Pressure Wave and CO_2 Seismic Events Profile Viewer Java Applet

by John R. Victorine

Introduction

This applet is a profile viewer in time that will display the pressure wave data and the selected CO_2 seismic sensor wave data for a specific seismic event (earthquake). The user selects a seismic event they wish to view and the program automatically retrieves from the Kansas Geological Survey (KGS) Server the Pressure Comma Separated Values (CSV) file and the Seismic Sensor miniSeed file that corresponds to the time of the seismic event and displays in the profile plot. The user is allowed to perform simple filtering on both data sets and to display a Frequency vs. Magnitude plot of each of the data sets.

The pressure measurements started at 25 April 2016 at 13:49, each data step is at 1 second interval. Each miniSeed file is in 1 hour time interval. All data files are stored on the KGS Server. The miniSeed files for one day contained up to 7 seismic sensors with 3 channels at one hour intervals, i.e. 504 miniSeed files per day.

The Applet automatically downloads the necessary data from the Kansas Geological Survey (KGS) ORACLE database to access the Pressure Files and the miniSeed files that are stored on the KGS Server. The following are ORACLE PL/SQL stored procedures that will generate an Extensible Markup Language (XML) data stream, which the applet will then parse and store in data structures. The 5 XML Files are listed as follows,

CO_2 Seismic Events predicted from the 15 CO_2 Seismic Sensor Array are in the following ORACLE PL/SQL,

http://chasm.kgs.ku.edu/ords/iqstrat.co2_events_pkg.getXML.

The Pressure sensor is set at the Arbuckle Formation in the Wellington KGS 1-28 (15-191-22590) Well. The well information can be accessed from the KGS ORACLE database by an ORACLE PL/SQL,

http://chasm.kgs.ku.edu/ords/iqstrat.kgs_well_headers_pkg.getXML?sAPI=15-191-22590.

The CO_2 seismic sensors name, id and location can be accessed from the KGS ORACLE database by an ORACLE PL/SQL,

http://chasm.kgs.ku.edu/ords/iqstrat.co2_miniseed_pkg.getXML.

The location of the Pressure files information can be accessed from the KGS ORACLE database by an ORACLE PL/SQL,

http://chasm.kgs.ku.edu/ords/iqstrat.co2_pressure_files_pkg.getXML.

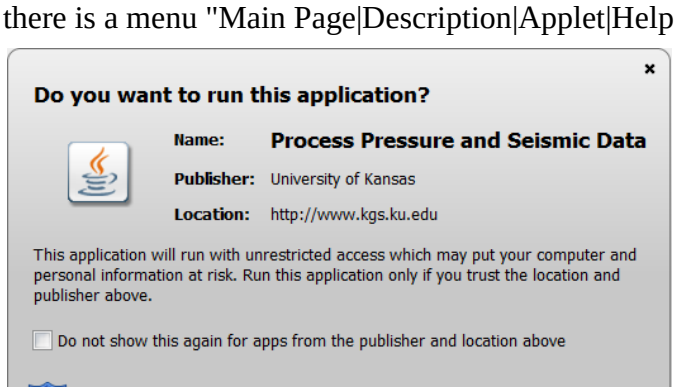
The location of the miniSeed file information can be accessed from the KGS ORACLE database by an ORACLE PL/SQL,

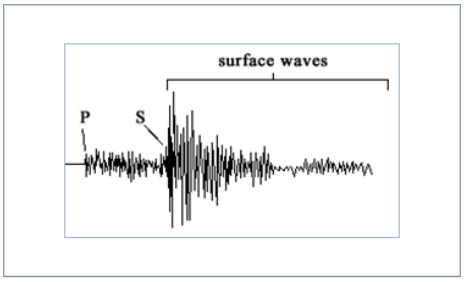
http://chasm.kgs.ku.edu/ords/iqstrat.co2_miniseed_files_pkg.getXML.

The individual miniSeed file names are not stored, just the main directory location information. Since all files follow a specific file format YYYY.DAY.HR.00.00.ID.1.CHANNEL.m

where YYYY is the year the data was measured,
DAY is the day of the year of the measured data,
HR is the Hour (0-24) that the data was measured, each miniSeed file is 1 hour in length,
ID is the sensor id, i.e. Sensor WK12 id is 92C7,
CHANNEL is the channel number, i.e. 1 = vertical orientation, 2 = North-South orientation and 3 = East-West orientation,
m is the file extension to represent a miniSeed file type.

To access the Pressure Wave and CO2 Seismic Events Profile Viewer web site, go to the web address **http://www.kgs.ku.edu/PRS/Ozark/Software/PSISeismic/**. At the top of the web page there is a menu "Main Page|Description|Applet|Help|Copyright & Disclaimer|". Select the "Applet" menu option a "Warning - Security" Dialog will appear *("Do you want to run this application?")*. The program has to be able to read and write to the user's PC and access the Kansas Geological Survey (KGS) Database and File Server, ORACLE requires this dialog. The program does not save your files to KGS, but allows you to access the KGS for well information. The program does not use Cookies or any hidden software. The blue shield on the warning dialog is a symbol that the Java web app is created by a trusted source, which is the University of Kansas. Select the "Run" Button, which will display the Seismic Image Icon Button in the "Enter" Panel illustrated below,

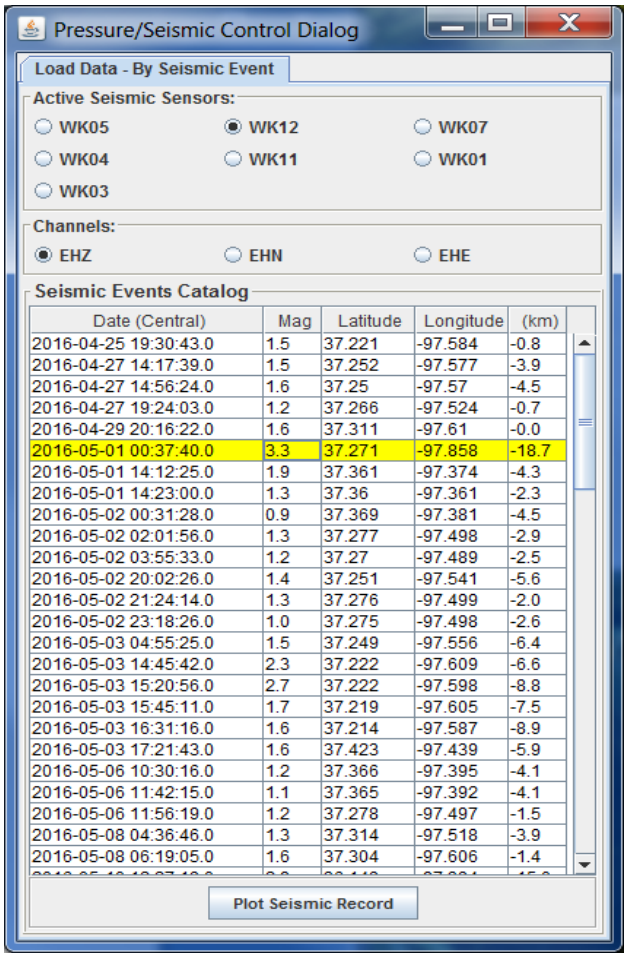




Enter

Click on the seismic wave icon button to display the Pressure/Seismic Control Dialog. The program begins by downloading all the necessary data from the KGS ORACLE Database to run the program.

Pressure/Seismic Control Dialog



This dialog allows the user to select a seismic event they wish to plot, e.g. magnitude 3.3 earthquake at -18.7 km deep occurring at 1 May 2016 at 00:37:40 Central time or 05:37:40 Coordinated Universal Time (UTC), which is highlighted in the "Seismic Events Catalog" table.

