SWARM

Seismic Wave Analysis and Real-time Monitor: User Manual and Reference Guide

Version 2.7.0

May 11, 2017

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1 Introduction

1.1 About

SWARM, Seismic Wave Analysis and Real-time Monitor, is a Java application designed to display and analyze seismic waveforms in real-time. SWARM is a functional replacement to the traditional helicorder, but also has many other tools for visualizing wave forms, such as frequency spectra plots and spectrograms. Other features include ability to obtain station metadata for plotting on map, and support for IRIS DMC connections. Recent additions include ability to view NEIC events and do basic picks.

SWARM was developed at the Alaska Volcano Observatory (AVO) in 2004 and is still used at various volcano observatories around the world. The latest version of SWARM can be obtained from https://volcanoes.usgs.gov/software/swarm/download.php.

2 Getting Started

2.1 System Requirements

SWARM is platform independent (will run on any operating system) but requires a graphical display and a Java Virtual Machine 1.6 or greater. Due to the large volume of data and complex calculations performed it is recommended to run on SWARM with modern specifications for memory and processing speed. The less memory and processing speed the computer has, the more likely that SWARM's performance is affected when pulling and analyzing large data sets. Minimum screen display of 1024 x 768 is also recommended. Maximizing the application window to full screen size will provide the best user experience.

2.2 Installing SWARM

To install SWARM, unzip the download swarn-x.y.z-bin.zip file downloaded from the USGS SWARM website. In Windows, your unzipped swarm-x.y.z directory will look like this:

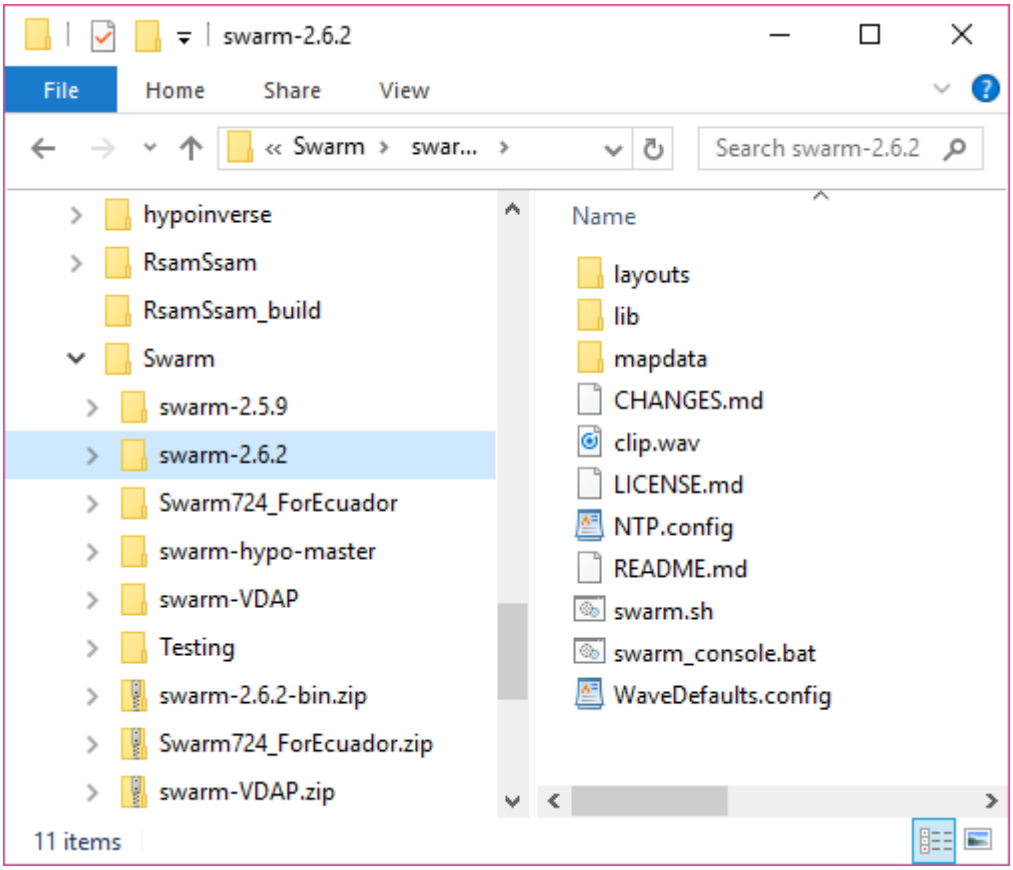


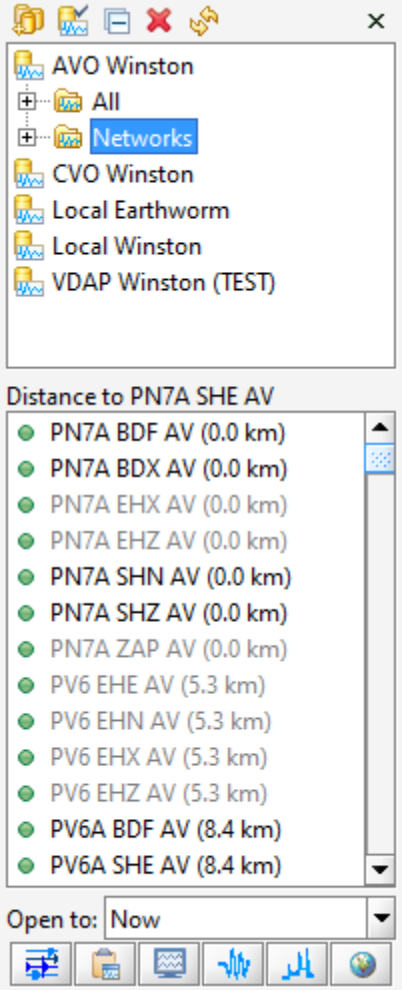
Figure 1 Swarm Directory Contents

2.3 Running SWARM

On Windows, double clicking on swarm_console.bat will open the SWARM user interface. If nothing happens, you can run the application from a command (or DOS) prompt to see if there are any errors that can be used for troubleshooting. On Linux or Mac operating systems, you will need to execute swarm.sh from the terminal (command-line).

3 Data Sources and Channels

3.1 Introduction



After starting SWARM, a panel will be visible on the left side of the main screen. This is the Data Source Chooser and Channel Selector. It's possible to adjust the size of the two panels by adjusting the split line in the center, either by dragging with the mouse or clicking on one of the small arrows.

The Data Source Chooser, the top half of the panel, is used to select the source of the waveform or helicorder data. The box contains the list of all available data sources, both ones that have been used before and new ones that are created.

The Channel Selector, the bottom half of the panel, is used to select a channel, either
the waveform or the helicorder. Once a data source is selected, the Channel Selector will
be populated with the available channels. The contents of both theWaves and Helicorders
lists depend on the data available from the selected data source.

Figure 2Data source chooser and the channel selector

3.2 General Usage

SWARM is preconfigured with AVO Winston Wave Server. To add another data source click on the 'New data source' icon . Existing data sources can be modified by clicking on the 'Edit data source' icon . The next icon will let you collapse the data source trees. To remove an existing data source, select the data source to delete and click on 'Remove data source' icon . A data source can be refreshed by clicking on it and selecting the 'Refresh data source' icon .

The ✕ icon in the upper right lets the user dismiss the whole data source chooser window if more space is desired. To get it back, type CTRL-D or go to the Window menu and select Data Chooser.

The icons associated with the different data sources have the following meaning:

- A data server that the user manually added with the 'New data source' option.
- A data server that is in the DataSources.config file. The small padlock denotes that it is not possible to edit or delete it from SWARM.
- A data server that is broken; e.g. not responding.
- Data channels available after opening a wave in a file (e.g. SEED, SAC format) from the File menu.

Double clicking on a data source will cause a channel tree to appear, listing the available channels. Double clicking on a channel will bring up a helicorder. Alternatively, it's possible to select a channel (or channels, with CTRL- or Shift-click on Windows) and press one of the five buttons at the bottom of the data chooser:

- Opens helicorder views
- Puts waves on the clipboard
- Puts waves on the real-time monitor
- Opens waves in the real-time view window
- Opens RSAM viewer
- Shows channels on a map

3.3 Data Source Types

Clicking on the 'New data source' icon will open a New Data Source dialog window. Currently supported data source types for SWARM are Winston Wave Server, Earthworm Wave Server, FDSN WS, and SeekLink Server.

3.3.1 Winston Wave Server

Winston is a Java-based seismic wave server developed by USGS that provides data and plots to clients. It can be obtained from https://volcanoes.usgs.gov/software/winston/. Connection to Earthworm requires the IP address or host name of the server, port number, and communication time out in seconds.

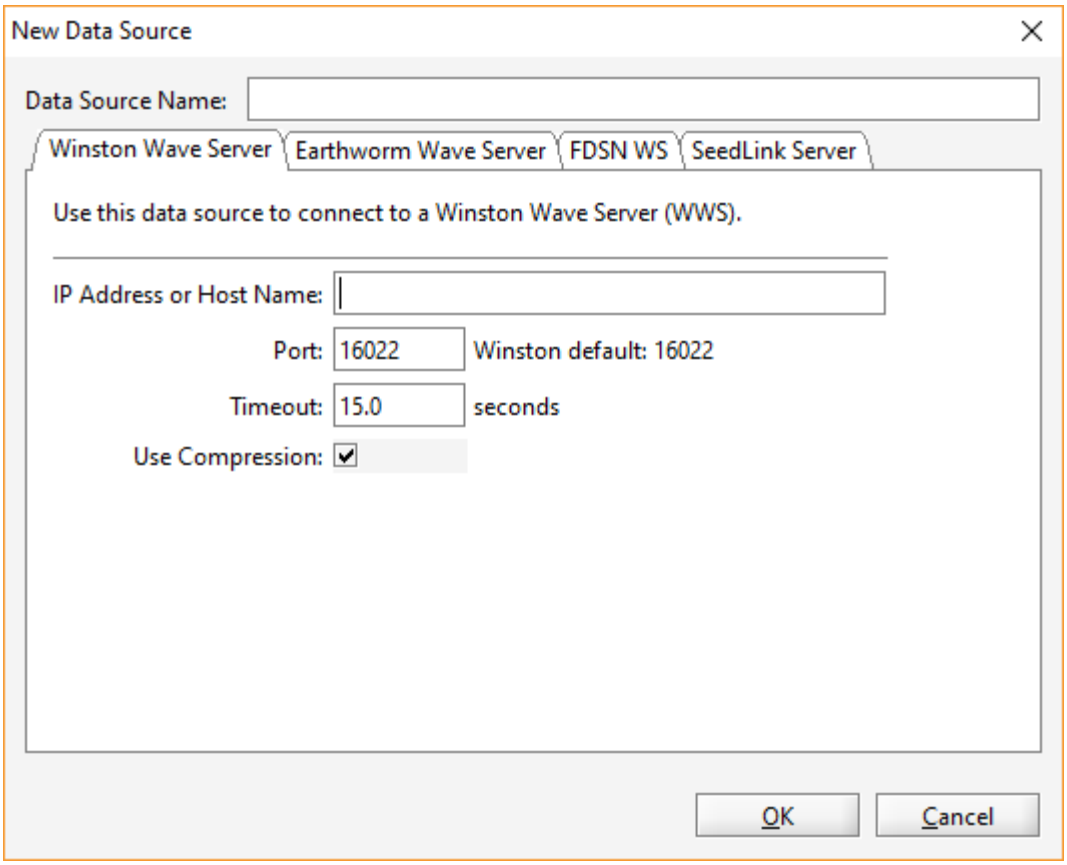


Figure 3 Adding new Winston data source

3.3.2 Earthworm Wave Server

Earthworm is an open-source software system used globally for regional local network seismology. Earthworm Wave Server is essentially the wave_serverV module of the Earthworm system. Connection to Earthworm requires the IP address or host name of the server, port number, and communication time out in seconds. Earthworm data provides raw wave data only. The Gulp size setting determines how much past data to retrieve at a time, and Gulp delay determines how much time between past data retrieval.

