



## Network of European Research Infrastructures for Earthquake Risk Assessment and Mitigation

### Report

#### Software tools for data exchange and analysis [D8.3]

Activity:	<i>Networking School Seismology programs</i>
Activity number:	<i>NA8</i>
Deliverable:	<i>Software tools for data exchange and analysis</i>
Deliverable number:	<i>D8.3</i>
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**Seventh Framework Programme**  
**EC project number: 262330**



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## Summary

As part of the NERA NA8 activity software tools have been developed to facilitate the easy sharing of seismic data between national datacentres and for the analysis of this data at a level and sophistication appropriate for a high school science student.

In this report we describe a software toolbox that can be attached to an archive database and enable easy export of the data using a set of webservice protocols which make the data accessible to any user through a web-browser or to website developers programmatically. Throughout the course of this work great efforts have been made to ensure compatibility with emerging international standards for data exchange agreed by the Federation of Digital Seismograph Networks <http://www.fdsn.org/webservices/>

In addition we describe enhancements to a simple data analysis software package SEISGRAM2K which enables students to easily understand and interpret the data that they are looking at. This software is written in JAVA and will run on PC windows, MacOs and Linux.

Both software tools have been made available as open-source resources to the community through links at the ORFEUS and IRIS international datacentre websites. This work was carried out substantially by software developers in France working with CNRS with close support and advice provided by BGS and ETHZ. The data sharing webservices have been installed on the database for French school seismology networks.

## Introduction

Educational seismology networks across Europe (and worldwide) encourage schools to develop an interest in geoscience by providing tools and resources to enable students to study data from recent earthquakes. This provides a relevance and excitement to their education, which is hard to match in other scientific fields. The data that schools access and analyse can be from simple (or more sophisticated) sensors that they install in their own school or from professional seismic observatories that make their data available on the internet in an accessible and timely manner.

## Source and download reference

Links to the software developed under this workpackage are maintained at the websites of European and US international seismology datacentres

<https://Seiscode.iris.washington.edu>

[http://www.orneus-eu.org/software/seismo\\_softwarelibrary.html](http://www.orneus-eu.org/software/seismo_softwarelibrary.html)

with software downloads and source code available directly from

<http://alomax.free.fr/projects/eduseis/ws/dist/>

<http://alomax.free.fr/projects/java/>

<http://alomax.free.fr/seisgram/SeisGram2K.html>

## Description of the School Seismology Web-service

The following documentation describes how to use the School Seismology Webservices built for the NERA WP8 by E. Pritchard of the CNRS Geoazur and A. Lomax of Alomax Scientific.

These web-services give access to school seismology data and event and station information. A first implementation for the French Sismo at school program ("SISMOS à l'Ecole" <http://www.edusismo.org/>) provides data that is event linked, data can only be retrieved within windows from several minutes before to several minutes after a seismic event and the school catalog.

The School Seismology Webservices include 4 "services" : availability, station, event, timeseries that will be detailed in full in this document. The functions are built to match the basic functions of the IRIS Edu webservices (<http://www.iris.edu/ws/>).

A 1<sup>st</sup> version of a URL builder to aid in constructing School Seismology web services requests has been created by Alomax Scientific <http://alomax.free.fr/projects/eduseis/ws/builder/>. It will be redeployed to a location on the Edusismo servers soon.

A technical description of the webservice functions can be viewed at [http://alomax.free.fr/projects/eduseis/ws/dist/Documentation\\_School\\_Seismology\\_Webservices\\_Edusismo.pdf](http://alomax.free.fr/projects/eduseis/ws/dist/Documentation_School_Seismology_Webservices_Edusismo.pdf)

A technical description of how to install the webservice tools onto your own database server can be viewed at [http://alomax.free.fr/projects/eduseis/ws/dist/Installation\\_School\\_Seismology\\_Webservices\\_Edusismo.pdf](http://alomax.free.fr/projects/eduseis/ws/dist/Installation_School_Seismology_Webservices_Edusismo.pdf)

## Description of Enhancements to the data analysis software SeisGram2K

Seisgram2K has been modified for enhanced use in schools and is available with menu options in English, French, Italian, Portuguese and Turkish. This software is distributed freely under the terms of the Gnu General Public Licence. It is written in the JAVA language and can be run either as a standalone application or installed on a webserver and accessed as a Java applet through any java enabled web-browser.

Attached are the Seisgram2K guidelines. The chapters indicating (NERA) refer developments done in the context of NERA. Urrently, the guidelines are also available electronically at: [http://alomax.free.fr/seisgram/beta/SG2K\\_School\\_Users\\_Guide.pdf](http://alomax.free.fr/seisgram/beta/SG2K_School_Users_Guide.pdf)

# SeisGram2K-School Users Guide



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Supported by NERA-Seismology@School, EC FP7 grant n° 262330. 

15 Jan 2015

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# The SeisGram2K Program

## Overview

The SeisGram2K Seismogram Viewer is a Java program for interactive viewing of earthquake seismogram traces locally or over the Internet.

SeisGram2K displays one or more sets of single trace or 3-component seismograms. The viewer supports: zooming, scaling and transformation of the seismograms; rotation of horizontal component traces; time and amplitude picking; animated, 3D particle motion display; time-domain integration and differentiation; interactive spectral and spectrogram displays; frequency-domain filtering, instrument removal and other processing; and much more.

