Barometric Pressure Activity: Teacher Worksheet

Target Age: Junior and Senior Secondary School (Ages 12-18)

Subject: Geography and Mathematics

Duration: 1 hour

Type: Guided classroom activity

Learning Goals:

- Use the scientific process to find a relationship between barometric pressure and altitude
- Use data from the School2School.net website
- Use statistics to verify the relationship between barometric pressure and altitude

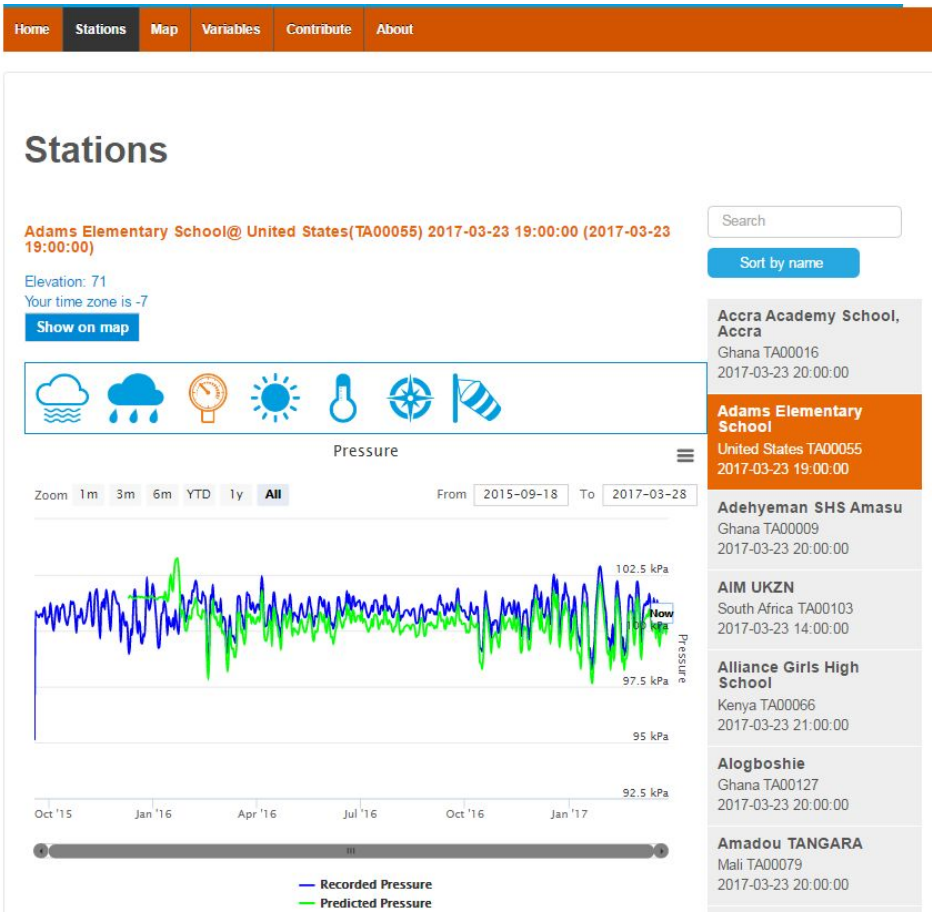
Materials:

- Access to the School2School.net website
- Barometric Pressure Powerpoint - https://docs.google.com/presentation/d/1G8R3GJ9aHg2me2-z3OdZV4ke-arQ_ualpZ_AgEE1ycE/edit?usp=sharing
- Pressure and Elevation Spreadsheet - https://drive.google.com/file/d/0BxNcyc_sE4pPcnZya1FIb3BaRlE/view?usp=sharing

