JPLANET 1.4

@DIDACO, Lars Gislén

Dala 7163, SE-242 97 Horby, SWEDEN

larsg@tvasterstad.se

Homepage: http://home.thep.lu.se/~larsg/

Introduction

JPLANET is an application for studying the locations of the planets visible to the naked eye (Mercury, Venus, Mars, Jupiter and Saturn), the sun and the moon, and also some stars. The coordinates of these objects are given in different coordinate systems: the *geocentric ecliptic* and also the *equatorial* and *horizontal* systems of the observer. Further you can determine the magnitude of the planets and the phases of the moon and also sidereal time, mean solar time and the equation of time.

When a solar or lunar eclipse is possible you can also investigate how the eclipse looks from any place on earth. You can study heliacal risings and settings of planets and stars and also conjunctions and planetary stations. Finally you can study the transits of Mercury and Venus and occultations of planets and stars by the moon.

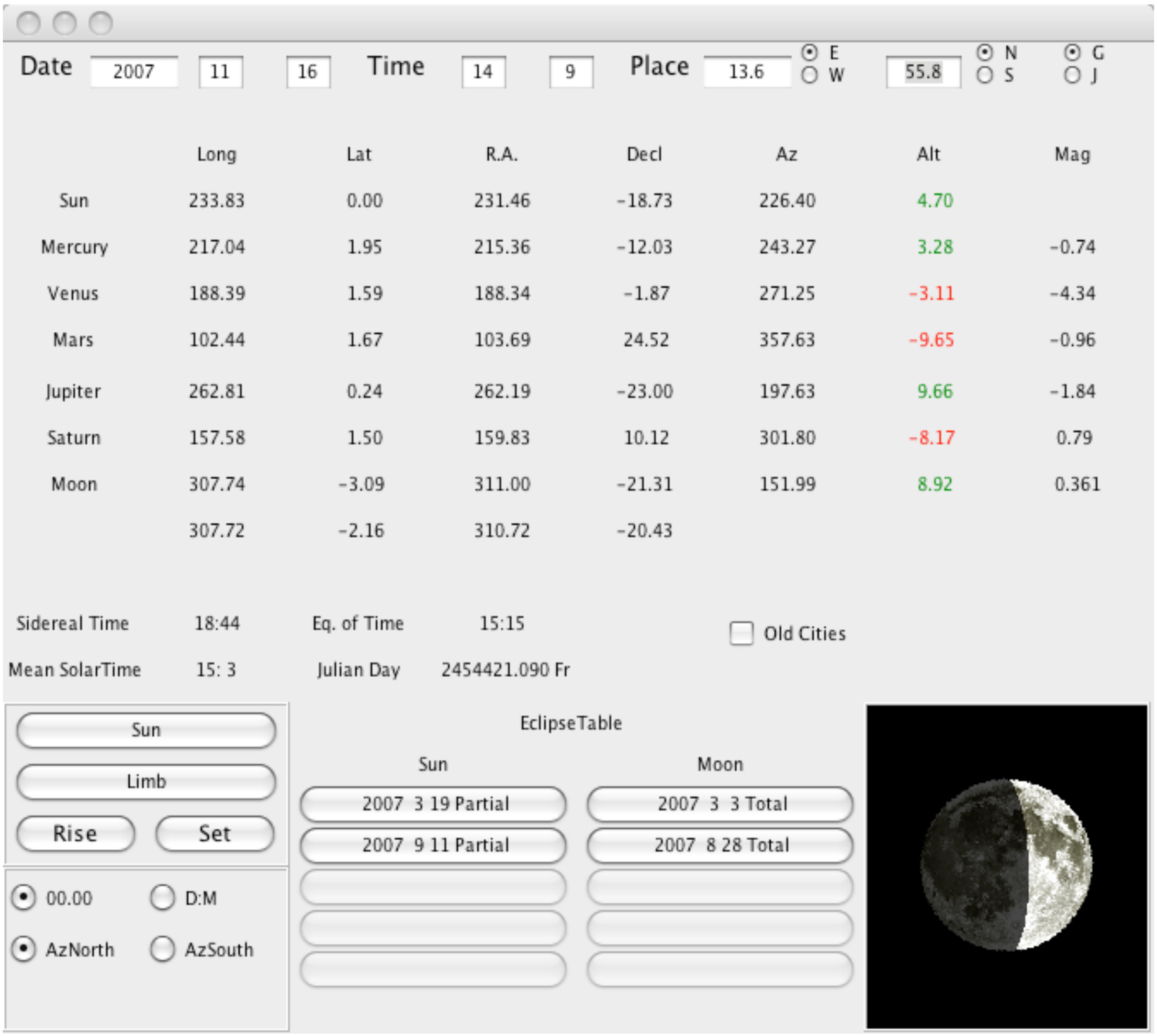
JPLANET is written in Java 1.5. The Macintosh version Mac OS X 10.4 or higher) looks like an ordinary application; the PC version is an .exe file. PC owners may have to download the latest (free) Java Runtime Environment (JRE) from http://java.sun.com/javase/downloads/index.jsp.

Start the application by double-clicking on the JPLANET icon. The screen will display a data table showing current positions of the sun, the moon and the planets. Altitude data for objects above the horizon have refraction included.

Setting time and location

At the top of the screen you will see the *space-time bar*.

