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The Influence of MPSAS Values and SQM Angles in Determining Fajr Time in a Mathematical Review

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ABSTRACT

In Indonesia, a dip of -20 degrees has been adopted for dawn, which so far has no known scientific reference and indicates that dawn in Indonesia is too early. The results of this research show that the MPSAS value and SQM angle have an influence in determining the time of dawn so that several considerations that can be made in researching the time of dawn using SQM include paying attention to the MPSAS value of a place, the direction of the SQM angle, moonlight, weather, calibration of the SQM tool, data processing methods. etc. Research at Pondok Permai beach shows changes in sky brightness, namely at a sun depth of 15 degrees and research at Sri Mersing beach at 14 degrees. There are differences in the value of changes in sky brightness in SQM which lead to different observation angles, if it is a sunny day the difference is around 0.25-0.75 degrees, whereas if it is a cloudy day the change in the graph at each angle does not remain at an angle of 0 degrees. From the results of the research carried out, there is more often interference in the form of clouds.

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INTRODUCTION

The time for dawn is from the time of dawn shadiq until the time of sunrise.(Arwin Juli Rakhmadi Butar-Butar, 2016; Hidayat, 2018) To detect the appearance of dawn shadiq as a sign of the beginning of dawn, it can be done using a portable, light and relatively cheap photometer with a USB connection, namely the Unihedron Sky Quality Meter (SQM).(Raisal et al., 2017) Sky Quality Meter (SQM) is a tool for measuring the brightness of the night sky. Measurements using SQM produce sky brightness data in a place and can be practically used. The results of SQM measurements are defined in terms of sky brightness, namely magnitude per unit square arc second (MPSAS).(Ahyar et al., 2019)

Calls and efforts to correct the dawn time have emerged from various parts of the world, from various groups with various expertise backgrounds, including scholars, officials, astronomy experts, and the like. Muhammadiyah through the Tarjih National Conference has set the criteria for dawn time being -18 degrees below the horizon in 2021 (Jayusman, 2023). According to (Butar-Butar, 2018) The 20 degree standard that applies in Indonesia comes from the idea of Saadoe'ddin Jambek who once studied with Shaykh Thahir Jalaluddin who set the Shubuh standard of 20 degrees in his book entitled "Nukhbah at-Taqrirat fi Hisab al-Auqat wa Samt al-Qiblah bi al-Lugharitmat "However, the scientific reference for this standardization is unknown because there is no information that previous Indonesian ulama had a tradition of simultaneous observation. Recent research conducted (Herdiwijaya, 2016) from ITB Astronomy in 2016 using the Sky Quality Meter tool produced a value of -15 in areas with high light pollution and -18 in areas with low light pollution. This study shows that different locations produce different results because they are influenced by the surrounding environment. And the ISRN Uhamka Team obtained a score of -13.4 through observations with SQM (Saksono, 2017).

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Fajr time occurs when the shadiq dawn appears on the eastern horizon until the time the sun rises. To observe the presence of the shadiq dawn, one can use an astronomical tool called the Sky Quality Meter (SQM). This tool functions to measure the brightness of the sky in a place in the form of units of magnitude per square arc second (MPSAS). With this tool the data obtained is then processed using various methods used to determine when changes in sky brightness occur or often also called the turning point of the curve in the data. . So from processing this data the value of the depth of the Sun below the horizon can be determined in determining the time of dawn. So far, Indonesia has adopted a value of the depth of the Sun below the horizon of -20 degrees, but according to several recent studies, the value of -20 degrees means that dawn shadiq has not been seen or is still too low.

Several dawn researchers in Indonesia have various views and methods in collecting/processing data, especially using SQM tools. Therefore, this article aims to provide information related to the influence of MPSAS values and SQM angles in determining the time of dawn carried out by the UMSU OIF Team. The OIF UMSU team has conducted dawn time research from 2017 to 2020 in various locations such as at OIF UMSU (Medan), Pondok Permai Beach, Sri Mersing Beach (Deli Serdang) and Barus (Central Tapanuli) and with various data collection/processing methods .

Researchers are interested in uncovering OIF UMSU data which has conducted initial research on dawn time since 2017 to enrich insight and discourse on the dawn time issue.

