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VOL. 1

SIGHT REDUCTION TABLES

FOR

AIR NAVIGATION

(SELECTED STARS)

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NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY

INTRODUCTION

Example. On 2008 January 1 in DR position N54° 17′, E175° 46′ at height 9,000 ft. (3 km), an observation of *PROCYON* is obtained at $12^h\ 21^m\ 25^s$ UT; the sextant reading is 40° 34′ and the correction for the instrument error and dome refraction is –4′.

		°	′		°	′	
From Table 4, for 2008 Jan 1	(a) =	100	02	Sextant altitude	40	34	
for 12^h UT on day 1	(b) =	180	30	Dome refraction, etc.		–4	
for $21^m\ 25^s$	(c) =	5	22	Refraction (Table **8**)		–1	
Sum, GHA ♈ for UT $12^h\ 21^m\ 25^s$	GHA ♈ =	285	54	Corrected Sextant altitude (Ho)	40	29	
Assumed longitude, added because east		+176	06	From the main tables (page 52)			
Sum, less 360°	LHA ♈ =	102		Tabulated altitude (Hc)	40	04	Az. (Zn) 163°
				Intercept		25	*towards*

The assumed latitude is N54°, the assumed longitude is E176° 06′, and the intercept of 25′ is plotted from this position in true bearing 163°. The position line is drawn perpendicular to this direction.

Usually, sights of several stars will be taken in rapid succession to give a fix. The example below illustrates the use of tables for the reduction of a typical set of observations.

Example. On 2008 January 1, in DR position N45° 49′, W25° 35′ (for $23^h\ 47^m$ UT) at height 3,000 ft. (1 km), sights are taken as follows:

Star	UT h	m	s	Sextant altitude °	′	Instrument error, etc. ′
Dubhe	23	44	15	37	43	–5
RIGEL	23	47	33	35	55	–5
Alpheratz	23	51	55	33	19	–6

	Dubhe					*RIGEL*					*Alpheratz*				
	UT			GHA♈		UT			GHA♈		UT			GHA♈	
From Table 4:	h	m	s	°	′	h	m	s	°	′	h	m	s	°	′
For Jan 1 at 23^hUT = (a) + (b), less 360°	23			85	59	23			85	59	23			85	59
Correction for minutes and seconds (c)		44	15	11	06		47	33	11	55		51	55	13	01
Sum = GHA♈ for given UT	23	44	15	97	05	23	47	33	97	54	23	51	55	99	00
Assumed longitude, subtracted because west				–25	05				–24	54				–25	00
Sum = LHA ♈				72					73					74	

	Altitude °	′	Az.	Altitude °	′	Az.	Altitude °	′	Az.
Sextant altitude	37	43		35	55		33	19	
Instrument error and dome refraction		–5			–5			–6	
Refraction (Table 8)		–1			–1			–1	
Corrected sextant altitude (Ho)	37	37		35	49		33	12	
Tables, p. 68 assumed Lat. 46° N and LHA ♈ as above; Hc and Zn	37	35	037°	35	34	173°	32	41	280°
Intercept		2	*towards*		15	*towards*		31	*towards*

In this example, the assumed longitudes for all observations are taken as close as possible to the DR longitude at $23^h\ 47^m$; shorter intercepts can often be obtained by relating the assumed position to the DR position at the time of observation. The intercepts are plotted from the respective assumed positions, latitude N46°, respective longitudes W25° 17′, W25° 06′ and W25° 12′, transferred as necessary for the motion of the aircraft between the time of observation and that of the fix, for the effect of Coriolis acceleration and for precession and nutation. These shifts may be made to the position lines instead of to the assumed positions from which they are constructed, or, for the last two corrections, directly to the fix.

TABLE 6 — CORRECTION (*Q*) FOR *POLARIS*

LHA ♈	*Q*	LHA ♈	*Q*	LHA ♈	*Q*	LHA ♈	*Q*	LHA ♈	*Q*	LHA ♈	*Q*	LHA ♈	*Q*	LHA ♈	*Q*
° ′	′	° ′	′	° ′	′	° ′	′	° ′	′	° ′	′	° ′	′	° ′	′
359 01	− 31	**87 17**	− 28	**123 10**	− 5	**155 56**	+ 18	**209 49**	+ 41	**284 52**	+ 18	**317 47**	− 5	**353 11**	− 28
1 06	− 32	**89 10**	− 27	**124 34**	− 4	**157 29**	+ 19	**232 32**	+ 40	**286 25**	+ 17	**319 11**	− 6	**355 04**	− 29
3 18	− 33	**90 59**	− 26	**125 58**	− 3	**159 03**	+ 20	**238 15**	+ 39	**287 56**	+ 16	**320 35**	− 7	**357 00**	− 30
5 35	− 34	**92 46**	− 25	**127 21**	− 2	**160 39**	+ 21	**242 31**	+ 38	**289 27**	+ 15	**321 59**	− 8	**359 01**	− 31
8 01	− 35	**94 30**	− 24	**128 44**	− 1	**162 16**	+ 22	**246 05**	+ 37	**290 56**	+ 14	**323 24**	− 9	**1 06**	− 32
10 38	− 36	**96 12**	− 23	**130 08**	0	**163 54**	+ 23	**249 14**	+ 36	**292 25**	+ 13	**324 49**	− 10	**3 18**	− 33
13 27	− 37	**97 52**	− 22	**131 32**	+ 1	**165 35**	+ 24	**252 05**	+ 35	**293 53**	+ 12	**326 15**	− 11	**5 35**	− 34
16 33	− 38	**99 30**	− 21	**132 55**	+ 2	**167 17**	+ 25	**254 42**	+ 34	**295 20**	+ 11	**327 41**	− 12	**8 01**	− 35
20 05	− 39	**101 07**	− 20	**134 19**	+ 3	**169 02**	+ 26	**257 10**	+ 33	**296 46**	+ 10	**329 08**	− 13	**10 38**	− 36
24 18	− 40	**102 41**	− 19	**135 42**	+ 4	**170 50**	+ 27	**259 29**	+ 32	**298 12**	+ 9	**330 35**	− 14	**13 27**	− 37
29 57	− 41	**104 15**	− 18	**137 06**	+ 5	**172 40**	+ 28	**261 41**	+ 31	**299 38**	+ 8	**332 04**	− 15	**16 33**	− 38
52 24	− 40	**105 47**	− 17	**138 30**	+ 6	**174 34**	+ 29	**263 48**	+ 30	**301 03**	+ 7	**333 33**	− 16	**20 05**	− 39
58 03	− 39	**107 18**	− 16	**139 54**	+ 7	**176 32**	+ 30	**265 49**	+ 29	**302 27**	+ 6	**335 03**	− 17	**24 18**	− 40
62 16	− 38	**108 48**	− 15	**141 18**	+ 8	**178 33**	+ 31	**267 47**	+ 28	**303 51**	+ 5	**336 34**	− 18	**29 57**	− 41
65 48	− 37	**110 17**	− 14	**142 43**	+ 9	**180 40**	+ 32	**269 41**	+ 27	**305 15**	+ 4	**338 06**	− 19	**52 24**	− 40
68 54	− 36	**111 46**	− 13	**144 09**	+ 10	**182 52**	+ 33	**271 31**	+ 26	**306 39**	+ 3	**339 40**	− 20	**58 03**	− 39
71 43	− 35	**113 13**	− 12	**145 35**	+ 11	**185 11**	+ 34	**273 19**	+ 25	**308 02**	+ 2	**341 14**	− 21	**62 16**	− 38
74 20	− 34	**114 40**	− 11	**147 01**	+ 12	**187 39**	+ 35	**275 04**	+ 24	**309 26**	+ 1	**342 51**	− 22	**65 48**	− 37
76 46	− 33	**116 06**	− 10	**148 28**	+ 13	**190 16**	+ 36	**276 46**	+ 23	**310 49**	0	**344 29**	− 23	**68 54**	− 36
79 03	− 32	**117 32**	− 9	**149 56**	+ 14	**193 07**	+ 37	**278 27**	+ 22	**312 13**	− 1	**346 09**	− 24	**71 43**	− 35
81 15	− 31	**118 57**	− 8	**151 25**	+ 15	**196 16**	+ 38	**280 05**	+ 21	**313 37**	− 2	**347 51**	− 25	**74 20**	− 34
83 20	− 30	**120 22**	− 7	**152 54**	+ 16	**199 50**	+ 39	**281 42**	+ 20	**315 00**	− 3	**349 35**	− 26	**76 46**	− 33
85 21	− 29	**121 46**	− 6	**154 25**	+ 17	**204 06**	+ 40	**283 18**	+ 19	**316 23**	− 4	**351 22**	− 27	**79 03**	− 32
87 17		**123 10**		**155 56**		**209 49**		**284 52**		**317 47**		**353 11**		**81 15**	

The above table, which does *not* include refraction, gives the quantity *Q* to be applied to the corrected sextant altitude of *Polaris* to give the latitude of the observer. In critical cases ascend.

Polaris: Mag. 2.1, SHA 318° 49′, Dec N 89° 18.7′

TABLE 7 — AZIMUTH OF *POLARIS*

LHA ♈	Latitude 0°	30°	50°	55°	60°	65°	70°	LHA ♈	Latitude 0°	30°	50°	55°	60°	65°	70°
°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
0	0.5	0.5	0.7	0.8	0.9	1.1	1.4	**180**	359.5	359.5	359.3	359.2	359.1	358.9	358.7
10	0.4	0.4	0.6	0.6	0.7	0.9	1.1	**190**	359.6	359.6	359.5	359.4	359.3	359.2	359.0
20	0.2	0.3	0.4	0.4	0.5	0.6	0.7	**200**	359.8	359.7	359.6	359.6	359.5	359.4	359.3
30	0.1	0.2	0.2	0.2	0.3	0.3	0.4	**210**	359.9	359.8	359.8	359.8	359.7	359.7	359.6
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**220**	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	359.9	359.9	359.8	359.8	359.8	359.7	359.7	**230**	0.1	0.1	0.2	0.2	0.2	0.2	0.3
60	359.8	359.7	359.6	359.6	359.5	359.5	359.3	**240**	0.2	0.3	0.3	0.4	0.4	0.5	0.6
70	359.7	359.6	359.5	359.4	359.3	359.2	359.0	**250**	0.3	0.4	0.5	0.6	0.7	0.8	0.9
80	359.6	359.5	359.3	359.2	359.1	359.0	358.7	**260**	0.4	0.5	0.7	0.7	0.8	1.0	1.2
90	359.5	359.4	359.2	359.1	358.9	358.8	358.5	**270**	0.5	0.6	0.8	0.9	1.0	1.2	1.5
100	359.4	359.3	359.1	359.0	358.8	358.6	358.2	**280**	0.6	0.7	0.9	1.0	1.2	1.4	1.7
110	359.4	359.3	359.0	358.9	358.7	358.5	358.1	**290**	0.6	0.7	1.0	1.1	1.3	1.5	1.9
120	359.3	359.2	358.9	358.8	358.6	358.4	358.0	**300**	0.7	0.8	1.0	1.2	1.3	1.6	2.0
130	359.3	359.2	358.9	358.8	358.6	358.4	358.0	**310**	0.7	0.8	1.1	1.2	1.4	1.6	2.0
140	359.3	359.2	358.9	358.8	358.6	358.4	358.0	**320**	0.7	0.8	1.1	1.2	1.4	1.6	2.0
150	359.3	359.2	359.0	358.9	358.7	358.5	358.1	**330**	0.7	0.8	1.0	1.1	1.3	1.6	1.9
160	359.4	359.3	359.1	359.0	358.8	358.6	358.3	**340**	0.6	0.7	0.9	1.1	1.2	1.4	1.8
170	359.5	359.4	359.2	359.1	358.9	358.8	358.5	**350**	0.5	0.6	0.8	0.9	1.1	1.3	1.6
180	359.5	359.5	359.3	359.2	359.1	358.9	358.7	**360**	0.5	0.5	0.7	0.8	0.9	1.1	1.4

When Cassiopeia is left (right), *Polaris* is west (east).

