User's Guide for SP-iOS

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1 Quick Start Instructions

This User's Guide is specific to the StarPilot (SP-iOS) for iPhone, iPad, and iPod touch and closely resembles the version of the documents created for StarPilot-PC and the calculator based products StarPilot-86 (SP-86) and StarPilot-89 (SP-89). If you are familiar with the workings of SP-PC, SP-86, or SP-89 then you will feel right at home with SP-iOS. If you are new to the product line then you will find StarPilot intuitive and easy to use.

All StarPilot features can be accessed through the menu links on the main Index Menu or via the tab bar below the menus. The menus are broken down into basic categories; Program options, DR and Piloting functions (Utilities), and Celestial Navigation calculations. The most common functions are accessible via icons on the tab bar. Icons on the tab bar are a pictorial representation of the function they invoke. The icons shown there are user selectable to meet your needs at hand.

Enter angles as deg.min (d.m), i.e.

48.325 = 48° 32.5'

N Lat & E Lon are +, S Lat & W Lon are - i.e. 122° 14.2' W = -122.142. A Lat or any angle like 12° 5.3' must be entered as 12.053, the leading 0 is important.

Enter times as hr.minsec (h.ms), i.e.

12.3247 = 12h 32m 47s

On output they are displayed as 12:32:47. Note that sometimes you might enter a time of 19.2100 and then see the display as 19:20:60.

StarPilot uses "watch time" (WT) for all events and bookkeeping. For celestial computations, GMT is obtained from:

GMT = WT + WE + ZD

where ZD is the zone description of the watch and WE is the watch error. If WE = 0 and ZD = 0, then WT = GMT which is the same as UT or UTC. All times are 24h, i.e. 2 min and 5 sec past 2pm = 14.0205. WE and ZD are entered in the Settings dialog. WE is in seconds, ZD in whole hours, + for West, -East, but we do not enter the + sign but we must enter the negative.

All fixes are running fixes, so course and speed must be entered if underway. You will be prompted for these when needed.

Old routines, new manual...

The basic computations and mathematical routines of the StarPilot have been tested for many years now, but each new edition of this User's Guide presents us with new opportunities for typos as we add

new features to the program or improve its interface. If you run across typos, errors, or unclear sections, please drop us a note at info@StarPilotLLC.com. We will address the issue immediately, and update the online version.

Quick Start Examples

In the following pages we start immediately with some numerical examples for those with experience with such computations. As needed, postpone these and skip to the more detailed explanations which follow these.

Some users, prefer to record and analyze all sights using only GMT. In these cases we must be careful about the date since it could change or not change within a series of sights or during a long running fix depending on our longitude. To accommodate this approach, we now store the date of each sight reduction along with the other data, which means that unless the date is stored in the settings, it will be requested at each sight reduction and again when computing a fix from that set of sights. The example below will illustrate the modification. You may prefer to read through the rest of the Guide before going over this example.

Example of Running fix using GMT and date

Sight 1:
22h 05m 10s on Apr 14, 2000 GMT, DR = 40° 58'N, 135° 20'W, S = 8.0 kts, C = 225 T, lower limb sun Hs = 55° 31.2', HE = 9 ft, IC = 1.5' On.

Sight 2:
01h 36m 02s on Apr 15, 2000 GMT, DR = 40° 38'N, 135° 46'W, S = 8.0 kts, C = 225 T, lower limb sun Hs = 22° 36.2', HE = 9 ft, IC = 1.5' On.

Solution:

(1) First Set factory defaults under the "Settings" menu, so all start the same way.

(2) From the "Index" menu select "Sight Reduction...". Then input the data from sight 1 as shown below:

Input Sight #1:

Body	Sun
Watch Time	22:05:10
Date	4/14/2000
DR Lat	40°58'
DR Lon	W135°20'
IC(min)	-1.5'
He(ft)	9

Limb	Lower
Hs	55°31.2'

Answer

Int(nm)	-4.0
Zn	208.8°T

Date input for Sight Reductions and Fixes

Earlier versions of the program assumed that celestial fixes were made from data on the same date, since we assumed most users would choose to use the optional Zone Description input and thus be using effectively local time for the sights. In practice this is still the most convenient means of sight reduction since you can store the Watch Error and thus correct all sight times automatically at the input.

This first sight yielded an LOP of a = 4.0' Away from 208.8, based on an assumed position equal to the DR position we entered. The a-value was valid at the time and date we entered.

Now from the "Sight Reduction" dialog, select Sun again and enter the data for Sight 2, as shown:

Input Sight #2:

Body	Sun
Watch Time	01:36:02
Date	4/15/2000
DR Lat	40°38'
DR Lon	W135°46'
IC(min)	-1.5'
He(ft)	9
Limb	Lower
Hs	22°36.2

Answer

Int(nm)	-5.8
Zn	263.2°T

This is an LOP of 5.8' Away from 263.2, again based on the DR position and time we entered. To get a

fix from these, we must now advance the first to the second with the course and speed. This is done from the "Celestial Fix" menu under "Fix by Computation".

StarPilot will first ask for a DR position. It does not matter which you use, but generally one would choose the DR position that corresponds to the Fix time that you will be asked for since these two positions are automatically compared at the end of the computation. A fix time rounded off to something near the time of the last LOP might be reasonable (i.e. 0136 GMT on 4/15/00). The input and results are as follows:

Input Running Fix Computation:

Speed	8
Course	225
Fix Time	01:36:00
Date	4/15/2000
DR Lat	40°38'
DR Lon	W135°46'

Output

Fix Lat	N40°39.5'
Fix Lon	W135°38.5'
Range	5.89
Bearing	75.0°T

The running fix is at 40° 39.5'N, 135° 38.5'W. From the entered DR position, you would get to this fix by traveling 5.89 miles in direction 075T, that is how much the DR was off. The update DR button places this last fix position into the stored DR location in settings for future use.

How StarPilot handles Times

StarPilot performs all time functions using "Watch Time" (WT) which differs from GMT by a Watch Error and a Zone Description: GMT = WT ± WE + ZD. These two offsets from GMT, or UT as it is now called, are entered under the "Advanced" tab in the "Settings" dialog. Set Defaults puts both of these equal to zero so that WT = GMT. If you have a ZD other than zero set, then many of the time-dependent answers will be labeled as being valid at, for example, GMT-8 for times in PST or ZD = +8. If you prefer GMT only, then set defaults and leave ZD and WE = 0.

Same running fix using local or other time zone and other shortcuts

Suppose in the last example we kept all clocks set to ZD = +7 corresponding to PDT as we sailed across. Now we work the same set of sights using this option, plus a couple other shortcuts.

Sight 1:

15h 05m 10s on Apr 14, 2000 (ZD=7), DR = 40° 58'N, 135° 20'W, S = 8.0kts, C = 225 T, lower limb sun Hs = 55° 31.2', HE = 9 ft, IC = 1.5' On, WE = 0.

Sight 2:

18h 36m 02s on Apr 14, 2000 (ZD= 7), lower limb sun Hs= 22° 36.2', HE = 9 ft, IC = 1.5' On, WE =0. Note we have Watch error = 0 and we do not yet know the DR at the second sight, but course and speed are the same.

Set defaults (INDEX/Settings/Restore Factory Defaults), then under "Advanced" tab, enter ZD = 7 and WE = 0. Under the "General" tab also set IC = -1.5' HE = 9.0 ft, limb = Lower. Then set the date in as day = 14, month = 4, year = 2000. Then start new sequence: INDEX/Celestial Fix/New Sight Seq.

Then set DR Lat = 40.58 and DR Lon = -135.20. Then go to the "DR Parameters" tab and set DR mode = Speed, which will ask for DR time = 15.0510, Course = 225, and Speed = 8.0.

Then do the first sight reduction, but note you will only be asked for the time and Hs and then will get the same LOP.

Now go INDEX/Update DR, select Update DR, and enter the time of the second sight.

Pushing the [Compute] button while the "Update DR" is set to "ON" will update the stored DR in the settings for use by the sight reduction procedure in the next screen. (The 18:36:02 DR should be 40º 38.1' N, 135º 46.2' W.)

Now we do the second sight and arrive at the same LOP we got before (very slightly different since we have a slightly different DR). Performing the Celestial Fix we see the same answer as before.

The logical next step is to update the DR and then carry on with the navigation. The running fix is now complete. *A reminder that screen caps of the process are in Appendix 1.*

This illustration of using stored values is not so much shorter in this particular example, but note we have only 2 sights here. Normally you would have (or should have) 4 or 5 sun sights at each sight session, and then this method is very much quicker. Note, too, how the DR function is incorporated into the sight routine automatically, and we do not have to re-enter that position. We could also update the DR using log settings (set DR mode = log).

We could also have updated the DR after a series of course and speed changes if these had been made between the two sets of sights, but if that were the case, then when doing the fix itself, one should use the speed made good and course made good between sight sessions when "course" and "speed" are asked for. We will add an example of this process of multiple course changes during a running fix and post a link to it shortly at http://davidburchnavigation.blogspot.com. It is the same process we would use when solving the problem by traditional books and plotting, we just get the benefit of fast efficient DR updating with the StarPilot.

2 StarPilot

StarPilot the State of the Art in Navigational Computations

Introduction

Welcome to StarPilot and congratulations on your purchase. StarPilot has been serving the mariner community since November 1999 with reliable and easy to use computation software. Thousands of users worldwide find the StarPilot an indispensable tool in their travels and we know you will too. Enjoy!

Disclaimer

This sight reduction procedure is provided to the sailing community on an AS IS basis. No warranty of any kind, including MERCHANTABILITY or FITNESS FOR PURPOSE, is made with regard to this software. Although the author has made every effort to comply with equations and methods described in the explanation section of the Nautical Almanac and other sources, no guarantees are made concerning the accuracy of this sight reduction procedure. The author or StarPilot, LLC, or any of their agents or resellers shall not be liable for any errors or for incidental or consequential damages in connection with the furnishing, performance, or use of this software. Please use this product at your own risk.

GPS

GPS functionality can be enabled in the iPhone settings under StarPilot.

On GPS capable iPhones and iPads enabling GPS support adds a GPS Console to the Utilities Menu, allows entry of Lat/Lon or DR position in the keyboard picker, and displays Fix range and bearing to GPS position in Fix by computation under celestial fix.

Refer to the context sensitive help for additional information on this feature.

Data Representation

Periodically StarPilot will prompt you for data such as the time of a sight, DR latitude or longitude, GHA, SHA, and Declination. The format used to enter these and other values depends on the type of data to be entered.

All time values are entered in hour-minute-second (h.ms) format. This is accomplished by entering the time values as numbers in the following format hh.mmss where the hh corresponds to hour portion of the time and the .mmss correspond to the minutes and seconds. Note that 2 digits must be used to represent each of the minutes (mm) and seconds (ss) fields. For example the time corresponding to 15h 5m 42s is entered as 15.0542.

On the other hand, times are displayed in the hh:mm:ss format. For example, a time entered as 17.0822 would then be displayed as 17:08:22, and the various times computed by StarPilot are displayed in that format.

Compass bearings, courses, and heading data are entered in ddd.d format. That is, three digits and a decimal - the decimal is optional. Leading zeros (i.e. 090) are optional but recommended.

Sextant altitude (Hs), latitude, longitude, GHA, SHA, and declination (DEC) values are entered in ddd.mmm format, which we abbreviate as "d.m" format. For example the value 34° 55.2' is entered as 34.552, 34° 5.1' as 34.051, and 35° 0.6' as 35.006.

Index Correction (IC) is entered as decimal minutes (mm.m) format, i.e. an index error of -3.3' is entered as -3.3. When entering IC, values should have a minus (-) for "on the scale" errors and no sign (i.e. implicit +) for "off" errors. Horizontal Parallax (HP) and Additional Planet Correction (PCORR), used in some specialized applications, are also entered as mm.m.

Resultant data, such as computed altitude (Hc), azimuth (Zn), and time, are also displayed in d.m format. Unlike the data entry format above, you will see results displayed as nnn° nn.n'. All resultant values are displayed in this format with a few exceptions such as the intercept which is displayed in nautical miles (nm).

The following sign conventions apply when entering data. Positive values for LAT, DEC and LON are entered for North and East. Negative values for LAT, DEC and LON are entered for South and West. A positive intercept is considered to be TOWARDS the sighted body while a negative intercept value is considered to be AWAY.

Note, however, that we do not use the "+" sign for entering positive numbers. Values entered into the calculator are assumed to be positive unless a "-" is entered before the value. Entering a "+" will cause an error.

The year of an event should always be entered in full 4-digit format 1998, not 98. Valid values for days are 1 through 31, and 1 through 12 for month. StarPilot will happily complete sight reductions for the year 98 AD, without blinking, so be sure to use the full date you want. Other than that obvious caution, there are no so-called Y2K concerns with this product.

StarPilot Operation

All StarPilot features can be accessed through the applications menus located on the main Index Menu or via the tab bar below the menus. The menus are broken down into basic categories; Program options, DR and Piloting functions (Utilities), and Celestial Navigation calculations. The most common functions are accessible via icons on the tab bar. Icons on the tab bar are a pictorial representation of the function they invoke.

StarPilot's tab bar can be customized to suite your particular requirements. Four of the most commonly functions can be displayed at any time. Additional functions can be accessed by tapping on the "More" icon. Tapping on "More" will display a list of 13 additional commonly used functions. When in the "More" list, pushing the "Edit" button allows the customization of the tab bar. Selecting the Sunrise Icon, for example, and dragging it down to the tab bar will cause this function to replace one of the tab bar icons.

Upon selecting a function via a menu entry or a toolbar icon, StarPilot pops up a customized data entry dialog box. Once all data is entered hitting the [COMPUTE] button produces the result. For example, Selecting the "Moon" icon displays the moon rise and moon set dialog.

Resetting Factory Defaults

At times it may be desirable to reset your program to a known state. This can easily be accomplished by selecting "Set Factory Defaults" from the "Settings" menu.

The StarPilot comes prepackaged with a set of reasonable results. The Resetting Factory Defaults section of the manual discusses these settings in greater detail. It is possible to customize the default settings with "Make Default Settings". "Make Default Settings" takes the values stored into the current settings and stores them to the registry. Future calls to "Set Defaults" will extract the customized values stored in the registry and write them into the program default values.

There are many optional settings in the StarPilot so you may want to use this process at some point to get reoriented. See section Resetting Factory Defaults for details, including a complete list of the specific values of the default settings, in the help for "Settings".

3 About

The StarPilot programs were developed by Luis Soltero and David Burch.

