

# Report on Progress at the Center for Engineering Strong Motion Data (CESMD)



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## **SUMMARY:**

Strong-motion data of engineering and scientific importance from the United States and other seismically active countries are served through the Center for Engineering Strong Motion Data (CESMD) at [www.strongmotioncenter.org](http://www.strongmotioncenter.org). Recently, the CESMD staff, with cooperation from colleagues at international strong-motion seismic networks, has disseminated strong-motion data from significant earthquakes that occurred in Italy, Haiti, Mexico, New Zealand, Chile, Japan, Turkey, and the United States.

The CESMD now automatically posts strong-motion data from an increasing number of seismic stations in California within a few minutes following an earthquake as an Internet Quick Report (IQR). As appropriate, IQRs are updated by more comprehensive Internet Data Reports that include reviewed versions of the data and maps showing, for example, the finite fault rupture along with the distribution of recording stations. Automated processing of strong-motion data will be extended to post the strong-motion records of the regional seismic networks of the Advanced National Seismic System (ANSS) outside California.

Transfer of the operational and maintenance responsibilities for the Consortium of Organizations for Strong Motion Observation Systems (COSMOS) Virtual Data Center (VDC) from the University of California at Santa Barbara to the CESMD is nearing completion. The VDC Tagged Format (VTF) file format has been adopted by the CESMD as the standard for converting strong motion data to facilitate the process of uploading data into the VDC database.

The CESMD now provides strong-motion records from lower magnitude ( $<M3.5$ ) and smaller amplitude ( $<0.5\%g$ ) records for use in developing ground motion prediction equations in areas with less frequent earthquakes, such as the Central and Eastern US.

*Keywords: Earthquake strong motion data, strong motion networks*

## **1. CESMD OBJECTIVES AND OPERATION**

The Center for Engineering Strong Motion Data (CESMD) collects and disseminates records of ground and structural responses to earthquake strong motions of engineering interest. It is a cooperative effort between the California Geological Survey and the U.S. Geological Survey. Within the United States the primary sources for these records are the extensive accelerograph networks operated by the USGS National Strong Motion Project nationally and the CGS California Strong Motion Instrumentation Program in California, and records are also contributed by many other local, state, and federal agencies. Increasingly, international agencies are also contributing strong-motion records from significant earthquakes that occur globally. More information about the history and background of the CESMD is given in Shakal et al., 2000, and 2003, Lin et al., 2002, Huang et al., 2004, and Haddadi et al., 2008.

The [CESMD website](http://www.strongmotioncenter.org) allows users to view and download records from recent or archived historical

earthquakes, or to search for and download records selected based on various parametric values. Currently there are two domains in which to search for data: *U.S. Structural and Ground Response* and *Worldwide Ground Response at VDC* (sponsored by COSMOS). The main differences between the holdings accessible through these two alternatives are that, for the VDC, the magnitude range is limited to greater than  $\sim M5$ , and as of the time of submitting this paper, the most recent earthquakes at VDC are from August, 2007, but it is planned to update the VDC with the recent strong-motion records later this year. The VDC is not designed for rapid response to earthquakes as it requires virtual links to the servers of the seismic networks in order to download records. The records usually are posted at VDC within a few days when data become available at the local strong-motion networks servers. As discussed below, the CESMD is in the process of revitalizing and updating the holdings of the VDC. Records from some larger earthquakes worldwide that are not yet available through the VDC can be accessed from the Internet Data Reports page (Archive) of CESMD. Unlike the VDC, rapid access to automatically processed records of recent California earthquakes is available from the Internet Quick Report of CESMD. The automatic posting of records will extend to include strong-motion records of regional seismic networks of the Advanced National Seismic System (ANSS) outside California. A future goal of the CESMD is to integrate the data holdings and search capabilities of these two domains into a single access portal.

## **2. RECENT EARTHQUAKE DATA UPLOADED TO CESMD**

The  $M_w$  9.0 Tohoku earthquake of March 11, 2011, serves as an example of the types of earthquake information and data provided at the CESMD website for recent large and damaging earthquakes. The basic page, the Internet Data Report (Figure 1), is an interactive table listing basic earthquake information and parametric values for the available records. On this page are options to view or download individual records and to view earthquake highlights, detailed earthquake information, an interactive map of stations and the earthquake rupture, and the ShakeMap for the earthquake. More detailed information about the CESMD operation and its features can be found at Haddadi et al., 2008.

