the 5% of rejections will be due in the main to the pilot not having moved over the proper amount at the beginning of the strips.

During the last 4,000 square miles mapped by an experienced pilot, the mean azimuth of his strips was 13′ from the desired direction.

At the present time the solar navigator is installed on three airplanes which are engaged on mapping a tropical territory in Central America. This terrain would be extremely difficult to fly without some such aid because the jungle is of a solid monotonous character and is completely devoid of distant landmarks which can be recognized.

In addition to the uses of the solar navigator already described, it may be used for establishing triangulation of a very rough nature in inaccessible country. For example, there are many sections of the world where astronomical determinations are unreliable because of deflection of the vertical. There are other regions where because of jungle or inaccessible mountains it is too expensive to establish control on the ground. In such cases, flights may be made with the solar navigator starting over a known point and taking a strip of photographs toward some objective at which control is desired. A second strip may be similarly flown to some different azimuth starting at some other point and intersecting the first strip. In this manner a regular triangulation net can be built up and the intersection of the various picture strips computed according to the direction in which the flight was made. Under these circumstances, the precision of the solar navigator should be very good as an altitude may be selected at which the air is smooth and a time of day selected at which the instrument is at its maximum effectiveness. In other words, the method offers a means of triangulation with angles that can be depended upon within 15′. If greater accuracy is desired three or more lines may be flown to intersect at a common point and the mean thus determined should prove accurate enough for most inaccessible and unchartered regions.

NOTE: The solar navigator is manufactured by the Fairchild Aerial Surveys Inc.

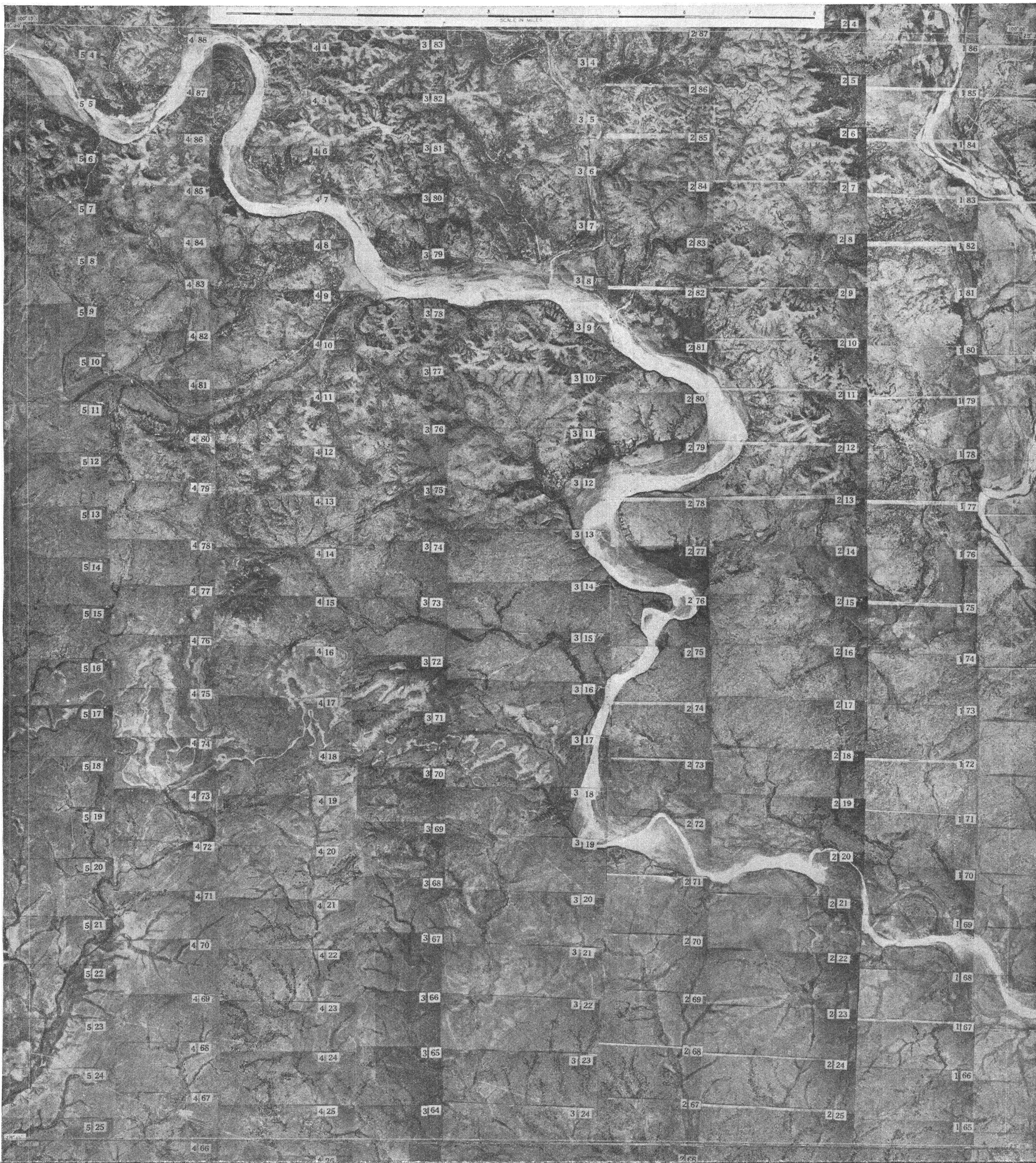
TABLES OF SOLAR ALTITUDE

C. L. Nelson

In 1935, the Committee on Specifications of the American Society of Photogrammetry made several drafts of standard specifications for single lens aerial photographs. None of these drafts restricted the angle of elevation of the sun above the horizon at which photographs could be taken.

