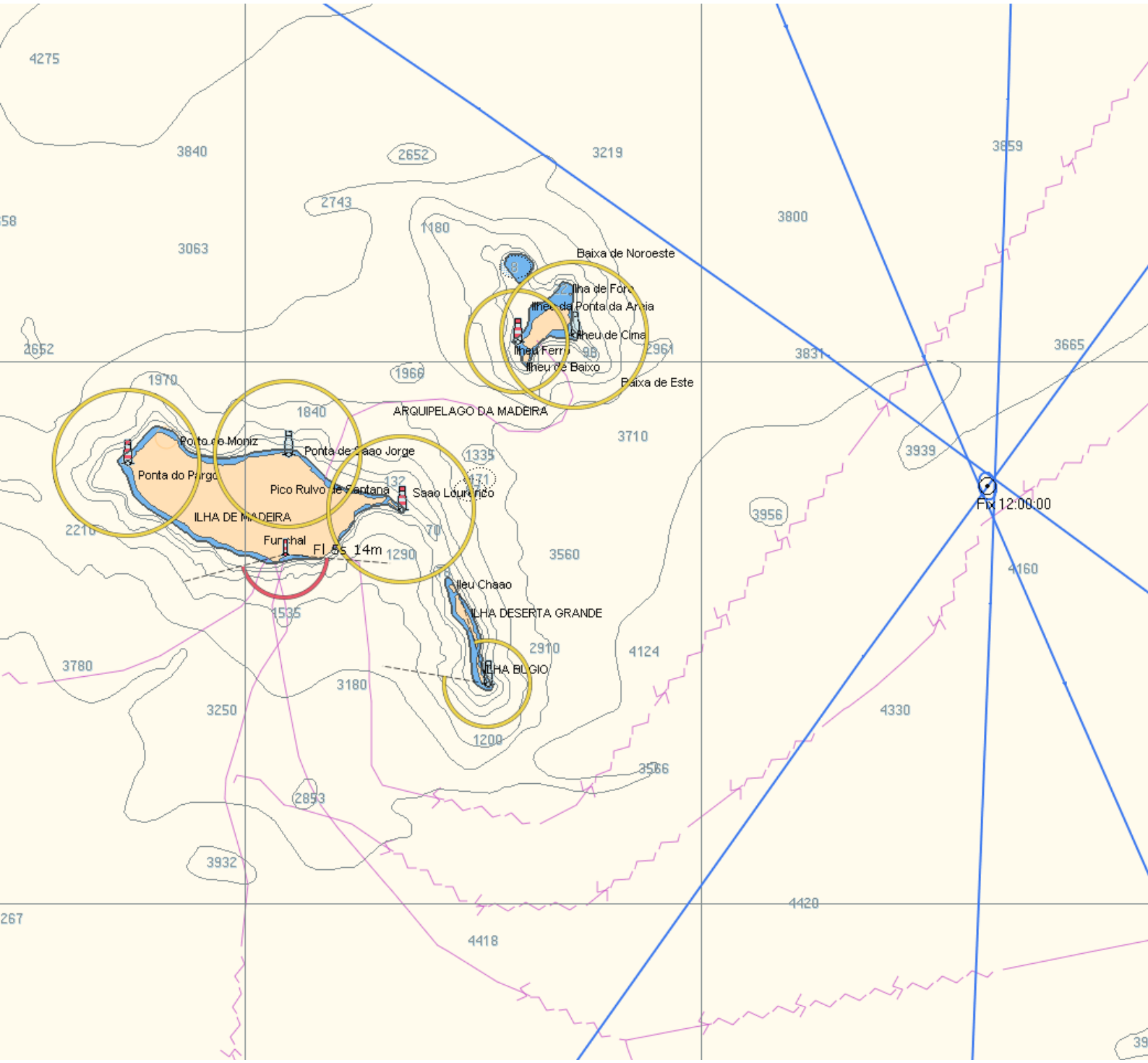
NAVIGATIONAL ALGORITHMS

Celestial Navigation

example



The software used to solve this example is available on the [Navigational Algorithms](http://sites.google.com/site/navigationalalgorithms/) Website.

San Sebastián – Donostia
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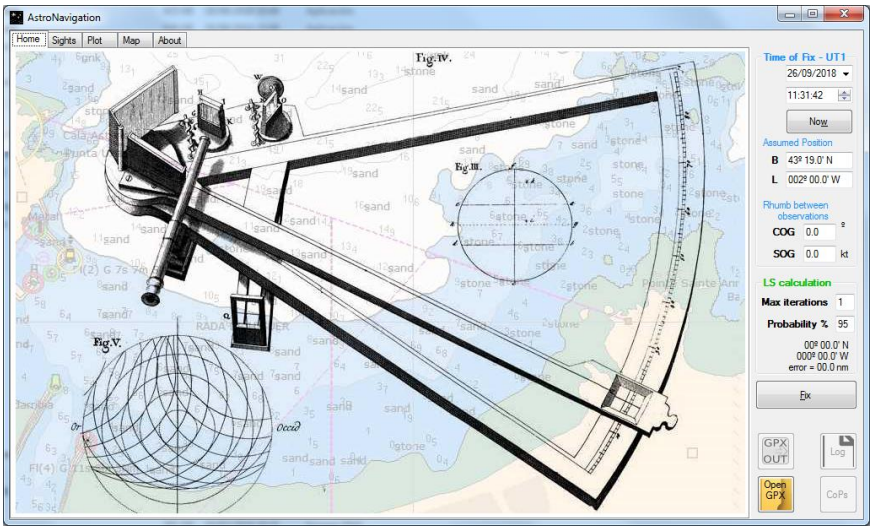
http://sites.google.com/site/navigationalalgorithms/

Example

The following example is taken from the book: *NavPac and Compact Data 2001-2005. ISBN 011887311 3. C.Y. Hohenkerk and B.D. Yallop , Her Majesty's Nautical Almanac Office. The Stationery Office*.

