2.15 Declination Angle

太阳倾角

The declination angle, denoted by δ, varies seasonally due to the tilt of the Earth on its axis of rotation and the rotation of the Earth around the sun. If the Earth were not tilted on its axis of rotation, the declination would always be 0°. However, the Earth is tilted by 23.45° and the declination angle varies plus or minus this amount. Only at the spring and fall equinoxes is the declination angle equal to 0°. The rotation of the Earth around the sun and the change in the declination angle is shown in the animation below.

太阳倾角，用δ表示，由于地球本身的自转和绕太阳的公转会发生季节性的变化。假设地球的自转轴不是倾斜的（相对于公转平面），太阳倾角就一直为 0 度。然而，地球自转轴的倾角是 23.45 度，因此太阳倾角在±23.45 度之间变化。太阳倾角只有在春分和秋分这两天才等于 0 度。下面的动画给出了地球绕太阳公转和太阳倾角的变化（译者注：只在原网页中有效）。

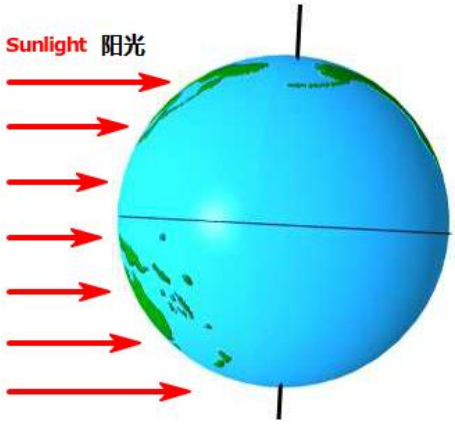
Animation showing how the tilt angle changes from the summer solstice in the northern hemisphere (or winter in the southern hemisphere) to the northern hemisphere winter solstice (summer in the south).

该动画（译者注：只在原网页中有效）给出了太阳倾角从北半球的夏至（或者南半球的冬至）到北半球冬至（或者南半球的夏至）之间的变化。

The declination of the sun is the angle between the equator and a line drawn from the centre of the Earth to the centre of the sun. The seasonal variation of the declination angle is shown in the animation below.

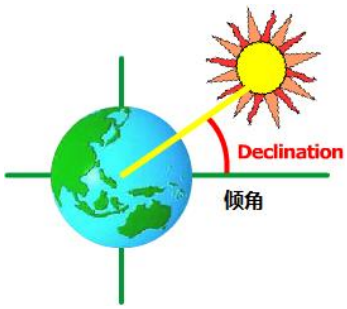
太阳的倾角指的是赤道与地球球心和太阳球心连线之间的夹角。下面的动画（译者注：只在原网页中有效）给出了太阳倾角的季节性变化。

原文地址：http://www.pveducation.org/pvcdrom/properties-of-sunlight/declination-angle
PDF 版本下载地址：https://dl.dropboxusercontent.com/u/52743103/PVCDROM/2.15%20Declination%20Angle.pdf
博主邮箱：nkukarl@gmail.com

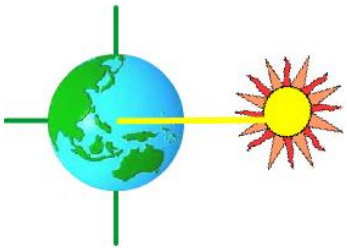


Despite the fact that the Earth revolves around the sun, it is simpler to think of the sun revolving around a stationary Earth. This requires a coordinate transformation. Under this alternative coordinate system, the sun moves around the Earth.

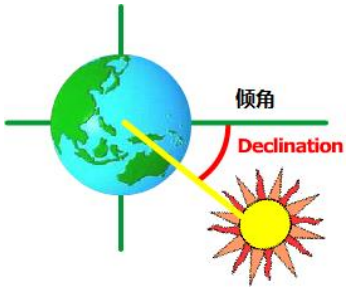
尽管事实上地球是围绕太阳旋转的，但是如果我们认为地球是不动的，太阳围绕着地球旋转，则更有利于我们分析太阳倾角。这样一来，我们需要做一个坐标变换。在变换后的坐标系统里，太阳是围绕地球旋转的。



Summer solstice in the northern hemisphere. The declination angle (δ) is at its maximum and is 23.45°.
北半球的夏至。太阳倾角达到最大值，为 23.45 度。



Spring equinox in the northern hemisphere and autumn equinox in the southern hemisphere. The declination angle (δ) is 0°.
北半球的春分或者南半球的秋分。太阳倾角为 0 度。



Winter solstice in the northern hemisphere and summer solstice in the southern hemisphere. The declination angle (δ) is -23.45°.
北半球的冬至或者南半球的夏至。太阳倾角为-23.45 度。

The declination angle can be calculated by the equation[1]:

$$\delta = 23.45° \sin\left[\frac{360}{365}(d - 81)\right]$$

where d is the day of the year with Jan 1 as $d = 1$. A more accurate expression is:

$$\delta = \sin^{-1}\left\{\sin(23.45°) \sin\left[\frac{360}{365}(d - 81)\right]\right\}$$

太阳倾角可以通过以下公式计算[1]：

$$\delta = 23.45° \sin\left[\frac{360}{365}(d - 81)\right]$$

公式中的d是某一天在一年中的序数（比如，1 月 1 日对应的d等于 1）。一个更为准确的表达式为：

$$\delta = \sin^{-1}\left\{\sin(23.45°) \sin\left[\frac{360}{365}(d - 81)\right]\right\}$$

The declination is zero at the equinoxes (March 22 and September 22), positive during the northern hemisphere summer and negative during the northern hemisphere winter. The declination reaches a maximum of 23.45° on June 22 (summer solstice in the northern hemisphere) and a minimum of -23.45° on December 22 (winter solstice in the northern hemisphere).

在昼夜平分点（3 月 22 日和 9 月 22 日），太阳倾角为 0 度。在北半球的夏季和冬季，太阳倾角分别为正值和负值。6 月 22 日（北半球的夏至日），太阳倾角达到最大值，为 23.45 度。12 月 22 日（北半球的冬至日），太阳倾角达到最小值，为-23.45 度。

参考文献

1.Cooper PI. The absorption of radiation in solar stills. Solar Energy [Internet]. 1969;12:333 - 346. Available from: http://www.sciencedirect.com/science/article/B6V50-497BD6C-27/2/a4ca2069fe8c8b0cfa571de016d93cc5