The Dunlap Sunrise – Sunset Computer

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The Dunlap Sunrise – Sunset Computer is certainly among the rarest of navigational slide rules. A search of NavList produces a few hits and mostly just passing mentions of the device, primarily by myself. In over a decade of searching, I have encountered precisely one and that one is now in my possession. I am pleased to share this device, and so, without further ado, on with the examination.

Dutton's Navigation and Piloting

The Dunlap Sunrise – Sunset Computer is mentioned in my copy of "Dutton's Navigation & Piloting", 1972, 12th edition. The device is produced under the sanction of the Weems System of Navigation, with my individual device dated 1964. In Dutton's, the photographed device appears to also have that date. G.D. Dunlap is the editor of the 12th edition of Duttons. It is uncertain if the editor and the inventor are one in the same person, although the coincidence is certainly striking! In the chapter entitled "Celestial Navigation: Special Cases and Phenomena", the determination of the time of sunrise and sunset, which are critical to LOP navigation, is given a detailed explanation.

The problem statement is fundamental. Given your latitude, longitude and day of the year, find the time of sunrise, sunset and meridian crossing of the sun. The time should be expressed using the standard time for our time zone. The problem solution must account for the equation of time, the latitude, the longitude, and the declination of the sun.

HOW DOES THE NAUTICAL ALMANAC SOLVE THE PROBLEM?

[The following text follows Dutton's proscribed methodology and, if not mistaken, the current NA methodology.]

Sample problem: Find the standard zone time of sunset on 26 April, at latitude 17°15'.5 South, Longitude 150°54'.6 East.

Enter the appropriate daily page of the NA and extract and record the LMT of sunset for the next smaller tabulated latitude. In this case, the next smaller tabulated latitude is 10° S and the LMT of sunset at that latitude is 1752. Then note the difference of latitude between the tabulated values on either side of the latitude for with the information is desired, and the difference in the time of the phenomena between the smaller and the larger tabulated latitudes, with its sign. In this case the tabular interval is 10° and the difference in time is -11 minutes (1752 at latitude 10°S and 1741 at latitude 20°S).

Next, enter Table I (page xxxii of the NA) and obtain the correction to the tabulated LMT. Table I is entered on the left, using the tabular interval found in the first step. Table I Tabular intervals are 10°, 5° and 2°. In our example, the tabular interval is 10°. Searching this column for the difference between the true latitude and the tabulated latitude (7°15'.5) we find the appropriate horizontal line. Horizontal line 14 has 7°00' which is very close to our offset. Searching under the vertical headings of "Difference between the times of consecutive latitudes", we find the closest value to 11 minutes, to wit, 10 minutes or column 2. At the intersection of the line and column, we find 7 minutes. Dutton advises that interpolation may be made in this table and gives the resultant value of 8 minutes, since 7°15’ is greater than 7°00’ and the difference in time is 11 minutes is greater than 10 minutes.

Next, convert the difference of longitude between the standard meridian and the ship into time, adding this difference if the ship is west of the standard meridian and subtracting if it is east. Each degree of longitude is 4 minutes of and each 15’ of longitude 1 minute of time. The standard meridian for the problem is E150°, (Zone -10) and our ship’s position is given as 150°54’.6E. The difference is 0°54’.6 further east. As this is approximately 1 degree, we should subtract an additional 4 minutes.
Thus we have

Tabulated values for S 10°	1752
Table I Latitude Correction	- 8
Longitude Correction	- 4
Sunset occurs at	1740

The same procedure is followed for sunrise.

HOW DOES THE DUNLAP SUNRISE – SUNSET COMPUTER SOLVE THE PROBLEM?

Firstly, the Nautical Almanac is not referenced at all! The Dunlap Sunrise – Sunset Computer is 100% self contained.

On the back of the computer is a table. It tabulates, given the day of the year, the GHA of the sun for 1200 hours GMT and the average declination of the sun. It should be noted that the tabular values are denoted “G” and they simply the GHA’s of the sun minus the first two figures. For example, 9.1 is used instead of 359.1; 0.7 represents 000.7; etc. Consult figure 1.

