A New Method of Measuring the Shadow Length

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Keywords: Solar zenith angle, Latitude angle，MATLAB

Abstract. In this paper, we mainly use the solar zenith angle, solar azimuth angle, the angle of the red and weft, the relationship between the date sequence number and some specific geometric relations. The formula is related to the concept of the degree of latitude and the time angle, which can be defined as the relationship between the latitude and longitude and the height of the sun.

Introduction

To establish the mathematical model of the long shadow, first consider the factors associated with the shadow length, we can know that the solar zenith angle is directly related to the shadow length. Factors affecting the solar altitude angle have three: angle, declination, the local latitude, these three factors can be calculated the solar altitude angle formula, the latitude and longitude of the requirements of the subject, rod is high, the time interval is substituted into the formula, using MATLAB simulated 9 to 15 straight rod long shadow curves.

Under the assumption that the sun is parallel to the light, this problem can be considered as a simple mathematical solution questions. The key to this problem is to find out the relationship between each parameter and the shadow length. We take into account that the object at a certain point.The shape of the shadow (the length and position) of the sun is determined by the relative position of this point on the earth.And this relative position by the local geographical latitude, season (day, month) and time (here's time accurate)Three factors determine the moment of speaking

Model preparation

The factors known to influence one's solar altitude angle, to find relevant information shows that the selected angle should be based on the local sun prevail, the national general "Beijing time" is not the actual local sun, can only be used by the "longitude correction".

Model hypothesis

1.Assuming that the sun is light, there is no refraction.
2.It is assumed that altitude is often negligible
3.Suppose the time zone is east eight

Model building

From the basis of physical knowledge, in the light of the sun, the object and the shadow of the object, through the object to the top of the light to form a triangle, as shown in figure:

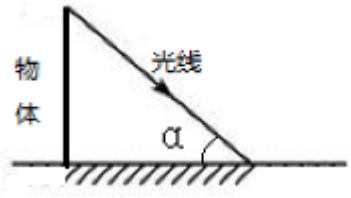

Fig1. Basic physical model

Among them, the angle alpha is the height angle of the sun. Matter is high, the shadow is long, so. It can be known that there are three factors that affect the solar height angle:

1.Red weft, show season, date change;

2.Time angle, indicates the time change;

3.Geographical latitude, the location of the observation point;

Declination angle is the angle between the equatorial plane of the sun and the earth was the center of the connection, namely direct solar latitude. It on a year to year cycle, within the range of + 23 degrees 26 'and 23 degrees 26' mobile. δ representation.

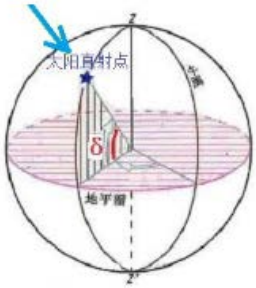

Fig2. Direct sunlight to the surface of the earth

The formula for the:

$$\delta = 23.45\sin(\frac{2\pi(284+n)}{365})$$

n is the date when the serial number, date of January 1st, n =1 and so on.

When the angle of the numerical representation of the object and when the angular distance of Kenneth Chiko circle to local time at 12 o'clock when the angle is zero, a positive number indicates that it has a few hours before the local meridian, negative expresses it in a few hours later by the local meridian, the angle is 0 said the day is on the local meridian.1 hours is equal to 15 degrees.

$$\omega = 15(t_s - 12)$$

When the sun is the place. 120 degrees east longitude of the local solar time (T) is the standard time, it is necessary to know the location of the place where the sun, the need for longitude correction. Longitude at one time, revised 4 minutes on time. x for location longitude.

$$t_s = t - \frac{4}{60}(120 - x)$$

Plug type available angle can be expressed as:

$$\omega = 15(t + \frac{1}{15}x - 20)$$

The latitude of the observation point ϕ is represented by the latitude.

$$\sin\alpha = \sin\phi \cdot \sin\delta + \cos\phi \cdot \cos\delta \cdot \cos\omega$$

Analysis of the changes in the length of the shadow of the parameters of the law

Change with altitude:

As the figure shows, for the same object, the higher the height angle of the sun, the shorter the length of the object.

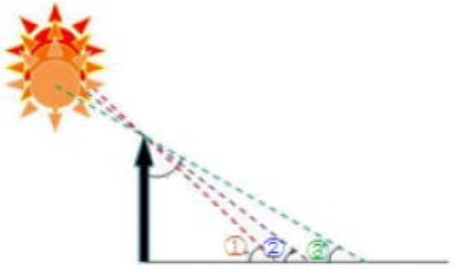

Fig3. The change of direct solar angle

With the declination angle variation:

There are three kinds of objects in the location of the object, the object in the Tropic of cancer in the north, the object in the south of the Tropic of cancer, the object in the north and south between the return line. Suppose a thing in a fixed position under the position, when the local sun is the same, the latitude angle of different (date), the analysis of the variation of the shadow of the law:

a. The object is north of the Tropic of cancer

From June 22nd to December 21st each year, the shadow grows longer and longer;

From December 22nd to June 21st the following year, the shadow length gradually become shorter.

b. Object in the south of the Tropic of Capricorn

From June 22nd to December 21st each year, the shadow length becomes shorter and shorter;

From December 22nd to June 21st the following year, the shadow of a long gradually longer.

c. Between the objects in the north and the south.

