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It contains material that has been copyrighted by Sky and Telescope magazine. These include snips from the Skygazer's Almanac © 2013 Sky & Telescope, as well as old copies of the Graphical Almanac made in 1942.

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It also contains some old snippets of the Nautical Almanac, which is – to the best of my knowledge – is not copyrighted because it has been published by the US Government.

Otherwise, it is copyrighted by the Astronomical Society of Bay County. Although it has been read and commented-on by various people, remaining errors are the fault of the author.

# Reading the Skygazer's Almanac in Sky & Telescope

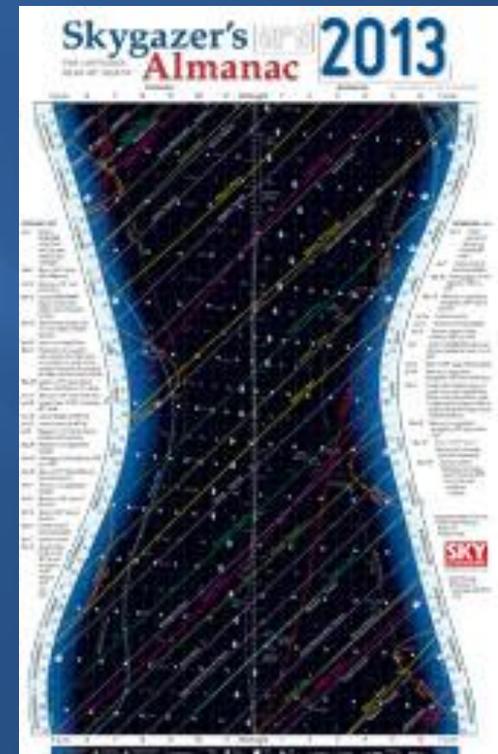
Or finding out more info than you ever thought possible  
By Dick Suiter

Every January issue, they toss in a free insert with *Sky & Telescope* magazine that looks like this:

Most people never look at it again or throw it away. (C'mon, confess!)

This is a crying shame, because it is literally stuffed with interesting data

This is calculated now by senior contributing editor Roger W. Sinnott, but has appeared at least since 1942; then it was calculated by the Maryland Academy of Sciences in Baltimore. Roger took over in 1983.



# GRAPHIC PORTRAYAL OF CELESTIAL EVENTS

BY CARROLL F. MERRIAM

While still available, copies of the Graphic Time Table of the Heavens for 1942 may be secured without charge directly from the Maryland Academy of Sciences, 2724 N. Charles St., Baltimore, Md., by readers of *Sky and Telescope* and their friends and by teachers of astronomy for their classes. The latter may be interested in securing blueprints of the original before reproduction, size 40 by 27 inches, at cost of printing.

IN the center pages of this issue of *Sky and Telescope* is a facsimile reproduction of the Graphic Time Table of the Heavens for 1942, issued annually by the Maryland Academy of Sciences in Baltimore, Md. This is accompanied by directions for the use of this chart, but there

time to see Mercury as an evening star is in the spring, and as a morning star in the fall, as is shown by comparing the twilight curves with the rising and setting of this elusive planet. Furthermore, it is easy to pick out the six opportunities for best observing Mercury in each year, when

year. There were in that year two total eclipses of the moon which were visible in the United States; the solar eclipses

Probably original maker, but I'm not sure

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## JUPITER, 1914. GREENWICH MEAN TIME.

SEPTEMBER.						OCTOBER.					
Day of Month.	Apparent Right Ascension.	Var. of R. A. for 1 Hour.	Apparent Declination.	Var. of Decl. for 1 Hour.	Meridian Passage.	Day of Month.	Apparent Right Ascension.	Var. of R. A. for 1 Hour.	Apparent Declination.	Var. of Decl. for 1 Hour.	Meridian Passage.
	Noon.	Noon.	Noon.	Noon.			Noon.	Noon.	Noon.	Noon.	
	h m s	s	° ' "	"	h m		h m s	s	° ' "	"	h m
1	21 9 51.63	-1.091	-17 25 14.6	-4.84	10 28.7	1	21 1 16.31	-0.268	-18 1 6.4	-0.93	8 22.3
2	21 9 25.68	1.071	17 27 9.5	4.73	10 24.4	2	21 1 10.28	0.235	18 1 27.0	0.78	8 18.3
3	21 9 0.19	1.051	17 29 1.9	4.61	10 20.0	3	21 1 5.03	0.202	18 1 44.1	0.64	8 14.3
4	21 8 35.18	1.031	17 30 51.7	4.52	10 15.7	4	21 1 0.58	0.169	18 1 57.8	0.50	8 10.3
5	21 8 10.68	1.010	17 32 38.8	4.40	10 11.3	5	21 0 56.93	0.135	18 2 8.0	0.35	8 6.3

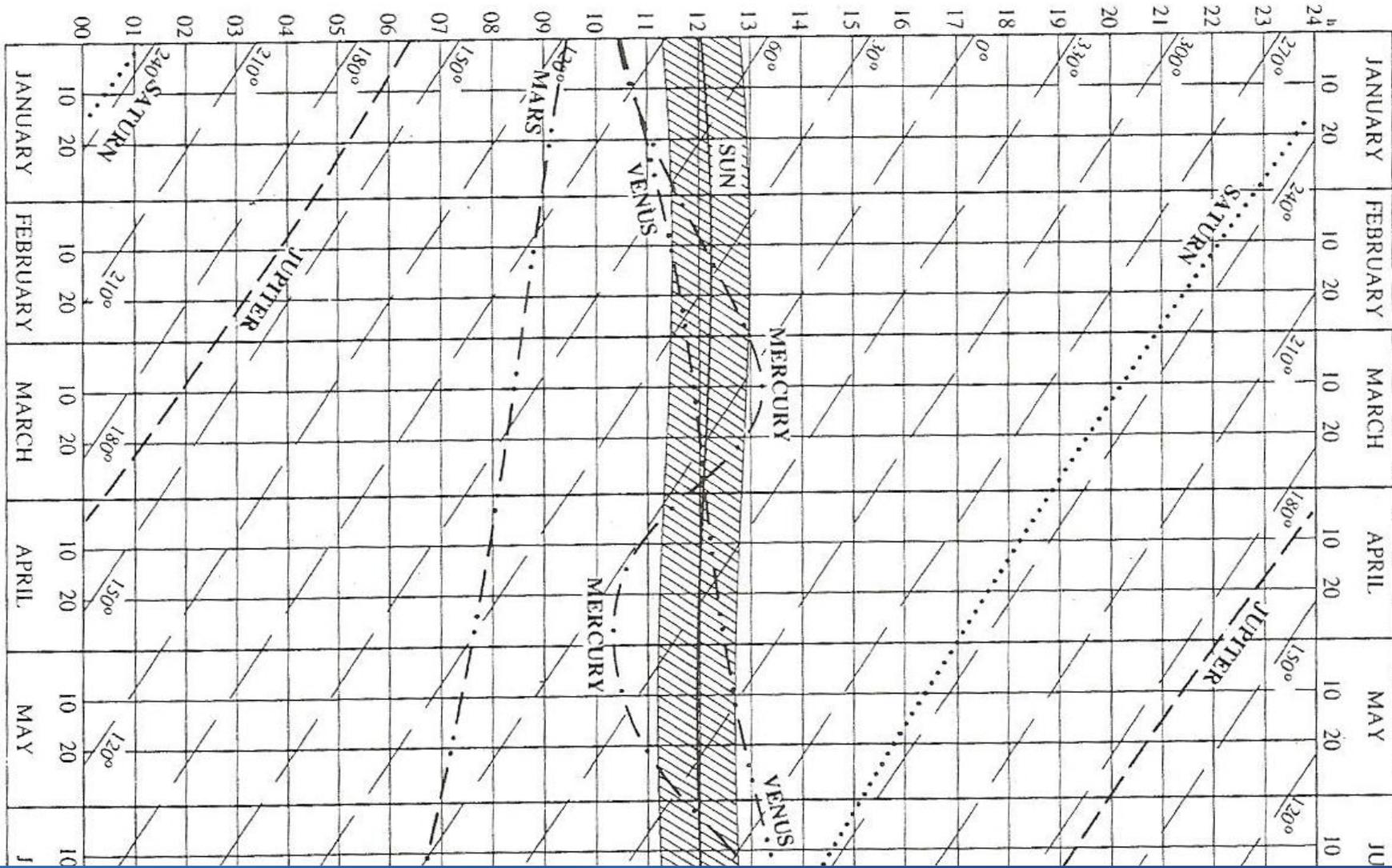
From an old USNO astronomical almanac

-- also plotted from something called  
Astronomical Phenomena

There are roughly equivalent things in the Nautical Almanac (this one from 2005)



### LOCAL MEAN TIME OF MERIDIAN PASSAGE



$HP$  = horizontal parallax of the Sun, Moon, Venus or Mars.  
 $PA$  = parallax in altitude of the Sun, Moon, Venus or Mars.  
 $S$  = semi-diameter of the Sun or Moon.  
 $p$  = intercept =  $H_O - H_C$ . Towards is positive, away is negative.  
 $T$  = course or track, measured as for azimuth from the north.  
 $V$  = speed in knots.

3. *Entering Basic Data.* When quantities such as  $GHA$  are entered, which in *The Nautical Almanac* are given in degrees and minutes, convert them to degrees and decimals of a degree by dividing the minutes by 60 and adding to the degrees; for example, if  $GHA = 123^\circ 45.6$ , enter the two numbers 123 and 45.6 into the memory and set  $GHA = 123 + 45.6/60 = 123.7600$ . Although four decimal places of a degree are shown in the examples, it is assumed that full precision is maintained in the calculations.

When using a computer or programmable calculator, write a subroutine to convert degrees and minutes to degrees and decimals. Scientific calculators usually have a special key for this purpose. For quantities like  $Dec$  which require a minus sign for southern declination, change the sign from plus to minus after the value has been converted to degrees and decimals, e.g.  $Dec = S 0^\circ 12.3 = S 0.2050 = -0.2050$ . Other quantities which require conversion are semi-diameter, horizontal parallax, longitude and latitude.

4. *Interpolation of  $GHA$  and  $Dec$ .* The  $GHA$  and  $Dec$  of the Sun, Moon and planets are interpolated to the time of observation by direct calculation as follows: If the universal time is  $a^h b^m c^s$ , form the interpolation factor  $x = b/60 + c/3600$ . Enter the tabular value  $GHA_0$  for the preceding hour ( $a$ ) and the tabular value  $GHA_1$  for the following hour ( $a + 1$ ) then the interpolated value  $GHA$  is given by

$$GHA = GHA_0 + x(GHA_1 - GHA_0)$$

If the  $GHA$  passes through  $360^\circ$  between tabular values add  $360^\circ$  to  $GHA_1$  before interpolation. If the interpolated value exceeds  $360^\circ$ , subtract  $360^\circ$  from  $GHA$ .

