Practice Sights from *Hawaii by Sextant*

A basic familiarity with StarPilot as presented in the Manual will be beneficial to this extended exercise.

The book *Hawaii by Sextant* (HBS, Starpath Publications, 2024) is a detailed record of an ocean passage from Victoria, BC to Maui, HI made in 1982, navigated by celestial navigation alone. It includes 227 sights of sun, moon, stars, and planets that lead to 27 position fixes. The book includes a full logbook of course changes and DR positions, along with complete analysis of the fixes. *Nautical Almanac* data are included for those reducing the sights in the traditional manner. The fixes and DR tracks between them are all plotted, forming a continuous track across the ocean.

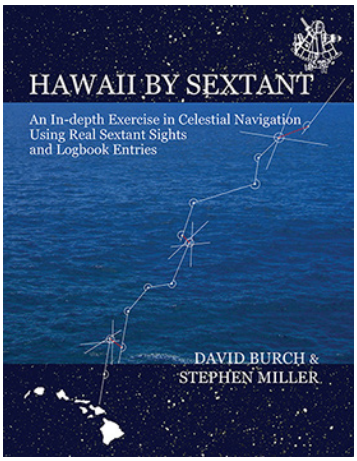
All the paper logbooks were saved, then decades later reformatted using modern tools. The manual solutions are presented in Starpath Work Forms, and the numerical solutions were computed with the StarPilot, as shown in the excerpted examples below that can be used for practice with the StarPilot. Working through the full voyage presented in that book is an excellent way to hone your skills in cel nav.

Table 1. Summary of sights in the HBS Examples set.

There are eight sight sessions included using various bodies. You can load individual sight sessions (for example sights from July 19th, Fix 22, named *Fix_22.spj*) or load the accumulated set, *Fix_17-25.spj*.

If you load the single session, *Fix_22.spj*, sight 1 will be the first Polaris sight on Jul 19. If you load the full set, the same sight would be sight 30.

You can choose to compute a fix, plot the LOPs, or do a sight analysis for specific sights within any set.



See www.starpath.com/HBS

Fix	Date (UTC, 1982)	Body	Sights	Sight #	Time span (UTC)	Total
17	Jul 16	Deneb	1	1	1355	5
		Venus	1	2	1358	
		Moon	3	3, 4, 5	1414–1417	
18	Jul 17	Jupiter	5	6, 7, 8, 9, 10	0453–0459	9
		Vega	4	11, 12, 13, 14	0508–0516	
20	Jul 18	Venus	5	15, 16, 17, 18, 19	1440–1446	8
		Sun	3	20, 21, 22	1820–1822	
21	Jul 19	Vega	3	23, 24, 25	0523–0537	7
		Alkaid	4	26, 27, 28, 29	0530–0540	
22	Jul 19	Polaris	3	30, 31, 32	1426–1433	15
		Vega	5	33, 34, 35, 36, 37	1436–1444	
		Capella	1	38	1446	
		Venus	6	39, 40, 41, 42, 43, 44	1444–1456	
23	Jul 20	Jupiter	4	45, 46, 47, 48	0518–0521	8
		Altair	4	49, 50, 51, 52	0536–0541	
24	Jul 20	Sun (morning)	6	53, 54, 55, 56, 57, 58	1642–1645	11
		Sun (later)	5	59, 60, 61, 62, 63	1925–1930	
25	Jul 20	Sun (near noon)	15	64–78	2211–2228	15
All				1–78		78

Below is a logbook excerpt corresponding to the sample sights in Table 1. The sight sessions are identified here by Fix numbers; in the book they are called Problem numbers. The voyage uses watch time (WT) with ZD = +7 and a height of eye (HE) = 9 ft, with index correction IC = 0.0. The logbook section below is from about three-quarters through the voyage. Year = 1982, Month = July. Lat and Lon uses the StarPilot convention (dd.mmm). All courses and bearings are true. Looking at the columns, we have the date (Day), WT, and DR at that WT. Then we have the fix that we found at that WT.

For the starting fix at 0717 on 7/16, we do not know from this logbook excerpt what course (C, true) and speed (S, kts) were used to compute the fix shown—it was 245 @ 7.7—but we do know that after that fix, we sailed away on course 247 at 7.7 kts. After each fix, we DR to the time of the next fix, using the new C and S listed. This is standard DR procedure, fundamental to ocean navigation. The StarPilot is designed to make this important process simple and efficient.

Logbook Excerpt adapted from *Hawaii by Sextant*						
Day	*WT*	*DR*	*Fix*	*Course*	*Speed*	*Notes*
16	0717	28.35, -142.43	28.319, -142.400	247	7.7	Fix 17. Use this fix to find DR for next sights
16	2213	27.47, -144.39	27.576, -144.314	243	7.5	Fix 18. This WT is near the end of sights.
17	1128	27.12, -146.11		243	6.8	No sights on 7/17. Next Fix was 1121 on 7/18.
17	1450	27.02, -146.34		240	7.4	So “Fix 19” is just do careful DR from
17	1611	26.57, -146.43		240	8.6	2213 7/16 to 1121 7/18 using the logbook
18	0000	26.23, -147.48		240	7.4	entries shown here.
18	0740	25.55, -148.42		242	7.3	Use StarPilot Update DR function.
18	1121	25.42, -149.09	25.552, -149.101	242	6.9	Fix 20. Venus and Sun
18	2240	25.186, -150.262	25.150, -150.259	232	6.3	Fix 21. Vega and Alkaid
19	0753	24.393, -151.161	24.414, -151.105	238	5.8	Fix 22. Vega, Venus, Polaris, and Capella
19	2241	23.559, -152.299	24.097, -152.294	230	5.3	Fix 23. Jupiter and Altair
20	1227	23.228, -153.301	23.077, -153.190	228	4.3	Fix 24. Sun running fix
20	1520	22.594, -153.290	23.169, -153.31	217	5.7	Fix 25. Lat and Lon from LAN