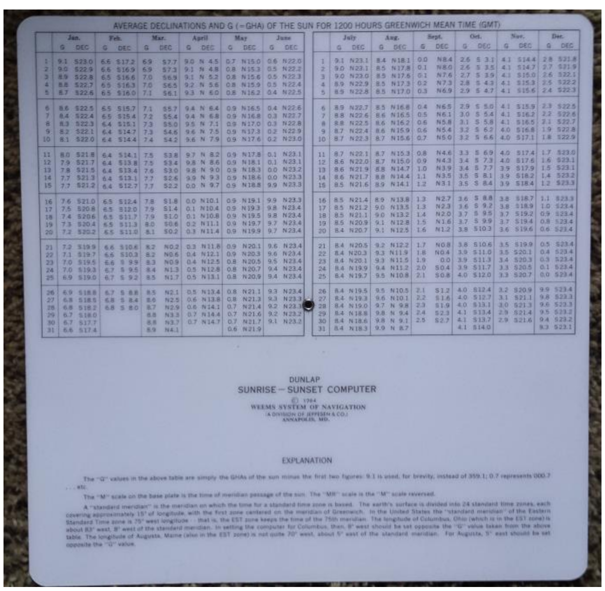

Figure 1: *Reverse side of the Dunlap Sunrise-Sunset Computer, showing the tabulated values of G and Declination as a function of the day of the year.*

For 26 April, the G value is 0.5. Set the circular disk index (0°) on the G scale to 0.5. Consult figure 2.

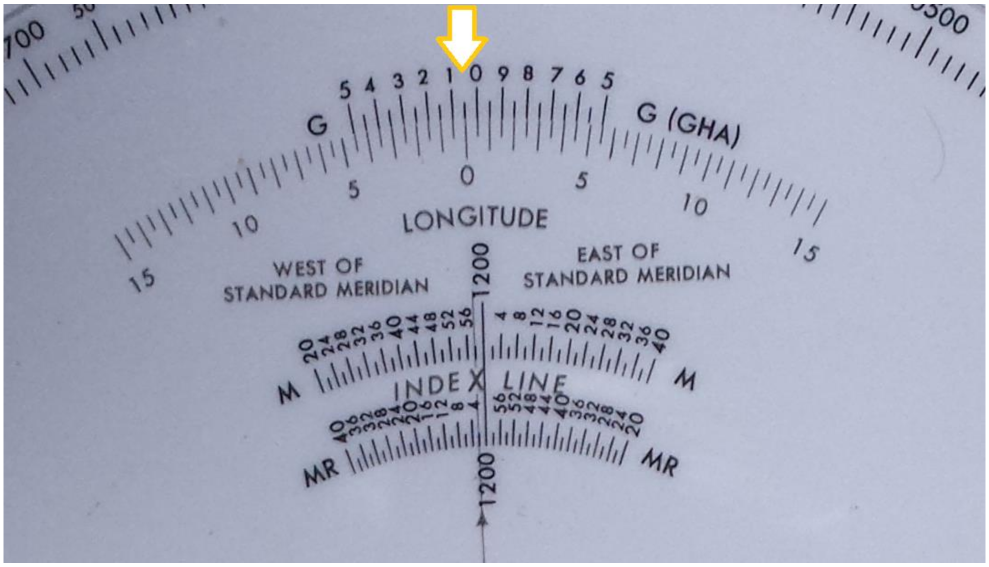

Figure 2: *Set the circular disk index to the G value given for the date. The white/ yellow arrow is added for emphasis, so that the reader can see this setting. It is not present on the actual device.*

Determine the longitude difference, to the nearest 0.5° between the ships position and the standard meridian. In this case, the value is E1°. Move the index of the circular disk by 1° eastward. See figure 3.

