

Jonathan Tytell^{*1}, Frank Vernon¹, Jennifer Eakins¹, Bob Busby², and Katrin Hafner²¹University of California, San Diego, CA²Incorporated Research Institutions for Seismology**1. ABSTRACT**

The National Science Foundation's EarthScope Initiative has begun redeploying its USArray Transportable Array (TA) network into Alaska, which is scheduled to continue operating through at least 2018. Similar to the previous station installations in the Lower 48, each station will be equipped with a suite of equipment that will be capable of monitoring surface barometric pressure changes in real-time at 1 and 40 sps. These stations will be installed in a Cartesian grid style with approximately 85 km between stations. In addition, there will be a Vaisala WXT520 weather station installed at a minimum of seventy-five stations located in more rural regions of Alaska where weather monitoring is sparse or non-existent. This network will be capable of tracking sudden changes associated with storm events and can assist with now-casts of such events. Data will be publicly available and accessible both in real-time and via archived formats.

2. INTRODUCTION

The primary objective of the USArray TA Network is to monitor the interior of the Earth, as directed by the EarthScope Initiative. The capability of the TA Network to monitor surface weather pressure came later via additional NSF awards. We have previously presented ways in which the surface pressure TA data, and sometimes the combination of surface pressure and seismic data, can be utilized to observe weather features (Tytell et. al. 2011, Vernon et. al. 2011, Tytell et. al. 2012, Vernon et. al. 2012).

At the time of this presentation the TA Network has reached the east coast of the United States as well as the end of its planned deployment for the Lower 48. Crews have already started removing stations from the footprint or transitioned them into one of the TA's next objectives; the Central Eastern United States Network (CEUSN). By the end of 2015, all remaining stations from the Lower 48 will either be decommissioned, part of CEUSN for up to five years, or permanently adopted by a third party.

The next major objective of the TA is to continue its monitoring objective throughout Alaska. Approximately 25 stations have already been installed prior to 2015, and over 200 more are scheduled for installation through the end of 2017. The deployment will remain in place through at least 2018. This presentation will go into further detail regarding station installations, data

coverage provided and the benefits of the proposed footprint within Alaska.

3. SITE INSTALLATION AND DATA COVERAGE

The standard installation procedure throughout the Lower 48 was heavily modified in order to accommodate the terrain and other challenges of installing TA stations within Alaska. In order to achieve the goal of installing stations within a ~ 85 km Cartesian grid extending into Northwestern Canada, as seen in Figure 1, numerous new installation strategies were incorporated for each site.

A majority of sites require deployment via helicopter or fixed-wing aircraft due to the lack of road networks throughout much of the state. Payloads are carefully organized in order to reduce costs for the installations as the helicopters especially can only carry so much. Installation procedures follow a "hub and spoke" pattern, where sites are grouped such that a central site acts as a base station that holds the equipment and fuel needed for the surrounding sites as they are installed.

The TA installations in the Lower 48 involved housing all equipment within specially fabricated vault enclosures buried ~2.5 m with solar power and communications located on a pole a few meters away. The weather and ground conditions in Alaska necessitated a different approach. Instead of placing seismometers at the base of a vault, they are now placed at the bottom of a posthole drilled ~ 5 m down, with the rest of the site's equipment located in a specially designed hut nearby (Figure 2). This imposes a significant payload consideration on the installation crews, as the auger machine needs to be brought to each site in addition to the crew and materials. Despite this challenge installation of these sites in Alaska continues successfully.

The meteorological equipment onboard the TA Alaska stations is the same as in the Lower 48 deployment in that each site has a combination of three sensors: one VTI SCP1000 MEMS barometer, one Setra 278 barometer, and one Hyperion Infrasound microphone. These will all record data at 1 sps, rather than 1 and 40 like the deployment in the Lower 48 in order to more efficiently use the bandwidth from satellite communications. Additionally, approximately 75 of the Alaska sites will be equipped with Vaisala WXT520 weather stations, though should sufficient additional funding be available it may even be possible to outfit up to 265 sites with the Vaisala weather stations.

Communications and data transmission from the TA sites in the Lower 48 were largely governed with cell phone networks, which understandably will not be possible for most of the Alaska deployment since many

* Corresponding author address: Jonathan E. Tytell, Univ. of California, San Diego, IGPP, La Jolla, CA 92093-0225; e-mail: jtytell@ucsd.edu

of the sites will be located in remote areas. The new strategy will be to use a combination of communication and data access methods. Cell phone networks will still be utilized where available, but primarily the data will be transmitted via satellite burst communication at least three times per day. BGAN, OmniSpace, and Iridium satellite networks are potential satellite providers for the USArray in Alaska.