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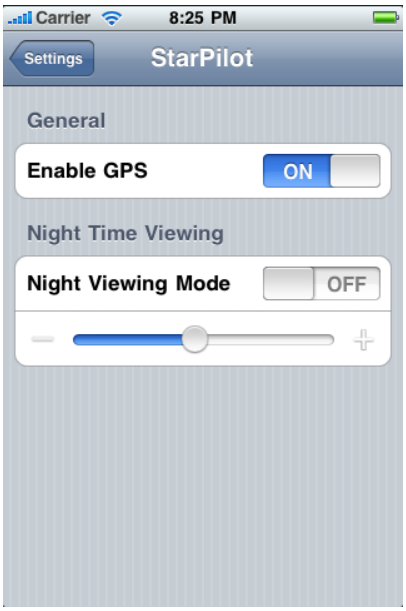
4 Settings

StarPilot's settings are split into two distinct categories. The program settings are used to configure program features such as nighttime viewing and to enable the GPS. The celestial settings are used to enter values such as height of eye which do not change between sights to aid in data input.

Program settings are found in the iPhone system settings while celestial settings are accessed from within the program.

4.1 Program Settings

StarPilot's program settings are accessed by exiting the program (tapping the home button) and then running the iPhone system preferences application. The StarPilot settings are usual found towards the bottom of the form. Tap the StarPilot icon to access the settings.



4.1.1 Enable GPS

Turning on the GPS results adds a new menu entry to the utilities menu called "GPS Console" which displays a number of GPS related parameters such as time, date, lat, lon, heading, speed and course over the ground if available.

Enabling the GPS also actuates the GPS button in the keypad entry screen. Pressing the GPS button when entering Latitude or Longitude selects the current GPS position. This is handy, for example, when doing sight reductions since your current position is can be used for the DR Lat/Lon.

4.1.2 Night Time Viewing

Enabling Night Viewing Mode turns the StarPilot's screen a shade of red to help preserve nighttime

vision when working sights in the dark. The slider sets the redness of the display. "-" removes while + adds red hughes. The default value should be adequate for most viewing conditions.

4.2 Navigational Settings

The settings dialog is used to store semi-permanent data that is to be used in your calculations. Values stored here are used to pre-initialize data inputs in many of the dialogs. Settings dialog can be invoked from the Settings menu in the main index or the settings tab bar icon.

The following is a discussion of each settings parameter ordered by tab name in the Settings dialog.

Setting and Making Defaults

The "Restore from Default Settings" function will set the values stored in the global settings to a known state. Unless "Make Curr Settings Default" has been executed at some previous point, settings will be restored from factory defaults (see below for details). Note that it's possible to store your own defaults by executing "Make Curr Settings Default". This last function takes the current values stored in the settings and writes in permanent storage for later retrieval by "Restore from Default Settings".

Note that StarPilot also writes the current settings to a file when Save is selected in the sight archiver. In the sight archiver, when restoring a file with the Open function the settings are restored back to the state prior to the original state.

The following actions take place when restoring the factory default settings:

- The internal date is cleared.
- DR Lat/Lon in memory is erased.
- Dest position in memory is cleared.
- DR mode set to OFF.
- Body limb is set to LOWER.
- Dip mode is set to NORMAL.
- Index error is set to 0.
- Height of eye is set to 0.
- Units are set to °F, mb, and ft.
- Temperature is set at 50° F.
- Pressure is set to 1010 Millibars.
- Magnetic variation set to 0.
- ZD is set to 0.
- Watch Error is set to 0.
- Course, Speed, Log each set to 0.
- Hc min/max/Mag cutoff set to 0°/90°/2.
- Max number of sights is set to 60.
- All sights stored are cleared.
- Find sights is OFF in the sight planner.
- Planner control step=8, slop=16, grid wt=0.7, mag wt=0.2, Hc Wt=0.1

Reset Form from Settings

Many of the dialogs in StarPilot have a menu entry called "Reset Form from Settings". This function restores the values in the form to program global settings. This makes it easy to "experiment" with input values since all the values in the form can be reset quickly to their user defined defaults.

4.2.1 General Settings

The general settings is used to set default values for the most commonly used inputs.

Date

The date is used to identify celestial sight times as well as the current DR position, and for sight planning. The date to enter is the date on your watch that you are using for the sight times. If using GMT time, use GMT date, and if local time, use local date.

DR Position

The stored date and DR position will be assumed as the current date and DR position in all calculations and StarPilot will therefore place these values as defaults in all dialogs requiring this input.

Destination Position

This position is used for routing computations and for an automatic update of range and bearing to destination at the end of each fix. It can be very convenient to have it stored to save entering it for every update.

Index Correction

Enter the IC in minutes of angle, positive when OFF the scale, and negative when ON the scale, i.e. -2.5. The stored IC is used in sight reductions and all other computations requiring this input. By initializing this setting the value stored here is used as a default in dialogs needing this value.

Height of Eye (HE)

The height of eye is entered in feet or meters depending on how you selected the units. Units an be entered in feet or meters by simply selecting the appropriate radio button.

Limb

The default limb for sun and moon sights is stored here. Normally this would be the Lower Limb.

Note that instead of *Lower* or *Upper* you can also enter *Center* here and compute to the center of the body if you have use for that information. This option can be used for some artificial horizon sights where the direct and reflected images are superimposed in the sextant.

Naturally, if you have Lower limb stored here and then choose to do an upper limb sight, then this setting must be changed for that sight.

4.2.2 Advanced Settings

Advanced settings is used to set default values for more advanced features.

UT Offsets (ZD / WE)

StarPilot navigates using "Watch Time" (WT), which is defined from: UT = WT +WE +ZD, where WE is the watch error (fast is -) and ZD is the zone description (east is -). The total UT offset (WE + ZD) is entered in this setting in two steps by entering the values into the corresponding boxes in the dialog. Note that for computations done by the StarPilot there is no distinction between UT and GMT.

Temperature and Pressure

Enter temperature and pressure in the corresponding boxes making sure to select the appropriate units.

Extreme variations in temperature and pressure affects the magnitude of the atmospheric refraction correction. Valid temperature and pressure settings should be entered if low-altitude sights are to be taken in extreme conditions. StarPilot default values are 1010 millibars and 50°F — which correspond to "no additional corrections" data from the Nautical Almanac.

Maximum No. of Sights

StarPilot has memory enough to store an unlimited number of celestial sights. With this setting you can limit this maximum number, which might help with your bookkeeping and prevent slowing down data review and some computations. Also note that a Running Fix uses all stored sights, so if you end up with more than you want in the list, the results may be wrong or not optimum.

To set this option, simply type in the desired number at the prompt. By default the StarPilot keeps track of the last 60 sights. If a sixty first sight is taken then the first sight in the sequence is discarded. Note that the order of the sights is important. When replacing sights it is not the oldest sight (time wise) which is discarded but the sight which was reduced the earliest. Sights are numbered in the list. With a max set to 15, when #16 is entered, #1 is discarded and #2 becomes #1, and your new one becomes #15.

Local Magnetic Variation

StarPilot, by default, displays and queries bearing data in True format. Changing the default value of the magnetic variation causes the program to display and prompt for data in magnetic compass bearing format. The only function which does not compensate for magnetic variation is the Great Circle which only displays values in true format. All prompts for bearings and heading displays will contain a (T) for true or an (M) for magnetic depending on the state of the magnetic variation value.

To change the default of the local magnetic variation from 0° to 7° W simply execute the menu entry and enter the requested data making sure to select the West.

Note that all celestial utilities only use (T) when displaying results or prompting for values.

Dip Mode for Dip Short

"Normal" is the usual choice corresponding to typical sights using the true sea horizon, or more specifically, using the visible horizon as cut off by the actual curvature of the earth.

When using a shoreline beneath the sighted object as a horizon instead of a proper sea horizon, the dip correction must often be figured in a special manner, called "Dip Short." This method is required whenever we are actually seeing the shoreline and not the true curvature of the earth. Dip short depends on the Height of Eye and the distance to the shoreline directly below the object sighted.

To decide if dip short is needed, compare the square root of HE in feet with the distance to the shoreline in nautical miles. If the latter is larger than the former, then you are indeed seeing the curvature of the earth cut off the shoreline and you can do sight reductions in the normal manner. If this is not the case, then you should use Dip Short (i.e. set dip mode = short), and StarPilot will prompt you for the necessary extra input when doing sight reductions.

Dip short is very useful for sextant practice on inland waters, even rather small lakes. It is usually much better to practice this way than to use an artificial horizon. For practice, the general procedure would be to take the sights, then figure Zn from the sight reduction, then return to the chart and from the known practice location and Zn you can determine the necessary distance to the shoreline.

Underway dip short can also, though rarely, be of value if you happen to get close to shore but do not know where you are and the only sextant sight is of the sun or moon over nearby land. Please refer to Bowditch (or other piloting sources) for various piloting techniques used to figure distance off shore even without knowing where you are.

4.2.3 DR Parameter Settings

This dialog is used to control StarPilot's automatic DR update feature.

Setting the DR mode

The DR mode determines how the Update DR function operates as well as several others. StarPilot has 3 DR modes: Off, Speed & Time, or Log. The default mode is "Off" which means that all functions that use course, speed, or time will prompt for the values needed to complete the computations. This is a "normal" or "non-interfaced" mode. It is simple and easy to use, but not the most efficient.

The Speed and Time mode (abbreviated Speed) assumes the traditional method of doing DR by speed and time. That is, the log book records positions and course changes by the time of the event, and also records the active speed.

When in the DR mode = Speed, each DR position stored in the calculator is associated with a specific time and speed. In this mode, you can update the DR by simply telling StarPilot the next time you care about. It knows the time of the last DR position, your course and your speed, so it can compute the new DR and store it.

The "Log" mode assumes you are keeping DR records by Log reading. This works like the Speed mode, but to update DR you simply input the next log reading you care about.

With these two modes we can project our present position into the future two ways: by either telling

StarPilot we ran 45.8 miles on our course (Log mode), or that we ran for, say, 12h 30m on our course at whatever our speed is (Speed mode). It is also simple to switch back and forth between modes to select the one that is most convenient for the task at hand.

These computations can be made as part of your ongoing navigation or as a simple navigation computation. Once the computation is done, you have the choice of updating the stored DR with that result or just abandoning it.

If you choose to update DR after the computation, then the DR Lat and Lon stored will be changed to these new values. In Off mode, that is all that happens. In Log mode, the DR Log is updated and in Speed mode, the DR clock is updated.

With this function, you can almost literally type your log book into the StarPilot, line by line, and figure the final DR position, just entering the new course and or speed as you come to them. To get started, whenever executed, the DR mode function first prompts for the desired DR mode and then automatically enables the Course/Speed entries in the dialog. Set the appropriate course, speed, DR Log, and DR Time depending on the mode.

The most common mode to use will most likely be the Speed and time mode, unless you specifically use log readings or distance run to figure a new position. We include the log mode since this is indeed the most accurate way to keep DR records underway in small-craft at sea - that is, at each course change we record the log reading, since this is a more accurate measure of our progress than the corresponding time and speed.

See the Update DR function under the DR-and-Piloting menu for more information on DR tracking and updating.

Course and Speed

The Course/Speed entry in the Advance Settings dialog is used to set the vessel's Course and Speed needed for the DR function.

The course will be requested with a (T) or (M) for true or magnetic depending on whether or not the magnetic variation has been set to a non-zero value in. By definition, a zero variation is a true course. You can change this back and forth as you see fit.

These values of Course and Speed are used automatically for DR updates, but when it comes time to evaluate a running fix, you will be asked to enter these for each fix so you are certain that the proper values are entered for the fix computation. In principle, you could be doing a routine DR computation with one set of values, but then want to use some effective CMG or SMG for evaluating sights with course changes made during the sight sequence. (The Traverse table function is a convenient way to figure CMG over a series of course changes.)

4.2.4 Sight Planner Control Settings

The planner control settings dialog is used to set parameters that control the searching of bodies in the almanac for display in the sight planner. These parameters also control the automatic Find Sights feature of the sight planner which automatically selects the best bodies in the sky to shoot to obtain the best possible fix.

Hc Min, Max, Mag Cutoff

Hc-min and Hc-max are used to set limiting values for the body search routines used in the Sight Planner and Star/Planet ID . Bodies with altitudes greater than Hc max and smaller than Hc min will not be displayed. The default magnitude cutoff is 2, which means the Sight Planner will stop looking for stars and switch to planets once it finds a star with magnitude greater (i.e. dimmer) than 2. The sight planner searches for stars in order of Brightness. Only stars brighter than the magnitude cutoff will be displayed.

The default values for Hc are 10°, 85°, but for use underway, settings of 10°, 80° might be better. Lower sights have a larger uncertainty due to refraction uncertainties and sights higher are more difficult to take and require a more careful analysis.

Likewise, although 2. will usually get all the bright stars you need, sometimes their will not be enough there and you will have to go higher, but more often you can get by with a lower number maybe just 1.8 or so. Once you optimize this, it will typically be the same for many nights on a voyage.

Find Sights Control

The find sights control enables or disables the automatic find sights feature of the sight planner. When OFF the sight planner will display all bodies which match the search criteria. When the control is set to something other than off then only the selected bodies will be displayed and a sequence of the best 3 bodies to shoot is displayed on the sight planner screen. Selecting "Stars Only" will cause the sight planner to display and compute best sights only on stars. The other selections simply change which bodies to display and compute best sights for.

See the sight planner page for more information on the use of this function.

Step

The sight planner invokes the optimizer after sets of bodies have been found that meet the almanac search criteria defined above. The optimizer then lays a grid consisting of 3 lines that meet at the center of the sky projection and extend towards the horizon at approximately 120 degrees apart. Stars that fall close to the grid are considered as possible candidates for running fix triads.

The Step parameter controls the coarseness in degrees of grid as it "steps through the sky" from 0,120,270 degrees to 120, 270, 360. For example a Step of 8 would define grids at (0,120,270), (8, 128, 278), (16, 136, 286), etc. Decreasing the step value increases the computational and memory demands of the operation which results in longer compute times while increasing the step speeds things with a possible loss in accuracy.

Slop

The sight planner invokes the optimizer after sets of bodies have been found that meet the almanac search criteria defined above. The optimizer then lays a grid consisting of 3 lines that meet at the center of the sky projection and extend towards the horizon at approximately 120 degrees apart. Stars that fall close to the grid are considered as possible candidates for running fix triads.

The Slop parameter controls the distance in degrees a given body must be from the grid before it will

be considered as a member of a triad. In order to find all possible triads the Slop factor must be at least 2 times greater than the step. Increasing the slop factor by more than 2x the step yields a larger number of duplicate triads that must be removed before the optimizer analyzes the triads. Decreasing the value may result in the optimizer missing some triads.

Grid Weight

The sight planner invokes the optimizer after sets of bodies have been found that meet the almanac search criteria defined above. The optimizer then lays a grid consisting of 3 lines that meet at the center of the sky projection and extend towards the horizon at approximately 120 degrees apart. Stars that fall close to the grid are considered as possible candidates for running fix triads.

After all possible triads have been located the optimizer weighs them according to their optimal sight and running fix performance. Grid Wt, Mag Wt, and Hc Wt are parameters that control the "goodness" of a sight triad. Grid Wt controls how close a set of bodies must be to the grid to be considered "good". A value of 1 indicates that the grid factor is very important while a value 0 indicates that any triad is good as long as the bodies lie within the "slop" factor from a grid.

