AD-A148 049 COMPUTING WORLDWIDE SUNRISE SUNSET MOONRISE MOONSET AND TWILIGHT TIMES US..(U) WEATHER WING (5TH) LANGLEY AFB VA K W HERTZLER JUL 84 5WW/TN-84/001 SBI-AD-E850 735 1/1

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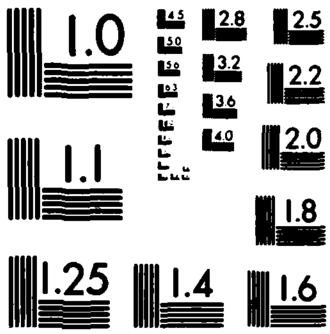
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5 WW/TN-84/001

5TH WEATHER WING
TECHNICAL NOTE

COMPUTING WORLDWIDE SUNRISE, SUNSET, MOONRISE, MOONSET AND TWILIGHT TIMES USING 5 WWPs 105-3 AND 105-4

JULY 1984

5 WW/DNC

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: 5 WW/TN-84/001
2. GOVT ACCESSION NO.: AD-A148046
3. RECIPIENT'S CATALOG NUMBER:
4. TITLE (and Subtitle): Computing Worldwide Sunrise, Sunset, Moonrise, Moonset and Twilight Times using 5 WWPs 105-3 and 105-4
5. TYPE OF REPORT & PERIOD COVERED: Final
6. PERFORMING ORG. REPORT NUMBER:
7. AUTHOR(s):

Lt Col Kenneth W. Hertzler
Chief, Climatology Branch

8. CONTRACT OR GRANT NUMBER(s):
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Aerospace Sciences Division, HQ 5 WW, Langley AFB VA 23665
10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS:
11. CONTROLLING OFFICE NAME AND ADDRESS: HQ 5 WW, Langley AFB VA 23665
12. REPORT DATE: JULY 1984
13. NUMBER OF PAGES: 7
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office):
15. SECURITY CLASS. (of this report): Unclassified
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:
16. DISTRIBUTION STATEMENT (of this Report): This publication is approved for public release. There is no objection to unlimeted distribution of this document to the public at large or by the Defense Technical Information Center (DTIC) to the National Technical Information Service (NTIS).
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report):
18. SUPPLEMENTARY NOTES:
19. KEY WORDS (Continue on reverse side if necessary and identify by block number):

Civil Twilight
Nautical Twilight
Moonrise
Moonset
Sunrise
Sunset

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This technical note describes a technique which permits calculation of times of sunrise/set, moonrise/set and the twilights. The technique requires the use of 5 WW Pamphlets 105-3 and 105-4 as a data source.

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COMPUTING WORLDWIDE SUNRISE, SUNSET MOONRISE, MOONSET, AND TWILIGHT TIMES USING 5 WWPs 105-3 AND 105-4

I. SUNRISE, SUNSET AND TWILIGHTS

1. GENERAL. The times of sunrise, sunset and the twilights vary based on both longitudinal (east - west) and latitudinal (north - south) position. The rate of longitudinal time change is constant; four minutes per degree as the earth rotates on its axis. The rate of latitudinal time change is not constant, but is small near the equator and large near the poles. The technique described in this technical note eliminates consideration of the latitudinal variation by using data from a station in 5 WWP 105-3 with the same latitude as the location in which you're interested. The longitudinal correction is then computed at the rate of four minutes per degree of longitudinal difference between the location of interest and the selected station.

2. INSTRUCTIONS.

a. Select a station from 5 WWP 105-3 that has the same latitude (north - south coordinate) as the location in which your're interested. Try to get within 10 minutes (10') of latitude. Station coordinates are listed in the front of the volumes of 5 WWP 105-3.

b. Write down the station coordinates and the event times from the appropriate tables.

c. Compute the difference in longitude between your location of interest and the station you've selected by adding the values if one location is east of Greenwich (0° Meridean) and the other west, or by subtracting if both values are east or west. Convert the values from degrees and minutes to a decimal value to the nearest tenth of a degree.

d. Convert the longitudinal difference to time difference by multiplying by four minutes per degree. Round off to the nearest whole minute.

e. Compute the desired time. If the location of interest is west of the selected station, add the time difference to the selected station's times. If your location is east of the selected station, subtract the time difference. Do not cross the International Dateline when figuring east or west. Times listed in Volume II through VI of 5 WWP 105-3 are GMT. You must convert Volume I times from local to GMT before performing any calculations.

f. Convert times for any location to or from GMT by referring to the Flight Information Publication (FLIP) for the appropriate difference in hours from GMT.

3. EXAMPLE.

You are interested in a location in the wastelands of Saudi Arabia (19° 30'N, 51° 22' E). When will the sun set on 10 September?

a. Select a station from 5 WWP 105-3.

A world map shows that possible stations with the same latitude can be found in Latin America, the Middle East and Southwest Asia, northern Africa, southern Asia and some of the Pacific Islands. Therefore, look in Volumes II, III, IV, and V. The station closest to your latitude is:

Cibao, Dominican Republic (19° 28'N, 70° 42'W).

b. Write down station coordinates and times.