Discussion

We use the StarPilot angle notation, ddd.mmm. Remember, as you work through these examples—or underway at sea—you can save your work at any point, and add or remove sights as you like.

Start by loading the full set of sights (*Fix_17-25.spj*) so you can follow through on the important role of DR between sights. In ***Settings/DR Parameters*** use DR mode = Speed throughout the examples.

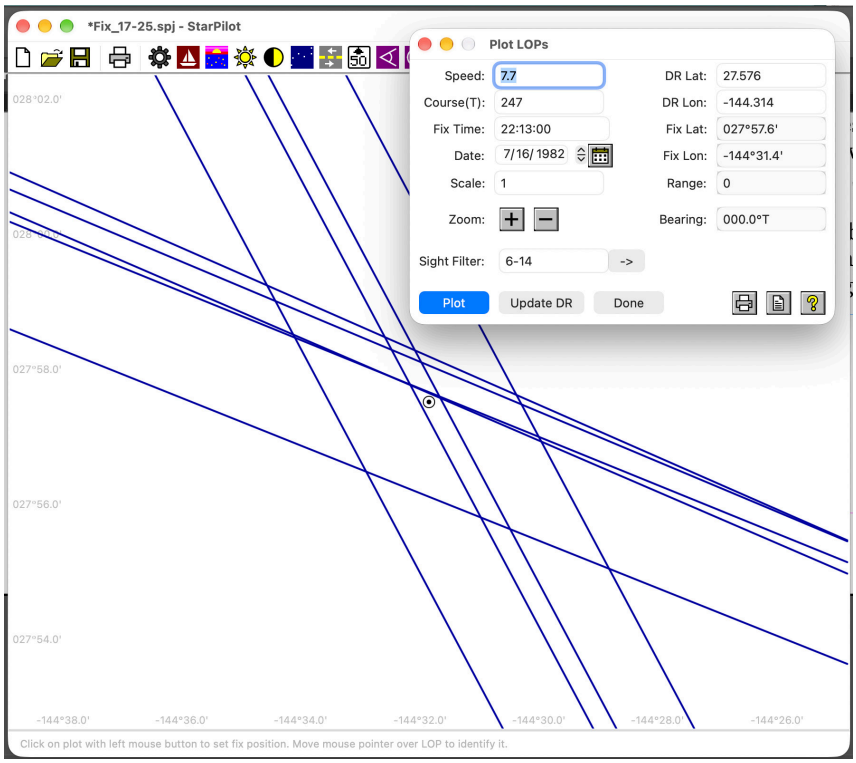
When working the full route from the book, you could use DR Mode = Log, which is typically more accurate for ocean DR, and the book includes the log entries. StarPilot lets you do DR by Speed or Log, or shut it off, and do all DR updates manually. The logbook entries above may differ slightly from those in the printed book, because we analyzed some sights differently, which led to slightly different fix positions.

If not familiar with the basic procedure for doing sights and sight reduction, see notes at the end of this document, plus refer to the StarPilot Manual by clicking the Help icon (?) in the tool bar. We assume this familiarity for these examples. Here is the basic sequence carried out as the voyage progresses:

1. From latest fix position, DR to the estimated time of the next fix.
2. Take the sights, enter them into StarPilot and Sight reduce each of them.
3. When all entered, use the Review sights function to double check the inputs.
4. When multiple sight sessions have been saved, note the sight numbers that apply to the session of interest.
5. Plot the sights to see what the intersections look like compared to the DR location, plus look for outliers.
6. Remove obvious outliers and Compute a fix, and then update the DR position.
7. When striving for the best possible fix, use Sight Analyzer. Apply Sight Filter to isolate the sights for the body of interest, and then Analyze, which applies our Fit Slope method to help fine-tune the choice of outliers. Note their sight numbers, remove them, and do another Compute fix.
8. During a long voyage, you can periodically, save your sights with a unique name, then delete them to carry on with the same DR track.

Procedure for working through the sample sights.

Step 1, Fix 17. Load *Fix_17-25.spj*. You can do this by double-clicking that file name, or dragging it onto the SP screen, or use menu ***File/Open***. This will load all 68 sights of this example set, while keeping the Settings for 7/16 0717 at S=7.7 and C= 245, which was used for computing Fix 17. The logbook then shows the course we sailed away from the fix on (247), which is slightly different. We are using the full set of sights so we can practice the DR between sights, but this means that when we Review the Sights, Plot sights, Compute a fix, or Analyze sights, we must use the Sight filter on each function to choose only the sights we want.



If you updated the DR after the computed fix, and then look at the plot, you will see what the app chose as best fix.

