Nautical Almanac

2022

The Nautical Almanac 2022

Compiled with *NauticalAlmanac* revision V2.6 - Sep 2020, using NOVAS version C3.1 - Mar 2011
The Almanac data have been produced with the JPL Ephemerides DE405

Warning and Terms of Usage:

The following pages have been generated by a computer program. Complex computer programs often have bugs and may produce wrong data. The data in this Nautical Almanac is believed to be accurate but no warranty is given for its correctness.
Use this Nautical Almanac only for training and exercising!

Compiled by Erik De Man (mail2erik@siranah.de) on Fri Oct 29 11:53:22 2021

Introduction

This Nautical Almanac contains the Ephemerides of the Sun, the Moon, Venus, Mars, Jupiter and Saturn. It is designed for determination of Position (geographical Latitude and Longitude) from astronomical observations (Altitude of Celestial Objects).

The data compiled in this Nautical Almanac is based on calculations done with the software package "NOVAS" from the U.S. Naval Observatory (http://aa.usno.navy.mil/AA/software). The basic ephemerides are taken from the "DE405" files published by the Jet Propulsion Laboratory (http://ssd.jpl.nasa.gov).

Values for "deltaT"
For the astrodynamical calculations, the following values for "delta T" (the difference between terrestrial time realized by atomic clocks and UT defined by the irregular rotation of the Earth) have been used:

Jan : 69.3 s	Apr : 69.3 s	Jul : 69.3 s	Oct : 69.2 s
Feb : 69.3 s	May: 69.3 s	Aug : 69.2 s	Nov : 69.2 s
Mar : 69.3 s	Jun : 69.3 s	Sep : 69.2 s	Dec : 69.2 s

Interpolation of the integral-hour GHA and Dec values
This Nautical Almanac uses a slightly different approach for the interpolation of the integral-hour values of Greenwich Hour Angle and Declination, compared to the techniques used in most commercially available Almanacs.

The almanc pages in this Nautical Almanac are compiled according to the following scheme:

```
    UT       GHA     ddGHA       Dec      dDec
            °   ′     ′/h       °   ′     ′/h
 ...
 13:00   176 41.8  −31.3   S 23 09.6  +01.8
 14:00   191 10.5  −31.3   S 23 11.4  +01.8
 15:00   205 39.2  −31.3   S 23 13.2  +01.6
 16:00   220 07.9  −31.3   S 23 14.8  +01.5
 ...
```

The values for the Greenwich Hour Angle (GHA) and Declination (Dec) are given for the integral hours of Universal Time (UT). In the columns "ddGHA" and "dDec" , the increase or decrease of these values for the next full hour of time are recorded. However, for the Greenwich Hour Angle (GHA), this differential value is not the total change. An hour angle basically increases with 15° per hour and the value "ddGHA" is only the variation additional to this fixed increment of 15° per hour.
It is important to note that when interpolating the GHA values, this fixed increase of 15° per hour must also be taken into account.

For more information please refer to the following internet site: *"http://www.siranah.de/"*

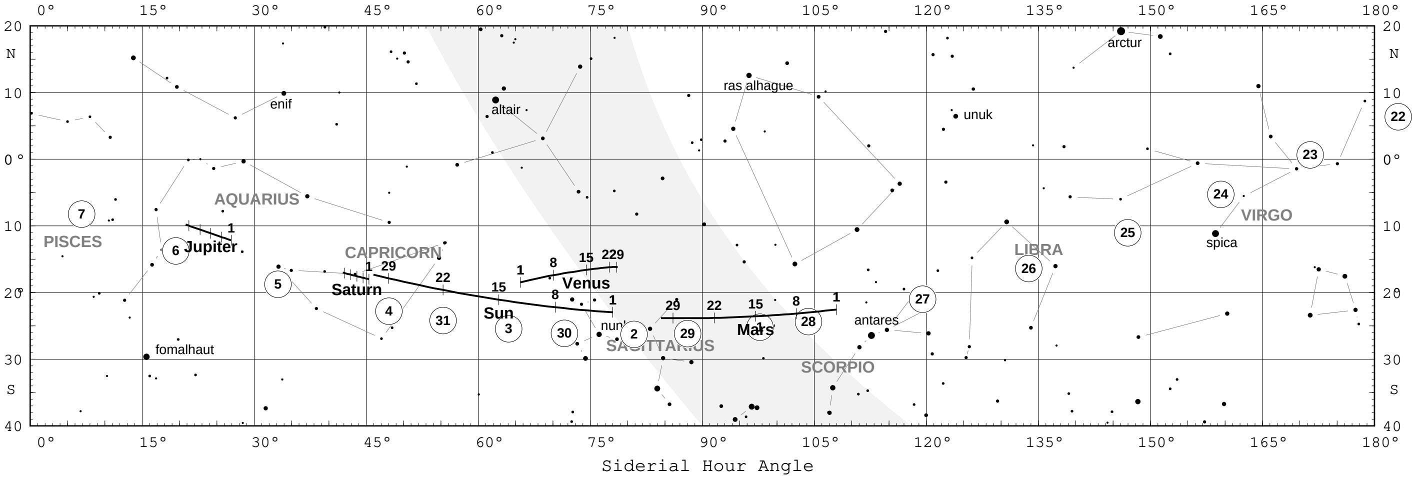
Positions of the Celestial Objects

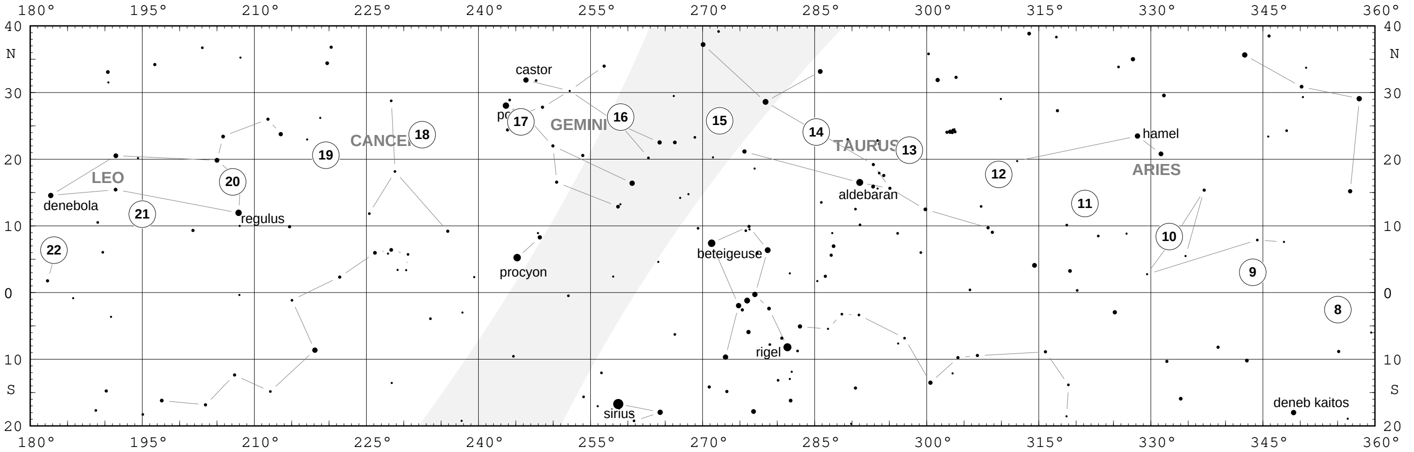
The charts on the following pages show the position of the Celestial Objects used in this Nautical Almanac relative to the stars (celestial background). The charts can be used to find the location of the planets and also for the planning of astronomical observations.

The charts are provided for each month of the year. Each chart has two parts showing a part of the celestial sphere around the ecliptic. Note that the position of the Celestial Equator (Declination = 0°) is not on the same position in the two different parts of each of the charts.

The changing position of a Celestial Object through the month is drawn as a solid line (not for the Moon). Marker tics along this line are shown to indicate the position of the Object on the 1st, 8th, 15th, 22nd and 29th day of the month (at 12:00 UT). For Jupiter and Saturn only the first day is marked since their apparent position does not change significantly over the period of one month. The position of the Moon is shown by a small circle for each individual day of the month. Notice that the circles are much larger than the apparent size of the Moon.

