The first sight of the Crescent on earth according to Yallop, SAAO and Odeh Criteria,, and the introduction of the Hijri Date Line as the Sunset Terminator Line of the opposite point of Mecca from its latitude

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1# Introduction:

This article is a supportive document of the author's Arabic book: "The Crescent between sighting and calculating" (الهلال بين الرؤية والحساب).

In this book, we have discussed concepts related to crescent sighting and its calculation without going in depth to its' equations. Therefore, the purpose of this article is to provide in details the equations related to the sighting's equations.

There are three major concepts explained in the book, which we will discuss here in brief:

1# The introduction of the Hijri Date Line (HDL for short).

This is not a new concept; it has been suggested by Mohammed Ilyas (Ref: Ilyas) in 1986 and by Ahmad Ezzat (Ref: Ezzat) in 2016. However, our arguments here is that this HDL needs to be the Sunset Terminator Line (STL for short) at a point opposite to Mecca in its latitude line. We named this point N.Kamma (NK for short) located at 21.4225N 140.1738W.

The major reason for this argument is that the day in the Islamic culture starts from sunset (rather than midnight), therefore all the points in the STL will have a new Arabic day at the same moment (i.e. the moment of sunset).

> To clarify the terminology here, the days (i.e. Saturday to Friday) will be regarded as Western days if it start from midnight, and Arabic days if it start from sunset.

To use the analogy of the International Date Line (IDL):

The western day starts on earth from a specific Line (which is the IDL) at specific time (which is midnight at that line). The same analogy should be applied for Arabic days: The Arabic day should start at a specific line on earth and a specific time.

But how to locate this line and choose this time?

The Time is clear, it should be the sunset time, as the day in Islamic culture starts from sunset (as mentioned before).

Therefore, the line should be the Sunset Terminator Line (STL), as all the points in that line will enter the new day at the same moment.

But the real question here is: which STL should we choose to be the HDL?

As it will be clear in this article, the location of the HDL has a direct effect on the start and end of the Hijri months. Therefore, The HDL location is an Islamic matter and should be treated as such.

In this regard, the Quran (in verse 6.92) has referred to Mecca as “the mother of towns” (أم القرى). Therefore, we argue that Mecca need to be regarded as the reference point, then we choose the location of HDL accordingly.

If Mecca was the reference point, then the HDL needs to be the parallel STL of Mecca at the opposite side of earth. This will be the STL passing through the point opposite to Mecca from its Latitude line, which is the point that we referred before as NK.

Note that HDL is not a fixed line, but the angle of HDL will vary slightly every day. But HDL is a solid line at a specific time. And at all times, HDL will pass through the point NK.

2# At any point on earth that confirms seeing the crescent (or the method of confirming the possibility of seeing the crescent at that point is proven and highly reliable) then the Arabic day at that point (after sunset) is the first day of the Hijri month. Afterward, we will determine the equivalent Western day accordingly.

3# The concept of the “Sight Line”: which is the STL at the point that has observed the crescent first time (or the method of confirming the possibilities of seeing the crescent first time at that point is proven and highly reliable).

Notice that the Sight Line will be parallel to HDL, as both are sunset terminator lines.

It is important to determine if the Sight Line is before or after HDL (i.e. if the sun sets at the Sight Line before or after setting at HDL), as this will determine the Arabic day of the Sight Line.

This article is about discussing the method of calculating the Sight Line.

2# Summary of findings:

There are many proposed equations for calculating the possibility of seeing the crescent at specific location and time (therefore determining the first point that can see the crescent).

But none of these equations has been proven; as it is very difficult to chase the crescent from one location to another every month.

All of these equations have been composed by analyzing and interpreting crescent sighting data.

The recent and widely accepted equations are for Yallop and SAAO (South African Astronomical Observatory).

There is also the equation of Odeh which is recognized and accepted in many Islamic institutions.

The results of obtaining the Sight Line (i.e the STL at the first point on earth that have seen the crescent first time) were not consistent in these three equations.

This demonstrate the need for all efforts to verify at least one of the above three equations.

However, the one thing that is consistent with all the three equations is T18.59, i.e at any lunar month; the crescent can be seen at one point on earth that the sun sets at it after 18.59 hours from the new moon (according to the three equations).

The conclusion of this article is that the Sight Line T19 (which is the round figure for 18.59) is the confirmed Sighting Line that is consistent with all the above three equations.

> To clarify the terminology here: T19 is the Sight Line after 19 hours from the new moon. This is the sunset time at the observation site. Sighting the crescent will be few minutes after that (about 20 minutes later).

It should be noted here that our calculations have been made through a vb6/vba program that we have compiled. The algorithm for the Sun coordinates and the coordinate's transformation were taken from Duffett-Smith book: "Practical Astronomy with your calculator" (Ref: Duffett).

The Moon coordinates were taken from a vba code for Keith Burnett (Ref: Burnett). The New Moon Timings were taken from another vba code for Andreas Killer (Ref: Killer) which he has modified from a code for Michael Friedrich (Ref: Friedrich).

The results from our vb program were compared with data and tables available in different internet sites (as calsky.com, nasa.gov, etc.). The differences were very minimal and acceptable for this article. Furthermore, we will provide our program in VB6 format at our website in due time.

3# The Discussion:

The Sight Line is the Sunset Terminator Line (STL for short) that passes through the point on earth where the first sighting of the crescent is expected.

For example: suppose the first confirmed sighting of the crescent was at a place A, then the STL that passes through A is the Sight Line. The STL is a line that represents all the points on earth that are at sunset.

This Sight Line is identified by the geocentric moon age. So if we say that the Sight Line for this lunar month is 18.45 (T18.45 for short) then it means that the observation site of the crescent is at STL after 18.45 hours from the new moon. If the new moon happened at 13.55 GMT then the Sight Line will be at 32 GMT (i.e. 8:00:00 Next Day GMT).

We will determine the Sight Line using Yallop, SAAO, and Odeh equations. It should be noted here that there are many other equations for sighting the crescent, recorded sense the time of Babylon, but the latest of these equations and the most accepted ones (at the moment) are the three mentioned above.

#3.1 Yallop Equation:

BD Yallop (Ref: Yallop) has produced his equation and Criterion on 1997. He used available recorded data of sighting the crescent. The set of data that he used consisted of 295 recorded sighting attempts.

He introduced the concept of **Best Time** for viewing the crescent after sunset:

Bt = St + 4/9 * (Mt –St)

Where:
- Bt is the best time to view the crescent.
- St is the sunset time.
- Mt is the moonset time.

Note that the observation of the crescent cannot be taken just after sunset, but rather few minutes after that when the sky is dark enough. Also this observation cannot be taken just before moonset, but rather few minutes before; as far objects near the horizon are very difficult to observe due to the dust and humidity accumulated at the upper level of the horizon.

Therefore, the “Best Time” equation indicates the best time to view the crescent, which is about half the time between sunset and moonset.

Note that the time between sunset and moonset is just few minutes at the first few hours of the crescent. For example:

> The sunset at point 0N 129E was at 09:12 GMT on 2017-10-20. The age of the moon at that time was 14 hours. The moonset was at 9:41 GMT. The difference between moonset and sunset (Lag) was just about 30 minutes. Therefore the “Best Time” is 09:25 GMT

Yallop has used the sighting recorded data, then identified the Best Time, then computed the moon data (ArcL, Daz, ArcV, etc). Afterwards, he analyzed the patterns emerged from these data and formalized his equation for the possibility of sighting the crescent at specific time and location:

$$Yq = (ARCV - (11{\cdot}8371 - 6{\cdot}3226\ tWm + 0{\cdot}7319\ tWm^2 - 0{\cdot}1018\ tWm^3)) / 10$$

Where:

- Yq: Yallop q test.
- ArcV: Geocentric Arc of Vision (in degrees): the difference in altitude between the center of the Sun and the center of the Moon for a given latitude and longitude, ignoring the effects of refraction.
- tWm: Topocentric width of the crescent in arc minutes. So if the width of the crescent is 0.002 degree then we need to transfer this value to arc minutes (0.12) then use it in the above equation.
- tWm^3 = tWm * tWm * tWm

The data required for this equation (i.e. ArcV and tWm) are calculated at Best Time at the location of the observation site.

