

Data Timescales: Teacher Guide

Level: Intermediate

Subject: Mathematics

Duration: 1 hour

Type: Guided Classroom Activity

Learning Goals:

- Summarize daily or monthly weather data in Excel using Pivot Tables
- Define a timescale to view data for different research questions

Materials:

- Internet access to download a dataset at School2School.net
- Computer access with Excel or comparable spreadsheet program

Background:

When the TAHMO data is downloaded, hourly data is available. Discuss with the class some advantages and disadvantages of having high temporal resolution data. While hourly data is useful for looking at daily trends, having such a large quantity of data entries can make it difficult to find trends across days, weeks, months, or years. In contrast, using daily averages can reduce the amount of information about the variable of interest. For example, looking only at average daily temperature you will miss the time of the maximum temperature for that day, but looking only at maximum daily temperature will mean you miss the average daily temperature trend. There are different circumstances and questions for which different timescales (hourly, daily, weekly, monthly, and yearly, etc.) are best. The Pivot Table tool in Excel is a convenient way to change the timescale that your data is presented in. This lesson plan will introduce using Pivot Tables to view data at different timescales. By the end of this activity the students should be able to define the best timescale to look at different research questions.

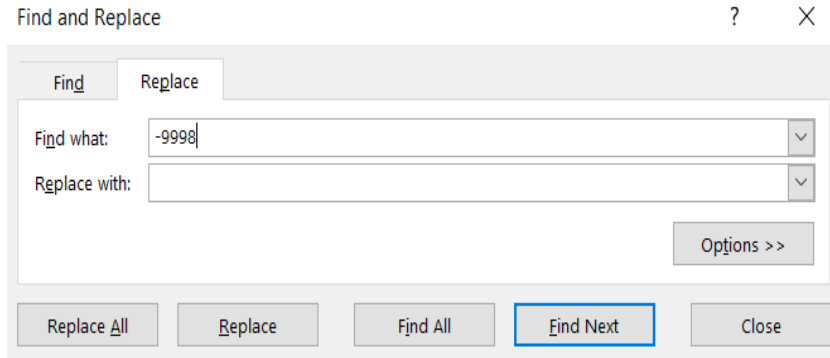
Preparation:

Before class, you may want to download the data and format it so that it is ready to use. You may also do this with the class as an exercise. Below are instructions on how to prepare the data for analysis in

this lesson plan. First, navigate to the School2School.net website. In the stations tab choose the school that you would like to analyze. Directly below the plots there is a section to fill out the username and password associated with that site. The login information is site specific, so if you were given login information it will only work for your one station. After typing your username and password and clicking the “login” button, the page will reload and a new button to download the hourly data will appear. Choose that button and the hourly data for the station will download in a CSV format. This format is compatible with spreadsheet programs like Excel. Open the downloaded data in your spreadsheet program. [Note: There is an instructional video with step-by-step directions on how to download the TAHMO station data on the S2S website].

The image shows two identical screenshots of the School2School.net website interface for the station 'Alliance Girls High School@Kenya(TA00066)'. The top section shows the station name, elevation (1996), and time zone (-7). Below this is a weather icon bar and a 'Relative Humidity' chart. The chart displays 'Recorded Relative Humidity' (blue line) and 'Predicted Relative Humidity' (green line) from February 2017 to May 2017. Below the chart is a login section with 'Username' and 'Password' input fields and a 'login' button. In the right screenshot, a 'download (TA00066) per hour' button has appeared, and a yellow arrow points to it. Another yellow arrow points to the 'login' button in the left screenshot.

