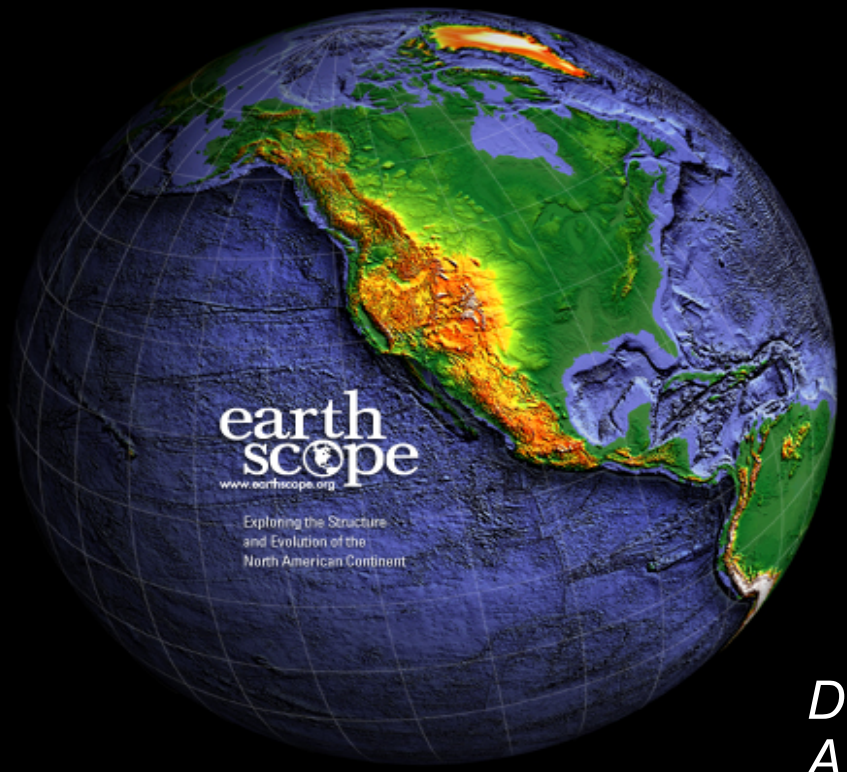
EarthScope Transportable Array

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 14th 3:30 - 5:00pm
Hampton Inn & Suites, Dauphine I Room
1201 Convention Center Blvd

Agenda:

•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.

Overview

- 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:

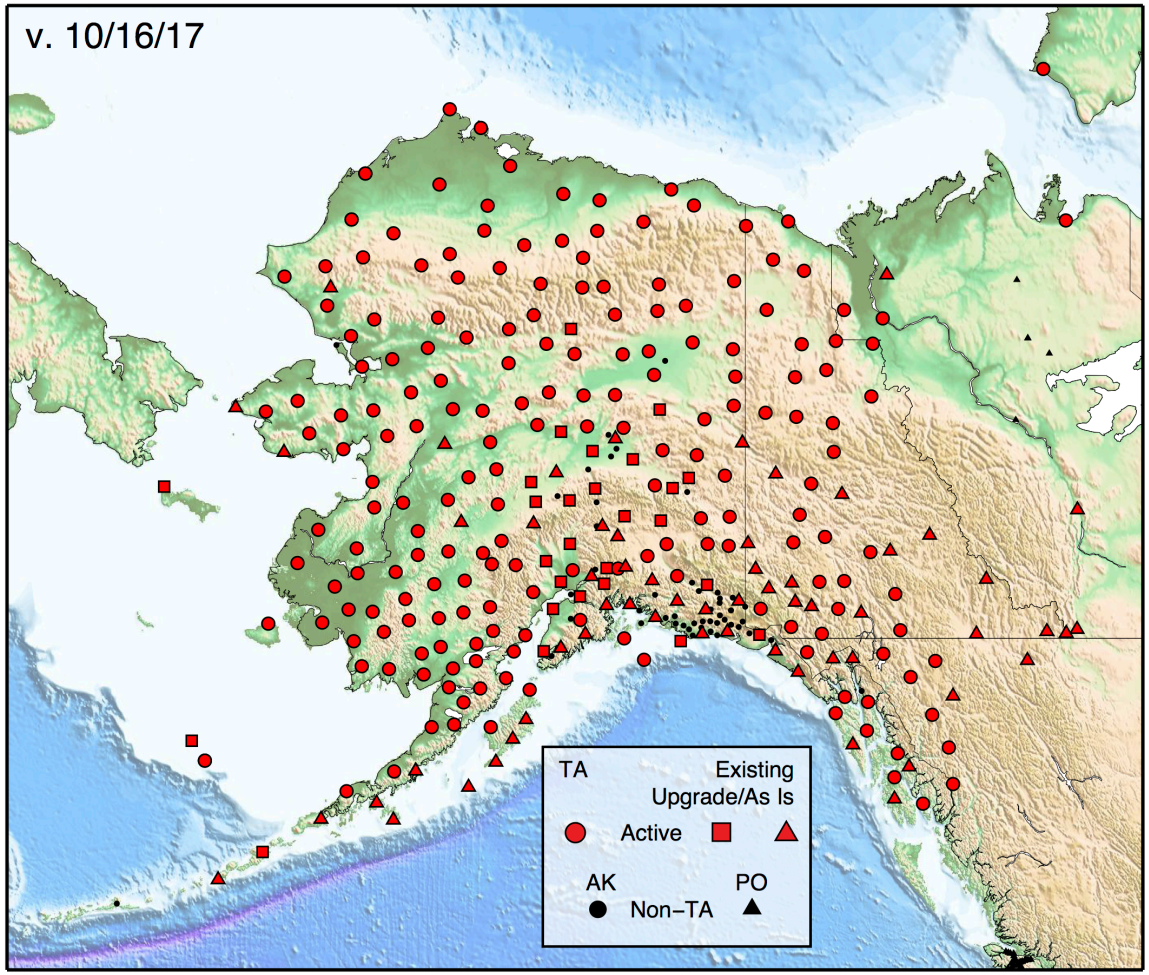
KTUU Anchorage TV did a nice story on TA two weeks ago with deployment videos;