The criterion for this test is:

- If Yq > +0.216 then the crescent is easily visible.
- If +0.216 >= Yq and Yq > -0.014 then the crescent is visible under perfect conditions.
- If -0.014 >= Yq and Yq > -0.160 then an optical aid (as a telescope) might be needed to see the crescent.
- If -0.160 >= Yq and Yq > -0.232 then an optical aid is needed to see the crescent.
- If -0.232 >= Yq then the crescent cannot be seen.

For the purpose of this article we need to check if the crescent is possible to be seen (with or without an optical aid). Therefore, we are only looking for this condition:

Sighting the crescent is possible (according to Yallop Criterion) if Yq > -0.232.

It should be noted that Yallop has provided the raw data of his equation (the coordination and moon data at the observation site).

#3.2 SAAO Equation:

SAAO stand for the South African Astronomical Observatory. The Equation and Criterion that was later named as the SAAO Criterion was developed by two astronomers in SAAO: John Caldwell and David Laney (Ref: Caldwell & Laney) in 2001.

The equation they have provided (based on their data analysis) is simple:

Sq = tAltR + (1/3) * ArcL
Where:

- Sq: the SAAO q test.
- tAltR: The topocentric altitude of the lower limb of the moon with refraction corrections.
- ArcL: The Arc of Light; the angle subtended at the center of the Earth by the center of the Sun and the center of the Moon.

The data required for this equation (i.e. tAltR and ArcL) are calculated at the moment of sunset at the location of the observation site.

The Criterion for this test is:

- If Sq > 11 then the crescent is easily visible.
- If 11 > Sq and Sq > 9 then an optical aid is needed to see the crescent.
- If 9 >= Sq then the crescent cannot be seen.

Therefore: Sighting the crescent (according to SAAO Criterion) is possible if Sq > 9.

#3.3 Odeh Equation:

Odeh Criterion has been provided by Mohammad Odeh in 2005 (Ref: Odeh). He used data set consisted of 737 recorded sighting attempts, half of them has been obtained by the Islamic Crescent Observation Project (ICOP).

His equation and criterion are similar to Yallop:

$$Oq = tArcV - (-0.1018\ tWm^3 + 0.7319\ tWm^2 - 6.3226\ tWm + 7.1651)$$

Where:

- Oq: Odeh q test.
- tArcV: Topocentric Arc of Vision (in degrees); the difference in altitude between the center of the Sun and the center of the Moon for a given latitude and longitude, ignoring the effects of refraction, and taking into account the parallax of the moon.
- Topocentric width of the crescent in arc minutes.

The data required for this equation (i.e. tArcV and tWm) are calculated at Best Time at the location of the observation site.

The Criterion for this test is:

- If Oq >= 5.65 then the crescent is easily visible.
- If 5.65 > Oq and Oq >= 2 then an optical aid might be needed to see the crescent.
- If 2 > Oq and Oq >= -0.96 then an optical aid is needed to see the crescent.
- If -0.96 > Oq then the crescent cannot be seen.

<u>Therefore: Sighting the crescent (according to Odeh Criterion) is possible if Oq >= -0.96.</u>

It should be noted that Odeh has provided the raw data of his equation (the coordination and moon data at the observation sight), however, care need to be taken when looking at these data:

- The observation date is the Local Date and not the GMT Date, therefore, it is normal that this date might be shorter one day than the JDay provided in the data set.
- The age of the moon in Odeh data set is the topocentric age and not geocentric.
- ArcV, ArcL, and Daz in Odeh data set are all topocentric values and not geocentric.
- Note that if the moon age, ArcV, ArcL, and Daz have been mentioned without any clarification then it is assumed to be geocentric and not topocentric.

#3.4 The approach of obtaining the Sight Line:

What we are trying to obtain here is: the first Sight Line of the crescent. As mentioned before, The Sight Line is the STL line at the first location where the crescent can be seen. Our objective here is to determine the Sight Line using the above equations.

We have provide here two approaches (Approach A and B). Approach A is very direct, while Approach B involves some numerical methods.

Approach A:

We used this approach as a starter, to familiarize ourselves with the problem in hand; as this approach is direct and doesn't need clarification. Figure 1 represents Earth between 60N to 60S, with 10 degrees intervals.

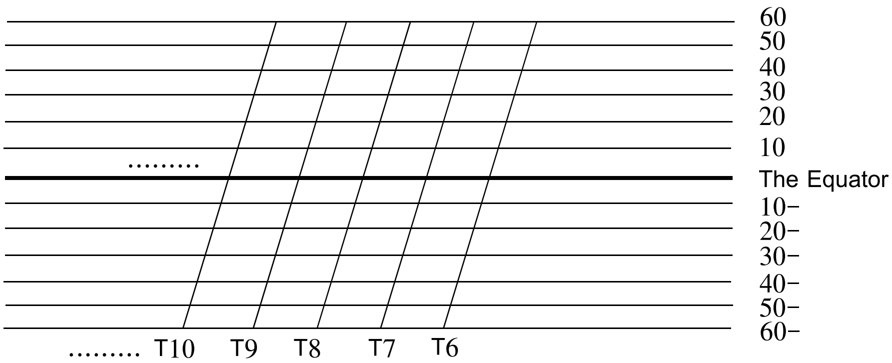

Figure 1

T6 is the Sunset Terminator Line after 6 hours from the new moon, T7 is the STL after 7 hours, and so forth.

We want to calculate Yq (and later Sq and Oq) for each intersection between the latitude lines in the above figure for each STL starting from T6 upward.

If Yq at any point in the STL line was positive (i.e. sighting the crescent is possible) then that STL will be the Sight Line.

Therefore, Approach A can be summarized as follows:

1- Define the time of the new moon
2- Add 6 hours to the new moon time to obtain T6.
3- Identify the longitude at 60N at which the sun will set after 6 hours from the new moon (i.e. Identify the longitude at the point of intersection between 60N and T6).
4- Calculate the needed data for Yq equation (for Yq it is ArcV and tWm).
5- If Yq is positive then save the STL (in this case T6) and exit the loop.
   If Not then go to the next latitude (in this case 55N).
6- Continue until the end of the latitude set (i.e. 60S)
7- If there were no positive value for Yq then go to the next STL (in this case T7).
8- Continue until Yq is positive.

Then we do the same approach for Sq and Oq.

This approach has been applied for every lunar month from 2000 until 2038 (This set of years covers the two cycles (18.6 years each) of the Lunar Standstill, and four cycles (8.9 years each) of the moon apsidal precession.

The Minimum and Maximum values for the Sight Line are in the following table:

Approach A	Ty	Ts	To
Min Earliest Date	11 2008-05-05	11 2005-01-10	7 2001-09-17
Max Earliest Date	19 2000-01-06	19 2015-09-13	15 2000-12-25

Where:
Ty: The Sight Line (the earliest STL) according to Yallop equation.
Ts: The Sight Line according to SAAO equation.
To: The Sight Line according to Odeh equation.

We have provided a sample of one page of these results (as this approach is just a starter and not the main approach) from 2000 to 2006. The results are in appendix A.

As it was mentioned before, this approach is very useful as it doesn't need clarifications or justifications; it is a direct method of finding the earliest STL (i.e. the Sight Line).

However, the margin of error in this approach is 10 degrees of latitude and One hour of time. This margin of error can be reduced by applying some numerical methods.

Approach B:

We used a simple approach with a margin of error of about 2 degrees of latitude, and 3 minutes of time, through using the Bracketing Method (i.e. Bolzano's Theorem):

The First Loop:

- We know from the data collected by the previous approach that sighting the crescent first time can vary between T6 (i.e. T7 minus one-hour margin of error) and T19. Before T6 the sighting is not likely, and after T19 the sighing is highly assured. However, as a precaution we decided to start our bracket from T5 to T20.
- So we can take T5 and T20 as the side parts of our bracket (i.e. [T5, T20]).
- We test the middle line between them (i.e. T12.5).
  If Yq is negative then our new bracket will be [T12.5, T20].
  But if Yq is positive then our new bracket will be [T5, T12.5].
- We continue this approach of reducing the size of the bracket until a reasonable size has been reached and we exit the loop.

