

Diurnal variation of solar radiation: Teacher Guide

Level: Intermediate

Subject: Mathematics and Statistics

Duration: 40 Min

Type: Small Group Exercise

Learning Goals:

- To understand how solar radiation varies in a day
- To understand what time of the day solar radiation reaches its maximum value
- To gain basic skills of plotting graphs using MS Excel

Material:

- Working computer and strong and stable internet and MS Excel. The computer will be shared in groups depending on the available computers

Introduction

Solar ultraviolet (UV) radiation is an important environmental factor that affects human health. Moderate UV radiation triggers vitamin D synthesis in the skin which contributes to protection against breast cancer, prostate cancer and non-Hodgkin's lymphoma etc. However, excessive solar UV radiation has various direct and indirect effects on human health, which may lead to skin cancer, cataracts, immune suppression, photo-aging, and other ailments.

Methodology

Access the TAHMO school to school website and download daily solar radiation data for a particular station. Sort and analyse the data for plotting using Ms Excel. 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.

Adams Elementary School@ United States(TA00055) 2017-06-08 15:10:00 (2017-06-08 15:00:00)

Elevation: 71

Your time zone is -7

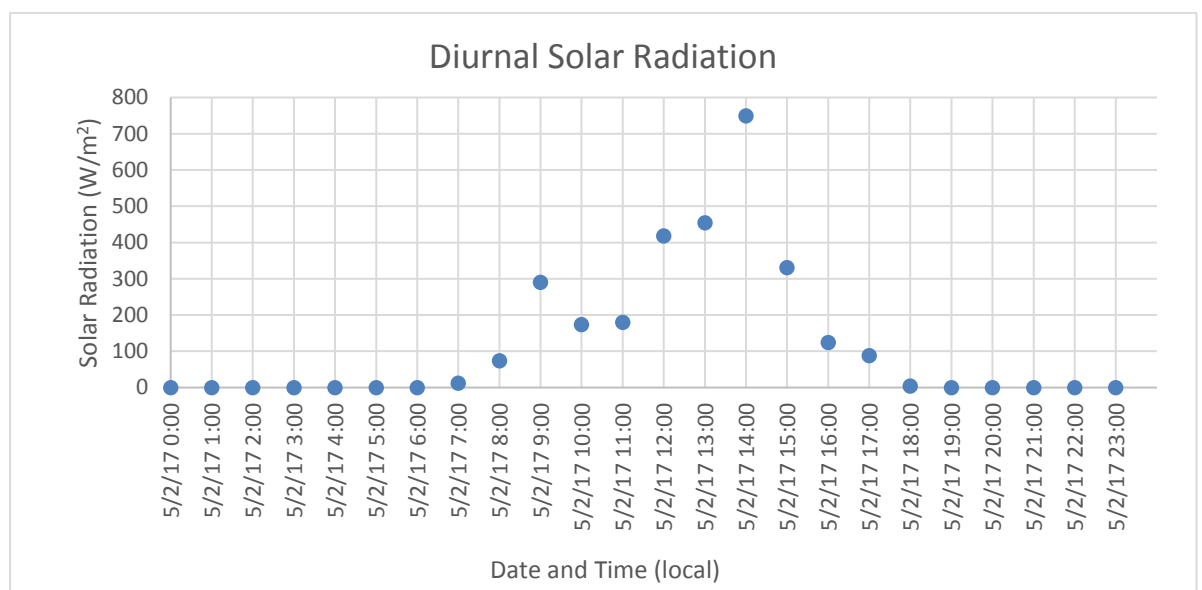
Show on map



Select one day of data, from 12am to 11pm local time. The figure below is an example of solar radiation data selected for date 02 May 2017 from 0:00 to 23:00 (12am to 11pm local time).

