# EarthScope Transportable Array

### Alaska Deployment and collaborations



Bob Busby TA Manager

Bob Woodward IRIS Director of Instrumentation Services

Kasey Aderhold & Andy Frassetto IRIS Project Associates

Max Enders Station Deployment Coordinator

Dec 14, 2017 Fall AGU 2017 Fall Meeting ATA SIG

# **Meeting Plan**

Thursday, December 14<sup>th</sup> 3:30 - 5:00pm Hampton Inn & Suites, Dauphine I Room 1201 Convention Center Blvd

## Agenda:

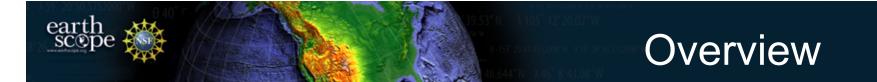
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Alaska TA: Introduction and Plans
Seismicity of Alaska
Emerging Science Lightning Talks - 5-minute pop-ups on recent research results using the Alaska TA

•Collaborations with ATA - 2-minute pop-ups focused on current instrumentation from collaborators at AVO, NASA, NOAA, NWS, etc.

•Short info updates focused on future directions like CCArrray, SZO, etc.

•Open Discussion - Data user feedback, unexpected observations, etc.



- Update on the Alaska Transportable Array;
   Current status: 194 new stations in a completed 280 station grid
- Review of observational capabilities available Seismometers, Strong Motion, Infrasound, Weather, Soil Temp

In the News:

KTUU Anchorage TV did a nice story on TA two weeks ago with deployment videos;

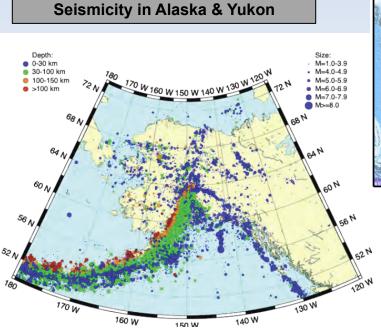
http://www.ktuu.com/video/?vid=461140883

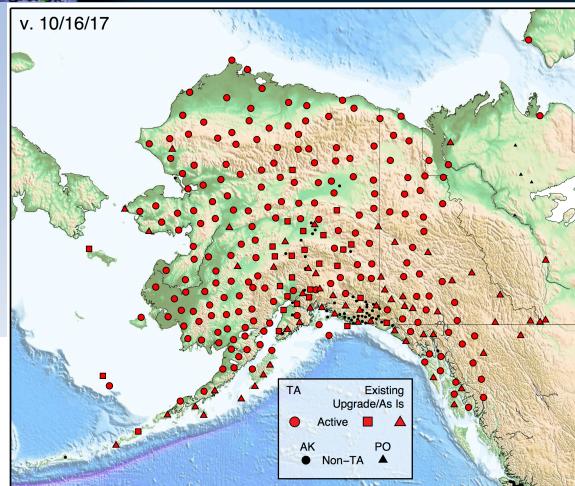
See also: www.usarray.org/Alaska



# TA in Alaska / Yukon

- ~280 sites
- 85 km spacing
- Broadband Seismometers Infrasound, pressure meteorlogical, Soil Temp
- <4hr Communications</li>
- Fully deployed 2017

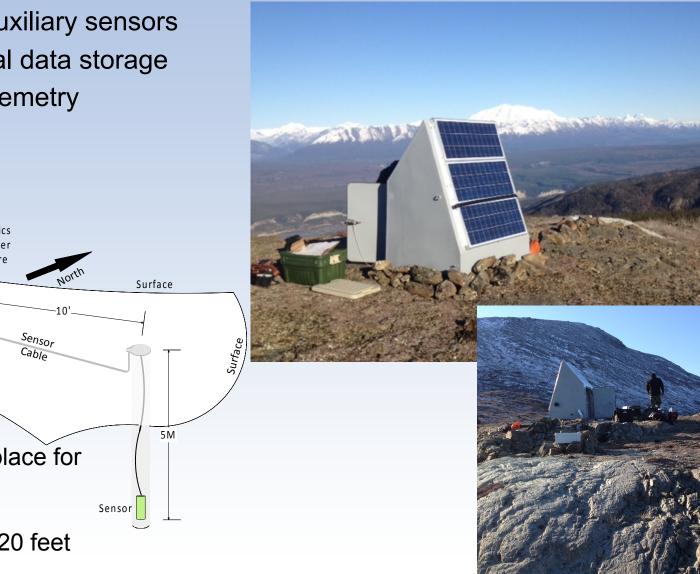




#### www.usarray.org/alaska

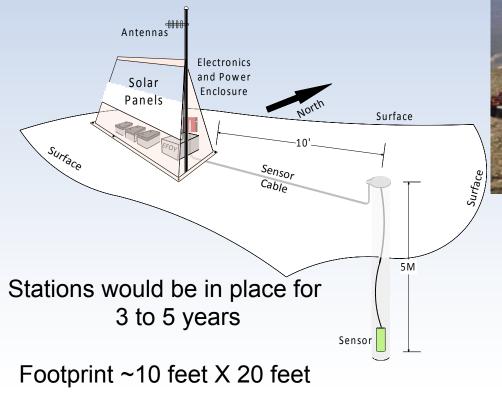
## **Basic Description of Buried** Sensor Design for AK

#### N25K Seismic Station



- Sensor: 3 component Broadband • seismometer & auxiliary sensors
- Datalogger & local data storage •
- Power & data telemetry

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# **TA Station details**

G25K: Hut Exterior view showing Hut antenna mount and interior view of electronics panel and battery bag.

earth scope

> 16.2 KWH of LiFePO4 Lithium Ion Batteries.

> > 7

## Sensor Emplacement

Most sites are installed via helicopter with custom portable drill.

earth scor

> Drill a 6 inch diameter hole 3 m into soil or rock. A steel casing follows bit and is grouted into place. In soil, an auger bit and PVC casing can reach depths of 5m.

3-4 person team constructs site and installs equipment



Drill on sling, and onsite below





# **Operations Summary**

## Activity in 2018

ear

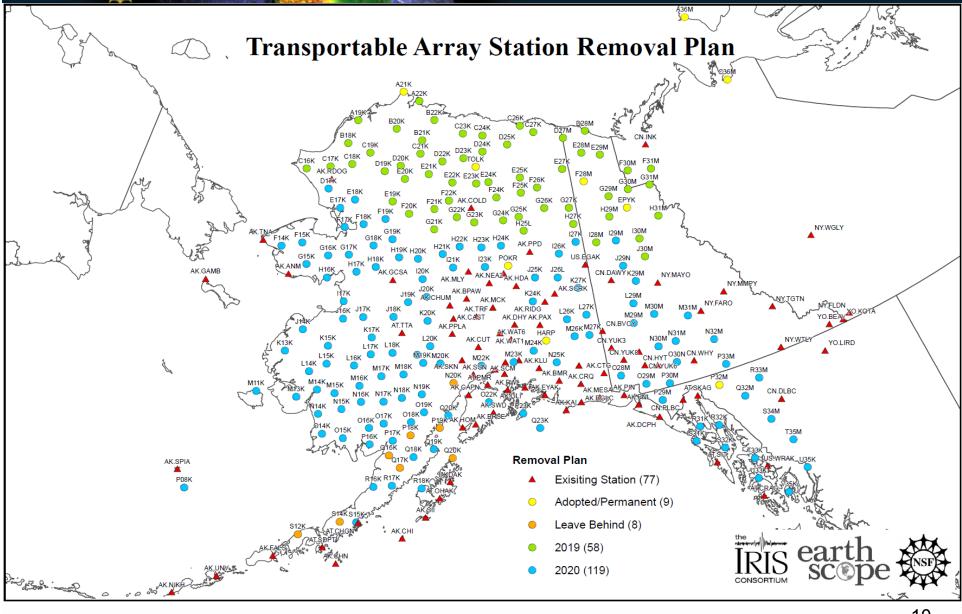
- Monitor and assess performance and diagnostics
- maintain data availability through station service
- adapt stations to lower cost comms as available

## **Proposed activity for 2019-2020:**

Station removals to begin in 2019 with about (60) Stations in the north, and continue in 2020 with about (120) stations further south, closer to subduction zone.