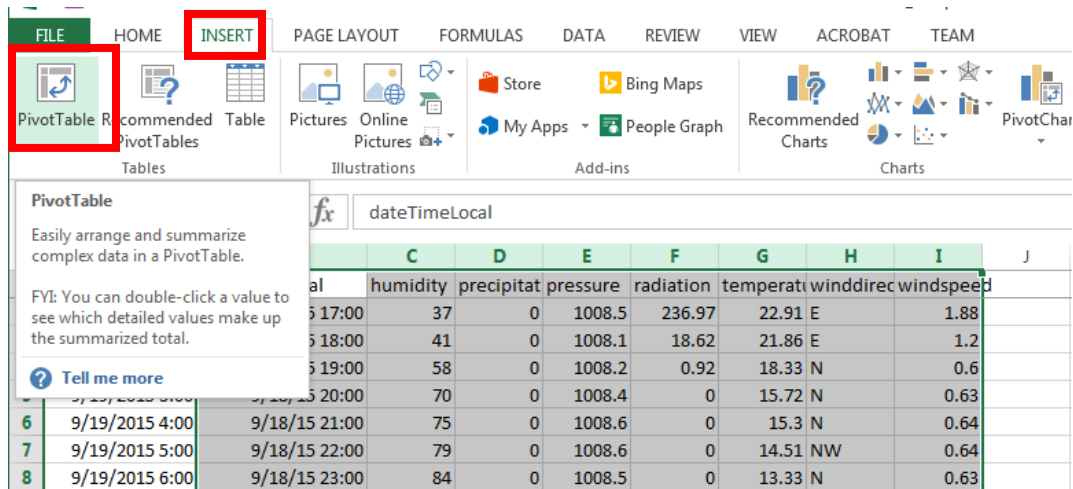
For TAHMO stations, any measurement with a value of -9998 is an error message. It is common for instruments to only be able to log numerical values, so when there is an error in the sensor it assigns a default error value. Any cell containing a value of -9998 should not be considered in analysis. In order to exclude -9998 error value from the analysis, we can delete all cells with this value and replace them with blank cells, signifying no data (replacing the value with a 0 would indicate the measured value was actually 0 and we don't want that). To do this, type Control + H while your cursor is on your Excel sheet. This will bring up the replace command in Excel, type -9998 into the find bar and leave the replace bar blank, click replace all.



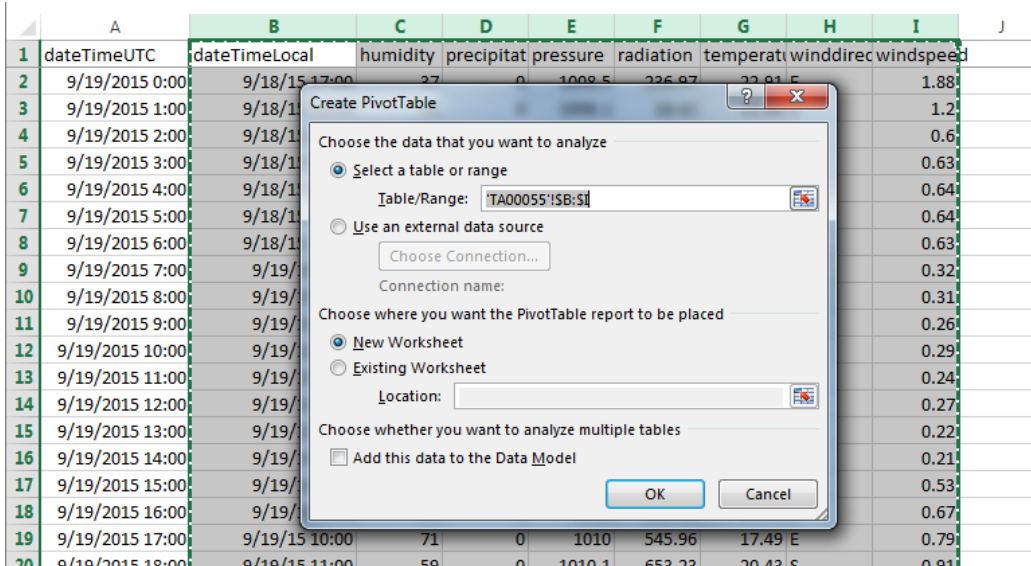
Next you will want to change the date from UTC to local time. The first column in the spreadsheet has the date and time of the data record in Universal Time Coordinates. Please note that the time in the downloaded file is given in Coordinated Universal Time (UTC) and not local time. To convert from UTC to local time, use the time zone to either add or subtract from the UTC time. The time zone can be found on the School2School.net website for each station under the name of the school. You will need to convert UTC to local time for each station for the following analysis. A video tutorial showing how to convert from UTC to local time is available on the S2S website under Teaching Materials, or at this link: <https://youtu.be/5G5nRsej77A>.