Magnitude Weight

The sight planner invokes the optimizer after sets of bodies have been found that meet the almanac search criteria defined above. The optimizer then lays a grid consisting of 3 lines that meet at the center of the sky projection and extend towards the horizon at approximately 120 degrees apart. Stars that fall close to the grid are considered as possible candidates for running fix triads.

After all possible triads have been located the optimizer weights them optimal sight and running fix performance. Grid Wt, Mag Wt, and Hc Wt are parameters that control the "goodness" of a sight triad. Mag Wt controls the importance of brightness when computing the "goodness" of triads. A value of 1 for Mag Wt means that the brighter triads should be considered better than dull ones. A value of 0 indicates that brightness is not important.

Hc Weight

The sight planner invokes the optimizer after sets of bodies have been found that meet the almanac search criteria defined above. The optimizer then lays a grid consisting of 3 lines that meet at the center of the sky projection and extend towards the horizon at approximately 120 degrees apart. Stars that fall close to the grid are considered as possible candidates for running fix triads.

After all possible triads have been located the optimizer weights them optimal sight and running fix performance. Grid Wt, Mag Wt, and Hc Wt are parameters that control the "goodness" of a sight triad. Hc Wt control the importance of Altitude when computing the "goodness" of triads. A value of Hc Wt of 1 means that triads where the bodies are at similar altitudes is important while a value of 0 indicates that Altitude is not important in the computation of the "goodness" of a triad.

5 Celestial Bodies

The functions found in this menu are used to compute properties of celestial bodies such as time of rise and set, star and planet identification and compass calibration. Note that most of the operations performed in this menu use values stored in the settings menu.

5.1 Sunrise

Sunrise, Sunset, Twilight, and LAN

Sunrise/LAN/Sunset computes the times of sunrise, sunset, nautical and civil twilight, and meridian passage (LAN). Also output are the bearing to the sun at rising and setting, height of the sun at LAN, and the LHA Aries at the midpoint between nautical and civil twilights. Input is DR position and date. To compute July 4, 2000 at 47.39, -122.20, enter these data in the settings. To see local times, input ZD , in this case +7 for PDT, and then select "Compute Sunrise" from the menu. You should observe the following results.

Date: 7/4/00
Latitude: N47°39.0'
Longitude: W122°20.0'
Nautical Twilight: 03:44:04
Civil Twilight: 04:37:33
Sunrise: 05:17:49
Sunset: 21:09:29
Civil Twilight: 21:49:44
Nautical Twilight: 22:43:14
LAN: 13:13:45
Equation of Time: -00:04:25
Hc: 065°08.4'
Zn Rise: 053.7°
Zn Set: 306.2°
AM Twilight: 04:10:49
AM GHAA: 328°08.4'
PM Twilight: 22:16:29
PM GHAA: 240°18.2

"Equation of Time" is the difference between 12:00 UT and the UT of LAN observed at Lon = 0°.

The values of LHA Aries is used for setting up Star Finders or Pub 249 for sight planning and star ID, although StarPilot will itself perform these planning functions for you.

The bearing of the sunrise and set relative to 090 and 270 is called the "amplitude" of the sun.

5.2 Sight Planner

The sky view function (Sight Planner) graphically displays a radar-like projection of the sky at a specific time and place. The Sight Planner can also compute the best bodies to "shoot" to obtain the best possible fix. This feature is called Find Sights and is documented in the next section.

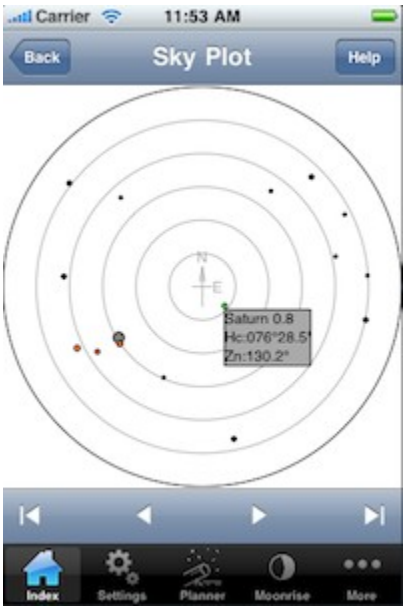
Input are the date, time, and DR position. Active settings also used are found in DR Parameters in Settings which set upper and lower limits on Hc and a cutoff magnitude of stars to compute. Please review that section for important details.

The program then searches through the internal almanac for the visible stars and planets, followed by displaying a graphical view of the sky. Note that stars are displayed as black points on the screen, planets are identified by small orange dots, the Sun is a yellow filled circle, and the moon is displayed as a gray filled circle.

First a quick check for the sun and moon is carried out, then the star search. Stars are searched in order of brightness with the magnitude of the current star in view. Once the picture is drawn, finger touches to move around the screen. To select a specific body on the screen and obtain further information simply tap the body with a finger.

Mercury is included and you can take sights of it for navigation, although it is not listed in the Nautical Almanac because it is only rarely useful. Nevertheless, StarPilot will nicely warn you when it is there so it won't get confused with another star or planet.

The following example displays the position of the brightest stars, moon, and the planets at 2200 GMT on January 1, 1998 at 12° N, 68° W.



"Plot Sky" displays the star map on the StarPilot's main display. "List Bodies" will list in tabular form, information about all the visible bodies. "Best Sights" is only active when using the find sight feature of the sight planner discussed in the next section. Enable Twilight is used to plot sky maps at mid twilight times for doing star sights.

Find Sights - Sight Control

StarPilot includes a "Find Sights" feature which is part of the sight planner which will compute sets of 3 body triads which will yield optimal running fixes.

Settings

The following settings are used to control "Find Sights" feature of the sight planner. These settings are accessed through the Settings menu and their function is reviewed here for you convenience.

Hc Min/Max/Max Mag are used by both the sight planner and optimizer to set clip values during the search for bodies. Hc Max/Min set the Maximum and Minimum altitudes to be considered when displaying a body. Bodies with altitudes higher than the Max setting or lower than the Min setting will not be displayed. Max mag defines the magnitude cutoff during the search for bodies. Only bodies brighter or equal to Max mag will be displayed.

Steps, Slop, Grid Wt., Mag Wt., and Hc Wt. are used to control the sight optimizer and are ignored by the sight planner.

Theory of operation

The sight planner invokes the "Find Sights" optimizer after sets of bodies have been found that meet the almanac search criteria defined above. It then lays a grid consisting of 3 lines that meet at the center of the sky projection and extend towards the horizon at approximately 120 degrees apart. Stars that fall close to the grid are considered as possible candidates for running fix triads.

The Step parameter controls the coarseness in degrees of grid as it "steps through the sky" from 0,120,270 degrees to 120, 270, 360. For example, a Step of 8 would define grids at (0,120,270), (8, 128, 278), (16, 136, 286), etc. Decreasing the step value increases the computational and memory demands of the operation which results in longer compute times while increasing the step speeds things with a possible loss in accuracy.

The Slop parameter controls the distance in degrees a given body must be from the grid before it will be considered as a member of a triad. In order to find all possible triads the Slop factor must be at least 2 times greater than the step. Increasing the slop factor by more than 2x the step yields a larger number of duplicate triads that must be removed before the optimizer analyzes the triads. Decreasing the value may result in the optimizer missing some triads.

A step factor of 8 with a slop of 16 has been found to be a good compromise. If a particular sky yields a small number of triads (or none at all) the step factor should be decreased and/or the slop factor should be increased.

After all possible triads have been located the "Find Sights" optimizer weights the grids for optimal sight quality and running fix performance. Grid Wt, Mag Wt, and Hc Wt are parameters that control the "goodness" of a sight triad. Grid Wt controls how close a set of bodies must be to the grid to be considered "good". A value of 1 indicates that the grid factor is very important while a value 0 indicates that any triad is good as long as the bodies lie within the "slop" factor from a grid.

Mag Wt and Hc Wt control the importance of brightness and Altitude when computing the "goodness" of triads. A value of 1 for Mag Wt means that the brighter triads should be considered better than dull ones. A value of 0 indicates that brightness is not important. A value of Hc Wt of 1 means that triads where the bodies are at similar altitudes is important while a value of 0 indicates that Altitude is not important in the computation of the "goodness" of a triad.

The StarPilot uses a default grid factor of .7, magnitude weight of .2, and Altitude value of .1. To make brighter triads "more important" increase the value of Mag Wt.

Operation

The "Find Sights" pull down menu controls the bodies that should be considered when computing triads.

A value of "OFF" switches the optimizer off resulting in a display of the sky with no triads. The Sun, Moon, Stars, and Planets are included in the almanac search.

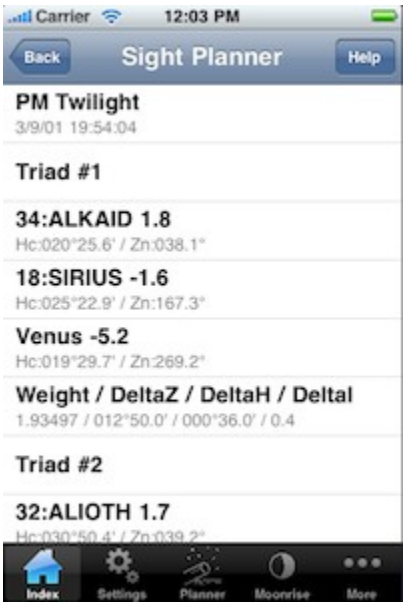
"Star only" turns the optimizer on for Stars only.

"Stars and (Moon, Planets, Moon and Planets)" includes the corresponding bodies when computing triads. Note that the optimizer never uses the sun and that the magnitude of planets is set to 0 when computing the weight factors of triads.

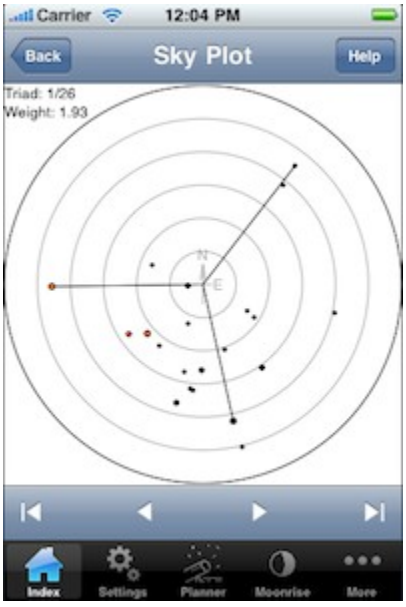
"Plot Sky" or "Best Sights" starts the ball rolling. First the almanac is searched. After the sky search has been completed the optimizer is invoked to compute running fix triads.

Finally a picture of the Sky and weighted triads are displayed.

The following example computes triads for PM Twilight on 3/9/2001 at 47.40N 122.20W using stars and planets. Note that Zone description in the settings is set to 7 hours yielding local times for AM and PM twilight times.



A picture of the sky with the "preferred" triad is initially displayed on the screen. The 1/26 in the upper section of the screen indicates that triad 1 of 26 is currently being displayed and that it has a computed goodness value of 1.93. Clicking the "right" arrow button on the tool bar will move you forward through the grids in order of increasing to decreasing "goodness". Clicking the "left" arrow button will cause StarPilot to move through the triads in reverse order of "goodness".



5.2.1 Sky Plot

Sky Plot displays a pictorial view of visible bodies in the sky. The plot is oriented true north and is a 2-dimensional projection of the heavens. When holding the unit pointed north plot should line up with the heavens. The sun is displayed as a yellow disk, moon is gray, planets are orange and stars are black. The size of the disk represents the magnitude brightness of the body. i.e. dim stars are displayed as dots while brighter stars are displayed as larger disks.

The plot can be zoomed by pinching the screen with 2 fingers. Tapping on a body will cause the selected item to turn green. A pop up window appears with the name of the body, Hc, and Zn.

The arrow keys on the tool bar are used to page through triads displaying "Best Sight" plots.

Please see help for Sight Planner for a full discussion.

5.3 Sight Analyzer

The goal is to effectively average a series of sights to determine which one is a proper representative of the full set. To do this, we compute the theoretical values of Hc over the time interval of the sights stored-taking into account the motion of the vessel-and then compare the slope or curve of these data with the actual sights. This process shows which sights are outside of statistical fluctuation, so they can be deleted or not considered, and lets you choose the best of the set.

To execute Sight Analyzer in StarPilot, enter a set of sights of the same body over a reasonably short time period (10 to 20 minutes or so) using the normal Sight Reduction function. If the Hs values change too much during your sight period (time is too long), then the Hs scale on the calculator display is too compressed and differences do not show up well. Once the sights are stored, set DR mode to Speed, DR time to the time of the first sight and enter the correct DR position for that time, along with your course and speed made good over the sight period.

Then from the Celestial Fix menu, select Sight Analyzer. The sample here shows its use for a series of sights at LAN, but it would more typically be used for any sequence of sights of the same body.

The Analyzer will then compute the Hc value (actually a computed Hs, since we undo all the corrections that have been applied to the sight at that time), then store this theoretical value, and then proceed on down your sight list, advancing the DR to the time of the next sight, computing Hc, and storing it, until all are done. Next the curve of theoretical sight values is drawn as a graph and your actual sights are plotted on the graph. Any sights that are far from the plot are most likely wrong.

To best compare the data, move the curve by swiping the screen or using the double up/down arrows in the tool bar, and this way find the best fit to the data. Hs and watch time at the current cursor location are displayed at the top of the screen. You can tap the screen or use the arrow buttons in the tool bar to move the cursor. Find a location off of a data point that will place the curve (line) such that there are about the same number of points above as below the line, but disregard any that are clearly far off the

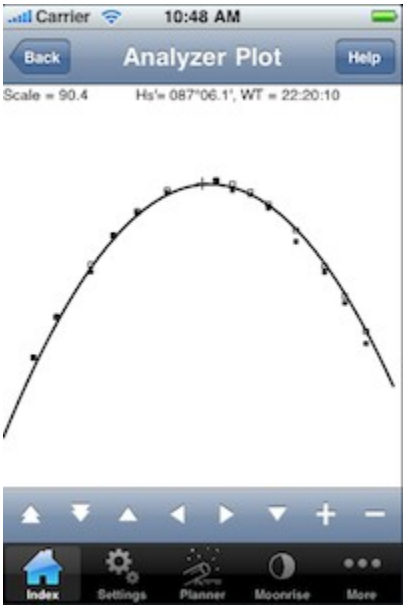
line. Then choose any one sight that is on the line as your best. That one sight will be as good for a fix (or better) than all the sights plotted together.

This process can also be applied to any sights. Those taken before or after LAN could be used for a "reduction to the meridian" analysis (see older versions of Bowditch for reference).

This tool is best suited for poor or sparse data. The LAN example sights have little spread, yet we can still improve the analysis as shown.

The sight analyzer provides a mechanism for selecting specific sights out of the sight array to analyze using a sight filter. By default, all sights in the sight array are displayed. You can select a sub range of sights to display checking the desired sights and unchecking the undesired ones.