Similarly for declination, enter the tabular value  $Dec_0$  for the preceding hour ( $a$ ) and the tabular value  $Dec_1$  for the following hour ( $a + 1$ ), then the interpolated value  $Dec$  is given by

$$Dec = Dec_0 + x(Dec_1 - Dec_0)$$

5. *Example.* (a) Find the  $GHA$  and  $Dec$  of the Sun on 2005 January 17 at  $16^h 57^m 44^s$  UT.

The interpolation factor  $x = 57/60 + 44/3600 = 0.9622$

page 21  $16^h GHA_0 = 57^\circ 26.4 = 57.4400$

$17^h GHA_1 = 72^\circ 26.2 = 72.4367$

$16^h 9622 GHA = 57.4400 + 0.9622(72.4367 - 57.4400) = 71.8701$

$16^h Dec_0 = S 20^\circ 37.9 = -20.6317$

$17^h Dec_1 = S 20^\circ 37.4 = -20.6233$

$16^h 9622 Dec = -20.6317 + 0.9622(-20.6233 + 20.6317) = -20.6236$

$GHA$  Aries is interpolated in the same way as  $GHA$  of a body. For a star the  $SHA$  and  $Dec$  are taken from the tabular page and do not require interpolation, then

$$GHA = GHA \text{ Aries} + SHA$$

where  $GHA$  Aries is interpolated to the time of observation.

In the days before calculators and computers the navigation reduction procedure was closely related to constructing a graphical almanac

Although straightforward, it had to be incredibly tedious.

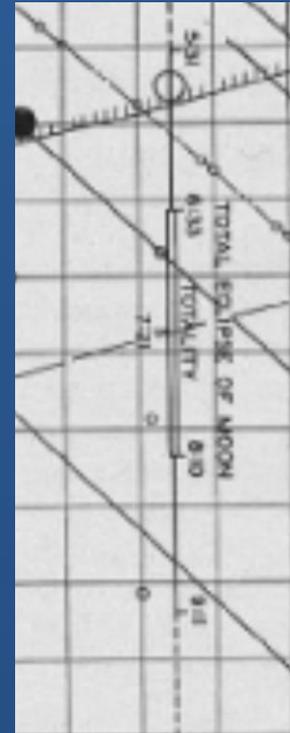
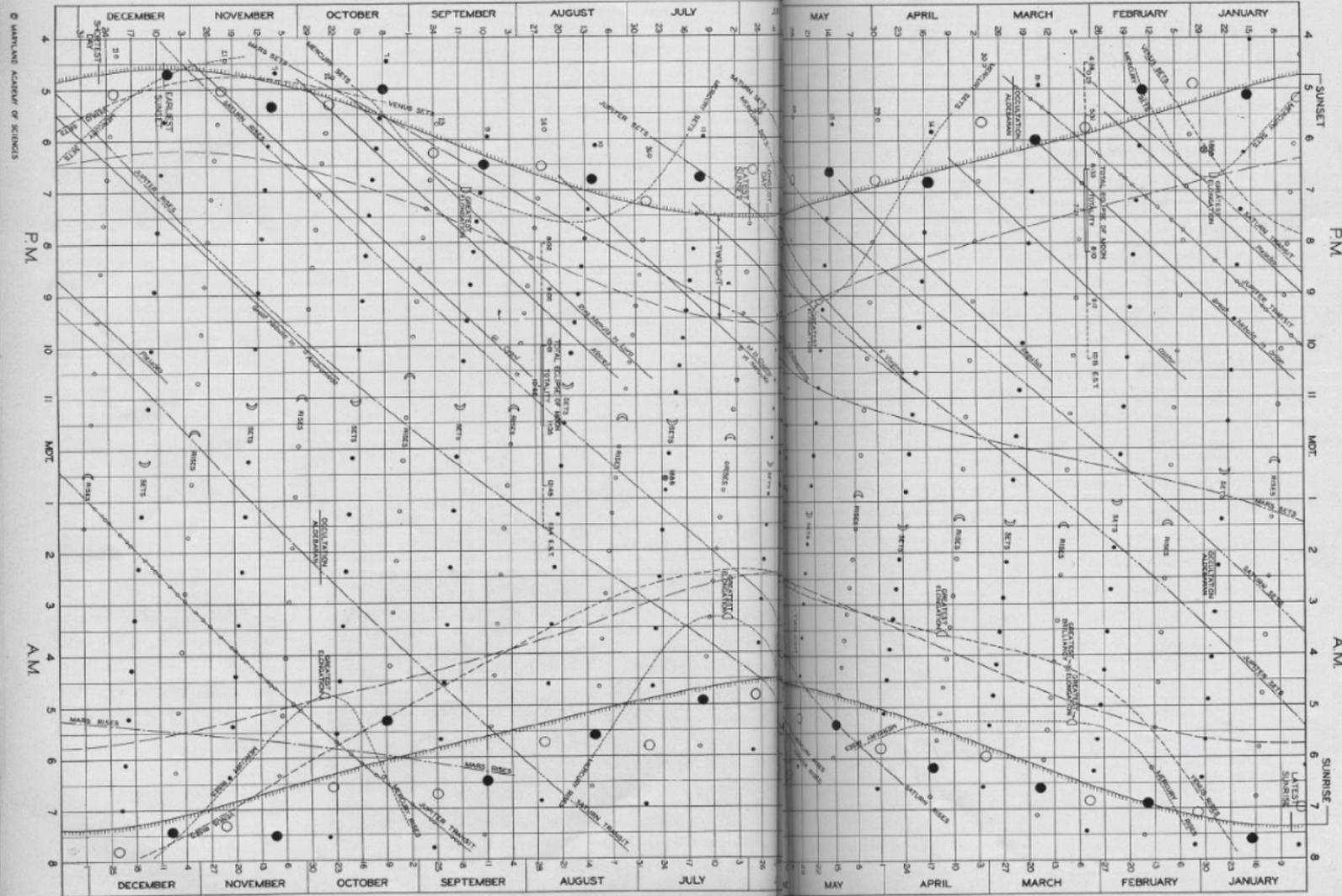
If precision or exact location was not necessary, then you could prepare a coarse overview of the entire year.

That became the original graphical almanac...

There has been a lot of refinement during the years, and a few losses (was once so heavily east-coast dominated that eclipses and occultations were included -- calculated for 40N 75W)

# Graphic Time Table The Heavens == 1942

PREPARED BY THE MARINE ACADEMY OF SCIENCES



Lunar eclipse times EST

Nowadays, this info easily computed by things like MICA 2.0 (the USNO's Multi-year Interactive Computer Almanac) or with planetarium programs like Stellarium, but the advantage of graphical presentation is that it still offers the least searching. For example, you can easily locate the opposition of Saturn (or any more distant planet) visually just by sliding your finger along the planet's transit line until it crosses midnight.

OPPOSITIONS WITH SUN

From: 2013 Jan 01 To: 2013 Dec 31

Object	Date (TT)	Geocentric						
		R.A.			Declination			
		d	h	m	s	°	'	"
Saturn	2013 Apr 28	8:28	14	26	54	-11	42	04

GREATEST ELONGATIONS

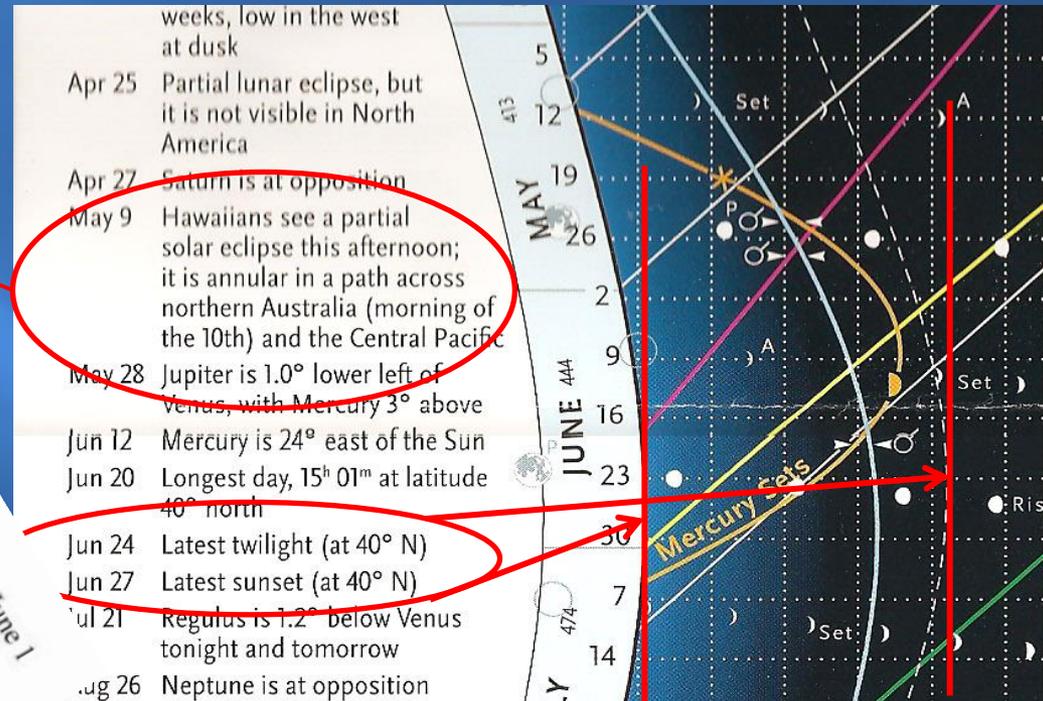
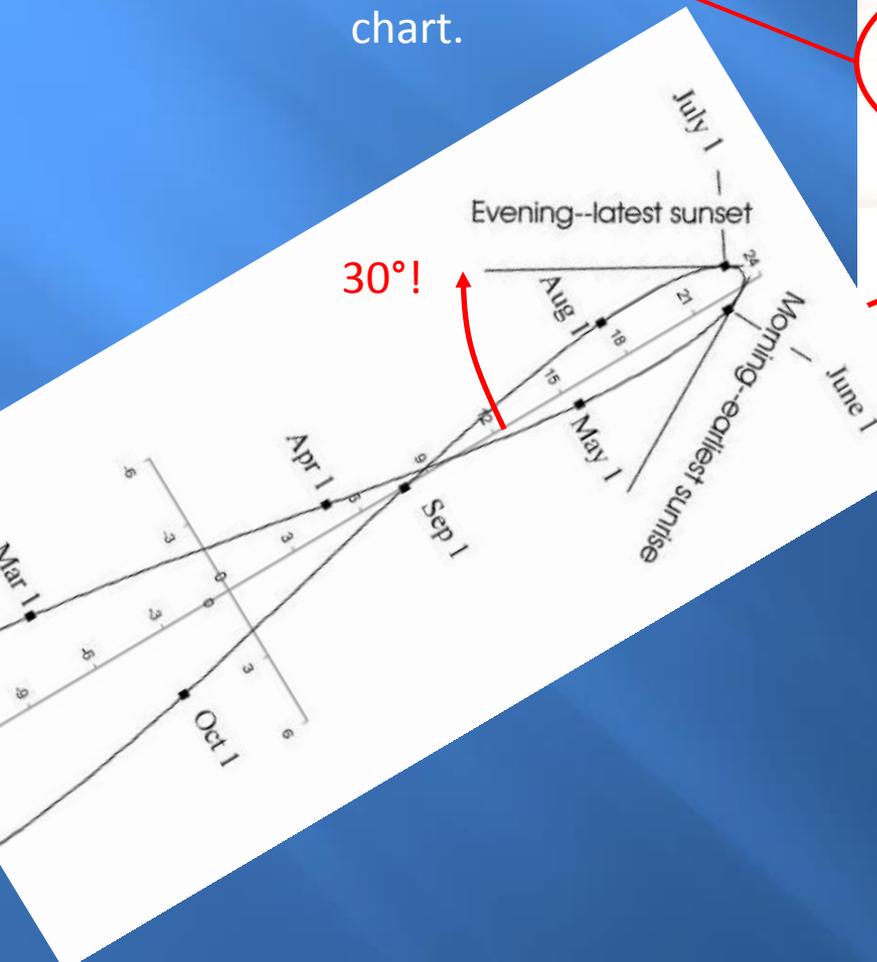
From: 2013 Jan 01 To: 2013 Dec 31

