TABLE 1: CORRECTION TO ALTITUDE

Correction expressed in tenths of a degree of altitude, observer being north of projection. If south of projection, apply with contrary sign.

LAT. DIFF.	APPROXIMATE BEARING																											
	0°	20°	40°	50°	60°	70°	80°	90°	100°	110°	120°	130°	140°	160°	180°	200°	220°	230°	240°	250°	260°	270°	280°	290°	300°	310°	320°	340°	360°
1°	-1.0	-.9	-.8	-.6	-.5	-.3	-.2	0	+.2	+.3	+.5	+.6	+.8	+.9	+1.0	+.9	+.8	+.6	+.5	+.3	+.2	0	-.2	-.3	-.5	-.6	-.8	-.9	-1.0
1/2°	-.5	-.5	-.4	-.3	-.3	-.2	-.1	0	+.1	+.2	+.3	+.3	+.4	+.5	+.5	+.5	+.4	+.3	+.3	+.2	+.1	0	-.1	-.2	-.3	-.3	-.4	-.5	-.5
1/4°	-.3	-.2	-.2	-.2	-.1	-.1	-.0	0	+0	+.1	+.1	+.2	+.2	+.2	+.3	+.2	+.2	+.2	+.1	+.1	+0	0	-0	-.1	-.1	-.2	-.2	-.2	-.3

TABLE 2: CORRECTION TO AZIMUTH

Correction expressed in tenths of a degree of azimuth for one degree of latitude difference, observer being north of projection. If south of projection, apply with contrary sign.

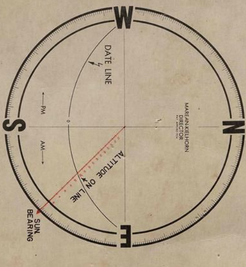
ALTITUDE	APPROXIMATE BEARING																	
	10°	30°	50°	70°	90°	110°	130°	150°	170°	190°	210°	230°	250°	270°	290°	310°	330°	350°
0°	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5°	0	0	+.1	+.1	+.1	+.1	+.1	0	0	0	0	-.1	-.1	-.1	-.1	-.1	0	0
10°	0	+.1	+.1	+.2	+.2	+.2	+.1	+.1	0	0	-.1	-.1	-.2	-.2	-.2	-.1	-.1	0
15°	+.1	+.1	+.2	+.3	+.3	+.3	+.2	+.1	+.1	-.1	-.1	-.2	-.3	-.3	-.3	-.2	-.1	-.1
20°	+.1	+.2	+.3	+.3	+.4	+.3	+.3	+.2	+.1	-.1	-.2	-.3	-.3	-.4	-.3	-.3	-.2	-.1
25°	+.1	+.2	+.3	+.4	+.5	+.4	+.3	+.2	+.1	-.1	-.2	-.3	-.4	-.5	-.4	-.3	-.2	-.1
30°	+.1	+.3	+.4	+.5	+.6	+.5	+.4	+.3	+.1	-.1	-.3	-.4	-.5	-.6	-.5	-.4	-.3	-.1
35°	+.1	+.4	+.5	+.7	+.7	+.7	+.5	+.4	+.1	-.1	-.4	-.5	-.7	-.7	-.7	-.5	-.4	-.1
40°	+.2	+.4	+.5	+.8	+.8	+.8	+.5	+.4	+.2	-.2	-.4	-.5	-.8	-.8	-.8	-.5	-.4	-.2
45°	+.2	+.5	+.6	+.9	+1.0	+.9	+.6	+.5	+.2	-.2	-.5	-.6	-.9	-1.1	-.9	-.6	-.5	-.2
50°	+.2	+.6	+.8	+1.1	+1.2	+1.1	+.8	+.6	+.2	-.2	-.6	-.8	-1.1	-1.2	-1.1	-.8	-.6	-.2
55°	+.3	+.7	+.9	+1.3	+1.4	+1.3	+.9	+.7	+.3	-.3	-.7	-.9	-1.3	-1.4	-1.3	-.9	-.7	-.3
60°	+.3	+.9	+1.1	+1.6	+1.7	+1.6	+1.1	+.9	+.3	-.3	-.9	-1.1	-1.6	-1.7	-1.6	-1.1	-.9	-.3