You can change the numbers in the space-time bar by editing the text slots. The number in a selected date or time slot can also be stepped up or down one unit by using the arrow keys on the keyboard. Likewise, you can change your location by editing the longitude and latitude text slots and switch from the northern to southern hemisphere and from longitude east of Greenwich to west of it, by clicking on the relevant radio buttons. Note that time is by default *Universal Time* (UT or GMT). At start-up the application will display the current date and UT time.



Radio button **G** means *Gregorian calendar* (the normal). By clicking the radio button **J** you can switch to *Julian calendar*, which was used before about AD 1600. Years can be zero or negative for years Before Christ. Remember that 1 BC = 0, 2 BC = -1 and so on.

After editing the space-time slots, a carriage return or pressing the ENTER key or just having the cursor leave the space-time area will cause the application to re-compute the table for the current parameters.

The altitude values for objects above the horizon (refraction included) are green; the altitudes of objects below the horizon are red. The last column of the table displays the magnitude, i.e. the brightness of the respective planet. For Saturn, this includes the effect of the rings.

For the moon, a number indicating the illuminated fraction of the disk of the moon is displayed. Negative numbers mean waning phase, positive mean waxing phase. In the bottom right panel of the main window, the phase of the moon is shown as seen from the current geographical location and at the time set in the space-time bar. In computing the moon picture the librations of the moon are neglected.

The moon has additional numbers in its Longitude / Latitude and R.A. / Declination columns. The upper pair is *with* parallax included (i.e. as seen from the observer's location on earth (*topocentric* coordinates), the lower pairs are *without* parallax (i.e. as seen from the centre of the earth, *geocentric* coordinates).

The moon sometimes displays one, two, or three small letters after the magnitude digits. This shows that the moon's azimuth and elevation difference from the sun is such that the moon crescent is visible. This is handy for checking when the new/old moon is first/last visible at sunset/sunrise, an event that is important in for example the Moslem and Babylonian calendars.

Moon	45,45	3,56	2,4817	20,19	283,34	15,29	0,026NC

The criteria for the visibility of the moon crescent are still a matter of debate. If Neugebauer's [3] visibility criterion is valid, a small 'N' is displayed. If the criterion of Caldwell and Laney [2] is valid, a small 'C' is displayed. If the criterion of Yallop[20] is valid, a small 'Y' is displayed and on the line below there will be a "*q*" value. If the *q* value is black, the crescent will be easily visible, if it is red it will be visible under perfect conditions, the visibility increasing with the value of *q*. If several criteria are valid several letters will be displayed. NOTE! *In order to check the visibility two actions must be taken (see below): a) the sun (upper) limb option must be set, b) a rise/set button must be clicked.* The Yallop criterion will only be operative for the set button. Neugebauer's criterion is of limited value outside the Middle East region.

The sidereal time and the mean solar time are given in hours and minutes, the equation of time in minutes and seconds. The *Julian day* is used in chronological work. It begins at Greenwich *noon*. Day 0 is the day starting at *noon* on BC 4713, January 1. The day of the week is also shown.

Marking the checkbox "Old Cities" will display some ancient cities on the map (see below).

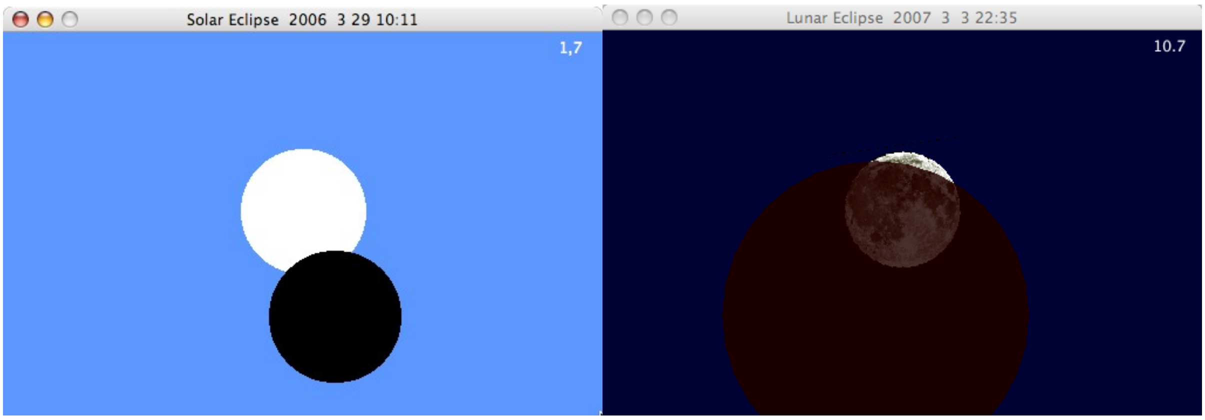
In the upper bottom panel to the left are buttons handling rising and setting times of the sun and the moon. The top button toggles between sun and moon. The next button toggles between the upper limb of the centre of the sun/moon. Rise and set buttons give a recomputed table at the rising or setting times as set by the upper buttons. For geographical latitudes above 60° the sunrise/sunset calculation may be in error by several minutes or more.