Planet	Date (TT)	Elongation		Mag.
		d	h m	
Mercury	2013 Feb 16	21	31	18.1 East -0.5
Mercury	2013 Mar 31	21	51	27.8 West 0.3
Mercury	2013 Jun 12	16	46	24.3 East 0.4
Mercury	2013 Jul 30	8	49	19.6 West 0.1
Mercury	2013 Oct 9	10	12	25.3 East -0.0
Venus	2013 Nov 1	8	00	47.1 East -4.3
Mercury	2013 Nov 18	2	23	19.5 West -0.6

MICA output  
– tables only

# The Almanac, even though it superficially looks like the night sky, depicts EVENTS, not positions

Side columns point out highlights, even some that weren't inferred from the chart.

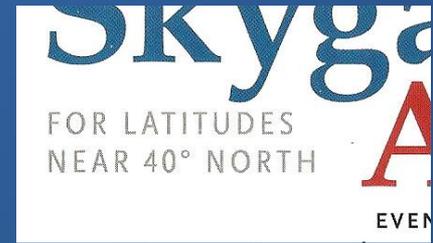


Example of how the approximate timing of an event can be estimated (these are latitude-dependent, and not quite accurate for all locations). Above, latest sunset at June 27 does not equal  $30^\circ$  value, which has scooted around to about July 1. ... Still, it's close.

# It is latitude specific

It is also longitude specific, but this means less for such a low res chart.

I believe the one included with the magazine is calculated for about 20 miles northwest of Springfield Illinois, at 40° N, and 90° West, the center of the time zone, but it is approximately correct within the whole north temperate zone.



Other latitudes (sold on website)...

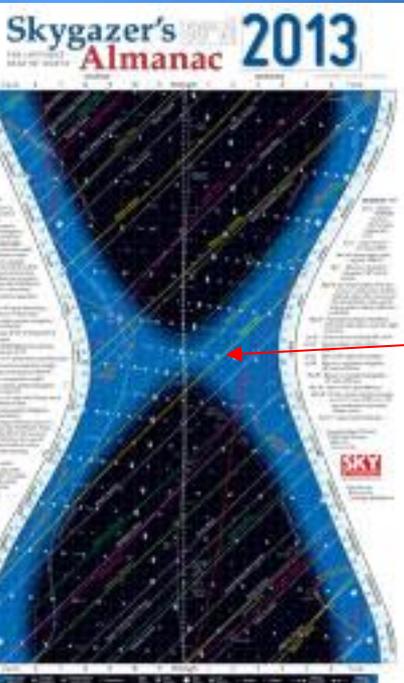
$-(90-50)+23.4 \text{ dec} = -16.6^\circ$  (midnight sun never reaches  $-18^\circ$  astronomical twilight)

50°N

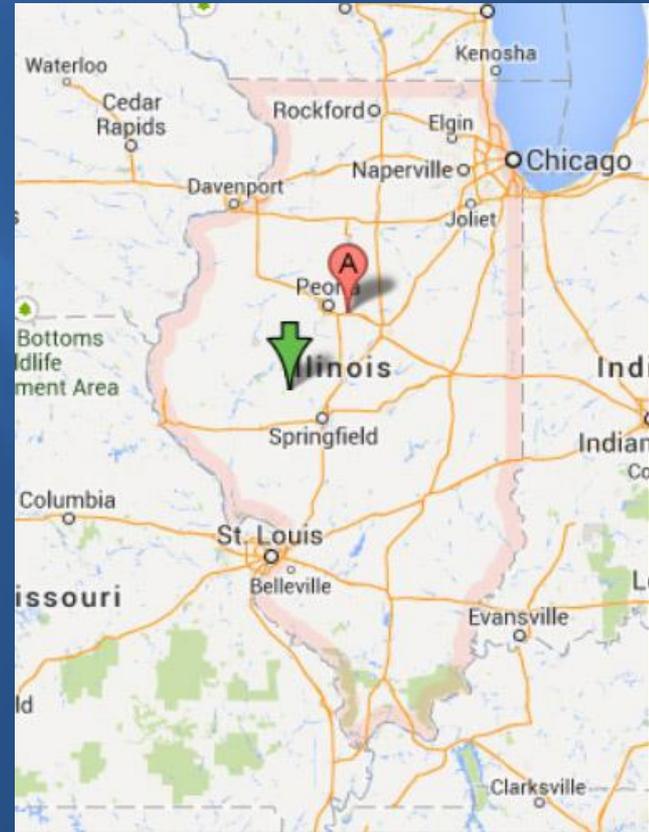
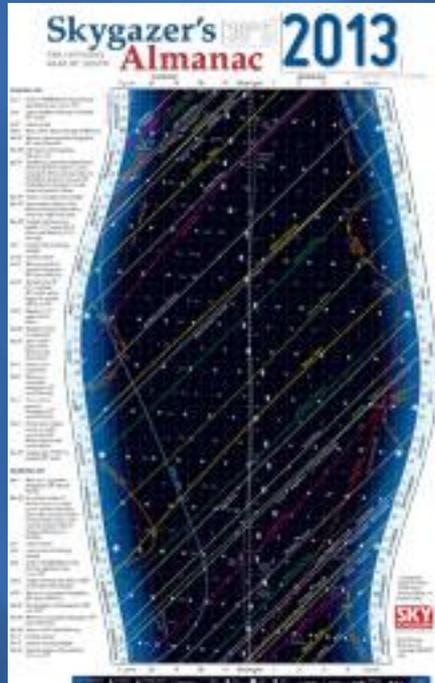


Southern hemisphere winter solstice is in June

↓ 30°S



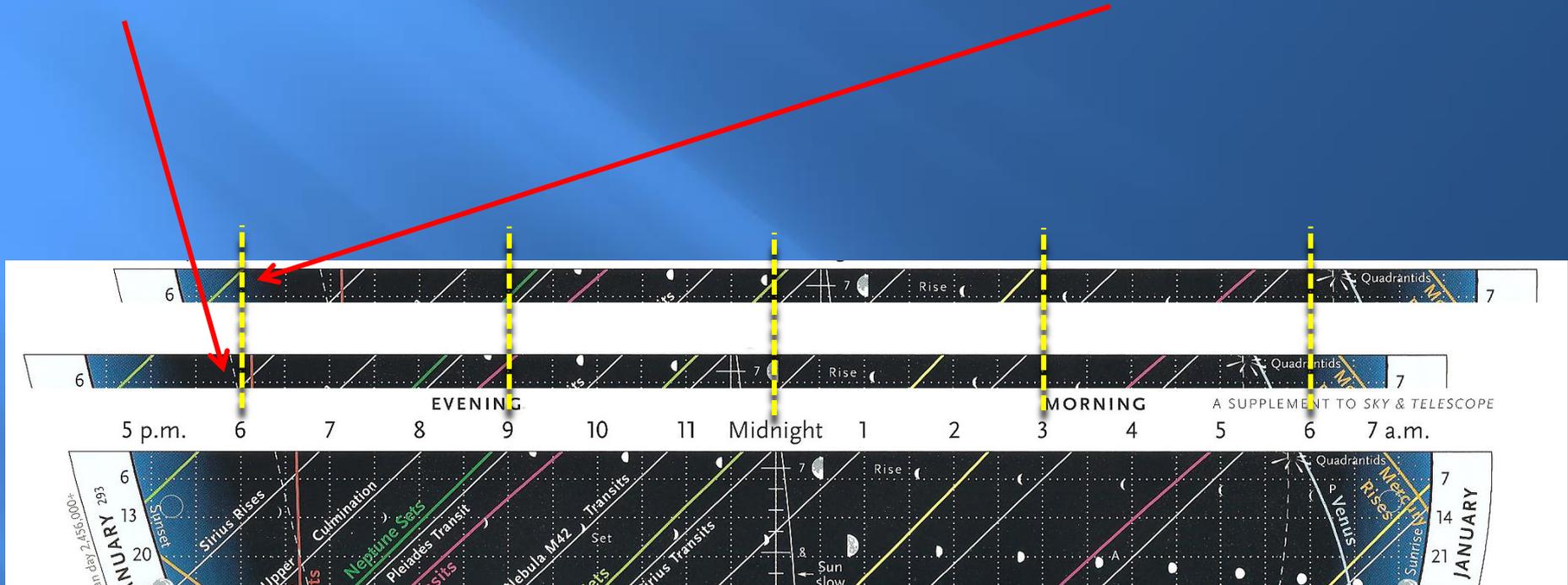
Twilight nights



# CHANGING TIMES IF YOU ARE NOT AT THE CENTER OF A TIME ZONE

Eastern edge of time zone (darker at 6PM)