MANUAL OF INSTRUCTIONS

LIFEBOAT MODEL

of the

MAREAN-KIELHORN DIRECTOR



An instrument for determining direction at sea

Manufactured by AIR INSTRUMENTS, Incorporated

Boston, Massachusetts

CONDENSED INSTRUCTIONS

THIS INSTRUMENT IS TO BE USED WITH THE SUN TO FIND YOUR TRUE COURSE

1. **Use Correct Dial.** Remove transparent cover dial by nut on back. Select paper dial covering your estimated latitude and place it on top of all other dials, making certain the proper end is to "N" on instrument. Replace cover dial.
2. **Obtain Altitude.** Raise all sight vanes. Hold instrument in vertical position, pointing it toward sun. With eye at slotted vane bring the amber vane and frosted center vane score-lines in line with the sea horizon. Then rotate cover dial until the green vane score-line casts a shadow precisely on the score-line of the center frosted vane. The sun's altitude is then read in degrees on the rim of the dial. Repeat for accuracy.
3. **Find Date Line.** On back of instrument, under "Date Lines," find the number given for your date, and note its color. Turn instrument over again and find the line having this same number and color (odd-numbered lines not shown and must be estimated). As you hold the instrument, with "N" uppermost, your red or black number will be right side up. The line marked by this number is your date line.
4. **Put Altitude Scale on Date Line.** Find the point on the altitude scale equal to the altitude of the Sun. Place this point on the date line by turning the cover dial. Note that the right side of the paper dial is for the morning. When the altitude point is on your date line, tighten the brass nut on back.
5. **Direct Boat on True Course.** Take position in keel line of boat. Hold instrument face up and level. Turn the whole instrument horizontally until shadow of the green vane score-line falls along the altitude scale line. You now have a **TRUE** compass. Turn the boat until the course you wish to steer lies in the keel line. You can read the time by the vertical lines on the paper dial. Set your watch to this time or repeat altitudes of sun for constant use all day.

(Lifeboat Model)

Foreword

The lifeboat model of the Marean-Kielhorn Director is designed to enable you, the lifeboatman, to put your boat on a correct heading with little or no previous knowledge of navigation, and regardless of how the magnetic compass heads. It does this; first, by finding the true direction (or bearing) of the sun, and second, by acting as a sun compass. After a boat is once placed on its course by the Director, the magnetic compass is only used for reference; that is, you note its heading when on the proper course and steer by it as you would steer by a cloud or point on shore.

In the operation of the Director there are but two things that must be known beforehand - (1) the day of the year, and (2) the latitude (approximately). If you do not know the latter, your instrument will help you get it. The method employed by the Director is so short and easy that satisfactory results will be attained by any one who reads carefully the instructions in Part 1.

If you are a deck officer, or are familiar with navigation, you may desire to utilize the remarkable advantages of the Director in regular navigation. Although the lifeboat model is less convenient and not as well suited to such work as the navigator model; it is, none the less, an instrument of precision and capable of yielding the accuracy required for ship use, provided the navigator complies with the instructions contained in Part 2.

General Observations

The best time to take a bearing of the sun is when it is in the true horizon; that is, at the instant of rising or setting. If the sun cannot be seen when it is thus favorably placed, the bearing should be taken as soon after as it becomes bright enough to cast a shadow. Observations for altitude should be avoided when the sun is more than thirty degrees high.

In general, the instrument is at its best in low and intermediate latitudes and during the season of summer in the observer's latitude, for in these circumstances a moderate error in the observed altitude will have comparatively little effect in the bearing. During winter, and in high latitudes, however, care in observing altitudes must be taken in order to get the most satisfactory results.