In September 1935, the last draft of these specifications was submitted to the Director of Procurement, Treasury Department, for consideration and adoption as standard specifications. Director of Procurement referred the specifications to the Inter-departmental Committee of Contracts and Adjustments, which held many meetings before the specifications were approved. Two members of the Committee on Specifications served as technical advisers to the Interdepartmental Committee.

The first draft of the specifications as revised by the Inter-departmental Committee, sent to the members of the American Society of Photogrammetry in July, 1936, contained the specification that photographs would be rejected "which are taken when the sun is at an angle of elevation above the horizon of less than 30°." This provision resulted in objection by several aerial photographers because it would restrict the taking of photographs in northern latitudes of the United States to a few months in the summer season. The Inter-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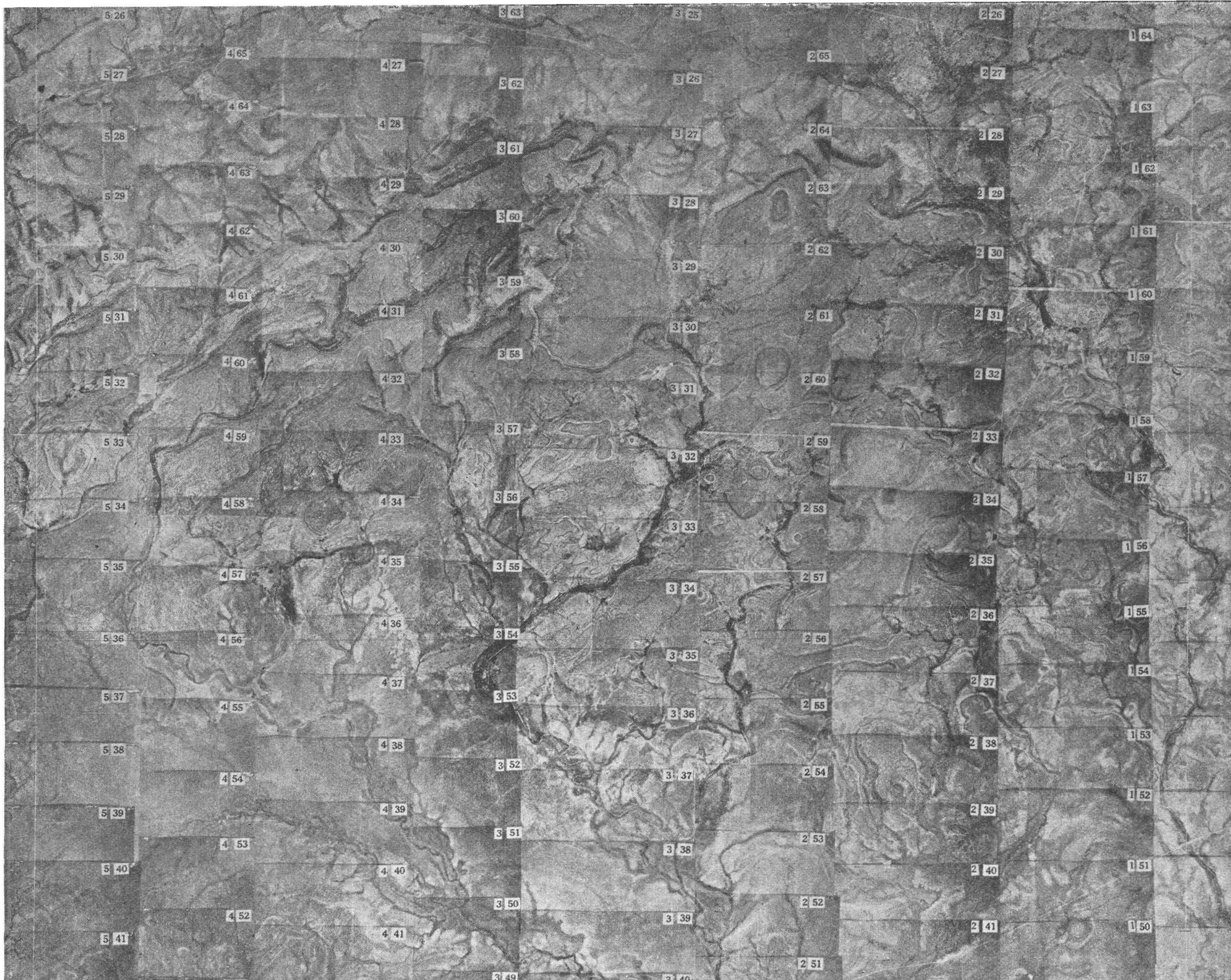

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departmental Committee changed this specification to provide for the rejection of photographs "which are taken when the sun is less than three hours above the horizon," and this wording appears in paragraph 12 (a) of the Standard Specifications for Aerial Photography for General Map Work and Land Studies, approved by the Secretary of the Treasury on May 27, 1937.

The technical advisers felt that both of these specifications were uncertain and requested the author of this paper to make a complete analysis of the conditions.