Methods:

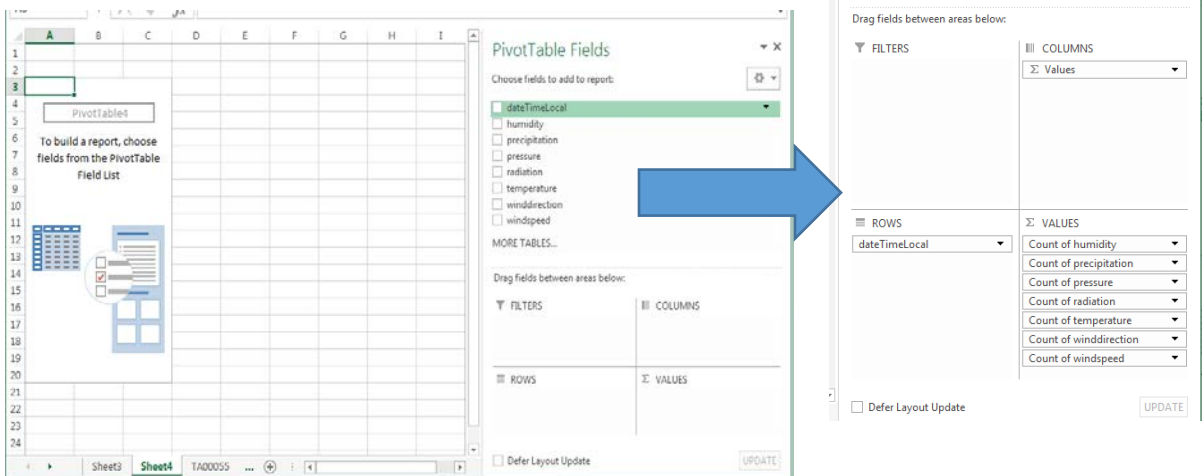
Select the columns B-I to include the Local Time Column and all of the weather variables. Under the INSERT tab, select the PivotTable option.



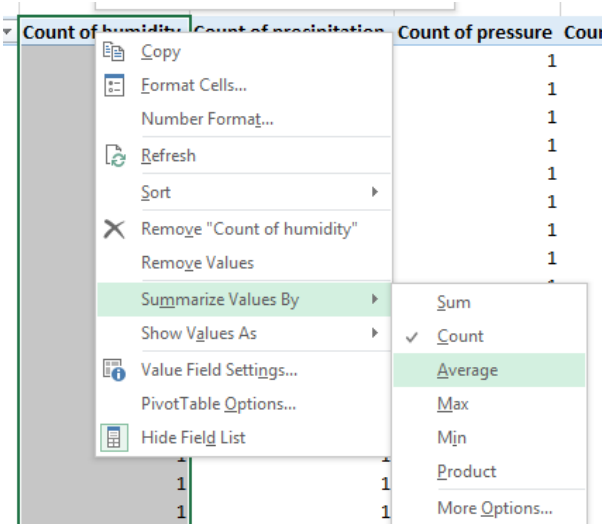
A new dialog box will open, press okay. A new worksheet will open with the pivot table.



In the new worksheet, the PivotTable menu bar will appear. Here you will select the variables of interest for your table. Use your cursor to check the boxes next to the variables, once the variable has been added to the grid below you can drag them between fields. You will want to use the Local Time as the Rows and the other variables under values. As you add the variables to the Pivot Table Fields you will notice the table start to populate in the spreadsheet page.