RESEARCH METHOD

This research is a quantitative research using a portable, light and relatively cheap photometer with a USB connection, namely the Unihedron Sky Quality Meter (SQM). Sky Quality Meter (SQM) is a tool for measuring the brightness of the night sky. Measurements using SQM produce sky brightness data in a place and can be practically used. The results of SQM measurements are defined in terms of sky brightness, namely magnitude per unit square arc second (MPSAS). This dawn research data uses OIF UMSU data starting from 2017 to 2021 in various locations such as OIF UMSU (Medan), Pondok Permai Beach, Sri Mersing Beach (Deli Serdang) and Barus (Central Tapanuli) and using various collection methods/ data processing

RESULTS AND DISCUSSION

Influence of MPSAS scores

Magnitude per unit square arc second (MPSAS) is a unit used to measure the brightness of the sky. The higher the value obtained, the brighter the sky will be in a place. Take a look at Figure 1 below

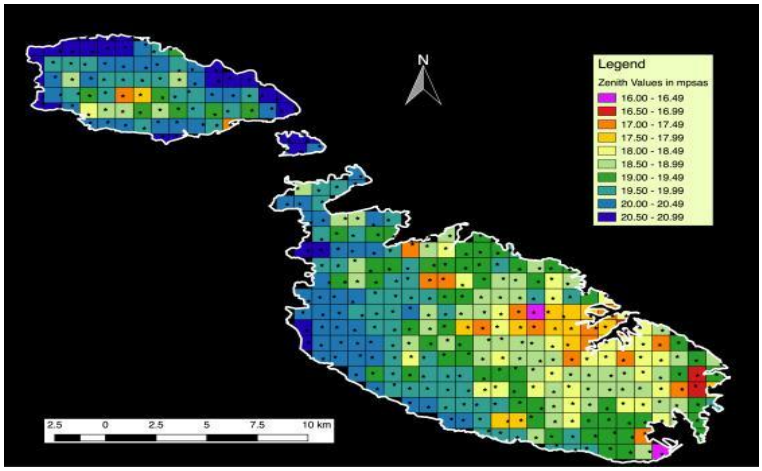

Figure 1. Map of sky brightness levels for each region

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From Figure 1, it can be seen that areas with high light pollution have high MPSAS values, while areas with low light pollution have low MPSAS values. Next, we will try to analyze the influence of the MPSAS value on the value of the depth of the Sun below the horizon in determining the time of dawn as shown in Figure 2 and Figure 3 below:

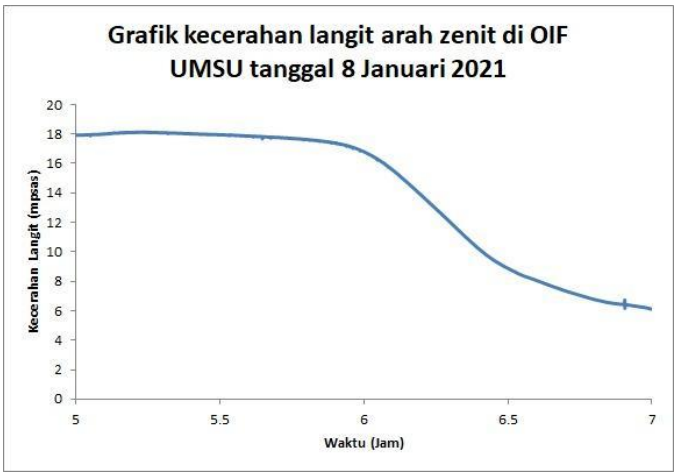

Figure 2. Graph of sky brightness towards the zenith at OIF UMSU on January 8 2021

From Figure 2, it can be seen that the maximum MPSAS value obtained is 18 and the value of the depth of the Sun below the horizon is -11.4 degrees using the Moving Average method. Next, try to look at Figure 3. Below