Adoption of stations or transitions to other Agencies may reduce removal need but must have plans in place by Sept 2018, with commitment by March 2019. 9

## Notional Removal Pattern



earth scope

# Collaborations

#### Seismology Partners:

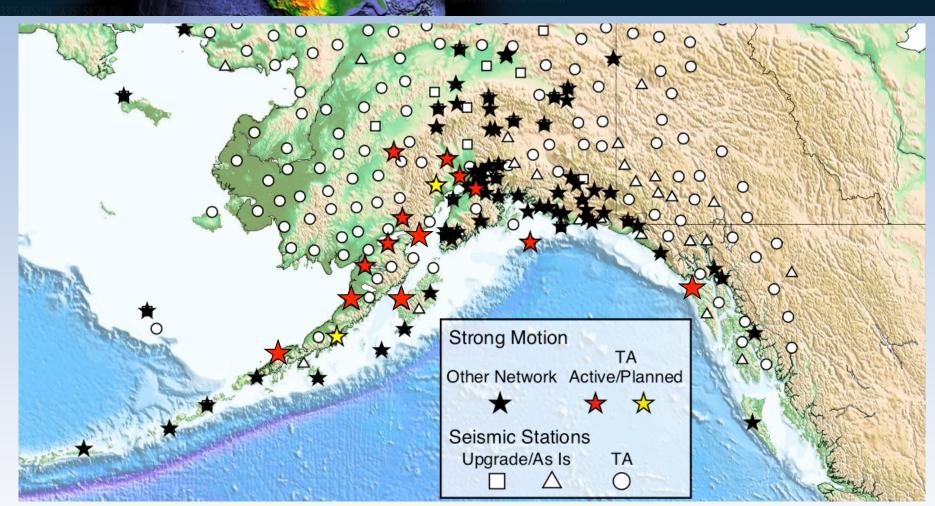
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> UAF Alaska Earthquake Center (AEC) USGS Alaska Volcano Observatory NOAA Tsunami Warning Center EarthScope Plate Boundary Observatory (PBO) Canadian Hazards Information Service (CHIS) Univ of Ottawa

**Other Science Partners:** 

UCSD Scripps Infrasound group Yukon Geological Survey NASA Arctic Boreal Verification Experiment (ABoVE) Soil Temperature and Meteorological Instruments National Weather Service Alaska Region Univ of Utah MesoWest Yukon Wildlands Fire Division

# **Strong Motion Sensors**

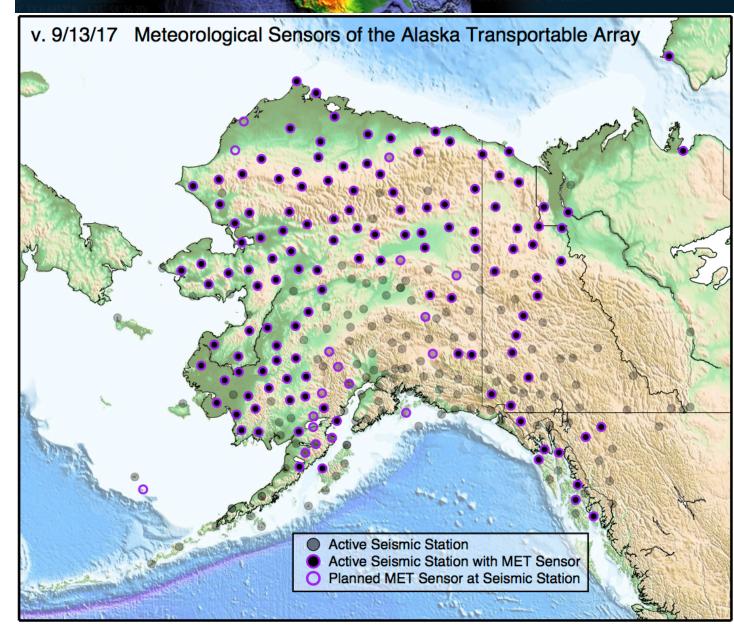


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 (13) SM sensors installed and operating (red stars),
 (2) additional sensors planned (yellow stars)
 Many existing stations have SM sensors (Black stars) in this region of Alaska Continuous telemetry at 40 sps for TA and 50 sps for AK.

# earth

## Met sensors in AK



35 TA, NSF 35 UCSD, NSF 32 NOAA NWS 40 NASA ABoVE 2 Yukon

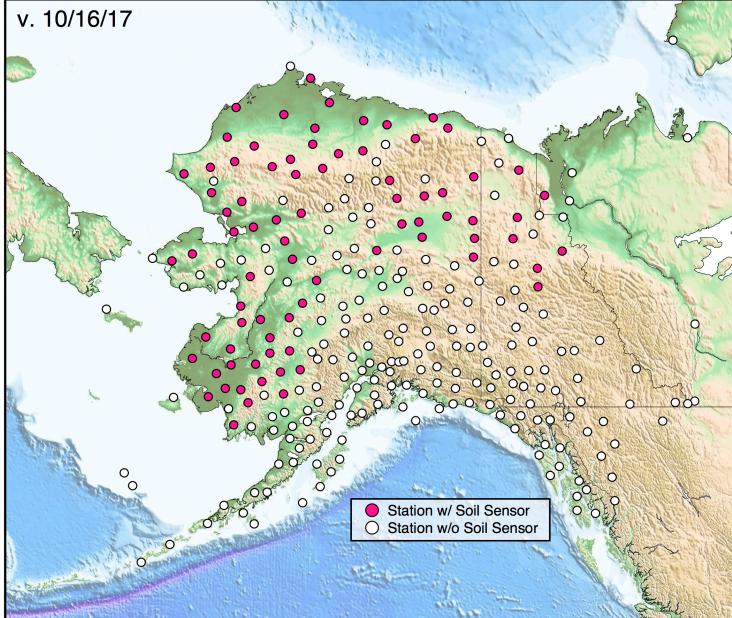
144 sensors

139 installed 13 planned

At 1 sps, telemetry: Temperature Pressure Wind Speed / Dir Humidity Rain Intensity

# earth

# Soil Temperature Profile



(78) Stations Supported by: NASA ABoVE Yukon Geo Survey

1-2.5M depths w/ 4 thermistors

Data stored locally

UAF PermaFrost Group V. Romanovsky P. Lipovsky

## Thanks to TA Team



2017 Transportable Array Team Meeting La Jolla, California

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# Want More Info?

## On the Web

- EarthScope www.earthscope.org
- USArray

earth

www.usarray.org

National Science Foundation
 *www.nsf.gov*

#### busby@iris.edu

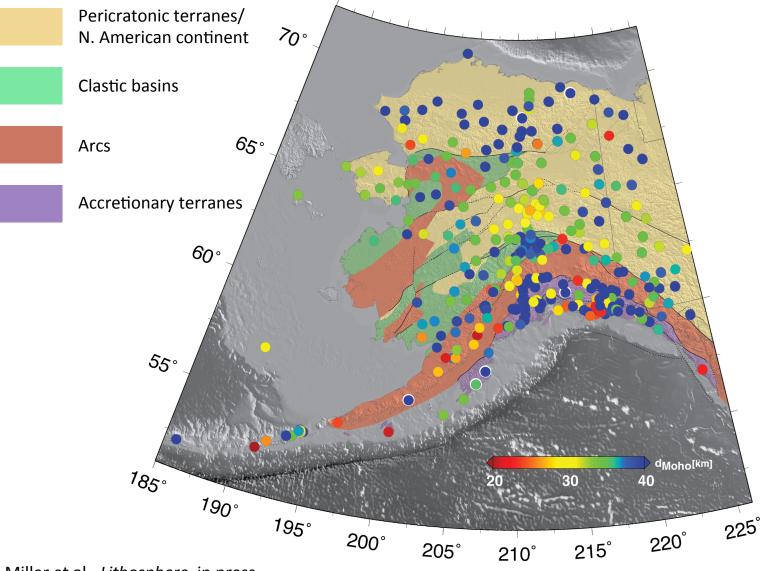
NSF

EarthScope is funded by the National Science Foundation.

**EarthScope** is being constructed, operated, and maintained as a collaborative effort with UNAVCO, and IRIS, with contributions from the US Geological Survey, NASA and several other national and international organizations.

