

## “SOLAR ANALEMMA”

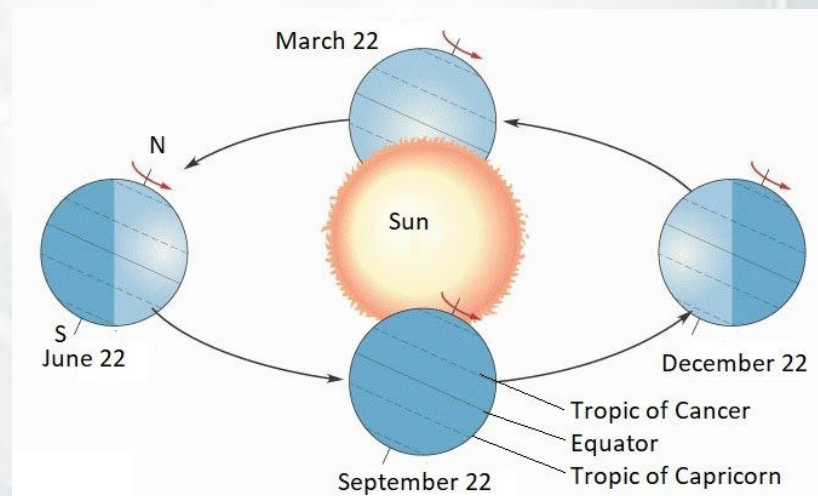


**Mr. K. M. Jadhav**

Assistant Professor,  
Department of Mechanical Engineering,  
VPKBIET, Baramati.

The ancients observed the apparent motion of the Sun in the sky and guessed that the sun was revolving around us. In 1543, Nicolaus Copernicus proposed that the sun is stationary in the center of the universe and the earth revolving around it. His theory took more than a century to become widely accepted.

Nowadays also people say sunrises in the east and sunsets in the west, but this is not true throughout the year. Sun rises due east sets due west only twice a year that too for the locations between tropic of cancer and tropic of Capricorn. Also summer, winter, and rainy seasons are observed in different months for different locations on the earth.



*Fig. Positions of Earth with respect to Sun in a year*

Earth has different seasons because Earth's axis of rotation is tilted at an angle of  $23.5^\circ$  with respect to its orbital plane, that is, the plane of Earth's orbit around the Sun. India comes in the northern hemisphere and the tropic of cancer line (which is situated  $23.5^\circ$  north of equator) passing from India. As a result of this in June month Sun's rays are nearly perpendicular in the northern hemisphere (locations near the tropic of cancer). 22<sup>nd</sup> June is the longest day (whereas 22<sup>nd</sup> December is the shortest day) in India and the maximum amount of sunlight received by the northern hemisphere during this time.



In contrast, the locations near the tropic of Capricorn like Australia (in the southern hemisphere) have 22<sup>nd</sup> December as the longest day (whereas 22<sup>nd</sup> June shortest day) when the northern hemisphere has its longest night. You might have heard that there is six months day and six month night at the north pole and south pole of the Earth, this is because of the tilt of Earth's axis. If you understand the position of Earth with respect to the Sun during a year then it will be clear that at the north pole there will be Sun rays between 22<sup>nd</sup> March to 22<sup>nd</sup> September whereas sunlight will be available at the south pole between 22<sup>nd</sup> September to 22<sup>nd</sup> March.

It will be very interesting to know about the Sun's positions in the sky from the north pole or/and from the south pole of the Earth. Sun will not appear moving up in the sky (like it appears from morning to afternoon from the regions near the equator), it will be observed moving near to the horizon. The sun never sets in the Antarctic (region near the south pole) between late November and late January.



Fig. Photo shots of the Sun taken every 10 minutes 10:48 p.m. on Dec. 22, 2016, from the deck of Japan's icebreaker Shirase (Source: [www.japantimes.co.jp/news/2017/02/08](http://www.japantimes.co.jp/news/2017/02/08))