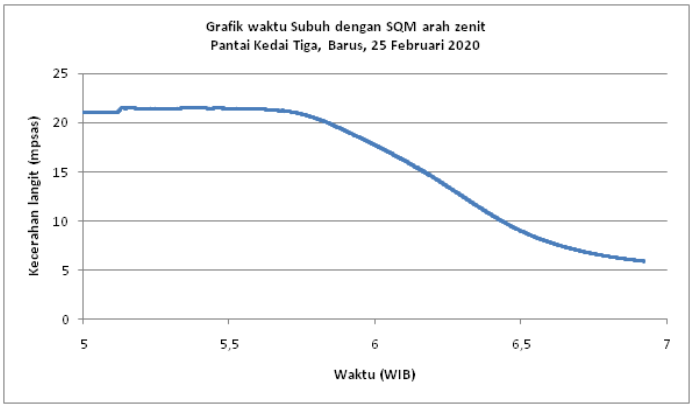

Figure 3. Sky brightness graph in Barus on February 25 2020

From Figure 3, it can be seen that the maximum MPSAS value obtained is 21.87 and the value of the depth of the Sun below the horizon is -16.86 degrees using the same method, namely Moving Average. Therefore, from the explanation above, it is known that the MPSAS value influences the value of the depth of the Sun below the horizon while still paying attention to the weather, direction of the SQM angle, tool calibration, additional equipment such as SQM protectors, etc., because if ignored it could be that the MPSAS value is high but has no effect on the value. the depth of the Sun above the horizon, as found in the data held by OIF UMSU in figure 5 (angle 0 degrees).

From research conducted by OIF UMSU, the following are several factors that influence the MPSAS score:

1. Light Pollution (Lights)
2. Moonlight
3. Weather
4. SQM angle direction

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Research at Pondok Permai Beach

Fajar Sadiq's research was carried out by the UMSU OIF Team and MTT PWM SU. This research was carried out on September 16 2017 to October 16 2017, namely for 30 days from 04:00 to 04:00 05.30 WIB located at Pondok Permai Beach, Cermin Beach, Serdang Bedagai, North Sumatra (03°39'22" N & 98°58'39" E). Instruments used by SQM - LU, Laptop, Camera Tripod, Nikon Camera, GPS. Briefly, it will be shown in table I.1 the sun rise data obtained using SQM directed at an angle of 0 degrees within a time frame of 1 minute.

From the research that was carried out for 30 days, there was no day that had a change in the brightness of the sky with a sun depth of -20 degrees. This research did not consider the moon in the sky so that from the results of the SQM data there was some data that had quite high noise and there were also some data that cannot be used due to cloudy and cloudy conditions. A fairly sunny day was October 7 2017 and will be shown in figure 4

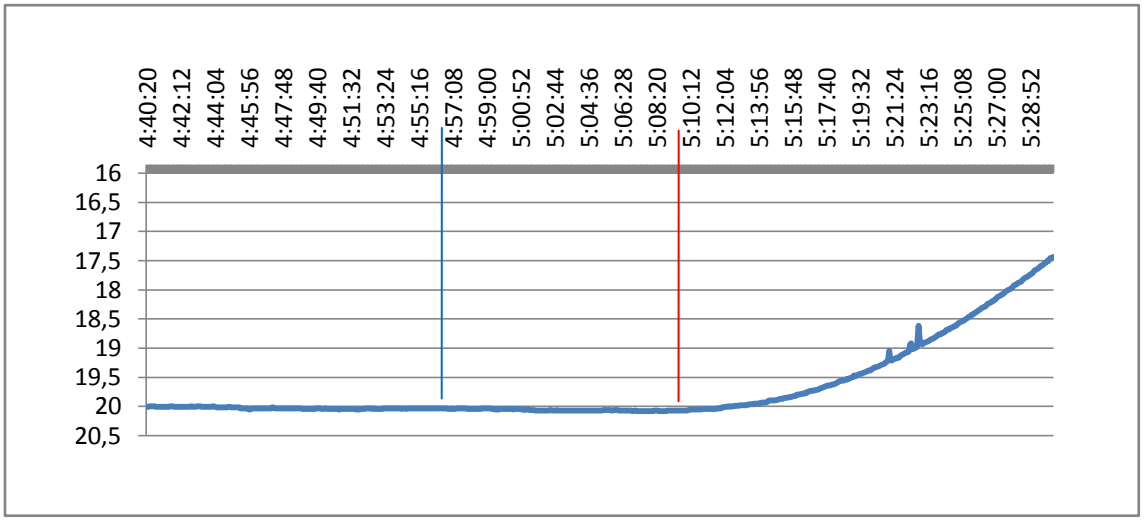

Figure 4 Graph of Changes in Sky Brightness Observation Location at Pondok Permai Beach on October 7 2017

From Figure 4, it is known that changes in sky brightness on October 7 2017 are shown on the red line, the depth of the sun is 15 degrees, while dawn is shown on the blue line with a depth of 20 degrees. So this research confirms that dawn with a sun depth of 20 degrees is too early and it is still dark.