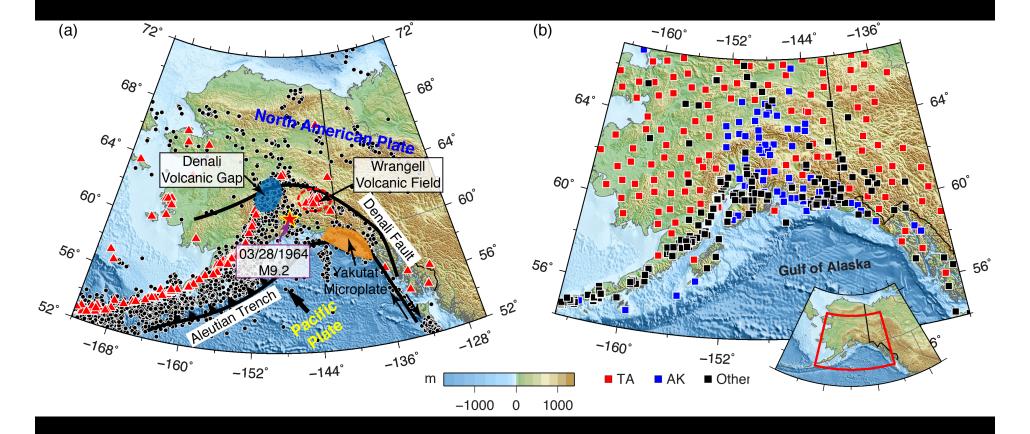
Dr. Meghan S. Miller Associate Professor, Research School of Earth Sciences The Australian National University

## Moho picks with major faults & terrane boundaries



Miller et al., Lithosphere, in press

# Explore Dynamics of the Alaska Subduction System using Full-Wave Anisotropy Tomography

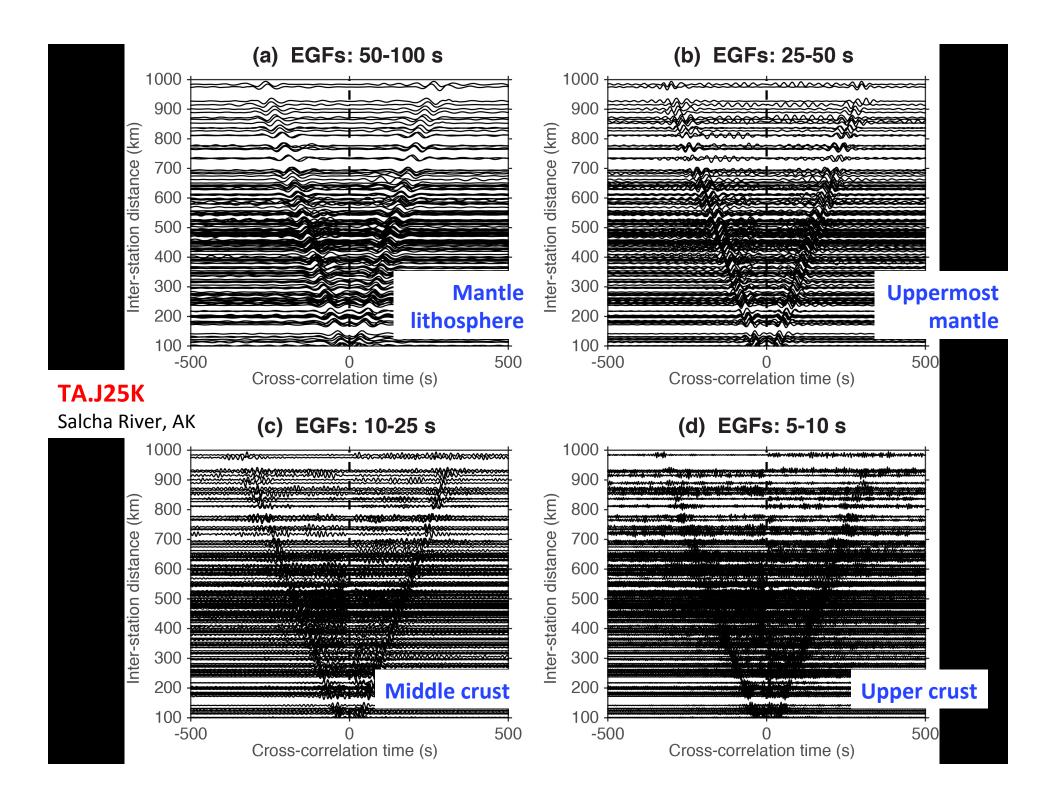


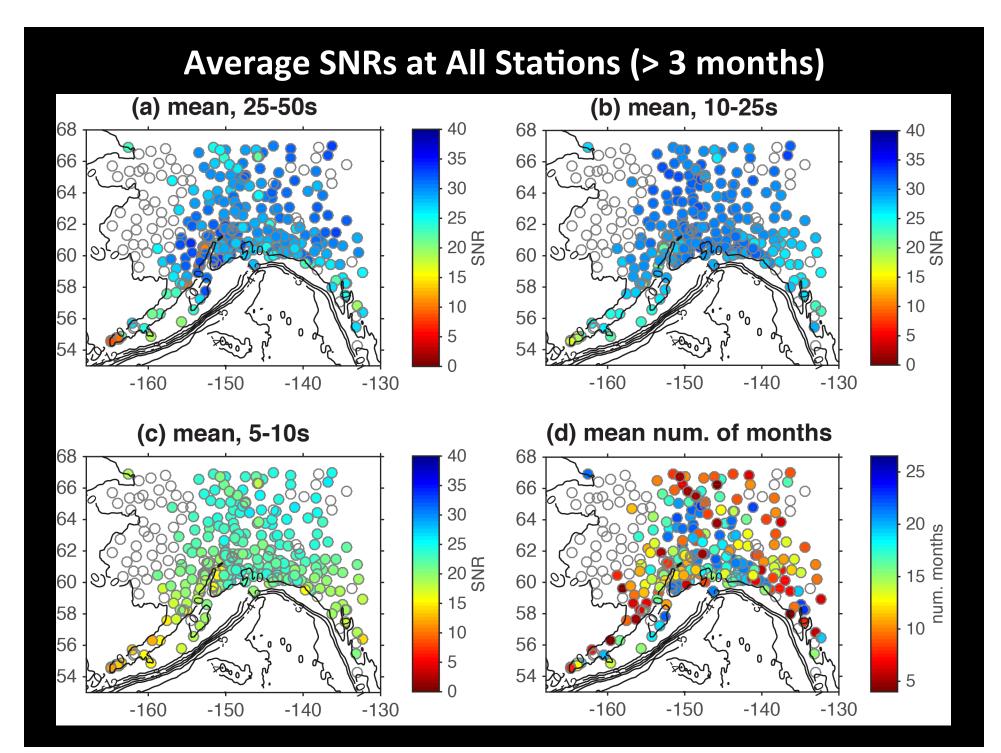
Xiaotao Yang Haiying Gao

Department of Geosciences University of Massachusetts Amherst

## Scientific Questions

- What controls the along-strike segmentation of seismicity and magmatism?
- What are the properties of the mantle flow?
- How does the subducting slab interact with mantle materials and impact mantle flow patterns?