4. CURRENT AND PROPOSED ALASKA DEPLOYMENT

Figure 3 is a map that depicts the current and proposed station sites for the TA Alaskan deployment. There are currently 25 TA sites that have been installed in Alaska. Many of the future sites will be installed at locations that already exist with other networks, so the site reconnaissance steps are essentially already planned out for those sites. The rest of the sites, especially during the 2017 construction cycle, will be more intensive. By the end of 2017 there will be ~ 290 sites installed.

To illustrate the benefit of the TA Alaskan coverage we have plotted it with National Weather Service stations throughout Alaska (Figure 4). Many sites coincide with established NWS sites, but there are also large regions of Alaska where there are currently little to no surface observations. The ability to provide 1 sps surface pressure data, and perhaps additional data from the Vaisala weather stations, can be very beneficial to the forecast community throughout Alaska.

5. DATA EXAMPLE

We can provide a brief glimpse at the quality of data provided by the TA sites currently in place in Alaska. Figure 5 shows a one-week period of time of the 1 sps Setra 278 barometric pressure data. The stations in this example are arrayed from the north to the south.

6. DISCUSSION

All data from the USArray project, for the Lower 48, CEUSN program and Alaska are accessible from the Incorporated Research Institutions for Seismology (IRIS) Data Management Center (DMC) in Seattle, Washington. Furthermore, we process our data into 5-minute averages and supply them to MesoWest at the University of Utah, where they are also delivered to NOAA's Meteorological Automated Data Ingest System (MADIS) (Jacques, et al., 2015).

For more information and updates on the USArray redeployment to Alaska, please visit <http://www.usarray.org/alaska>. For more information regarding NSF's EarthScope Initiative, please visit: <http://www.earthscope.org>.

7. ACKNOWLEDGEMENTS

A lot of hard work and planning has been underway for years to bring the USArray TA Network to Alaska, as such both IRIS and the station installation crews in

Alaska deserve praise for their accomplishments. The next few years will be challenging but these teams are certainly up to this task.

8. REFERENCES

Amante, C. and B.W. Eakins, 2009. ETOPO1 1 Arc-Minute Global Relief Model: Procedures, Data Sources and Analysis. NOAA Technical Memorandum NESDIS NGDC-24. National Geophysical Data Center, NOAA. doi:10.7289/V5C8276M [2014].

Jacques, A. A., J. D. Horel, E. T. Crosman, and F. L. Vernon, 2015: Central and Eastern United States Surface Pressure Variations Derived from the USArray Network. *Monthly Weather Review*, In Press.

Tytell, J. E., J. Eakins, and F. Vernon, 2011: Tracking Outflows from Severe Thunderstorms Using NSF EarthScope USArray Pressure Sensors. *Extended Abstracts, 24th Conference on Weather and Forecasting/20th Conference on Numerical Weather Prediction*, Seattle, WA, Amer. Meteor. Soc., <http://ams.confex.com/ams/91Annual/webprogram/Paper180739.html>.

Tytell, J. E., F. Vernon, B. Busby, J. Eakins, M. Hedlin, A. Muschinski, K. Walker, and B. Woodward, 2011: Real-Time Observations of the May 22nd Joplin, Missouri EF5 Tornado by the USArray Transportable Array Network. *Extended Abstracts, Special Symposium on the Tornado Disasters of 2011*, New Orleans, LA, Amer. Meteor. Soc., <https://ams.confex.com/ams/92Annual/webprogram/Paper200061.html>.

Vernon, F.L., J. E. Tytell, and J. Eakins, 2011: Tracking Observations of Weather Phenomena by NSF EarthScope USArray Seismic and Pressure Sensors. *Extended Abstracts, 24th Conference on Weather and Forecasting/20th Conference on Numerical Weather Prediction*, Seattle, WA, Amer. Meteor. Soc., <http://ams.confex.com/ams/91Annual/webprogram/Paper180671.html>.

Vernon, F.L., J. E. Tytell, B. Busby, J. Eakins, M. Hedlin, A. Muschinski, K. Walker, and B. Woodward, 2012: Scientific Viability of the USArray Transportable Array Network As a Real-Time Weather Monitoring Platform. *Extended Abstracts, 16th Symposium on Meteorological Observation and Instrumentation*, New Orleans, LA, Amer. Meteor. Soc., <https://ams.confex.com/ams/92Annual/webprogram/Paper200044.html>.