A sample 1982 LAN sighting including 14 measurements is included with the StarPilot distribution. The sample sight is called 102-LAN.sp. To analyze this sight sequence first restore the sample from the sight archive (under Index->Celestial Fix->Site Archive). Then return to the Sight Analyzer function to view. The following image shows the sight analyzer in action.



5.3.1 Analyzer Plot

Analyzer plot is used to analyze a series of plots. Please refer to the Sight Analyzerhelp in the previous screen for a full description of the function.

The plot can be zoomed by pinching the screen with 2 fingers. Alternately, you can use the +/- buttons on the toolbar to zoom in/out.

The theoretical Hc curve can be moved by either swiping the screen or by using the double up/down arrows. The curve should be moved such that it fits the most number of points on the screen.

Hs and Watch Time (WT) at the cursor location are displayed at the top of the screen. The cursor can be moved by taping the screen or by using the arrow keys on the tool bar.

5.4 Precompute

The precompute function is used to compute Hc and Zn for a body when planning sights, working problems from a text book, or evaluating existing sight data. The function works exactly like the Sight Reduction from the main menu with the exception that only Hc and Zn are displayed. To precompute the expected Hc and Zn for the Sun on September 10, 1996 at N34°55'/W35°50' you get the following results:

Body: SUN
Hc: 055°55.6
Zn: 211.3°T
GHA: 052°47.7'
DEC: 004°40.2'
SHA: 190°51.7'
SD: 15.9'
HP:0.1'
Mag: NA

5.5 Star/Plant ID

With this function it is possible to identify a star or planet by simply noting the altitude and bearing to the heavenly body. For example, say one would like to identify a bright body observed at GMT = 21h 7m on September 10, 1996 at an altitude of 31° 36' bearing 171° true, our DR position is 34° 30' N, 36° 30' W and our observation height is 10 feet.

Press "Compute Star/Planet ID" to start the search through the internal star and planet catalog to identify all bodies within ±5° of the observed data, First sun and moon are checked (this is automatic) and then through the stars starting from the brightest.

Input:
Watch Time: 21:07:26
Date: 9/10/1996
DR Lat: N34°30'
DR Lon: W36°30'
IC(min):0'
He(ft): 10
Hs: 31°36'

Bearing: 171°.0T

Result:
GHA: 028°08.6
SHA: 081°06.7
DEC: S23°26.2'

Body: Jupiter
Magnitude: -2.4
Hc: 031°35.6'
Zn: 171.3°T

We find that Jupiter, a very bright body with magnitude -2.4, meets the search criteria precisely. Note that magnitude difference of -2.4 to +2.1 is 4.5 magnitudes or some factor of 100 in brightness.

Star and Planet ID uses the same internal function used for the Sight Planner. That means that it also reads the settings for Hc min and max in "Sight Planner Settings". If you have found a low or high star that is outside of the range you have set, then you need to first open up that range to find it. StarPilot will not find a star at Hc = 8°, when Hc min is set to, say, 10°.

5.6 Moonrise

Moon Rise, Set, Phase, Age

The example computes the moon rise for February 2, 1998 at 12° N, 068° W.

Rise Time: 2/2/98 15:19:52
Set Time: 2/3/98 03:58:51
Phase: 0.28
Age: Waxing Crescent (5)

The first half of the output screen displays the Watch Time (GMT - ZD) for rise and set of the moon. (If the ZD had been set to, say, +5, then the time reported here would have been "GMT - 5" which is what we call "Watch Time.") The second portion of the display indicates the phase of the moon and its age. The moon is full when the value of its phase is 1 and new when the phase is 0. The moon age indicates the exact day in the moon cycle. Day 1 indicates a new moon while day 14 indicates a full moon.

6 Sight Reduction

StarPilot easily, accurately, and quickly reduces sights for the Sun, Moon, five major planets, and 173 selected stars using its perpetual internal almanac. This section describes procedures for doing sight reductions using the internal almanac.

To follow through the next examples, first Set Defaults so we start at the same place.

The StarPilot uses the same dialog to do sight reduction of all bodies. To do a sight reduction of a specific body select the body from the "Body" selector. This will bring up a scrolling list of bodies. The list can be sorted in a number of different formats and can be searched. Filling in the rest of the form and hitting "Compute Sight Reduction" provides the result.

If you make a mistake the "Delete Sight" button can be used to erase the sight from the sight array. Note that only the current sight can be removed. For more extensive editing of the sight array review sights must be used.

Hitting "New Sight" allows you to start the next sight.

Following are several examples:

Sun Sight Reduction

The procedure for doing celestial sight reductions is best illustrated by an example. Suppose we wish to reduce a Sun sight given the following parameters.

GMT = 15h 35m 42s
Date = Sept 10, 1996
DR Latitude = 34° 55' N
DR Longitude = 35° 50' W
Hs = 54° 58.8' for Lower limb Sun
HE = 10 feet
IC = 2.5' (ie 2.5' OFF the scale)

Result:
Body: Sun
WT: 15:35:42
HS: 54°58.8
Zn: 214.3°T
Intercept: 9.6

Note that GMT = Greenwich Mean Time, which is the traditional name for the modern term universal coordinated time (UTC), which is the same as what we call watch time (WT) with the zone description (ZD) and watch error (WE) set to 0.

Before doing the sample sun sight please turn on the calculator and reset it to its factory default state. Once the StarPilot has been reset return to the main menu and select the Sight Reduction dialog.

Select Sun for a Sun sight. The program will then inform you that you are performing sight number one and then prompts you for the time of the sight.

In StarPilot, all times are entered as Watch Times (WT), which are defined by this equation

GMT = WT + WE + ZD,

where the Watch Error in seconds and the Zone Description in hours are stored in the Advanced Settings dialog. The default has both = 0, which makes WT the same as GMT.

Now enter the data being careful to observe the data entry conventions described in the Quick Start section and Introduction.

Note the minus in the -35.5 representation of 35° 50.0' West. IC is used to enter the index error in decimal minutes. The IC is simply added to the Altitude reading (Hs) and therefore should have a minus (-) for "on" errors and no sign (i.e. implicit +) for "off" errors, ie, "If it is on, take it off."

The output screen shows the body sighted, sight number, and then a review of the input, WT and Hs, then the Azimuth Zn and the altitude intercept, called here "Int" but usually abbreviated "a" or the "a-value." Here a = 9.5' T 214.3, where the Azimuth Zn is always a true bearing. Int(nm) is the intercept (a-value) in nautical miles, positive values are TOWARDS, negative values AWAY.

StarPilot records this sun sight for future use in a LOP plot or Celestial Fix option [4], described later.

If you detect an obvious error in the input simply hit the "Delete Sight" menu entry to remove the sight from the sight array.

Star Sight Reduction

To reduce star sights, select Star from the Sight Reduction menu. Sample:

Star = Capella
GMT = 7h 11m 21s
Date = May 2, 1988
DR LAT = 49° 32' N, DR Lon = 165° 12' W,
IC = -3.0', HE = 16 ft
Hs = 36° 14'

Result:
Intercept: -18.50
Zn: 300.8°T

The a-value = 18.5' A 300.8°.

To prepare and evaluate star sights, StarPilot provides an easy method for identifying stars and planets and also a comprehensive Sight Planner.

Planet Sight Reduction

Select Planet for a planet sight reduction. Here is an example.

Planet = Jupiter,
GMT = 21h 07m 26s
Date = Sept 10, 1996
DR Lat = 34° 30'N
Lon = 36° 30'W
Hs = 31° 36.0'
IC = 0
HE = 10 Feet

Result:
Intercept: -4.20
Zn: 171.3°T

Sight #3, a = 4.2' A 171.3.

Note that although these sights are numbered as we do them in this series of examples, they are totally unrelated and not part of any fix sequence. The "5" before Jupiter is simply the number of the planet in StarPilot, which includes 6 planets. This number is useful in judging progress in search routines such as Star/Planet ID and Sight Planner.

Moon Sight Reduction

Moon, Lower Limb,
GMT = 10h 01m 04s,
Date = October 22, 1996,
IC = -1.7, HE = 18 feet,
DR Lat = 26° 20' S, Lon = 99° 27' E,
Hs = 33° 39.3'.

Result:
Intercept: -12.40
Zn: 079.9°T

Answer, a = 12.4' A 079.9.

7 Celestial Fix

StarPilot will record a series of sights over time and given more than 2 will advance them to a common time and calculate a position fix which we call "celestial fix.". Alternately, the program provides for a method of graphically displaying the LOPs from various sights. The user then manipulates the arrow keys to select the coordinates of the fix. Plotted LOPs can be advanced to a common time or not advanced based on user input.

Generally the first step in doing any fix would be to review the sight data stored, which can be done with the "Review Sights" option of this menu. If you execute the function right now, however, you would see the 4 sights from the last example, but it would not make sense at all to execute a fix from that data since they were from different times, places, etc.

Hence to show how celestial fixes work in StarPilot, let us start all over again with a new set of data.

3-Star Fix Example

On July 6, 1996 a vessel traveling at 20 knots on a heading of 325 True at approximately 32°N and 15° W made the following 3 observations. The index error was 0.0 and the height of eye was 10 ft. What is the expected position of the vessel at 2100 GMT determined from the following three sights? The ZD of the watch was set to 0 (WT = GMT) and there was no watch error.

1. Regulus (#26)
   WT = 20h 39m 23s, Hs = 25° 00.6'.
2. Antares (#42)
   WT = 20h 45m 47s, Hs = 27° 05.7'.
3. Kochab (#40)
   WT = 21h 10m 34s, Hs = 47° 27.6'.

Given that most of the parameters for these 3 sights are the same, it would be most expedient to use the StarPilot settings menu to set up the sight parameters before actually doing the sight reductions and then use Sight Reduction Mode = Sequential which will read the values for each sight. Refer to explanations in earlier sections as needed to complete the following sequence of instructions.

1. Reset the program to its defaults. In practice this step is not necessary, you would generally just use New Sequence. We do it here for a common basis for this problem.
2. Set the date in General Settings
3. Set the DR position, HE = 10, and IC = 0 also in General Settings
4. Check your Settings and compare with the following.

   DR Lat: N32°00.0'
   DR Lon: W015°00.0'
   Dest Lat: 0
   Dest Lon:
   IC: 0.0'
   HE: 10

   ZD: 0
   WE: 0:00:00
   Temp: 50
   Pres: 1010mb

Mag Var: 0
Max Sight: 60

Now enter the 3 star sight reductions listed below. We will check your work in the next step. Here is what the data screens will look like:

Sight #1
Body: REGULUS
WT: 20:39:23
Date: 7/6/1996
DR Lat: N32°
DR Lon: W015°
IC: 0'
He: 10
Hs: 25°00.6'
Int: -2.6
Zn: 268.8°T

Sight #2
Body: ANTARES
WT: 20:45:47
Hs: 27°05.7'
Int: 23
Zn: 154.2°T

Sight #3
Body: KOCHAB
WT: 21:10:34
Hs: 47°27.6'
Int: -21.20
Zn: 357.9°T

Alternately, you can restore the sights stored in "s-star-fix.sp" in the sight archive. See help on the sight archiver for information on restoring sights.

Additional Help Topics:

- Review Sights
- Fix by Computation
- Fix by Plotting LOPs
- Sight Archive
- Delete Sight(s)
- New Sight Seq (Del ALL) - If you wish to remove all stored sights but otherwise leave all the settings unchanged, then use this New Sequence Option. This is the more common way to move

on to a new set of sights underway. On the other hand, if you have a lot of changes to make, then the Set Defaults might be a better option.

7.1 Review Sights

The Review Sights function displays the full list of sights stored in the sight array. This is a way to check that you have what you want before executing a fix, and it is also the only way to delete a specific sight.

If you execute Review Sights now, you should see the 3-star sights you just entered. Use the arrow keys at the bottom of the Review Sights dialog to navigate through the sights in the sight array. The trashcan icon can be used to delete the currently displayed sight from the sight array. The arrow keys are used to move forwards/backwards through the sight array.

Note that although it will not affect the final fix in any manner, the actual a-values displayed in the Review Sights list always depend on how the DR Mode is set in DR Parameter Settings . The intercepts displayed in this sequence are the same ones reported at the time of the sight reductions, since DR mode is currently set to OFF. In other words, these a-values are not advanced. These particular a-values do not know you actually had a course and speed during the sights. When it comes time to do a fix, however, you will be asked for the course and speed so they will all be adjusted properly.

On the other hand, if DR mode is set to "Speed," the Review Sights function will first use the internally stored values of course, speed, and DR position to advance each of the sights to a common time before presenting the a-values. The common time used is the time of the first sight and all intercepts are computed and displayed relative to this common time. This is a crucial option for evaluating a set of sequential sights of the same body from a moving vessel, but it has no significance in these three

individual sights of different bodies. Also note that this option has no influence on the subsequent fix, since that will always require course and speed adjustment.

DR mode = Log acts like DR mode = Off as regards the Review Sights display. The log mode only makes a difference in the DR Update operation.

While displaying a sight with Review Sights corrections to the data can be made and the sight recomputed by issuing a [Recompute]. The newly computed sight will replace the old sight in the sight array.

7.2 Running Fix – Fix by Computation

Once you have a set of sights stored in the sight array, you can obtain a fix two ways, either by direct computation or by plotting the LOPs and selecting the fix graphically yourself, discussed elsewhere under Fix by Plotting LOPs .

The Fix by Computation option uses the standard US Naval Observatory (USNO) algorithm found in the Nautical Almanac. This is a set of formulas and procedures that take the raw data and compute the corresponding fix. The lines of position are advanced to a common time and a least squares fitting method is applied to compute the fix.

When you select either from within the Celestial Fix menu, StarPilot will prompt you for your current speed in knots, course track (magnetic if the variation is set, otherwise true), and time (WT). The WT of the fix you desire could be a time of one of the sights, or any other time.

All sights will be advanced (or retarded) to the fix time you entered. Entering a value of 0 for the speed causes the application to suppress the course and time prompts bypassing the advance of the LOPs to a common time. Note that the DR position used in the running fix computation need not be the same one used in the original sight reductions since all sights are recomputed for the fix computation.

Note too, that if you are not moving (S=0) then the time of the fix does not matter. It just assumes you are at the same place but took sights at various times.

When doing sight reductions by tables we are used to using Assumed Positions. With calculators, however, we do not have a separate Assumed Position but instead all sights are reduced form the stored or advanced DR position. When using the USNO method, if the DR Position is in error by more than 20 miles StarPilot will recompute your position after temporarily updating your DR position. Once the running fix computation has completed pushing the [Update DR] button will cause StarPilot to update the stored DR position with your newly calculated fix. The following screens depict a running fix computation. Do not update DR yet for purposes of this example.

The R(nm)/Brg(T) on the output screen are the range and bearing from the DR position to the computed fix. This data should be recorded at this stage since it is very valuable in evaluating your overall navigation and it will be replaced in the display in the next step if the R is bigger than 20 miles.

