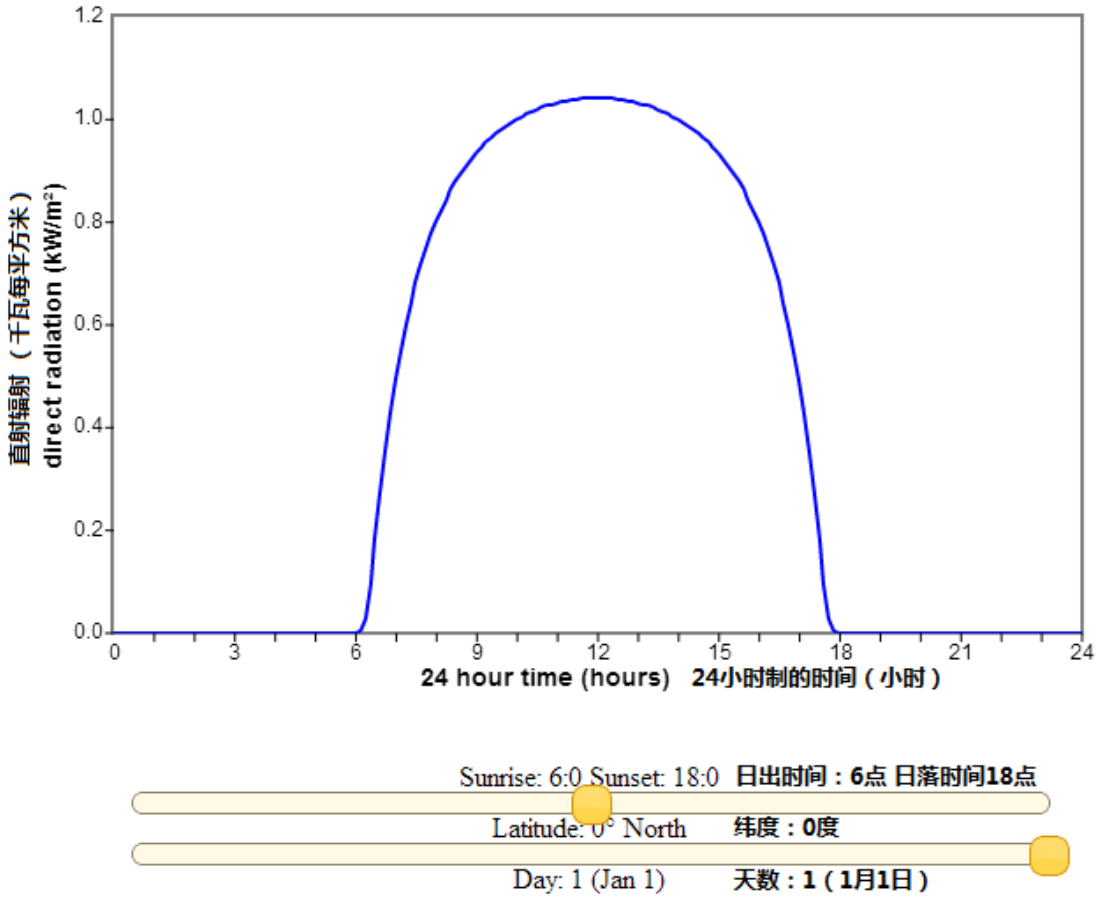
2.23 Calculation of Solar Insolation

计算日照度

Based on the equation of the sun's position in the sky throughout the year, the maximum amount of solar insolation on a surface at a particular tilt angle can be calculated as a function of latitude and day of the year. These calculations are also essential in using experimental data from sunshine hour recorders. The following animations calculate the daily solar irradiance, the solar insolation and the number of hours during the day which the sun is shining. They do not include local weather effects and so these theoretical graphs are not used in system sizing or prediction of operation. A description of each graph is given in the caption underneath.