Second Loop:
We can use another bracket, parallel to the previous one as the following:

- We obtain the latitude maximum and minimum at T20:
  It is highly assumed that the first sighting of the crescent will happen at a particular point on earth, then it will propagate north and south as demonstrated in figure 2:

  Suppose that the first sighting of the crescent was at point A. Afterword the area that can see the crescent will increase. This area is between curves B and C (so the area above B and below C will not be able to see the crescent at the first hours of it.).

  Therefore, we first compute the maximum and minimum latitude in T20 by taking the first point (from 60N) that Yq is positive (which is the nearest intersection point between T20 and curve B), then we take the first point from 60S, that Yq is positive (which is the nearest intersection point between T20 and curve C). Therefore we have a bracket of LtMax & LtMin.

- Afterward, for every positive Line in the first loop we reduce the Bracket size for LtMax and LtMin.

We continue the first and second loop until we reach our desired margin of error (in our case it was 3 minutes time difference between the current line and the previous one).

The results obtained from Approach B (from 2000 to 2038) are provided in Appendix B.

The Minimum and Maximum values for the Sight Line are in the following table:

Approach B	Ty	Ts	To
Min Sight	10.99	10.96	6.65
Earliest Date	2008-05-05	2005-01-10	2008-05-05
Latitude at Sight	52:39:00 N	24:41:16.8 S	60:00:00 N
Longitude at Sight	55:46:13.83 W	61:31:54.01 W	17:46:54.11 E
Max Sight	18.59	18.02	14.23
Earliest Date	2033-09-23	2015-09-13	2012-05-20
Latitude at Sight	23:09:36 S	20:42:25.63 S	09:30:00 N
Longitude at Sight	145:35:53.63 E	102:05:31.49 W	63:23:32.53 E

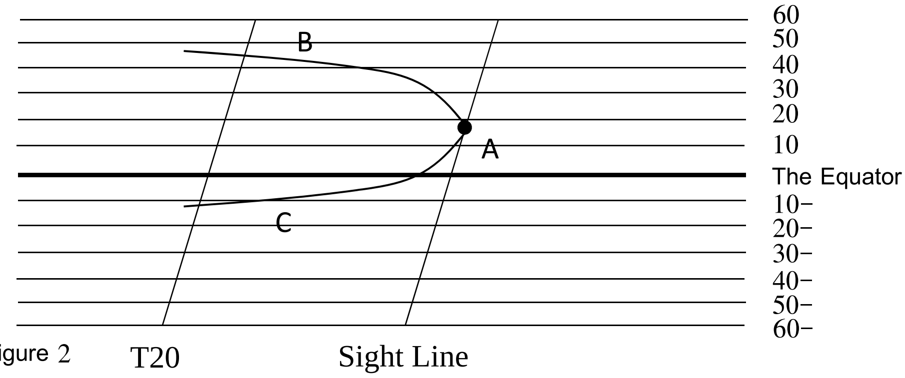

Figure 2

#4.The Conclusion:

As we have explained in the introduction: we are looking for a confirmed method for calculating the sighting of the crescent to identify the starting date of the Hijri months.

By looking at the three highly accepted equations (Yallop, SAAO, and Odeh) we found that the results were not consisted with each other (except for Yallop and SAAO were the result are “generally” similar with a margin of difference of about 50 minutes maximum).

Furthermore, the minimum value of To is highly unlikely; as the earliest recorded sighting of the crescent was at T11.37 (Moon age at sighting was 11.7) by M.G. Mirsaeed in Iran in 2002-09-07 (Ref: ICOP). The second earliest recorded sighting was at T11.92 (Moon age at sighting was at 12.12) by James Stamm in 1996-01-21.

It should be noted that Mirsaeed sighting is not consistent with Yallop or SAAO equations but only with Odeh’s equation. But Stamm sighting is consistent with all the three equations.

Note that on 2002-9-7 the Sight Line for the three equations were as the following:

	Ty	Ts	To
2002-9-7	11.32	11.21	7

But at Mirsaeed observation site (31:04N 56:28S) Yallop q test and SAAO q test were both negative.

As none of the above equations have been thoroughly tested and verified, and as the results of these equations are not consistent with each other, therefore the author conclusion is that these equations cannot be used for determining the starting dates of the Hijri months.

This is not to disqualify the above three equations:

> The above three equations have been composed through analyzing the available recorded sighting data. However, there are so little data regarding the first hours of sighting the crescent (before 14 hours from the new moon). Therefore, the crescent visibility might not behave according to these equations at its early hours.

However, all the three equations are consistent with the notion that the crescent is possible to be seen in every lunar month at a point in T19 (that is the STL after 19 hours from the new moon).

Therefore, our conclusion here is that T19 (or to be precise T18.59) is a line that the crescent will be visible at every lunar month.

Therefore, our recommendation is to calculate the Hijri months according to T19 (if it has not been sighted directly before that), **until** one of the above equations has been thoroughly tested and verified.

5# Calculating the First Hijri Date:

We have discussed this subject thoroughly in our book mentioned at the introduction, and we discuss it here in brief.

If the Sight Line of the crescent was before HDL (i.e. the sun sets at the Sight Line before setting at HDL) then the first dawn of the new Hijri month will be at the next day of the new moon, i.e. the day (Arabic and Western) of the geocentric conjunction.

If the Sight Line was after HDL (i.e. the sun sets at HDL before setting at the Sight Line) then the first dawn of the new Hijri month will be after two days from the new moon.

If we regarded the Sight Line to be T19 (unless the crescent has been sighted directly before that) then we need to obtain the GMT time of sunset at HDL.

The sunset time (GMT) of HDL is the sunset time (GMT) of the point NK at 21.4225N 140.1738W. This time can be easily calculated by available programs. It could also be calculated manually with a margin of error less than 30 seconds:

HDL Sunset GMT = Mecca Sunset GMT + 12
HDL Sunset GMT = Mecca Sunset Local + 9

Example: The new moon happened in Thursday 2017-10-19 at 19:12 GMT.
When is the first dawn of the new Hijri month?

The Sunset at the Sight Line was at 19 + 19:12 = 38:12 GMT
Mecca Sunset at 2017-10-19 was at 17:53 Local Time
HDL Sunset Time = 9 + 17:53 = 26:53 GMT
Therefore, HDL is before the Sight Line
Therefore, the first dawn of the new Hijri month is at Saturday (Western and Arabic) at 2017-10-21.

6# Recommendations:

We stress here on two recommendations:

- The need to test and verify an equation that represents the visibility of the crescent at a specific location and time. If this happened, then the Sight Line of the crescent can be obtained and used for every lunar month rather than depending on the generalized figure of T19.

- There is a well know argument between different schools in the Islamic world about the calculation of crescent sightings. Many schools of thoughts don't regard these calculations as an accepted method for determining the Hijri months (especially for Ramadan and Shawal).

  But this argument can be put to rest (for both opposite schools) if the Islamic world authorities have decided and collaborated to create a research vessel with proper equipment, and to be stationed just westward of HDL (The Hijri Date Line).

  Therefore, the crescent sighting calculation can be carried on and the results can be verified and confirmed by this research vessel.

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Appendix A:

Sample of the data calculated by Approach A (2000 to 2006)
#: order of the record
UDate UTime: the GMT date and time of the new moon.
Ty: The earliest Sight Line according to Yallop equation.
Ts: The earliest Sight Line according to SAAO equation.
To: The earliest Sight Line according to Odeh equation.