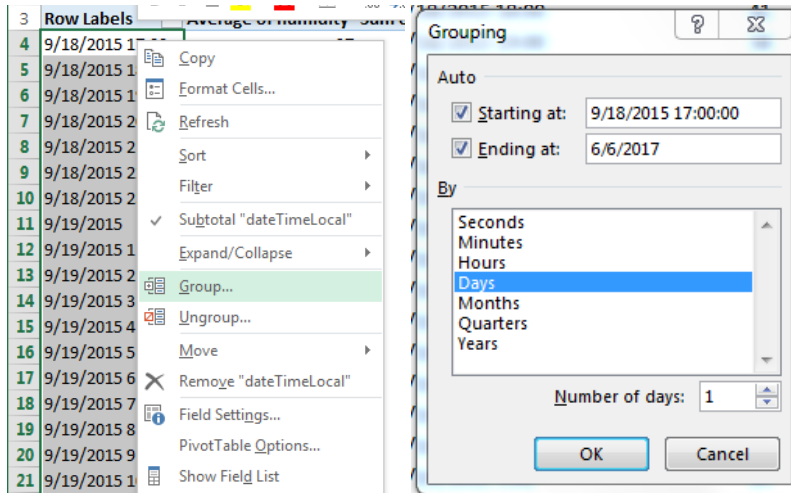


As the table is now, there is not a lot of information we can gain. Instead of having the count of each variable, which simply reports a 1 if there is data recorded and a 0 if the field is empty, we can assign a more meaningful summary for each column variable. Right click on the column header and select "Summarize Values By" and then "Average".

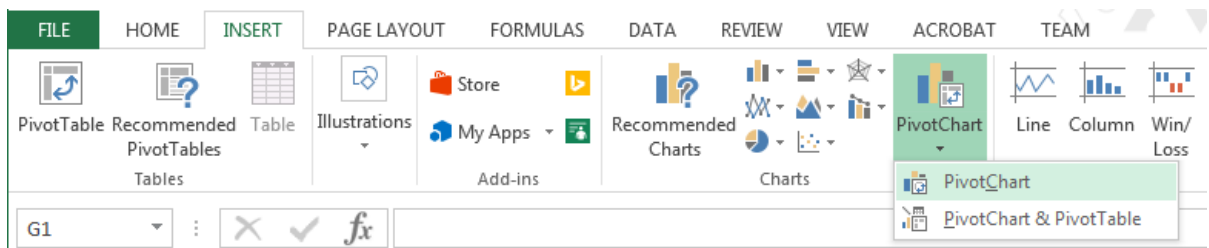


Discuss with your class different scenarios that we would want to summarize by a different metric such as the summation, maximum, or minimum. Ask the class what is an example where we might want to look at the minimum for each time? [Answers vary: example could be that we would want to know the minimum for each time step if we wanted the low temperature at night, or the least windy time.] When might you want to use the maximum for each time? [Answers vary: example could be that we would want to know the maximum for each time step if we wanted the hottest temperature reached or the windiest gusts.] When might you want to use the average for each time? [Answers vary: example could be that we would want to know the averages for each time step if we wanted to know the general trends over a long period of time.] For this example, we will use the average to gain a general understanding of the trends. Do the same for all of the columns. You may notice that there are two columns that don't make a lot of sense: Precipitation and Wind Direction. For precipitation, the total precipitation is more meaningful than the average precipitation so instead of summarizing by average, choose summarize values by "Sum". Wind direction is recorded in North, East, South, and West which are not numeric and thus can't be averages or summed. If you would like, you may deselect the wind direction variable from the Field List values.

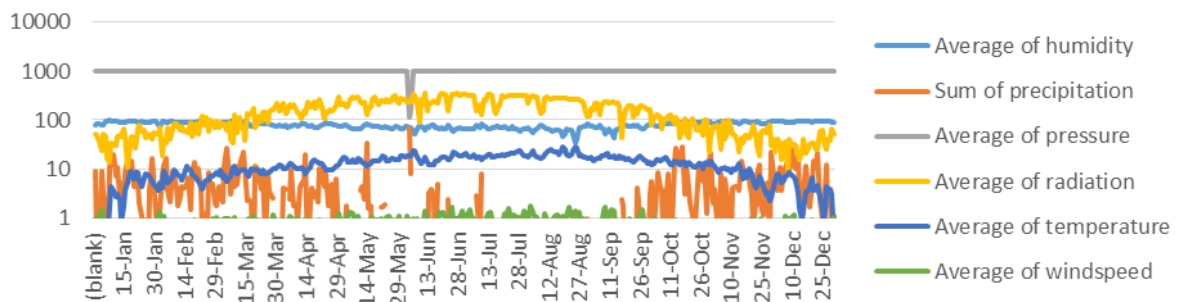
Now we are ready to change the timescale for which the data is presented. Right click on the time column and select "Group". A new dialog box will appear allowing you to choose the time range you wish to apply this grouping to and by what timescale. Choose "Days" as the grouping type.