Example On 2001 February 9 at $12^h\,00^m\,00^s$ UT the dead reckoning (DR) position of a ship was W 15° 30′, N 32° 45′. Before sunrise, at $06^h\,58^m\,52^s$ the sextant altitude of *Vega* (No 49) was 49°.5850. At $07^h\,01^m\,45^s$ the sextant altitude of *Spica* (No 33) was 38°.7067, and at $07^h\,03^m\,52^s$ the sextant altitude of the lower limb of the Moon was 20°.4300. After sunrise, at $09^h\,53^m\,45^s$ the sextant altitude of the lower limb of the Sun was observed to be 22°.6733. The ship maintained a constant track and speed of 315° and 12 knots, respectively. Calculate the position of the ship at $12^h\,00^m\,00^s$ from these data, assuming that the height of eye above the horizon is 6 m and the sextant index error is zero



The Running Fix problem is easily solved using the application ***AstroNavigation****.exe*

Input the data for the four observations:

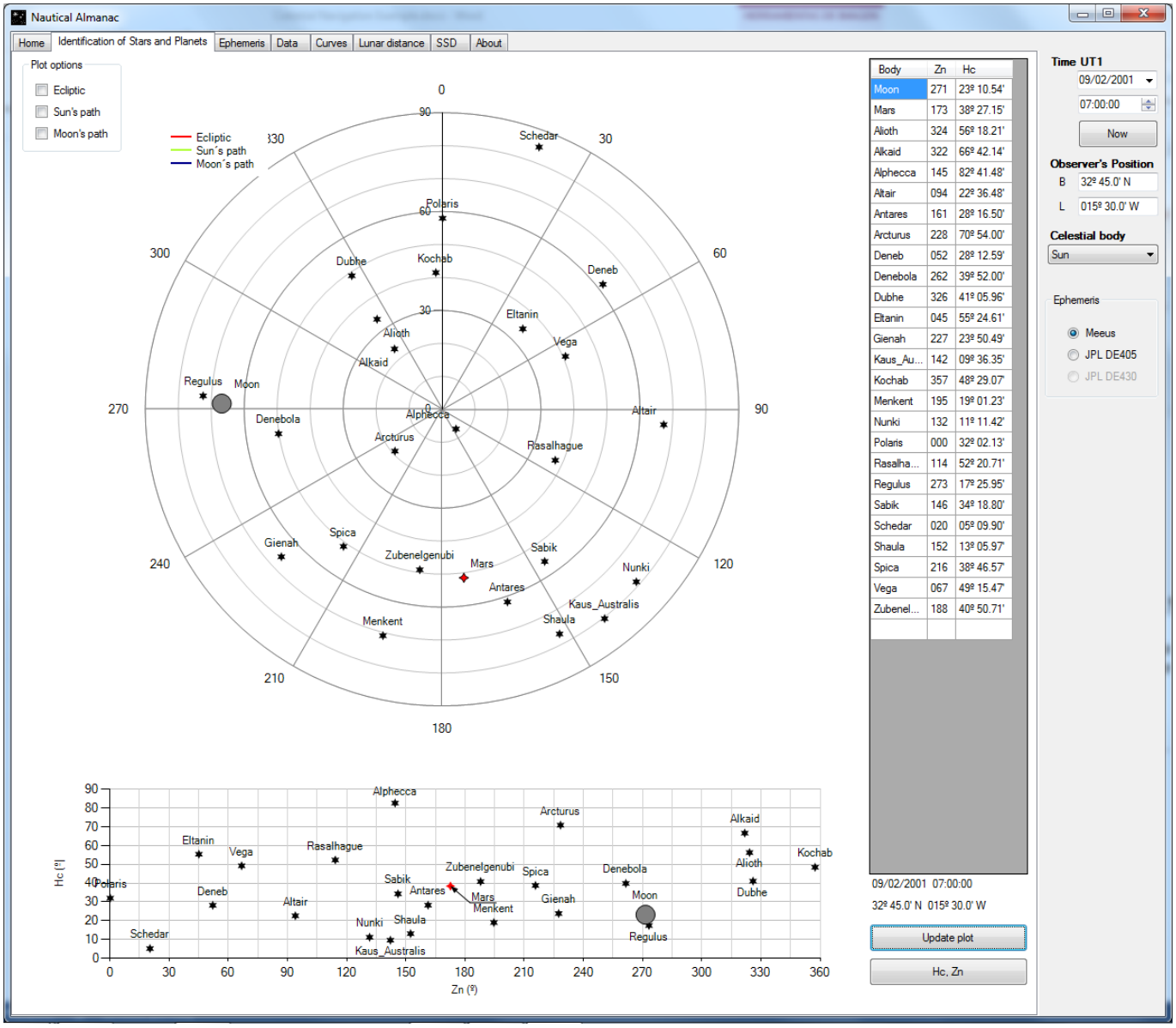
- Date
- Time UT1 of the observation
- Name of the body
- Declination
- Greenwich Hour Angle
- Observed altitude

and time of fix and course COG and speed SOG between the observations.

The estimated position is needed as an initial position for the iterative solution process, if is very rough the required number of iterations is greater.