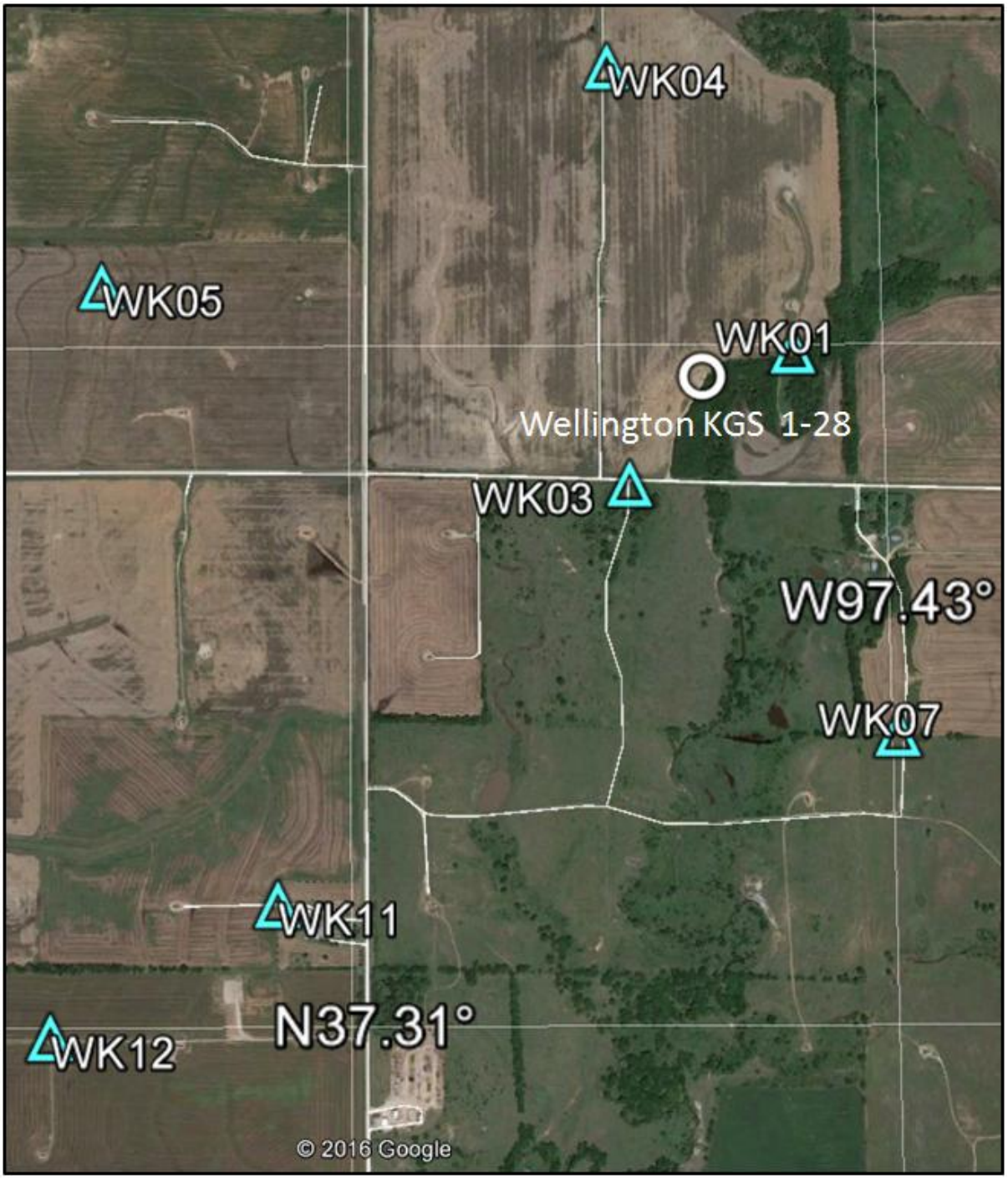
The date of the seismic event will determine the Pressure file that will be opened and displayed. The miniSeed file uses the same date and the radio button selections for the sensors/channels to build the miniSeed file name.

There are up to 7 seismic sensors that were used to compute the seismic event and the location of the event. The "Active Seismic Sensors" panel holds the seismic sensors name, which are automatically mapped to their ID. The "Channels" panel holds the orientation of the sensor, WK12 and EHZ are initially selected by default.

The individual miniSeed file names are not stored, just the main directory location information. Since all files follow a specific file format YYYY.DAY.HR.00.00.ID.1.CHANNEL.m

where
YYYY is the year the data was measured,
DAY is the day of the year of the measured data,
HR is the Hour (0-24) that the data was measured, each miniSeed file is 1 hour in length,
ID is the sensor id, i.e. Sensor WK12 id is 92C7,
CHANNEL is the channel number, i.e. 1 = vertical orientation, 2 = North-South orientation and 3 = East-West orientation,
m is the file extension to represent a miniSeed file type.

Once the filenames of the Pressure & miniSeed file are determined the program automatically downloads both files from the KGS Server and imports the files into the web app. The data is parsed into data structures and then the Profile Plot Control and Profile Plot dialogs are displayed with the Pressure & Seismic Wave data plotted side by side.



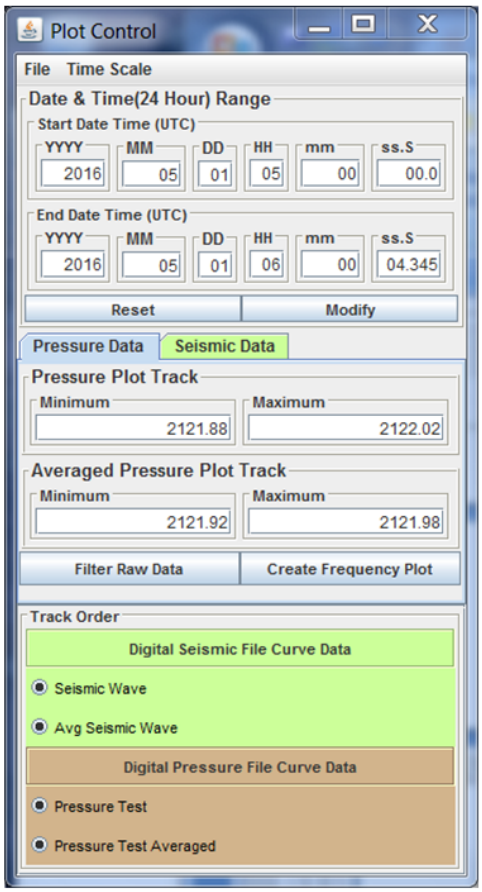
Map of the locations of the CO_2 Seismic Sensors and the Wellington KGS 1-28, location of the pressure sensor.

Profile Plot Control Dialog

The Profile Plot Control dialog allows the user to control the Profile Plot. The user can change the time range on the profile plot, the limits on the plot tracks for both the Pressure and Seismic Data. This dialog will allow the user to perform simple filtering on both data sets and to display a Frequency vs. Magnitude plot of each of the data sets.

Menu: →
File Menu option:
- Create PDF Document Plot – allows the user to create a Portable Network Graphics (PNG) file with the option of creating a Portable Document Format (PDF) of the PNG Image.
- Exit – Exit the dialog and close all dialogs opened by this dialog.

Time Scale Menu option:
This allows the user to scale the profile plot time scale to number of minutes per inch, i.e.
- 1 min / in
- 2 min / in
- 5 min / in
- 15 min / in
- 30 min / in
- 60 min / in
- 120 min / in