TABLE 4 — GHA ♈ FOR THE YEARS 2006-2014

a. GHA ♈ AT 00^h ON THE FIRST DAY OF EACH MONTH

Year	Jan. 1	Feb. 1	Mar. 1	Apr. 1	May 1	June 1	July 1	Aug. 1	Sept. 1	Oct. 1	Nov. 1	Dec. 1
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
2006	100 30	131 04	158 40	189 13	218 47	249 20	278 55	309 28	340 01	009 35	040 09	069 43
2007	100 16	130 49	158 25	188 59	218 33	249 06	278 40	309 14	339 47	009 21	039 54	069 29
2008	100 02	130 35	159 10	189 44	219 18	249 51	279 25	309 59	340 32	010 06	040 39	070 13
2009	100 47	131 20	158 56	189 29	219 03	249 37	279 11	309 44	340 18	009 52	040 25	069 59
2010	100 33	131 06	158 42	189 15	219 49	249 22	278 57	309 30	340 03	009 37	040 11	069 45
2011	100 18	130 52	158 27	189 01	218 35	249 08	278 42	309 16	339 49	009 23	039 56	069 31
2012	100 04	130 37	159 12	189 45	219 20	249 53	279 27	310 00	340 34	010 08	040 41	070 15
2013	100 49	131 22	158 58	189 31	219 05	249 39	279 13	309 46	340 19	009 53	040 27	070 01
2014	100 34	131 08	158 43	189 17	218 51	249 24	278 58	309 32	340 05	009 39	040 12	069 47

b. INCREMENT OF GHA ♈ FOR DAYS AND HOURS

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
h	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
00	0 00	0 59	1 58	2 57	3 57	4 56	5 55	6 54	7 53	8 52	9 51	10 51	11 50	12 49	13 48	14 47
01	15 02	16 02	17 01	18 00	18 59	19 58	20 57	21 56	22 56	23 55	24 54	25 53	26 52	27 51	28 50	29 50
02	30 05	31 04	32 03	33 02	34 01	35 01	36 00	36 59	37 58	38 57	39 56	40 55	41 55	42 54	43 53	44 52
03	45 07	46 07	47 06	48 05	49 04	50 03	51 02	52 01	53 01	54 00	54 59	55 58	56 57	57 56	58 55	59 54
04	60 10	61 09	62 08	63 07	64 06	65 06	66 05	67 04	68 03	69 02	70 01	71 00	72 00	72 59	73 58	74 57
05	75 12	76 11	77 11	78 10	79 09	80 08	81 07	82 06	83 05	84 05	85 04	86 03	87 02	88 01	89 00	89 59
06	90 15	91 14	92 13	93 12	94 11	95 10	96 10	97 09	98 08	99 07	100 06	101 05	102 04	103 04	104 03	105 02
07	105 17	106 16	107 16	108 15	109 14	110 13	111 12	112 11	113 10	114 09	115 09	116 08	117 07	118 06	119 05	120 04
08	120 20	121 19	122 18	123 17	124 16	125 15	126 15	127 14	128 13	129 12	130 11	131 10	132 09	133 09	134 08	135 07
09	135 22	136 21	137 20	138 20	139 19	140 18	141 17	142 16	143 15	144 14	145 14	146 13	147 12	148 11	149 10	150 09
10	150 25	151 24	152 23	153 22	154 21	155 20	156 19	157 19	158 18	159 17	160 16	161 15	162 14	163 13	164 13	165 12
11	165 27	166 26	167 25	168 25	169 24	170 23	171 22	172 21	173 20	174 19	175 18	176 18	177 17	178 16	179 15	180 14
12	180 30	181 29	182 28	183 27	184 26	185 25	186 24	187 24	188 23	189 22	190 21	191 20	192 19	193 18	194 18	195 17
13	195 32	196 31	197 30	198 29	199 29	200 28	201 27	202 26	203 25	204 24	205 23	206 23	207 22	208 21	209 20	210 19
14	210 34	211 34	212 33	213 32	214 31	215 30	216 29	217 28	218 28	219 27	220 26	221 25	222 24	223 23	224 22	225 22
15	225 37	226 36	227 35	228 34	229 34	230 33	231 32	232 31	233 30	234 29	235 28	236 27	237 27	238 26	239 25	240 24
16	240 39	241 39	242 38	243 37	244 36	245 35	246 34	247 33	248 33	249 32	250 31	251 30	252 29	253 28	254 27	255 27
17	255 42	256 41	257 40	258 39	259 38	260 38	261 37	262 36	263 35	264 34	265 33	266 32	267 32	268 31	269 30	270 29
18	270 44	271 43	272 43	273 42	274 41	275 40	276 39	277 38	278 37	279 37	280 36	281 35	282 34	283 33	284 32	285 31
19	285 47	286 46	287 45	288 44	289 43	290 43	291 42	292 41	293 40	294 39	295 38	296 37	297 36	298 36	299 35	300 34
20	300 49	301 48	302 48	303 47	304 46	305 45	306 44	307 43	308 42	309 42	310 41	311 40	312 39	313 38	314 37	315 36
21	315 52	316 51	317 50	318 49	319 48	320 47	321 47	322 46	323 45	324 44	325 43	326 42	327 41	328 41	329 40	330 39
22	330 54	331 53	332 52	333 52	334 51	335 50	336 49	337 48	338 47	339 46	340 46	341 45	342 44	343 43	344 42	345 41
23	345 57	346 56	347 55	348 54	349 53	350 52	351 52	352 51	353 50	354 49	355 48	356 47	357 46	358 45	359 45	0 44

Day	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
h	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
00	15 46	16 45	17 44	18 44	19 43	20 42	21 41	22 40	23 39	24 38	25 38	26 37	27 36	28 35	29 34	30 33
01	30 49	31 48	32 47	33 46	34 45	35 44	36 44	37 43	38 42	39 41	40 40	41 39	42 38	43 37	44 37	45 36
02	45 51	46 50	47 49	48 49	49 48	50 47	51 46	52 45	53 44	54 43	55 43	56 42	57 41	58 40	59 39	60 38
03	60 54	61 53	62 52	63 51	64 50	65 49	66 48	67 48	68 47	69 46	70 45	71 44	72 43	73 42	74 42	75 41
04	75 56	76 55	77 54	78 53	79 53	80 52	81 51	82 50	83 49	84 48	85 47	86 47	87 46	88 45	89 44	90 43
05	90 59	91 58	92 57	93 56	94 55	95 54	96 53	97 53	98 52	99 51	100 50	101 49	102 48	103 47	104 46	105 46
06	106 01	107 00	107 59	108 58	109 58	110 57	111 56	112 55	113 54	114 53	115 52	116 52	117 51	118 50	119 49	120 48
07	121 03	122 03	123 02	124 01	125 00	125 59	126 58	127 57	128 57	129 56	130 55	131 54	132 53	133 52	134 51	135 51
08	136 06	137 05	138 04	139 03	140 02	141 02	142 01	143 00	143 59	144 58	145 57	146 56	147 56	148 55	149 54	150 53
09	151 08	152 08	153 07	154 06	155 05	156 04	157 03	158 02	159 02	160 01	161 00	161 59	162 58	163 57	164 56	165 55
10	166 11	167 10	168 09	169 08	170 07	171 07	172 06	173 05	174 04	175 03	176 02	177 01	178 01	179 00	179 59	180 58
11	181 13	182 12	183 12	184 11	185 10	186 09	187 08	188 07	189 06	190 06	191 05	192 04	193 03	194 02	195 01	196 00
12	196 16	197 15	198 14	199 13	200 12	201 11	202 11	203 10	204 09	205 08	206 07	207 06	208 05	209 05	210 04	211 03
13	211 18	212 17	213 17	214 16	215 15	216 14	217 13	218 12	219 11	220 11	221 10	222 09	223 08	224 07	225 06	226 05
14	226 21	227 20	228 19	229 18	230 17	231 16	232 16	233 15	234 14	235 13	236 12	237 11	238 10	239 10	240 09	241 08
15	241 23	242 22	243 21	244 21	245 20	246 19	247 18	248 17	249 16	250 15	251 15	252 14	253 13	254 12	255 11	256 10
16	256 26	257 25	258 24	259 23	260 22	261 21	262 20	263 20	264 19	265 18	266 17	267 16	268 15	269 14	270 14	271 13
17	271 28	272 27	273 26	274 26	275 25	276 24	277 23	278 22	279 21	280 20	281 19	282 19	283 18	284 17	285 16	286 15
18	286 31	287 30	288 29	289 28	290 27	291 26	292 25	293 25	294 24	295 23	296 22	297 21	298 20	299 19	300 19	301 18
19	301 33	302 32	303 31	304 30	305 30	306 29	307 28	308 27	309 26	310 25	311 24	312 24	313 23	314 22	315 21	316 20
20	316 36	317 35	318 34	319 33	320 32	321 31	322 30	323 29	324 29	325 28	326 27	327 26	328 25	329 24	330 23	331 23
21	331 38	332 37	333 36	334 35	335 35	336 34	337 33	338 32	339 31	340 30	341 29	342 28	343 28	344 27	345 26	346 25
22	346 40	347 40	348 39	349 38	350 37	351 36	352 35	353 34	354 34	355 33	356 32	357 31	358 30	359 29	0 28	1 28
23	1 43	2 42	3 41	4 40	5 39	6 39	7 38	8 37	9 36	10 35	11 34	12 33	13 33	14 32	15 31	16 30