A review of the aerial photographs in the files of the Geological Survey shows great variation in the quality of the photographs and their usefulness for mapping work. Good photographic quality does not indicate necessarily that such photographs are the most useful, for usefulness is greatly dependent on the season of the year and the time of day in which the photographs were made.

Aerial photographs of both single and multiple lens types have been used by the Geological Survey since 1920 and are found increasingly valuable in mapping work. Quality has gradually improved with development of better emulsions, but such improvements can never offset the lack of good judgment as to the season when the photographs should be made. This is particularly true in the case of multiple lens photographs where the large angle of view greatly increases the difficulty in securing photographs having satisfactory quality at the outer limits of the field of view.

Examination of the photographs on file shows that about 10% are eminently satisfactory for radial line mapping use, consideration being given to the nature, coloration and cover of the terrain as well as to the illumination and quality of the photography. About 25% of these photographs, including those of timber-covered regions, can be classed as superior. The remaining 75% grade downward in quality until the zero of utility is reached. About 5% of the total must be considered as useless and should necessarily, for one reason or another, be retaken for mapping purposes. The results of having to use unsatisfactory photographs are to increase the cost of map compilation, due to the greater time required in the interpretation of images of ground points, and to decrease the dependability of the plotting. The group of photographs falling in the superior class showed in all cases that shadows were short, naturally signifying a high sun.

It may be, in the concentration of effort to improve equipment and technique, that the importance of adequate illumination, an essential of good photography, may have been overlooked. With this thought in mind, tables have been prepared to show by pairs of limiting dates the season during which the sun has a given minimum altitude for periods of one to seven hours in the States and from one to twelve hours in Alaska. These tables are reproduced as a part of this paper and simple interpolation makes them generally applicable.

The limiting dates shown in the "Tables of Solar Altitudes" were obtained from curves plotted from data appearing in the *American Ephemeris and Nautical Almanac of 1937*, by the U. S. Naval Observatory, and *Simultaneous Altitudes and Azimuths of Celestial Bodies* by the U. S. Hydrographic Office. The use of these graphs greatly reduced the time required in preparing the tables without introducing errors exceeding one day. The results are predicated on solar declination at 0 hour, Greenwich Mean Time, and theoretically the date interval is between midnights at which the days shown begin. For this reason, the first date of a pair is inclusive and the other is not. The tables should prove true for any year in the future, including leap years, except for the possible initial error of not to exceed $\frac{2}{3}$ of a day.

The possible period available for photography is shown in hours daily during which the sun is above a given altitude and obviously extends for half that interval before, and half after, solar noon. The photogrammetrist requesting aerial photography should always specify the minimum altitude of the sun at which the photographs can be made, as this will be influenced by the topography and the nature and method of abstracting the desired information from the aerial photographs. The relation between solar time and local mean time is shown in Fig. 1. The maximum difference is 16 minutes, 22 seconds on November 3, with another peak in the curve on February 12 when the difference is 14 minutes, 23 seconds. Between March 25th and September 18th the maximum difference is 6 minutes, 22 seconds (July 26th) but the average difference during this spring and summer period is less than three minutes and may be ignored so far as the use of these tables is concerned. It is necessary that one keep in mind and make due allowance for the fact that one's watch carries the standard time of the time meridian governing the area in which he is working. These time meridians in the United States are the 75°, 90°, 105° and 120° W. meridians, and the local mean time of the location of the photographic flights will differ from standard time at the rate of four minutes of time for each degree of longitude from the time meridian.

Aerial photographs may be made with a camera that is entirely satisfactory both mechanically and optically and yet their quality may be so poor as to greatly reduce the usefulness of the photographs for mapping. This condition may arise because the terrain was obscured by haze, smoke or mist and important detail thereby lost, but when under exposure cannot be laid to these causes it is probable that it can be traced to insufficient illumination resulting from the effort to work when the sun is too low. The actinic value of sunlight falling on a unit of horizontal surface varies greatly with the sun's altitude as is shown in Fig. 2. The value at an elevation of 30° is approximately four-tenths that at 60°, and when the elevation is 25° it is only one-third its value at 60°. These figures reveal the importance of making aerial photographs as near solar noon as possible.

Use of the Tables

The tables are so arranged that the aerial photographer and photogrammetrist can easily find the information they need. They are prepared for latitudes differing by four degree intervals in the States and Alaska, and for 5° variations in altitude of the sun beginning with 10° in Alaska and 20° in the States. The second column from the left indicates hours in the day during which the sun exceeds altitudes indicated at the head of other columns of the tables. The pairs of dates appearing in the body of the table show the two days in the year on which the sun reaches the maximum altitude indicated at the top of the column for the number of hours shown in the column to the left. As previously stated, this period of hours is equally divided by the epoch of solar noon. Blank spaces in the upper left portion of the tables signify that the conditions are met every day in the year, while blank spaces in the lower right portion signify that the conditions are never fulfilled.