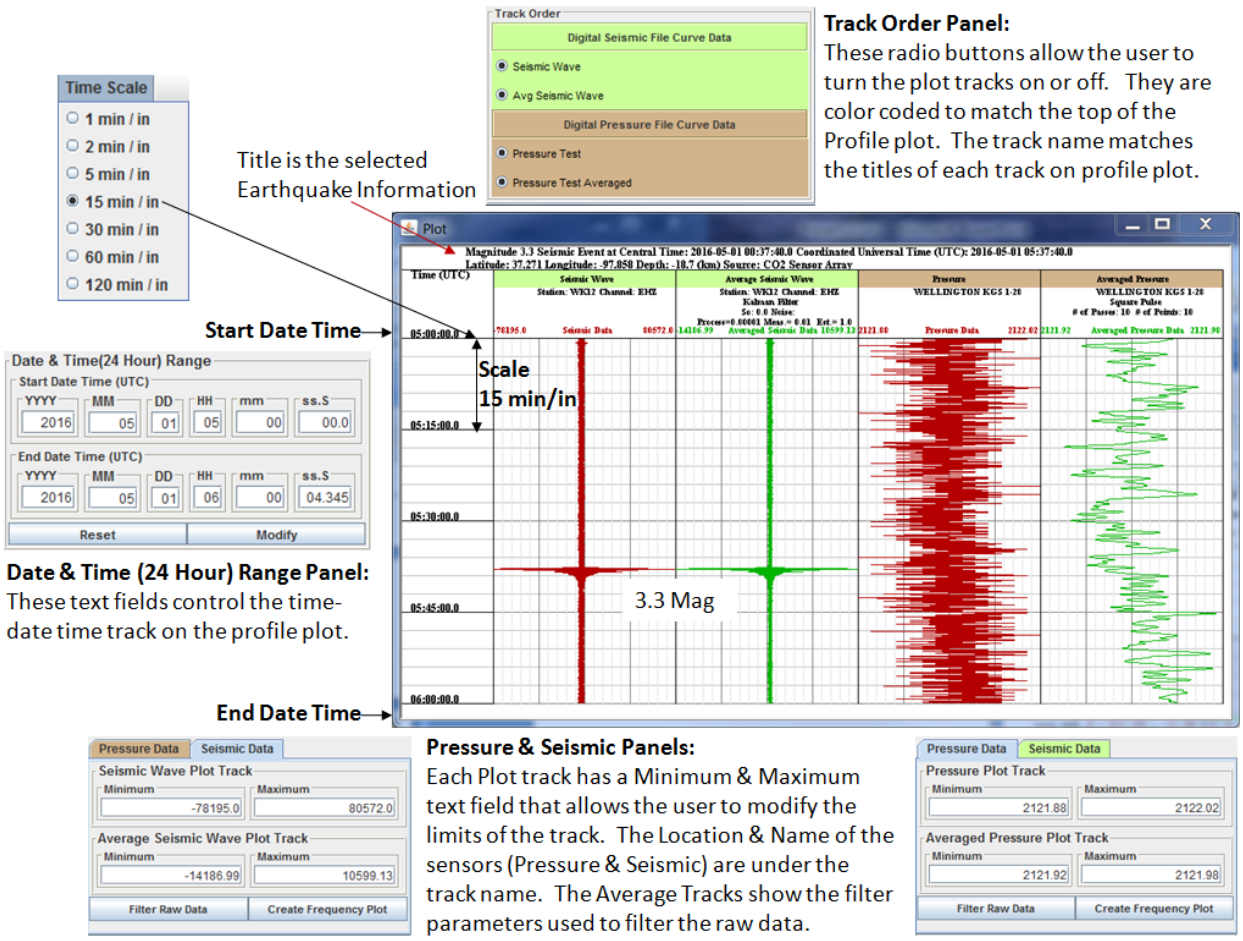


Date & Time (24 Hour) Range Panel:
These text fields control the time-date depth track on the profile plot.

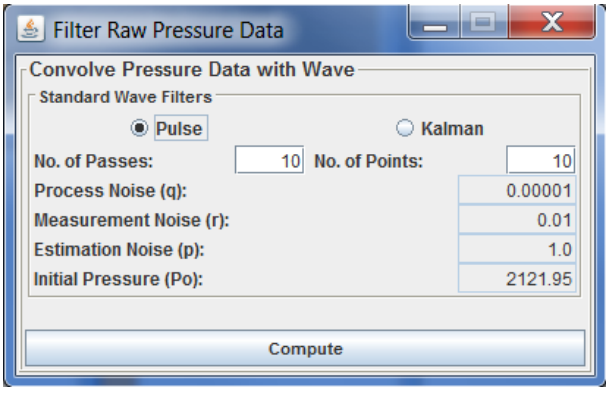
Pressure & Seismic Panels:
These tabbed panels allow the user to change the plot scales on the profile plot. The tabs when NOT selected displays the color of the plot track.
Buttons,
- Filter Raw Data – Allows the user to filter the raw data.
- Create Frequency Plot – Allows the user to plot the data as a Frequency vs. Magnitude Plot.

Track Order Panel:
These radio buttons allow the user to turn the plot tracks on or off. They are color coded to match the top of the Profile plot.

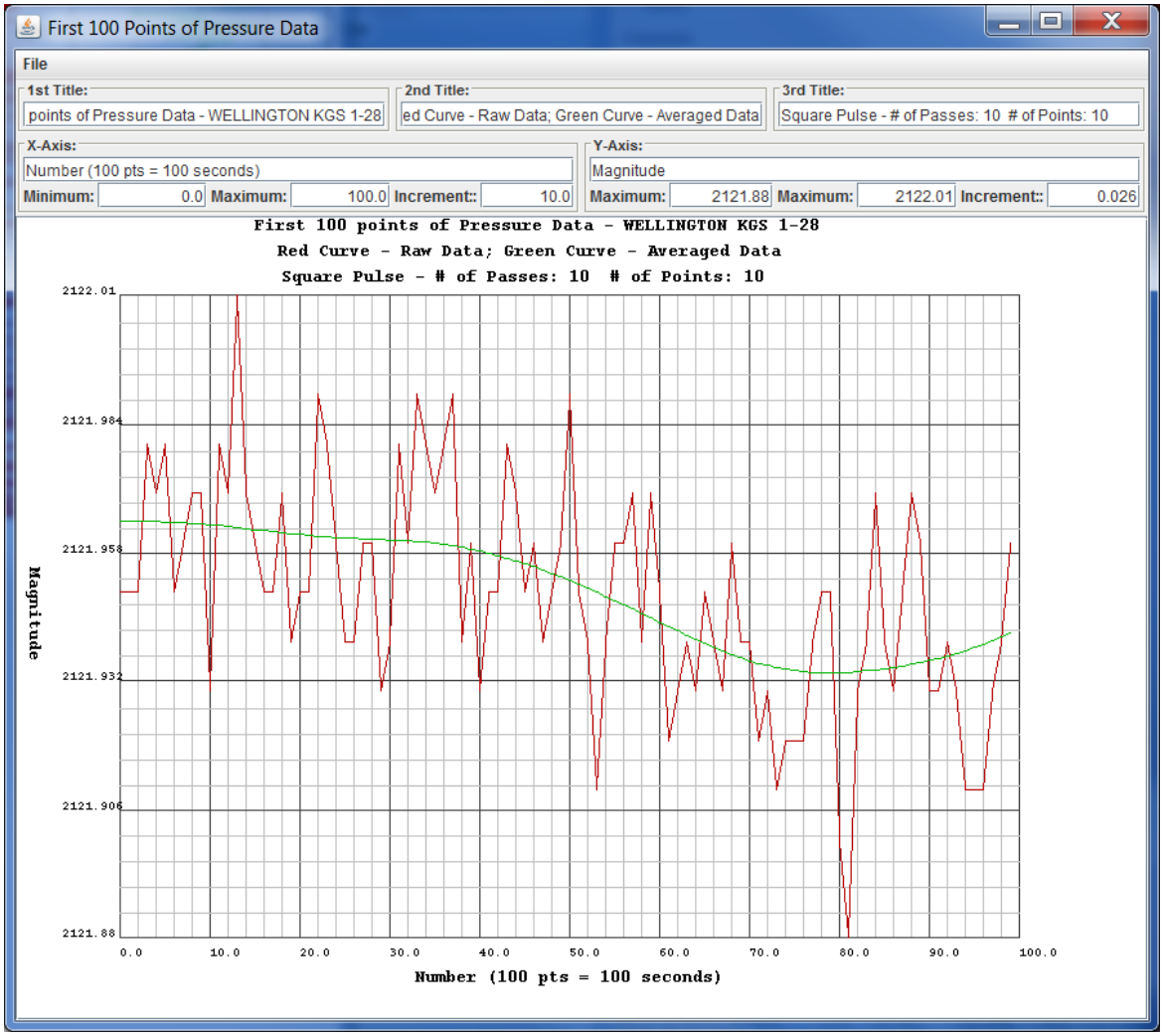
The Pressure Data & Seismic Data panels hold the limits of their respective plot tracks, which the user may modify. Each panel has a "Filter Raw Data" and a "Create Frequency Plot" buttons. The first allows the user to filter the raw data to remove some of the noise. The web app automatically filters the Raw Pressure data with a pulse of 10 points making 10 passes through the data, i.e. taking the output from each pass and performing the pulse convolution on the resultant. This seems to smooth the data signal considerably making it easier to see the pressure data. Each "Profile Plot Control" panel on the Control Dialog can modify the profile plot.