By clicking on the radio buttons marked 00.00 and D:M you can switch between *decimal* (degrees.fraction) and *sexagesimal* (degrees:minutes) data representation. In the sexagesimal mode, rectascension is displayed in hours, minutes and seconds (hh:mmss). There is also a pair of radio buttons that can be clicked to switch between azimuth origin north and south.

Eclipses

At the bottom right of the main window there are buttons showing the possible eclipses during the current year. The eclipse buttons indicate the eclipse type: Partial, Total, Annular for solar eclipses and Partial, Total for lunar eclipses.

Clicking on an eclipse buttons will transfer that eclipse date to the space-time bar. Also the approximate time for the middle eclipse will be determined and a new table is computed with these settings. Now choose the **Eclipse** option in the **Event** menu. This option is not enabled unless the label text "Sun" or "Moon" is marked red. You will get a new window that displays the eclipse as seen from the current location and time.



In the case of a solar eclipse, it might not be visible from the current location as the appearance and time of a solar eclipse depends on the moon parallax at the actual position of the observer. On the other hand a lunar eclipse looks the same for all observers, but of course the moon has to be above the observer's local horizon in order to be seen. By changing time and location you can investigate the eclipse, its duration and magnitude as seen from a particular location. As the moon and the sun are drawn to correct scale you will also be able to see if the solar eclipse is annular or not. A number in the upper right of the eclipse window shows the size of the eclipse expressed in "digits", where 12 digits represent a total eclipse. If the sun/moon is below horizon this will be marked by a green "haze" covering the part of the picture that is obscured by the horizon.

The eclipse frames can be saved using **Event>Save Frame**. The name suggested by the save dialog for the saved file is Eyyyymddhhmm, i. e. showing the current date and time.

Transits

Transits of Mercury and Venus may be investigated in the same way as eclipses by choosing **Transit** in the **Event** menu. This item is not enabled unless the respective planet is within 0.3 degrees of the solar centre. The name of the planet that transits the solar disk will then be marked red. The transits are corrected for light-time.

Recent transits of Mercury:

1907 Nov 14	1914 Nov 7	1924 May 7
1927 Nov 10	1937 May 11	1940 Nov 11
1953 Nov 14	1957 May 6	1960 Nov 7
1970 May 9	1973 Nov 10	1986 Nov 13
1993 Nov 6	1999 Nov 15	2003 May 7

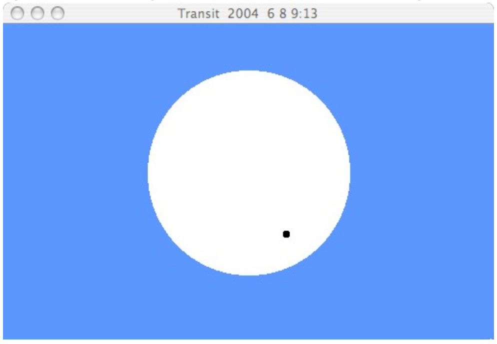
Some transits of Venus:

1882 Dec 6 2004 June 8 2012 June 6 2117 Dec 11

Information on transitsnof Mercury and Venus can be found on several sites in the web for example:

https://eclipse.gsfc.nasa.gov/transit/catalog/MercuryCatalog.html

https://eclipse.gsfc.nasa.gov/transit/catalog/VenusCatalog.html

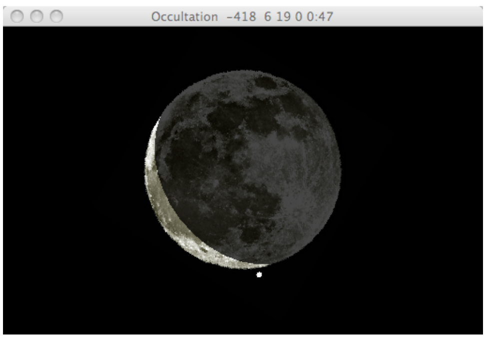


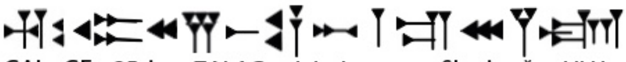
There is a repeating cycle for the Venus transits intervals of 121.5, 8, 105.5, 8 years.

The transit frame can be saved using **Event>Save Frame**. The name suggested by the save dialog for the saved file is Tyyyymmddhhmm.

Occultations

If there is a possible occultation between the moon and a planet or an imported star (see below) the name of that planet or star will be marked green. The menu item **Occultation** will now be accessible from the **Event** menu and will display the moon and the object. Note that because of the moon's parallax, the display of the occultation will depend on the observer's location.





GAL_2 GE_6 25 ina $ZALAG_2$ dele-bat ana SI sin $ša_2$ ULU_3

"Night of the 25th, last part of the night, Venus came close to the southern horn of the moon…". [19].

View as seen from Babylon of the Venus occultation on -418 June 19 at UT 0:48.

The occultation frame can be saved using **Event>Save Frame**. The name suggested by the save dialog for the saved file is Oyyyymmddhhmm.

The map

In the **Show** menu it is possible to select **Map**. This option will open a large world map. The map displays the *terminator*, the border between night and day, the night part of the earth being darker.

The title of the window will display the longitude and latitude of the location to which the cursor arrow is pointing as you move the cursor in the active map. If you have chosen the **Map** option with the space-time bar set for a *total* or *annular* solar eclipse, the map will display a black curve on the earth's surface where the eclipse is central. For any solar eclipse the map also displays the red *penumbra outline curve* at the given time. In most cases part of this curve is on the terminator.