SeisGram2K displays trace channels in one or more "trace-group" windows. Each trace-group window displays all of its traces with identical time and amplitude scales.

Most viewing and processing operations act on all traces in a trace-group. A trace-group may contain one or more channels from one or more stations or instruments. For trace-groups containing an orthogonal, three-component set of channels from a unique site, the rotation of horizontal components, an animated particle motion view, and a set of multi-component analysis tools are available.

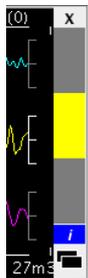
## Basic Interactive Viewing

### Seismogram Group View

Zooming:	Press the left mouse button and drag the mouse slowly over the middle trace to form a zoom window. Release the left mouse button to apply the zoom.
Changing the Time Window:	Roll the mouse wheel, or click the left mouse button on the seismogram at two times (second after the first) to rescale the time window.
Resetting the Time Window:	Click the left mouse button at two times (second before first) to reset to the initial time window.
Selecting the Active Trace and Trace-Group:	Click on an inactive trace-group to select it as the active group. Click on one of the vertical bars to the right of the traces to select the active trace and trace-group.
Active Trace and Trace-Group operations:	See Seismogram Group View below.
Keyboard operations (active only when mouse focus is in a trace-group window):	Press the PageUp / PageDown buttons to change the active trace-group. Press the UP / DOWN arrow buttons to increase / decrease the amplitude of the traces in the active trace-group Press the LEFT / RIGHT arrow buttons to shift the time window to the left or right

Press the HOME / END increase / decrease the width of the time window for the traces in the active trace-group

## Seismogram Group Toolbar



X	close seismograms
<vertical bars on right>	selects a trace in the seismogram group
	display the station and event information for the currently selected seismogram trace
	create a copy of the current seismogram trace-group truncated in time at its current viewing window

## Menus

### File Menu

Select File...	open seismogram files on the local file system
Open Web Location...	specify seismogram files on the Internet
Open SeedLink...	create a connection to a SeedLink server and display specified seismograms
Open Bud dir...	browse for IRIS-Bud directory seismogram files locally or over the Internet
Close Active	close currently selected seismograms
Close All	close all seismograms
Save Active As...	save selected seismograms to disk
Duplicate Active	create a copy of the currently selected seismograms in the viewing window
Reset Active	reset currently selected seismograms to their initial state
Print...	print all visible seismograms
Snapshot	save an image of the entire viewing window
Exit	close the viewing window and exit the program

### View Menu

Spectrum	open a spectral view (amplitude vs. frequency) for the selected trace
Spectrogram	open a spectrogram view (frequency vs. time) for the selected trace
Helicorder	display seismograms in multi-line, helicorder mode
Seismogram info	display the station and event information for the selected seismogram
Number trace groups...	set the maximum number of trace groups to display before scrolling
Full Window	toggles display of the selected seismograms in the full SeisGram2K window

Align time to... Active	align all seismograms to the time window of the selected seismogram
Align time to... Global	align all seismograms within a time window encompassing all seismograms
Lock Alignment	keep current seismogram time alignment during seismogram analysis
Full Window	display only the selected seismograms in the full viewing window
Viewing Toolbar	toggle the visibility of the viewing tools (amplitude, time alignment ...)
Analysis Toolbar	toggle the visibility of the analysis tools (pick, filter ...)
Message Window	toggle the visibility of the message window
Enable Expert Mode	enable/disable expert features of SeisGram2K (Rotate, Travel-time, ...)
Invert Colours	toggles seismogram colours between normal and inverted colours
Grey Scale	toggles seismogram colours between coloured and greyscale

## Utilities Menu

Language...	change the language of the user interface (English, French or Italien)
Header Editor	edit the station and event information for the currently selected seismogram
Enable Travel Time	enable display of theoretical phase arrivals (PREM Earth model)
EduCarte	open EduCarte at <a href="http://www.edusismo.org">www.edusismo.org</a> in your browser

## Help Menu

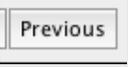
Help	display the program help information
About SeisGram2K	display the program information
Update	open on-line program support page at <a href="http://www.edusismo.org">www.edusismo.org</a> in your browser

## Principal Toolbars

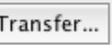
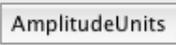
### Viewing Toolbar



	increase or decrease the signal amplitude
	decrease or increase the time window width
	move backwards or forwards in time

	reset currently selected seismograms to their initial time and amplitude windows
	display currently selected seismograms with their previous time and amplitude windows
	align all seismograms within a time window encompassing all seismograms
	lock or unlock seismogram time alignment
	align signal amplitudes to the maximum visible amplitude
	display the selected seismograms or all seismograms in the full viewing window
	reset selected seismogram to its initial state (undo all)
	tools to estimate the epicentral distance: Hodo-local for a local earthquake (distance < 300km), or Hodo-tele for a distant earthquake (regional or teleseismic, distance > 300km)
	display theoretical phase arrival times for certain seismic wave types (PREM Earth model)
	open EduCarte at <a href="http://www.edusismo.org">www.edusismo.org</a> in your browser

