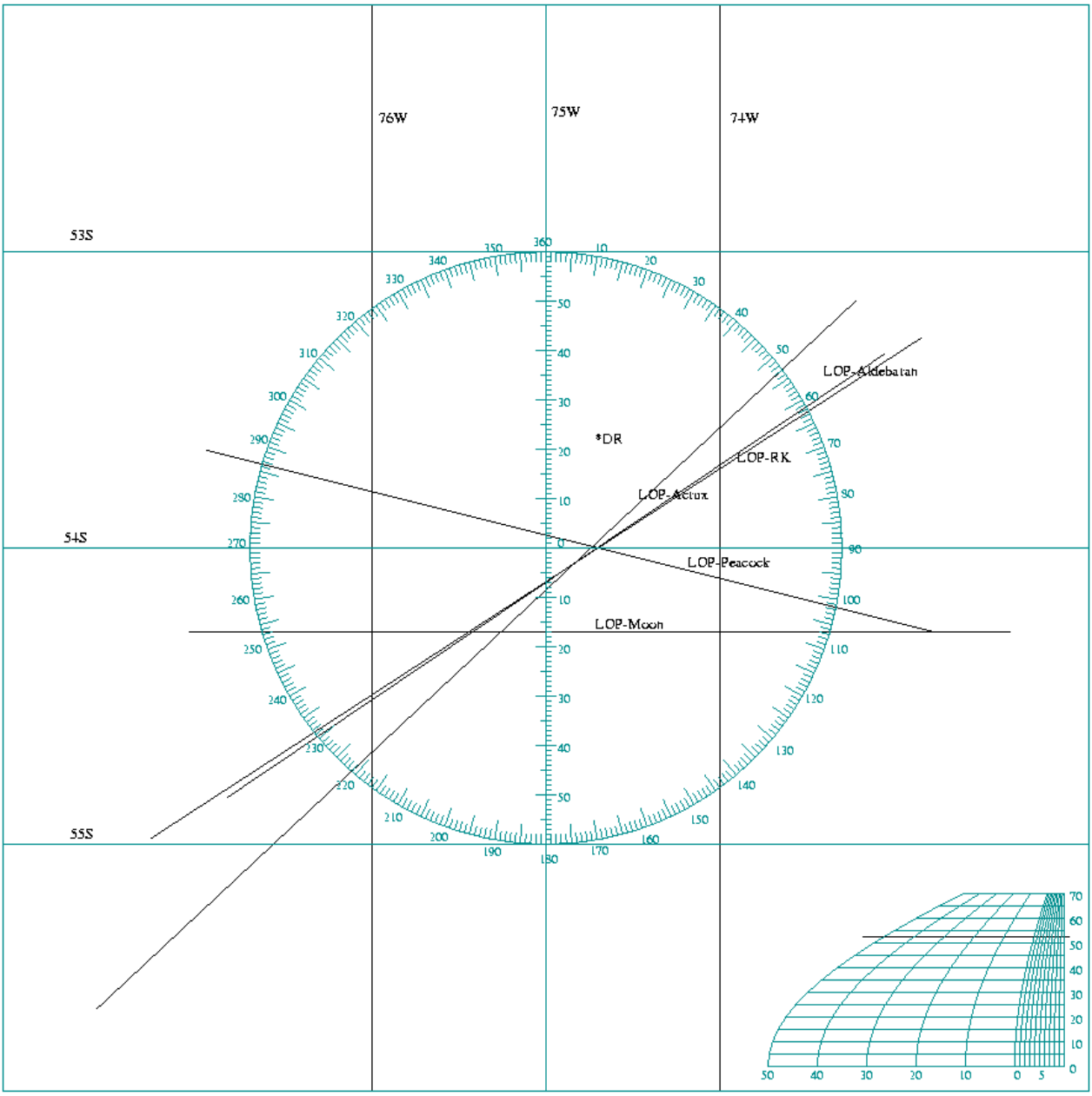
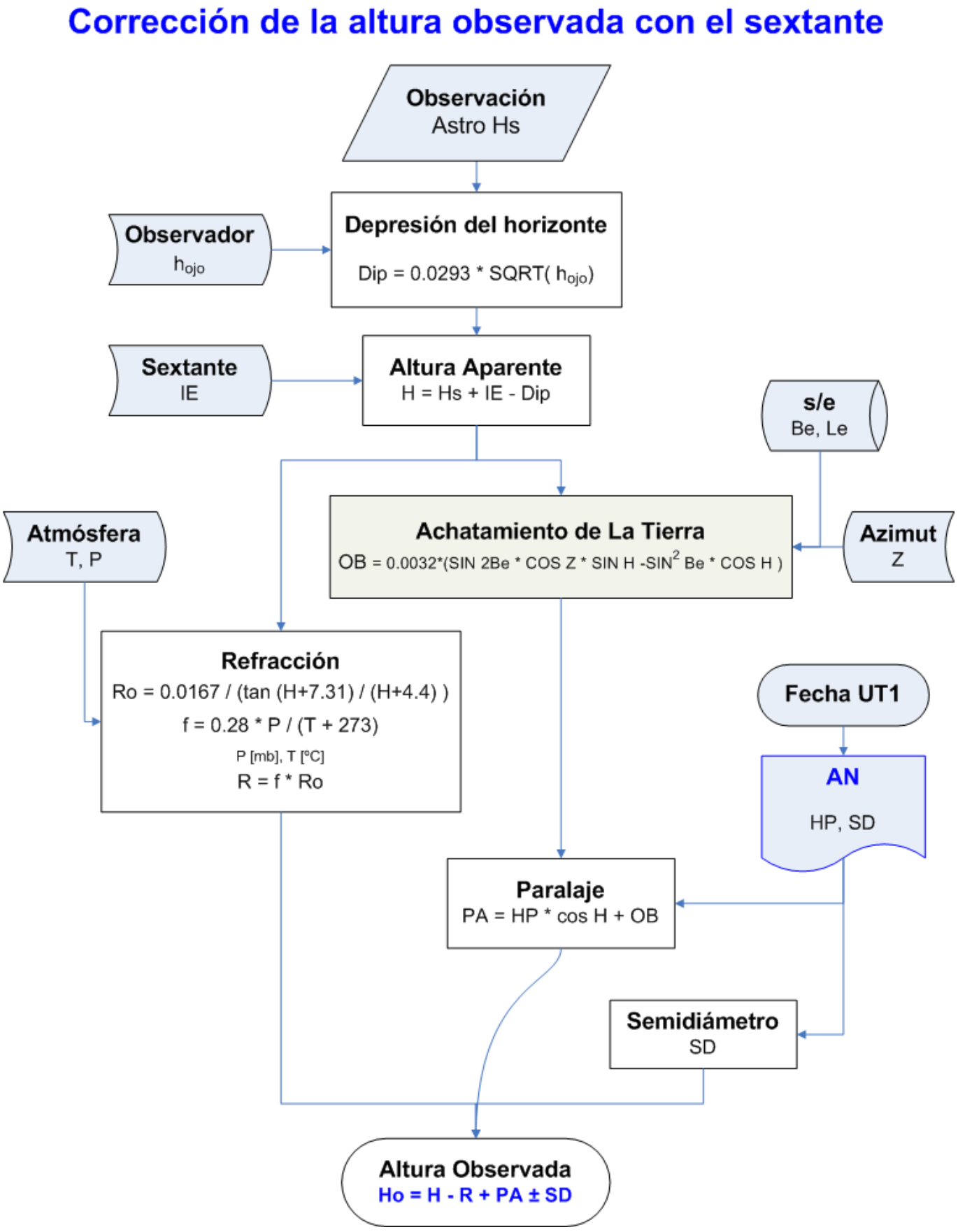
NAVIGATIONAL ALGORITHMS
Celestial Navigation with a Calculator