TABLE 4 — GHA ♈ FOR THE YEARS 2006-2014

c. INCREMENT OF GHA ♈ FOR MINUTES AND SECONDS

	00^{s}	04^{s}	08^{s}	12^{s}	16^{s}	20^{s}	24^{s}	28^{s}		32^{s}	36^{s}	40^{s}	44^{s}	48^{s}	52^{s}	56^{s}	60^{s}	
m	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	m	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	m
00	0 00	0 01	0 02	0 03	0 04	0 05	0 06	0 07	**00**	0 08	0 09	0 10	0 11	0 12	0 13	0 14	0 15	**00**
01	0 15	0 16	0 17	0 18	0 19	0 20	0 21	0 22	**01**	0 23	0 24	0 25	0 26	0 27	0 28	0 29	0 30	**01**
02	0 30	0 31	0 32	0 33	0 34	0 35	0 36	0 37	**02**	0 38	0 39	0 40	0 41	0 42	0 43	0 44	0 45	**02**
03	0 45	0 46	0 47	0 48	0 49	0 50	0 51	0 52	**03**	0 53	0 54	0 55	0 56	0 57	0 58	0 59	1 00	**03**
04	1 00	1 01	1 02	1 03	1 04	1 05	1 06	1 07	**04**	1 08	1 09	1 10	1 11	1 12	1 13	1 14	1 15	**04**
05	1 15	1 16	1 17	1 18	1 19	1 20	1 21	1 22	**05**	1 23	1 24	1 25	1 26	1 27	1 28	1 29	1 30	**05**
06	1 30	1 31	1 32	1 33	1 34	1 35	1 36	1 37	**06**	1 38	1 39	1 40	1 41	1 42	1 43	1 44	1 45	**06**
07	1 45	1 46	1 47	1 48	1 49	1 50	1 51	1 52	**07**	1 53	1 54	1 55	1 56	1 57	1 58	1 59	2 00	**07**
08	2 00	2 01	2 02	2 03	2 04	2 05	2 06	2 07	**08**	2 08	2 09	2 10	2 11	2 12	2 13	2 14	2 15	**08**
09	2 15	2 16	2 17	2 18	2 19	2 20	2 21	2 22	**09**	2 23	2 24	2 25	2 26	2 27	2 28	2 29	2 30	**09**
10	2 30	2 31	2 32	2 33	2 34	2 35	2 36	2 37	**10**	2 38	2 39	2 40	2 41	2 42	2 43	2 44	2 45	**10**
11	2 45	2 46	2 47	2 48	2 49	2 50	2 51	2 52	**11**	2 53	2 54	2 55	2 56	2 57	2 58	2 59	3 00	**11**
12	3 00	3 01	3 02	3 04	3 05	3 06	3 07	3 08	**12**	3 09	3 10	3 11	3 12	3 13	3 14	3 15	3 16	**12**
13	3 16	3 17	3 18	3 19	3 20	3 21	3 22	3 23	**13**	3 24	3 25	3 26	3 27	3 28	3 29	3 30	3 31	**13**
14	3 31	3 32	3 33	3 34	3 35	3 36	3 37	3 38	**14**	3 39	3 40	3 41	3 42	3 43	3 44	3 45	3 46	**14**
15	3 46	3 47	3 48	3 49	3 50	3 51	3 52	3 53	**15**	3 54	3 55	3 56	3 57	3 58	3 59	4 00	4 01	**15**
16	4 01	4 02	4 03	4 04	4 05	4 06	4 07	4 08	**16**	4 09	4 10	4 11	4 12	4 13	4 14	4 15	4 16	**16**
17	4 16	4 17	4 18	4 19	4 20	4 21	4 22	4 23	**17**	4 24	4 25	4 26	4 27	4 28	4 29	4 30	4 31	**17**
18	4 31	4 32	4 33	4 34	4 35	4 36	4 37	4 38	**18**	4 39	4 40	4 41	4 42	4 43	4 44	4 45	4 46	**18**
19	4 46	4 47	4 48	4 49	4 50	4 51	4 52	4 53	**19**	4 54	4 55	4 56	4 57	4 58	4 59	5 00	5 01	**19**
20	5 01	5 02	5 03	5 04	5 05	5 06	5 07	5 08	**20**	5 09	5 10	5 11	5 12	5 13	5 14	5 15	5 16	**20**
21	5 16	5 17	5 18	5 19	5 20	5 21	5 22	5 23	**21**	5 24	5 25	5 26	5 27	5 28	5 29	5 30	5 31	**21**
22	5 31	5 32	5 33	5 34	5 35	5 36	5 37	5 38	**22**	5 39	5 40	5 41	5 42	5 43	5 44	5 45	5 46	**22**
23	5 46	5 47	5 48	5 49	5 50	5 51	5 52	5 53	**23**	5 54	5 55	5 56	5 57	5 58	5 59	6 00	6 01	**23**
24	6 01	6 02	6 03	6 04	6 05	6 06	6 07	6 08	**24**	6 09	6 10	6 11	6 12	6 13	6 14	6 15	6 16	**24**
25	6 16	6 17	6 18	6 19	6 20	6 21	6 22	6 23	**25**	6 24	6 25	6 26	6 27	6 28	6 29	6 30	6 31	**25**
26	6 31	6 32	6 33	6 34	6 35	6 36	6 37	6 38	**26**	6 39	6 41	6 41	6 42	6 43	6 44	6 45	6 46	**26**
27	6 46	6 47	6 48	6 49	6 50	6 51	6 52	6 53	**27**	6 54	6 55	6 56	6 57	6 58	6 59	7 00	7 01	**27**
28	7 01	7 02	7 03	7 04	7 05	7 06	7 07	7 08	**28**	7 09	7 10	7 11	7 12	7 13	7 14	7 15	7 16	**28**
29	7 16	7 17	7 18	7 19	7 20	7 21	7 22	7 23	**29**	7 24	7 25	7 26	7 27	7 28	7 29	7 30	7 31	**29**
30	7 31	7 32	7 33	7 34	7 35	7 36	7 37	7 38	**30**	7 39	7 40	7 41	7 42	7 43	7 44	7 45	7 46	**30**
31	7 46	7 47	7 48	7 49	7 50	7 51	7 52	7 53	**31**	7 54	7 55	7 56	7 57	7 58	7 59	8 00	8 01	**31**
32	8 01	8 02	8 03	8 04	8 05	8 06	8 07	8 08	**32**	8 09	8 10	8 11	8 12	8 13	8 14	8 15	8 16	**32**
33	8 16	8 17	8 18	8 19	8 20	8 21	8 22	8 23	**33**	8 24	8 25	8 26	8 27	8 28	8 29	8 30	8 31	**33**
34	8 31	8 32	8 33	8 34	8 35	8 36	8 37	8 38	**34**	8 39	8 40	8 41	8 42	8 43	8 44	8 45	8 46	**34**
35	8 46	8 47	8 48	8 49	8 50	8 51	8 52	8 53	**35**	8 54	8 55	8 56	8 57	8 58	8 59	9 00	9 01	**35**
36	9 01	9 02	9 03	9 04	9 05	9 06	9 07	9 08	**36**	9 10	9 11	9 12	9 13	9 14	9 15	9 16	9 17	**36**
37	9 17	9 18	9 19	9 20	9 21	9 22	9 23	9 24	**37**	9 25	9 26	9 27	9 28	9 29	9 30	9 31	9 32	**37**
38	9 32	9 33	9 34	9 35	9 36	9 37	9 38	9 39	**38**	9 40	9 41	9 42	9 43	9 44	9 45	9 46	9 47	**38**
39	9 47	9 48	9 49	9 50	9 51	9 52	9 53	9 54	**39**	9 55	9 56	9 57	9 58	9 59	10 00	10 01	10 02	**39**
40	10 02	10 03	10 04	10 05	10 06	10 07	10 08	10 09	**40**	10 10	10 11	10 12	10 13	10 14	10 15	10 16	10 17	**40**
41	10 17	10 18	10 19	10 20	10 21	10 22	10 23	10 24	**41**	10 25	10 26	10 27	10 28	10 29	10 30	10 31	10 32	**41**
42	10 32	10 33	10 34	10 35	10 36	10 37	10 38	10 39	**42**	10 40	10 41	10 42	10 43	10 44	10 45	10 46	10 47	**42**
43	10 47	10 48	10 49	10 50	10 51	10 52	10 53	10 54	**43**	10 55	10 56	10 57	10 58	10 59	11 00	11 01	11 02	**43**
44	11 02	11 03	11 04	11 05	11 06	11 07	11 08	11 09	**44**	11 10	11 11	11 12	11 13	11 14	11 15	11 16	11 17	**44**
45	11 17	11 18	11 19	11 20	11 21	11 22	11 23	11 24	**45**	11 25	11 26	11 27	11 28	11 29	11 30	11 31	11 32	**45**
46	11 32	11 33	11 34	11 35	11 36	11 37	11 38	11 39	**46**	11 40	11 41	11 42	11 43	11 44	11 45	11 46	11 47	**46**
47	11 47	11 48	11 49	11 50	11 51	11 52	11 53	11 54	**47**	11 55	11 56	11 57	11 58	11 59	12 00	12 01	12 02	**47**
48	12 02	12 03	12 04	12 05	12 06	12 07	12 08	12 09	**48**	12 10	12 11	12 12	12 13	12 14	12 15	12 16	12 17	**48**
49	12 17	12 18	12 19	12 20	12 21	12 22	12 23	12 24	**49**	12 25	12 26	12 27	12 28	12 29	12 30	12 31	12 32	**49**
50	12 32	12 33	12 34	12 35	12 36	12 37	12 38	12 39	**50**	12 40	12 41	12 42	12 43	12 44	12 45	12 46	12 47	**50**
51	12 47	12 48	12 49	12 50	12 51	12 52	12 53	12 54	**51**	12 55	12 56	12 57	12 58	12 59	13 00	13 01	13 02	**51**
52	13 02	13 03	13 04	13 05	13 06	13 07	13 08	13 09	**52**	13 10	13 11	13 12	13 13	13 14	13 15	13 16	13 17	**52**
53	13 17	13 18	13 19	13 20	13 21	13 22	13 23	13 24	**53**	13 25	13 26	13 27	13 28	13 29	13 30	13 31	13 32	**53**
54	13 32	13 33	13 34	13 35	13 36	13 37	13 38	13 39	**54**	13 40	13 41	13 42	13 43	13 44	13 45	13 46	13 47	**54**
55	13 47	13 48	13 49	13 50	13 51	13 52	13 53	13 54	**55**	13 55	13 56	13 57	13 58	13 59	14 00	14 01	14 02	**55**
56	14 02	14 03	14 04	14 05	14 06	14 07	14 08	14 09	**56**	14 10	14 11	14 12	14 13	14 14	14 15	14 16	14 17	**56**
57	14 17	14 18	14 19	14 20	14 21	14 22	14 23	14 24	**57**	14 25	14 26	14 27	14 28	14 29	14 30	14 31	14 32	**57**
58	14 32	14 33	14 34	14 35	14 36	14 37	14 38	14 39	**58**	14 40	14 41	14 42	14 43	14 44	14 45	14 46	14 47	**58**
59	14 47	14 48	14 49	14 50	14 51	14 52	14 53	14 54	**59**	14 55	14 56	14 57	14 58	14 59	15 00	15 01	15 02	**59**

Example. The value of GHA♈ for 2012 August 17 at $05^{h}\ 11^{m}\ 41^{s}$ UT is (**a**) 310° 00′ + (**b**) 090° 59′ + (**c**) 002° 55′ = 043° 54′.

TABLE 8 — REFRACTION

To be subtracted from sextant altitude

Each R_0 value (and the R values on the right) stands between the sextant altitudes printed above and below it. In this table it is written on the same row as the lower of those two altitudes.

R_0	0	5	10	15	20	25	30	35	40	45	50	55	R_0	R (f = 0.9)	R (f = 1.0)	R (f = 1.1)	R (f = 1.2)
	Height above sea level in thousands of feet — Sextant Altitude													$R = R_0 \times f$			
′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	′	′	′	′	′
	90	90	90	90	90	90	90	90	90	90	90	90					
0	63	59	55	51	46	41	36	31	26	20	17	13	0	0	0	0	0
1	33	29	26	22	19	16	14	11	9	7	6	4	1	1	1	1	1
2	21	19	16	14	12	10	8	7	5	4	2 40	1 40	2	2	2	2	2
3	16	14	12	10	8	7	6	5	3 10	2 20	1 30	0 40	3	3	3	3	4
4	12	11	9	8	7	5	4 00	3 10	2 10	1 30	0 39	+ 0 05	4	4	4	4	5
5	10	9	7	5 50	4 50	3 50	3 10	2 20	1 30	0 49	+ 0 11	− 0 19	5	5	5	5	6
6	8 10	6 50	5 50	4 50	4 00	3 00	2 20	1 50	1 10	0 24	− 0 11	− 0 38	6	5	6	7	7
7	6 50	5 50	5 00	4 00	3 10	2 30	1 50	1 20	0 38	+ 0 04	− 0 28	− 0 54	7	6	7	8	8
8	6 00	5 10	4 10	3 20	2 40	2 00	1 30	1 00	0 19	− 0 13	− 0 42	− 1 08	8	7	8	9	10
9	5 20	4 30	3 40	2 50	2 10	1 40	1 10	0 35	+ 0 03	− 0 27	− 0 53	− 1 18	9	8	9	10	11
10	4 30	3 40	2 50	2 20	1 40	1 10	0 37	+ 0 11	− 0 16	− 0 43	− 1 08	− 1 31	10	9	10	11	12
12	3 30	2 50	2 10	1 40	1 10	0 34	+ 0 09	− 0 14	− 0 37	− 1 00	− 1 23	− 1 44	12	11	12	13	14
14	2 50	2 10	1 40	1 10	0 37	+ 0 10	− 0 13	− 0 34	− 0 53	− 1 14	− 1 35	− 1 56	14	13	14	15	17
16	2 20	1 40	1 20	0 43	+ 0 15	− 0 08	− 0 31	− 0 52	− 1 08	− 1 27	− 1 46	− 2 05	16	14	16	18	19
18	1 50	1 20	0 49	+ 0 23	− 0 02	− 0 26	− 0 46	− 1 06	− 1 22	− 1 39	− 1 57	− 2 14	18	16	18	20	22
20	1 12	0 44	+ 0 19	− 0 06	− 0 28	− 0 48	− 1 09	− 1 27	− 1 42	− 1 58	− 2 14	− 2 30	20	18	20	22	24
25	0 34	+ 0 10	− 0 13	− 0 36	− 0 55	− 1 14	− 1 32	− 1 51	− 2 06	− 2 21	− 2 34	− 2 49	25	22	25	28	30
30	+ 0 06	− 0 16	− 0 37	− 0 59	− 1 17	− 1 33	− 1 51	− 2 07	− 2 23	− 2 37	− 2 51	− 3 04	30	27	30	33	36
35	− 0 18	− 0 37	− 0 58	− 1 16	− 1 34	− 1 49	− 2 06	− 2 22	− 2 35	− 2 49	− 3 03	− 3 16	35	31	35	38	42
40		− 0 53	− 1 14	− 1 31	− 1 47	− 2 03	− 2 18	− 2 33	− 2 47	− 2 59	− 3 13	− 3 25	40	36	40	44	48
45		− 1 10	− 1 28	− 1 44	− 1 59	− 2 15	− 2 28	− 2 43	− 2 56	− 3 08	− 3 22	− 3 33	45	40	45	50	54
50			− 1 40	− 1 53	− 2 09	− 2 24	− 2 38	− 2 52	− 3 04	− 3 17	− 3 29	− 3 41	50	45	50	55	60
55				− 2 03	− 2 18	− 2 33	− 2 46	− 3 01	− 3 12	− 3 25	− 3 37	− 3 48	55	49	55	60	66
60							− 2 53	− 3 07	− 3 19	− 3 31	− 3 42	− 3 53	60	54	60	66	72

Each f value stands between the temperatures printed above and below it. In this table it is written on the same row as the lower of those two temperatures.

f	0	5	10	15	20	25	30	35	40	45	50	55	f
	Height above sea level in thousands of feet — Temperature in degrees Celsius (centigrade)												
	+ 47	+ 36	+ 27	+ 18	+ 10	+ 3	− 5	− 13		For these heights no temperature correction is necessary: use $R = R_0$			
0.9	+ 26	+ 16	+ 6	− 4	− 13	− 22	− 31	− 40					0.9
1.0	+ 5	− 5	− 15	− 25	− 36	− 46	− 57	− 68					1.0
1.1	− 16	− 25	− 36	− 46	− 58	− 71	− 83	− 95					1.1
1.2	− 37	− 45	− 56	− 67	− 81	− 95							1.2

Refraction $R = R_0 \times f$

When R_0 is less than 10′ or the height is more than 35, 000 ft.: use $R = R_0$

Choose the column appropriate to height, in units of 1,000 feet, and find the range of altitude in which the sextant altitude lies; thus find R_0. This is the refraction corresponding to the sextant altitude unless conditions are extreme. In that case find f from the lower table corresponding to the range of temperature for the appropriate height, and use the table on the right to find R. Example: at a height of 30,000 feet and temperature (-) 60° C, a celestial body is observed at altitude (-) 2° 36′. R_0 is 50′, f is 1.1 and R is 55′. Subtracting this from sextant altitude gives (–) 3° 31′.

TABLE 9 — CORIOLIS (*Z*) CORRECTION

Ground speed knots	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	Ground speed knots
	Latitude										
	′	′	′	′	′	′	′	′	′	′	
50	0	0	0	1	1	1	1	1	1	1	**50**
100	0	0	1	1	2	2	2	2	3	3	**100**
150	0	1	1	2	3	3	3	4	4	4	**150**
200	0	1	2	3	3	4	5	5	5	5	**200**
250	0	1	2	3	4	5	6	6	6	7	**250**
300	0	1	3	4	5	6	7	7	8	8	**300**
350	0	2	3	5	6	7	8	9	9	9	**350**
400	0	2	4	5	7	8	9	10	10	10	**400**
450	0	2	4	6	8	9	10	11	12	12	**450**
500	0	2	4	7	8	10	11	12	13	13	**500**
550	0	3	5	7	9	11	12	14	14	14	**550**
600	0	3	5	8	10	12	14	15	16	16	**600**
650	0	3	6	9	11	13	15	16	17	17	**650**
700	0	3	6	9	12	14	16	17	18	18	**700**
750	0	3	7	10	13	15	17	18	19	20	**750**
800	0	4	7	10	13	16	18	20	21	21	**800**
850	0	4	8	11	14	17	19	21	22	22	**850**
900	0	4	8	12	15	18	20	22	23	24	**900**

To be applied by moving the position line a distance *Z* to starboard (right) of the track in northern latitudes and to port (left) in southern latitudes.

STANDARD DOME REFRACTION

To be *subtracted* from observed altitude when using sextant suspension in a perspex dome.

Alt.	Refn.	Alt.	Refn.
°x	′	°	′
10	8	50	4
20	7	60	4
30	6	70	3
40	5	80	3

This table must not be used if a calibration table is fitted to the dome, or if a flat glass plate is provided, or for non-standard domes.