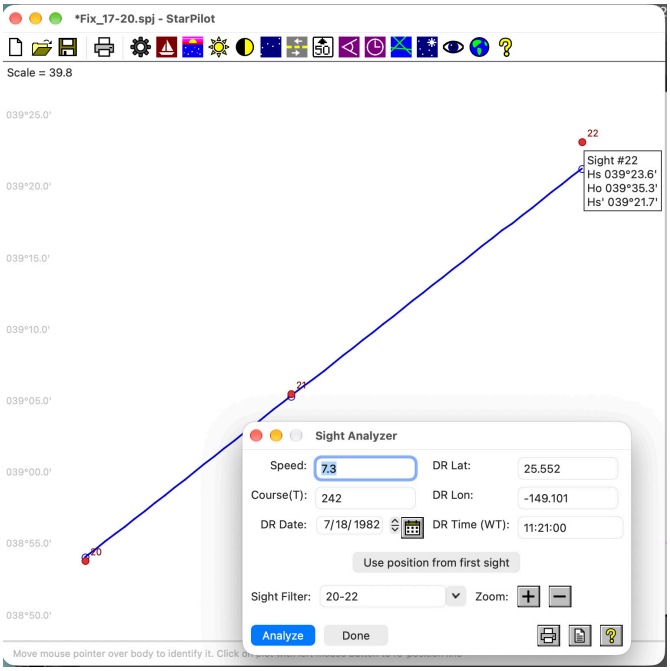
Again, when working with this full set of sights, you will have to shut off the ones not yet taken before analyzing, computing, or plotting. Working on Fix 17 set, you would shut off all but 1 to 5. When working on Fix 18, you would use only 6 to 14. Refer to Table 1 on the previous page to learn which sights belong to each sight session.

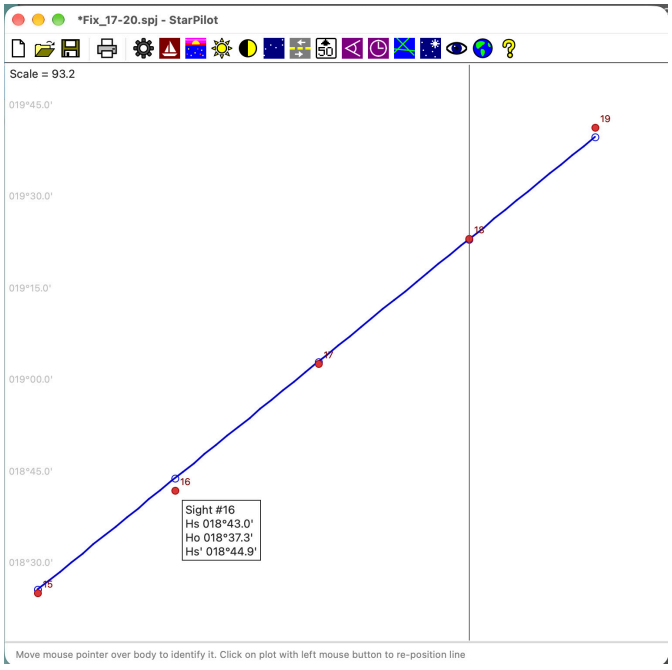
Alternatively, you can always look at the plot of the LOPs and ID them, then go back to the Review of sights (eye icon in the tool bar or under Celestial Fix) and remove ones you don't want, then recompute the fix. We will come back to this exercise later. The plot and sight analysis helps determine which are the best sights to keep.

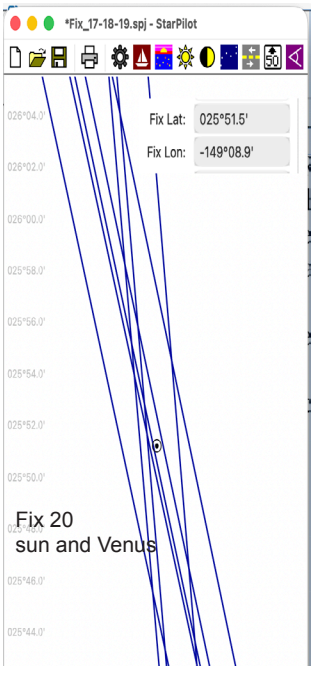
Step 2, DR to Fix 18. Once you have the Fix 17 determined, update the DR to that position. You should see something like what is in the logbook above, but it may not be identical if you chose to eliminate some sights. Once the DR is updated to the fix at 0717, we can then use ***Update DR*** (boat icon) to set new time to 22:13:00 (same day), C =247, S = 7.7, then click Compute and then Update DR to get the DR position for the next round of sights (18). Then Done to close the DR function. Check DR position in the logbook above.

