring watersheds in our area. Throughout these activities, you will learn how to use the portal to view and interpret data collected at the sensor stations, investigate significant events, analyze the information, and create new understandings about the dynamics and interactions of variables in your local waterways. As you go through the activities, be sure to record the data and your analyses on your lab sheet.

This lab activity is designed as a "post assessment" for students who have learned about the properties of water. Water is a polar molecule with a high specific heat, which makes water heat up and cool down more slowly than air. Throughout this lab students should observe this pattern as the equipment temperature increases and decreases faster than water. The water temperature will fluctuate less and change more gradually. Also, water temperature should not go below 0ºC unless ice forms around the sensor. This lab could also be a "phenomenon" to spark curiosity as a precursor to learning about the properties of water.

Learning Objective:

By the end of this lab you will explain temperature patterns in watersheds and develop analytical and reasoning skills by accessing and interpreting real world data.

Introduction

What do you think of when you hear the word "temperature?" Write your definition for temperature below.

_____

_____

Prediction #1: Which is warmer, air temperature or water temperature? (Circle one below)

Air Temperature **Water Temperature**

Explain your prediction: _____

_____

_____

Prediction #2: Which changes faster, air temperature or water temperature? (Circle one below)

Air Temperature **Water Temperature**

Explain your prediction: _____

Answers will vary. Look for prior knowledge of the properties of water – High Specific Heat.

Note: For the duration of this lab we will be comparing the temperature in the stream (water) to the temperature of the Mayfly Data Logger Board™ in the station box (equipment). The actual air temperature has not been measured at the sensor station, although the air temperature would follow a similar pattern. Equipment temperatures are usually higher than actual air temperature due to being in an insulated box that could be in direct sunlight. The equipment temperature sensor was not designed for low temperatures, so you will notice a "saw-tooth" pattern below 5ºC, and these temperature readings are not accurate.

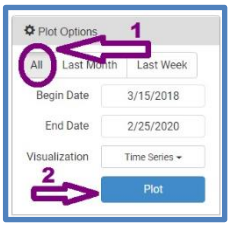
Explore the Sensor Station Data

1. On a computer load the website: https://www.monitormywatershed.org
2. Click on ***Browse Sites*** in the top banner
3. In the "Search sites" box (top center of the map) type in "BCMC4." As you type the map will zoom in and center over a sensor station site balloon.
4. **Left click** on the site balloon logo, and then **right click** on "View data for this site" and select "Open link in new tab."
5. When the new window loads, fill in the following information:

Site Name: **Marsh Creek at Fairview Rd**

Site code: **BCMC4S** *(in parentheses after the site name)* Site Type: **Stream**

6. Scroll down and click on the "Time Series Analyst" box above the variable graphs. A new tab will open displaying all of the variables measured at this site over the last month.
7. In the "Plot" column on the left, click the two boxes for "Temperature" (Decagon_CTD-10_Temp and EnviroDIY_Mayfly_Temp) and then click on the "Visualization" tab (top left above the list of variables).
8. When the new graph loads, change the date range to "All" in the "Plot Options" box and then click the "Plot" button.



When the new graph loads take a moment to make some general observations about the data displayed. Uncheck and re-check each variable to view them one at a time and together. Record your initial observations below.

Student answers will vary but may include:

Temperatures go up in the summer and down in the winter in similar patterns and "bands" of temperature. Equipment ("air") temperature fluctuates much more than stream (water) temperature. The sensor station did not transmit data between 8/11/19 and 8/28/19. The equipment temperature goes much higher than the stream temperature.

Observing the Data

Follow the directions below to collect and record important observations and data on daily stream and equipment temperature changes at this sensor station during a summer and winter date range.

NOTE: All data points displayed on the Monitor My Watershed graphs are in UTC (Universal Time Coordinated). To convert readings during Eastern Standard Time subtract 5 hours (winter) and during Daylight Savings Time subtract 4 hours (spring to fall).

Summer

9. In the plot options box, change the "Begin Date" to **7/7/2018** and the "End Date" to **7/11/2018** and then click on "Plot."
10. Move your cursor through the data graph to explore the behavior differences between stream temperature (CTD-10) and equipment temperature (Mayfly). (*EST = UTC – 4 hours*)

Record your observations below. **Student answers will vary but may include:**

Equipment ("air") temperature fluctuates much more than stream (water) temperature and change much faster (steeper slopes on the line graphs). Equipment temperatures have a ~36ºC range. Water temperature fluctuates gradually and in a more consistent pattern within a ~10ºC range.