The "Seismic Wave Plot Track" & the "Pressure Plot Track" panels have a "Filter Raw Data" button which holds the simple filtering processes for both data panels. The Pressure Data has a Square Pulse filter and a one dimensional Kalman filter. The Square Pulse filter is automatically run when the profile plot is displayed using a Square Pulse 10 points wide (10 seconds wide) and passing it through the data 10 times to smooth out the noise.

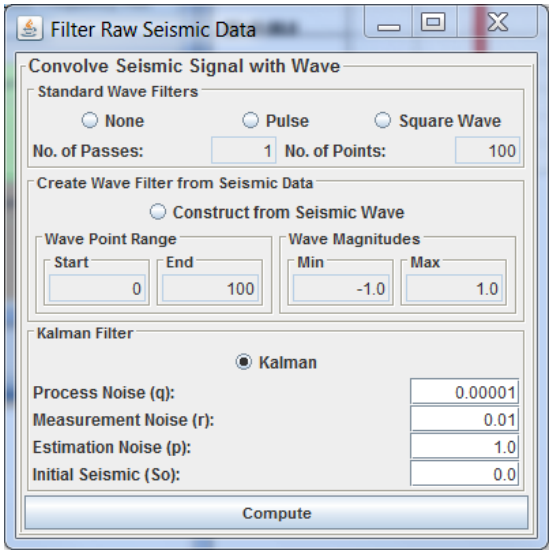


When the user selects the "Compute" button the program will apply the filter to the raw pressure data and plot the data to the Average Pressure plot track on the profile plot and display the "First 100 points of Pressure Data" XY Plot to show the effects of the filter on the raw data.

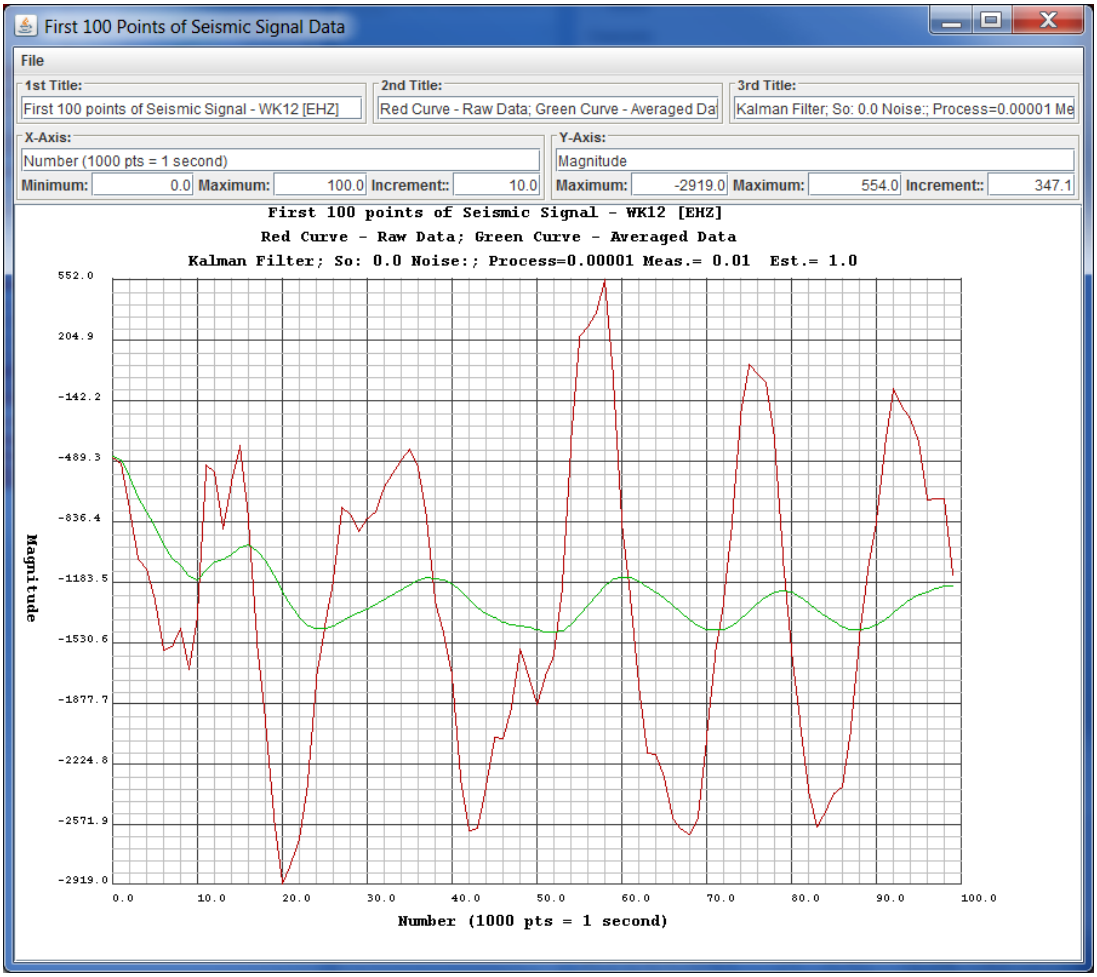


In the above plot the red curve is the raw data and the green curve is a square pulse (10 seconds) wide which was passed through the pressure data 10 times to remove the noise in the data. The titles & plot limits are controlled at the top panel of the dialog.

The Seismic Data has a couple more filters besides the Square Pulse filter and one dimensional Kalman filter, because of the nature of the data. This dialog also has a Square Wave filter that the user can change the width to match the seismic data wave to filter the data. This panel also has a "Create Wave Filter from Seismic Data" panel that allows the user to construct a filter from the 1st 100 points of the seismic wave. The default setting is all the 100 points normalized to +/- 1.0, but the user can use the First 100 points XY-Plot to choose the starting point and ending point of the constructed wave filter.

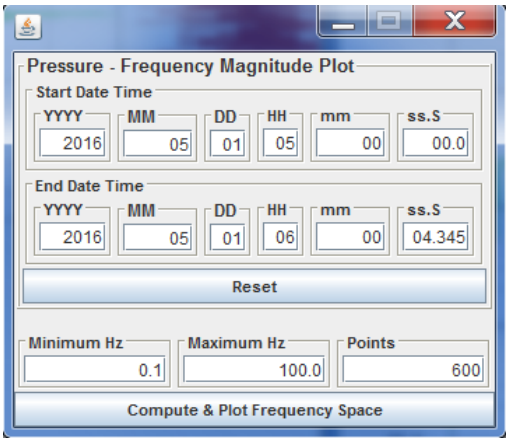


When the user selects the "Compute" button the program will apply the filter to the raw seismic wave data and plot the data to the Average Seismic Wave plot track on the profile plot and display the "First 100 points of Seismic Wave Data" XY Plot to show the effects of the filter on the raw data.

