

**HP 40**



# CNAV

USER MANUAL

**Version 4.0**



Koninklijke Marine | Dienst der Hydrografie

# CNAV 4.0

# Manual

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## 1. Introduction

CNAV 4.0 contains course and distance calculation, tides, celestial navigation and geodetic datum transformations. The program is developed by the Royal Netherlands Naval College and is used in nautical education and voyage planning and execution. The program is running under the operating systems Windows XP, 2000, NT and Windows 95/98.

For CNAV 4.0 program support contact the CNAV support desk at +31-70-3162845, fax +31-70-3162843 or at [support@hydro.nl](mailto:support@hydro.nl).

## 2. Description

CNAV 4.0 contains the following modules:

### **Astro**

This section is an aid in celestial navigation. Next to the determination of times of sun- and moon rise, astro- and solar fixes can be calculated. The planning of the fix can be performed in a routine where the, for the observer, visible part of the celestial globe is projected on the screen. Stars and planets used in the fix can be selected using the mouse.

### **Tide**

This section calculates the vertical and horizontal tides for a certain port and time according to the Admiralty Tide Tables method. The tidal curves are presented graphically. Next to the pre-installed ports, additional ports can be created.

### **Route**

The route section is an aid in voyage planning. Loxodrome and Great Circle course and distance calculations can be performed between waypoints of a defined route.

### **Tools**

The Tools section is to support navigational calculations. The following calculations can be performed:

- Geo/UTM, for transforming geographicals to Eastings and Northings
- UTM/Geo, for transforming Eastings and Northings to geographicals
- Distance and Azimuth, for course and distance calculations
- Dead reckoning
- Transformations, for datum transformations



### **3. Installation**

CNAV 4.0 can be downloaded via [www.hydro.nl](http://www.hydro.nl). The file 'Setup.exe' is a Windows based installation program that should be run from Windows XP, 2000, NT and Windows 95/98. When run under Windows NT, log in as 'administrator'.

- Double-click on the 'Setup.exe' program
- Follow the instructions of the 'Install Manager'

*Note When installing under Windows NT provide the user with access to the CNAV directories in order to have the possibility to save calculations*



## 4. Modules

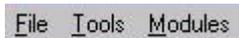
Once the main program has started by pressing the icon on the desktop, via the Windows Start menu or by activating the CNAV40.exe program in the Program Files folder, the start page of the program is displayed. On this page all modules and sub modules are displayed. The modules can be started either by using the left mouse button click, using the [TAB] key on the keyboard to 'jump' to the desired (sub)module or using the [ALT] key in combination with the underlined letter of the desired (sub)module. The CNAV 4.0 program is constructed according to the modern Windows standards and in the following descriptions of the modules knowledge of the standard Windows actions such as the use of left and right mouse clicks and the use of the standard Windows buttons above the menu bar is assumed.

All modules consist of:

- An '(In)Active window bar' with a minimise, a restore and a close button in the top of the screen.



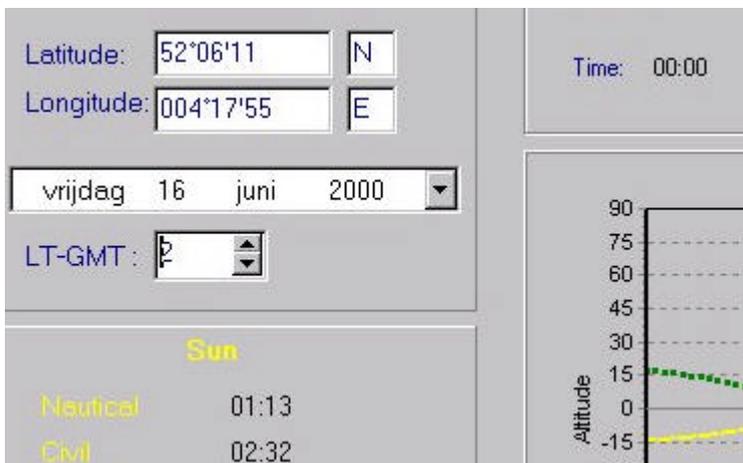
- A menu bar containing the module menus



- A button bar



- The module dependent in- and output fields and graphic displays. Calculations are generally performed when leaving the input field. The date is displayed in the language selected in the Windows Regional Settings Properties.