January 2022





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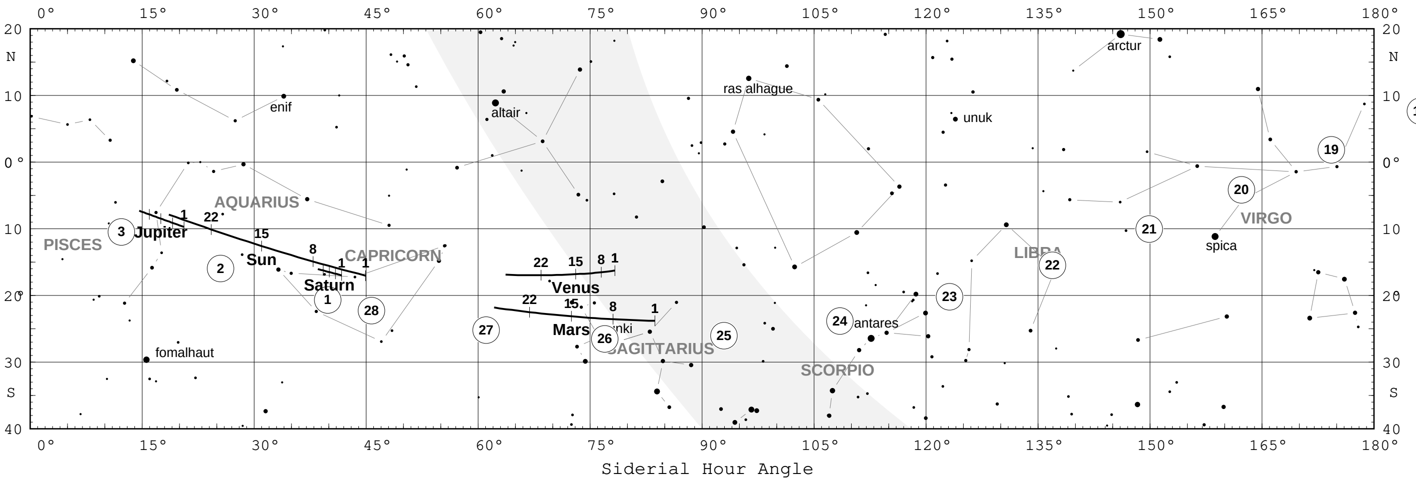

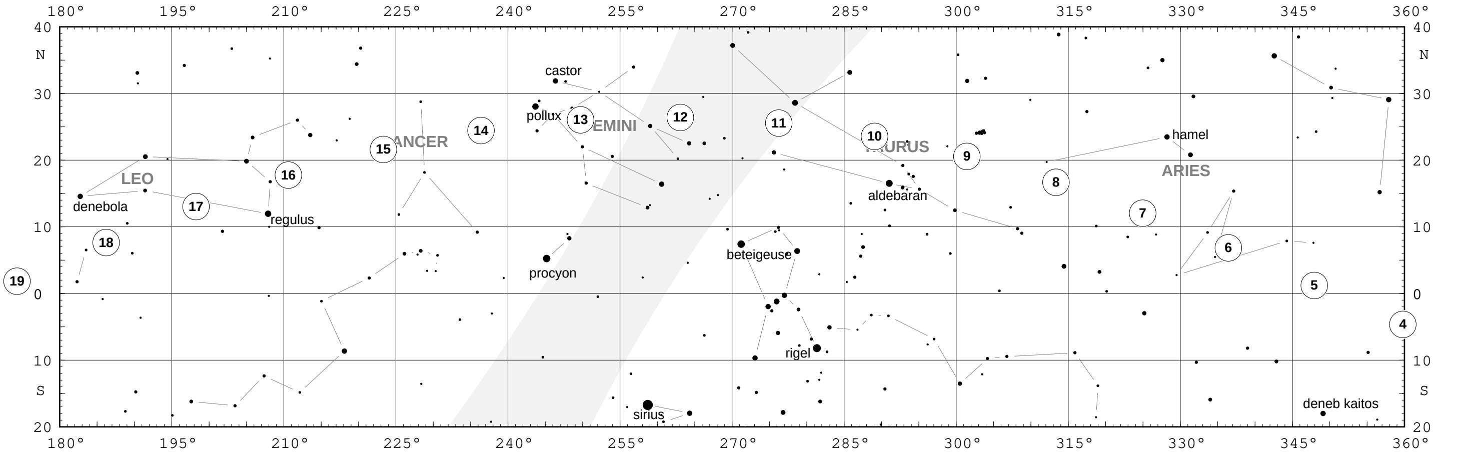

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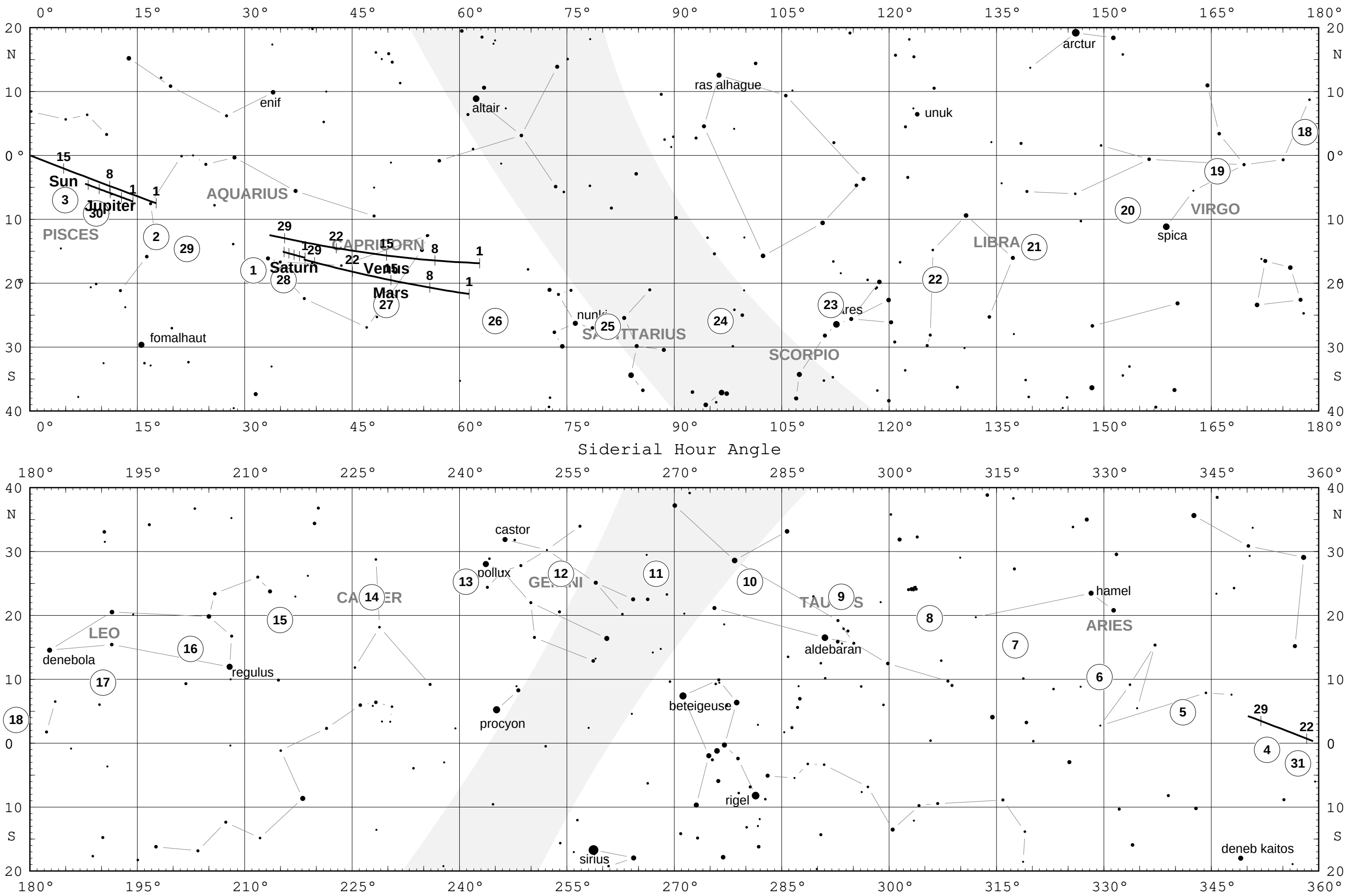