Most tasks are automated using Astronavigation.exe

Identification

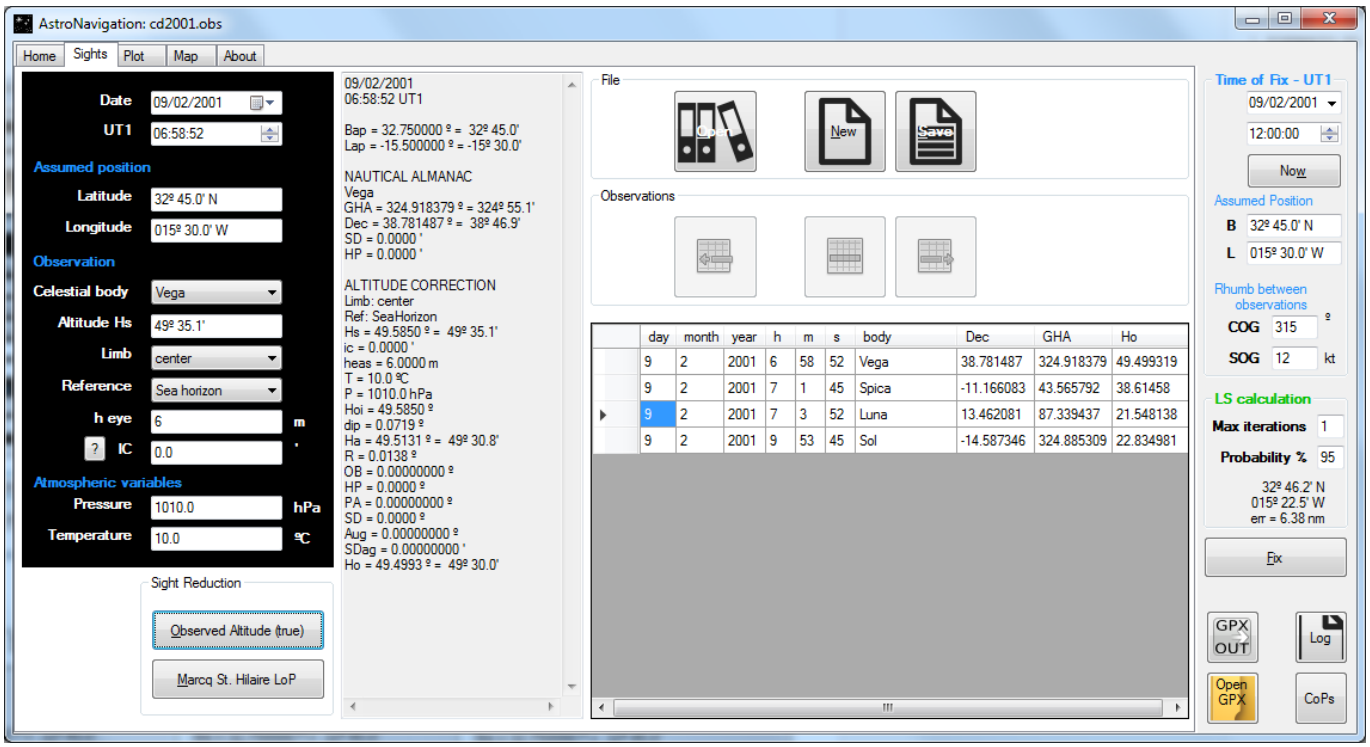


Nautical Almanc application.

Sights

After the stars are identified, we proceed to calculate the observed altitude of each star from the instrumental altitude. The parameters of the circle of equal altitude can be inserted in the grid of observations using the pushbutton Insert Observation .

Use the [Sights] tab in order to obtain Ho from Hs and insert each observation.
The built in Nautical Almanac calculates al the needed data like declination, GHA, HP, SD.