Via the 'Tools' menu in the menu bar of all modules the navigation tools can be used. Via the 'Modules' menu the other modules can be accessed.

Following is a description of all CNAV 4.0 modules including some examples.

### 4.1 Astro

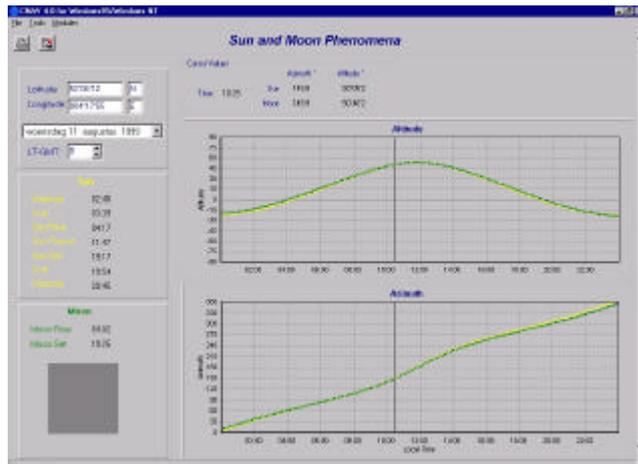
The Astro module is used for astronomical calculations and is divided into three sub modules. The position input for all three sub modules is in degrees, minutes and decimal minutes (DD.MM.mm)



### 4.1.1 Sun Moon

Using the input fields for position, date and LT-GMT time shift the times of sun- and moon rise and set are calculated. When using the mouse in the graphics the azimuth in degrees and altitude of sun and moon can be viewed above of the graph. In the left-bottom corner of the screen the phase of the moon, as it is visible for an observer on the Northern Hemisphere, is displayed.

Via the file menu in the menu bar the graphs can be printed or saved in the Windows Meta Format (\*.WMF). These two options are also provided in the button bar.



*Graphs of the eclipse of 11th August 1999*

### 4.1.2 Astro Planning

Via the file menu in the menu bar, files containing the selection of stars and planets can be opened and saved. An observation form and a star diagram can be printed from the file menu. These three options are also provided in the button bar.

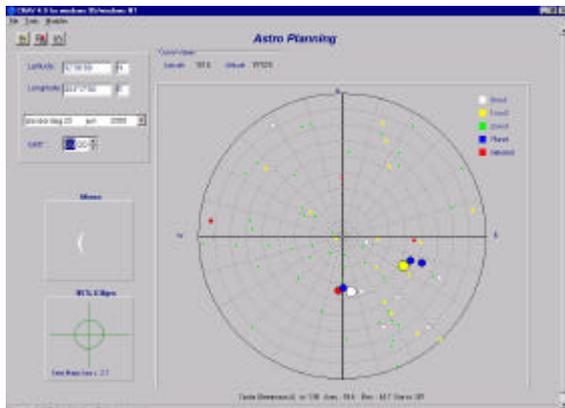
The module provides the possibility to select the, for the observer, visible stars and planets at a certain position at a certain time. Using the input fields for position, date and time in GMT the visible stars and planets are displayed in the graph on the right with a colour code for the magnitude. The Moon is displayed as a big white circle, the Sun as a big yellow circle. Using the mouse, celestial bodies can be selected. Selected bodies are displayed in red. Below the graph the name, magnitude, azimuth, elevation and catalogue number of the last selected star or planet is displayed. The current cursor azimuth and altitude values are displayed at the top left of the graph. **It is not possible to calculate a fix using the sun or moon.**

Once more than one celestial body is selected the 95% ellipse resulting from observations to the selected bodies is presented in the bottom left of the screen, providing assistance on the selection of the stars and planets. Because of the influence of random errors in every measurement process, redundant measurements have to be carried out. The more measurements, the better the positional accuracy, the smaller the 95% ellipse will become. The ellipse shows red when the selection must be improved and green for a good selection. The semi-major axis is the largest possible distance in nautical miles from a point on the ellipse to the middle.



Above the error ellipse a box is shown presenting the moon, as it is visible in the Northern Hemisphere at the entered date, time and position.