	A	B	C	D	E	F	G	H
1	dateTimeUTC	3:00	humidity	precipitation	pressure	radiation	temperature	winddirectic
13035	5/1/2017 15:00	5/1/17 18:00	99		1.45	804.1	0	15.35 E
13036	5/1/2017 16:00	5/1/17 19:00	100		11.52	804.8	0	15.44 SW
13037	5/1/2017 17:00	5/1/17 20:00	100		1.45	805.3	0	14.08 N
13038	5/1/2017 18:00	5/1/17 21:00	100		0.04	805.9	0	14.82 N
13039	5/1/2017 19:00	5/1/17 22:00	100		0.02	806.4	0	15.3 N
13040	5/1/2017 20:00	5/1/17 23:00	100		0	806.2	0	15.24 N
13041	5/1/2017 21:00	5/2/17 0:00	100		0	805.6	0	14.76 N
13042	5/1/2017 22:00	5/2/17 1:00	100		0	805.4	0	14.7 N
13043	5/1/2017 23:00	5/2/17 2:00	100		0.1	804.7	0	14.3 N
13044	5/2/2017 0:00	5/2/17 3:00	100		0	804.4	0	14.44 N
13045	5/2/2017 1:00	5/2/17 4:00	100		0	804.4	0	14.4 N
13046	5/2/2017 2:00	5/2/17 5:00	100		0	804.8	0	14.48 N
13047	5/2/2017 3:00	5/2/17 6:00	100		0	805.2	0	14.5 N
13048	5/2/2017 4:00	5/2/17 7:00	100		0	805.6	11.9	14.56 N
13049	5/2/2017 5:00	5/2/17 8:00	100		0	805.9	73.7	14.68 N
13050	5/2/2017 6:00	5/2/17 9:00	99		0	806.1	290.04	15.76 N
13051	5/2/2017 7:00	5/2/17 10:00	87		0	806.1	173.95	17.67 S
13052	5/2/2017 8:00	5/2/17 11:00	93		0	806.2	180.06	16.83 SW
13053	5/2/2017 9:00	5/2/17 12:00	77		0	805.5	418.4	19.73 SW
13054	5/2/2017 10:00	5/2/17 13:00	71		0	804.3	454.1	21.09 W
13055	5/2/2017 11:00	5/2/17 14:00	72		0	803.5	749.82	21.58 S
13056	5/2/2017 12:00	5/2/17 15:00	76		0	802.8	331.19	20.3 SW
13057	5/2/2017 13:00	5/2/17 16:00	77	0.07	802.5	124.36		19.94 SW
13058	5/2/2017 14:00	5/2/17 17:00	86		0	802.6	87.89	18.3 S
13059	5/2/2017 15:00	5/2/17 18:00	92		0	803	3.89	17.21 SW
13060	5/2/2017 16:00	5/2/17 19:00	93		0	803.5	0	17 SW
13061	5/2/2017 17:00	5/2/17 20:00	93		0	804.4	0	16.46 S
13062	5/2/2017 18:00	5/2/17 21:00	96		0	805	0	16.13 SW
13063	5/2/2017 19:00	5/2/17 22:00	97		0	805.5	0	16.1 S
13064	5/2/2017 20:00	5/2/17 23:00	97		0	805.4	0	15.95 S
13065	5/2/2017 21:00	5/3/17 0:00	98		0	805.2	0	15.8 S

Using MS Excel, plot a line graph of solar radiation for period of twenty-four hours. This plot will show you the diurnal variation in solar radiation. The figure below is a graph showing diurnal variation of solar radiation at station TA00066 on 02 May 2017.



Questions

These questions will assist in discussing the graph plotted

- 1) What do the units of solar radiation (W/m^2) mean?
- 2) Describe the variation of solar radiation for the whole day
- 3) What time of the day shows the maximum solar radiation? Why?
- 4) What time of the day shows the minimum solar radiation? Why?
- 5) From the graph, what time does the sun rise and sun set?
- 6) How is the solar radiation information important for our daily activities?