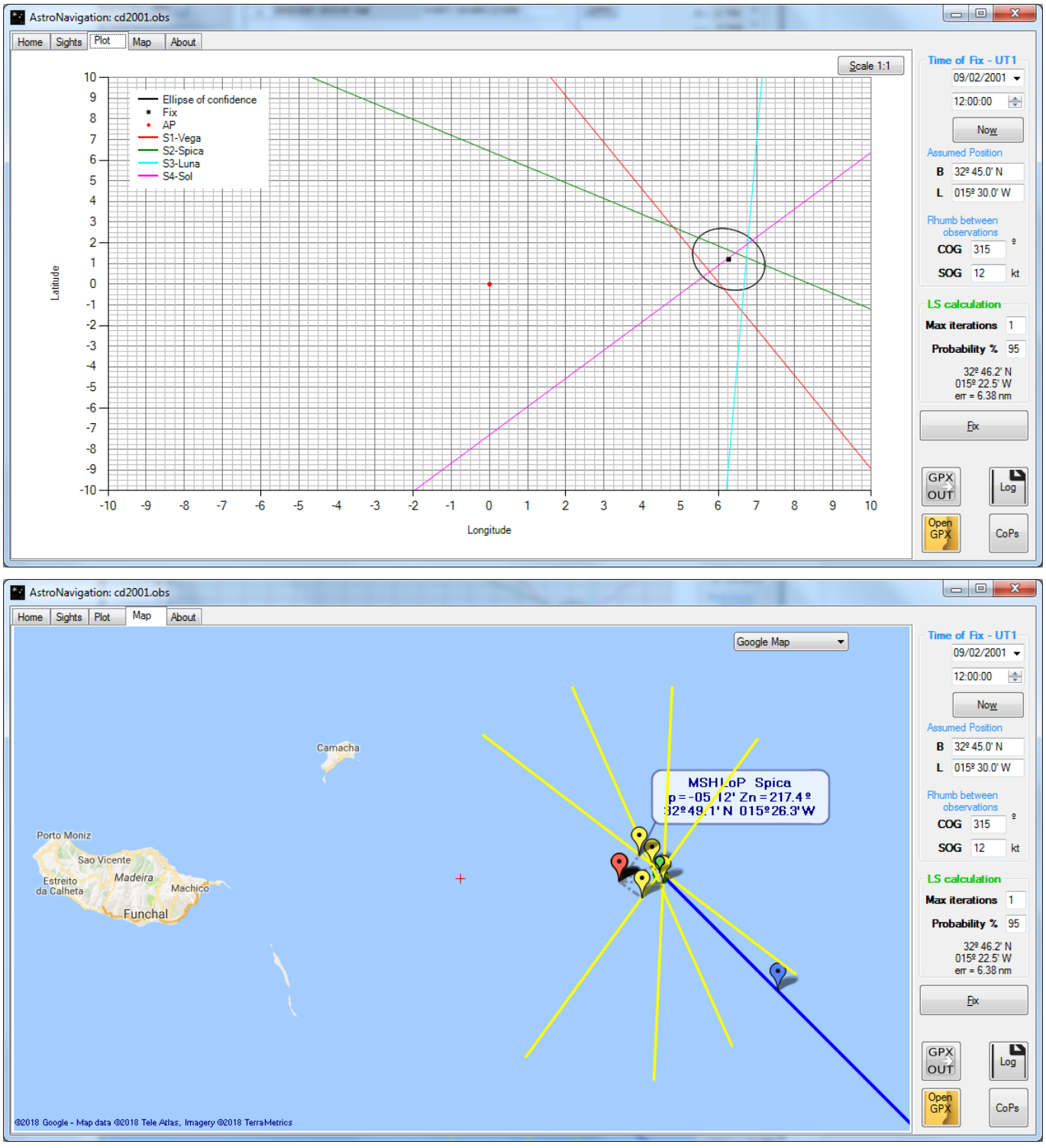


AstroNavigation - [Sights] tab

Spica	Moon	Sun
09/02/2001 07:01:45 UT1 Bap = 32.750000 ° = 32° 45.0' Lap = -15.500000 ° = -15° 30.0' NAUTICAL ALMANAC Spica GHA = 43.565792 ° = 43° 33.9' Dec = -11.166083 ° = -11° 10.0' SD = 0.0000 ' HP = 0.0000 ' ALTITUDE CORRECTION Limb: center Ref: SeaHorizon Hs = 38.7067 ° = 38° 42.4' ic = 0.0000 ' heas = 6.0000 m T = 10.0 °C P = 1010.0 hPa Hoi = 38.7067 ° dip = 0.0719 ° Ha = 38.6348 ° = 38° 38.1' R = 0.0203 ° OB = 0.00000000 ° HP = 0.0000 ° PA = 0.00000000 ° SD = 0.0000 ° Aug = 0.00000000 ° SDag = 0.00000000 ' Ho = 38.6145 ° = 38° 36.9'	09/02/2001 07:03:52 UT1 Bap = 32.750000 ° = 32° 45.0' Lap = -15.500000 ° = -15° 30.0' NAUTICAL ALMANAC Moon GHA = 87.339523 ° = 87° 20.4' Dec = 13.462108 ° = 13° 27.7' SD = 16.6561 ' HP = 61.1279 ' ALTITUDE CORRECTION Limb: lower Ref: SeaHorizon Hs = 20.4300 ° = 20° 25.8' ic = 0.0000 ' heas = 6.0000 m T = 10.0 °C P = 1010.0 hPa Hoi = 20.4300 ° dip = 0.0719 ° Ha = 20.3581 ° = 20° 21.5' R = 0.0437 ° OB = -0.00090000 ° HP = 1.0188 ° PA = 0.95425497 ° SD = 0.2776 ° Aug = 0.00172782 ° SDag = 16.75980629 ' Ho = 21.5463 ° = 21° 32.8'	09/02/2001 09:53:45 UT1 Bap = 32.750000 ° = 32° 45.0' Lap = -15.500000 ° = -15° 30.0' NAUTICAL ALMANAC Sun GHA = 324.885315 ° = 324° 53.1' Dec = -14.587348 ° = -14° 35.2' SD = 16.2097 ' HP = 0.1485 ' ALTITUDE CORRECTION Limb: lower Ref: SeaHorizon Hs = 22.6733 ° = 22° 40.4' ic = 0.0000 ' heas = 6.0000 m T = 10.0 °C P = 1010.0 hPa Hoi = 22.6733 ° dip = 0.0719 ° Ha = 22.6015 ° = 22° 36.1' R = 0.0389 ° OB = -0.00000395 ° HP = 0.0025 ° PA = 0.00228167 ° SD = 0.2702 ° Aug = 0.00000449 ° SDag = 16.21001843 ' Ho = 22.8350 ° = 22° 50.1'

Position

The Fix pushbutton gives the solution shown in figure 1.