BUBBLE SEXTANT ERROR

Sextant No.

Alt.	Corr.
°	′

POLE STAR TABLES

Table 6 gives the *Q* correction to be applied to the corrected sextant altitude of *Polaris,* in the same form as in *The Air Almanac*; the only difference is that it is based on the position of *Polaris* for epoch 2010.0. Refraction is not included. It should be noted that the table in *The Air Almanac* is re-calculated each year and is therefore slightly more accurate than Table 6.

Table 7 gives the azimuth of *Polaris*, to 0.1°, for latitudes up to N70° and for all hour angles; interpolation in LHA ♈ may sometimes be necessary.

Example. On 2008 January 1 at $02^h\ 43^m\ 32^s$ UT at height 10,000 ft. (3 km), in longitude W48° 06′, an observation was made of the altitude of *Polaris*, sextant reading 54° 51′, instrument error and dome refraction –4′; the latitude is found as follows:

		°	′		°	′
From Table 4:						
For 2008 Jan 1,	(a) =	100	02	Sextant altitude	54	51
For 02^h UT on day 1,	(b) =	30	05	Instrument error, etc.		–4
For $43^m\ 32^s$,	(c) =	10	55	Refraction (Table **8**)		–1
GHA ♈ at $02^h\ 43^m\ 32^s$ UT	GHA ♈ =	141	02	Corrected Sextant altitude (Ho)	54	46
Longitude (west, subtract)		–48	06	(Table **6**, LHA ♈ = 93° 08′)		–25
	LHA ♈ =	92	56	Latitude	54	21

A correction is theoretically necessary for precession and nutation. Table 5 indicates that the deduced position line (here a parallel of latitude) should be shifted a distance of 1 mile in direction 270°; this leaves the latitude unchanged. The position line should, of course, be shifted for Coriolis acceleration.

Entering Table 7 with the nearest latitude (N55°) and the value of LHA ♈ (93°), the azimuth of Polaris is found as 359.0°.

SPECIAL TECHNIQUES

The arrangement of the tabulations in this volume lends itself to the use of special techniques of observation and reduction, designed to save calculation and plotting or to allow for precomputation. These techniques are not fully described here, but the principles upon which they are based are given below; users will doubtless develop methods to suit their own requirements.

1. If the interval between observations is four minutes (4^m), or a multiple of 4^m, LHA ♈ need only be calculated for one of the observations, since GHA ♈ changes by 1° (to within the accuracy of these tables) in 4^m. For the remaining observations, the same value of LHA ♈ can be used and the intercepts plotted from assumed positions adjusted by the appropriate number of whole degrees of longitude; alternatively the same assumed position can be used and the values of LHA ♈ adjusted by the appropriate number of whole degrees. Since the rate of change of GHA ♈ is not exactly 1° in 4^m these procedures are most accurately used for a three-star fix when LHA ♈ is calculated for the middle observation.

For latitudes greater than 69° (for which LHA ♈ is tabulated in even degrees only) the alternative procedure may be used with an 8^m interval between observations, or with a 4^m interval providing that assumed positions are selected which differ by 1° of longitude and which, together with 1° adjustment to LHA ♈ for the 4^m interval, produce values of LHA ♈ in even degrees.

2. By making the observations at predetermined times ("scheduled shooting"), the tabulated altitudes and azimuths can be extracted beforehand and the same values used both for presetting the sextant and for the subsequent reduction of the sights.

3. All corrections, normally applied to the sextant altitude, may be applied to the tabulated altitude (with reversed signs), or to the assumed position, before an observation is made; similarly, corrections for Coriolis acceleration (Table **9**) and precession and nutation (Table 5) may be applied to the assumed position, and the respective azimuth and its reciprocal

NAVIGATIONAL STARS, EPOCH 2010.0

Alphabetical Order

Name	No.	Magnitude Visual	Magnitude S-4	SHA	Dec
				° ′	° ′
Acamar	**7**	3.2	3.2	315 20	S 40 16
ACHERNAR	**5**	0.5	0.1	335 29	S 57 11
ACRUX	**30**	1.3	0.5	173 13	S 63 09
**Adhara*	**19**	1.5	1.2	255 15	S 28 59
ALDEBARAN	**10**	0.9	3.1	290 53	N 16 32
Alioth	**32**	1.8	1.5	166 23	N 55 54
Alkaid	**34**	1.9	1.5	153 01	N 49 16
**Al Na'ir*	**55**	1.7	1.8	27 47	S 46 55
**Alnilam*	**15**	1.7	1.3	275 49	S 1 12
Alphard	**25**	2.0	4.4	217 59	S 8 42
Alphecca	**41**	2.2	2.1	126 13	N 26 41
Alpheratz	**1**	2.1	1.8	357 46	N 29 09
ALTAIR	**51**	0.8	1.0	62 11	N 8 54
**Ankaa*	**2**	2.4	3.9	353 18	S 42 15
ANTARES	**42**	1.0	3.7	112 30	S 26 27
ARCTURUS	**37**	0.0	1.9	145 58	N 19 08
**Atria*	**43**	1.9	4.1	107 34	S 69 03
**Avior*	**22**	1.9	3.3	234 19	S 59 33
**Bellatrix*	**13**	1.6	1.2	278 35	N 6 21
BETELGEUSE	**16**	0.1-1.2	2.5-3.6	271 04	N 7 24
CANOPUS	**17**	– 0.7	– 0.8	263 57	S 52 42
CAPELLA	**12**	0.1	1.3	280 39	N 46 01
DENEB	**53**	1.3	1.4	49 33	N 45 19
Denebola	**28**	2.1	2.2	182 36	N 14 31
Diphda	**4**	2.0	3.6	348 59	S 17 56
Dubhe	**27**	1.8	3.4	193 55	N 61 42
**Elnath*	**14**	1.7	1.4	278 16	N 28 37
**Eltanin*	**47**	2.2	4.6	90 47	N 51 29
Enif	**54**	2.4	4.8	33 50	N 9 55
FOMALHAUT	**56**	1.2	1.3	15 27	S 29 34
**Gacrux*	**31**	1.6	4.1	172 04	S 57 10
Gienah	**29**	2.6	2.5	175 55	S 17 36
**HADAR*	**35**	0.6	0.3	148 52	S 60 25
Hamal	**6**	2.0	3.8	328 04	N 23 31
**Kaus Australis*	**48**	1.9	2.0	83 47	S 34 23
Kochab	**40**	2.1	4.3	137 20	N 74 07
**Markab*	**57**	2.5	2.3	13 41	N 15 16
Menkar	**8**	2.5	5.3	314 18	N 4 08
**Menkent*	**36**	2.1	3.5	148 11	S 36 25
Miaplacidus	**24**	1.7	1.8	221 40	S 69 46
Mirfak	**9**	1.8	2.4	308 44	N 49 54
Nunki	**50**	2.0	1.9	76 02	S 26 17
Peacock	**52**	1.9	1.7	53 24	S 56 42
POLLUX	**21**	1.1	2.5	243 31	N 28 00
PROCYON	**20**	0.4	0.8	245 03	N 5 12
Rasalhague	**46**	2.1	2.2	96 09	N 12 33
REGULUS	**26**	1.4	1.0	207 46	N 11 55
RIGEL	**11**	0.1	0.0	281 15	S 8 11
RIGIL KENT.	**38**	– 0.3	0.9	139 54	S 60 53
**Sabik*	**44**	2.4	2.5	102 16	S 15 44
Schedar	**3**	2.2	4.1	349 44	N 56 36
Shaula	**45**	1.6	1.3	96 26	S 37 07
SIRIUS	**18**	– 1.5	– 1.5	258 36	S 16 44
SPICA	**33**	1.0	0.7	158 34	S 11 13
Suhail	**23**	2.2	4.6	222 55	S 43 28
VEGA	**49**	0.0	0.0	80 41	N 38 48
**Zubenelgenubi*	**39**	2.8	3.2	137 08	S 16 05

Order of SHA

Name	No.	Magnitude Visual	Magnitude S-4	SHA	Dec
				° ′	° ′
**Markab*	**57**	2.5	2.3	13 41	N 15 16
FOMALHAUT	**56**	1.2	1.3	15 27	S 29 34
**Al Na'ir*	**55**	1.7	1.8	27 47	S 46 55
Enif	**54**	2.4	4.8	33 50	N 9 55
DENEB	**53**	1.3	1.4	49 33	N 45 19
Peacock	**52**	1.9	1.7	53 24	S 56 42
ALTAIR	**51**	0.8	1.0	62 11	N 8 54
Nunki	**50**	2.0	1.9	76 02	S 26 17
VEGA	**49**	0.0	0.0	80 41	N 38 48
**Kaus Australis*	**48**	1.9	2.0	83 47	S 34 23
**Eltanin*	**47**	2.2	4.6	90 47	N 51 29
Rasalhague	**46**	2.1	2.2	96 09	N 12 33
Shaula	**45**	1.6	1.3	96 26	S 37 07
**Sabik*	**44**	2.4	2.5	102 16	S 15 44
**Atria*	**43**	1.9	4.1	107 34	S 69 03
ANTARES	**42**	1.0	3.7	112 30	S 26 27
Alphecca	**41**	2.2	2.1	126 13	N 26 41
Kochab	**40**	2.1	4.3	137 20	N 74 07
**Zubenelgenubi*	**39**	2.8	3.2	137 08	S 16 05
RIGIL KENT.	**38**	– 0.3	0.9	139 54	S 60 53
ARCTURUS	**37**	0.0	1.9	145 58	N 19 08
**Menkent*	**36**	2.1	3.5	148 11	S 36 25
**HADAR*	**35**	0.6	0.3	148 52	S 60 25
Alkaid	**34**	1.9	1.5	153 01	N 49 16
SPICA	**33**	1.0	0.7	158 34	S 11 13
Alioth	**32**	1.8	1.5	166 23	N 55 54
**Gacrux*	**31**	1.6	4.1	172 04	S 57 10
ACRUX	**30**	1.3	0.5	173 13	S 63 09
Gienah	**29**	2.6	2.5	175 55	S 17 36
Denebola	**28**	2.1	2.2	182 36	N 14 31
Dubhe	**27**	1.8	3.4	193 55	N 61 42
REGULUS	**26**	1.4	1.0	207 46	N 11 55
Alphard	**25**	2.0	4.4	217 59	S 8 42
Miaplacidus	**24**	1.7	1.8	221 40	S 69 46
Suhail	**23**	2.2	4.6	222 55	S 43 28
**Avior*	**22**	1.9	3.3	234 19	S 59 33
POLLUX	**21**	1.1	2.5	243 31	N 28 00
PROCYON	**20**	0.4	0.8	245 03	N 5 12
**Adhara*	**19**	1.5	1.2	255 15	S 28 59
SIRIUS	**18**	– 1.5	– 1.5	258 36	S 16 44
CANOPUS	**17**	– 0.7	– 0.8	263 57	S 52 42
BETELGEUSE	**16**	0.1-1.2	2.5-3.6	271 04	N 7 24
**Alnilam*	**15**	1.7	1.3	275 49	S 1 12
**Elnath*	**14**	1.7	1.4	278 16	N 28 37
**Bellatrix*	**13**	1.6	1.2	278 35	N 6 21
CAPELLA	**12**	0.1	1.3	280 39	N 46 01
RIGEL	**11**	0.1	0.0	281 15	S 8 11
ALDEBARAN	**10**	0.9	3.1	290 53	N 16 32
Mirfak	**9**	1.8	2.4	308 44	N 49 54
Menkar	**8**	2.5	5.3	314 18	N 4 08
Acamar	**7**	3.2	3.2	315 20	S 40 16
Hamal	**6**	2.0	3.8	328 04	N 23 31
ACHERNAR	**5**	0.5	0.1	335 29	S 57 11
Diphda	**4**	2.0	3.6	348 59	S 17 56
Schedar	**3**	2.2	4.1	349 44	N 56 36
**Ankaa*	**2**	2.4	3.9	353 18	S 42 15
Alpheratz	**1**	2.1	1.8	357 46	N 29 09

The star numbers and names are the same as in *The Air Almanac*.
* Not in tabular pages of Volume 1.

CORRECTION FOR PRECESSION AND NUTATION FOR SURFACE NAVIGATION

Although designed for use in the air, this volume is being increasingly used for the reduction of astronomical sights at sea.

The altitudes and azimuths of stars as tabulated in this volume are calculated for the mean equinox of 2010.0. For strict accuracy it is necessary to apply to a position line or fix, deduced from these tables, a correction for the effects of precession and nutation. Table 5 gives such corrections, but only to the nearest minute of arc for use in air navigation.

The accompanying tables give the corrections for the years 2006-2014, to the nearest 0.1′ in distance and 1° in true bearing; they follow the design of Table 5 and should be used in the same way. It is suggested that they be used instead of Table 5 whenever the additional accuracy is required.