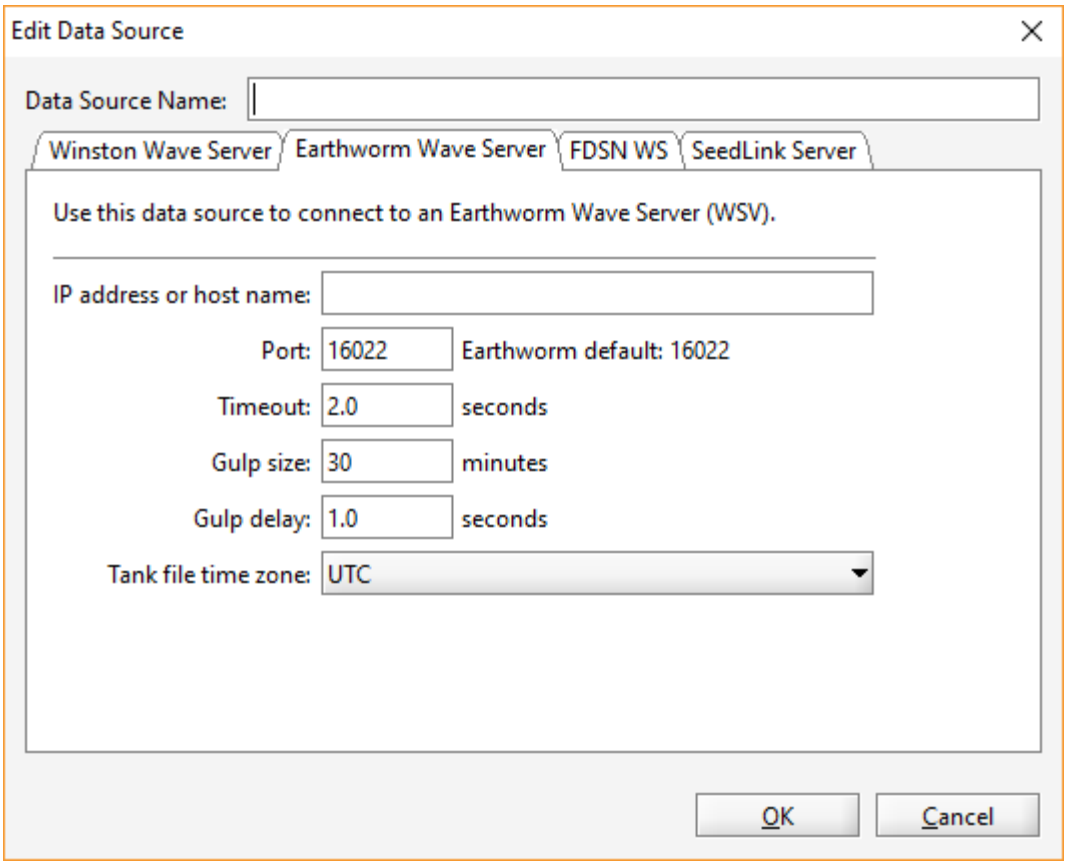


Figure 4 Adding new Earthworm data source

3.3.3 FDSN Web Services

International Federation of Digital Seismograph Networks (FDSN) provides RESTful web service interfaces for accessing wave data. See https://www.fdsn.org/webservices/ for more information on the FDSN web services.

To add an FDSN web service data source, enter in the dataselect and station URL. A list of available web services can be found at https://www.fdsn.org/webservices/datacenters/. Then click on the Update button to get a list of Networks to choose from. You may choose to filter the data further with station, channel, and location information.

The Gulp size setting determines how much past data to retrieve at a time, and Gulp delay determines how much time between past data retrieval.

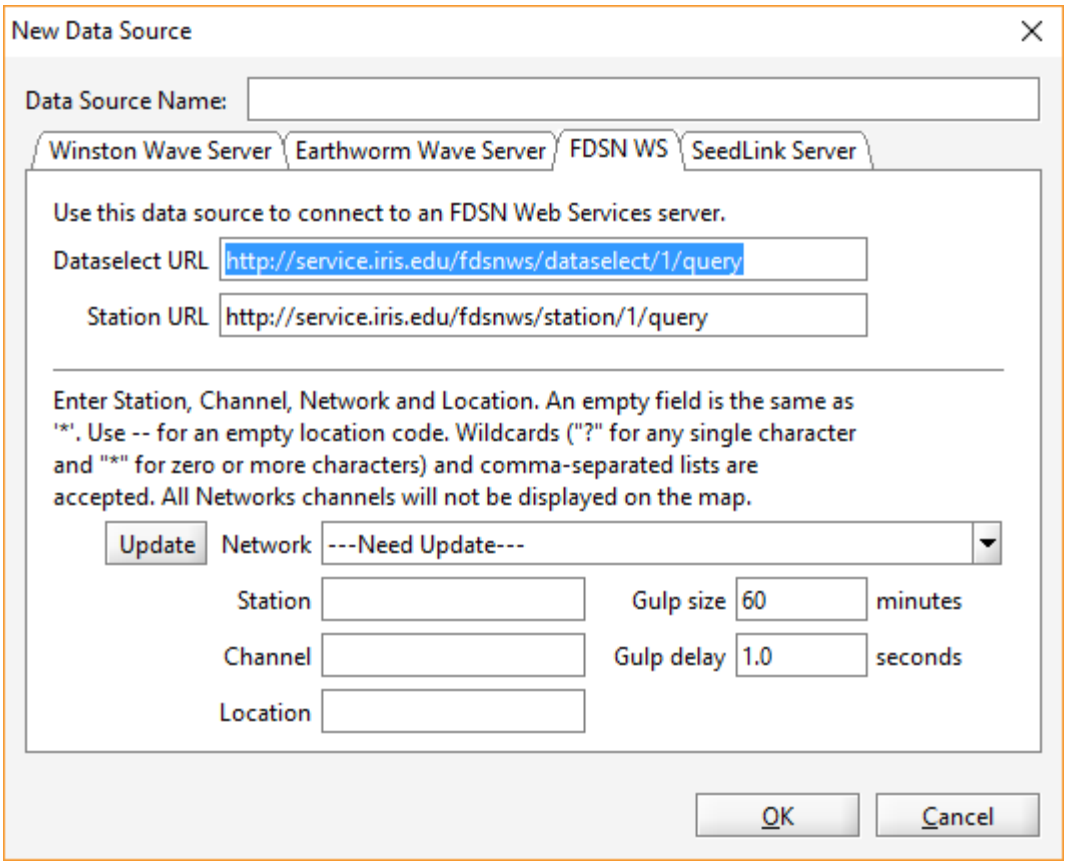


Figure 5 Adding new FDSN data source

3.3.4 SeedLink Server

SeedLink protocol transmits data packets in 512-byte Mini-SEED records. IRIS Data Management Center (DMC) hosts a public accessible SeedLink server. More information on SeedLink and IRIS DMC's server can be found at http://ds.iris.edu/ds/nodes/dmc/services/seedlink/. To connect to a SeedLink server enter in the IP address or host name, and the port.

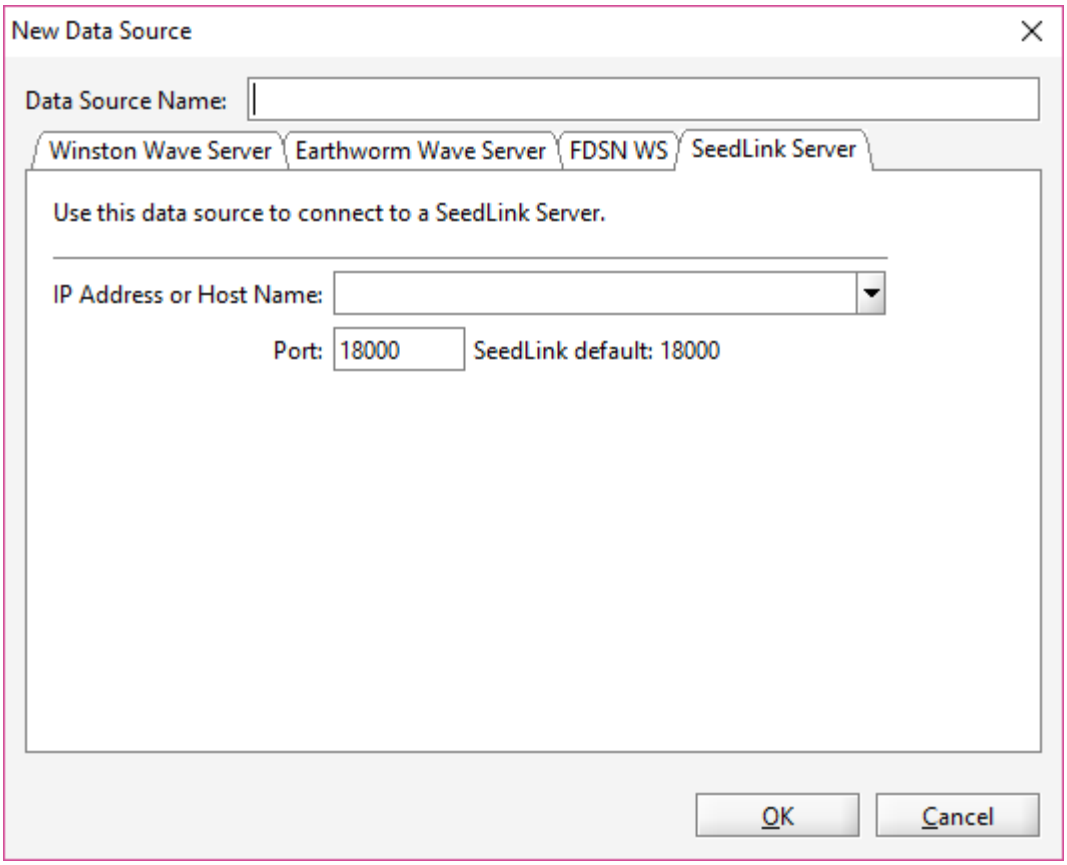


Figure 6 Adding a new SeedLink data source

3.3.5 Files

Swarm can open waveform data stored in files through the File -> Open File… menu. Supported formats are SAC, SEED, miniSEED, SEISAN, and Matlab-readable text file.

4 Helicorder Views

4.1 Introduction

One of SWARM's primary functions is to display helicorders and allow user interactions with it. The helicorder below is displaying channel PN7A SHZ AV from AVO Winston data source. Helicorders derived from an active source, like a Wave Server or Winston connection, will automatically update when new data are available.

