

# AWB Solar System Help

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## 2 Introduction

AWB Solar System is one of a set of applications under my AstroWorkBench (AWB) collection that I use during my observational sessions. I wrote this application with the purpose of calculating and displaying key Solar System object's information for the specified date and location.

### 3 Startup

Upon startup the screen below is presented with the local date and time defaulted to now.

It is **very important** that you change the Time Zone, Longitude and Latitude values to match your location and then click the 'Save Values' button and then the 'Calculate' button.

Subsequent invocations of this application will then default the Time Zone, Longitude and Latitude to the previous values you entered and saved.

The screenshot shows the 'AWB Solar System' application window. The 'Local Date and Time' is set to 29 December 2019 at 16:25:07. The location is set to Dublin, with longitude 0° 39' 20" West and latitude 51° 15' 13" North. The 'Calculated Quanta' section shows the Julian date as 2458847.184109 and the longitude as -000.655556. The 'Sun (29/12/2019)' section shows a rise at 08:07 and set at 16:02. The 'Moon (29/12/2019)' section shows a rise at 10:31 and set at 19:26. The 'Geocentric Equatorial & Horizontal' tab is selected, showing a table of celestial data for the Sun, Mercury, Venus, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto. The 'Altitude & Azimuth for Sun' graph shows the Sun's altitude and azimuth over a 24-hour period, with the Sun rising at 08:07 and setting at 16:02.

Name	RA	Dec	Rise	Set	Mag	Size	Phase	Dist AU	Max Size %
Sun	18h 33m 18s	-23° 12' 56"	08:09	15:58	-26.70	+0° 32' 32"	100	0.983	100% (1952.0")
Mercury	18h 03m 17s	-24° 29' 44"	07:48	15:20	-0.79	+0° 00' 05"	98	1.427	36% (12.9")
Venus	20h 58m 17s	-19° 05' 34"	10:07	18:51	-4.00	+0° 00' 13"	83	1.291	20% (66.0")
Mars	15h 38m 30s	-19° 04' 17"	04:48	13:31	1.58	+0° 00' 04"	96	2.201	17% (25.1")
Jupiter	18h 26m 43s	-23° 12' 07"	08:03	15:52	-1.84	+0° 00' 32"	100	6.211	68% (46.9")
Saturn	19h 31m 18s	-21° 43' 24"	08:58	17:07	0.00	+0° 00' 15"	100	10.988	75% (20.1")
Uranus	02h 02m 45s	+11° 56' 54"	12:28	02:41	5.73	+0° 00' 04"	100	19.382	88% (4.1")
Neptune	23h 10m 53s	-6° 22' 56"	11:11	22:11	7.92	+0° 00' 02"	100	30.278	92% (2.4")
Pluto	19h 36m 47s	-22° 13' 46"	09:07	17:08	14.43	+0° 00' 00"	100	34.824	100% (0.1")

### 4 Usage

All of the data displayed on the main screen (as shown above) and the data on the four additional tab pages (detailed in subsequent sections below) is re-calculated every time you click the 'Calculate' button which uses the specified date, time, time zone, longitude and latitude to calculate all of the data shown.

## 5 Solar System Data explained

The main screen (as shown below) displays the following data calculated for the specified local date, time, time zone, longitude and latitude.

The screenshot shows the 'AWB Solar System' application window. The 'Local Date and Time' is set to 06 January 2019 at 18:52:44. The location is set to (UTC+00:00) Dublin, Edinburgh, Lisbon, London, with coordinates 0° 39' 20" West and 51° 15' 13" North. The calculated data for Sun (06/01/2019) shows a rise at 08:06 and set at 16:11. The 'Calculated Quanta' section shows UTC as 06 Jan 2019 18:52:44, Julian as 2458490.28662, and Longitude as -000.655556. The 'Geocentric Equatorial & Horizontal' tab is selected, displaying a table of planetary data.