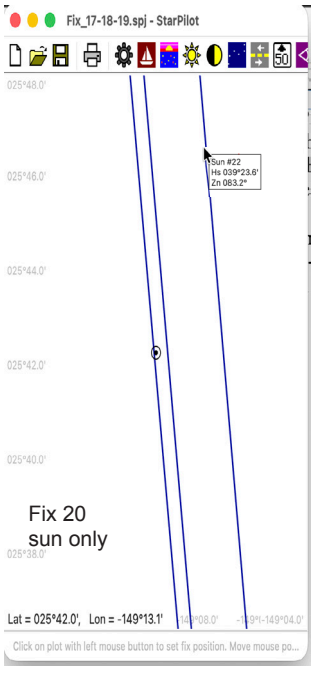
Step 3, Fix 18. This sight session has nine sights (5 Jupiter, 4 Vega) so we will only analyze those nine. After having entered the sights and done the sight reductions of each, you would Review the sights to check your inputs, and then move on to finding a fix. You can plot and choose a fix, or compute a fix, doing the latter we get what is in the logbook. If we then update DR to that computed fix and then Plot the sights, you will see where the computation chose the fix, as shown below.

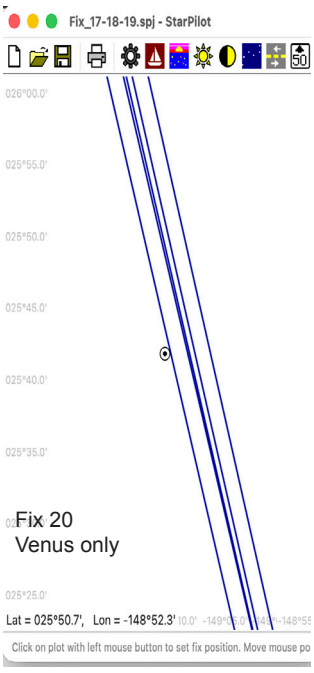
The bottom LOP is Jupiter 6. If you check it out in the Sight analyzer, you will see it is notably off the line of the other four and could be safely deleted, and then an improved fix computed. This was not done in the logbook fix.

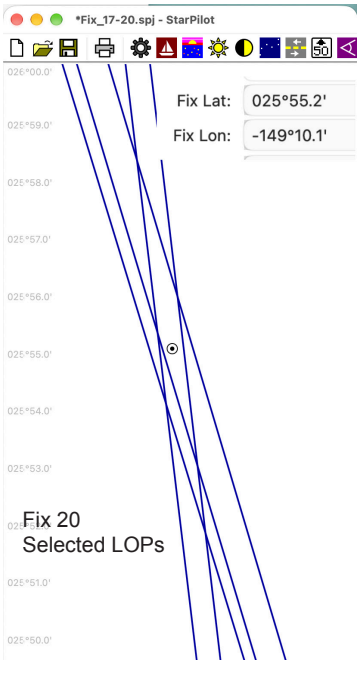












Step 4, Long DR. There were no sights available on 7/17 so "Fix 19" is just the multi-leg DR from Fix 18 (2213, 7/16) to the time of Fix 20 (1121, 7/18). The last DR update wrote the last fix into Settings, and also changed the DR time in Settings to the time of that fix, 2213. So now we just need to step through the logbook in the ***Update DR*** function to set up for the Fix 20 sights. Compare with the logbook at each step to check your results. The first leg starts off on 243 at 7.5 kts.

Step 5, Fix 20. For Fix 20 we have five sights of Venus and 3 of the sun. Referring to Table 1 and the logbook, first do a plot of all sights (15 to 22) for 1121 on 7/18 from DR 25.424, -149.086, using C = 242, S = 7.3.

Looking at all sights, this appears to be a weak fix. There is spread in the LOPs and the intersection is narrow. *** The computed fix with all sights then update DR we see on the left what the result was. We can also plot the sun lines and Venus lines separately, to see there is some hope for improving the result with sight analysis. One sun line seems off (22) and the midpoint of the Venus sights is likely a good average.

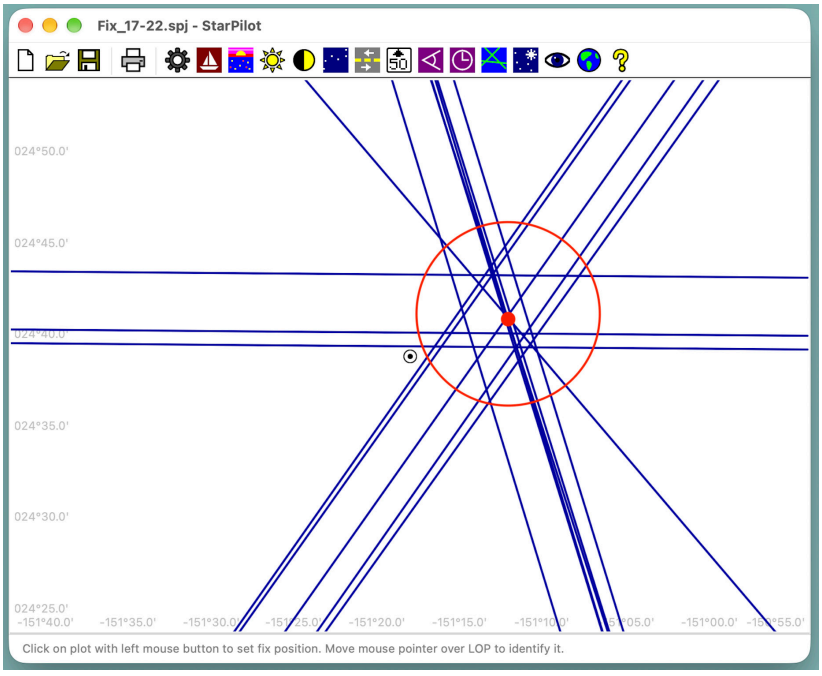
The sight analyzer shows that sun 22 is definitely high (by ~1.9'), and Venus 19 is high (~1.8') and Venus 16 is low (~1.8'), relative to the other three that follow the predicted slope very closely. For a more detailed discussion of the Fit-slope method see: www.starpath.com/calc/Fit-slope.html.