Besides obtaining the bearing of the sun and getting the latitude, the Director will be found useful in determining, among other things, the sun-time of your locality. This will afford a means of running watches on schedule, fixing hours for rationing water and food, and serving the general purpose of a time piece.

INSTRUCTIONS - (Part 1)

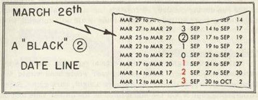
Use correct dial.

Remove the clear plastic cover dial by the nut on the back of the instrument. Take the paper dial marked with the latitude nearest to your position and place it on top of the other paper dials. If you are in north latitude (that is, north of the equator), place the north end of the dial towards the "N" of the instrument. If you are in south latitude, place the south end of the paper dial to "N" of the instrument. Replace the cover dial.

The only trouble you may encounter in this first step is in deciding what dial to use. It may be that the navigator has not informed you of your latitude, or it is possible the chart isn't marked with your position. Perhaps you lack a good understanding of what latitude is. In such a predicament, refer to the appendix of this pamphlet, which will explain very simply an easy way to find latitude with the Marean-Kielhorn Director.

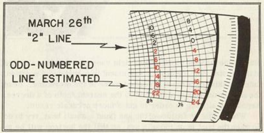
Remember your date.

Refer to the white calendar on the back of the instrument and find the period of days that includes your present date. As an example, take March 26th as your date. First find March, and then the days "Mar 25 to Mar 27". Refer to the drawing:



For the 26th of March you will find a black numbered "2". (Notice that the same number also applies to September 18th). Now refer to the paper dial in the front of the instrument. Holding the instrument so that "N" is away from you, you will see that black numbered lines are above the red numbered lines. Read only those numbers that are upright and find the line marked with a black "2". This is your date line. In passing it should be remarked that had "2" on the calendar been in red you would have selected a line marked with a red "2".

If your date number is odd, you must estimate its position between the even-numbered lines. In the drawing, the odd-numbered line estimated is a red 19, which lies half-way between the printed 18 and 20 line.

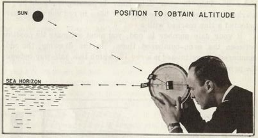


It is along this line that you will place the varying altitudes of the sun during the day, by rotating the cover dial so the point registering your altitude on the altitude scale will coincide with it.

To find the sun's altitude.

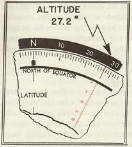
Raise all the sight vanes to a vertical position. Hold the instrument in your right hand, putting your whole hand within the handle, fingers spread out. This allows a tight, sure grip. Refer to the photograph of how the black lines on the amber vane and on the frosted center vane are sighted along the sea horizon, your eye being placed at the vane with a slot in it. Note that the line on the amber vane is exactly in line with the horizon.

Rotate the cover dial until the green vane line casts a shadow precisely on the line of the center frosted vane. When you have



placed the shadow of the green sight vane exactly along the line of the frosted vane, return the instrument to a horizontal position, face up, taking care the dial doesn't move in the meantime. Read the altitude on the rim of the dial to the nearest tenth of a degree. Repeat the altitude in order to get a more accurate result.

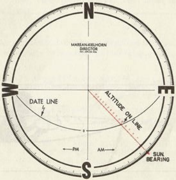
When taking an altitude of the sun from a small boat, try to do so when the boat is on top of a sea, so that the horizon will be as



far away as possible. By all means avoid making the mistake of using the crest of a wave close by as your horizon, for in that case the altitude, very probably, will be badly in error.

To find the sun's bearing.

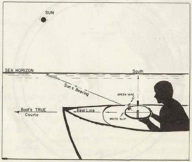
Having found the altitude of the sun above the sea horizon, find the exact point on the altitude scale corresponding to this altitude. Then rotate the plastic cover dial until this point lies exactly on top of your particular date line, and tighten the brass nut to hold it there. You will note that there are two places where



you can do this, one on the side of the dial labeled "AM", and the other on the side "PM". If the altitude was taken in the morning the "AM" side, of course, is used; likewise the "PM" side is used for afternoon. This being done, the bearing of the sun is read directly on the circumference of the dial, as the illustration on the preceding page shows.