Each year in June 22nd to the point of direct sunlight, the shadow length gradually become shorter;

The sun points directly to the point in December 21st, the shadow grows longer;

December 22nd to the next year, the sun direct point, the shadow length gradually become shorter;

The next year the sun points directly to the next year in June 21st, the shadow grows longer.

Solving model

The time t=9:00-15:00, latitude latitude 39 degrees 54 minutes 26 seconds, X longitude longitude 116 degrees 23 minutes and 29 seconds. H=3 meters are substituted into the equations, using MATLAB show the curve as follows:

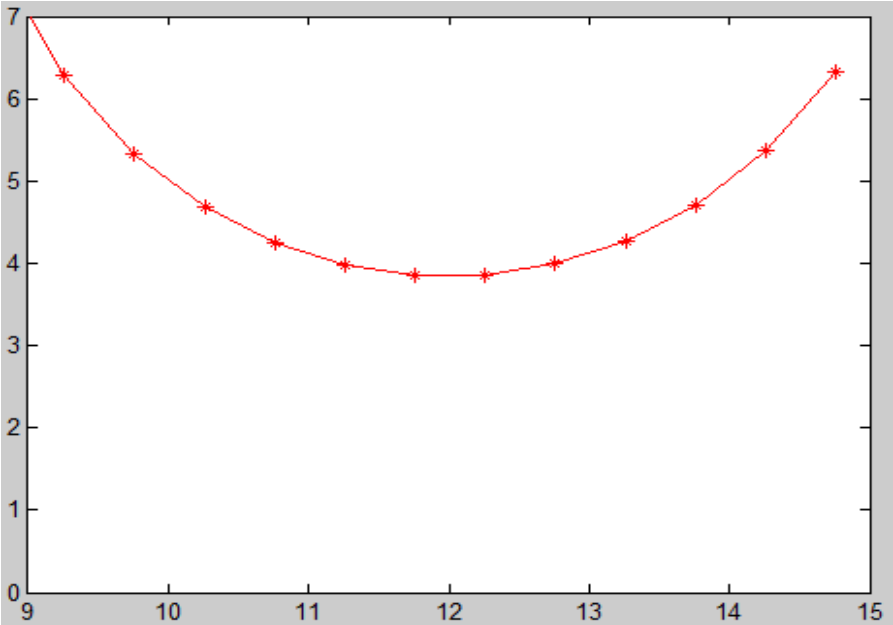

Fig4. The change of shadow length with time

Summary

Finally, the result is derived by using the above formula. We can see from the picture that the length of the shadow has a significant change with time. First of all, at about 12, the length of the shadow is the shortest, which is consistent with our common sense. Second, the entire shadow length change pattern is symmetrical.

In the establishment of the model, it is very important to understand the parameter n. If the understanding of the N fuzzy, it will result in the error of the results and the model is not accurate.

In the process of solving the model, the MATLAB is used to solve the problem, especially after the simplification of the formula, which greatly reduces the difficulty of the calculation. And the use of MATLAB to improve the accuracy of the results of the model.

This model is simple and easy to understand, calculation, the model is simple and easy to understand, calculation, and the actual situation has not produced a large gap, the actual situation has a certain guiding significance. In order to make the calculation results do not appear too big deviation and simple, this paper assumes that the sun parallel in order to make the calculation results do not appear too big deviation and simple, this paper assumes that the sun parallel light, so the result in fact is a theoretical value than the measured data are relatively large. As the gas reservoir is stored in the light, the result is in fact a theoretical value which is larger than the measured data. As the gas reservoir is stored in the light, the result is in fact a theoretical value which is larger than the measured data. As the gas reservoir is stored in the light, the result is in fact a theoretical value which is larger than the measured data. In due to the presence of water vapor, carbon dioxide and dust on the gas, the density and outer space really is not the same so when the sun from the water vapor, carbon dioxide and dust, the density and outer space really is not the same so when the sun from the water vapor, carbon dioxide and dust, the density and outer space really is not the same so when the sun from the water vapor, carbon dioxide and dust, the density and outer space really is not the same so when sunlight from outer space completely into the atmosphere must be deflection. Therefore, there will be a certain degree of error in the solar altitude angle. The refractive index of air is supposed to be a factor that needs to be considered.

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