USGS
science for a changing world

PRISM Software—Processing and Review Interface for Strong-Motion Data

Rapidly available and accurate ground-motion acceleration time series (seismic recordings) and derived data products are essential to quickly providing scientific and engineering analysis and advice after an earthquake. To meet this need, the U.S. Geological Survey National Strong Motion Project has developed a software package called PRISM (Processing and Review Interface for Strong-Motion data). PRISM automatically processes strong-motion acceleration records, producing compatible acceleration, velocity, and displacement time series; acceleration, velocity, and displacement response spectra; Fourier amplitude spectra; and standard earthquake-intensity measures. PRISM is intended to be used by strong-motion seismic networks, as well as by earthquake engineers and seismologists.

What Is PRISM?

PRISM (Processing and Review Interface for Strong-Motion data) is a software package developed by the U.S. Geological Survey (USGS) National Strong Motion Project. Robust, automated earthquake ground-motion data processing is essential for generating corrected ground-motion acceleration time series (seismic recordings) and derived data products needed for immediate use by seismologists and earthquake engineers after an earthquake.

PRISM automatically processes raw ground-motion acceleration records to generate data products that include corrected acceleration, velocity, and displacement time series; acceleration, velocity, and displacement response spectra; Fourier amplitude spectra; and standard earthquake-engineering intensity measures (fig. 1). PRISM is integrated into the USGS Advanced National Seismic System Quake Monitoring System (AQMS), which processes earthquake recordings from seismic networks in real-time to calculate earthquake locations, magnitudes, and mechanisms and produce ShakeMaps (automatically generated maps of earthquake shaking).

PRISM uses widely accepted methods for processing strong-motion records and related quality-control assessments. The software package consists of two applications—(1) the PRISM record-processing engine for automatically processing a large number of records and (2) a review tool that is an interactive graphical user interface (GUI) for visually inspecting, editing, and processing individual records. The automated processing engine and the review tool share a common processing core library to ensure computational consistency between the applications. The processing core library tracks parameters used in each of the processing steps and embeds them in

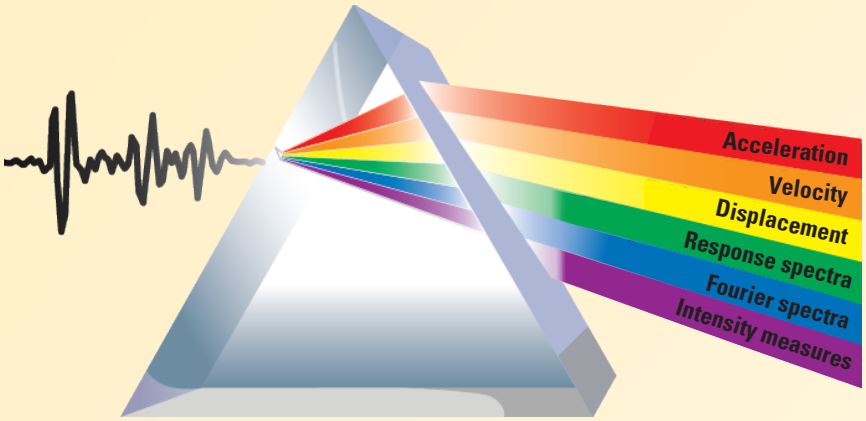

Figure 1. Like an optical prism splitting light into different colors, this illustration conceptually shows the earthquake ground-motion data components that PRISM (Processing and Review Interface for Strong-Motion data) software automatically generates from raw strong-motion acceleration records. These data components include corrected acceleration, velocity, and displacement time series; acceleration, velocity and displacement response spectra; Fourier amplitude spectra; and standard earthquake-intensity measures.

U.S. Department of the Interior
U.S. Geological Survey

Techniques and Methods 12–A2
December 2017

the metadata of the PRISM data products to ensure the ability to replicate the processed record from the original input.