CORRECTION FOR PRECESSION AND NUTATION

LHA ♈	North latitudes							South latitudes						LHA ♈
	N 80°	N 70°	N 60°	N 50°	N 40°	N 20°	0°	S 20°	S 40°	S 50°	S 60°	S 70°	S 80°	
							2006							
°	′ °	′ °	′ °	′ °	′ °	′ °	′ °	′ °	′ °	′ °	′ °	′ °	′ °	°
0	**1.3** 208	**1.6** 222	**1.9** 232	**2.2** 238	**2.4** 242	**2.8** 246	**2.9** 247	**2.7** 245	**2.3** 239	**2.0** 234	**1.7** 226	**1.4** 214	**1.2** 195	0
30	**1.5** 231	**1.8** 239	**2.2** 244	**2.5** 248	**2.7** 250	**2.9** 251	**2.8** 251	**2.5** 248	**1.9** 240	**1.5** 232	**1.2** 218	**1.0** 195	**1.0** 166	30
60	**1.6** 253	**2.0** 257	**2.3** 259	**2.6** 260	**2.8** 261	**2.9** 261	**2.7** 260	**2.2** 258	**1.4** 251	**1.0** 243	**0.6** 221	**0.5** 168	**0.8** 127	60
90	**1.6** 275	**2.0** 274	**2.4** 274	**2.6** 273	**2.8** 273	**2.9** 273	**2.7** 273	**2.1** 274	**1.3** 276	**0.8** 280	**0.4** 294	**0.2** 051	**0.7** 078	90
120	**1.6** 297	**1.9** 291	**2.3** 288	**2.5** 286	**2.7** 285	**2.9** 284	**2.8** 285	**2.3** 288	**1.6** 296	**1.2** 305	**0.9** 323	**0.7** 357	**0.8** 033	120
150	**1.4** 320	**1.7** 309	**2.0** 302	**2.3** 298	**2.6** 295	**2.9** 292	**2.9** 292	**2.6** 295	**2.1** 302	**1.7** 308	**1.4** 319	**1.2** 336	**1.1** 359	150
180	**1.2** 345	**1.4** 326	**1.7** 314	**2.0** 306	**2.3** 301	**2.7** 295	**2.9** 293	**2.8** 294	**2.4** 298	**2.2** 302	**1.9** 308	**1.6** 318	**1.3** 332	180
210	**1.0** 014	**1.0** 345	**1.2** 322	**1.5** 308	**1.9** 300	**2.5** 292	**2.8** 289	**2.9** 289	**2.7** 290	**2.5** 292	**2.2** 296	**1.8** 301	**1.5** 309	210
240	**0.8** 053	**0.5** 012	**0.6** 319	**1.0** 297	**1.4** 289	**2.2** 282	**2.7** 280	**2.9** 279	**2.8** 279	**2.6** 280	**2.3** 281	**2.0** 283	**1.6** 287	240
270	**0.7** 102	**0.2** 129	**0.4** 246	**0.8** 260	**1.3** 264	**2.1** 266	**2.7** 267	**2.9** 267	**2.8** 267	**2.6** 267	**2.4** 266	**2.0** 266	**1.6** 265	270
300	**0.8** 147	**0.7** 183	**0.9** 217	**1.2** 235	**1.6** 244	**2.3** 252	**2.8** 255	**2.9** 256	**2.7** 255	**2.5** 254	**2.3** 252	**1.9** 249	**1.6** 243	300
330	**1.1** 181	**1.2** 204	**1.4** 221	**1.7** 232	**2.1** 238	**2.6** 245	**2.9** 248	**2.9** 248	**2.6** 245	**2.3** 242	**2.0** 238	**1.7** 231	**1.4** 220	330
360	**1.3** 208	**1.6** 222	**1.9** 232	**2.2** 238	**2.4** 242	**2.8** 246	**2.9** 247	**2.7** 245	**2.3** 239	**2.0** 234	**1.7** 226	**1.4** 214	**1.2** 195	360
							2007							
0	**0.9** 210	**1.1** 223	**1.3** 232	**1.5** 238	**1.7** 242	**1.9** 246	**2.0** 247	**1.8** 245	**1.5** 239	**1.3** 233	**1.1** 225	**0.9** 212	**0.8** 193	0
30	**1.0** 233	**1.3** 241	**1.5** 245	**1.7** 248	**1.8** 250	**2.0** 252	**1.9** 251	**1.7** 248	**1.2** 240	**1.0** 232	**0.8** 217	**0.6** 193	**0.6** 163	30
60	**1.1** 255	**1.4** 258	**1.6** 260	**1.8** 261	**1.9** 262	**2.0** 262	**1.8** 261	**1.5** 259	**1.0** 253	**0.7** 245	**0.4** 223	**0.3** 163	**0.5** 123	60
90	**1.1** 277	**1.4** 276	**1.6** 275	**1.8** 274	**1.9** 274	**2.0** 274	**1.8** 274	**1.4** 275	**0.9** 279	**0.6** 283	**0.3** 301	**0.2** 042	**0.5** 074	90
120	**1.1** 299	**1.3** 293	**1.5** 289	**1.7** 287	**1.9** 286	**2.0** 285	**1.9** 286	**1.6** 289	**1.1** 297	**0.9** 306	**0.6** 324	**0.5** 355	**0.6** 030	120
150	**1.0** 322	**1.2** 310	**1.4** 303	**1.6** 299	**1.7** 296	**2.0** 293	**2.0** 292	**1.8** 295	**1.4** 302	**1.2** 308	**1.0** 318	**0.8** 334	**0.8** 357	150
180	**0.8** 347	**0.9** 328	**1.1** 315	**1.3** 307	**1.5** 301	**1.8** 295	**2.0** 293	**1.9** 294	**1.7** 298	**1.5** 302	**1.3** 308	**1.1** 317	**0.9** 330	180
210	**0.6** 017	**0.6** 347	**0.8** 323	**1.0** 308	**1.2** 300	**1.7** 292	**1.9** 289	**2.0** 288	**1.8** 290	**1.7** 292	**1.5** 295	**1.3** 299	**1.0** 307	210
240	**0.5** 057	**0.3** 017	**0.4** 317	**0.7** 295	**1.0** 287	**1.5** 281	**1.8** 279	**2.0** 278	**1.9** 278	**1.8** 279	**1.6** 280	**1.4** 282	**1.1** 285	240
270	**0.5** 106	**0.2** 138	**0.3** 239	**0.6** 257	**0.9** 261	**1.4** 265	**1.8** 266	**2.0** 266	**1.9** 266	**1.8** 266	**1.6** 265	**1.4** 264	**1.1** 263	270
300	**0.6** 150	**0.5** 185	**0.6** 216	**0.9** 234	**1.1** 243	**1.6** 251	**1.9** 254	**2.0** 255	**1.9** 254	**1.7** 253	**1.5** 251	**1.3** 247	**1.1** 241	300
330	**0.8** 183	**0.8** 206	**1.0** 222	**1.2** 232	**1.4** 238	**1.8** 245	**2.0** 248	**2.0** 247	**1.7** 244	**1.6** 241	**1.4** 237	**1.2** 230	**1.0** 218	330
360	**0.9** 210	**1.1** 223	**1.3** 232	**1.5** 238	**1.7** 242	**1.9** 246	**2.0** 247	**1.8** 245	**1.5** 239	**1.3** 233	**1.1** 225	**0.9** 212	**0.8** 193	360
							2008							
0	**0.5** 213	**0.6** 226	**0.7** 234	**0.8** 239	**0.9** 243	**1.1** 246	**1.1** 247	**1.0** 244	**0.8** 238	**0.7** 232	**0.6** 223	**0.5** 209	**0.4** 189	0
30	**0.6** 236	**0.7** 243	**0.8** 247	**0.9** 250	**1.0** 252	**1.1** 253	**1.0** 252	**0.9** 249	**0.6** 240	**0.5** 231	**0.4** 216	**0.3** 189	**0.3** 157	30
60	**0.6** 258	**0.7** 261	**0.9** 262	**1.0** 263	**1.0** 263	**1.1** 264	**1.0** 263	**0.8** 261	**0.5** 256	**0.3** 249	**0.2** 226	**0.1** 153	**0.3** 116	60
90	**0.6** 280	**0.7** 278	**0.9** 277	**1.0** 276	**1.0** 276	**1.1** 276	**1.0** 276	**0.8** 278	**0.5** 283	**0.3** 289	**0.2** 312	**0.1** 031	**0.3** 067	90
120	**0.6** 302	**0.7** 296	**0.8** 292	**0.9** 289	**1.0** 288	**1.1** 287	**1.0** 287	**0.9** 291	**0.6** 299	**0.5** 308	**0.4** 325	**0.3** 353	**0.3** 025	120
150	**0.5** 326	**0.6** 313	**0.7** 305	**0.8** 300	**0.9** 297	**1.1** 294	**1.1** 293	**1.0** 296	**0.8** 302	**0.7** 308	**0.6** 318	**0.5** 332	**0.4** 353	150
180	**0.4** 351	**0.5** 331	**0.6** 317	**0.7** 308	**0.8** 302	**1.0** 296	**1.1** 293	**1.1** 294	**0.9** 297	**0.8** 301	**0.7** 306	**0.6** 314	**0.5** 327	180
210	**0.3** 023	**0.3** 351	**0.4** 324	**0.5** 309	**0.6** 300	**0.9** 291	**1.0** 288	**1.1** 287	**1.0** 288	**0.9** 290	**0.8** 293	**0.7** 297	**0.6** 304	210
240	**0.3** 064	**0.1** 027	**0.2** 314	**0.3** 291	**0.5** 284	**0.8** 279	**1.0** 277	**1.1** 276	**1.0** 277	**1.0** 277	**0.9** 278	**0.7** 279	**0.6** 282	240
270	**0.3** 113	**0.1** 149	**0.2** 228	**0.3** 251	**0.5** 257	**0.8** 262	**1.0** 264	**1.1** 264	**1.0** 264	**1.0** 264	**0.9** 263	**0.7** 262	**0.6** 260	270
300	**0.3** 155	**0.3** 187	**0.4** 215	**0.5** 232	**0.6** 241	**0.9** 249	**1.0** 253	**1.1** 253	**1.0** 252	**0.9** 251	**0.8** 248	**0.7** 244	**0.6** 238	300
330	**0.4** 187	**0.5** 208	**0.6** 222	**0.7** 232	**0.8** 238	**1.0** 244	**1.1** 247	**1.1** 246	**0.9** 243	**0.8** 240	**0.7** 235	**0.6** 227	**0.5** 214	330
360	**0.5** 213	**0.6** 226	**0.7** 234	**0.8** 239	**0.9** 243	**1.1** 246	**1.1** 247	**1.0** 244	**0.8** 238	**0.7** 232	**0.6** 223	**0.5** 209	**0.4** 189	360

The above table gives the correction to be applied to a position line or a fix for the effects of precession and nutation from the mean equinox of 2010.0. Each entry consists of the distance (in bold type) in nautical miles, and the direction (true bearing) in which the position line or fix is to be moved. The table is entered firstly by the year, then by choosing the column nearest the latitude and finally the entry nearest the LHA ♈ of observation; no interpolation is necessary, though in extreme cases near the beginning or end of a year (but not the end of 2009 or the beginning of 2010 when the corrections are zero) values midway towards those of the previous or following years may be taken.

Example. In 2007 a fix is obtained in latitude N 22° when LHA ♈ is 84°. Entering the table with the year 2007, latitude N 20°, and LHA ♈ 90° gives **2.0**′ 274° which indicates that the fix is to be transferred 2.0 miles in true bearing 274°.

