C-Nav®

C-Tides® Offline User Manual

Revision 7

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C-Nav® Positioning Solutions
730 E. Kaliste Saloom Road
Lafayette, LA 70508 U.S.A.
oceaneering.com/cnav

OCEANEERING®

Release Notice

This is the August 2018 release of the C-Tides® Offline User Manual.

Revision History

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7	08/15/2018	Updated for C-Tides v2.2.2	C. Thompson
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5	05/16/2017	Updated for C-Tides v2.1.0	C. Thompson
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3	06/10/2015	Added C-Tides and C-Tides data Installation	B.Mathweg
2	11/08/2013	Added troubleshooting section	C. Thompson
1	05/09/2013	Initial document creation	C. Thompson

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Manual Organization

This manual describes how to install, configure, and operate the post-processing version of the **Oceaneering® C-Tides®** worldwide tidal data software, the C-Tides® Offline application. Sections are organized in a manner that facilitates quick operator orientation.

Section 1 - Overview (Page 11) gives a brief overview of the C-Tides® Offline application and its purpose.

Section 2 - Controls (Page 13) gives detailed descriptions of the different settings and controls used to run the C-Tides® Offline application.

Section 3 - Menus (Page 19) describes the various options and dialogs available via the different menus of the C-Tides® Offline application.

Section 4 - Calculations (Page 28) gives a brief description of each of the various values output by the C-Tides® software suite and how they are derived.

Appendix A - Plot Functions (Page 30) describes the buttons available on the various plots that can be used to better investigate the plotted data.

Appendix B - Example Plots (Page 31) provides sample plots created by the C-Tides® Offline application.

Appendix C - Frequently Asked Questions (Page 36) explains how to resolve a few of the common errors that occur while running the C-Tides® Offline application.

Appendix D - Glossary (Page 43) provides definitions for various terms used in this manual.

The user may also be interested in the User Manual for the companion C-Tides® Online application, which processes real-time data.

Related Documents

CNAV-MAN-018.7 (C-Tides Online User Manual)

Similar to this manual, the C-Tides® Online User Manual describes how to configure and operate the C-Tides® Online application. It is available on the **Oceaneering® C-Nav®** website at https://www.oceaneering.com/C-Nav/Software/C-Tides/PDFDownloads/CNAV-MAN-018.7%20%28C-Tides%20Online%20Users%20Manual%29.pdf.

CNAV-MAN-022.6 (C-Tides Quick Start Guide)

The C-Tides® Quick Start Guide is a short tutorial explaining the minimum steps required to configure a fresh C-Tides® software installation. It is available on the C-Nav® website at https://www.oceaneering.com/C-Nav/Software/C-Tides/PDFDownloads/CNAV-MAN-022.6%20%28C-Tides%20Quick%20Start%20Guide%29.pdf. .

CNAV-MAN-020.3 (Sentinel Driver Installation Manual)

This is a short tutorial explaining the how to install Sentinel security driver that is required to run the C-Tides® software. It is available on the C-Nav® website at https://www.oceaneering.com/C-Nav/Software/Utilities/PDFDownloads/CNAV-MAN-020.3%20(Sentinel%20Driver%20Installation%20Manual).pdf.

CNAV-MAN-021.4 (MATLAB Compiler Runtime Installation Manual)

This is a short tutorial explaining the how to install the MATLAB Compiler Runtime (MCR) library that is used by the C-Tides® software. It is available on the C-Nav® website at https://www.oceaneering.com/C-Nav/Software/C-Tides/PDFDownloads/CNAV-MAN-021.4%20%28MATLAB%20Compiler%20Runtime%20Installation%20Manual%29.pdf.

Modelling the global ocean tides: modern insights from FES2004

Details the methodology used to determine the predicted tide values used in the C-Tides® software. It is available on the C-Nav® website at https://www.oceaneering.com/C-Nav/Software/C-Tides/PDFDownloads/FES2004%20Modern%20Insights.pdf.

Unified Tidal Analysis and Prediction Using the UTide Matlab Functions
Describes the underlying methodology of the UTide harmonic analysis used in the C-Tides® Offline application. It is available on the C-Nav® website at https://www.oceaneering.com/C-Nav/Software/C-Tides/PDFDownloads/2011Codiga-UTide-Report.pdf.

Manual Conventions

Arial font is used for plain text in this document.
Arial italic font is used for settings names.
“Arial quoted” font is used for settings values.
Arial Bold font is used for button names.
Arial Bold Italic font is used for menu items.
Arial Blue font is used for cross-references.
Arial Blue Underline font is used for hyperlinks.
Arial red italic is used for typed commands.
Arial Bold font size 10 is used for captions.
ARIAL BLACK ALL-CAPS font is used for port connection names.

This symbol means Reader Be Careful. It indicates a caution, care, and/or safety situation. The user might do something that could result in equipment damage or loss of data.

This symbol means Danger. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical and RF circuitry and be familiar with standard practices for preventing accidents.

Important notes are displayed in shaded text boxes.

> ***Please note***:
> Such note boxes display important information that should not be ignored.

Simple file content is displayed in Courier New Black font in a text box.

```
#Sample File
Version 0.1
```

Section 1 - Overview

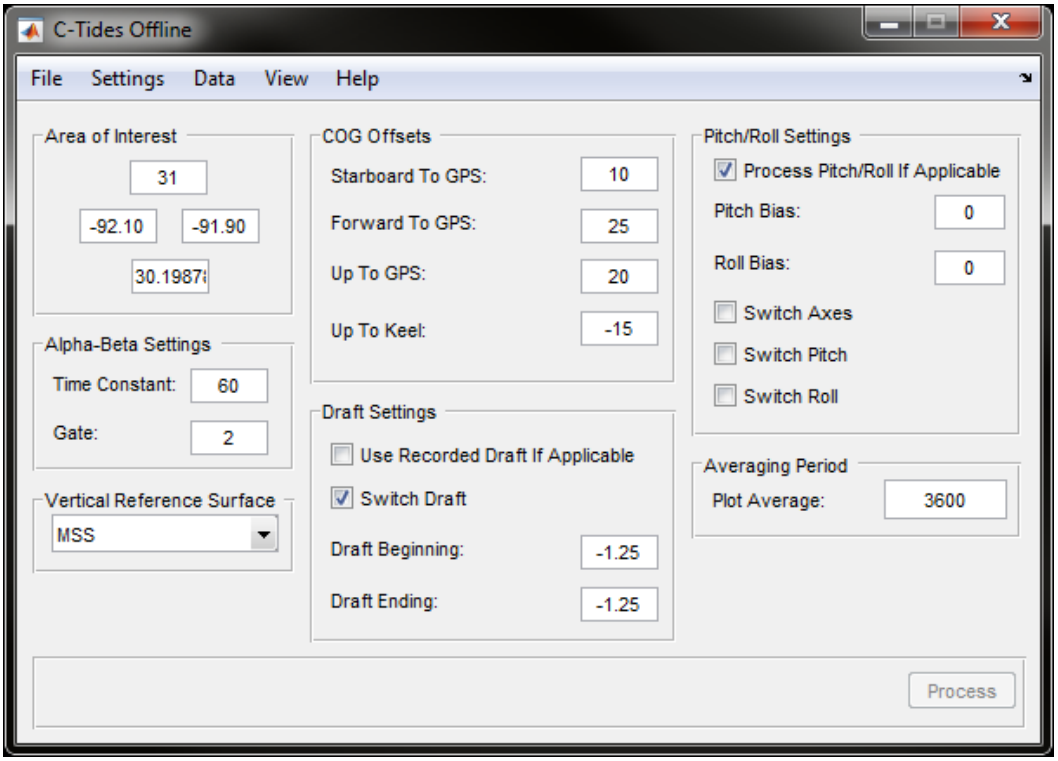


Figure 1: C-Tides Offline

Introduction

The C-Tides® software is a suite of two programs which enables ocean tidal data to be derived from high accuracy **Oceaneering® C-Nav3050®** GNSS receiver data in real-time, and further processed offline for increased accuracy and harmonic derivations.

The software consists of the C-Tides® Online application, which processes C-Nav3050® receiver data and optional TSS1 and / or draft information to give real-time tidal height about the vertical reference surface. The C-Tides® Offline application can be used to further process the data obtained by the online program to smooth, spike reject, and Doodson XO (Page 17) filter the data. In addition, the C-Tides® Offline application can generate harmonic analysis constituents for the site and predict tide plots for the area. Comprehensive output files are generated for further analysis by the user.

Installation

Instructions for installing the C-Tides® Offline application and its dependencies can be found in the C-Tides® Quick Start Guide, available on either the installation thumb drive or our website https://www.oceaneering.com/positioning-solutions/customer-access-and-resources/#sw-ctides.

Section 2 - Controls

Area of Interest

The C-Tides® Offline application reads large, worldwide databases in the form of MATLAB .mat files. They cannot all be held in memory simultaneously. On the other hand, the user only operates in a local area (AOI), not the whole world. The purpose of this panel is to extract the AOI from the worldwide databases.

The AOI will automatically be set when the raw data is loaded. The user can manually alter the AOI by entering the northern, eastern, southern, and western extents after loading the raw data.

