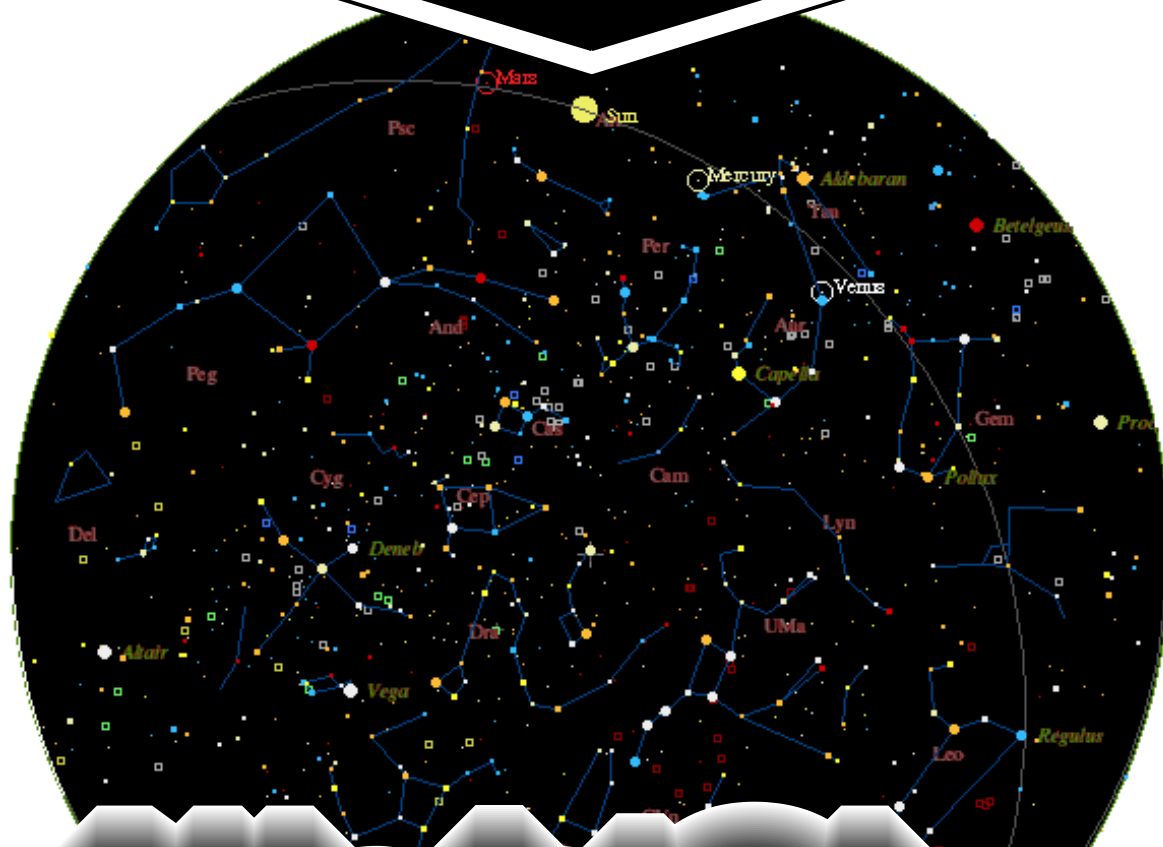


C L A R E S



NightSky

"NightSky has set a standard which
competitors will find hard to surpass."
RISC User

ProAction

3QD
DEVELOPMENTS LTD

APDL

NightSky

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About NightSky

NightSky is a RISC OS application which generates star maps on any scale and as seen from anywhere on earth and at any past, present or future date and time. Because of the processing power and speed of the Acorn family of RISC OS computers, the calculations of positions of the sun, moon and planets can be biased in favour of accuracy rather than speed, so that realistic views of events such as eclipses of the sun and moon, occultations of stars by the moon and transits of Venus and Mercury can be obtained. Even so no whole or part sky view ever takes more than a few seconds to construct.

NightSky is intended to accompany and to encourage active observation of the heavens, if possible using binoculars or a small telescope. It features

- Whole or part-sky view of the heavens at any place on earth and any time displayed in seconds. You can edit the file of places, and create new ones. You can control which stars and planets will be labelled, and add more annotations of your own after the map is drawn.
- A large database of stars, held in memory for processing speed. There is a (present) maximum of 26,104 stars down to magnitude 7.55; this is three times fainter than the faintest star that can ever be seen by an unaided eye. This maximum catalogue requires 500K of memory, but does not have to be loaded in full. The minimum catalogue is 2704 stars down to magnitude 5.4, needing only 52K of memory.
- Computation of the positions of sun, moon and planets that allows demonstration of solar eclipses and lunar occultations with errors in space of no more than a few kilometres on the earth's surface and, typically, a couple of minutes in time. A facility to generate a file of predictions (or *ephemeris*) of occultations for any particular place is provided.
- Comprehensive identification and finding routines for any object.
- Tagging of any object and storage of notes on it. A few hundred interesting stars and *Deep Sky Objects* (star clusters, nebulae and galaxies external to our own Milky Way) are tagged already, and you can read and edit (or delete) the notes on these. Most of these objects are double stars that can be observed as such with modest equipment.
- Demonstration of changes in the sky over long periods of time due to *Precession* of the equinoxes, and the *Proper Motions* through space of the stars themselves.
- Comprehensive saving routines. Maps may be saved to disc or other applications as sprite or draw files. Much more economically, the parameters necessary for NightSky itself to re-create the map in a few seconds can be saved in a special file of standard format. You can construct sequences of linked maps that will be generated automatically. In this way you might show the changes in the sky at a particular place over the course of a year; or the progress of an eclipse or occultation.
- RealTime facility. You can arrange to have the map refreshed after a set delay with an interval between maps that can range from one minute in normal real-time mode to 10000 years, for study of how constellation shapes change due to the real motion of the stars through space.
- Customisation. You have complete control over the operation of NightSky and can arrange for it to operate as you wish. This covers matters such as the default place initially selected; type of plot; faintest stars considered; which stars if any are labelled with proper names and/or their constellation IDs; fonts selected for all labelling activities; and all colours used. You do not have to trouble yourself with these technicalities, of course. Two sensible default sets of parameters are stored within NightSky, one appropriate to coloured maps on-screen and the other to monochrome hard copy for your printer. All of this means that having installed NightSky on the icon bar you can examine the state of the sky "here and now" with a single choice from the main menu, a total of two mouse clicks.

Conventions used in this guide

We use the standard Acorn conventions for the mouse buttons:

- **SELECT** is the left button, and the most commonly used.
- **MENU** is the middle button and is usually for opening menus.
- **ADJUST** is the right mouse button.

Unless otherwise stated *Choose* means move over something and click on it with **SELECT** or **ADJUST**.

Error or message *dialogue boxes* may appear from time to time. They contain action icons with labels that vary with context, for instance **Save**, **Quit**, **Cancel**. This would appear if you tried to quit NightSky when the file of places in memory had been altered but not saved. In such a case **Save** would cause the standard dialogue box to appear to allow your work to be stored on disc, **Quit** would do just that, losing the new information, whilst **Cancel** would abort the exit procedure.

It is assumed that you have read the Welcome Guide supplied with your computer and are familiar with the RISC OS Desktop environment

Animations

This term is used to refer to a series of screens calculated in real-time by NightSky. There is so much calculation to do that true animation is not attainable, though use could certainly be made of NightSky images in movie-making applications. NightSky animations will be smooth and flicker-free provided adequate screen memory is available.

1. Tutorial

Introduction

Before looking at each of the program features in detail, it is important to have an overall understanding of the way NightSky operates. It is recommended that you work through this chapter before you explore any of the menu options.

Loading the Program

Run NightSky by double clicking on the !NightSky icon in the directory display. After a few seconds NightSky's icon appears on icon-bar, with the number **2000** beneath. Click **SELECT** on the icon to display the program's initial menu, **Draw a Map**.

Plotting a Map

Choose the first item **Here : Now** from this menu. NightSky will plot a star map using the default settings of its configuration file, and the *default location* which is where the computer is assumed to be. Initially this is Northwich, Cheshire. You will probably want to amend this to reflect your own location and this will be described later.

The map represents the whole visible sky for the place and time chosen. The stars at the bottom part of the map correspond to those in front of you (by default you are facing South), the central part is the area more or less overhead (the *zenith region*), and the top represents the part of the sky behind you. The brighter stars are named in green, although their labels are so small that you cannot easily read them. This is because these initial settings are designed to produce a neatly labelled printout when you send the map to your printer. You can easily alter the size or colour of such labels. If it is day-time, the position of the sun is marked by a small yellow circle; in such a case of course the sun (and moon) are all you can really see ! NightSky still shows everything that is there however, the only difference being that the Milky Way is only plotted in the hours of darkness.

Basic Map Operations

If you move the pointer around the map and click **SELECT** over an object, a window of information about it will appear instantly. The picture below shows the information window that appears after you click **SELECT** on a planet: however all the information windows are quite similar.

Planet Jupiter			
Altitude	5.8	Azimuth	111.9
		Mag	-1.7
R.A.	13h 28.3m	Dec	- 8° 06.3'
Phase	0.999	Distance (AU)	6.37421
Elongation from sun	21.1	Diameter"	30.9
Rises	7h 58m	Sets	18h 39m
Heliocentric			
Distance (AU)	5.45031	Field	
Latitude	+ 1° 14.9'	Long	207° 12.4'

Altitude gives the elevation in degrees above the horizon: 0 means just rising or setting, 90 would be overhead. Azimuth is the direction of the object measured in degrees from North (0) through East (90), South (180) and West (270) back to North again (360).

R.A. and **dec** stand for Right Ascension and declination, effectively celestial longitude and latitude respectively (see Chapter 6).

Magnitude means brightness, and a smaller number means brighter. The twenty-five brightest stars, loosely described as of the *first magnitude* range from -1.5 to 1.5. In favourable conditions (moonless night, no light pollution, a transparent atmosphere) an acute eye can see stars somewhat fainter than the sixth magnitude at 6.3. Such stars are 100 times fainter than stars of magnitude 1.0, and in general each magnitude step means an

increase or decrease in brightness by a factor of approximately 2.25. Here, the -2.4 means that Jupiter is very bright: in fact Jupiter is never surpassed in brightness except by the sun, moon, Venus and, rarely and briefly, Mars.

Phase is the fraction illuminated, as planets shine by reflected sunlight only and so show phases like the moon's. 1 is full (we look at the illuminated hemisphere, as at full moon) and zero is new (we are looking at the dark side, only possible with Venus and Mercury).

Distances of the planets are conventionally measured in *Astronomical Units* (AU). 1 AU is the mean distance of the earth from the sun (149 597 870 km).

Elongation is the angular separation of the planet from the sun in the sky. This is an important guide to the visibility of the object, as if this is close to zero (or 360°), the planet is near the sun in the sky and so is above the horizon mostly in the daytime, and invisible. 180° on the other hand means diametrically opposite the sun and visible all night. This is called *Opposition* and is possible only for the outer planets that are further from the sun than we are, i.e. not Venus or Mercury.

If you click on the **Field** icon in this window, you will get an enlarged view of the part of the sky close to the planet: 10° across if the map on-screen is a small scale one. This is useful for studying the motions of the planets relative to the fixed stars, and also for finding (with binoculars) the faint outer planets Uranus and Neptune. If you click on **Field** when the view is already 10° or less, then the magnification will be increased by a factor of 4, subject to a minimum field of view of one-eighth of a degree. Hence you can view the current phase of a planet, the four bright satellites of Jupiter or the rings of Saturn. Clicking with **ADJUST** will zoom the other way.

For stars, information is given in a similar window. The title bar holds the star's catalogue number: they are in order of brightness (rounded to nearest tenth of a magnitude). Many stars are **tagged**, shown by the icon in the bottom right of the information panel being selected. This means that additional information on the star is stored within NightSky. If you click on the **Tag** icon, you can read this in another window.

The screenshot shows two windows from the NightSky application. The main window, titled 'Star 6', displays various astronomical data for a star. The data includes: Pointer altitude (53.2), Azimuth (282.1), Pointer R.A. (5h 15m), Declin'n (45.7), Star name (alpha Aur = Capella), R.A. (5h 16.7m), Dec (+45° 59.9'), Magnitude (0.1), Distance (pc) (13), Absolute mag. (-0.4), Surface temp (5200K), Luminosity (130 suns), Spectral class (G8), Rises (Does not set), and Sets (Does not set). There are checkboxes for 'Tag' (checked) and 'Field' (unchecked). A smaller window, titled 'alpha Aur = Capella', is overlaid on the main window. It contains the text: 'alpha Aur = Capella', '= "little she-goat"', 'Furthest N of the mag 1 stars (but six first-mag lie closer than this to the S pole!)', and 'same col & spec as sun'. An 'OK' button is at the bottom right of this window.

Field	Value
Pointer altitude	53.2
Azimuth	282.1
Pointer R.A.	5h 15m
Declin'n	45.7
Star	alpha Aur = Capella
R.A.	5h 16.7m
Dec	+45° 59.9'
Magnitude	0.1
Distance (pc)	13
Absolute mag.	-0.4
Surface temp	5200K
Luminosity (suns)	130
Spectral class	G8
Rises	Does not set
Sets	Does not set
Tag	☒
Field	☐

alpha Aur = Capella
= "little she-goat"
Furthest N of the mag 1 stars
(but six first-mag lie closer than
this to the S pole!)
same col & spec as sun
OK

The notes provided mainly flag **double** or **variable** stars likely to be of interest to an amateur astronomer. If the star you have clicked is at present untagged, clicking on the **Tag** icon will open the tag window? empty; you can now type in up to 7 lines of text (you have to press **Return** at the end of each line). Click on **OK**, and, if you have write permission, NightSky will store your comments. Similarly, with a star that is already tagged, you can delete or change the tag text before pressing **OK** and the file will be updated. Before this operation takes place however, you will have to prove that you have the necessary write access (you have to supply a password). Note also that no "garbage collection" is performed on the file of comments, so you cannot "untag" a star. We therefore suggest that you perform your initial experiments in tagging on a backup copy of NightSky, and then make a new working copy when you are ready to do so, destroying the first as you are licensed only for one working copy of the application.

SELECT-drag

If you press and hold down **SELECT** whilst making a slight movement with the mouse you start a drag operation. A rectangle appears on the screen, which will define (approximately) the area of an enlarged view. You can move this around within the map area simply by moving the mouse. Pressing **SELECT** will make the chosen area smaller (zoom in), whilst **Ad** just will make it larger (zoom out). Press **MENU** to draw the new view, or **Escape** to cancel the zoom operation and leave the map unchanged. You can zoom in by stages to a field as small as 1/8°.

ADJUST

Clicking **ADJUST** within the map area will cause the map to be redrawn facing in the direction of the point where you clicked. If the map is an enlargement rather than the whole sky, that point will be at the centre of the new view. However when the point clicked on is very close to the horizon, NightSky adjusts the centre of the field so that the horizon is close to the bottom of the screen.

Home

Any time after experimenting with enlarged views and different directions you can press the **Home** key. The whole sky map facing 180° (South) will then be redrawn. Note also that at any time **Shift-F4** will give you back your last enlarged view and **Ctrl-F4** a whole sky view preserving the current orientation.

MENU

Pressing **MENU** within the map area will display NightSky's Map menu, which gives access to several options. Most of these are fairly straightforward, such as Save and Print. Choosing **Moon** will display a window with information on the moon, including a large image showing how it appears in the sky in both phase and orientation.

RealTime is an important menu item here. This menu item may be ticked. If so the map will be updated, normally once a minute. The present orientation and scale are preserved for this. Clicking on **RealTime** toggles the real-time status. The keyboard shortcut **F9** achieves the same result - toggling the real-time status - much more quickly, and you will usually want to start or suspend the RealTime option using this key. Note that starting a new map with either of the **Now** options resets the real-time parameters to updating the screen every one minute.

The remaining menu-items lead to sub-menus which are explained in detail in Chapter 3, *The Map Menu*.

Keyboard Short-cuts

F5 to F8 and Shift-F5 to Shift-F8

These hot keys allow you to change the place and time of your map. They duplicate the first four options of the opening menu. In all cases the effect of the **Shift** key is to force NightSky to read the scale and orientation of the map from the file of stored places held in memory. When **Shift** is not used, the present values of these parameters are preserved. **F5** gives the **Here : Now** view, which uses the default place and current time, with RealTime updating selected. The other three keys all lead to the map plotting dialogue box. You would use **F6** to plot the default location but not at the present time. For example to preview tonight's sky in the day time. RealTime update is not selected.

F7 and **F8** work similarly, for other locations.

Press **F7** for example. To see the available places you can select from, click and hold down **SELECT** in the icon to the right of "place #". As you cycle through them the time displayed changes to what it is there and now ". Using **ADJUST** will work back through the file in the same way. To search for a place delete the contents of the **Name of place** dialogue and type in a few letters of the desired location name (case immaterial) followed by **Return**.: the first matching place in the file will be displayed. For example **LON** is likely to give you **London**, **CZ** will certainly yield somewhere in the Czech Republic, but a common combination such as **NEW** might yield almost anywhere - Newcastle, New York or New Zealand. The place displayed in the window will be the first such match for what you typed, working from the start of the file. For a more specific search type more letters. Click on **GO** to draw the map when you have found the required place.

Demonstration animations

In the directory **Demos** are a number of saved NightSky positions which when run give a good idea of the capabilities of NightSky. To run one of these animations just drag the relevant file onto the NightSky icon bar icon. All the animations use NightSky's RealTime menu option. You are recommended to try all of them in turn. In what follows it is assumed that you have not deleted places from NightSky's default places file, or edited any of the **Choices** files in the application directory; if you have and a missing location is specified, the default place is used instead, with possibly uninteresting result.

The **Demos** directory is divided into a number of sub-directories according to to topic.

Demos.Month by month

Is to help familiarise yourself with the star patterns (constellations) and the changes in them over a year (or longer).

Northern1

Shows the march of those stars that never set as seen from U.K., the *circumpolar* stars, round the north celestial pole. Successive views are a month apart, a change equivalent to waiting two hours on a single evening. The main stars depicted are those of Ursa Major (the Great Bear, including the Plough), Cassiopeia, Perseus, Draco and Copheus plus the bright stars Capella, Vega and Deneb, all moving anticlockwise round the almost stationary Polaris, the Pole Star. These are the first star groups that a beginner in these latitudes will learn, as they are always visible.