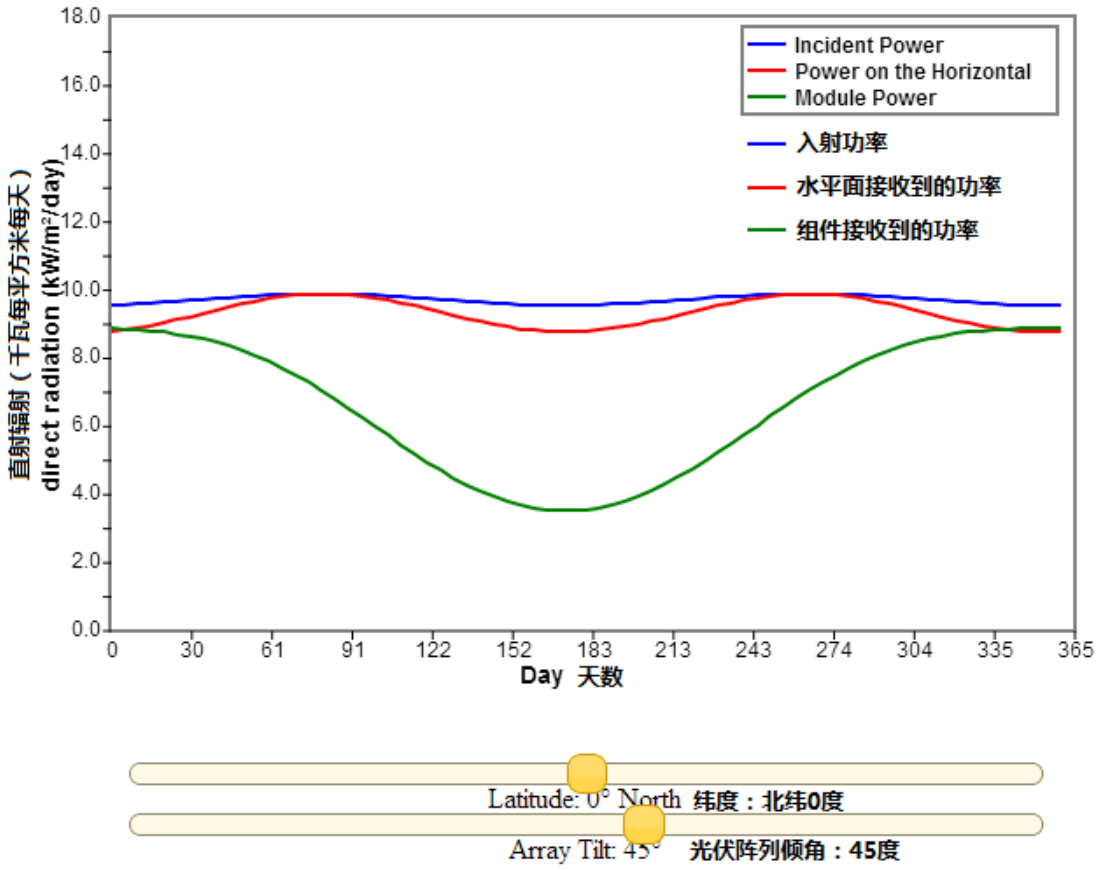
利用计算一年中太阳在天空中位置的公式，我们可以计算处于特定倾角的平面所能接收的最大日照度，它的值受观测点纬度和一年中的某一天影响。这些计算对于从日照时间记录仪获取的实验数据来说也很重要。下面的动画（译者注：只在原文有效）计算每天的太阳照度，日照度以及日照时间（单位为小时）。这些计算没有考虑局部地区天气条件的影响，所以选择系统容量或是预测系统运行情况时并不采用这些理论图。图片下方有对该图的注解。



The graph shows the intensity of direct radiation in W/m^2 throughout the day. It is the amount of power that would be received by a tracking concentrator in the absence of cloud.

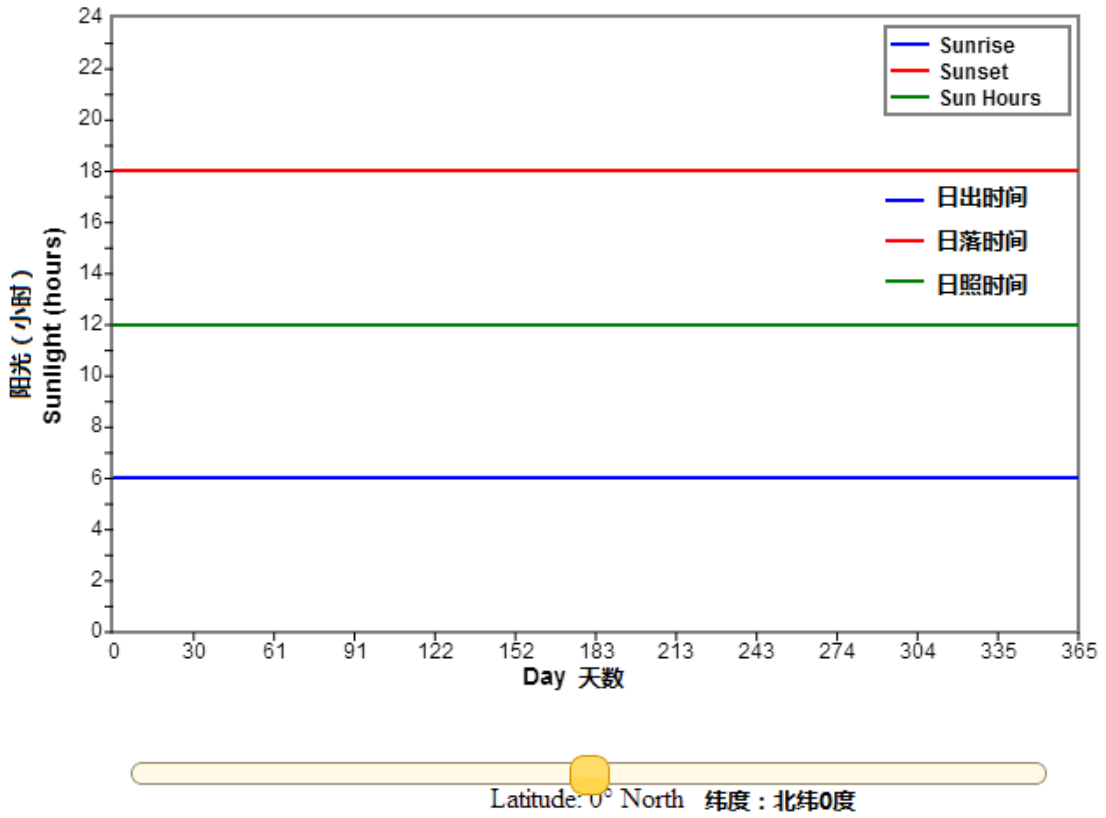
The time is the local solar time. Set the latitude to your location and then adjust the day slider to see how much radiation there is for each day of the year.