AstroNavigation - [Plot] & [Map] tab

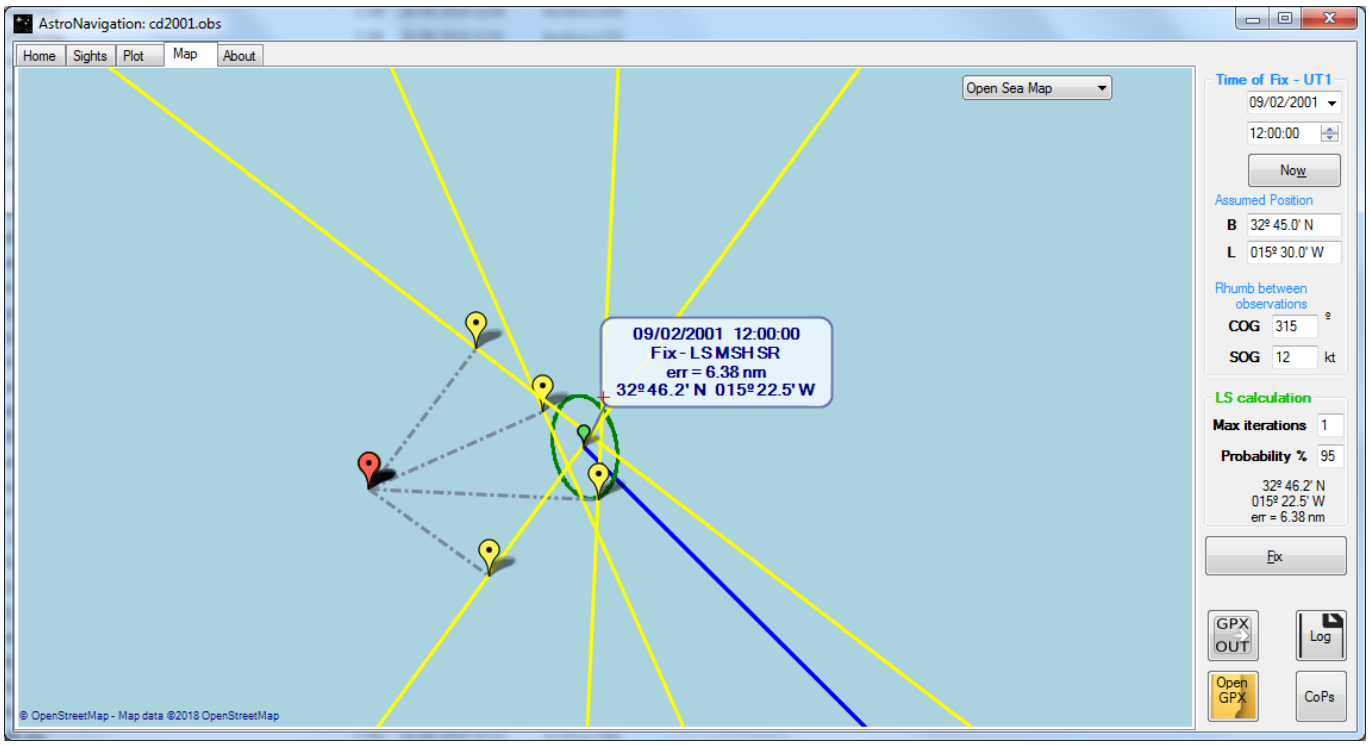


Fig 1. Solution with AstroNavigation.exe

Plot of the circumferences of equal altitude

Map tab could plots the circles of equal altitude on Google Map, Open Sea Map and others: Figure 2.

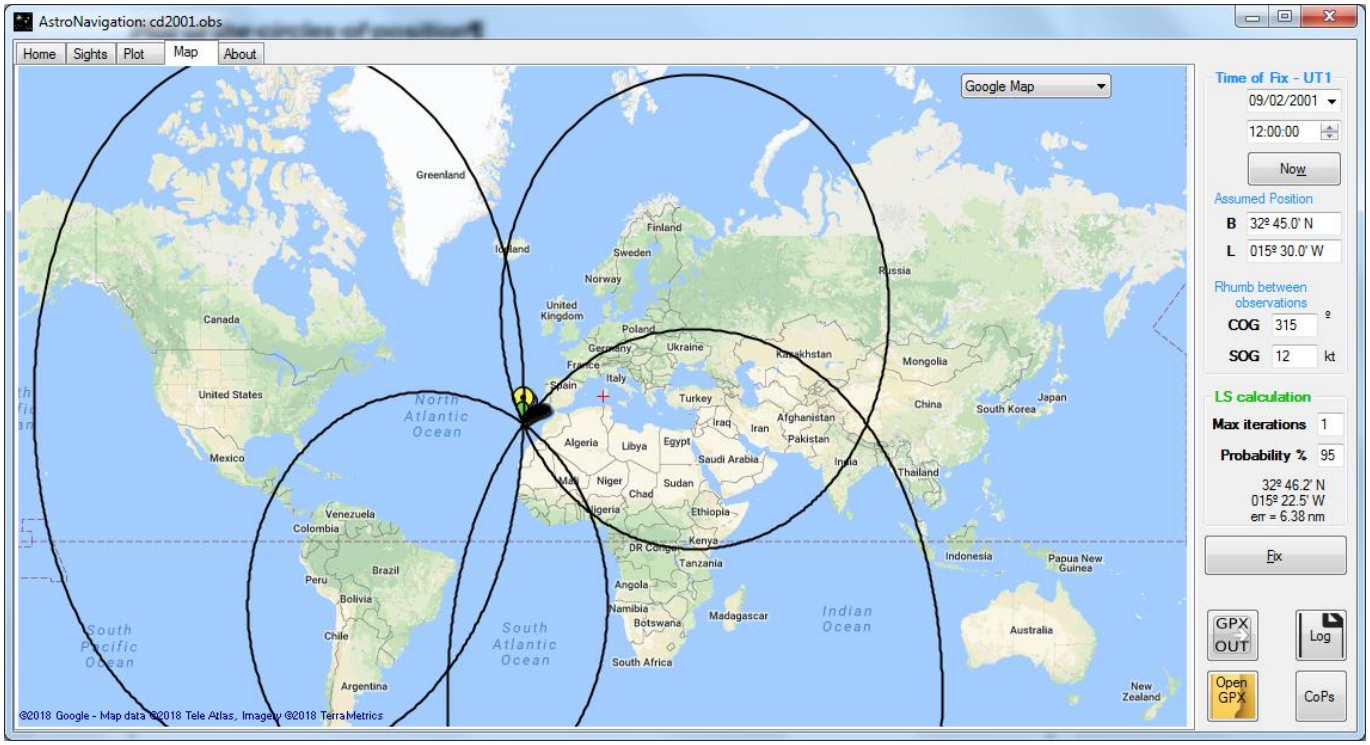
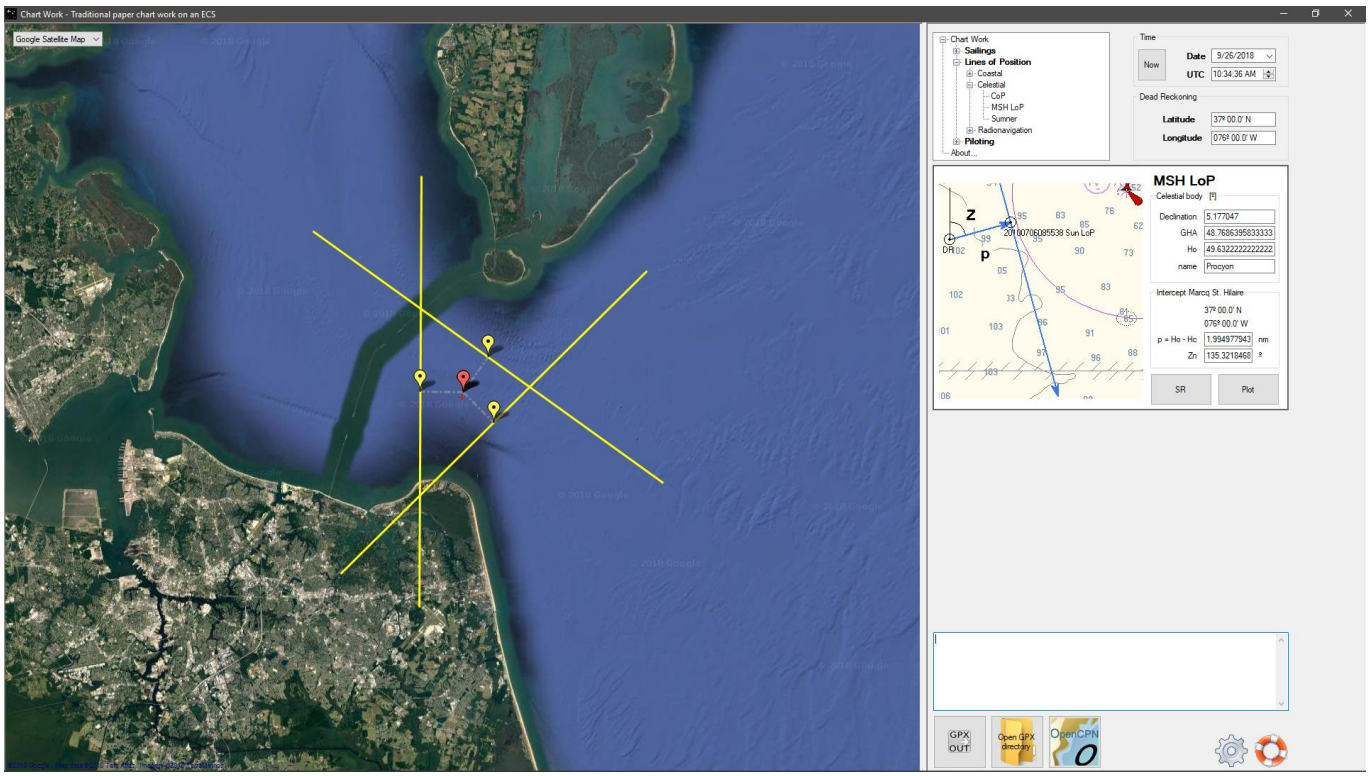


