Sight reduction

Sight reduction, is the process of deriving from a sight the information needed for establishing a line of position.

Sight is defined as the observation of the altitude, and sometimes also the azimuth, of a celestial body for a line of position; or the data obtained by such observation.[1]

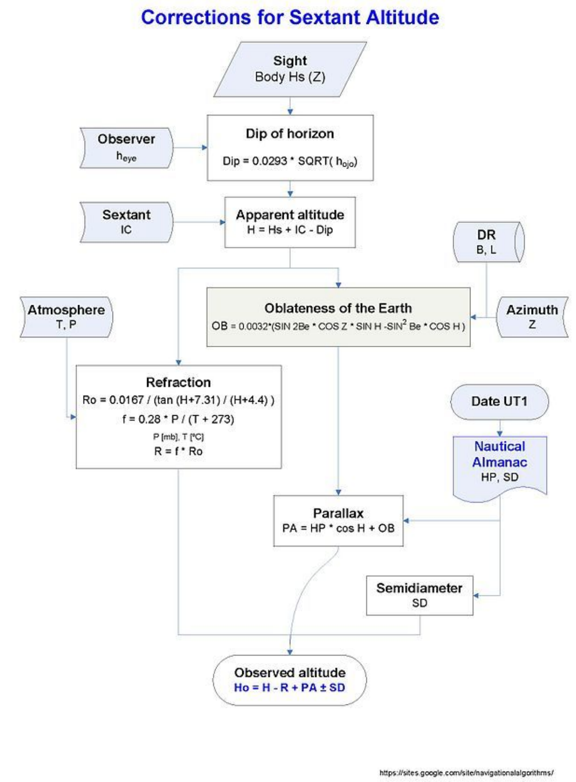
Nowadays sight reduction uses the equation of the circle of equal altitude to calculate the altitude of the celestial body,

$$sinHc = sinB * sinDec + cosB * cosDec * cosLHA$$

and the azimuth Zn is obtained from Z by:

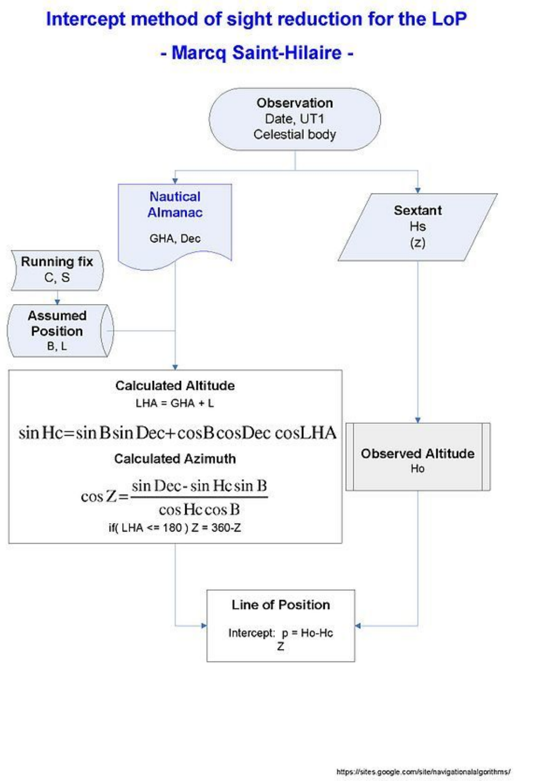
$$cosZ = (sinDec - sinHc * sinB)/(cosHc * cosB)$$

With the observed altitude Ho, Hc and Zn are the parameters of the Marcq St Hilaire intercept for the line of position:



Correction to the sextant altitude

With B the latitude (+ N / S), L the longitude (+ E / - W). LHA = GHA + L is the local hour angle, Dec and GHA are the declination and Greenwich hour angle of the star observed. And Hc is the calculated altitude. Z is the calculated azimuth of the body.



Marcq St Hilaire intercept for the line of position

Basic procedures involved computer sight reduction or longhand tabular methods.