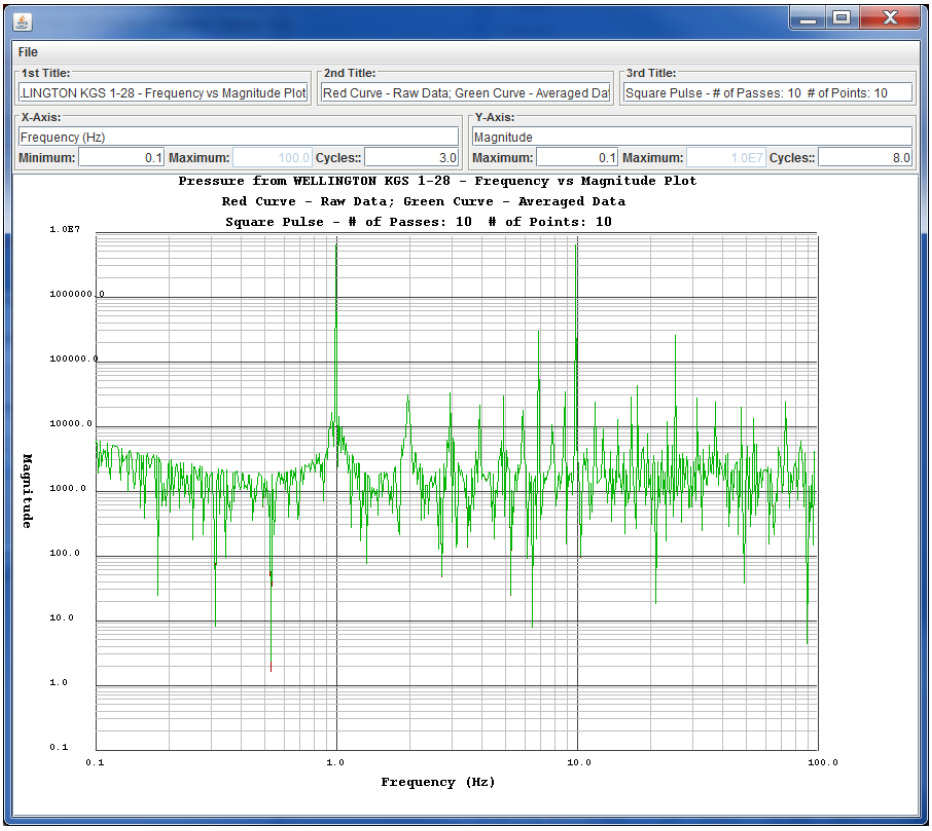


In the above plot the red curve is the raw data and the green curve the one dimensional Kalman filter. The titles & plot limits are controlled at the top panel of the dialog.

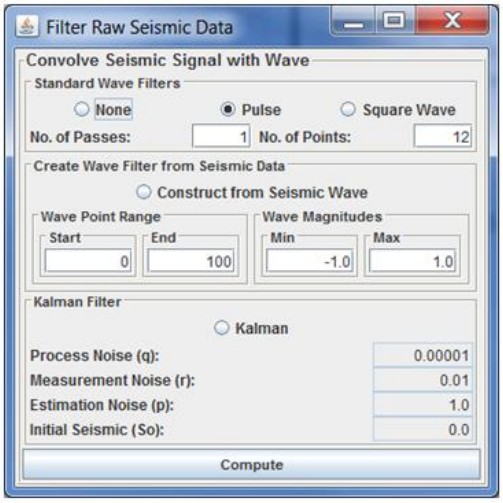
The "Seismic Wave Plot Track" & the "Pressure Plot Track" panels have a "Create Frequency Plot" button which allows the user to make a frequency plot with both the raw and filtered data plotted. Selecting the button will display the Frequency Magnitude Plot dialog.

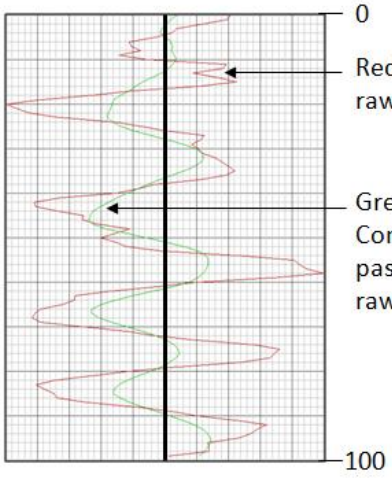


This dialog allows the user to set the data/time limits of the Frequency vs. Magnitude XY plot as well as the frequency limits in Hz, the number of points is spread equal across the limits. Clicking on the "Compute & Plot Frequency Space" button will display the Frequency vs. Magnitude XY plot.



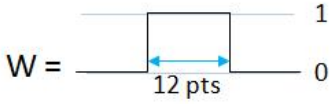
Square Pulse Filter





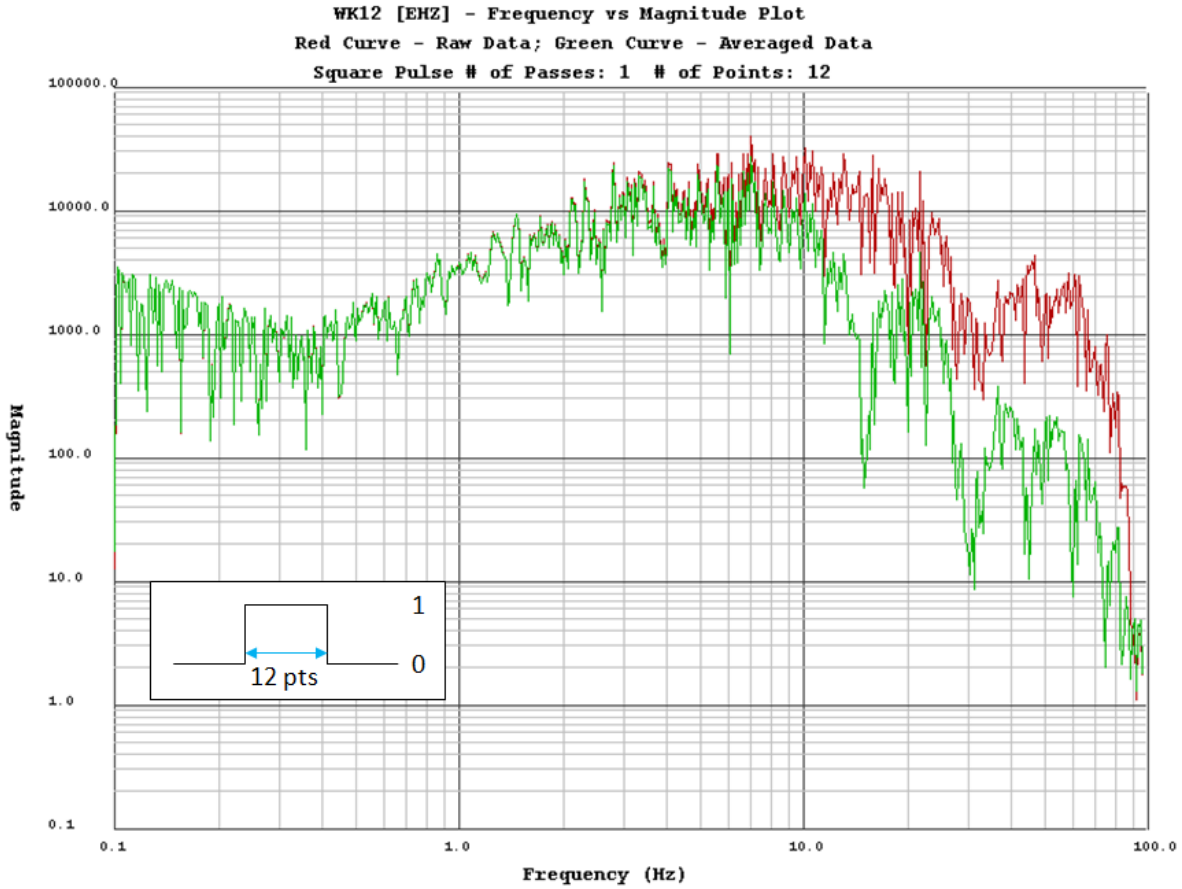
Red Curve is the raw seismic curve

Green Curve is the Construct waveform passed through the raw seismic curve

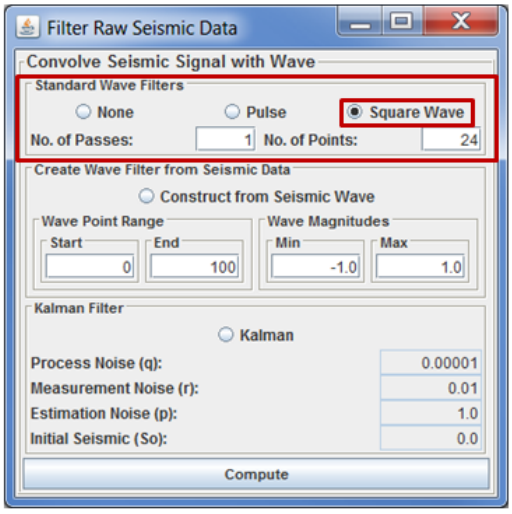


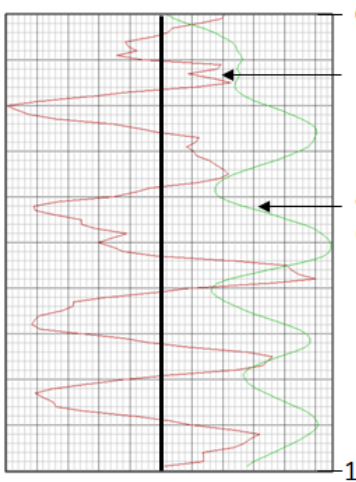
$$S_i = \frac{1}{N} \sum_{k=-N/2}^{N/2} S_{i+k} * W_{k+N/2}$$