Within the area enclosed by the outline curve, the solar eclipse is seen as partial or total. The flattening of the earth is neglected in the computation of the penumbra outline.

If the solar eclipse is total, there will be a black patch on the map showing the umbral region where the eclipse is seen as total. If the eclipse is annular the patch will be gray and show the region where the moon disk is seen within the borders of the sun disk. The flattening of the earth is included in the computation of the umbral shape.

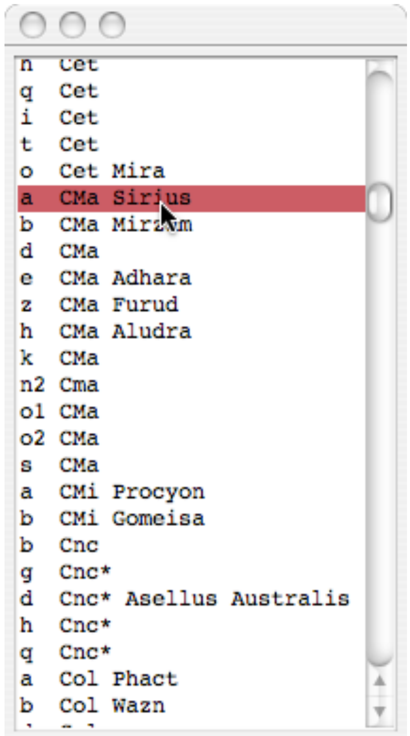
The map frame is resizable by dragging in the lower right corner. Also by pressing the mouse and dragging the map, any part of the globe can be placed within the map frame.

Major towns, in most cases capitals, are marked on the map by small yellow dots. Positioning the cursor close to a place will display its name in the window title bar. The current location set in the main window (if within the map frame) is marked by a red cross. You can directly set a new location by clicking in the map, the space-time bar in the main window will then automatically be updated. For making the current location the default location see below.

If the checkbox "Old Cities" in the main window is marked, you will get a number of some important ancient cities, mainly in the classic Mediterranean region, marked as red dots on the map. I included this option mostly because of my own interest in ancient eclipse dating.

The map frame can be saved using **Show>Save Map**. The name suggested by the save dialog for the saved file is Myyyy-mm-dd-hh-mm.

Importing data from the star catalog



JPLANET contains a small star catalog of the 400 brighter and more well-known stars with declinations up to 60 degrees north and south. It contains all the Babylonian "normal" or *zigpu* stars, these stars being marked with an asterisk in the catalog.

The catalog will appear as a separate window if you choose the menu **Show>Star Catalog**. To choose a star you click the star name. The name will be highlighted and the star data will be inserted on the bottom line of the main window of Planet with the coordinates corrected for precession and proper motion.

The stars are identified by names consisting of a Greek letter and a constellation name (Bayer). For a few stars the Greek letter is substituted by a number. Many stars have also a special name attached to them like α Tauri = *Betelgeuse*. In the list of stars that appears in the window of the *Star Catalog*, the Greek letters are represented by Latin letters according to the following scheme:

$\alpha = a$	$\eta = h$	$\nu = n$	$\tau = t$
$\beta = b$	$\theta = q$	$\xi = x$	$\upsilon = u$
$\gamma = g$	$\iota = i$	$o = o$	$\phi = f$
$\delta = d$	$\kappa = k$	$\pi = p$	$\chi = c$
$\varepsilon = e$	$\lambda = l$	$\rho = r$	$\psi = y$
$\zeta = z$	$\mu = m$	$\sigma = s$	$\omega = w$

The constellation names are written with standard three-letter combinations:

Andromeda	And	Dorado	Dor	Orion	Ori
Aquila	Aql	Draco	Dra	Pavo	Pav
Aquarius	Aqr	Equuleus	Equ	Pegasus	Peg
Aries	Ari	Eriadanus	Eri	Perseus	Per
Auriga	Aur	Fornax	For	Phoenix	Phe
Bootes	Boo	Gemini	Gem	Pictor	Pic
Capricornus	Cap	Grus	Gru	Pisces	Psc
Carina	Car	Hercules	Her	Puppis	Pup
Cassiopeia	Cas	Horologium	Hor	Pyxis	Pyx
Centaurus	Cen	Hydra	Hya	Scorpio	Sco
Cetus	Cet	Indus	Ind	Scutum	Sct
Canis Major	CMa	Lacerta	Lac	Serpens	Ser
Canis Minor	CMi	Leo	Leo	Sagitta	Sge
Cancer	Cnc	Lepus	Lep	Sagittarius	Sgr
Columba	Col	Libra	Lib	Taurus	Tau
Corona Borealis	CrB	Leo Minor	LMi	Telescopium	Tel
Crater	Crt	Lupus	Lup	Triangulum	Tri
Crux	Cru	Lynx	Lyn	Tucana	Tuc
Corvus	Crv	Lyra	Lyr	Ursa Major	UMa
Canes Venatici	CVn	Monoceros	Mon	Vela	Vel
Cygnus	Cyg	Norma	Nor	Virgo	Vir
Delphinium	Del	Ophiucus	Oph	Volans	Vol

The data is taken from the *Hipparchos* catalog and includes star magnitudes and proper motions at epoch 2000.0. The data of the Star Catalog is stored in a text file "StarCat.txt" that has to reside in the same folder as the application. The data in the text file consists of one line per object, each line being composed of up to eight items: rectascension, declination, proper motion in rectascension, proper motion in declination, magnitude, star letter, constellation and special name.

