How is the Weather?

Task

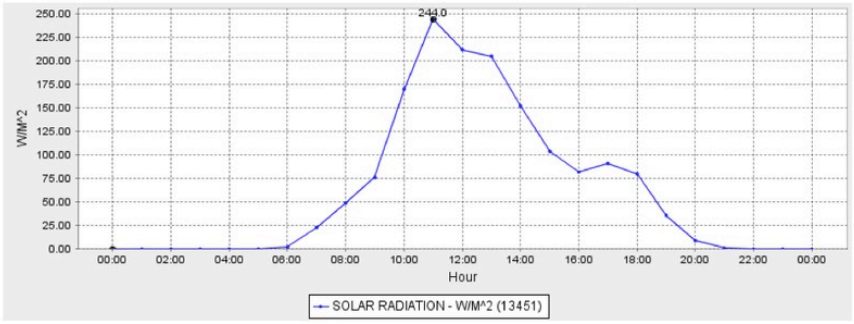
Given below are three graphs that show solar radiation, S, in watts per square meter, as a function of time, t, in hours since midnight. We can think about this quantity as the maximum amount of power that a solar panel can absorb, which tells us how intense the sunshine is at any given time. Match each graph to the corresponding description of the weather during the day.

a. It was a beautifully sunny day from sunrise to sunset – not a cloud in the sky.

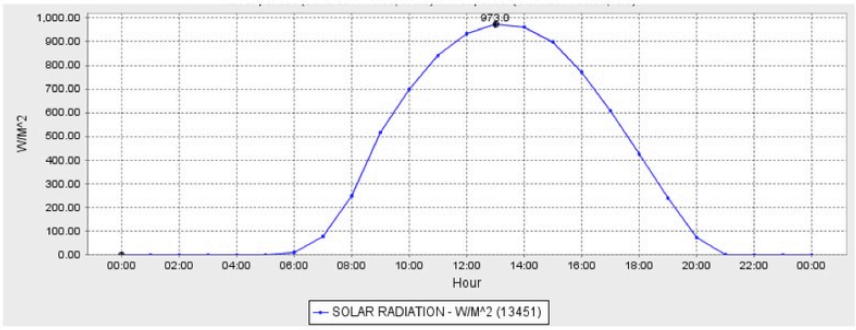
b. The day started off foggy but eventually the fog lifted and it was sunny the rest of the day.

c. It was a pretty gloomy day. The morning fog never really lifted.

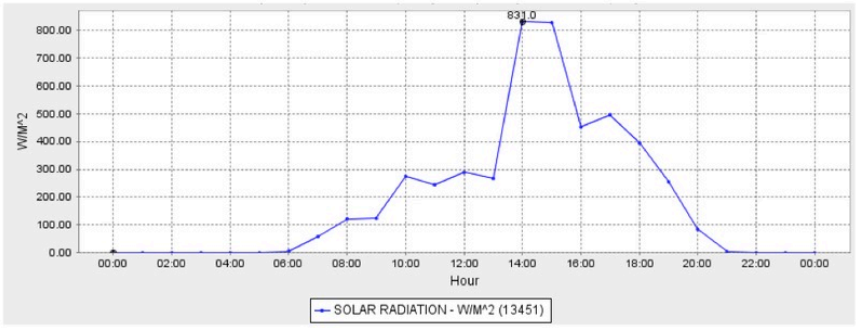
1.



2.



3.



All three graphs show solar radiation measured in Santa Rosa, a city in northern California. What other information can you get from the graph?

Commentary

This task can be used as a quick assessment to see if students can make sense of a graph in the context of a real world situation. Students also have to pay attention to the scale on the vertical axis to find the correct match. The first and third graphs look very similar at first glance, but the function values are very different since the scales on the vertical axis are very different. The task could also be used to generate a group discussion on interpreting functions given by graphs.

The graphs come from the website of the California Department of Water Resources at Department of Water Resources .

The follow-up question could lead into a discussion about the seasons, hours of daylight as a function of latitude, etc. There are many interesting questions that can be investigated in this area mathematically.

Technically, the graphs only show some values of the functions they are meant to represent. A bivariate data plot is a representation of a function in the same way that a table is a representation of a function; while it has some gaps in information, there is an underlying function that the bivariate data plot is assumed to sample. (In this case, the data points are joined by lines which means we are interpolating between our given values.) So the tasks implicitly expect students to answer the question about the solar radiation as a function of time based on the sampled data alone. Given the qualitative nature of the tasks, this does not present a problem.

Solution

a. Graph (2): Graph (2) is the most striking by its symmetry. Once the sun starts rising shortly after 6 a.m., the solar radiation increases steeply until it reaches a maximum of 973 watts per square meter around 1 pm, at $t = 13$. Then the solar radiation decreases until the sun sets around 9 p.m.

b. Graph (3): We can see again that sunrise is around 6 a.m. but this time the solar radiation does not increase as fast as in graph (2). Solar radiation stays below 300 watts per square meter (consistent with foggy weather) until 1 pm and then increases very quickly to 833 watts per square meter (consistent with the fog clearing away). This value is close to the solar radiation on the day that started out sunny at the same time of day, indicating sunny skies in the afternoon.

c. Graph (1): Aside from using the process of elimination we observe that for this graph the solar radiation never gets above 244 watts per square meter. Even though the shape is similar to graph (3), the function values are much lower for the majority of the day, especially the afternoon. This suggests that the sky was overcast for the entire day.

   We already mentioned that sunrise is at 6 a.m. and sunset is around 9 p.m. for graph (2). We can quickly check that this is actually true for all three graphs. Even though the weather was very different on those three days, since the location is the same and sunrise and sunset are the same, the three days must have happened in the same season. We can also conclude that the season was summer, since we have 15 hours of daylight and 9 hours of darkness. (Some research would reveal an even closer estimate of the date (June 17) if we use the latitude of Santa Rosa.)

   It would also be interesting to investigate how much power a solar panel produces on a sunny day vs. a cloudy day.