Ideally, the smallest AOI possible should be entered. However, an AOI that is too small will prevent processing of the data. The difference in AOI values should be no less than the selected Vertical Reference Surface (Page 13). For example, if using MSS the AOI should be no smaller than 2-minutes by 2-minutes in size.

Note:
When processing data, the C-Tides® Offline application will reject any points outside of the AOI.

The maximum AOI allowed is 10 degrees by 10 degrees. The AOI only needs to be extracted once, unless the extents are changed. The AOI will automatically be extracted when needed.

Selecting ***Data / Trim*** will open a dialog that allows the user to trim the loaded data on the entered AOI, thus editing or reducing the size of the data set.

Vertical Reference Surface

Choose the *Vertical Reference Surface* (VRS) for processing. All surfaces are referenced at the centimetric level to WGS84. The default VRS is “MSS”.

The MSS model is based on satellite altimetry readings that utilize a 10 km beam. Because of this, the vessel must be 10 kilometers from the nearest land mass to use MSS. MSS data is available in 2-minute by 2-minute grid intervals.

The EGM model is the EGM08 geoidal model. EGM most closely approximates MSL where there are no geographic influences on tides. While there is no minimum distance from land requirement to use EGM; the vessel must be in water with a depth of at least 10 meters, preferably 25 meters. EGM data is available in 2-minute by 2-minute grid intervals.

Alpha-Beta Settings

Tidal heights are smoothed with a double-sided alpha-beta filter; however, the unsmoothed tidal height is always available.

The *Constant* determines the alpha-beta parameters. The higher the *Constant*, the heavier the filtering. The *Constant* value can be any number between 0 and 1500 seconds.

Height outliers are rejected with a *Gate*; the difference in meters between the predicted tide and the actual tidal height. The smaller the *Gate*, the more values will be rejected. A valid *Gate* value is between 0 and 20 meters.

Averaging Period

Tidal height is averaged based on the *Plot Average* period. The *Plot Average* can be set from 10 seconds to 3600 seconds.

The averaged value is the average of 1-second tidal height for the selected period centered on current event (that is, before and after data, a "boxcar" smoother). Outliers are not gated or rejected.

Center of Gravity Offsets

Vessel offsets are in meters with respect to the center of gravity (COG) of the vessel. For COG measurements to the GPS, the convention is positive starboard, forward, and up while negative is port, aft, and down. For COG to keel the convention is positive up and negative down.

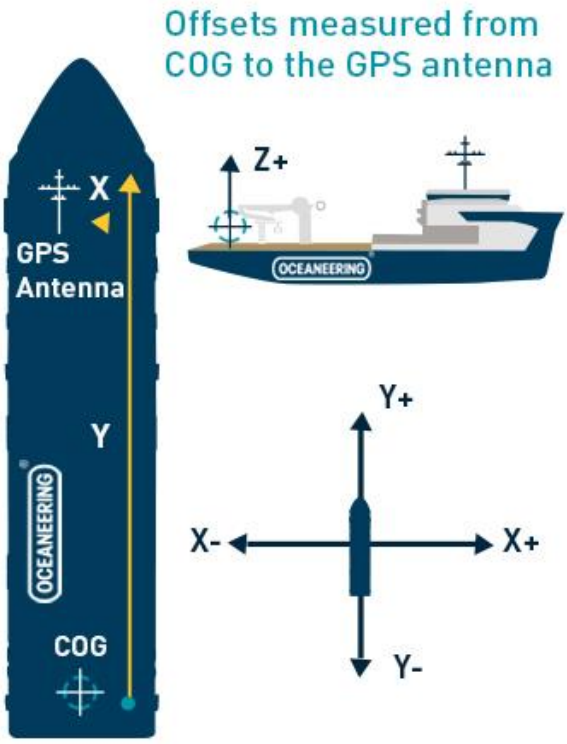


Figure 2: COG Offset Sign Conventions

Note:
The COG can be any navigation reference point (NRP), but it is advisable that it be as close to the physical center of gravity as possible, recognizing that the COG changes with dynamics and ballasting.

Draft Settings

There are two methods for using draft in the tidal height calculations. If you are processing a C-Tides® software data format file, one recorded by the C-Tides® Online application, and you want to use the draft recorded in the file, then check the *Use Recorded Draft If Applicable* box. The Draft Beginning and Draft Ending values will be ignored.

If there is no draft data available in the loaded data, then the user can enter a manual draft value. There are two entries for *Draft*, beginning and ending. If they are the same, that number will be used as the draft value in calculations. If they are different, the processing will vary the draft linearly from the beginning value to the ending value. The draft actually used will be recorded in the data that can be saved.

The convention for draft data values is positive down and negative up. This convention can be reversed by checking the *Switch Draft* box.

Pitch / Roll Settings

If processing PVT1B data, no pitch or roll is used. However, if processing a C-Tides® software data format file, pitch and roll can be used. If a motion sensor is calibrated, the calibration values can be entered here. The values entered here are added to the pitch and roll values in the raw data.

The axes or rotation senses of the motion sensor may not be consistent with the convention used by the C-Tides® software. These conventions can be mapped with these checkboxes. At the end of data processing, a Raw minus Smoothed (RMS) value is reported to the Show Log (Page 24) dialog. This value can be used to confirm correct orientation and rotation senses.

Load Data

Two types of data can be loaded into the C-Tides® Offline application: PVT1B and the C-Tides® software data format. PVT1B is the C-Nav® proprietary binary GNSS data format. The C-Tides® software data format is the data format produced by the C-Tides® Online application, which can be generated to enter data into the C-Tides® Offline application.

Note:
Loading PVT1B files is considerably slower than loading the C-Tides® software data format files.

Data is loaded with either the Load PVT1B Data (Page 19) or Load C-Tides Data (Page 19) menu. Both types of data cannot be loaded at the same time.

Once the data is read the pitch, roll, heave, raw height, and track plots will be displayed. After these plots are dismissed, they can be re-plotted from the Plot Raw Data (Page 23) menu.

Note:
Heave is not used by this version of the C-Tides® software.

Process Data

The next step is the processing of data with the **Process** button. This reduces the raw height at the C-Nav3050® receiver antenna to the water level tidal height referenced to a vertical surface. The default vertical reference surface is MSS, but others can be chosen (see Vertical Reference Surface (Page 13)). Height reduction from the antenna also requires knowledge of the vessel offsets between the waterline and the center of gravity and between the COG and the C-Nav3050® receiver antenna (see Center of Gravity Offsets (Page 14)).

The C-Tides® Offline application reduces the C-Nav3050® receiver antenna height to the waterline using pitch, roll, and draft data when available and desired. Processing progress will be reported every 2000 records.

When processing is completed, plots of the tidal heights are provided with smoothed tidal height, averaged tidal height, and predicted tide. Another plot is smoothed tidal height minus predicted tide and Doodson XO (Page 17). Vessel track is the third plot offered. After these plots are dismissed, they can be re-plotted from the Plot Processed Data (Page 23) menu.

Note:
There is a 19.5 hour gap at the beginning and end of any Doodson XO plot due to the 39-hour length of the Doodson X0 filter.

Doodson XO

The Doodson XO filter process is useful for deriving a local VRS approximating MSS, valid during the period of observations. The Doodson XO filtering process includes any weather or seasonal effects plus any errors in the vertical offset used between the GPS antenna and the waterline. The value is the separation between the Doodson XO derived VRS and the selected VRS.

The Doodson XO value is the best indicator of an offset error, but the vessel would need to stay in the same location while collecting the data. Unless working under a very high or low pressure weather system Doodson XO errors are a reflection of both the granularity of the model used and any offset error (also any significant movement of the vessel during data collection).

Note:
The Doodson XO value is provided for reference and QC purposes only. It is not used in any of the C-Tides® calculations.

Section 3 - Menus

File

Load PVT1B Data

The ***Load PVT1B Data*** menu opens up a standard Windows Open File dialog. Files can be loaded either one at a time or all at once. As the application reads each file, the file name and path will be echoed to the Show Log (Page 24) dialog. Progress will be reported every 2000 records in the Show Log (Page 24) dialog.

Load C-Tides Data

Load C-Tides Data will load C-Tides® software data format files. Files can be loaded either one at a time or all at once. As the application reads each file, the file name and path will be echoed to the Show Log (Page 24) dialog.

Save Raw Data

The ***Save Raw Data*** menu will save only the raw data in 1-second intervals in the C-Tides® software data format. Progress will be reported every 2000 records in the Show Log (Page 24) dialog.

Save Processed Data

The ***Save Processed Data*** menu will save the processed data in 1-second intervals in the C-Tides® software data format. The processed data can only be saved after the loaded data has been processed. Progress will be reported every 2000 records in the Show Log (Page 24) dialog.

Quit

Selecting ***Quit*** will close the C-Tides® Offline application.

Settings

Import Settings

Loads a configuration from a previously saved instance of the C-Tides® Offline application.

Export Settings

Saves the current configuration of the C-Tides® Offline application to file.

Reset Settings

Resets all settings to default.