So we can improve the fix by removing those three sights. Doing that and then computing the new fix, updating DR and plotting, we get what is shown in the right-hand panel. This moved the fix about 4 nmi north and 1 nmi west—a notable change in that using all sights put the fix 9.8 nmi off the 1121 DR, and the presumably improved fix now has DR to fix = 13.6 nmi off at 356. Note that even with this improvement, the fix remains weak because the intersection angles are so narrow, Vega Zn = 074, sun Zn = 083.

With such a narrow intersection angle, these sights would not be reasonable to reduce and plot by hand, but with precise reductions and plotting, we can give it a hope—keeping in mind this was on a voyage that had no position fixing other than cel nav, so it was crucial to get anything we could. This also shows that in such conditions (i.e., only cel nav to go by) the power of the StarPilot really stands out. Since we are going to use this as a fix, and DR from it, the test will be the range and bearing from DR to fix on the next good set of sights.

Step 6, Fix 21. Now DR to the time of Sights 21 at 2240 WT on 7/18. With ZD=+7 this will be the next day on UTC, but that does not affect our Update DR which is using WT and will keep track of such things. This will be a 78.1 nmi run since the last, possible weak, fix. Here we get three sights of Vega and four of Alkaid. Again, a good approach is to plot all the sights to see what we have (23 to 29), then look into analysis and fix computation.

Our DR to fix using all sights is just 3.5 nmi in direction 177, so the last fix was not so bad after all. But note that this means our DR was too far north, and recall that when we tweaked the sights to improve them based on the Fit-slope analysis, we actually moved the fix north by 4 nmi. This result might imply that what we did was wrong or did not help, but that is not a fair conclusion. We have to keep track of this DR to Fix distance for some time before making such conclusions. The fit slope analysis is sound science, plus we ran 78 nmi in 11h 19m between fixes. To be off by 3.5 nmi would only take a southerly current of 3.5 nmi/11.3 hr = 0.3 kts, easily possible in any ocean, anywhere. For now we just accept the all-sights fix, update the DR position, and then DR to the next sight set 22, at WT 0753, 7/19 WT.



Step 7, Fix 22. This will be a 58.1 nmi run in direction 232 at 6.3 kts to end up at the DR shown in the logbook. We will be using sights 30 to 44. This is a lot of sights—more than needed! For now just plot them all to see where the intersections are relative to the DR, then compute a fix from all sights. We will use that to carry on here, but looking at the image below it is likely we could improve the fix. The red ring centered at the computed fix has a radius of 5 nmi. All the intersections are inside that ring, and the DR is just outside of it.

Step 8, Fix 23. This was an 85.8 nmi run to a session with four Jupiter sights and four Altair sights (45 to 52). Plotting these looks like a reasonable fix, although it is just two bodies and we prefer three if possible. Compute the fix using all sights and update DR, and we move on to the next sight session. Remember that in actual practice you would be Reviewing the list of sights you had sight reduced before plotting or computing a fix. This fix was 13.8 nmi south of the DR, which is somewhat more than we would hope for after 85 nmi over 15 hr. The fix was likely accurate to ± 1 nmi.

Step 9. Fix 24. We leave Fix 23 on C=230 at 5.3 kts for about 13.5 hr run (73 nmi) to Fix 24, which is a weak running fix from the sun—it was a cloudy morning, and this was all we got to see. The sights are numbers 53 to 63 (three hours later the sky cleared and we got a good LAN fix). The fix with all sights is 23.067, -153.187. The analyzer shows that sight 60 was definitely higher (1.0') than the others, relative to the computed slope, so we can try removing it, which gives a computed fix that is 1 nmi more north, so we will use it (23.077, -153.190) and DR from there to the noon sight coming up.

Looking ahead, we will see that for some reason this weak running fix had other issues with it. The fix was ~16 nmi SE of the DR, and we shall see that the next (stronger) fix, just a couple hours later moved the position back up to near its 1227 track. There was likely some errors in the logbook records for that period.

Step 10. Fix 25. This is a fix at LAN. Normally we get a good Lat this way, but rather uncertain Lon. In this case, the sights were so high, that we can get a good estimate of the time of peak Hs, which is all we need for the Lon—GHA of the sun at the UTC of our LAN is our Lon.