PRISM is written in the Java programming language. It is open source and is easy to install and run as stand-alone software on common operating systems, such as Linux, Mac OS X, and Windows (version 7 or later). Inputs to PRISM are currently limited to single-component data files in the COSMOS (Consortium of Organizations for Strong-Motion Observation Systems, 2001) volume 0 (V0) data format. Output products are COSMOS volume 1, 2, and 3 (V1, V2, and V3) files.

The PRISM Processing Engine

The PRISM processing engine is an application that can be run from the command line or executed within a larger system such as AQMS to automatically process many strong-motion records. The main features of the processing engine are:

- Platform-independent, extensible, open-source software that processes strong-motion records using customizable parameters specified in a configuration file to automatically (1) resample in frequency domain; (2) pick phase-arrival time and maximum amplitude; (3) demean, integrate, and differentiate in time domain; (4) perform acausal bandpass filtering; (5) make baseline correction; and (6) generate data products that include compatible acceleration, velocity, and displacement time series; response spectra; Fourier amplitude spectra; and standard earthquake-engineering intensity measures.
- Log files created for (1) tracking of data products, (2) summaries of critical record parameters, and (3) quality control.

PRISM's automated workflow (Jones and others, 2017a,b) has been verified by extensive testing (Kalkan and Stephens, 2017) and uses a set of conservative processing parameters for generating COSMOS V1, V2, and V3 data products. The processing includes quality-assurance steps to flag particular records that require further review by analysts.

Figure 2 shows an example of the final suite of acceleration, velocity, and displacement time histories (V2 products) generated by PRISM for a low-amplitude ground-motion record from the 2014 moment-magnitude-6.0 South Napa, California, earthquake. The pseudospectral acceleration, pseudospectral velocity, and displacement response spectra (V3 products) generated by PRISM for this record are shown in figure 3.

The PRISM Review Tool

The PRISM Review Tool is a desktop application that provides an interactive GUI for visually inspecting, editing, and processing COSMOS V1 data to create corresponding new or replacement V2 and V3 data products. The tool shares the same processing core library as the PRISM processing engine for data processing and for generation of COSMOS data products.

The main interface of the PRISM Review Tool (fig. 4) provides a standard menu and toolbar options for performing common tasks, including setting application preferences, loading COSMOS files, generating plots, navigating generated plot sets, and editing. The interface comprises several panels, including the Node Explorer, Content Area, Properties, and Status. The Node Explorer displays a hierarchical tree structure of nodes denoting COSMOS files currently loaded into the application. The structure stratifies the nodes by event name, station code, COSMOS-file data type, and file names. The Content Area is the area in which generated plots are displayed. The viewer has two tab pages that display the Seismic Trace Viewer and Fourier Spectrum Viewer. The Properties panel displays a table of various attributes that pertain to a file that is currently selected in the Node Explorer, and the Status panel displays output messages that are generated during runtime.

Editing can be performed in either the time domain (for applying baseline corrections) or the spectral domain (for selecting bandpass-filter corners) of a selected data channel. Separate editors, named the Seismic Time History Editor and Fourier Amplitude Spectrum Editor (fig. 5), are used to perform editing and processing of seismic and spectral data, respectively.