A study of the table will quickly indicate to the observer the lag of the seasons in responding to the sun's altitude and light. Assume that one has pending a photographic project in northern Maine (Latitude 48°) requiring two hours time for its completion. One might give little consideration to the height of the sun during the nice Indian summer days of October but his reaction might be quite different in February, the feeling being that in this latitude the winter sun would be too low for aerial photography. Reference to the table will show

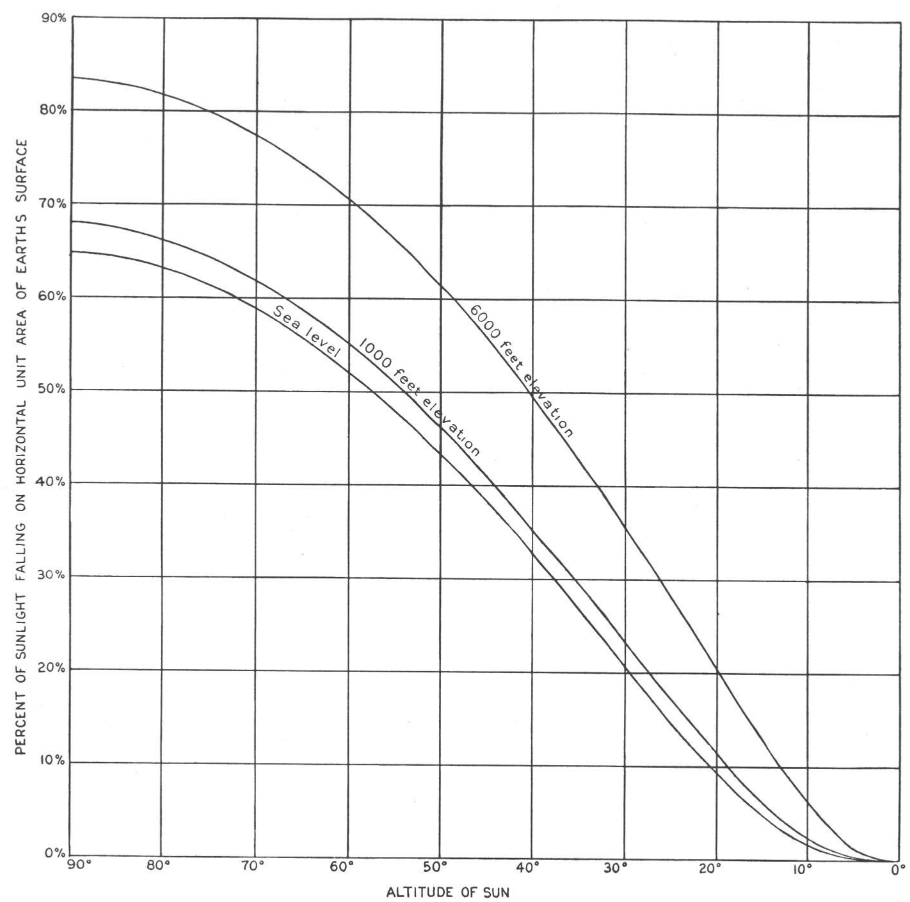
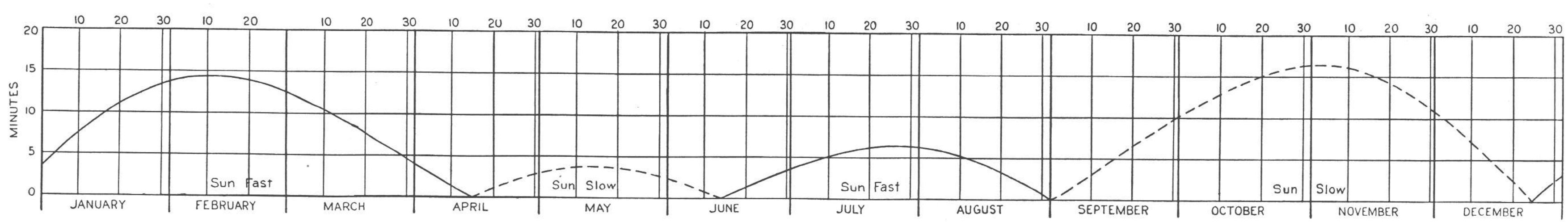


FIGURE 2 - SUN'S BRIGHTNESS



DURING THE "SUN FAST" PERIOD, ADD THE INDICATED CORRECTION TO LOCAL MEAN TIME TO OBTAIN SOLAR TIME; SUBTRACT THE CORRECTION DURING "SUN SLOW" PERIODS

FIGURE 1 - EQUATION OF TIME

LATITUDE	HOUR INTER[illegible]
28°	1 2 3 4 5 6 7
32°	1 2 3 4 5 6 7
36°	1 2 3 4 5 6 7
40°	1 2 3 4 5 6 7
44°	1 2 3 4 5 6 7
48°	1 2 3 4 5 6 7
56°	1 2 3 4 5 6 7 8 9 10 11 12
60°	1 2 3 4 5 6 7 8 9 10 11 12
64°	1 2 3 4 5 6 7 8 9 10 11 12
68°	1 2 3 4 5 6 7 8 9 10 11 12