Cibao: 19° 28' N, 70° 42' W   Sunset: 10 Sep 2250Z

c. Compute longitudinal difference.

Your location of interest is 52° 22' (or 52.37°) east of Greenwich. Cibao is 70° 42' (70.70°) west of Greenwich. Total longitudinal difference between your location and Cibao is:

$$\begin{array}{r} 70.70^\circ \\ +\ 51.37^\circ \\ \hline 122.07^\circ \end{array} \text{ or } 122.1^\circ \text{ difference}$$

d. Convert longitudinal difference to time difference.

$$\begin{array}{r} 122.1^\circ \\ \times\ 4 \text{ min/deg} \\ \hline \end{array}$$

488.4 minutes or 8 hours and 8 minutes.

e. Sunset at your location.

$$\begin{array}{r} 2250 \\ -\ 808 \\ \hline 1442Z \end{array}$$

f. Correct to local time.

From the FLIP, Saudi Arabia is 3 hours ahead of GMT. Sunset will be:

$$\begin{array}{r} 1442 \\ +\ 300 \\ \hline 1742 \end{array} \text{ local standard time.}$$

II. MOONRISE AND MOONSET

1. GENERAL. The times of moonrise and moonset also vary based on both longitudinal and latitudinal position. However, unlike solar times, neither the longitudinal nor the latidudinal change is constant for lunar data. Moonrise/set times are progressively later each day; and because the moon's orbit is elliptical and at a 5°-7° angle to the earth's equator, the rate of change of moonrise/set times varies from one day to the next (i.e. varies with time). Thus a simple conversion of four degrees per minute is not sufficient. We must add one more step to our technique which will calculate the portion of the daily change that occurs while the moon is traveling from the station with known lunar times to your location of interest (or from your location to the selected station if it is west of you).

2. INSTRUCTIONS

a. Select a station from 5 WWP 105-4 that has the same latitude as the location in which you're interested. Try to get within 10 minutes (10') of latitude. Also try to get as close as possible longitudinally to your location of interest. This is an additional factor not required for solar calculations. Station coordinates are listed in the front of the volumes of 5 WWP 105-4.

b. Write down the station coordinates.

c. Select from the appropriate tables the times of moonrise or moonset and write them down, with the date.

d. Also write down the date and times of moonrise/set for the previous day.

e. Compute the difference in longitude between your location of interest and the station you've selected by adding the values if one location is east of Greenwich and the other west, or by subtracting if both values are east or west. Convert the values from degrees and minutes to a decimal value to the nearest tenth of a degree.

f. Convert the longitudinal difference to time difference by multiplying by four minutes per degree. Round off to the nearest whole minute.

g. Compute the desired time. If your location of interest is west of the selected station, add the time difference to the selected station times. If your location is east of the selected station, subtract the time difference. Do not cross the International Dateline when figuring east or west. Times listed in Volume II through VI of 5 WWP 105-4 are GMT. You must convert Volume I times from local to GMT before performing any calculations.

h. Compute the daily change factor as follows:

(1) From f. above, express the time difference as a decimal value of hours and hundredths of hours.

(2) Divide the time difference by 24 hours to obtain the fraction of a day it takes the moon to travel between the selected station and your location of interest.

(3) Using the times from c. and d. above, find the difference in time of moonrise/set for the required day and the previous day. This value represents the time change for a complete day.

(4) Multiply the time change from (3) by the fraction of day from (2). This value represents the amount of daily change that occurs as the moon travels between the two locations.

(5) Add this value to the time computed in g. above if your location of interest is west of the selected station; subtract if east.

i. Convert times for any location to or from GMT by referring to the FLIP for the appropriate difference in hours from GMT.

3. EXAMPLE.

When does the moon set in northwest Costa Rica, 10° 49' N, 85° 45' W, on 20 December 1984?

a. Select a station from 5 WWP 105-4.

A world map shows that possible stations with the same latitude can be found in northern South America, central Africa, southeast Asia and the islands of the western Pacific. Therefore, look in Volume II, IV and V. Tan Son Nhut, Vietnam is at the same latitude as your location in Costa Rica, but half a world away. For greater accuracy, use:

Ernesto Cortissoz, Columbia (10° 54 N, 74° 47 W)

b. Write down the moonset times for 19 and 20 December 1984.

Moonset	20 Dec 84	2107
	19 Dec 84	2014

c. Compute longitudinal difference

Your location of interest = 85°45'W
Ernesto Cortissoz = 74°47'W
10.97° = 11.0° difference

d. Convert longitudinal difference to time difference

11.0°
x 4 min/°
44 minutes

e. Uncorrected moonset at your location

2107
+ 44
2151 Z

f. Compute daily change factor

44 min ÷ 60 min per hour = .73 hours

.73 ÷ 24 hours per day = .03 days

So 2107 (20 Dec)
- 2014 (19 Dec)
53 min
x.03
1.59 or 2 minutes

g. Corrected moonset

2151
+ 02
2153 Z or 1653 LST