To place the boat on any true course.

Having found the bearing of the sun as described in the foregoing paragraph, take a position in the boat over the keel line, and hold the instrument, face up and level to the sea. Keeping it in this position, turn it until the line of the green vane casts a shadow toward the center of the dial; i.e., along the altitude scale line. You now have a true, or sun, compass. Still keeping the sun's shadow on the altitude scale line, place the white clip in line with the bow. This will give you your present true course. If you desire to change your course at this time, place the red clip at the new desired course, and direct the boat to turn until such time as the bow is in line with the red clip, in the meantime constantly aligning the instrument with the sun so as to keep the shadow falling along the altitude scale.



During the foregoing procedure it is probable that some time has elapsed since the taking of the altitude, and that the sun has changed its bearing noticeably. You should, therefore, check your work by taking another altitude and bearing while the boat is on the new course.

To find the time of day.

In looking at the dial you have, no doubt, observed that certain lines cross the date lines at right angles to them. These lines show the hours and ten minute subdivisions, and are marked in clock time. Thus "11h" means 11 a.m., and "3h" stands for 3 p.m., meaning your time of day. Since this time is obtained from the sun, it is known to navigators as "local apparent time". Each time you find the sun's bearing, you automatically find your own time by reading on your date line the hours and minutes indicated by the point where your altitude point touches the date line. Therefore, if you have a watch that is running, set it to this time unless it is adjusted to Greenwich time. If, indeed, you should be so fortunate to have a watch reading Greenwich time; and you are familiar with navigation, you ought to be able to get a fairly approximate longitude by applying the time you thus find to the Greenwich time, after the latter has been changed from mean to apparent time.

Examples:

In order to make sure that you understand what you have read, test your knowledge by working the following examples:

Problem: Latitude 40° North, April 16, sun's altitude is 25.5°. What is bearing and time? Sight made in forenoon.
Ans. 98.6° 7h-40m A.M.

Problem: Latitude 40° North, October 19th, sun's altitude in afternoon is 30.5°. What is bearing and time?
Ans. 221° 2h-20m P.M.

Problem: Latitude 40° South, May 12th, sun's altitude in the morning is 18.5°. What is bearing and time?
Ans. 45° 9:00 A.M.

To find the compass error.

In order to determine the compass error follow this procedure: Align the instrument correctly for the present altitude, keeping the boat on the desired course by means of the white clip. Place the red clip on the outer rim for the course the compass reads. This will give the difference between the two courses and hence, the compass error. If the red clip is to the left of the white clip, as viewed from the center of the paper dial, the error is east; if the red clip is to the right of the white clip the error is west.

INSTRUCTIONS - (Part 2)

The following instructions are primarily for the navigator who desires to make accurate use of the Marean-Kielhorn Director in azimuth work.

There are two principal methods generally used for determining the azimuth of a body. The one known as "altitude-azimuth" requires a knowledge of the latitude, declination, and altitude of the body for solution, and is the method described in Part 1 of these instructions. The other is the "time-azimuth", which requires latitude, declination, and the hour angle of the body. Both methods are orthodox and may be computed from formulae given in the chapter on azimuth in "The American Practical Navigator" (Bowditch). The Marean-Kielhorn Director permits a graphic solution of either with equal facility.