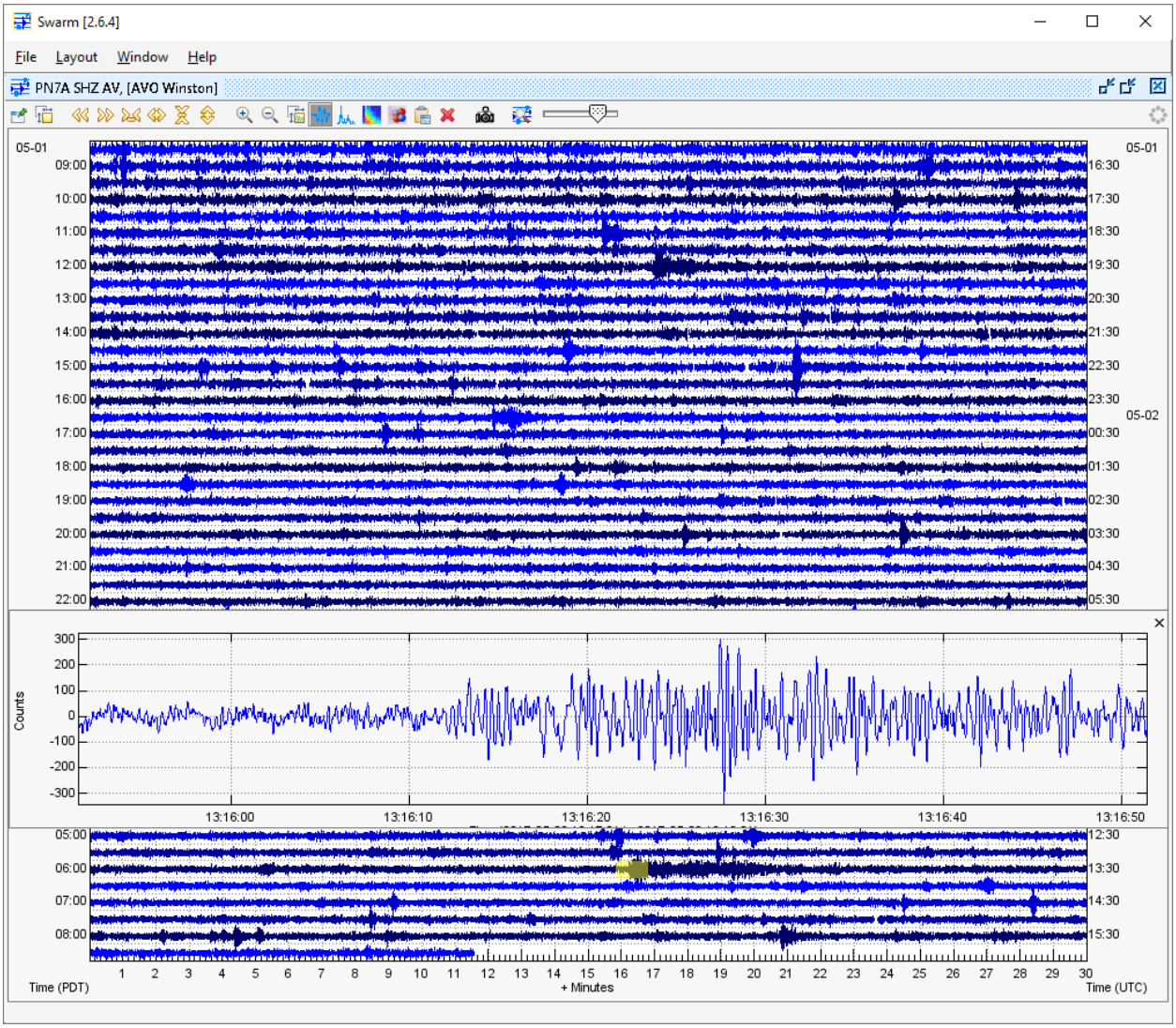


Figure 7 Helicorder view

4.2 Wave Inset Panel

Clicking on the helicorder opens a wave panel for a magnified view of the area highlighted in yellow. See section on Wave Views for more information on wave view settings and types.

4.3 Status Bar

The status bar at the bottom will display information about the wave when in Wave, Spectra, or Spectrogram view in inset panel.

First Line

The top line of the status bar always has information on the entire wave displayed:

- Start time in UTC

- End time in UTC
- Number of samples (duration in seconds)
- Sample rate
- Minimum amplitude (does not account for bias)
- Maximum amplitude (does not account for bias)

Example: [2017-05-02 13:16:20.130 - 2017-05-02 13:16:40.130 (UTC), 1000 samples (20.00 s), 50 samples/s, -285, 361]

Second Line

If the panel is in time series view (Wave and Spectrogram), it will display the time on the x-axis that the mouse is hovering over in local and UTC time. Other information shown:

- Y-axis value if in Wave view; e.g.:

  2017-05-01 23:19:35.261 (PDT), 2017-05-02 06:19:35.261 (UTC), Counts: -31.764
- Frequency and Power in Spectra view; e.g.: Frequency (Hz): 1.569725, Power: 341.370
- Frequency in Spectrogram view; e.g.:

  2017-05-01 23:16:23.990 (PDT), 2017-05-02 06:16:23.990 (UTC), Frequency (Hz): 10.645

4.4 Helicorder Toolbar

Below are the functions available in the toolbar above the helicorder. Hovering over an icon will also provide a tooltip indicating the function of the button and the hot keys, if available.

-  Helicorder always on top
-  Helicorder view settings
-  Scroll back time (A or left arrow)
-  Scroll forward time (Z or right arrow)
-  Compress X-axis (Alt and left arrow)
-  Expand X-axis (Alt and right arrow)
-  Compress Y-axis (Alt and down arrow)
-  Expand Y-axis (Alt and up arrow)
-  Decrease zoom time window (+)
-  Increase zoom time window (-)
-  Wave view settings (?)
-  Wave view (W or ,)
-  Spectra view (S or .)

- Spectrogram view (G or /)
- Particle motion view (R or ‘)
- Copy inset to clipboard (C or Ctrl-C)
- Remove inset wave (Delete or Esc)
- Save helicorder image (P)
- Toggle between adjusting helicorder scale and clip

4.4.1 Helicorder View Settings

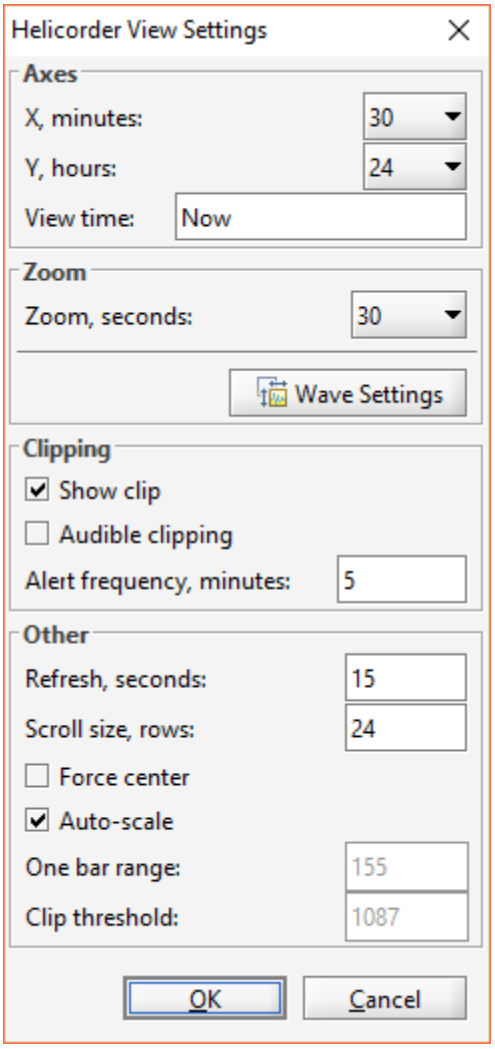


Figure 8 Helicorder View Settings

There are two main ways in which the user can interact with the a helicorder view: manipulating the helicorder view itself or zooming in and looking at the underlying waveform. All of the settings for the helicorder view can be manipulated in the helicorder view settings dialog which can be opened by clicking on the button.

4.4.1.1 Axes

- *X* is the number of minutes to display along the bottom of the helicorder. Default is 15 minutes.
- *Y* is the total time in hours to display on the helicorder. Default is 12 hours.
- View time setting allows user to set the time at the bottom of the helicorder. Default is ‘Now’, or current time. The format for specifying the bottom view time is YYYYMMDD or, if more resolution is needed, YYMMDDHHMMSS.

4.4.1.2 Zoom

- *Zoom* determines the amount of time, in seconds, on either side of the mouse cursor to zoom.
- Also available is a button to display the Wave View Settings Dialog.

4.4.1.3 Clipping

- *Show clip* will display the data in red when clip threshold is exceeded.

- *Audible clipping* enables audio alarm when clip threshold is exceeded.
- *Alert frequency* sets the frequency of audio alarm in minutes.

4.4.1.4 Other

- *Refresh* is the number of seconds between attempts to refresh the helicorder with the latest data. The default value is 15.
- *Scroll size* is the number of helicorder rows to scroll up or down on user scroll requests with mouse-wheel or scroll bar buttons.
- *Force center* forces each helicorder sample to be centered on its current line. This effectively eliminates all drift and is useful for broadband stations with lots of low frequency energy. This feature is to be used with caution though: it can make an obviously false signal look like an earthquake.
- *Auto-scale* toggles helicorder auto-scaling on and off. When auto-scaling is on an attempt is made to produce a “pleasant” looking helicorder. If this fails, or if more control over the appearance of the helicorder is wanted, set the One bar range.
- *One bar range* is the number of counts on either side of zero that make up one bar. For example, if there is a seismometer that reports counts between -3600 and 3600 and a bar range of 1200 is selected, a full-range waveform will take 3 bars, overlapping one above and one below. This is best understood through experimentation.
- *Clip threshold* allow user to set a counts threshold after which the trace will be shown in red.

5 Wave Views

5.1 Introduction

Wave views are one of the fundamental data views in SWARM. There are four wave view types: standard wave view, spectra, spectrogram, and particle motion. Any time a wave view is seen in SWARM there are settings associated with that individual view. For example, a wave view pasted into the clipboard from somewhere else has its own view settings.

5.2 Wave View Settings Dialog

The Wave View Settings allow users to change how to look at the plots. The settings can be edited by clicking on the wave view settings icon  or pressing the ? key.