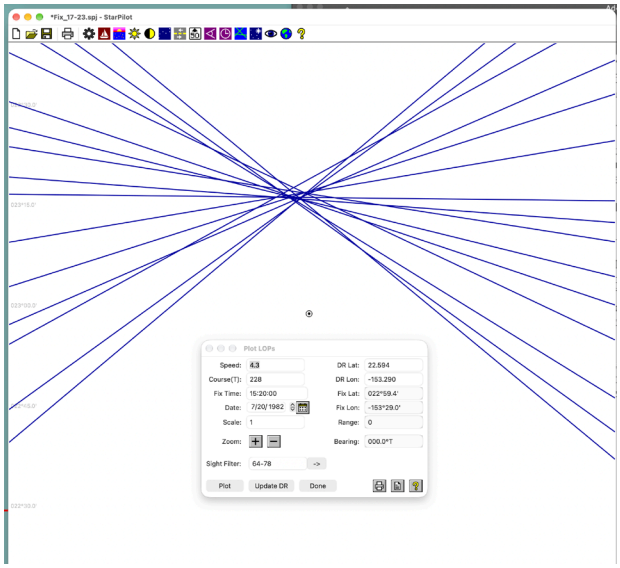
The DR is a short run from Fix 24 (1227) to the peak Hs at 1520. C =228 at 4.3 kts to the position shown in the logbook above. This is also the last example from the book, which shows what a great job the Sight Analyzer can do with noon sights. For noon sights the "fit slope" is actually fitting a curve, which produces the Hs vs. WT curve, taking into account the motion of the boat in the process. Without that correction, when the vessel is moving the conventional center of the curve is not likely the correct LAN. This is illustrated in our textbook *Celestial Navigation: A Complete Home-study Course* (www.starpath.com/celnavbook).

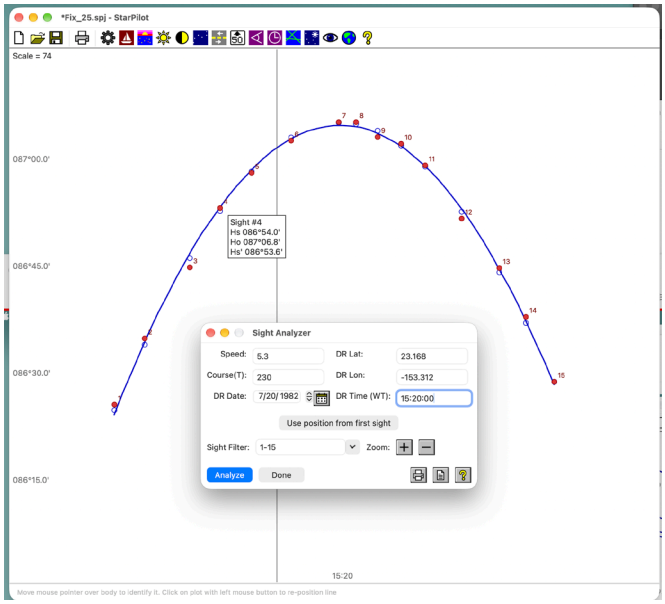
The LAN sights are numbers 64 to 78, 15 sights from 1511 to 1528, which is frankly more than is needed for a typical LAN sight. To fit these curves properly we must be at the right place and time, else the computed Hc values will not match what we observed as we were moving.

So for an LAN analysis, one procedure would be to take a quick look at the plot of all LOPs fanned out around LAN as shown below, which also shows the relative location of the DR (~17 nmi south of the fix), and then Compute a fix from all sights (23.169, -153.311), and update the DR and have another look at the plot, and then do the analysis of all sights to see if you need to tweak the curve up or down a bit, or confirm you have a good fit and therefore dependable fix.

You can also get a Lat Lon fix by reading the max Hs and its WT (in this example, 87.060 and WT 15:20:40, which is halfway between sights 7 and 8). We can use these values in the ***Lat/Lon by Mer Pass*** function which gives a fix of 23.167, -153.342, which is about 3' west of the fix from all LOPs, which at 23N is about 3 nmi.

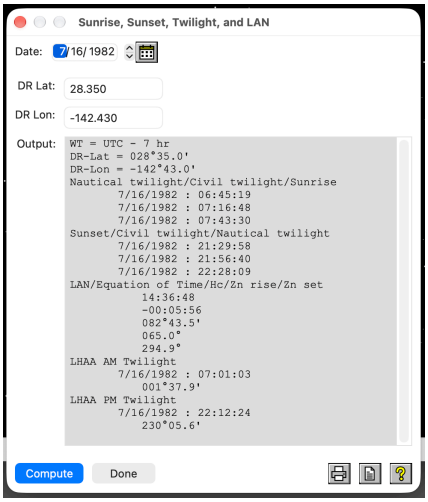
If you had just a few sights but were confident of the peak height, then the ***Lat/Lon by Mer Pass*** would do the job, keeping in mind the uncertainty in WT of LAN translates to Lon error as 1 minute of time error = 15' of Lon error.