Figure 1 – Original hypothesized deployment for the USArray TA footprint throughout Alaska and into Canada from 2012. Red circles represent sites that already were installed at this time in 2012, blue circles indicate potential sites, and green circles represent sites that were already surveyed and at the time were planned for installation. The main purpose of this figure is to indicate that the objective of the Alaskan deployment is the same as in the Lower 48: to provide a Cartesian grid deployment of seismic stations at a ~85 km grid space interval for the purpose of monitoring the interior of the Earth.

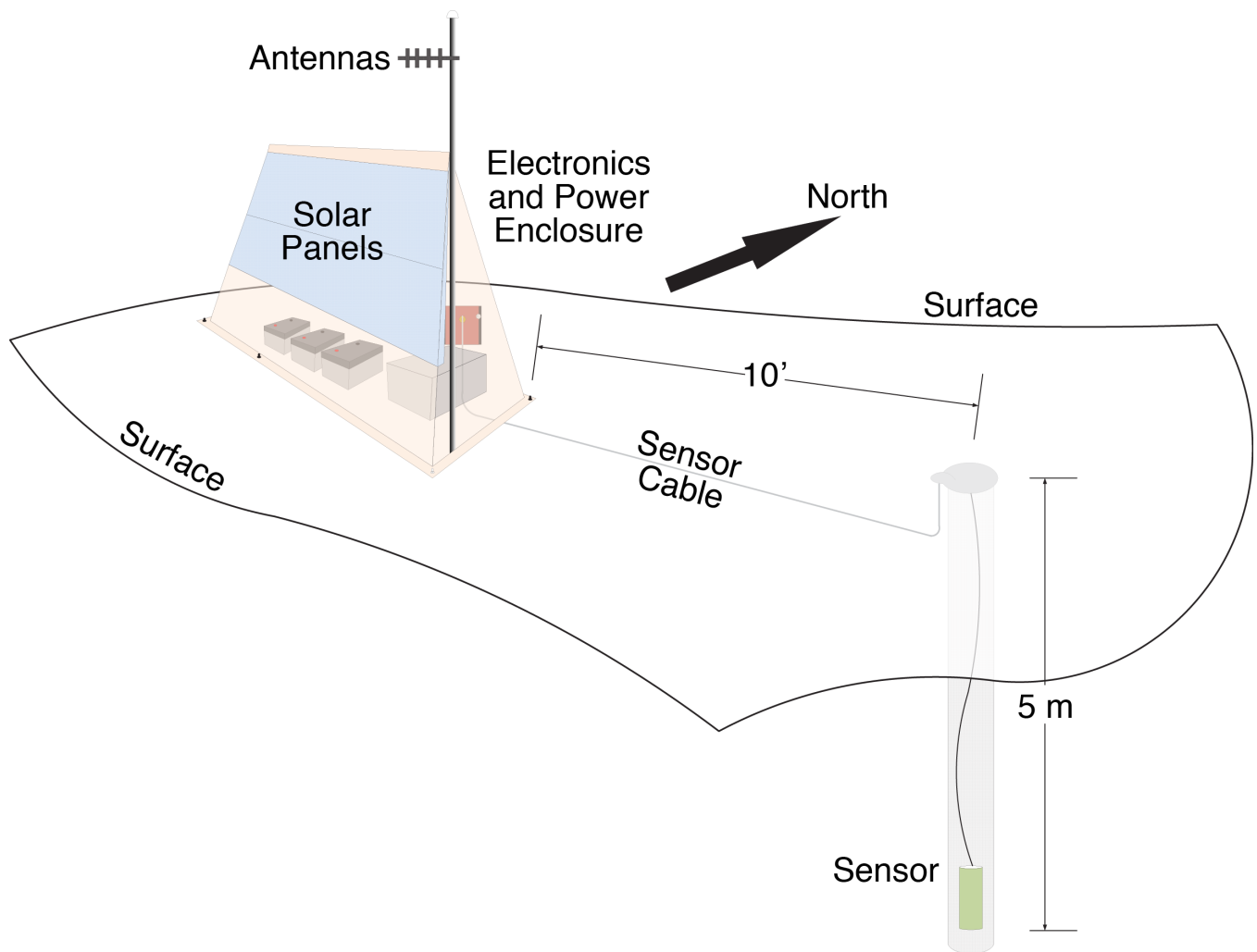


Figure 2 – Schematic of the typical site design for stations throughout Alaska. A posthole containing the seismometer is located away from the site and is augured down about 5 m. Most of the equipment is housed within a specialized hut enclosure designed to withstand typical weather conditions in Alaska.