The format of the numerical items is:

Rectascension: hhmmss.ss

Declination: ddmmss.ss

Motion in R.A: xx.xxxx secs/year

Motion in decl.: xx.xxx arcsecs/year

Magnitude x.xx

Locations

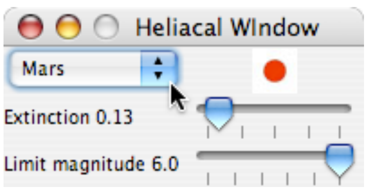
Shortcuts to frequently used locations can be set and saved. Set the location on the map by clicking. Then open the Locations window under **Show>Locations**. Write a name for the location in the text slot at the top. Click the "Add" button and then "Save". The location will be saved using the latitude and longitude set on the map. Selecting a location in the list and clicking "Remove" will erase that location. Selecting a location in the list and then clicking on the "Set" button will insert the coordinates of that location in the space-time bar in the main window and the table will be recomputed.

The heliacal tool

It is sometimes interesting to investigate heliacal risings and settings of planets and stars. A *heliacal setting* of a star occurs when the sun has approached the star such that the object is last seen setting at the horizon after *sunset*. The star is then too close to the sun to be seen. In the same way a *heliacal rising* occurs after the conjunction when the sun has passed the star and it is first visible in the morning, rising at the horizon before *sunrise*. The computation of heliacal phenomena requires a quite complicated computation involving the changing brightness of the twilight sky background, the magnitude and location in the sky of the stellar object, and the extinction of the atmosphere as a function of the stellar object elevation. JPlanet uses the theory formulated in several articles by Bradley Schaefer [4-8] modified according to Pickering [15].

Seing quality	*k*
Perfect mountain	0.10
Good mountain	0.15
Average mountain	0.20
Good, dry sea-level	
Humid, good	0.25
Humid, average	0.30
Humid, poor	0.40
Bad, cirrus	0.50

In order to use the heliacal tool you choose **Heliacal** in the **Show Menu**. There are two sliders in the window with which you can set the *extinction* (*k*) to values between 0.1 and 0.5. The default value is 0.13. The extinction value corresponds roughly to "seeing" quality according to the table above. For ancient observations it seems that the extinction value should be close to 0.13 [15].



The *limit (zenith) magnitude* is the magnitude of the faintest star that can be seen at zenith. It can be varied between 1.0 and 6.0. The default value is 6.0. Normally the default extinction and limit zenith magnitude need not be changed although for modern observations the former value should be increased to 0.2–0.3, which in most cases will lead to the planet's not being visible when rising/setting at the horizon. You enter a planet or an imported star in the heliacal tool by selecting from the fold-down menu in the heliacal tool. The sun and the moon cannot be used with the heliacal tool. You then click one of the sunrise/sunset buttons in the main window with button **Limb** selected. The circular indicator in the upper right part of the heliacal window will then turn red (stellar object not visible) or green (visible). When the stellar object coordinates are outside the validity region of the formulas (sun-object azimuth difference > 90°, elevation > 30°) the indicator will be yellow.

For stars you always have heliacal risings at sunrise and heliacal settings at sunset.

For the planets we can classify the situation by Neugebauer's "Greek Letter Phenomena":

Outer planet:

Γ Heliacal rising at sunrise
Φ First station before the retrograde motion
Θ Opposition
Ψ Second station
Ω Heliacal setting at sunset

Inner planet:

Ξ Heliacal rising in the west.	
Φ Maximum elongation	evening star
Ω Heliacal setting in the west	
Γ Heliacal rising in the east	
Φ Maximum elongation	morning star
Σ Heliacal setting in the east	

If an *outer* planet or star can be seen rising (evening) or setting (morning) at the horizon the indicator will be green and also display a letter 'A' (for *acronycal*). To find the *acronycal* rising or setting date you step backward or forward from the day of opposition until the indicator changes from green to red or vice versa. For an outer planets the acronychal rising date is the last evening before opposition when you can see the planet rise in the evening at the eastern horizon. The acronycal (or cosmical) setting (for a planet) date is the first morning after the opposition when you can see the planet set at the western horizon. For some days around the opposition you cannot see the planet rise or set at the horizon because of twilight. A suitable tool for finding the time of the Greek letter phenomena is my Java application **Phenomena** 1.0 that can be downloaded from my home page. **Phenomena** is based on the algorithm in Meeus [16].

Example: Click Sirius (α CMa) from the Star Catalog. Open the Heliacal Window and in the fold-down menu choose Sirius. Set the location to Alexandria (longitude E 30.0, latitude N 31.3). Sirius then has heliacal setting at sunset AD 2007 May 28 and a heliacal rising at sunrise AD 2007 August 4. There is a cosmical setting at sunrise 2007 December 18 and an achronycal rising at sunset 2007 December 2009.

