Final Report 2007-2009

Mid-America Integrated Seismic Network – SLU

USGS Cooperative Agreement 07HQAG0122

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R. B. Herrmann

Earthquake Center

Department of Earth and Atmospheric Sciences

O'Neil Hall, 3642 Lindell Boulevard

St. Louis, Mo 63108

TEL: 314 977 3120

FAX: 314 977 3117

Email: rbh@eas.slu.edu

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ABSTRACT

The Saint Louis University contribution to the USGS Advanced National Seismic system (ANSS) consists of providing calibrated digital monitoring of earthquake activity in the seismically active portions of the mid-west as well as larger earthquakes outside the region. Seismic instruments are installed in the states of Missouri, Arkansas, Alabama, Tennessee, Kentucky, Illinois, Indiana and Ohio to accomplish this purpose. All data streams are forwarded in real time to the USGS NEIC for use in rapid location and quantification of earthquakes. This report highlights the operation of the network during the three-year period from May 1, 2007 through January 31, 2010.

1. Introduction

The seismic stations operated by Saint Louis University (Figure 1) focus on providing backbone monitoring of the seismically active region of the Central United States. Although the pattern of small earthquakes (Figure 1) associated with New Madrid, Missouri (near 36.5N 90W) are co-located with the locations of the great earthquakes of 1811-1812, experience during the past 50 years shows that damaging earthquakes are not restricted to the New Madrid area, but also occur on the periphery. Because of this observation, the broadband stations operated by Saint Louis University are distributed to uniformly monitor other significant seismic zones such as the lower Wabash Valley of Illinois and Indiana. The University of Memphis monitors earthquakes in the New Madrid region with a dense network of short-period and some broadband instruments. The University of Memphis also monitors earthquakes the Appalachians of eastern Tennessee. Farther east, the University of South Carolina is responsible for earthquakes in that state.

The Saint Louis University contribution to ANSS regional monitoring consists of two complementary elements: broadband monitoring of the earthquake process in a large area surrounding the New Madrid seismic zone and the ANSS urban monitoring stations. The broadband stations are shown in Figure 1 as large red circles. As a result of America Recovery and Reinvestment Act (ARRA) all ANSS broadband stations (e.g., not the IRIS GSN CCM, WVT and WCI) will have a co-located strong motion sensor that meets ANSS standards. The existing ANSS strong motion stations shown as triangles only do not have an associated broadband sensor. The urban strong-motion stations monitor the St. Louis urban area, the earthquakes near Evansville, Indiana and the site of historical damaging earthquakes in western Ohio with the expectation/hope that a significant earthquake will be recorded during the lifetime of the instruments.

SLU is responsible for 13 ANSS broadband/accelerometer sites (SLM, FVM, MGMO, PVMO, PBMO, UALR, MPH, UTMT, PLAL, SIUC, OLIL, USIN and BLO) and 17 ANSS GMD5-TD free-field accelerometer sites (SCMO, MVMO, JCMO, SLM, STIL, EDIL, BVIL, WVIL, HAIL, MCIL, CGMO, CBMO, SCIN, TCIN, EVIN, OHIN, MVKY and PIOH) and supports the GSN at 3 sites (CCM, WVT and WCI). The accelerometer MVKY Maysville, KY (38.646, -83.761) is not shown on the map. We have a CMG5-TD for installation at the Toyota plant (39.20, -87.56 not installed) once we get secure internet access. Several of the Evansville, Indiana, and the Toyota sites are the result of local interest and lobbying.

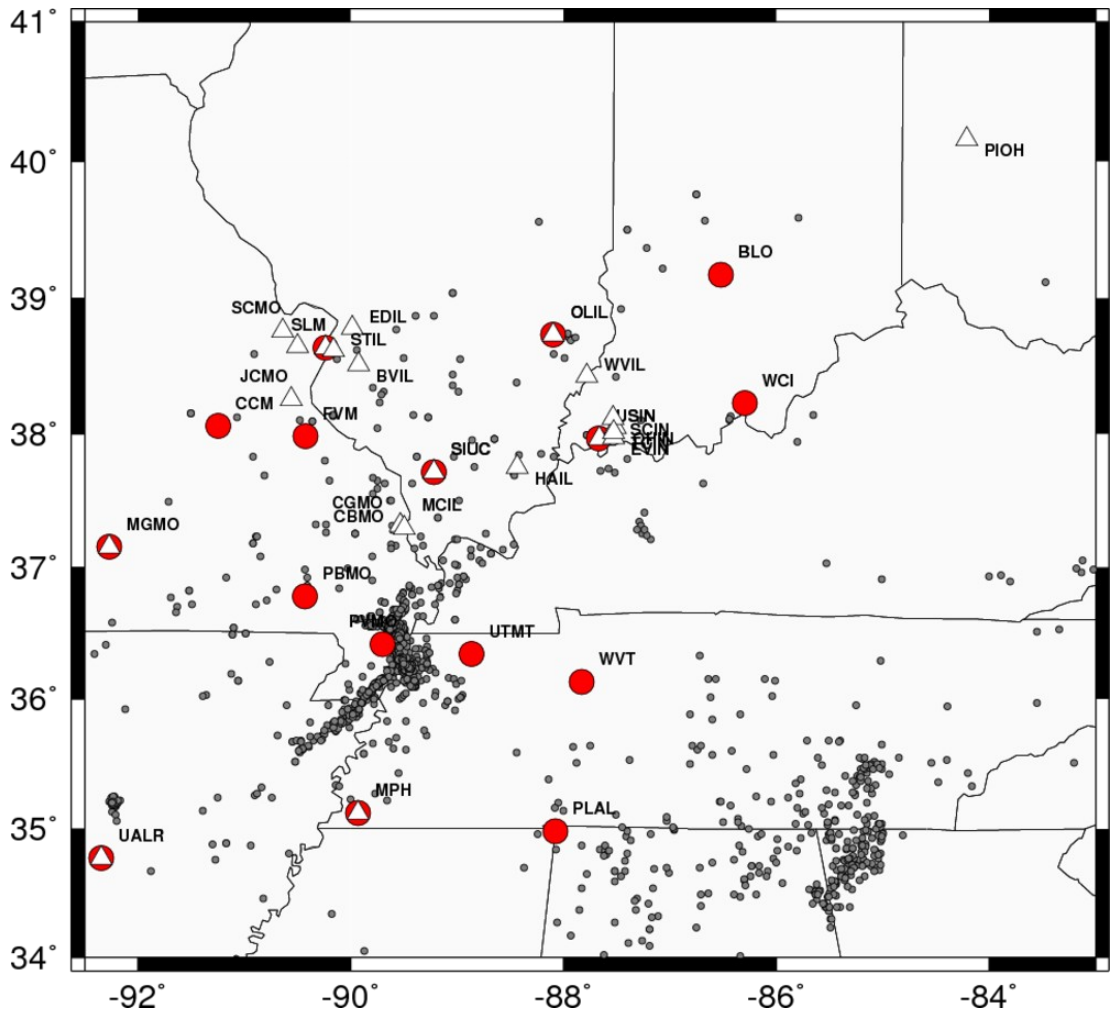


Fig. 1. Locations of SLU digital seismic stations. Circles indicate broadbands and triangles indicate accelerometer sensors. CCM, WVT and WCI are IRIS stations supported independently. SLU records a few analog streams, but these are only used for public relations and not for science. The seismicity plot shows all earthquakes with M > 1.5 in the ANSS Catalog from 1974/01/01 to 2003/12/31

The broadband stations currently transmit data to the Saint Louis University Earthquake Center in real time using Earthworm or DACOMMO/COMSERV protocols. In addition all state-of-health and data are transmitted continuously. This arrangement is currently accomplished by connecting a SUN Sparc computer to each Quanterra (usually an older Q380/680) data logger. This Sparc runs an Earthworm and also software for communicating with and repackaging of the Quanterra data stream. In some cases the Sparc and Quanterra are separated by a few meters (BLO, MPH, USIN, SIUC), a few kilometers (UALR) or hundreds of kilometers (UTMT, FVM, PVMO). Except for the PLAL site, which uses USGS satellite communication, the direct connection to the Quanterra ensures recovery of data should there be an outage in the transmission link or archiving computers at Saint Louis University. The Earthworm is for real-time use, e.g., the streams are forwarded to the University of Memphis and the USGS NEIC. The data streams to the NEIC are available internally and externally through the USGS CWBQuery request mechanism. Finally the collected mini-SEED is QC'd and forwarded to the IRIS

DMC.

The approved ARRA upgrade will replace existing Quanterra Q380/680's with Quanterra Q330 dataloggers, add accelerometers at broadband sites, but will not replace existing broadband sensors. In addition the ARRA upgrade provides redundant computer support at SLU to support archiving and data forwarding functions.

2. Network Operation

Background

As a Tier 2 component of the Mid-America Integrated Seismic Network, Saint Louis University has subsidiary roles. We maintain digital accelerometer and broadband stations in the region. We acquire and forward digital data streams to the University of Memphis (all data streams) and to the USGS NEIC (all broadband data). We locally archive the strong motion triggers from significant earthquakes, but the continuous broadband data are preserved on CDROM, are available on our web site, and are typically deposited as QC'd data at the IRIS DMC within 3-4 working days. Metadata exist locally for the strong motion data stream. Metadata for the broadband data streams are available locally on our web site, have been submitted to the NEIC and are current at the IRIS DMC.

Location of local and regional earthquakes is performed at the University of Memphis and the NEIC, respectively. In the event that we see a small earthquake that has fallen through the cracks of the automatic systems, we will locate it and provide the location and phase information to the University of Memphis.

The Saint Louis University contribution is to provide quality calibrated data streams to the system in an economical manner that avoids unnecessary duplication of efforts. Appendix 1 describes how to review the data deliveries to the IRIS DMC.

Accomplishments 2007

New Installations and Upgrades:

The broadband station was installed at Poplar Bluff, MO (PBMO) became operational June 22, 2007. The station consists of a CMG3-ESP sensor and a Q380 data-logger. Site preparation included provisions for a future installation of an Episensor (accomplished December 2009).

Accomplishments 2008

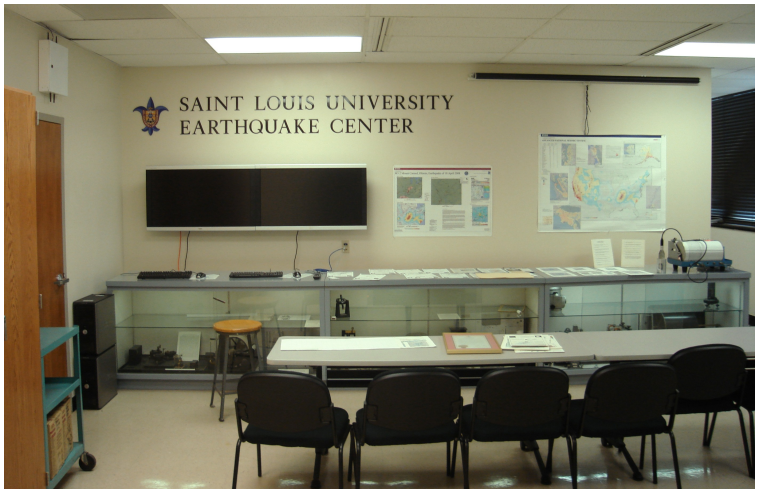
The significant event was the on-scale recording of the Mw 5.23 Mt. Carmel, Illinois earthquake on April 18, 2008 at 15:14:16. This earthquake was the first significant earthquake in the region recorded digitally on scale. Because of the earthquake size, the recordings will significantly affect strong motion scaling studies for eastern North America.

The analysis of the earthquake sequence was published quickly in Seismological Research Letters:

Herrmann, R. B, M. Withers and H. Benz (2008). The April 18, 2008 Illinois earthquake – an ANSS monitoring success, *Seism. Res. Letters* **79,** 830-843.

Earthquake Center:

The Department of Earth and Atmospheric Sciences was relocated to another building on campus in August, 2006. The seismic network operations stayed in Macelwave Hall, although there was a major reallocation of space. By April, 2008 the new public face of the Earthquake Center was completed using University funding. A former classroom was split into a display area for media and tours and into a setup area for field deployment.



Congressional Visit:

Extracts from the Saint Louis University press release: http://www.slu.edu/x22705.

“With members of the local media in tow, Congressman Russ Carnahan (MO-3) toured the Saint Louis University Earthquake Center May 2. He met with SLU researchers to discuss the recent seismic activity that rocked the Midwest.
A member of the U.S. House of Representatives Science Committee, Carnahan also was interested in learning what Congress can do to advance earthquake research and reporting.

The center's director Robert Herrmann, Ph.D., talked about SLU's cutting-edge research, which is furthering understanding of the seismic hazards facing the region.

He also discussed SLU's network of earthquake monitoring devices and showed the congressman several new machines that will be deployed into the field after testing. The center keeps an eye on the New Madrid Fault and seismic hot spots in the central United States.”

Earthquake Center Director Robert Herrmann, Ph.D., talks with Congressman Russ Carnahan

New Installations and Upgrades:

SCIN – Scott School, Evansville, IN. CMG5TD accelerometer installed. We are awaiting an IP address but running in triggered mode. The system is set to record continuously at 100 Hz and triggered at 200 Hz. This is an ANSS installation.

OHIN – Oak Hill School, Evansville, IN. CMG5TD accelerometer installed. We are awaiting an IP address but running in triggered mode. The system is set to record continuously at 100 Hz and triggered at 200 Hz. This is an ANSS installation.

MVMO – Maryville University, MO. We finally got the IT department to speak to us and are awaiting an IP address and may be able to convert from solar power to commercial power in 2009.

MGMO – Mountain Grove, MO. Installed a 40 sec Trillium and episensor with a Q330 with baler. An ethernet drop has been assigned. The signals will be sent by spread spectrum a short distance. This station is at ANSS standards.

Princeton, Indiana. An ANSS CMG5TD accelerometer is ready to be installed at the Toyota Plant in Princeton, IN. this summer the vault and wiring were installed. When we receive an IP address, the electronics and sensor will be deployed.

Evansville, Indiana. An ANSS CMG5TD accelerometer will be installed at the Evansville Tech School. We need to lay cables, install the vault, obtain an IP address and deploy the field package.

UTMT – University of Tennessee, Martin. The new vault has been installed. We will replaced the existing CMG3-ESP and Q380 in an inter-building utility tunnel, with a 40 second Trillium, Episensor and Q330. The field system is on the test bench. We will require a new IP address for the site, which may take awhile since the university is reconfiguring subnets.

We have a complete prototype system running seedlink from seiscomp, earthworm Version 7.2 and the Berkeley SEED utilities running under Ubuntu 8.0.4 LINUX. In addition the latest version of scream is installed and recording on the test systems. When this system goes operational, we will be able to transmit all data in miniSEED to IRIS and NEIC, e.g., all the continuous broadband and accelerometer data.

As a result of requirement for the accelerometers, we have started to ensure a 100 Hz continuous data stream. As of December 12, 2008 the following CMG5TD's are transmitting at 100 Hz: BVIL, EVIN, JCMO and SLM. The CMG5TD's that are still at 50 Hz are CBMO, CGMO, EDIL, HAIL, MCIL, PIOH, SCMO, STIL and WVIL and WVMO.

Accomplishments 2009

New Installations and Upgrades:

CMG5-TD accelerometers:

All have been converted over to 100 Hz continuous and 200 Hz triggered sampling. The distant site at PIOH was converted on October 13, 2009. The most distant site, Maysville, KY, had a collar installed to extend the vault which was required due to the repaving of a parking lot there; however there is still an internet issue at this site. New accelerometers in Evansville, IN.

Broadband sites:

UTMT, University of Tennessee, Martin, has a completely new location. We now use the location code 01 to describe this site since the sensor was moved to a quieter location. Before this there was no location code. This site has a Q330 datalogger, CMG3-ESP broadband sensor and an Episensor accelerometer.

MGMO, Mountain Grove, Missouri, had a problem with the line-of-sight spread-spectrum communication between the sensor and the internet hub. We could not change the receive antenna position because the internet hub is in a historic building on campus. We are awaiting the installation of fiber optic and/or permission to put the receive antenna on the dormitory. This site has a Q330 datalogger, 40 sec Trillium broadband sensor and an Episensor accelerometer.

The FVM vault had a severe flooding problem in May. The vault had 24” of water. The Trillium broadband seismometer survived, but the communication electronics has some problems. This site is slated for an upgrade to a Q330/Trillium/Episensor which we already have. We deferred summer work until now because of ticks. One difficulty is the running of a new buried cable 500 feet from the ISDN connect to the buried vault. Hopefully progress will be made before the end of January, 2010.

Data collection hub:

We have acquired the SeedLink software and are becoming familiar with it. Our plan is to use SeedLink to communicate with all field Q330's and also to use a Scream → SeedLink connection to handle the continuous data streams from the CMG-5TD accelerographs.

ARRA (Separate ARRA stimulus funding for FY2010-2011)

We accomplished the following during November and December, 2009

Station	Action
SLM	Replaced Q380 with a Q330, replaced STS-2 with Trillium-120, added Episensor
PBMO	Replaced Q380 with a Q330, added Episensor and Baler
SIUC	Added Baler
USIN	Added Baler
OLIL	Added Baler
BLO	Replaced Q380 with a Q330, added Episensor and Baler
MPH	Replaced Q380 with a Q330, added Episensor and Baler

Software:

An advantage of having continuously recording broadband and accelerometer channels at the same site is to use recorded earthquake signals to verify component orientation and sensor performance. After installing the MGMO station we noticed that there was a disjoint between the two sensor recordings. The complete system, Q330 and both sensors, was returned to St. Louis and placed on the SLM pier to compare with other sensors. We learned that the vote was one STS-2 and 3 Episensors against the Trillium from MGMO. Herrmann modified his **gsac** program to permit rotation of the sensor ZNE output to the internal UVW sensor coordinate system. We quickly discovered that the U channel was not working correctly. The sensor was returned to the manufacturer for repair. The **gsac** code knows the difference in internal orientations of the Trillium and STS-2 sensors.

We have installed Seedlink and are using it to retrieve data from field stations.

Other stations:

Although not supported by this Cooperative Agreement, we are in contact with USGS Albuquerque concerning the GSN station CCM which has a severed fiber optic link. The discussion concerns the most cost effective means of resolving this issue.

Partnerships

Network operation would not be possible without the assistance of many organizations for permission to install instruments on their property.

Broadband stations

- Saint Louis University

- Missouri Department of Conservation, FVM
- Southern Illinois University, SIUC
- University of Southern Indiana, USIN
- University of Tennessee Martin, UTMT
- University of Memphis, MPH
- University of Arkansas Little Rock, UALR
- University of Indiana, BLO
- University of Missouri Delta Research Center, PVMO
- Olney Central College, OLIL
- USGS, PLAL telemetry

ANSS Urban Strong Motion Monitoring

- Saint Louis University, St. Louis, MO, SLM
- Southeastern Illinois College, Harrisburg, IL, HAIL
- University of Evansville, Evansville, IN, EVIN
- Wabash Valley College, Mt. Carmel, IL, WVIL
- Edison Community College, Piqua, OH, PIOH
- Southeast Missouri State University, Cape Girardeau, MO, CGMO
- West Bridge Complex, Cape Girardeau, MO, CBMO
- East Bridge Complex, McCluer, IL, MCIL
- Southwestern Illinois College, Belleville, IL, BVIL
- Southern Illinois University Edwardsville, Edwardsville, IL, EDIL
- Jefferson College, Hillsboro, MO, JCMO
- Maryville College, Town and Country, MO, MVMO
- St. Charles Community College, St. Peters, MO, SCMO
- East St. Louis Higher Education Center, East St. Louis, IL, STIL
- Southern Indiana Career & Technical Center, Evansville, IN, TCIN
- Oak Hill Middle School, Evansville, IN, OHIN
- Scott Elementary School, Evansville, IN, SCIN

Costs for operation and communication are minimized because most of these sites provide free Internet access, AC power, and often a direct contact to assist in diagnosing operational problems.

Saint Louis University provides internet, computing support, as well as the use of technical staff. Dr. Herrmann's time spent managing the network is an unofficial university contribution.
A reasonable estimate of total contributions would be 60% provided by the USGS, 30% by SLU and 10% by the cooperating institutions.

Reports

Data and Information are distributed by several mechanisms, although primarily through CERI. Event information for events within the past 6 months is provided by *recenteqs*. Events from 1974 to present are available through the ANSS composite catalog and through the CERI online catalog (available at http://folkworm.ceri.memphis.edu). Submissions are made to the ANSS composite catalog weekly by CERI with a one week delay (to assure inclusion of partial weeks at month boundaries). An event Data Handling Interface (DHI) also connects the CERI catalog to the IRIS DMC. IRIS extracts waveform data from CERI waveservers which IRIS will make publicly available when INV at CERI is

populated (initial prototype implementation complete) and we are able to provide dataless SEED to the DMC. Event waveforms are also made available via anonymous ftp on request. The 6,000+ ma_quake earthquake email notification list was migrated to ENS in May 2006 with assistance from Stan Schwarz at USGS Pasadena. CISN Display is operated in select emergency operations centers. ShakeMap is initiated following automatically located earthquakes. Due to the relative immaturity of our ShakeMap effort, the maps are currently only available on a password protected website (http://webworm.ceri.memphis.edu).

We also maintain a web page http://www.eas.slu.edu/Earthquake_Center which provides links to appropriate internal and external sites. From the point of view of network management, the link http://www.eas.slu.edu/Earthquake_Center/NM/bbsta.html provides dataless seed, real-time seismograms, and access to miniSEED waveforms. This page is heavily used by the PI. This page also provides topical documents, e.g., http://www.eas.slu.edu/Earthquake_Center/NM/INSTRUMENT/ , which discusses the acausal FIR description for the Quanterra Q330's in conjunction with the behavior of the a version of the IRIS program *evalresp.c.* This study occupied the PI full time for one-month. It was brought about through testing a Q330 and trying then using the dataless SEED to reduce the different data channels (with differing sample rates) to ground displacement and noting the unreasonable time offsets in the ground motions. The problem was that *evalresp* assumed symmetric FIRS and also ignored time offsets in the FIR description. This has been fixed by IRIS. In addition the RESP files for the California Integrated Seismic Network were examined and inconsistencies in the FIR descriptions were noted.

This page also links to http://www.eas.slu.edu/Earthquake_Center/NM/NOISE/index.html. Whenever we acquire a new instrument or have a repaired instrument returned, a noise cross-correlation study is performed to compare the instrument to the STS-2 using a local implementation of the USGS Albuquerque software. This is possible because the STS-2 only used 3 of the 6 channels of the Quanterra Q-680 datalogger. The only difficulty is that the long period noise estimates on the horizontals may be slightly in question because the longer period STS-2 is more sensitive to tilt than the CMG-3ESP or 40 second Nanometrics Trillium sensors. We have found this testing to be absolutely essential to maintining network performance.

Personnel

During the period of this cooperative agreement, there were no changes in personnel.

Robert Herrmann is the principal investigator of this effort with no charge to the project. He is the one that looks at the seismological aspects of the data to ensure that all metadata describing the digital data streams is current.

Eric Haug is responsible for all technical aspects of the SLU broad-band systems, including installation, maintenance, monitoring data acquisition, programming and managing the data archiving. He has an M. S. E. E. and has designed seismic data acquisition equipment, both the electronics and digital computer implementation. He brings almost 25 years experience of low level (kernel) UNIX programming to the project. He has been working with the seismic networks at Saint Louis University for more than 30 years. He is currently paid half time by university funds to ride herd on the department's computer systems.

Melanie Whittington is a data technician responsible for routine observatory operation, e.g., daily

monitoring of computer performance, bulletin preparation, and focal point for public information. She will spend her time archiving the digital data in SEED at the IRIS DMC. Melanie has been working with the network over 25 years, and has recently improved our home page with a collection of photographs from damaging earthquakes. During 2006 Melanie has been spending 70% of her time manually downloading field data and performing quality control on the digital data. With full network operation, we anticipate that she must review 300 Mb daily or 100 Gb yearly.

Robert Wurth is the departmental technician responsible for PC's, meteorological instrumentation and other general services to the department. Bob also maintains the CCM, WCI and WVT broadband stations as well as the ANSS Urban Hazard accelerometers installed during 2002 and 2003. He is a qualified electronic technician who works well with the University of Memphis technical staff. The department is partially reimbursed for the use of his time.

3. Future directions

The current broadband network meets the design objectives of broad area coverage of possible earthquakes in the central United States, high quality digital data and timeliness. As such, no major expansion of geographical coverage or station density is of high priority. However, improvement of data quality is a concern.

The initial station deployment focused on direct internet access to provide reliable, low-cost data transfer. Some of the station sites have proven to be problematic.

The Southern Illinois University at Carbondale sensors are on a bedrock pier in the basement of the geology building. This was adequate when we recorded using a 20 Hz sampling rate of the Quanterra Q-380. However when we upgraded the instrumentation to a 40 Hz sampling rate of a Quanterra Q-330 we noticed significant noise at 15 and 16 Hz, due to the cycling on-and-off of the building air handling units on the roof. This site can be improved only by moving the sensors to a free-field location. The instruments will be relocated to another site on campus using independent ARRA funding.

4. Progress Report

Map of Seismic Stations:

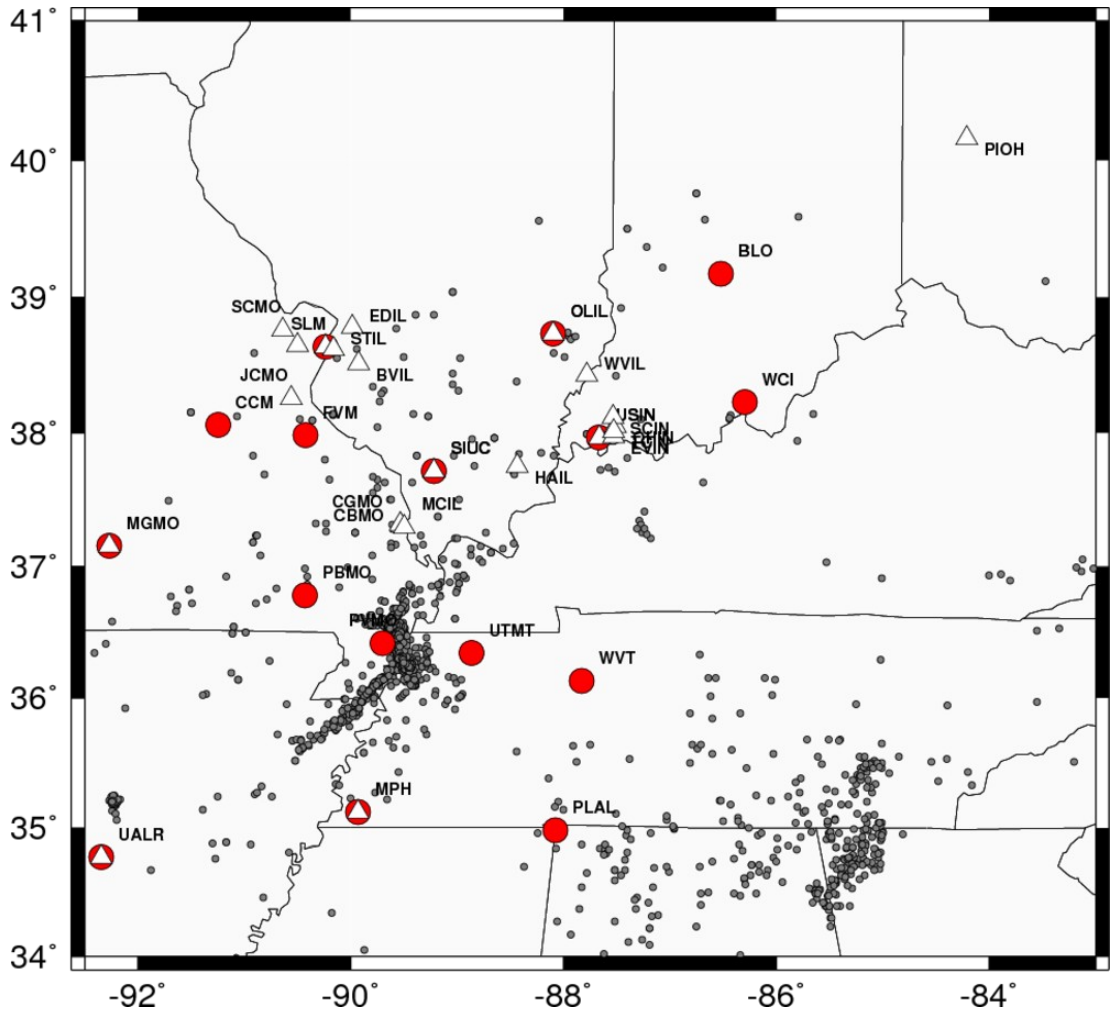


Fig. 1. Locations of SLU digital seismic stations. Circles indicate broadbands and triangles indicate accelerometer sensors. CCM, WVT and WCI are IRIS stations supported independently. SLU records a few analog streams, but these are only used for public relations and not for science. The seismicity plot shows all earthquakes with M > 1.5 in the ANSS Catalog from 1974/01/01 to 2003/12/31

Station Characteristics:

stations	BB	CHNLS	#	SM	CHNLS	#	Short Period	CHNLS	#
BLO	BLO	bhz, bhn, bhe, lhz, lhn, lhe	6						
MGMO	MGMO	bhz, bhn, bhe, hhn, hhe, hhz, lhz, lhn, lhe	9	MGMO	enz, enn, ene, hnz, hnn, hne	6			
FVM	FVM	bhz, bhn, bhe, lhz, lhn, lhe	6						
MPH	MPH	bhz, bhn, bhe, lhz, lhn, lhe	6						
OLIL	OLIL	bhz, bhn, bhe, hhz, hhn, hhe, lhz, lhn, lhe	9	OLIL	hlz, hln, hle	3			
PBMO	PBMO	bhz, bhn, bhe, lhz, lhn, lhe	6						
PVMO	PVMO	bhz, bhn, bhe, lhz, lhn, lhe	6						
PLAL	PLAL	bhz, bhn, bhe, lhz, lhn, lhe	6						
SIUC	SIUC	bhz, bhn, bhe, hhz, hhn, hhe, lhz, lhn, lhe	9	SIUC	hlz, hln, hle	3			
SLM	SLM	bhz, bhn, bhe, lhz, lhn, lhe	6	SLM	hnz, hnn, hne	3	SLM	ehe, ehe, ehz	
UALR	UALR	bhz, bhn, bhe, hhn, hhe, hhz, lhz, lhn, lhe	9	ULAR	enz, enn, ene, hnz, hnn, hne	6			
USIN	USIN	bhz, bhn, bhe, hhz, hhn, hhe, lhz, lhn, lhe	9	USIN	hlz, hln, hle	3			
UTMT	UTMT	bhz, bhn, bhe, lhz, lhn, lhe	6						
CCM	CCM	bhz, bhn, bhe, lhz, lhn, lhe, uhz, uhn, uhe, vhz, vhn, vhe, vk1, ve1	14						
WCI	WCI	bhz, bhn, bhe, lhz, lhn, lhe, uhz, uhn, uhe, vhz, vhn, vhe, hhe, hhn, hhz, ume, umn, umz, ve1	14						
WVT	WVT	bhz, bhn, bhe, lhz, lhn, lhe, uhz, uhn, uhe, vhz, vhn, vhe, hhe, hhn, hhz, ume, umn, umz, uci	14						
BVIL				BVIL	hnz, hnn, hne	6			
CBMO				CBMO	hnz, hnn, hne	6			
CGMO				CGMO	hnz, hnn, hne	6			
EDIL				EDIL	hnz, hnn, hne	6			
EVIN				EVIN	hnz, hnn, hne	6			
HAIL				HAIL	hnz, hnn, hne	6			
JCMO				JCMO	hnz, hnn, hne	6			
MCIL				MCMO	hnz, hnn, hne	6			
MVMO				MVMO	hnz, hnn, hne	6			
OHIN				OHIN	hnz, hnn, hne	6			
PIOH				PIOH	hnz, hnn, hne	6			
SCIN				SCIN	hnz, hnn, hne	6			
SCMO				SCMO	hnz, hnn, hne	6			
STIL				STIL	hnz, hnn, hne	6			
TCIN				TCIN	hnz, hnn, hne	6			
WVIL				WVIL	hnz, hnn, hne	6			
CGM1							CGM1	ehz, ehn, ehe	3
CMG2							CGM2	ehz, ehn, ehe	3
CMG3							CGM3	ehz, ehn, ehe	3
CGM4							CGM4	ehz, ehn, ehe	3
totals	16		135	19		120	5		12

Summary Statistics for Regional/Urban Seismic Network

Total no. of stations operated and/or recorded	**37**
Total no. of channels recorded	**267**
No. of short-period (SP) stations	**5**
No. of broadband (BB) stations	**16**
No. of strong-motion (SM) stations	**20**
No. of stations maintained & operated by network	**36**
No. of stations maintained & operated as part of ANSS	**33**
Total data volume archived (mbytes/day)	**2000**

Progress on Metadata Development

All broadband data are archived at the IRIS DMC. The dataless SEED are available at
ftp://ftp.eas.slu.edu/pub/CNMSN/nmrspon/DATALESS
and at
ftp://ftp.iris.washington.edu/pub/RESPONSES/DATALESS_SEEDS/NM.seed

Statistics, responses and metadata summaries are available at the IRIS Metadata Aggregator at
http://www.iris.edu/mda/
for the New Madrid (NM) network
http://www.iris.edu/mda/NM?timewindow=1997-2500
Station noise analysis is available at

http://www.iris.washington.edu/servlet/quackquery/budFileSelector.dostation=BLO&network=NM

We have recently initiated several procedures for review of metadata associated with the broadband station.

We test new dataless SEED for a station with an internal procedure that provides the history of the response and channel orientation as a function of time. The response information is tested by computing the amplitude and phase response from the complete response (analog and digital stages) using evalresp to read the RESP files. In addition we compute the amplitude response from the pole-zero files (SAC format). For both types of response, we also compute the step acceleration response of the sensor as a check on the orientation. We found it necessary to test both the RESP and pole-zero responses because of the way that rdseed normalizes the pole-zero response. An example of the output of this procedure is given for the station OLIL at

http://www.eas.slu.edu/Earthquake_Center/NM/OLIL/OLILindex.html

We work with IRIS by using their Metadata Aggregator. This is very useful in pointing out errors in the submitted metadata.
The dataless SEED that we place in the location

ftp://ftp.eas.slu.edu/pub/CNMSN/nmrspon/DATALESS

is examined daily by NEIC for changed dataless files. The new versions of the dataless are then uploaded to the NEIC metadata server for use with both the internal and external versions of the continuous wave buffer (CWB). At present, there is no feedback mechanism testing for inconsistencies. For the immediate future we will rely on the IRIS Metadata Aggregator and our internal tests.

We have also developed another method for evaluating the correctness of the response and instrument orientation. This was developed primarily to assist NEIC for use with the many contributed broadband data streams. Given a moment tensor solution for an earthquake, the procedure compares observed and model predicted teleseismic P, SV and SH waveforms, flagging those differing by a greater than a factor of 2. Examples of this procedure are given at

http://www.eas.slu.edu/Earthquake_Center/MECHQC.TEL/

and

http://usra2.iris.washington.edu/synthetics/event/MECHQC.TEL/

A version of this software is running on an algorithm development machine at NEIC.

Although we have the broadband and accelerometer responses well under control (accelerometers at OLIL, SIUC, USIN). For the CMG5TD accelerometers, we have created prototype RESP files and dataless files. We have tested these with data from the April 18, 2008 Illinois earthquakes and are satisfied that we have these correct for the 50 Hz data stream. We will test the 100 Hz responses shortly.

Unless directed otherwise, we will not worry about the few short-period analog channel responses. We will archive the triggered waveforms.

Progress on ANSS Integration

The SLU Component of the Mid-America Seismic Network is that of a Tier 2 provider of data streams to the processing center. In the responses given below, the term CERI indicates that the function is performed by the data center at CERI, University of Memphis.

Earthquake Data and Information Products

Network Products		
Does the network provide the following?	**Yes/No**	**Comments/Explanation**
Primary EQ Parameters	**NA**	**CERI**
Picks	**“**	**CERI**
Hypocenters	“	CERI
Magnitudes (& Amplitudes)	“	CERI
Focal mechanisms	“	CERI
Moment Tensor(s)	Yes	Done in cooperation with NEIC for continental US/Canada exclusive of California

Network Products		
Does the network provide the following?	**Yes/No**	**Comments/Explanation**
Other EQ Parameters/Products		
ShakeMap	No	
Finite Fault	No	
Supplemental Information		
Felt Reports	No	
Event Summary	**No**	
Tectonic Summary	**No**	
Collated Maps	**No**	
Refined Hypocenters (e.g. double-difference)	**No**	
Web Content		
Recent EQ Maps	**Yes**	
Station Helicorder	**Yes**	
Station noise PDF	**No**	Prototypes are present. Will be done in next Cooperative Agreement
Station Performance Metrics	**No**	
Network Description	**Yes**	
Station List	**Yes**	
Station Metadata	**Yes**	
Email Notification Services	**?**	**What does this mean?**
Contact Info	**Yes**	
Region-specific FAQs	**Yes**	
Region-specific EQ info	**Yes**	
Waveforms		
Triggered	**Yes**	
Continuous	**Yes**	

Network Products		
Does the network provide the following?	**Yes/No**	**Comments/Explanation**
Processed	**No**	
Summary Products		
Catalogs	**No**	**CERI contributes to national catalog**
Metadata		
Instrument Response	**Yes**	
Site Info (e.g. surface geology, Vs30)	**No**	
Descriptions:		
***Tectonic Summary*: Text and/or figures describing the tectonic setting of the event and related activity No**		
***Event Summary*: Text and/or figures (press releases, collated media/disaster agencies info) that describes the earthquake and its effects - No**		
***Collated Maps*: Any map or set of maps that illustrates the event properties, tectonics, hazards, etc No**		
***Processed Waveforms*: Specialized processing that is required by some portion of the community, e.g. processed strong motion records for the engineering community - Yes**		
***Catalogs*: Lists of parameters that describe an earthquake(s) or information used to describe an earthquake (e.q., picks, locations, amps,..) - Yes for pre-1990**		
***Region-specific earthquake information*: Description (text and/or maps) of historical earthquakes, faults/ geology, etc. - Yes**		

ANSS Cooperating Network Performance Self-Rating

Question	Answer	Explanation (if needed)
1. What is the minimum magnitude detection threshold for your network?	2.5	
2. What is the minimum magnitude detection threshold for the best instrumented part of your network?	2.5	
3. What is the typical hypocentral location accuracy for earthquakes occurring within your network? Is it the same for automated vs reviewed?	NA	Location if performed by Mid-America Regional Data Center at CERI, University of Memphis

ANSS Cooperating Network Performance Self-Rating

Question	Answer	Explanation (if needed)
4. Does your network report automated earthquake locations into QDDS? If yes, how long does it take?	NA	Performed by CERI
5. Does your network report analyst-reviewed earthquake locations for all quakes into QDDS (i.e., the little ones)?	NA	If yes, what is the typical processing delay?
7. Describe the velocity model used to locate earthquakes in your network (1-D?, multiple models?, 3-D?). Does it differ for automated vs reviewed?	NA	Performed by CERI
8. What software/program does your network use to locate earthquakes? Does it differ for automated vs reviewed?	NA	Performed by CERI
9. What magnitudes does your network routinely report in real time (Md, ML, Me, Mw, Ms etc.)? How long does it take to compute them?	NA	Performed by CERI
10. Does your network archive phase information at a datacenter?	NA	If yes, how long is the delay to report? In what year does archiving begin? Where is the information archived?
11. Does your network archive summary (i.e., earthquake catalog) information at a public datacenter?	NA	If yes, how long is the delay to report? In what year does archiving begin?
12. Does your network archive event waveforms at a public datacenter?	NO	
13. Do you archive continuous waveforms at a public datacenter?	YES	BH, HH and LH Channels archived at IRIS and in USGS/NEIC Continuous Wave Buffer. Archiving at IRIS DMC is continuous
14. If your network archives waveforms, does it supply supporting instrument response metadata to support generation waveforms in SEED? For all waveforms?	NA	
15. Does your network compute focal mechanisms?	No	If yes, what type (first motion, moment tensor). In real-time? Do you archive them at a public datacenter?
16. Does your network automatically distribute email to the public in near real-time for significant events?	No	If yes, Do you offer a website where they can sign up?

ANSS Cooperating Network Performance Self-Rating

Question	**Answer**	**Explanation (if needed)**
17. Does your network automatically distribute alphanumeric pages to the public in near real-time for significant events?	No	If yes, Do you offer a website where they can sign up?
18. Does your network automatically compute *ShakeMaps* and make them publicly available? If so, how long does it take?	No	
19. Does your network operate a fault-tolerant system (e.g., redundant computers, UPS, back-up generator with lots of fuel)?	Yes	
20. What does your network do with the data recorded on ANSS strong motion instruments? For example, do you make it available to the engineering community through a Data Center?		Currently locally archived