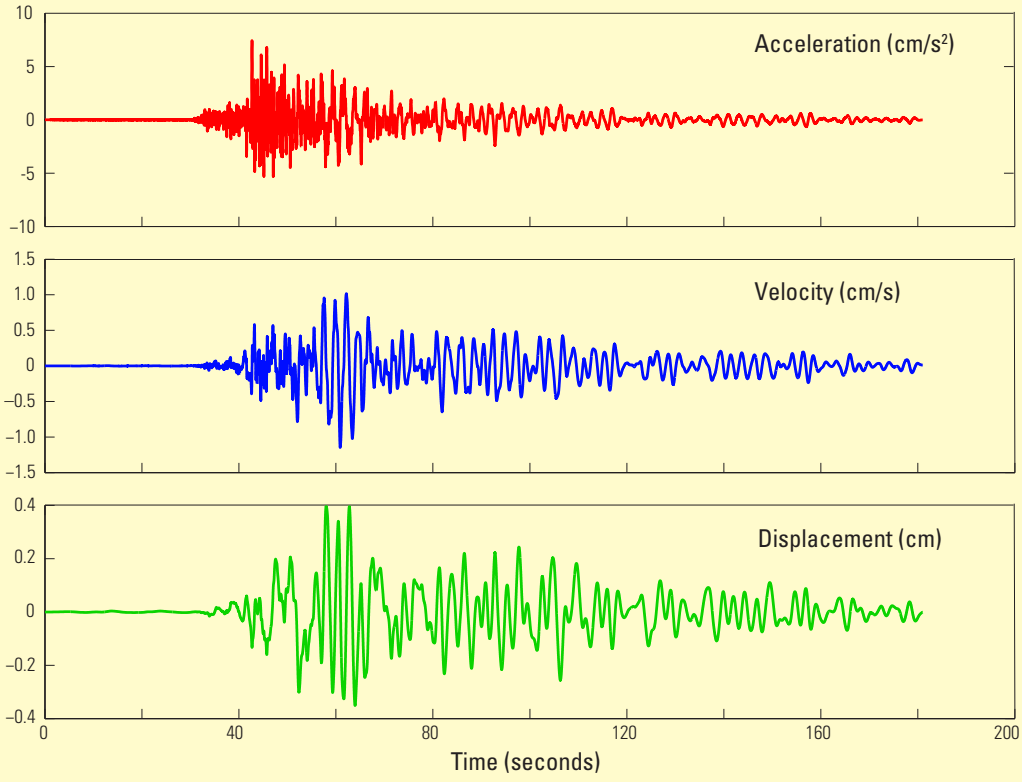

Figure 2. Graphs showing a final suite of acceleration, velocity, and displacement time series (Consortium of Organizations for Strong-Motion Observation Systems, 2001, volume-2 data products) generated by the PRISM (Processing and Review Interface for Strong-Motion data) software package. These PRISM data products were generated for a ground-motion recording (200 samples-per-second) from the 2014 moment-magnitude-6.0 South Napa, California, earthquake. cm/s^2, centimeters per second squared; cm/s, centimeters per second; cm, centimeters.