Fig 2. Circles of position or Circles of equal altitude.

It is also possible to use the application *Chart Work.exe* that generates a GPX for an observation. It is useful for simultaneous sights.



The GPX out pushbutton generates a gpx file with the circles of position associates to each observation, the Fix and the Confidence Ellipse. This GPX file serves as an input to OpenCPN figures 3, 4, and Google Earth figure 5.

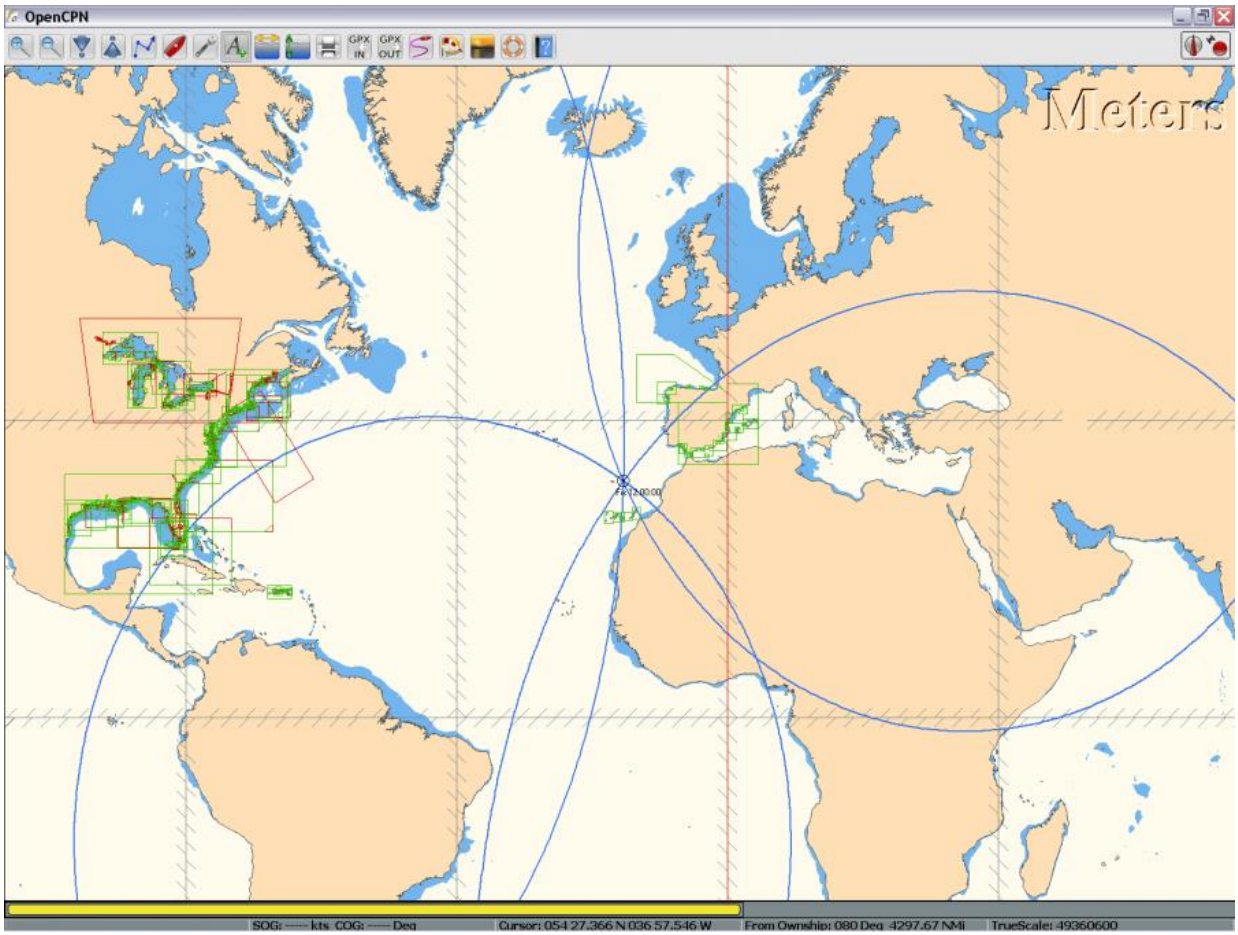


Fig 3. GPX file in OpenCPN. Circles of equal altitude. General scale.