On the interactive map for the Tohoku event shown in Figure 2, a red star shows the event epicenter and the red lines show the surface projection of the inferred extent of the fault rupture. Circles (for ground sites) and squares (for structures) are plotted at the station location for each available record, with the fill color corresponding to the PGA as indicated in the symbol key at the upper right. From this map one can access more detailed station information or download data for a particular station.

Other important recent earthquakes for which strong motion data are now being served from the CESMD include the  $M_w$  7.2 Sierra El Mayor earthquake in northern Mexico on April 4, 2010 (Figure 3), the  $M_w$  8.8 Maule, Chile earthquake of February 27, 2010 (Figure 4), and the  $M_w$  5.8 Virginia, United States, earthquake of August 23, 2011 (Figure 5).



Figure 1. CESMD Internet Data Report of Japan, Tohoku earthquake of March 11, 2011.

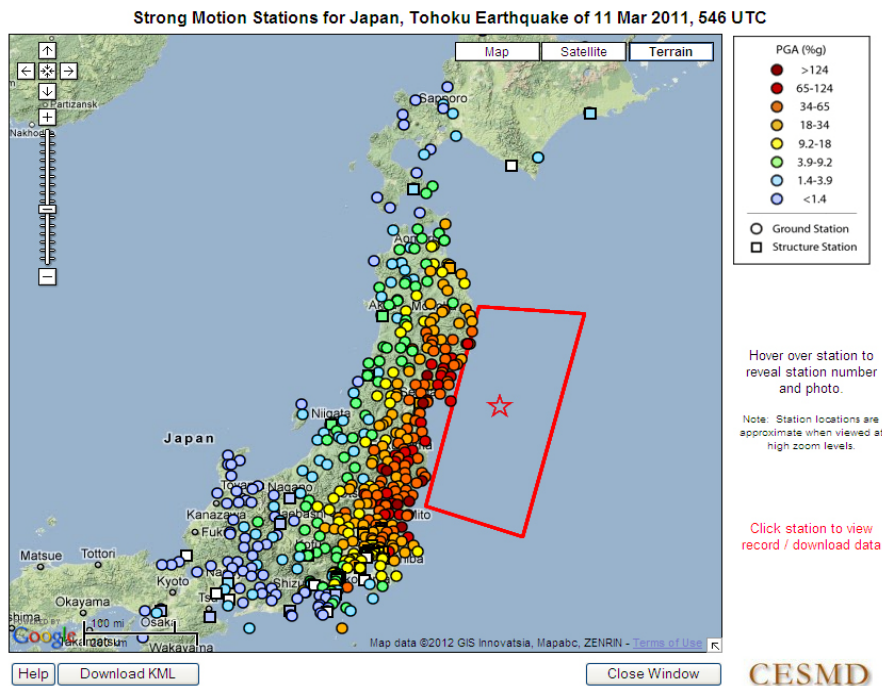
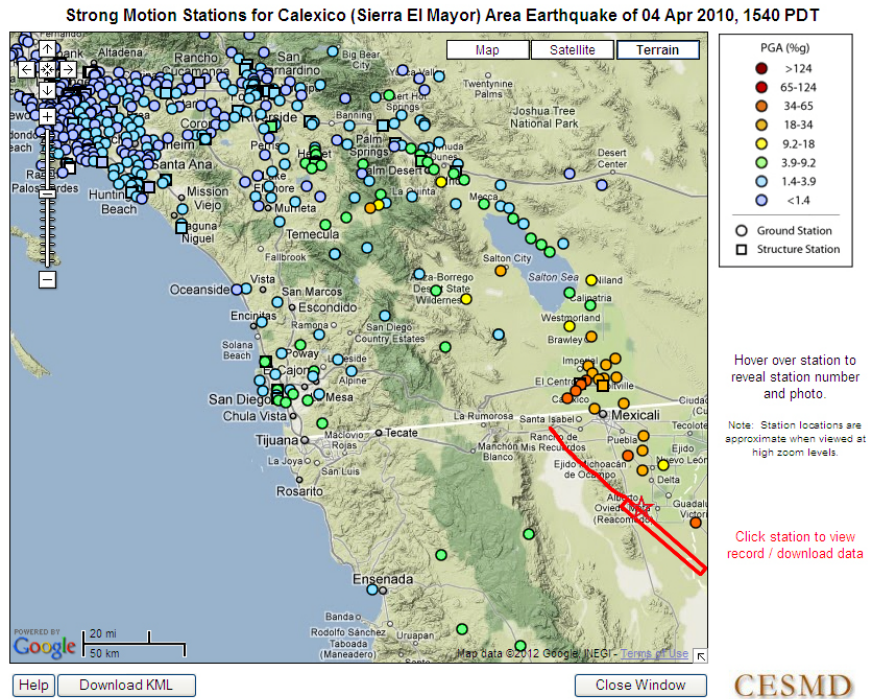
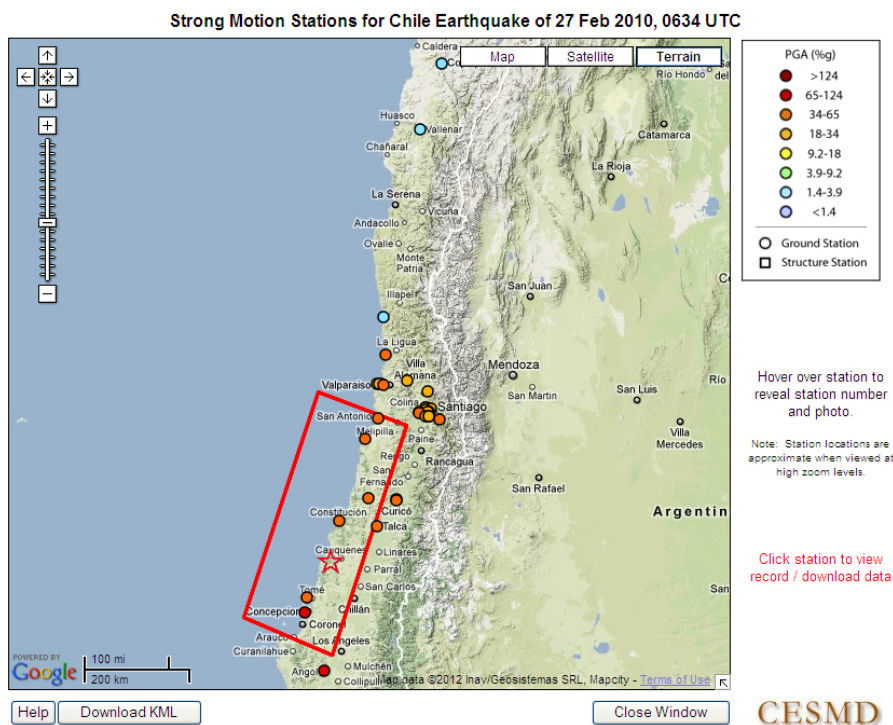