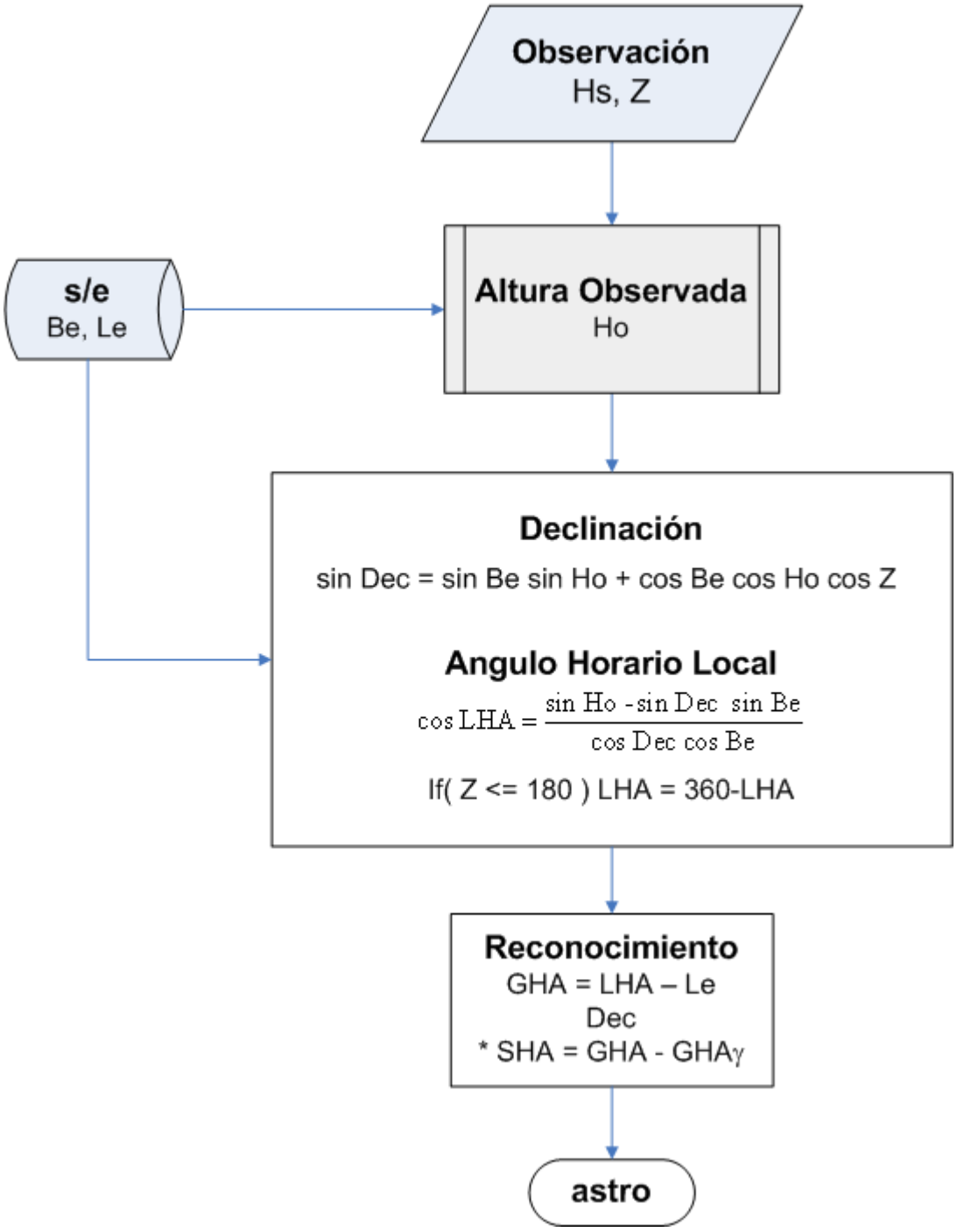


© Andrés Ruiz
San Sebastián – Donostia
43º 19'N 002ºW
http://sites.google.com/site/navigationalalgorithms/