TABLES OF SOLAR ALTITUDES

Y AL	MINIMUM ALTITUDE OF SUN 10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°
			Jan. 21 Nov. 22	Jan. 20 Nov. 23 Feb. 15 Oct. 28	Jan. 22 Nov. 21 Feb. 14 Oct. 29 Mar. 10 Oct. 5	Jan. 7 Dec. 6 Jan. 27 Nov. 16 Feb. 14 Oct. 29 Mar. 6 Oct. 9 Apr. 1 Sept 12	Jan. 13 Nov. 30 Jan. 21 Nov. 22 Feb. 1 Nov. 11 Feb. 16 Oct. 27 Mar. 5 Oct. 10 Mar. 26 Sept 18 Apr. 30 Aug. 14	Feb. 4 Nov. 8 Feb. 10 Nov. 2 Feb. 19 Oct. 24 Mar. 5 Oct. 10 Mar. 23 Sept 22 Apr. 22 Aug. 22	Feb. 20 Oct. 23 Feb. 25 Oct. 18 Mar. 6 Oct. 9 Mar. 21 Sept 24 Apr. 14 Aug. 30	Mar. 5 Oct. 10 Mar. 11 Oct. 4 Mar. 22 Sept 23 Apr. 9 Sept 4 May 21 July 24	Mar.18 Sept 27 Mar.25 Sept 19 Apr. 7 Sept 6 May 6 Aug. 8	Mar. 31 Sept 13 Apr. 9 Sept 4 Apr. 29 Aug. 15	Apr. 14 Aug. 30 Apr. 27 Aug. 17	May 1 Aug. 13 May 29 July 16	May 25 July 20
			Dec. 31 Dec. 13 Feb. 3 Nov. 9	Jan. 8 Dec. 5 Feb. 3 Nov. 9 Feb. 24 Oct. 19	Jan. 19 Nov. 24 Feb. 6 Nov. 6 Feb. 23 Oct. 20 Mar. 16 Sept 29	Jan. 6 Dec. 7 Jan. 15 Nov. 28 Jan. 26 Nov. 17 Feb. 9 Nov. 3 Feb. 24 Oct. 19 Mar. 14 Sept 30 Apr. 7 Sept 6	Jan. 31 Nov. 12 Feb. 6 Nov. 6 Feb. 14 Oct. 29 Feb. 26 Oct. 17 Mar. 13 Oct. 2 Apr. 3 Sept 10 May 8 Aug. 6	Feb. 16 Oct. 27 Feb. 21 Oct. 22 Mar. 2 Oct. 13 Mar. 13 Oct. 1 Mar. 31 Sept 13 Apr. 26 Aug. 18	Mar. 2 Oct. 13 Mar. 8 Oct. 7 Mar. 17 Sept 28 Mar. 30 Sept 14 Apr. 21 Aug. 23	Mar. 15 Sept 30 Mar. 21 Sept 24 Mar. 31 Sept 13 Apr. 18 Aug. 26 May 27 July 18	Mar.28 Sept 16 Apr. 4 Sept 9 Apr.17 Aug. 27 May 16 July 29	Apr. 11 Sept 2 Apr. 20 Aug. 24 May 11 Aug. 3	Apr. 26 Aug. 18 May 10 Aug. 4	May 15 July 30 May 29 July 16	June 15 June 29 (79°)
			Jan. 22 Nov. 21 Feb. 13 Oct. 30	Jan. 7 Dec. 6 Jan. 27 Nov. 16 Feb. 14 Oct. 29 Mar. 5 Oct. 10	Jan. 9 Dec. 4 Jan. 21 Nov. 22 Feb. 2 Nov. 10 Feb. 15 Oct. 28 Mar. 4 Oct. 11 Mar. 23 Sept 21	Jan. 27 Nov. 16 Feb. 1 Nov. 11 Feb. 9 Nov. 3 Feb. 20 Oct. 23 Mar. 5 Oct. 10 Mar. 21 Sept 24 Apr. 13 Aug. 31	Feb. 13 Oct. 30 Feb. 18 Oct. 25 Feb. 25 Oct. 18 Mar. 7 Oct. 8 Mar. 21 Sept 24 Apr. 9 Sept 4 May 8 Aug. 6	Feb. 28 Oct. 15 Mar. 4 Oct. 11 Mar. 12 Oct. 3 Mar. 22 Sept 22 Apr. 7 Sept 6 May 3 Aug. 11	Mar. 13 Oct. 2 Mar. 18 Sept 27 Mar. 25 Sept 19 Apr. 8 Sept 5 Apr. 28 Aug. 16	Mar. 25 Sept 19 Mar. 31 Sept 13 Apr. 10 Sept 3 Apr. 27 Aug. 17	Apr. 7 Sept 6 Apr.14 Aug. 30 Apr.27 Aug. 17 May 28 July 17	Apr. 22 Aug. 22 May 1 Aug. 13 May 24 July 21	May 9 Aug. 5 May 25 July 20	June 3 July 11	
			Jan. 18 Nov. 25 Feb. 5 Nov. 7 Feb. 21 Oct. 22	Jan. 14 Nov. 29 Jan. 27 Nov. 16 Feb. 9 Nov. 3 Feb. 24 Oct. 19 Mar. 12 Oct. 3	Jan. 23 Nov. 20 Jan. 28 Nov. 15 Feb. 5 Nov. 7 Feb. 14 Oct. 29 Feb. 26 Oct. 17 Mar. 12 Oct. 3 Mar. 29 Sept 15	Feb. 10 Nov. 2 Feb. 14 Oct. 29 Feb. 21 Oct. 22 Mar. 2 Oct. 13 Mar. 14 Oct. 1 Mar. 28 Sept 16 Apr. 16 Aug. 28	Feb. 25 Oct. 18 Mar. 1 Oct. 14 Mar. 7 Oct. 8 Mar. 17 Sept 28 Mar. 30 Sept 14 Apr. 15 Aug. 29 May 13 Aug. 1	Mar. 10 Oct. 5 Mar. 14 Oct. 1 Mar. 21 Sept 24 Mar. 31 Sept 13 Apr. 15 Aug. 29 May 9 Aug. 5	Mar. 22 Sept 22 Mar. 27 Sept 17 Apr. 4 Sept 9 Apr. 16 Aug. 28 May 6 Aug. 8	Apr. 5 Sept 8 Apr. 10 Sept 3 Apr. 20 Aug. 24 May 7 Aug. 7	Apr.19 Aug. 25 Apr.26 Aug. 18 May 9 Aug. 5	May 5 Aug. 9 May 15 July 30	May 27 July 18	June 13 July 1 (72°)	