Name	RA	Dec	Rise	Set	Mag	Size	Phase	Dist AU	Max Size %
Sun	19h 10m 06s	-22° 27' 29"	08:09	16:08	-26.70	+0° 32' 32"	100	0.983	100% (1952.0")
Mercury	18h 10m 45s	-23° 58' 46"	07:20	14:58	-0.48	+0° 00' 05"	93	1.355	38% (12.9")
Venus	15h 51m 27s	-16° 38' 24"	04:15	13:26	-4.43	+0° 00' 25"	51	0.679	38% (66.0")
Mars	00h 14m 20s	+1° 21' 57"	11:03	23:22	0.55	+0° 00' 07"	88	1.310	28% (25.1")
Jupiter	16h 46m 30s	-21° 43' 49"	05:41	13:50	-1.79	+0° 00' 32"	100	6.144	68% (46.9")
Saturn	18h 52m 15s	-22° 24' 50"	07:50	15:50	0.00	+0° 00' 15"	100	11.041	75% (20.1")
Uranus	01h 47m 04s	+10° 28' 46"	11:48	01:45	5.76	+0° 00' 04"	100	19.626	87% (4.1")
Neptune	23h 03m 19s	-7° 06' 26"	10:35	21:29	7.93	+0° 00' 02"	100	30.447	92% (2.4")
Pluto	19h 29m 56s	-21° 56' 13"	08:26	16:32	14.40	+0° 00' 00"	100	34.621	100% (0.1")

The 'Altitude & Azimuth for Sun' graph shows the sun's path over a 24-hour period. The y-axis represents Altitude (0 to 90 degrees) and the x-axis represents Time (24Hr Local) and Azimuth (12 to 163 degrees). The sun rises at 08:06 and sets at 16:11. The graph is centered on midnight local.

**UTC:** The calculated Coordinated Universal Time (also known as just UT) for the local date, time and time zone specified. The application also determines if Daylight Saving time is currently active which is also taken into account when calculating the UTC.

In the example screen shown above the local and UTC are the same as the location and time zone are for near London, England in the winter when local time is always the same as UTC.

In the example screen snippet shown below the UTC date and time is one day and 4 hours ahead of the local entered date as the time zone is 5 hours behind UTC and daylight saving is in affect for the local date specified. Note that this means that the UTC date is the next day.

Local Date and Time

10 July 2019 [calendar icon] - + 21:24:12 [dropdown] Set to Now

(UTC-05:00) Eastern Time (US & Canada) [dropdown]

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Calculated Quanta

UTC: 11 Jul 2019 01:24:12

Daylight Saving?

**Daylight Saving:** This checkbox is ticked if the local date entered has daylight saving in effect.

**Julian:** This is the Julian date for the specified date and time.

**Longitude:** This is a real number representation of the longitude degrees, minutes and second specified (negative if West)

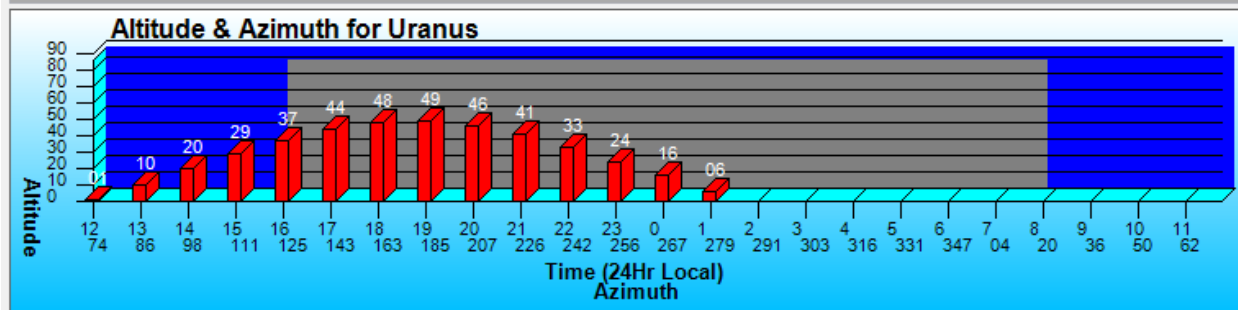
**Latitude:** This is a real number representation of the latitude degrees, minutes and second specified (negative if South)

**Geocentric Planet data:** This table shows fundamental data for the Sun and nine planets (my vote is that Pluto is a planet!). Times are 24Hr local.

**Altitude and Azimuth Graph:** The graph displayed is for the currently selected planet (or the Sun) in the table. It shows the altitude and azimuth over the specified day's 24-hour period and hence is a very quick way to tell if the currently selected object is visible for that day.

For example, the screen snippet below shows that Uranus is well placed for observation, reaching a max altitude of about 49 degrees at azimuth 185 degrees on about 19:00 hours local time (for the date, time, time zone, longitude and latitude specified of course). The rise and set times shown in the grid are also reflected in the graph (rises 11:48, sets 01:45 in this example).