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

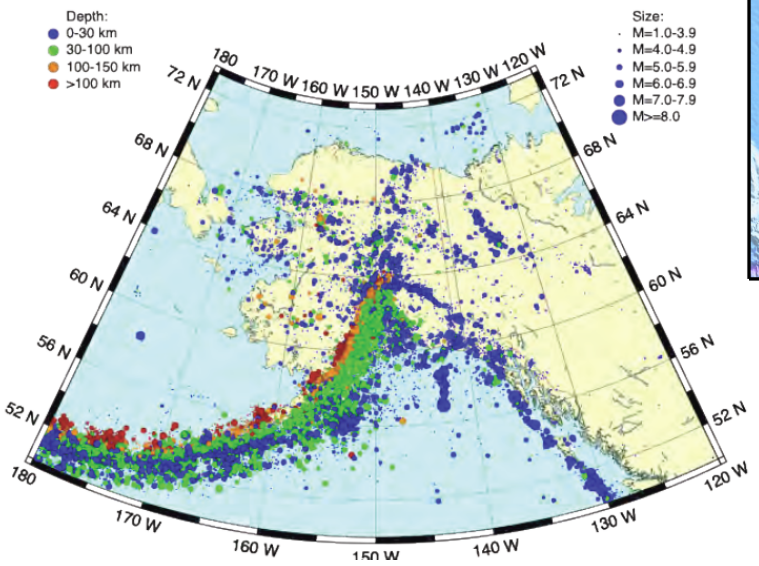
See also: www.usarray.org/Alaska

TA in Alaska / Yukon

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



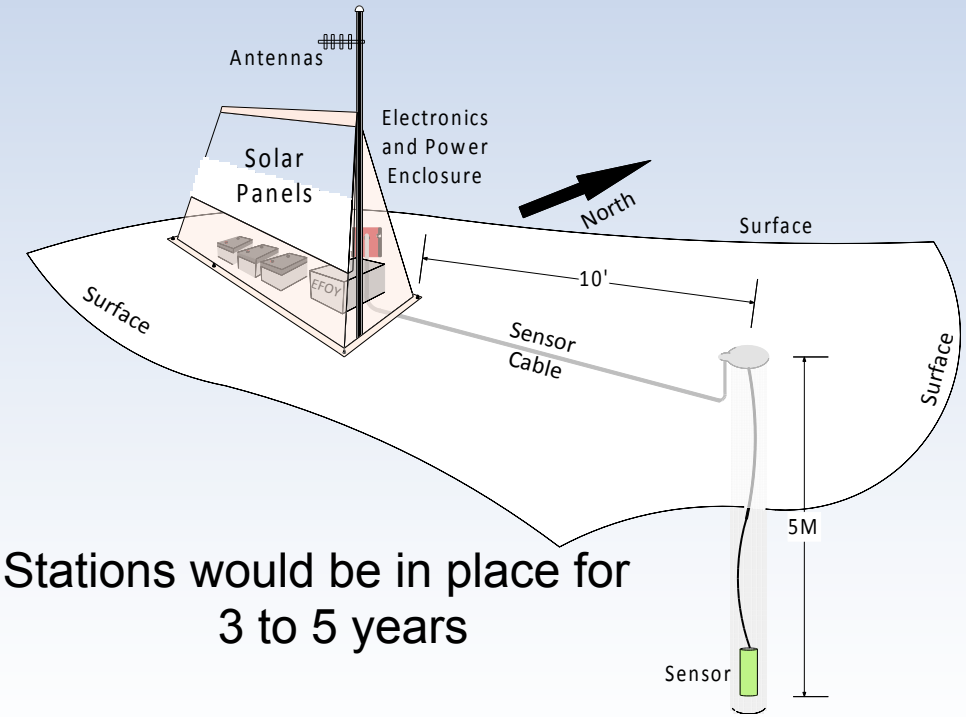
Seismicity in Alaska & Yukon



www.usarray.org/alaska

Basic Description of Buried Sensor Design for AK

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

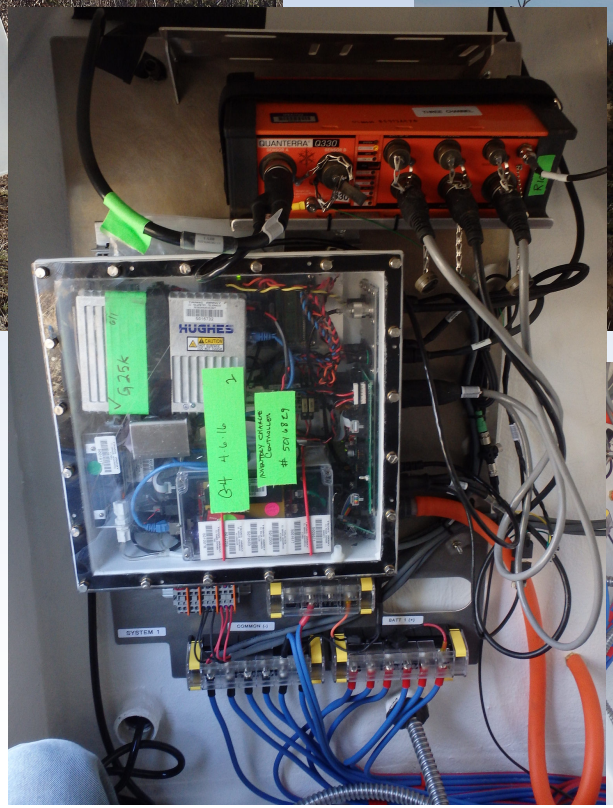


Stations would be in place for 3 to 5 years

Footprint ~10 feet X 20 feet

N25K Seismic Station

TA Station details



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

16.2 KWH of LiFePO4 Lithium Ion Batteries.

Sensor Emplacement

Most sites are installed via helicopter with custom portable drill.

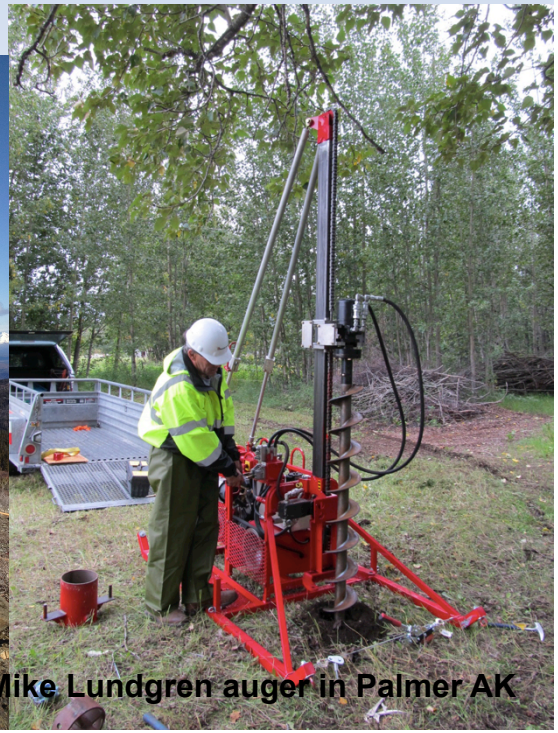
Drill a 6 inch diameter hole 3 m into soil or rock. A steel casing follows bit and is grouted into place. In soil, an auger bit and PVC casing can reach depths of 5m.

3-4 person team constructs site and installs equipment

Drill on sling, and onsite below

Hammer Drilling, AK.SCRK

Hammer drill, N25K



Mike Lundgren auger in Palmer AK

Operations Summary

Activity in 2018

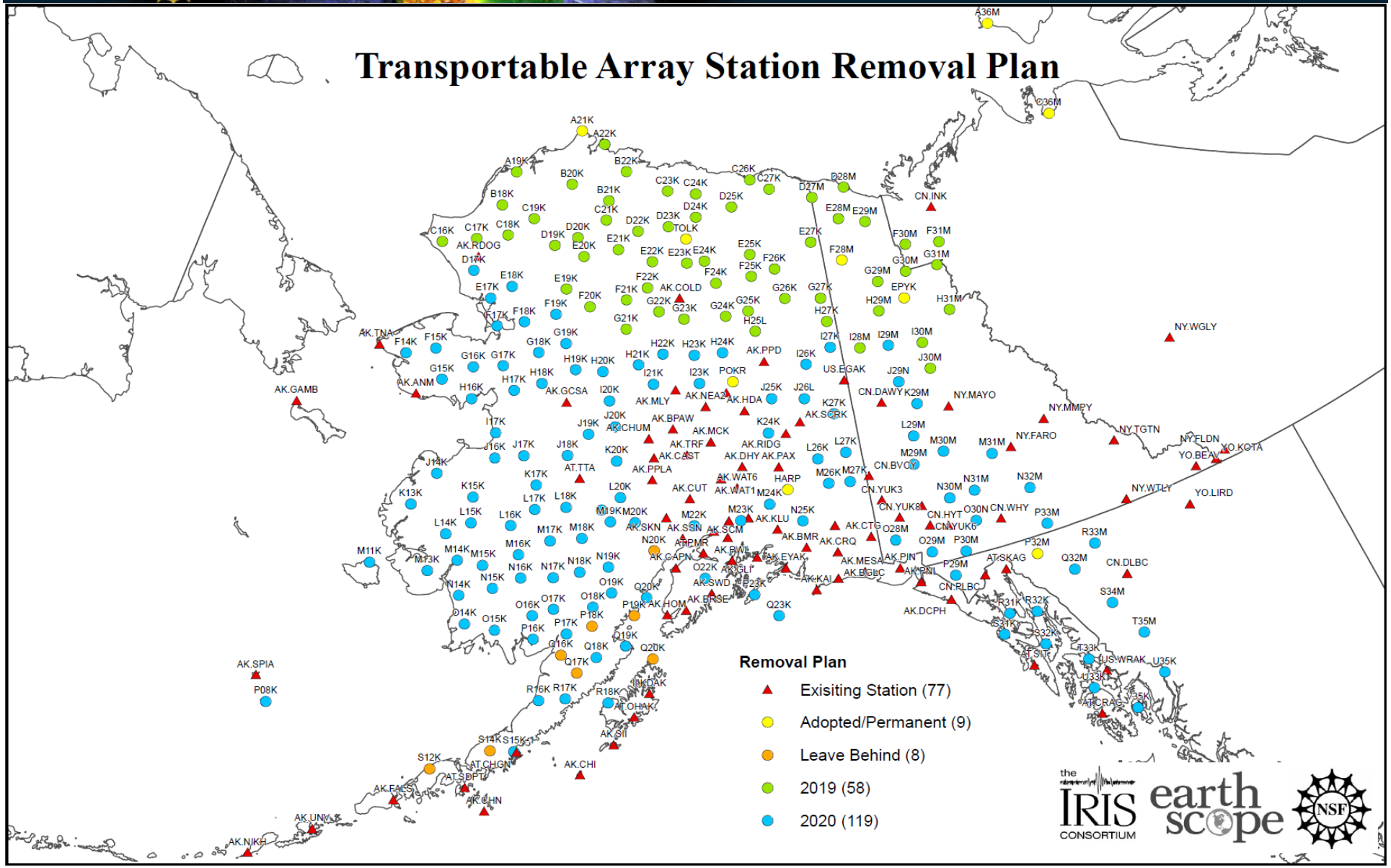
- Monitor and assess performance and diagnostics
- maintain data availability through station service
- adapt stations to lower cost comms as available

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.