Default settings

By choosing **Location** in the **Defaults** menu you will set the space-time bar to the current default location on earth and with **Time** the current date and UT time will be set and the table and associated windows will be recomputed. The default location is stored in a preference file and can be set either by using the Preferences menu item or more simply by setting a location in the map by clicking and then choosing **Default>Set Default Location**. The preference file is created the first time the application is run on a computer with the default location 0.0˚ N, 0.0˚E. On a PC it will be saved in the same folder as the application (where it has to remain), on Macintosh it is stored in

/user/Library/Preferences/planet.prefs

Quitting

You quit by selecting **Quit** from the **File** menu.

Accuracy

The epoch of the program algorithm is in general January 0.5, 2000. For the moon the algorithm in [10] is used, discarding only very small terms, of the order of less than 0.01″.

This gives an error in the moon position that is normally less than 1″ in longitude and latitude for modern times. (A check with 30 data in [10], evenly spaced in time from 1952 to 1959 gave a RMS error in longitude of 0.34″ and in latitude of 0.17″). This high precision is used internally in solar and lunar eclipse calculations.

As laser lunar rangings [12,13] seem to give a slightly different value for the lunar secular acceleration the mean lunar longitude of [10] has been amended by the terms

$$-1.54'' + 2.33''T - 1{,}78''T^2$$

where T is measured in centuries from 1900.0.

For the other bodies, except Jupiter and Saturn, the algorithm in [1] is used. The error is less than 30″ for the time 2000 B.C to 4000 A.D. For those times you can thus expect the accuracy shown in the table. For Jupiter and Saturn I use the PLAN404 modules [11] based on methods from the *Astronomical Almanac.* This means that the positions of all the planets will formally be accurate at least to the precision shown in the display window. However, the practical accuracy is much less, especially for epochs far back in time. See next paragraph.

Eclipses are normally accurate to within a minute for modern times and to about 15 minutes for B.C 1000, the inaccuracy determined by our lack of information about the secular deceleration of the rotation of the earth. The application should be used with great care for dates before 1500 BC and you cannot step beyond 4000 AD.

It should be noted that the application uses TDT, *terrestrial dynamical time* internally but Universal Time externally, something that will represent the correct "civil" time at the epoch considered. TDT is used everywhere in the internal calculations.

For years before 700 BC and after AD 2150 we use

$$TDT - UT = -20 + 32.0T^2$$

From 700 BC to AD 2007 interpolation of tabular values taken from [12, 17] are used.

Between AD 2007 and AD 2050 we use [18]

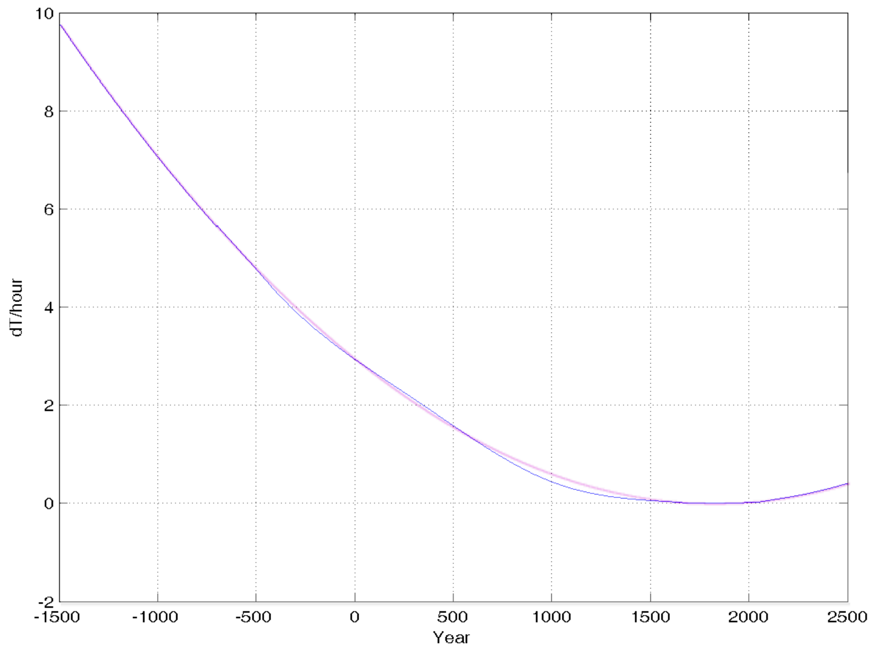
$$TDT - UT = 62.95 + 0.32217(year - 2000) + 0.005589(year - 2000)^2,$$

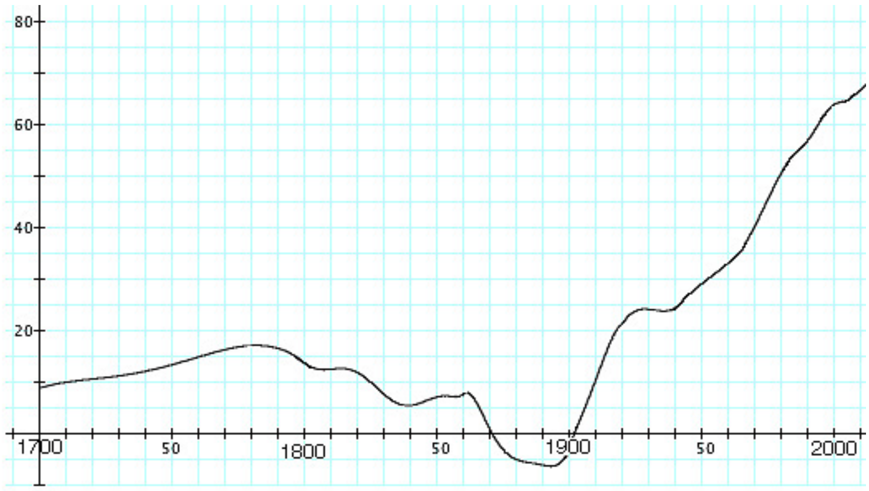
between AD 2050 and AD 2150

$$TDT - UT = -20 + 32.0T^2 - 0.5628(2150 - year)$$

T is the time in Julian centuries since January 0.5 1820.