Saturn	18h 52m 16s	-22° 24' 49"	07:50	15:50	0.00	+0° 00' 15"	100	11.041	75% (20.1")
Uranus	01h 47m 04s	+10° 28' 47"	11:48	01:45	5.76	+0° 00' 04"	100	19.627	87% (4.1")
Neptune	23h 03m 19s	-7° 06' 25"	10:35	21:29	7.93	+0° 00' 02"	100	30.448	92% (2.4")
Pluto	19h 29m 56s	-21° 56' 13"	08:26	16:32	14.40	+0° 00' 00"	100	34.621	100% (0.1")

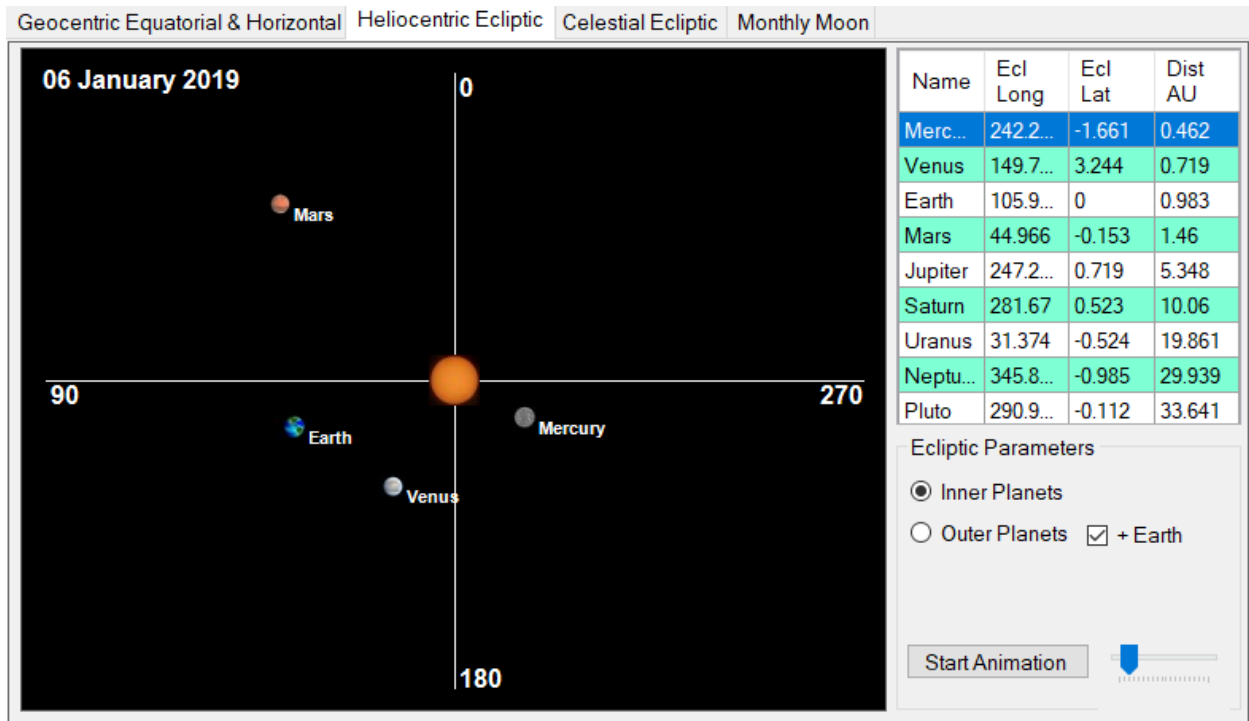


**Sun Data:** The local times for Civil and Astronomical based Sun rise and set are displayed.

**Moon Data:** The local times for Moon rise and set are displayed along with azimuth, phase (percentage) and age (days).