CORRECTION FOR PRECESSION AND NUTATION

LHA ♈	North latitudes							South latitudes						LHA ♈
	N 80°	N 70°	N 60°	N 50°	N 40°	N 20°	0°	S 20°	S 40°	S 50°	S 60°	S 70°	S 80°	
							2009							
°	′ °	′ °	′ °	′ °	′ °	′ °	′ °	′ °	′ °	′ °	′ °	′ °	′ °	°
0	**0.1** 235	**0.1** 240	**0.2** 244	**0.2** 246	**0.2** 248	**0.2** 248	**0.2** 246	**0.1** 241	**0.1** 228	**0.1** 214	**0.1** 194	**0.1** 169	**0.1** 148	0
30	**0.1** 259	**0.1** 261	**0.2** 262	**0.2** 262	**0.2** 263	**0.2** 262	**0.2** 261	**0.1** 258	**0.1** 248	**0.0** —	**0.0** —	**0.0** —	**0.1** 110	30
60	**0.1** 283	**0.1** 281	**0.2** 280	**0.2** 279	**0.2** 279	**0.2** 279	**0.2** 280	**0.1** 283	**0.1** 295	**0.0** —	**0.0** —	**0.0** —	**0.1** 068	60
90	**0.1** 307	**0.1** 301	**0.2** 297	**0.2** 295	**0.2** 293	**0.2** 293	**0.2** 294	**0.1** 300	**0.1** 313	**0.1** 326	**0.1** 345	**0.1** 009	**0.1** 030	90
120	**0.1** 332	**0.1** 321	**0.1** 314	**0.2** 309	**0.2** 305	**0.2** 302	**0.2** 301	**0.2** 304	**0.1** 312	**0.1** 319	**0.1** 329	**0.1** 342	**0.1** 358	120
150	**0.1** 000	**0.1** 343	**0.1** 330	**0.1** 320	**0.1** 313	**0.2** 304	**0.2** 301	**0.2** 301	**0.2** 305	**0.2** 308	**0.1** 313	**0.1** 320	**0.1** 330	150
180	**0.1** 032	**0.1** 011	**0.1** 346	**0.1** 326	**0.1** 312	**0.1** 299	**0.2** 294	**0.2** 292	**0.2** 292	**0.2** 294	**0.2** 296	**0.1** 300	**0.1** 305	180
210	**0.1** 070	**0.0** —	**0.0** —	**0.0** —	**0.1** 292	**0.1** 282	**0.2** 279	**0.2** 278	**0.2** 277	**0.2** 278	**0.2** 278	**0.1** 279	**0.1** 281	210
240	**0.1** 112	**0.0** —	**0.0** —	**0.0** —	**0.1** 245	**0.1** 257	**0.2** 260	**0.2** 261	**0.2** 261	**0.2** 261	**0.2** 260	**0.1** 259	**0.1** 257	240
270	**0.1** 150	**0.1** 171	**0.1** 195	**0.1** 214	**0.1** 227	**0.1** 240	**0.2** 246	**0.2** 247	**0.2** 247	**0.2** 245	**0.2** 243	**0.1** 239	**0.1** 233	270
300	**0.1** 182	**0.1** 198	**0.1** 211	**0.1** 221	**0.1** 228	**0.2** 236	**0.2** 239	**0.2** 238	**0.2** 235	**0.2** 231	**0.1** 226	**0.1** 219	**0.1** 208	300
330	**0.1** 210	**0.1** 220	**0.1** 227	**0.2** 232	**0.2** 235	**0.2** 239	**0.2** 239	**0.2** 236	**0.1** 227	**0.1** 220	**0.1** 210	**0.1** 197	**0.1** 180	330
360	**0.1** 235	**0.1** 240	**0.2** 244	**0.2** 246	**0.2** 248	**0.2** 248	**0.2** 246	**0.1** 241	**0.1** 228	**0.1** 214	**0.1** 194	**0.1** 169	**0.1** 148	360
							2010							
0	**0.3** 017	**0.3** 035	**0.4** 047	**0.5** 055	**0.6** 060	**0.7** 065	**0.7** 067	**0.7** 066	**0.6** 061	**0.5** 057	**0.4** 051	**0.4** 041	**0.3** 026	0
30	**0.3** 042	**0.4** 052	**0.5** 059	**0.6** 063	**0.6** 066	**0.7** 068	**0.7** 068	**0.6** 066	**0.5** 059	**0.4** 052	**0.3** 041	**0.3** 023	**0.3** 359	30
60	**0.4** 064	**0.5** 070	**0.5** 073	**0.6** 075	**0.7** 076	**0.7** 077	**0.7** 076	**0.6** 073	**0.4** 065	**0.3** 056	**0.2** 037	**0.2** 002	**0.2** 325	60
90	**0.4** 086	**0.5** 087	**0.6** 087	**0.6** 088	**0.7** 088	**0.7** 088	**0.6** 088	**0.5** 087	**0.3** 085	**0.2** 083	**0.1** 072	**0.0** —	**0.2** 279	90
120	**0.4** 108	**0.5** 104	**0.6** 102	**0.6** 101	**0.7** 100	**0.7** 100	**0.7** 100	**0.5** 103	**0.4** 110	**0.2** 118	**0.2** 139	**0.1** 189	**0.2** 230	120
150	**0.4** 130	**0.4** 122	**0.5** 116	**0.6** 113	**0.6** 111	**0.7** 109	**0.7** 110	**0.6** 113	**0.5** 121	**0.4** 128	**0.3** 142	**0.2** 163	**0.2** 192	150
180	**0.3** 154	**0.4** 139	**0.4** 129	**0.5** 123	**0.6** 119	**0.7** 114	**0.7** 113	**0.7** 115	**0.6** 120	**0.5** 125	**0.4** 133	**0.3** 145	**0.3** 163	180
210	**0.3** 181	**0.3** 157	**0.3** 139	**0.4** 128	**0.5** 121	**0.6** 114	**0.7** 112	**0.7** 112	**0.6** 114	**0.6** 117	**0.5** 121	**0.4** 128	**0.3** 138	210
240	**0.2** 215	**0.2** 178	**0.2** 143	**0.3** 124	**0.4** 115	**0.6** 107	**0.7** 104	**0.7** 103	**0.7** 104	**0.6** 105	**0.5** 107	**0.5** 110	**0.4** 116	240
270	**0.2** 261	**0.0** —	**0.1** 108	**0.2** 097	**0.3** 095	**0.5** 093	**0.6** 092	**0.7** 092	**0.7** 092	**0.6** 092	**0.6** 093	**0.5** 093	**0.4** 094	270
300	**0.2** 310	**0.1** 351	**0.2** 041	**0.2** 062	**0.4** 070	**0.5** 077	**0.7** 080	**0.7** 080	**0.7** 080	**0.6** 079	**0.6** 078	**0.5** 076	**0.4** 072	300
330	**0.2** 348	**0.2** 017	**0.3** 038	**0.4** 052	**0.5** 059	**0.6** 067	**0.7** 070	**0.7** 071	**0.6** 069	**0.6** 067	**0.5** 064	**0.4** 058	**0.4** 050	330
360	**0.3** 017	**0.3** 035	**0.4** 047	**0.5** 055	**0.6** 060	**0.7** 065	**0.7** 067	**0.7** 066	**0.6** 061	**0.5** 057	**0.4** 051	**0.4** 041	**0.3** 026	360
							2011							
0	**0.7** 024	**0.8** 040	**1.0** 050	**1.1** 057	**1.3** 061	**1.5** 065	**1.6** 067	**1.5** 065	**1.2** 060	**1.1** 055	**0.9** 048	**0.8** 037	**0.7** 020	0
30	**0.8** 048	**1.0** 057	**1.1** 062	**1.3** 066	**1.4** 068	**1.5** 070	**1.5** 070	**1.3** 067	**1.0** 059	**0.8** 052	**0.7** 039	**0.6** 018	**0.5** 351	30
60	**0.8** 070	**1.0** 074	**1.2** 076	**1.4** 078	**1.5** 079	**1.6** 079	**1.5** 079	**1.2** 076	**0.8** 069	**0.6** 060	**0.4** 040	**0.3** 354	**0.4** 314	60
90	**0.9** 092	**1.1** 091	**1.2** 091	**1.4** 091	**1.5** 091	**1.6** 091	**1.4** 091	**1.1** 091	**0.7** 092	**0.4** 094	**0.2** 099	**0.1** 254	**0.4** 266	90
120	**0.8** 114	**1.0** 109	**1.2** 106	**1.4** 104	**1.5** 103	**1.6** 102	**1.5** 103	**1.2** 106	**0.8** 114	**0.6** 123	**0.4** 142	**0.3** 181	**0.4** 219	120
150	**0.8** 136	**0.9** 126	**1.1** 120	**1.3** 116	**1.4** 113	**1.5** 111	**1.5** 111	**1.4** 114	**1.1** 121	**0.9** 128	**0.7** 140	**0.6** 158	**0.6** 184	150
180	**0.7** 160	**0.8** 143	**0.9** 132	**1.1** 125	**1.2** 120	**1.5** 115	**1.6** 113	**1.5** 115	**1.3** 119	**1.1** 123	**1.0** 130	**0.8** 140	**0.7** 156	180
210	**0.5** 189	**0.6** 162	**0.7** 141	**0.8** 128	**1.0** 121	**1.3** 113	**1.5** 110	**1.5** 110	**1.4** 112	**1.3** 114	**1.1** 118	**1.0** 123	**0.8** 132	210
240	**0.4** 226	**0.3** 186	**0.4** 140	**0.6** 120	**0.8** 111	**1.2** 104	**1.5** 101	**1.6** 101	**1.5** 101	**1.4** 102	**1.2** 104	**1.0** 106	**0.8** 110	240
270	**0.4** 274	**0.1** 286	**0.2** 081	**0.4** 086	**0.7** 088	**1.1** 089	**1.4** 089	**1.6** 089	**1.5** 089	**1.4** 089	**1.2** 089	**1.1** 089	**0.9** 088	270
300	**0.4** 321	**0.3** 359	**0.4** 038	**0.6** 057	**0.8** 066	**1.2** 074	**1.5** 077	**1.6** 078	**1.5** 077	**1.4** 076	**1.2** 074	**1.0** 071	**0.8** 066	300
330	**0.6** 356	**0.6** 022	**0.7** 040	**0.9** 052	**1.1** 059	**1.4** 066	**1.5** 069	**1.5** 069	**1.4** 067	**1.3** 064	**1.1** 060	**0.9** 054	**0.8** 044	330
360	**0.7** 024	**0.8** 040	**1.0** 050	**1.1** 057	**1.3** 061	**1.5** 065	**1.6** 067	**1.5** 065	**1.2** 060	**1.1** 055	**0.9** 048	**0.8** 037	**0.7** 020	360

The above table gives the correction to be applied to a position line or a fix for the effects of precession and nutation from the mean equinox of 2010.0. Each entry consists of the distance (in bold type) in nautical miles, and the direction (true bearing) in which the position line or fix is to be moved. The table is entered firstly by the year, then by choosing the column nearest the latitude and finally the entry nearest the LHA ♈ of observation; no interpolation is necessary, though in extreme cases near the beginning or end of a year (but not the end of 2009 or the beginning of 2010 when the corrections are zero) values midway towards those of the previous or following years may be taken.

Example. Early in 2011 a fix is obtained in latitude S 55° when LHA ♈ is 111°. Entering the table with the year 2011, latitude S 50°, and LHA ♈ 120° gives **0.6**′ 123° as compared with **0.2**′ 118° for 2010 which indicates that the fix is to be transferred 0.4 miles in true bearing 120°.