Discussion

Discuss some of the factors affecting the amount of solar radiation reaching the earth surface and thus the weather station

Possible Answers:

- The amount of solar radiation reaching the earth's surface varies greatly because of changing atmospheric conditions and the changing position of the sun, both during the day and throughout the year.
- Clouds are also atmospheric condition that determines the amount of solar radiation that reaches the earth. Regions of the nation with cloudy climates receive less solar radiation than the cloud-free desert climates. Therefore, the solar radiation reaching the earth's surface decreases with increasing cloud cover.
- The amount of solar radiation also varies depending on the time of day and the season. More solar radiation is present during midday than during either the early morning or late afternoon. At midday, the sun is positioned high in the sky and the path of the sun's rays through the earth's atmosphere is shortened.

In which period of the year do you experience maximum solar radiation in your region? [Answer: This depends on the location of the country and the period of the year in which sun is close to the given latitude i.e. when the sun is over Equator, Tropic of Cancer or Tropic of Capricorn]

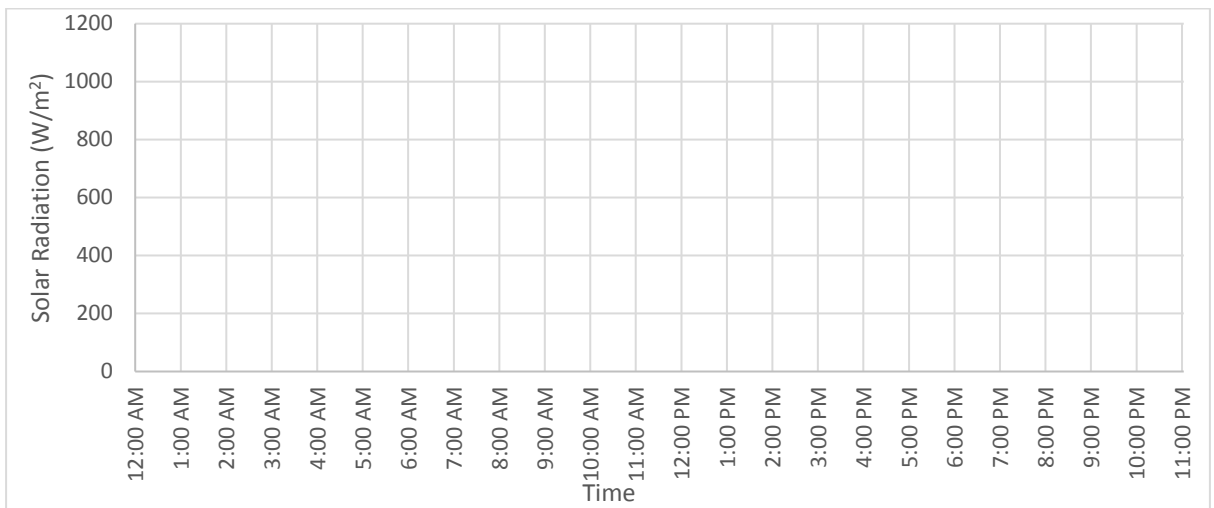
In which period of the year is the sun over the Equator, Tropic of Cancer and Tropic of Capricorn? [Answer: Over equator: the period is 21st – 22nd March and 22nd – 23rd September; Over Tropic of Cancer: the period is 20th – 22nd June; Over Tropic of Capricorn: the period is 21st – 22nd December]

Diurnal variation of solar radiation: Student Worksheet

What do the units of solar radiation (W/m^2) mean?

How is the solar radiation information important for our daily activities?

Access the School2School.net website and download solar radiation data. Sort and analyse the data using MS Excel. Make sure to convert the downloaded time in UTC to local time using the time zone. Select the column of solar radiation and choose one day of data from 12 am to 11pm local time. Create a line graph of Solar Radiation in Excel, draw the plot on the graph below.



Describe the variation of solar radiation for the whole day.

What time of the day shows the maximum solar radiation? Why?

What time of the day shows the minimum solar radiation? Why?

From the graph what time does the sun rise and sun set?

Questions

Discuss some of the factors affecting the amount of solar radiation reaching the earth surface and thus the weather station.

In which period of the year do you experience maximum solar radiation in your region?

In which period of the year is the sun over the Equator, Tropic of Cancer and Tropic of Capricorn?