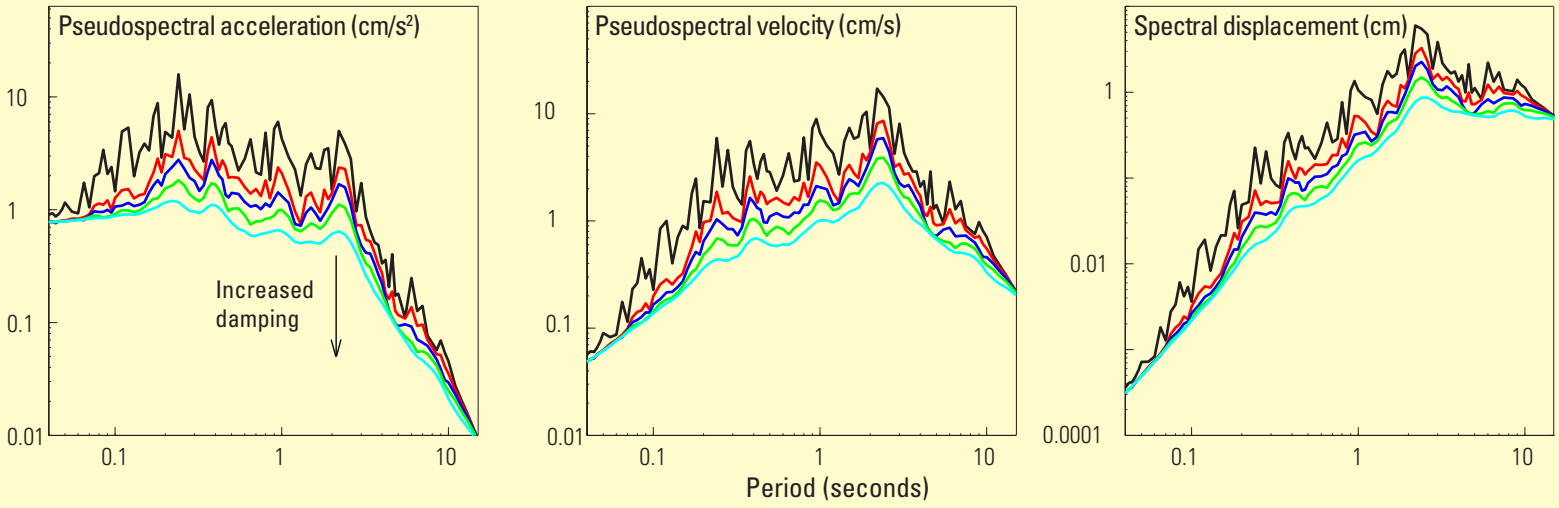

Figure 3. Graphs showing the pseudospectral acceleration, pseudospectral velocity, and spectral displacement ordinates (in Consortium of Organizations for Strong-Motion Observation Systems, 2001, volume-3 data format) at five damping levels (colored lines for 0, 2, 5, 10, and 20 percent) generated by the PRISM (Processing and Review Interface for Strong-Motion data) software package. These PRISM data products were generated for a ground-motion recording from the 2014 moment-magnitude-6.0 South Napa California, earthquake. cm/s^2, centimeters per second squared; cm/s, centimeters per second; cm, centimeters.