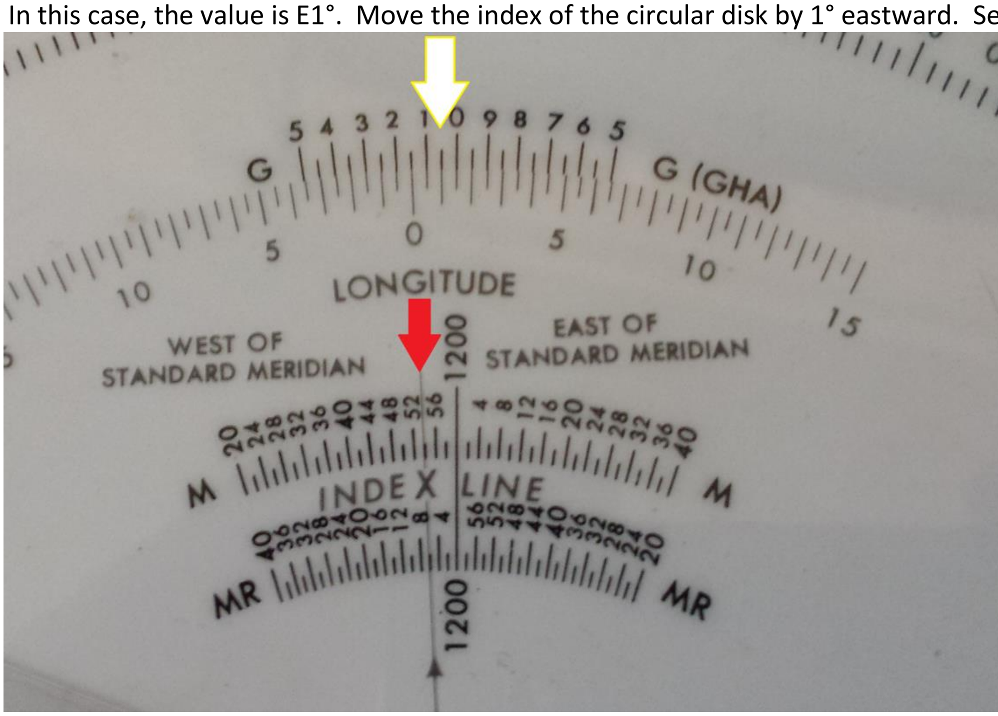

Figure 3: *Adjusting for longitude at the white/ yellow arrow. Time of meridian crossing given at red arrow, to wit 1154.*

At this point, the device provides the time of meridian crossing. On the M scale, we can directly read 1154. See figure 3.

From the tabulated values on the back of the device, obtain the declination of the sun for the given date. In this case, it is N13.4°. Turn the cursor until the declination (N or S) on the cursor intersects the latitude curve (N or S). Once set, the Dunlap Sunrise – Sunset Computer yields 1740. See figure 4

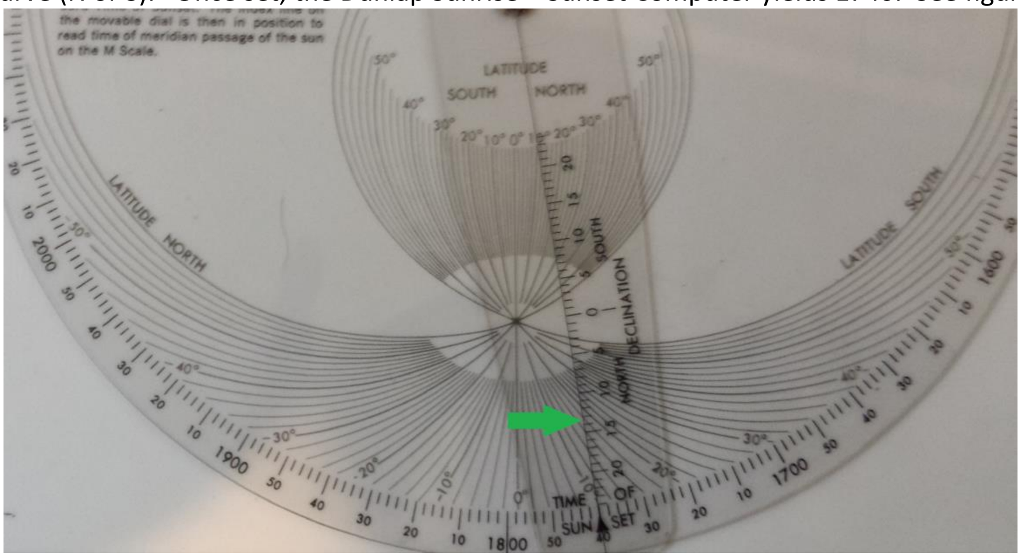

Figure 4: *Setting the Declination onto the Latitude, the green arrow shows the intersection of the declination and the latitude. Note the green arrow is not present on the physical device. With all the settings made, we can see the words "TIME OF SUNSET" and the cursor directly on 1740.*

The overall setting of the device may now be observed in figure 5.

