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Solar Calculation Details

General

The calculations in the NOAA Sunrise/Sunset and Solar Position Calculators are based on equations from ***Astronomical Algorithms***, by Jean Meeus. The sunrise and sunset results are theoretically accurate to within a minute for locations between +/- 72° latitude, and within 10 minutes outside of those latitudes. However, due to variations in atmospheric composition, temperature, pressure and conditions, observed values may vary from calculations.

The following spreadsheets can be used to calculate solar data for a day or a year at a specified site. They are available in Microsoft Excel and Open Office format. Please note that calculations in the spreadsheets are only valid for dates between 1901 and 2099, due to an approximation used in the Julian Day calculation. The web calculator does not use this approximation, and can report values between the years -2000 and +3000.

	Microsoft Excel	Open Office
Day	NOAA_Solar_Calculations_day.xls	NOAA_Solar_Calculations_day.ods
Year	NOAA_Solar_Calculations_year.xls	NOAA_Solar_Calculations_year.ods

Data for Litigation

The NOAA Solar Calculator is for research and recreational use only. NOAA cannot certify or authenticate sunrise, sunset or solar position data. The U.S. Government does not collect observations of astronomical data, and due to atmospheric conditions our calculated results may vary significantly from actual observed values.

For further information, please see the U.S. Naval Observatory's page [Astronomical Data Used for Litigation](#).

Historical Dates

For the purposes of these calculators the current [Gregorian calendar](#) is extrapolated backward through time. When using a date before 15 October, 1582, you will need to correct for this.

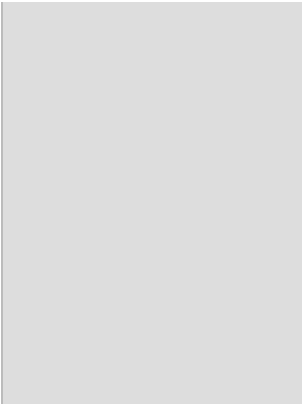
The year preceding year 1 in the calendar is year zero (0). The year before that is -1.

The approximations used in these programs are very good for years between 1800 and 2100. Results should still be sufficiently accurate for the range from -1000 to 3000. Outside of this range, results may be given, but the potential for error is higher.

Atmospheric Refraction Effects

For sunrise and sunset calculations, we assume 0.833° of [atmospheric refraction](#). In the solar position calculator, atmospheric refraction is modeled as:

Solar Elevation	Approximate Atmospheric Refraction Correction (°)
85° to 90°	0
5° to 85°	$\frac{1^\circ}{3600''} \left[\frac{58.1''}{\tan(h)} - \frac{0.07''}{\tan^3(h)} + \frac{0.000086''}{\tan^5(h)} \right]$
-0.575° to 5°	$\frac{1^\circ}{3600''} (1735'' - 518.2''h + 103.4''h^2 - 12.79''h^3 + 0.711''h^4)$



$< -0.575^\circ$	$\frac{1^\circ}{3600''} \left(\frac{-20.774''}{\tan(h)} \right)$
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The effects of the atmosphere vary with atmospheric pressure, humidity and other variables. Therefore the solar position calculations presented here are approximate. Errors in sunrise and sunset times can be expected to increase the further away you are from the equator, because the sun rises and sets at a very shallow angle. Small variations in the atmosphere can have a larger effect.

[NOAA Solar Calculator](#)
[Solar Calculator Links](#)

[Time Zone Table](#)
[Solar Calculator Glossary](#)