After completing the selection an observation form can be printed, containing azimuth and elevation of all the selected stars at a 4 minute interval, so the sextant can be set up accordingly, providing a short observation time. The results of the observations can be written down on the observation form.



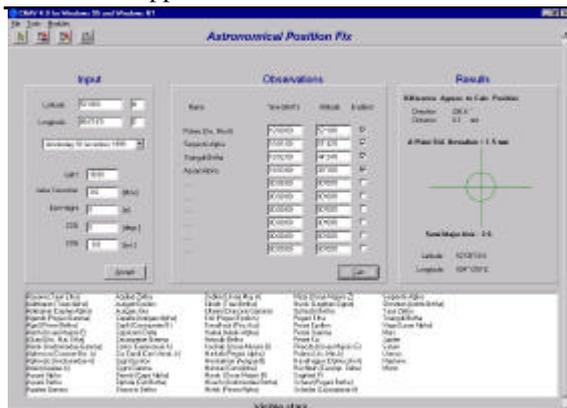
*Example of selection display*

### 4.1.3 Astro Pos. fix

Via the file menu in the menu bar, files containing the astro fix observations can be opened, saved and saved as. The observations and results can be printed from the file menu. These four options are also provided in the button bar. The file menu also contains an option to view the star diagram. This option will be discussed later.

The module provides the possibility to calculate an astro fix. Once the input fields for the dead reckoning position, date and time in GMT, Index Correction, Eye height, COG and SOG are entered the calculated position can be compared to the dead reckoning or approximate position. This comparison will also be presented in the 'Results' box. It is also possible to open a previously saved file. After opening the file the measurements have to be selected in the 'choose record to replay' box.

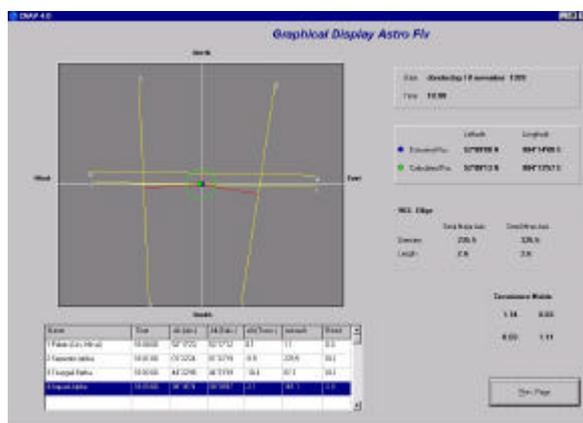
Stars used in the observations must be selected via the listing in the bottom of the screen. The observations taken with a sextant must be entered in the observations listing together with the time in GMT. By enabling and disabling celestial bodies with the check boxes under 'enabled' the precision of the calculated position might be improved, as illustrated by the 95% error ellipse in the 'Results' box. The Results section shows the A priori standard deviation. To recalculate with new observations the [Calc] button must be pressed.



Example of calculation display

By double clicking in the Results graph or using the File menu the star diagram can be viewed. The star diagram consists of a Graphical Display Astro Fix showing a 'Lines of Position (LOP)' graph with all the celestial bodies used in the calculation. The yellow LOPs show all possible positions resulting from an observation to a single celestial body. The red lines represent a residual vector from a LOP to the calculated position. The quality control figures are displayed on the right side of the display.

A red ellipse in the 'Astronomical Position Fix' and 'Graphical Display Astro Fix' windows mean that large inconsistencies exist between the various measurements. Check the input or add more measurements until the ellipse is green.



Example of a star diagram display

## 4.2 Tide

The Tide module is used for calculating the horizontal and vertical tides and is divided into two sub modules.