1 Tabular Sight Reduction

The methods included are:

- The Nautical Almanac Concise method (NASR)
- Pub. 249 (formerly H.O. 249, Sight Reduction Tables for Air Navigation, A.P. 3270 in the UK)
- Pub. 229 (formerly H.O. 229, Sight Reduction Tables for Marine Navigation
- H.D. 486 in the United Kingdom)
- H.O. 214 (Tables of Computed Altitude and Azimuth)
- H.O. 211 (Dead Reckoning Altitude and Azimuth Table, Third Edition, known as Ageton, and the

Modified H.O. 211 Compact Sight Reduction Table, known as Ageton-Bayless)

- H.O. 208 (Navigation Tables for Mariners and Aviators, Sixth Edition, known as Dreisonstok)

- S-Table

2 Longhand Haversine Sight Reduction

This method is a practical procedure to reduce celestial sights with the needed accuracy, without using electronic tools such as calculator or a computer. And it could serve as a backup in case of malfunction of the positioning system aboard.

2.1 Doniol

The first approach of a compact and concise method was published by R. Doniol in 1955[2] The altitude is derived from Sin Hc = n − a(m+n), in wich n = Cos(B−Dec), m = Cos(B+Dec), a = haversine(LHA)

The calculation is:

n = Cos(B-Dec) m = Cos(B+Dec) a = haversine(LHA) sin_Hc = n - a(m+n) Hc = asin(sin_Hc)

2.2 Ultra Compact Sight Reduction

A practical and friendly method using haversines was developed between 2014 and 2015,[3] and published in NavList.

A compact expression for the altitude was derived[4] using haversines, hv, for all the terms of the equation:

hv(ZD) = hv(B-Dec) + [1 - hv(B-Dec) − hv(B+Dec)]* hv(LHA)

where ZD is the zenith distance

Hc = (90 - ZD) the calculated altitude

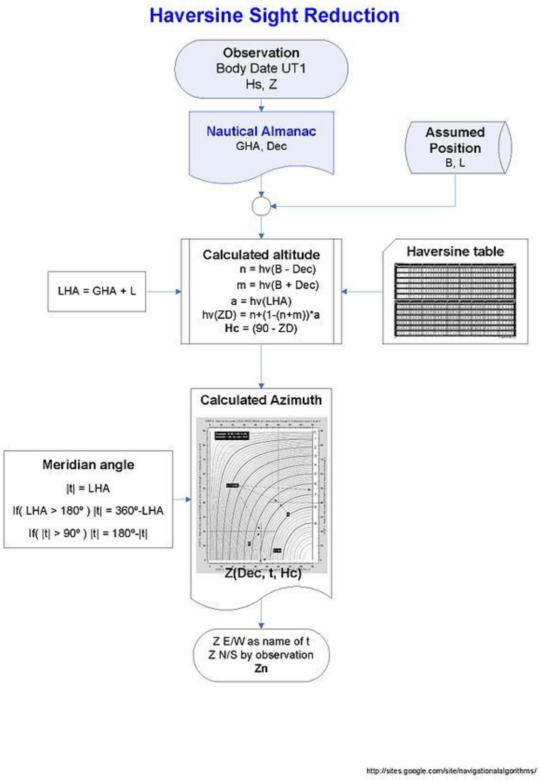
The algorithm if absolute values are used is:

if same name for latitude and declination n = hv(|B| - |Dec|) m = hv(|B| + |Dec|) if contrary name n = hv(|B| + |Dec|) m = hv(|B| - |Dec|) q = n + m a = hv(LHA) hv(ZD) = n+(1-q)*a ZD = inverse hv -> look at the haversine tables Hc = 90° - ZD

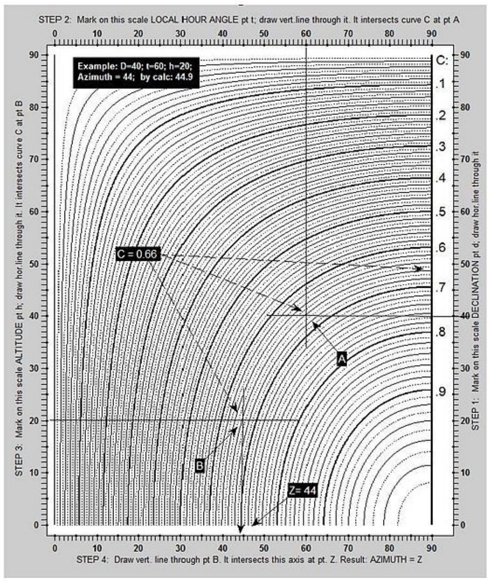
For the azimut a diagram[5] was developed for a faster solution without calculation, and with an accuracy of 1°.