The left graph shows the coarse *TDT-UT* as a function of time. The pink parabola shows $-20 + 32.0\,T^2$ (seconds). The right graph shows the fine structure of *TDT-UT* for the period AD 1700 to AD 2010.





About the application

JPLANET is freeware. On condition that this documentation is included it may be freely copied and used non-commercially. The source code of the applications was originally made in Basic, then in THINK Pascal 4.0, then converted to CodeWarrior Pascal, then to Code Warrior C++ and now (hopefully) finally to Java. You should use Macintosh OS X 10.4 or later. On the PC, I have tested it with Windows XP. For the PC you may have to download the Java Runtime Environment as mentioned above.

Application history

Macintosh Version 3.3. THINK Pascal adaption of a program written in Basic.

Macintosh Version 3.4 adds possibility to save the map and display sunrise and sunset times. The user can choose decimal or sexagesimal representation from the default menu and also switch between azimuth origin north/south.

Macintosh Version 3.5 directly computes the sunrise and sunset times by clicking on icons on the screen and produces a new table. Sunset and sunrise may be calculated for the sun centre in the horizon without refraction or the upper limb touching the horizon with refraction. Also decimal/sexagesimal switching is handled by clicking icons on the screen. A bug in the conversion decimal to sexagesimal routine is fixed. Balloon help is included under system 7.0. A more sophisticated **About Planet** dialog is added.

Macintosh Version 4.0 uses improved algorithms for the sun, the moon, Mercury, Venus and Mars based on ephemeris time. Using ephemeris time makes it necessary to convert to UT that is done by standard methods described above. In order to accommodate future changes in this formula the coefficients were stored in resources.

Version 4.0 also includes possibility to study transits of the inner planets. An editable menu with standard locations is included. Animation of eclipses and transits is possible.

Macintosh Version 4.1. Window dragging is supported. A bug in the location menu is fixed.

Macintosh Version 5.0. A bug in the moon algorithm fixed.

Macintosh Version C 5.0. Colour is introduced. This version only runs on machines with 68020 or higher and an 881 FPU processor.

Macintosh Version C 5.1. A bug that crashed machines that didn't have QuickDraw2 is fixed.

Macintosh Version C 5.2. Minor improvements in the moon algorithm.

Macintosh Version C 5.3. Major improvements in the precision and efficiency of the moon algorithm. Possibility to switch between UT and ET. Possibility to save window contents as PICT files. Possibility to have the ecliptic drawn in the eclipse or transit windows. A bug that sometimes made the transit icon for Mercury disappear is fixed.

Version C 5.4. Possibility to command-click the main world map to get more detailed sub-maps.

Macintosh Version C 6.0. Converted to CodeWarrior code and now in two versions FPU and PPC. Cursor changes shape to indicate clickable areas. Recalculation of data is automatic in most circumstances.

Macintosh Version C 6.1. The eclipse part of the application is further developed: The world map displays the penumbral outline curve; the sub-maps display the umbral region. Some minor bugs are exterminated and cosmetic changes in the map displays are made. A bug causing a crash on the PPC when trying to edit a location in the Location Menu is fixed. The location editing is simplified, only the location name has to be inserted, the longitude and latitude values are automatically taken from the current settings in the space-time bar.

Macintosh Version C 6.2. Fixed a slow memory leak. Sub-map resource data is compressed making the application considerably smaller. International borders are included in the maps, taken from World Data Base II. (Unfortunately the borders of many of the states of the former Soviet Union are not marked on the maps.) The eclipse table option is removed from the Compute menu and is now automatic because of the greater computing speed of the PPC. New approach to ephemeris time taking into account recent research results. The Planet package now also includes a Fat = PPC+FPU application.

Macintosh Version C 6.3. Fixed a silly bug in the Jupiter-Saturn corrections.

Macintosh Version C 6.4. Jupiter and Saturn algorithms for times after the birth of Christ are considerably improved. Difference of ET and UT are updated according to the latest state of the art. Only the PPC version is now supported.

Macintosh Version 7.0. Jupiter and Saturn use the very accurate PLAN404 modules. A tool for determining the first/last visible moon crescent is added using Neugebauer's criterion.

Macintosh Version 7.1. The tool for determining the first visible moon crescent is refined. Visibility criteria from two authorities are used and displayed.

Macintosh Version 7.2. The umbral region showing up in a solar eclipse sub-map is coloured dark blue if the eclipse is annular. The transit display is now corrected for light-time.

Macintosh Version7.3. Double clicking in the main map can now bring up the sub-maps.