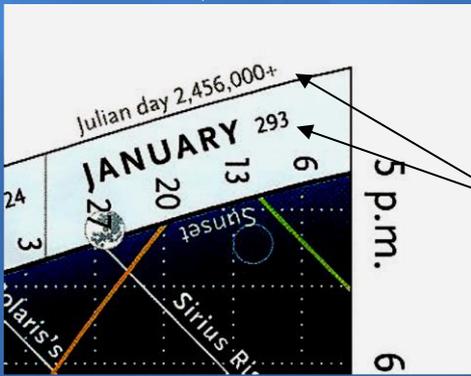
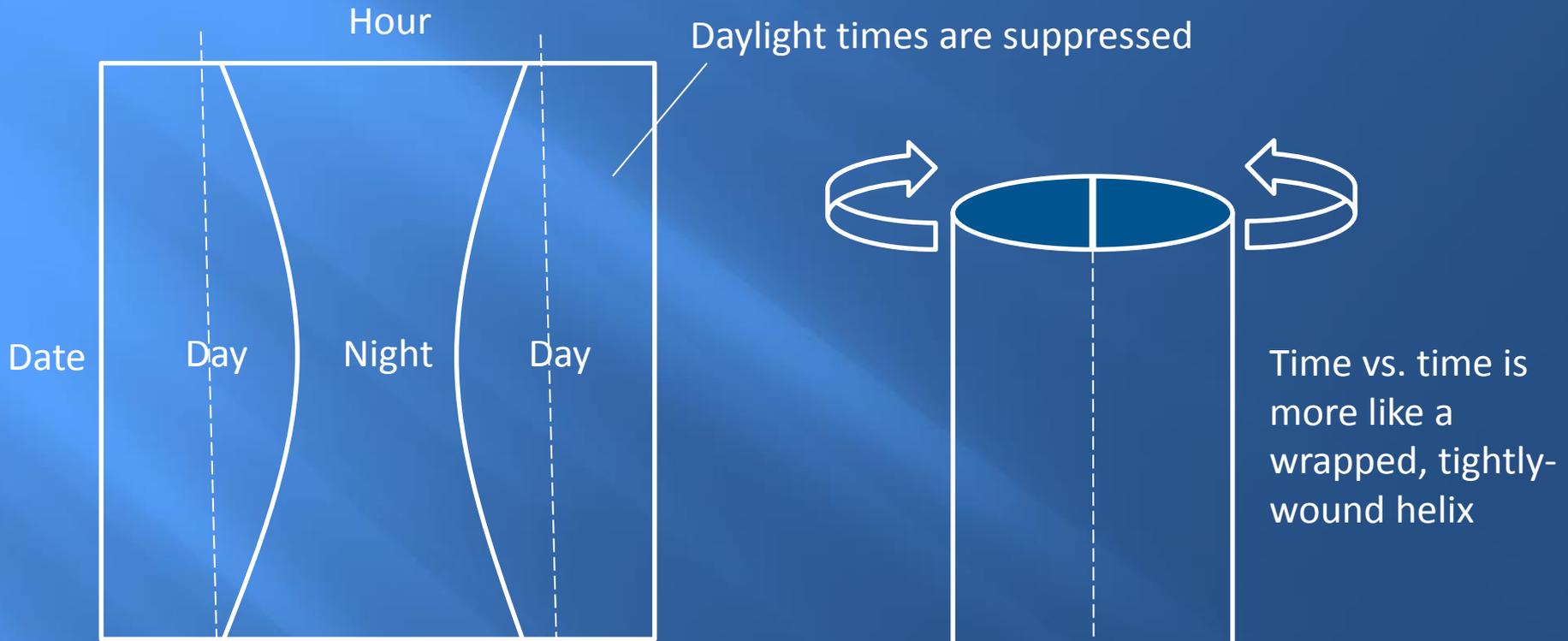
Western edge of time zone (lighter at 6 PM)



“wiggling the time”

Panama City is ~ 17 minutes of time east of the center of the time zone

The northern chart looks superficially like a space-time diagram, but it isn't even a geometric chart



JD boundary is noon in Greenwich

$JD(\text{Jan } 2013) = 2,456,000 + 293 + \text{day of month}$

# Key bar at bottom helps translate chart



## Planetary phenomena

- Conjunction between two planets (appulse means closest approach rather than true conjunction or the same ecliptic coordinate)
- Greatest elongation (inferior planets only – like quarter moon)
- Greatest illuminated extent (area of lit side with no assumption about actual illumination – could have larger area but less light)
- Opposition (superior planets only)

## Moon phenomena

- New, first quarter, full, and last
- Apogee
- Perigee
- Small icons for in-between phases

Not appearing in legend – little fireworks for meteor shower! Self-explanatory

# Conjunctions

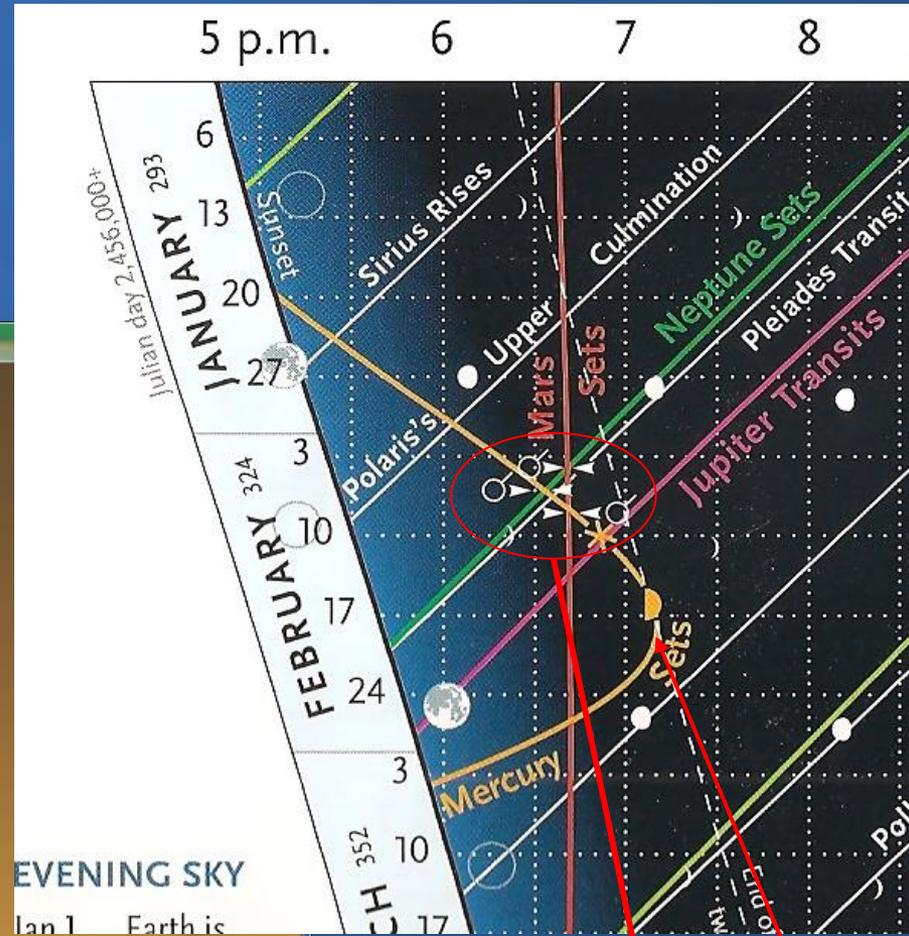
Three conjunctions on this snip of the chart

- Mars-Neptune
- Mercury-Neptune
- Mercury-Mars

Stellarium 0.10.2



Here is the Mercury-Mars conjunction on 2/8/2013

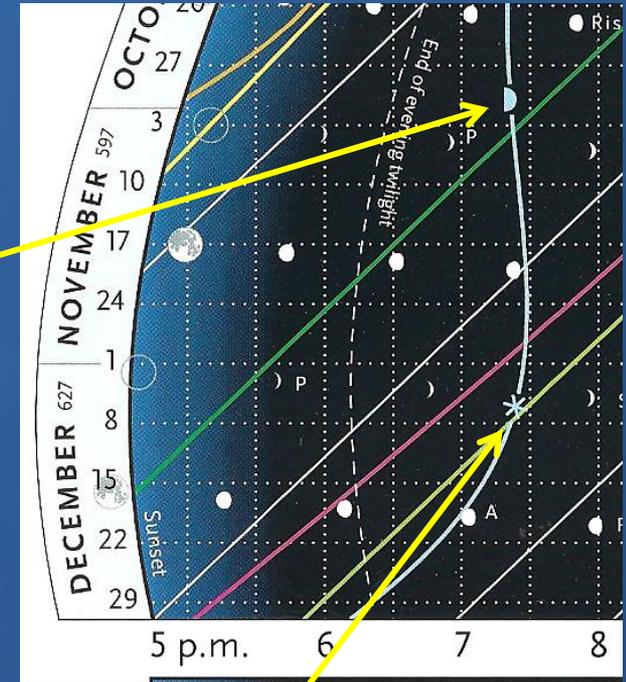


Three conjunctions

Greatest elongation

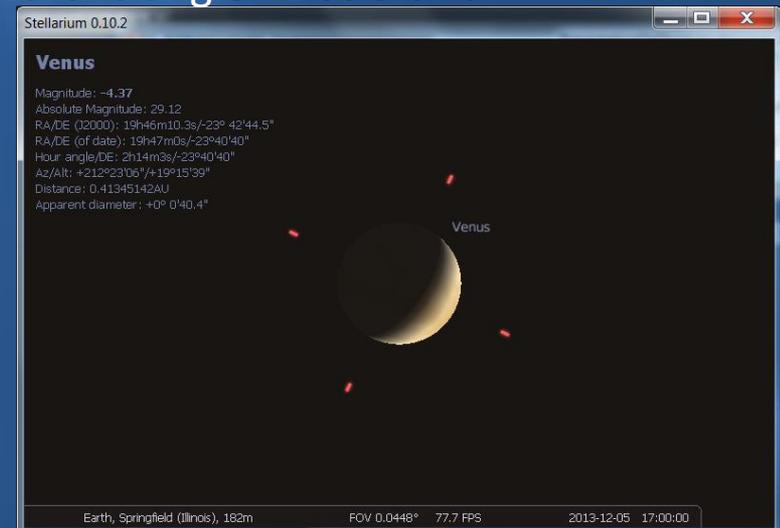
# Greatest elongation (GE) and greatest illuminated extent (GIE)