Northern2

Shows the corresponding view facing south. Here are found the equatorial and some southern hemisphere groups, and the stars on view are different at different seasons. Planets appear sometimes which they never do in the previous set, as do all the zodiacal groups plus such important and prominent objects as the Square of Pegasus, Orion and the bright stars Sirius, Procyon and Arcturus, Altair and Fomalhaut. They move clockwise across the southern sky, and the beginner will need up to a year to learn them all, unless observation in the unsocial hours before dawn is also undertaken, in which case six months or so will suffice !

Southern1 and Southern2

Are corresponding views from a location in the temperate southern hemisphere, in this case in New Zealand. Note that the circumpolar stars (the Southern Cross, Canopus and Achernar and alpha and beta Centauri, the Pointers to the Cross) move clockwise around the (empty) southern pole, whilst the same groups as seen in Northern2 move anticlockwise (and "upside down") across the northern sky.

EquatN and EquatS

Give similar north- and south- facing views using a site in the tropics and close to the equator.

Demos.TotalSolar

Allows you to run animations of selected total solar eclipses, a good way to get an idea of the accuracy (and limitations) of NightSky. The animations run at an acceptable speed on all machines, but benefit strongly from the presence of one of the faster chips supplied with the more recent Acorn RISC OS computers (and available as an upgrade for the older family members). Occasional stars intrude - these are in fact sky maps for the given place and time and the whole catalogue is examined. There is no special separate eclipse routine within NightSky.

Falmouth99, Manchester99 and Wien99

Are views of the total eclipse of 1999 August 11. This will be the first such event visible from anywhere on the British mainland since 1927. From southwest Cornwall the eclipse is total, but from typical British sites such as London, Manchester or all of Scotland, only a large partial eclipse is seen, while Vienna is on the (northern) limit of totality. NightSky faithfully reproduces events from each site, though exact times are only reliable within a minute or two. Other relevant locations for exploration of this eclipse might be Paris (south of the zone), Munich, Prague, Budapest, Istanbul, Tehran and New Delhi. To change site, when any animation is in progress hit **F9**, **F8** and **Ctrl-U**: now enter (part of) the new place name followed by **Return** and finally click on **Ok**. Mexico91 and Borneo88 are two other total eclipse sequences and will illustrate the variation in the track of the moon across the sun and in the duration of totality seen in different eclipses.

Demos.Annular

Shows views of the other variety of central eclipse: sometimes the moon is too far from the earth to block out the whole of the sun's disc. A thin ring (*annulus*, Latin) of sunlight remains round the outside of the moon, and

the event is called an *annular eclipse*. Welling91 shows an annular eclipse that occurred in the middle of the day, but Calif92 is one where annularity was achieved just as the sun was setting while Reykjav03 previews the annular eclipse of May 31, 2003 in Iceland which happens at sunrise. Such events, where the geometry is very oblique, are a sensitive test of computational accuracy requiring for example allowance for the figure of the earth (not a sphere) in addition to the calculations on the sun and the moon. NightSky does not need to flag eclipses and then make a special effort to calculate for them - the same algorithms are used for every plot of the sun, moon 'tars and planets.

Demos.Lunar

Deals with eclipses of the moon. June93 and Nov93 show the sequence of events for the total lunar eclipses 1993, visible from Australasia and the U.K. respectively. The disc of the full moon is shown crossing the earth's shadow. The inner dark circle represents the earth's shadow or *umbra* at the distance of the moon. Parts of the moon within this circle receive no direct sunlight. The outer circle is the *penumbra*; within this as seen from the moon, the earth partially blocks the sun's light. Penumbral stages of a lunar eclipse are all but unobservable in practice, as no change in the moon is noticed by the eye until part of its disc enters the umbra. However the changes in brightness for both the penumbral and umbral stages of a lunar eclipse could be monitored automatically with the dataloggers readily available in schools these days and there is the possibility of interesting projects here. Consult the Bibliography under *Eclipses* for suggestions.

Demos.Partial

Has views of a partial solar eclipse (November 1993) from various locations in New Zealand and Antarctica, including the South Pole. Auckland is on the eclipse limiting line in this case, with 0.3% of the sun obscured at 0838 NZST.

Demos.Precess

Shows how the appearance of the sky changes dramatically over long periods due to the phenomenon of precession of the equinoxes, discovered by Claudius Ptolomey in the first century. The axis of rotation of the earth, the line joining the north and south poles, does not point in a fixed direction in space, but like that of a spinning top "wobbles", tracing a small circle in the sky with a period of 26000 years. Since the poles of the sky are not fixed, the co-ordinates of the stars change in time and a frequent astronomical calculation is to correct them from a standard epoch used in catalogues, atlases and computer files to the actual date of observation. NightSky uses the standard epoch of 2000.0 and for maps drawn for dates in the current (and next) decade the correction is very small and need not be made except for calculations or demonstrations of occultations of stars by the moon, when it is essential. Over longer periods the effect of precession is drastic: for example the Tropics of Cancer and Capricorn are named from the zodiacal groups in which the sun stood at the time of greatest north and south displacement from the equator two or three thousand years ago when the constellations were named. Now when the sun is "on" the tropic of Cancer it is in fact located on the borders of Taurus and Gemini, and when "on" Capricorn lies in the constellation of Sagittarius. The demonstration shows this by depicting the winter night sky seen from the U.K. at intervals of 1000 years.

UrsaMa

Shows views of this famous constellation at 10000 year intervals. At epochs very remote (more than one precessional cycle) from the present, precession itself is ignored, as the intention is to show the effect of the actual motion of the stars themselves. A typical star like the sun makes an orbit around the centre of our galaxy (milky way system) in a million years or so. Over very long periods the present constellations become unrecognisable, mostly due to relatively "rapid" motion of nearby bright stars like Sirius, Aldebaran, Arcturus, Fomalhaut and (of course) alpha Centauri.

When using the Precession demonstrations, you will notice that the precession year of the catalogue is displayed on the icon bar underneath NightSky's icon. For everyday use there is no need to process the catalogue: the standard epoch (currently 2000) is sufficiently accurate for ordinary star maps. Lunar occultations of stars are another matter.

Occn/Trans

Has demonstrations of recent or forthcoming occultations of stars by the moon and transits of Venus and Mercury across the sun. Such an event occurs when an interior planet (Venus or Mercury) passes almost exactly between the sun and the earth. Because each planet orbits the sun in its own plane, such events are rare, especially for Venus. At the largest scales used by NightSky, both Mercury and Venus are shown to scale on the disc of the sun (or indeed elsewhere).

Demos.Planets

Contains the animations Jupiter and Saturn which give views of the changing appearances of Jupiter's four main moons and of Saturn's rings. The step sizes in these two files are 4 hours and 4 months respectively. The other files in this sub directory are examples of those exceedingly rare events when one planet passes in our view directly in front of another (mutual occultations). There is no such event at all in the present century. On "1170 September 12, one Gervase, monk of Canterbury Cathedral, noted that as Mars and Jupiter rose late in the evening that it was impossible to separate them by eye - their light had merged into one source. Calculation shows that a few hours earlier Mars had in fact passed right across the face of Jupiter as seen from earth. Gervase appears to have been the only observer on our planet who left a record of an event that were it to occur today would cause immense excitement among astronomers and the general public and would form the subject of thousands of photographs, videos, newspaper articles in all languages, TV programmes and so forth. Astrologers too would pontificate at great length on such an event!

Coincidentally(?) it is interesting to note that three months later Canterbury was the scene of the notorious *Murder in the Cathedral*.

Several such events before the year 1570 are given in this sub directory.

This concludes the preliminary tour of NightSky. The following chapters form a comprehensive reference section on the options and actions available at all points within NightSky, organised by considering the menu options on offer.

2. The Desktop

The Program Icon

Clicking **SELECT** on the program icon on the icon bar causes the *Draw a Map* menu to be displayed. You use this to plot a map and also to vary the settings that will be used for the next map to be drawn.

Clicking **MENU** on the program icon displays the *icon bar menu*. This is your route to other aspects of NightSky such as processing the catalogue in memory, operations on files of places and generating files of predictions for lunar occultations of stars and planets.

Various kinds of file can be loaded into NightSky, as a rule by dragging the item to this same program icon:

- **Files of places:** these are text files. A places file is limited to 255 locations. Each record is a single line of the file in CSV format, so they can be edited in a text editor such as Edit as well as within NightSky.
- **Configuration files** of choices that tell NightSky how to plot a map. These too are text files and can be edited by **Edit** or another text editor. It is preferable to save such files from NightSky itself. If a badly-formed choices file is loaded, no error will occur, but NightSky will reinitialise itself using the default choices file specified in NightSky's own !Run file.
- **Map instructions.** These are also text files, but are stamped with file type &DFE (CSV file). They are produced by NightSky but again can be edited in a text editor if you know what you are doing. The files in the Demos directory discussed in the tutorial are of this type.
- **Star catalogues** are contained in sub directories of the NightSky program directory, with the largest one on the resources disc NightSky_2. Load a new catalogue by dragging the directory icon to the program icon.

Catalogue	Number of stars	Size, k	Use
StarsX	26104 to 7.55	510	General use
StarsZ	2845 to 7.55	55	Occultation prediction/demonstr.

The **StarsZ** directory contains all the stars down to magnitude 7.55 that can be occulted by the moon at epochs close to the present, plus a few bright stars for orientation purposes. When it is loaded constellation joins are not selectable. By excluding 90% of stars that cannot possibly be occulted by the moon, it permits those calculations to be much faster (if not fast).

The Palette Icon

When you use this icon to change display mode, or when another application imposes a new mode on the desktop display, NightSky responds as follows:

- If a map is on-screen NightSky does nothing. The Window manager will do its best to display the previously created map as faithfully as possible in the new mode. If a map has been created in a high resolution mode you can therefore select say mode 0 before printing it: this will free memory that will allow the printer driver to do its work much more quickly.
- With no map on-screen NightSky reorganises its memory to use the new mode for future plots. This may involve claiming or releasing memory.

Note that if you change mode with a map on-screen and close the map window, NightSky is still organised to use the previously selected mode. To use the current one for the next map you must select the new mode after closing NightSky's map window. Select the new mode again if you forget to follow this sequence of actions.

Remember that if you choose a mode, NightSky will try to use that mode even if it has to reduce the size of the star catalogue in memory; however if you try to increase the catalogue size (more stars), NightSky will not reduce resolution or sacrifice Drawfile saving unless the catalogue is at minimum size.

Interactive Help

NightSky provides a degree of interactive help which may be accessed by loading the !Help application supplied with your computer. The help messages generated by NightSky cover both the computing and the astronomical features of the application.

Iconised ('minimized') windows

If you **Shift**-click on the close icon of a map window, or other NightSky window, it is reduced to the size of an icon bar icon; that is the window disappears and a small icon is left of the desktop background, labelled with the first word of its title bar. The window remains active, and anything you could do before can still be done. In particular, in **RealTime** mode the window will still be refreshed at regular intervals, a process which deprives other applications of processor time for a few seconds whilst it is updating, (the hourglass will appear during this time). Double click on the iconised window to restore it to full size, or Shift-click with **MENU** to get the menu associated with the window, if any.

High resolution icons

If NightSky is started up in a high resolution mode, such as a multiscan mode, a VGA mode or an SVGA mode, it will use a different set of icons for its files and on the icon bar.

The Territory Manager

NightSky does NOT use the RISC OS territory manager due to problems with the current system. In the meantime it is suggested that you operate NightSky as follows.

First, ignore daylight saving time for all locations other than those in your own country. If you are in U.K. you probably neither know nor care when New South Wales goes onto or off summer time: so leave Sydney as zone +10 in the places file. If you are in Sydney, then leave London as zone 0 for the same reason.

Star maps will be correct, provided the next point is followed. When the time setting of your computer is varied to reflect the change in civil time, you need to edit the places file. In the U.K. for example, after BST comes into force you need to change all UK (and Irish) records from zone 0 to zone +1, and back again when GMT comes into use, leaving all others as they are. This actually has been done for you already, the resulting file in your NightSky directory being placesDST. All that is necessary 's to ensure that the correct file is loaded for the time of year. Follow the procedure in the box below in order to do this.

In other countries, follow the same procedure, but you also need to edit (once only) the file placesDST so that (a) places in the UK and Ireland are changed back to zone 0; (b) places in your own country are labelled with their correct daylight saving zone. This will usually be 1 hour ahead of the standard value. If you live in a place where daylight saving is not used (or in one like Singapore where it is permanent), you need do nothing: the files are correctly set up as supplied.

At the start and finish of Daylight Saving Time:

- Once, after daylight saving comes into force:

Open the NightSky directory, with !Edit installed and double click on the file **ChoicesD** to load it into the text editor. A window opens. In this window, look for the line "`#3 Places file...`", and in it change **Places** to **PlacesDST**

Press **F3** and click **OK** to save the amended file.

- Once, after daylight saving ends

Follow the above procedure, but edit **PlacesDST** back to **Places**

Press **F3** and click **OK** to save the amended file.

3.The Menus

NightSky has three main menus: the **Icon bar menu** and the **Draw a Map menu** are accessed from the icon bar, and the **Map menu** which is accessed by clicking **MENU** when the pointer is within a map window.

3.1 The Icon Bar Menu

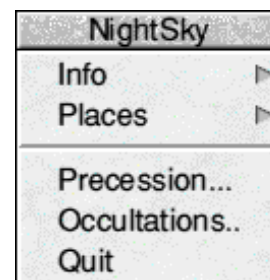
Click **MENU** on the program icon to open a menu containing five items -

Info

This leads to a standard information box giving your version of the application and its date.

Places

This leads to a submenu of three items, each of which in turn leads to a dialogue box. They will be discussed in reverse order.



Places -> Save places

This will save a file of places used by NightSky after editing. The filename in the usual save box will initially be that of the place file NightSky is configured to load on initialisation. To change, alter the leaf name (after the final dot), and then click **OK** or press **Return**. This applies if the new file is to be stored in your NightSky directory. Otherwise, delete by typing **Ctrl U**, enter your own leaf name and drag the file icon to the directory display of your choice.

Places -> Create new file

Following this arrow will remove all but the first ("Default") place from memory. You would choose this option to create a totally new places file.

Note that the default place cannot be deleted, though it can of course be edited. If you choose this menu option by mistake, drag a places file from the NightSky directory into the empty dialogue box window, or to the program icon, and the places lost are restored.

Places -> Show places

Use this choice to examine and edit the current file of places.

 A screenshot of the 'Show places' dialog box in NightSky. The window title is 'IDEFS::ide-4.\$\$.Programs.NightSky.temp.!NightSky.Northwich, England'. The dialog contains several fields and controls:

- Record Num.:** A dropdown menu showing '1 (DEFAULT)'.
- Total Records:** A text box showing '160'.
- Name of Place:** A text box showing 'Northwich, England'.
- Latitude (N is +):** A text box showing '53.2'.
- Time Zone (fast on GMT is +):** A text box showing '0'.
- Longitude (E is +):** A text box showing '-2.3'.
- Facing direction:** Four radio buttons: North, East, South (selected), and West.
- Other:** A text box showing '180'.
- View:** Two radio buttons: Zenith (selected) and Horizon.
- Other:** A text box showing 'Z'.
- Field:** A text box showing '180'.
- Buttons:** At the bottom, there are four buttons: a left arrow, a right arrow, 'Delete', and 'Update' (which is highlighted with a yellow border).

Clicking **SELECT** on the right/left arrows will move to the next/ previous record. Holding the key down will cycle rapidly through the available records. Using **ADJUST** will reverse this effect. **Ctrl-SELECT** (hold down the **Ctrl** key and press **SELECT**) on the relevant arrow will take you to the first record and the last record respectively.

Adding a new record

Clicking **SELECT** on the right arrow when the last record is on display will give a blank box ready for entry of a new record at the end of the file. You must enter something in the writable fields for place name, latitude, longitude, and time zone. By default the **Field** and **Direction** are both set to 180°, which gives a whole sky view facing south. This standard map makes it easy to compare views from different places: you can always zoom in

on an area of interest after the first map is drawn. However, to edit the direction, click on one of the direction icons or enter your own value in the box. The zenith / horizon icons are relevant only if the field of view is less than whole sky. If you choose zenith, the map will be centred on the overhead point, if horizon then the horizon will be placed at the bottom part of the map; its extent is governed by your choice of the field. You may also type a value in the box to the right of this pair of icons. This will then specify the **altitude** above the horizon of the centre of the map (degrees, range 0°-90°). NightSky will ignore this if it is not sensible, e.g. it leads to the area viewed being mainly below the horizon. Whole sky maps are always centred on the zenith, irrespective of your selections.

When you create a new record (or amend an old one) the values you type in the places dialogue box have no effect on the places stored in memory until you click on the **Update** icon. It is when you do this that the number of records is incremented if you are adding a new record, or the previous information is over-written if you are changing an old one. **Update** and **Save** will present you with a save box to store the new file away.

Note particularly that when you are amending several records, for example editing their time zones to reflect daylight saving time, it is necessary to click on Update for every edited record before moving on to the next, otherwise the changes are lost.

Clicking on the **Delete** icon removes that record from memory and the total is adjusted downwards. You cannot delete record #1, the **default place**, which is a special record. You can of course amend it, and will naturally want to edit this record to reflect your actual location as soon as you have installed NightSky.

Pressing **MENU** anywhere in the dialogue box causes a small menu of three items to appear:

- **Default** - Will make the current record the default place, the special record #1. This is the place for which maps chosen via **Here** options are plotted. Also NightSky assumes that machine time refers to the time zone of the default place. After first installing NightSky and creating a record for your own place you will use this option to make that record the default one if you prefer not to delete the original default (Northwich) from the file.

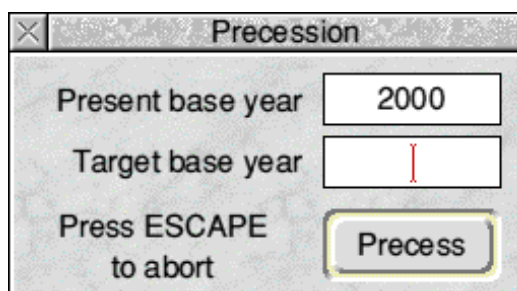
The map you will most often want - the sky **here** and **now** - can then be created with just two clicks of **SELECT**. **Default** can also be used to "transport" the computer to a far away place, in the opposite hemisphere say.