This diagram could be used also for star identification.[6]

An ambiguity in the value of azimuth may arise since in the diagram 0 ≤ Z ≤ 90°. Z is E/W as the name of the meridian angle, but the N/S name is not determined. In most situations azimuth ambiguities are resolved simply by observation.



Haversine Sight Reduction algorithm



Azimuth diagram by Hanno Ix

When there are reasons for doubt or for the purpose of checking the following formula[7] should be used.

hv(Z) = [hv(90°-Dec) - hv(B-Hc)]/[1 - hv(B-Hc) -

hv(B+Hc)]

The algorithm if absolute values are used is:

if same name a = hv(90°-|Decl|) if contrary name a = hv(90°+|Decl|) m = hv(B+Hc) n = hv(B-Hc) q = n + m hv(Z) = (a-n)/(1-q) Z = inverse hv -> look at the haversine tables if Latitude N: if LHA> 180°, Zn = Z if LHA< 180°, Zn = 360° − Z if Latitude S: if LHA> 180°, Zn = 180° − Z if LHA< 180°, Zn = 180° + Z

This computation of the altitude and the azimuth needs a haversine table. For a precision of 1 minute of arc, a four figure table is enough.[8]

2.2.1 An example

Data: B = 34° 10.0′ N (+) Dec = 21° 11.0′ S (-) LHA = 302° 43.0′ Altitude Hc: a = 0.2298 m = 0.0128 n = 0.2157 hv(ZD) = 0.3930 -> table -> ZD = 77° 39′ Hc = 12° 21′ Azimuth Zn: a = 0.6807 m = 0.1560 n = 0.0358 hv(Z) = 0.7979 Zn = 126.6°

3 See also

- Navigation
- Celestial navigation
- Circle of equal altitude
- Intercept method

4 References

[1] The American Practical Navigator (2002). https://en.wikisource.org/wiki/The_American_Practical_Navigator

[2] . Table de point miniature (Hauteur et azimut), by R. Doniol, Navigation IFN Vol. III Nº 10, Avril 1955 Paper

[3] Ultra Compact Sight Reduction. Greg Rudzinski, Ocenan Navigator, July/August 2015, Issue nº 227 pg 42,43 http://issuu.com/navigatorpublishing/docs/on227_download_edition.

[4] Altitude haversine formula by Hanno Ix http://fer3.com/arc/m2.aspx/Longhand-Sight-Reduction-HannoIx-nov-2014-g29121

[5] Azimuth diagram by Hanno Ix. http://fer3.com/arc/m2.aspx/Gregs-article-havDoniol-Ocean-Navigator-HannoIx-jun-2015-g31689

[6] Hc by Azimuth Diagram http://fer3.com/arc/m2.aspx/Hc-Azimuth-Diagram-finally-HannoIx-aug-2013-g24772

[7] Azimuth haversine formula by Lars Bergman http://fer3.com/arc/m2.aspx/Longhand-Sight-Reduction-Bergman-nov-2014-g29441

[8] http://fer3.com/arc/m2.aspx/Longhand-Sight-Reduction-HannoIx-nov-2014-g29172

5 External links

- Navigational Algorithms: resources for Longhand Haversine Sight Reduction
- Correction to the sextant altitude https://en.wikipedia.org/wiki/File:Corrections_for_Sextant_Altitude.en.jpg
- Marcq St Hilaire intercept for the line of position https://en.wikipedia.org/wiki/File:MarcqSaintHilaire.en.jpg
- NavList
- Celestial Tools for the USPS/CPS JN/N Student

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6.1 Text

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6.2 Images

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