Figure 3 – A map of installed and proposed sites throughout Alaska as of November 2014. Red sites have been installed. Blue sites will be installed during 2015 at existing or new locations. In 2016 the sites in yellow will be installed, including into the Aleutian arc. Finally, the remaining sites, green circles, will be installed in 2017.

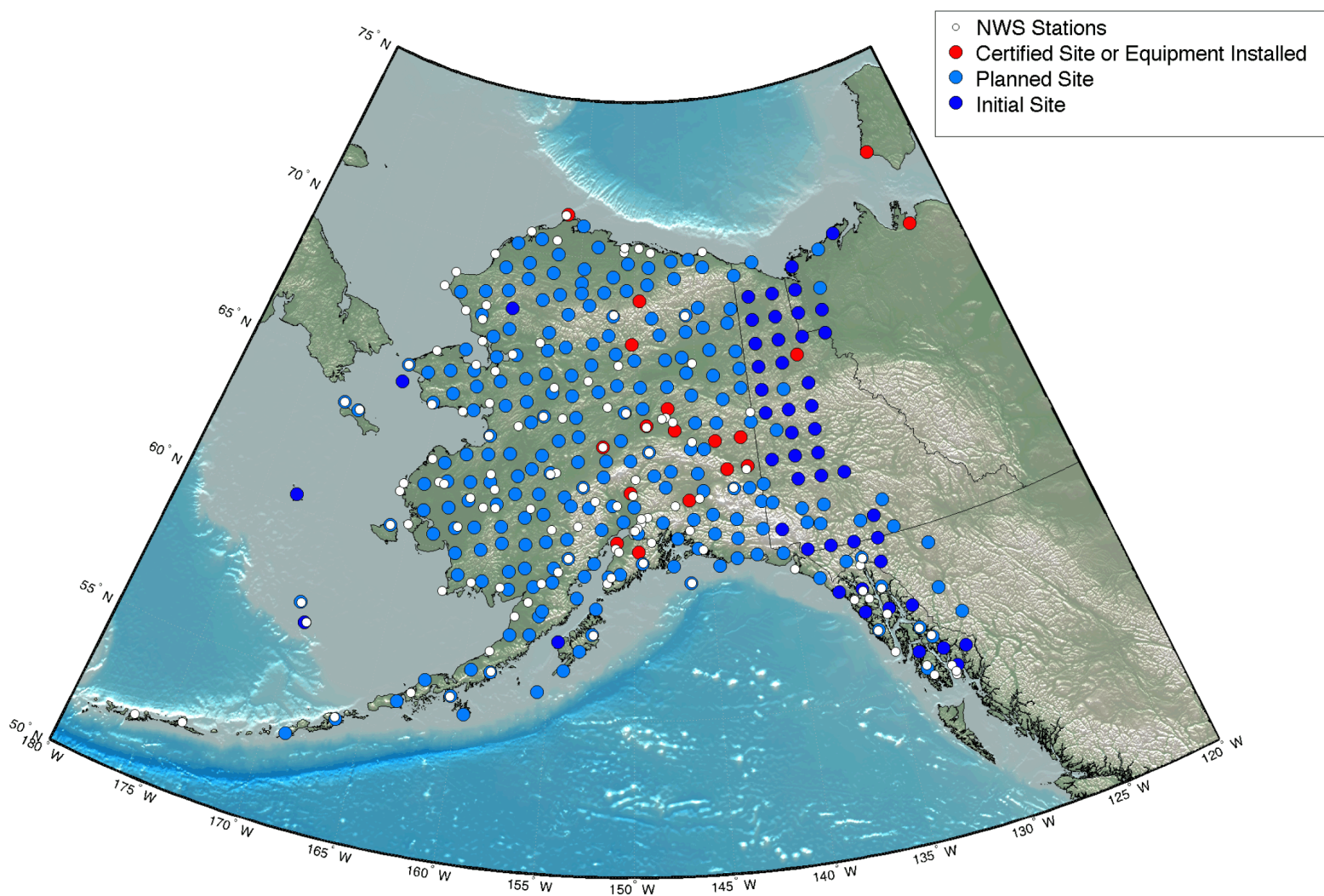


Figure 4 – Map of current and potential Alaska TA deployment as of August 2014, with National Weather Service stations (small white circles) overlaid. Red circles are TA sites that have been certified or have had equipment installed but waiting for certification. Light blue circles are planned TA sites that are in various states of planning, either via early reconnaissance, permits filed for construction, etc. Dark blue circles are initial locations for future potential TA sites. Terrain data provided by NOAA's ETOPO1 product.