Data

Prediction

The ***Prediction*** dialog will allow the user to plot the predicted tidal data for a given time period, at a given coordinate. Time is entered in UTC time in the format "YYYY/MM/DD HH:MM:SS."

The latitude and longitude of the prediction location must be entered in decimal degrees. When the **Predict** button is pushed, a plot of the tide (hourly tides in decimal days from the beginning of the year of the selected period will display. Additionally, the tidal constituents and their amplitude, phase and frequency will be written in the to the Show Log (Page 24) dialog where it can be saved.

For more information on the interpretation of tidal constituents follow this link http://en.wikipedia.org/wiki/Theory_of_tides. The **Save As** button will prompt the user to save a file that will contain two columns of information, UTC time in one-hour intervals in the first column and the tide with respect to sea level in meters in the second column.

Note:
The predicted coordinate must be within the AOI set on the main screen. This means that the AOI bound by the extents on the main screen will be extracted when the ***Prediction*** dialog is opened.

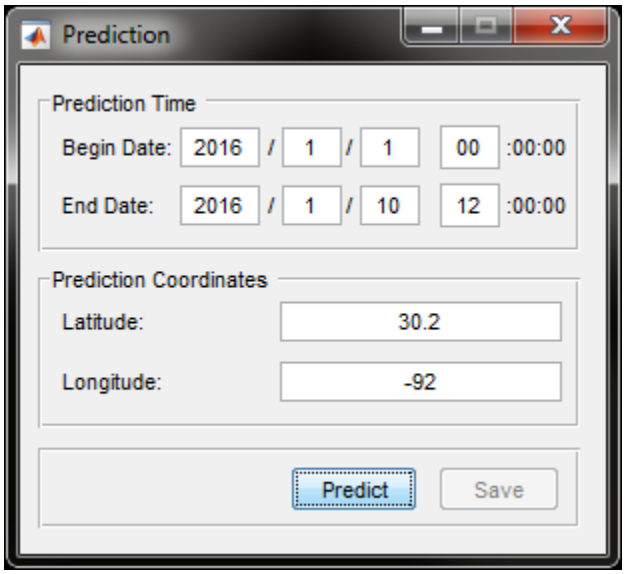


Figure 3: Prediction Dialog

UTide

The **UTide** button performs harmonic analysis on the data. Information on UTide can be found in the reference document *Unified Tidal Analysis and Prediction Using the UTide Matlab Functions*. If data spanning more than 3 days have been processed in the C-Tides® Offline application, then the ***UTide*** menu will compute the tidal constituents from the reduced data using default options and predict the tide using those constituents. A plot of the smoothed tidal height, predicted tide, UTide tide, and Doodson X0 is displayed. Tidal constituents and their error bars are reported to the Show Log (Page 24). Visit the link above for an interpretation of these parameters.

Trim Data

The ***Trim Data*** menu has two functions. When unchecked, pressing the ***Trim Data*** menu will open the ***Trim Data*** dialog. This dialog allows the user to trim the loaded data set to a particular period or AOI. This can remove outliers from the processed data. Time is entered in UTC time in the format "YYYY/MM/DD HH:MM:SS." The AOI used is defined by the main window.

When the ***Trim Data*** menu is checked, pressing the menu item will revert to the full data set.

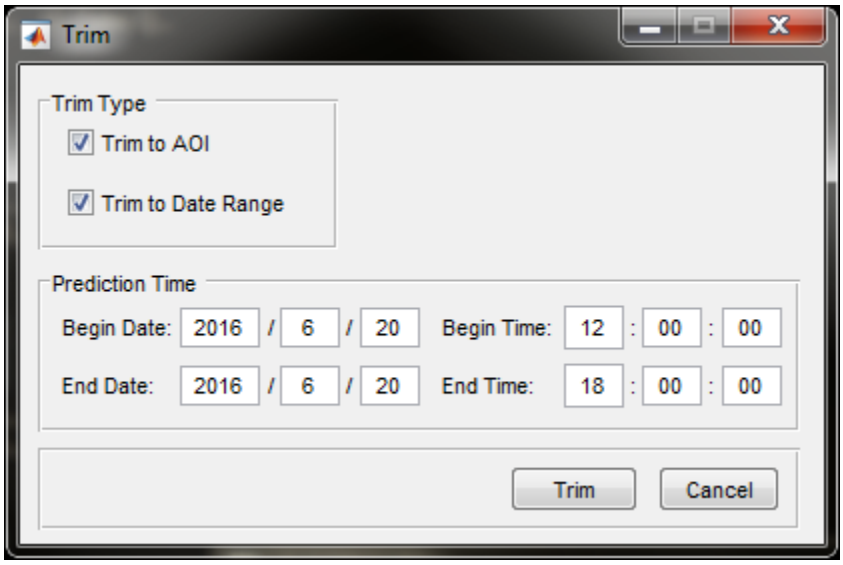


Figure 4: Trim Data Dialog

Decimate

Some users may not want a long file of 1-second data. Once the loaded data has been processed, the ***Decimate*** dialog will save a reduced file of averaged data. The averaging period can be entered between 2 and 600 seconds. The output format will be the same as the normal processed data, but there will be fewer rows of data and all the columns will be averaged. Further processing a decimated file by the C-Tides® Offline application is not recommended, but a decimated file is suitable for analysis in a spreadsheet.

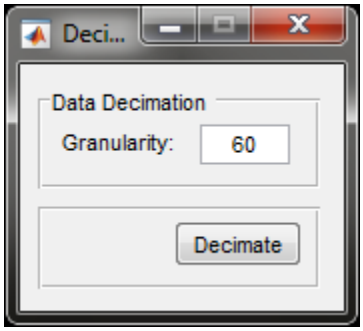


Figure 5: Decimate Dialog

Flush Data

Flushes all loaded and processed data from memory.

View

Plot Surfaces

Plot Surfaces will produce the following contour plots of the selected AOI:

- EGM
- MSS
- The difference between EGM and MSS

Sample surface plots can be found in Appendix B - Example Plots (Page 31).

Plot Constituents

Plot Constituents will produce plots of the amplitude and phase for the 14 tidal constituents (28 plots total). A 29th plot estimates LAT (Lowest Astronomic Tide) with respect to MSL by amplifying ISLW (Indian Spring Low Water, computed as the sum of the amplitudes of 4 tidal constituents) by a factor empirically-derived and verified in the VORF area. The quality of this estimate is 2 to 3 decimeters. Appendix A - Plot Functions (Page 30) offers advice about examining and saving the plots. These plots consume memory. After inspection and before processing data, they should be deleted individually with the **X** or en masse with ***View / Close All Plots***. They can be re-plotted at any time.

Sample surface plots can be found in Appendix B - Example Plots (Page 31).

Plot Raw Data

Allows the user to reopen the raw data plots without having to reload the data. Opens the following plots:

- GNSS Antenna Height
- Vessel Track
- Pitch
- Roll
- Heave

Plot Processed Data

Allows the user to reopen the processed data plot without having to reprocess the data.

Close All Plots

Closes all open plots and dialogs. The same functionality can be achieved by pressing **Control + W** in the main C-Tides® Offline application screen.

Show Log

Opens the ***Log Data*** dialog, which displays the last 500 log messages output by the C-Tides® Offline application. These messages can be status updates, error messages, or the results of calculations.

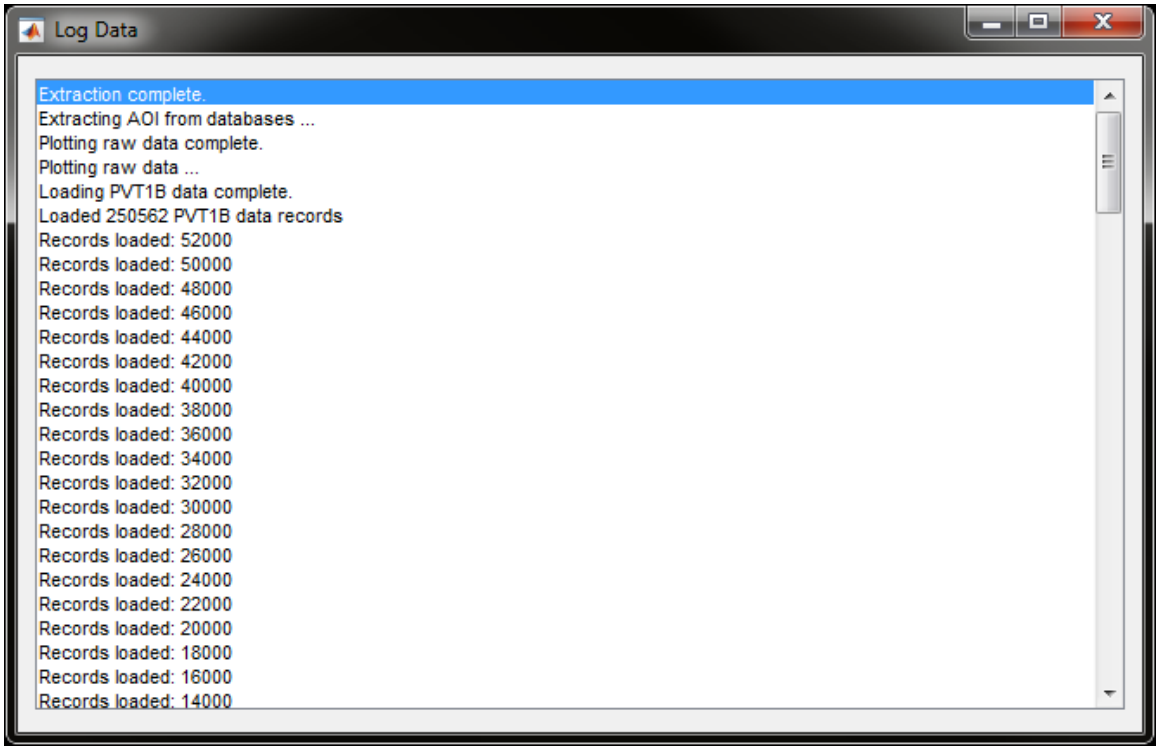


Figure 6: Log Data Dialog

Help

Show Help

Selecting the ***Show Help*** menu or pressing **F1** will display a brief set of instructions to run the C-Tides® Offline application. The same instructions can be found in the C-Tides® Quick Start Guide, available on either the installation thumb drive or our website https://www.oceaneering.com/positioning-solutions/customer-access-and-resources/#sw-ctides.