- **Find** - Leads to a writable icon in which you can type a few letters. On pressing **Return** the first record in the file with a place name matching these letters will be displayed, or, if no such record exists there will be no change.
- **Sort** - Leads to a submenu of three items: the records in the file (apart from the default place) can be sorted alphabetically by place name, or north to south, or east to west. As supplied NightSky has records sorted north to south, which has the advantage that records from the same area, in the same country for instance, are usually fairly close in the file.

If you close the places dialogue box after editing in any way, that is adding, changing or deleting records, changing the default location or sorting the records, you will be prompted to save the changes. You can decline this and save from the icon bar menu later if you prefer.

Precession...

This menu choice from the icon bar menu causes a small dialogue box to appear. You enter a year and when you then click on **OK** the catalogue currently in memory will be adjusted so that the co-ordinates are correct for the date entered (year and fractions of a year, for example 1993.5). NightSky does not support the saving of processed catalogues. The amount of computation involved is very large, and the hourglass will appear with a percentage indicating how the work is progressing. The calculation allows for the proper motions of the stars, that is their actual motions through space, as well as for the precession of the equinoxes which is just an alteration of the co-ordinates of the stars caused by a change in the direction in space in which the earth's axis of rotation points.



Precession of the Equinoxes is very slow: it takes some 26000 years for the complete cycle. It causes no readily perceptible alteration to the positions of the stars over a single human lifetime. On a whole sky map, its effect even over a century is insignificant. For routine studies of the night sky, precession may therefore be disregarded. However, the largest scale maps supported by NightSky have a field of $1/8^\circ$: scales of 1° or less would most likely be used for eclipses of the sun and moon, transits of Venus and Mercury across the face of the sun, and occultations of stars by the moon. On such maps ignoring precession even over the seven years between 1993 and 2000 (the epoch of the catalogues) could cause an error in star (not planet) positions amounting to one-tenth of the moon's diameter. To represent occultations adequately therefore, you must use a processed catalogue. This is the only context within NightSky for which this is the case, except when the effect itself is the object of study. After the catalogue has been processed, NightSky's icon bar icon is updated to show the (integer) year to which it applies.

More information on precession is given in Chapter 6.

Occultations...

A star is **occulted** when the moon lies directly between the observer and the star, which then cannot be seen. An occultation of a star (or planet) can last from a few seconds (for a *grazing occultation*) to somewhat more than an hour. Occultations of faint stars are much more easily observed when they take place at the dark limb of the moon. This normally means that between new and full moon (seen in the evening skies) the disappearance is observable, and from full moon to new moon (seen in the morning skies), the reappearance of the star. Both can be seen readily for the brighter stars and planets.

Observation of occultations, especially of a bright star, makes a very suitable learning project for keen beginners in astronomy. The record made of the event should include drawings showing the phase and position of the moon, and exact timings. For a grazing occultation a star may disappear and reappear several times before finally vanishing. This is due to the irregular terrain of the moon: as the moon cuts across it, the star is occulted behind lunar mountains, but shines through valleys. Observations of such occultations are very valuable in refining knowledge of the moon, provided times are accurate to 1s or better and position on earth is known exactly.

On choosing this option a dialogue box lets you set the place and start time of the search for occultation events. The results are deposited in a CSV file in the sub-directory Occns of the NightSky directory. The file will have a name like **SydFeb93**, if say the place was Sydney and the search began in February, 1993. The time needed for a whole year's search will be an hour or even considerably more, depending on machine. You can see in the -window what date has been reached and how many events have been found, and interrupt the search at any time by pressing **Escape**. Other active applications will have no access to the processor while the search is in progress. The resulting file can be examined in a spreadsheet application such as **Schema2**, or other application which understands the CSV file type and can format the display properly.

Technical Note

An event discovered is added to the file if:

- **Disappearance:** star magnitude better than 5.5, or moon's elongation not between 180 and 285 degrees (i.e. not bright limb near full moon)
- **Reappearance:** star magnitude better than 5.5, or moon's elongation not between 85 and 180 degrees (as above)

Provided (in both the above cases):

1. star's altitude more than 5° if fainter than 2.0, or more than 9° if fainter than 5.0

and

2. sun's altitude less than -4° for stars fainter than 4.0.

Thus bright stars and planets are predicted even in the hours of daylight.

Quit

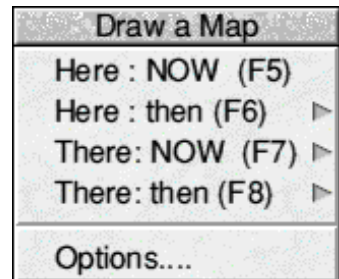
This exits NightSky. It is envisaged that you will generate many more maps than you will want to save or print. Therefore NightSky makes no complaint if the work on-screen is unsaved, but exits directly.

The Draw a Map Menu

Click **SELECT** on the program icon to bring up a menu of four choices.

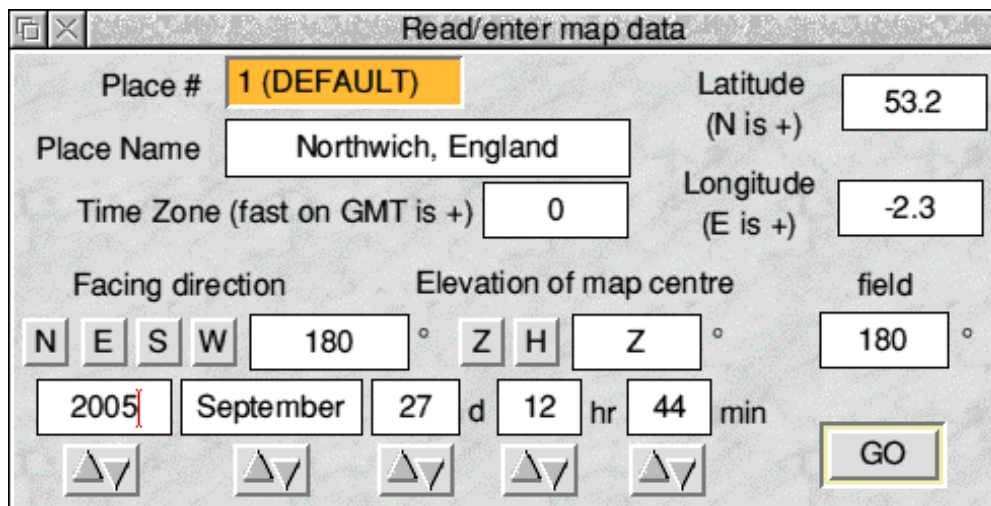
Here: NOW

This will cause a map to be plotted immediately using the star catalogue and configuration set-up currently in force (i.e. according to the last file of choices loaded, possibly as amended subsequently by you). The map will be refreshed every minute after drawing (RealTime mode on.)



Here:then

Like the two following menu items, this choice leads to the **map plotting dialogue box**. In the present case it is presumed you want to alter the time but not the place, and the caret (text cursor) is in the year box. The time will not be reset, it will be whatever was last used for a map or other NightSky operation (**now** if there has not been one).



The simplest way to set the time is to use the blue *bump* arrows under each field. **SELECT** advances and **ADJUST** reverses the cycle. Holding the button down repeats this until you release it. You can also type in the date/time fields if you prefer: pressing **Return** will move the caret to the next box, except for the last, min. Pressing **Return** with the caret in min starts the plot, it is equivalent to clicking on **GO**.

You may also change the place or edit the location fields, in which case this menu choice is the same as **There: then**. See below.

RealTime mode is **off**: after plotting the map will not be refreshed.

There: NOW and There: then

These choices open the same dialogue box, but the caret is in the place name field. The place shown is the last one used by NightSky, and may be the default place. To bring up the required place remove the present contents of the field by typing **Ctrl-U**, enter a few characters of the name, and press **Return**. This operation is not case sensitive. The record appears, or if there is no match the current record is re-displayed. If you have chosen **There: NOW** then each time you bring up a place in this way the date and time boxes will show the present local time at the location, and after plotting RealTime mode will be on with update every one minute.

Alternatively you can click **SELECT** to cycle forwards through the available records, or **ADJUST** to go back. The process auto-repeats if the mouse button is held down.

You may change any of the location fields, for example you might "decide" to move Nottingham into the southern hemisphere with a judicious minus sign. The map will reflect your entries, but the **place record** is not

altered and next time this dialogue box is opened the information will follow the record in memory, which you cannot amend from the present menu. The facility can be useful however, for instance to show how quite small changes in position can affect eclipses and occultations.

If you want to use a new location, add it to the file of records via the icon bar menu (**Show places >**), but don't save the file if your interest in the place is transient.

Options...

This opens NightSky's **Options Window**, which is an important and flexible part of the application. It allows you to control precisely the way map plotting is done and is described in full in Chapter 4. With the map window open **Shift-F1** has the same effect provided NightSky owns the caret, which it automatically does after a click in the map window.

The Map Window

Whenever a map is plotted from the opening menu, it will be placed in a window on screen that the first time fills the whole screen area, and later has the extent and position that it had when last closed. Note that if the menu choice was made using **SELECT** over **Here: NOW** or over **GO** in the dialogue box, the map will be opened in front of any other open windows. If **ADJUST** is used to click on the menu, the map window will retain its current position in the "stack" of open windows.

Mouse clicks in the Map Window

- **SELECT** - Clicking **SELECT** on any object shown on the map (stars, sun, moon, planets or deep sky objects) will cause it to be identified and a window of information about it displayed. The window disappears if you click anywhere within it. A tag file of additional comments on objects is maintained. You can read this file by clicking on the tag icon of the information window; to write to it (to add comments or edit those already there) you must supply a password. Star identification is explained in Section 6.1.
- **SELECT-drag** - Hold down **SELECT** and move the mouse slightly. This starts a drag operation, and a rectangle appears in the map window. You can use this to zoom in on an area you want to examine on a larger scale:

The zoomed-in view you get will not as a rule match exactly the contents of the rectangle, because of differences in scale at different points of the map. NightSky measures the angular separation of the mid-points of opposite sides, and sets the new field to the larger of these values. In practice this means that you always get what you want, but sometimes the scale is slightly smaller than desired, so you also get an "extra" region round the edges. Near the horizon, NightSky makes its usual adjustment of the map centre to avoid displaying mainly the invisible region below the horizon. For purposes of orientation, the enlarged view will have a directed arrow on the lower left part of the map: this shows the direction towards the north celestial pole at that point of the map (when the field is under 90°).

- **ADJUST** - Clicking **ADJUST** anywhere in the map window causes the map to be redrawn. If the map is small scale, that is it covers a large fraction of the sky, all that happens is that the azimuth of the point in the map where you clicked is made the direction of view. For large scale maps, this point is made the centre of the new view.

The Tagtext File

Within NightSky is stored a file of comments on a selection of interesting stars and deep sky objects (not the solar system). Any user can read this text by clicking on the **Tag** icon in an information window. You can also enter up to seven lines of text on an object (press **Return** at the end of each line). However when you press on **OK** in the tagtext window, you must supply a password before your comments can be stored. A small dialogue box appears. Type the appropriate characters into the box: the corresponding text will not appear. When you have finished, press **Return** or click on **OK**; the window will disappear. If you now click on ok again in the tag window?, then provided you have given the correct code, the contents of the window will be copied to the tagtext file. Otherwise the password box will simply open again. Once gained, write authority over the tagtext file lasts for ten minutes, after which you will have to resupply it.

If security is not a problem you can see the password as you enter it by clicking on **Show password**. This reveals the text in the box and changes Show password to Hide password; a second click will hide it again.

The password for NightSky as initially set up is *Achernar*. The password checking process NightSky uses is case-sensitive (e.g. not ACHERNAR).

Editing the password

It requires a higher level of authority to set the password than to write to the tagtext file: otherwise it is possible to imagine that in say a school environment a student might configure the application so that only he or she had access. Proceed as follows:

- Open the password dialogue box by clicking on **OK** in the tag window at a time when access is not established, or has lapsed.
- Enter the password but do not press **Return**: click on **OK** with **ADJUST**; then click on **Edit**.
- A second dialogue box opens, the Password edit box.
- Enter the security code, which is a number of up to nine digits (0-9). Ex-stock this is 15121943 (I never

forget my wife's birthday).

- Press **Return**. If your code is accepted, you can change both it (Use **Ctrl-U** and type in a new number) and then the desired password (any printable characters, maximum length 8). To retain the current code, simply press **Return** a second time after entering the right code: the caret moves to the lower box.

Keep a careful note of your passwords, and in particular keep the security code in a safe (unshared) place. If they can mess it up for you, they will.

The Map Menu

Click **MENU** anywhere in the map window to bring up the Map menu. There are ten options, which are arranged in three groups.

Save map

NightSky can save maps as sprites, CSV map instructions and Drawfiles, which are the best for hard copy. The CSV files allow NightSky to recreate the view and are very compact. Sprites are for hard copy if memory is too tight for a Drawfile. Sprites and Drawfiles (which themselves each contain a large sprite) can optionally be compressed as they are saved, using Acorn's Squash module. This will typically reduce storage space needed by a factor of ten or more. **Save map** -> leads to a submenu from which any of the above options can be chosen. If the chosen save method differs from the last one used, read from a file of choices on initialisation, or set from the **Options** window (whichever is most recent), then the new method becomes current. This means that it will be used in saves initiated by the hot keys **F3**, **Shift-F3** and **Ctrl-F3**. (See below).

Map	
Save map (F3)	▶
Print	
Moon	
Planets	▶
Faint stars	▶
Find (F4)	
✓ RealTime (F9)	▶
Zoom	▶
Label	▶
Map title	▶
New Map	▶

Automatic saving

After a first save has been made a *save path* has been defined. NightSky can make further saves automatically without having to pop up the save box: **Shift-F3** and **Ctrl-F3** will both do this. If the first saved map had the leaf-name **NSmap1** then the following ones will be **NSmap2**, **NSmap3** and so on, and all will go into the directory you chose for the first save.

Shift-F3 causes the current map image to be stored in this way. On the other hand **Ctrl-F3**, pressed during an animation, will cause even image generated to be saved, until either RealTime mode is cancelled or **Ctrl-F3** is pressed again. If the destination storage area becomes full (as can easily happen), the Filer will send you a message in an error box: you should cancel RealTime when this happens. You will probably only want to use this feature of NightSky if the current save method compresses the image to be saved.

Print ->

NightSky does not support direct production of hard copy at present. There are a number of ways in which your maps may be printed out. If memory is plentiful, then install !Paint or !Draw, and "save" the map by dragging the file icon in NightSky's save box onto the appropriate application's icon bar icon. You can then print it from within that application. Note that Draw files print much better, as printer resolution is much higher than screen resolution. Draw can exploit this when printing, but Paint just prints a copy of the screen.

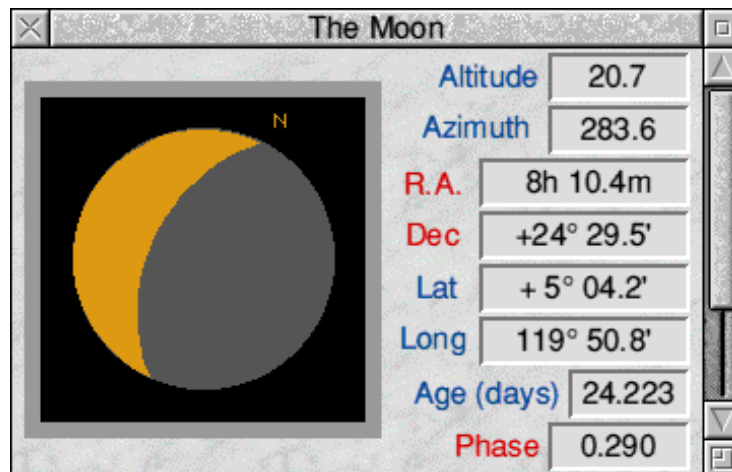
If memory is not plentiful, say on a 1Mb machine, it is always possible to produce quality print-outs of your maps, but a little ingenuity has to be used. For a one-off print-out of a single map, an obvious way is to save the map to disc, exit NightSky, load !Draw or !Paint, and then load the saved file into that application. (Double click on the saved file to achieve the same result in a single step). You can then print the file in the usual way.

If you want to avoid quitting !NightSky, proceed as follows. First, produce the map using the star catalogue, screen mode and save method of your choice, preferably Draw files. When you have the map you want to print, make sure that RealTime mode is not selected, or the map may be over-written before you have finished with it. Now use the **Options** window (**F1**, see Chapter 4) to adjust the star catalogue to minimum size. This will free a lot of memory, enough to install !Draw (or !Paint). Save the map into this application. With the file loaded in Draw or Paint, close the map window and deselect Draw file saving if selected. This will free yet more memory that the printer module can use.

Moon

Choosing this option pops up an information box on the moon, including a large image showing its *phase* (fraction of visible disc in sunlight) and orientation in the sky at the place and time of the map. The moon's north pole is marked with a letter N so that you can appreciate the orientation of its globe in space relative to

yourself. The information given in the box refers in part to the moon's position as seen by you and in part to its objective location in space:



Altitude and **Azimuth** are relative to the observer, and so are **Right Ascension** and **Declination**, which locate the moon relative to the stars. The next two views are of a waxing crescent moon in the western sky seen at the same moment. You will note that there is a difference of as much as 1.5 degrees in its position relative to the stars, and the further north your viewpoint is, the further south the moon appears in the sky. This is the effect of parallax and occurs because the moon is very close to us compared with any other astronomical object. NightSky allows for parallax affecting the positions of the sun and planets, as well as the moon; it is very much smaller in their cases.

Phase is the fraction of the area of the visible disc that is sunlit. This also is slightly dependent on your position on earth.

The remaining data items are given relative to a fictitious observer at the centre of the earth (*geocentric*). The orbit of the earth around the sun defines a plane in space whose projection on the distant stars is a practically unchanging circle called the *ecliptic*. By definition the sun is always somewhere on it. The ecliptic provides a natural measuring system for the positions of objects in the solar system.

Longitude is the angle round the ecliptic from an arbitrary reference zero which is chosen as the position of the sun at the time of the northern spring equinox on March 20 or 21 each year. This is the *vernal equinox*, and the associated point of the ecliptic is technically named the *first point of Aries*, even though due to precession it is actually in the constellation Pisces.

Latitude is angular distance north or south of the ecliptic; the moon can be up to five or so degrees north or south of it. The other planets have similarly small *inclinations* (angles) of their orbits to the ecliptic and hence are always found close to the ecliptic and so "in" one of the familiar constellations of the zodiac - Aries, Taurus and so on. The exception is Pluto whose inclination is a high 17°.