Research at Sri Mersing Beach

Based on research I, there are several considerations to pay attention to in research II, including:

1. Observation time is carried out when the moon is not in the sky, especially in the east. (to avoid noise)
2. Using more than one SQM with different angle directions.
3. Temporal resolution of observations of 3 seconds for better observation accuracy.

Based on the considerations above, OIF UMSU in collaboration with MTT PWM SU again conducted observations at Sri Mersing Serdang Bedagai Beach, North Sumatra (03o39'22" N & 98o58'39" E) on 21 Nov 2017 to 02 Dec 2017 and 17 Dec 2017 to 30 Dec 2017 when the moon was not above or to the east, using an observation resolution of 3 seconds and also using four SQMs as shown in Figure 5:

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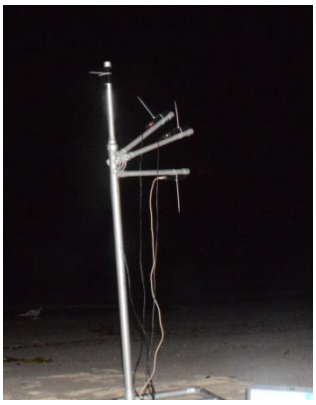

Figure 5. SQM pole

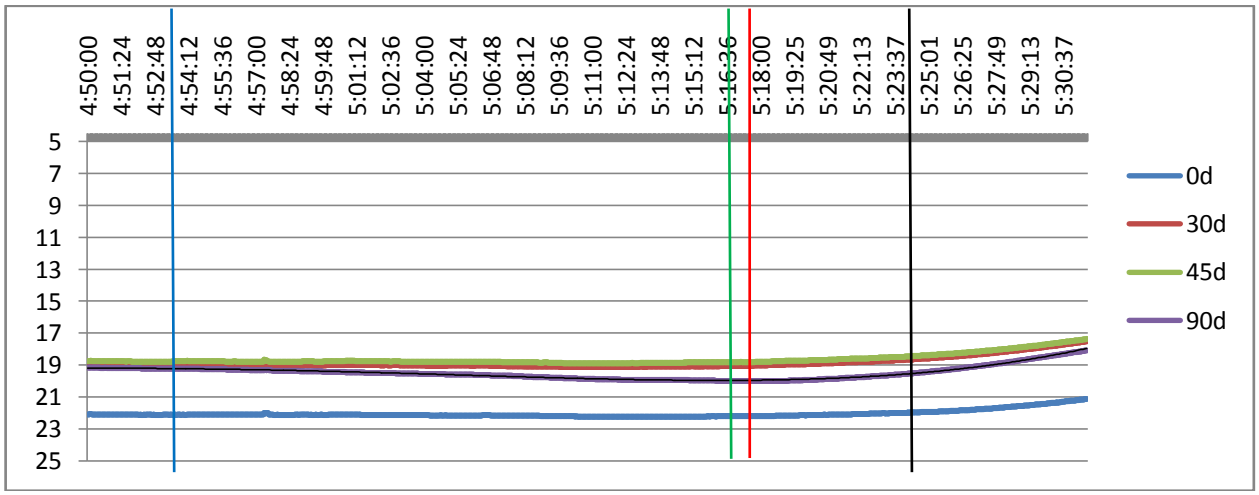

Figure 5. Graph of changes in sky brightness on 22 Nov 2017

From Figure 5. above, it is known that the blue graph is SQM data pointing at an angle of 0 degrees, the red graph is pointing at an angle of 30 degrees, the green graph is pointing at an angle of 45 degrees, the purple graph is pointing at an angle of 90 degrees.