### 4.2.1 Tide

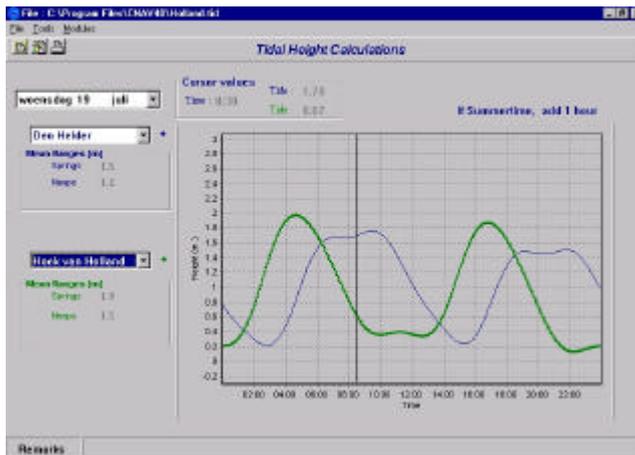
Via the file menu in the menu bar, files containing the harmonic constants used in predicted tides can be opened, edited and a printed. These options are also provided in the button bar. On opening files there are two options. Either to open a \*.str file for stream data or opening a \*.tid file for vertical tides data. Via the File menu the hourly values and high and low water times can be viewed.



## CNAV 4.0 Appendices

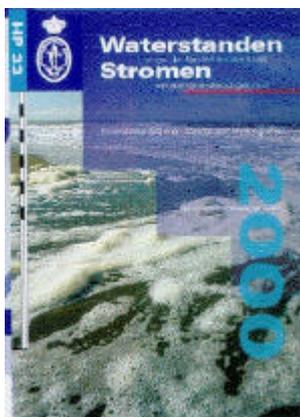
On installing the CNAV program two tide files are provided. These files contain the harmonic constants for ports as provided in part III of the Admiralty Tide Tables (ATT). After entering the date and selecting one or two ports the graph displays the tidal curve for the location(s). While using the mouse in the graph the current cursor position time and height(s) can be viewed above the graph.

CNAV can provide world wide tidal predictions. Via the File menu files for other parts of the world can be created using the harmonic constants section of the ATT. The time in both sub modules is equivalent to the time standard used in the ATT for a specific port.



*Example of tidal calculations display*

The calculations performed using the ATT harmonic constants do not provide very accurate tidal predictions. Along the Dutch coast the tides are too complex for a proper description using the ATT method. For this area the HP33 Tide tables published by the Netherlands Hydrographic Office are more reliable. It is emphasized that there may be considerable differences between predicted and observed tidal heights. These differences are nearly always due to meteorological conditions, only predictable for a short period of time. An onshore breeze usually causes higher water levels and earlier times of high and low waters. Offshore winds tend to cause an opposite effect. The barometric pressure also has an influence on the water level. The higher the pressure, the lower the water level and the other way round.



*HP33 cover*



## 4.2.2 Streams

Via the file menu in the menu bar, files containing the harmonic constants used in predicted streams can be opened, edited and a printed. These options are also provided in the button bar. On opening files there are two options. Either to open a \*.str file for stream data or to open a \*.tid file for vertical tides data. Via the File menu the hourly values and maximum stream times can be viewed.



*Example of a stream graph display*

On installing the CNAV program a stream file is provided. The file contains the harmonic constants for tidal streams for two ports as provided in the Admiralty Tide Tables (ATT). After filling in the date and selecting one or two ports the graph displays the stream curve for the location(s). While using the mouse in the graph the current cursor position time and rate(s) can be viewed above the graph. The two main directions in which the streams are heading are displayed left of the graphs.

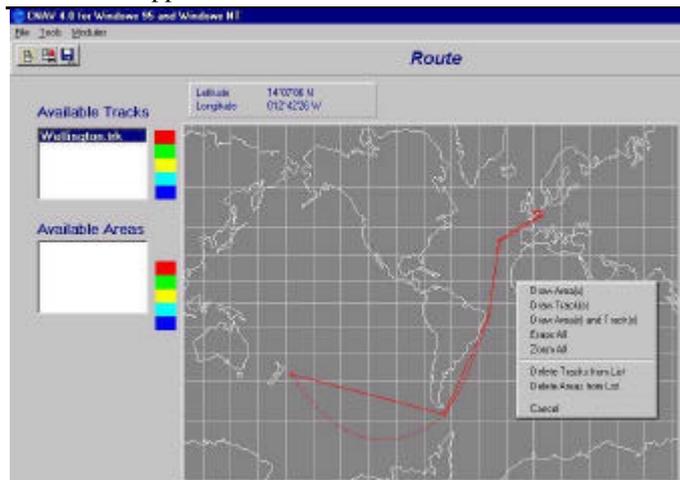
## 4.3 Route

Via the file menu in the menu bar, files containing the Track (\*.trk) and Area (\*.are) positions and calculations can be opened, saved and saved as. These three options are also provided in the button bar. The file menu also provides an option to create a new file.