## Greatest elongation



GIE or greatest illuminated area visible from Earth's angle ~ Dec 5 or 6

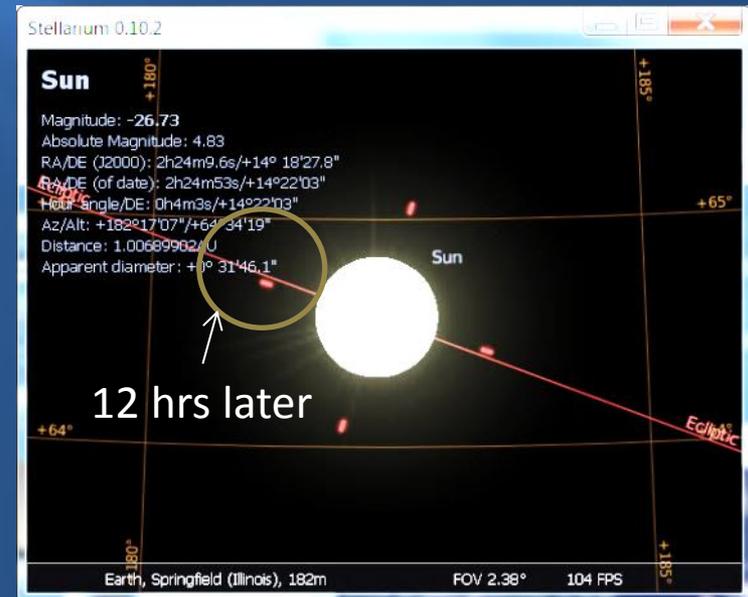
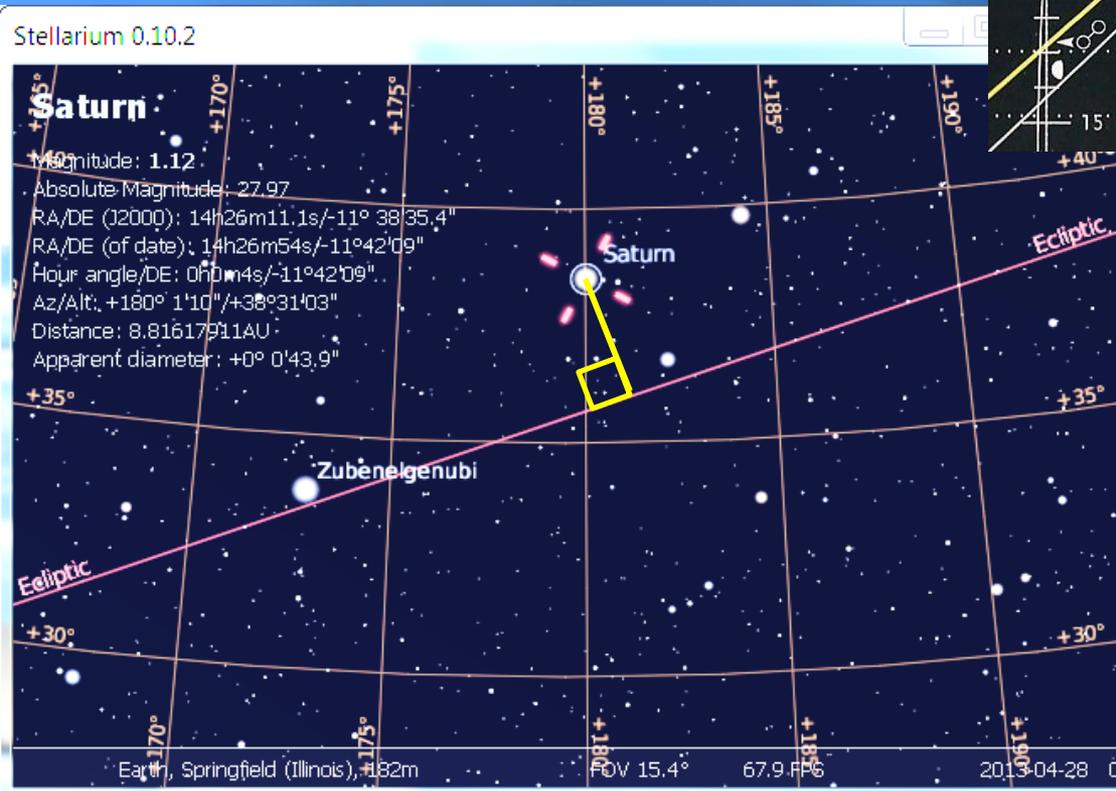
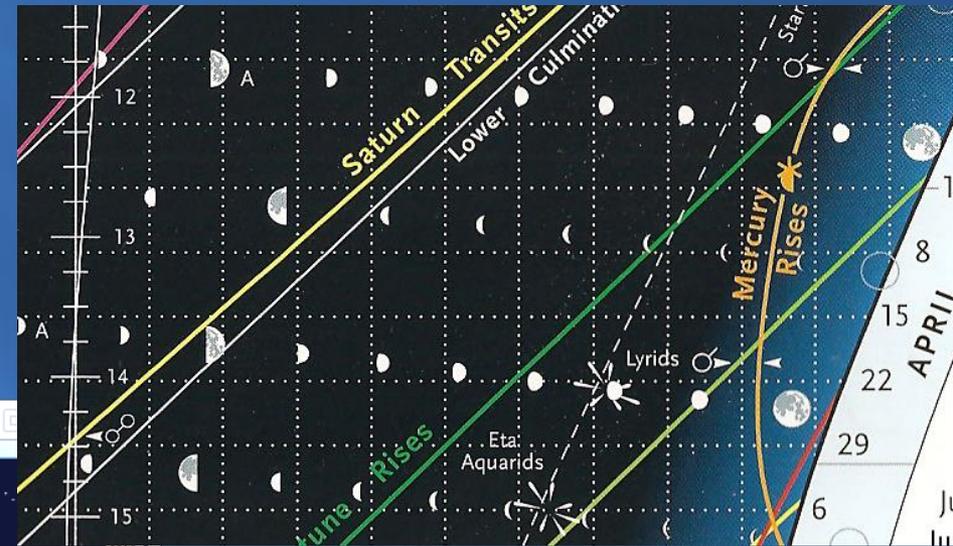
The maximum measured illumination is not on the chart. It depends on albedo model and may not even be between GE and GIE.



# Opposition (have to be near transit line at midnight)

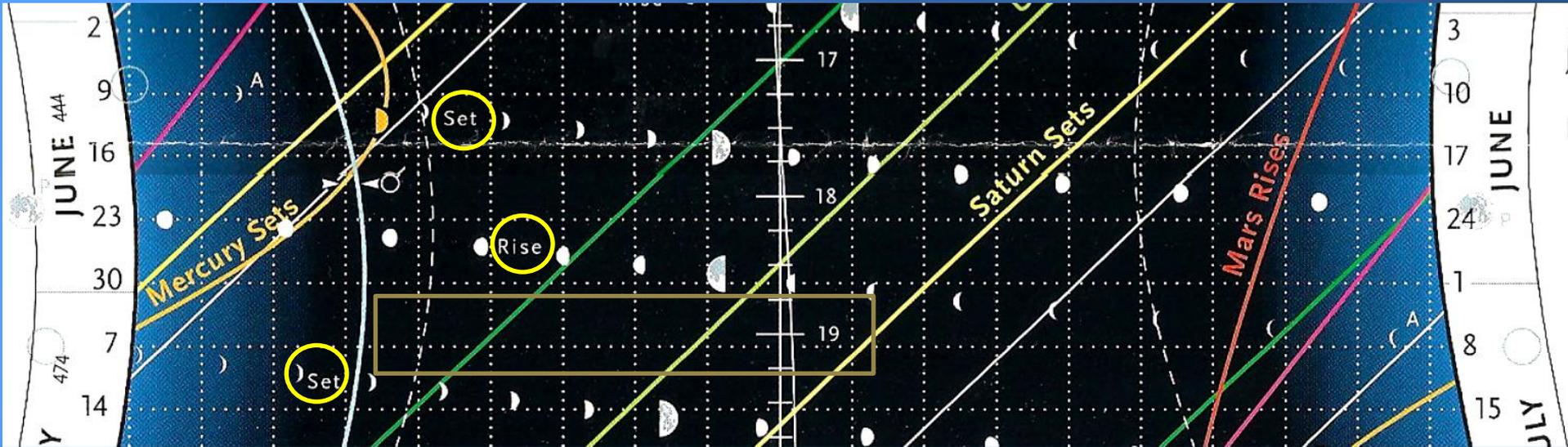
Note that in 2013, Jupiter didn't have an opposition (happened just before beginning of year and shortly after end.

Neither did Mars, but common with that planet.