where S_i = i-th Seismic data point
N = total waveform points



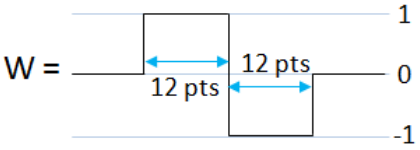
Square Wave Filter





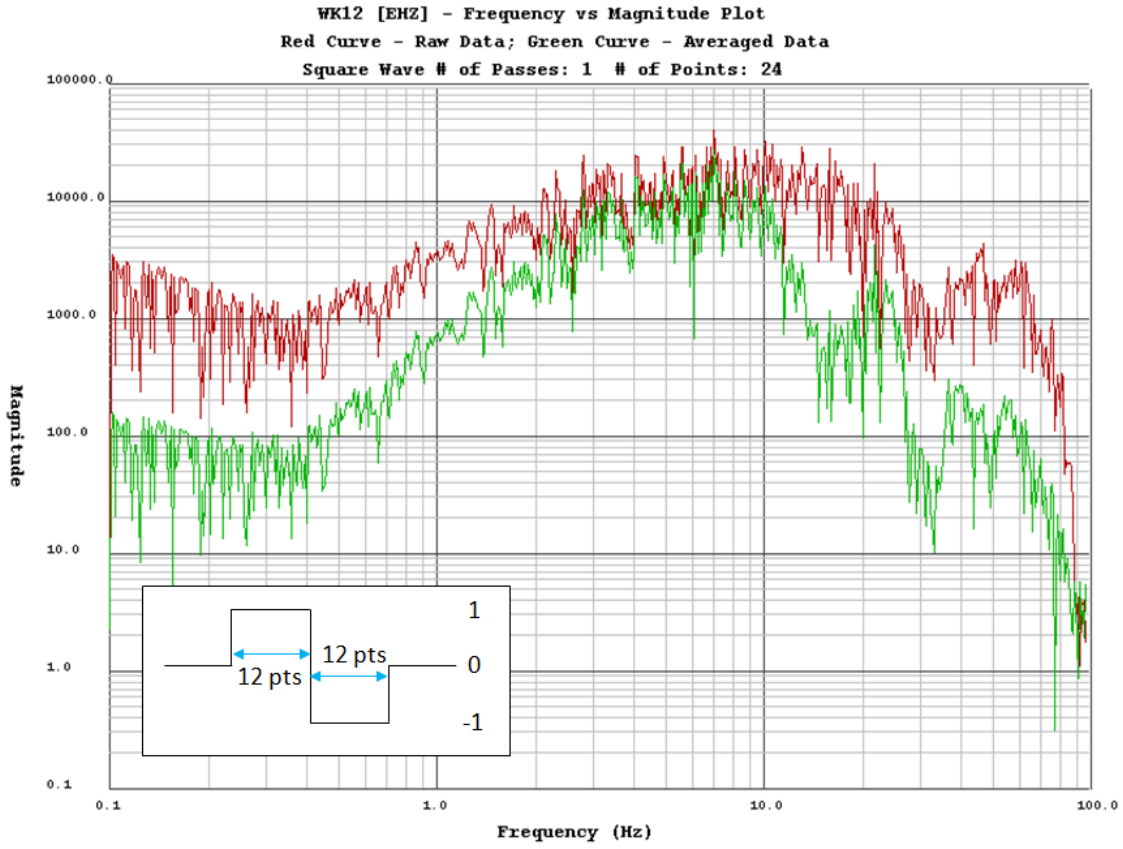
Red Curve is the raw seismic curve

Green Curve is the Construct waveform passed through the raw seismic curve

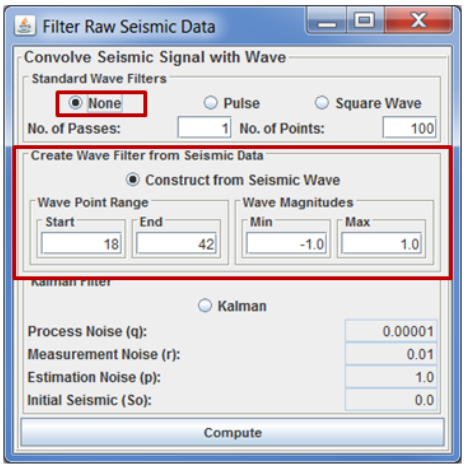


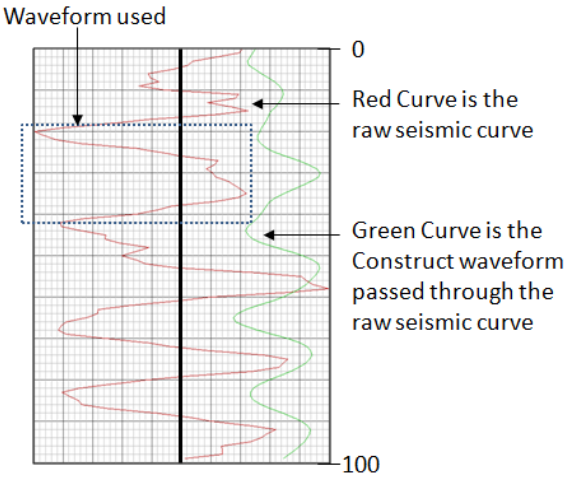
$$S_i = \frac{1}{N} \sum_{k=-N/2}^{N/2} S_{i+k} * W_{k+N/2}$$