Notional Removal Pattern



Collaborations

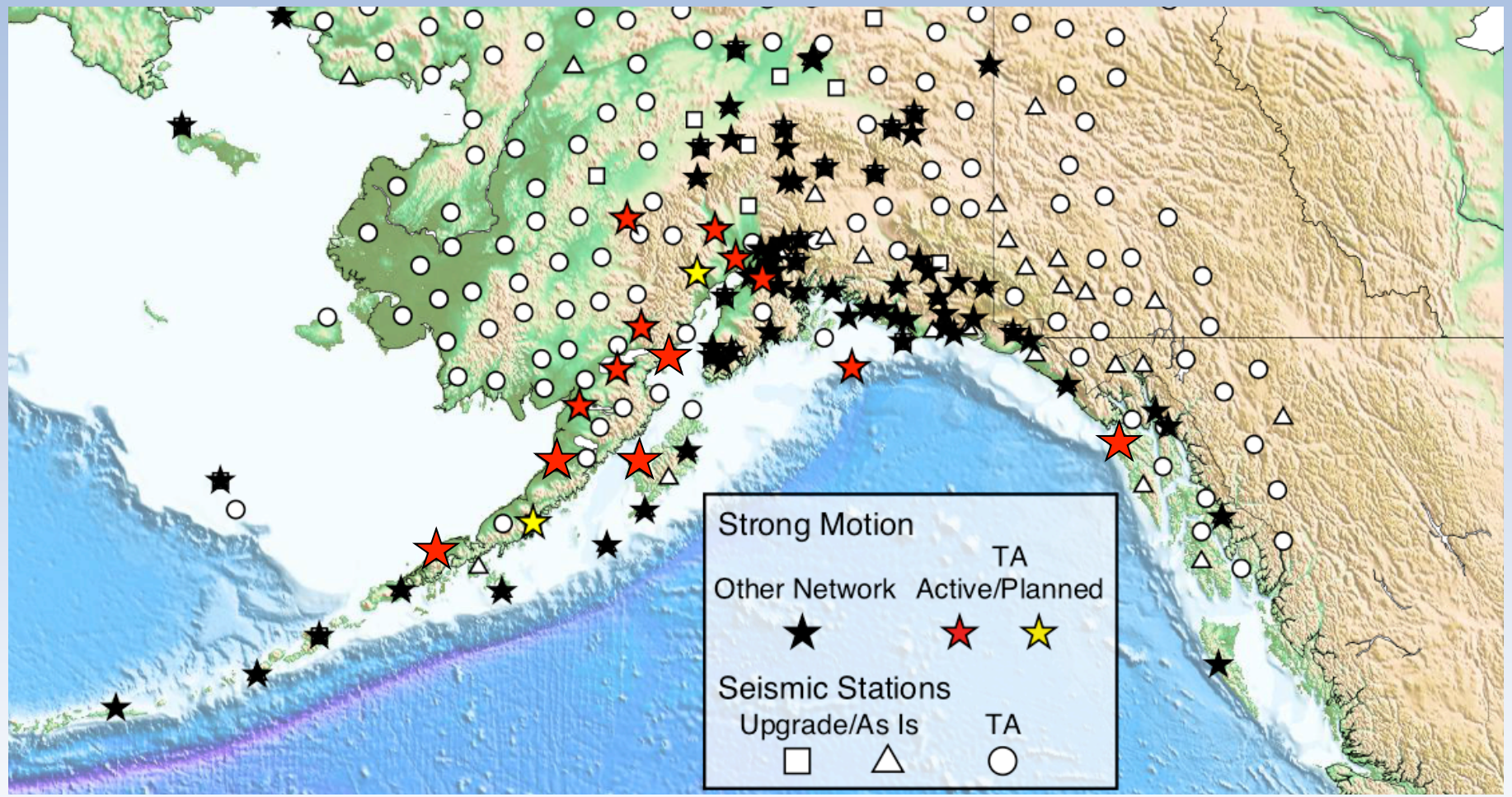
Seismology Partners:

- 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:

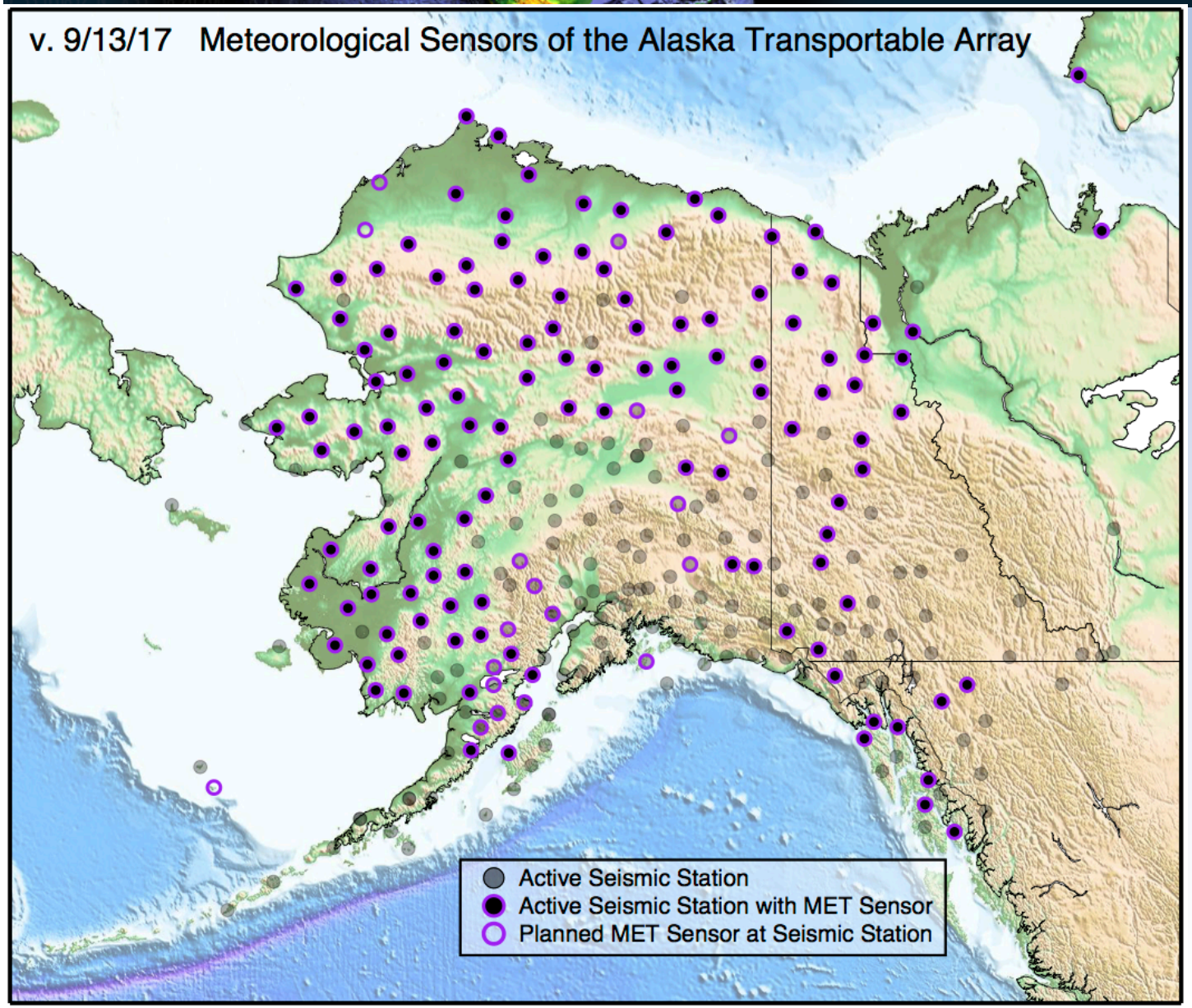
- UCSD Scripps Infrasound group
- Yukon Geological Survey
- NASA Arctic Boreal Verification Experiment (ABoVE)
  - Soil Temperature and Meteorological Instruments
- National Weather Service Alaska Region
- Univ of Utah MesoWest
- Yukon Wildlands Fire Division

Strong Motion Sensors



(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.