> ***Note***:
> Pressing **F1** in any dialog will display help for that particular dialog.

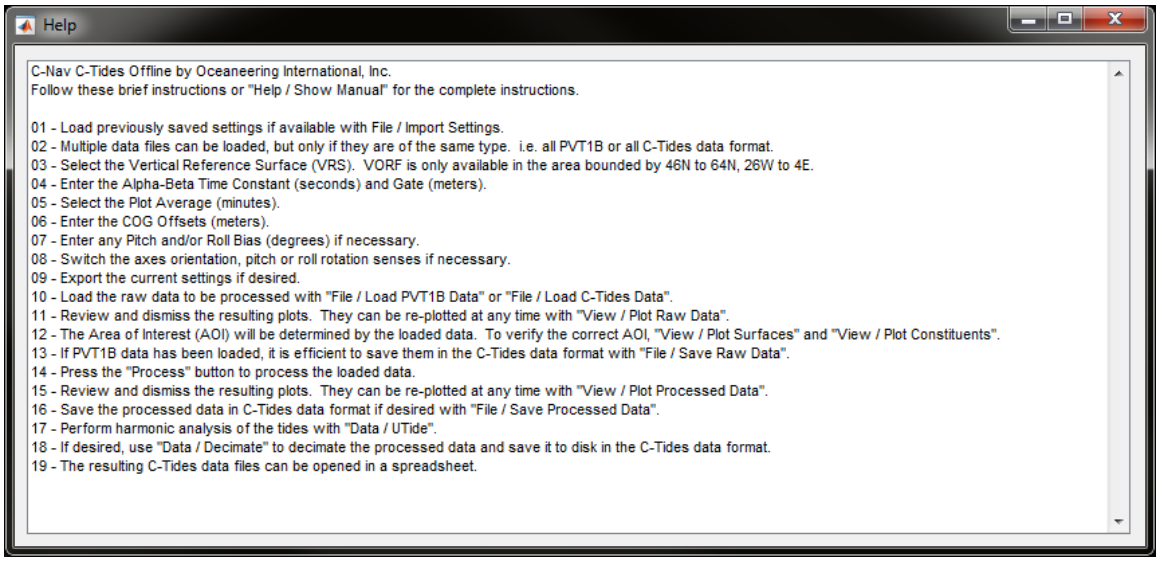


Figure 7: Help Dialog

Show Manual

Opens the current C-Tides® Offline User Manual.

Note:
A PDF reader must be installed to open the C-Tides® Offline User Manual.

C-Nav Dongle Check

Information about the currently connected dongle can be found in the ***C-Nav Dongle Check*** dialog.

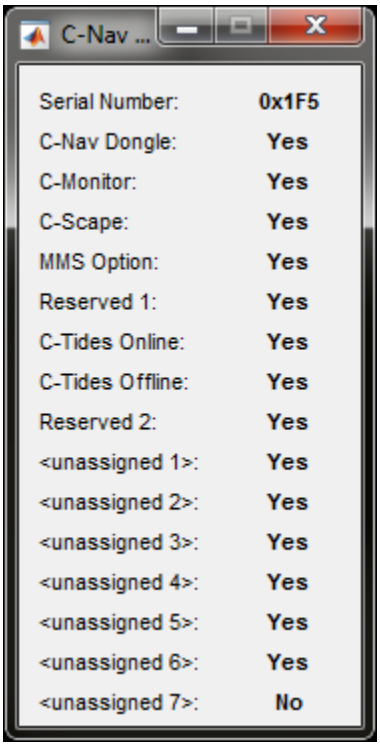


Figure 8: C-Nav Dongle Check Dialog

About

Support contact information for C-Nav® can be found by selecting ***About***. The current version number, contact information, etc. to assist the operator should problems arise can also be found in this dialog.

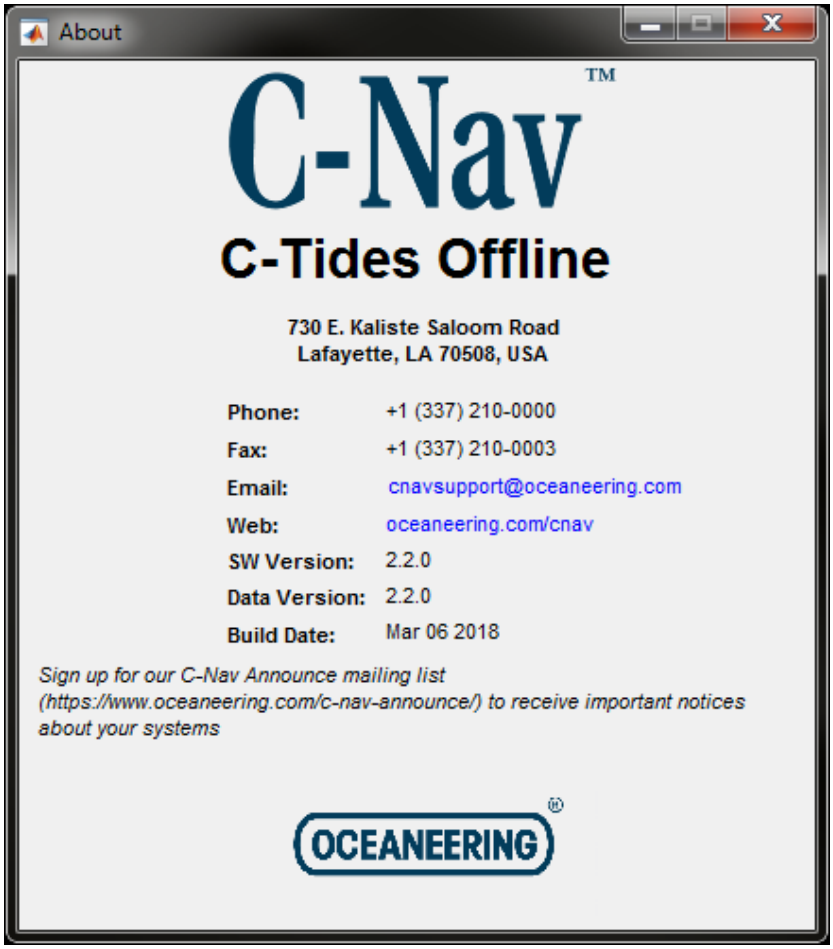


Figure 9: About Dialog

Section 4 - Calculations

The C-Tides® software calculates several values useful when dealing with tides. Below are some details about each.

Predicted Tide

The predicted tide values are derived from an independent solution that is detailed in the paper *FES 2004 Modern Insights*, available on the C-Nav® website. The values are based on a combination of MSS and tide gauge values around the world. Within the C-Tides® software, the values are interpolated to the coordinates of the C-Nav3050® receiver. This value is typically within 50 cm any of the Vertical Reference Surface (Page 13) models. The value is output in meters.

Calculated Tidal Height

The calculated tidal height is derived based on the real-time ellipsoidal height of the C-Nav3050® receiver, the Center of Gravity Offsets (Page 14) adjusted for any pitch, roll, or draft movement, and the selected Vertical Reference Surface (Page 13). The result gives the user the tidal height above the selected VRS in meters.

Filtered Tidal Height

Using the *Time Constant* and *Gate* settings, the C-Tides® software will perform an alpha-beta filtering technique on the calculated tidal height. The result is a smoothed tidal height above the selected VRS in meters.

Averaged Tidal Height

Using the *Plot Average* setting, calculates an average of the filtered tidal heights. The result is a tidal height above the selected VRS in meters.

Averaged Tidal Height Minus Predicted Tide

A simple subtraction of the average tidal height value by the predicted tide value. The result is given in meters.

Doodson XO

The Doodson XO filter process is useful for deriving a local VRS approximating MSS, valid during the period of observations. The value is the separation

between the Doodson XO derived VRS and the selected VRS in meters. This value is only available via post-processing in the C-Tides® Offline application.