The dials furnished with the Director form a series of projections of the celestial sphere in the plane of the horizon, with the observer at the center of the projection. The curved lines running in a northerly-southerly direction are hour circles; those running in an easterly-westerly direction are diurnal circles, showing the apparent paths of celestial bodies as they sweep across the sky. The diurnal circles are spaced north and south of the equator for each two degrees of declination, beginning with the equator, and resemble parallels of latitude. The hour circles are spaced for each ten-minute interval, and resemble meridians on the earth's surface. Thus a celestial body may be plotted in its correct position relative to the observer by means

of its declination and local hour angle, just as a terrestrial position is marked upon a chart by its latitude and longitude. For accuracy the table on the inside of the back cover should be used for declinations instead of the one on the back of the instrument.

When the time-azimuth method is employed the body is plotted as explained in the foregoing paragraph. Its direction from the center of the projection, as measured on the periphery, is the azimuth; its distance from the center, as indicated by the altitude scale, is the altitude.

Altitude-azimuths are to be preferred in low and intermediate latitudes. Time-azimuths are better in high latitudes, especially during the winter months (of the observer).

The Director may be used for solving graphically nearly all the problems of the astronomical triangle, including the identification of stars, great circle courses and distances (within the limits of the projection), and in checking computations. These uses are fully described in the manual of instructions for the navigator model.

It is to be observed that when the latitude of the observer is the same as the projection he uses, the solution is rigorous, with an accuracy limited only by the correctness of the projection and the care taken in plotting. Should the observer be in a latitude not greatly different (one degree, for example), two simple and quickly made adjustments will afford a correct solution for any such interim latitude. In the navigator model these operations are facilitated in the construction of the instrument, but they may be made quite satisfactorily with the lifeboat model by referring to the tables on the outside of the back cover.

The first correction is to the altitude. The observer notes the approximate bearing of the body, and whether his position is north or south of the latitude of the projection he uses. With this information he applies the correction to his altitude from Table 1. He then proceeds to find his azimuth in the usual way. Generally this single correction is all he needs, for the sole effect of a change of latitude on azimuth is small. At zero altitude there is no correction; at five degrees altitude the maximum effect is a tenth of a degree of azimuth for a degree difference in latitude, and this effect increases at the rate of a tenth of a degree for each five degrees of altitude up to forty degrees. It is obvious, therefore, that if the sun is low no additional correction is required in usual cases. However, should the navigator desire close work, the final correction is taken from Table 2 and applied to the azimuth. If the time-azimuth method is used, the single correction from Table 2 is all that is required.

The following examples illustrate the use of the tables for interim latitudes:

Problem: Lat. 31° N, morning of May 20, sun bearing east, roughly, has an altitude of 33.2°. Find correct azimuth.

<u>Solution:</u>

Use dial marked Lat. 30°. From table 1, corr. to alt. is zero. Using alt. of 33.2° azimuth is found to be 84.6°. From table 2 corr. to azimuth is +.6°. Therefore correct azimuth for 31° N is 85.2°

Problem: Lat. 17° South, afternoon of June 13, sun bearing NW roughly, has an altitude of 13.4°. Find correct azimuth.

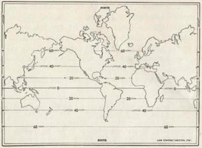
<u>Solution:</u>

Use dial marked Lat. 18°. From table 1, altitude corr. is -.5, making corrected altitude 12.9°. Now, using altitude of 12.9° azimuth is found to be 300°. From table 2, correction for latitude difference of 1° is -.2. Therefore correct azimuth for Lat. 17° South is 299.8°

APPENDIX

<u>A method for finding the approximate latitude.</u>

Latitude is a term given to indicate the number of degrees or distance a point is north or south of the equator. One degree of latitude is equal to sixty nautical miles. Therefore, a point in Latitude 40° North is 40 x 60 miles, or 2400 miles north of the equator; similarly a point in Latitude 10° South is 600 miles south of the equator. A point that is twenty degrees north of Latitude 40° N is in Latitude 60° North; a point fifty degrees south of Latitude 40° North, is in Latitude 10° South.