In summary, the 3 star sights gave a fix of 31° 37.2' N, 15° 01.6' W and this fix was a distance of 22.8 miles off where we thought we were in the direction of 183.5 True.

The full effect of "Update DR position" depends on the DR Mode you are in, as explained further in "DR Settings". When DR Mode = Speed, "yes" will update the stored DR position and the stored DR Time.

When in Log mode, StarPilot will update the position and turn the Log mode to Off, since we lose track of actual log readings during the sights. If you wish, you can switch back to Log mode at this point and re-enter the appropriate log reading.

Please review the Quick Start Examples and discussion for more details.

7.3 Sight Archive

StarPilot includes a facility for storing and managing groups of sights along with their corresponding settings.

The Sight Archive is accessed from the "Celestial Fix" menu under the heading "Sight Archive". When initially invoked, the sight archive presents on the screen a list of archived sights.

"Save Current Settings" creates a new entry in the archive. The StarPilot will prompt for a file name to store the current sight array. The edit box under the file name is used to enter a descriptive comment. Note that the first few words in the comment are displayed along with the file name in the sight list. So you may want to create short descriptive text at the beginning of your comments. Hitting the "Save button" will save the sight. Hitting the "Back" button will cancel save and not store the sight.

Once the sight has been stored it is displayed at the bottom of the "Sight Archive" screen. Comments for any of the sights can be viewed by clicking the "Detail Disclosure" round blue arrow button to the right of the filename. The StarPilot comes with a few samples sights. Feel free to experiment with these.

To restore or delete a sight(s) first place a check mark next to the file name for the corresponding sight(s). Then select the desired action from the "Actions" menu. Note that when restoring sights only one sight can be selected.

7.3.1 Save Sights

Save Sight creates a new entry in the archive. StarPilot will prompt for a file name to store the current sight array. The edit box under the file name is used to enter a descriptive comment. Note that the first few words in the comment are displayed along with the file name in the sight list. So you may want to create short descriptive text at the beginning of your comments. Hitting the "Save button" will save the sight. Hitting the "Back" button will cancel save and not store the sight.

7.4 Delete Sights

Delete sights is used to remove unwanted sights from the sight array. Place a check mark next to the unwanted sights and then hit "Delete Selected" to remove. Use "Delete All" to clear the sight array.

8 Update DR

Updating DR Position

It is often useful to determine a DR position from log book data without actually plotting out the track on a chart or plotting sheet. This functionality is provided in StarPilot by the Update DR function. Considerable effort has been taken to make this a convenient and versatile function since it is so crucial to the day's work in ocean navigation.

The operational behavior of Update DR as well as how this interacts with the Celestial Fix routines is controlled by two settings: DR Mode and Course/Speed .

When DR Mode = OFF, the Update DR function will ask for your course and then the distance run in nautical miles. Then it computes your new DR position. If you did not have a DR position stored in the Settings, then it will first ask for the starting point. At the end of the computation it will ask if you wish to update the stored DR position to this new value.

Example, we are at 47° 39' N, 126° 50' W. Our log reads 100.0. We wish to find our new position if we sail 123.7 miles on course 245 T, We do this first in the Off mode, then Log and Speed modes.

From the Settings dialog select the DR Parameters tab and type in 47.39 and -126.50 for the DR Lat and Lon, respectively.

DR mode = Off

Now set DR mode = Off from DR parameters menu in the Settings dialog. Then select Update DR from the DR-and-Piloting menu and then input the course and distance run.

Input:
Auto Update DR: OFF
DR Lat: N47°39'
DR Lon: W126°50'
Course: 245°
Dist Run: 123.7

Output:
New DR Lat:N46°46.7'
New DR Lon:W129°34.5'

RL Course: 245.0°T
RL Dist(nm): 123.7

Pushing the "Update DR" menu entry will store this new position into the DR

The output shows the new DR position as well as a summary of the leg we just computed. This is a double check that we entered the right values, but this latter info would be of more interest in the speed mode. Note that these values reported back may differ by a few tenths or so, since this is not just a repeat of what we entered, but an actual independent second computation of the Rhumbline route from departure point to answer point and there may be some rounding off errors.

DR mode = Log

Now set DR mode = Log from the DR Parameters menu entry. StarPilot will then prompt for Log (enter 100) and Course (enter 245). In this mode, to figure our position 123.7 miles along from here, we have to realize that our log will then read 223.7 - or if we were not using real log entries, we could just enter 0 here for our current log reading, and then enter 123.7 for the computation, which is like doing it in Off mode.

Now execute "Update DR" and notice that all you need to enter is the new log reading (i.e. 223.7) and "Compute DR" to get the new DR position.

Input:
Auto Update DR: OFF
DR Lat: N47°39'
DR Lon: W126°50'
Course: 245°
New Log: 223.7

Result:
New DR Lat:N46°46.7'
New DR Lon:W129°34.5'
RL Course: 245.0°T
RL Dist(nm): 123.7

You will get the same screen as in the Off mode. If you "Update DR" then this position will replace the one in storage and also the log in storage will go from 100.0 to 223.7. To carry on with these examples, choose "Update DR".

DR mode = Speed

First do "Set DR Parameters" to confirm what we have so far. You should have the new DR position stored along with a log reading of 223.7 and a course of 245.

To start doing DR by speed and time, change DR mode to Speed, enter DR time = 12.04, Course = 245, Speed = 8.5.

Now let us ask where we will be at DR time = 1445. Do Update DR, and enter 14.45, and you should get:

Input:
Auto Update DR: OFF
DR Lat: N47°39'
DR Lon: W126°50'
Course: 245°
Speed: 8.5
DR Time: 14:45:00

Result:
New DR Lat:N46°37.1'
New DR Lon:W130°4.5'
RL Course: 245.0°T
RL Dist(nm): 22.81

Again, the bottom part of the display is the RL (rhumbline distance) from departure to destination. It should be very nearly the same as the timed run of the input, i.e. 14.45 - 12.04 = 2h 41m at 8.5 kts = 22.8 miles.

Updating DR position will now store this new location along with the new DR time of 14.45. Do this and then view settings to check what you have.

Here is a logbook Sample A, to be computed.

Before going on to the next example note the Auto Update DR is set to ON in the Update DR dialog. When this feature is selected the DR is automatically updated when the "Compute" is tapped. Auto Update eliminates having to push the "Update DR" when executing a sequence of log book entries. Use this feature in the following examples to reduce the number of events required to complete the computation.

Log Course Position

102 245° N47°39', W126°50'
150 260°
178 270°
190 170°
255 170° find position here

Using Update DR in Log mode, you should get N46°09.8', W128°35.9'

Course Speed Position

1204 245° 8.5 N47°39', W126°50'
1512 260° 7.0
1806 270° 7.5
1900 170° 6.0
1950 170° 6.0 find position here

Using Update DR in Speed mode, you should get N47°19.3, W128°03.8'

DR Mode and Review-Sights Display

When DR Mode = Speed, the Review Sights function uses the course and speed to advance the sights before displaying them. The common time used is the time of the first sight (#1). Hence for most logical presentation of the data, it is best to have the stored DR position consistent with the DR track in effect at the time of the sights. To do that, just set the DR mode to Speed (set it again, even if it is set there now) and at the input enter any valid time and point on the DR track. If you care to, you could then do Update DR to the time of the first sight to double check with your printed records that all is correct, although if your input was correct this would not be needed. The program will automatically update the DR before presenting each sight.

Normally this is not a concern, since when the fix is computed it will be done right no matter where the DR is - it might just take a few iterations to converge. But things will work more smoothly and make more sense if you use, for a DR position, the one that corresponds to the sight time you requested. Needless to say you need to do it this way if you wish to test your GPS with celestial or vice versa.

9 Utilities

In addition to celestial navigation aids, StarPilot also provides a host of useful general purpose navigational functions. Access to these functions is via a series of cascading menus. Functions are loosely categorized and placed in a menu with other similar utilities. For example, the Route Sailings menu contains functions which cover the various ways to compute routes from point to point. Please follow the appropriate links to find information on a particular topic.

9.1 Speed/Time/Distance

Speed - Time - Distance computations are needed daily in marine navigation. StarPilot has a convenient routine for these computations. This utility will prompt you for three values. Enter ***0***(zero) for the one that you wish to compute.

As an example, how long does it take to go 112.8 miles at 14.5 knots? Input Values from the Speed-Time-Dist screen are as follows: [Speed]***14.5***[Done], [DR Time]***0***[Done], [Distance]***112.8***[Done]. [Compute] for the result, which is 7 hours, 46 minutes and 46 seconds, displayed as 07:46:46.

Please Note: speed is always in knots, distance is always in nautical miles.

9.2 True Wind

Marine navigators often need to know the true wind speed and direction although only the apparent data are available. Use this convenient utility for the conversion.

Given a ship course of 115^{o}(true or magnetic, it does not matter, the output is all relative to the input) traveling at 6.5 knots, with an apparent wind direction of 145 ^{o}(i.e. from 30^{o}on the starboard bow), and apparent wind speed 16 knots we calculate a true wind direction and speed as follows. [Course]***115.0***[Done], [Speed]***6.5***[Done], [AW Dir]***145.0***[Done], [AW Spd]***16.0***[Done]. [Compute True Wind] for the result, which is Wind Dir = 162.4^{o}and Wind Speed = 10.87 kts.

The above example is in terms of actual wind direction. If you prefer to use relative values, then set course = 000, and all input and output will then be relative values. You will get that an apparent wind of 16 kts at 30oon the bow when traveling at 6.5 kts is the result of a true wind of 10.9 kts at 47.4oon the bow. The faster you go, the more you push the wind forward.

9.3 Route Sailings

These functions are used to compute routes from a start position to the destination. They use the stored DR position and Dest position if they have been set in the Settings Menu. Go to [Settings] [General] to see what is stored in these positions or to change them as needed.

9.3.1 Rhumbline

The **Rhumbline (RL)** function computes the straight line course to the destination on a mercator chart and the corresponding distance. The course shown will be the one true course that will take you from departure to destination on a constant heading, assuming no current, no leeway, nor any other errors.

An arbitrary waypoint on the rhumbline can be computed by enabling and entering a chart latitude. This feature allows navigators to easily transfer the rhumbline from one chart to another while underway. To use this feature compute the rhumbline from the DR Lat/Lon to the destination Lat/Lon and enter any latitude on the chart for "Chart Lat". StarPilot will compute the course and distance between the start and destination points. It will also display the longitude that corresponds to the chart lat entered in the program. To transfer the rhumbline to the new chart simply plot the chart lat/lon on the new chart and then draw the rhumbline through it using the appropriate course.

Consider the course between San Francisco, at 37° 50.8' N, 122° 25.5' W and Yokohama at 34° 52' N, 139° 42' E. We calculate the Rhumbline with Input Values as follows: [DR Lat] 37.508 [Done], [DR Lon] -122.255 [Done], [Dest Lat] 34.520 [Done], [Dest Lon] 139.42 [Done]. [Compute Rhumbline] for the result, which is RL Course = 267.8^{o}T, RL Dist(nm) = 4752.29, GC Course = 302.6^{o}T, GC Dist(nm) = 4488.76.

For comparison, the Great Circle (GC) results are also displayed for each RL computation. These latter data represent the shortest distance; but the shortest route is a curved track on a mercator chart. The CG Course shown here is only the initial heading on the GC route.

In this example, the straight line course on heading 267.8°T will take you there in 4752.3 nautical miles, whereas the actual shortest route will be a curved one, starting off at a higher course of 302.6 °T but eventually being a lower course than the RL heading. The GC Course is shorter by 263.5 miles, but the actual heading of the course will vary throughout the passage. The Great Circle function in StarPilot takes the curved GC route and breaks it up into a series of straight RL segments.

9.3.2 Great Circle

The Great Circle function computes the great circle distance between two points and the course heading to a series of waypoints, determined by a user input Lon interval (5 °is typical), on the Great Circle route to the destination. A variant called Composite Sailing is used when a limiting latitude is desired.

The following sequence computes the Great Circle route between San Francisco, CA at 37 °50.8'N, 122°25.5'W and Yokohama, Japan at 34°52'N, 139°42'E.

[DR Lat]***37.508***[Done], [DR Lon] -***122.255***[Done], [Dest Lat]***34.52***[Done], [Dest Lon]***139.42***[Done], [Delta Long]***5***[Done], [Limit Lat]***OFF***. [Compute Great Circle Route] will take you to the list of course segments that make up the Great Circle Route.

Notice that the Lon has gone up 5°each step, and you are told the corresponding Lat if you are to plot this route on a mercator chart. For each segment you are given the distance left to travel (in nautical miles) and the initial course for that Leg, which would generally be treated as the Rhumbline course to the Great Circle waypoint.

9.3.3 Traverse Course/Distance

The Traverse Course-Distance function finds the single equivalent course given by a series of headings and distances such as might result from a sailing vessel beating and tacking its way to a windward point.

For example, entering the course headings and distances for each Leg, we compute the single equivalent Course Made Good (CMG) and Distance Made Good (DMG) and Total Distance traveled (Tot Dist).

[Course]***158***[Done], [Distance]***15.5***[Done], [Add Waypoint]; [Course]***135***, [Done], [Distance]***33.7***[Done], [Add Waypoint]; [Course]***259***[Done], [Distance]***16.1***[Done], [Add Waypoint].

[Compute Traverse] for the result CMG(T) 161.5°T, DMG(nm) 43.53, Tot Dist(nm) 65.3.

9.3.4 Traverse Lat/Lon Waypoint

The Traverse Lat/Lon Waypoint function finds the single equivalent course given by a series of headings and waypoints such as might result from a sailing vessel beating and tacking its way to a windward point. The course and speed for a leg is computed using standard rhumbline computation. With waypoints added, this function yields Course Made Good (CMG), Distance Made Good (DMG), and Total Distance Traveled (Tot Dist).

As an example: [DR Lat]***48.30***[Done], [DR Lon]***-123.320***[Done], [Dest Lat]***48.52***[Done], [Dest Lon]***-123.43***[Done], [Add Waypoint].

[Compute Traverse] for the result CMG(T) 341.7°T, DMG(nm) 23.17, Tot Dist(nm) 23.17.

9.3.5 Mag Var

Use Compute Magnetic Variation to compute the magnetic variation for any location on earth, at sea level, during the current epoch.

By entering a date and location StarPilot computes the main components of the geomagnetic field and their annual changes.

The seven computed magnetic components displayed are:

TI - Total Intensity of the geomagnetic field.
HI - Horizontal Intensity.
X - North Component.
Y - East Component.
Z - Vertical Component.
DIP - Geomagnetic Inclination.
DEC - Geomagnetic Declination (Magnetic Variation).

For example: [Date]***January 01 2010***[Select], [DR Lat]***47.390***[Done], [DR Lon]***-122.20***[Done]. [Compute Magnetic Variation] yields the results Magnetic Var E17°00.4', Annual Change -00°10.8'. The AnnualChange in each of the seven magnetic components above is also displayed. The annual change is computed by subtracting the main field vaues for the desired input date from the main field values one year later. The output units are displayed using the abbreviations nT (nanoTesla) and nT/yr (nanoTesla per year).