On installing the CNAV program two \*.trk and a \*.are files are provided. These files contain several waypoints. The track files define a route. The area files define an area such as an anchorage or exercise area. These files can be selected using the open option in the file menu. By using the right mouse button in the map the tracks and areas can be drawn, erased and deleted. By dragging from the left bottom corner to the top right corner and pressing the left mouse button the map can be zoomed in.



## CNAV 4.0 Appendices



*Example of Track display*

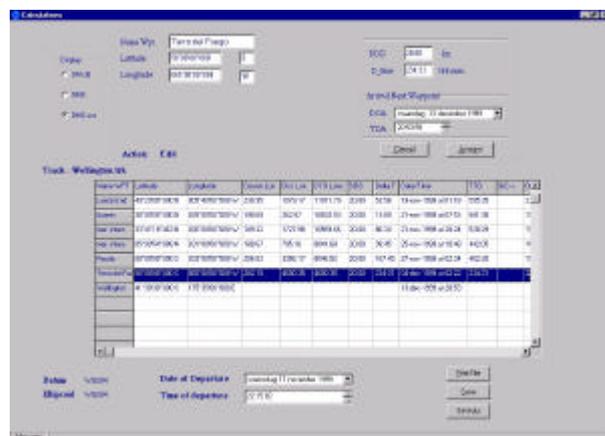
The track data can be displayed by double clicking the desired track in the ‘Available Tracks’ box. The page shows the display format of the coordinates, the geodetic datum and ellipsoid, the date and time of departure and a list of coordinates. The list consists of the following parameters:

- Name WPT, the name of the waypoint
- Latitude, longitude
- Course lox, loxodrome (rhumbline) course to the next waypoint, calculated by the program
- Dist. lox, loxodrome distance to the next waypoint, calculated by the program
- DTG loxo, loxodrome distance to destination, calculated by the program
- SOG, speed over ground, either calculated by CNAV or set by user
- delta T, time to next waypoint, either calculated by CNAV or set by user
- Date/Time, on arrival at waypoint
- TTG, time to go to destination

Following are Great Circle (geodetic line) parameters [-->GrC]

- COD/COA, course of departure/course of arrival
- Distance, distance to the next waypoint
- DTG, distance to destination

*The geodetic datum must be provided at the creation of the file and cannot be altered.*





*Example of Route and Planning display*

Parameters can be edited by double clicking a waypoint in the list. A change in one of the parameters causes a change in the other parameters as well. Using the right mouse click opens up another menu. Using this menu waypoints can be edited and deleted. To insert waypoints, tracks and crossings first select a waypoint with the left mouse button.



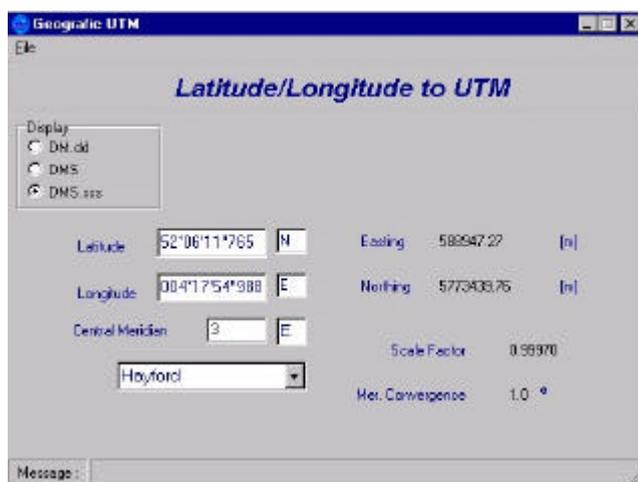
A new track can be created by opening a new file in the file menu. After selecting a geodetic datum and adding a required waypoint the next waypoint can be added after pressing the add button. The new track or area can be saved by pressing the finish button. Track files must be saved as \*.trk file and area files as \*.are file.