Met sensors in AK

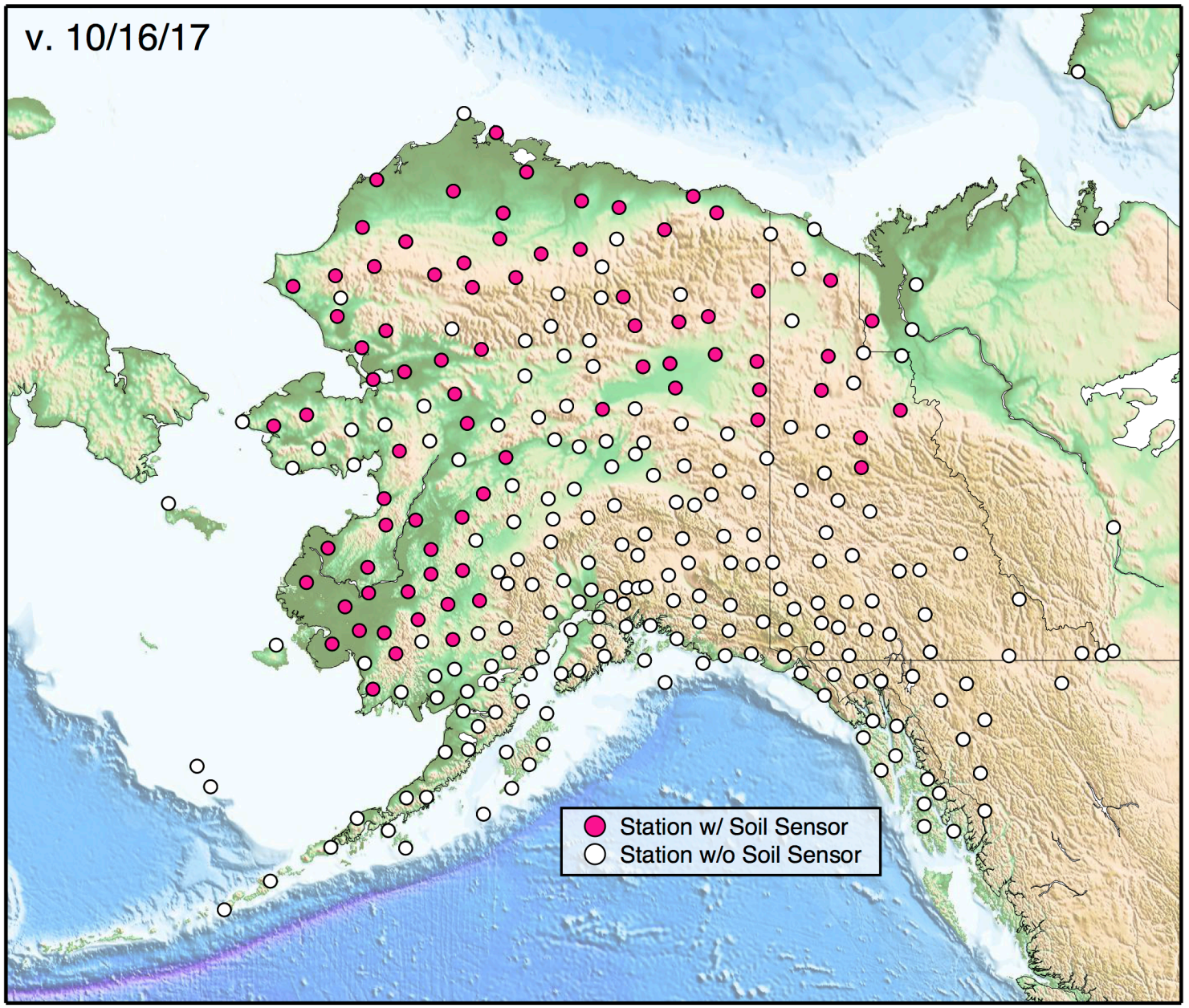


35 TA, NSF
35 UCSD, NSF
32 NOAA NWS
40 NASA ABoVE
2 Yukon
==========
144 sensors

139 installed
13 planned

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

Soil Temperature Profile



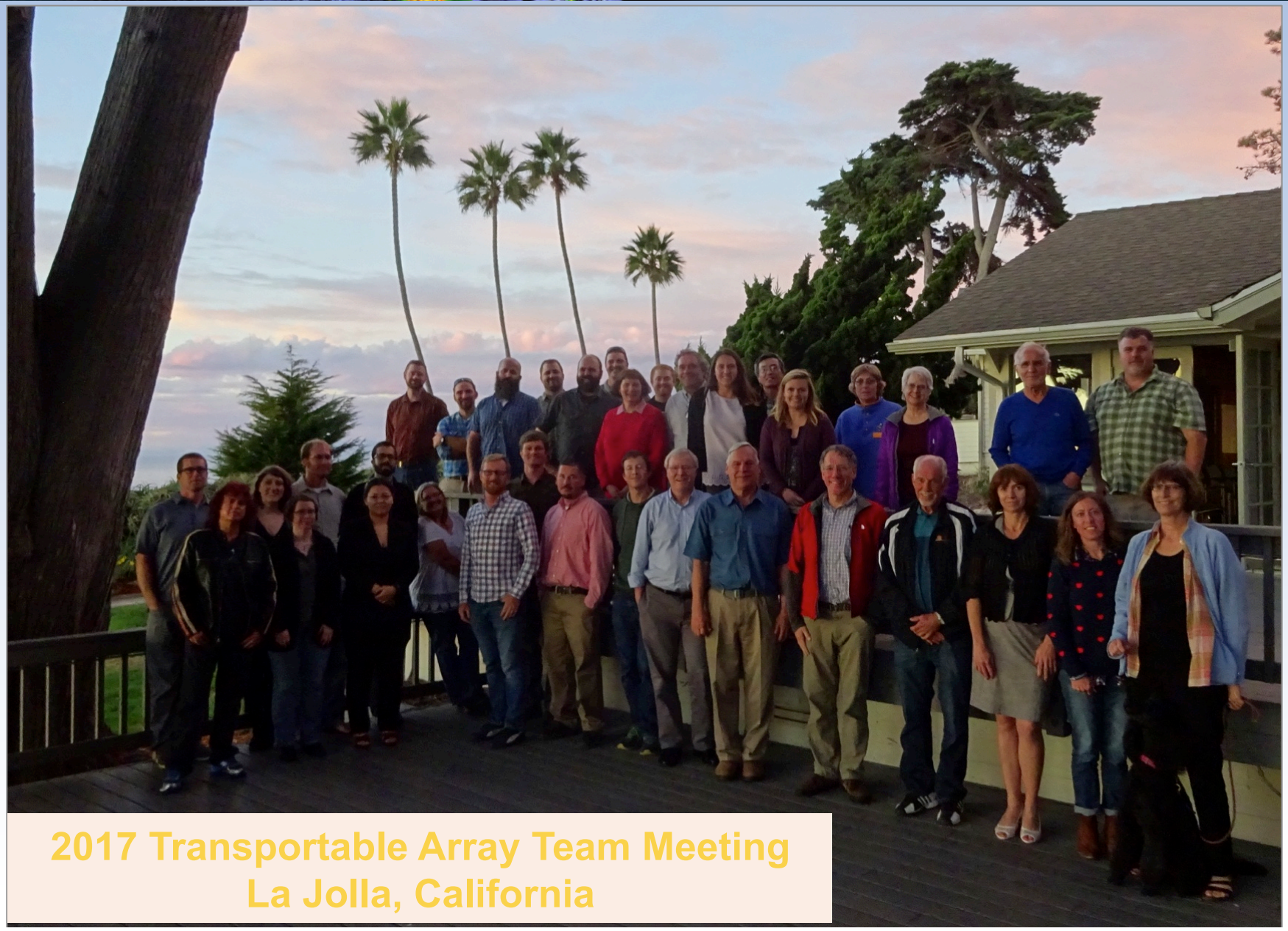
(78) Stations Supported by:
NASA ABoVE
Yukon Geo Survey

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

Want More Info?

On the Web

- EarthScope
  www.earthscope.org
- USArray
  www.usarray.org
- National Science Foundation
  www.nsf.gov

