For the Sun there is often significant movement of the vessel between the morning and afternoon sights as shown in the following example.

Example. During a voyage from Mauritius to the Seychelles, three observations of the lower limb (LL) of the Sun were made on 2003 October 26. The observations were timed at $07^h 38^m 47^s$, $11^h 58^m 59^s$ and $16^h 39^m 40^s$ local time; 4^h ahead of UT. The morning altitude was recorded at 27° 29′·1, when the temperature was 18°C. The temperature rose to 25°C when the second observation was made with altitude 83° 04′·0. The sextant altitude of the last observation was 22° 23′·7, when the temperature had fallen to 20°C. The pressure remained constant at 1016 mb throughout the day. The height of the navigator's eye above the horizon was 6 m (20 ft.), and the index error of the sextant was 1′·3 *on the arc* (−1′·3). A fix is required at 08^h UT (12^h local time), when the DR position was S19° 15′, E56° 15′. During the passage the course was 345°(T) and the speed varied between 8 and 10 knots. Thus the navigator estimated that during the morning run the distance made good was 30 nm, while the distance during the afternoon run was 50 nm.

1 DR position S 19° 15′, E 56° 15′, 2003 October 26 at $12^h 00^m 00^s$ local time, the time of the fix.

2 Convert Sun observation time to UT:		h m s		h m s		h m s	
Local time 2003 October 26		07 38 47		11 58 59		16 39 40	
Zone Correction		−4		−4		−4	
UT of the observation		03 38 47		07 58 59		12 39 40	
UT of Fix		08 00 00		08 00 00		08 00 00	
Time of Fix − Time of Observation		+4 21 13		+1 01		−4 39 40	
The Fix is		*later*		*later*		*earlier*	
than the observation by		4 21 13		1 01		4 39 40	
3 Dec and GHA or (SHA and GHA♈) from the NA:			° ′		° ′		° ′
Dec 2003 October 26 at UT^h			S 12 15·9		S 12 19·3		S 12 23·6
Correction for *d* and minutes of time		(0′·9)	+0·6	(0′·9)	+0·9	(0′·9)	+0·6
Sum = Declination for UT of observation			S 12 16·5		S 12 20·2		S 12 24·2
GHA Sun 2003 October 26 at UT^h		03	228 59·2	07	288 59·5	12	3 59·8
Increment for minutes and seconds		38 47	9 41·8	58 59	14 44·8	39 40	9 55·0
Sum = GHA Sun given UT		03 38 47	238 41·0	07 58 59	303 44·3	12 39 40	13 54·8
4 Calculate LHA: assumed longitude, add as east			+56 19·0		+56 15·7		+56 05·2
LHA Sun = Sum			295		360		70
5 Extracted quantities from main tables, arguments:							
Assumed latitude		S 19° } Same		S 19° } Same		S 19° } Same	
Declination, degrees (Dec°)		S 12°		S 12°		S 12°	
Declination, minutes (Dec′)		16′		20′		24′	
LHA		295°		000°		70°	
Tabular page		114		114		115	
			° ′ ′ °		° ′ ′ °		° ′ ′ °
Extracted H_C, *d*, Z			27 18 +15 86		83 00 +60 180		22 35 +16 85
Correction for *d* and Dec′, Table **5**			+4		+20		+6
Calculated altitude	H_C		27 22		83 20		22 41
6 Correct sextant altitudes:			° ′		° ′		° ′
Sextant altitude	H_S		27 29·1		83 04·0		22 23·7
Index error	IE		−1·3		−1·3		−1·3
Dip, Table **6**a, height 6 m	*D*		−4·3		−4·3		−4·3
Apparent altitude	H_a		27 23·5		82 58·4		22 18·1
Altitude correction, Sun, Table **6**d, Oct.			+14·4		+16·0		+13·9
Additional refraction **6**c (T° C, 1016 mb)			0·0		0·0		+0·1
Observed altitude	H_O		27 37·9		83 14·4		22 32·1
7 Intercept: calculated altitude, step 5	H_C		27 22		83 20		22 41
$H_O - H_C$	*p*		+15·9		−5·6		−8·9