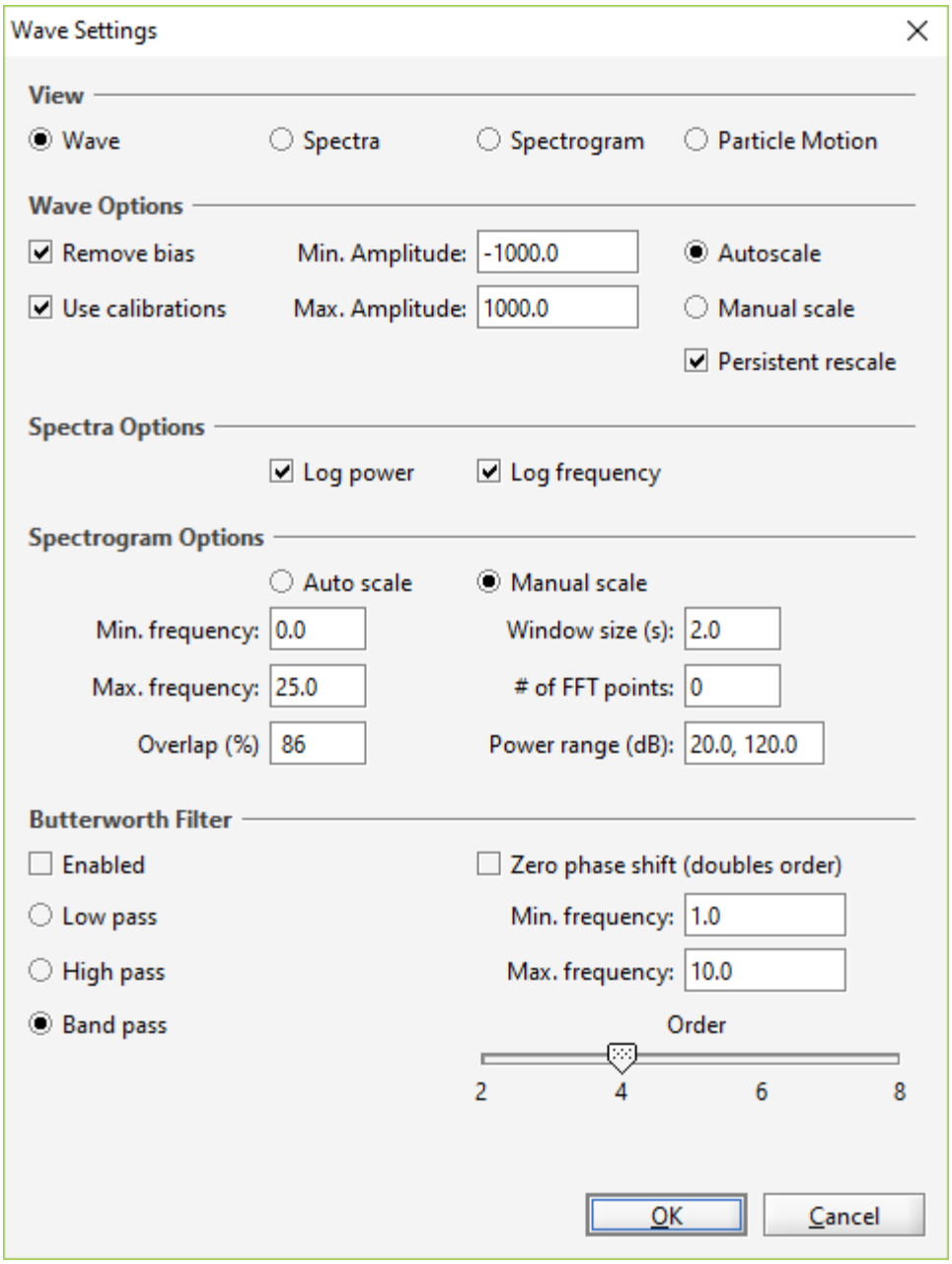


Figure 9 Wave View Settings dialog window

5.2.1 View

The general display mode can be set under the View section. Options are Wave, Spectra, Spectrogram, or Particle Motion.

5.2.1.1 Wave

W or , will also toggle Wave view mode.

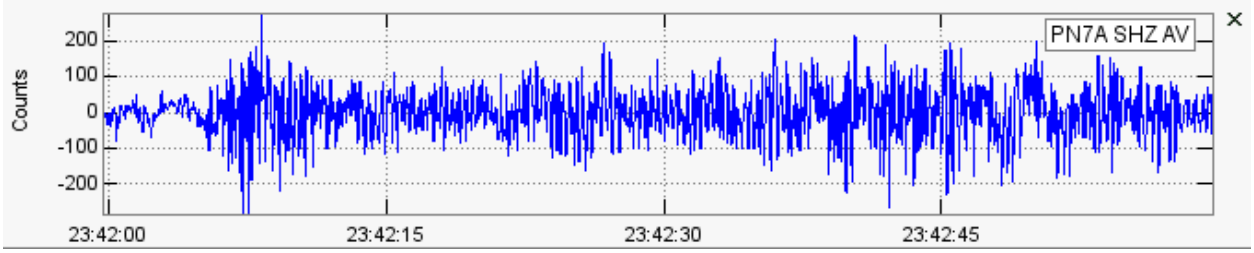


Figure 10 Wave view

In certain windows (e.g. Helicorder View, Clipboard), users can zoom in on a wave by left clicking and dragging over the portion of the wave you want to see. The selected section will highlight in yellow prior to zooming in.

When in Helicorder View, if Duration Magnitude option is enabled (see Options under File menu) users can left click on the wave panel to create two green markers. Once marked, the status bar at the bottom will display the duration time and magnitude at the end of the first line. Example:

[2017-05-03 14:35:59.489 - 2017-05-03 14:36:59.489 (UTC), 3000 samples (60.00 s), 50 samples/s, -6468, 5152],Duration: 8.12s (Md: 0.84)

If the wave panel is subsequently copied to the Clipboard, the duration markers become Coda markers for use in Pick Mode.

5.2.1.2 Spectra

S or . will also toggle Spectra view mode.

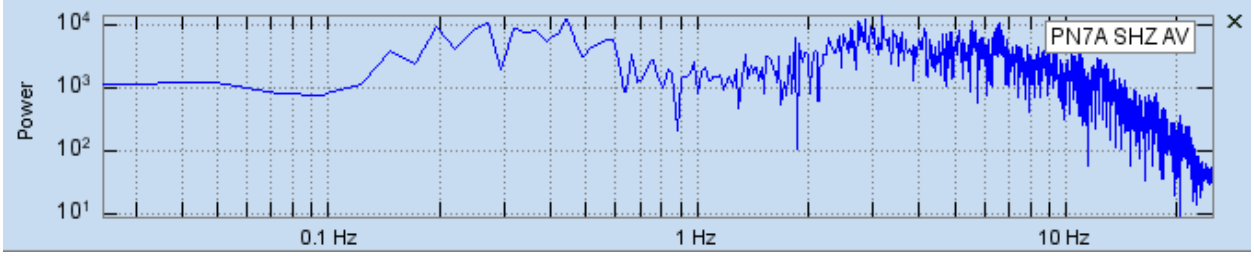


Figure 11 Spectra view

5.2.1.3 Spectrogram

G or / will also toggle Spectrogram view mode.

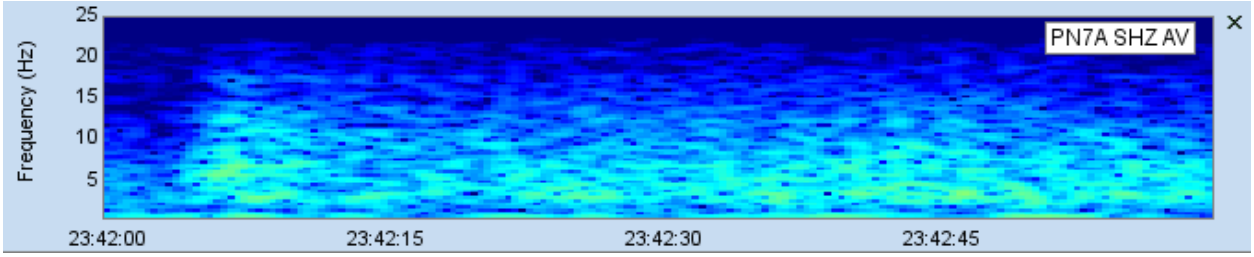


Figure 12 Spectrogram view

5.2.1.4 Particle Motion

R or ‘ will also toggle Particle Motion view mode.

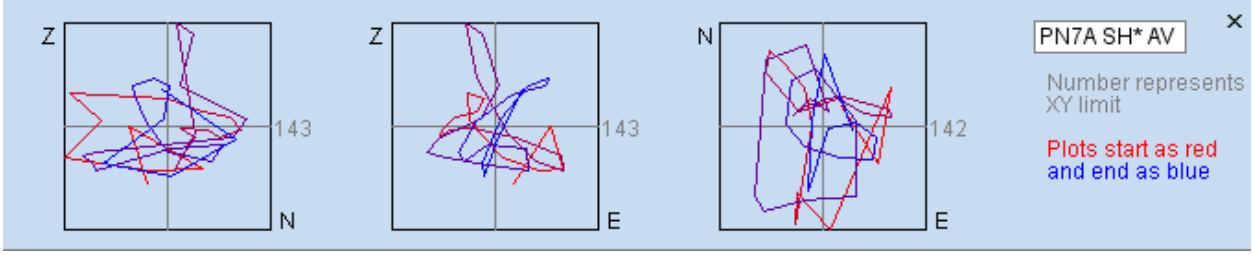


Figure 13 Particle Motion view

The particle motion view will plot the amplitude of one component against the amplitude of another component from the same station. The plot begins as red at start time and gradually turns to blue at end time. The gray number next to each plot indicates the limit of the x and y axis. This view is supported only for the traditional orientation codes (Z N E) and only in certain windows (e.g. Helicorder View, Clipboard). The plot is also only supported for channels that have metadata and associated SCNL information since retrieval of the wave form for other components is currently automated. Some wave data, such as those imported from Matlab-readable text files, may not have the required station and channel information to perform this plot.

5.2.2 Wave Options

- *Remove bias* will remove the mean value from the wave if on. It is enabled by default.
- *Use calibrations*, if enabled, will use conversion factor information available from the data source to convert the data to real velocity.
- *Min. Amplitude* is the y-axis minimum limit.
- *Max. Amplitude* is the y-axis maximum limit.
- *Auto scale* will scale the y-axis automatically if selected. The y-axis will be set to contain the minimum and maximum values attained by the wave in the shown time interval.
- *Manual scale*, if selected, will set the y-axis to the user specified Min. Amplitude and Max. Amplitude settings.
- *Persistant rescale*, if unchecked, will rescale the x and y axis to use the whole screen based on the current max amplitude being displayed.

5.2.3 Spectra Options

- *Log Power*, if checked, will set the power axis to log mode.

- *Log frequency*, if checked, will set the frequency axis to log mode.

5.2.4 Spectrogram Options

- *Auto scale* to scale power automatically.
- *Manual scale* to scale power manually.
- *Min. frequency* specifies the x-axis minimum in Spectra view and the y-axis minimum limit in Spectrogram view.
- *Max. frequency* specifies the x-axis minimum in Spectra view and the y-axis maximum limit in Spectrogram view. While SWARM will allow the maximum frequency to be set to any positive value greater than the minimum frequency, this value will adjust automatically if it is greater than the Nyquist frequency of the wave being manipulated.
- *Overlap (%)* determines the amount of overlap in consecutive FFTs. Legal values are between 0 and 95. The higher this value is set the smoother the FFT will look. However, artifacts can occur when excessive overlap is used.
- *Window size*
- *FFT points* is the number of samples to be used in each FFT. Adjusting this value affects the dimensions of each pixel of the spectrogram. Increasing the number of samples increases the vertical resolution while decreasing the horizontal resolution. Decreasing the number of samples increases the horizontal resolution while decreasing the vertical resolution.
- *Power range*

5.2.5 Butterworth Filter

- *Enabled* checkbox will turn Butterworth filtering on and off.
- *Low pass* filter removes signal above corner frequency (Max. frequency) setting.
- *High pass* filter removes signals below corner frequency (Min. frequency) setting.
- *Band pass* filter removes signals above Max. frequency or lower than Min. frequency.
- *Zero phase shift* option runs the specified filter both forward and backward. This eliminates any phase shift effects due to the filter at the expense of effectively doubling the filter order.
- *Min. frequency* specifies the lower bound to filter on.
- *Max. frequency* specifies the upper bound to filter on.
- *Order* slider bar sets the order of the filter as even values between 2 and 8, inclusive. In general, the higher the order the steeper the cutoff at the corner frequencies.

6 Wave Clipboard

The Wave Clipboard holds as many simultaneous wave views as desired. This allows users, for example, to compare arrival times across many stations, look at the same waveform with three different filters, or compare different events from one station.