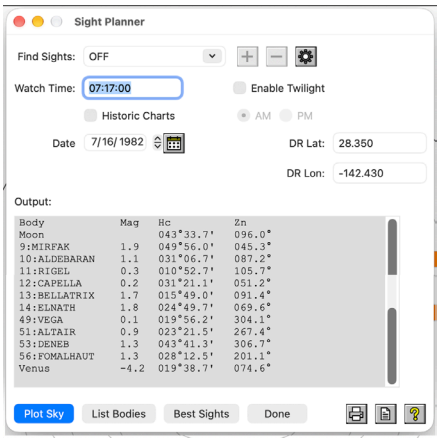


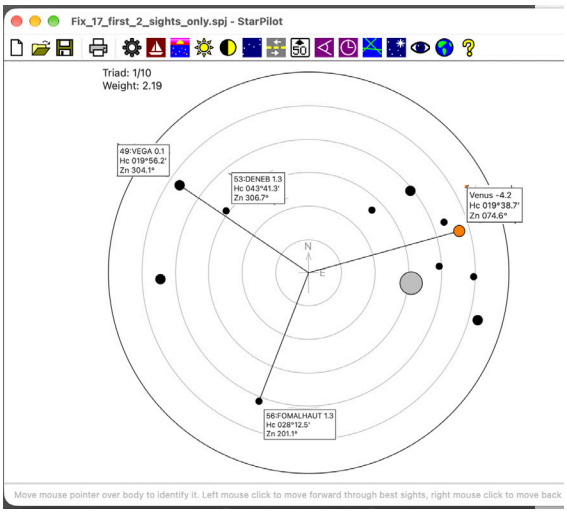


Review of Sights and Sight Reduction

Step 1. Take the sights: This means DR to the planned sight time, which you can learn from the ***Sunrise/LAN/Sunset*** function (sun icon in the tool bar). Then run the ***Sight Planner*** function which lets you set a specific time or choose Enable Twilight, to know what will be the best sights to take at that time. Enable Twilight sets the time to halfway between civil and nautical twilight. Record the Hc and Zn for the bodies you plan to use, also record C and S and WT so we can determine the average C and S during the session. On deck, check and record the IC, then take 3 or 4 sights of the three bodies, recording Hs and WT for each. When done, record again C and S and WT so we know if this changed notably during the sights. See www.starpath.com/celnavbook for more details on sight taking.



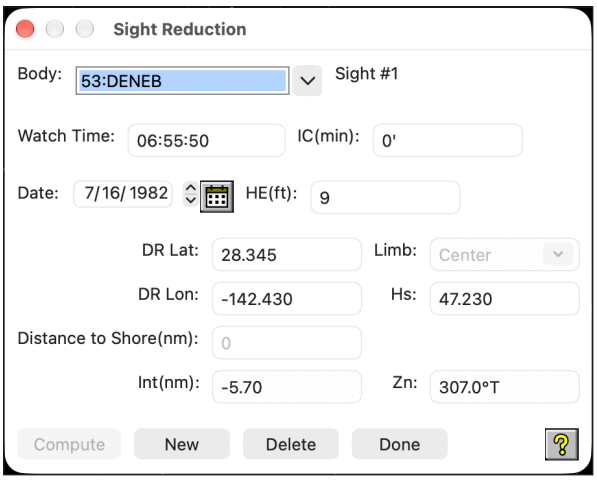


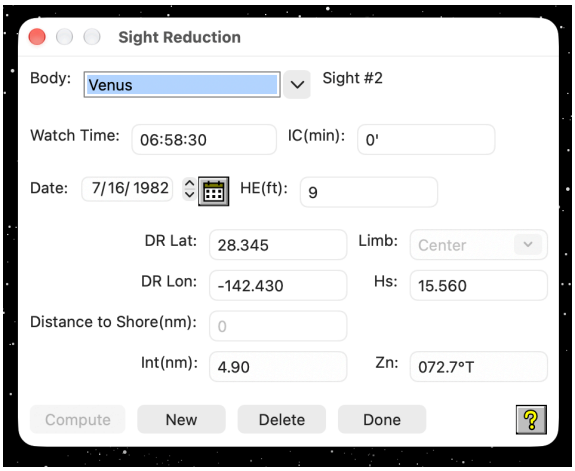


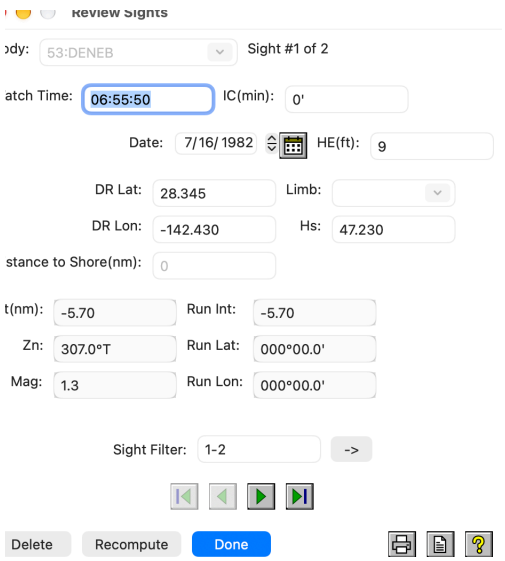
Step 2. In the ***Sight Reduction*** function, enter the data from the sights as shown in the sample from Fix 17 below. When selecting the body, you can click the input field then type the first few letters of the body name or the star number. When entering the time, you can type 12.3456 tab to get 12:34:56

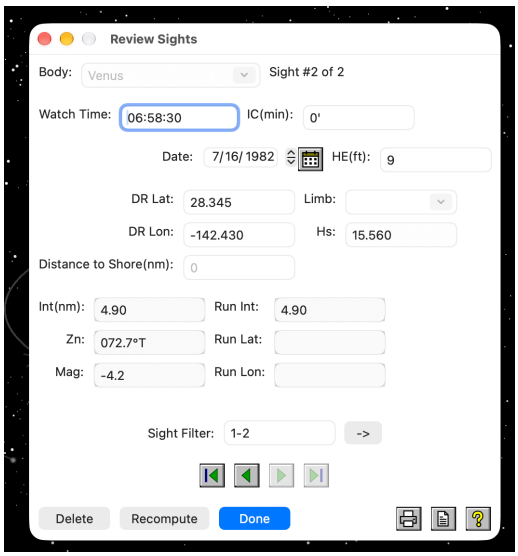
Step 3. Use the ***Review sights*** option to double-check the inputs, as shown in the images below.