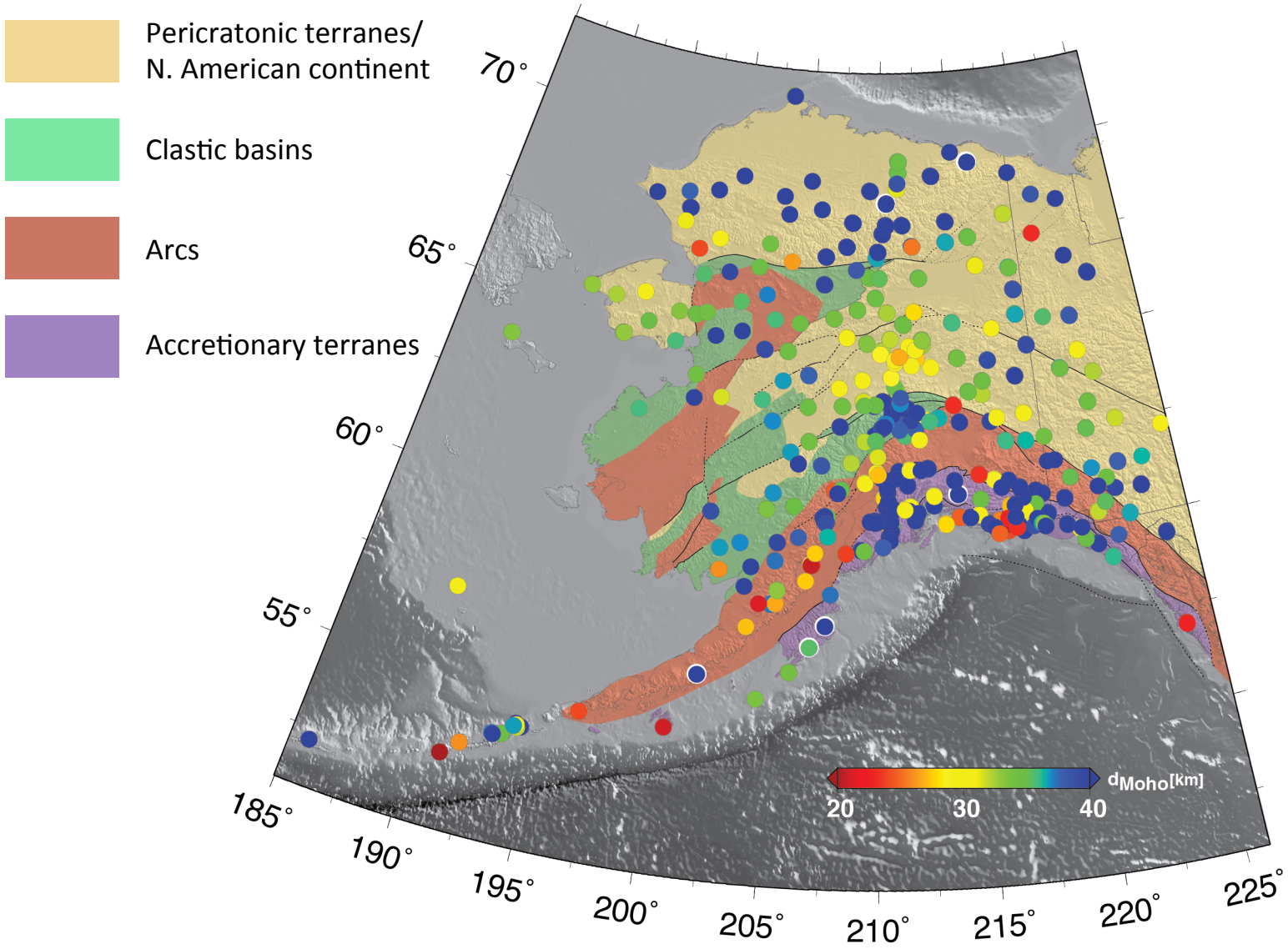
busby@iris.edu

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.

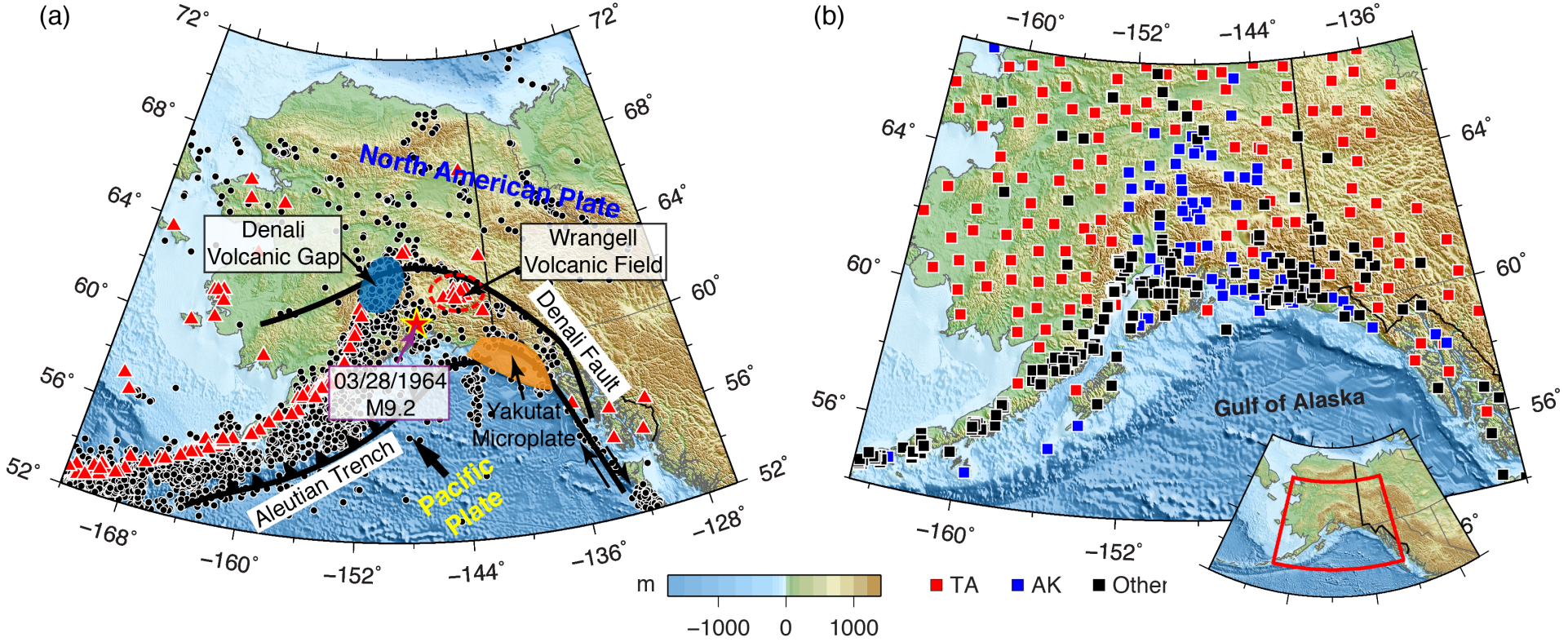
Dr. Meghan S. Miller
Associate Professor, Research School of Earth Sciences
The Australian National University