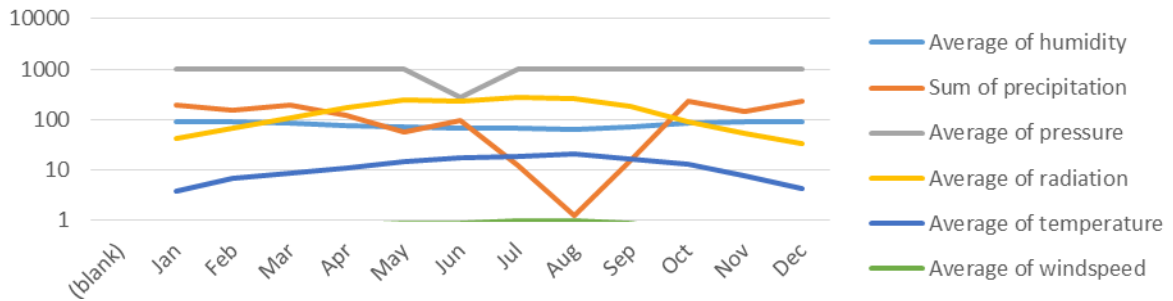
You will notice that your hourly data has now been condensed into daily data. For this daily data, the average daily temperature is averaged for all of the years of record. You can Insert a Pivot Chart to visualize the data.



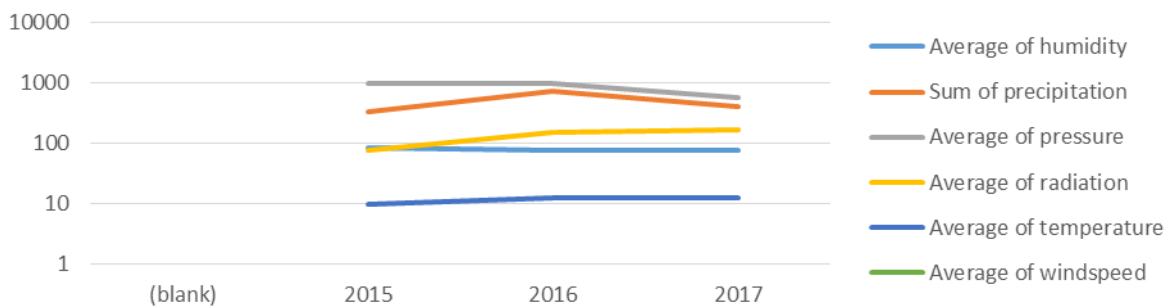
Discuss with the class what trends you can see. Answers will vary on location, but use observational skills to analyze the graph and make generalizations about the weather variable throughout the year. How does pressure change throughout the year? [Answers vary: example could be that pressure remains almost constant throughout the year.] How does precipitation change throughout the year? [Answers vary: example could be that you can tell when there is a rainy season or a dry season based on the total precipitation.] How does humidity change? [Answers vary: example could be that relative humidity is fairly constant but decreases slightly during the dry season.] How does solar radiation change? [Answers vary: example could be that solar radiation tends to be higher during the dry season which corresponds to times of less clouds.] How does average temperature change? [Answers vary: example could be that temperature has a similar trend to solar radiation] How does windspeed change? [Answers vary: example could be that average wind speed is very low, but we do see large increases during storm events.]



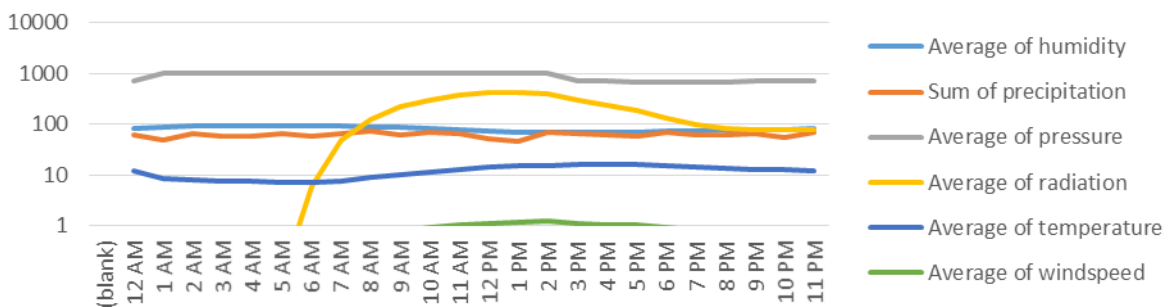
Next regroup the time data by “month” and observe how the graph changes. Can you see the same trends in the monthly data compared to the daily data? [Answer: The same trends will be visible in the monthly averaged data but they will be a lot less noise with less variation]