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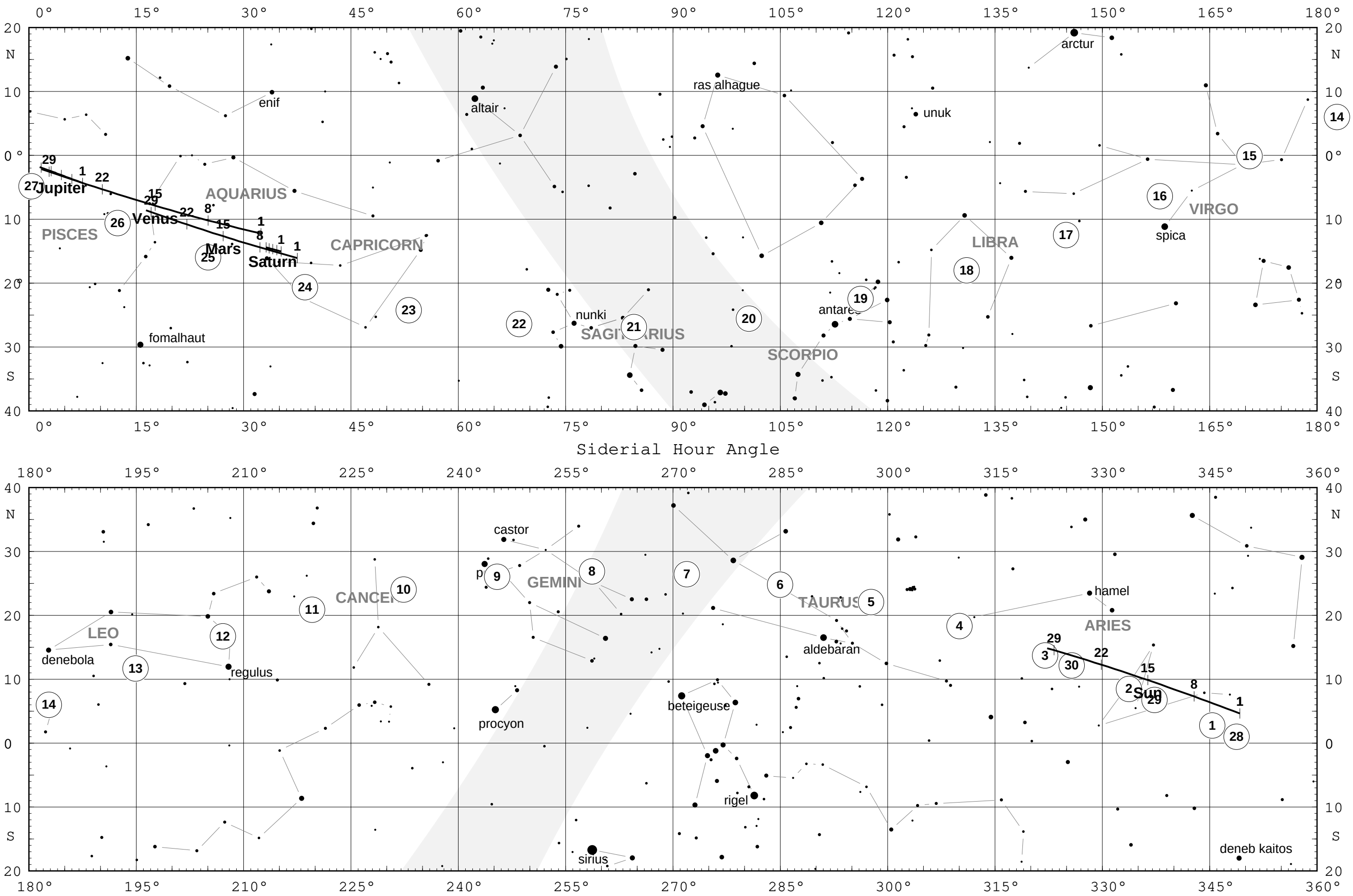

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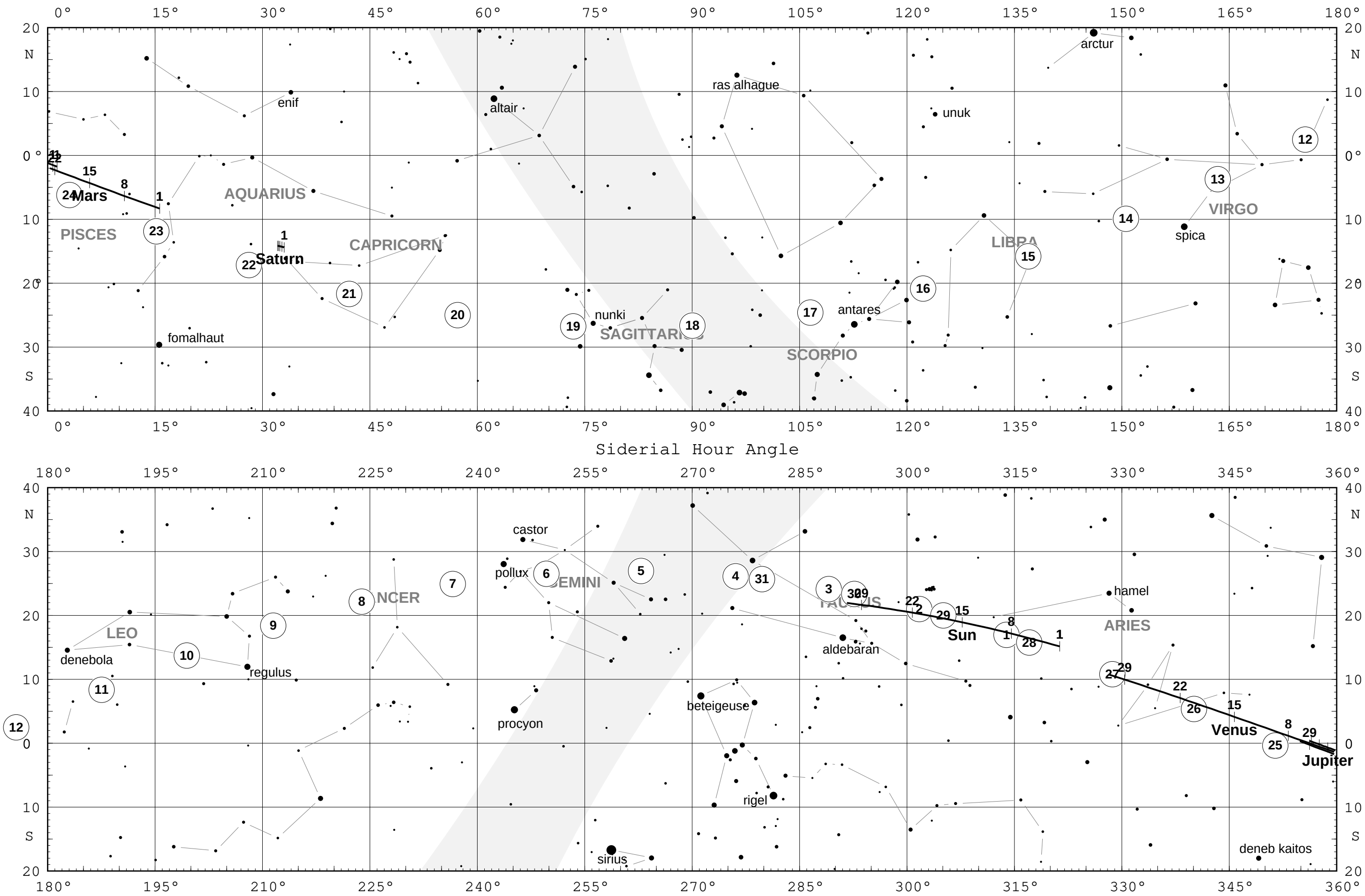

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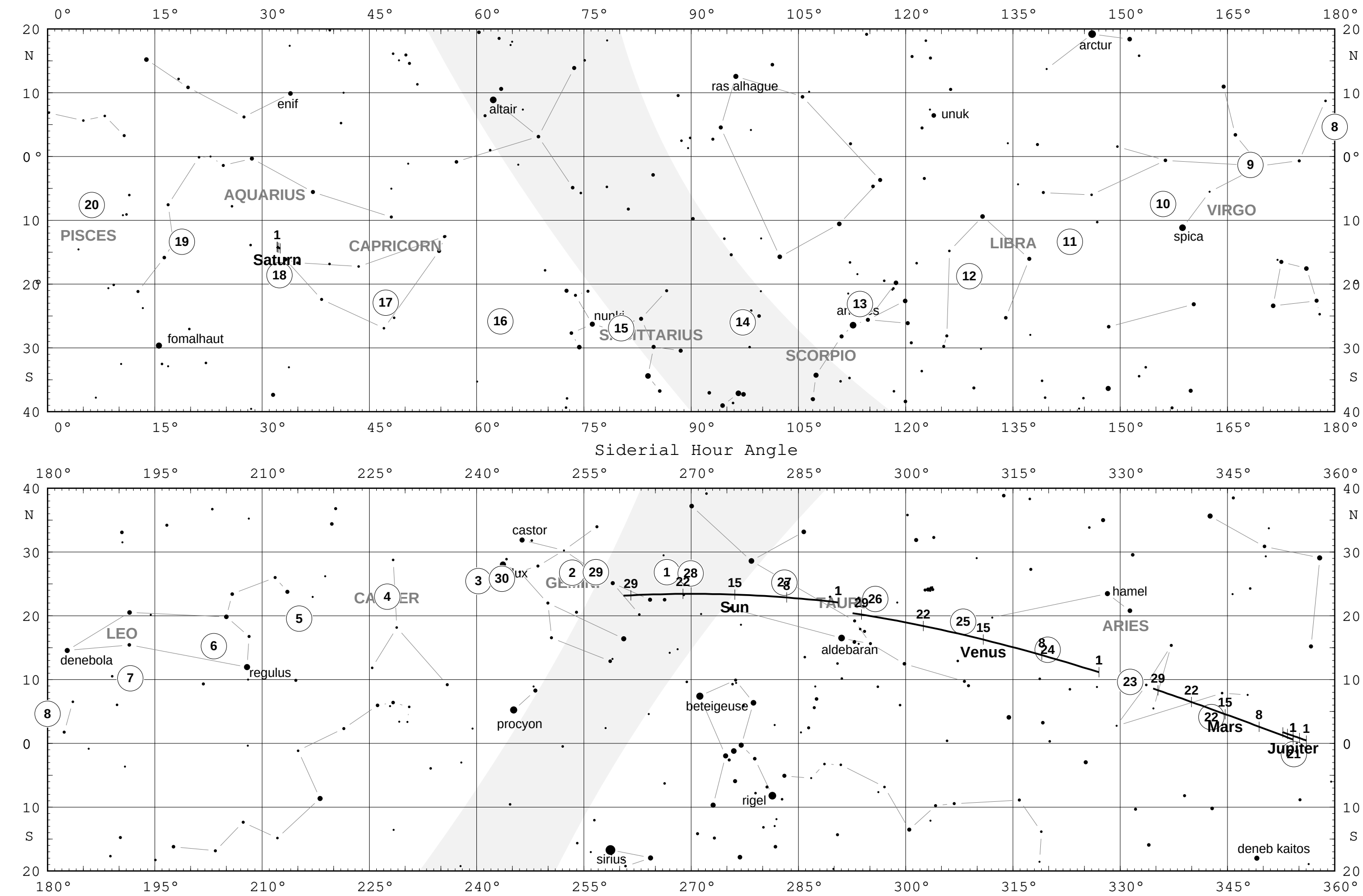