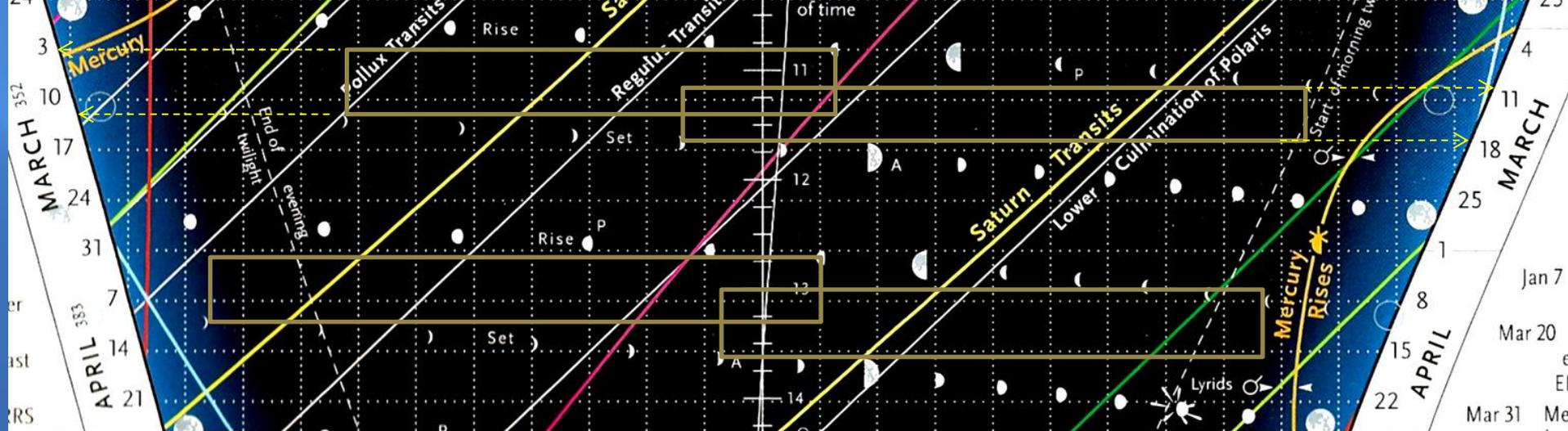
# Moonrise, moonset and phase

7:30 8:00 9:00 10:00 11:00 12:00 1:00 2:00 3:00 4:00 4:30 CST



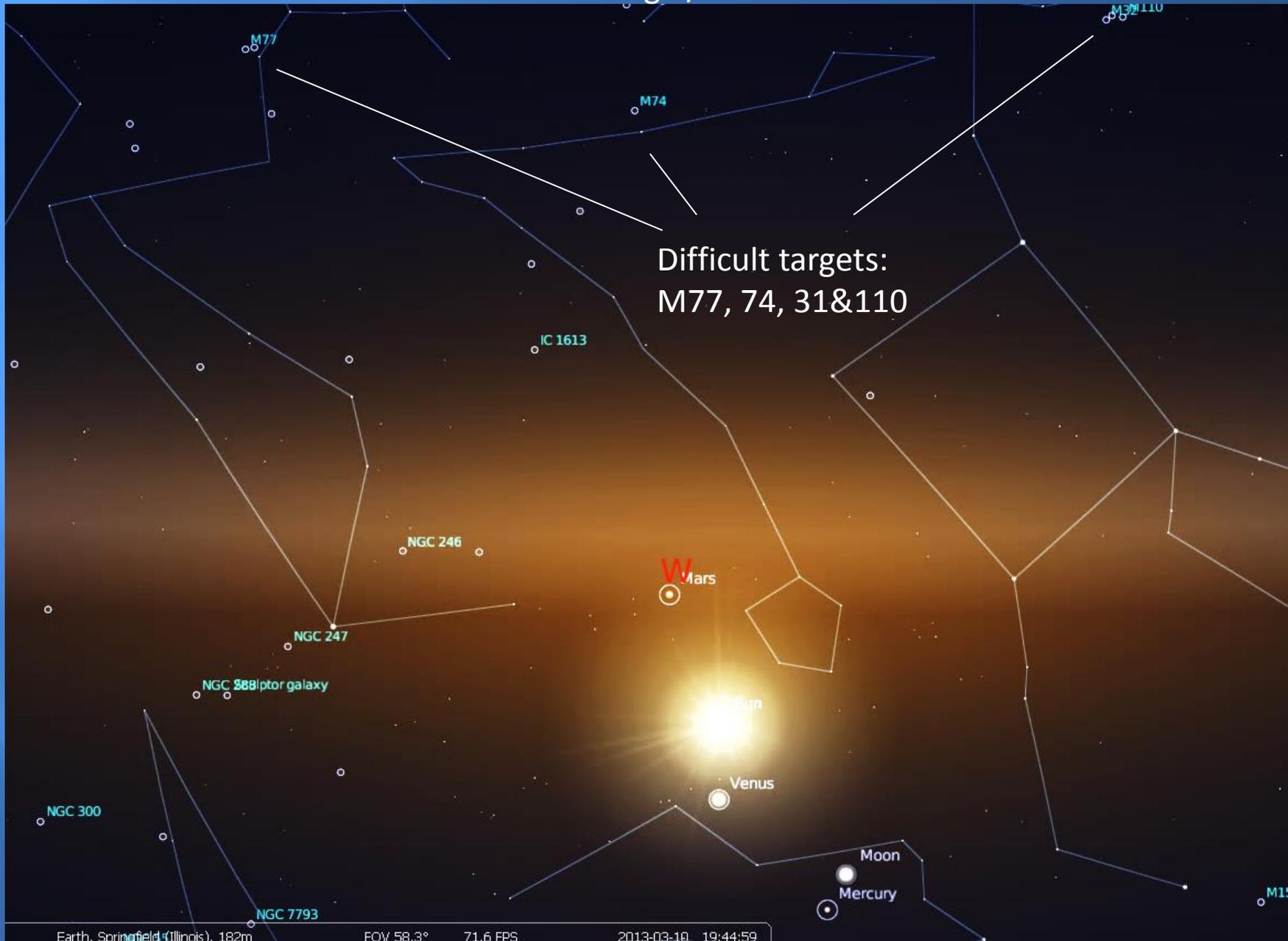
Everyday observing – how to “box out” a region of dark sky

7:00 8:00 9:00 10:00 11:00 12:00 1:00 2:00 3:00 4:00 5:00 CST



Planning a Messier Marathon – 3/9-12/13 would be best, with 4/6-10/13 rain dates

# Evening 3/10



3-10-2013 Candidate day for a Messier Marathon (ground invisible)

# Following morning 3/11

## M55 (M 55 - NGC 6809)

Type: Globular cluster  
Magnitude: 7.00  
RA/DE (J2000): 19h40m0.0s/-30°58'00.0"  
RA/DE (of date): 19h40m50s/-30°56'08"  
Hour angle/DE: 21h7m47s/-30°56'08"  
Az/Alt: +143°39'43"/+8°47'06"  
Size: +0°19'00"

Difficult target:  
M55



Earth, Springfield (Illinois), 182m

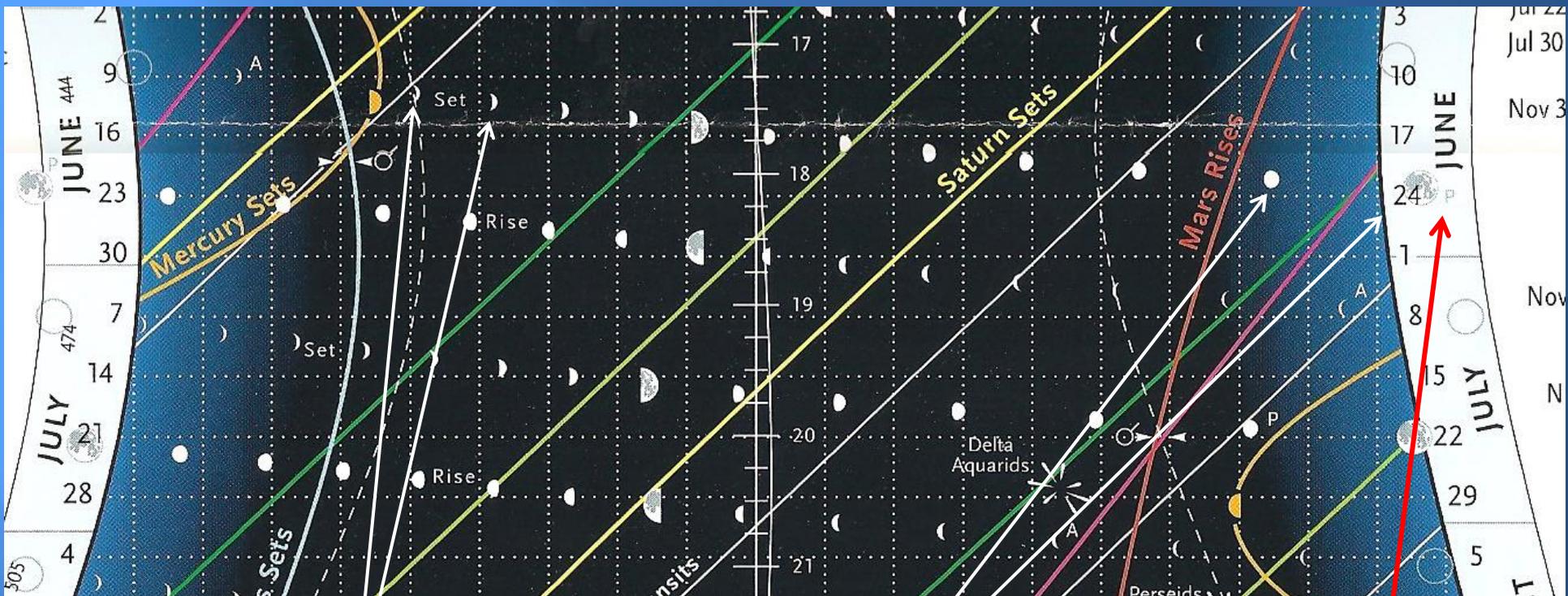
FOV 60°

45.1 FPS

2013-03-11 06:30:00



# Moon plots



Note differences in set times of adjacent days...

P means  
Moon perigee

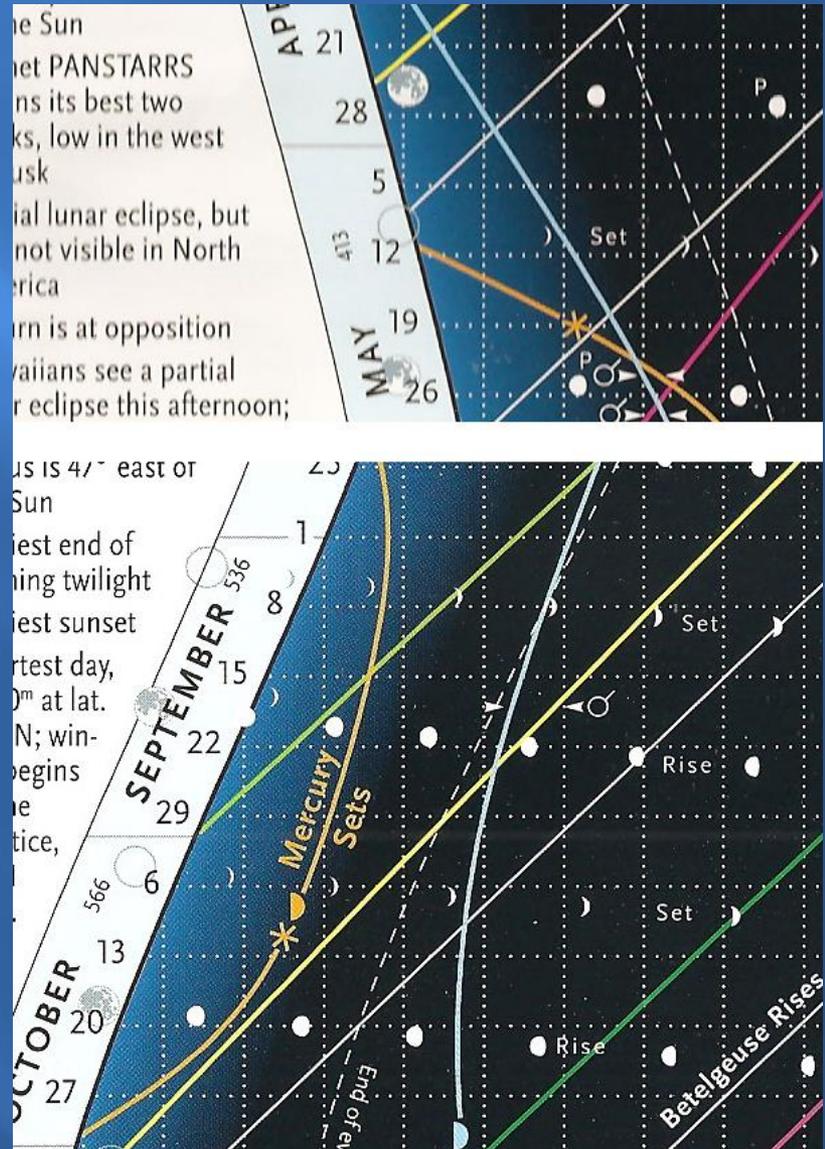
Caused somewhat by high speed of "supermoon" but also by height of moon along ecliptic..

best observing Mercury in each year, when it is at greatest elongation.