#### 4.4 Tools

The Tools module is used for navigational calculations and is divided into 5 sub modules. The menu bar of the sub modules in the Tools module consist of only the file menu with a print and an exit function. There is no button bar in the sub modules.

##### 4.4.1 Geo UTM

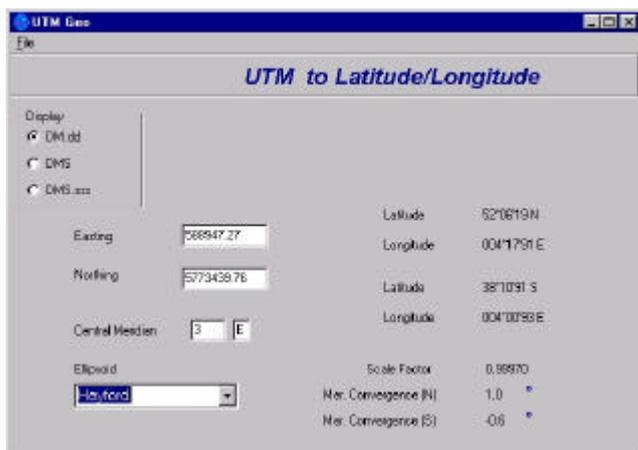
After selecting a position format and an ellipsoid, geographical positions can be converted to grid positions. On leaving the position field a central meridian is automatically proposed. The scale factor and convergence for the position are presented as well.



*Example of Geo UTM display*

##### 4.4.2 UTM Geo

After selecting a position format and an ellipsoid grid, positions can be converted to geographical positions. On leaving the position field a central meridian is automatically proposed. The scale factor and meridian convergence for the position are also presented for both northern and southern latitudes.



Example of UTM Geo display

### 4.4.3 Dist. Azimuth

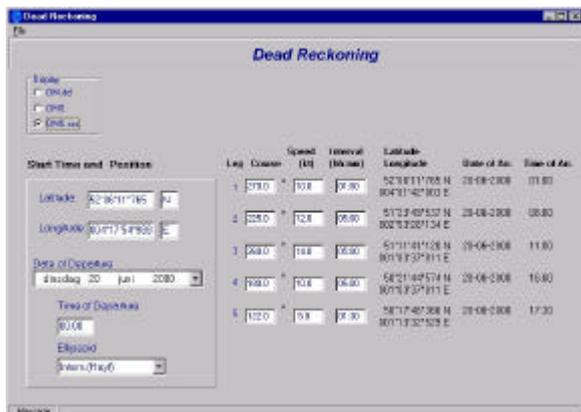
After selecting a position format and a datum or ellipsoid the great circle and loxodrome distance and course between two geographical positions can be calculated. The difference between the great circle and the loxodrome distance is also presented. The vertex is shown in the box at the bottom.



Example of Distance Course display

### 4.4.4 Dead reckoning

After selecting a position format, an ellipsoid, a start date and time and a start position the different legs must be filled in. The results are arrival positions and times.

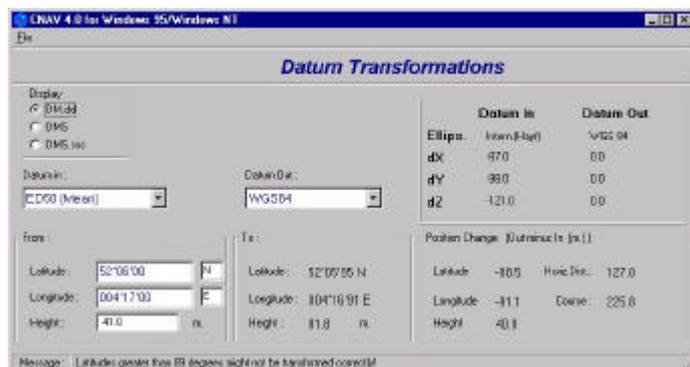




*Example of Dead reckoning display*

### 4.4.5 Transformations

After selecting a position format and the two datums, a datum transformation between the two can be performed using the parameters on the right. For comparison the 'virtual' difference between the two coordinates is also displayed on the right.