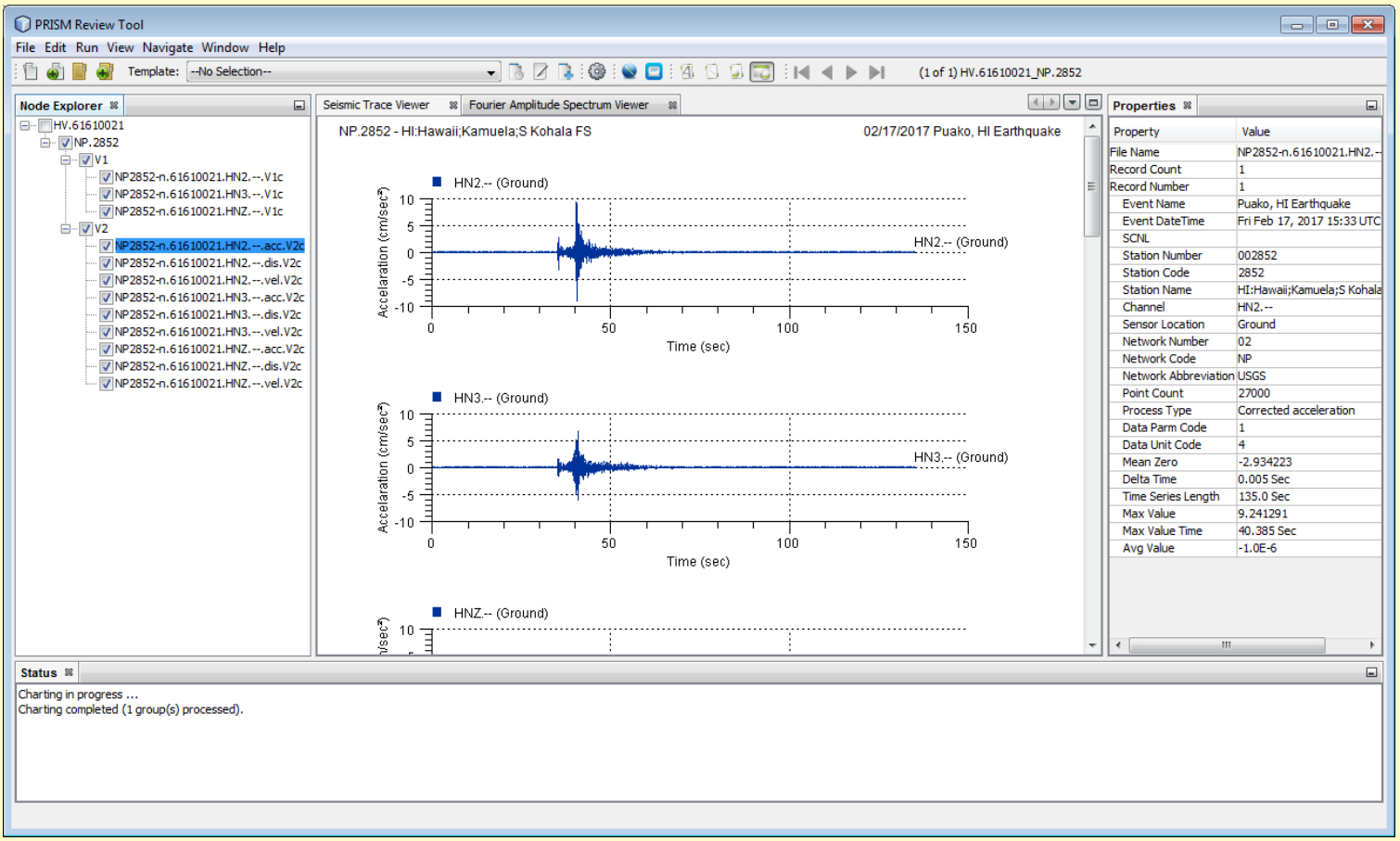

Figure 4. Screenshot of the main interface of the PRISM (Processing and Review Interface for Strong-Motion data) Review Tool. The PRISM Review Tool provides standard menu and toolbar options for performing common tasks, including setting application preferences, loading input files, generating plots, navigating plot sets, and editing.