## Analysis Toolbar

					
Pick...	open pick toolbar: pick in time seismic phases and other features on the seismograms				
Filter...	open filter toolbar: filter the selected seismograms within a specified frequency window (Hz)				
Transfer...	open transfer toolbar: convert selected seismograms from one instrument type to another				
Spectrum	open a spectral view (amplitude vs. frequency) for the selected trace				
Spectrogram	open a spectrogram view (frequency vs. time) for the selected trace				
AmplitudeUnits	convert displayed amplitudes from instrument units to ground motion units for the selected trace				

## Pick Toolbar

						
-------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------

<input type="button" value="P"/> <input type="button" value="S"/> <input type="button" value="Other"/>	pick at current cursor position P and S seismic phases and other features on the seismograms
<input type="button" value="Del All"/> <input type="button" value="Del Prev"/>	delete all picks or the previous pick

## Filter Toolbar

Filter: Low Freq:  Hz High Freq:  Hz

Low / High Freq:	set the filter frequency window (Hz)
Apply	filter the selected seismograms with the specified frequency window

## Transfer Toolbar (NERA)

Transfer:  FROM:  Gain  T (sec)  Damping  TO:  Gain  T (sec)  Damping

Apply	apply the conversion with specified FROM and TO transfer functions for selected seismograms
FROM:	sets transfer function (instrument type, gain, period and damping) of currently displayed seismogram
TO:	sets transfer function (instrument type, gain, period and damping) of desired transformed seismogram

## Rotate Toolbar

Rotate: Angle:

Angle:	set the rotation angle of the Y trace in degrees clockwise from North
<buttons>	Increment the rotation angle the specified number of degrees

## Phases Toolbar

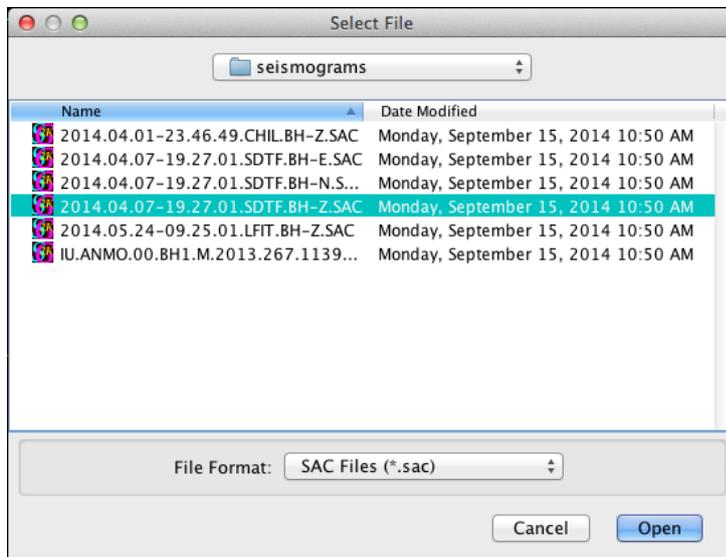
Phases: To: h   m   s   D: deg   h: km

To: (h, m, s)	Sets the origin time (To) for the event
D:	Sets the distance from the event to the station
H:	Sets the depth of the event
Options...	Displays the Theoretical Phase Arrival Dialogue
SaveAsPicks	Convert the theoretical arrivals to picks which can be edited using the Pick Toolbar
Ray Info	Displays information on the ray (path through the Earth) for each displayed phase

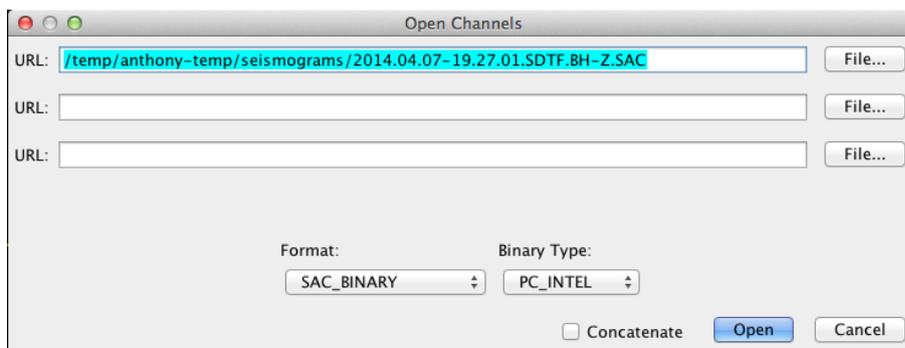
## Dialogues

### Select File Dialogue

Select one or more files to open in two steps. First, select a file format filter, the directory and a file or files to open, and press Open:



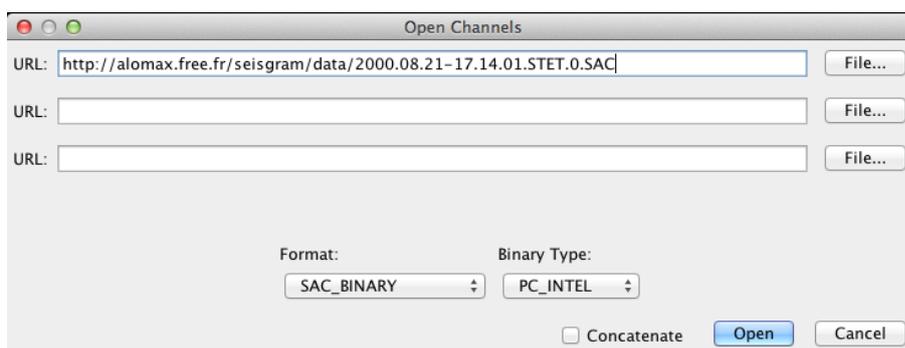
Second, confirm the file URL's, file format and binary type and press Open.