CORRECTION FOR PRECESSION AND NUTATION

LHA ♈	North latitudes						0°	South latitudes						LHA ♈
	N 80°	N 70°	N 60°	N 50°	N 40°	N 20°		S 20°	S 40°	S 50°	S 60°	S 70°	S 80°	
							2012							
°	′ °	′ °	′ °	′ °	′ °	′ °	′ °	′ °	′ °	′ °	′ °	′ °	′ °	°
0	**1.0** 026	**1.2** 041	**1.5** 051	**1.7** 057	**2.0** 061	**2.3** 065	**2.4** 067	**2.2** 065	**1.9** 060	**1.6** 055	**1.4** 047	**1.2** 035	**1.0** 018	**0**
30	**1.2** 049	**1.5** 058	**1.7** 063	**2.0** 067	**2.1** 069	**2.4** 071	**2.3** 070	**2.0** 067	**1.5** 059	**1.2** 052	**1.0** 038	**0.8** 017	**0.8** 349	**30**
60	**1.3** 072	**1.6** 075	**1.9** 078	**2.1** 079	**2.2** 080	**2.4** 080	**2.2** 079	**1.8** 077	**1.2** 070	**0.8** 061	**0.5** 040	**0.4** 351	**0.6** 311	**60**
90	**1.3** 093	**1.6** 093	**1.9** 092	**2.1** 092	**2.3** 092	**2.4** 092	**2.2** 092	**1.7** 093	**1.1** 094	**0.7** 097	**0.3** 106	**0.2** 241	**0.6** 262	**90**
120	**1.3** 115	**1.6** 110	**1.8** 107	**2.1** 105	**2.2** 104	**2.4** 103	**2.2** 104	**1.9** 107	**1.3** 115	**1.0** 124	**0.7** 143	**0.5** 179	**0.7** 216	**120**
150	**1.2** 138	**1.4** 127	**1.7** 121	**1.9** 117	**2.1** 114	**2.3** 111	**2.3** 112	**2.1** 114	**1.6** 121	**1.4** 128	**1.1** 139	**0.9** 157	**0.9** 181	**150**
180	**1.0** 162	**1.2** 145	**1.4** 133	**1.6** 125	**1.9** 120	**2.2** 115	**2.4** 113	**2.3** 115	**2.0** 119	**1.7** 123	**1.5** 129	**1.2** 139	**1.0** 154	**180**
210	**0.8** 191	**0.8** 163	**1.0** 142	**1.2** 128	**1.5** 121	**2.0** 113	**2.3** 110	**2.4** 109	**2.1** 111	**2.0** 113	**1.7** 117	**1.5** 122	**1.2** 131	**210**
240	**0.6** 229	**0.4** 189	**0.5** 140	**0.8** 119	**1.2** 110	**1.8** 103	**2.2** 101	**2.4** 100	**2.2** 100	**2.1** 101	**1.9** 102	**1.6** 105	**1.3** 108	**240**
270	**0.6** 278	**0.2** 299	**0.3** 074	**0.7** 083	**1.1** 086	**1.7** 087	**2.2** 088	**2.4** 088	**2.3** 088	**2.1** 088	**1.9** 088	**1.6** 087	**1.3** 087	**270**
300	**0.7** 324	**0.5** 001	**0.7** 037	**1.0** 056	**1.3** 065	**1.9** 073	**2.2** 076	**2.4** 077	**2.2** 076	**2.1** 075	**1.8** 073	**1.6** 070	**1.3** 065	**300**
330	**0.9** 359	**0.9** 023	**1.1** 041	**1.4** 052	**1.6** 059	**2.1** 066	**2.3** 068	**2.3** 069	**2.1** 066	**1.9** 063	**1.7** 059	**1.4** 053	**1.2** 042	**330**
360	**1.0** 026	**1.2** 041	**1.5** 051	**1.7** 057	**2.0** 061	**2.3** 065	**2.4** 067	**2.2** 065	**1.9** 060	**1.6** 055	**1.4** 047	**1.2** 035	**1.0** 018	**360**
							2013							
0	**1.4** 026	**1.7** 041	**2.0** 051	**2.3** 057	**2.6** 061	**3.0** 066	**3.1** 067	**2.9** 065	**2.5** 060	**2.2** 055	**1.8** 047	**1.5** 035	**1.3** 017	**0**
30	**1.6** 050	**2.0** 059	**2.3** 064	**2.6** 067	**2.9** 069	**3.1** 071	**3.1** 070	**2.7** 067	**2.0** 060	**1.7** 052	**1.3** 038	**1.1** 016	**1.0** 348	**30**
60	**1.7** 072	**2.1** 076	**2.5** 078	**2.8** 079	**3.0** 080	**3.1** 080	**2.9** 080	**2.4** 077	**1.6** 070	**1.1** 062	**0.7** 041	**0.5** 350	**0.8** 310	**60**
90	**1.7** 094	**2.2** 093	**2.5** 093	**2.8** 092	**3.0** 092	**3.1** 092	**2.9** 092	**2.3** 093	**1.4** 095	**0.9** 098	**0.4** 109	**0.2** 238	**0.7** 261	**90**
120	**1.7** 116	**2.1** 111	**2.4** 107	**2.7** 105	**3.0** 104	**3.1** 103	**3.0** 104	**2.5** 107	**1.7** 115	**1.3** 124	**0.9** 143	**0.7** 178	**0.9** 215	**120**
150	**1.5** 138	**1.9** 128	**2.2** 121	**2.5** 117	**2.8** 114	**3.1** 112	**3.1** 112	**2.8** 114	**2.2** 121	**1.8** 128	**1.5** 139	**1.2** 157	**1.1** 181	**150**
180	**1.3** 163	**1.5** 145	**1.8** 133	**2.2** 125	**2.5** 120	**2.9** 115	**3.1** 113	**3.0** 114	**2.6** 119	**2.3** 123	**2.0** 129	**1.7** 139	**1.4** 154	**180**
210	**1.0** 192	**1.1** 164	**1.3** 142	**1.7** 128	**2.0** 120	**2.7** 113	**3.1** 110	**3.1** 109	**2.9** 111	**2.6** 113	**2.3** 116	**2.0** 121	**1.6** 130	**210**
240	**0.8** 230	**0.5** 190	**0.7** 139	**1.1** 118	**1.6** 110	**2.4** 103	**2.9** 100	**3.1** 100	**3.0** 100	**2.8** 101	**2.5** 102	**2.1** 104	**1.7** 108	**240**
270	**0.7** 279	**0.2** 302	**0.4** 071	**0.9** 082	**1.4** 085	**2.3** 087	**2.9** 088	**3.1** 088	**3.0** 088	**2.8** 088	**2.5** 087	**2.2** 087	**1.7** 086	**270**
300	**0.9** 325	**0.7** 002	**0.9** 037	**1.3** 056	**1.7** 065	**2.5** 073	**3.0** 076	**3.1** 077	**3.0** 076	**2.7** 075	**2.4** 073	**2.1** 069	**1.7** 064	**300**
330	**1.1** 359	**1.2** 023	**1.5** 041	**1.8** 052	**2.2** 059	**2.8** 066	**3.1** 068	**3.1** 068	**2.8** 066	**2.5** 063	**2.2** 059	**1.9** 052	**1.5** 042	**330**
360	**1.4** 026	**1.7** 041	**2.0** 051	**2.3** 057	**2.6** 061	**3.0** 066	**3.1** 067	**2.9** 065	**2.5** 060	**2.2** 055	**1.8** 047	**1.5** 035	**1.3** 017	**360**
							2014							
0	**1.7** 026	**2.1** 041	**2.5** 051	**2.9** 057	**3.2** 061	**3.8** 066	**3.9** 067	**3.7** 065	**3.1** 060	**2.7** 055	**2.3** 047	**1.9** 035	**1.6** 017	**0**
30	**2.0** 050	**2.4** 059	**2.9** 064	**3.3** 067	**3.6** 069	**3.9** 071	**3.8** 070	**3.3** 067	**2.5** 060	**2.0** 052	**1.6** 038	**1.3** 016	**1.3** 348	**30**
60	**2.1** 072	**2.6** 076	**3.1** 078	**3.5** 079	**3.7** 080	**3.9** 080	**3.6** 080	**3.0** 077	**1.9** 070	**1.4** 062	**0.9** 041	**0.7** 350	**1.0** 310	**60**
90	**2.2** 094	**2.7** 093	**3.1** 093	**3.5** 092	**3.7** 092	**3.9** 092	**3.6** 092	**2.8** 093	**1.7** 095	**1.1** 098	**0.5** 109	**0.3** 238	**0.9** 261	**90**
120	**2.1** 116	**2.6** 111	**3.0** 107	**3.4** 105	**3.7** 104	**3.9** 103	**3.7** 104	**3.1** 107	**2.1** 115	**1.6** 124	**1.1** 143	**0.9** 178	**1.1** 215	**120**
150	**1.9** 138	**2.3** 128	**2.7** 121	**3.1** 117	**3.5** 114	**3.9** 112	**3.9** 112	**3.4** 114	**2.7** 121	**2.3** 128	**1.9** 139	**1.5** 157	**1.4** 181	**150**
180	**1.6** 163	**1.9** 145	**2.3** 133	**2.7** 125	**3.1** 120	**3.7** 115	**3.9** 113	**3.8** 114	**3.2** 119	**2.9** 123	**2.5** 129	**2.1** 139	**1.7** 154	**180**
210	**1.3** 192	**1.3** 164	**1.6** 142	**2.0** 128	**2.5** 120	**3.3** 113	**3.8** 110	**3.9** 109	**3.6** 111	**3.3** 113	**2.9** 116	**2.4** 121	**2.0** 130	**210**
240	**1.0** 230	**0.7** 190	**0.9** 139	**1.4** 118	**1.9** 110	**3.0** 103	**3.6** 100	**3.9** 100	**3.7** 100	**3.5** 101	**3.1** 102	**2.6** 104	**2.1** 108	**240**
270	**0.9** 279	**0.3** 302	**0.5** 071	**1.1** 082	**1.7** 085	**2.8** 087	**3.6** 088	**3.9** 088	**3.7** 088	**3.5** 088	**3.1** 087	**2.7** 087	**2.2** 086	**270**
300	**1.1** 325	**0.9** 002	**1.1** 037	**1.6** 056	**2.1** 065	**3.1** 073	**3.7** 076	**3.9** 077	**3.7** 076	**3.4** 075	**3.0** 073	**2.6** 069	**2.1** 064	**300**
330	**1.4** 359	**1.5** 023	**1.9** 041	**2.3** 052	**2.7** 059	**3.4** 066	**3.9** 068	**3.9** 068	**3.5** 066	**3.1** 063	**2.7** 059	**2.3** 052	**1.9** 042	**330**
360	**1.7** 026	**2.1** 041	**2.5** 051	**2.9** 057	**3.2** 061	**3.8** 066	**3.9** 067	**3.7** 065	**3.1** 060	**2.7** 055	**2.3** 047	**1.9** 035	**1.6** 017	**360**

The above table gives the correction to be applied to a position line or a fix for the effects of precession and nutation from the mean equinox of 2010.0. Each entry consists of the distance (in bold type) in nautical miles, and the direction (true bearing) in which the position line or fix is to be moved. The table is entered firstly by the year, then by choosing the column nearest the latitude and finally the entry nearest the LHA ♈ of observation; no interpolation is necessary, though in extreme cases near the beginning or end of a year (but not the end of 2009 or the beginning of 2010 when the corrections are zero) values midway towards those of the previous or following years may be taken.

Example. In 2014 a fix is obtained in latitude N 35° when LHA ♈ is 199°. Entering the table with the year 2014, latitude N 40°, and LHA ♈ 210° gives **2.5**′ 120° which indicates that the fix is to be transferred 2.5 miles in true bearing 120°.

TABLE 4.—GHA and Declination of the Sun for the Years 1981–2016 — Argument “Orbit Time”

OT 00h	JAN E	JAN Dec.		FEB E	FEB Dec.		MAR E	MAR Dec.		APR E	APR Dec.	
d	° ′	° ′		° ′	° ′		° ′	° ′		° ′	° ′	
1	4 12	S 23 03	5	1 38	S 17 16	17	1 52	S 7 49	23	3 58	N 4 19	23
2	4 05	22 58	5	1 36	16 59	18	1 55	7 26	23	4 02	4 42	23
3	3 58	22 53	6	1 34	16 41	17	1 58	7 03	23	4 07	5 05	23
4	3 51	22 47	7	1 32	16 24	18	2 01	6 40	23	4 11	5 28	23
5	3 44	22 40	6	1 31	16 06	18	2 05	6 17	23	4 16	5 51	23
6	3 37	S 22 34	7	1 30	S 15 48	19	2 08	S 5 54	24	4 20	N 6 14	22
7	3 31	22 27	8	1 29	15 29	18	2 11	5 30	23	4 24	6 36	23
8	3 24	22 19	8	1 28	15 11	19	2 15	5 07	23	4 29	6 59	22
9	3 18	22 11	9	1 27	14 52	20	2 19	4 44	24	4 33	7 21	23
10	3 12	22 02	8	1 27	14 32	19	2 22	4 20	23	4 37	7 44	22
11	3 06	S 21 54	10	1 26	S 14 13	20	2 26	S 3 57	24	4 41	N 8 06	22
12	3 00	21 44	10	1 26	13 53	20	2 30	3 33	23	4 45	8 28	22
13	2 54	21 34	10	1 27	13 33	20	2 34	3 10	24	4 49	8 50	22
14	2 48	21 24	10	1 27	13 13	20	2 38	2 46	24	4 53	9 12	21
15	2 43	21 14	11	1 28	12 53	21	2 43	2 22	23	4 56	9 33	22
16	2 38	S 21 03	12	1 28	S 12 32	21	2 47	S 1 59	24	5 00	N 9 55	21
17	2 32	20 51	12	1 29	12 11	21	2 51	1 35	24	5 04	10 16	21
18	2 28	20 39	12	1 30	11 50	21	2 55	1 11	24	5 07	10 37	21
19	2 23	20 27	12	1 31	11 29	21	3 00	0 47	23	5 10	10 58	21
20	2 18	20 15	13	1 33	11 08	22	3 04	S 0 24	24	5 14	11 19	20
21	2 14	S 20 02	14	1 34	S 10 46	21	3 09	N 0 00	24	5 17	N 11 39	21
22	2 09	19 48	13	1 36	10 25	22	3 13	0 24	23	5 20	12 00	20
23	2 05	19 35	14	1 38	10 03	22	3 17	0 47	24	5 23	12 20	20
24	2 02	19 21	15	1 40	9 41	22	3 22	1 11	24	5 26	12 40	20
25	1 58	19 06	15	1 42	9 19	23	3 26	1 35	23	5 28	13 00	19
26	1 54	S 18 51	15	1 45	S 8 56	22	3 31	N 1 58	24	5 31	N 13 19	20
27	1 51	18 36	15	1 47	8 34	23	3 36	2 22	23	5 33	13 39	19
28	1 48	18 21	16	1 50	8 11	22	3 40	2 45	24	5 36	13 58	19
29	1 45	18 05	16	1 52	7 49	23	3 45	3 09	23	5 38	14 17	18
30	1 42	17 49	16				3 49	3 32	23	5 40	14 35	19
31	1 40	S 17 33	17				3 54	N 3 55	24			

OT 00h	MAY E	MAY Dec.		JUN E	JUN Dec.		JUL E	JUL Dec.		AUG E	AUG Dec.	
d	° ′	° ′		° ′	° ′		° ′	° ′		° ′	° ′	
1	5 42	N 14 54	18	5 35	N 21 58	8	4 05	N 23 09	4	3 24	N 18 10	15
2	5 44	15 12	18	5 32	22 06	8	4 02	23 05	5	3 25	17 55	16
3	5 46	15 30	18	5 30	22 14	8	3 59	23 00	5	3 26	17 39	15
4	5 47	15 48	17	5 28	22 22	7	3 56	22 55	5	3 28	17 24	16
5	5 49	16 05	17	5 25	22 29	6	3 54	22 50	5	3 29	17 08	17
6	5 50	N 16 22	17	5 22	N 22 35	6	3 51	N 22 45	6	3 31	N 16 51	16
7	5 51	16 39	17	5 20	22 41	6	3 48	22 39	7	3 32	16 35	17
8	5 52	16 56	16	5 17	22 47	6	3 46	22 32	7	3 34	16 18	17
9	5 53	17 12	16	5 14	22 53	5	3 44	22 25	7	3 36	16 01	17
10	5 54	17 28	16	5 11	22 58	4	3 42	22 18	7	3 38	15 44	17
11	5 54	N 17 44	15	5 08	N 23 02	5	3 39	N 22 11	8	3 40	N 15 27	18
12	5 55	17 59	15	5 05	23 07	3	3 37	22 03	8	3 43	15 09	18
13	5 55	18 14	15	5 02	23 10	4	3 36	21 55	9	3 45	14 51	19
14	5 55	18 29	14	4 59	23 14	3	3 34	21 46	9	3 48	14 32	18
15	5 55	18 43	15	4 56	23 17	2	3 32	21 37	10	3 51	14 14	19
16	5 55	N 18 58	13	4 53	N 23 19	3	3 31	N 21 27	9	3 54	N 13 55	19
17	5 55	19 11	14	4 50	23 22	1	3 29	21 18	11	3 57	13 36	19
18	5 54	19 25	13	4 46	23 23	2	3 28	21 07	10	4 00	13 17	19
19	5 54	19 38	13	4 43	23 25	1	3 27	20 57	11	4 03	12 58	20
20	5 53	19 51	13	4 40	23 26	0	3 26	20 46	11	4 07	12 38	19
21	5 52	N 20 04	12	4 36	N 23 26	0	3 25	N 20 35	12	4 10	N 12 19	20
22	5 51	20 16	12	4 33	23 26	0	3 24	20 23	12	4 14	11 59	21
23	5 50	20 28	11	4 30	23 26	1	3 23	20 11	12	4 18	11 38	20
24	5 49	20 39	11	4 27	23 25	1	3 23	19 59	12	4 21	11 18	20
25	5 48	20 50	11	4 23	23 24	1	3 23	19 47	13	4 25	10 58	21
26	5 46	N 21 01	11	4 20	N 23 23	2	3 22	N 19 34	13	4 29	N 10 37	21
27	5 44	21 12	10	4 17	23 21	3	3 22	19 21	14	4 34	10 16	21
28	5 43	21 22	9	4 14	23 18	3	3 22	19 07	14	4 38	9 55	21
29	5 41	21 31	10	4 11	23 15	3	3 23	18 53	14	4 42	9 34	21
30	5 39	21 41	9	4 08	23 12	3	3 23	18 39	15	4 47	9 13	22
31	5 37	N 21 50	8				3 24	N 18 24	14	4 51	N 8 51	21