Nodes: twice each month in its orbit the moon crosses the ecliptic, from south to north at the *ascending node* and from north to south at the *descending node*. Eclipses can only occur if the moon is close to one of these points at either full or new moon, and when it is sufficiently close an eclipse is inevitable. Eclipses in 1992-3 thus take place in November-December (ascending node) or May-June (descending node). The nodes move steadily backwards around the ecliptic however, and by 1999, the year of the next British total eclipse of the sun, the moon will be at its ascending node in August. The nodes return to their original positions after 18 years 11 days and 8 hours, the famous *Saros Cycle*. The Saros was discovered in Iraq some three millennia ago and was and is used in eclipse prediction. After this interval the same conditions very nearly recur. So the famous and very long 6 minute 58 second total eclipse of the sun seen in Mexico on 1991 July 11, will have a successor on 2009 July 22 when an eclipse of practically the same duration will be seen from south-central China.

Age gives the time in days since last new moon, and is related to elongation which here is the (geocentric) angle between moon and sun. Similarly the moon's geocentric distance (in km) is related to its apparent size in the sky which can vary by some 7% either side of its mean value, which is why when an eclipse occurs at new moon, the moon is not always large enough to blot out the whole of the sun's disc, yielding an annular eclipse.

Planets ->

There is a sub-menu of three options .

Info

Opens the standard planet information window for the last-chosen planet (initially Mercury), as though you had clicked **SELECT** on the planet in the map, except that a click on field does not re-plot the map. Click anywhere within the window to advance to the next planet, and anywhere outside it to remove it from the screen.

The information given in this box corresponds pretty closely to that for the moon except that there is no image of the planet and the distance is given in *Astronomical Units*, the usual measure used in astronomy within the solar system. 1 AU is the mean distance of the earth from the sun.

Plot RA/dec and Plot Altaz

Add lines to your map to show how the positions of planets change over time. **RA/dec** shows the movement relative to the stars, whilst **Altaz** will show it with respect to you. Both lead to the same submenu. Choose the planet you want to follow from the list. You can choose the sun, but the moon is not available. The three faint outer planets, Uranus, Neptune and Pluto, are only plotted on large scale (detailed) views, and can only be chosen here from such maps. If you choose with **ADJUST** the menu will stay open and you can add other objects, or set the time over which the plot will be made. By default this is one year, but the plot will end sooner than this if the body leaves the map area. Too many objects chosen will of course produce a mess on your screen and two is a practical maximum. You cannot mix **RA/dec** and **Altaz** plots, though you could do them (say for the same planet) successively.

Faint Stars

This leads to a small submenu of just two items and lets you control precisely where stars are plotted. The upper value, initially ticked, is the faintest star plotted on the present map. If you enter a value that is numerically smaller than this, corresponding to a **brighter** limiting value and therefore fewer stars NightSky will replot the map using that limit instead of the present one. This can be a very useful route to a map uncluttered by faint stars that are often invisible without optical aid, especially from light polluted towns.

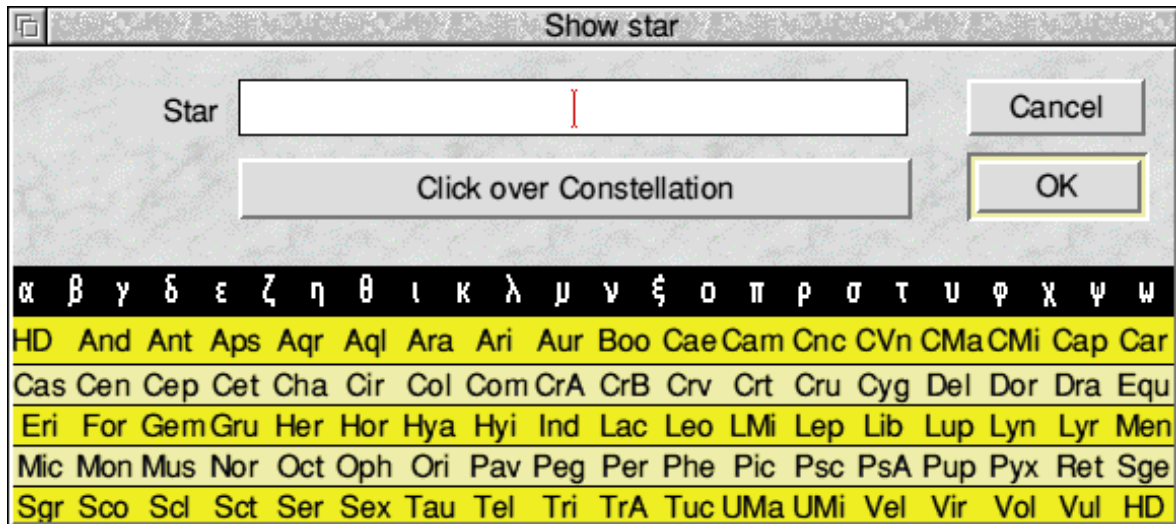
Silly limits such as -1.0 are ignored. NightSky always plots the brightest stars, though if you do set a silly limit you won't be able to identify stars fainter than that limit by clicking on them.

For small scale maps NightSky always at first restricts the faintest star plotted to a magnitude dependent on the current field size, 5.2 for whole sky view for example. If you enter a value larger than this and click on it (or press **Return**) then all stars down to your chosen level of faintness will be added to the map providing the faint stars in question are already in memory. However choosing from this menu does not load catalogues or otherwise reorganise NightSky's workspace. If you choose say a 7.5 limit on a whole sky map in this way you will get a vivid pictorial impression of just how many stars NightSky knows about but the map is too crowded for use and when the map is replotted for any reason NightSky will use its normal limits. 75° is the largest field for which no restriction at all is made, then the limit is 7.0 magnitude up to 115°, the 6.5 and 6.0 140° and 170° and finally 5.2 for small scale maps including all-sky views at 180°.

Find (F4)

In normal Acorn style, **F4** will bring up the **Find** submenu when a map is on-screen . You may search for a Planet, from the list of planets above the horizon. If planet plotting is not selected, all the names will be greyed out. Named star lets you search for a star by its proper name, for instance Capella, Sirius, Rigel Centaurus. This search is case sensitive, so enter each word to start with a capital letter with the other letters lower case. NightSky knows 199 proper names, note however that **if you try to edit the file of names NightSky will not work.**

In this submenu **Star** leads to the large **Show Star** dialogue box. Click first over the three letter abbreviation of the desired constellation: the full genitive (possessive) form of the latin constellation name will appear. Now type in front of this the required ID of the star and/or click over the appropriate Greek letter. Then click **OK** or press **Return** to start the search. NightSky has only one ID for each star. For example it knows Aldebaran as a Tauri, which means a search for 87 Tauri (the same star) will fail.



Bright stars will usually have an ID with a single Greek letter, though sometimes a number is needed as well. Otherwise there may be one or more roman letters of either case such as G Scorpii, d Centauri, ET Virginis. Or the star may have a Flamsteed number, as 110 Tauri. If the star has none of these IDs then it is not found with reference to its constellation, but from its Harvey-Draper (HD) catalogue number. NightSky does not know about SAO numbers, and those stars (around 1%, all faint) that have none of the above identifications are anonymous (they are filed as HDO, printed as "- - -" in the star ID window). Usually you will want to employ this routine to locate a bright star, a double star or a variable star, and you will not often need to use HD numbers.

Deep Sky is greyed out unless plotting deep sky objects is enabled. If so, enter either M and a number for the Messier Catalogue objects, or NGC and a number for the others.

Once a search has been started, NightSky behaves as follows.

- If the object is unknown to NightSky because it does not exist, is too faint to have been included in the current catalogue, or you have misspelled its name (examples Ursae Minoris, a Velorum, M200), then the menu will close with no error message. (Nothing will happen).
- If the object is visible at the map place/time and on screen, the pointer will move to it and an information window about the star, planet or deep sky object will appear.
- If the object is visible but not on screen, the map will be redrawn with the object at its centre, the information window opened, and the pointer moved over the object. At very large scales, with a field size of under a degree, rounding errors may mean that occasionally the object is still not in view: if so zooming out slightly (using the map menu) should restore the object to view.
- If the object is below the horizon, the information window will be opened, with the pointer inside it, pointing at the object's current (negative) altitude.

NightSky does not check the size of its map window in its Find routine but assumes it is full-screen, so open the map to full size before using it.

The Information Windows

The information windows for the moon and for the sun and planets have been described already in this chapter. For deep sky objects the window only offers the name and type of object and its position (altitude, azimuth, R.A. and Declination). If you want more information then tag it and add your own comments.

The Star Information Window

NightSky knows quite a lot about each star, and fairly comprehensive help on the fields and their contents for this window is available if you have the 'Help application running as well as NightSky. The top four icons refer to the point where **SELECT** was clicked to start a search routine; if the window is opened after Find has been used the **Pointer R.A.** and declin'n boxes will be empty and the two boxes above them will have the actual altitude and azimuth of the star. The star's actual position (in 2000.0 unless you have processed the catalogue) is shown underneath its ID. The constellation is abbreviated to its standard 3 letter code if, as here, there is a proper name: otherwise it is spelled out in the full Latin (possessive) form used in the **Find** window.

Star 12			
Pointer altitude	13.8	Azimuth	93.9
Pointer R.A.	19h 49m	Declin'n	8.7
Star	alpha Aql = Altair		
R.A.	19h 50.8m	Dec	+ 8° 52.1'
Magnitude	0.8	Distance (pc)	5.1
Absolute mag.	2.2	Surface temp	8100K
Luminosity (suns)	10	Spectral class	A7
Rises	12h 38m	☐ Tag	
Sets	2h 24m	☒ Field	

Star magnitudes are explained in Chapter 6. Star distances, being immensely great are measured in a special unit called the **parsec** (the Astronomical Unit, like the kilometre is simply too small for the purpose). One parsec is the distance of a star which would have a parallax of 1 *second of arc* (1/3600) on a baseline equal to the radius of the earth's orbit. No star is this close and no parallax was measured until 1820 because the angle is so very tiny. 1" is the angle subtended by a coin 1 centimetre in diameter at a distance of about 210 kilometres. Absence of perceptible parallax was a valid argument in olden times for the earth being at rest rather than revolving around the sun, though naturally arguments based on the absence of a small effect arc always likely to fail when measurement techniques advance sufficiently. 1 parsec is the distance travelled in free space by light (or any other form of electromagnetic radiation) in 3.26 years, hence it is 3.26 *Light Years* (LY), a unit often used in astronomical literature aimed at the general public.

The **absolute magnitude** of a star is what its visual magnitude would be at a standard distance of 10 parsecs (32.6 Light Years). It enables comparisons between stars to be made easily. Since Procyon is one of the nearest stars, it "would actually look fainter at 10pc than it does in the sky. Most of the bright stars you can see in the sky are actually much further away than 10pc, and so have absolute magnitudes lower (brighter) than their actual visual ones. They are thus in themselves much more luminous than Procyon is, or the sun for that matter. The luminosity field repeats this information in a different way, by comparing the energy output of the star in the visible region with that of the sun. At 7 suns, Procyon is well above average for all the stars in the galaxy, but well below it for the stars we can see with the unaided eye, as in this category very bright but far away objects are, naturally, much over-represented.

Surface temperatures are in degrees kelvin (subtract 273 to get the ordinary Celsius value),. The hotter a star's surface is, the more it will radiate and it will also be different in colour. For example, an electric iron is perceptibly hot, you can feel the radiant heat (infra-red radiation) coming from it, but it does not glow. Heated further an object glows red like a poker in a fire; here most energy is still emitted in the infra red. The sun is yellowish-white in colour (but red through haze or at sunset because the sky is blue) and emits principally visible light though there is still much TR and also some UV. A star oven hotter than the sun may radiate mainly in the ultra-violet, in which case it would look blueish-white to us. To see this compare the stars in Orion's belt (blue) with Betelgeuse (reddish- orange); or Arcturus (orange) with Spica (blue). Visible star's surfaces range from under 3000K (cool, red) to well over 30000K (hot, blueish- white).

Star temperatures are measured by comparing the relative intensities of the radiation of different kinds (wavelengths) in the energy received. These measurements enable a **spectral class** of the star to be assigned, and it is from these that NightSky estimates the actual temperature. There are eight main classes, in order from the hottest O,B,A,F,G,K,M,N (with the immortal mnemonic Oh Be A Fine Girl Kiss Me Now). These strange letters reflect not so much astronomers' problems with the alphabet, as the difficulty they had in sorting all this out in the 19th Century. The sun is a G class star and so distinctly cooler than Procyon: F5 means middle of the F class, FO being nearly A and F9 nearly G. However the subdivisions are often uncertain, even meaningless as in F9.5 (indistinguishable from GO).

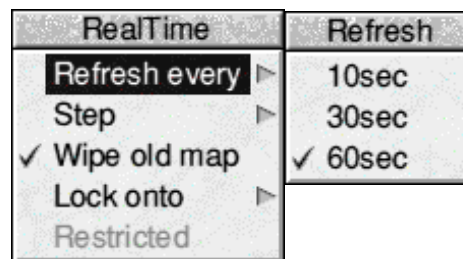
Stars and deep sky objects can be **tagged**; the button indicates there is a record for Procyon. Click on the **Tag** icon to read or edit this text, or to add comments for an untagged star if you have write access.

Finally (if the object is above the horizon) click on **Field** to view it at the centre of a field 10° across. This is particularly useful for printing out maps suitable for studying variable stars, many of which are tagged already for you, and also for printing out the field of stars surrounding the faint planets Uranus and Neptune. To find Uranus and identify it from such a map is a fairly easy and satisfying beginner's project. The hardest part is to locate the field itself in the sky.

RealTime (F9)

This menu option leads to one of the most important and powerful feature? of NightSky, its ability to refresh a map automatically and in a manner that you decide.

When NightSky owns the caret, **F9** is an important key as it will toggle the present real time mode, that is turn it off when it is on and vice versa. When you plot a map using one of the **NOW** options, real time mode is selected, with the map refreshed every minute and the time plotted advanced the same amount. The **RealTime** menu option allows you to vary these parameters.



Refresh every ->

This controls how frequently the map is refreshed. By default this is every minute. If you increase the rate to twice a minute you can still open the map menu or do a drag operation to zoom in on an area. On the 10sec setting however, the processor works almost flat out, each refresh beginning to be calculated only a second after the last was finished. This is the best setting used for viewing events such as eclipses. You can stop (and then restart) the animation with **F9**. If **F9** seems ineffective in gaining you control of the machine, NightSky does not own the caret: click anywhere in the map window and press **F9** again.

Step ->

This leads to a small dialogue box which is used to control the time increment between plots. By default it is one minute, but any multiple (up to 99) of a minute, hour, day, month, year or century can be chosen. When the step is in Centuries, it is assumed that you are interested in the changes in star positions caused by precession, so the catalogue is processed for every update. Likewise 10000 years is to study the effects of the stars' actual motions through space (proper motions) on the appearance of our familiar constellations. For this setting only a multiple of 1 is allowed, and precession itself is ignored. Also, you will probably want to Lock on a particular star (see below). In addition, plotting of the planets will quickly cease. NightSky cannot preserve even rough accuracy over such long periods for solar system calculations, so anywhere in NightSky, if the year calculated is more than one whole precessional cycle (27000 years) from the present, planet calculation is automatically cancelled to avoid crashes. You will need to re-select it again when you have finished the animation. Also remember that all precession and proper motion studies will go much faster when a small star catalogue is installed, such as the 5.4 minimum size you can set in the options Window (Chapter 4).

Wipe old map

This is usually ticked (chosen). Click on it to toggle this state. If it is deselected then the old map will not be erased at the start of each refresh. Use this to

- Build up an image of the course of an eclipse or other event. You will need to experiment with the field size and initial position of the important body or bodies.
- Produce an image of star trails across the screen.

You can get the real thing by pointing a camera at an area of dark sky (no moon or street lighting interfering) and leaving the shutter open for minutes to hours. You can then compare with the NightSky view. You will probably want to cancel labelling of planet, star and constellation names, and also deselect constellation joins and boundaries and any co-ordinate grid you usually show before trying out this option.

Lock onto ->

This important choice leads to the **Find** submenu again. When you make a choice there, the chosen object will remain at the centre of successive views. It is essential to choose a body to Lock onto in large scale views, say of an eclipse, otherwise the earth's rotation will move the object of interest out of the view. Once a body has been chosen as a lock, you can click on **Lock onto** to toggle the locked state. If the lock body sets during the animation, then NightSky will continue incrementing the time and calculating without refreshing the screen until the body rises again, when the screen will be updated. This may take some time, but you can always use **F9** or **Escape** to abort the animation.

Lock onto Earth's Shadow

If a map is drawn for a time very close to New Moon and the sun is below the horizon, then the Earth's shadow at the distance of the moon is drawn. When this has been done, you can select **Shadow** rather than **Sun** as a Lock object. This allows you to keep the shadow centred on the screen as you view a lunar eclipse.

Hint - many animations such as views of Jupiter's satellites or of transits of Venus or Mercury are essentially the same as viewed from any point on earth where the body in question is visible. In such cases view the events from either the North or South Pole, depending in which hemisphere of the sky the object is located. You will not then be troubled by the object setting, and the view will also be simplified by the fact that North (or South) is always "up" in the display.

Restricted ->

This may be chosen only after a Lock Object has been defined. When chosen, only the following objects are plotted:

- the horizon and milky way
- the sun, moon and planets
- if the Lock Object is a star, then that star only.

In other words no pass is made through the star catalogue with all the calculation that that involves. This greatly speeds up views of eclipses for instance. However for each moment considered, a full calculation of the solar system is made, so screen refreshes are certainly not instantaneous.

Starting RealTime mode

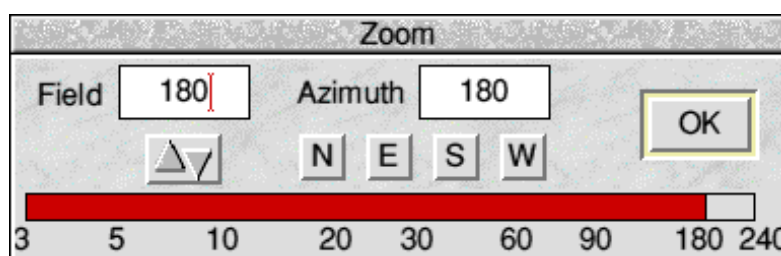
When you click with **SELECT** on one of the choices anywhere in the **RealTime** menu, plotting will begin within a second or so; if there are several parameters to set, use **ADJUST** to make the choices. This will keep the menu structure open, and, just as important, plotting will not begin immediately so you have time to make the other settings.