Please note that westerly variations are displayed as a negative number. Also, as geomagnetic model data is only reliable for 5 years from the epoch date of the model, computing data for a date that exceeds the life of the model may produce inaccurate results. Therefore, when a date is entered that exceeds five years from the epoch date, a warning is printed on the screen. Data sets for new epochs will be incorporated as they are made available.

9.4 Current Sailings

The**Current Sailings** menu provides access to a series of functions for solving typical vector problems encountered when planning around currents. It includes the following functions:

CMG and SMG- Course Made Good and Speed Made Good through a Current
CTS and Speed- Course and Speed to Steer to Achieve a CMG and SMG
CTS and SMG- Course to Steer at Given Speed to Achieve a CMG
Find Current from GPS
Current Interpolator to find velocity of tidal stream
Tide Interpolator computes the height of tide at selected time

Note that all current sailings functions override the mag variation — all input and output are labeled True. We do this since current set data are usually given in True, so if you are working in magnetic for other headings you will need to first convert any magnetic headings to True to use these functions. Likewise, convert any output here to Magnetic if needed. Current set is always the true direction toward which the current flows, drift is always in knots. We use this convention to remind you that all input must be consistent, and the output will then match. You can, of course, use all magnetic inputs and then will get magnetic outputs, but the labels will still be "T."

9.4.1 CMG and SMG

Compute the Course Made Good and Speed Made Good when the **course steered** and **speed** through the water are given. The **current set** and **drift** must also be known.

Given that the course steered is 080^{o}T, the speed through the water is 10 knots, the set is towards 140^{o}T, and the drift is 2 knots, the entry to compute the course made good (CMG) and speed made good (SMG) would be as follows:

[Course(T)]***80***[Done], [Speed(kt)]***10***[Done], [Cur Set(T)]***140***[Done], [Drift(ft)]***2***[Done]. [Compute CMG and SMG] for the result, which is CMG 088.9^{o}and SMG 11.14.

9.4.2 CTS and Speed

Compute the True Course To Steer and the knot meter Speed required when the **course** to make good and **speed** to make good are given, and the **set** and **drift** of the current are known.

This is valuable when the arrival time is crucial after a passage through current. You know the CMG (where you are to where you want to go) and you know the distance to get there, and you know the time interval you have to cover it so you can figure the required SMG to get there on time. Knowing that, what course do I steer and how fast should I go? Note that the answer may not always be achievable with your vessel.

Given that the course to make good is 265°, the speed to make good is 15 knots, the set and drift of the current are 185°T and 3 knots respectively, compute the course to steer (CTS) and knotmeter speed in the following sequence:

[CMG(T)] 265o[Done], [SMG(kt)]***15***[Done], [Cur Set(T)]***185***[Done], [Drift(ft)]***3***[Done]. [Compute CTS and Speed] for the result, which is CTS 276.5°and Speed(kt) 14.78.

9.4.3 CTS and SMG

Compute the Course To Steer and the knot meter Speed Made Good when the **course** to make good and **speed** through the water are given. Additionally, the **set** and **drift** of the current must be known.

Given that the course to make good is 095°T, the speed to maintain through the water is 12 knots, the current set is towards 170°T, and the current drift is 2.5 knots, enter the following sequence:

[Speed(kt)]***12***[Done], [CMG(T)]***095***[Done], [Cur Set(T)]***170***[Done], [Drift(ft)]***2.5***[Done]. [Compute CTS and SMG] for the result, which is CTS 083.4°and SMG(kt) 12.4.

9.4.4 Find Current

Using data from your GPS, input your SOG (speed over ground) and your COG (course over ground) from your GPS and also your knot meter speed and course steered. This function computes the set and drift of the current which would account for any difference between these two.

As an example: If you are sailing a course of 200°T at a knot meter speed of 7.5 kts, the GPS indicates you are making good course 220°T at a speed of 6.0 kts. Enter the following sequence:

[Course(T)]***200***[Done], [Speed(kt)]***7.5***[Done], [COG(T)]***220***[Done], [SOG(kt)]***6.0***[Done]. [Compute Current] for the result, which is Cur Set (Current Set) 332.2°T and Drift(kt) 2.77.

NOTE: Do not use instantaneous values for the GPS input. Watch the GPS, compass, and knot meter outputs for some time and use a realistic average value for the input. (You can input True or Compass headings, providing both inputs are the same, the set will be in those units as well.)

9.4.5 Current Interpolator

Use this function to find the velocity of a tidal stream given the time of slack and maximum tide and the maximum velocity of the tide.

For example, to find the tidal velocity at 3h 30m given a slack water at 1h 42m and a peak current flow at 4h 43m with a drift of 4.6 knots, enter the following sequence:

[Time Slack]***1:42:0***[Select], [Time Max]***4:43:0***[Select], [Max Spd(kt)]***4.6***[Done], [Select Time]***3:30:0***[Select]. [Compute Current Velocity] for the result, which is Current Velocity(kt) 3.71.

9.4.6 Tide Interpolator

Use this function to compute the height of tide at any selected time, given the time height of low and high tide.

For example, to compute the height of the tide at 7h 35m given that the time and height of low tide is 1h 45m at 0.6 feet and the time and height of high tide is 9h 06m at 11.9 feet, enter the following sequence:

[Time Low]***1:45:0***[Select], [Height Low]***.6***[Done], [Time High]***9:6:0***[Select], [Height High]***11.9***[Done], [Select Time]***7:35:0***[Select]. [Compute Tide Height] for the result, which is Tide Height 10.75.

NOTE: The computed tide height is displayed using the same units as the input low and high tide. If the tide heights were to be entered in meters, the result would be displayed in meters.

9.5 Celestial Utilities

The functions in Celestial Utilities compute miscellaneous taks based on celestial sightings.

All of these functions are controlled by Settings entered in the Settings Menus, such as Date and DR Lat/Lon.

9.5.1 Lat/Lon by Meridian Passage

Measure the peak height of the sun at noon and note the GMT of the event. The height will give your latitude, the time will determine your longitude.

For example, Hs max for lower limb sun viewed to the south on March 4, 2000 at 20h 55m was 35°15.2'. IC=2.0' ON, HE = 9 ft. Enter the following sequence:

[Watch Time]***20:55:0***[Select], [Date]***March:04:2000***[Select], [IC(min)]***-2.0***[Done], [He(ft)]**9**[Done], for Limb select**[Lower]**, [Hs]***35.152***[Done]**[South]**. [Compute Pos by Mer Passage] for the result, which is Latitude N48°30.9', Longitude W130°51.8'. Note that since the Sun is observed to the South, a negative (-) value is used to represent the altitude of the Sun, -2.0. Sun sightings towards the North are positive.

NOTE: For Limb, you must select [Lower] , [Center] or [Upper]. For Hs, you must select [North] or [South].

This function reads the Settings, so if non-zero to begin with, you must go in and set them properly. Also, although accurate peak sextant height is relatively easy to obtain underway, accurate time of the peak is not. Take care to determine this value accurately, from a series of sights. In general, a simple running fix from two sets of sun lines is a more reliable approach to finding position from the sun.

To best use this function, take a series of sights spanning LAN as shown in the Sight Analyzer section, then analyze them that way to get the best values of Hs max and time of LAN. If that curve and the fit looks good, then chances are this is a reasonable fix. Note that with such a large set of data you might also try just computing a fix for comparison. Also compare the plot of all these LOPs, zoomed in to the fix position.

9.5.2 Lat by Polaris

Polaris Sights for Latitude and Azimuth

This function provides an alternate method for obtaining latitude using the pole star *Polaris*.

Suppose your vessel is at DR position 12°N,68°W and you observe Polaris with an altitude of 12°30' at 2200 GMT on January 1, 1998 from an observation height of 10 feet with no index error. The vessel's latitude, actual azimuth for Polaris, and intercept can be obtained using the following sequence:

[Watch Time]***22:0:0***[Select], [Date]***January:01:1998***[Select], [DR Lat]***12***[Done], [DR Lon]***-68***[Done], [IC(min)]***0***[Done], [He(ft)]***10***[Done], [Hs]***12.30***[Done]. [Compute Lat by Polaris] for the result, which is Latitude N11°44.9', Zn 000.4°T, Int(nm) -14.1.

This routine can also be used to determine the azimuth of Polaris for compass or gyro calibration or for any surveying application that needed precise bearing reference.

Note that LOPs based on Polaris can also be obtained using standard sight reduction procedures such as described in the "Celestial Sight Reduction" sections of this program.

9.5.3 UT by Lunar Distance

The Lunar Distance Method for determining time (often called "Lunars") was developed during the mid 1700s to synchronize inaccurate chronometers enabling the determination of Longitude. The method presented here can be used to set time to within 1 minute of accuracy -- and sometimes better. Although not as accurate as using a short wave radio tuned to WWV, it is included in the event that some accident prevents the setting of time by more conventional methods.

Time may be determined by measuring the angle between the Moon and any of the 179 bodies in the almanac (Sun, 5 planets, and 173 stars). Time can be set most accurately when measuring the Lunar-Solar distance (or angle) and decreases with accuracy for lunar-planetary distances and it is at it's worst

when measuring angles between the moon and stars. The faster the ground movement of the celestial bodies, the better the time accuracy.

When measuring Lunar-Solar distances, 1' of arc error in the reading of the angle yields about 3 minutes of error in time. It is, therefore, crucial that all lunar distances be measured as accurately as possible. Unfortunately, Lunar-Solar angles can only be measured about 7-10 days a month. If the Lunar-Solar distance cannot be measured then the navigator can measure angles between the moon and one of the 5 visible planets or a bright star on the ecliptic.

With IC = 0, and He = 10 ft., to compute the correct UT using the outer rim of the sun and the moon's inner rim with an angle of 62° 41.8' on June 19, 1998 at 12° 46' N , 70° 22 W at approximately 11h 54m 05s GMT, one would enter the following sequence:

[Watch Time]***11:54:5***[Select], [Date]***June:19:1998***[Select], [DR Lat]***12.46***[Done], [DR Lon]***-70.22***[Done],[IC(min)]***0***[Done], [He(ft)]***10***[Done], [Angle]***62***[Done], [Limb] [Inner-Outer], [Body] [Solar] [Sun], [Iterations]***10***[Done]. [Compute Detailed Output] for the result, which shows:

Corrected Watch Time*11:48:26*; Watch Error-*00:05:39*; Lunar Distance corrected for semi-diameters-*70°22.0'*; Calculated Distance*062°42.6'*, Slope of the Distance vs. Time Curve* *62°40.8', -189*; Change in Measured Distance that would account for the observed time difference *1.79*(This shows how sensitive the answer is to accurate input data.)

*Expressed in time seconds per lunar distance arc minutes (i.e. in this example, the lunar distance was changing at a rate of 1' per 189 seconds)

NOTE: To do Lunars accurately an iterative process is required.

OR [Compute Lunar Distance] for the result which shows:

Computed WT 11:51:12 for computed watch time
Delta WT -00:02:53
Longitude W69^{o}38.9'

9.5.4 UT from Known Position

This function is a sight reduction; but, instead of entering it with a known WT to compute an LOP, you enter it with a known position to recover UT.

For example, Hs max for lower limb sun on September 10, 1996 at 15h 35m 42s was 54^{o}58.8', IC=0', He = 10 ft., at position N34^{o}55.0', W35^{o}50.0'. Enter the following sequence:

[Body] [Solar] [Sun], [Watch Time]***15:35:42***[Select], [Date]***September:10:1996***[Select], [Lat]***34.550***[Done], [Lon]***-35.500***[Done],[IC(min)]***0***[Done], [He(ft)]***10***[Done], for Limb select [Lower] [Done], [Hs]***54.588***[Done]. [Compute UT] for the result, which shows: WT 15:34:41, Delta WT -00:01:01

9.5.5 Sight Reductions by NA

Sight Reduction with Nautical Almanac

This function is a sight reduction; but, using ephemeris information entered from the Nautical Almanac instead of the internal one. Refer to the help Sight Reduction for details on doing sight reductions.

When prompted for GHA0 enter the GHA value at the whole hour before the time of the sight. Likewise, when prompted for GHA1 enter the data for the whole hour after the sight. DEC0, DEC1, SHA, SD, PA are also entered from the almanac in similar manner.

The results are added to the sight array and can be used for all other StarPilot analysis including Running Fixes, Sight Analyzer, etc.

Following is an example of doing a sight reduction using this function.

Input:
Body: Sun
Watch Time: 15:35:42
Date: 9/10/1996
GHA0: 45°48.1
GHA1: 60°48.3
DEC0: 4°40.7
DEC1: 4°39.9
Limb: Lower
DR Lat: N34°55'
DR Lon: W35°50'
IC(min):2.5'
He(ft):10
Hs:54°58.8'
SD(min): 15.9

Results:
Int(nm): 9.6
Zn: 214.3°T

9.5.6 Compass Calibration

An accurate way to check a compass is to compare the compass heading of the vessel with the shadow of the sun cast across the compass. This procedure can be used at the dock or far out of sight of land.

This function predicts where the Sun's shadow should fall on the compass given the GMT of observation, a DR position and the local magnetic variation. Subtracting the bearing of the Sun's shadow with the actual reading yields the compass deviation for the current heading. The adjustments can then be made to remove the deviation, or the deviation may be noted on a card. To swing a

compass, or to create a compass deviation card, follow the given procedure while traveling along each of the cardinal and intercardinal compass headings.

For example, the compass calibration sequence for a vessel at 35°15' N, 70°25' W, on June 3, 1975 1330 GMT, with a local magnetic variation of 7° 15' W is as follows:

[Watch Time]***13:30:0***[Select], [Date]***June:3:1975***[Select], [DR Lat]***35.150***[Done], [DR Lon]***-70.250***[Done],[MagVar]***-7.15***[Done]. [Compute Compass Cal] for the result, which shows: Sun Shadow Angle 281.6oM

Note: You do not need to enter the DR LAT/LON and/or the local magnetic variation if they have been previously set in [Settings] [Advanced] [Mag Var].

9.6 Piloting

The Piloting Utilities contain miscellaneous routines used to help in piloting your vessel.

ETA functions are also included in this section.

9.7 ETA by Distance

You can compute your Estimated Time of Arrival in the destination time zone with this function. You can account for a fixed delay along the way called Bunk Time (bunkering).

For example, if you leave Cape town at 0530 (ZD = -1) on Dec 20, 1981 bound for New York at ZD + 5, estimated SMG = 25 kts, distance = 6762 nautical miles. Compute your arrival time with no delays underway, using the following sequence:

[Time]***5:30:0***[Select], [Date]***December:20:1981***[Select], [ZD]***-1***[Done], [Dest ZD]***+5***[Done], [Dist(nm)]***6762***[Done], [Bunk Time]***0***[Select], [SMG(kt)]***25***[Done]. [Compute ETA by Distance] for the result, which shows: Total Dist(nm) 6762, Arrival Time 05:58:48, Arrival Date 12/31/81, Num Days 11, Num Hours 06:28:48.