The user interface consists of a clipboard toolbar at the top and then as many stacked clipboard wave views as desired, each with its own toolbar. It's also possible to zoom into any portion of a wave by left clicking and dragging over the portion to zoom in on (the transparent yellow block is showing the act of zooming). The status bar at the bottom displays information about the wave. The panel shaded blue is the *selected* wave for the purposes of the clipboard toolbar.

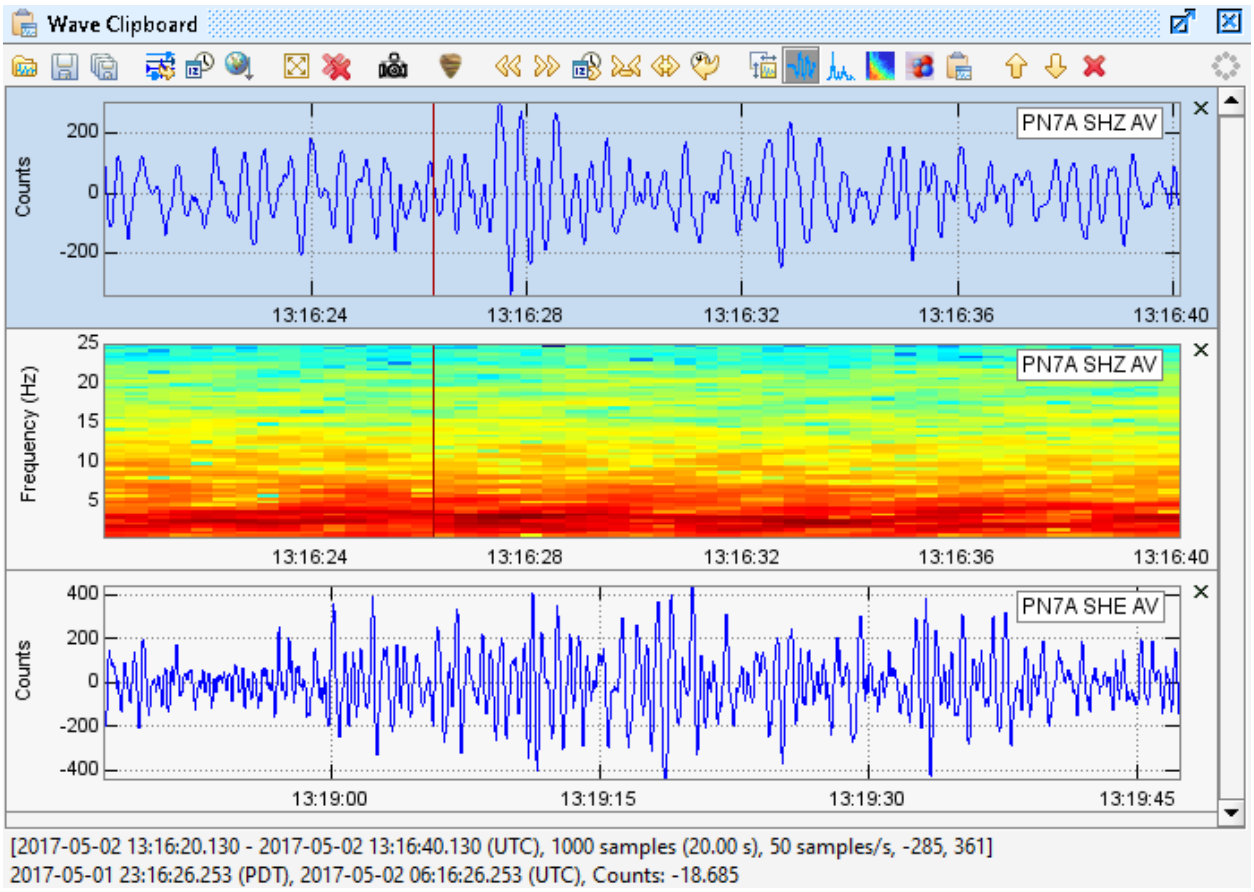


Figure 14 Wave Clipboard

6.1 Clipboard Toolbar

Below are the functions available in the clipboard toolbar. Hovering over an icon will also provide a tooltip indicating the function of the button and the hot keys, if available.

- Open a saved wave

-  Save selected wave
-  Save all waves
-  Synchronize times with helicorder wave
-  Synchronize times with selected wave
-  Sort waves by nearest to selected wave
-  Set clipboard wave size
-  Remove all waves from clipboard
-  Save clipboard image (P)
-  Pick Mode
-  Scroll back time (A or left arrow)
-  Scroll forward time (Z or right arrow)
-  Go to time (Ctrl-G)
-  Shrink sample time 20% (Alt left arrow or +)
-  Expand sample time 20% (Alt right arrow or -)
-  Last time setting (Backspace)
-  Wave view settings (?)
-  Wave view (W or ,)
-  Spectra view (S or .)
-  Spectrogram view (G or /)
-  Particle motion view (R or ‘)
-  Place another copy of wave on clipboard (C or Ctrl-C)
-  Move wave(s) up in clipboard (Up arrow)
-  Move wave(s) down in clipboard (Down arrow)
-  Remove wave from clipboard (Delete or Esc)

6.2 Pick Mode

When the  button is enabled, users are able to make picks for P and S times, and coda start and end times in the wave and spectrogram view for each panel. To make a pick, right click over the pick time in the appropriate channel and select the desired pick type. Available choices include P and S, Emergent or Impusliv, under the Phase menu; and Coda 1 and Coda 2 under Coda menu. SWARM will attempt to

determine polarity for a pick automatically and indicate it on the marker tag as either positive (+) or negative (-) if successful.

6.2.1 P and S

The P and S pick markers are propagated to the other channels of the same station, network, and location. The pick tag on the channel where it was originally selected will have a colored background (green for P and purple for S). The pick tag on other channels will have a white background. Selecting a P or S when one exists for the station will simply replace the existing pick with the new one. P or S picks may be cleared or hidden using the right-click menu. Once both, P and S, picks are made, the S-P duration and distance will display on the third line in the status bar when hovering over a wave panel.

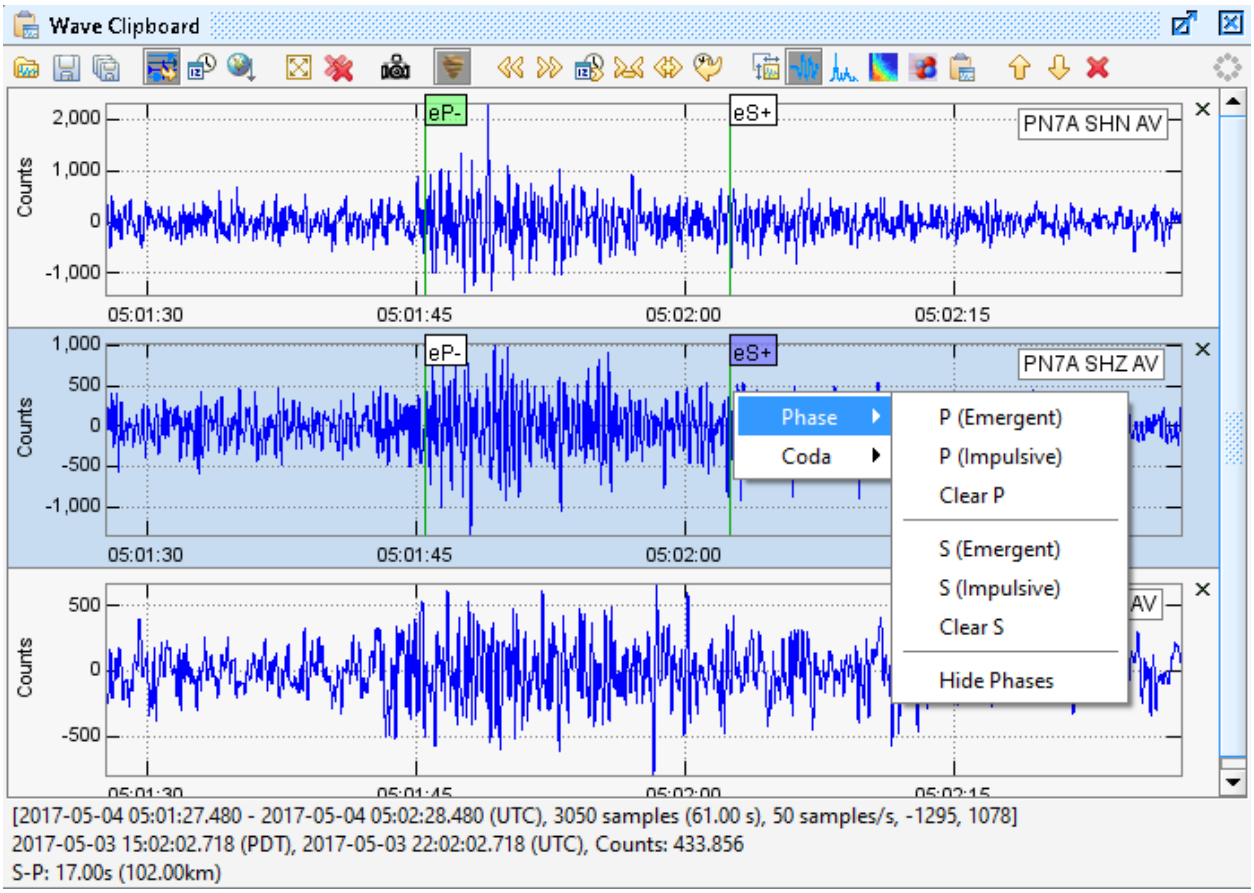


Figure 15 P and S picks

6.2.2 Coda

The Coda 1 or Coda 2 does not map specifically to coda start or coda end. SWARM will simply take which ever coda pick is earlier as the start time and the other for end time. As with the P and S picks, right-click menu options exist to hide or clear coda picks. The background color of the coda marker tags

will be yellow. Once both coda picks are made, the coda duration and magnitude for the channel are displayed in the third row of the status bar when hovering over the applicable panel. Calculations use the same Duration Magnitude parameters configured under File->Options (see section 12.1.1.2.) The average coda duration and magnitude of all coda windows on the clipboard are also displayed.

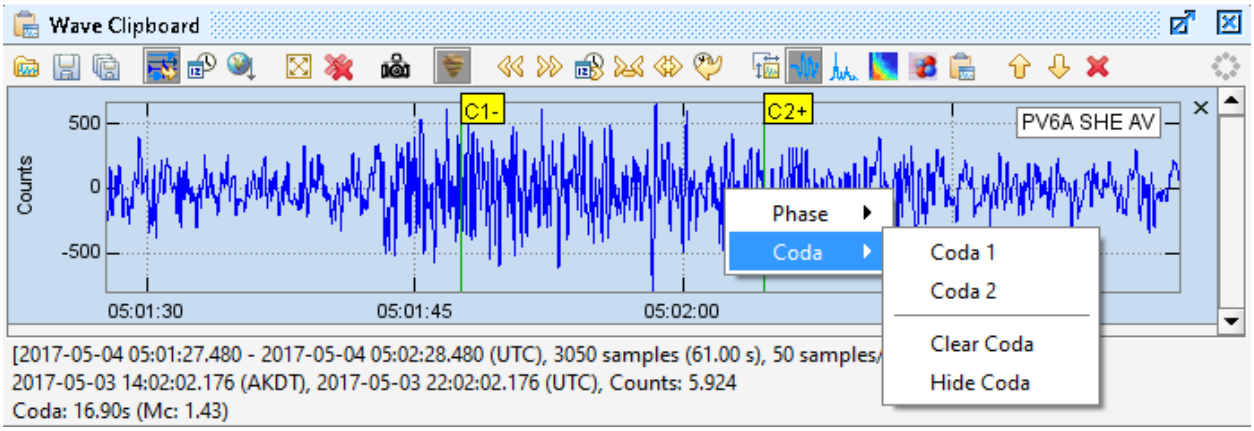


Figure 16 Coda picks

When a wave is added to the clipboard from the helicorder view, if the wave had the green duration markers on them in helicorder view, they are translated to coda markers in the clipboard and will be visible in Pick Mode.