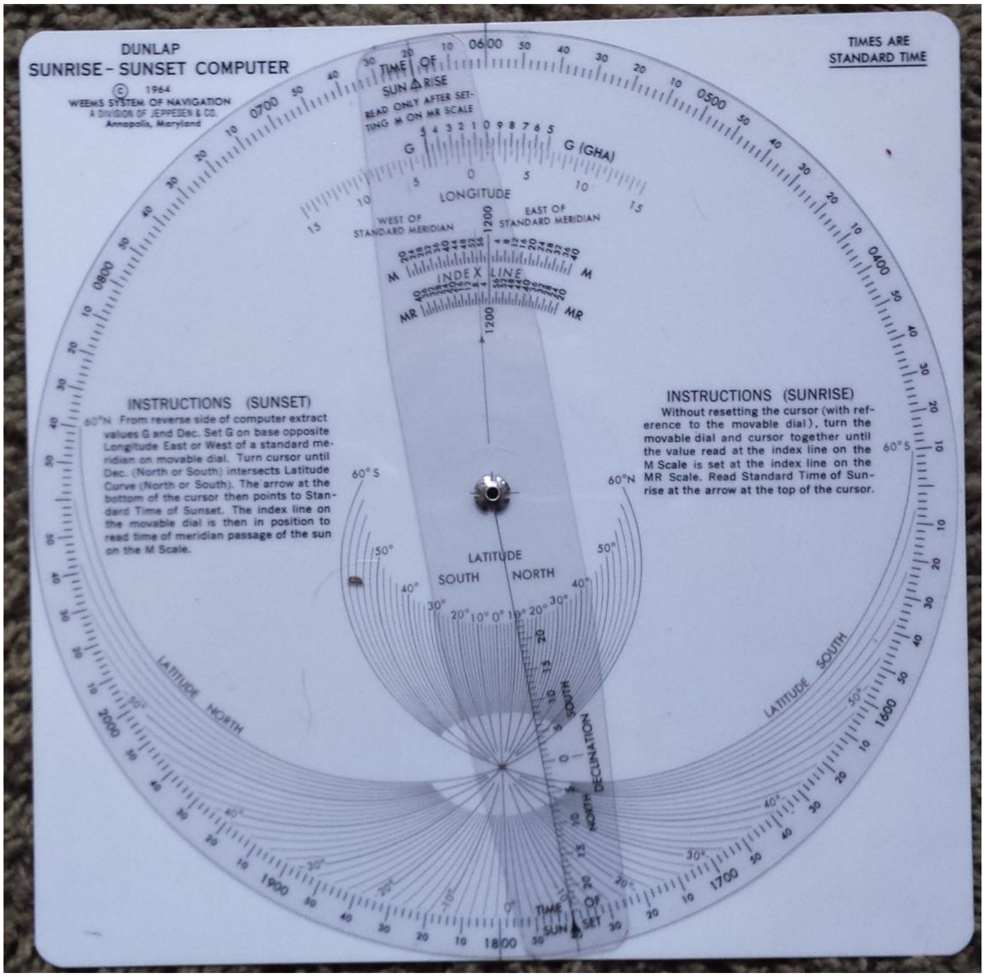

Figure 5: *The Dunlap Sunrise-Sunset Computer, set for the problem resolution.*

Adjust the circular disk, so that the M (meridian) reading is now on the MR (meridian reversed) scale. Sunrise is now given as 0609.

The solution set of 0609, 1154 and 1740 for sunrise, meridian crossing and sunset is obtained in less than 2 minutes! A rapid fire solution indeed!

USNO SOLUTION

Sunrise 0608, Meridian Crossing 1154 and Sunset 1741. Of course, this is an electronic, internet based solution, not available to the US Navy in 1964. It does, however, show the close agreement between the three methods.

LIMITATIONS

The Dunlap Sunrise – Sunset Computer is only valid for latitudes between 60°S and 60°N. No attempt is made at high latitude solutions.

The device is not intended to be extraordinarily accurate. The G scale is resolved to the nearest 0.5 degrees. The Longitude adjustment scale is resolved to the nearest 0.5 degrees. The declination scale is resolved to the nearest 1 degree whilst the latitude curves are to the nearest 2 degrees.

The Navigators Day

Dutton dictates that a day's work involves the computation of sunrise, sunset to assist in planning for the twilight observations. The navigator is to determine the time twilight begins (or ends) and obtain LHA Aries and that further, upon setting his star finder to LHA Aries, he can forecast the approximate altitudes and azimuths of celestial bodies which will be visible at that time. The Dunlap Sunrise – Sunset Computer is merely an extension of the US Navy process of methodizing every step of the operation so as to reduce errors. With the planning reduced to a series of rote steps on these navigational slide rules, the navigator can confidently proceed to obtaining observations. That is, the navigator will determine the time of sunrise (or sunset) using the Dunlap Sunrise Sunset Computer. The navigator will then find LHA Aries and using that on the 2102D, determine what stars to observe, and their approximate altitudes and azimuths.