LAB 2: Earth Sun Relations

The amount of solar energy striking the Earth's atmosphere is not uniform; distances, angles and seasons play a dominant role on this distribution of radiation. Needless to say, the distribution is unequal, and Solar Radiation at any location on the earth’s Surface/Atmosphere is determined by the Sun's intensity and duration. This lab will examine what happens to solar radiation as it enters and interacts with the Earth system, as well as examine the effects that the sun angle has on intensity and duration of solar radiation. Before beginning, it is fair to assume that the earth's weather and temperature is a direct reaction of the earth sun relations- so what does that mean?

Weather is the state of the atmosphere at a particular place for a short period of time. The condition of the atmosphere at any place and time is described by measuring the four basic elements of weather: temperature, humidity, air pressure, and wind. Of all the controls that are responsible for causing global variations in the weather elements, the amount of solar radiation received at any location is certainly one of the most important.

Temperature is an important element of weather and climate because it greatly influences air pressure, wind, and the amount of moisture in the air. The single greatest cause of temperature variations over the surface of Earth is differences in the reception of solar radiation. Secondary factors such as the differential heating of land and water, ocean currents, and altitude can also modify local temperatures. The unequal heating that takes place over the surface of the Earth is what sets the atmosphere in motion, and the movement of air is what brings changes in our weather.

The two most important factors when understanding solar radiation are:

1. ______________________

2. ______________________
Energy Budget

Continuing the topic of energy, we have what is known as a solar budget, this budget is a 100% total value that is distributed among the earth. The approximate average value cited of energy from the sun to the earth is, 1.366 kW/m², or is equivalent to 1.96 calories per minute per square cm, or 1.96 Langley’s per minute. Please answer the following questions using the diagram provided.

3. What percentage of energy is absorbed at the surface?

4. What percentage of the total energy is reflected?

5. What are some of the reasons why energy is reflected?

6. What are some of the reasons why energy is absorbed?

7. What are some of the reasons why energy is scattered?
The analemma takes into consideration the changing declination of the sun throughout the year. Please find the subsolar point for the following questions using the analemma provided:

8. October 15
9. August 15
10. June 22
11. December 22
12. September 23
13. March 21
14. Today’s Date
15. Your Birthdate
**Aphelion & Perihelion**

The shape of the Earth's orbital path is not symmetrical; please observe the following table to find when the earth is nearest and farthest from the sun:

<table>
<thead>
<tr>
<th>Month</th>
<th>Average Earth-Sun Distance³</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>147,000,000 km</td>
</tr>
<tr>
<td>March</td>
<td>149,000,000 km</td>
</tr>
<tr>
<td>June</td>
<td>153,000,000 km</td>
</tr>
<tr>
<td>July</td>
<td>153,000,000 km</td>
</tr>
<tr>
<td>September</td>
<td>150,000,000 km</td>
</tr>
<tr>
<td>December</td>
<td>148,000,000 km</td>
</tr>
</tbody>
</table>

16. The earth is closest to the sun in this month:

17. During the month that the earth is closest to the sun, what season are we experiencing in Los Angeles?

18. The earth is farthest from the sun in this month:

19. During the month that the earth is farthest from the sun, what season are we experiencing in Los Angeles?

20. Explain your findings and perhaps why they are not as you expected:
Solar Radiation at Outer Edge of the Atmosphere

To help visualize the pattern of energy, plot the data from the table below onto the graph provided. Using a different color for each latitude, draw lines through the monthly values to obtain yearly curves.

<table>
<thead>
<tr>
<th>Latitude</th>
<th>March</th>
<th>June</th>
<th>September</th>
<th>December</th>
</tr>
</thead>
<tbody>
<tr>
<td>90°N</td>
<td>50</td>
<td>1050</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>40°N</td>
<td>700</td>
<td>950</td>
<td>720</td>
<td>325</td>
</tr>
<tr>
<td>0°</td>
<td>890</td>
<td>780</td>
<td>880</td>
<td>840</td>
</tr>
</tbody>
</table>
Length of Daylight

Each day, different lines of latitude receive different lengths of daylight and darkness. The table below shows the length of daylight at specific latitudes during the solstices and equinoxes. Remember that North Americas Summer is South Americas Winter. Please answer questions 13 through 17.

What is the length of daylight at the following latitudes during the Winter Solstice?