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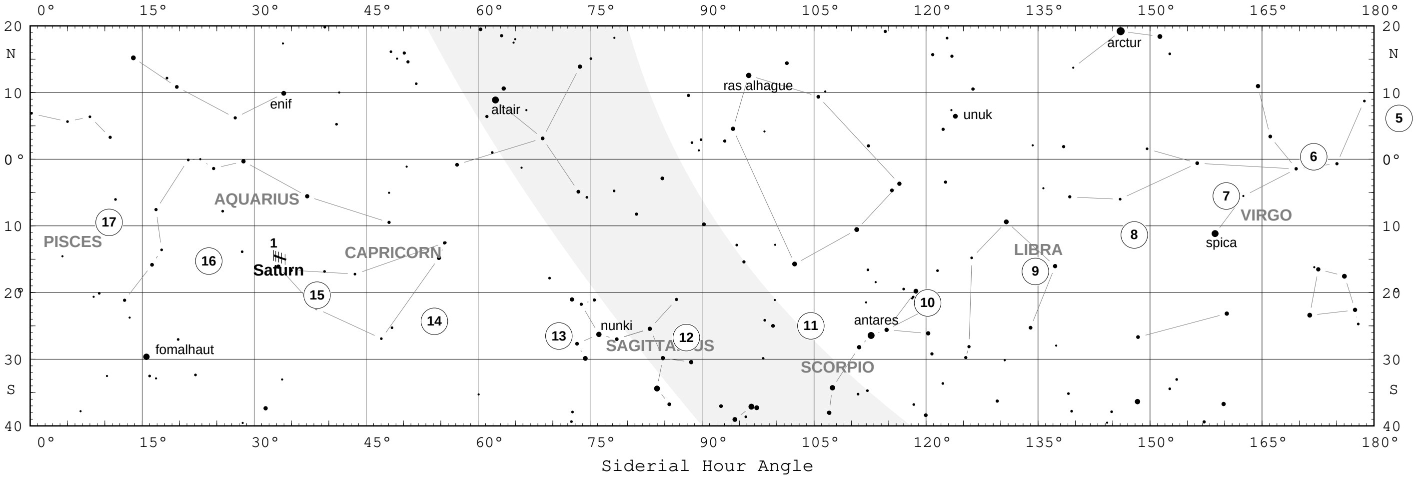

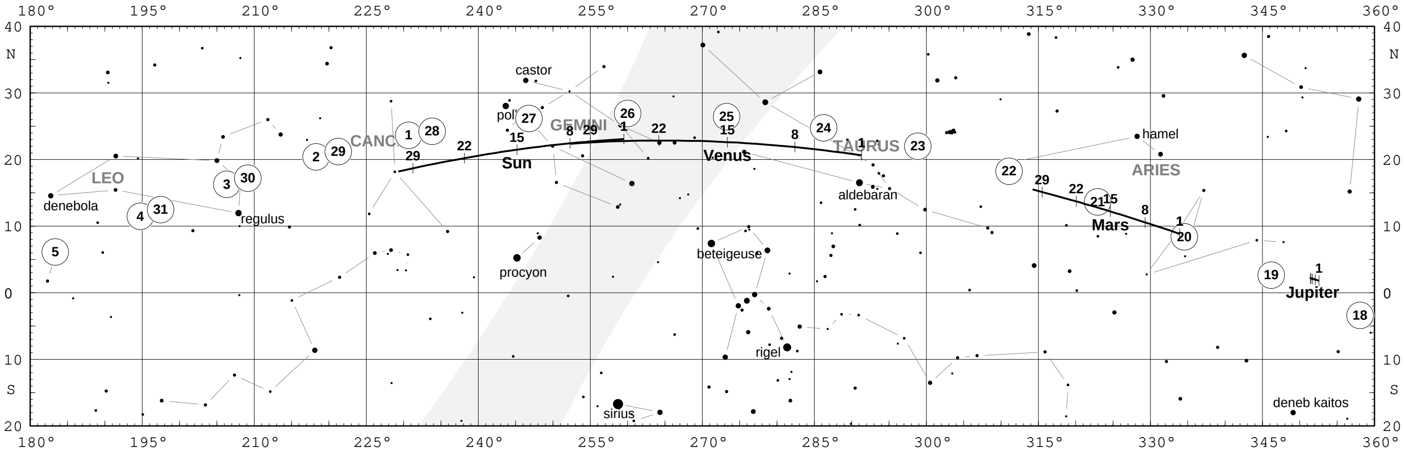

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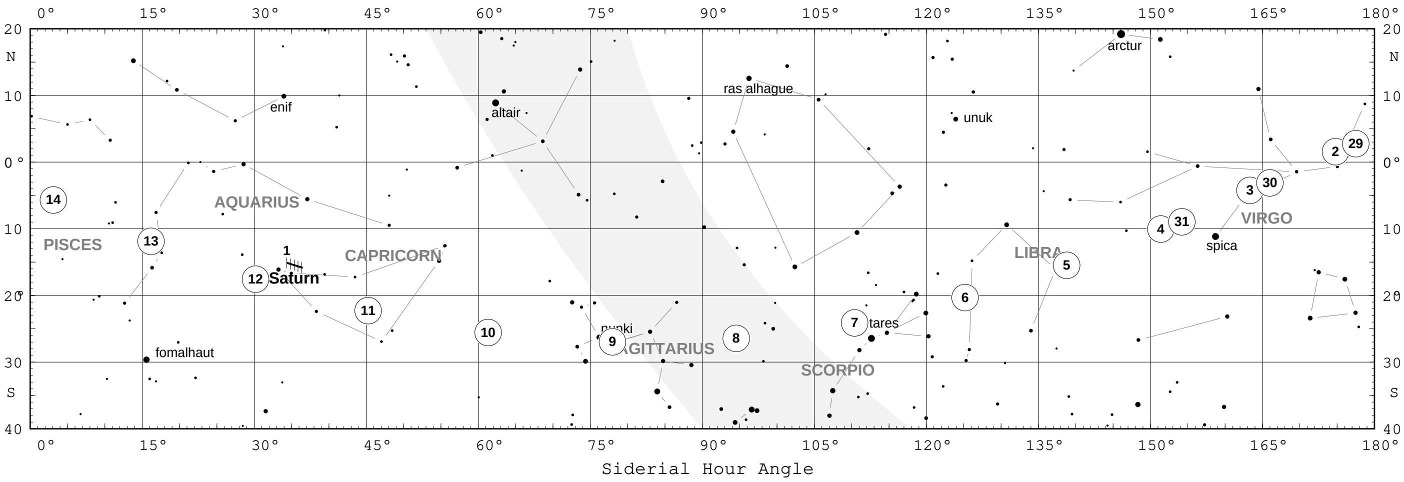