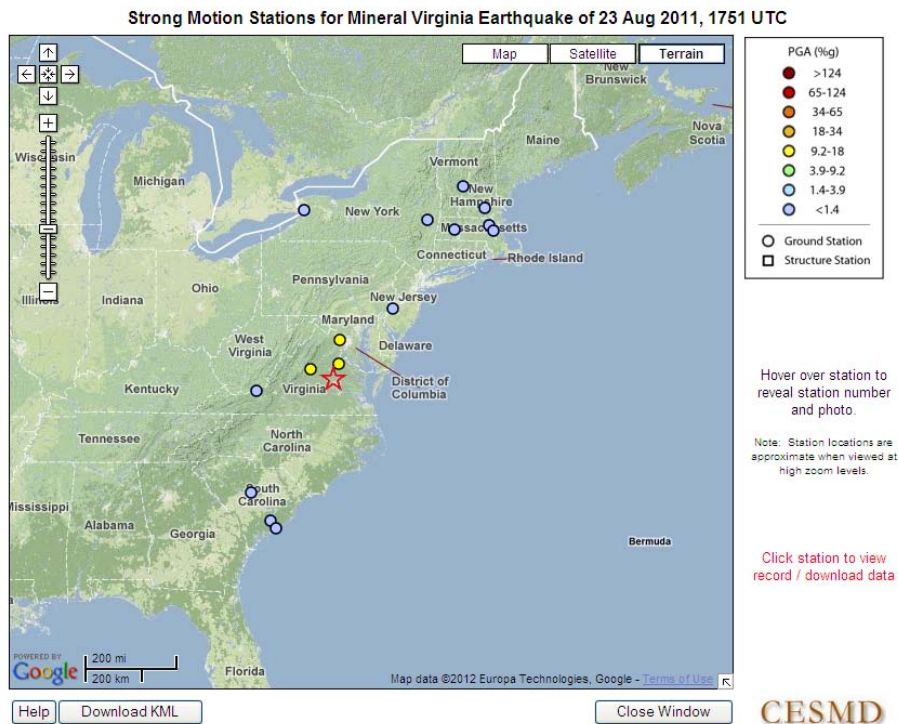
Figure 2. CESMD Interactive Map for the Japan, Tohoku earthquake of March 11, 2011.