6.3 Status Bar

The status bar at the bottom will display information about the wave when in Wave, Spectra, or Spectrogram view.

First Line

The top line of the status bar always has information on the entire wave displayed:

- Start time in UTC
- End time in UTC
- Number of samples (duration in seconds)
- Sample rate
- Minimum amplitude (does not account for bias)
- Maximum amplitude (does not account for bias)

Example: [2017-05-02 13:16:20.130 - 2017-05-02 13:16:40.130 (UTC), 1000 samples (20.00 s), 50 samples/s, -285, 361]

Second Line

If the panel is in time series view (Wave and Spectrogram), it will display the time on the x-axis that the mouse is hovering over in local and UTC time. Other information shown:

- Y-axis value if in Wave view; e.g.:

  2017-05-01 23:19:35.261 (PDT), 2017-05-02 06:19:35.261 (UTC), Counts: -31.764

- Frequency and Power in Spectra view; e.g.: Frequency (Hz): 1.569725, Power: 341.370
- Frequency in Spectrogram view; e.g.:

  2017-05-01 23:16:23.990 (PDT), 2017-05-02 06:16:23.990 (UTC), Frequency (Hz): 10.645

Third Line

If the clipboard is in Pick Mode, the third line will display:

- S-P duration and distance, if P and S phases are picked.
- Coda duration and magnitude, if coda start and end are picked.

Example: S-P: 16.77s (100.63km), Coda: 32.55s (Mc: 1.96)

7 Real-time Monitor

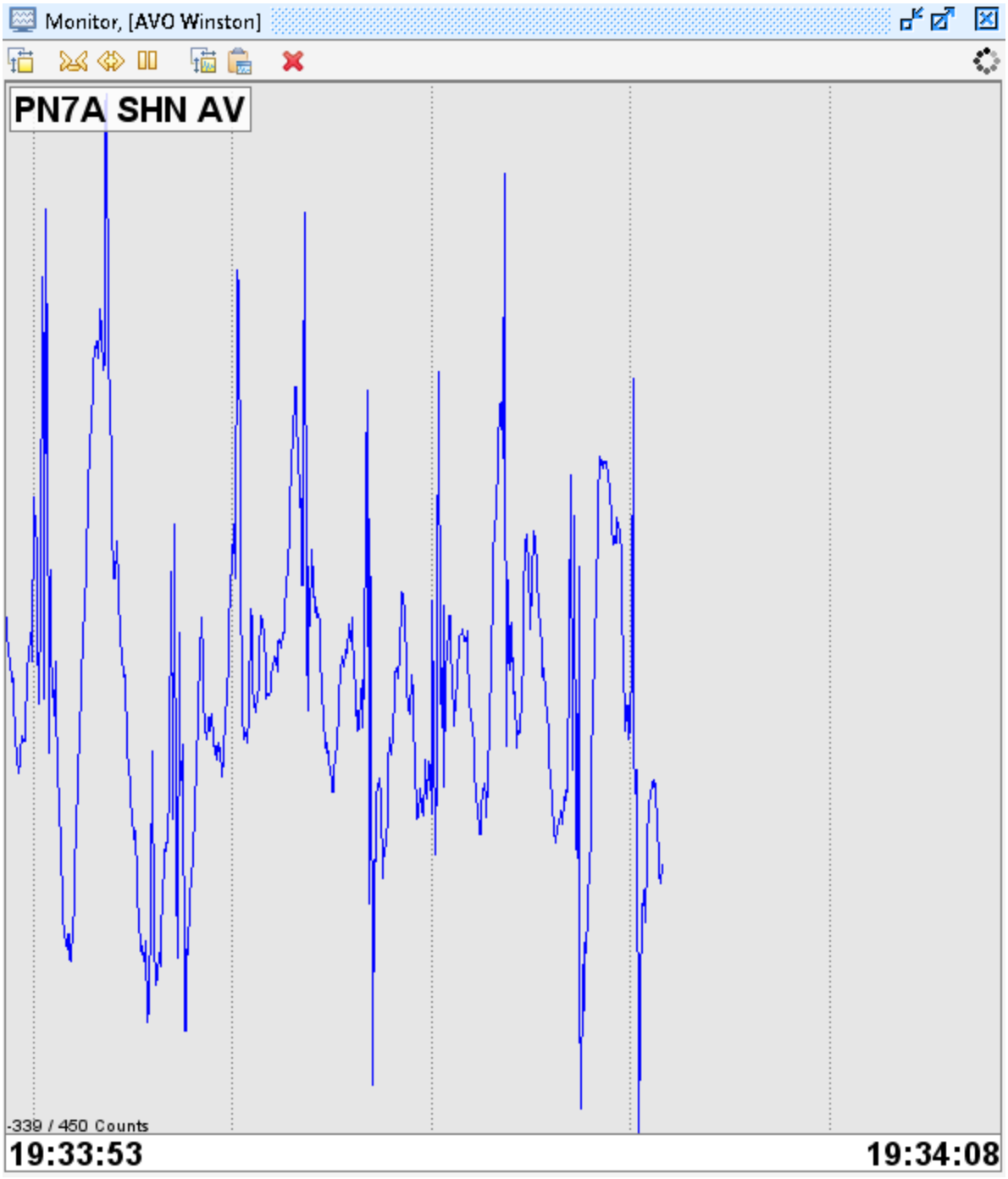


Figure 17 Real-time Monitor

The real-time monitor is useful to see new data coming in. Multiple waves can be plotted in the same window.

8 Real-time Wave Viewer

Clicking on at the bottom of the Data Chooser window will open real-time wave viewer. The white area to the right shows the lag between now and the last available data at the time of refresh (which occurs every two seconds.) It is possible to switch between views of 15, 30, 60, 120 (default), 180, 240, or 300 seconds. The time displayed is UTC. Each wave is in its own window.

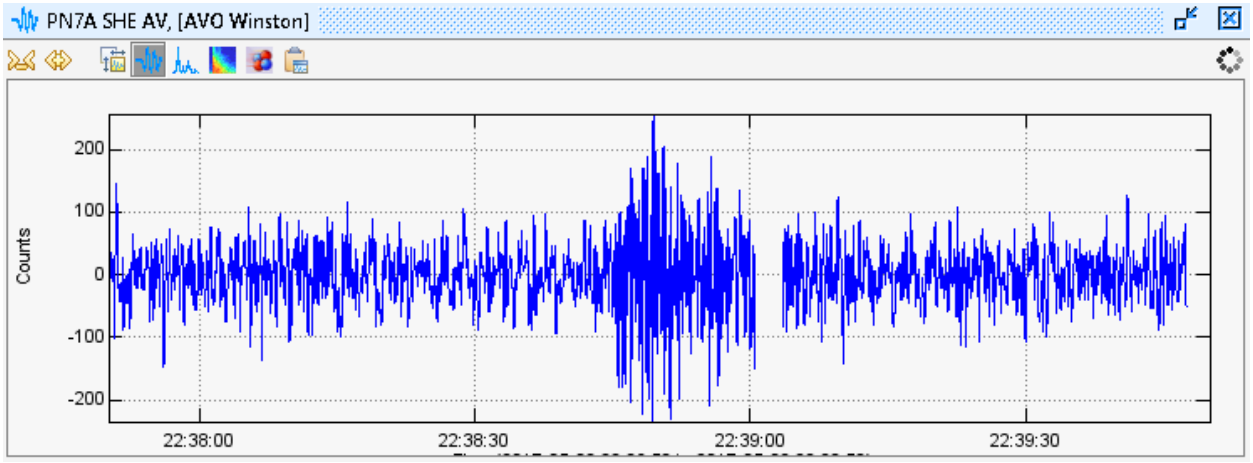


Figure 18 Real-time Wave Viewer

9 RSAM

Clicking on at the bottom of the Data Chooser window will open the Real-time Seismic-Amplitude Measurement (RSAM) viewer. The buttons at the top let you choose between values view and counts view.

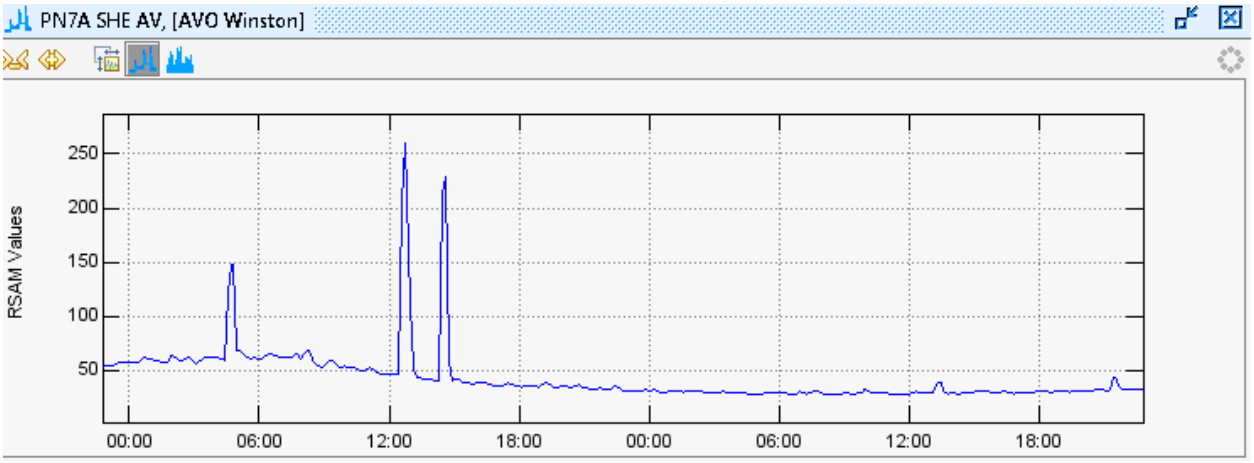


Figure 19 RSAM values view

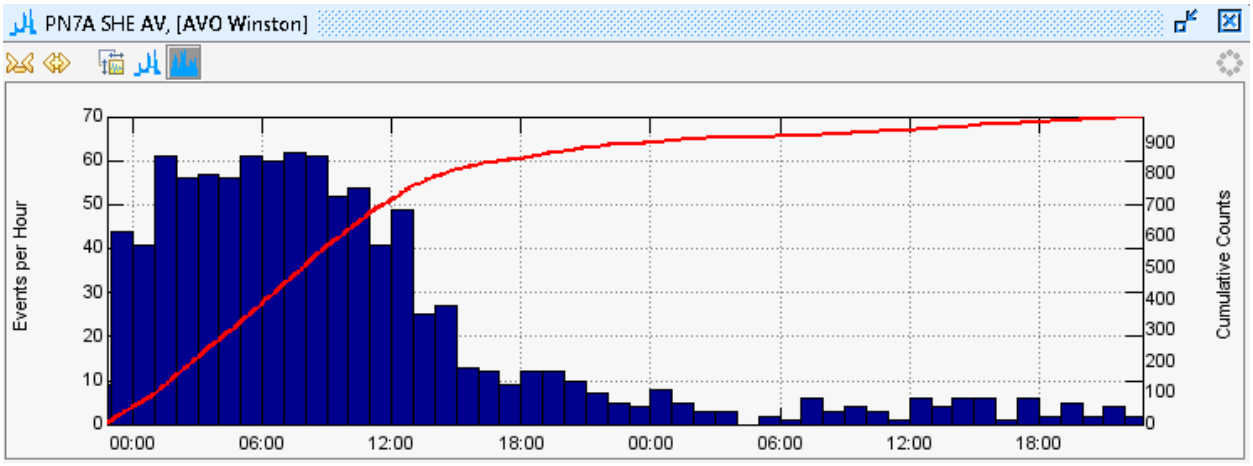


Figure 20 RSAM counts view

9.1 RSAM Settings

Clicking on the icon opens the RSAM Settings dialog.