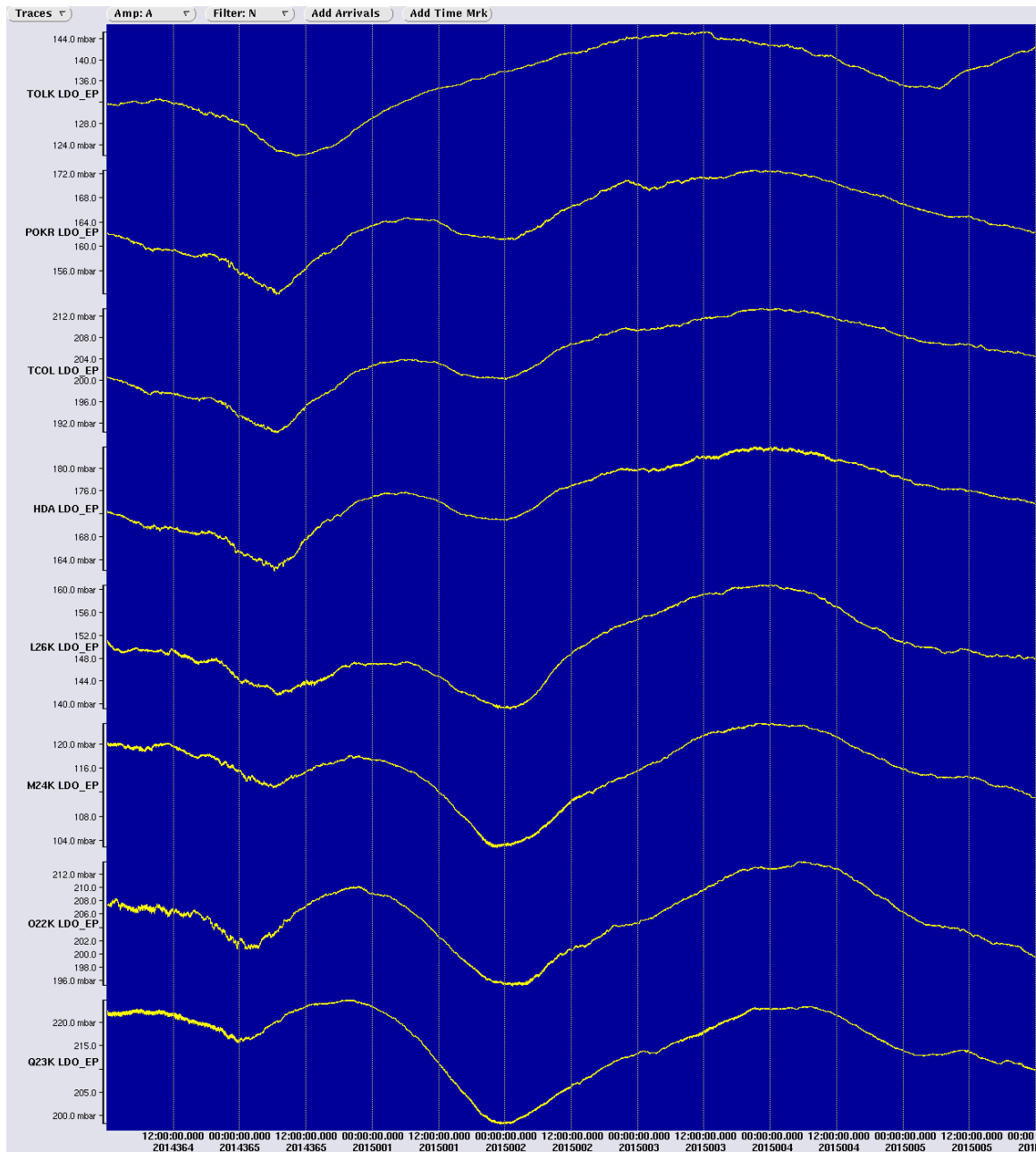


Figure 5 – A one-week snapshot of 1 sps Setra 278 barometric pressure data from 8 stations currently deployed in Alaska. Please note that the Setra records data at a static 800 mb below the absolute pressure measurements. We can see two troughs of low pressure in this one-week snapshot.