Use the “concatenate” button to combine a sequential set of data files into one seismogram trace.

### Open Web Location Dialogue

Enter one or more data file URL's, confirm the file format and binary type and press Open.



Use the “concatenate” button to combine a sequential set of data files into one seismogram trace.

## Open SeedLink Dialogue (NERA)

The Open SeedLink dialog allows specification of a connection to a SeedLink Server to open one or more seismogram channels for real-time display in SeisGram2K SeedLink Monitor. In the main, “SeedLink Server” panel of the dialog, choose a server hostname and port, and then, sequentially, the desired network, station, location and channel codes. For some servers SeisGram2K will provide a pull-down list of available choices for these codes, otherwise, you must enter accurately a server hostname and port, and the network, station, location and channel codes. You can also enter the window length to display and several options controlling the scaling, labelling and processing of the data.

Open a SeedLink Monitor connection

SeedLink Server SeedLink View Options

Connection (-seedlink):

Server hostname and port (ex: rtserve.iris.washington.edu:18000):  (-seedlink->hostname:port)

Network code (ex: IU, GE, MN):  (-seedlink->network)

Station code (ex: ANMO, RUSF, AQU, \*):  (-seedlink->station)

Location code (ex: , 00, 01):  (-seedlink->location)

Channel code (ex: BHZ, BH?, LPZ):  (-seedlink->channel)

Window length in seconds (ex: 3600):  (-seedlink->>windowLength(sec))

Options:

Minimum peak-Peak amplitude to display (ex: 5000):  (-seedlink->minPeakToPeakAmplitude)

Maximum peak-Peak amplitude to display (ex: 80000):  (-seedlink->maxPeakToPeakAmplitude)

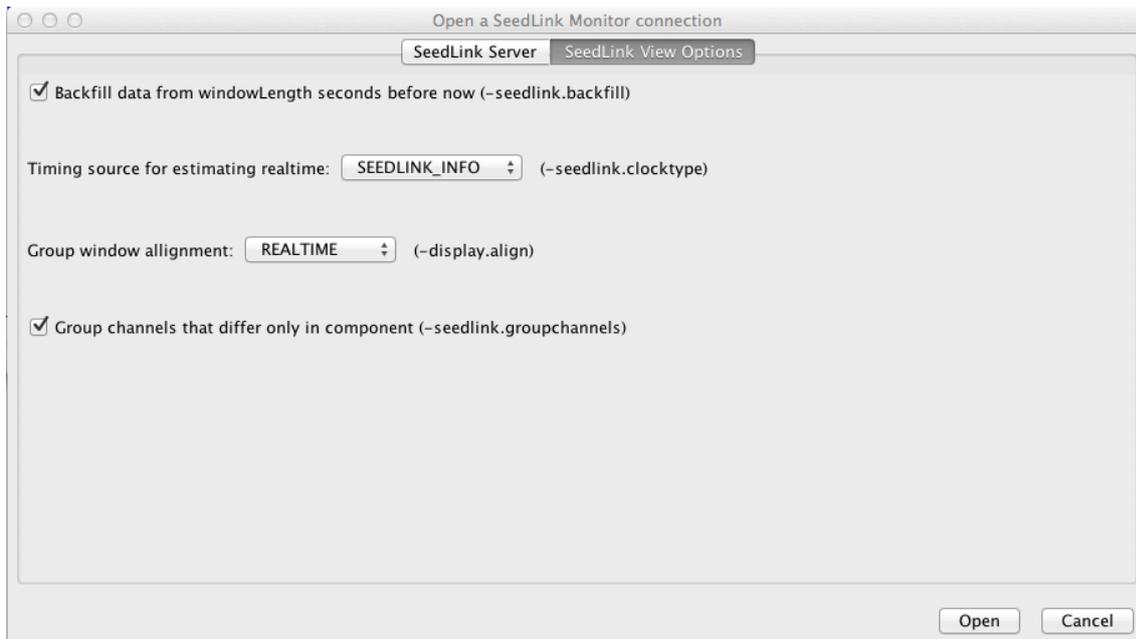
Group Title (ex: Broadband):  (-seedlink->title)

Constant multiplied into stream amplitude (ex: 4.5e-8):  (-seedlink->multiplier)

Commands to apply on data read (ex: rmean,int):  (-seedlink->commandsOnRead)