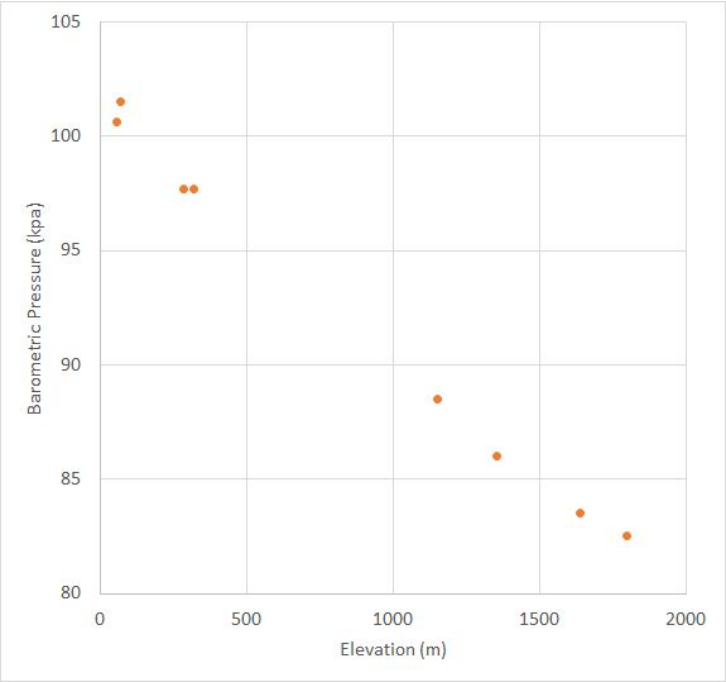
Methods:

As a class work though the Barometric Pressure Powerpoint using the scientific process

1. The first step of the scientific process is to ask a question. In this case, the question is: is barometric pressure different between stations? Start making observations by going to School2School.net, and clicking on the "Stations" tab. Navigate to your school's station if you have your own TAHMO station, or else just choose a close station. Pick the Barometric Pressure icon (third from the left) to display the graph of the recorded pressures (See image below). Note the maximum, minimum, and average pressure values (using estimations is okay). Choose another station and compare your results, do you see a difference in the range of pressures for different stations?



2. The second step of the scientific process is to develop a hypothesis. Now that you have seen that there are different pressure ranges for different stations, ask the class why they think barometric pressure is different for different stations? Have students develop multiple hypothesis for explaining the different barometric pressure ranges, remember that all hypotheses should be considered, this step is all exploring a wide variety of different explanations. What information from the School2School site can help formulate these hypotheses? Another piece of information given for each station is the elevation (in meters) and is located just under the station name. Once the concept of a relationship between pressure and altitude is suggested by a student, suggest that you use this as your primary hypothesis for the remainder of the activity. A good hypothesis is that barometric pressure is controlled by elevation, or that barometric pressure and elevation and inversely related.
3. The third step of the scientific process is to test the hypothesis. Brainstorm with the class how you might test the hypothesis. A great way to start testing the hypothesis is to start collecting data for the two variables of interest: barometric pressure and elevation. Which variable is the explanatory variable (elevation) and which one is the response variable (pressure)?
4. The fourth step of the scientific process is to record the data, so create a spreadsheet with barometric pressure vs altitude for numerous stations (columns A-E in Sheet 1). A good question to ask the class is how many stations they think should be compared. As a general rule, more than 7 data points is best. An example of the spreadsheet and data is provided.
5. The fifth step of the scientific process is making conclusions. Once the data has been recorded, creating a plot is useful for seeing the relationship between the two variables (see image below). What kind of relationship do the data points show? The trend that can be identified from the plot is that for lower elevations there is a higher pressure, and for higher elevations the pressure is lower- this is an inversely proportional relationship.



Discussion

Start an open discussion with the class. Now that the relationship has been identified, can it be validated using meteorology and mathematics. Ask questions like: How can we look for a mathematical relationship barometric pressure and elevation? Can this model be used to extrapolate the barometric pressure for elevations much higher than we have data for? How can we quantify how well our model fits the data?

There is a known mathematical relationship between pressure and elevation based on the barometric formula: Pressure = 101.325 * exp(-1.37*10-4*elevation). This formula is given in the spreadsheet on Sheet2 in columns L-M. Plotting the data collected with this mathematical relationship, does our data seem to follow the trend?

We can use statistics and the sum of the square error to determine how well our data fits fits the known relationship (Sheet2 columns G-H). By calculating the theoretic pressure given elevation from the mathematical relationship and comparing it with the recorded average pressure from the website, we can use the spreadsheet functions to calculate to calculate the coefficient of determination (R^2). The coefficient of determination indicates that the model explains a certain percent of the variability of the response data. In the example spreadsheet, the R^2 is in cell H14 of Sheet2, with a value of 0.88. The correct interpretation of this value is that 88% of the variability in pressure is explained by the elevation. Ask the class, does this value mean that we have a good agreement between our data and the mathematical model? Generally, a value for R^2 greater than 0.75 indicated good agreement between the data and the model.

Conclusions

Have the class summarize the activity by asking questions such as: What is the relationship between pressure and elevation? How did we use the scientific theory to reach our conclusions? Does the statistical analysis confirm our hypothesis?