
# Measuring Earth with GPS, Unit 3: Glaciers
# Activity 1 Student Exercise: Observe and Describe

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*GPS stations precisely record the position of the solid ground they are on, and they were first installed to measure plate motion. However, geoscientists analyzing GPS data realized that earthquakes and plate motion are not the only geological processes that cause the ground to move.*

*Hi, I'm Lizette, a geoscientist who uses GPS data to better understand the impact glaciers have on the motion of nearby bedrock. In this activity, I will guide you to describe scientific data from a GPS station on the bedrock near Skagway Glacier in Alaska by making careful observations, and you will use those observations to make a scientific interpretation. I hope to model for you the process that scientists like me use when we work to solve scientific questions.*

## Part 1: The ground is moving?

*When I, as a scientist, look at data, I begin by determining what the graph is showing and then make observations by describing the trends. We will focus on motion over individual years.*

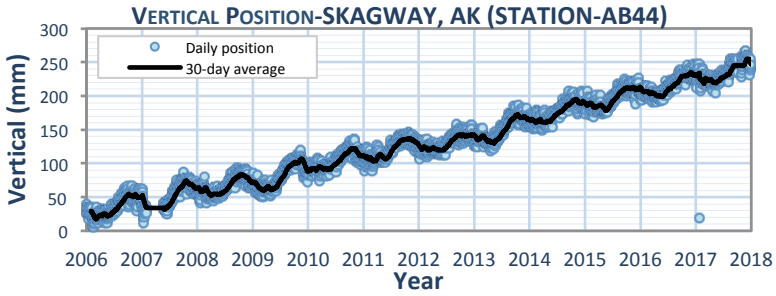



Figure 1. Vertical GPS data from station AB44 near Skagway Glacier in Alaska from the beginning of January 2006 to the end of December 2017.

*Let's first examine Figure 1 that shows the GPS data. A larger version of this figure is included separately because it's easier and more accurate to read the numbers off a larger graph.*

1. The first thing I do when looking at a graph is to read the title, look at the axes, and make some general observations. What do the axes show, including units?

Horizontal (x-axis): _____ Vertical (y-axis): _____

2. Look at the time scale. The points on the graph rise and fall in a cycle that lasts how long?

day month year decade

3. How do you know the ground is moving?

## Part 2: What hypotheses might explain why the ground is moving?

*When scientists first noticed that the ground was moving up and down each year, we wanted to know why. Two of the hypotheses we came up with are:*

> **Hypothesis A**: The ground elevation rises because the ground expands when it freezes, and it lowers when the ground contracts as it thaws.
>
> **Hypothesis B**: The ground elevation lowers because the weight of the snow presses it down, and the ground elevation rises when the snow melts.

*Geoscientists often work with more than one hypothesis (we call them "multiple working hypotheses"), and that is what we'll do here. We will keep both of our hypotheses in mind as we better describe the data to try to determine which one explains the data better.*

4. Let's make some predictions based on these hypotheses, and then we will later compare the GPS data to them. Fill in the table below by circling predictions based on the hypotheses.

| **Hypothesis** | **When this hypothesis predicts the highest point to be** | | **When this hypothesis predicts the lowest point to be** | |
|---|---|---|---|---|
| Hypothesis A | Jan–Mar | Aug–Oct | Jan–Mar | Aug–Oct |
| Hypothesis B | Jan–Mar | Aug–Oct | Jan–Mar | Aug–Oct |

## Part 3: How much does the ground move and when?

*After making overall observations as we did in Part 1, I describe the data using numbers. Using numbers allow us be more precise in our observations and description of vertical movement.*

5. I find that it is helpful to use tables to organize data. Fill in the table below using data from two years of your choosing. Include units!

| | **Year #1** | **Year #2** |
|---|---|---|
| Year | | |
| High point (maximum height) | | |
| Estimate during which month | | |
| Low point (minimum height) | | |
| Estimate during which month | | |
| Range of vertical movement (difference between high point and low point) | | |
| Convert the range to inches (there are 0.039 inches in 1 millimeter*) | | |

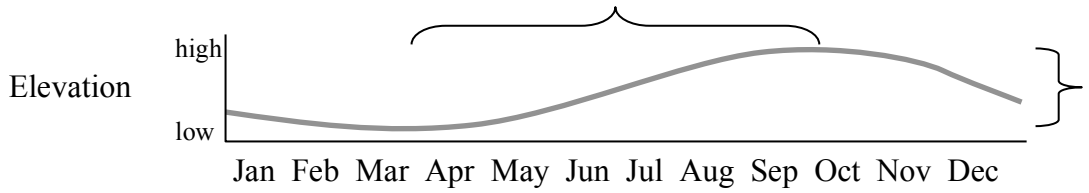
**I used to mix up my conversions, so I always double-check that my answer makes sense. An inch is close to 25 times larger than a millimeter, so double-check your answer.*