#	UDate	UTime	Ty	Ts	To
1	1999-12-07	22:31:39.75	18	17	12
3	2000-02-05	13:03:17.68	18	17	14
5	2000-04-04	18:12:1.2	13	13	8
7	2000-06-02	12:13:57.33	14	14	10
9	2000-07-31	02:24:59.12	14	14	11
11	2000-09-27	19:52:59.56	13	13	8
13	2000-11-25	23:11:21.16	17	17	12
15	2001-01-24	13:06:48.9	18	18	14
17	2001-03-25	01:21:7.19	15	14	9
19	2001-05-23	02:46:3.26	16	15	12
21	2001-07-20	19:44:15.03	14	14	11
23	2001-09-17	10:27:16.21	12	12	7
25	2001-11-15	06:40:1.96	16	15	12
27	2002-01-13	13:28:42.26	17	17	13
29	2002-03-14	02:02:35.32	16	15	10
31	2002-05-12	10:45:6.6	18	17	14
33	2002-07-10	10:25:56.8	15	15	11
35	2002-09-07	03:10:6.97	12	12	8
37	2002-11-04	20:34:23.97	15	14	11
39	2003-01-02	20:22:47.5	15	15	11
41	2003-03-03	02:34:52.29	15	14	9
43	2003-05-01	12:14:41.65	19	18	15
45	2003-06-29	18:38:30.35	16	16	12
47	2003-08-27	17:26:15.07	13	13	9
49	2003-10-25	12:50:12.63	15	15	11
51	2003-12-23	09:42:57.61	13	13	9
53	2004-02-20	09:17:42.57	14	13	9
55	2004-04-19	13:21:12.08	18	18	14
57	2004-06-17	20:26:45.44	17	16	12
59	2004-08-16	01:23:45.49	15	15	10
61	2004-10-14	02:48:9.02	16	16	12
63	2004-12-12	01:28:55.8	13	12	9
65	2005-02-08	22:27:53.47	13	13	9
67	2005-04-08	20:31:55.54	16	16	13
69	2005-06-06	21:55:7.11	15	15	10
71	2005-08-05	03:04:43.19	17	16	11
73	2005-10-03	10:27:48.67	18	17	14
75	2005-12-01	15:00:48.84	13	13	9
77	2006-01-29	14:14:30.2	13	13	9
79	2006-03-29	10:15:11.45	15	15	11
81	2006-05-27	05:25:31.32	13	13	9
83	2006-07-25	04:30:53.25	16	16	11
85	2006-09-22	11:44:58.65	19	18	15
87	2006-11-20	22:17:52.84	15	14	10

#	UDate	UTime	Ty	Ts	To
2	2000-01-06	18:13:41.22	19	18	14
4	2000-03-06	05:16:48.75	15	15	11
6	2000-05-04	04:12:0.04	13	13	8
8	2000-07-01	19:19:52.54	14	14	11
10	2000-08-29	10:19:12.65	13	13	10
12	2000-10-27	07:58:0.09	14	14	9
14	2000-12-25	17:21:43.35	19	18	15
16	2001-02-23	08:21:9.6	16	16	11
18	2001-04-23	15:25:36.68	15	14	10
20	2001-06-21	11:57:45.12	15	15	13
22	2001-08-19	02:55:06	12	12	9
24	2001-10-16	19:23:16.17	13	13	9
26	2001-12-14	20:47:31.6	17	17	13
28	2002-02-12	07:40:57.64	16	15	11
30	2002-04-12	19:21:10.27	17	16	12
32	2002-06-10	23:46:28.99	17	17	13
34	2002-08-08	19:15:5.48	13	12	9
36	2002-10-06	11:17:21.85	13	13	9
38	2002-12-04	07:34:21.43	15	15	12
40	2003-02-01	10:48:22.21	14	14	9
42	2003-04-01	19:18:32.06	17	17	12
44	2003-05-31	04:19:45.96	18	18	14
46	2003-07-29	06:52:36.67	14	13	9
48	2003-09-26	03:09:2.54	14	14	10
50	2003-11-23	22:58:54.98	14	14	11
52	2004-01-21	21:04:54.29	12	12	8
54	2004-03-20	22:41:20.43	16	16	12
56	2004-05-19	04:51:56.68	18	18	14
58	2004-07-17	11:23:40.84	15	15	10
60	2004-09-14	14:28:55.34	16	16	12
62	2004-11-12	14:27:4.21	15	14	11
64	2005-01-10	12:02:41.55	12	11	7
66	2005-03-10	09:10:14.2	15	15	11
68	2005-05-08	08:45:23.19	16	16	12
70	2005-07-06	12:02:31.37	15	14	9
72	2005-09-03	18:45:22.36	18	18	14
74	2005-11-02	01:24:28.91	16	16	12
76	2005-12-31	03:11:37.57	12	12	8
78	2006-02-28	00:30:40.05	14	14	11
80	2006-04-27	19:43:49.16	14	14	10
82	2006-06-25	16:05:13.36	14	14	9
84	2006-08-23	19:09:41.53	19	18	14
86	2006-10-22	05:13:59.58	17	17	12
88	2006-12-20	14:00:37.61	14	14	9

Appendix B

The data calculated by Approach B (from 2000 to 2038).

#: order of the record
UDate UTime: the GMT date and time of the new moon.
Ty: The earliest Sight Line according to Yallop equation.
Ts: The earliest Sight Line according to SAAO equation.
To: The earliest Sight Line according to Odeh equation.

#	UDate	UTime	Ty	Ts	To
1	1999-12-07	22:31:39.75	17.11	16.42	11.94
3	2000-02-05	13:03:17.68	17.17	16.70	13.06
5	2000-04-04	18:12:1.2	12.56	12.24	7.91
7	2000-06-02	12:13:57.33	13.29	13.24	9.75
9	2000-07-31	02:24:59.12	13.66	13.62	10.52
11	2000-09-27	19:52:59.56	12.38	12.04	7.73
13	2000-11-25	23:11:21.16	16.61	16.05	11.95
15	2001-01-24	13:06:48.9	17.92	17.30	13.41
17	2001-03-25	01:21:7.19	14.17	13.53	8.65
19	2001-05-23	02:46:3.26	15	14.78	11.22
21	2001-07-20	19:44:15.03	13.36	13.31	10.13
23	2001-09-17	10:27:16.21	11.17	11.04	6.88
25	2001-11-15	06:40:1.96	15.08	14.80	11.21
27	2002-01-13	13:28:42.26	16.65	16.14	12.30
29	2002-03-14	02:02:35.32	15.05	14.23	9.06
31	2002-05-12	10:45:6.6	17.24	16.77	13.02
33	2002-07-10	10:25:56.8	14.26	14.04	10.54
35	2002-09-07	03:10:6.97	11.32	11.21	7.01
37	2002-11-04	20:34:23.97	14	13.93	10.69
39	2003-01-02	20:22:47.5	14.26	14	10.41
41	2003-03-03	02:34:52.29	14.52	13.83	8.90
43	2003-05-01	12:14:41.65	18.55	17.95	14.09
45	2003-06-29	18:38:30.35	15.63	15.14	11.14
47	2003-08-27	17:26:15.07	12.71	12.41	8
49	2003-10-25	12:50:12.63	14.13	14.09	10.95
51	2003-12-23	09:42:57.61	12.46	12.39	8.89
53	2004-02-20	09:17:42.57	13.14	12.77	8.38
55	2004-04-19	13:21:12.08	17.90	17.37	13.70
57	2004-06-17	20:26:45.44	16.12	15.46	11.05
59	2004-08-16	01:23:45.49	14.73	14.13	9.46
61	2004-10-14	02:48:9.02	15.46	15.26	11.98
63	2004-12-12	01:28:55.8	12.03	11.99	8.34
65	2005-02-08	22:27:53.47	12.20	12.07	8.13
67	2005-04-08	20:31:55.54	15.87	15.61	12.26
69	2005-06-06	21:55:7.11	14.96	14.40	9.92
71	2005-08-05	03:04:43.19	16.09	15.33	10.56
73	2005-10-03	10:27:48.67	17.39	16.96	13.40
75	2005-12-01	15:00:48.84	12.84	12.67	8.57
77	2006-01-29	14:14:30.2	12.50	12.41	8.67
79	2006-03-29	10:15:11.45	14.09	14.04	10.92
81	2006-05-27	05:25:31.32	12.85	12.59	8.24
83	2006-07-25	04:30:53.25	15.85	15.22	10.80