			Jan. 4 Dec. 9 Jan. 19 Nov. 24 Feb. 2 Nov. 10 Feb. 16 Oct. 27 Mar. 2 Oct. 13	Jan. 18 Nov. 25 Jan. 23 Nov. 20 Jan. 30 Nov. 13 Feb. 9 Nov. 3 Feb. 19 Oct. 24 Mar. 4 Oct. 11 Mar. 18 Sept 27	Feb. 6 Nov. 6 Feb. 10 Nov. 2 Feb. 16 Oct. 27 Feb. 25 Oct. 18 Mar. 7 Oct. 8 Mar. 19 Sept 26 Apr. 4 Sept 9	Feb. 21 Oct. 22 Feb. 25 Oct. 18 Mar. 3 Oct. 12 Mar. 11 Oct. 4 Mar. 22 Sept 23 Apr. 4 Sept 9 Apr. 22 Aug. 22	Mar. 7 Oct. 8 Mar. 11 Oct. 4 Mar. 17 Sept 28 Mar. 25 Sept 19 Apr. 6 Sept 7 Apr. 22 Aug. 22 May 17 July 28	Mar. 20 Sept 25 Mar. 23 Sept 21 Mar. 30 Sept 14 Apr. 10 Sept 3 Apr. 24 Aug. 20 May 16 July 29	Apr. 2 Sept 11 Apr. 6 Sept 7 Apr. 14 Aug. 30 Apr. 26 Aug. 18 May 16 July 29	Apr. 16 Aug. 28 Apr. 22 Aug. 22 May 1 Aug. 13 May 19 July 26	May 1 Aug. 13 May 8 Aug. 6 May 24 July 21	May 20 July 25 June 3 July 11	June 9 July 5 (68°)		
			Jan. 12 Dec. 1 Jan. 17 Nov. 26 Jan. 25 Nov. 18 Feb. 3 Nov. 9 Feb. 13 Oct. 30 Feb. 24 Oct. 19 Mar. 8 Oct. 7	Feb. 3 Nov. 9 Feb. 7 Nov. 5 Feb. 12 Oct. 31 Feb. 20 Oct. 23 Feb. 28 Oct. 15 Mar. 11 Oct. 4 Mar. 24 Sept 20	Feb. 19 Oct. 24 Feb. 22 Oct. 21 Feb. 27 Oct. 16 Mar. 6 Oct. 9 Mar. 15 Sept 30 Mar. 26 Sept 18 Apr. 8 Sept 5	Mar. 4 Oct. 11 Mar. 7 Oct. 8 Mar. 12 Oct. 3 Mar. 20 Sept 25 Mar. 29 Sept 15 Apr. 11 Sept 2 Apr. 28 Aug. 16	Mar. 17 Sept 28 Mar. 21 Sept 24 Mar. 26 Sept 18 Apr. 3 Sept 10 Apr. 13 Aug. 31 Apr. 29 Aug. 15 May 25 July 20	Mar. 30 Sept 14 Apr. 2 Sept 11 Apr. 8 Sept 5 Apr. 18 Aug. 26 May 3 Aug. 11 May 26 July 19	Apr. 12 Sept 1 Apr. 16 Aug. 28 Apr. 24 Aug. 20 May 7 Aug. 7 May 30 July 15	Apr. 27 Aug. 17 May 3 Aug. 11 May 13 Aug. 1 June 5 July 9	May 15 July 30 May 24 July 21	June 8 July 6 (64°)			
	Jan. 2 Dec. 11 Jan. 12 Dec. 1 Jan. 22 Nov. 21 Feb. 1 Nov. 11 Feb. 10 Nov. 2 Feb. 20 Oct. 23 Mar. 3 Oct. 12 Mar. 14 Oct. 1 Mar. 26 Sept 18 Apr. 8 Sept 5 Apr. 23 Aug. 21	Jan. 27 Nov. 16 Jan. 30 Nov. 13 Feb. 3 Nov. 9 Feb. 9 Nov. 3 Feb. 17 Oct. 26 Feb. 26 Oct. 17 Mar. 7 Oct. 8 Mar. 18 Sept 27 Mar. 29 Sept 15 Apr. 11 Sept 2 Apr. 26 Aug. 18 May 13 Aug. 1	Feb. 13 Oct. 30 Feb. 15 Oct. 28 Feb. 19 Oct. 24 Feb. 25 Oct. 18 Mar. 4 Oct. 11 Mar. 12 Oct. 3 Mar. 22 Sept 23 Apr. 1 Sept 12 Apr. 14 Aug. 30 Apr. 29 Aug. 15 May 18 July 27	Feb. 27 Oct. 16 Mar. 1 Oct. 14 Mar. 5 Oct. 10 Mar. 11 Oct. 4 Mar. 17 Sept 28 Mar. 26 Sept 18 Apr. 5 Sept 8 Apr. 18 Aug. 26 May 3 Aug. 11 May 23 July 22	Mar. 12 Oct. 3 Mar. 14 Oct. 1 Mar. 19 Sept.26 Mar. 24 Sept 20 Apr. 1 Sept 12 Apr. 10 Sept 3 Apr. 21 Aug. 23 May 6 Aug. 8 May 26 July 9	Mar. 24 Sept 20 Mar. 27 Sept 17 Mar. 31 Sept 13 Apr. 7 Sept 6 Apr. 15 Aug. 29 Apr. 25 Aug. 19 May 10 Aug. 4 June 3 July 11	Apr. 7 Sept 6 Apr. 10 Sept 3 Apr. 15 Aug. 29 Apr. 22 Aug. 22 May 1 Aug. 13 May 16 July 29	Apr. 20 Aug. 24 Apr. 24 Aug. 20 Apr. 30 Aug. 14 May 10 Aug. 4 May 24 July 21	May 7 Aug. 7 May 11 Aug. 3 May 20 July 25 June 5 July 9	May 29 July 16 June 9 July 5					