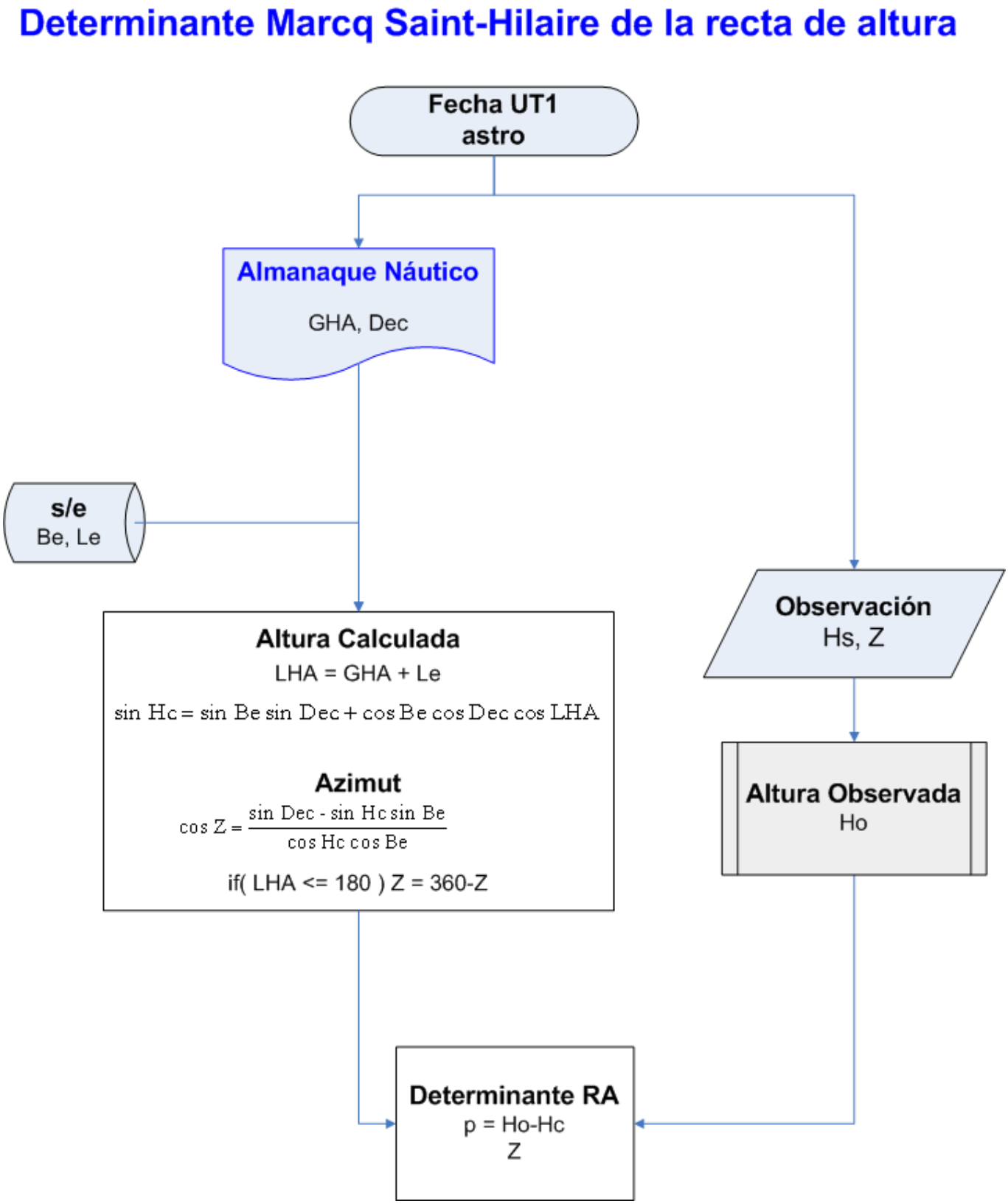
Corrections for Sextant Altitude



Identification of Stars and Planets



Marcq Saint Hilaire intercept



Sight Reduction with a calculator

Estimated Position	B =	L =	UT1 =	date:
Course & Speed	R =	V =		

Observation	UT1				
	Celestial body				

Observed Altitude Ho

Sextant Altitude: **Hs**				
Instrumental Error: EI				
DIP				
Height of eye above sea level: h [m]				
D = 0.0293 √h [º]				
Apparent Altitude **H** = Hs + EI - D				
Refraction				
if(H > 15º) R0 = 0.0162 / TAN(H)				
P [mb]				
T [ºC]				
f = 0.28 P/ (T+ 273)				
R = f R0				
Parallax – *Sun, Moon, Venus, Mars*				
HP *(Sun HP = 0.0024º)*				
Moon OB = 0.0032(sin 2B cos z sin H - $\sin^2$B cos H)				
PA = HP COS H + OB				
Semidiameter				
• *Sun SD ≈ 16'*				
• *Moon SD ≈ 0.2724° HP*				
Ho = H - R + PA ± SD				