9.8 ETA by Great Circle

You can compute your Estimated Time of Arrival in the destination time zone with this function. You can account for a fixed delay along the way called Bunk Time (bunkering).

For example, if you leave Cape town, located at 33°55.0'S, 18°25.0'E at 0530 (ZD = -1) on Dec 20, 1981 bound for New York, located at 40°47.0'N, 73°58.0'W at ZD + 5, estimated SMG = 25 kts, distance = 6762 nautical miles. Compute your arrival time with no delays underway, using the following sequence:

[Time]***5:30:0***[Select], [Date]***December:20:1981***[Select], [ZD]***-1***[Done], [DR Lat] -33.55 [Done], [DR Lon] 18.25 [Done], [Dest ZD]***+5***[Done],[Dest Lat]***40.470***[Done], [Dest Lon] -73.580 [Done], [Bunk

Time]***0***[Select], [SMG(kt)]***25***[Done]. [Compute ETA by GC Route] for the result, which shows: Dist(nm) 6779.54, Time 06:40:53, Date 12/31/81, Num Days 11, Num Hours 07:10:53.

NOTE: You do not need to enter ZD, Date, DR and Destination positions if they are already stored in [Settings].

9.9 Dist by Sextant

Distance Off by Sextant

The sextant is a powerful piloting tool for determining distance off a landmark whose height is known. This can be used for distances that are tens of miles off, on down to less than a mile off. It can also be used to find distance off of objects whose height is not known, provided they are fairly close and viewed from a higher eye height. Practice these three methods. They can easily be tested by radar or GPS so that when/if these electronic aids are not available, you can fall back on your trusty sextant.

In each example IC=2.0', and He=30 ft.

Example 1:

The landmark base is hidden over the horizon. The landmark mountain height is 3520 ft. and Hs = 1°34'. The Method used is Horizon to Top. Enter the following sequence:

For Method, choose [Hor-Top], [IC(min)]***2.0***[Done], [He(ft)]***30***[Done], [Height(ft)]***3520***[Done], [Hs]***1.34***[Done]. [Compute Dist off by Sextant] for the result: Distance(nm) 19.92. Changing Hs to 0°25' changes the result to: Distance(nm) 47.35. A very clear day.

NOTE: The Horizon to Top method is commonly used for coastal runs and for judging large distance off at first landfall.

Example 2:

The landmark base is showing and is distinctly closer than the horizon. The Method used is Base to Horizon. Using a Sextant Height (base to horizon) of 0°12', enter the following sequence:

For Method, choose [Base-Hor], [IC(min)]***2.0***[Done], [He(ft)]***30***[Done], [Height(ft)]***3520***[Done], [Hs]***0.12***[Done]. [Compute Dist off by Sextant] for the result: Distance(nm) 0.88. If He=9 ft., the result is: Distance(nm) 0.3; if He=80 ft., the result is: Distance(nm) 2.04.

NOTE: The Base to Horizon method is one way to investigate how far off a shoreline has to be to be useful for an index error check. Also, it can sometimes be used to determine how far off a vessel is. This is not a common technique as it requires higher precision in measurements.

Example 3:

The landmark base is showing and appears close to the horizon. The Method used is Base to Top. Using a landmark height of 460 ft. and Hs=2°30', enter the following sequence:

For Method, choose [Base-Top], [IC(min)]***2.0***[Done], [He(ft)]***30***[Done], [Height(ft)]***460***[Done], [Hs]***2.30***[Done]. [Compute Dist off by Sextant] for the result: Distance(nm) 1.71.

NOTE: the Base to Top method is commonly used for close-in piloting.

9.10 Dist by 2 Bearings

Use this function to compute distance off at the second bearing and the distance you will pass abeam based on two bearings and a distance run between them. It assumes a constant course. Bearings are bow bearings, equal to the difference between actual bearing and vessel heading.

For example, given an initial angle on the bow to an object (land or vessel) is 18°(1st bearing) and after a distance of 1.7nm the angle of the same object is 45°(2nd bearing), enter the following sequence:

[1st Brng]***18.0***[Done], [2nd Brng]***45.0***[Done], [DstRun(nm)]***1.7***[Done].[Compute Dist off by 2 Bearings] for the result:

Dist@Bearing 2(nm) 1.16 (This is the current distance off the object.)

Dist@Beam(nm) 0.82 (If you continue on the same course, this is the distance off at the closest point, when abeam.)

This is a versatile piloting technique. For charted objects, it gives a position fix, but can also be used without reference to a chart.

9.11 Geographical Range

Geographical range is the distance off at which the object first appears or disappears over the horizon viewed from a specific height of eye. The visible range of a navigation light will be the smaller of its geographic range and its luminous range. Luminous range depends on the prevailing atmospheric visibility and can be read from tables in the Light List. It is the same as the charted nominal range in clear weather.

Geographical range is needed to predict the visible range of a light or land given the height of the object above the waterline.

For example, if a light is 125 ft. high when observed from an eye height of 10 ft. above sea level, use the following sequence:

[IC(min)]***0.0***[Done], [He(ft)]***10.0***[Done], [Height(ft)]***125.0***[Done].[Compute Geographical Range] for the result which is Geo Range(nm) 16.35.

10 Data Input

10.1 Body Selector

Tap the desired body to select and return to the requesting dialog. There are several ways to sort the bodies by selecting one of the choices in the segmented control on the navigation bar.

"All" sorts all 173 selected stars, 5 planets (including Mercury), Sun, and Moon in alphabetical order. "Solar" selects bodies within the solar system, and "Stars" lists the named 58 celestial navigation stars.

The search function will find bodies in the selected sort list style. Bodies can be searched by name, scientific name, or body number. So, for example, selecting all and then entering "53" in the search bar will yield two choices: Deneb (Alpha Cygni - #53) and Kappa Corpii (#153).

10.2 Date/Time Selector

Enter the local time or date. Note that StarPilot defines local time/date to be the iPhone/iPod local time/date (displayed up in the status bar) + iPhone/iPod GMT offset (set in the iPhone/iPod system settings) - ZD (the zone descriptor defined in the StarPilot settings). That is

Watch Time = GMT Time - ZD

The "Now Button" computes the local watch time and presets the time picker to this date/time.

10.3 Keypad Input

Periodically StarPilot will prompt you for data such as the time of a sight, DR latitude or longitude, GHA, SHA, and Declination. The format used to enter these and other values depends on the type of data to be entered.

The keypad is used to enter data into the StarPilot and supports the following entry formats.

- Generic Floating point numbers
- Degrees decimal degrees as in 253.2°
- Minutes, decimal minutes as in 1.2'
- Degrees, minutes, decimal minutes as in 53°54.5'
- N/S or E/W degrees, minutes, decimal minutes as in W122°34.5'
- Hours, minutes, and seconds

All time values are entered in hour-minute-second (h.ms) format. This is accomplished by entering the time values as numbers in the following format **hh.mmss** where the **hh** corresponds to hour portion of the time and the .**mmss** correspond to the minutes and seconds. Note that 2 digits must be used to represent each of the minutes (**mm**) and seconds (**ss**) fields. For example the time corresponding to 15h 5m 42s is entered as 15.0542.

On the other hand, times are displayed in the **hh:mm:ss** format. For example, a time entered as 17.0822 would then be displayed as 17:08:22, and the various times computed by StarPilot are displayed in that format.

Compass bearings, courses, and heading data are entered in ddd.d format. That is, three digits and a decimal - the decimal is optional. Leading zeros (i.e. 090) are optional but recommended.

Sextant altitude (Hs), latitude, longitude, GHA, SHA, and declination (DEC) values are entered in ddd.mmm format, which we abbreviate as "**d.m**" format. For example the value 34° 55.2' is entered as 34.552, 34° 5.1' as 34.051, and 35° 0.6' as 35.006.

Index Correction (IC) is entered as decimal minutes (mm.m) format, i.e. an index error of -3.3' is entered as -3.3. When entering IC, values should have a minus (-) for "on the scale" errors and no sign (i.e. implicit +) for "off" errors. Horizontal Parallax (HP) and Additional Planet Correction (PCORR), used in some specialized applications, are also entered as mm.m.

The following sign conventions apply when entering data. Positive values for LAT, DEC and LON are entered for North and East. Negative values for LAT, DEC and LON are entered for South and West.

Arithmetic

It's possible to do antithetic when entering values. For, example, it's possible to add 3 angles when entering a bearing or a course.

120° 43.0' + 5° 58.4' - 10° 3.5' = 116° 37.9'

or

12h 4m 12s - 32m +1h 0m 4s = 12h 32m 16s

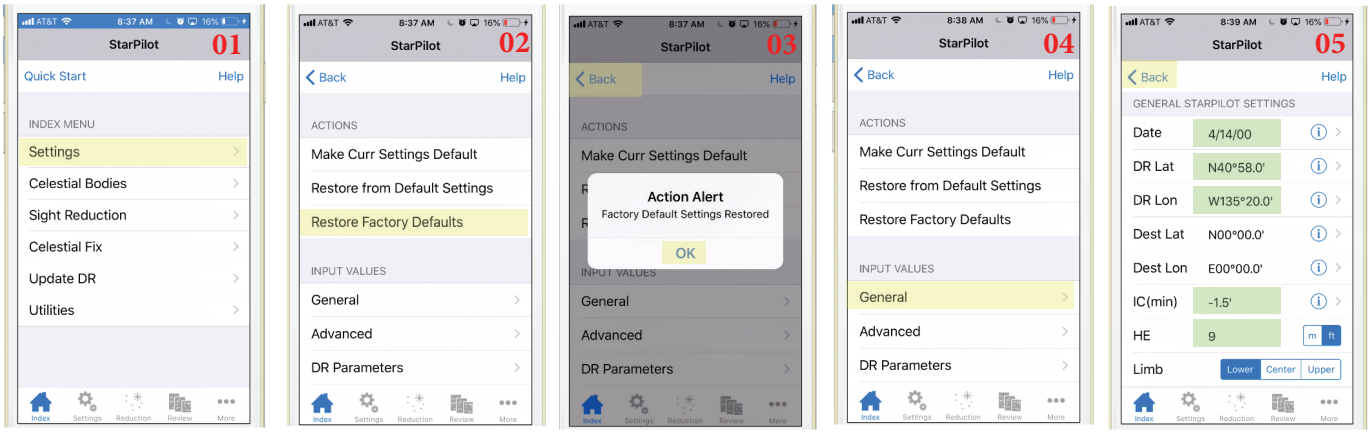
when adding times.

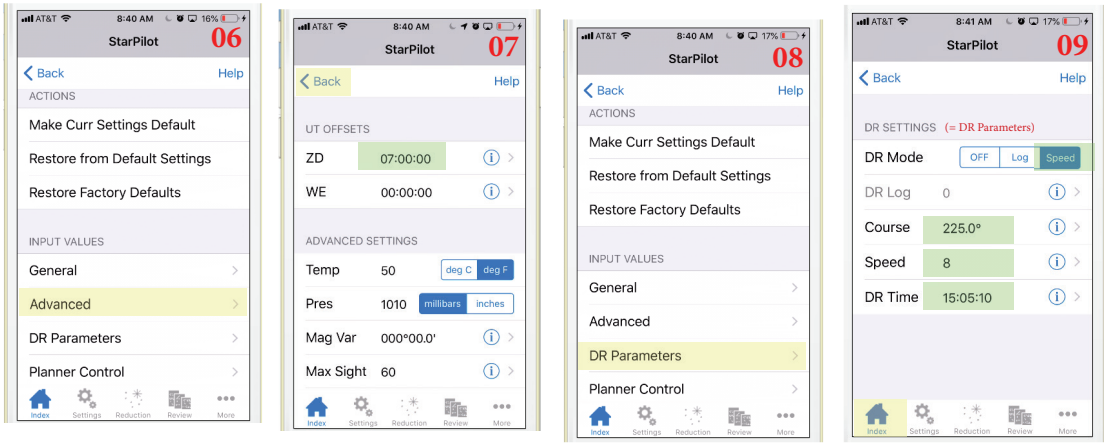
Appendix 1. Running Fix with DR updates (from page 9)

Step 1. Set up the sight session.

Input

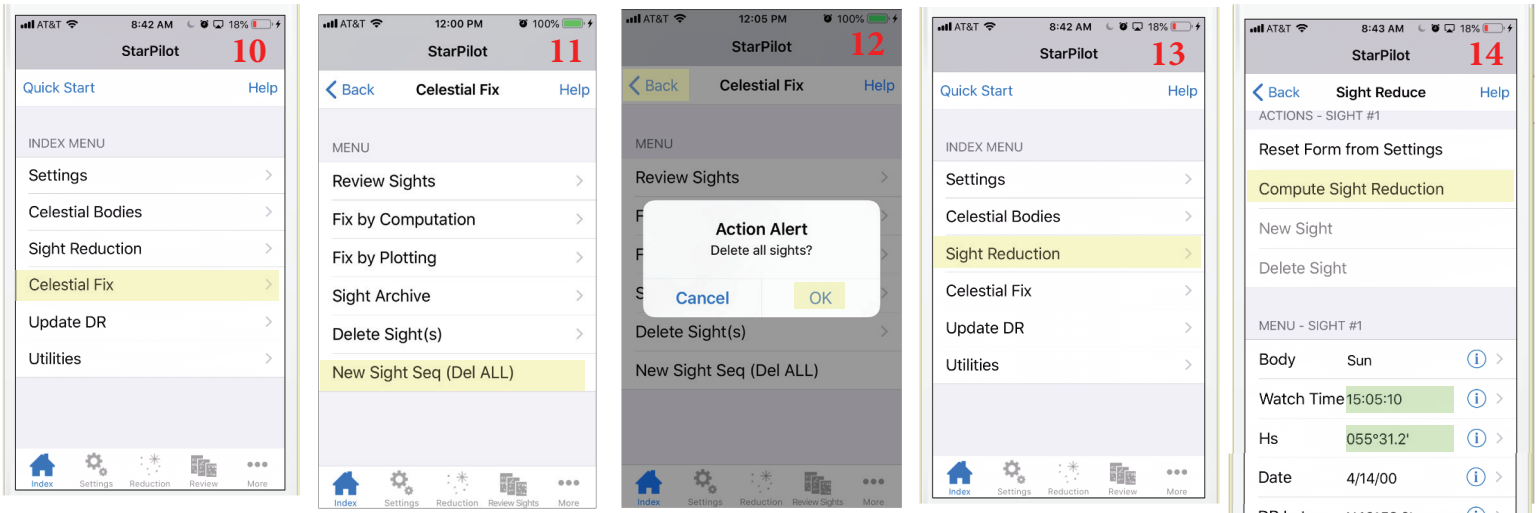
Key strokes

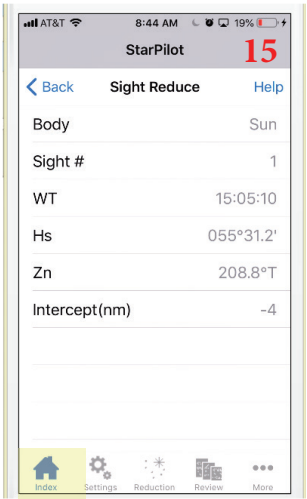




The above steps only have to be done once, then future sights and DR evolves from that data.