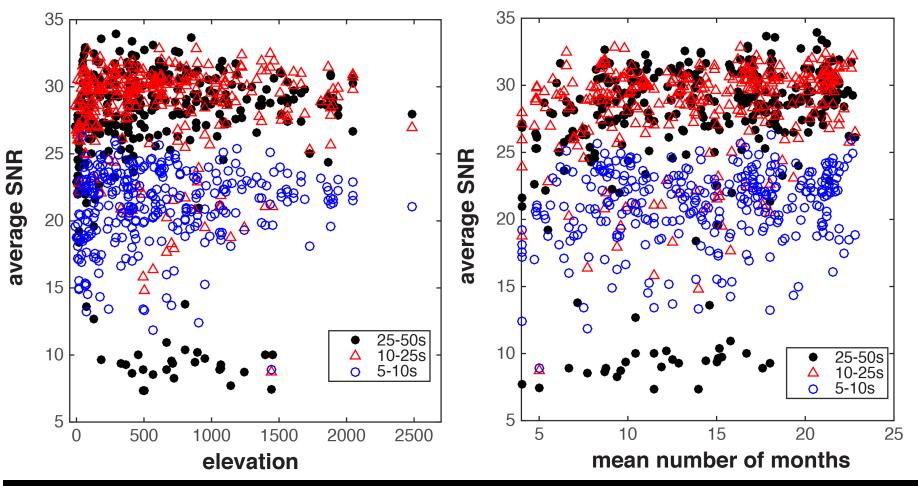




## Average SNRs at All Stations (> 3 months)

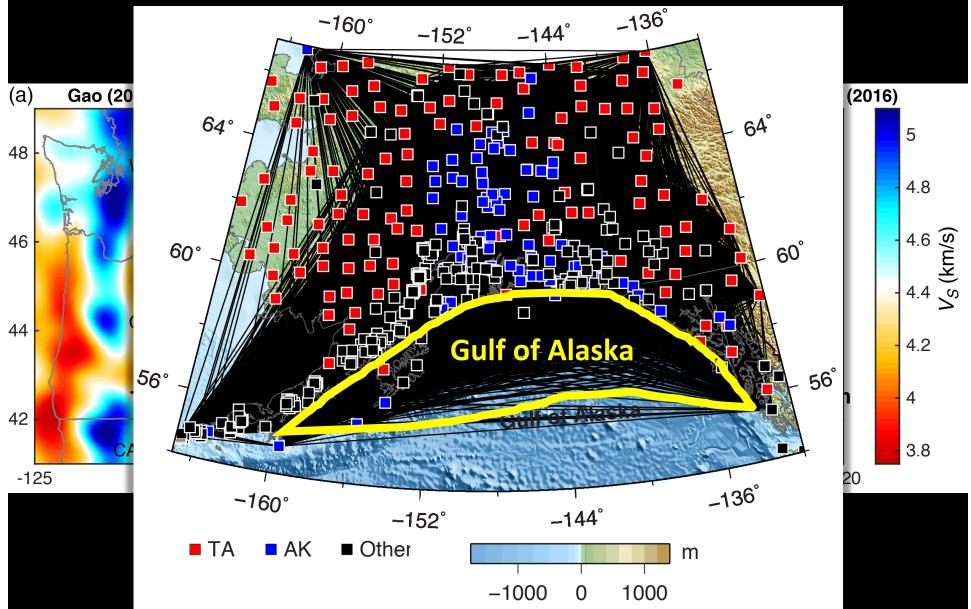
**SNR vs. Station Elevation** 

SNR vs. Duration



- Higher SNRs at higher elevations
- Sufficiently high SNRs with > 7-8 months data

# Two Advantages: higher resolution & coverage for offshore region (Gulf of Alaska)



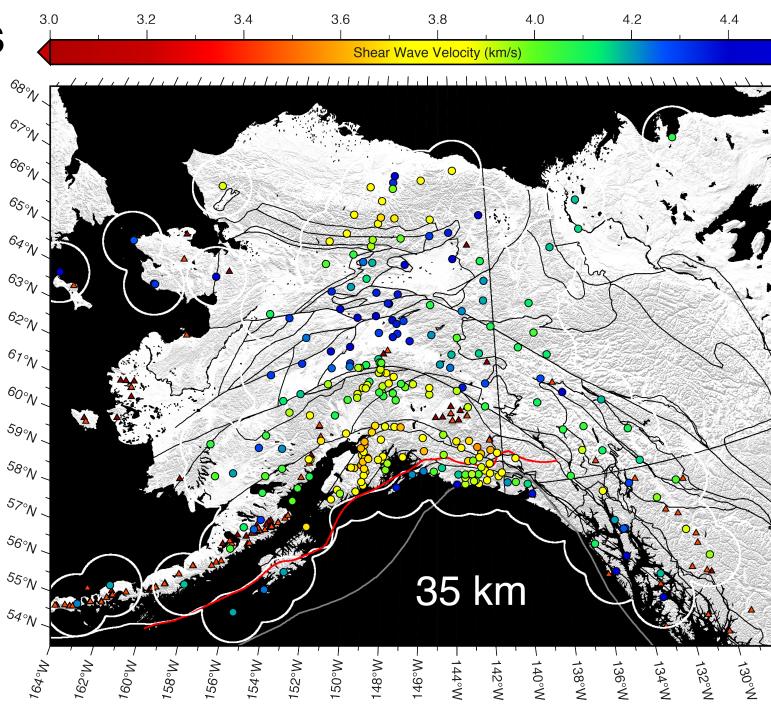
## Expectations

- Well-defined lithospheric velocity model before the start of the Alaska Amphibious Community Seismic Experiment (AACSE), summer 2018
- Inclusion of anisotropy
- Incorporation of AACSE stations (in particular, OBS for better offshore coverage)

Kevin M. Ward Department of Geology and Geophysics The University of Utah

# **Iodel Results**

cles show 1-D It surface-wave d receiver ction inversion ults for each tion

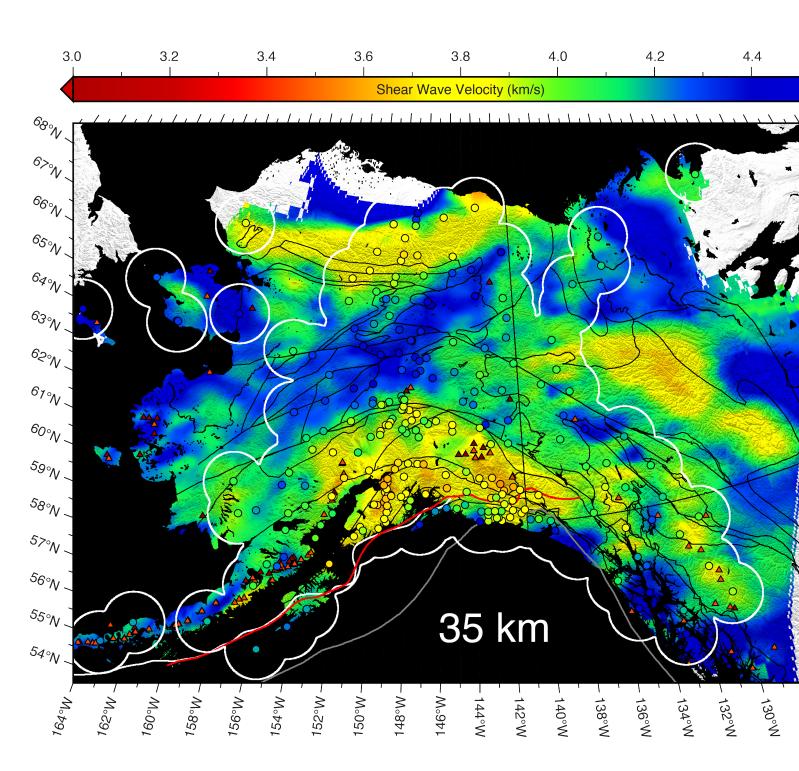


Lin (in-prep)

# epth Slice

cles show 1-D It surface-wave d receiver ction inversion ults for each tion

p slice shows face-wave only ersion results

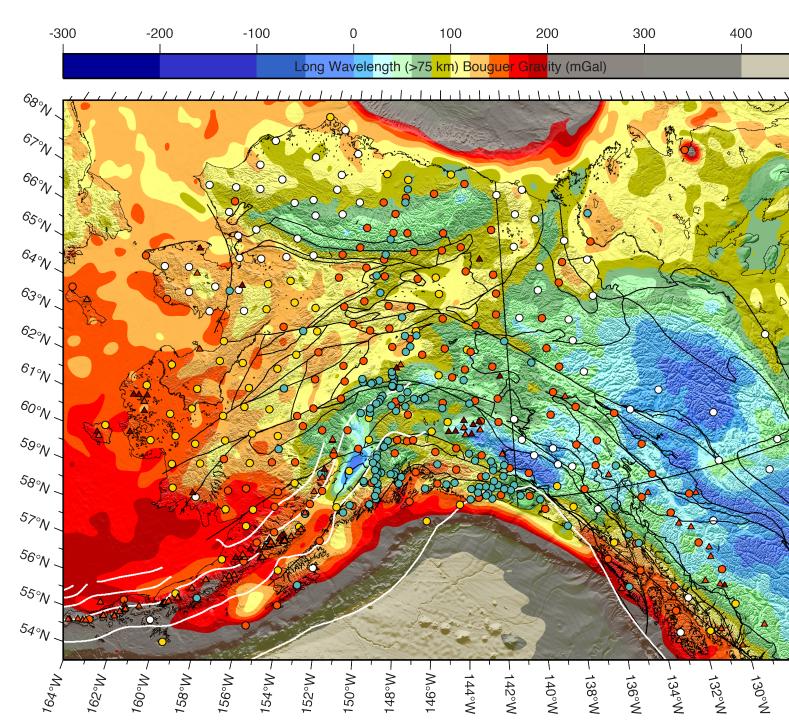


Lin (in-prep)