上图给出了一天中直射辐射强度（单位：瓦每平方米）的变化情况。它表示的是一个跟踪太阳的聚光器在没有云影响的条件下接收到的功率，图中的时间为地方太阳时。可以尝试把纬度调成你的所在地纬度，而后调整天数滑块来查看一年中每天的辐射值。



The average daily solar insolation as a function of latitude. The three curves are the incident solar insolation, the horizontal solar insolation and the solar insolation on a titled surface as defined in the page Module Tilt. The daily insolation is numerically equal to the number of sunhours in a day. The module is assumed to face the equator so that it faces South in the northern hemisphere in North in the southern hemisphere. As the latitude is adjusted through zero going across the equator, the module faces in the opposite direction. The graph changes suddenly at the equator since the module is now facing in the opposite direction.

上图给出了日均日照度随纬度变化的关系。图中的三条曲线分别为总日照度，水平面接收的日照度和倾斜平面（其定义在“斜面上的太阳辐射”页面中给出）接收的日照度。每天的日照度在数字上等于每天的日照小时。我们假定组件朝着赤道方向摆放，因此北半球的组件朝南，南半球的组件朝北。赤道两侧的纬度值有正负之分，因此组件的朝向也相反。图中曲线在赤道附近的突变是因为组件朝向发生了翻转。



The number of hours the sun is shining each day, that is the number of hours between sunrise and sunset each day. In latitudes above 67° the sun shines for 24 hours during part of the year. Surprisingly, when averaged over the year, the sun shines an average of 12 hours per day everywhere in the world. In the northern latitudes the average intensity is lower than at the southern latitudes.

日照时间指的是每天日出和日落之间间隔的小时数。纬度高于 67 度的地区在一年中的某些时候会出现 24 小时日照的情况。令人惊讶的是，地球上每个地区的年平均日照时间都为 12 小时。北半球的平均日照强度低于南半球。

The equations to generate the above plots are given below. These equations are calculated in solar time, and not in local time. The correction between local solar time and local time is given in the page The Sun's Position.

上面 3 个图用到的公式如下所示。这些公式采用的是太阳时，而非地方时。地方太阳时和地方时之间的修正关系已经在“太阳位置”的页面中给出了。

The number of sun hours is simply the time between sunrise:

$$\text{Sunrise} = 12 - \frac{1}{15^\circ}\cos^{-1}\left(-\frac{\sin\varphi\sin\delta}{\cos\varphi\cos\delta}\right)$$

and sunset:

$$\text{Sunset} = 12 + \frac{1}{15°}\cos^{-1}\left(-\frac{\sin\varphi\sin\delta}{\cos\varphi\cos\delta}\right)$$

日照时间即为日出与日落之间的时间差：

$$\text{Sunrise} = 12 - \frac{1}{15°}\cos^{-1}\left(-\frac{\sin\varphi\sin\delta}{\cos\varphi\cos\delta}\right)$$

$$\text{Sunset} = 12 + \frac{1}{15°}\cos^{-1}\left(-\frac{\sin\varphi\sin\delta}{\cos\varphi\cos\delta}\right)$$

The direct component of the solar radiation is determined from the air mass:

$$I_D = 1.353 \times 0.7^{(AM^{0.678})}$$

The airmass can be determined from the Air Mass formula:

$$AM = \frac{1}{\cos\theta}$$

太阳辐射的直射分量可以通过大气质量计算

$$I_D = 1.353 \times 0.7^{(AM^{0.678})}$$

大气质量的值可以通过大气质量公式计算

$$AM = \frac{1}{\cos\theta}$$