where S_i = i-th Seismic data point
N = total waveform points

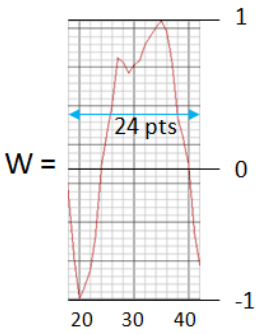


Constructed Wave Filter



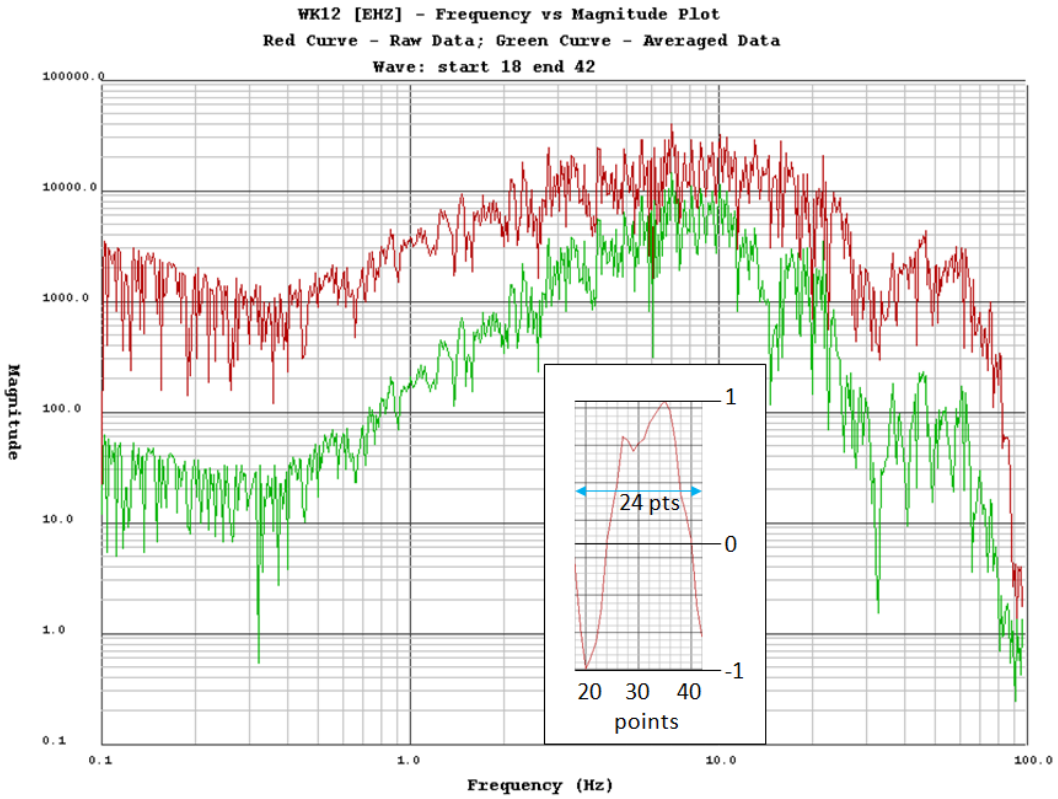


Constructed waveform from the original seismic wave using the 1st 100 points of the wave to choose from. This wave was constructed by selecting the signal from point 18 to point 42 and normalizing the data to +1 to -1 magnitude values. This wave form is passed through the seismic signal to filter the noise in the raw data.

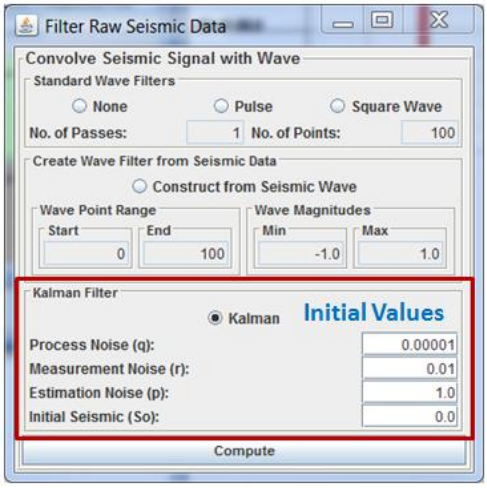


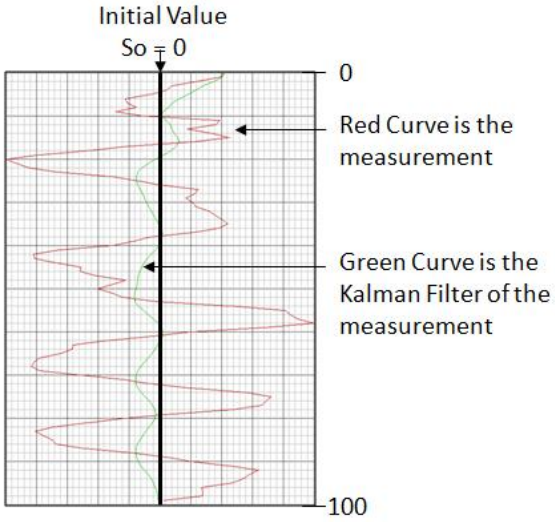
$$S_i = \frac{1}{N} \sum_{k=-N/2}^{N/2} S_{i+k} * W_{k+N/2}$$

where S_i = i-th Seismic data point
N = total waveform points



One Dimensional Kalman Filter





Variables:
- x – filtered value
- q – process noise
- r – sensor noise
- p – estimation error
- k – Kalman Gain

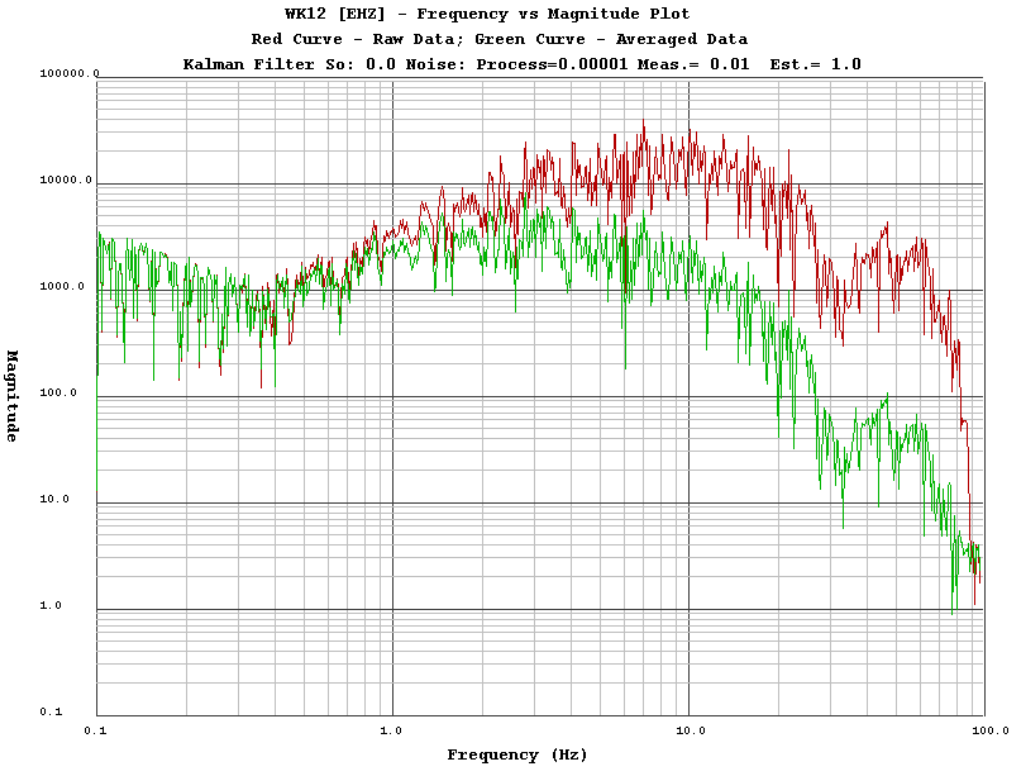
One dimensional Kalman Filter

x = So (initial value)
for each measurement
p = p+q

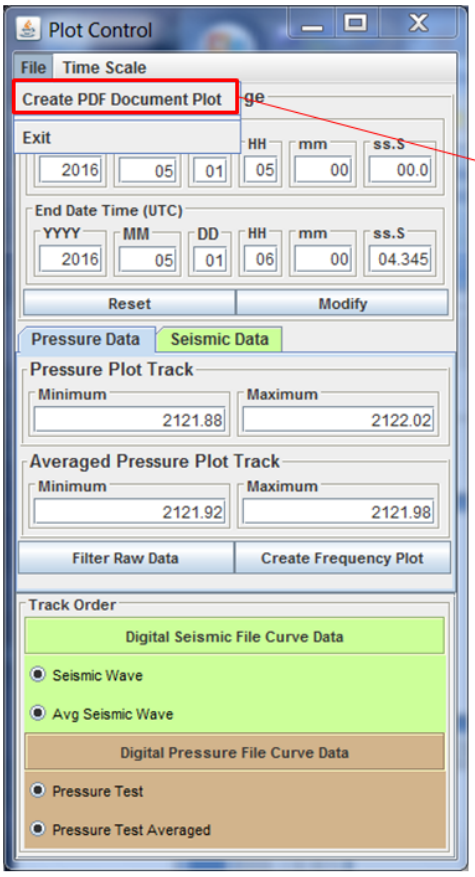
Prediction of the Kalman Filter

k = p / (p+r)
x = x + k * (measurement – x)
p = (1-k) * p
end for each measurement