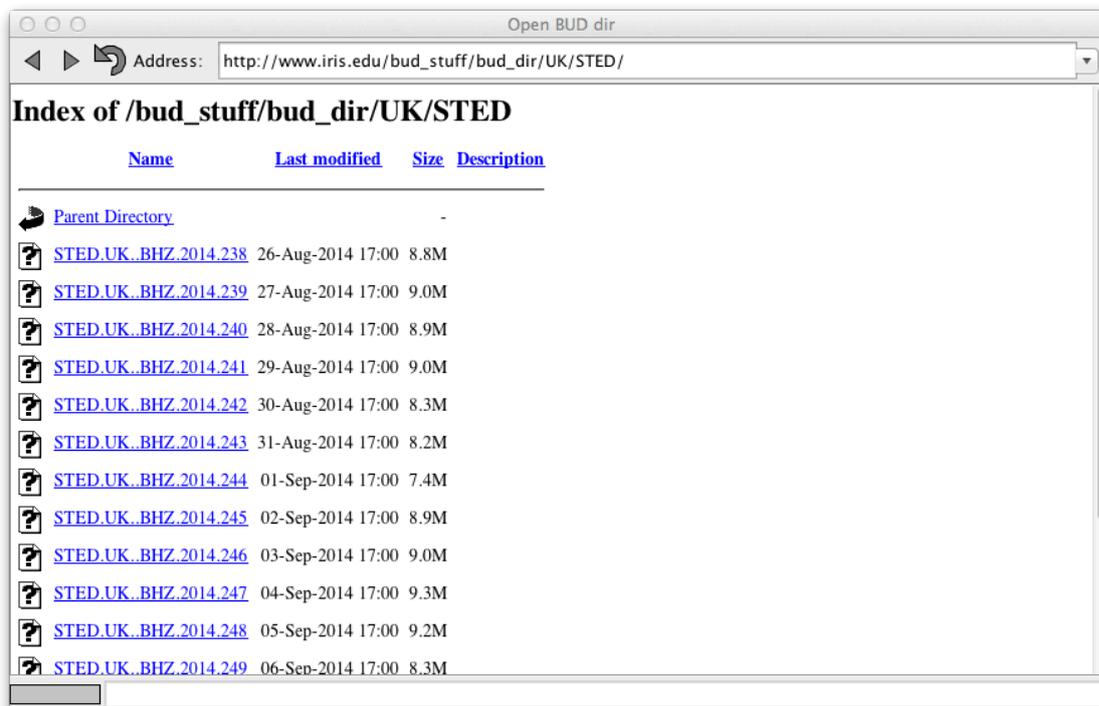
Open Cancel

The “SeedLink View Options” panel of the dialog, allows set specific SeedLink and SeisGram2K display options:

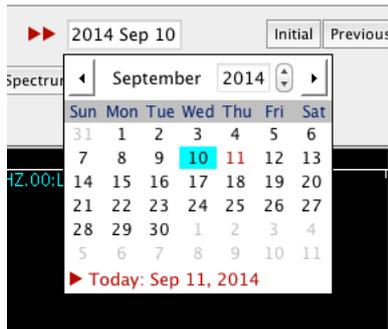


## Open Bud Dir Dialogue (NERA)

The Open Bud Dir dialog allows the browsing of an IRIS Bud format directory structure locally or over the internet.



When a seismogram trace data file is clicked, SeisGram2K loads and displays the trace data the file. You can then scroll or jump in time beyond the limits of the selected data file, and SeisGram2K will find and display the necessary data from the available data in the Bud directory. SeisGram2K also provides a calendar tool to jump in time to display data in the Bud directory:

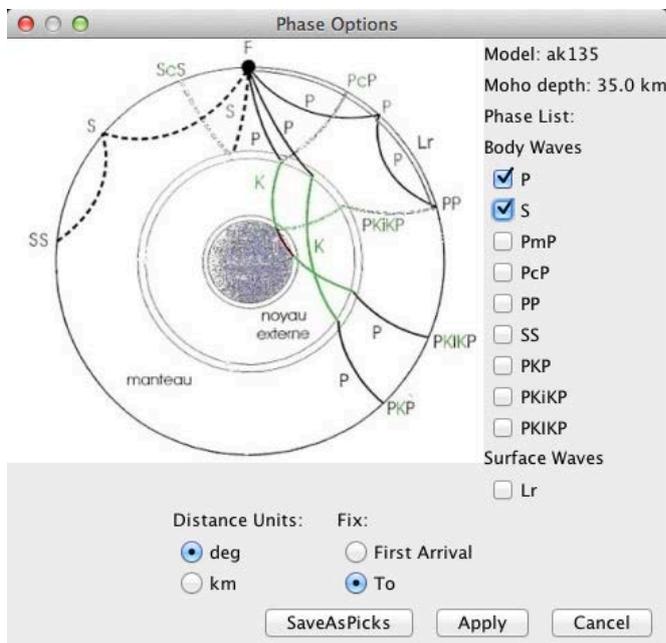


Note that the loading and update of data from a Bud directory may be slow, depending on the size of the data files, the amount of data required, and the speed of the connection to the Bud directory.

It is useful to activate Helicorder view mode when large time windows (e.g. several hours or more) of data from a Bud directory is displayed.

## Theoretical Phase Arrival Dialogue

Use this dialogue to select the theoretical phase types to display on the seismograms:



Select one or more body or surface wave phase types to display on the seismograms. Select the Distance Units for the Phases Toolbar and if the time of the First Arrival or the origin time (To) is fixed when changes are made in the Phases Toolbar. Press Apply to display the theoretical arrivals on the seismogram. Press SaveAsPicks to convert the theoretical arrivals to picks which can be edited using the Pick Toolbar.