	Jan. 22 Nov. 21 Jan. 25 Nov. 18 Jan. 30 Nov. 13 Feb. 5 Nov. 7 Feb. 11 Nov. 1 Feb. 19 Oct. 24 Feb. 27 Oct. 16 Mar. 8 Oct. 7 Mar. 18 Sept 27 Mar. 28 Sept 16 Apr. 9 Sept 4 Apr. 21 Aug. 23	Feb. 10 Nov. 2 Feb. 12 Oct. 31 Feb. 15 Oct. 28 Feb. 20 Oct. 23 Feb. 26 Oct. 17 Mar. 5 Oct. 10 Mar. 14 Oct. 1 Mar. 23 Sept 21 Apr. 2 Sept 11 Apr. 13 Aug. 31 Apr. 25 Aug. 19 May 10 Aug. 4	Feb. 24 Oct. 19 Feb. 26 Oct. 17 Mar. 1 Oct. 14 Mar. 6 Oct. 9 Mar. 12 Oct. 3 Mar. 19 Sept 26 Mar. 27 Sept 17 Apr. 6 Sept 7 Apr. 18 Aug. 26 Apr. 30 Aug. 14 May 16 July 29 June 14 June 30	Mar. 9 Oct. 6 Mar. 11 Oct. 4 Mar. 15 Sept 30 Mar. 19 Sept 26 Mar. 25 Sept 19 Apr. 2 Sept 11 Apr. 11 Sept 2 Apr. 22 Aug. 22 May 4 Aug. 10 May 23 July 22	Mar. 22 Sept 23 Mar. 24 Sept 20 Mar. 27 Sept 17 Apr. 2 Sept 11 Apr. 8 Sept 5 Apr. 16 Aug. 28 Apr. 27 Aug. 17 May 10 Aug. 4 May 31 July 14	Apr. 3 Sept 10 Apr. 6 Sept 7 Apr. 10 Sept 3 Apr. 16 Aug. 28 Apr. 23 Aug. 21 May 3 Aug. 11 May 18 July 27	Apr. 17 Aug. 27 Apr. 20 Aug. 24 Apr. 25 Aug. 19 May 2 Aug. 12 May 12 Aug. 2 May 29 July 16	May 3 Aug. 11 May 6 Aug. 8 May 13 Aug. 1 May 25 July 20	May 23 July 22 May 29 July 16 June 13 July 1	June 5 July 9 (52°)					
	Feb. 6 Nov. 6 Feb. 8 Nov. 3 Feb. 11 Nov. 1 Feb. 16 Oct. 27 Feb. 21 Oct. 22 Feb. 27 Oct. 16 Mar. 6 Oct. 9 Mar. 14 Oct. 1 Mar. 22 Sept 22 Mar. 31 Sept 13 Apr. 10 Sept 3 Apr. 20 Aug. 24	Feb. 21 Oct. 22 Feb. 23 Oct. 20 Feb. 26 Oct. 17 Mar. 2 Oct. 13 Mar. 7 Oct. 8 Mar. 13 Oct. 2 Mar. 20 Sept 25 Mar. 27 Sept 17 Apr. 5 Sept 8 Apr. 15 Aug. 29 Apr. 26 Aug. 18 May 8 Aug. 6	Mar. 6 Oct. 9 Mar. 8 Oct. 6 Mar. 11 Oct. 4 Mar. 15 Sept 30 Mar. 21 Sept 24 Mar. 26 Sept 18 Apr. 3 Sept 10 Apr. 11 Sept 2 Apr. 20 Aug. 24 May 1 Aug. 13 May 15 July 30 June 5 July 9	Mar. 19 Sept 26 Mar. 21 Sept 23 Mar. 23 Sept 21 Mar. 28 Sept 16 Apr. 2 Sept 11 Apr. 10 Sept 3 Apr. 17 Aug. 27 Apr. 26 Aug. 18 May 7 Aug. 7 May 24 July 21	Apr. 1 Sept 12 Apr. 3 Sept 10 Apr. 6 Sept 7 Apr. 11 Sept 2 Apr. 17 Aug. 27 Apr. 24 Aug. 20 May 4 Aug. 10 May 17 July 28 June 7 July 7	Apr. 15 Aug. 29 Apr. 16 Aug. 27 Apr. 20 Aug. 24 Apr. 25 Aug. 19 May 3 Aug. 11 May 12 Aug. 2 May 27 July 18	Apr. 29 Aug. 15 May 2 Aug. 12 May 6 Aug. 8 May 13 Aug. 1 May 24 July 21	May 18 July 27 May 22 July 23 May 30 July 15	June 16 June 28 (49°)						
	Feb. 18 Oct. 25 Feb. 20 Oct. 23 Feb. 22 Oct. 21 Feb. 26 Oct. 17 Mar. 2 Oct. 13 Mar. 7 Oct. 8 Mar. 13 Oct. 2 Mar. 19 Sept 26 Mar. 25 Sept 19 Apr. 2 Sept 11 Apr. 10 Sept 3 Apr. 18 Aug. 26	Mar. 4 Oct. 11 Mar. 5 Oct. 10 Mar. 8 Oct. 7 Mar. 11 Oct. 4 Mar. 16 Sept 29 Mar. 20 Sept 25 Mar. 26 Sept 18 Apr. 2 Sept 11 Apr. 9 Sept 4 Apr. 17 Aug. 27 Apr. 26 Aug. 18 May 6 Aug. 8	Mar. 17 Sept 28 Mar. 18 Sept 27 Mar. 21 Sept 24 Mar. 24 Sept 20 Mar. 28 Sept 16 Apr. 2 Sept 11 Apr. 9 Sept 4 Apr. 16 Aug. 28 Apr. 24 Aug. 20 May 3 Aug. 11 May 14 July 31 May 30 July 15	Mar. 29 Sept 15 Mar. 31 Sept 13 Apr. 2 Sept 11 Apr. 6 Sept 7 Apr. 11 Sept 2 Apr. 17 Aug. 27 Apr. 24 Aug. 20 May 2 Aug. 12 May 12 Aug. 2 May 26 July 19	Apr. 11 Sept 2 Apr. 13 Aug. 31 Apr. 16 Aug. 28 Apr. 20 Aug. 24 Apr. 26 Aug. 18 May 3 Aug. 11 May 11 Aug. 3 May 23 July 21	Apr. 26 Aug. 18 Apr. 28 Aug. 16 May 2 Aug. 12 May 7 Aug. 7 May 14 July 31 May 23 July 22 June 11 July 3	May 14 Aug. 31 May 17 July 28 May 22 July 23 May 31 July 14	June 15 June 29							