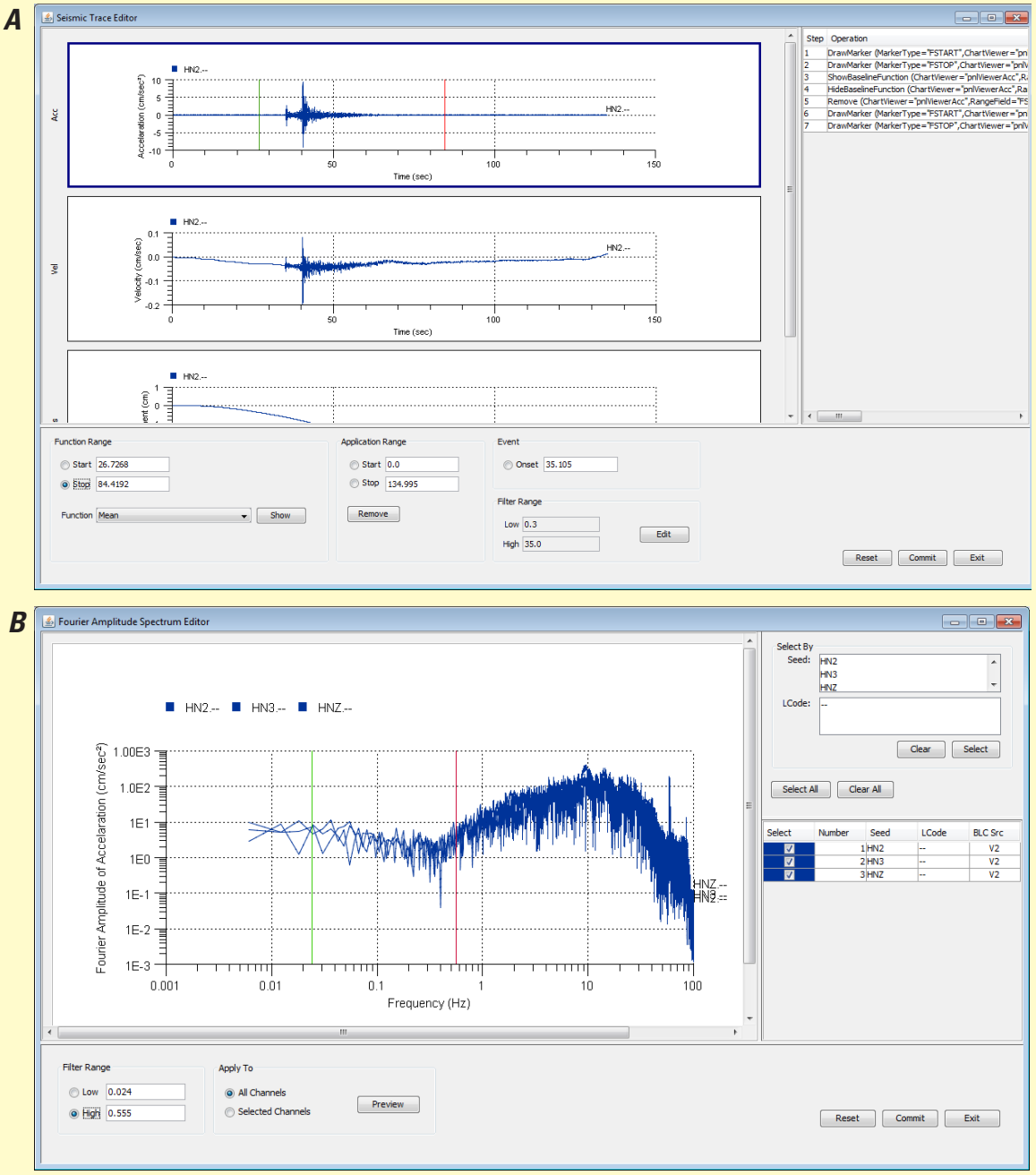

Figure 5. Screenshots of the (*A*) Seismic Time History Editor and (*B*) Fourier Amplitude Spectrum Editor of the PRISM (Processing and Review Interface for Strong-Motion data) Review Tool. The Seismic Time History Editor is used to perform editing and baseline correction of seismic-acceleration time series, and the Fourier Amplitude Spectrum Editor is used to perform bandpass filtering.

PRISM Availability and Installation

PRISM example datasets, documentation, installation requirements, and an installer are available at https://earthquake.usgs.gov/research/software/#prism. Users are encouraged to e-mail the authors—Jeanne Jones (jmjones@usgs.gov), Erol Kalkan (ekalkan@usgs.gov), Christopher Stephens (cdstephens@usgs.gov), and Peter Ng (png@usgs.gov)—for questions about PRISM.

Jeanne M. Jones, Erol Kalkan, Christopher D. Stephens, and Peter Ng

Edited by *James W. Hendley II*
Graphic design by *Cory D. Hurd*

References Cited

Consortium of Organizations for Strong-Motion Observation Systems, 2001, Strong-motion data format, version 1.20: Consortium of Organizations for Strong-Motion Observation Systems, 16 p., accessed October 16, 2017, at https://www.strongmotioncenter.org/vdc/cosmos_format_1_20.pdf.

Jones, J., Kalkan, E., and Stephens, C., 2017a, Processing and Review Interface for Strong-Motion data (PRISM)—Methodology and automated processing, version 1.0.0: U.S. Geological Survey Open-File Report 2017–1008, 81 p., https://doi.org/10.3133/ofr20171008.

Jones, J., Kalkan, E., Stephens, C., and Ng, P., 2017b, PRISM Software—Processing and Review Interface for Strong-Motion data: Seismological Research Letters, v. 88, no. 3, p. 851–866, https://doi.org/10.1785/0220160200.

Kalkan, E., and Stephens, C., 2017, Systematic comparisons between PRISM version 1.0.0, BAP, and CSMIP ground-motion processing: U.S. Geological Survey Open-File Report 2017–1020, 108 p., https://doi.org/10.3133/ofr20171020.

For more information, contact:
Earthquake Science Center
U.S. Geological Survey
Menlo Park, CA 94025
https://earthquake.usgs.gov/
Earthquake Information Hotline:
(650) 329–4085

ISSN 2328-7047 (print)
ISSN 2328-7055 (online)
https://doi.org/10.3133/tm12A2