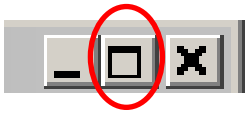
> ***Note***:
> The Doodson XO value is provided for reference and QC purposes only. It is not used in any of the C-Tides® calculations.

UTide

The UTide harmonic analysis process will make an estimate of the 14 highest order harmonics of the measured tide. The calculation requires a minimum of three days of data. The value output for each epoch is the tidal height resulting from the use of the 14 harmonic parameters above the VRS in meters. This value is only available via post-processing in the C-Tides® Offline application.

Appendix A - Plot Functions

Expand to full screen



Save in 16 formats

Print

Zoom in

Zoom out

Pan

Rotate 3D figure

Mark coordinates

Reset to original view …right click with cursor in plot

Appendix B - Example Plots

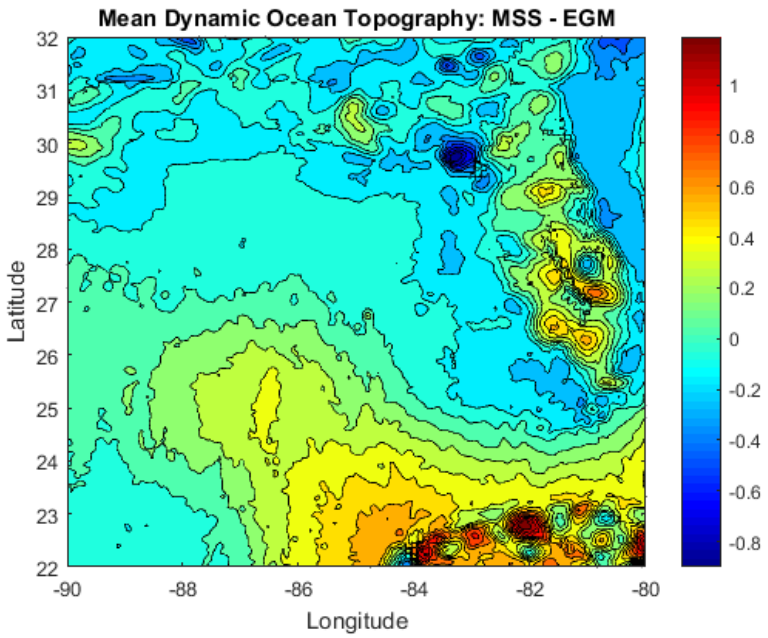


Figure 10: MSS - EGM Surface Plot

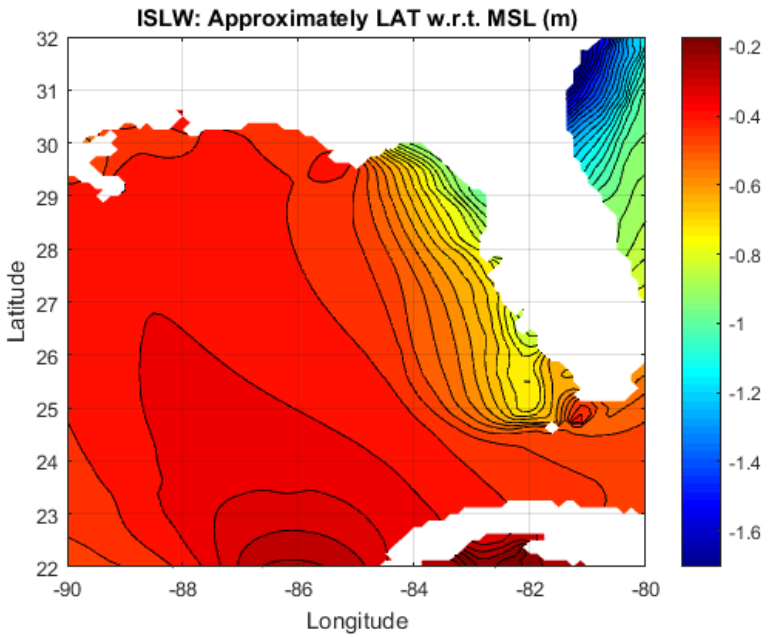


Figure 11: Amplified ISLW Constituents Plot

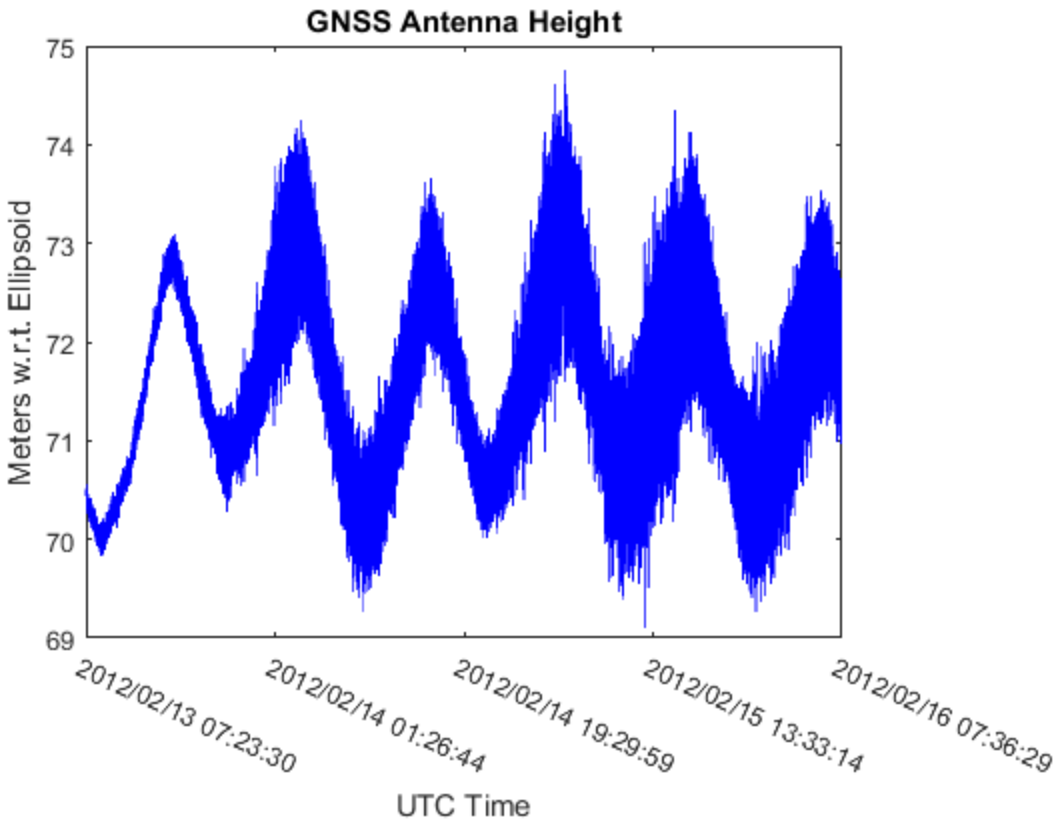