# guer Gravity

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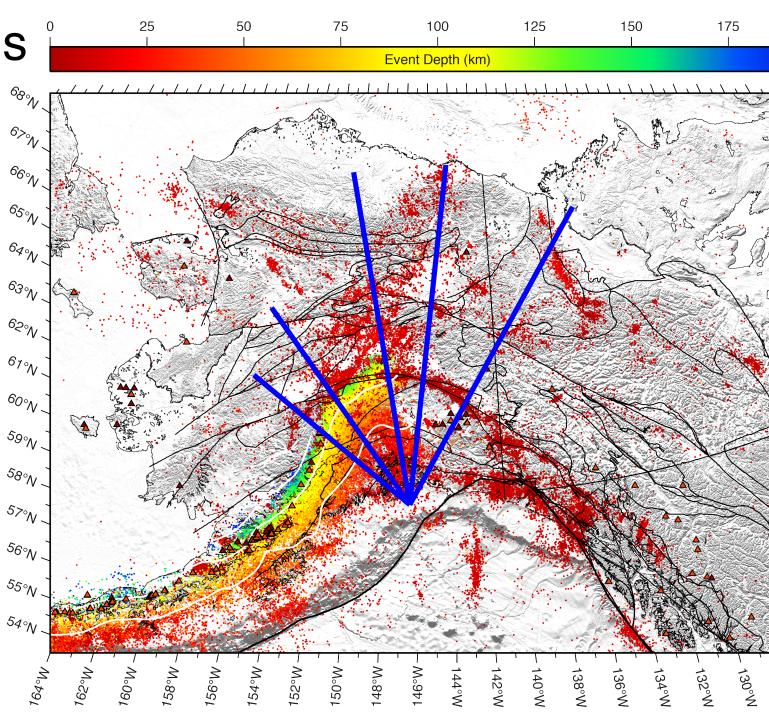
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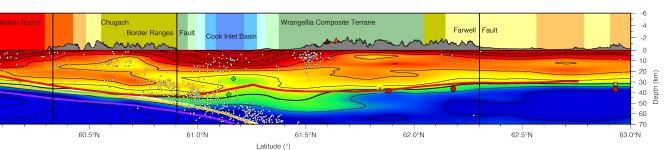
o et al., 2012

# ross-Sections

est-to-east fan of ss-sections own in next slide m top-to-bottom

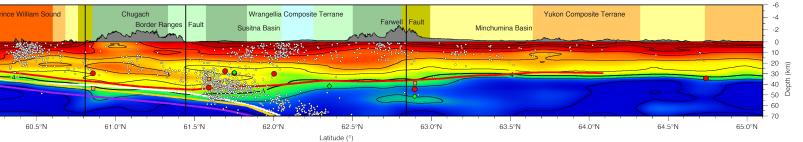


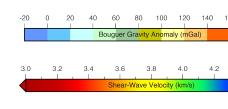
Earthquake Center

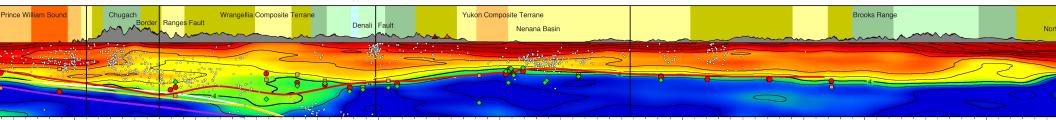


# Vs Cross-Sec

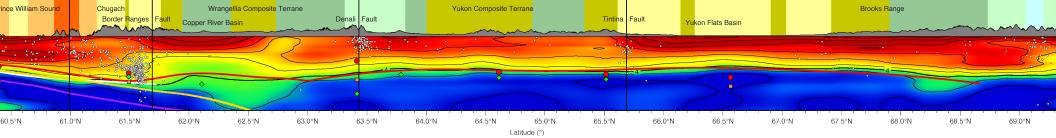
#### Ward & Lin (i

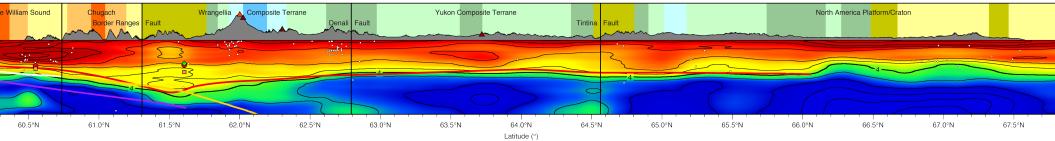


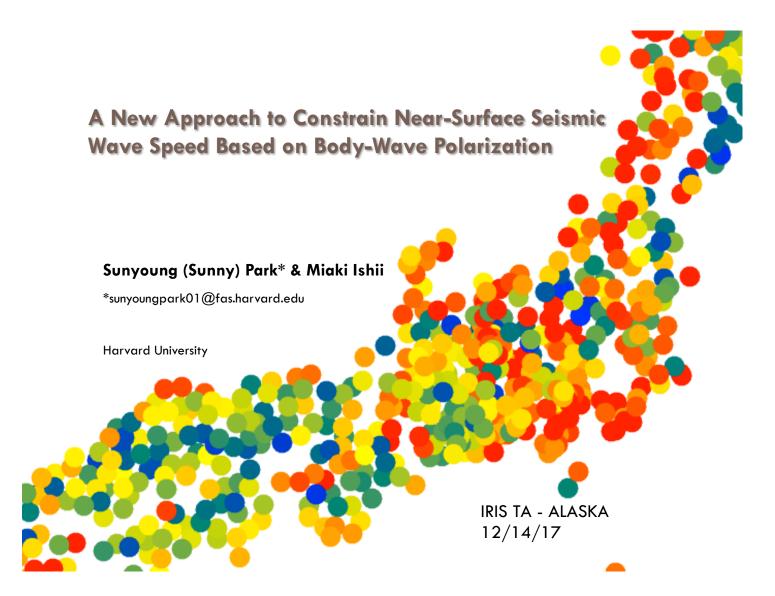




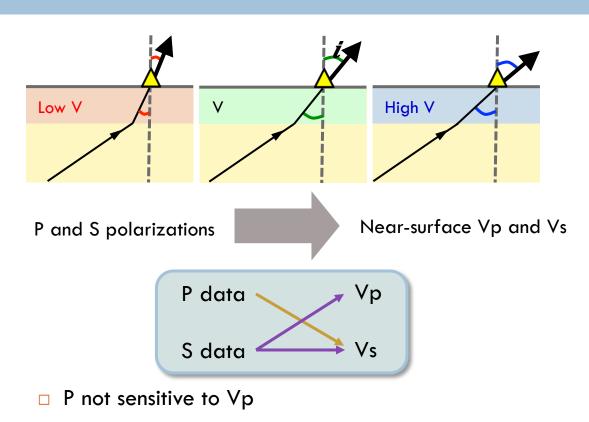
63.0°N 63.5°N 65.5°N 66.0°N 66.5°N 67.0°N 67.5°N 68.0°N 68.5°N 60.5°N 61.0°N 61.5°N 62.0°N 62.5°N 64.0°N 64.5°N 65.0°N 69.0°N Latitude (°)