How Latitudes are Shown

The point on the earth exactly under the sun is known as the geographic position of that body. Since any point on earth may be measured by its distance from the equator, it follows that the sun's geographical position has a latitude. Thus, if a ship be directly under the sun at any instant, the sun's latitude, as taken from the table on the inside of the back cover, will be the latitude of the ship. Let us say, however, that a ship is not directly under the sun; that it is sixty miles north of it. Then the ship's latitude is one degree away from the latitude of the sun's geographic position. Thus, if we know the latitude of the sun, and also our distance, either in miles or degrees north or south of the sun, we may always determine our latitude.

Now, it is a very simple matter to find how far a vessel is away from the geographic position of the sun. We have merely to subtract the sun's altitude from 90° to find it. We call this difference between the sun's altitude and ninety degrees, the zenith distance, and once found we arrive at our latitude by applying it to the latitude of the geographic position.

Accordingly, to find latitude, take the sun at its maximum daily elevation, for at this time it bears either north or south of the observer. In practice this is done by repeating observations before noon until the sun no longer gains altitude, being sure by waiting until it begins to descend. Then, having subtracted the altitude from ninety degrees, look in the table on the inside of the back cover and take the sun's latitude for the date in question. If you are north of the sun, your latitude will be north of the sun's latitude by the amount of the zenith distance; if you are south of the sun your latitude will be to southward by the amount of the zenith distance. It is as simple as that!

The following examples will increase your confidence in working these sights:

Problem: Sept. 2 - maximum alt. is 60.3°, sun bearing south. Find your latitude.

Solution:
Lat. of sun on Sept. 2 is 8° N. Zenith Distance (90 - 60.3) = 29.7°. Since sun bears south, observer is north of sun's lat. by 29.7°. Therefore he is in Lat. 37.7° N.

Problem: May 1 - maximum alt. is 65°, sun bearing north. Find your latitude.

Solution:
Lat. of sun on May 1 is 15° North. Zenith Distance (90 - 65) = 25°. Since sun bears north, observer is south of sun's latitude by 25°. Therefore he is in Latitude 10° South.

Problem: Dec. 11 - maximum alt. is 80°, sun bearing south. Find your latitude.

Solution:
Lat. of sun on Dec. 11 is 23° South. Zenith Distance (90 - 80) = 10°. Since sun bears south of observer, he is north of sun's latitude by 10°. Therefore he is in Latitude 13° South.

The observer will find that he can estimate divisions of a degree of altitude closely, and with but little practice he should be able to read altitudes to a tenth of a degree (6 miles).

The table of sun's latitudes on the inside of the back cover has a maximum error for any year of about .25 of a degree (15 miles). This error, which is largest in March and September, decreases to nearly zero in June and December. A small additional error is introduced unless a correction is made for longitude, because of the daily difference in the sun's latitude. Dip and refraction errors may be considered negligible.

SUN'S APPROXIMATE GEOGRAPHIC LATITUDE EACH DAY

(Declination of the zenith at 12h G.C.T.)