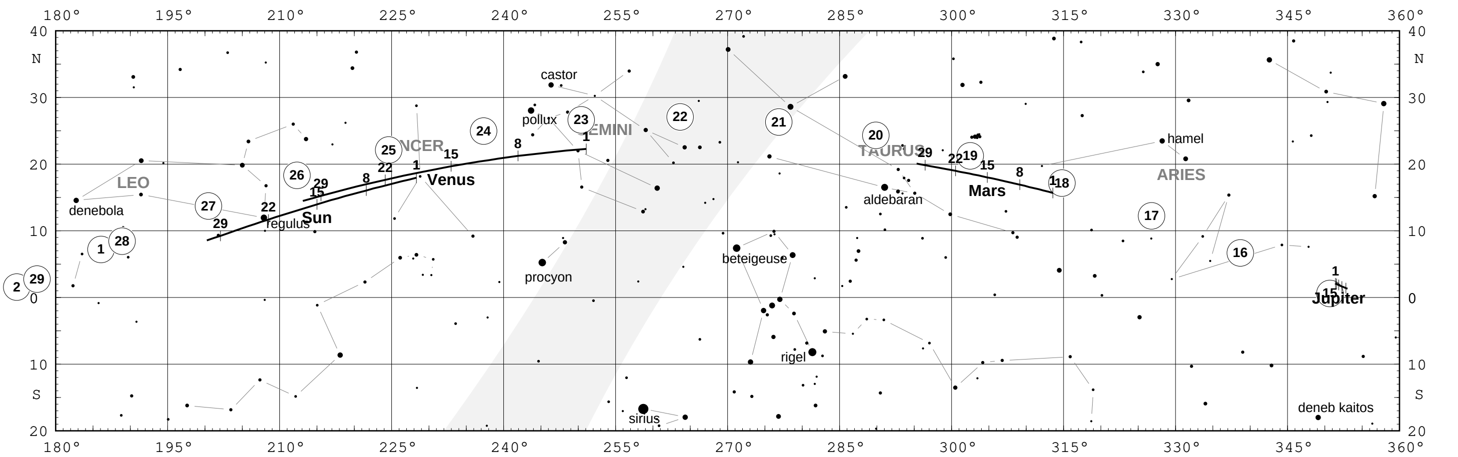

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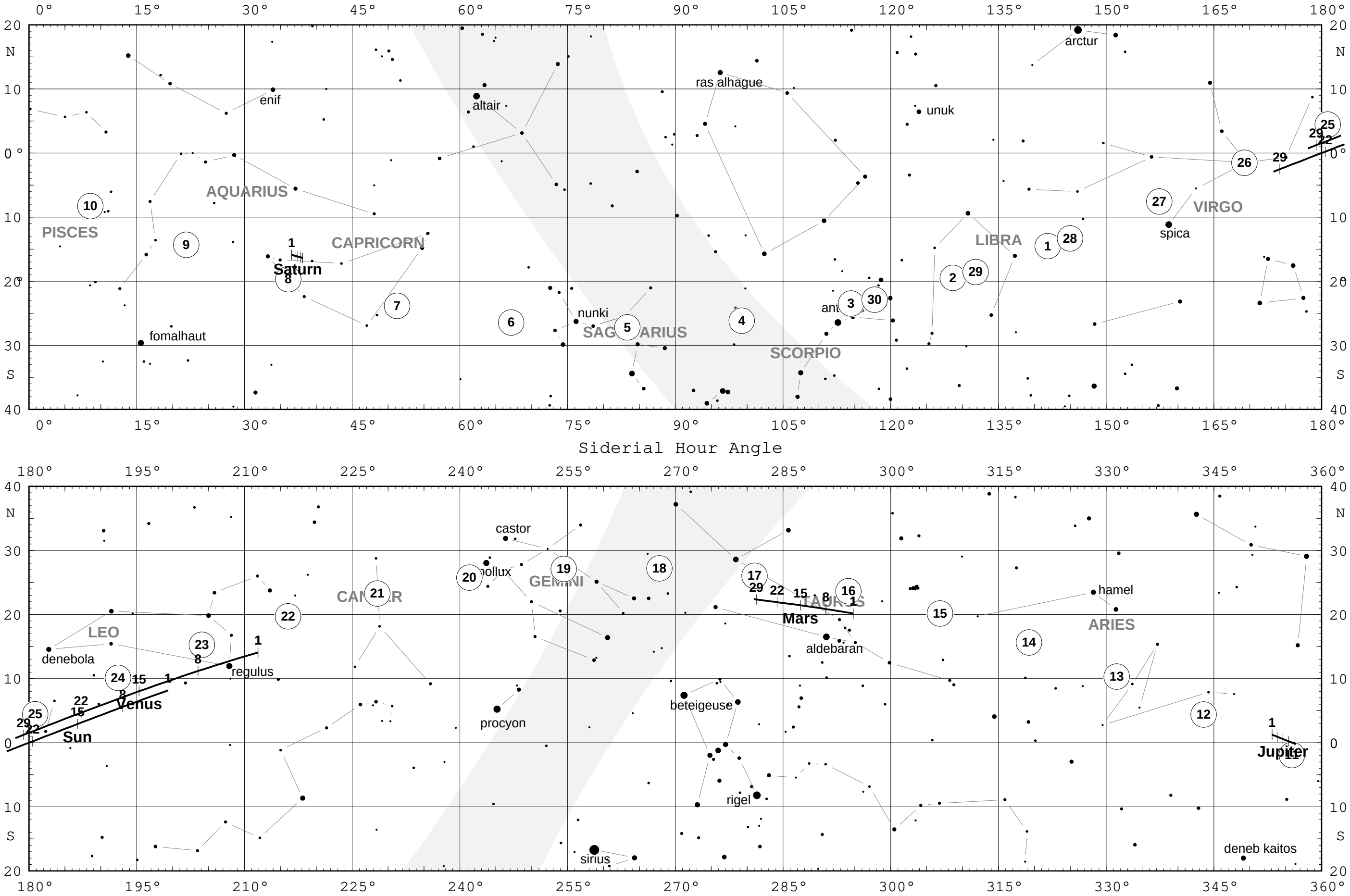
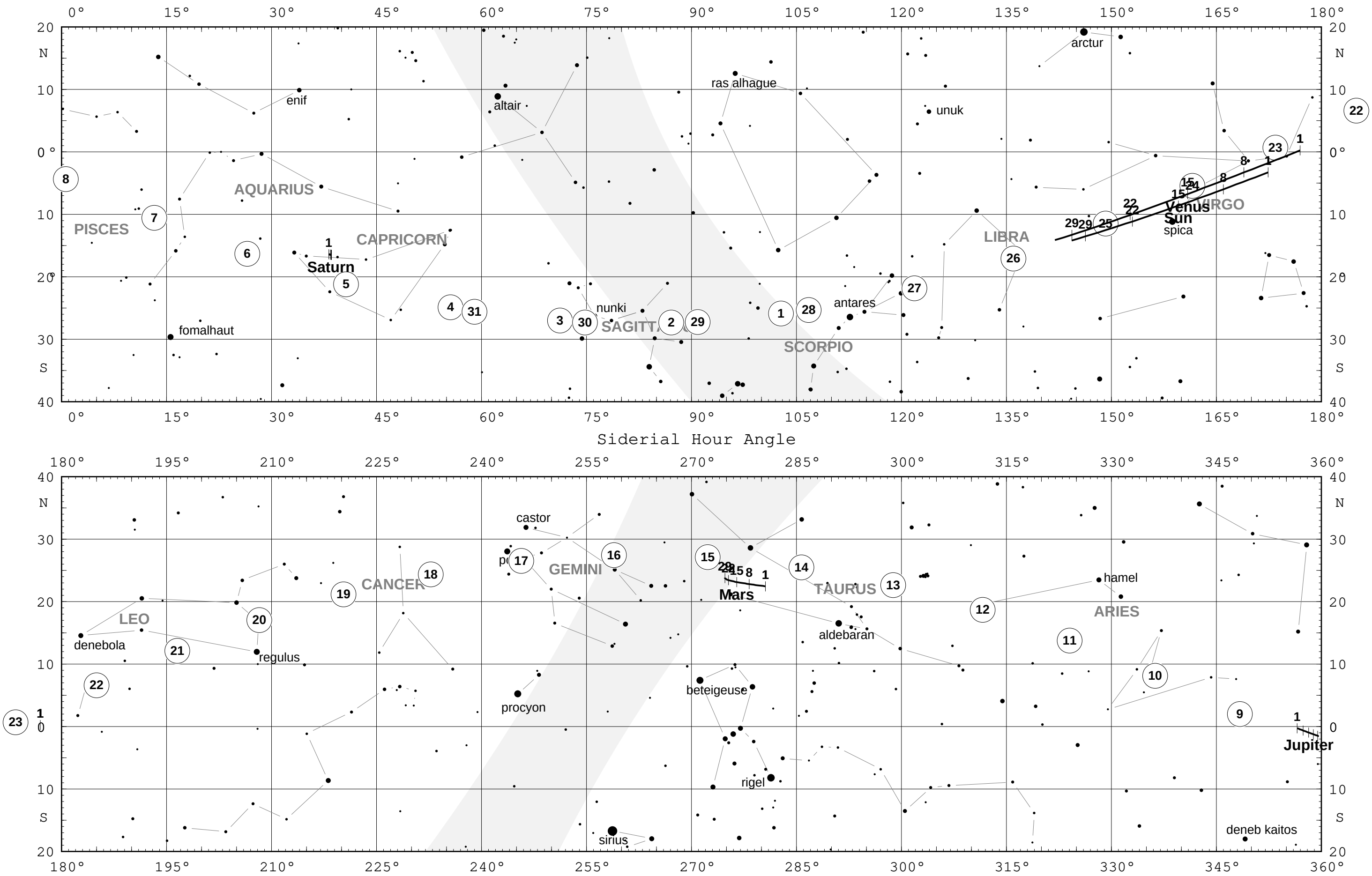
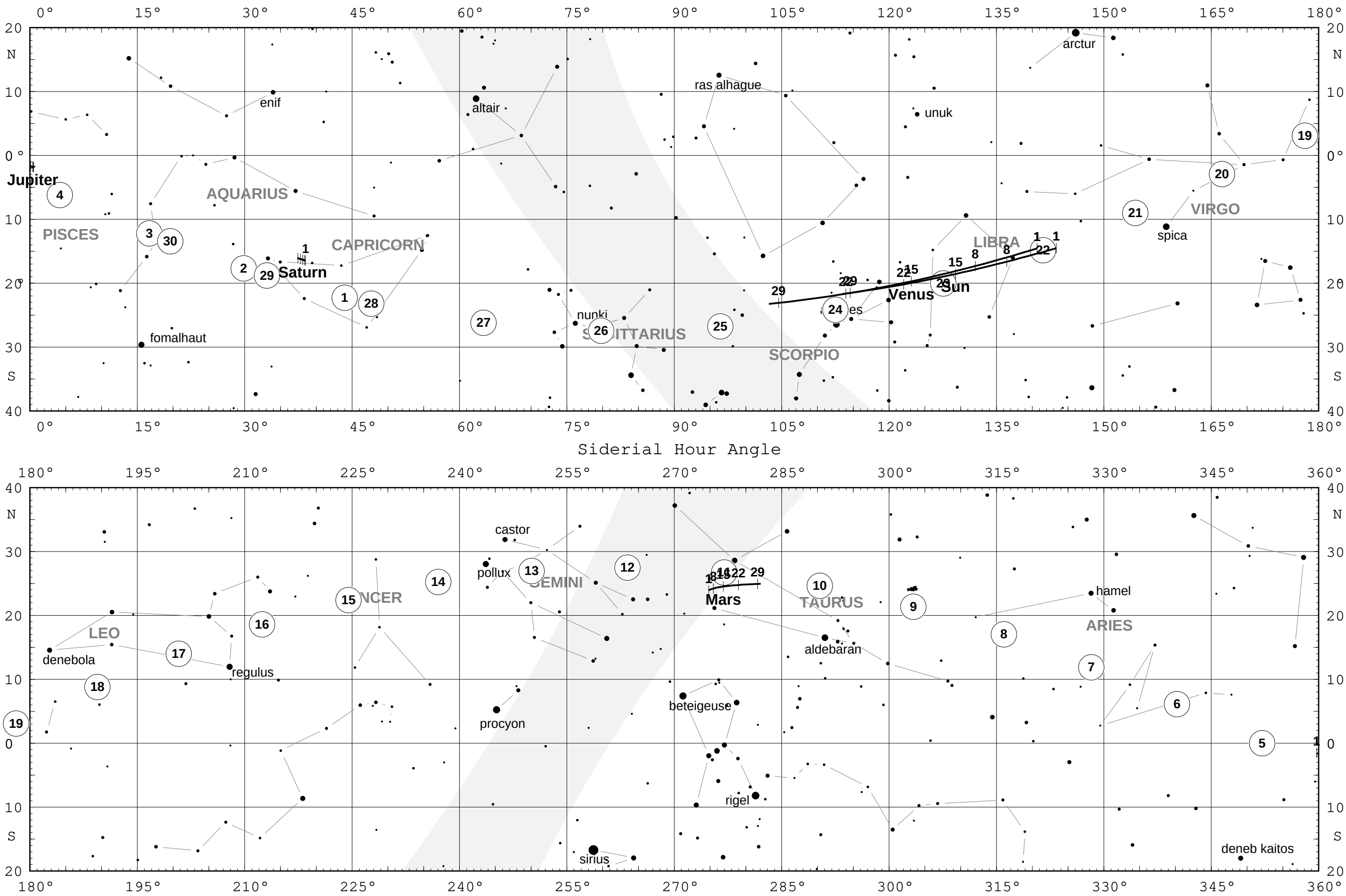