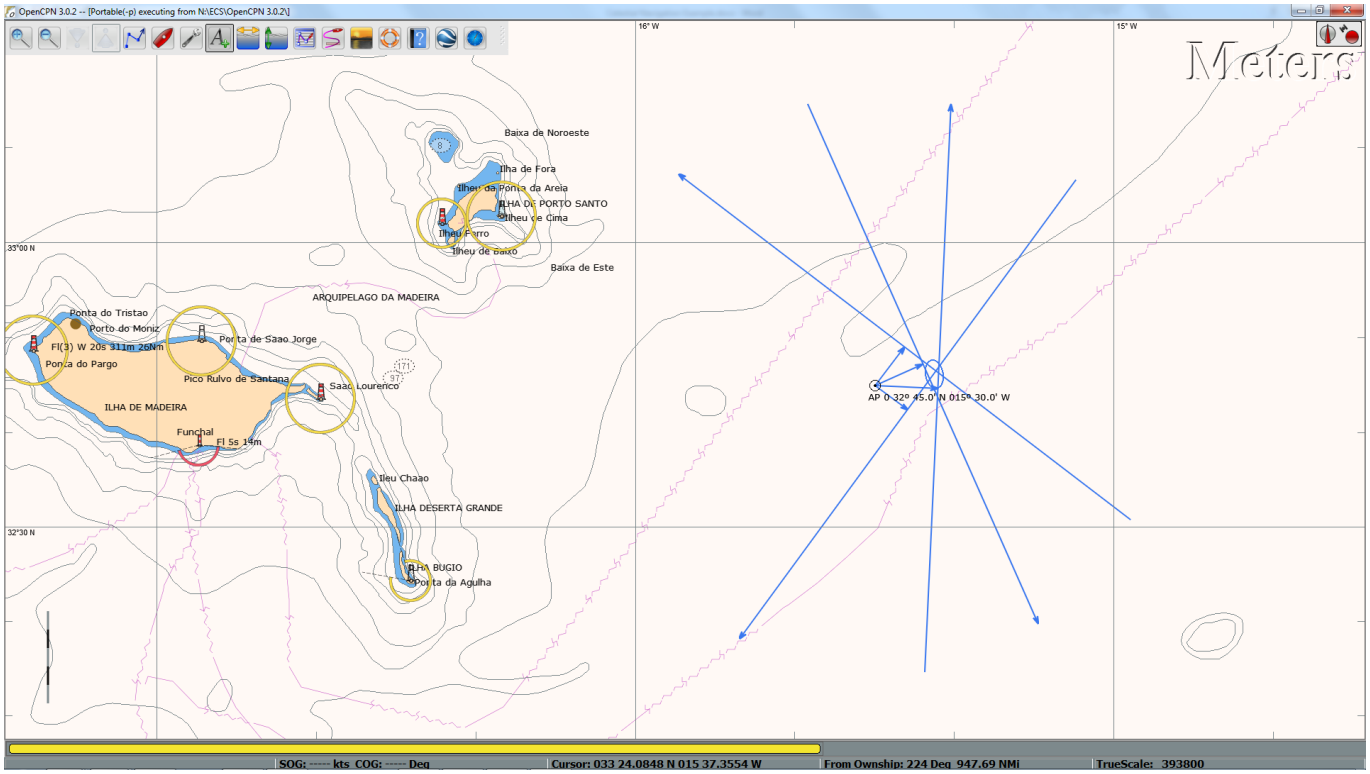


Fig 4. GPX file in OpenCPN. Fix and confidence ellipse. Coastal scale.