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

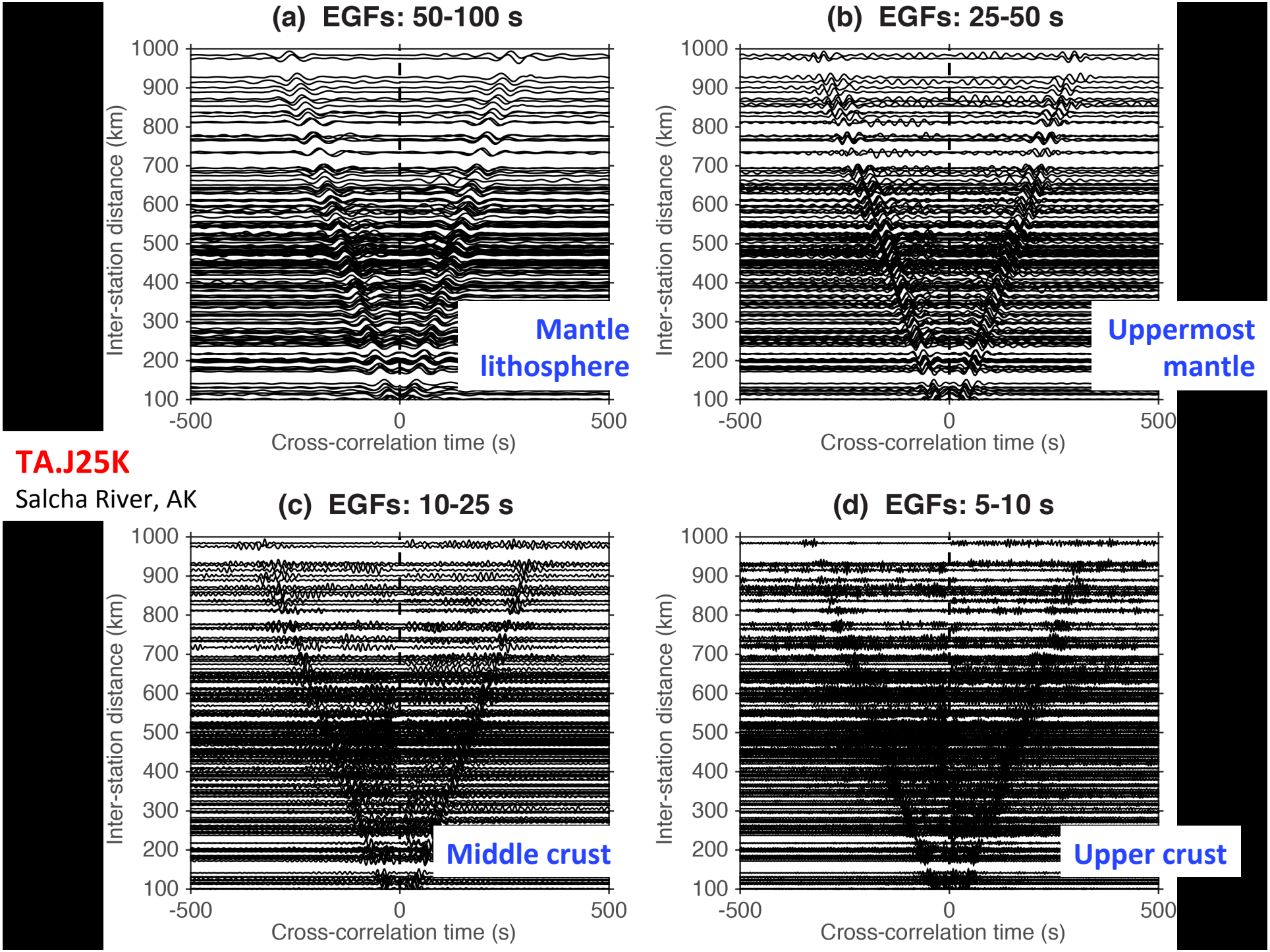


Xiaotao Yang
Haiying Gao

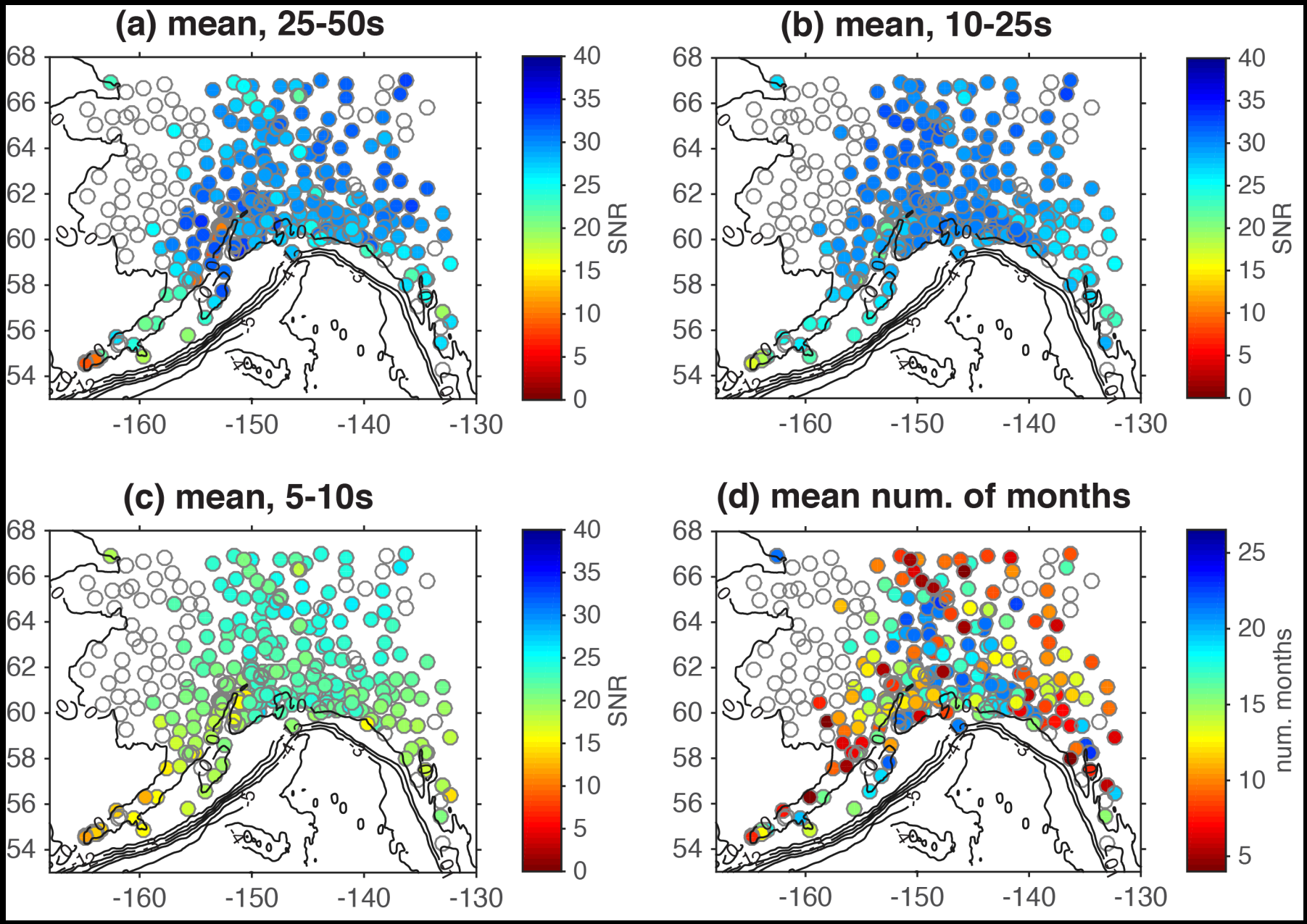
Department of Geosciences
University of Massachusetts Amherst

Scientific Questions

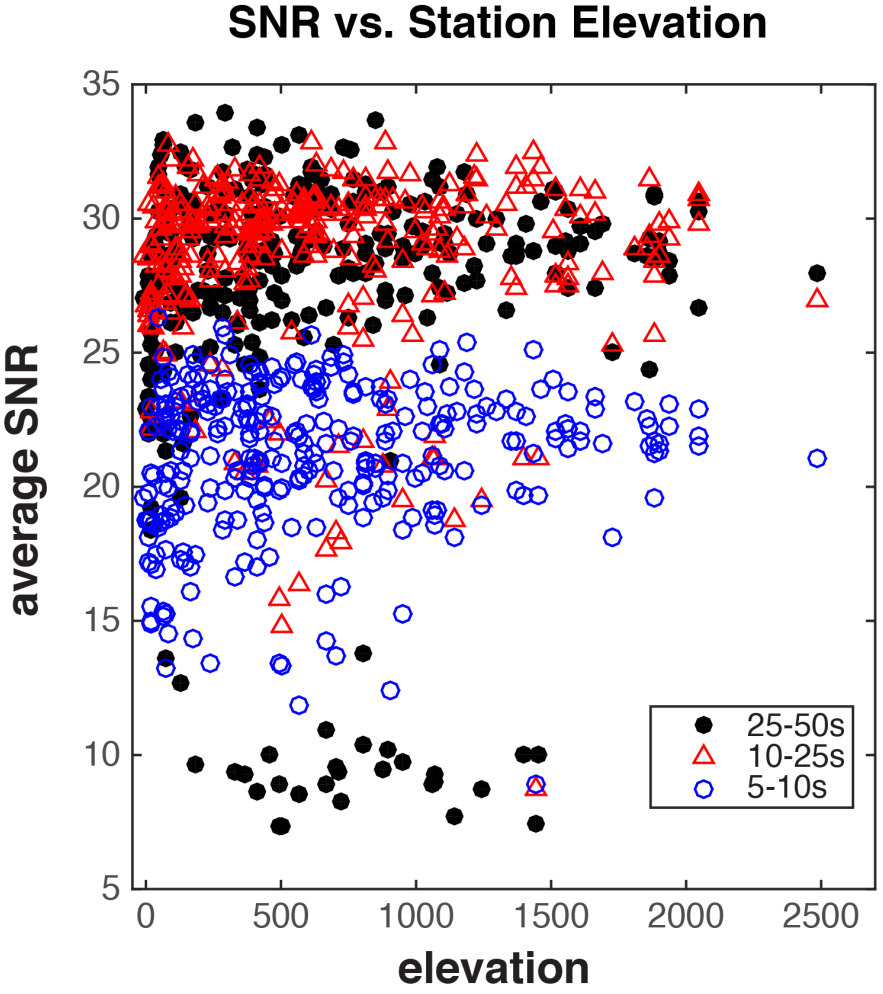
- What controls the along-strike segmentation of seismicity and magmatism?
- What are the properties of the mantle flow?
- How does the subducting slab interact with mantle materials and impact mantle flow patterns?