that the sun reaches a maximum altitude of 30° for a two hour period on February 22nd and again on October 21st. Aside from this low sun, probable snow cover on the ground on the first date and a smoky atmosphere on the second would make either one undesirable. Following along this same two-hour line for 48° latitude in search of something better, one finds that from May 3rd to May 24th and from July 21st to August 11th, the sun has an elevation of 55° to 60° for a two hour period, and above 60° from May 24th to July 21st. The trees begin to leaf out between May 15th and June 1st, so the very best time of the year for this project would be about May 10th.

As a matter of interest it should be noted that for a two hour period in this latitude, the sun has a maximum altitude of 15° to 20° from January 11th to February 3rd and again from November 10th to December 2nd, while its altitude for the same period of time is only 15° from December 3rd to January 10th. In other words, during the most favorable time of day at Latitude 48° N, the illumination at the worst season is only one-ninth that of the best season.

Another example of the usefulness of the tables may be cited. The Olympics, in the state of Washington, are difficult to photograph on account of the altitude and ruggedness of these mountains, the dense forest cover and the unfavorable weather conditions. The lower level of the cloud mass clears the mountain peaks about July 10th of each year, and then follows the only generally fair weather in the year which usually lasts for about six weeks. Because this area is extremely rugged, it is important that every effort be made to minimize the shadows. For this reason the photography should be carried on when the sun is at the greatest possible altitude, confining the work period to the middle of the day. Reference to the tables (Latitude 48°) reveals that the sun is above 60° altitude for two hours daily from May 24th to July 21st. As the clouds do not clear the peaks until about July 10th, it is probable that on July 20th the conditions would be most satisfactory.

Undoubtedly greater consideration must be given in the future to the matter of securing photographs during the time of day and the season of the year when the most favorable conditions exist. The probable extended use of stereophotogrammetric methods of mapping emphasizes this need and experience to date has shown conclusively that neither dense shadows nor snow on the ground can be tolerated, for they entirely destroy the stereoscopic effect and thus prevent the use of these methods.

Consequently, the need for photographs should be anticipated well in advance of their use, so that a project may be flown at the time best suited to its requirements. The photographer should be prepared to wait for sunlight and clear air. This may increase the expense and time required, and the administrator must judge if this is warranted.

In general, the best flying time will be the midday period of a clear day following precipitation. The best season will be as near June 21st as clearing of the snow from the ground and leafing of the trees will permit.

The curve "Brightness of the Sun" expresses the illumination on an exposed horizontal surface. A slope away from the sun will lose illumination with a lowering sun more rapidly than the curve shows, and a slope towards the sun will lose it less rapidly. However, the need is to have the whole surface clearly visible in the picture.

The "exposed horizontal surface" predication leaves out the matter of shadows from trees, building, or other cover or from relief. A shadow on a horizontal surface is approximately three times as long with a 30° sun as with a 60° sun.

Therefore, where slope illumination or shadows are factors in a project, a high sun is even more desirable than the preceding pages have indicated.