21. 70°N:_______________________
22. 40°S:_______________________
23. 0°:_______________________
24. 10°S:_______________________
25. 90°N:_______________________

<table>
<thead>
<tr>
<th>Latitude (Degrees)</th>
<th>Summer Solstice</th>
<th>Winter Solstice</th>
<th>Equinoxes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>12 hr</td>
<td>12 hr</td>
<td>12 hr</td>
</tr>
<tr>
<td>10</td>
<td>12 hr 35 min</td>
<td>11 hr 25 min</td>
<td>12 hr</td>
</tr>
<tr>
<td>20</td>
<td>13 hr 12 min</td>
<td>10 hr 48 min</td>
<td>12 hr</td>
</tr>
<tr>
<td>30</td>
<td>13 hr 56 min</td>
<td>10 hr 04 min</td>
<td>12 hr</td>
</tr>
<tr>
<td>40</td>
<td>14 hr 52 min</td>
<td>9 hr 08 min</td>
<td>12 hr</td>
</tr>
<tr>
<td>50</td>
<td>16 hr 18 min</td>
<td>7 hr 42 min</td>
<td>12 hr</td>
</tr>
<tr>
<td>60</td>
<td>18 hr 27 min</td>
<td>5 hr 33 min</td>
<td>12 hr</td>
</tr>
<tr>
<td>70</td>
<td>2 mo</td>
<td>0 hr 00 min</td>
<td>12 hr</td>
</tr>
<tr>
<td>80</td>
<td>4 mo</td>
<td>0 hr 00 min</td>
<td>12 hr</td>
</tr>
<tr>
<td>90</td>
<td>6 mo</td>
<td>0 hr 00 min</td>
<td>12 hr</td>
</tr>
</tbody>
</table>
Finding the Latitude Using the Sun Angle

The ability to find one’s latitude came before longitude. We can use the angle of the stars in the sky to calculate our angle of latitude. For this lab we will use the sun, but both Polaris (the North Star) and the Southern Cross constellation can be used depending on your hemisphere.

Now that you can use the Analemma, you are ready to find latitude based on the sun’s angle in the sky. As long as you know the sun’s angle, the date, your hemisphere (north or south), and the correction based on the Analemma you can locate your current line of latitude.

“Using” a sextant to measure the Sun’s altitude

To determine latitude you only need to know three things. They are:

- The sun’s angle above the horizon at the highest point in its daily arc found using a sextant (or protractor for this lab),
- The date
- The correction for Earth’s seasonal variations for that day as shown on the analemma.

Here is the formula used by sailors to determine their latitude:

\[
Latitude = (90 - \text{solar angle at midday}) \pm \text{the analemma correction for that day}
\]
Assume that the figure below shows the location of a person at mid-day on April 20.

First, draw a pencil line from the X at the bottom of the sextant through the middle of the sun. Measure this angle exactly using a protractor. This is the solar angle for this location:

Solar angle _________________

Subtract the solar angle from 90

90 - ___________ = ___________

Analemma correction for this date is:

April 20th = _________________

Notice that the formula both adds and subtracts (±) the analemma correction giving us two possible locations. Write them here:

_________________ & _______________

Generally one is in the northern hemisphere and the other in the southern hemisphere. The larger of the two possible numbers will be located the hemisphere which is experiencing longer days (i.e. experiencing spring or summer). Let’s assume that the April 20th figure is from somewhere in the Northern Hemisphere. What is the latitude of our lost person?
Practicing Finding Latitude
Using the technique outlined above, find the latitude for the following locations.

Location 1 – Northern Hemisphere, February 1

Location 2 – Northern Hemisphere, May 20
Earth/Sun Relations

Complete the crossword below- vocab comes from lab and textbook.

Across
4. The earth is closest to the sun during this month
7. Of, relating to, or occurring in the spring.
8. ___ wave radiation is what the earth absorbs from the sun.
9. The point nearest the sun in the orbit of a planet or other celestial body.
10. The direct transfer of energy by electromagnetic waves through empty space.
11. The time during which something continues.
16. The reflection of light in all directions.
17. 51% of the sun’s energy is ____ by the surface.
18. ____ wave radiation is emitted from the earth, back into the atmosphere.

Down
1. The point on the celestial sphere that is directly above the observer.
2. A scale in the shape of a figure eight, indicating the sun’s declination and the equation of time for every day.
3. The distance between two crests or troughs.
5. Either of the two times during a year when the sun crosses the celestial equator with equal length of day and night.
6. The ___ scale covers a wide range of wavelengths and photo energetics.
12. Approximately 30% of the total energy emitted from the sun is ____ off the earth’s surface.
13. Exceptionally great concentration, power, or force.
14. The point on the orbit of a celestial body that is farthest from the sun.
15. Of or relating to autumn.