Figure 12: Raw Height Plot

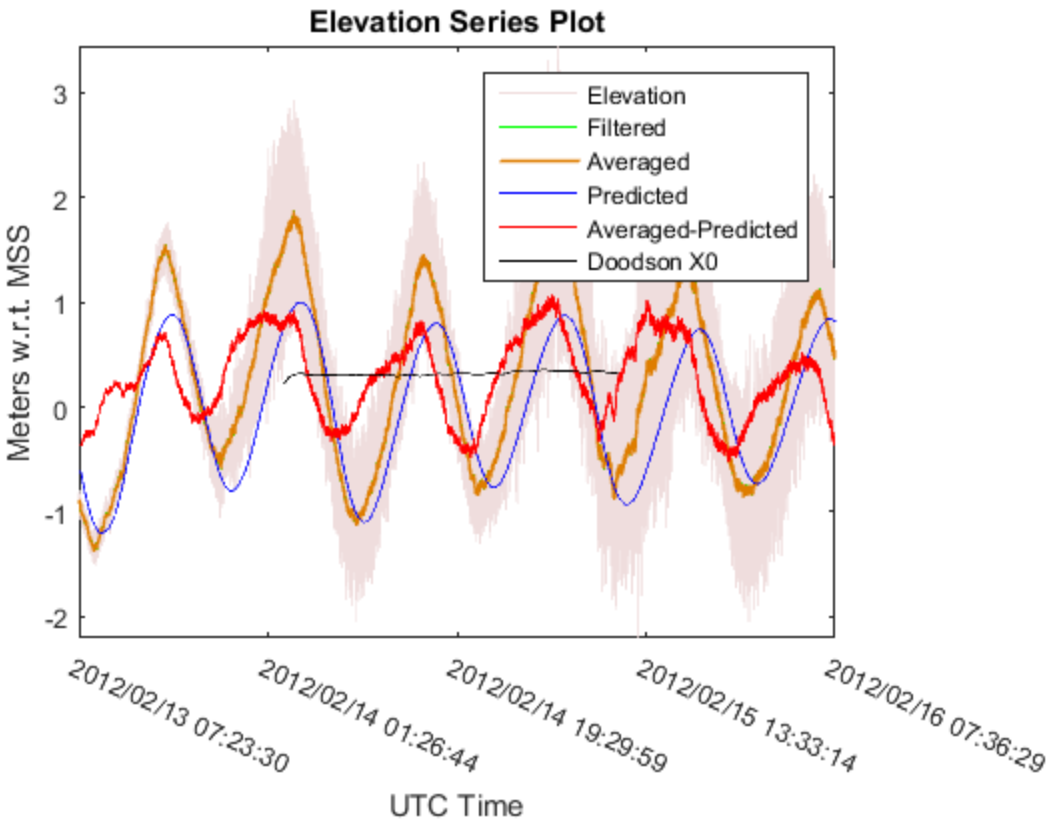


Figure 13: Processed Data Plot

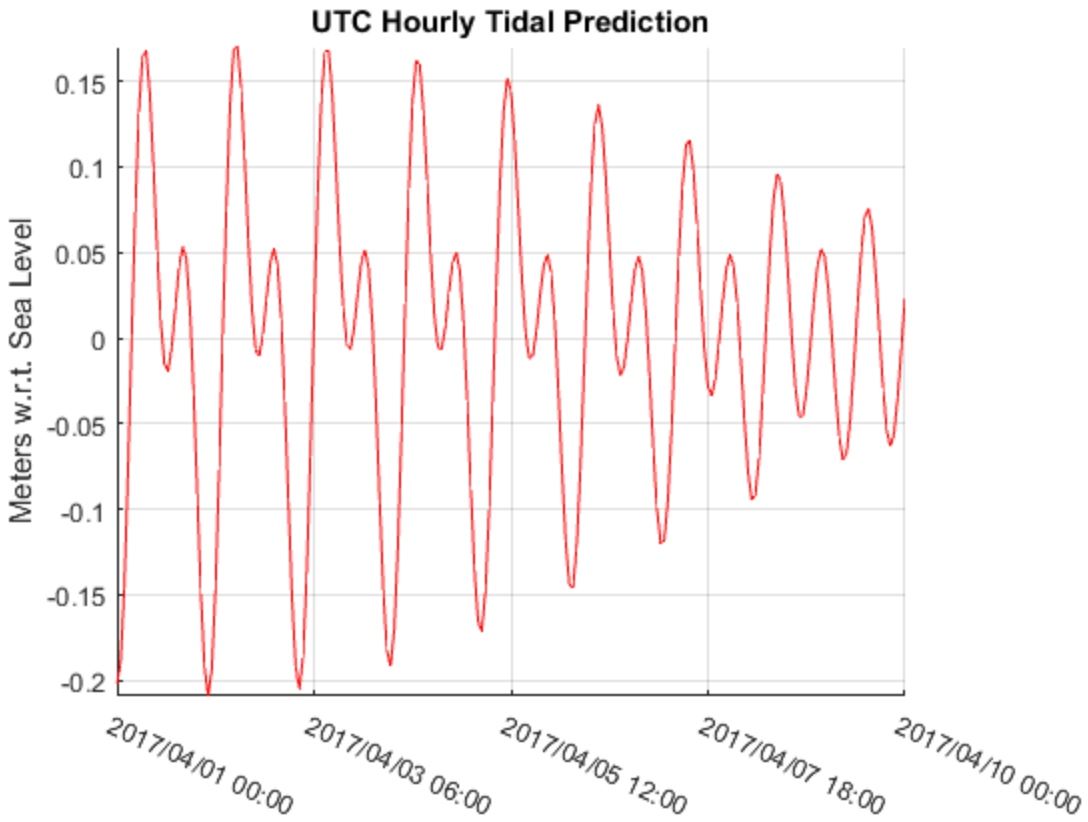


Figure 14: Predicted Data Plot

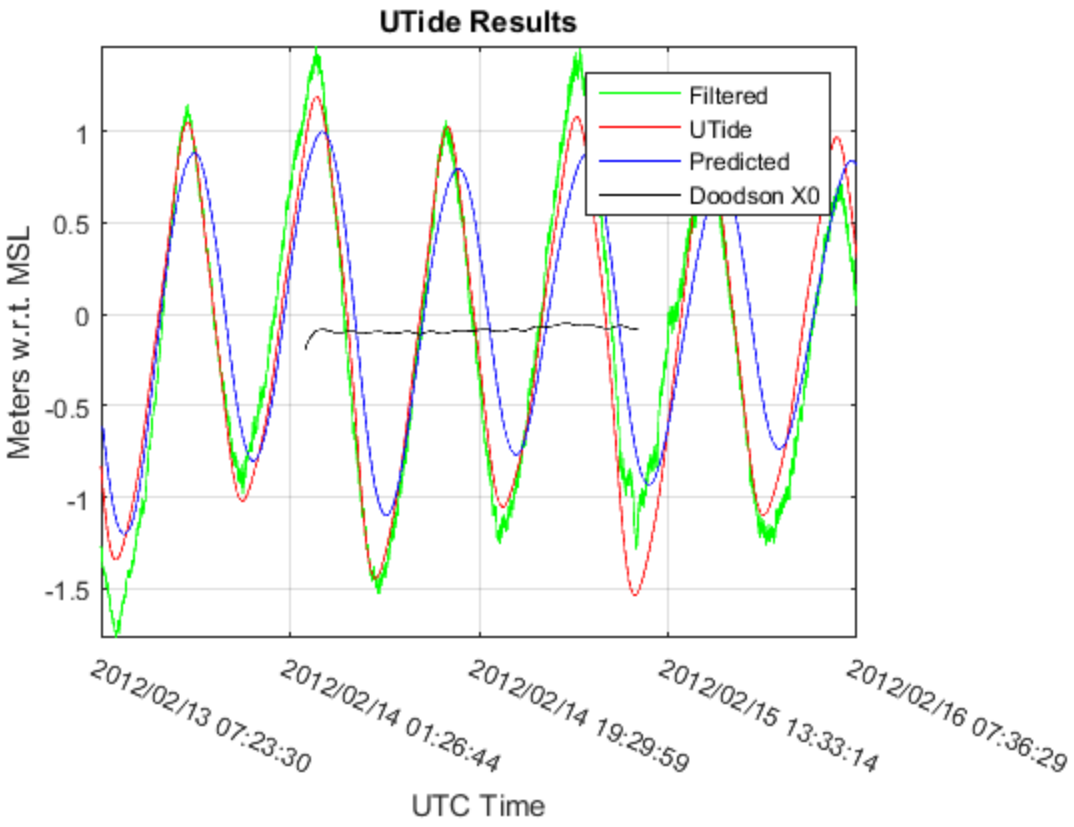


Figure 15: UTide Plot

Appendix C - Frequently Asked Questions

When I start the C-Tides® application, I get an error message about the MATLAB Runtime?

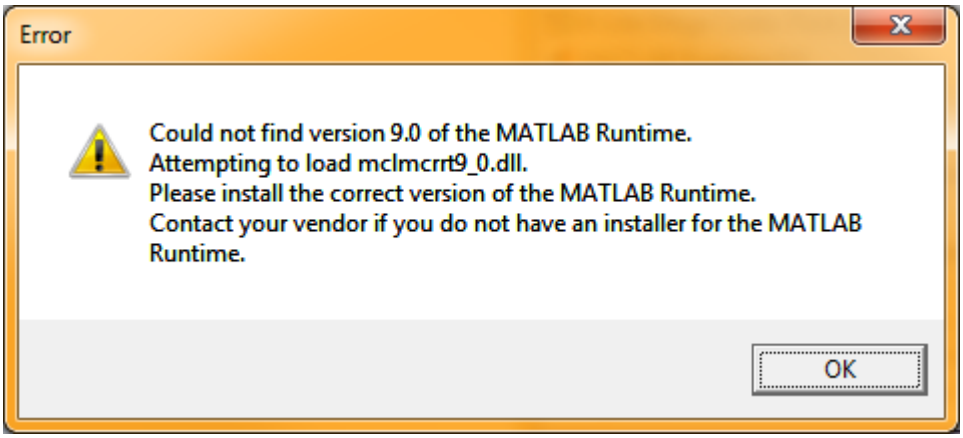


Figure 16: Missing MATLAB Runtime Error Dialog

This occurs when the proper MATLAB Compiler Runtime has not been installed. Please follow the instructions in the C-Tides® Quick Start Guide, available on either the installation thumb drive or our website https://www.oceaneering.com/positioning-solutions/customer-access-and-resources/.

When I try to extract an AOI, why do I get the error message "Can't find "XXXX.mat" on path"?

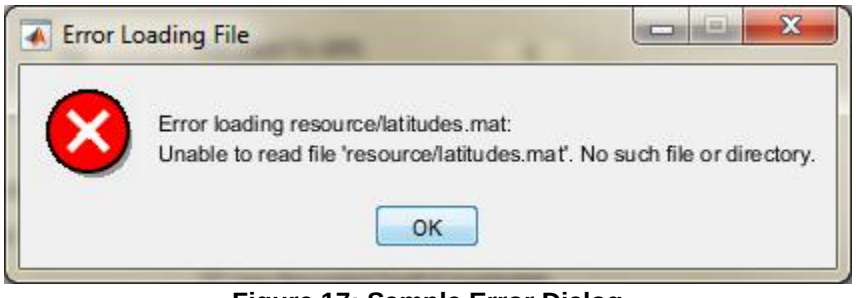


Figure 17: Sample Error Dialog

There are three possible reasons for this error.