Circle the answers for each of the following:

Which temperature increases fastest during the day? **Stream (CTD_10)**

Which temperature cools the fastest at night? **Stream (CTD_10)**

Which temperature changes the most in the summer? **Stream (CTD_10)**

Winter

11. In the plot options box, change the "Begin Date" to **1/9/2019** and the "End Date" to **1/13/2019** and then click on "Plot."
12. Move your cursor through the data graph to explore the behavior differences between stream temperature (CTD-10) and equipment temperature (Mayfly). (*EST = UTC – 5 hours*)

Record your observations below. **Student answers will vary but may include:**

Equipment ("air") temperature fluctuates much more than stream (water) temperature and change much faster (steeper slopes on the line graphs). Equipment temperatures have a ~30ºC range. The equipment temperature behaves erratically below 0ºC with a saw-tooth pattern. Stream temperature fluctuates gradually and in a less consistent pattern than summer within a ~5ºC range. An uncharacteristic event (anomaly) in the water temperature happened between 3:45 and 4:30 (UTC) on 1/10/2019 when the water temperature dropped at a time that it would normally be rising.

Circle the answers for each of the following:

Which temperature increases fastest during the day? **Stream (CTD_10)**

Which temperature cools the fastest at night? **Stream (CTD_10)**

Which temperature changes the most in the winter? **Stream (CTD_10)**

Analyze the Data

What were the biggest differences that you observed between the summer and the winter data graphs?
Student answers will vary but may include:

Temperature fluctuations in the summer for both equipment ("air") and stream (water) follow a similar pattern more consistently. Temperature fluctuation patterns for both variables in the winter are more erratic. Equipment temperature changes shape between summer and winter. In the summer the

temperature rises more gradually and drops steeply. In the winter the equipment temperature seems steeper as it warms up and then cools more gradually. Stream temperature has a larger range in the summer (~10ºC) and a smaller range in the winter (~5ºC).

Conclusion

What do you know that would explain the differences in temperature changes observed between the equipment (Mayfly) and stream (CTD-10) sensors? Support your claim with evidence and reasoning.

Students should include water's high specific heat as an explanation for the lag between equipment temperature and stream temperature changes and include evidence from the graphs to support their claims. Some may question the validity of the results as this lab looks at a very small (and targeted) portion of data with which students are to draw conclusions.

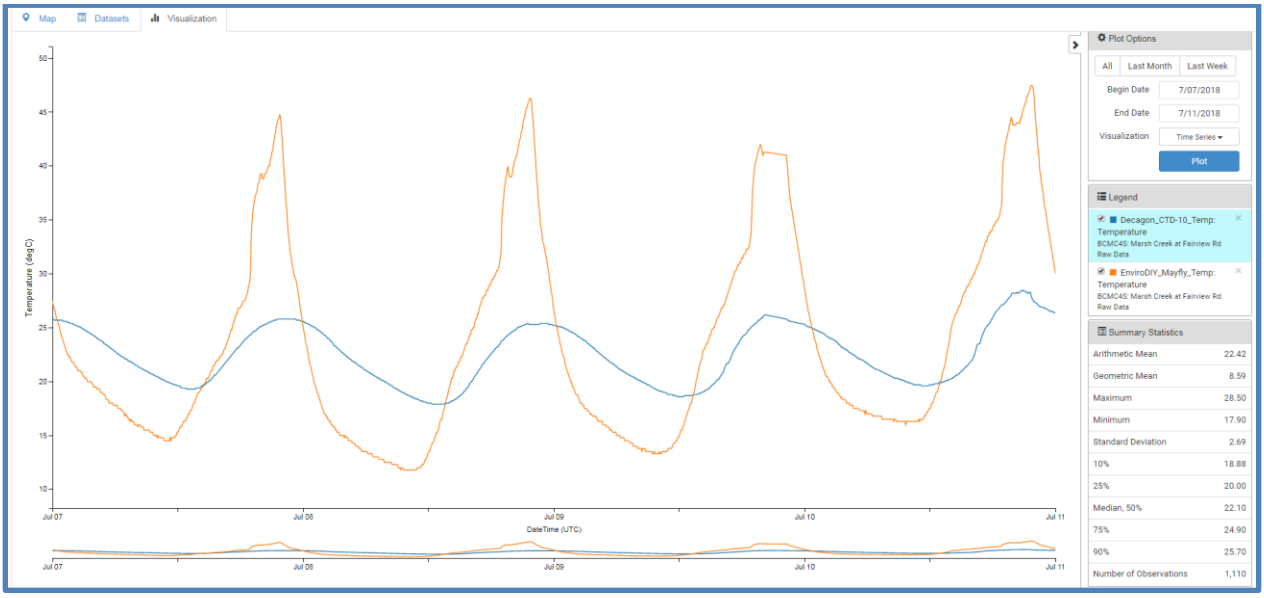
Brainstorm Questions for Further Studies

Based on what you explored and learned in this lab activity, what questions do you have about how temperature variables interact in our waters? Can you think of relationships or comparisons that you would like to investigate further?

Students may suggest:
Widen the scope of the date ranges to determine the consistency of this pattern.
Investigate how stream temperature changes at different locations (urban vs rural).
Investigate the cause of the winter temperature drop anomaly seen at happened between 3:45 and 4:30 (UTC) on 1/10/2019 when the water temperature dropped at a time that it would normally be rising.

Understanding Temperature Data Summary

Summer 7/7/2018 – 7/11/2018



Winter 7/7/2018 – 7/11/2018