The time of dawn at the observation location is shown by the blue longitude line, namely at 04:53 WIB with a sun depth of 20 degrees and conditions are still dark and there has been no change in the graph. The green longitude line shows the change in sky brightness at SQM which is at an angle of 30, 45 degrees, namely at 05:16 WIB with a sun depth of 14 degrees, for the red longitude line it shows the change in sky brightness at SQM which is at an angle of 90 degrees, namely at at 05:17 WIB with a depth of 13.75 degrees and the red longitude line shows the change in sky brightness in SQM which is at an angle of 0 degrees, namely at 05:24 WIB with a depth of 12 degrees. Determining changes in brightness on the graph uses the 6th degree polynomial line equation. So there are differences in SQM values which lead to different observation angles, Angles 30 and 45 generally have the same value and capture changes in sky brightness more quickly than angles 90 although the difference is not very significant and the 0 degree angle from research results is carried out more often get interference in the form of clouds. But this is not always the case, as on November 24 2018 which shows that there is noise at angles 0 and 30, this will be shown in Figure 6 below.

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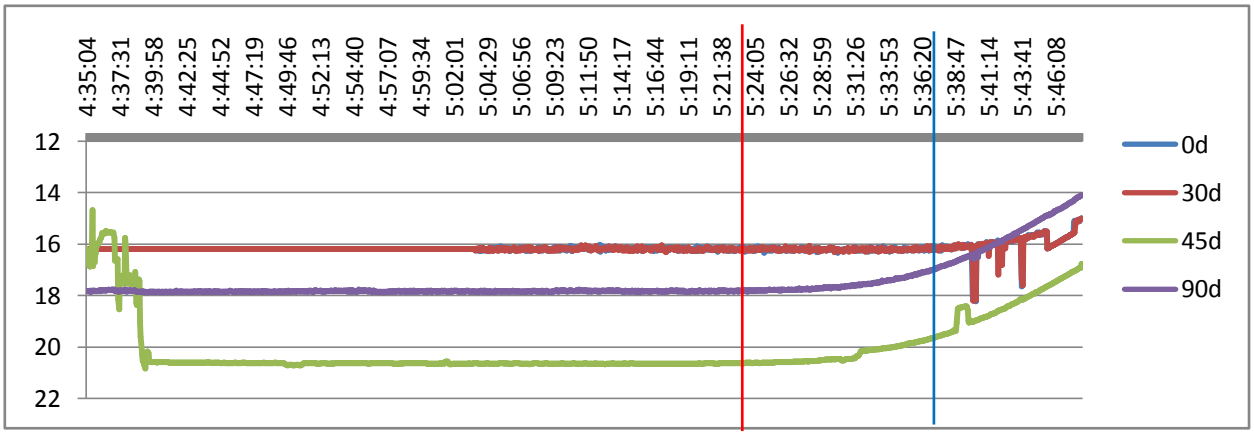
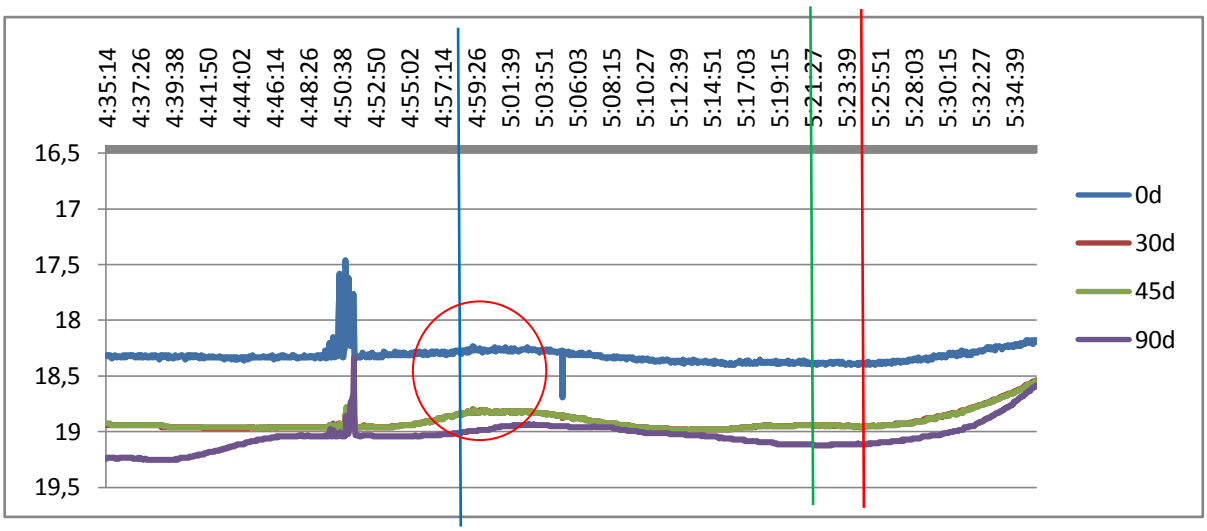