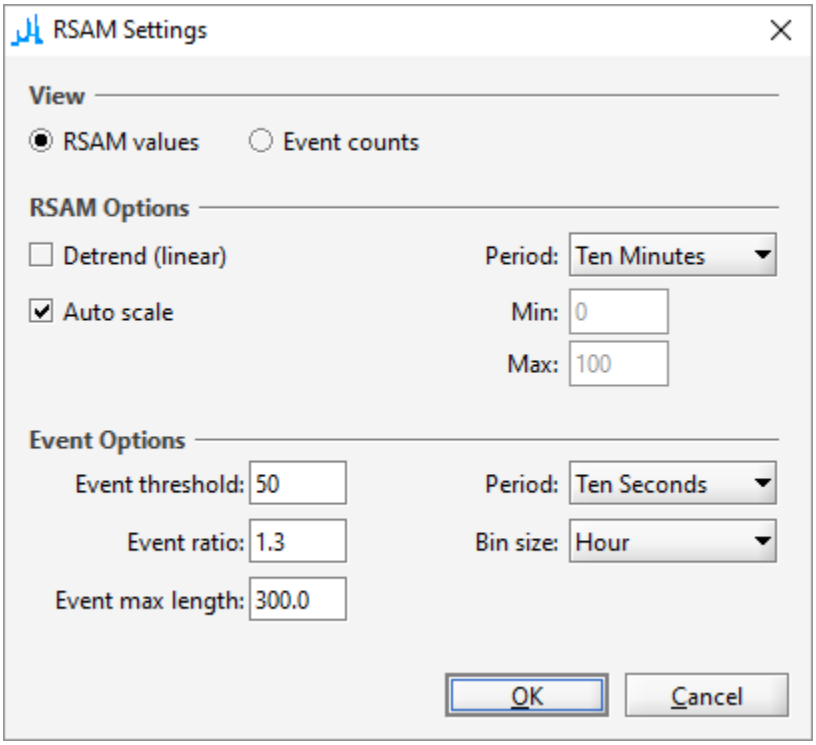


Figure 21 RSAM Settings

Default RSAM settings can be found in RsamDefaults.config. Each SWARM execution will read this file upon start up to determine initial RSAM view configurations.

10 Map Interface

10.1 Introduction

The map shows station locations on geographically projected background imagery. Imagery can be, for example, shaded DEMS, satellite imagery, aerial photos, coastlines, etc. By default a basic world map taken from NASA Blue Marble imagery is provided. Custom imagery can be added provided that unprojected, geo-registered image files are available. See map packs for more information. The map interface can be opened by checking on the Window -> Map menu item or pressing Ctrl-M.

10.2 Displaying Station on Map

The map can also be opened by clicking on the  button at the bottom of the Data Chooser to display the selected stations or network. For example, selecting the All group under AVO Winston data source and then clicking on the map button will display the Aleutian arc along with transparent station markers. To avoid clutter not all stations are displayed at this scale. The number of hidden channels is displayed in the lower left of the map panel.

10.3 Map Toolbars

Map related functions:

- Map Options - or map settings
- Change label settings - toggles between showing some, all, or none of the station labels
- Zoom out to full scale (home)
- Drag map (D) – left click and hold to pan the map
- Zoom into box (B) – left click and hold to draw a box to zoom in on
- Measure distances (M)
- Zoom in (+)
- Zoom out (-)
- Last map view (Ctrl-Backspace)

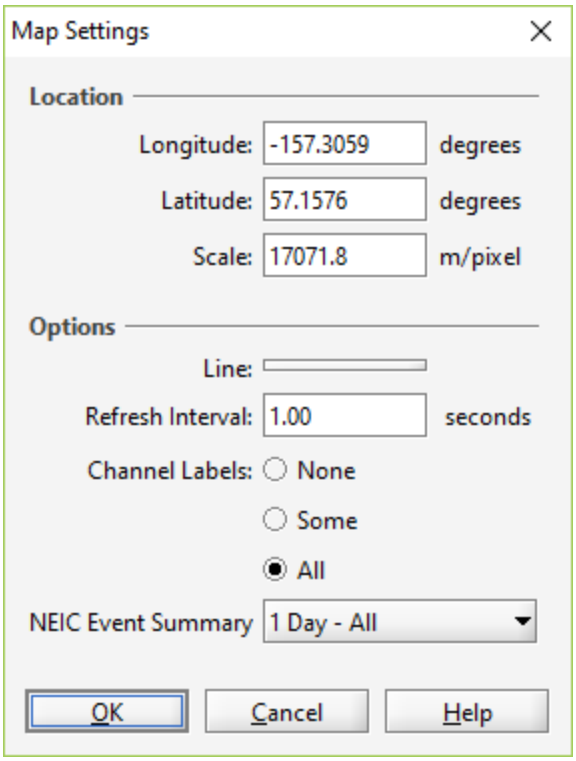
Wave related functions:

- Real-time mode

-  Synchronize times with helicorder wave
-  Scroll back time 20% (A or left arrow)
-  Scroll forward time 20% (Z or right arrow)
-  Go to time (Ctrl-G)
-  Shrink time axis (Alt left arrow)
-  Expand time axis (Alt right arrow)
-  Last time settings (Backspace)
-  Wave view settings (?)
-  Wave view (W or ,)
-  Spectra view (S or .)
-  Spectrogram view (G or /)
-  Particle motion view (R or ‘)
-  Copy inset to clipboard (C or Ctrl-C)
-  Save map image (P)

10.4 Map Settings

Clicking on  will open the Map Settings dialog. You can enter in the longitude and latitude to center on, and the map scale to display. Other options



10.4.1 Displaying NEIC Events

To display events from the National Earthquake Information Center (NEIC), choose an option from NEIC Event Summary. See Events section for more information.

10.5 Ruler Tool

The ruler tool measures great circle distances and azimuths. Distances are measured by left-clicking on the map at the desired start point and then moving the mouse, while still holding down the left button, to the desired end point. The distance and azimuth will be displayed at the lower left of the map panel. Note that because great circles are used, the distances and azimuths may seem counter-intuitive when looking at large scale maps. Once finished with the ruler, it's possible to click on the or icons to re-enable drag box area selection or panning.

10.6 Understanding Map Scale

The map scale is shown in the upper left of the map panel. The scale is accurate at the center of the map and diminishes in accuracy with distance from the center. Inaccuracy is high for small maps and low for large maps.

10.7 Channel Interactions

Left-clicking a station marker will produce a wave view on the map. The wave view can be moved around the map by dragging the title bar. A tie line will point back to the station location. An individual wave view can be resized by holding the mouse over the panel and moving the mouse wheel. Moving the mouse to spots not over a wave panel and moving the mouse wheel while holding the CTRL key will resize all the wave view panels simultaneously.

A left double-click will open a helicorder. Right-clicking on a station marker will show multiple channels (if present) and allow a selection from them.

10.8 Wave Panel Time Spans

All wave view panels on a map have the same time span. The vertical line on the wave panels always points to the same time on every panel.

10.9 Map Packs

SWARM uses un-projected, geo-referenced JPEG or PNG images to produce map background. By default, the imagery is in the mapdata directory of its installation. This can be changed in Swarm.config. Sub-directories in mapdata are called Map Packs. The binary distribution of SWARM includes world and NASA 2k Map Packs. The file MapPack.txt provides SWARM the information needed to render the imagery. This is the first line from MapPack.txt in world subdirectory:

world.jpg, 2700, 1350, -180, 180, -90, 90, 0, 2000000, 0

The comma-separated fields are defined as follows:

1. The name of image being described.
2. Pixel width
3. Pixel height
4. West longitude extent (-180 to 180)
5. East longitude extent (-180 to 180)
6. South latitude extent (-90 to 90)
7. North latitude extent (-90 to 90)
8. Minimum scale (m/pixel) this image will be displayed at
9. Maximum scale (m/pixel) this image will be displayed at
10. Precendence - higher numbered images are rendered on top of lower rendered images.

Note that a longitude extent (west to east) from 175 to -175 spans 10 degrees of longitude and one from -175 to 175 spans 350 degrees of longitude. That is, the 4th and 5th columns do not specify minimum and maximum longitude but western and eastern boundaries.

11 Events

11.1 Importing Events

Events can be imported into Swarm by enabling NEIC Event Summary option in Map Settings (see section 10.4.1.) Events in QuakeML file formats can also be imported from the File -> Import Event menu.

11.2 Map Display

Events displayed on the map are represented by unlabeled circles as markers. The size and color of the marker is based on how recent the event is, and its magnitude. The larger the magnitude, the larger the marker. Below table shows the colors associated with the age of event.

Event Age	Color
< 1 hour	Red
1 hour or more but < 1 day	Orange
1 day or more but < 1 week	Yellow
1 week or more	White

Hovering over the marker will turn the color green and display basic information about the event.

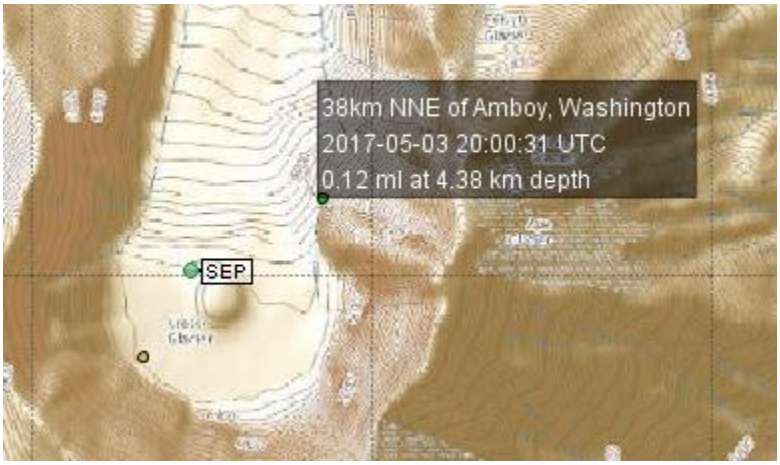


Figure 22 Example of hover over event

Clicking on the marker will open the Event Frame.

11.3 Event View

The event view can be opened by clicking on an event marker on the map. The top of the event window will display basic information about the event; such as the description, origin date, event type, hypocenter, etc. The bottom part of the event window will display the wave views of the picks associated with each arrival within the event. Pick times are marked by a green line and label tag indicating the time weight of arrival; and onset, phase, and polarity of the pick. The gray area to either side of the pick mark represents time residual associated with the arrival. The toolbar above the picks contain buttons that perform functions similar to that found in other views. The buttons related to waves are enabled only after a wave is selected.