The moon shows interesting variations from season to season, as demonstrated by the unequal spacing of the points marking the times of rising and setting. This crowding, which signifies less than average difference in the rising time from night to night, is more pronounced near daybreak at the end of March, around midnight at the end of June, and around sunset in the fall. When this crowding comes in the fall of the year, and the full moon rises not far from the same time for several nights in succession—a phenomenon that is much more pronounced in more northern latitudes—it is called the harvest moon. Near the Arctic Circle the moon may actually rise earlier on the second night than on the first, but not this year.

Another curious result of the inclination of the moon's orbit relative to the plane of

## From the 1942 verbal description



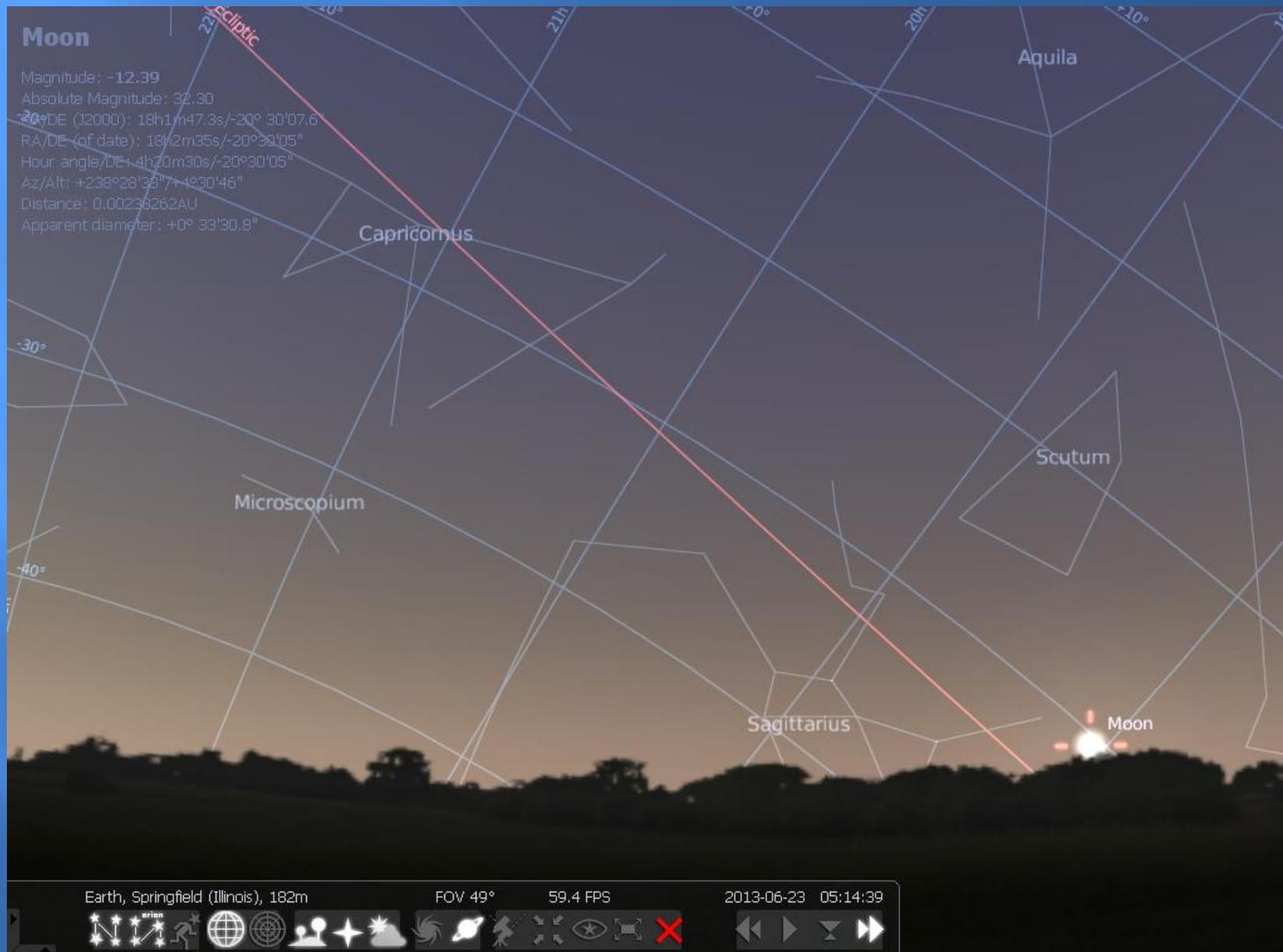
Look at the moon separation between successive days

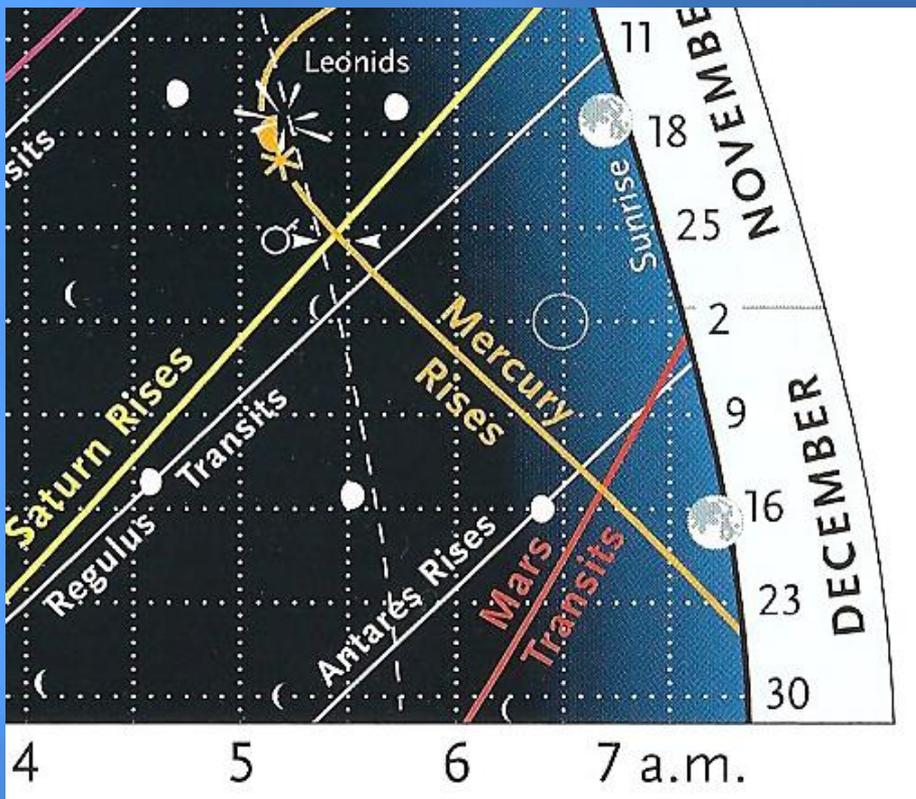


On 6/11 ecliptic is northward of the Moon

Stellarium view

On 6/23 it is southward of the Moon





# METEOR SHOWERS

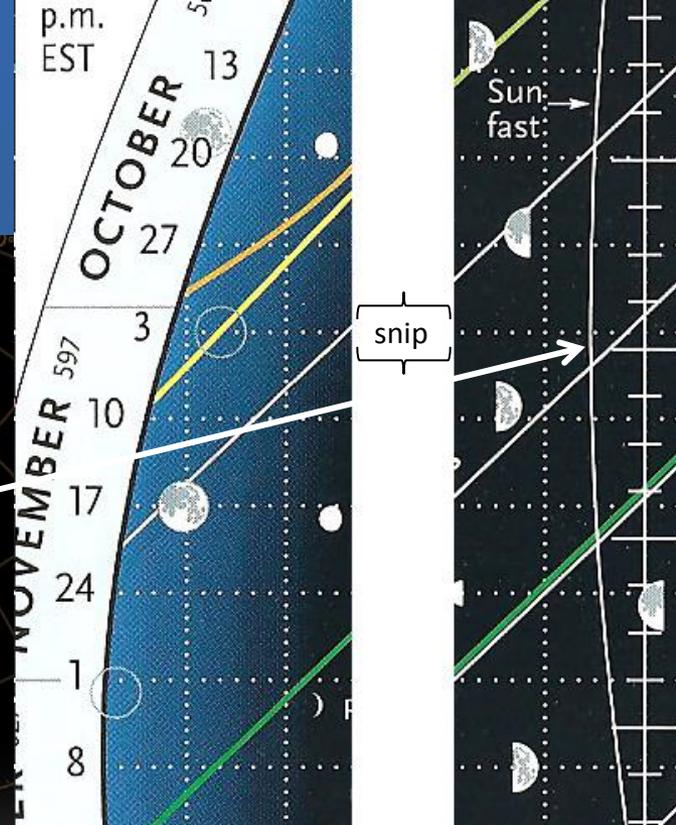
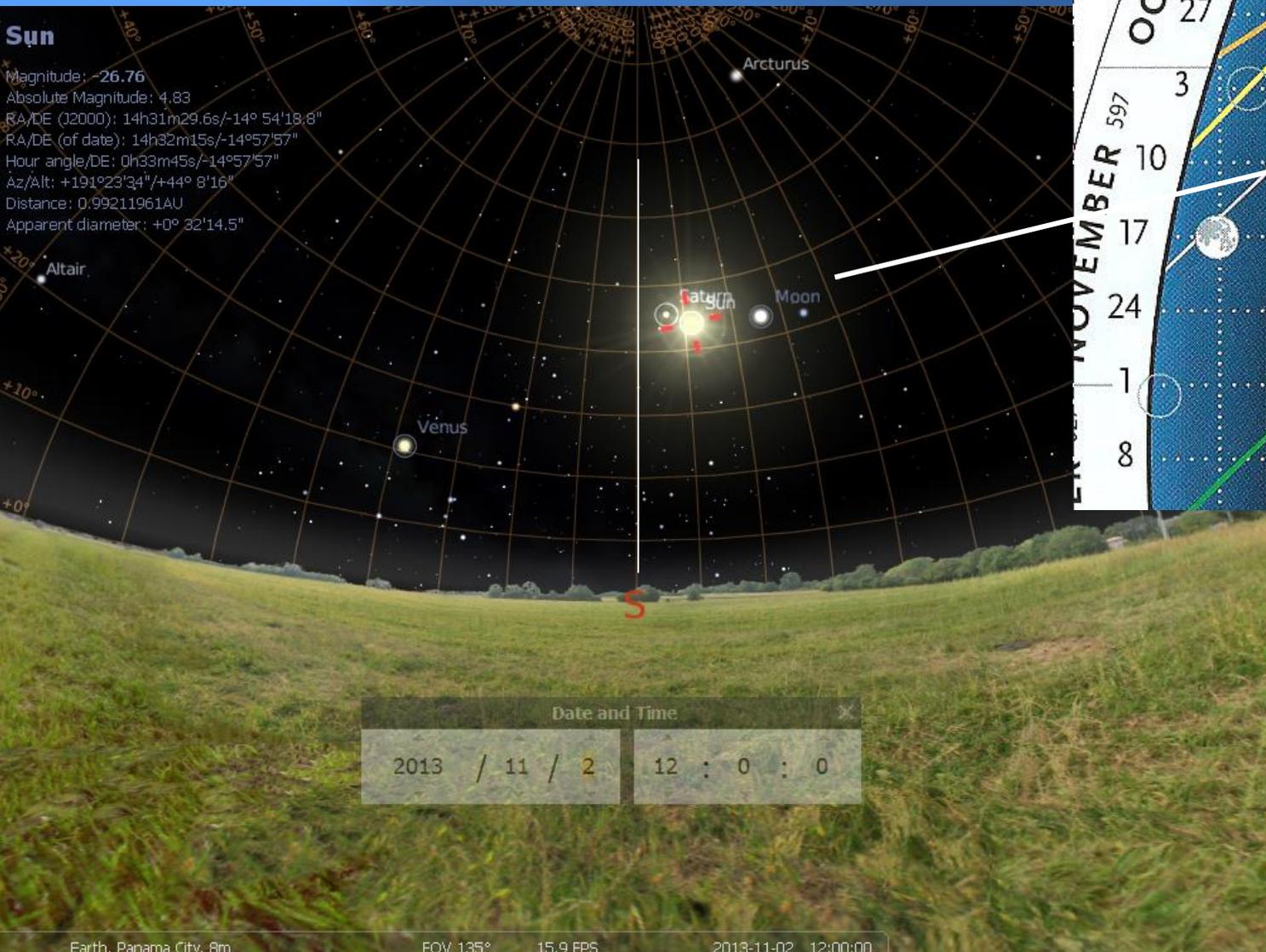
Remember, this is a plot of time instead of space. The thing plotted is not the time of maxima (that is only within the day).