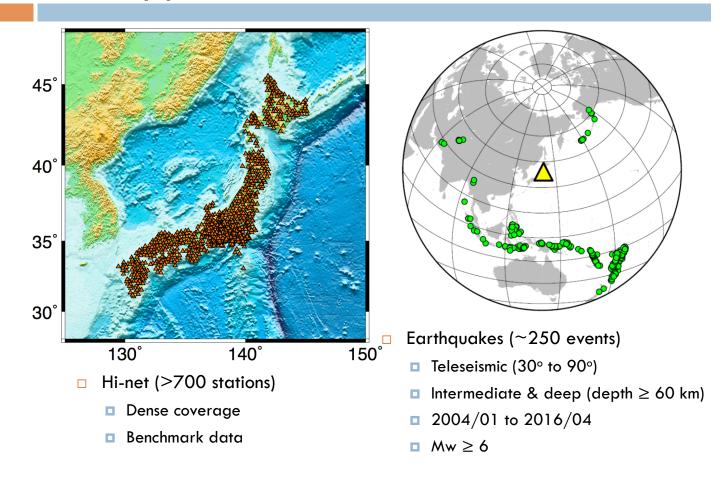


## **Polarization Analysis**

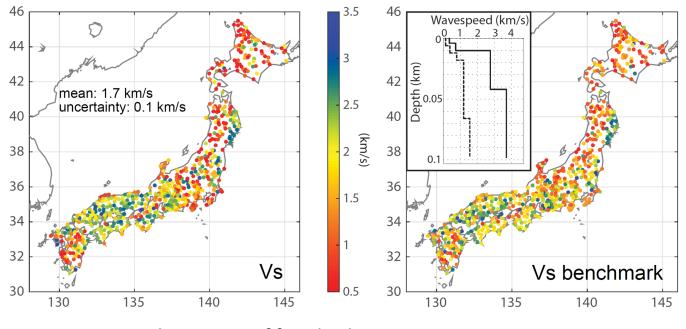


Highest frequency information on Vs

### Application to the Hi-net Data



## Near-Surface Vs

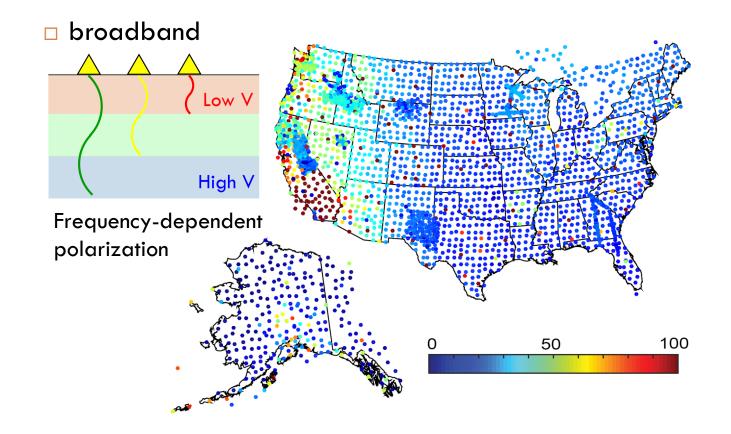


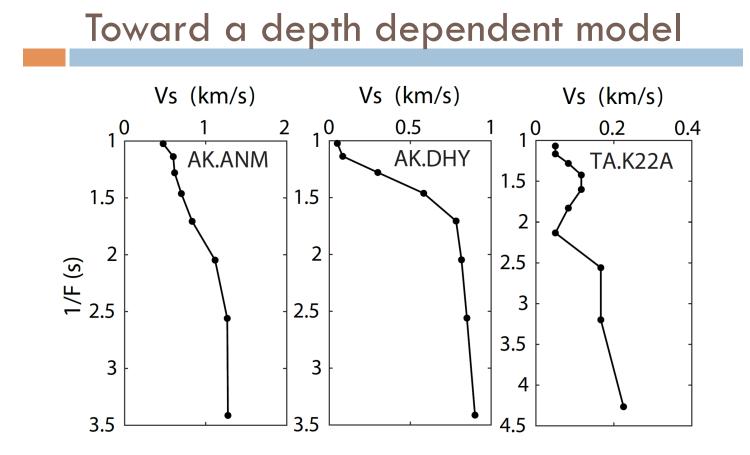
□ Resolves Vs at ~100-m depth

Correlation with topography, geology, and volcanoes

Park & Ishii, in review

## Application to the U.S. Data





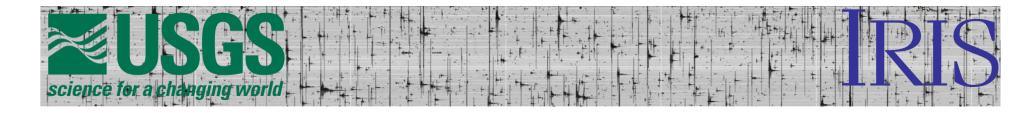
### Conclusions

- □ A new approach to constrain near-surface seismic structure
  - Single station
  - Non-invasive & Computation-efficient
  - Detection of instrument response issues
  - **D** P-wave polarization  $\rightarrow$  Vs (high frequency)
- □ Hi-net
  - Estimates ~ Well measurements
  - Correlation with geology, topography, and the volcanoes
- □ U.S. stations
  - Frequency dependence  $\rightarrow$  Depth varying  $\checkmark$

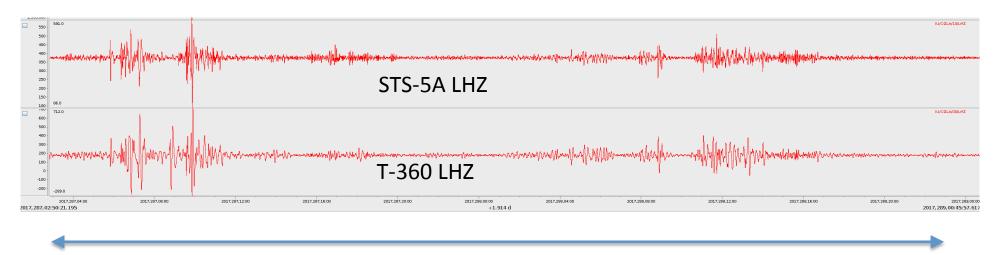
Friday Afternoon Poster:

**S53A-0658**: P- and S-Wave Speeds of the Very Upper Crust Estimated by a New Technique Based Upon Body-Wave Polarization

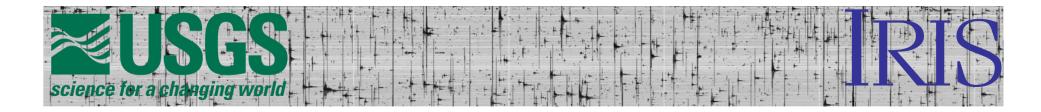
Rob Anthony and Adam Ringler Albuquerque Seismological Laboratory

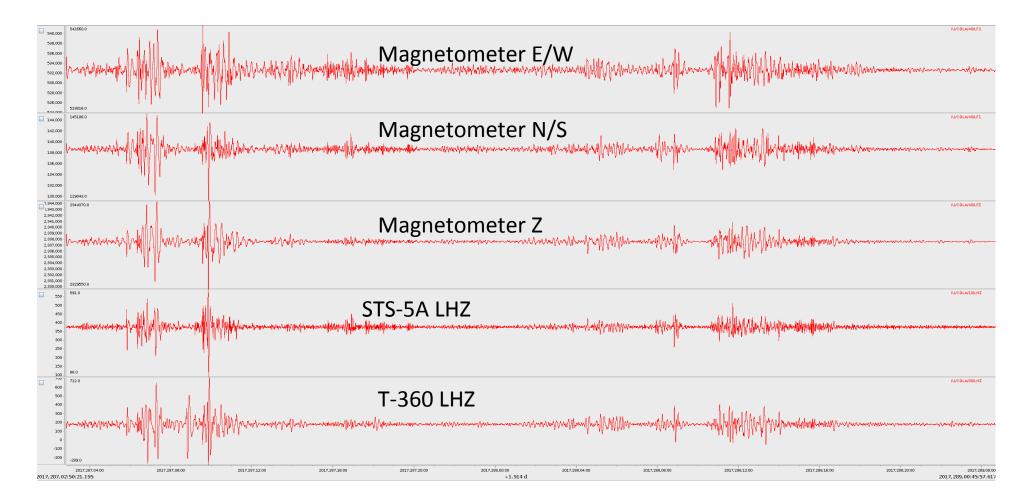


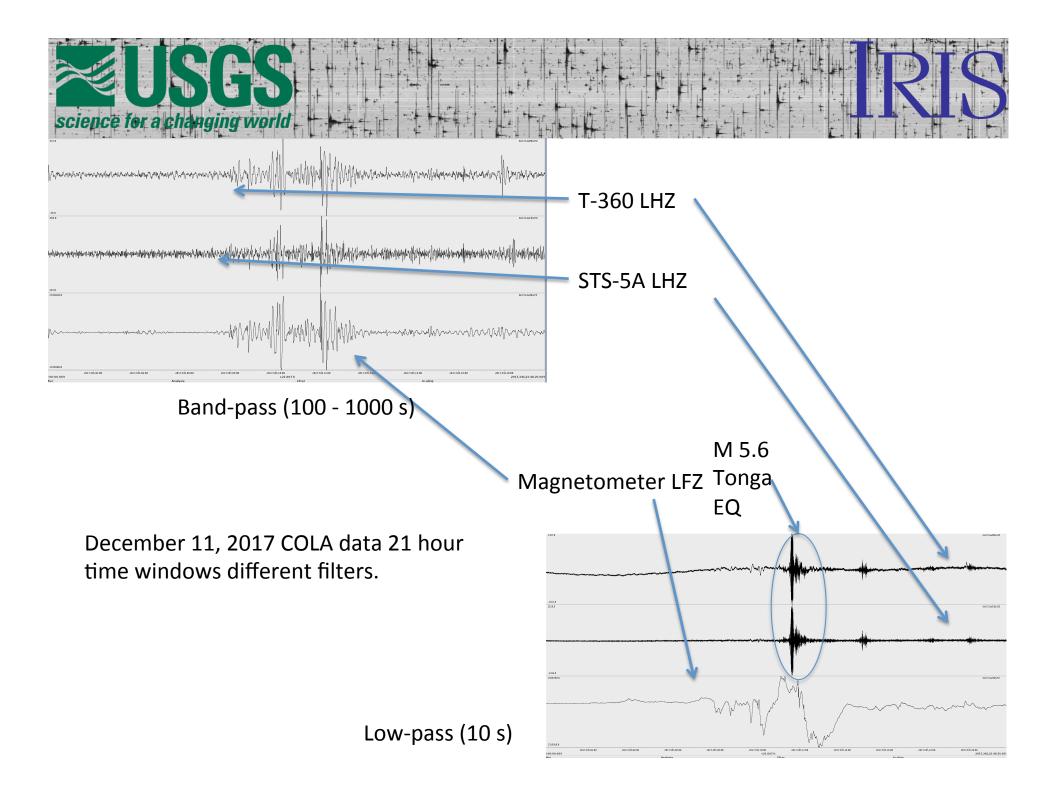
## Signals Recoded on the GSN station COLA (Fairbanks, Alaska)