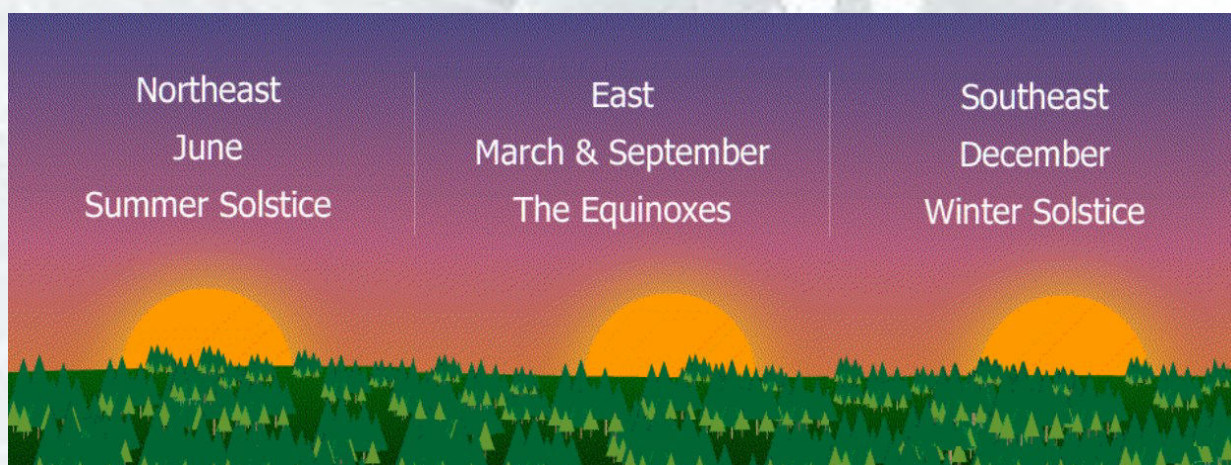


Fig. Approximate sunrise directions



Imagine that you are standing at the north pole of earth and if you point any direction from that point it will be South direction only, because all longitudes meet at the north pole. But if you take a few steps to the south (any direction will do!) then you can now walk east or west - but you will certainly wind up walking around in a small circle.

If we look at the position of the Sun from locations near the equator of the Earth like Brazil then on 22<sup>nd</sup> March and on 22<sup>nd</sup> September sunrise in due east and sunset in due west and Sun will be exactly on head at midday time. The Sunrise position will be moving from east towards northeast from 22<sup>nd</sup> March to 22<sup>nd</sup> June and back to east from 22<sup>nd</sup> June to 22<sup>nd</sup> September. The Sunrise position will be moving from east towards southeast from 22<sup>nd</sup> September to 22<sup>nd</sup> December and back to east from 22<sup>nd</sup> December to 22<sup>nd</sup> March. But this apparent position of the Sun is different as we move towards the north pole or towards the south pole from equator position.

Another interesting thing to know about the position of the Sun is, solar analemma. If we take a picture of the Sun's position at the same time of the day; from a fixed location on the Earth; for one complete year and plot a graph of positions of the Sun, it is called solar analemma. We will see the positions of the Sun form the shape slightly similar to figure 8, with one loop bigger than the other. This is called the Sun's Analemma curve. The shape of solar analemma is the result of Earth's elliptical orbits path around the Sun and the tilt of the axis of rotation at  $23.5^\circ$  to its orbital plane.

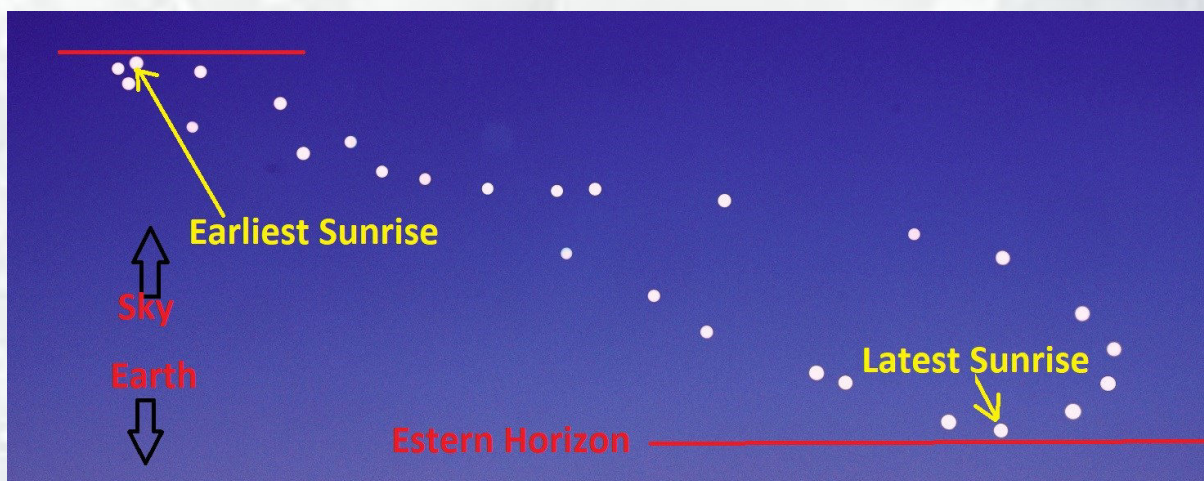


Fig. A typical solar analemma can be observed from India

“A lot of prizes have been awarded for showing the universe is not as simple as we might have thought”

- Stephen W. Hawking