Time Flow

When NightSky is in real time mode, pressing **Ctrl-R** will reverse the flow of time, that is you can view the event both with time flowing backwards and normally. After a **Ctrl-R**, all animations will run backwards until you press **Ctrl-R** a second time. The current **Ctrl-R** setting is remembered if you just press **F9** to stop and **F9** or the **RealTime** submenu to restart RealTime mode. When a new map is plotted from the Draw a Map Menu or via key-presses **F5-F8**, normal time flow is restored.

Zoom ->

This is the second method NightSky offers for changing the scale of your map. Use it mainly for zooming out to make the scale smaller: when you are zooming in it is more straightforward to demarcate the desired area of interest by means of a **SELECT-drag** operation. The present menu choice is also useful when you want to set a predetermined value to the field, or to operate at a very large scale.



Set the value by entering a number in the field box (**Return** here is equivalent to a click on **Ok** - it starts the new map), by clicking anywhere on the red slider or its outer frame, or by dragging the slider to right or left. The bump arrows when clicked causes the field to be increased (**SELECT**) or decreased (**ADJUST**) by 1 degree. You can accept the current direction of view, or force it to a chosen value by entering a value in the **Azimuth** box or clicking on one of the four direction icons.

The field used is always a whole number of degrees down to 2°, although 3° is the smallest field you can set with the slider. However you can type in a smaller value, NightSky will adjust it to be a multiple of 1/8 of a degree down to the smallest field supported, which is 1/8°. At this scale the phases of the planetary discs

become visible and of course Saturn's rings in correct orientation and size. For Jupiter's satellites a somewhat larger field of $1/2^\circ$ to 1° is better, and 1° is also the optimum scale for viewing eclipses and occultations.

Label ->

Follow the arrow across this menu option and you are presented with an editable field in which you can enter a line of text. This will then be printed on the map at the point where you clicked **MENU**, and in the font, size and colour set for user labels. Click again on label and the same text will be printed again at the new site. You set the font (which could be the system font) and size to be used in the Options Window (Chapter 4), or by using the keyboard shortcut **Ctrl-F1** which will bring up a menu that allows these to be chosen and set.

Map Title ->

The standard NightSky title bar display for a map gives place name, latitude, longitude, field size, direction of view and time in the standard astronomical format of year, month, day, hour, and minute. You can edit this, to something much simpler perhaps via this menu option. The new title will be displayed in the window title bar, and also will be saved away if Draw or Sprite saving is in force (but not CSV instructions). Your edited title is not however preserved over map refreshes, not even over plotting an enlargement, so it is only worthwhile using this menu choice when you know that what is on the screen is what in fact you want to save. An alternative procedure (and the only one feasible when automatic saving is in force) is to edit the Draw file produced by NightSky. The title is a text object like any other and you can edit it in Draw; it is necessary to **Ungroup** first.

New Map ->

The final menu option on the map menu leads to another copy of the **Draw a Map** menu. Any new map plotted will have the field and orientation of the current map (when the choice is made from the icon bar copy of this menu, these are read from the file of places). When a map is on-screen, the function key shortcuts **F5 - F8** duplicate the first four choices on this submenu. The **Options Window** is the subject of the next chapter.

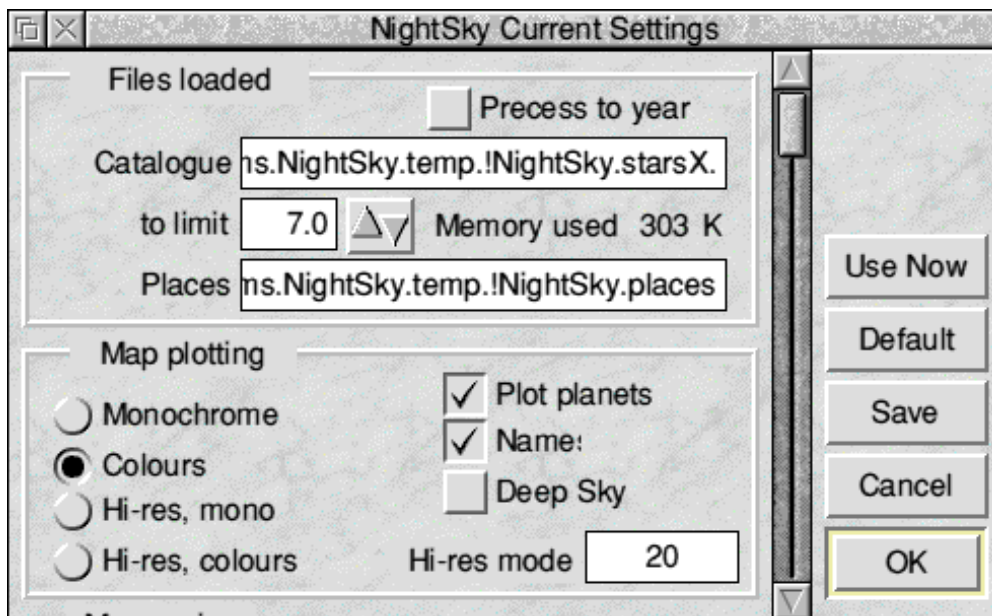
Additional Note

Zooming in on Jupiter's Satellites

At high magnifications (Field set to 0.5° to 1°) the current appearance of the satellites of Jupiter can be seen. These are shown as they are in the sky, not as seen in an inverting astronomical telescope. They are coded with colours 11-14 of the current screen palette, so normally Io (satellite I) is red, Europa (II) is cream, Ganymede (III) is dark green and Callisto (IV) is orange. NightSky does not at present predict occultations, transits etc for the satellites. However the screen generated should correspond closely to what you can observe with good binoculars or (inverted) a small telescope. You can observe their motions in real time by starting an animation, with NightSky locked on to Jupiter and (preferably) the **Restricted** switch on. A step of 1 or 2 hours is suitable. There will be a jump of twelve hours or so each time Jupiter sets; continuous viewing can be obtained by choosing as the place used the pole of the hemisphere in which Jupiter is. From 1993 to 1998 this is the South Pole. The views are reliable for about 25 years either side of 1980.

4. The Options Window

NightSky's **Options Window** allows you full control over the operation of the program. As well as determining the current behaviour of the program it can generate files of settings which can be loaded at any time by dragging them to the program icon, so you can have different sets of program options always available for different purposes. It can be opened either from the opening menu, or by pressing **Shift-F1** when a map is displayed.



The window has a large panel on the left, a section of which is on view at a time, controlled by the vertical scroll bar, and five action buttons on the right which are always on view. Note that any changes you make are at first confined to the options window; you manipulate here a copy of NightSky's settings, not the settings themselves. The five action buttons function as follows when clicked on. (Note that clicking with **ADJUST** will keep the options window in view, with **SELECT** it vanishes.)

Action buttons

The five action buttons function as follows when clicked on. (Note that clicking with **ADJUST** will keep the options window in view, with **SELECT** it vanishes.)

OK - Click here to make the settings in the Option Window current, so that NightSky will use them for future map plots.

Cancel - Abandon the Option Window settings and leave NightSky's settings as they were when the window was opened. Always closes the options window.

Save - Open a save dialogue box to enable you to save the settings in the option window as a text file. If the resulting file is dragged to the NightSky icon on the icon bar, it will be recognised and those settings enforced. Saving also makes the settings current that is the action is **OK** and **Save**.

Default - Overwrite the present NightSky settings with those in the file of choices that NightSky uses on initialisation (normally **ChoicesD** in NightSky's own directory).

Use now - As **OK**, and if the map window is open, also re-plot the map to reflect the new settings. Click here with **ADJUST** to keep the options window in view.

The left hand part of the window is divided into a number of panels which will be described in turn.

Files Loaded

This panel gives information on the data files that NightSky is currently using, namely the star catalogue and the file of places.

If you click **SELECT** on the text in the first line, **Catalogue**, a message will be shown telling you about the catalogue in use - either the standard one or the special zodiacal one for occultation predictions.

In this message box, a click on **Cancel** closes it, **Next** switches between the two catalogues ("X" and "S"), and **OK** enters that catalogue into the options window. It is not of course loaded until the new options are enforced, as described above. For the X (normal) file only, you can set the extent of it that is to be loaded by clicking **SELECT** or **ADJUST** on the blue bump arrow. You are informed how much memory this catalogue size will consume.

Similar clicks on the other **Place** line yield a message only but no action:

Place files can only be loaded by dragging them to the program icon, or by editing a choices file in a text editor such as !Edit.

Note that the default choices file used on initialisation can only be changed by editing (in a text editor) NightSky's !Run file. Find and alter the line

Set NightSky\$Opts <Obey\$Dir>.ChoicesD
towards the end of that file. Edit and resave, making sure you do not change the file type (Obey file).

Precess to Year If on will cause a star catalogue to be processed to the start of the current year on first being loaded, and subsequently whenever the year of the map being plotted alters. The year in question is displayed on the icon bar under the NightSky icon. Precessing the catalogue from the Icon Bar Menu does not by itself turn this switch on: it must be explicitly set here. Switch it on if you want to see the stars in their exact positions, but leave it off if for example you want to see where today's planets would be in the sky if we had the stars of say BC5000. As always where precession is involved, plotting will be much quicker if you can operate satisfactorily with a small catalogue size, say the minimum 5.4 magnitude limit.

Map plotting

Plot planets - This switch is normally on. You might turn it off if you wanted to produce a series of maps showing the sky at your location at different times of year: in order to be valid for any year **Planets** must be deselected. This switch will be turned off automatically if you plot so far from the present epoch that there is a risk of the attempted calculation crashing the programme.

NightSky cannot maintain accuracy of calculation over tens of millennia. You will need to re-select planet plotting from this present window after an adventure of more than 27000 years into the past or future. Real accuracy for the planets, sun and moon is of course confined to much narrower limits from the present day, typically a few centuries. An interesting test is the near-discovery of Neptune by the world's then only telescopic observer, Galileo Galilei on 1612 December 28 at around 3am. He saw Neptune in the same telescopic field as Jupiter, whose satellites he had discovered and was observing, and even noticed that it had moved the next night in relation to the fixed stars. Had he investigated this obscure and faint object further, the actual discovery of Neptune might well have been anticipated by 233 years. NightSky shows Neptune around 0.1° east of Jupiter and very slightly south of it, which is what Galileo drew in his notebook.

Names - This puts the name of each planet found beside it. The switch is ignored if Plot planets is off.

Deep Sky - Turn this switch on to have these objects added to the map. NightSky's catalogue contains 267 assorted deep space objects, each classified as one of the following five types.

- **Galaxies** - External star systems like our own Milky Way
- **Nebulae** - Nebula means cloud in Latin, and in astronomy the term describes a vast cloud of dust and gas which is luminous because it is heated by stars within it, or which shines by the reflected light of local stars. Such clouds are often the sites where new stars are forming. Not plotted are dark, non-luminous nebulas which also exist; they can only be seen in silhouette against a brighter background. Two "local" and huge examples are the great rift in the Milky Way between Deneb and Altair, and the famous Coalsack near the Southern Cross, both of which are plotted when NightSky outlines the Milky Way.
- **Open Clusters** - These are concentrations of stars that are related by having been born from the same gas cloud and which are held together fairly loosely by gravitational attraction. The Pleiades are the most prominent example, though NightSky plots the individual members in their case.
- **Globular Clusters** - Much more concentrated aggregations of stars, which were all formed together and are strongly bound gravitationally.
- **Planetary Nebulae** - These are much smaller systems, consisting of an old central small and hot star which has undergone an explosion in the distant past and is now surrounded by a luminous ring of ejected material. They have nothing to do with planets, but have borne this title since first being identified as a

species of deep sky object by William Herschel in 1785.

The different classes of object are colour coded in a simple way, which, like all colours in NightSky can be adjusted by you.

Many of the objects included here (especially planetary nebulae) are very faint, far fainter than the faintest stars known to NightSky, but all can be seen either with binoculars or a modest telescope. Once Deep Sky is turned on, these objects can be identified, found and tagged as normal.

Map plotting action

One of the four "radio" buttons here will be on, indicating the currently chosen way of drawing the map. Two sets of colours are provided for use with NightSky; the first set is used when colours is chosen, the other when monochrome is chosen. In fact they can be any two sets of colours you want, as they are all user-definable. Notionally the first is what you want to see on screen and the second is what you want to send to the printer. The other two options here, hi-res colour and hi-res mono will, if free memory allows, keep the map as a sprite in a specified mode, whereas the usual action is to use the current display mode. This will not improve the appearance of printed labels on your map, as when a Draw file is rendered to the printer the full resolution of the printer is utilised, which is much higher than that of the screen. However it will improve the resolution of the printed images of stars, the horizon, and the milky way as these are simply dumped to the printer.

Map saving

One of the four options in this panel -will always be chosen, and this will determine how maps are saved. CSV here stands for Comma Separated Variable, a text file with a simple standardised structure.



Sprite - Simply saves a copy of the screen as a direct image (bit image). Such images will not print with optimum resolution either of star images or of the labels added to the map. However the option may have to be chosen if memory is too limited to allow one of the Draw options to be employed. Sprite files saved from NightSky can be very large, but compress very readily to a small fraction of their initial size by selecting the **Compressed** option when saving. NightSky cannot reload saved sprites. To examine the saved screens (or print them) load them into !Paint.

CSV - Is the save method that is least wasteful of disc storage space, the saved files being only a few hundred bytes in size. The file is in fact a file of instructions that NightSky understands, so that the map is recreated when the file icon is dragged to the icon bar. The real time status is saved in the file, so if an animation was in progress at save time, it will continue on re-loading. CSV maps cannot be printed except by re-saving from NightSky in sprite or Draw format; neither will they retain any user labels added to the map before the save was made. Since the saved file is plain text, you can edit normally. However if the file is badly formed the plot will be aborted without an error message.

Draw colour - Is the normal method used to obtain hardcopy (printed maps) from NightSky. It increases by approximately the size of screen memory the workspace needed by NightSky, so when memory is limited (1Mb machine or many applications in use) it will not be possible to combine Draw file saving with use of a large star catalogue. The Draw files produced by NightSky still contain a sprite of size equal to the full screen. All the labels, constellation joins, and co-ordinate grids used are extra vector graphics objects in the file and so can be rendered, for example to a printer, much more finely than is the case with a sprite. Such files are no more compact than sprite files, indeed they are even larger. However they are similarly easy to compress and do not then take up excessive room on disc.

Draw mono - Is a special save method which is only available in 16 colour modes. If chosen, it is automatically replaced by Draw colours if the display mode changes to one with 2, 4, 256 or more colours. It allows you to have a coloured map on the screen, but save a monochrome version to disc. A fixed grey palette is imposed on the map saved, the settings of which are not editable in NightSky. For precise control over the monochrome saved maps select monochrome map plotting together with Draw colours for save action. You can then use this **Options Window** to edit the colours.

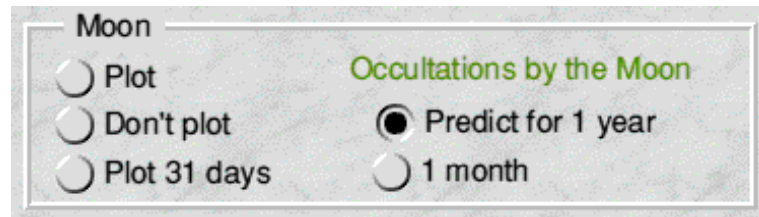
Squashed - This switch, if selected will cause saved Draw or Sprite files to be saved in compressed form. Since star maps contain huge areas of one colour, they compress markedly, 10% or less of initial size being not

unusual for smaller field settings. If you want to assemble a demonstration using NightSky's automatic save routine it is much better to select this action unless you have a large hard disc that you do not mind filling up temporarily with star maps! The squash process itself needs some extra temporary workspace - if this cannot be made available when NightSky asks for it, the save will be a normal (unsquashed) one: no error is reported. Note that squashed files must be unsquashed by 'Squash before they can be transferred to Draw, Paint, Impression, Ovation and similar packages.

Any save method as selected in this window may be overridden at the actual save time by another choice from the Save map submenu of the map menu. That choice then becomes the currently selected method. The map is re-plotted if need be.

The Moon

This panel has two sets of "radio" buttons to control how NightSky handles the moon.



The moon can be ignored, plotted normally or the **Plot 31 days** option can be chosen. This last is intended to be used when you use NightSky to produce a map that is part of a monthly article on the sky seen from your location. Such articles regularly appear in newspapers and might also appear in say a school or sailing club magazine. The moon's position will be shown on the map as it is at the original time and also every other day for a month ahead, in each case at the time for which the map is now correct. Thus if the original plot is for 2200 hrs local time on the 1st of the month, the moon will be shown in its correct position then, and at 2152 on the 3rd, 2144 on the 5th, and so on, in each case labelled with the day of the month in the font and size selected for user labels.

The other pair of radio buttons control the time over which NightSky's Occultation routine looks for events. By default this is a year, but you can change this to a single month if preferred. Remember that such a search can always be terminated cleanly by pressing **Escape** at any time after it has started.

Constellations

There are three independent switches in this panel.

Join up causes the more prominent stars of each constellation to have lines joining them, so emphasizing their familiar patterns and aiding recognition.

Boundaries uses a large file of data which is held on disc in NightSky's directory, so selecting it will slow down the plot perceptibly.

Names will print the standard three letter abbreviations of each constellation found on the map.

NightSky deals with the constellations in a straightforward manner. With each constellation is associated a single key point. If this point is above the horizon, that constellation is added to a list of active ones. After the stars have been plotted the names, boundaries and joins of the active constellations are plotted. Therefore a constellation that is partly above and partly below the horizon may or may not have its name plotted or be joined up. Boundaries will always be plotted in full, because if for example the boundary between Leo and Virgo is plotted because Leo is active, then Virgo will be added to the active list even if its key point is below the horizon, and all its boundaries currently above the horizon will be dealt with. For this reason when.