The thing that is plotted is the highest transit within a dark sky. Since many showers transit during the daytime or have not yet transited at dawn, the showers “pile up” on the astronomical twilight line.

Of major showers, only the Geminids and Taurids transit far from morning twilight.

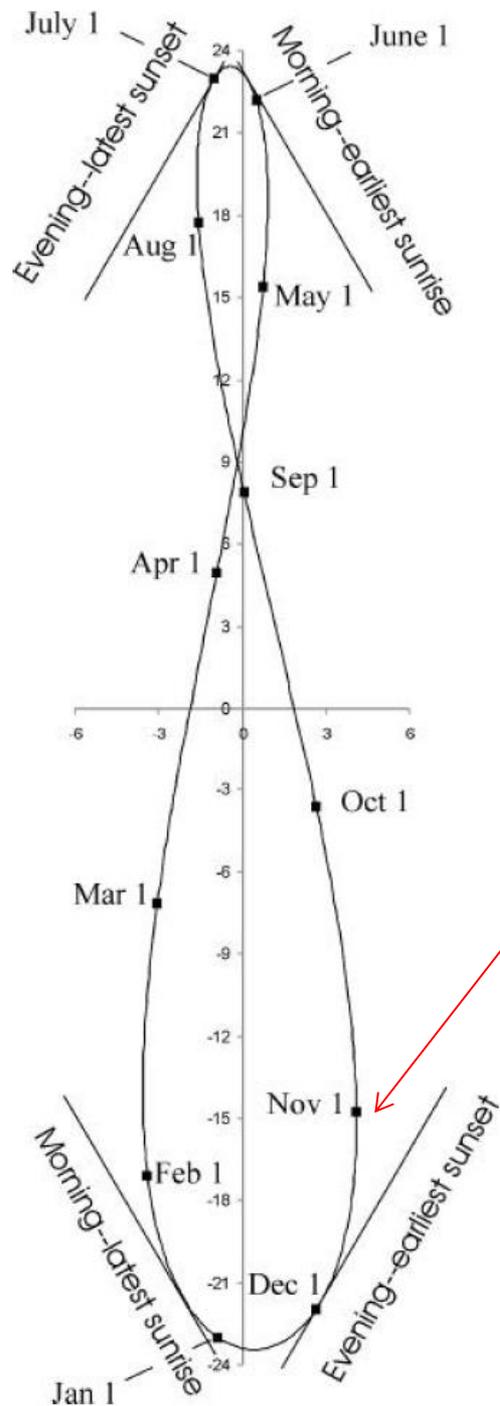


# THE EQUATION OF TIME (mean vs. solar time)



11/2 with no atmosphere – greatest azimuth of sun at noon mean time

A reminder...  
33 min 45 seconds in the  
hour angle of the  
previous page contains  
about 17 min of “time  
zone shift” in addition to  
about 17 min of  
“equation of time” shift.



From my November 2000  
article on the analemma,  
most advanced Sun is  
after November 1

# PLANETARY ORBITS

Can tell how far away a planet is by tilt with respect to the “stellar” line.

Stellar lines make one full circle per year

If a planet is very far away, its tilt is more nearly the same.

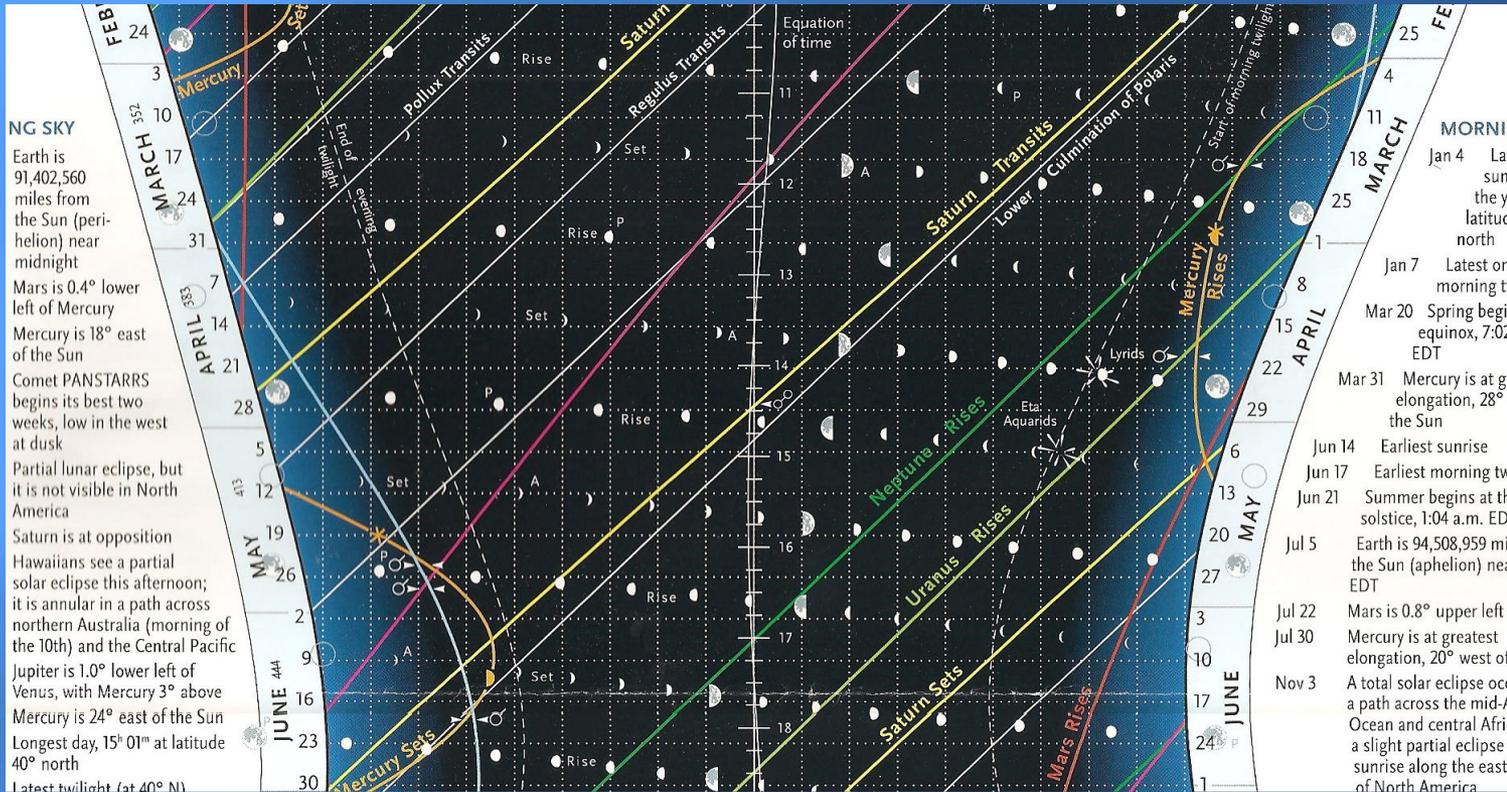
Inferior planets (no value judgment here – that is just the terminology for planets closer to the sun) are bound to the sun in hour angle

Superior planets have tilted curves, and can be anywhere along the ecliptic

General trend is west to east with respect to the background star (i.e., with the planet tilted higher in the Almanac)

Mars, because its orbit is so nearly the same as the Earth’s seems as if it is a different case entirely

# Speed of Apparent Motion



retrograde motion

Stellar-line slope

regular motion of planet

## Recap:

- The graphical almanac in the form of the *S&T Skygazer's Almanac* encapsulates a huge amount of information in a compact and easily-read manner.
- The graphical almanac is a convenient tool to predict brief solar system events and observing windows.
- A properly-made graphical almanac is a useful adjunct to a detailed planetarium simulator or numerical almanac program in much the same way as a low-powered telescope is useful as a finder for a high-powered telescope.
- Detailed study of the graphical almanac can yield benefits throughout the year.

## Sites with self-calculated graphical almanacs:

[www.calsky.com](http://www.calsky.com)

[www.ngc7000.com](http://www.ngc7000.com)