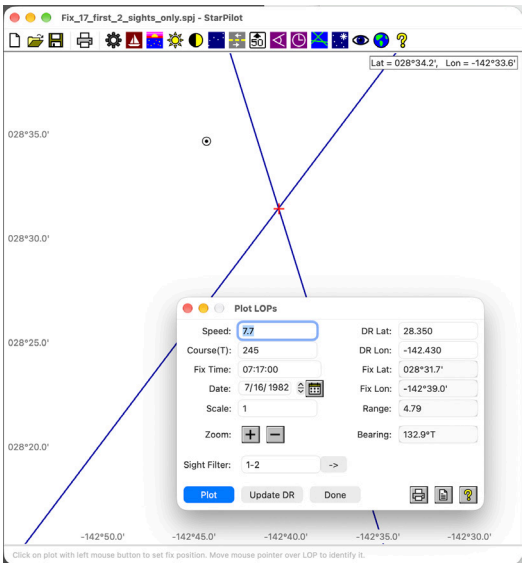
Step 4. That was the end of the sight reduction process, but to experiment more in preparation for the above exercises, you can ***Plot*** the two LOPs, then ***Compute*** the fix, or even go directly to a ***Van Allen Fix*** for a fix from these two sights that is completely independent of DR. Examples are also shown below. We can't do Sight analysis as that is for evaluating a series of sights, not individual ones.

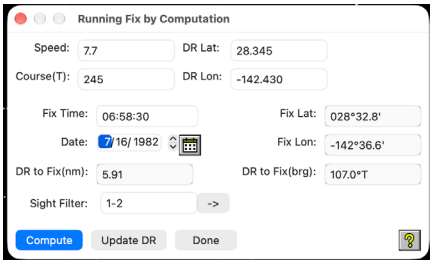


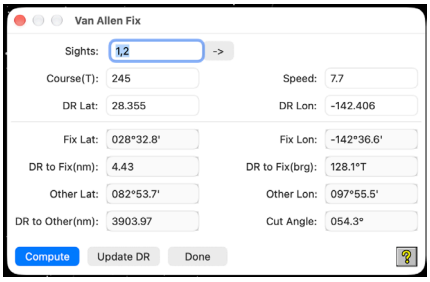



Review Sights
Body: 53:DENEB
Sight #1 of 2
Watch Time: 06:55:50
IC(min): 0'
Date: 7/16/1982
HE(ft): 9
DR Lat: 28.345
Limb:
DR Lon: -142.430
Hs: 47.230
Distance to Shore(nm): 0
Int(nm): -5.70
Run Int: -5.70
Zn: 307.0°T
Run Lat: 000°00.0'
Mag: 1.3
Run Lon: 000°00.0'
Sight Filter: 1-2
->
Delete
Recompute
Done


Review Sights
Body: Venus
Sight #2 of 2
Watch Time: 06:58:30
IC(min): 0'
Date: 7/16/1982
HE(ft): 9
DR Lat: 28.345
Limb:
DR Lon: -142.430
Hs: 15.560
Distance to Shore(nm): 0
Int(nm): 4.90
Run Int: 4.90
Zn: 072.7°T
Run Lat:
Mag: -4.2
Run Lon:
Sight Filter: 1-2
->
Delete
Recompute
Done


Fix_17_first_2_sights_only.spj - StarPilot
Lat = 028°34.2', Lon = -142°33.6'
028°35.0'
028°30.0'
028°25.0'
028°20.0'
-142°50.0'
-142°45.0'
-142°40.0'
-142°35.0'
-142°30.0'
Plot LOPs
Speed: 7.7
Course(T): 245
Fix Time: 07:17:00
Date: 7/16/1982
Scale: 1
Zoom:
Sight Filter: 1-2
->
DR Lat: 28.350
DR Lon: -142.430
Fix Lat: 028°31.7'
Fix Lon: -142°39.0'
Range: 4.79
Bearing: 132.9°T
Plot
Update DR
Done
Click on plot with left mouse button to set fix position. Move mouse pointer over LOP to identify it.


Running Fix by Computation
Speed: 7.7
Course(T): 245
Fix Time: 06:58:30
Date: 7/16/1982
DR to Fix(nm): 5.91
Sight Filter: 1-2
->
DR Lat: 28.345
DR Lon: -142.430
Fix Lat: 028°32.8'
Fix Lon: -142°36.6'
DR to Fix(brg): 107.0°T
Compute
Update DR
Done


Van Allen Fix
Sights: 1,2
->
Course(T): 245
DR Lat: 28.355
Fix Lat: 028°32.8'
DR to Fix(nm): 4.43
Other Lat: 082°53.7'
DR to Other(nm): 3903.97
Speed: 7.7
DR Lon: -142.406
Fix Lon: -142°36.6'
DR to Fix(brg): 128.1°T
Other Lon: 097°55.5'
Cut Angle: 054.3°
Compute
Update DR
Done