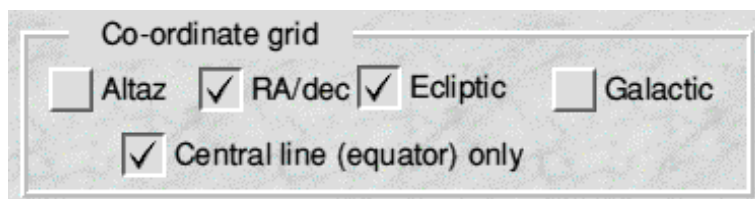
Boundaries is selected there will be a more complete plotting of the Joins for those constellations that are rising or setting.

Some constellations are small, and naming all of them on a small scale map would produce excessive clutter. The 89 constellations (there are only 88 really but one, Serpens, is in two separate parts) are therefore reduced to 49 areas by regarding each of the small constellations as associated with a larger one; or possibly several small faint ones are linked together. This can affect the look of the map. For example on a whole sky map, if Lyra is near the horizon it will not be joined up or labelled unless the key point of Cygnus is visible, and similarly the Southern Cross won't be processed unless the key point of Centaurus is above the horizon. On large scale maps NightSky will usually join up all the constellations on screen, unless the scale is very large and not a single key point is within the map area. In this case the Join and Boundaries constellation options are

automatically deselected, and will remain so even if you zoom out to whole sky. You must choose them again from this window to get them plotted. In fact you would not normally find joins or boundaries helpful when plotted on a field of only a few degrees, so this action of NightSky is appropriate.

Co-ordinate Grid

Nightsky supports four different co-ordinate grids for its maps.



Altaz - Plots a grid of altitude (horizontals) and azimuth (verticals). This is your local co-ordinate system whose pole is the zenith; it tells you in what direction and how high in the sky an object is located.

RA/dec - Plots a grid of **right ascension** and **declination**, akin to longitude and latitude respectively on earth. This grid has the celestial north and south poles as its poles, and is the co-ordinate system most used for specifying the positions of celestial objects in the sky. Due to precession the poles move and therefore all RA and declination co-ordinates have to be referred to a standard date or *epoch*. The epoch used in NightSky is 2000.0

Ecliptic - Treats the plane of the earth's orbit around the sun (which is practically invariant over long stretches of time) as the reference plane. Angular distance around the orbit measured from the sun's position at the northern spring equinox is called *longitude* and angular displacement north or south of the orbit, as seen from the centre of the earth is *latitude*. This grid is primarily of use for calculating the positions of solar system objects. Latitude does not vary with time, but longitude does, because due to precession the spring equinox is at different points of the ecliptic at different epochs.

Galactic - Takes the centre line of the Milky Way as the its equator. Galactic longitude is measured along this line, taking the direction to the central nucleus of our galaxy as zero. This direction lies in the constellation of Sagittarius.

The **resolution** of the grid plotted depends on the scale of the map. For whole-sky views it is 30°, and for the largest scales supported in NightSky it is 5°.

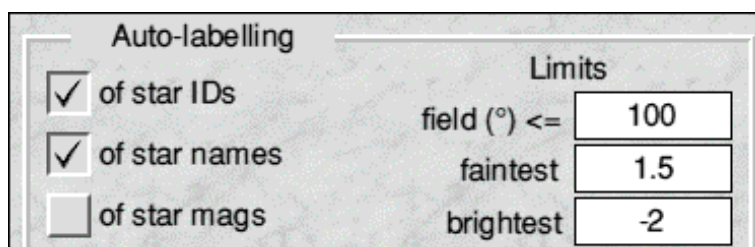
Two or more grids superimposed are confusing and unhelpful. Therefore if more than one type of grid is selected the second, third and fourth (if chosen) have only their central line (equator) plotted. The priority is given by the order of the explanations above. Thus if RA/dec and Ecliptic are both selected, just the ecliptic itself will be added to the grid of RA and declination previously plotted. If the **Central line** (equator) only switch is on then only the equator will be plotted for all grids selected.

Small crosses are always plotted at the visible pole(s) of a grid.

The default choice in NightSky as supplied is celestial equator and ecliptic only plotted, as in the example panel above. This is a generally useful setting.

Auto-labelling

This important panel gives you full control over which stars are automatically labelled when NightSky plots a map.



The writable fields under **Limits** determine whether or not auto-labelling will take place at all. If the field exceeds the maximum you enter, it will not. When auto- labelling is on, only stars within the magnitude range

given will be labelled. Both the brightest and faintest values are inclusive (stars of those values will be labelled). As an example, the values shown ensure that the brightest 25 stars, those of the "first magnitude" (or brighter) will be labelled, others not.

Naturally, the smaller the field of the map, the fainter the stars that you can label without excessive clutter. In the northern hemisphere it is usually helpful to have **Polaris**, the Pole Star, labelled. Its magnitude is 2.0. However some regions of the sky contain quite dense concentrations of bright stars with long names which then get plotted on top of each other, most confusingly.

If you want to use a 2.0 or fainter limit in a whole sky map and this overlapping occurs, you can correct it by editing your Draw file in !Draw before printing. From Draw's menu choose **Select all** and then **Ungroup** and **Clear**. You can then, with a little patience, select and reposition problem labels so that all can be read, or of course delete a few. A simpler solution is to stick to the 1.5 limit for whole-sky maps and then label Polaris by hand!

As NightSky plots the stars, it puts in a buffer the reference numbers of stars that might require a label, because they are within the specified range of brightness; it adds the actual labels at a later stage. Should the buffer become full, auto-labelling will be discontinued, but no error reported. The buffer has room for around 1000 stars, far more than could profitably be labelled on a single map, so this should not be restrictive.

There are three label types that can be chosen.

Star IDs - Adds the star's designation within its constellation, omitting the constellation name. The label added will be of one of the types a, p5, L, d, ET or 47. Catalogue numbers of faint (HD) stars with no constellation-based identification are not used as labels: these stars are ignored even when within range.

Star names - Refers to proper names, as Sirius, Canopus, Polaris. There are 199 stars with proper names in NightSky.

Star mags - Puts a label of the star's brightness under its image. The decimal point is suppressed for clarity, so Polaris would be labelled 20, and Sirius -15. This facility is mainly intended for labelling field stars near a variable of interest to help in making observations of its current brightness. Figure 58 on page 78 shows the field of omicron Ceti, better known as Mira (wonderful). Mira was the first variable star to be discovered, as late as 1596, and remains the most famous of long period variables. It has a period of some 330 days and a range of around 3 to 9 in magnitude, so that it is a bright star near maximum and invisible in binoculars at minimum.

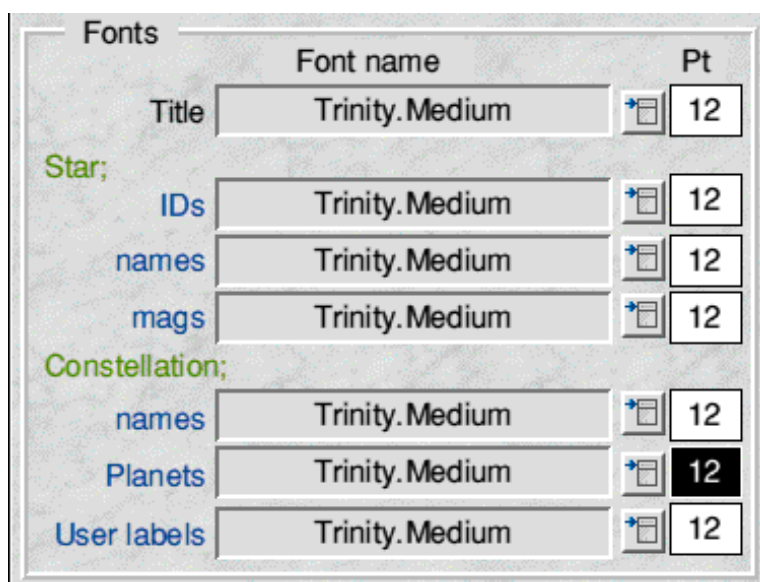
Star IDs

This small panel controls the appearance of Star Information windows. Greek letter names will produce labels such as "lambda Sco = Shaula" in this window. Those not averse to greek letters may prefer to select the **Greek letters** icon. Labelling of star IDs in the main map window always uses Greek letters, as does the **Find Star** window.

Note that when using Greek letters in the Star Information or Find Star windows, but not the main map window, NightSky is obliged to temporarily switch the system font to Greek. This may affect open windows of other applications. However when these windows are closed the system font prevailing when they were opened is restored. If somehow an unwanted Greek system font has been set by NightSky, as can occasionally happen because more than one window requires it, press **F12** and at the star prompt at the bottom of the screen and type "Alphabet Latin1" then press **Return**.

Fonts

The next panel controls the outline fonts and sizes used for NightSky's labels. The sizes (in points) on the right are writable: just click on the icon and the caret will be placed in it. Use **Ctrl -U** to clear the present value if appropriate. Press **Return** to move to the next size field below.



You cannot type into the font fields themselves. A click here pops up a menu of your available fonts from which you can choose. A click on the yellow arrow icon has exactly the same effect. As supplied, with the one exception of **Star IDs**, all the fonts set are Trinity.Medium, either plain or italic. NightSky will not work unless this font is available. If you change the settings and then run the program again in an environment where different fonts are available, then any fonts not found will be substituted with Trinity.Medium. No error message is given.

Title Font refers to the title bar that is attached to NightSky maps when saved as sprite or Draw files. The text of the title bar will be a copy of the title bar of NightSky's own map window, unless you edit it before saving. NightSky does not at the moment support changing this font. An information box appears if you try. You can of course change it once the map has been exported to the .Draw application. Changing the size has no effect either. Your new value is accepted, but ignored, as the font is scaled to fit the rectangle NightSky draws for it before the save is effected.

Star IDs is more complicated than the other font selections because of the problem of mixed greek and latin letters (and numerals). NightSky needs to find a font that supports the greek alphabet here. If you do not have one, then it is suggested that you choose System font in this icon. Stars will then be correctly labelled. The result is rather "chunky" on a print out, though very acceptable on the screen. If System font is not chosen for star IDs, NightSky will check for Greek letters in the label to be printed. These are then printed in the font and size specified in the icons under discussion and all other characters appear in Trinity .Medium font.

Customising Greek Fonts

Most Greek Fonts available for Acorn's RISC OS machines mimic a Greek language typewriter rather strangely. The number codes are those of the corresponding latin letter, rather than what simple alphabetical (= ap !) order would dictate. If you specify a Greek or maths/Greek font in NightSky and you do not get the correct labels then you must tell NightSky what the correct codes for the different letters are, and all should then be well. To do this:

- Load your currently active file of choices for NightSky, usually **ChoicesD** in your NightSky directory, into !Edit.
- In the Edit window, position the cursor at the very end of this file with **Ctrl-Down Arrow**. Immediately above the cursor will be a non- alphabetical line of characters, preceded by the word "**END**".
- Double click on the application !Chars, which is provided with your computer. A window appears.
- Click **MENU** in this window. From the list of fonts, choose the greek or maths/Greek font you plan to use with NightSky. The font is displayed in the !Chars window.
- Now click in turn on each lower case letter of the Greek alphabet. A character will appear at the cursor in your !Edit window. The Greek alphabet is -

α β γ δ ε ϕ ζ η ι κ λ μ ν ο π ϑ ρ σ τ υ φ ω ξ ψ ζ

- Position the cursor directly under the capital "V" in the old line (probably between "r" and "s"). Type a "V" into the new line. This is a dummy entry needed because of how the system Greek font is coded.
- Now delete the old line and make sure the new one follows END immediately with no blank line.
- Save the amended file of choices, and if you want it to take effect at once, drag the file icon to NightSky's program icon.

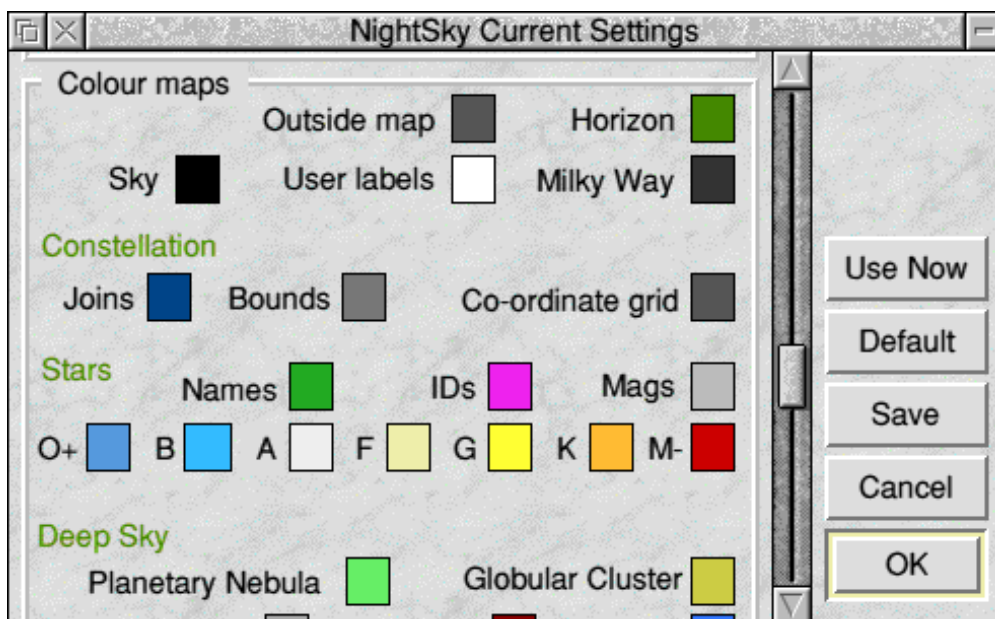
You will probably need to amend like this all your NightSky choices files. As supplied, NightSky is set up to give correct labels with the Greek font supplied with Computer Concepts' Impression or the **EFF MathGreek** font. Some maths/Greek fonts could have a different coding, but can be used successfully once the above procedure has been carried out.

The other labels

The remaining types of label, used for star proper names, magnitudes, constellation names, planet names and the user's own labels pose no problems. Remember that for a printed map the labels will need to be in very small sizes to look good, so small in fact that they will appear unclear on the screen. You may well choose to create a special file of choices for printed map5, and another for normal use. Then, once the map is what you want, simply drag the print settings to the program icon, open the Options Window and click on Use now to impose the print-customised settings. Then save and print the map.

Colours

NightSky is supplied with two complete sets of colours, referred to within this Options Window as *Colours* and *Monochrome*, it being sensible to suppose one is for use on the screen and the other for sending to a monochrome printer. However you can vary either set as you want.



Clicking on any of the coloured squares, or the labels to their left pops up NightSky's Colour **Tool Window**. When this opens it will display the label that you clicked on, together with the present setting in terms of red, green and blue components. These are given pictorially through the slider bars, and also displayed as percentages in the writable fields to the right. A large bar gives the best representation to this colour setting that the current display mode can offer (without dithering).

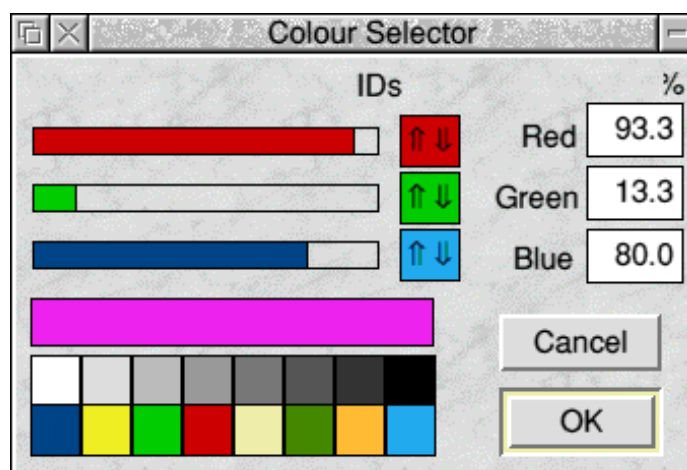
Using the Colour Tool

There are no less than five ways in which you can vary the setting of the colour in question.

- You can enter a value into one of the writable percentage fields. You then have to press **Return** to have the value accepted.
- You can click on the red, green or blue bar or within its outline box. The bar will now end at the point

where you clicked, and the window updated to show the new colour

- You can drag one of the same three bars, and the window will be updated when the drag is over.
- You can click on one of the coloured bump icons. **SELECT** to increase and **ADJUST** to decrease the value of this component. These icons support auto-repeat if you hold the mouse button down, and there is continuous update of the window.
- You can click on one of the sixteen coloured squares and so set the present colour to one of those that the window manager uses for its purposes. Click on **OK** to write the selected combination into the Options window and close this Colour Tool window. Click on **Cancel** to close the Colour Tool window and leave the setting as it was. Even so, new settings made with this tool are not enforced until **OK** or **Use now** is clicked in the Options window.



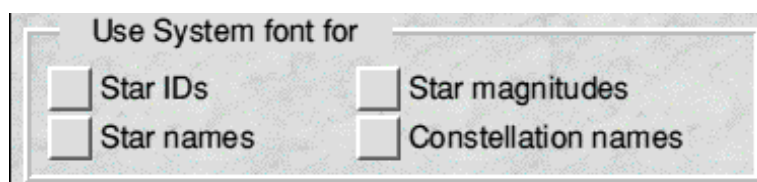
Notes on particular colours

- **Outside map** - Is also the colour used for the unilluminated hemisphere of the moon and also, at sufficiently high zoom-in settings, of the planets. If you wish to be able to distinguish the unlit part of the moon from the sky background (necessary for viewing occultations and eclipses), then this colour must not be the same as sky.
- **Milky Way** - Many monochrome printers render very pale greys as quite dark on paper. In order to render the Milky Way as an unobtrusive pale grey, the setting may well have to be so pale that it is plain white on the screen and so indistinguishable from the sky background.
- **Bounds** - Colour is also the colour in which the constellation names are labelled when that action is chosen.
- **O, B, A, F, G, K, M, N** - Are the different colours of stars from hot, (very slightly) blueish to cool orange-red. The human eye can only detect these hues in the brightest stars, but the camera or telescope reveals that the colours are there.

System font only onscreen

This final panel of the Options window is self-explanatory. Because labels of very small size which print well are virtually unreadable on the screen, NightSky lets your labels onscreen be in the system font, whilst using the chosen font for the label in the Draw file being created. The four switches here are independent of one another. Note that **Planets** is not included here: if they are named then the appropriate font and size are always used.

This option has no meaning unless one of the Draw file saving methods is in force.