1. The C-Tides Data package was not properly installed. Ensure that the C-Tides Data is installed into the same directory as the C-Tides® Offline application.
2. The *Area of Interest* is too large. Ideally, the AOI should be as small as possible around the desired location. Select a smaller bounding area.
3. The MATLAB runtime has run out of system memory. Restart the C-Tides® Offline application.

My computer made a ding sound while C-Tides was running, and now the application doesn't seem to be doing anything.

The ding sound indicates that the MATLAB Runtime has triggered an unexpected error that caused the C-Tides® software to stop execution. It is best to close the application and send the error to C-Nav® Support (cnavsupport@oceaneering.com) for further troubleshooting.

To close the application, press **Ctrl + C** in the busy dialog window. This will allow you to then close the main C-Tides® application window.

All errors are logged to a diagnostic log file. The most recent diagnostic log file can be found at:

C:\Users\{USERNAME}\AppData\Local\C-Nav\C-Tides\.

Why is there no predicted data in my AOI?

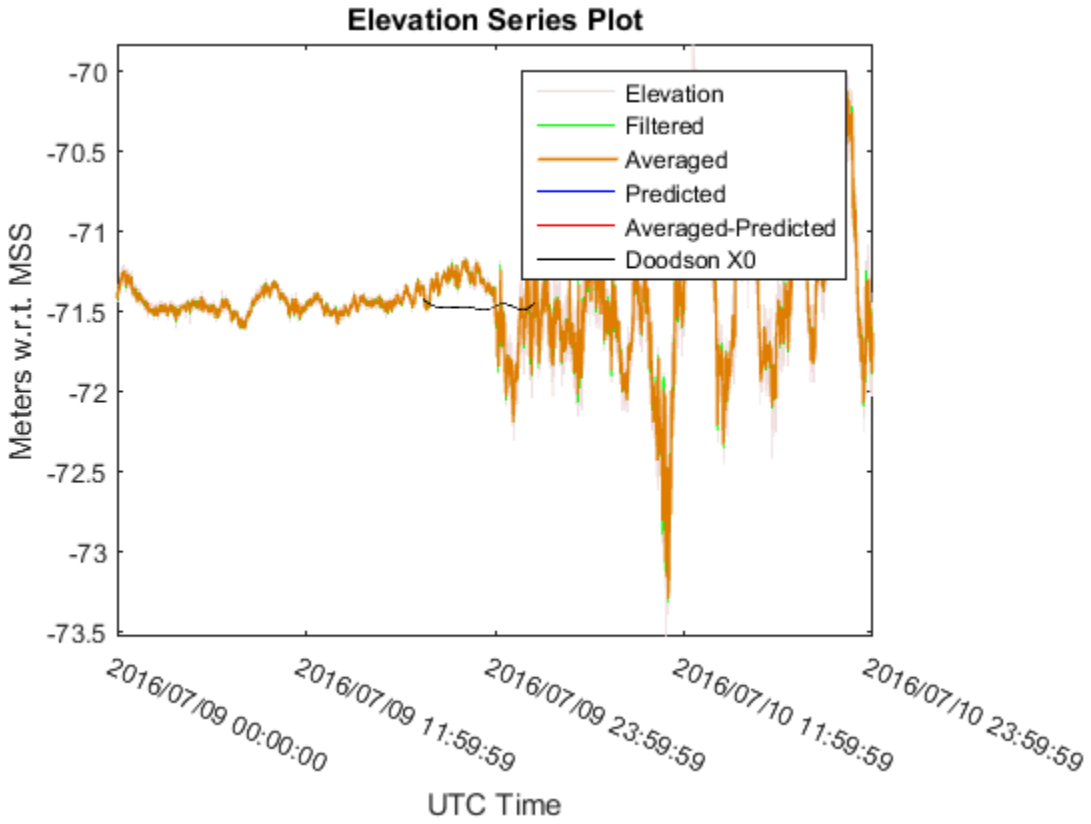


Figure 18: Missing Predicted Data

The predicted tide data is not available on land or in some areas near land. The easiest method to determine if the predicted tide data is available in your *Area of Interest* is to Plot Constituents (Page 23). The last constituents graph, “ISLW: Approximately LAT w.r.t. MSL (m)", will be non-white in areas with predicted tide data.

In certain areas there may be significant differences between the EGM and MSS model results. The MSS model should give a better correlation to the predicted tide beyond 10 km from shore. If both models are significantly different to the predicted tide, check the Center of Gravity Offsets (Page 14).

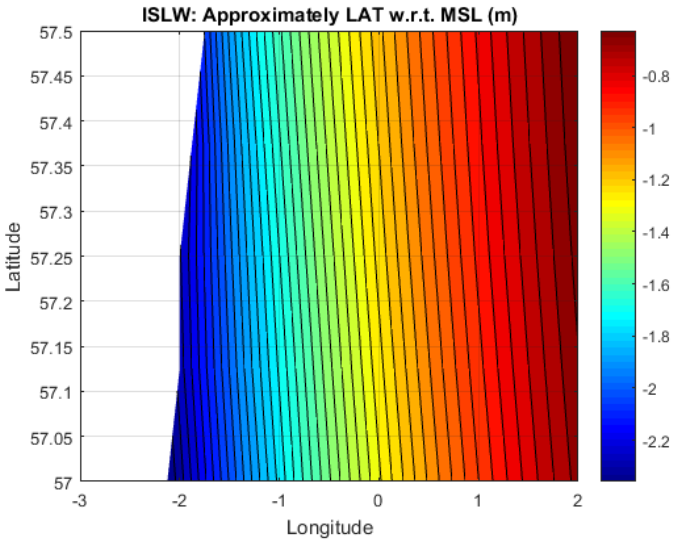


Figure 19: Sample Constituents Plot

Figure 19: Sample Constituents Plot (Page 39) shows an AOI with partially available predicted data. Figure 20: Predicted Data Worldwide Availability (Page 39) shows the availability of the predicted data worldwide. A larger version is available on the C-Nav® website: https://www.oceaneering.com/C-Nav/Images/islw_world.png

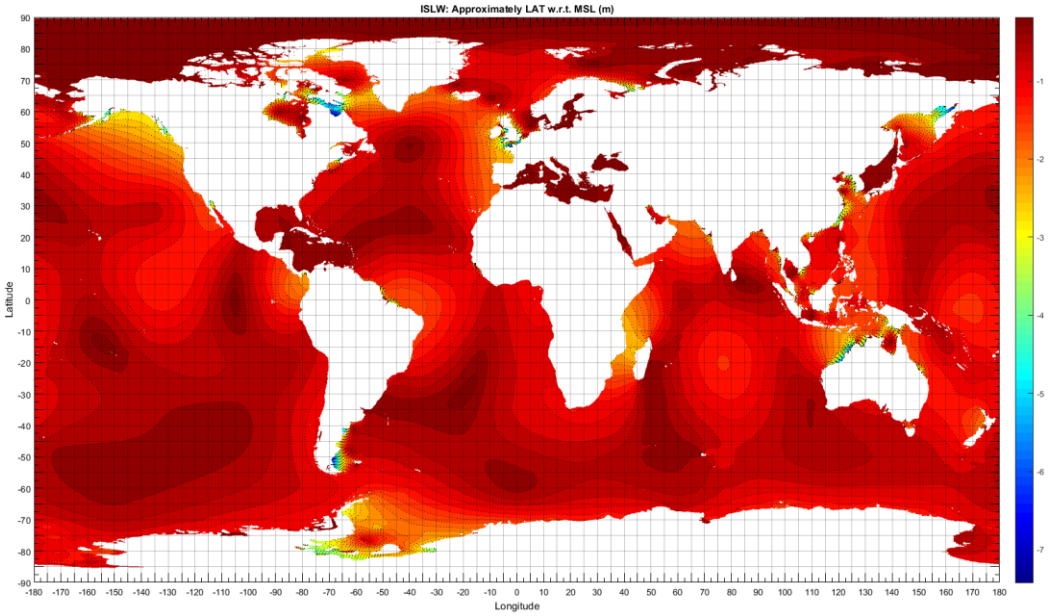


Figure 20: Predicted Data Worldwide Availability

When post-processing data I get a 'Discontinuities' error. How do I resolve this?