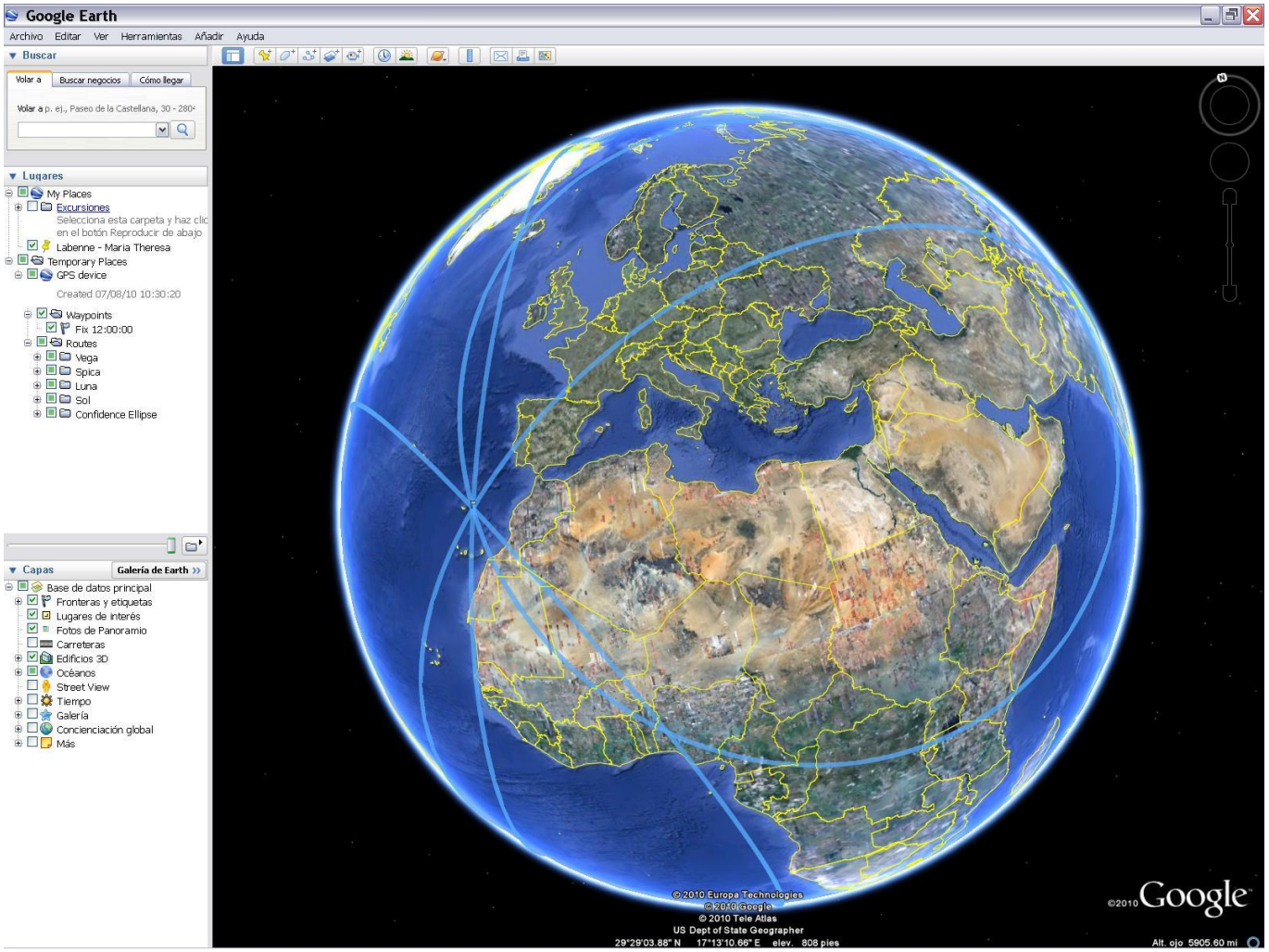
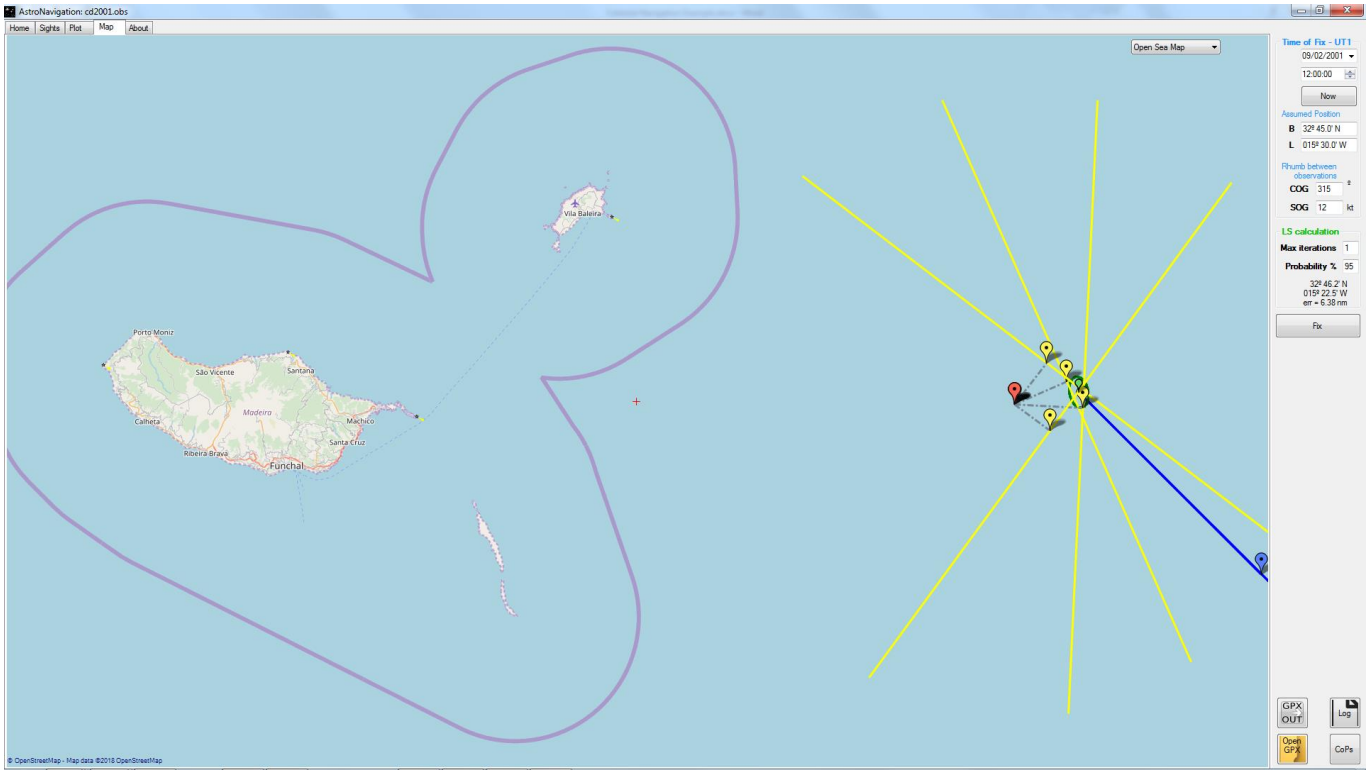


Fig 5. GPX file in Google Earth. Circles of equal altitude.



References

- GPX http://www.topografix.com/gpx.asp
- OpenCPN is a free software (GPL) project to create a concise chart plotter and navigation software for use as an underway or planning tool. http://www.opencpn.org/
- Google Earth http://earth.google.com/