A related problem can also occur. If you want large print labels on a large scale map, then when displayed on a whole sky view there will usually be so many of them that the display gets confused. Therefore NightSky disregards large settings of font size on small scale maps. You get the large labels you want as soon as you zoom in however.

5. Technical Reference Section

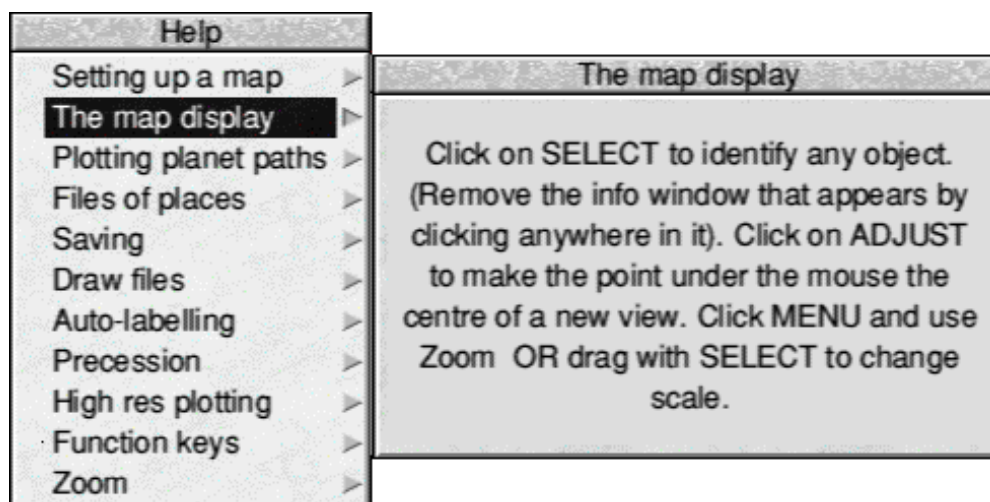
This chapter contains information on the computing aspects of NightSky. The section on keyboard shortcuts will be of interest to all users, but the rest will probably only be of interest to the more technically-minded. Resource information of an astronomical nature is found in Chapter 6.

Keyboard shortcuts

When you are familiar with any application, keyboard shortcuts save a lot of time by enabling you to compress the actions of opening a menu and choosing from it into the press of a single key, or anyway into simultaneous presses on a couple of keys. Note that **Shift-*nn*** means hold down the **Shift** key and press the key ***nn***, and similarly for **Ctrl**.

Keyboard shortcuts work only if the application in question owns the caret (text cursor). If this is in a window belonging to a different application, then neither NightSky nor any other active applications will be informed of the key press and so cannot act on it. In the case of NightSky key presses are really only of interest when the map window is open. Normally, just plotting a map will cause NightSky to gain the caret, even though it is not visible. However if you subsequently place it in a window belonging to another application, you will not be able to use these key shortcuts unless you restore the caret to NightSky: clicking anywhere in the map window should achieve this. If not another application is being aggressive.

- | | |
|-------------|--|
| Home | Re-plot currently selected place and time at 180° field (whole sky) and facing South. |
| F1 | Open a help menu which gives longer messages about various aspects of NightSky than are used with the .Help application. |



- | | |
|-----------------|---|
| Shift-F1 | Open the Options Window (Chapter 4) |
| Ctrl-F1 | Open a menu to set font and size for user labels |
| F2 | Load minimum star catalogue (to magnitude 5.4 only). |
| Shift-F2 | Load maximum star catalogue (to 7.5, or as much as will fit). |
| F3 | Save map. Offers edit of title bar and opens usual save box. |
| Shift-F3 | Automatic save using previous save path and with the file's (leaf) name incremented by 1, for example "NSmap2" follows "NSmap1", Ignored if no save has yet been made, as no save path yet exists in this case. |
| Ctrl-F3 | In RealTime mode, toggle Automatic Save of every map after a first save has defined a path. |
| F4 | Find objects. Opens Find submenu (page 53). |
| Shift-F4 | Re-plot last enlargement |
| Ctrl-F4 | Re-plot present map with 180° (whole sky) field and present orientation. |

F5	Plot Here: NOW map (default place, current time, real time refresh on), retaining current field size, and also present orientation and elevation of the map centre.
Shift-F5	As F5, except field and orientation read from file of places.
F6	Open map plotting dialogue box for default place so you can set required time of the plot. Real time off, current field, orientation and elevation retained.
Shift-F6	As F6, except field and orientation read from file of places.
F7	Open map plotting dialogue box for last non-default place used (if any). Caret in place name field so you can select a new place if desired. Each time a place is chosen, the present time there will be written to the lower part of the dialogue box. Real time on, current field, orientation and elevation retained.
Shift-F7	As F7, except field and orientation read from file of places.
F8	As F7, but time of plot is to be set and real time is off.
Shift-F8	As F8, except field and orientation set from file of places.
Ctrl-F8	Open Places dialogue box
F9	Toggle real time on/off.
Shift-F9	Open RealTime menu
Ctrl-F9	Toggle Wipe action
F10	Toggle Precess-to-Year switch
Shift-F10	Open Precession dialogue box
Ctrl-F10	Toggle Lock action if RealTime on: unlock if there is a lock on, otherwise lock on the previously set lock object if there is one
Ctrl-R	If real-time is on, reverse the flow of time. This applies when an animation is started from the real-time submenu, not to the ordinary NOW options where the map is refreshed every minute by reading the current time from the machine.
Print	Equivalent to selecting Print from the map window. At present just gives a message.

NightSky Choices Files

A choices file is a plain text file. Lines starting with "#" and blank lines are ignored. There are exactly 100 data lines, and the comment lines supplied make editing in . 'Edit a simple task if this is preferred to saving from the Options window in the program.

Notes on particular lines

Line 3 (place file): a leaf name is taken as belonging to the NightSky directory, otherwise full path name to be supplied.

Line 4 (load limit): if normal catalogue is specified, the magnitude of the faintest star to be loaded. Zero means all, or as much as will fit in memory.

Line 9 (saving): 0,1,2,3 are valid: add 256 to 0,1, or 2 for squashed saves.

Line 14 (centre line switch): applies to the first grid plotted. Always on for subsequent grids.

Lines 20-21 (title font): these are ignored.

Lines 22-32 (fonts): zero-terminated strings (Ctrl-@).

Lines 34-97 (colours): all &BBGGRROO where BB, GG and RR are hexadecimal numbers in the range 00 - FF

Line 99 (END): must be found or an error occurs.

Line 100 (Creek font mapping): when using a font for star IDs, to cope with Greek letters, NightSky maps character 224+n onto the nth character in this string.

NightSky places files

NightSky holds details of all the places in the current file in memory for maximum speed of access. There is a limit of 255 to the number of records that you can have in a file. The first few lines of an example file are shown in the table below.

```
#XXXplaces
# NightSky places file
# Format CSV
# Record format:
# Place.Time Zone,Lat,Long,Direction,Field,Z(enith) or H(orizon)
# Note file needs "places" at byte 4 to be loaded
# lines starting with # are comment lines
BEGIN
Bandar Seri Begawan,8,4.9,114.9,180,180,Z
North Pole,0,89.8,0,180,180,Z
Reykjavik,Iceland,-1,64.1,-24.5,180,180,Z
Eerwick,Shetland,0,60.1,-1.1,180,180,Z
St.Petersburg,Russia,3,59.6,30.3,180,180,Z
Inverness,Scotland,0,57.3,-4.2,180,180,Z
Edinburgh,Scotland,0,55.6,-3.1,180,180,Z
Manchester,England,0,53.3,-2.2,180,180,Z
Hamburg, Germany,1,53.3,10.0,180,180,Z
Dublin,Ireland,0,53.2,-A.2,180,180,Z
Northwich,England,0,53.2,-2.3,180,180,Z
```

All lines starting with # are comment lines. No such lines and no blank lines can occur between BEGIN and END. Bytes 0-3 are immaterial, but the string 'places' must occur at byte 4. Any number of comment lines may precede the line BEGIN. A record comprises

- Place name
- Time Zone (fast on GMT, i.e. east longitude, is +. Decimal fractions supported)
- Latitude, decimal degrees (north +)
- Longitude, decimal degrees (east +)
- Direction of view initially, integer degrees (180 = south)
- Field of view, integer degrees (180 = whole sky)
- Z | H (Z = centre on zenith, H = show horizon. H not for whole sky view)

Spaces are not allowed between the fields in a record, which occupies a single line. Fields are separated by commas. The place name can include commas and spaces and is taken to end at the first +, - or numeral. The first record is the default place. Machine time is assumed to be set according to the time zone of this place.

NightSky star catalogues

NightSky's star catalogues are not at present user-editable. Stars cannot be added or deleted because the entry number in the catalogues is the key to extracting proper names and user-added tag text. A star catalogue contains:

Header (40 bytes)

+0	Number of entries (32 bit integer)
+4	"stars", CR terminated
+10	"2000", CR terminated
+16-39	assorted statistical information
+40	records, 20 bytes per record:

Record format:

Location	Bits	Datum
R+0	32	COSra * COSdec * 224
R+4	32	SINra * COSdec * 224
R+8	32	SINdec * 224
R+12	8	10* visual magnitude + 20
R+13	4	Spectral class number 0-9
	4	Spectral class letter (0 = 0, B = 1, A = 2, etc)
R+14	7	First two sig. figs. of distance in parsec
	1	Tagged star flag
R+15	7	Distance exponent +1
	1	Named star flag
R+16	8	Number (or 1st character if >64)
R+17	8	-
R+18	8	(2nd) character: 65 =A, 225 = a, etc
R+19	8	Constellation (0-88) *

* When constellation = 0 (HD), R+16 to R+18 (24 bits) are the catalogue number.

Reading a Star Catalogue

There is a simple program *Cat_Read* in the Utils directory of your NightSky resource disc. Double click on the program icon and it will run within a window on the desktop. This utility is not a multi-tasking desktop application. You will be prompted for a directory to be converted, for a destination filename and for a starting point in the original file. If you supply a leaf-name such as *starsX* for the former, it will be looked for in your NightSky directory; the target should be a full path-name (unless you are operating from a hard disc). The program will end cleanly if your target storage area becomes full. You will be informed of how many stars had been processed when the disc full error condition arose, and can then run the program again to write the rest of the catalogue onto a new disc.

The text files produced can be loaded into any application which accepts CSV data, *Schema2* for example. Set the system font to Greek (Type "alphabet Greek" at the star prompt displayed after F12 has been pressed) to show the star IDs correctly.

Note that star catalogues cannot be transferred between copies of NightSky - different users tag files will be incompatible. Errors will occur.

NightSky Map Projection

It is impossible to represent a spherical surface, such as the sky, on a flat surface without distorting parts of the map in size, shape or both. NightSky uses a stereographic projection, with the map plane tangent to the sphere at the zenith and the centre of projection at the nadir. With this projection shapes are well represented in all parts of the map. The scale increases away from the zenith: the scale at the horizon is exactly twice that at the zenith, as will quickly be realised if you look at a series of whole sky maps.

This chapter contains miscellaneous resource material likely to be of interest to those using NightSky without an extensive background in the subject, especially in schools. It cannot be exhaustive and suggestions for further reading are included.

6. Astronomical Reference Section

This chapter contains miscellaneous resource material likely to be of interest to those using NightSky without an extensive background in the subject. It cannot be exhaustive and suggestions for further reading are included.

The Stars and Constellations

Stars are suns, vast globes of hydrogen and helium whose energy (except in extreme old age) largely comes from fusion of hydrogen into helium, a process replicated on earth so far only in the H-bomb. Only 3000 or so stars are bright enough to be seen with the naked eye, and naturally only half of this total can be viewed at a time. In towns and other light-polluted environments the number of visible stars can fall to a few dozen.

The brighter stars have names, almost all of them Arabic, and are grouped into 88 constellations which cover the whole sky. These have Latin names; some of them, like Orion, Scorpio, Leo, Virgo, Ursa Major and the Southern Cross make obvious and easily recognised patterns, but many like Camelopardalis, Lynx, Caelum and Mensa are faint and obscure. Some inexplicable decisions were made when the constellations were delineated, not that these will ever now be changed. One of the four corners of the Square of Pegasus belongs to Andromeda; the False Cross, an obvious and prominent grouping, is split between two constellations; and many pairs of stars that invite the eye to link them to each other are actually in different constellations. Such are a Herculis and a Ophiuchi; also (3 Lupi and k Centauri, two bright stars less than 2° apart; and El Nath, (i Tauri, really does ask the eye to associate it with Auriga. Thorough knowledge of the bright stars requires mastery of this confusion of two alphabets, three languages and four at least ways of naming stars within their constellations. Fortunately it is an easy and rewarding task to make friends "with a couple of hundred of the brightest stars, and in doing this you will probably make use mainly of their proper names plus learn the outlines of about 30 of the most important constellations.

In doing so you meet only our immediate neighbours in space: only a handful of the stars visible to the unaided eye lie more than 1000 LY (300 parsecs) away. Yet the diameter of our Galaxy, to which all these stars belong, is some 30 000 LY, and other galaxies are separated from us by distances measured in millions of light years, apart from our two satellite galaxies, the Larger and Smaller Magellanic Clouds deep in the southern hemisphere. Space is indeed empty and the old nineteenth century name for galaxies. Island Universes, was descriptive and apposite.

The Constellations

The table lists all 88 constellations with their standard three letter abbreviations used in all astronomical literature, and English translation.

Location is an indication of the part of the sky the constellation is in, and hence of its visibility from any area. Naturally, the larger groups may spread over more than one of these zones.

- **N** - within 30° or so of the north pole of the sky. Always visible (circumpolar) from temperate northern locations like Europe, low in the north at an appropriate season from equatorial locations, never rises at temperate southern locations.
- **MN** - mid-northern group. High in the sky from Europe at some time in the year, mid-way up the northern sky from the equatorial regions in the same season, low in the north from Australia, New Zealand etc.
- **E** - equatorial group. Visible from the entire inhabited globe.
- **MS** - mid-southern group. High in the sky at some time in the year from temperate southern locations, mid-way up the southern sky from the equatorial zone then, low in the south, maybe only partly visible, from the latitudes of Europe.
- **S** - within 30° or so of the south pole of the sky. Circumpolar in the temperate southern hemisphere, low in the south in the equatorial zone, never rises at temperate northern locations.

Notes are coded as follows:

- **F** - constellation without bright stars, but not insignificant or without objects of interest.
- **FF** - faint and insignificant group.
- **Z** - zodiacal group, through which the ecliptic passes. Sun, moon and planets may be found here at times.

As well as the 13 constellations through which the sun actually passes, the moon and planets may stray into corners of the constellations Cetus and Sextans. These are not flagged.

- **A** - these constellations originally comprised the huge and magnificent group of Argo Navis, the Ship of the Argonauts. It was officially divided into keel, poop, sails and compass in the nineteenth century. A single set of Greek letters is used for all these constellations. For example Canopus is alpha Carinee, so none of Vela, Puppis or Pyxis have an alpha, and likewise with the other letters of the Greek alphabet.

10pm best flags the time of year when the constellation is best seen at 10pm local time.

Constellation	Code	Meaning	Location	Notes	best 10pm
Andromeda	And	A Chained Maiden	MN		October
Antlia	Ant	Air Pump	MS	FF	March
Apus	Aps	Bird of Paradise	S	F	June
Aquarius	Aqr	Water Carrier	E	Z	September
Aquila	Aql	Eagle	E		August
Ara	Ara	Altar	MS		July
Aries	Ari	Ram	E-MN	Z	November
Auriga	Aur	Charioteer	MN		January
Bootes	Boo	Herdsman	MN		May
Caelum	Cae	Chisel	MS	FF	December
Camelopardalis	Cam	Giraffe	N	FF	January
Cancer	Cnc	Crab	E-MN	F,Z	February
Canes Venatici	CVn	Hunting Dogs	MN		April
Canis Major	CMA	Greater Dog	E-MS		February
Canis Minor	CMi	Lesser Dog	E		March
Capricornus	Cap	Goat	E	Z	September
Carina	Car	Keel	S	A	February
Cassiopeia	Cas	A Queen	N		November
Centaurus	Cen	The Centaur	MS-S		April
Cepheus	Cep	A King	N		September
Cetus	Cet	Whale	E		November
Chamaeleon	Cha	Chameleon	S	F	March
Circinus	Cir	Compasses	S	F	May
Coma Berenices	Corn	Berenice's Hair	MN	F	April
Corona Australis	CrA	Southern Crown	MS		July
Corona Borealis	CrB	Northern Crown	MN		June
Corvus	Crv	Crow	E		May
Crater	Crt	Cup	E	F	May
Crux Australis	Cru	Southern Cross	S		April
Cygnus	YS	Swan (also N. Cross)	MN		August
Delphinus	Del	Dolphin	E		August
Dorado	Dor	Goldfish	S		December
Draco	Dra	Dragon	N		Apr-July
Equuleus	Equ	Little Horse	E	FF	September
Eridanus	Eri	River of Heaven	S/MS/E		December
Fornax	For	Furnace	MS	FF	November
Gemini	Gem	Twins	E/MN	Z	February
Grus	Gru	Crane	MS		September
Hercules	Her	A Labourer	MN		July
Horologium	Hor	Pendulum Clock	MS	FF	December
Hydra	Hya	Water Snake	E/MS		Feb - May
Hydrus	Hyi	Another Sea Serpent	S		May

Indus	Ind	Indian	S	F	August
Lacerta	Lac	Lizard	MN	FF	September
Leo	Leo	Lion	E	Z	March
Leo Minor	LMi	Lesser Lion	MN	FF	March
Lepus	Lep	Hare	E		January
Libra	Lib	Scales	E		June
Lupus	Lup	Wolf	MS		June
Lynx	Lyn	Lynx	N	FF	February
Lyra	Lyr	Orpheus' Lyre	MN		July
Mensa	Men	Table Mountain	S	FF	January
Microscopium	Mic		MS	FF	August
Monoceros	Mon	Unicorn	E	F	February
Musca	Mus	Fly	S		April
Norma	Nor		MS	F	
Octans	Oct	Octant	S	F	-
Ophiuchus	Oph	Serpent Holder	E	Z	July
Orion	Ori	Hunter	E		January
Pavo	Pav	Peacock	S		August
Pegasus	Peg	Winged Horse	E/MN		September
Perseus	Per	A Hero (see And)	MN		December
Phoenix	Phe	Phoenix	MS		October
Pictor	Pic	Painter's Easel	S	FF	January
Pisces	Psc	Fishes	E	F,Z	October
Piscis Austrinus	PsA	Southern Fish	MS		September
Puppis	Pup	Poop	MS	A	February
Pyxis	Pvx	Ship's Compass	MS	A,FF	February
Reticulum	Ret	Net	S	F	December
Sagitta	Sge	Arrow	E	F	August
Sagittarius	Sgr	Archer	E/MS	Z	July
Scorpius (Scorpio)	Sco	Scorpion	E/MS	Z	June
Sculptor	Scl	Sculptor	MS	FF	October
Scutum	Set	Shield	E	F	July
Serpens	Ser	Serpent	E		Jun - Jul
Sextans	Sex	Sextant	E	FF	March
Taurus	Tau	Bull	E/MN		December
Telescopium	Tel	Telescope	MS	FF	July
Triangulum	Tri	Triangle	MN		November
Triangulum Australe	TrA	Southern Triangle	S		June
Tucana	Tuc	Toucan	S		October
Ursa Major	UMa	Great Bear	N		Feb - May
Ursa Minor	UMi	Lesser Bear	N		-
Vela	Vel	Sails	S	A	March
Virgo	Vir	Virgin	E	z	May
Volans	Vol	Flying Fish	s	F	February
Vulpecula	Vul	Fox	MN	F	August

Star IDs within a constellation

Notionally, the brightest star in a constellation is labelled alpha, the next beta and so on. There are many exceptions. In Ursa Major the seven bright stars making up the Plough group are labelled by position; in Sagittarius, mysteriously, alpha and beta are faint, indeed a, P, γ, δ and ε are a sequence steadily increasing in brightness; beta is brighter than alpha in Gemini, Orion and others; and many constellations use only a handful of the available letters.