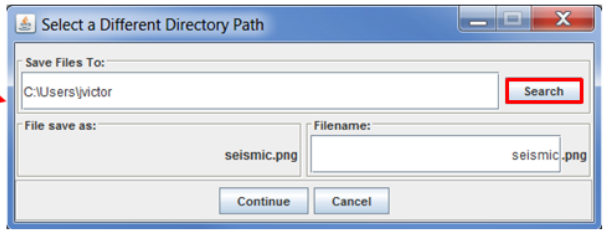
Measurement Update



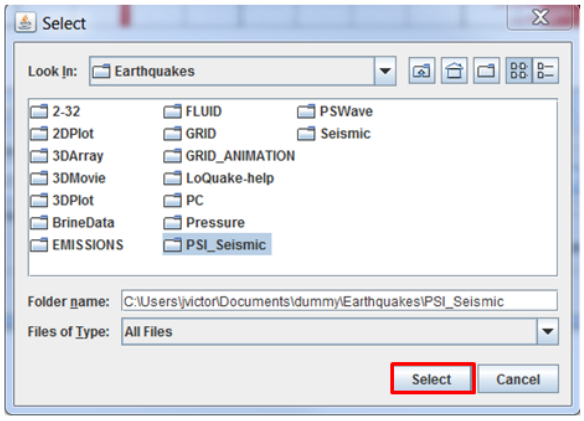
Creating a PDF Document:



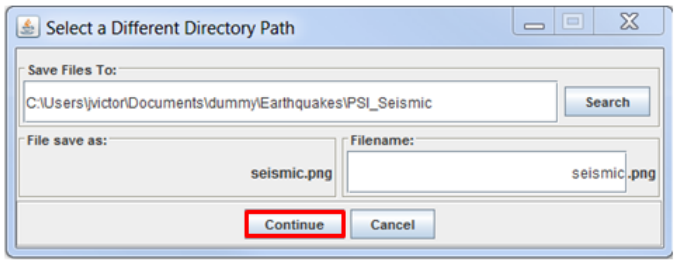
Select the File-Menu and click on the "Create PDF Document Plot" menu option to display the "Select a Different Directory Path" dialog.



Select the "Search" button to display the "Select Path" dialog, which allows the user to search their PC for the directory they wish to save the Portable Network Graphics file.



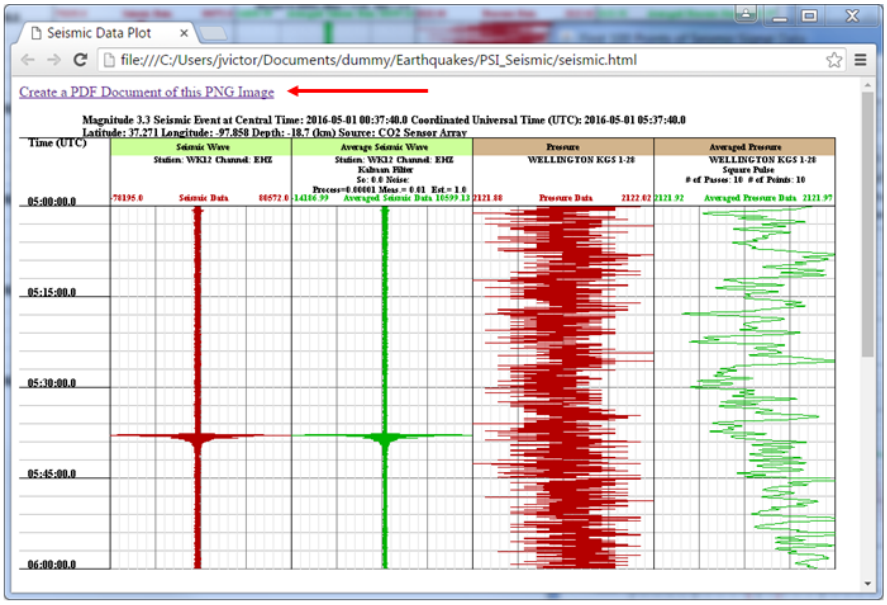
Highlight the directory and select the "Select" button to transfer the directory path to the "Save Files To:" text field.

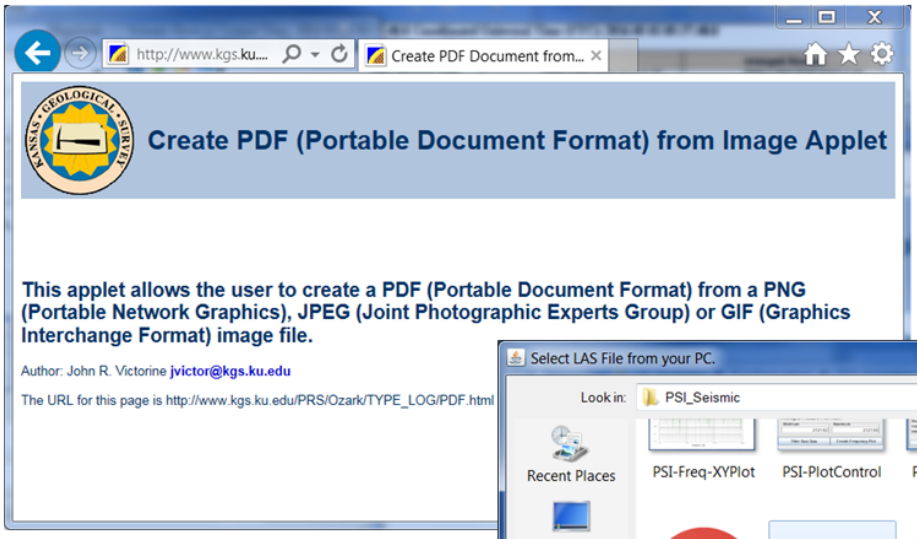


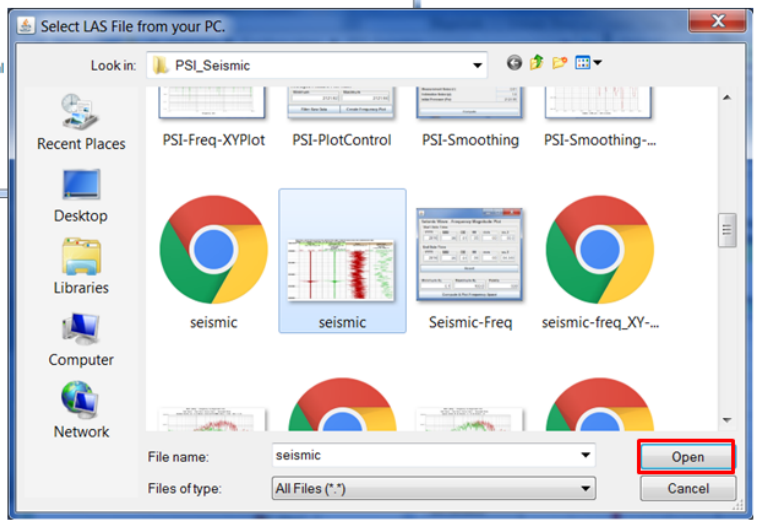
The user can change the filename and then select the "Continue" button To display the Portable Network Graphics (PNG) image in a browser window.

To generate a Portable Document Format (PDF) file of the generated image click on the "Create a PDF Document of the PNG Image" URL link at the top of the web page.

This will display the "Create PDF (Portable Document Format) from an Image Applet" web page. You will be ask "Do you want to run this application", select "Run" button and a file chooser dialog will display.







Go to the directory that you saved the PNG image file and highlight that document and then select the "Open" button to create a Portable Document Format (PDF) of that image.

The PDF document of the PNG Image will appear in a web page.


seismic.pdf - Adobe Acrobat Reader DC
File Edit View Window Help
Home Tools seismic.pdf Sign In
1 / 1
39.8%
Magnitude 3.3 Seismic Event at Central Time: 2016-05-01 00:37:40.0 Coordinated Universal Time (UTC): 2016-05-01 05:37:40.0
Latitude: 37.271 Longitude: -97.858 Depth: -18.7 (km) Source: CO2 Sensor Array
Time (UTC)
Seismic Wave
Station: WKI2 Channel: EHZ
Average Seismic Wave
Station: WKI2 Channel: EHZ
Kalman Filter
So: 0.0 Noise
Process=4.0000 Meas = 0.01 Est = 1.0
Pressure
WELLINGTON KGS 1-29
Averaged Pressure
WELLINGTON KGS 1-29
Square Pulse
# of Passes: 10 # of Points: 10
-79195.0
Seismic Data
84672.0
14484.99
Averaged Seismic Data 10599.83
2121.00
Pressure Data
2122.92
2121.92
Averaged Pressure Data 2121.97
05:00:00.0
05:15:00.0
05:30:00.0
05:45:00.0
06:00:00.0