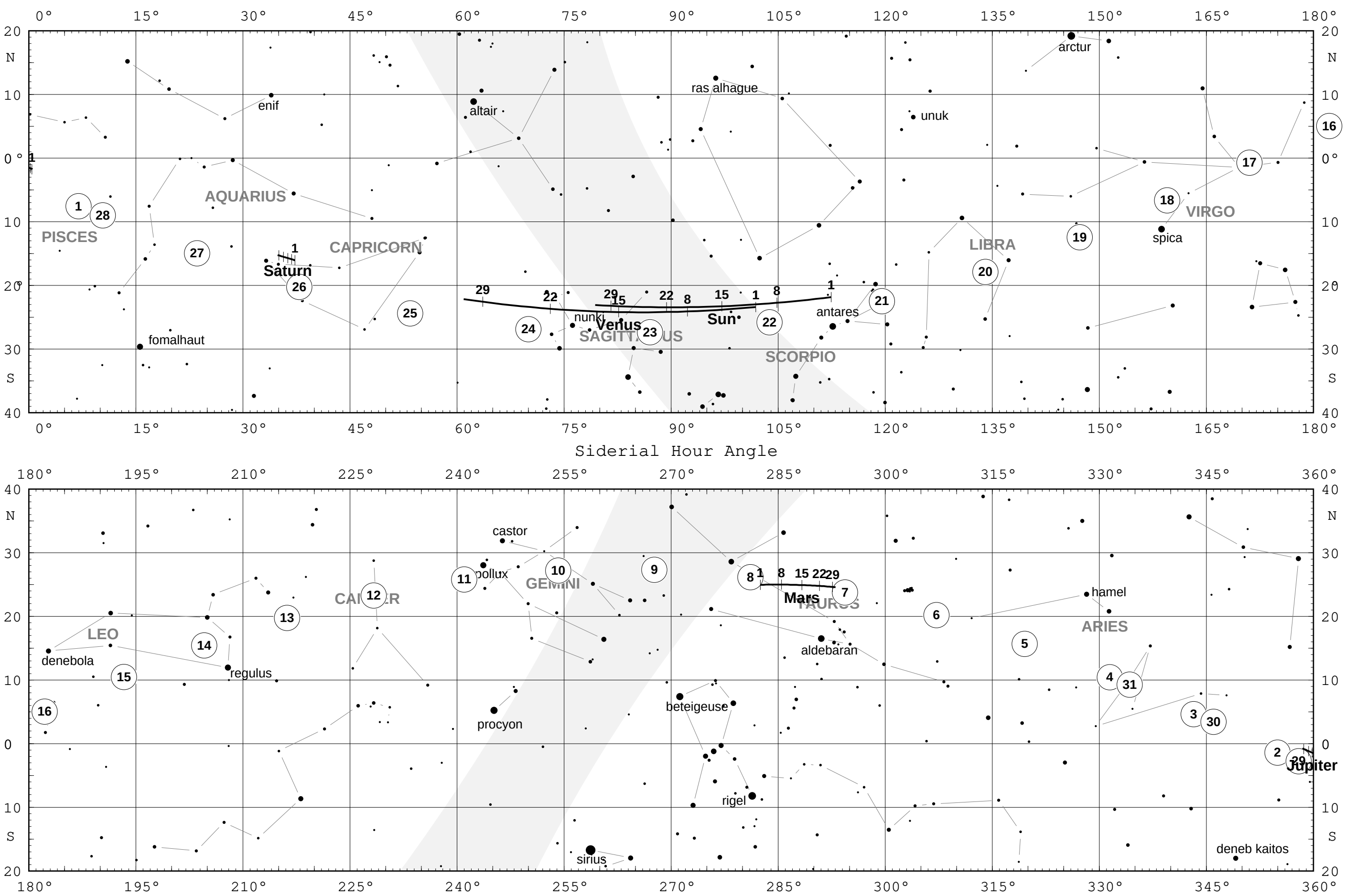
October 2022



November 2022



December 2022



Phases of the Moon

The following table lists the phases of the Moon through the year 2022. The table shows the day and the approximate time (in UTC) when the particular lunar phases occur. The calculations are based on the difference between the GHA of the Sun and the GHA of the Moon (Delta_GHA = GHA_sun - GHA_moon). The constellations "new moon", "first quarter", "full Moon" and "last quarter" are obtained when Delta_GHA is equal to 0°, 90°, 180° and 270° respectively.