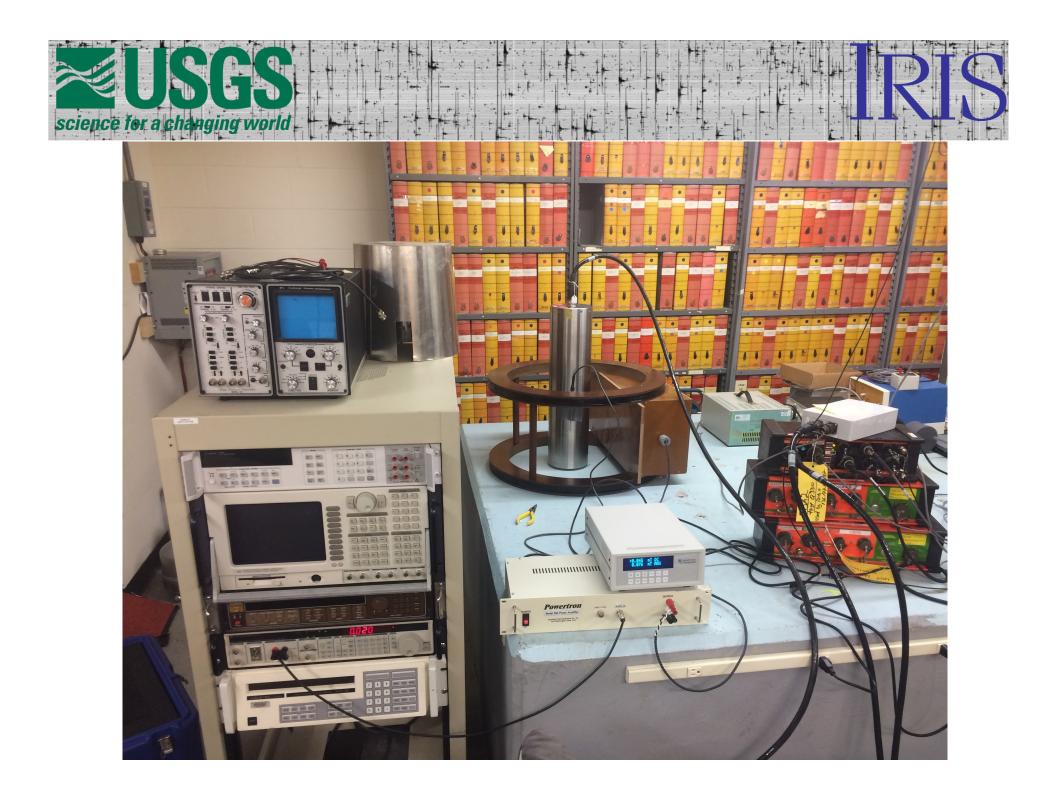


2 days (band-passed 100-1000 s)









#### **Collaborations with ATA - Jacques (MesoWest) Presentation Notes**

#### Slide 1:

To help facilitate access to the USArray TA data for meteorologists, researchers at the University of Utah developed algorithms to include the TA observations with other surface weather data collected across the continental United States and Alaska. TA 1 Hz observations from the atmospheric pressure and all-in-one weather sensors are accessed by MesoWest/SynopticLabs using the IRIS Web Services. These 1 Hz data are converted into 5-minute observations and stored in the a database archive. MesoWest provides real-time access to the 5-minute TA data via existing web products and the SynopticLabs Data API service. The data API is used to access the TA data by National Weather Service entities, including local weather forecast offices and regional offices including Western and Alaska regions. SynopticLabs also transmits the TA data to the NOAA Meteorological Automated Data Ingest System, or MADIS. From MADIS, the data can also be accessed by local National Weather Service forecast offices and the National Centers for Environmental Prediction.

#### Slide 2:

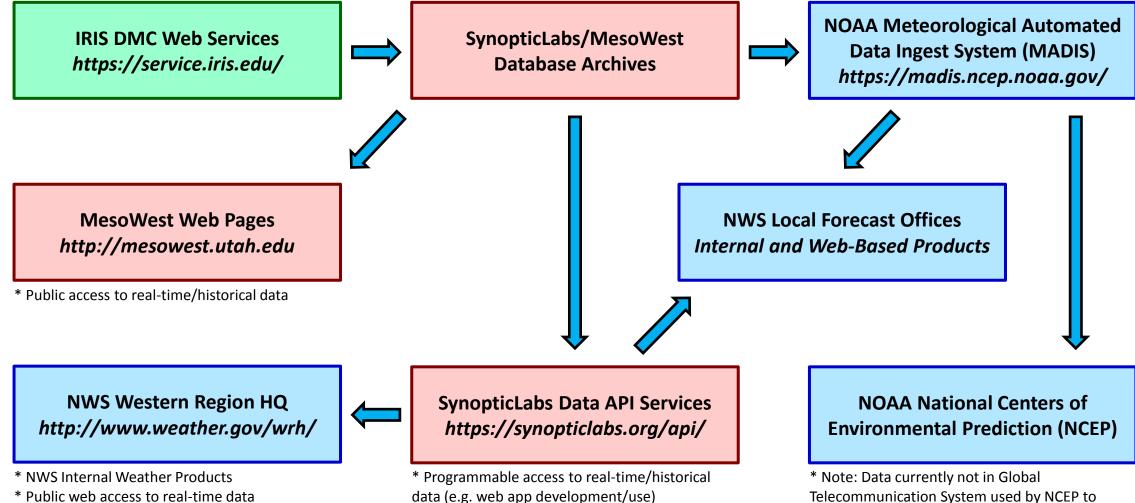
The National Weather Service and MesoWest have several web-based products where the Alaska TA data can be viewed. On the left is an interactive map available from the National Weather Service which shows the deployed Alaska TA stations. The two images on the right show data in tabular format for the Arctic Creek, Alaska TA site. The top-right product was developed by MesoWest, and the bottom right by National Weather Service Western Region headquarters.

#### Slide 3:

In addition to the dissemination of TA data by MesoWest, a recent NSF project initiative led to the development of two additional resources to improve TA pressure data access to the atmospheric science community. 1 Hz surface pressure observations continue to be collected, archived, and displayed on the NSF research project website shown on the left for atmospheric scientists to utilize. An official repository was also created within the National Center for Atmospheric Research's Research Data Archive (RDA), which contains TA 1 Hz surface pressure data from 2010 through 2015. Our group plans to update the archive through the end of 2017 early next year.