Identification of the celestial body

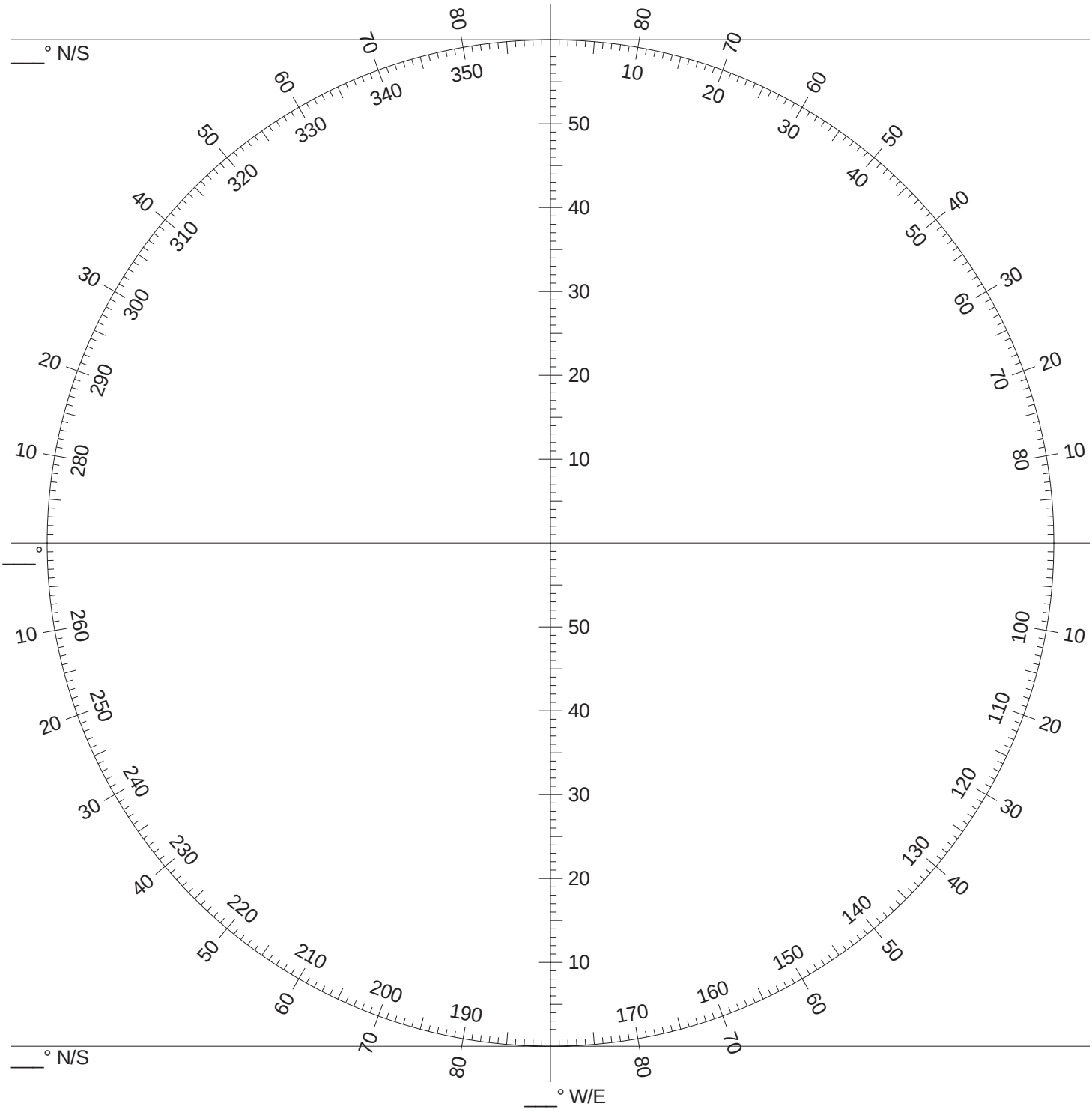
Z				
Dec = ASIN[Sin B Sin Ho + Cos B Cos Ho Cos Z]				
LHA = ATAN[(Tan Ho Cos B - Sin B Cos Z)/ Sin Z]				
GHA = LHA – L				

Geographical Position – Substellar Point

Dec					
☆ GHA_{Aries}					
☆ SHA					
$GHA_{☆}$ = GHA_{Aries} + SHA GHA					

Line of Position intercept – Marcq St Hilaire

LHA = GHA+L				
Hc = ASIN[sin B sin Dec + cos B cos Dec cos LHA]				
Z = ACOS[(sin Dec - sin Hc sin B)/(cos Hc cos B)]				
if(LHA = W) Z=360-Z				
p = Ho - Hc				



Universal Plotting Sheet for printing on 8.5” x 11” paper
Mark the middle lines of latitude and longitude as a whole degrees near your DR position.
Establish additional lines of longitude by connecting the longitude scale marks on the **outer** ring.
Use the minutes of latitude scale along the mid longitude to measure nautical miles.

NAVIGATIONAL STAR CHART

U.S. Naval Observatory / Astronomical Applications Dept.