## Header Editor Dialogue

Use the header editor to edit the header information for individual seismogram trace and trace-group:

The screenshot shows a 'Header Editor' dialog box with the following fields and checkboxes:

Field	Value	Apply to all traces in group
Network:	AG	<input checked="" type="checkbox"/>
Station:	SDTF	<input checked="" type="checkbox"/>
Station Latitude:	43.986	<input checked="" type="checkbox"/>
Station Longitude:	7.555	<input checked="" type="checkbox"/>
Station Elevation (m):	750.0	<input checked="" type="checkbox"/>
Instrument:	NOEMAX	<input checked="" type="checkbox"/>
Channel:	BHZ	<input type="checkbox"/>
Component:	Z	<input type="checkbox"/>
Comp Azimuth:	0.0	<input type="checkbox"/>
Comp Inclination:	0.0	<input type="checkbox"/>
Event Name:	FRANCE	<input checked="" type="checkbox"/>
Event Origin Time:	2014.04.07,19.27,0.998	<input checked="" type="checkbox"/>
Event Latitude:	44.57	<input checked="" type="checkbox"/>
Event Longitude:	6.62	<input checked="" type="checkbox"/>
Event Depth (km):	179,769,313,486,231,...	<input checked="" type="checkbox"/>
Distance (km):	98.891	<input checked="" type="checkbox"/>
Distance (deg):	0.888	<input checked="" type="checkbox"/>
Azimuth (deg):	131.102	<input checked="" type="checkbox"/>
Back Azimuth (deg):	-48.898	<input checked="" type="checkbox"/>
Magnitude:	-9.9	<input checked="" type="checkbox"/>

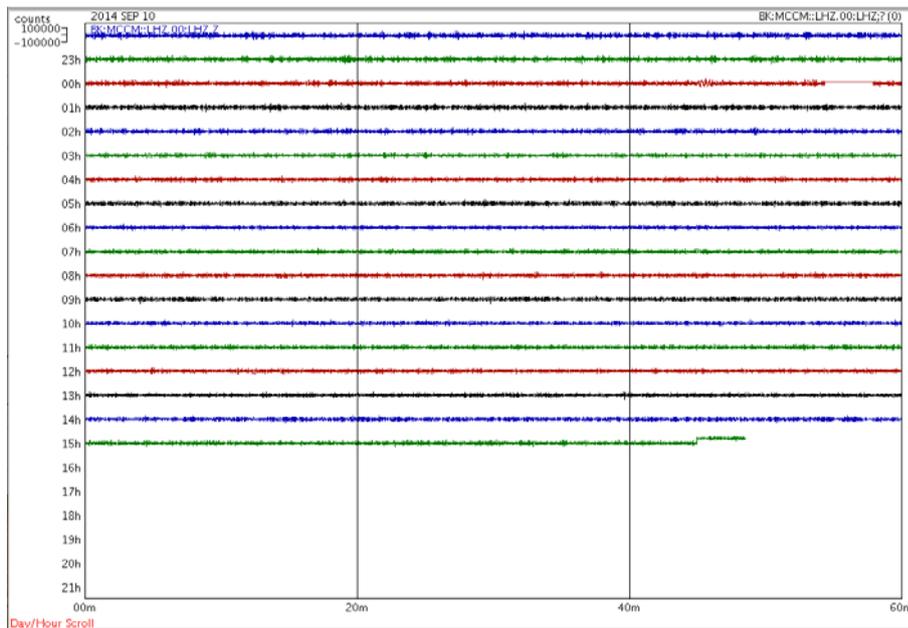
Buttons: Save, Cancel

Select “Apply to all traces in group” to make changes for all seismogram traces in the active trace-group.

## ***Additional View Modes***

### **Helicorder View Mode (NERA)**

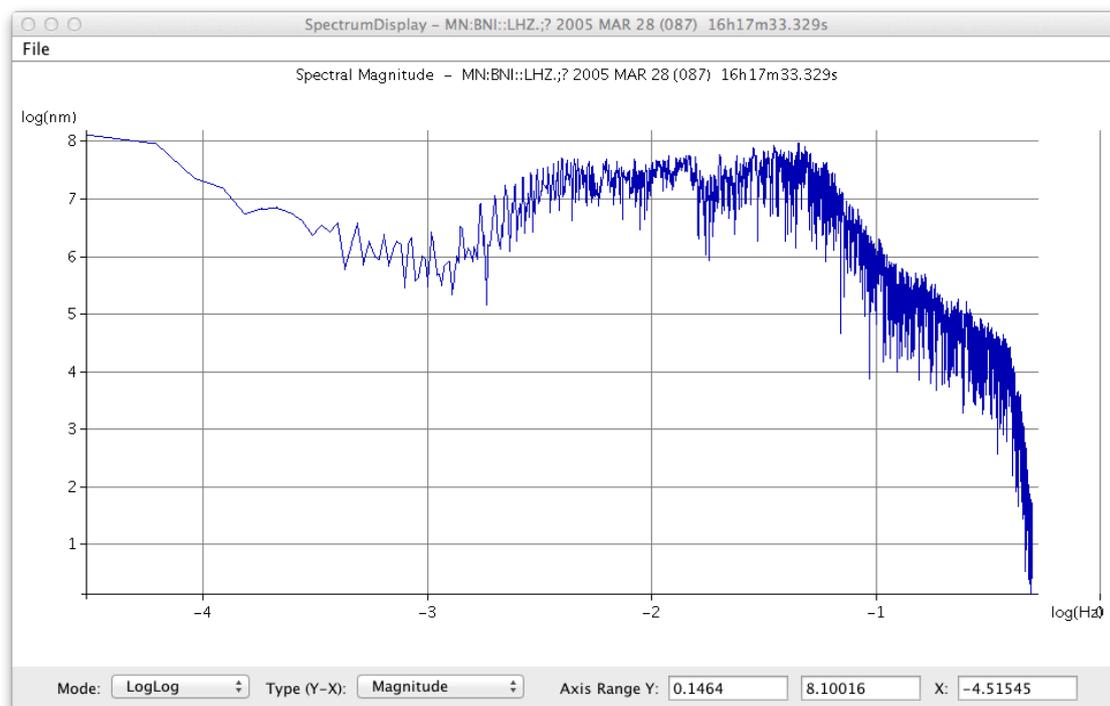
In this mode, the available seismogram data in each trace-group is displayed in 24 rows of one hour each, representing 1 day of data, much like a traditional, paper, “helicorder” seismogram. Helicorder view mode is useful when large time windows of data are displayed.