From Figure 6. above, it is known that the blue and red graphs are SQM data pointing at angles of 0 and 30 degrees. For the rise time of the graphs pointing at angles of 0 and 30 degrees, blue longitude lines are shown at 05:37 WIB, while the graphs are green and purple leads to angles of 45 and 90 degrees, for the time the graph rises to angles of 45 and 90 degrees, the longitude line is shown in red at 05:23 WIB. This explains the time of change in the graph increase depending on the weather conditions at the observation angle. Therefore, it is important for researchers to review changes in sky brightness from different observation angles



From Figure 7, you can see the presence of Fajar Kadzib as in the circle contained in the picture, the graph has increased, especially seen in the SQM data which is pointing at angles of 30 and 40 degrees and then the graph has decreased again. Kadzib dawn is also called the first dawn because it appears first and is followed by the dawn of sadik. The natural signs of dawn kazib is that he appears towering into the sky like a wolf and a moment later disappears.

The dawn time in the city of Medan is shown by the blue longitude line, namely at 04:58 WIB with a sun depth of 20 degrees. The green longitude line shows the change in sky brightness at SQM which is at an angle of 0, 30, 45 degrees, namely at 05:21 WIB with a sun depth of 17 degrees. The red longitude line shows the change in sky brightness at SQM which is at an angle of 90 degrees, namely at 05:24 WIB with a depth of 17.75 degrees.

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Table 1 Description of the sun's depth angle and the times

Masehi	Hijriyah	Syuruq	Waktu Subuh	Waktu kenaikan grafik				Kedalaman Matahari				Keterangan Cuaca
				0	30	45	90	0	30	45	90	
21 Nov 2017	02 Sha 1439	06:12	04:53	05:20	05:20	noise	05:03	13	13	-	17.25	Cloudy
22	03	06:13	04:53	05:24	05:16	05:16	05:17	12	14	14	13.75	Bright
23	04	06:13	04:54	noise	05:13	05:13	05:19	-	14	14	13.75	bright
24	05	06:13	04:54	05:37	05:37	05:20	05:23	8.75	8.75	13	12.25	Cloudy at angles 0 and 30
25	06	06:14	04:54	05:22	05:14	05:14	05:14	12.5	14.5	14.5	14.5	bright
26	07	06:14	04:54	04:58	05:17	05:17	05:15	3.5	13.75	13.75	14.25	bright
28	09	06:15	04:55	05:18	05:18	05:18	05:18	13.5	13.5	13.5	13.5	bright
29	10	06:15	04:55	05:23	05:22	05:22	05:25	12.25	12.5	12.5	11.75	bright
30	11	06:15	04:55	05:18	05:18	05:13	05:11	13.5	13.5	14.75	15.25	bright
01	12	06:12	04:53	noise	05:13	05:09	05:15	-	14.75	15.75	15.25	cloudy
02	13	06:13	04:53	05:17	05:17	05:17	05:16	13.75	13.75	13.75	14	bright
						Rata-rata		13	13.8	13.95	15	

From Table 1 above, observations made by OIF UMSU by taking representative data show that the presence of Fajar Sadiq all converges to an average of 14 degrees.

CONCLUSION

From some of the data analysis above, it can be concluded that the MPSAS value and SQM angle influence the determination of dawn time so that several considerations that can be made in researching dawn time using SQM include paying attention to the MPSAS value of a place, the direction of the SQM angle, moonlight, weather, calibration of the SQM tool. , Data processing methods and so on. Research at Pondok Permai beach shows changes in sky brightness, namely at a sun depth of 15 degrees and research at Sri Mersing beach at 14 degrees. There are differences in the value of changes in sky brightness in SQM which lead to different observation angles, if it is a sunny day the difference is around 0.25-0.75 degrees, whereas if it is a cloudy day the change in the graph at each angle does not remain at an angle of 0 degrees. From the results of the research carried out, there is more often interference in the form of clouds.

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