Date	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
	°	°	°	°	°	°	°	°	°	°	°	°
1	S23.0	S17.1	S7.6	N 4.5	N15.0	N22.0	N23.1	N18.1	N8.3	S 3.1	S14.4	S21.8
2	S22.9	S16.8	S7.2	N 4.9	N15.3	N22.2	N23.0	N17.8	N8.0	S 3.5	S14.7	S22.0
3	S22.8	S16.5	S6.9	N 5.3	N15.6	N22.3	N23.0	N17.5	N7.6	S 3.9	S15.0	S22.1
4	S22.7	S16.3	S6.5	N 5.6	N15.9	N22.4	N22.9	N17.3	N7.3	S 4.3	S15.3	S22.2
5	S22.6	S16.0	S6.1	N 6.0	N16.2	N22.5	N22.8	N17.0	N6.9	S 4.7	S15.6	S22.3
6	S22.5	S15.6	S5.7	N 6.4	N16.5	N22.6	N22.7	N16.7	N6.5	S 5.1	S16.0	S22.5
7	S22.4	S15.3	S5.3	N 6.8	N16.8	N22.7	N22.6	N16.5	N6.1	S 5.5	S16.3	S22.6
8	S22.3	S15.0	S4.9	N 7.1	N17.0	N22.8	N22.5	N16.2	N5.7	S 5.8	S16.5	S22.7
9	S22.1	S14.7	S4.5	N 7.5	N17.3	N22.9	N22.4	N15.9	N5.4	S 6.2	S16.8	S22.8
10	S22.0	S14.4	S4.1	N 7.9	N17.6	N23.0	N22.3	N15.6	N5.0	S 6.6	S17.1	S22.9
11	S21.8	S14.1	S3.8	N 8.3	N17.8	N23.1	N22.1	N15.3	N4.6	S 7.0	S17.4	S23.0
12	S21.7	S13.7	S3.4	N 8.6	N18.1	N23.1	N22.0	N15.0	N4.2	S 7.3	S17.6	S23.1
13	S21.5	S13.4	S3.0	N 9.0	N18.3	N23.2	N21.9	N14.7	N3.8	S 7.7	S17.9	S23.1
14	S21.3	S13.1	S2.6	N 9.3	N18.6	N23.3	N21.7	N14.4	N3.5	S 8.1	S18.2	S23.2
15	S21.1	S12.7	S2.2	N 9.7	N18.8	N23.3	N21.6	N14.1	N3.1	S 8.5	S18.5	S23.3
16	S21.0	S12.4	S1.8	N10.1	N19.1	N23.4	N21.4	N13.8	N2.7	S 8.8	S18.7	S23.3
17	S20.8	S12.0	S1.4	N10.4	N19 3	N23.4	N21.2	N13.5	N2.3	S 9.2	S18.9	S23.4
18	S20.6	S11.7	S1.0	N10.8	N19.5	N23.4	N21.1	N13.1	N1.9	S 9.6	S19.2	S23.4
19	S20.4	S11.3	S0.6	N11.2	N19.7	N23.4	N20.9	N12.8	N1.5	S 9.9	S19.4	S23.4
20	S20.1	S11.0	S0.2	N11.5	N20.0	N23.4	N20.7	N12.5	N1.1	S10.3	S19.7	S23.4
21	S19.9	S10.6	N0.2	N11.8	N20.2	N23.4	N20.5	N12.2	N0.7	S10.6	S19.9	S23.4
22	S19.7	S10.2	N0.6	N12.1	N20.4	N23.4	N20.3	N11.8	N0.4	S11.0	S20.1	S23.4
23	S19.5	S 9.8	N1.0	N12.5	N20.5	N23.4	N20.1	N11.5	S0.0	S11.3	S20.3	S23.4
24	S19.2	S 9.5	N1.4	N12.8	N20.7	N23.4	N19.9	N11.2	S0.4	S11.7	S20.5	S23.4
25	S19.0	S 9.1	N1.8	N13.1	N20.9	N23.4	N19.7	N10.8	S0.8	S12.1	S20.7	S23.4
26	S18.7	S 8.8	N2.1	N13.5	N21.1	N23.4	N19.5	N10.5	S1.2	S12.4	S20.9	S23.4
27	S18.5	S 8.4	N2.5	N13.8	N21.3	N23.3	N19.3	N10.1	S1.6	S12.7	S21.1	S23.3
28	S18.2	S 8.0	N2.9	N14.1	N21.4	N23.3	N19.0	N 9.8	S2.0	S13.1	S21.3	S23.3
29	S18.0	S 7.6	N3.3	N14.4	N21.6	N23.2	N18.8	N 9.4	S2.3	S13.4	S21.5	S23.2
30	S17.7		N3.7	N14.7	N21.8	N23.2	N18.6	N 9.1	S2.7	S13.7	S21.6	S23.2
31	S17.4		N4.1		N21.9		N18.3	N 8.7		S14.1		S23.1