#	UDate	UTime	Ty	Ts	To
2	2000-01-06	18:13:41.22	18.34	17.77	13.96
4	2000-03-06	05:16:48.75	14.60	14.19	10.31
6	2000-05-04	04:12:0.04	12.33	12.15	7.99
8	2000-07-01	19:19:52.54	13.96	13.93	10.83
10	2000-08-29	10:19:12.65	12.77	12.60	9.06
12	2000-10-27	07:58:0.09	13.79	13.29	8.73
14	2000-12-25	17:21:43.35	18.50	17.96	14.14
16	2001-02-23	08:21:9.6	15.72	15.03	10.62
18	2001-04-23	15:25:36.68	14.36	13.93	9.58
20	2001-06-21	11:57:45.12	14.70	14.61	11.44
22	2001-08-19	02:55:06	11.77	11.69	8.09
24	2001-10-16	19:23:16.17	12.56	12.37	8.33
26	2001-12-14	20:47:31.6	16.77	16.40	12.93
28	2002-02-12	07:40:57.64	15.40	14.69	10.06
30	2002-04-12	19:21:10.27	16.34	15.65	11.13
32	2002-06-10	23:46:28.99	16.39	16.09	12.67
34	2002-08-08	19:15:5.48	12.11	11.94	8.04
36	2002-10-06	11:17:21.85	12.38	12.28	8.56
38	2002-12-04	07:34:21.43	14.71	14.60	11.39
40	2003-02-01	10:48:22.21	13.66	13.16	8.69
42	2003-04-01	19:18:32.06	16.92	16.21	11.83
44	2003-05-31	04:19:45.96	17.92	17.37	13.64
46	2003-07-29	06:52:36.67	13.40	12.97	8.52
48	2003-09-26	03:09:2.54	13.46	13.29	9.63
50	2003-11-23	22:58:54.98	13.70	13.70	10.61
52	2004-01-21	21:04:54.29	11.78	11.57	7.34
54	2004-03-20	22:41:20.43	15.90	15.44	11.52
56	2004-05-19	04:51:56.68	17.80	17.23	13.37
58	2004-07-17	11:23:40.84	14.66	13.96	8.93
60	2004-09-14	14:28:55.34	15.55	15.16	11.35
62	2004-11-12	14:27:4.21	14.02	13.96	10.71
64	2005-01-10	12:02:41.55	11.04	10.96	6.78
66	2005-03-10	09:10:14.2	14.41	14.23	10.78
68	2005-05-08	08:45:23.19	15.86	15.51	11.77
70	2005-07-06	12:02:31.37	14.71	13.96	8.78
72	2005-09-03	18:45:22.36	17.62	17.02	13.06
74	2005-11-02	01:24:28.91	15.33	15.08	11.42
76	2005-12-31	03:11:37.57	11.68	11.56	7.22
78	2006-02-28	00:30:40.05	13.74	13.70	10.52
80	2006-04-27	19:43:49.16	13.49	13.37	9.81
82	2006-06-25	16:05:13.36	13.54	13.06	8.21
84	2006-08-23	19:09:41.53	18.12	17.52	13.58

#	UDate	UTime	Ty	Ts	To
85	2006-09-22	11:44:58.65	18.43	17.86	14.09
87	2006-11-20	22:17:52.84	14.23	13.79	9.03
89	2007-01-19	04:00:35.65	14.06	13.83	10.09
91	2007-03-19	02:42:26.22	13.58	13.58	10.52
93	2007-05-16	19:27:14.63	11.25	11.25	6.93
95	2007-07-14	12:03:42.3	14.65	14.28	10.41
97	2007-09-11	12:44:12.58	17.43	16.95	13.23
99	2007-11-09	23:03:3.36	14.97	14.35	9.06
101	2008-01-08	11:36:58.73	16.36	15.89	11.90
103	2008-03-07	17:14:3.99	14.40	14.28	10.91
105	2008-05-05	12:18:13.17	10.99	11.05	6.65
107	2008-07-03	02:18:32.91	13.63	13.53	10.11
109	2008-08-30	19:57:59.83	15.12	14.88	11.38
111	2008-10-28	23:13:52.73	14.22	13.70	8.56
113	2008-12-27	12:22:25.25	18.03	17.39	13.29
115	2009-02-25	01:34:59.22	15.94	15.56	11.74
117	2009-04-25	03:22:27.76	12.07	11.99	7.43
119	2009-06-22	19:34:55.62	13.71	13.67	10.44
121	2009-08-20	10:01:24.21	13.14	13.12	9.77
123	2009-10-18	05:32:59.65	12.56	12.37	7.74
125	2009-12-16	12:02:7.66	17.80	17.23	13.36
127	2010-02-14	02:51:16.72	16.81	16.27	12.05
129	2010-04-14	12:28:51.38	13.96	13.57	8.73
131	2010-06-12	11:14:31.82	15.03	14.87	11.55
133	2010-08-10	03:07:56.58	12.47	12.50	9.07
135	2010-10-07	18:44:20.26	11.38	11.43	7.26
137	2010-12-05	17:35:38.88	16.08	15.78	12.29
139	2011-02-03	02:30:36.66	16.02	15.42	11.14
141	2011-04-03	14:32:12.82	15.42	14.82	9.79
143	2011-06-01	21:02:28.95	17.08	16.69	13.14
145	2011-07-30	18:39:41.71	13.07	12.97	9.19
147	2011-09-27	11:08:29.66	11.48	11.57	7.53
149	2011-11-25	06:09:37.1	14.49	14.43	11.26
151	2012-01-23	07:39:14.51	13.75	13.49	9.37
153	2012-03-22	14:37:4.12	15.46	14.90	10.09
155	2012-05-20	23:47:0.06	18.55	17.98	14.23
157	2012-07-19	04:23:56.48	14.39	14	9.67
159	2012-09-16	02:10:31.52	12.86	12.77	8.60
161	2012-11-13	22:07:53.97	14.10	14.06	11.01
163	2013-01-11	19:43:25.93	11.85	11.78	7.83
165	2013-03-11	19:50:54.26	14.30	14.01	9.71
167	2013-05-10	00:28:25.13	18.11	17.56	13.87
169	2013-07-08	07:14:18.38	15.22	14.57	9.75
171	2013-09-05	11:36:8.43	15.08	14.69	10.27
173	2013-11-03	12:49:52.17	14.99	14.83	11.64
175	2014-01-01	11:14:2.81	11.27	11.26	7.27
177	2014-03-01	07:59:30.96	13.19	13.11	9.34
179	2014-04-29	06:14:10.16	16.03	15.70	12.26
181	2014-06-27	08:08:24.74	14.60	13.96	9.03
183	2014-08-25	14:12:43.45	16.87	16.27	11.81
185	2014-10-23	21:56:32.77	16.64	16.25	12.72
187	2014-12-22	01:35:42.98	12.07	11.90	7.60
189	2015-02-18	23:47:4.84	13.12	13.14	9.64
191	2015-04-18	18:56:42.72	13.92	13.79	10.58