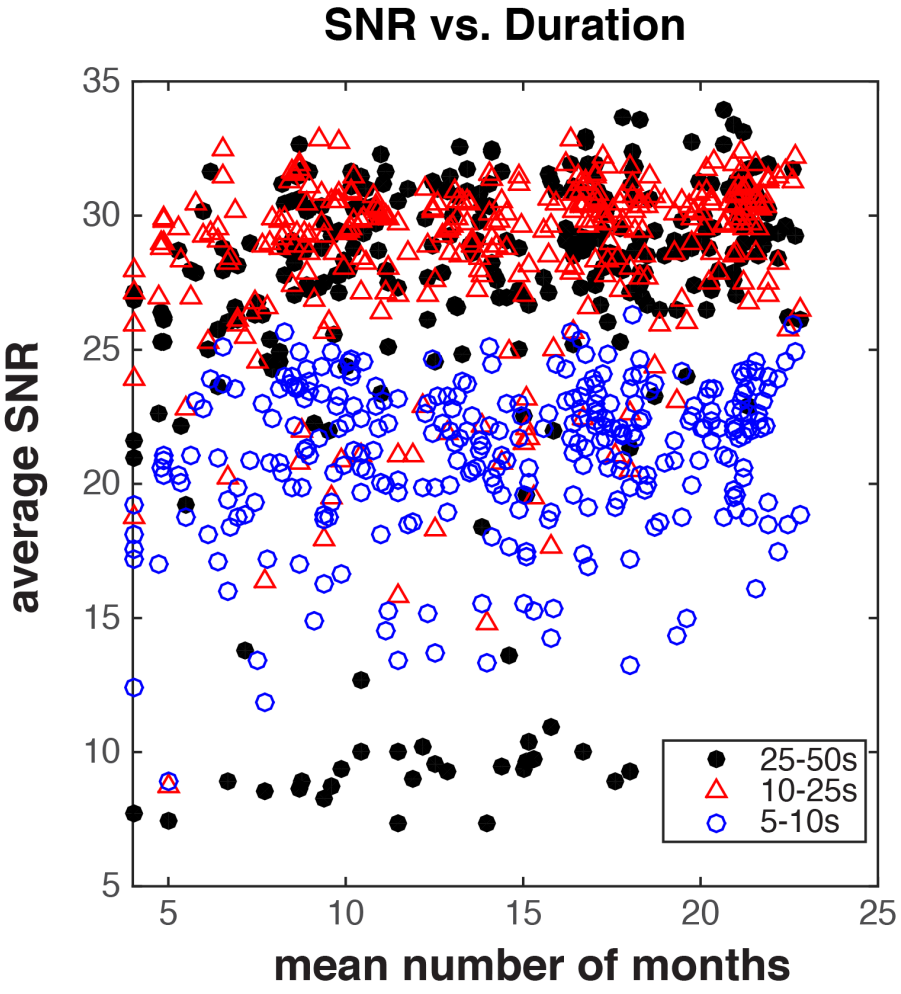

(a) EGFs: 50-100 s
(b) EGFs: 25-50 s
(c) EGFs: 10-25 s
(d) EGFs: 5-10 s
Inter-station distance (km)
Cross-correlation time (s)
1000
900
800
700
600
500
400
300
200
100
-500
0
500
Mantle lithosphere
Uppermost mantle
Middle crust
Upper crust
TA.J25K
Salcha River, AK

Average SNRs at All Stations (> 3 months)



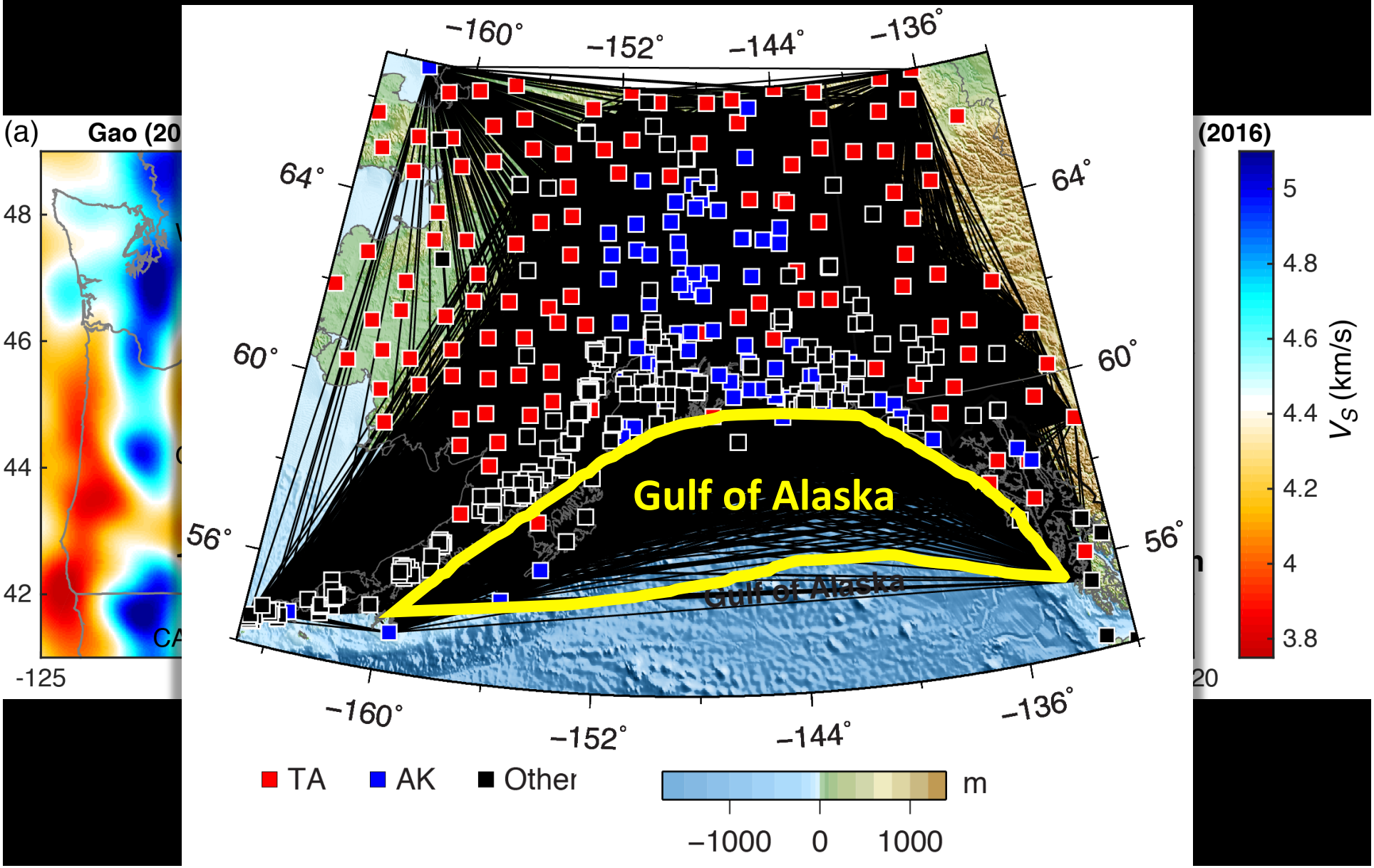
Average SNRs at All Stations (> 3 months)





- 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

Model Results

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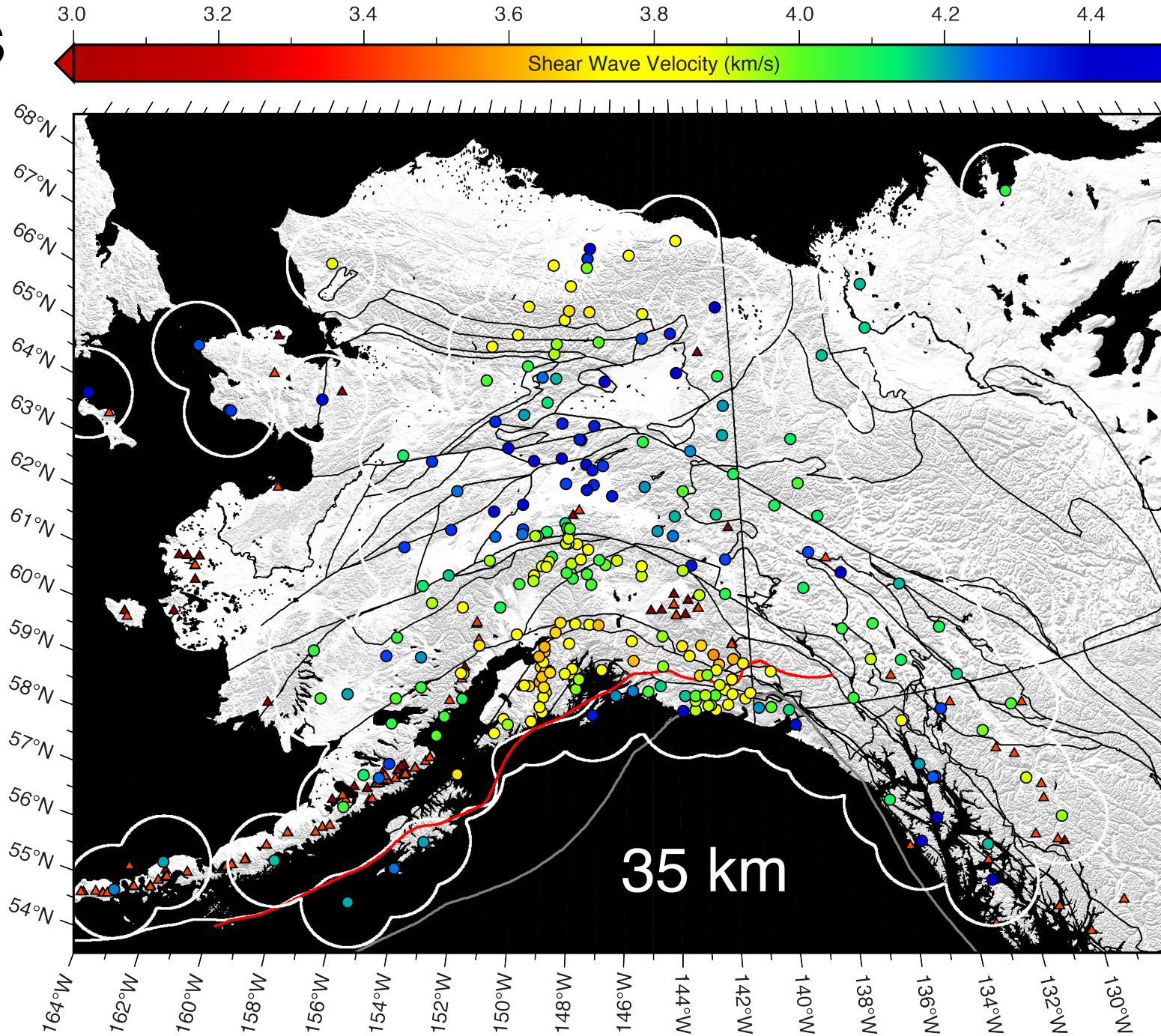