## **Real-Time ATA Data Flow to NOAA/NWS**

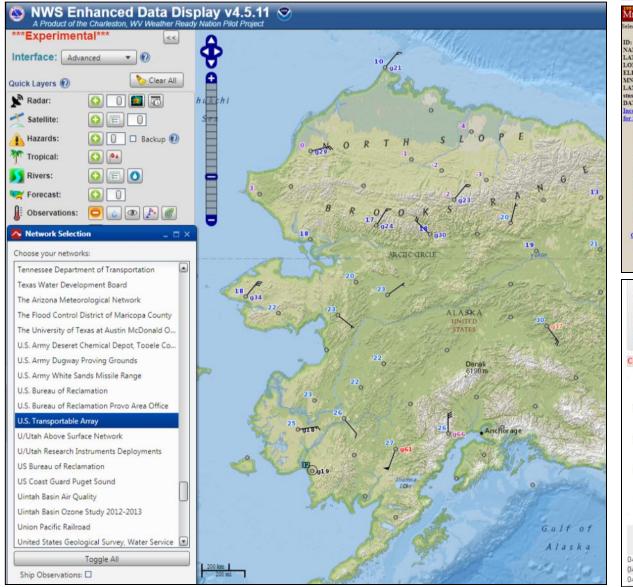
 Starting from IRIS DMC, TA 1 Hz weather data (Setra 278 pressure and Vaisala WXT520 sensors) are accessed in realtime on a SynopticLabs/MesoWest cloud server, transformed into 5-minute observations, and disseminated to multiple NOAA and NWS agencies/groups via automated routines. Data are also accessed from the SynopticLabs API Services.



distribute to other modeling groups

## **Real-Time ATA Data in NOAA/NWS and MesoWest**

#### http://preview.weather.gov/edd/



#### http://mesowest.utah.edu/cgi-bin/droman/meso\_base\_dyn.cgi?stn=F14KX

MESOWEST Region Al					-	er Maps 🔻 Go							
elected Profile: None Selected  STATION INFO		C											
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ATITUDE: 65.47420 ONGITUDE: -166.32880													
ELEVATION: 872 ft	G	raphical Link	s 1	12:50	fax Since 0:00 (	AKS) Min Since 0:0	00 (AKS) 2	4 Hour Maximum	24 Hour Minim	um			
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http://www.wrh.noaa.gov/mesowest/getobext.php?sid=F14KX

## Atmospheric Community – 1 Hz TA Pressure Data Access

• 2013-2017 NSF Project Task: Improved Access to TA 1 Hz pressure data to Atmospheric Science Research Community

#### Research Project Website: http://meso1.chpc.utah.edu/usarray/ NCAR Official Research Data Archive: http://dx.doi.org/10.5065/D6028PRS Home Real-Time Maps Last 24 Hours Archives Signatures References Research Data Archive weather $\bullet$ data $\bullet$ climate **USArray Archived Data Interface** Computational & Information Systems Lab This interface provides access to archived and real-time microbarograph data from 1225 USArray stations via graphical products. Go to Dataset: Data Archive Period: 2010-01-01 to 2017-12-01 Find Data Ancillary Services Web Services For Staff About/Contact Data Citation Stations Reporting in Real-Time: 384 EarthScope USArray Transportable Array (TA) Surface Pressure Observations Sampled at 1 Stations with Archived Data: 841 Hz Frequency The interactive map below displays active stations in green, while inactive stations are shown in gray. ds386.0 DOI: 10.5065/D6028PRS For those interested in downloading the 1 Hz surface pressure data from stations on this web interface, we encourage users to visit For assistance, contact Bob Dattore (303-497-1825) an official repository created within the NCAR Research Data Archive (RDA). Hide Radar Imagery Description Data Access Documentation Help with this page: RDA dataset description page video tour Abstract: The EarthScope USArray Transportable Array (TA) contains over 400 seismic station platforms deployed in a pseudo-grid fashion (spaced approximately 70 km apart) across a portion of the United States. This array is part of a large initiative within the geoscience field to improve earth mapping and understanding of subsurface properties. Individual platforms report for 1 to 2 years and then are retrieved and redeployed farther east. Atmospheric pressure sensors were added to many platforms in 2010 while the array was deployed in the Central U.S. to assist with identification of seismic signals produced by atmospheric phenomena. These sensors have resulted in a tremendous dataset of surface pressure observations with high temporal frequency not commonly found in atmospheric sciences outside of smaller field campaigns. This dataset provides surface pressure observations at 1 Hz frequency from these deployments beginning 1 January 2010. The years 2010-2011 feature deployments over the central U.S. Great Plains, 2012-2013 over the interior eastern U.S., and 2014-2015 along the U.S. east coast. While average station life is 1 to 2 years, some deployments have been kept in place and thus have longer records. Further, the next phase of the TA project has begun with several platforms deployed in Alaska, which will continue over the next few years. There are also deployments located near the Cascade Mountain range in the Pacific Northwest. Data files are provided in HDF5 format, where a single file contains data for a particular year and station. Basic metadata and quality control files are also available. Presently contains 1 Hz pressure data from 1 Jan 2010 - 31 Dec 2015 Plan to extend archive to 31 Dec 2017 upon completion and review of 2017 dataset Powered by Leaflet --- Map tiles by Stamen Design, CC BY 3.0 --- Map data @ Open Algorithms continue to collect/archive TA 1 Hz pressure observations daily

• Map/graphical products available to explore archived pressure observations and pressure perturbations produced by atmospheric phenomena

# Augmentation of the USArray sites with temperature profilers

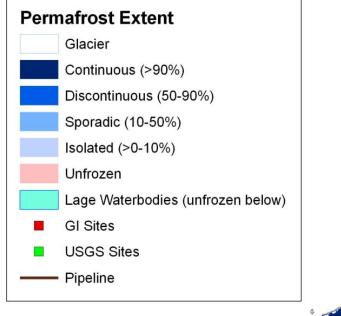
Dmitry Nicolsky, Alexander Kholodov, and Vladimir Romanovsky

University of Alaska Fairbanks, Geophysical Institute December, 2017

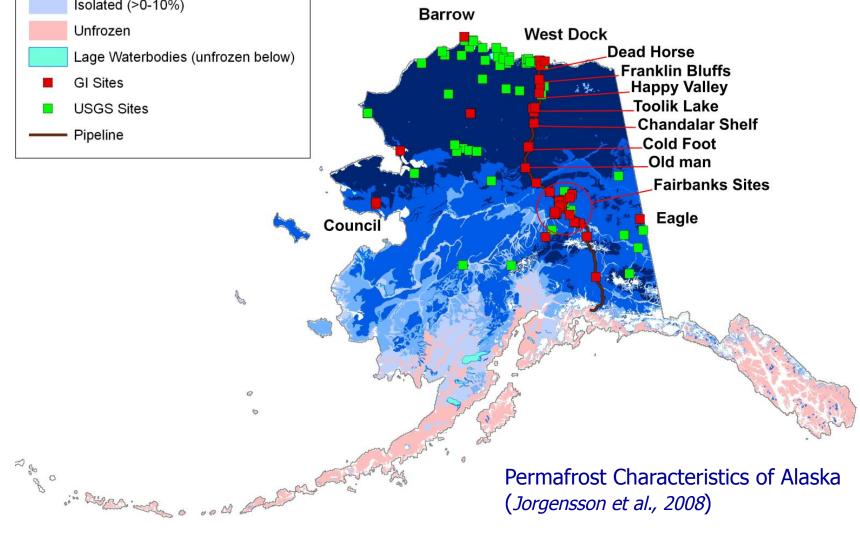




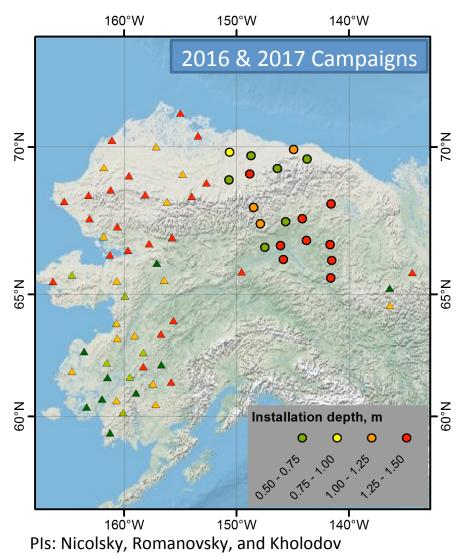




### Permafrost Distribution in Alaska and Permafrost Observatories Location



# Augmentation of the USArray sites with temperature profilers



**Project Goal:** To measure active layer and permafrost temperature distribution and dynamics across the ABoVE domain

- During 2016 campaign 19 USArray sites
- During 2017 campaign 55 USArray sites
- Currently the plan is to upload temperature data and distribute it to the public
- 4-8 sensors to measure temperature at and below the ground surface





## Conclusions

- Despite our accumulating knowledge of changing permafrost, future permafrost dynamics and its impacts remain poorly quantified especially on local scales
- USArray sites capture heterogeneity across the landscape and compliment existing data collection efforts
- Including observations of permafrost temperatures in the EarthScope set of instrumentation in Alaska will improve our ability to monitor and to predict near-term changes in permafrost