Macintosh Version 7.5. A tool for calculating the visibility of stars and planets during sunset/sunrise is added. Rapid one-day stepping with the +/– keys is added.

Macintosh Version 8.0. PLANET can now cooperate with the "Mini Star Catalog" application and import star data from its catalog via drag and drop.

Macintosh Version 8.2. Updated parameters according to IAU. Optional inclusion of refraction is added.

Macintosh Version 8.3. A heliacal rise/set is now defined for the object being assumed to occur at the horizon instead of at any angle close to the horizon. See Pickering[15].

Macintosh Version 8.4. Added code to handle acronychal phenomena.

Macintosh Version 9.0. Map and sub-map windows can be dragged and are communicating with the main window. Also animation of eclipses is correctly updated in these windows.

Version 9.1. Fixed a bug that affected the Animate function. Diverse cosmetic changes. All windows can be saved as PICT documents using the File/Save menu item.

Macintosh Version 9.1.1. As a result of my observation of the Venus transit 8 June 2004, Venus is now drawn to correct size in the Transit Window.

Macintosh Version 10.1. The code is translated to C++. The moon phase icon now displays the moon crescent as seen from the location and time set in the space-time bar. Occultations between the moon and the planets or imported stars can be displayed.

Macintosh Version 10.2. The Star Catalog that was earlier a separate application is now integrated in the Planet application.

Java Version 1.0. The essential parts of Version 10.2 converted to Java with some minor changes. Moonrise and moonset buttons added.

Java Version 1.1. The Map and Submaps are removed. Instead a very large draggable map is used. Minor layout changes.

Java Version 1.2. Various minor changes as suggested by Dr. J. C. Eade. Fixed a bug affecting occultations with an imported star. The moon is now displayed as a photographic image.

Java Version 1.3. Locations can now be set and saved for later use. Yallop's criterion for the visibility of the new moon is added. Corrected for that the direction of the axis of the lunar disk is not pointing to the north celestial pole. The PDF manual can now be opened from within the application. In the Macintosh version the Star Catalog text is hidden in the application bundle, for Windows the Star Catalog has to reside in the same folder as JPlanet.exe. The Windows version supports Windows NT and XP.

Java Version 1.4. Date and time can now be manipulated with the mouse wheel.

References

1. *Pierre Bretagnon, Jean-Louis Simon:* Planetary Programs and Tables from -4000 to 2800, ISBN 0-943396-08-5

2. *J. A.R. Caldwell, C. D. Laney:* First Visibility of the Lunar Crescent.
http://www.saao.ac.za/sky/vishome.html)

3. *P. V. Neugebauer:* Astronomische Chronologie, Zweiter Band, Tafeln, Berlin und Leipzig 1929)

4. *Bradley Shaefer:* Helical Rise Phenomena, *Archeoastronomy*, **11**, S19-S33 (Journal of the History of Astronomy, xiii (1987))

5. *Bradley Shaefer*: Visibility of the Lunar Crescent, *Quarterly Journal of the Royal Astronomical Society* (1988) **29**, 511-523.

6. *LeRoy E. Dogett, Bradey Schaefer:* Lunar Crescent Visibility, *Icarus* **107**, 388-403 (1994)

7. *Bradley Schaefer:* Astronomy and the Limits of Vision, *Vistas in astronomy*, **36**, 311-361, (1993)

8. *Bradley Schaefer:* Predicting Heliacal Risings and Settings, *Sky and Telescope*, ***70**, 1985.*

9. *Explanatory Supplement to the Astronomical Ephemeris and Nautical Almanac.* Issued by H.M. Nautical Almanac Office, London, 1961.

10. *Improved Lunar Ephemeris 1952-1959,* The Nautical Almanac Office, US Naval Observatory, Washington 1954

11. http://moshier.ne.mediaone.net/

12. *Stephenson*, Historical Eclipses and Earth's Rotation, Cambridge University Press, ISBN 0-521-46194-4

13. *J. O. Dickey et al.:* Lunar Laser Ranging: A Continuing Legacy of the Apollo Program,. Science **265**, 482-490, (1994)

14. *Explanatory Supplement to the Astronomical Almanac.* Edited by Kenneth Seidelmann. University Science Books 1992. ISBN 0-935702-68-7

15. *Keith Pickering*: The southern limits of the ancient star catalog and the *Commentary* of Hipparchos, DIOS, **12**, (2002) p.3

16. *Jean Meeus*: Astronomical Algorithms, Willman-Bell, Inc. ISBN 0-943396-61-1.

17. *L.V. Morrison and F. R. Stephenson*: Historical values of the Earth's clock error ΔT and the calculation of eclipses. Journal for History of Astronomy, **xxxv** (2004) p 328-336.

18. http://sunearth.gsfc.nasa.gov/eclipse/SEhelp/deltat2004.html

19. *A. J. Sachs and H. Hunger*: Astronomical Diaries and Related Text from Babylonia. Vol. I . Verlag der Österreichischen Akademie der Wissenschaften. ISBN 3-7001-1227-0.

20. *B. D. Yallop*: A Method for the Prediction of the First Sighting of the New Crescent Moon. NAO Technical Note No. 69, NM Nautical Almanac Office. http://www.crescentmoonwatch.org/download/NAOTN69.pdf .
The *q* value used in JPlanet is Yallop's value increased by 0.014 for all displayed values to be positive.