*Example of the Datum Transformations display*



## 5. Terms and Abbreviations

95% ellipse	An ellipse that shows the area in which the position of the observer lies with a 95% probability. The middle is the estimated position.
Altitude	The vertical angle between the plane of the horizon and the line to a celestial body.
Alt. (obs.)	Observed altitude.
Alt. (Calc.)	Calculated altitude.
Alt. (Trans.)	Difference between calculated and observed
A priori Std. deviation	The (expected) standard deviation of a random variable. In CNAV 1.5 nmi for an observation to a celestial body.
Azimuth	A horizontal angle measured clockwise from the meridian.
Civil twilight	The periods of incomplete darkness following sunset or preceding sunrise, as the darker limit occurs when the centre of the sun is $6^\circ$ below the celestial horizon (the horizontal plane through the centre of the earth perpendicular to the zenith-nadir line).
COA	Course Of Arrival.
COD	Course Of Departure.
COG	Course Over Ground.
Covariance matrix	Description of the precision of the calculated position. Top left is variance in N-S direction in nmi, bottom right is variance in E-W direction. The two other values are a measure for the relationship between the first two values.
D_Time	Delta time, difference between start and stop time or duration
Datum	Geodetic model of the earth acting as a reference surface for position control consisting of a reference ellipsoide and three translations X, Y and Z in meters to indicate the difference with the World Geodetic System 1984 (WGS'84) datum.
Dead reckoning	Position estimate based on speed and heading of a vessel, without reference to external aids.
DOA	Date Of Arrival.
DTG	Distance To Go.
Elevation	The vertical distance of a point or a level, on or affixed to the earth, measured from mean sea level.
Ellipsoid	Model of the earth constructed by rotating an ellipse around its minor axis. Often called reference spheroid.
Eye height	Eye height of the observer above mean sea level.
Geo	Geographical coordinates, a system of spherical coordinates for defining positions of points on the earth (example $52^\circ 04'$ North, $4^\circ 17'$ East)
GMT	Greenwich Mean Time. Time based upon the Greenwich meridian as a reference.
GrC	Great Circle. The intersection of a sphere and a plane through its centre. A great circle is the shortest connection between two waypoints with different courses at departure and arrival. This results in a curved line on a (Mercator) chart.
Index Correction	Known error of the sextant.



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Loxodrome	A curve on the surface of a sphere, intersecting all great circles of the sphere at a constant oblique angle. A loxodrome is a connection between two waypoints with the same course, this is a straight line on a chart with a Mercator projection.
LT	Local Time. The local time of a reference zone (i.e. Central European Time = GMT +1 hour)
m	In Astro Planning. 'm' is the magnitude of a celestial body. Relative brightness of a celestial body. According to the accepted classification a star of the 1st magnitude is a hundred times as bright as a star of the 6th magnitude (the faintest star that can be seen with the unaided eye).
Mer. Convergence	Meridian Convergence. At any point of a cartographic projection, the angle between the meridian, as represented on the plane of the projection and the grid in use, and the grid north line.
Nautical twilight	The periods of incomplete darkness following sunset or preceding sunrise, as the darker limit occurs when the centre of the sun is 12° below the celestial horizon (the horizontal plane through the centre of the earth perpendicular to the zenith –nadir line).
nmi	nautical miles (1852m)
Resid.	Difference in nmi between the Calculated position and the LOP for the observation the specific star in the first column of the row.
Scale factor	A multiplier used to convert a grid distance in a map projection to a true distance on a spheroid.
SOG	Speed Over Ground.
Sun Rise	Crossing of the (apparent) horizon by the upper limb of the ascending sun
Sun Set	Crossing of the (apparent) horizon by the upper limb of the descending sun
Sun Transit	Crossing of the sun over the meridian of the observer.
TOA	Time Of Arrival
TTG	Time To Go
UTM	Universal Transverse Mercator, a grid system in which a grid network is applied to Transverse Mercator projections of zones of the earth's surface. The earth is divided into 60 zones with a width of 6°. On the Northern Hemisphere the Northing coordinate is in metres from the equator and the Easting coordinate is in metres from the central meridian +500.000m.
Vertex	The highest point. On a great circle the point nearest to a pole.
Wpt	Waypoint, a position in a route which is the start or end point of a leg.