Many standard SeisGram2K mouse and toolbar viewing and analysis tools can be applied in Helicorder view model. When the data is windowed or zoomed to an interval much less than 1 day, the display automatically returns to standard view mode so the seismogram can be more easily analysed. Returning to a larger window of data automatically restores Helicorder view mode.

## Spectrum Analysis View Mode

When Spectrum view is selected, a new window with a spectral display for the selected seismogram is displayed.



The spectral display by default shows the magnitude of the amplitude (Y axis) of each frequency component (X axis) in the displayed seismogram window. Other

types of display for the Y axis are: signal phase, real component, imaginary component, and spectral density. The Spectrum View Toolbar provides options for the type and presentation of the display.

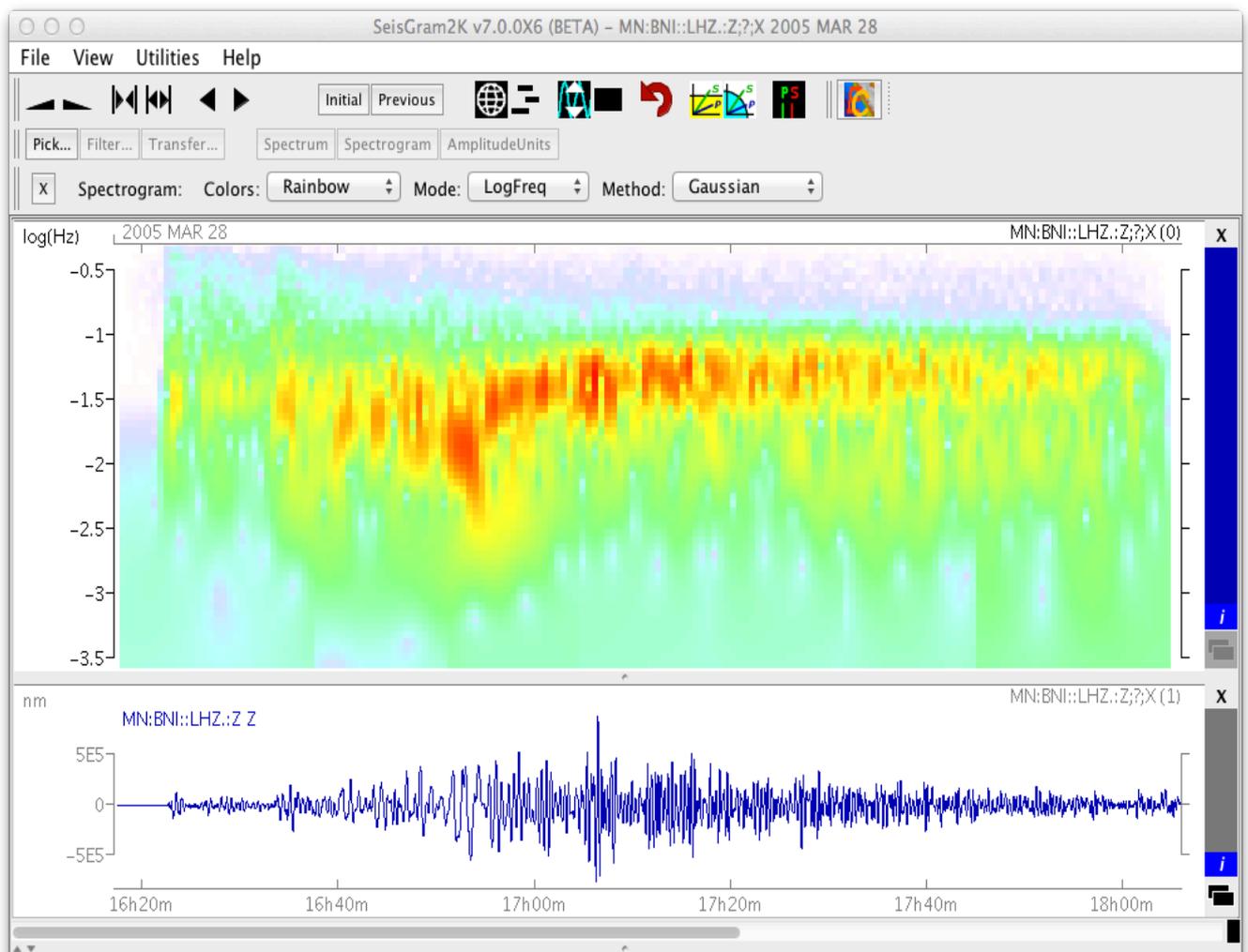
### **Spectrum View Toolbar**

Mode:  Type (Y-X):  Axis Range Y:   X:

Mode:	sets the spectrum display mode (linear or logarithmic frequency and time binning)
Type:	sets the quantity to display on the Y axis
Axis Range Y/X:	sets the minimum and maximum range for the Y and X axes

### **Spectrogram Analysis View Mode (NERA)**

When Spectrogram view is selected, a new window with a spectrogram display and the selected seismogram is displayed. The spectrogram and seismogram are aligned in time (X axis), and many standard SeisGram2K mouse and toolbar viewing and analysis tools can be applied.



The spectrogram display shows the signal amplitudes as a colour intensity plotted as a function of time (X axis) and frequency (Y axis). The Spectrogram Toolbar provides options for the type and presentation of the display.

### ***Spectrogram Toolbar***

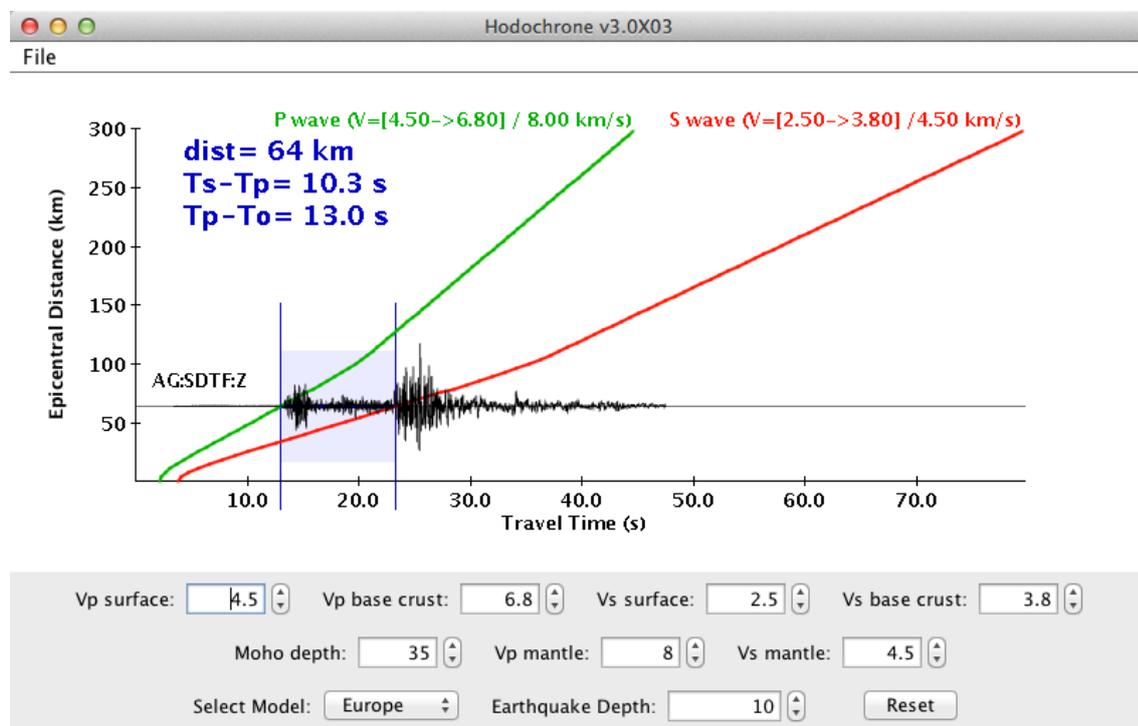


Colors:	sets the spectrogram colour palette
Mode:	sets the spectrogram display mode (linear or logarithmic frequency binning)
Method:	sets the spectrogram, narrow-band frequency filtering algorithm (Gaussian: non-causal Gaussian filter; Butterworth: causal filter; Amplitude: non-causal filter)

## Additional Tools

### Hodochrone Travel-time Graph (NERA)

The Hodochrone travel-time graph allows interactive matching of observed wave arrival energy with theoretical phase travel-times for a specified seismic wave velocity model:



The tool shows, for standard wave types (e.g. P and S), curves of predicted travel-times after the origin time of an earthquake at a range of epicentral distance from the earthquake source. The seismograms from the active trace-group are plotted over the travel-time curves, and can be positioned over the travel-time curves with the mouse to match arrival energy on the seismograms to the travel-time curves. The corresponding distance of the station from the earthquake epicentre, and the differential travel-times  $T_s - T_p$  and  $T_s - T_o$  are displayed.

In Hodochrone for local events, which uses a flat-layered velocity model, the parameters of the velocity model and the earthquake depth can be adjusted interactively in the dialogue below the graph.

In Hodochrone for distant, teleseismic events, which uses a spherical-Earth velocity model, the earthquake depth can be adjusted interactively in the dialogue below the graph, and the displayed wave types can be selected to the right of the graph:

