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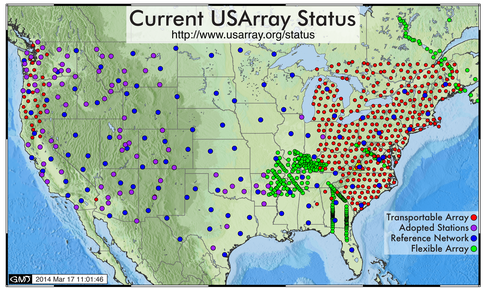
USArray

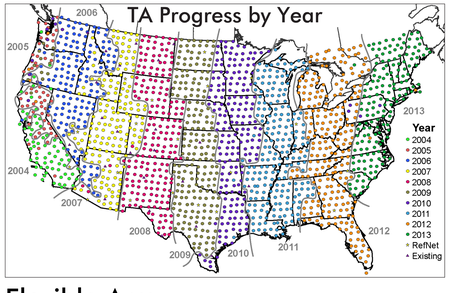
www.earthscope.org www.usarray.org

EarthScope's USArray

Introduction

Having been developed since late 2003, the IRIS-operated, National Science Foundation-sponsored EarthScope USArray facility consists of five main observatory components: Reference Network of permanent seismic stations; Transportable Array (TA) of migrating broadband seismic stations; Flexible Array (FA) pool of seismometers for use by Principal Investigators (PIs); atmospheric sensors co-located with the TA (funded via an NSF-MRI-R2 grant to Univ. California-San Diego); and magnetotelluric (MT) instruments providing transportable array capabilities. All USArray data is archived, most in real-time, and openly available either immediately or after two years for PI-specific FA experiment data.





Transportable Array

Over 10 years, the TA has installed and operated 1691 stations in North America, completing its migration to the Atlantic coast in October 2013 under budget and on schedule. Accrued savings and efficiencies funded additional stations in southern Canada. TA stations in Cascadia were reinstalled with ARRA funds in 2009-2010 as part of a combined onshore-offshore facility. The stations deployed in a grid-like pattern, spaced at ~70 km. At any given time about 450 stations operated continuously, and each station remained deployed for around two years. The TA will remain along the east coast until fall 2015. In summer 2014 it will begin to formally move to Alaska and adjacent Canada. A handful of initial TA stations currently operate in Alaska, the Yukon, and the Northwest Territories.

Flexible Array

The FA provides a pool of seismic instruments that are available for PI-driven experiments that address EarthScope program scientific goals. The instruments are available for use by operators unrelated to EarthScope on a non-interference basis.

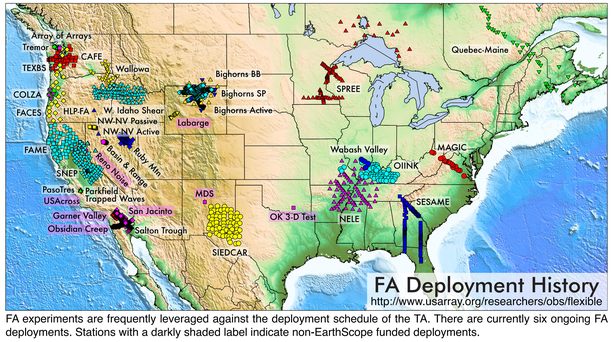
Available Equipment

Broadband Seismometer
Guralp CMG 3T
360 units

Short-period Seismometer
Guralp CMG 40T-1sec
137 units

Single Channel DAS
Reftek 125A, 256 Mb
w/ 4.5 Hz snsr
1698 units

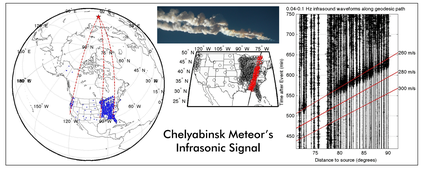
Accelerometer
Kinemetrics
Episensor
20 units



FA experiments are frequently leveraged against the deployment schedule of the TA. There are currently six ongoing FA deployments. Stations with a darkly shaded label indicate non-EarthScope funded deployments.

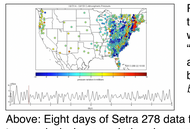
Atmospheric Transportable Array

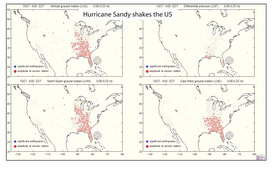
Included with TA installations since early-2011, each station's atmospheric sensor package contains a MEMS state-of-health barometer in its vault, an external high frequency infrasound microphone (NCPA), and a low to intermediate frequency barometer (Setra 278). These sensors capture both infrasound signals propagating through the upper atmosphere and large pressure variations from severe weather.



TA pressure data contribute to the MesoWest database of real-time weather observations: http://mesowest.utah.edu/index.html

Left: The bolide explosion near Chelyabinsk, Russia on February 15, 2013 produced an atmospheric pressure wave that travelled through the atmosphere globally. Filtered between 0.02-0.12 Hz, this record section of one sample-per-second (LDF channel) NCPA data slices through a segment of the TA in the eastern U.S. *Figure courtesy of Catherine Degroot-Hedlin (UCSD).*





Right: Atmospheric and seismic data from the TA (10/14-11/4/12) show the effect of weather on the microseism (the seismic "hum" of the oceanic waves). This animation highlights the signal produced by Hurricane Sandy. *Animation produced by Alex Hutko (IRIS DMC).*

Above: Eight days of Setra 278 data from early October 2013, filtered between two and six hour periods, show pressure fronts associated with a severe weather outbreak in the northeastern U.S. Red boxes indicate severe weather reports. *Animation produced by Andy Frassetto (IRIS HQ).*

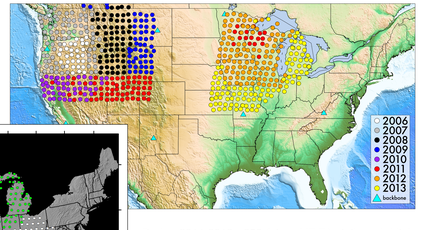
Reference Network

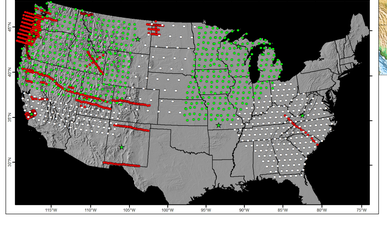
The Reference Network consists of 114 broadband seismometers spaced at ~300 km across the country. Seventy of these stations are maintained by the USGS as part of either the Advanced National Seismic System or Global Seismographic Network. The network also includes stations deployed with the TA and those upgraded in cooperation with regional networks.

Magnetotelluric Program

Operated by Oregon State University, the MT program consists of 20 stations that are deployed campaign-style each summer with TA-like 70 km spacing. A MT-TA station is typically deployed for about three weeks. OSU also operates a small backbone of formerly permanent MT stations and provides support for PI-driven MT-FA experiments.

The seven station permanent MT backbone network (blue triangles) and the 572 campaign MT stations from 2006-2013 (circles) show the current coverage of USArray MT data. Additional stations north of the US-Canada border represent complementary data contributed by the Univ. of Alberta. Map available here: http://www.usarray.org/researchers/obs/magnetotelluric



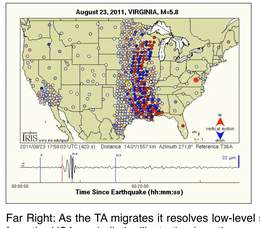


During 2014-2018 ~350 future MT-TA stations (white), targeted with input from the EarthScope community, will deploy across much of the central and southern Appalachians, southern Basin and Range, and northern Great Plains. Past and present MT deployments (red) show coverage of the U.S. without the contributions of the USArray MT-TA program.

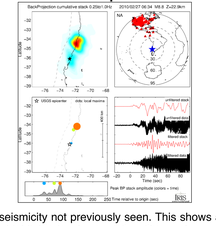
Data Products

USArray data enables many automated analyses; including ground motion visualizations (GMVs) and teleseismic back projections (preliminary earthquake fault rupture models) that are routinely produced within an hour for M6.5+ events. Event bulletins are assembled from local, regional, and teleseismic arrivals observed by TA stations. All events, which generate 10 or more arrivals on the TA, are located by the Array Network Facility (U.C.-San Diego), and the origins and phase arrivals are published via the IRIS DMC. Earth Model Collaboration (EMC) provides a way to distribute and compare models produced by geoscientists using USArray data.

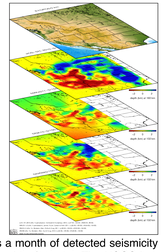
GMVs



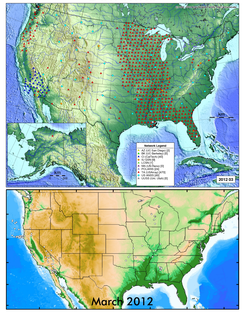
Back Projections



EMC

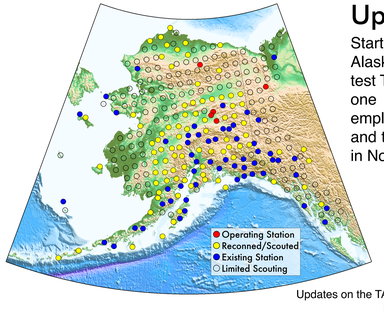


Bulletins



Far Right: As the TA migrates it resolves low-level seismicity not previously seen. This shows a month of detected seismicity from the USArray bulletin, illustrating how the array highlights local seismicity within and around its footprint. The USGS has used picks from USArray stations to locate noteworthy for the ANSS.

DMC data products are accessible at: http://www.iris.edu/spud/
Full event tables may be downloaded here: https://anf.ucsd.edu/tools/events/download.php



Up Next - Alaska

Starting in the summer of 2014, the TA will redeploy up to 294 stations in Alaska and Canada, spaced at ~85 km. Eight seismometers operating at five test TA stations (six 4-10 meter deep augered holes, one cored into rock, and one standard vault) were installed starting in August 2011. These emplacements tend to better insulate the sensor against environmental noise, and two stations (POKR.01, TOLK) record some of the quietest seismic data in North America.

Updates on the TA in Alaska are available here:
http://www.usarray.org/alaska

The TA's Legacy - Adoptions and CEUSN

The mission of the Central and Eastern United States Network (CEUSN) is to produce data that enables researchers and Federal agencies alike to better understand the basic geologic questions, background earthquake rates and distribution, seismic hazard potential, and associated societal risks of this region. To this end, approximately 159 TA stations will remain operational in the central and eastern United States through 2017, funded by a special Federal appropriation to NSF. CEUSN will hopefully then be adopted and operated by the USGS as part of their seismic monitoring program.

In addition, state and regional operators across the country have already adopted 59 complete stations (with three more pending) and another 31 vaults as the TA has rolled eastward. These stations are colored as purple on the USArray status map.

Updates on the CEUSN are available here:
http://www.usarray.org/ceusn