**Figure 3.** CESMD Interactive Map for the Mw7.2 Sierra El Mayor earthquake of April 4, 2010.

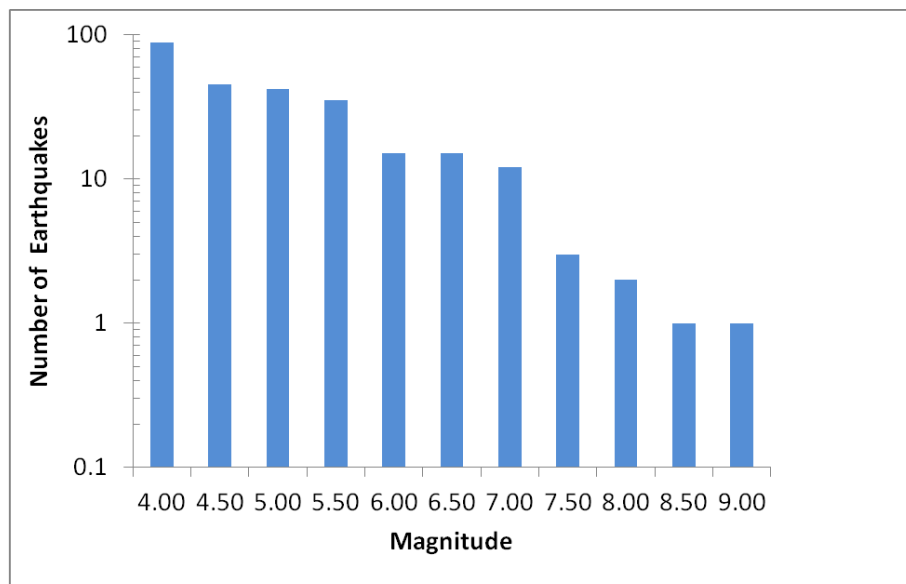


**Figure 4.** CESMD Interactive Map for the Mw8.8 Chile earthquake of February 27, 2010.



**Figure 5.** CESMD Interactive Map for the Mw5.8 Virginia earthquake of August 23, 2011.

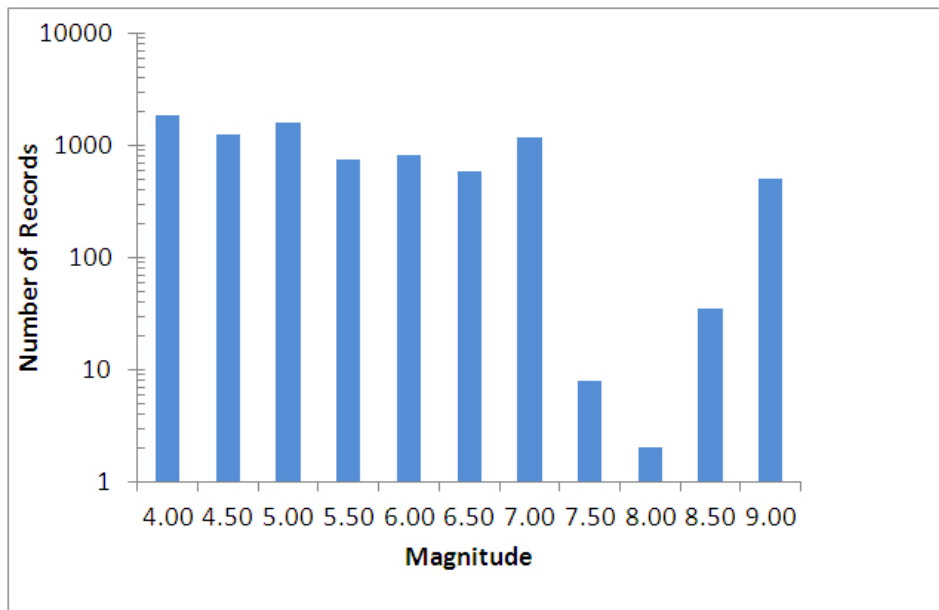
Currently, data for about 250 earthquakes of  $M \geq 4$  are being served from the CESMD, the largest being the  $M_w$  9.0 Tohoku earthquake of March 11, 2011. Figure 6 shows number of earthquakes for the magnitude intervals from  $M_{4.0}$  to  $M_{9.0}$  for which data are available in the CESMD.



**Figure 6.** Number of earthquakes in different magnitude intervals for which data are available in CESMD.



Collectively, data and metadata for about 8500 records in the magnitude range of 4.0 to 9.0 are available in the CESMD. The number of records for each magnitude interval is shown in Figure 7.



**Figure 7.** Number of records available in CESMD as a function of magnitude intervals.

### **3. CESMD AUTOMATED SYSTEM**

The California Integrated Seismic Network (CISN) partners (the California Geological Survey, the U.S. Geological Survey, the California Institute of Technology, and the University of California, Berkeley) automatically exchange strong ground-motion records from earthquakes in and near California with magnitudes of 3.3 and larger. The Center for Engineering Strong Motion Data processes the records and posts them automatically at the CESMD website after each earthquake. In general, the CESMD Internet Quick Report (IQR) pages become available to view and download records at about the same time that a ShakeMap becomes available, which is within a few minutes after the earthquake occurs. The automated IQR page provides critical information to emergency response teams immediately after earthquakes to evaluate the consequences of the level of shaking of ground and structures. The goal is to expand the automatic processing and posting of data for all U.S. strong-motion data.

### **4. VIRTUAL DATA CENTER (VDC) DEVELOPMENT**

Transfer of the operational and maintenance responsibilities for the Consortium of Organizations for Strong Motion Observation Systems (COSMOS) Virtual Data Center (VDC) from the University of California at Santa Barbara to the CESMD is nearing completion. The VDC Tagged Format (VTF) (Evans et al., 2008) file format has been adopted by the CESMD as the standard for converting strong-motion data to facilitate the process of uploading metadata (data about seismic stations, instruments, records, and sites) into the VDC database. Strong-motion records are converted into the VTF and XML formats for uploading metadata on the VDC database. The software utilities used to convert strong motion data from the local network formats of CGS, USGS (NSMP), New Zealand, and Japan (K-NET and KiK-net) to XML format are being finalized. The CESMD is also working with the Italian Accelerometric Archive (ITACA) to receive data in COSMOS V1.2 format (COSMOS publication 2001). The CESMD will soon start updating the VDC database and provide access to view, search and download records through the VDC portion of the CESMD website.

## 5. SMALL MAGNITUDE AND LOW AMPLITUDE RECORDS

In response to requests from engineers and seismologists, the CESMD now provides California strong-motion records from low magnitude ( $< \sim M3.5$ ) and small amplitude ( $< \sim 0.5\%g$ ) records for use in developing ground-motion prediction equations and for other applications. These records can be accessed via the link labeled "Small Records FTP", which appears on the [CESMD search page](#). The Small Records FTP site is a Beta site at the time of writing this paper and the input from data users will be used to improve the site.

## 6. NETWORKS CONTRIBUTIONS

The COSMOS serves as a liaison in facilitating data access from international strong-motion networks. As an advocate promoting the use of strong-motion data, COSMOS provides input and advice on developing tools and software applications. The COSMOS Strong-Motion Forum at the World Conference of Earthquake Engineering is an excellent opportunity for the representatives of strong-motion networks worldwide to discuss how to broaden cooperation and data exchange among the networks.

## ACKNOWLEDGEMENT

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