	New Moon	**First Quarter**	**Full Moon**	**Last Quarter**
January	Sun 2 18:02	Sun 9 22:30	Mon 17 21:58	Tue 25 21:39
February	Tue 1 03:19	Wed 9 00:08	Wed 16 13:11	Thu 24 05:19
March	Wed 2 13:51	Thu 10 14:32	Fri 18 03:41	Fri 25 04:09
April	Fri 1 03:26 Sat 30 19:41	Fri 8 23:25	Sat 16 17:15	Sat 23 02:12
May	Mon 30 12:01	Sun 8 10:31	Mon 16 04:21	Sun 22 07:00
June	Wed 29 02:25	Tue 7 05:34	Tue 14 12:05	Mon 20 23:28
July	Thu 28 15:16	Thu 7 05:09	Wed 13 17:28	Wed 20 21:58
August	Sat 27 04:20	Fri 5 20:26	Thu 11 22:47	Fri 19 14:32
September	Sun 25 18:52	Sat 3 23:47	Sat 10 06:40	Sat 17 23:49
October	Tue 25 10:04	Sun 2 21:01 Mon 31 19:49	Sun 9 18:58	Mon 17 08:02
November	Wed 23 23:34	Wed 30 04:15	Tue 8 11:11	Tue 15 23:10
December	Fri 23 10:12	Fri 30 02:01	Thu 8 04:47	Fri 16 02:55
Tidal Phase	spring	neap	spring	neap

Lunar Phases and Tides

The lunar phases may be used to roughly estimate the occurrence of spring and neap tides. Spring tide occurs around new and full moon. Neap tide occurs around the first and last quarter.
Each tidal region on Earth, has a characteristic "tidal delay" which, specifies the time difference between the occurrence of a particular lunar phase and the occurrence of the resulting tidal phase. The tidal delay can be a couple of hours for the open seas, or up to several days for branched tidal waters such as parts of the North Sea.

Reliable tidal predictions are obtained from a Tidal Almanac.

Lunar Eclipses

An eclipse of the Moon - or lunar eclipse - can only occur at Full Moon, and only if the Moon passes through some portion of the Earth’s shadow. The Earth’s shadow is composed of two concentric cone-shaped components. The outer or penumbral shadow is a region where the Earth blocks part (but not all) of the Sun’s light from reaching the Moon. The inner or umbral shadow is a region where the Earth blocks all direct sunlight from reaching the Moon. Based on this, three types of lunar eclipses are distinguised:

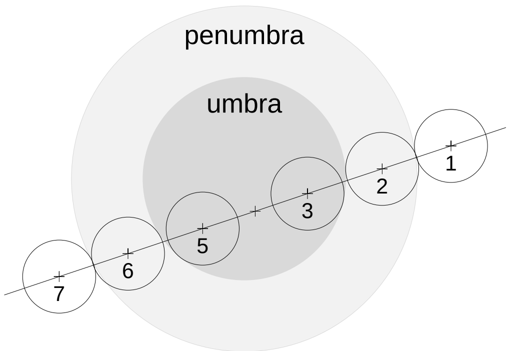
1. Penumbral Lunar Eclipse: the Moon passes through the Earth’s penumbral shadow. These kind of eclipses are subtle and very difficult to observe.
2. Partial Lunar Eclipse: a part of the Moon passes through the Earth’s umbral shadow.
3. Total Lunar Eclipse: the Moon passes entirely through the Earth’s umbral shadow. During this phase of the eclipse the Moon will take a vibrant range of dark red and brown colors.

NOTICE: Eclipse contact times depend on the angular diameters of the Sun and Moon. The calculations in this Almanac are based on a perfect circular form for the limb of the Moon, and do not take into account effects of refraction of the sunlight in the Earth atmosphere. Since this is only an approximation of reality, contact times are accurate only within a couple of minutes.

The following lunar eclipses may be observed during the year 2022:

May 16 : a total lunar eclipse begin [May 16, 01:40 UTC] / end [May 16, 06:45 UTC]

Rp = 1.295°
Ru = 0.762°
SD = 0.275°



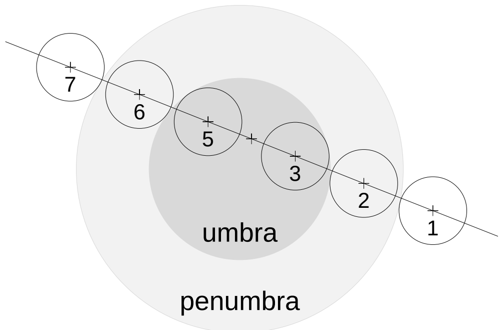
May 16

1 -	01:40	UTC	begin of penumbral eclipse (P1)
2 -	02:34	UTC	begin of partial eclipse (U1)
3 -	03:32	UTC	begin of total eclipse (U2)
	04:12	UTC	moment of greatest eclipse
5 -	04:53	UTC	end of total eclips (U3)
6 -	05:51	UTC	end of partial eclipse (U4)
7 -	06:45	UTC	end of penumbral eclipse (P4)

May 16

November 8 : a total lunar eclipse begin [Nov 8, 08:09 UTC] / end [Nov 8, 13:52 UTC]

Rp = 1.226°
Ru = 0.682°
SD = 0.255°



November 8

1 -	08:09	UTC	begin of penumbral eclipse (P1)
2 -	09:14	UTC	begin of partial eclipse (U1)
3 -	10:19	UTC	begin of total eclipse (U2)
	11:00	UTC	moment of greatest eclipse
5 -	11:41	UTC	end of total eclips (U3)
6 -	12:46	UTC	end of partial eclipse (U4)
7 -	13:52	UTC	end of penumbral eclipse (P4)

November 8

Solar Eclipses

An eclipse of the Sun - or solar eclipse - can only occur at New Moon, and only if the Earth passes through some portion of the Moon's shadow. Seen from the Earth, the Moon passes in front of the Sun and thus a part - or all - of the light of the Sun is eclipsed. The shadow cast by the Moon is composed of two concentric cone-shaped components. The outer or *penumbral* shadow zone is the region where the Moon blocks a part of the sunlight. The inner or *umbral* shadow zone is a region where the Moon blocks all sunlight. Based on this, three types of solar eclipes may be distinguised:

1. Total solar eclipse: occurs when the umbra of the Moon's shadow touches a region on the surface of the Earth.
2. Partial solar eclipse: occurs when the penumbra of the Moon's shadow passes over a region on the Earth's surface.
3. Annular solar eclipse: occurs when a region on the Earth's surface is in line with the umbra, but the distances are such that the tip of the umbra does not reach the Earth's surface

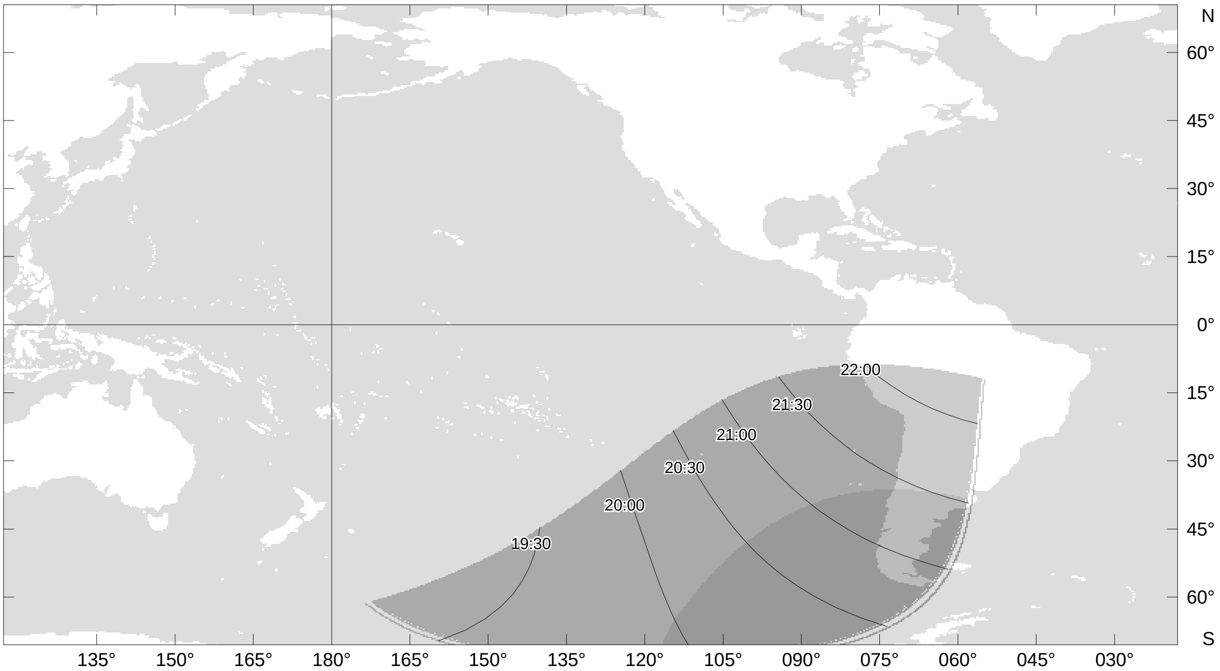
Because of the relative sizes of the Moon and Sun and their specific distances from the Earth, only a small part of the Earth surface is covered by the Moon shadow during a solar eclipse. Especially the path of totality is usually very narrow (a few hundreds of kilometers across). A much broader region is covered by the penumbral shadow of the Moon. However, an observer in this region will see only a partial solar eclipse.