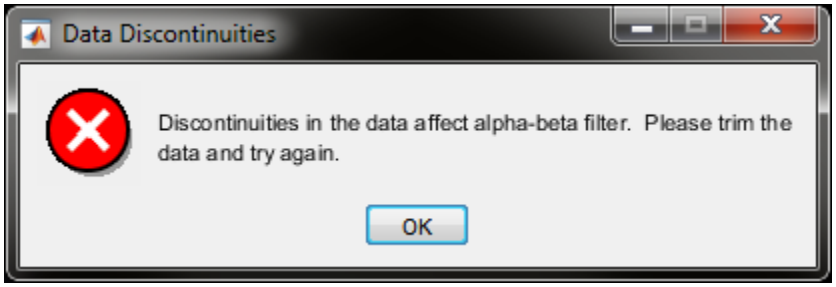


Figure 21: Data Discontinuities Filtering Error Dialog

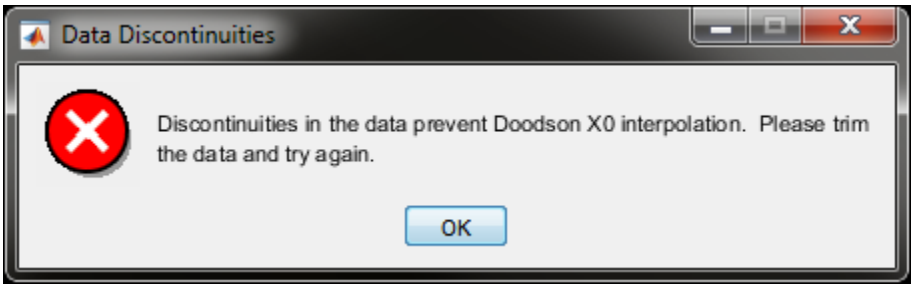


Figure 22: Data Discontinuities Doodson X0 Error Dialog

These errors occur when the data is not contiguous, as the example below shows.

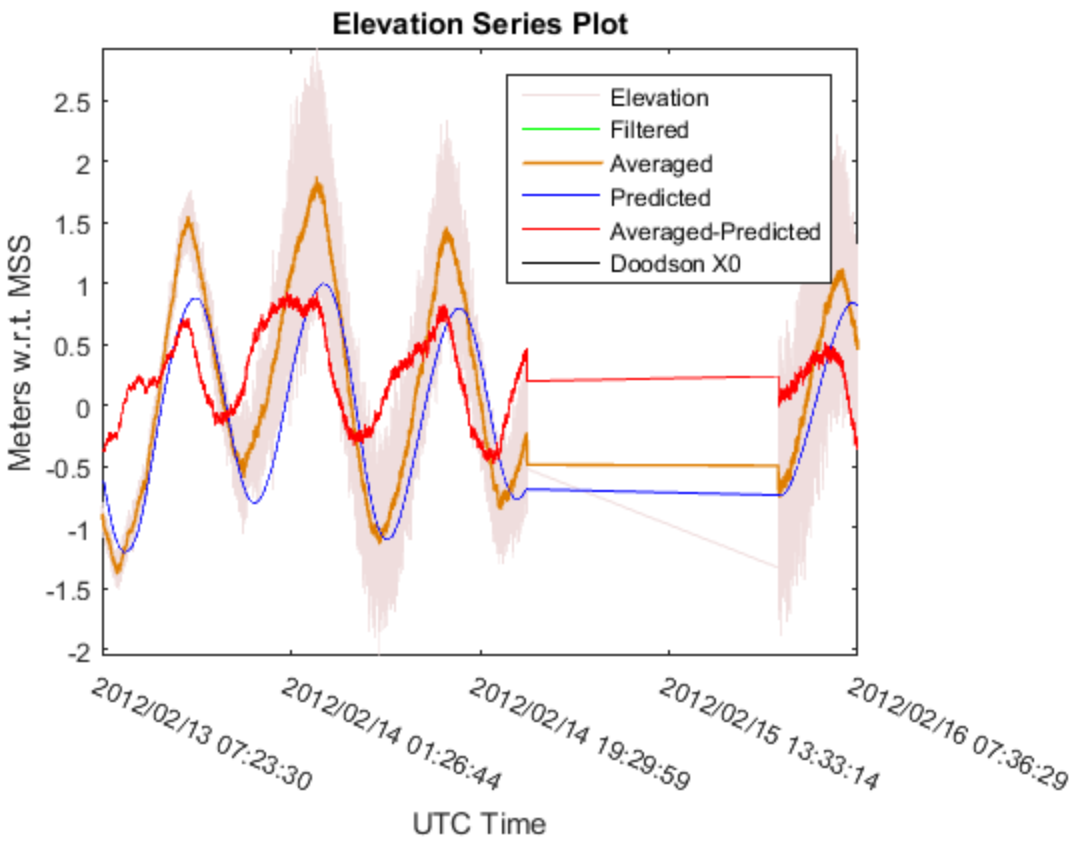


Figure 23: Non-Contiguous Data

The most likely reason for non-contiguous data is the coordinates for the gaps lie outside of the AOI and were therefore skipped. Increasing the size of the AOI or trimming the data can alleviate the problem.

Why is the tidal height not the same as the predicted tide height?

The predicted tide is a 14-year average of model data. The tidal height is based off real values that are open to influence by local conditions such as weather, GPS errors, or offset errors.

Why is the tidal height not the same as the tide gauge in my area?

The C-Tides® applications are not replacements for a tide gauge system. If the user is close enough to shore that tide gauges are available then the user is too close to shore to be using the C-Tides® software.

- To use the MSS model, the vessel must be 10 kilometers from the nearest land mass.
- To use the EGM model, the vessel must be in water with a depth of at least 10 meters. It is preferable to have a depth of at least 25 meters.

Using these models near-shore or in shallow water will affect the results due to land mass.

Appendix D - Glossary

AOI	(**A**rea **O**f **I**nterest) An AOI is a rectangle bounded by two latitudes and two longitudes and which covers the prospect (survey) and any port calls the vessel may have made. If the C-Tides® Offline application is used for tidal predictions, the extracted AOI must cover location (lat / lon) for the prediction.
C-Nav3050	The C-Nav3050® GNSS receiver has expanded capabilities including RTK, 1PPS output, etc. The C-Nav3050® receiver includes dual frequency precision GNSS receiver, with two additional channels for receiving SBAS signals and an L-Band demodulator for reception of C-Nav® subscription signals. For more information, go to oceaneering.com/cnav.
COG	(**C**enter **O**f **G**ravity) The COG is the point at which the mass or weight of a vessel is evenly distributed. A low COG contributes to vessel stability. The COG is the point with the least heave on the vessel. Consequently, draft is most easily measured from the COG.
EGM	(**E**arth **G**ravitational **M**odel) EGM is one of several geoidal models (e.g. EGM96, EGM08). The EGM models are a collaboration among the National Geospatial-intelligence Agency (NGA), the NASA Goddard Space Flight Center (GSFC), and Ohio State University. The C-Tides® software uses EGM08.
Geoid	The geoid is that geopotential surface that on average approximates MSL. The geoid defines the horizontal. Due to the dynamics of ocean currents, MSL / MSS are not horizontal.
Geopotential	The geopotential at a point is the acceleration of gravity at that point times the distance to the center of the Earth. At the surface of the Earth it is

	approximately 62 million meters squared per seconds squared, which is 62 million Joules / kilogram, or 62 million Geopotential Units (GPU).
Geopotential Surface	A geopotential surface is a surface around the Earth (like layers of an onion) in which the geopotential is constant. A satellite in space will orbit in a geopotential surface. Geopotential surfaces are neither parallel nor equally spaced. The vertical is everywhere perpendicular to the geopotential surface.
Height	Refers to the raw antenna height above (or below) the reference ellipsoid.
ISLW	(**I**ndian **S**pring **L**ow **W**ater) ISLW is a tidal datum originally used as a chart datum in Indian and later in Australia and elsewhere. It is lower than MSL by the sum of the amplitudes of the constituents M2, S2, K1 and O1.
LAT	(**L**owest **A**stronomic **T**ide) The lowest level of tide that can be predicted to occur over an 18.6 year period without regard to meteorological conditions. LAT is not utilized in the C-Tides® software with the exception of the parameter plot output where an approximation of its relationship to the chosen VRS is given. This approximation is derived empirically from VORF data, and is a good fit in that geographical area. Its accuracy in other parts of the world is unknown.
MSL	(**M**ean **S**ea **L**evel) MSL is a tidal datum that is the average of tidal heights observed at a tide gauge over an 18.6-year cycle during which the plane of the moon with respect to the Earth (Lunar Orbital Plane) rotates 360 degrees with respect to the plane of the Earth with respect to the sun (Ecliptic Plane), thus averaging out the effects of the sun and the moon.
MSS	(**M**ean **S**ea **S**urface) MSS is a model that combines satellite altimetry with tide gauges to extend MSL over the entire sea surface.

NRP	(**N**avigation **R**eference **P**oint) The NRP is any convenient point on the vessel from which to measure the dimension to other points of interest. It is recommended that the NRP be as close as possible to the COG.
SET	(**S**olid **E**arth **T**ides) The Earth's crust flexes during the day with solar and lunar gravity-induced tides, resulting in a distance variance from the earth's surface to its center by as much as 40cm in height. The C-Nav3050® receiver corrects for these variations by employing real-time integrated SET corrections in its CCS positioning algorithm.
VRS	(**V**ertical **R**eference **S**urface) The different types of VRS used in the C-Tides® software are EGM and MSS.

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