OT 00h	SEP E	SEP Dec.		OCT E	OCT Dec.		NOV E	NOV Dec.		DEC E	DEC Dec.		OT 00h
d	° ′	° ′		° ′	° ′		° ′	° ′		° ′	° ′		d
1	4 56	N 8 30	22	7 31	S 2 57	24	9 06	S 14 14	19	7 49	S 21 42	10	1
2	5 01	8 08	22	7 36	3 21	23	9 06	14 33	19	7 44	21 52	9	2
3	5 06	7 46	22	7 41	3 44	23	9 06	14 52	19	7 38	22 01	8	3
4	5 11	7 24	22	7 45	4 07	23	9 06	15 11	19	7 32	22 09	8	4
5	5 16	7 02	22	7 50	4 30	23	9 06	15 30	18	7 26	22 17	8	5
6	5 21	N 6 40	23	7 55	S 4 53	23	9 06	S 15 48	18	7 20	S 22 25	7	6
7	5 26	6 17	22	7 59	5 16	23	9 05	16 06	18	7 14	22 32	7	7
8	5 31	5 55	23	8 03	5 39	23	9 05	16 24	17	7 07	22 39	6	8
9	5 36	5 32	22	8 08	6 02	23	9 04	16 41	17	7 01	22 45	6	9
10	5 41	5 10	23	8 12	6 25	23	9 02	16 58	17	6 54	22 51	6	10
11	5 46	N 4 47	23	8 16	S 6 48	22	9 01	S 17 15	17	6 47	S 22 57	5	11
12	5 52	4 24	23	8 20	7 10	23	8 59	17 32	16	6 40	23 02	4	12
13	5 57	4 01	23	8 23	7 33	22	8 58	17 48	16	6 33	23 06	4	13
14	6 02	3 38	23	8 27	7 55	23	8 55	18 04	16	6 26	23 10	4	14
15	6 08	3 15	23	8 31	8 18	22	8 53	18 20	15	6 19	23 14	3	15
16	6 13	N 2 52	23	8 34	S 8 40	22	8 51	S 18 35	15	6 12	S 23 17	3	16
17	6 18	2 29	23	8 37	9 02	22	8 48	18 50	15	6 05	23 20	2	17
18	6 24	2 06	23	8 40	9 24	22	8 45	19 05	14	5 57	23 22	2	18
19	6 29	1 43	24	8 43	9 46	21	8 42	19 19	14	5 50	23 24	1	19
20	6 34	1 19	23	8 46	10 07	22	8 39	19 33	14	5 42	23 25	1	20
21	6 40	N 0 56	23	8 48	S 10 29	21	8 35	S 19 47	13	5 35	S 23 26	0	21
22	6 45	0 33	24	8 51	10 50	22	8 31	20 00	13	5 28	23 26	0	22
23	6 50	N 0 09	23	8 53	11 12	21	8 27	20 13	12	5 20	23 26	0	23
24	6 55	S 0 14	23	8 55	11 33	20	8 23	20 25	13	5 13	23 26	2	24
25	7 01	0 37	24	8 57	11 53	21	8 19	20 38	11	5 05	23 24	1	25
26	7 06	S 1 01	23	8 59	S 12 14	21	8 14	S 20 49	12	4 58	S 23 23	2	26
27	7 11	1 24	23	9 01	12 35	20	8 10	21 01	11	4 50	23 21	3	27
28	7 16	1 47	24	9 02	12 55	20	8 05	21 12	10	4 43	23 18	2	28
29	7 21	2 11	23	9 03	13 15	20	8 00	21 22	11	4 36	23 16	4	29
30	7 26	2 34	23	9 04	13 35	20	7 55	21 33	9	4 28	23 12	4	30
31				9 05	S 13 55	19				4 21	S 23 08	4	31

a. Corr. to GMT

Year	Corr.	Year	Corr.	Year	Corr.
	h		h		h
1981	+ 7	1993	+ 9	2005	+11
1982	+ 1	1994	+ 4	2006	+ 6
1983	- 5	1995	- 2	2007	0
1984	-10	1996	- 8	2008	- 6
1984	+14 *	1996	+16 *	2008	+18 *
1985	+ 8	1997	+10	2009	+12
1986	+ 2	1998	+ 4	2010	+ 6
1987	- 4	1999	- 2	2011	+ 1
1988	-10	2000	- 8	2012	- 5
1988	+14 *	2000	+16 *	2012	+19 *
1989	+ 9	2001	+10	2013	+13
1990	+ 3	2002	+ 5	2014	+ 7
1991	- 3	2003	- 1	2015	+ 1
1992	- 9	2004	- 7	2016	- 5
1992	+15 *	2004	+17 *	2016	+19 *

* After Feb. 29

b. Interpolation for Hours of OT

Diff.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
h	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
2	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2
3	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3
4	0	0	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4
5	0	0	1	1	1	1	1	2	2	2	2	3	3	3	3	3	4	4	4	4	4	5	5	5
6	0	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6
7	0	1	1	1	1	2	2	2	3	3	3	4	4	4	4	5	5	5	6	6	6	6	7	7
8	0	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	7	7	7	8	8
9	0	1	1	2	2	2	3	3	3	4	4	5	5	5	6	6	6	7	7	8	8	8	9	9
10	0	1	1	2	2	3	3	3	4	4	5	5	5	6	6	7	7	8	8	8	9	9	10	10
11	0	1	1	2	2	3	3	4	4	5	5	6	6	6	7	7	8	8	9	9	10	10	11	11

Diff.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
h	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
12	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12
13	1	1	2	2	3	3	4	4	5	5	6	7	7	8	8	9	9	10	10	11	11	12	12	13
14	1	1	2	2	3	4	4	5	5	6	6	7	8	8	9	9	10	11	11	12	12	13	13	14
15	1	1	2	3	3	4	4	5	6	6	7	8	8	9	9	10	11	11	12	13	13	14	14	15
16	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10	11	11	12	13	13	14	15	15	16
17	1	1	2	3	4	4	5	6	6	7	8	9	9	10	11	11	12	13	13	14	15	16	16	17
18	1	2	2	3	4	5	5	6	7	8	8	9	10	11	11	12	13	14	14	15	16	17	17	18
19	1	2	2	3	4	5	6	6	7	8	9	10	10	11	12	13	13	14	15	16	17	17	18	19
20	1	2	3	3	4	5	6	7	8	8	9	10	11	12	13	13	14	15	16	17	18	18	19	20
21	1	2	3	4	4	5	6	7	8	9	10	11	11	12	13	14	15	16	17	18	18	19	20	21
22	1	2	3	4	5	6	6	7	8	9	10	11	12	13	14	15	16	17	17	18	19	20	21	22
23	1	2	3	4	5	6	7	8	9	10	11	12	12	13	14	15	16	17	18	19	20	21	22	23

TABLE 4.—GHA and Declination of the Sun for the Years 1981–2016 — Argument “Orbit Time” — Continued

c. Hours and Tens of Minutes of GMT

h	00m ° ′	10m ° ′	20m ° ′	30m ° ′	40m ° ′	50m ° ′
00	175 00	177 30	180 00	182 30	185 00	187 30
01	190 00	192 30	195 00	197 30	200 00	202 30
02	205 00	207 30	210 00	212 30	215 00	217 30
03	220 00	222 30	225 00	227 30	230 00	232 30
04	235 00	237 30	240 00	242 30	245 00	247 30
05	250 00	252 30	255 00	257 30	260 00	262 30
06	265 00	267 30	270 00	272 30	275 00	277 30
07	280 00	282 30	285 00	287 30	290 00	292 30
08	295 00	297 30	300 00	302 30	305 00	307 30
09	310 00	312 30	315 00	317 30	320 00	322 30
10	325 00	327 30	330 00	332 30	335 00	337 30
11	340 00	342 30	345 00	347 30	350 00	352 30
12	355 00	357 30	0 00	2 30	5 00	7 30
13	10 00	12 30	15 00	17 30	20 00	22 30
14	25 00	27 30	30 00	32 30	35 00	37 30
15	40 00	42 30	45 00	47 30	50 00	52 30
16	55 00	57 30	60 00	62 30	65 00	67 30
17	70 00	72 30	75 00	77 30	80 00	82 30
18	85 00	87 30	90 00	92 30	95 00	97 30
19	100 00	102 30	105 00	107 30	110 00	112 30
20	115 00	117 30	120 00	122 30	125 00	127 30
21	130 00	132 30	135 00	137 30	140 00	142 30
22	145 00	147 30	150 00	152 30	155 00	157 30
23	160 00	162 30	165 00	167 30	170 00	172 30

d. Minutes and Seconds of GMT (in critical cases ascend)

m s	° ′	m s	° ′	m s	° ′	m s	° ′	m s	° ′	m s	° ′
00 00	0 00	01 37	0 25	03 17	0 50	04 57	1 15	06 37	1 40	08 17	2 05
01	0 01	41	0 26	21	0 51	05 01	1 16	41	1 41	21	2 06
05	0 02	45	0 27	25	0 52	05	1 17	45	1 42	25	2 07
09	0 03	49	0 28	29	0 53	09	1 18	49	1 43	29	2 08
13	0 04	53	0 29	33	0 54	13	1 19	53	1 44	33	2 09
17	0 05	01 57	0 30	37	0 55	17	1 20	06 57	1 45	37	2 10
21	0 06	02 01	0 31	41	0 56	21	1 21	07 01	1 46	41	2 11
25	0 07	05	0 32	45	0 57	25	1 22	05	1 47	45	2 12
29	0 08	09	0 33	49	0 58	29	1 23	09	1 48	49	2 13
33	0 09	13	0 34	53	0 59	33	1 24	13	1 49	53	2 14
37	0 10	17	0 35	03 57	1 00	37	1 25	17	1 50	08 57	2 15
41	0 11	21	0 36	04 01	1 01	41	1 26	21	1 51	09 01	2 16
45	0 12	25	0 37	05	1 02	45	1 27	25	1 52	05	2 17
49	0 13	29	0 38	09	1 03	49	1 28	29	1 53	09	2 18
53	0 14	33	0 39	13	1 04	53	1 29	33	1 54	13	2 19
00 57	0 15	37	0 40	17	1 05	05 57	1 30	37	1 55	17	2 20
01 01	0 16	41	0 41	21	1 06	06 01	1 31	41	1 56	21	2 21
05	0 17	45	0 42	25	1 07	05	1 32	45	1 57	25	2 22
09	0 18	49	0 43	29	1 08	09	1 33	49	1 58	29	2 23
13	0 19	53	0 44	33	1 09	13	1 34	53	1 59	33	2 24
17	0 20	02 57	0 45	37	1 10	17	1 35	07 57	2 00	37	2 25
21	0 21	03 01	0 46	41	1 11	21	1 36	08 01	2 01	41	2 26
25	0 22	05	0 47	45	1 12	25	1 37	05	2 02	45	2 27
29	0 23	09	0 48	49	1 13	29	1 38	09	2 03	49	2 28
33	0 24	13	0 49	53	1 14	33	1 39	13	2 04	53	2 29
37	0 25	17	0 50	04 57	1 15	37	1 40	17	2 05	09 57	2 30
01 41		03 21		05 01		06 41		08 21		10 00	

EXPLANATION

Table 4 and supplementary tables a, b, c, and d make possible the determination of the GHA and declination of the Sun for any time during the years 1981–2016. The main table gives E (5° + Equation of Time) and declination of the Sun for the argument “Orbit Time” OT, the latter is formed by applying the h correction from Table a to the nearest integral hour of GMT. In leap years, the upper value of the correction is to be used for January and February and the lower value for the rest of the year. Thus, OT’s corresponding to 1996 February $29^d\ 16^h\ 31^m$ GMT and 1996 March $1^d\ 05^h\ 29^m$ GMT are February $29^d\ 09^h\ 00^m$ and March $1^d\ 21^h\ 00^m$ respectively.

Corrections to E and declination for OT are determined by entering Table b with the differences between consecutive values of E and of declination respectively as the horizontal argument, and with the number of hours of OT as the vertical argument. The declination differences are given in the main table.

The GHA is obtained by adding to the corrected E the value of the diurnal arc obtained from Tables c and d. The latter two tables must be entered with argument GMT.

Example. To find the GHA and declination of the Sun on 1996 January 18 at $03^h\ 30^m\ 35^s$ GMT.

OT = GMT (nearest integral hour) + Corr. (Table a).

= Jan. $18^d\ 04^h - 8^h$ = Jan. $17^d\ 20^h$.

		° ′ Diff.		° ′ Diff.
Main Table, Jan. 17^d OT,	E	2 32 (-4)	Dec. S	20 51 (-12)
Table b for 20^h OT		-3		-10
Jan.$17^d\ 20^h$ OT, corrected	E	2 29	Dec. S	20 41
Table c for $03^h\ 30^m$ GMT		227 30		
Table d for $00^m\ 35^s$ GMT		0 09		
Sum	GHA Sun =	230 08		