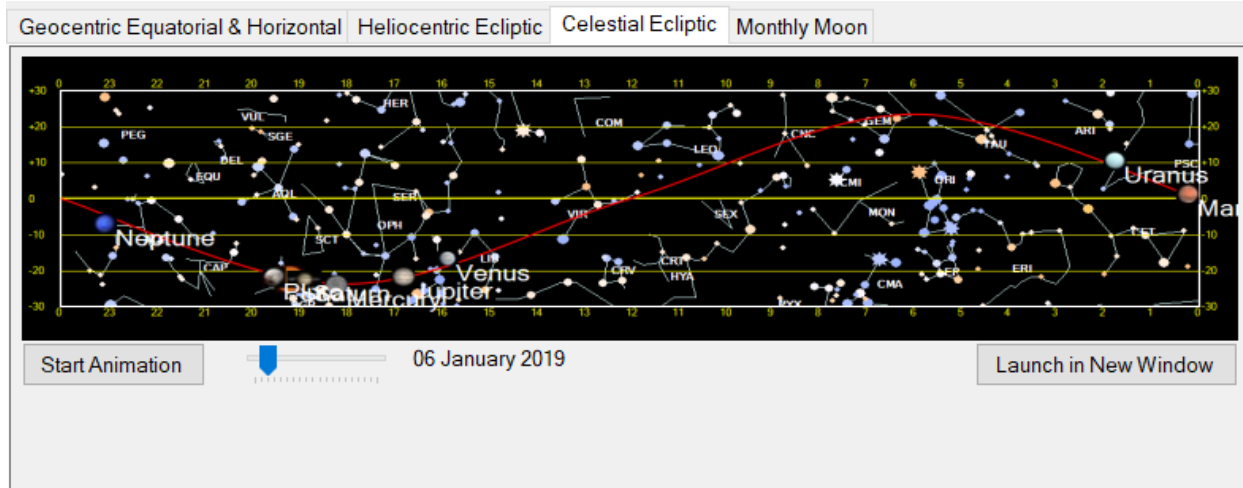
The second tab page (as shown below) displays a Heliocentric view of planets for the specified date, time, time zone, longitude and latitude. The ecliptic longitude and latitude along with the distance from the Sun are displayed in the table which are the metrics used for constructing the diagram.

The diagram can be animated via the 'Start Animation' and the slider which controls the speed. Note the date change as the animation progresses.

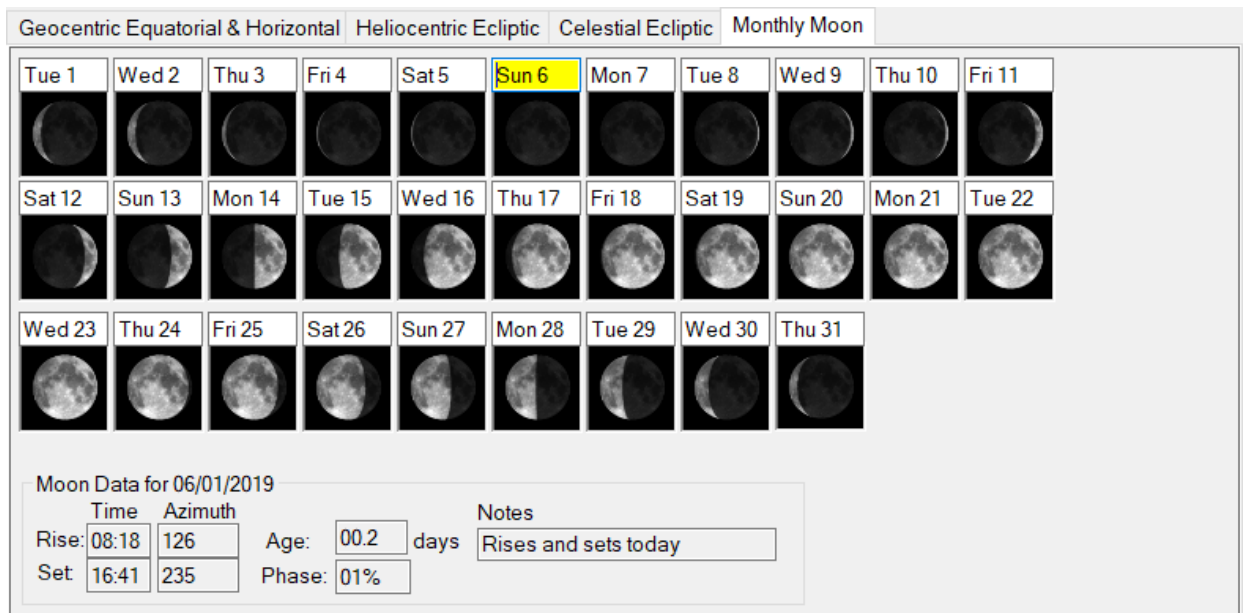


The third tab page (as shown below) displays the Celestial ecliptic with the planetary positions calculated for the specified date, time, time zone, longitude and latitude.

The diagram can be animated via the 'Start Animation' and the slider which controls the speed. Note the date change as the animation progresses.



The fourth tab page (as shown below) displays the Lunar data for each day of the month from the specified date, time zone, longitude and latitude.