The appearance of a specific solar eclipse can be summarized conveniently by mapping the path of totality and the region covered by the penumbral shadow of the Moon for the complete duration the eclipse. The lines of constant time, included in the charts, indicate the instances of greatest eclipse.

Warning: never look directly at the Sun without proper eye protection, even during an eclipse. Even when the Sun is partially covered, your eyes can be seriously damaged by looking directly at it. Sunglasses are not an adequate eye protection for viewing the Sun.

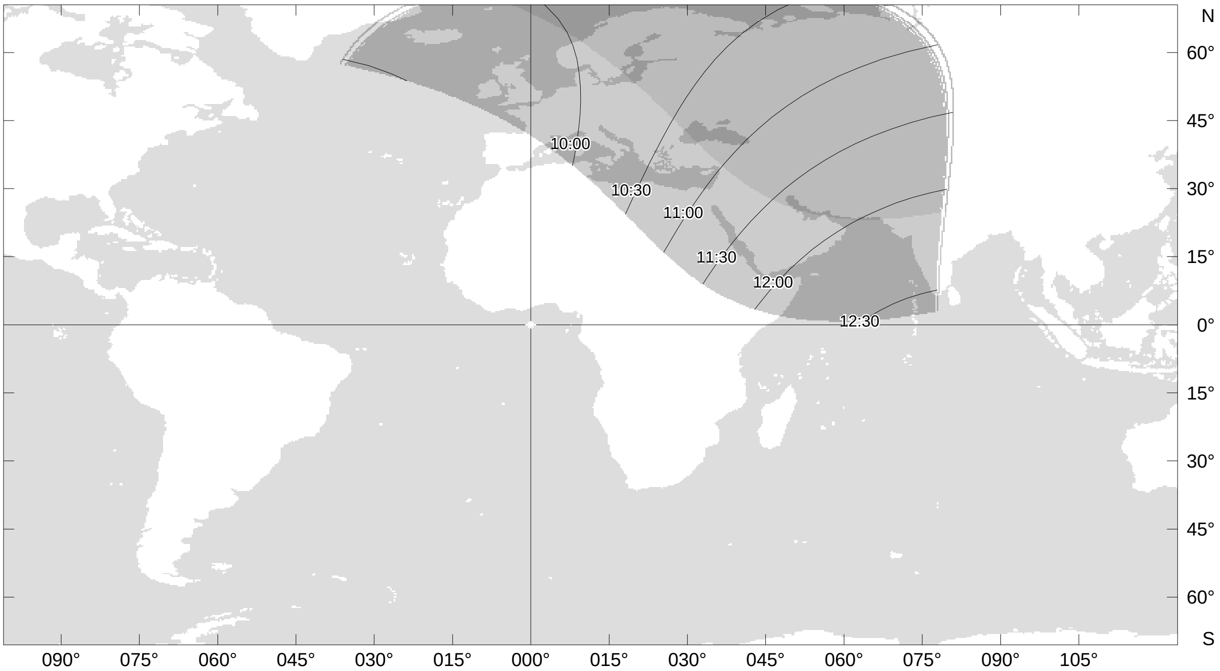
The following solar eclipses may be observed during the year 2022:

April 30 : **partial solar eclipse** begin [Apr 30, 18:45 UT] / end [Apr 30, 22:38 UT]



Circumstances at Moment of Greatest Eclipse		Fist Contacts (P1/U1)	Last Contacts (U4/P4)
Time:	20:39 UT	Penumbra	Penumbra
		18:45 UT	22:38 UT

October 25 : **partial solar eclipse** begin [Oct 25, 08:58 UT] / end [Oct 25, 13:02 UT]



Circumstances at Moment of Greatest Eclipse		Fist Contacts (P1/U1)	Last Contacts (U4/P4)
Time:	10:58 UT	Penumbra	Penumbra
		08:58 UT	13:02 UT

Equation of Time

The "Equation of Time" is the difference between the Apparent Solar Time and the Mean Solar Time at the Prime Meridian of Greenwich. The value for the Equation of Time (EoT) for a specific day can be obtained from the Nautical Almanac. The section of the Sun records the "Greenwich Culmination Time" (GCT), which is the UT time at which the Geographical Position of the Sun transits the Prime Meridian of Greenwich. This is also the UT time of Local Apparent Noon for the Prime Meridian. Thus, the value for the Equation of Time is obtained from: EoT = 12:00:00 - GCT.

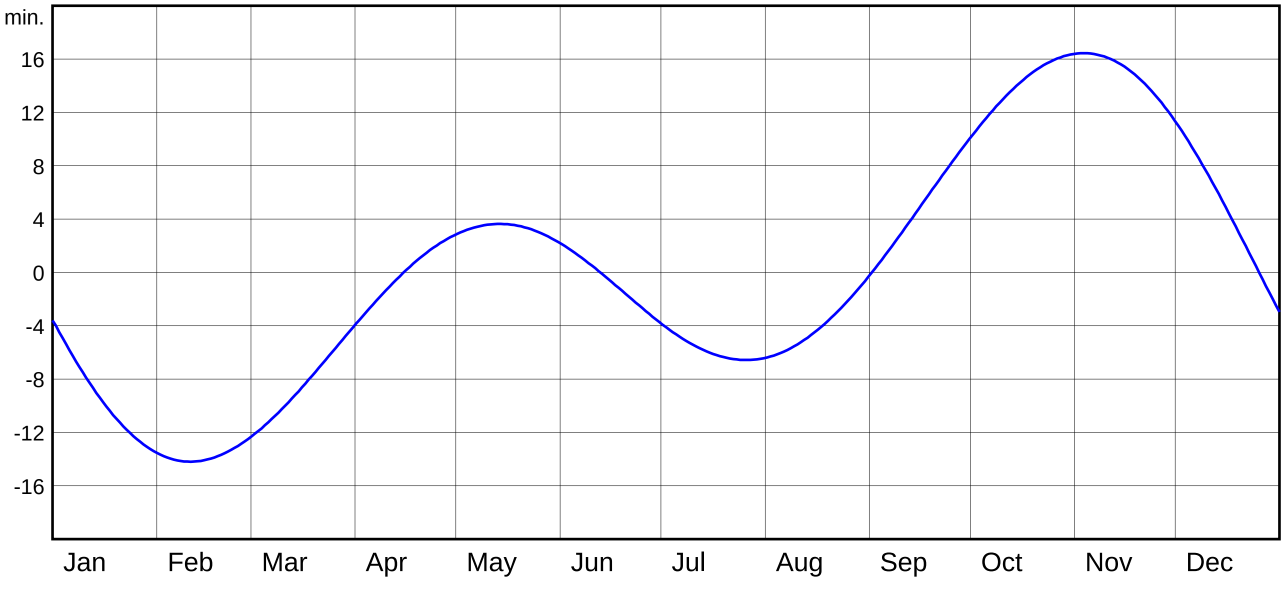
Examples:

```
GCT = 11:57:23
EoT = 12:00:00 - 11:57:23 = +00:02:37
```

```
GCT = 12:01:57
EoT = 12:00:00 - 12:01:57 = -00:01:57
```

Notice that EoT has a sign: positive if the Sun "culminates" before 12 UT (then Apparent Time is "leading" Mean Time) and negative if the Sun "culminates" after 12 UT (then Apparent Time is "lagging" Mean Time).

The graph below shows the values for the "Equation of Time" (in Minutes) for the year 2022.



Nautical Almanac

The following pages contain the coordinates of the Geographical Position (in Greenwich Hour Angle and Declination) for each integral hour of the year for the recorded celestial objects. Each page compiles the complete Almanac data for one day of the year. The time used in this Almanac is Universal Time (UT).

NOTICE:
This Nautical Almanac uses a slightly different approach for the interpolation of the integral-hour values of Greenwhich Hour Angle and Declination, compared to the techniques used in most commercially available Almanacs.
For more information please refer to the following web site: *"http://www.siranah.de/"*

Abbreviations used in the Almanac tables:		**Units:**	
UT	Universal Time		
GHA	Greenwich Hour Angle	°	[degrees]
Dec	Declination	°	[degrees]
ddGHA	the increment of the GHA value for the next hour of time, additional to the "linear" increment of 15°/h	'	[minutes of arc]
dDec	the increment of the Dec value for the next hour of time	'	[minutes of arc]
SD	Semi-Diameter of the celestial object	'	[minutes of arc]
HP	Horizontal Parallax	'	[minutes of arc]
SHA	the Siderial Hour Angle of the celestial object	°	[degrees]
A	the "Age" of the moon cycle, according to the following scheme:	A = 00%: new moon	
		A = 25%: first quarter	
		A = 50%: full moon	
		A = 75%: last quarter	