Certain resplendent constellations, rich in bright stars, may use up the whole Greek alphabet. In such cases some stars are assigned upper or lower case roman letters. This occurs for example in Scorpio, Centaurus and parts of Argo Navis. Elsewhere the numbering devised by Flamsteed in the seventeenth century is used; far southern constellations were not covered by his work.

Star Magnitudes

The brightness of a star is measured by its *magnitude*, which is a measure of the amount of energy received at the earth from the star in unit time interval. Visual magnitude is the only measure considered by NightSky refers to total amount of visible light, but stars radiate at all wavelengths of the electromagnetic spectrum, and photographic magnitudes may refer to blue (B) or ultra-violet (U) light as well as to the visual (V) value. Historically, the brightest stars were loosely described as being *of the first magnitude*, the astronomical meaning of this term being its original one. The faintest that the unaided eye could see were assigned to the sixth magnitude. Magnitude is thus a kind of ranking, and a smaller number denotes a brighter object, just as a lower finishing number in a race denotes a superior performance.

The magnitude scale or *Pogson Scale* was defined around 1860 by the English astronomer Norman Pogson. A magnitude 6.0 star is defined to be exactly 100 times fainter than one of 1.0, and because equal magnitude differences correspond to equal ratios of brightness this implies that if two stars differ in magnitude by exactly 1.0, the brighter is just over 2.5 times brighter than the fainter. (This number is the Pogson Ratio, value 2.5119). On this scale the faintest star the unaided eye can detect in ideally dark and clear conditions is about magnitude 6.3, down to which limit there are some 6000 stars. In brightly lit cities the corresponding limit can be as low as 3.5, when only two or three hundred stars would be visible, as the table below demonstrates.

Class	Range	Number	Total	Typical stars
-1	-1.5--0.49	2	2	Sirius , -1.46 and Canopus -0.72
0	-0.5- 0.49	7	9	Vega, 0.0
1	0.5- 1.49	13	22	Antares, 1.0
2	1.5- 2.49	71	93	Polaris, Diphda, o Sgr: all 2.0
3	2.5- 3.49	192	285	8 Per; p Tri, C, CMa: all 3.0
4	3.5- 4.49	625	910	
5	4.5- 5.49	1963	2873	
6	5.5- 6.49	5606	8479	
7	6.5- 7.49	15565	24044	

Other magnitudes

The Sun has an apparent magnitude around -26

The Full Moon can be about -8 or -9

Venus at greatest brilliance can reach -4.6; the effective minimum brightness is about -3.4, discounting a few days near inferior conjunction when we see only its night side and it is too near the sun in the sky to be observed.

Mars has a maximum brightness at a favourable opposition of -2.6, when, for a few weeks it can outshine Jupiter. This however is rare. The next few oppositions of Mars (1995, 1997, 1999) are unfavourable, -with the planet almost as far away from us as is possible. It will not outshine Sirius (magnitude -1.5) again this century. Far from opposition, when Mars is on the other side of the sun as seen from earth it can be a relatively insignificant object, as faint as +2, and so no brighter than many stars. Mars has far and away the greatest range between maximum and minimum brightness, some five magnitudes, a factor of 100.

Jupiter varies between -1.6 and -2.9, according to distance from the earth and slightly-variable angle of view. At opposition its brightness varies between -2.4 and -2.9. Venus cannot ever be this faint and should never be mistaken for Jupiter as a result. Their colours are very similar to the unaided eye.

Mercury can be as bright as -1.5. In the evening or morning sky it can appear as faint as about +2 when very close to the sun. Like Venus it can occasionally show us its entire night (unilluminated) hemisphere and transit across the sun, when of course its brightness is zero.

Saturn's opposition brightness varies with the angle at which its rings are viewed. When the rings are wide open they reflect more light back to us than does the planet itself. This happens when oppositions fall in June (magnitude 0.0) or December (a shade brighter at magnitude -0.2, because Saturn itself would then be close to perihelion). Such oppositions occur (red) in 1988 and 2003 respectively. At oppositions when the rings are seen

edge on, Saturn is much fainter, around magnitude +1. These oppositions occur in March (2010) or September (1995,1996). In any given year Saturn will fade away from opposition by a noticeable half magnitude or so due to its greater distance from the earth.

Uranus at opposition has a magnitude of about 5.6, a faint "star" but plainly visible to the naked eye on a dark clear night. Recognise Uranus by its motion with respect to the background stars, obvious over a week or two.

Neptune has the most circular orbit of all the planets except Venus, so at opposition its magnitude is always 7.8, rather fainter than the faintest stars supported by NightSky, but visible in good binoculars. Uranus overtakes Neptune in 1993, an event that happens only once in 171 years or so. Use Uranus to help locate Neptune in 1993 and 1994.

Pluto is never brighter than +14, and requires a substantial telescope.

A "nearby" supernova in our galaxy might shine at magnitude -8 or -9, easily visible by day. Such was SN1016 which occurred in 1016 in the constellation Lupus. The supernova SN1987A recently seen in our satellite neighbour-galaxy the Large Magellanic Cloud attained magnitude +3, the most distant star anyone now living has ever seen with the unaided eye. To shine at this brightness at the distance of the LMC, 52 kiloparsecs or 170 000 light years, requires an absolute magnitude in the region of -17, around 150 million suns: when a massive star destroys itself in a supernova explosion, it briefly radiates at a power roughly comparable to all the other stars in its galaxy combined.

The faintest objects detectable by long exposure photography using large telescopes have a visual magnitude around +24.

The Co-ordinate grids

To fix a point in space requires three co-ordinates. Most simply these are distances parallel to each of three mutually perpendicular axes, x, y, and z. Such a system is normally used by astronomers when calculating the positions of objects within the solar system, two of the three directions being in the plane of the earth's orbit around the sun, and the third perpendicular to it. NightSky uses this frame internally for the planets.

Most often in observational astronomy however what we measure are angles, and so it is natural to use most of the time a spherical co-ordinate system where we specify the distance of the object away from us and two directions, namely an angle measured along a reference great circle in the sky and a second along an appropriate perpendicular one.

Local co-ordinates use the horizon as the reference circle; its poles are the zenith (overhead) and nadir (opposite the zenith, underfoot) points. To describe the position of a point, we let the great circle through the point and the zenith meet the horizon at a certain position; the angle measured eastwards round the horizon to that position from north is the **azimuth** of the point; and the angle up from the horizon to the point is its **altitude**.

Equatorial co-ordinates use the projection of the earth's equator onto the celestial sphere as the reference circle; its poles are the north and south poles of the sky, the points found by extending the earth's axis of rotation indefinitely outwards. The zero direction, used as north was for local co-ordinates, is the point on the equator occupied by the sun when it crosses it in March, the northern spring (vernal) equinox. This is V. It is also called the *First Point of Aries*, though this has not been a correct description for nearly 2000 years. To fix the position of a star S, we draw a great circle through S and the two poles of the sky. The angle measured eastwards from V (or the arc VM) give the *Right Ascension* (RA) of the star, and the angle or arc MS measured towards the north (+) or south (-) pole is the *declination*. A simple way to express RA is as follows. Suppose the Vernal Equinox V is on the meridian at Greenwich, the meridian of reference for terrestrial longitude. Then the RA of a star is the longitude measured eastwards from Greenwich of any place where that star is on the meridian at that moment. For mainly historical reasons, RA is usually measured in time units; since 360° corresponds to 24 hours, 1 hr of RA is 15° in the sky, and this is then divided further into minutes and seconds. Anywhere at any time the RA of an object on the meridian is the current local sidereal time. Calculation of the l.s.t. is always the first step in preparing a sky map.

Ecliptic co-ordinates are precisely similar to equatorial ones, except that the projection onto the celestial sphere of the plane of the earth's orbit around the sun is used; ecliptic longitude and latitude then correspond to RA and declination respectively. Galactic co-ordinates similarly use the galactic equator (central line of the Milky Way) as the fundamental circle, with the direction to the centre of the Galaxy as the zero of longitude.

Precession

As the earth spins about its axis of rotation, its spin is affected by gravitational pulls from the moon and the sun, neither of which as a rule is found in the earth's equatorial plane, giving rise to asymmetrical tugs on the two hemispheres. These effects cause the earth to *precess* (wobble), as a spinning top does, that is to say its axis of rotation does not always point in the same direction, but rather describes a circle in space, the period of which is about 26000 years. Practically, the result is that the ecliptic is invariant, but the Vernal Equinox moves backwards along it at a rate of about 1° in 72 years. NightSky's fundamental epoch is the current standard one of 2000.0, and precession calculations can correct the values to any other epoch; as mentioned before for simple star maps this is not necessary at times close to the present, but for predictions of occultations of stars by the moon is essential. It also makes an interesting study in itself.

It will be several thousand years before there is again a decent South Pole- star, but from about 7500 to 9500 AD, the pole will lie within the False Cross, which will be spectacular. When Vega is close to the N-pole, Canopus will be no more than 7° from the S-pole, an amazing pair.

Interesting Events

This section lists interesting recent or forthcoming events that can be represented in NightSky and followed without the bother of contriving to occupy an appropriate point in space and time. All places required for these investigations are in the default places file supplied with NightSky.

Solar Eclipses - Total

Start an animation about an hour before totality for these events, and use a step of 10 minutes, switching to 1 minute near totality.

1988 March 18, Maratua Islands, Borneo

Three minutes of totality at 0848 local, 0048 UT. The moon's path makes an angle of about 28° with the horizon, crossing the vertical through the sun from south to north. The eclipse is at the ascending node.

1991 July 11, Mexico City

Over six minutes of totality at 1921 UT. The alignment in this eclipse of sun, moon and earth is virtually exact. The eclipse is at the descending node.

1999 August 11, Falmouth, England

Two minutes of totality, at 1014 UT (1114 BST), the first time since 1927 on the island of Great Britain. Compare animations for the following places -

Falmouth, on the centre line

London, north of the zone of totality

Paris, (just) south of the zone of totality

Vienna, on the north edge of the zone of totality and just within it.

The moon's shadow takes from 1014 to 1052 UT to travel from Falmouth to Vienna. The eclipse is at the ascending node.

2150 June 25, W. Pacific off Wake Island

The greatest eclipse of the next thousand years, 7 minutes 15 seconds of totality. The location given has 7 minutes of totality around 1050 local time. Virtually the whole central part of the eclipse where it is longest is over the watery north-central Pacific. That's life. This eclipse is the zenith of the Saros series which included the 1988 March 18 eclipse.

Solar Eclipses - Annular

1991 January 16, Wellington New Zealand

One of many eclipses in the last twenty years that have favoured a capital city. There were almost eight minutes of the annular phase between 1109 and 1117 local time (summer time ignored), corresponding to 2309-2317 on January 15th UT. Start an animation an hour or more before maximum eclipse as before.

1992 January 4, San Clemente Is, California.

This annular eclipse mostly crossed the vast empty eastern Pacific, but made a landfall here just before sunset. Maximum eclipse is at sunset. See page 20, Figure 8. This is a good eclipse to view with NightSky's normal Wipe option deselected (Figure 40). This eclipse is a partner to the 1991 annular eclipse. They are separated by the "perfectly aligned" eclipse of

July 1991; in January 1991 the shadow was thrown to the south of the moon's overhead location, in July it was directly beneath, and in this present case it is to the north. Symmetry between corresponding eclipses before and after July 1991 can be traced over several years.

2003 May 31, Reykjavik, Iceland

This non-central eclipse occurs near the descending node. Non-central means the axis of the moon's shadow at no time meets the earth's surface. An annular eclipse is visible at about 0408 UT, that is 0308 local time. The sun and moon are just above the horizon NNE, at an altitude of under 1°. Sunrise is at 0255 local time: start an animation at 0256 with a step of 1 minute. Ability to depict such an oblique event with fair accuracy is an extreme test of the precision of NightSky's calculation routines.

2005 April 8, Panama City

This eclipse is of the rather rare annular-total variety. The moon appears big enough to blot out the sun in the central part of the track (over the Pacific in this case), but not front the ends as it is further away from these vantage points. When the shadow reaches Panama City late in the afternoon, the moon is just not able to cover the sun, giving a few seconds of annular eclipse at 1716 local time (2116 UT). Descending node.

Lunar Eclipses

Near full moon every month NightSky draws the shadow? of the earth at the distance of the moon as seen by the observer, that is it treats the intersection of the earth's shadow with a sphere centred at the centre of the earth and radius equal to the moon's geocentric distance as an astronomical object in space. The observer's position is corrected roughly for the figure of the earth but not for height above sea level. The fact and times of lunar eclipses are as a result correctly shown within a minute or so for eclipses in the present era. Lunar eclipses are visible over the whole night hemisphere of the earth, so from the times of an eclipse it is a simple matter to select a station with a good view of the event.

1992 December 9-10; total from 2307 to 0021 UT

Visible from Europe among other places. The first of three total lunar eclipses that occur at six month intervals. Moon at ascending node.

1993 June 4; total from 1213 to 1349 UT

Visible from Australia, New Zealand, etc. The middle member of the three is the longest, most central eclipse. Descending node.

1993 November 29; total from 0602 to 0648 UT

This time the moon makes only a grazing passage through the umbra. Visible in the pre-dawn sky in UK. Ascending node.

2000 July 16; total from 1304 to 1450 UT

A very large eclipse. See the moon right in the centre of the earth's umbra at 1357 UT. Pacific regions including Australia, NZ and east Asia.

2003 November 9; total from 0110 to 0131 UT

In contrast this eclipse barely achieves totality. See the moon touching the umbra internally at 0120 UT.

Transits of Mercury and Venus

These events occur if Mercury or Venus happens to be very close to a node of its orbit round the sun at the moment of inferior conjunction; the planet then lies directly between the earth and sun and stands out in silhouette on the sun's disc. Observe all normal precautions when looking at the actual sun. Transits of Venus are exceedingly rare, there being none in the 20th century.

1993 November 6 0306-0447 UT: Mercury

Observable anywhere the sun is up at this time, for example all Australia. Local time in Sydney or Melbourne is 1306 -1447. This transit is a grazing event. Mercury is never more than 2% of a solar diameter from the sun's limb (edge). NightSky shows the night hemisphere of Mercury to scale at the largest scales supported (1° and below for field).

2003 May 7 0530-1000 UT: Mercury

The planet transits the northern part of the sun, the event being visible from anywhere in Europe, Africa or Asia.

2004 June 8 0500-1100 UT: Venus

Venus transits across the southern part of the sun between about 5 and 11 am GMT (UT). This transit is visible from Europe, Africa and Asia. Venus' disc in a transit is of course much larger than Mercury's.

2006 November 8 1900-2400 UT: Mercury

A transit across the southern part of the sun visible from most of the Americas, the Pacific, Australasia.

2012 June 5/6 2230-0430 UT

The second of the forthcoming pair of Venus transits is across the northern part of the sun. Area of visibility is the Pacific, Australasia and eastern Asia. The next transit of Venus thereafter is 2117 December 11. Beware the "transit" of Venus depicted by NightSky for 2000 June 11 for the "whole day (try 1030UT from anywhere in UK). Here Venus is at superior conjunction and so the sun passes in front of the planet, an unobservable event. Similar events occur in 1992, 2008 and 2016. Zooming in below 1° will show (wrongly) the tiny fully illuminated disc of Venus on the Sun.

Occultations by the Moon

All the planets and the first-magnitude stars Aldebaran, Regulus, Spica and Antares can be occulted, though some events are very rare. Two examples, the occultation of Regulus seen in London on 1988 September 9 at 1405 UT and the occultation of Venus seen from Sydney on 1993 February 25 at 0310 UT will be found in the directory Demos on your NightSky resource disc. For other occultations of stars remember that the star catalogue in use must be processed to the time (use decimal fractions of the year) before trying to view the event.

Mutual Occultations of Planets

For one planet to pass exactly in front of another is an exceedingly rare event. On average there is one such event about every fifty years, but there are none at all between 1850 and 2000. Some examples successfully calculated by NightSky are in the Planets sub directory of Demos. See J. Brit. Astron. Ass. 103 page 186 (August, 1993) for a list of old events.

Occultations of Stars by Planets

Rounding errors prevent these infrequent events being correctly displayed by NightSky. For instance an occultation of HD 123523 by Jupiter on 1993 November 29 0619 hrs occurs in NightSky, but twelve hours late.

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Like many guides, this is constellation based and accords too much space to the insignificant groups, but it is packed with details of easily found double and variable stars, and deep sky objects. The same authors Collins' Gem Guide The NightSky has much of the same information in a very compact and portable format for holiday use.

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Full details of forthcoming central solar eclipses are available (at present free of charge) on request to this

address, from one year before the event. This service to the scientific community is a great help to anyone seriously planning a trip, but obviously should not be abused.

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