#	UDate	UTime	Ty	Ts	To
86	2006-10-22	05:13:59.58	16.58	16.06	11.95
88	2006-12-20	14:00:37.61	13.40	13.03	8.37
90	2007-02-17	16:14:10.75	14.43	14.32	11.14
92	2007-04-17	11:36:1.36	12.08	12.15	8.56
94	2007-06-15	03:13:3.23	12.24	12.04	7.70
96	2007-08-12	23:02:28.75	16.80	16.39	12.80
98	2007-10-11	05:00:40.94	16.33	15.78	11.42
100	2007-12-09	17:40:16.9	15.25	14.65	9.62
102	2008-02-07	03:44:19.48	16.17	15.89	12.50
104	2008-04-06	03:55:13.2	12.12	12.15	8.33
106	2008-06-03	19:22:34.15	11.82	11.79	7.77
108	2008-08-01	10:12:28.08	14.95	14.79	11.55
110	2008-09-29	08:12:18.08	14.41	14.09	9.81
112	2008-11-27	16:54:37.67	15.99	15.22	10.27
114	2009-01-26	07:55:11	18.08	17.58	13.88
116	2009-03-26	16:05:54.07	13.27	13.10	8.87
118	2009-05-24	12:10:56.13	12.71	12.64	8.73
120	2009-07-22	02:34:26.41	13.92	13.88	10.82
122	2009-09-18	18:44:14.93	12.20	12.15	8.17
124	2009-11-16	19:13:36.4	15.03	14.58	10.11
126	2010-01-15	07:11:22.16	18.52	17.94	14.15
128	2010-03-15	21:01:9.03	14.56	14.10	9.46
130	2010-05-14	01:04:16.17	14.71	14.43	10.44
132	2010-07-11	19:40:19.35	14.15	14.09	10.96
134	2010-09-08	10:29:40.23	11.05	11.17	7.28
136	2010-11-06	04:51:38.27	13.70	13.54	9.66
138	2011-01-04	09:02:34.79	16.89	16.48	12.88
140	2011-03-04	20:45:48.7	14.78	14.19	9.36
142	2011-05-03	06:50:34.39	16.93	16.40	12.24
144	2011-07-01	08:53:46.24	15.46	15.22	11.78
146	2011-08-29	03:03:58.58	11.29	11.36	7.30
148	2011-10-26	19:55:40.62	13.19	13.19	9.63
150	2011-12-24	18:06:15.62	14.57	14.39	11.05
152	2012-02-21	22:34:38.07	13.59	13.20	8.47
154	2012-04-21	07:18:21.93	17.95	17.30	13.16
156	2012-06-19	15:02:0.35	16.94	16.43	12.60
158	2012-08-17	15:54:23.51	12.68	12.47	8.13
160	2012-10-15	12:02:23.06	13.87	13.83	10.41
162	2012-12-13	08:41:26.98	13.11	13.08	9.85
164	2013-02-10	07:19:58.97	11.98	11.85	7.36
166	2013-04-10	09:35:15.23	17.03	16.59	12.80
168	2013-06-08	15:56:22.39	17.11	16.46	12.41
170	2013-08-06	21:50:42.69	14.39	13.83	8.69
172	2013-10-05	00:34:29.66	15.69	15.46	11.90
174	2013-12-03	00:22:15.03	13.10	13.01	9.66
176	2014-01-30	21:38:23.89	11.21	11.25	6.92
178	2014-03-30	18:44:31.8	15.26	15.08	11.70
180	2014-05-28	18:40:4.88	15.46	14.96	10.97
182	2014-07-26	22:41:43.38	15.08	14.39	9.10
184	2014-09-24	06:13:43.77	17.80	17.30	13.54
186	2014-11-22	12:32:6.35	14.17	13.87	10.11
188	2015-01-20	13:13:33.17	11.85	11.82	7.60
190	2015-03-20	09:36:1.87	14.06	14.02	10.92
192	2015-05-18	04:13:2.82	13.15	12.90	9.10

#	UDate	UTime	Ty	Ts	To
193	2015-06-16	14:05:10.81	12.94	12.54	7.90
195	2015-08-14	14:53:23.78	17	16.43	12.24
197	2015-10-13	00:05:45.4	17.81	17.20	13.37
199	2015-12-11	10:29:13.92	13.66	13.19	8.38
201	2016-02-08	14:38:44.99	14.36	14.26	10.78
203	2016-04-07	11:23:30.51	12.97	12.90	9.72
205	2016-06-05	02:59:28.06	11.51	11.38	7.36
207	2016-08-02	20:44:31.25	15.72	15.38	11.66
209	2016-10-01	00:11:28.24	17.12	16.53	12.67
211	2016-11-29	12:18:17.92	14.99	14.23	9.03
213	2017-01-28	00:06:56.37	16.52	16.17	12.51
215	2017-03-28	02:56:59.48	13.41	13.27	9.83
217	2017-05-25	19:44:18.64	11.26	11.21	7.04
219	2017-07-23	09:45:27.32	14.32	14.23	10.92
221	2017-09-20	05:29:47.67	14.88	14.52	10.82
223	2017-11-18	11:42:0.05	14.92	14.18	9.12
225	2018-01-17	02:17:10.01	18.39	17.83	13.98
227	2018-03-17	13:11:29.19	14.74	14.31	10.41
229	2018-05-15	11:47:32.34	12.37	12.17	7.99
231	2018-07-13	02:47:42.99	13.93	13.89	10.79
233	2018-09-09	18:01:19.15	12.76	12.58	9.06
235	2018-11-07	16:01:55.41	13.70	13.24	8.67
237	2019-01-06	01:28:11.25	18.45	17.89	14.10
239	2019-03-06	16:03:49.38	15.77	15.09	10.69
241	2019-05-04	22:45:12.66	14.41	13.96	9.58
243	2019-07-02	19:15:59.62	14.75	14.65	11.48
245	2019-08-30	10:36:50.47	11.81	11.74	8.16
247	2019-10-28	03:38:17.66	12.51	12.33	8.29
249	2019-12-26	05:13:4.54	16.67	16.33	12.85
251	2020-02-23	15:31:48.05	15.38	14.65	10.09
253	2020-04-23	02:25:32.36	16.34	15.63	11.08
255	2020-06-21	06:41:9.69	16.49	16.17	12.73
257	2020-08-19	02:41:21.02	12.21	12.03	8.13
259	2020-10-16	19:30:43.89	12.38	12.29	8.56
261	2020-12-14	16:16:25.87	14.65	14.53	11.35
263	2021-02-11	19:05:32.11	13.57	13.10	8.65
265	2021-04-12	02:30:36.58	16.83	16.14	11.74
267	2021-06-10	10:52:28.19	18	17.43	13.70
269	2021-08-08	13:49:56.2	13.51	13.07	8.61
271	2021-10-06	11:05:7.27	13.53	13.36	9.66
273	2021-12-04	07:42:52.28	13.71	13.70	10.62
275	2022-02-01	05:45:51.26	11.72	11.52	7.31
277	2022-04-01	06:24:7.05	15.77	15.33	11.42
279	2022-05-30	11:29:57.96	17.74	17.18	13.36
281	2022-07-28	17:54:40.24	14.69	13.96	8.94
283	2022-09-25	21:54:15.3	15.63	15.22	11.38
285	2022-11-23	22:56:57.57	14.13	14.04	10.79
287	2023-01-21	20:53:0.89	11.05	10.97	6.83
289	2023-03-21	17:22:53.57	14.35	14.15	10.74
291	2023-05-19	15:53:0.11	15.76	15.39	11.72
293	2023-07-17	18:31:33.05	14.62	13.87	8.73
295	2023-09-15	01:39:37.6	17.65	17.03	13.03
297	2023-11-13	09:27:10.02	15.48	15.18	11.53
299	2024-01-11	11:57:8.9	11.77	11.61	7.30