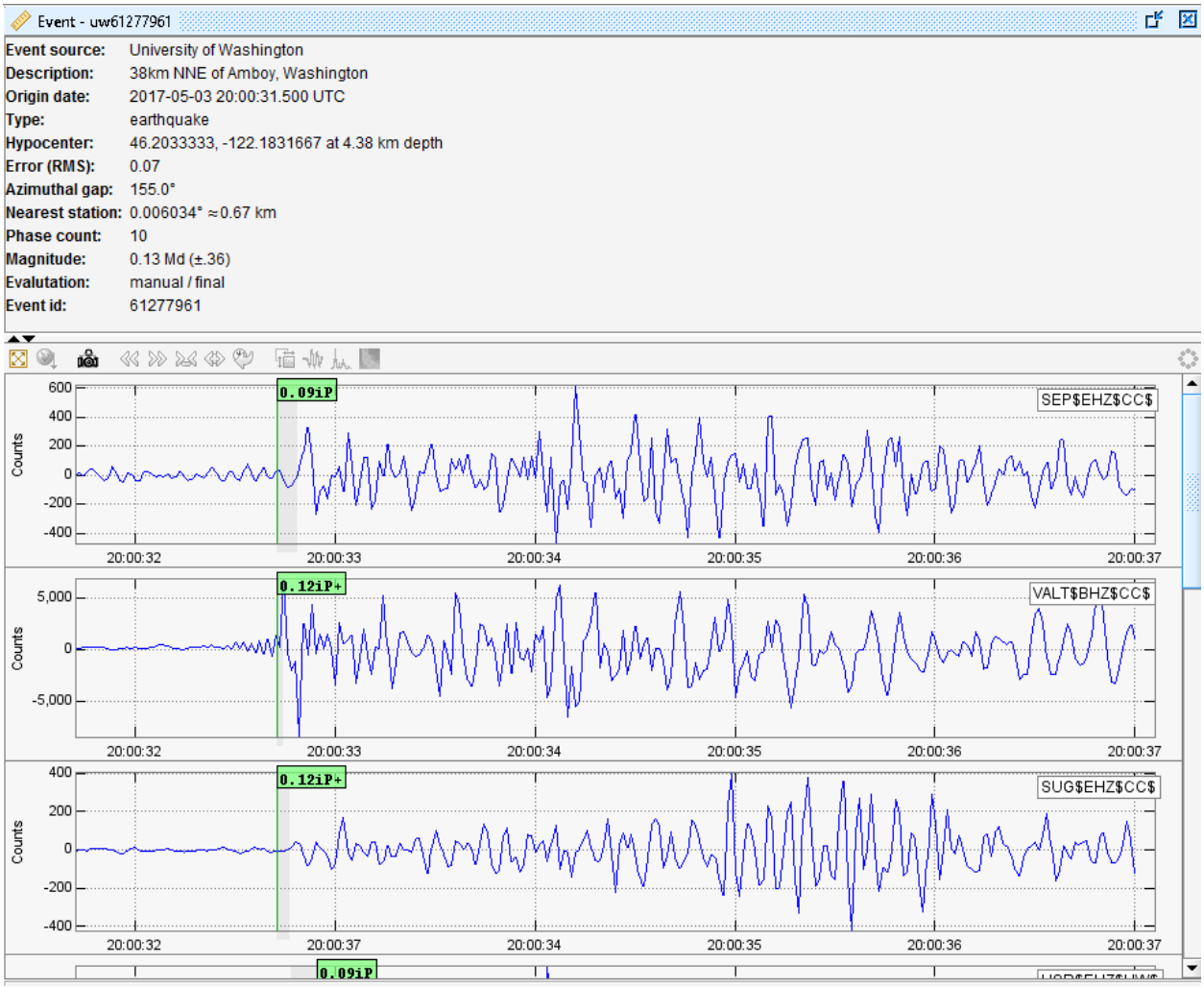


Figure 23 Event Frame

12 Menus

12.1 File

- Open File… (Ctrl-O) Allow user to open a wave as data source from a file. Supported formats are SAC, SEED, miniSEED, SEISAN, and Matlab-readable text file.
- Close File Closes all file based data sources.
- Clear cache (Ctrl-F12) Empty cache.
- Import Event… (Ctrl-I) Allow user to open a QuakeML event file for display on the map.
- Options… Opens the Options dialog window.
- Exit Closes the application.

12.1.1 Options

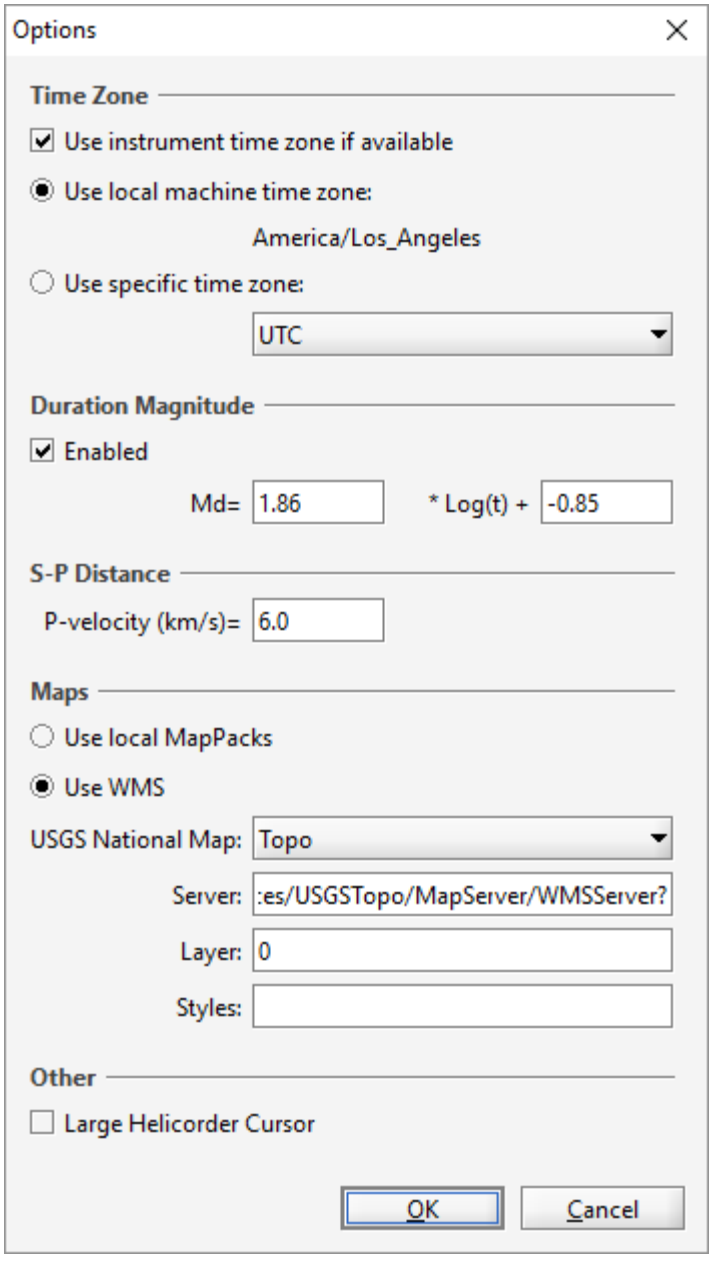


Figure 24 Options dialog

12.1.1.1 Time Zone

If a connection to a wave source has time zone metadata (such as in the case of connection to AVO Winston Server), checking the 'Use instrument time zone if available' box will do as the name suggests. If the instrument time zone is not available via the metadata, it is possible to use the machine time zone or select one manually.

12.1.1.2 Duration Magnitude

Users must opt in to be able to select duration and perform magnitude calculations in helicorder view. When enabled, users can place markers on the wave panel by left clicking on it. The duration magnitude is then displayed at the end of the first line in the status bar at the bottom of the helicorder.

12.1.1.3 S-P Distance

The P-velocity configured here will be used to calculate S-P distance when in

pick Mode and users have selected P and S times.

12.1.1.4 Maps

Users have the option of using local Map Packs (see section 10.9) or a Web Map Service (WMS). If using WMS the map type can be selected from the drop down, which changes the server URL. Users may optionally configure the server, layer, and styles options to another service if desired.

12.1.1.5 Other

Selecting the Large Helicorder Cursor checkbox will make the cursor over the helicorder bigger and red for better visibility.

12.2 Layout

A layout is a saved SWARM configuration that can be quickly reopened, either from the SWARM menu or via the command line.

- Save Layout… (Ctrl-L) Saves current layout.
- Overwrite Last Layout (Ctrl-Shift-L) Overwrite previously saved layout with current layout.
- Remove Layout… Allows user to select a layout to remove.

Saved layouts are shown at the bottom of the Layout menu and can be selected. The Layout Augustine is provided by default as an example.

12.3 Window

- Data Chooser (Ctrl-D) Hide or unhide Data Chooser window.
- Wave Clipboard (Ctrl-W) Hide or unhide Wave Clipboard window.
- Map (Ctrl-M) Hide or unhide Map window.
- Bring Map to Front (M) If map is hidden behind other windows, it brings it to the forefront.
- Tile Helicorders Tiles all open helicoders.
- Tile Waves Tiles all open waves.
- Kiosk Mode (F11) Enter or exit Kiosk Mode.
- Close All Closes all open helicorders and waves.

12.3.1 Kiosk Mode

In Kiosk Mode SWARM displays all of the open helicorders in full-screen mode for purposes of seismic monitoring. Since there are no menus or toolbars when in Kiosk Mode, keyboard shortcuts will have to

be used to interact the inset wave view. Alternatively, users can switch to normal mode. The F11 key toggles between Kiosk Mode and normal operation.

SWARM can start automatically in Kiosk Mode by running it with this option: '—kiosk=[parameters]'. It can also be started in Kiosk Mode through the configuration file. The value of the 'kiosk' parameter is [server name]; [channel]. Example: swarm --kiosk="localhost;BGL SHZ AK". The data source specified has to be one of the configured data sources.

12.4 Help

- About Displays software URL, version number, memory usage, etc.

13 Configuration Files

13.1 Swarm.config

When exiting SWARM, the application will automatically store user selected configurations to SWARM.config. Subsequent executions of SWARM from the same locations will read this file to determine starting configuration.

13.2 DataSources.config

Data sources specified in this file cannot be edited or deleted in Data Chooser. This may be desirable in cases when multiple people access SWARM from the same location. Example entry:

```
server=CVO Winston;wws:130.118.152.47:16022:15000:1
server=AVO Winston;wws:pubavo1.wr.usgs.gov:16022:10000:1
```

13.3 NTP.config

Oftentimes SWARM needs the current time in order to make requests to data sources. In order to make sure that SWARM asks for the correct time it attempts to synchronize with internet time servers (see http://tf.nist.gov/tf-cgi/servers.cgi#). This does not change the system clock but just calculates an offset from it. SWARM will attempt this sychronization by default approximately every 10 minutes.
The NTP.config file allows user to specify a list of NTP servers, a timeout value (ms), and a recalibration interval (ms). Example entry:

servers=130.118.179.207,129.6.15.28,132.163.4.101,128.138.140.44,192.43.244.18,131.107.1.10
timeout=600000

recalibrationInterval=10000

13.4 SwarmGroups.config

Channels can be grouped in the Channel Selector through SwarmGroups.config. File entries are a list of [channel]=[group] pairs. See default SwarmGroups.config that came with the distribution for example.

13.5 RsamDefaults.config

This file stores the RSAM view default configurations. Changes made in the RSAM Settings dialog does not alter this file.

13.6 WaveDefaults.config

This file stores the latest Wave Settings configurations.

13.7 SwarmMetadata.config

Metadata configuration file.

14 Support

Tickets for issues or enhancement requests can be opened in https://github.com/usgs/swarm/issues.