*After I make calculations, I find it's helpful to take a step back to make sure I understand what my calculations mean and put them into context so I can visualize them.*

6. Which of the following best matches the range of vertical movement each year?

Thickness of a penny  Length of a paper clip  Height of a table

7. You calculated the range of vertical movement. Label the correct parenthesis "range" to show this.




8. Could you feel the movement?  Yes  No  Why or why not?

9. Sometimes people mix up how they use the word "range." Which statement below uses the word "range" correctly?

a) Towards the end of the year, the range of vertical movement is near its highest point.

b) The range of vertical movement starts at the beginning of the year and the range reaches its highest point near the end.

c) The range of vertical movement for 2016 was approximately 35 mm.

*Like other scientists, I look at my data and try to find consistencies between times. These consistencies help me identify if there is a pattern that I can use to determine which one of my multiple working hypotheses is better supported by my data. I also like to summarize my findings, so I can feel confident that I understand and can describe what is happening.*

10. What number is the best to use when describing the movement of the ground over a single year to help compare it to other years?

a) The range of vertical movement, because it is consistent from year to year, even though the highs and lows aren't the same from year to year.

b) The height of the high point, because it shows how high the ground rises each year, even though it is changing from year to year.

11. Write a summary sentence describing the vertical bedrock movement near the glacier that combines (a) the timing (month) of the high point; (b) the timing (month) of the low point; and (c) the range of vertical movement (in millimeters).

## Part 4: What observations can help us understand why the ground is moving?

*The GPS data shows us when and how much the ground is moving, but it doesn't show us why. We need to look at other data to help us learn why, and below are photos of the GPS station to help do that. The GPS stations are drilled deep into the bedrock, so the only thing that causes the station to move is the movement of the bedrock.*

Figure 2. Photo of the GPS station AB44 taken October 19, 2016. Photo from: https://www.unavco.org/instrumentation/networks/status/pbo/photos/AB44

Figure 3. Photo of the GPS station AB44 taken December 20, 2011. Photo from: https://www.unavco.org/instrumentation/networks/status/pbo/photos/AB44

12. Read the paragraph above and summarize why you are including additional data in this analysis, beyond GPS data.

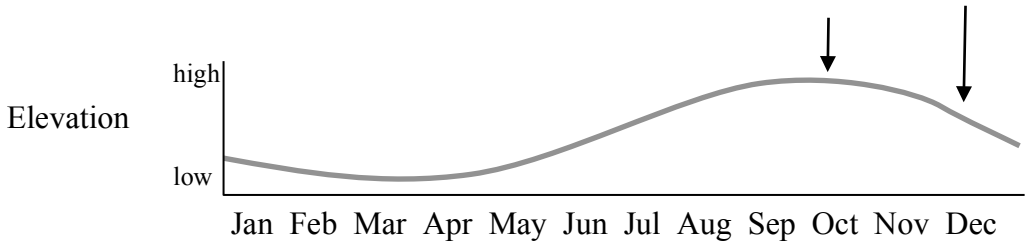
13. Based on your observations of Figure 2, on what is the GPS station located?

bedrock glacier ice

14. Which of the following observations is a key difference in what the photographs (Figures 2 and 3) are showing of the same GPS station at the two different times of year?

sunny/cloudy wet/dry snow/no snow

15. Find the months that the Figure 2 and 3 photos were taken. Label the arrows on the graph below "Fig 2: no snow" and "Fig 3: snow".




## Part 5: Which hypothesis best explains why the ground is moving?

*I often make observations that are puzzling. However, I try to make sense of the data and figure out why something is happening. Let's look back at our multiple working hypotheses and see which ones our observations and data support, so we can make sense of the ground movement recorded in the GPS data.*

16. Look at your predictions based on the hypotheses, and look at your observations of the data. Which hypothesis is best supported by the data?

Hypothesis A Hypothesis B

Summarize in your own words why the ground is moving.

17. Circle how confident you are in your explanation as to why the GPS station is moving.

Not confident Somewhat confident Confident

18. Name one piece of additional data that you would like in order to test your explanation. Explain why you chose that data and how it would test your explanation.