Next regroup the time data by “days” and observe how the graph changes. What trends do you see across the years? Do some variables seem to be increasing, staying the same, or decreasing? As a class discuss some possible reasons for these changes over the years. [Answers vary: Some examples include was it an El Nino or La Nina year? Can you see the effects of climate change?]



How else could you group the data by time? One example could be looking at hourly averages across the year. Regroup the data by hour and observe the plot. Ask the students to interpret the plot and what it means. One interpretation could be that this plot shows you the average value for each weather variable at a particular time of the day, averaged across each day and year.



Discussion:

Discuss with the class why it is important to look at data on different timescales. Are there difficult conclusions you can make based on different timescales of data? [Answer: Yes] Ask the students to turn their attention to their student worksheet. Discuss the questions below in order to determine the correct timescale and metric that should be used to analyze the data based on the research question.

1. Suppose you want to know if your local climate is getting warmer or colder on average from the year you were born compared to this current year.

[Answer: The keywords of “warmer or colder” which refers to temperature, “on average” with refers to the average summary metric, and “year to year” which is the timescale. Thus the Average Yearly Temperature should be analyzed for this research question.]

What if you wanted to understand which months receive the least sunshine intensity each year?

[Answer: The keyword of “months” which refers to the monthly timescale, “least” with refers to the minimum summary metric, and “sunshine intensity” is the weather variable of solar radiation. Thus the Minimum Monthly Solar Radiation should be analyzed for this research question.]

Imagine you want to learn about the amount of precipitation that falls each day and compare the daily trend across the entire year.

[Answer: The keywords of “the amount” refers to the total or sum metric, “precipitation” refers to the weather variable of interest, and “each day” is the daily timescale of interest. Thus the Total (sum) Daily Precipitation should be analyzed for this research question.]

Imagine you want to understand how the maximum wind speed changes at different hours of the day, what timescale and metric would you use to analyze this question?

[Answer: The keywords of “the maximum” refers to the maximum summary metric, “wind speed” refers to the weather variable of interest, and “different hours of the day” is the hourly timescale of interest. Thus the Maximum Hourly Wind Speed should be analyzed for this research question.]

Data Timescales: Student Worksheet

Suppose you want to know if your local climate is getting warmer or colder on average from the year you were born compared to this current year. What timescale and metric would you use to analyze this question? Check the correct box

- | | |
|---|---|
| <input type="checkbox"/> Average daily temperature | <input type="checkbox"/> Average yearly temperature |
| <input type="checkbox"/> Maximum yearly temperature | <input type="checkbox"/> Maximum daily temperature |

What if you wanted to understand which months receive the least sunshine intensity each year? What timescale and metric would you use to analyze this question? Check the correct box

- | | |
|--|--|
| <input type="checkbox"/> Minimum monthly solar radiation | <input type="checkbox"/> average monthly solar radiation |
| <input type="checkbox"/> Maximum daily solar radiation | <input type="checkbox"/> maximum monthly solar radiation |

Imagine you want to learn about how much precipitation falls each day and compare the daily trend across the entire year. What timescale and metric would you use to analyze this question? Check the correct box

- | | |
|---|---|
| <input type="checkbox"/> Average daily precipitation | <input type="checkbox"/> Average yearly precipitation |
| <input type="checkbox"/> Maximum yearly precipitation | <input type="checkbox"/> Total (sum of) daily precipitation |

Imagine you want to understand how the maximum wind speed changes at different hours of the day, what timescale and metric would you use to analyze this question? Check the correct box

- | | |
|--|---|
| <input type="checkbox"/> Minimum hourly wind speed | <input type="checkbox"/> Average daily wind speed |
| <input type="checkbox"/> Maximum hourly wind speed | <input type="checkbox"/> Total daily wind speed |

Create your own research question. Explain what timescale of data you would use to analyze your question.