The fifth tab page (as shown below) displays an event summary and animation of the four main Jupiter moons. The four buttons labelled *-1 Hr*, *-10 Min*, *+10 Min* and *+1 Hr* may be used to increment or decrement the time and date which will automatically update the event summary table if the time increment or decrement causes a date change, and the animated representation of the moon's positions.

The view may also be changed to Terrestrial, Inverted or Mirror so as to match your optical set up.

The screenshot shows the 'Jupiters Moons' software interface. At the top, there are tabs for 'Geocentric Equatorial & Horizontal', 'Heliocentric Ecliptic', 'Celestial Ecliptic', 'Monthly Moon', and 'Jupiters Moons'. Below the tabs are buttons for time adjustments: '-1 Hr', '-10 Min', '+10 Min', and '+1 Hr'. The local time is '29 Dec 2019 16:25:07' and the UTC time is '29 Dec 2019 16:25:07'. The main view is labeled 'Mirror View (e.g. Newtonian or SCT with diagonal)'. It shows a central image of Jupiter (C) with its four main moons (I, G, E) and a compass rose. A legend below the image identifies the moons: Io (red dot), Europa (green dot), Ganymede (white dot), and Callisto (orange dot). A 'Visibility Summary' indicates: 'I - Vis. E - vis. G - vis. C - vis.'. Below the image is a table of events:

UTC	Moon	Type	Description
29/12/2019 ...	Io	Shd	Starts to cross Jupiter
29/12/2019 ...	Io	Trn	Starts transit across...
29/12/2019 ...	Io	Shd	Exits Jupiter's disk
29/12/2019 ...	Io	Trn	Ends transit across ...
29/12/2019 ...	Europa	Ecl	Starts eclipse by Ju...
29/12/2019 ...	Europa	Occ	Appears from behin...
29/12/2019 ...	Ganymede	Shd	Starts to cross Jupiter
29/12/2019 ...	Ganymede	Trn	Starts transit across...
29/12/2019 ...	Ganymede	Shd	Exits Jupiter's disk

To the right of the table is a 'View' section with radio buttons for 'Terrestrial', 'Inverted', and 'Mirror' (which is selected). Below that is a 'Key' section with the following definitions:

- Occ - Moon in Occultation, behind Jupiter, not visible
- Ecl - Moon in eclipse, in Jupiters shadow, not visible
- Trn - Moon in transit, in front of Jupiter, visible
- Shd - Moons shadow on Jupiter, visible

The following settings screen is displayed via the *Utilities->Settings* menu option.

The animation options allow some control over the speed of the animations described above.

The screenshot shows the 'AWB Solar System Settings' dialog box. It has a title bar with 'AWB Solar System Settings' and a close button. The settings are as follows:

- Heliocentric animation step in days for inner planets: 1
- Heliocentric animation step in days for outer planets: 10
- Celestial ecliptic animation step in days:: 2

At the bottom right of the dialog is a 'Save' button.



## 6 Accuracy and references

This application is a conglomeration and fusion of algorithms and code routines that I have collated and written since the early 1980's up to the present. My main sources and references have been:

- VSOP87 for the Sun and planetary calculations – this is pretty rigorous and should be accurate to a couple arc minutes. Pluto is calculated separately and is nowhere near as accurate;
- Peter Duffett-Smith – his classic book *Astronomy with Your Personal Computer*, mine is a second edition I purchased about 1990 and consists of BASIC routines (full of GOTOs and GOSUBs for those of you old enough to remember coding with those constructs) that I first used on my BBC micro and now reside in my Microsoft Visual Studio .Net solutions (re-written to port to VB.Net);
- O. Montenbruck and T. Pfleger's *Astronomy on the Personal Computer*. Another book I purchased in the early 1990's whose modified code also lives on in my .Net solutions;
- Paul Schlyter and Don Cross have some great math and code snippets online;
- NASA, JPL, NOAA and NIST online apps and websites that I have used to verify my code results as it's safe to assume that those guys are accurate with their calculations;
- Wikipedia and a thousand other online sites and references that together can supply you with every algorithm and equation you need via judicious use of google – and a headache when translating them into code!

## 7 Further Information

Please visit my website [www.astroworkbench.co.uk](http://www.astroworkbench.co.uk) for further applications, documents and articles.

If you find this application helpful then please consider donating a beer token of £1 via my PayPal account – please see my website [www.astroworkbench.co.uk](http://www.astroworkbench.co.uk) for details.

Thanks.

Keith.