#	UDate	UTime	Ty	Ts	To
194	2015-07-16	01:24:17.24	14.40	13.89	9.11
196	2015-09-13	06:41:18.93	18.58	18.02	14.18
198	2015-11-11	17:47:4.48	15.48	14.90	10.61
200	2016-01-10	01:30:21.31	13.66	13.40	9.06
202	2016-03-09	01:54:15.99	14.18	14.13	11.05
204	2016-05-06	19:29:26.78	11.64	11.55	7.79
206	2016-07-04	11:00:52.85	13.27	12.99	8.85
208	2016-09-01	09:03:8.17	17.33	16.86	13.28
210	2016-10-30	17:38:18.85	15.70	14.96	10.36
212	2016-12-29	06:53:9.86	15.89	15.33	10.82
214	2017-02-26	14:58:11.62	15.55	15.30	11.99
216	2017-04-26	12:15:57.34	11.55	11.43	7.51
218	2017-06-24	02:30:35.11	12.64	12.58	8.89
220	2017-08-21	18:30:3.06	15.16	14.95	11.68
222	2017-10-19	19:11:58.02	14.30	13.70	9.15
224	2017-12-18	06:30:21.99	17.09	16.40	11.92
226	2018-02-15	21:05:5.17	17.28	16.80	13.14
228	2018-04-16	01:56:56.16	12.68	12.34	8
230	2018-06-13	19:43:6.15	13.27	13.20	9.68
232	2018-08-11	09:57:30.47	13.63	13.58	10.52
234	2018-10-09	03:46:46.09	12.33	12	7.73
236	2018-12-07	07:20:19.75	16.52	16.02	11.90
238	2019-02-04	21:03:24.41	17.92	17.30	13.42
240	2019-04-05	08:50:18.89	14.26	13.59	8.69
242	2019-06-03	10:01:43.51	15.03	14.79	11.21
244	2019-08-01	03:11:35.03	13.42	13.37	10.23
246	2019-09-28	18:26:9.61	11.17	11.04	6.91
248	2019-11-26	15:05:29.54	14.99	14.74	11.17
250	2020-01-24	21:41:52.11	16.58	16.05	12.25
252	2020-03-24	09:27:55.74	15.03	14.22	9.03
254	2020-05-22	17:38:34.99	17.30	16.80	13.01
256	2020-07-20	17:32:38.18	14.39	14.15	10.65
258	2020-09-17	10:59:50.51	11.38	11.23	7.05
260	2020-11-15	05:07:2.09	13.97	13.92	10.67
262	2021-01-13	04:59:59.02	14.17	13.93	10.32
264	2021-03-13	10:20:57.35	14.43	13.74	8.85
266	2021-05-11	18:59:39.53	18.53	17.93	14.04
268	2021-07-10	01:16:22.58	15.76	15.25	11.25
270	2021-09-07	00:51:32.82	12.80	12.46	8.03
272	2021-11-04	21:14:24.64	14.18	14.13	10.99
274	2022-01-02	18:33:19.15	12.42	12.37	8.86
276	2022-03-02	17:34:33.78	13.06	12.68	8.34
278	2022-04-30	20:27:48.14	17.77	17.27	13.62
280	2022-06-29	02:51:54.3	16.14	15.47	11.10
282	2022-08-27	08:16:47.78	14.78	14.14	9.42
284	2022-10-25	10:48:24.98	15.59	15.38	12.07
286	2022-12-23	10:16:38.11	12.08	12.04	8.39
288	2023-02-20	07:05:34.68	12.15	12.03	8.12
290	2023-04-20	04:12:16.96	15.76	15.52	12.17
292	2023-06-18	04:36:53.05	14.87	14.32	9.89
294	2023-08-16	09:37:54.34	16.02	15.25	10.48
296	2023-10-14	17:54:59.61	17.52	17.08	13.49
298	2023-12-12	23:31:47.16	12.95	12.76	8.67
300	2024-02-09	22:58:52.73	12.52	12.42	8.72

#	UDate	UTime	Ty	Ts	To
301	2024-03-10	09:00:9.71	13.74	13.70	10.52
303	2024-05-08	03:21:42.02	13.44	13.33	9.81
305	2024-07-05	22:57:8.59	13.40	12.90	8.12
307	2024-09-03	01:55:20.28	18.05	17.43	13.51
309	2024-11-01	12:47:6.1	16.69	16.17	12.07
311	2024-12-30	22:26:36.6	13.53	13.11	8.46
313	2025-02-28	00:44:30.4	14.49	14.39	11.21
315	2025-04-27	19:30:55.59	12.13	12.20	8.63
317	2025-06-25	10:31:17.93	12.09	11.91	7.60
319	2025-08-23	06:06:14	16.64	16.24	12.67
321	2025-10-21	12:24:54.74	16.34	15.81	11.47
323	2025-12-20	01:43:12.1	15.33	14.66	9.66
325	2026-02-17	12:00:59.35	16.30	16.02	12.59
327	2026-04-17	11:51:32.67	12.26	12.28	8.42
329	2026-06-15	02:53:53.85	11.77	11.72	7.73
331	2026-08-12	17:36:26.21	14.83	14.69	11.47
333	2026-10-10	15:49:47.16	14.36	14.04	9.79
335	2026-12-09	00:51:36.93	15.90	15.21	10.27
337	2027-02-06	15:55:53.52	18.16	17.64	13.94
339	2027-04-06	23:50:57.52	13.41	13.20	8.91
341	2027-06-04	19:40:3.13	12.72	12.64	8.72
343	2027-08-02	10:04:50.55	13.88	13.87	10.82
345	2027-09-30	02:35:51.37	12.17	12.15	8.16
347	2027-11-28	03:24:6.42	14.96	14.52	10.09
349	2028-01-26	15:12:17.35	18.48	17.92	14.13
351	2028-03-26	04:31:13.58	14.65	14.17	9.49
353	2028-05-24	08:16:2.71	14.78	14.47	10.52
355	2028-07-22	03:01:20.92	14.22	14.15	11.04
357	2028-09-18	18:23:25.39	11.08	11.19	7.34
359	2028-11-16	13:17:43.4	13.63	13.49	9.62
361	2029-01-14	17:24:14.52	16.78	16.39	12.80
363	2029-03-15	04:19:4.47	14.75	14.18	9.40
365	2029-05-13	13:41:59.61	16.97	16.42	12.24
367	2029-07-11	15:50:50.31	15.60	15.33	11.90
369	2029-09-08	10:44:8.98	11.38	11.43	7.43
371	2029-11-06	04:23:51.71	13.15	13.15	9.63
373	2030-01-04	02:49:15.01	14.47	14.30	10.97
375	2030-03-04	06:34:29.92	13.49	13.12	8.52
377	2030-05-02	14:11:53.64	17.84	17.23	13.10
379	2030-06-30	21:34:6.67	17.02	16.52	12.68
381	2030-08-28	23:07:10.26	12.76	12.54	8.08
383	2030-10-26	20:16:42.11	13.96	13.89	10.52
385	2030-12-24	17:31:53.39	13.10	13.07	9.83
387	2031-02-21	15:48:38.28	11.86	11.78	7.44
389	2031-04-21	16:56:52.27	16.89	16.45	12.67
391	2031-06-19	22:24:24.79	17.08	16.45	12.41
393	2031-08-18	04:32:6.56	14.39	13.84	8.81
395	2031-10-16	08:20:36.21	15.82	15.56	11.98
397	2031-12-14	09:05:30.49	13.19	13.07	9.68
399	2032-02-11	06:23:55.68	11.17	11.22	7
401	2032-04-10	02:39:13.45	15.13	14.96	11.61
403	2032-06-08	01:31:50.05	15.34	14.87	10.92
405	2032-08-06	05:11:19.71	14.97	14.31	9.06
407	2032-10-04	13:26:19.35	17.91	17.39	13.62