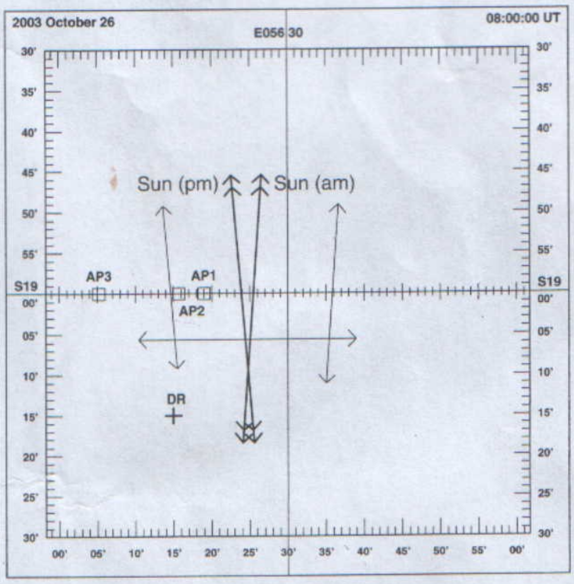
Continued . . .

	Continued ... $H_O - H_C$	*p*	+15·9		−5·6		−8·9	
	Convert Z to Z_n, South latitude		LHA > 180°	180	LHA < 180°	180	LHA < 180°	180
	Azimuth angle (step 5)	±Z		−86		+180		+85
	Azimuth, true bearing	Z_n	$Z_n = 180° - Z =$	094	$Z_n = 180° + Z =$	360	$Z_n = 180° + Z =$	265
8	Correction (a) Movement of vessel:			360				360
	Add or subtract 360° as appropriate			454				625
	True course (track) of vessel	*C*		345		345		345
	Relative bearing = $Z_n - C$	Rel.Z_n		109		15		280
	Distance made good	DMG		30nm		negligible		50nm
	Table 1, DMG, Rel.Z_n			−9′.8				+8′.7
	Fix is ... than the observation			*later*				*earlier*
	Thus the correction is	MOO	−9·8				−8·7	
	Intercept, corrected	*p*	+6·1		−5·6		−17·6	
		p	*towards* 6·1		*away* 5·6		*away* 17·6	
	Azimuth (true bearing) (step 7)	Z_n	094°		000°		265°	

Special care must be taken with the sign of MOO. In the above example, the value for the afternoon run was +8′.7. However, the rules given below Table 1 indicate that since the time of the fix was *earlier* than the time of the observation and the sign from the table was positive (+), then the correction must be *subtracted* from the intercept. Note that although the time difference is not explicitly used it will probably be needed for calculating the distance made good. The formulae for calculating this correction is given in 3.5.1, and is $(UT_f - UT)\, V \cos(\text{Rel.}Z_n)$, where the distance made good may be given by DMG = $(UT_f - UT)\, V$, (time in hours × speed (V) in knots), and ignores factors such as wind, tide and variable speed of the vessel.

9 The plot shows the position line of each observation of the Sun plotted with respect to the appropriate assumed position; latitude S 19°, E 56° 19′.0 (AP1), S 19°, E 56° 15′.7 (AP2) and S 19°, E 56° 05′.2 (AP3), respectively (see step 4). These are the lighter lines. The lines with the double arrows at each end are the position lines from the morning and afternoon observations transferred to the time that the fix is required at 08^h UT. The position line of the middle observation is close to the time of the fix and thus does not require to be transferred.

The fix is indicated by the tiny area of the cocked-hat, but may lie outside it, if the band of error either side of the position line exceeds the diameter of the cocked-hat.



An alternative to using *The Nautical Almanac* for the ephemeris of the Sun is to use the ephemeris given in Table 4 (page 250). These positions are less accurate than the NA (see 3.3), but the table is valid from 2001 to 2036. The working below illustrates the process using data from the pervious example.

GHA and Declination of the Sun for 2003 October 26 using Table 4

	h m s	h m s	h m s
UT of observation	03 38 47	07 58 59	12 39 40
Table 4a UT corr. 2003	−1	−1	−1
OT of observation	02 38 47	06 58 59	11 39 40