Step 2. Enter sight data.



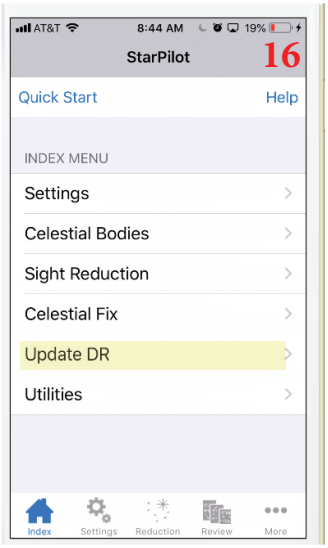


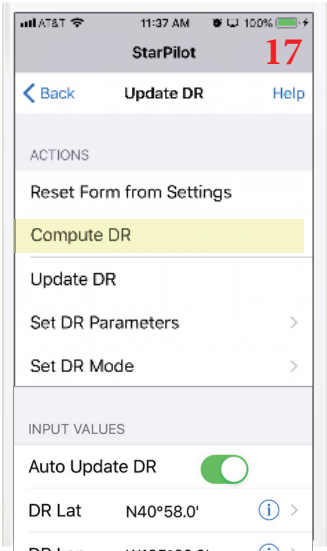
With all the set up done, in 14 we just enter WT and Hs. Note we need to scroll to see the full panel.

In 15 we just check that WT and Hs were input correctly and that the sight looks about right, ie Zn is the direction we looked to see the body, and that the intercept (a-value) is not excessive.

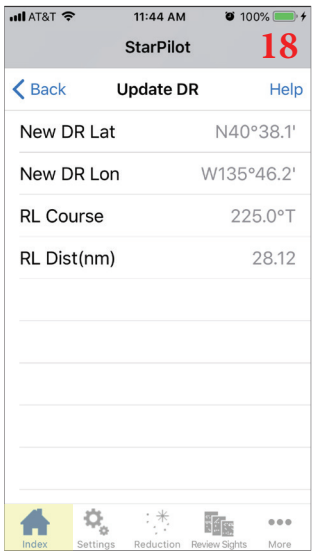
After this we go back to the main menu (INDEX) to update the DR for the next sight, but we could skip that step if we like as the final fix will advance all lines as needed. On the other hand, if the sights are a long time apart, it could be valuable to see that the a-values are reasonable, which we can only judge using best DR.

Note: until you set the right WT in a sight reduction it defaults to the present device time.

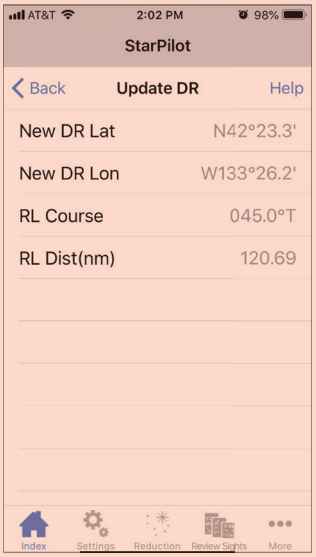




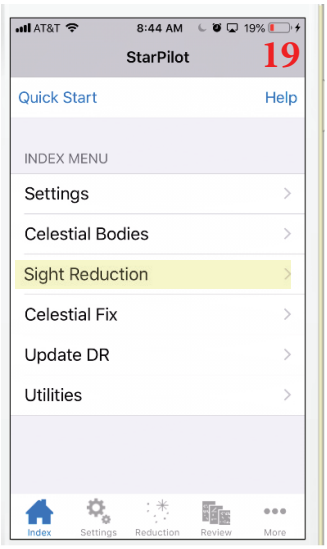
* * * In 17, it is crucial to scroll down to enter the time of the next DR position. This is a likely error, because on many screens, you have to scroll down to see the input field. Pressing Compute DR or Update DR with no time entered will give a false DR position—it DRs backwards to 00h00m00s.

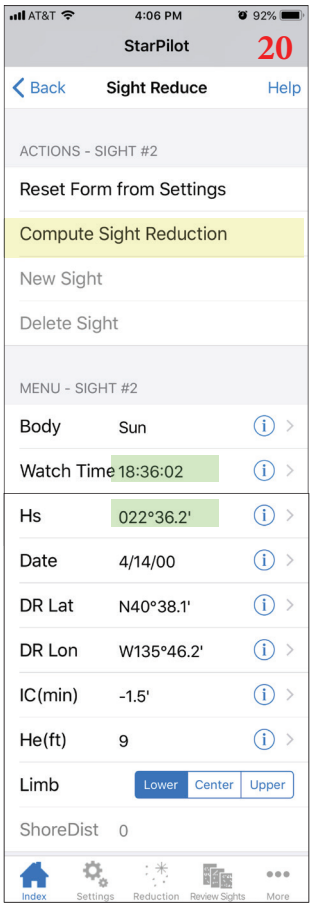


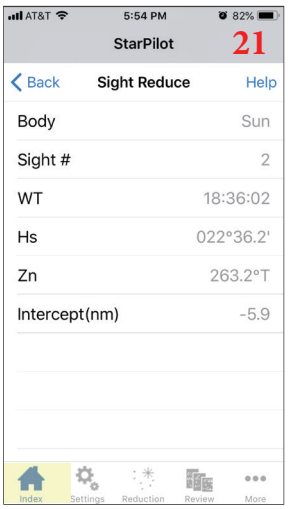
In 19 we can check to see the DR was right, as best we can tell. Check that the course and distance run is about right for the time interval between DR positions. Here we are going 8 kts for roughly 3.5 hr so we expect something like 28 nmi.



If you make the mistake just mentioned of doing Update DR without a new DR time you will get this: going backwards (045=225-180) for 120.69 nmi, which is how far you go at 8 kts from the last time (15:05:10) back to 00:00:00.

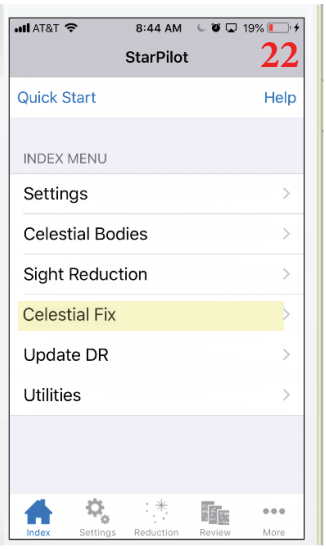


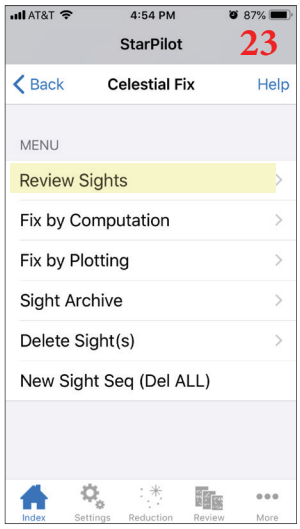


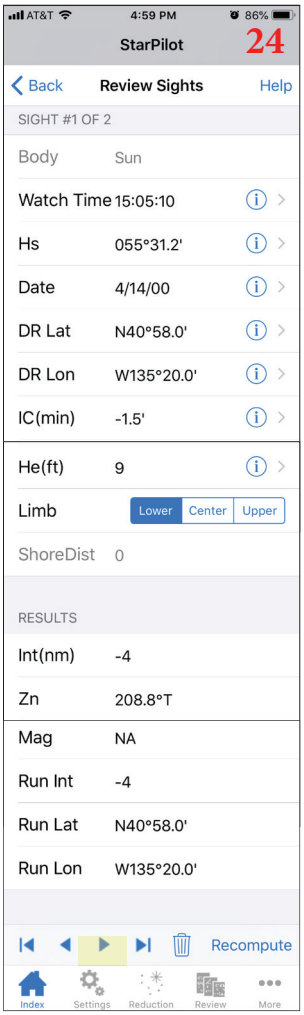


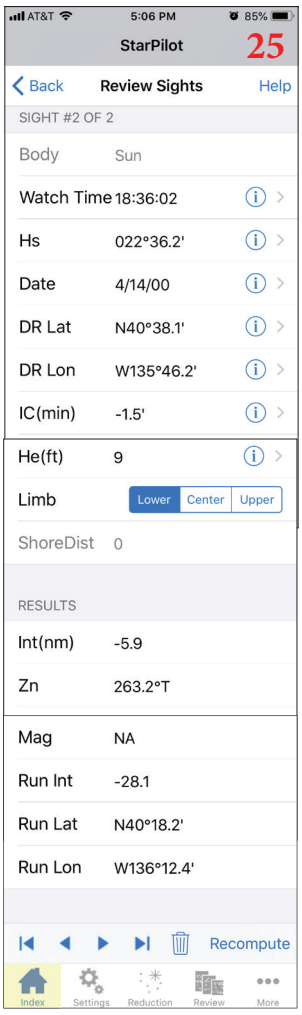
No. 21 is like 16; we are just checking that the values look about right, then we return to INDEX to review the sights and then do a fix.

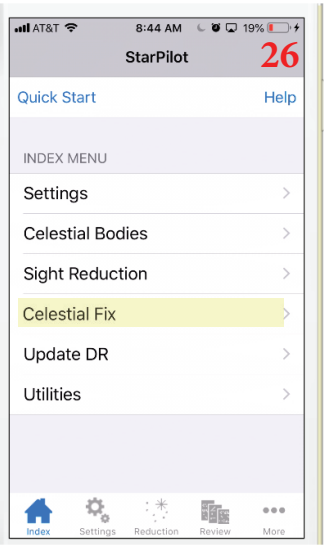
For the StarPilot SP-iOS Manual, see
https://www.starpilotllc.com/documentation.htm

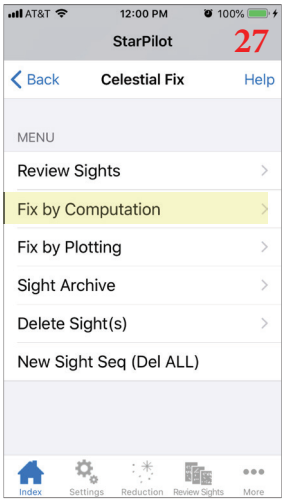


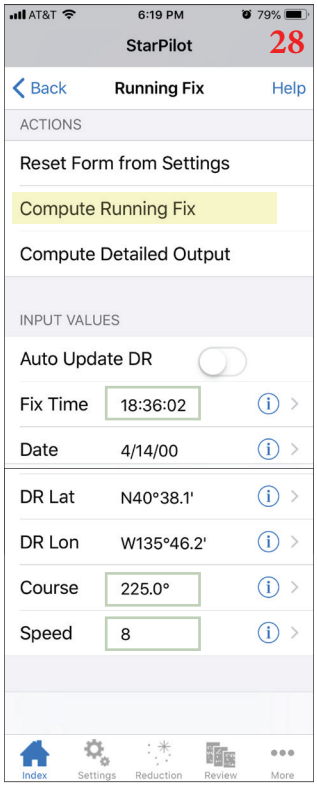


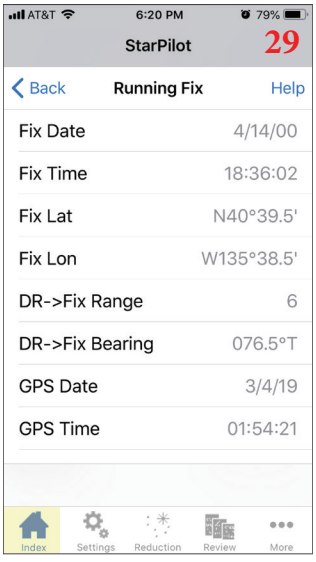






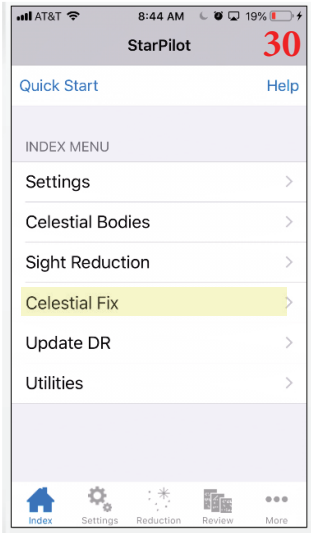


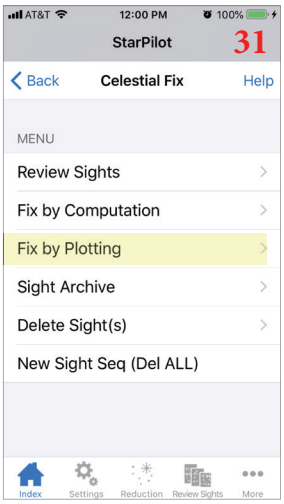


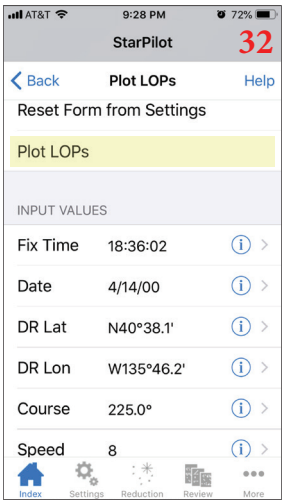


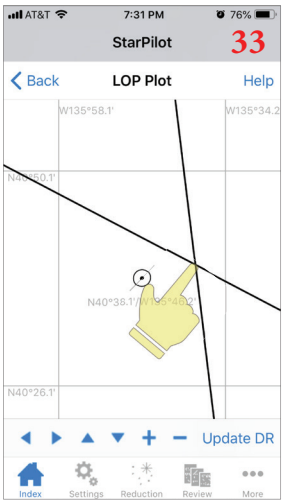
This fix can be compared to the one listed in the Manual on page 8.

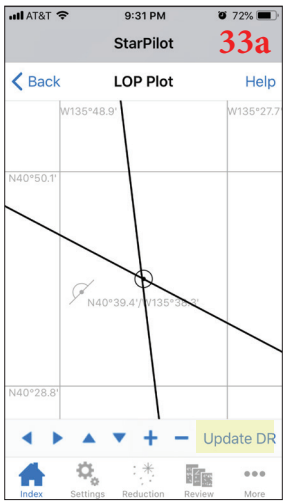
In 28, the green boxed data will default to the values for the last sight in the sequence, but you can change that at this point if desired. The DR records will not be consistent if that is done, however.











In 33, the plot shows the intersection and lists DR position. Touch the point you choose for a fix and its Lat, Lon appears. You can then Update DR to get a text record of that.