#	UDate	UTime	Ty	Ts	To
302	2024-04-08	18:20:39.12	14.06	14.02	10.91
304	2024-06-06	12:37:27.33	12.77	12.51	8.22
306	2024-08-04	11:12:47.42	15.68	15.08	10.65
308	2024-10-02	18:49:9.83	18.48	17.92	14.13
310	2024-12-01	06:21:19.46	14.36	13.87	9.15
312	2025-01-29	12:35:44.75	14.15	13.92	10.11
314	2025-03-29	10:57:30.02	13.66	13.66	10.52
316	2025-05-27	03:02:6.77	11.25	11.21	7
318	2025-07-24	19:10:53.64	14.43	14.10	10.26
320	2025-09-21	19:53:47.36	17.37	16.90	13.20
322	2025-11-20	06:47:5.8	15.03	14.36	9.15
324	2026-01-18	19:51:51.55	16.46	15.99	11.98
326	2026-03-19	01:23:14.81	14.53	14.40	11.01
328	2026-05-16	20:00:46.99	11.05	11.09	6.71
330	2026-07-14	09:43:20	13.50	13.41	9.98
332	2026-09-11	03:26:41.07	15.03	14.82	11.34
334	2026-11-09	07:01:47.76	14.19	13.67	8.46
336	2027-01-07	20:24:13.37	18.05	17.42	13.31
338	2027-03-08	09:29:17.36	16.05	15.68	11.85
340	2027-05-06	10:58:19.19	12.17	12.07	7.38
342	2027-07-04	03:01:46.94	13.70	13.66	10.40
344	2027-08-31	17:40:50.27	13.12	13.12	9.79
346	2027-10-29	13:36:16.65	12.52	12.33	7.57
348	2027-12-27	20:12:7.32	17.72	17.18	13.29
350	2028-02-25	10:37:12.66	16.84	16.30	12.08
352	2028-04-24	19:46:43.11	14.04	13.63	8.64
354	2028-06-22	18:27:19.55	15.09	14.92	11.60
356	2028-08-20	10:43:25.15	12.54	12.58	9.15
358	2028-10-18	02:56:31.28	11.47	11.42	7.69
360	2028-12-16	02:06:3.13	16.02	15.69	12.24
362	2029-02-13	10:31:16.62	15.87	15.38	11.09
364	2029-04-13	21:40:0.38	15.42	14.79	9.67
366	2029-06-12	03:50:22.34	17.17	16.77	13.20
368	2029-08-10	01:55:35.45	13.20	13.07	9.29
370	2029-10-07	19:14:14.14	11.51	11.60	7.49
372	2029-12-05	14:51:53.58	14.44	14.36	11.22
374	2030-02-02	16:07:18.1	13.63	13.40	9.28
376	2030-04-02	22:02:16.45	15.35	14.82	9.96
378	2030-06-01	06:21:4.14	18.56	18.02	14.23
380	2030-07-30	11:10:42.76	14.47	14.09	9.75
382	2030-09-27	09:54:24.83	12.93	12.84	8.63
384	2030-11-25	06:46:12.61	14.13	14.10	11.05
386	2031-01-23	04:30:42.62	11.77	11.74	7.77
388	2031-03-23	03:48:51.18	14.17	13.92	9.62
390	2031-05-21	07:17:0.29	18.02	17.46	13.79
392	2031-07-19	13:39:57.45	15.22	14.58	9.75
394	2031-09-16	18:46:45.92	15.14	14.74	10.28
396	2031-11-14	21:09:24.41	15.09	14.95	11.72
398	2032-01-12	20:06:23.01	11.25	11.27	7.22
400	2032-03-11	16:24:21.73	13.10	13.06	9.28
402	2032-05-09	13:35:26.4	15.94	15.59	12.17
404	2032-07-07	14:41:18.29	14.49	13.87	8.97
406	2032-09-04	20:56:28.35	16.86	16.25	11.74
408	2032-11-03	05:44:51.63	16.80	16.39	12.85

#	UDate	UTime	Ty	Ts	To
409	2032-12-02	20:52:42.74	14.27	13.98	10.19
411	2033-01-30	21:59:33.47	11.87	11.86	7.57
413	2033-03-30	17:51:20.81	14.04	14	10.91
415	2033-05-28	11:36:13.37	13.06	12.84	9.04
417	2033-07-26	08:12:19.92	14.19	13.72	8.90
419	2033-09-23	13:39:33.63	18.58	18.02	14.17
421	2033-11-22	01:39:1.97	15.59	14.99	10.67
423	2034-01-20	10:01:25.73	13.74	13.46	9.10
425	2034-03-20	10:14:12.95	14.26	14.19	11.12
427	2034-05-18	03:12:18.6	11.61	11.55	7.81
429	2034-07-15	18:14:56.23	13.01	12.81	8.63
431	2034-09-12	16:13:29.23	17.21	16.77	13.24
433	2034-11-11	01:16:1.51	15.72	14.99	10.45
435	2035-01-09	15:02:55.26	16.02	15.39	10.84
437	2035-03-09	23:09:5.01	15.65	15.42	12.09
439	2035-05-07	20:03:29.69	11.60	11.48	7.56
441	2035-07-05	09:58:58.57	12.51	12.47	8.74
443	2035-09-02	01:59:11.84	15.05	14.86	11.61
445	2035-10-31	02:58:26.02	14.26	13.67	9.15
447	2035-12-29	14:30:48.37	17.09	16.42	11.91
449	2036-02-27	04:59:7.44	17.39	16.89	13.24
451	2036-04-26	09:32:54.66	12.77	12.43	8.07
453	2036-06-24	03:09:19.39	13.24	13.20	9.62
455	2036-08-21	17:34:51.33	13.63	13.57	10.52
457	2036-10-19	11:49:40.46	12.26	11.96	7.70
459	2036-12-17	15:34:12.07	16.42	15.94	11.85
461	2037-02-15	04:53:47.84	17.98	17.31	13.44
463	2037-04-15	16:07:28.91	14.35	13.67	8.76
465	2037-06-13	17:09:57.02	15.09	14.83	11.21
467	2037-08-11	10:41:6.64	13.50	13.44	10.27
469	2037-10-09	02:34:5.92	11.17	11.04	6.91
471	2037-12-06	23:38:2.86	14.90	14.66	11.09
473	2038-02-04	05:52:1.34	16.50	16.02	12.21
475	2038-04-04	16:42:43.33	15.03	14.22	9.03
477	2038-06-03	00:23:51.78	17.33	16.83	13.01
479	2038-08-01	00:39:55.38	14.52	14.26	10.75
481	2038-09-28	18:57:7.01	11.42	11.27	7.08
483	2038-11-26	13:46:23.29	13.94	13.88	10.65

#	UDate	UTime	Ty	Ts	To
410	2033-01-01	10:16:48.8	12.11	11.96	7.61
412	2033-03-01	08:23:10.13	13.11	13.12	9.63
414	2033-04-29	02:45:55.13	13.85	13.74	10.54
416	2033-06-26	21:06:45.64	12.77	12.41	7.78
418	2033-08-24	21:39:32.38	16.86	16.30	12.08
420	2033-10-23	07:28:18.05	17.92	17.30	13.45
422	2033-12-21	18:46:22.94	13.74	13.27	8.42
424	2034-02-18	23:10:1.96	14.44	14.32	10.83
426	2034-04-18	19:25:33.38	13.01	12.97	9.76
428	2034-06-16	10:25:37	11.38	11.26	6.92
430	2034-08-14	03:52:45.97	15.52	15.21	11.48
432	2034-10-12	07:32:21.33	17.11	16.52	12.67
434	2034-12-10	20:14:14.92	15.01	14.26	9.03
436	2035-02-08	08:21:53.08	16.64	16.27	12.58
438	2035-04-08	10:57:21.34	13.53	13.36	9.92
440	2035-06-06	03:20:21.65	11.21	11.14	6.97
442	2035-08-03	17:11:27.28	14.18	14.10	10.82
444	2035-10-01	13:06:31.9	14.83	14.47	10.80
446	2035-11-29	19:37:20.73	14.90	14.17	9.08
448	2036-01-28	10:17:4.97	18.45	17.87	14.02
450	2036-03-27	20:56:34.36	14.87	14.44	10.52
452	2036-05-25	19:16:36.67	12.39	12.20	7.95
454	2036-07-23	10:16:35.97	13.88	13.87	10.75
456	2036-09-20	01:51:11	12.72	12.58	9.07
458	2036-11-18	00:14:7.9	13.62	13.16	8.63
460	2037-01-16	09:34:12.23	18.39	17.84	14.06
462	2037-03-16	23:36:1.96	15.86	15.16	10.75
464	2037-05-15	05:53:59.07	14.47	14	9.58
466	2037-07-13	02:31:28.04	14.82	14.70	11.51
468	2037-09-09	18:25:0.38	11.85	11.78	8.22
470	2037-11-07	12:02:42.27	12.46	12.28	8.24
472	2038-01-05	13:41:10.79	16.58	16.23	12.77
474	2038-03-05	23:14:48.41	15.34	14.65	10.09
476	2038-05-04	09:19:18.77	16.33	15.63	11.04
478	2038-07-02	13:31:44.32	16.59	16.27	12.80
480	2038-08-30	10:12:23.42	12.30	12.11	8.22
482	2038-10-28	03:52:22.96	12.39	12.30	8.56
484	2038-12-26	01:01:39.93	14.58	14.47	11.31