& Lin (in-prep)

epth Slice

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p slice shows
face-wave only
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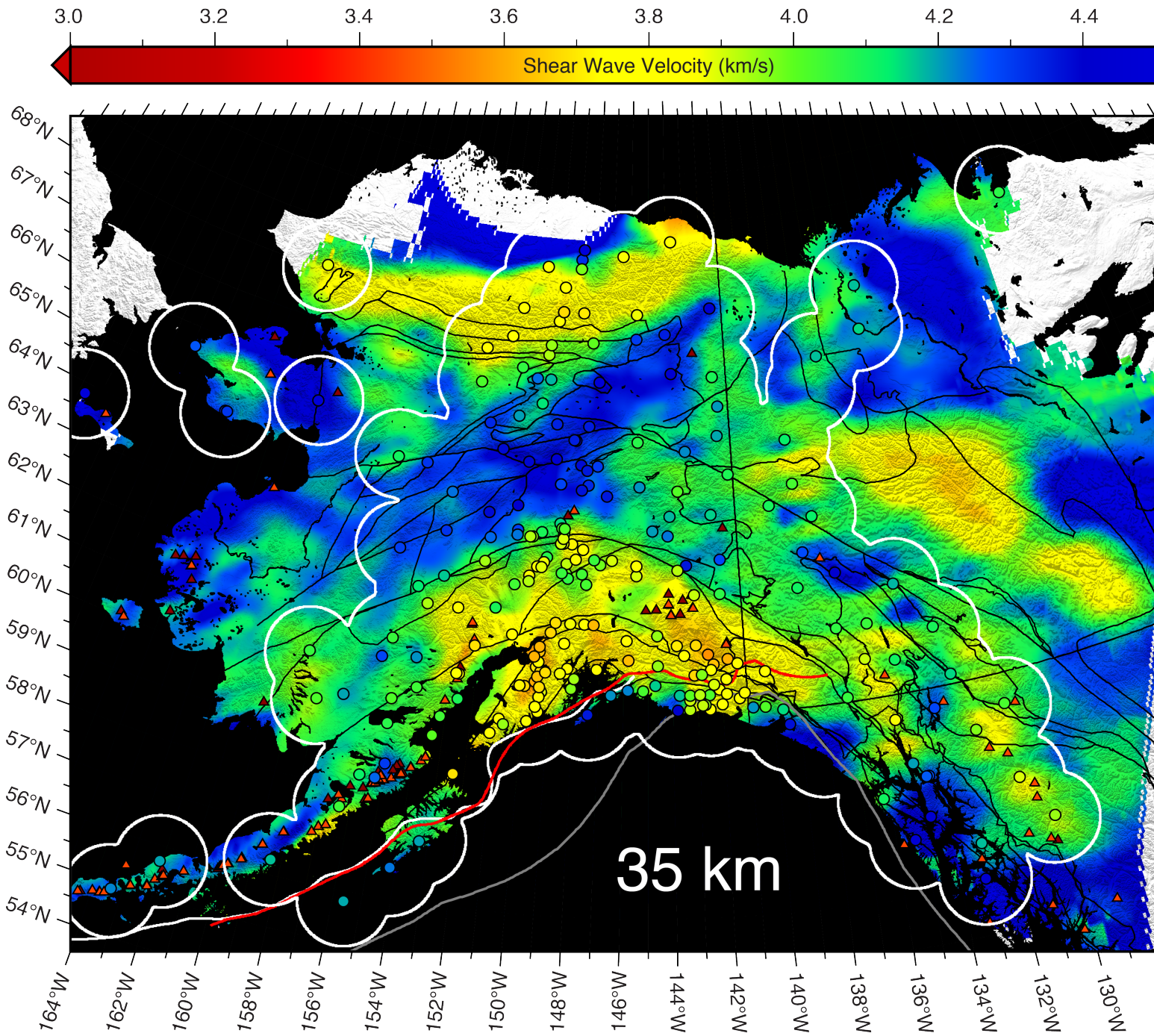
& Lin (in-prep)



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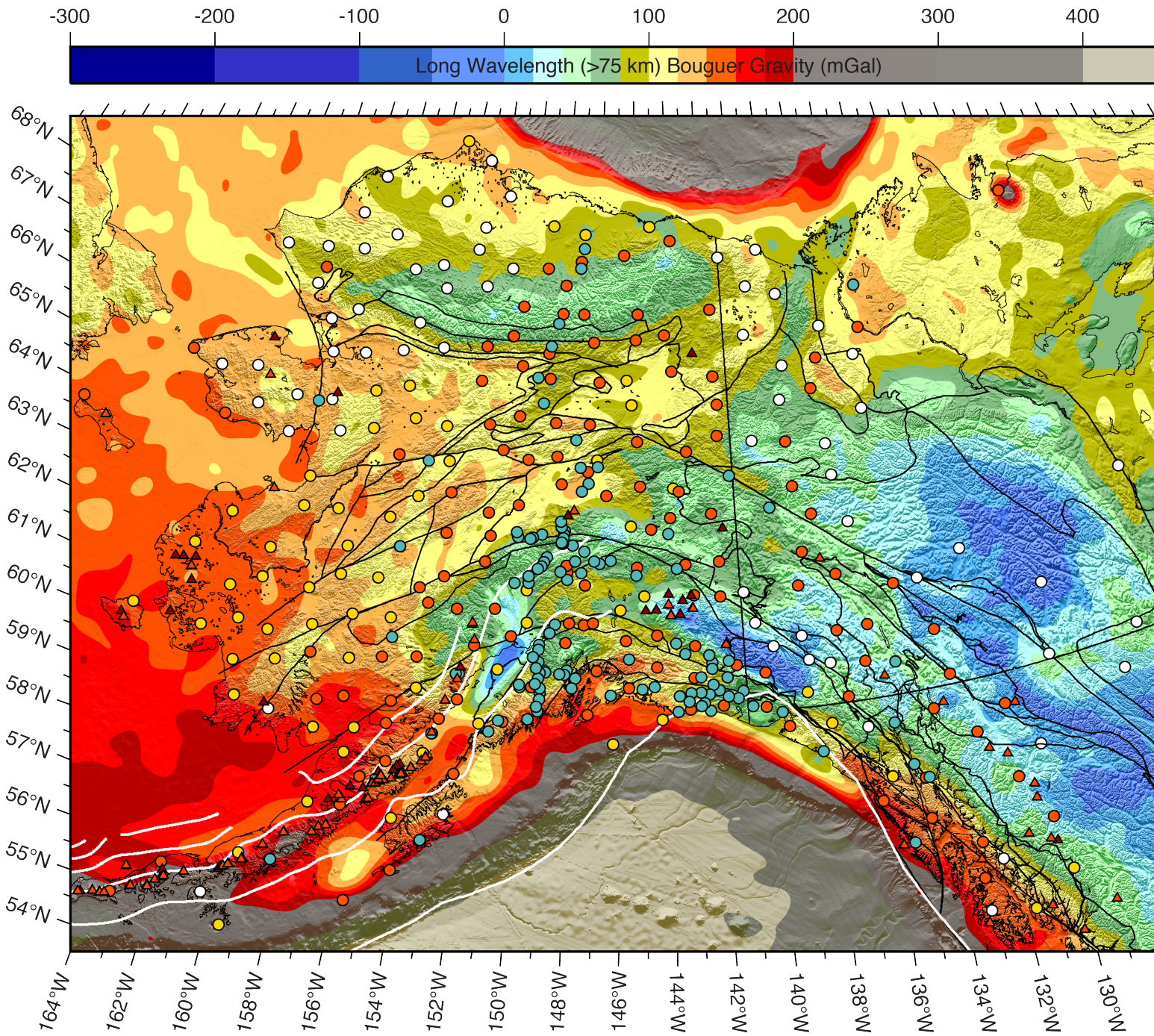
o et al., 2012



Cross-Sections

est-to-east fan of
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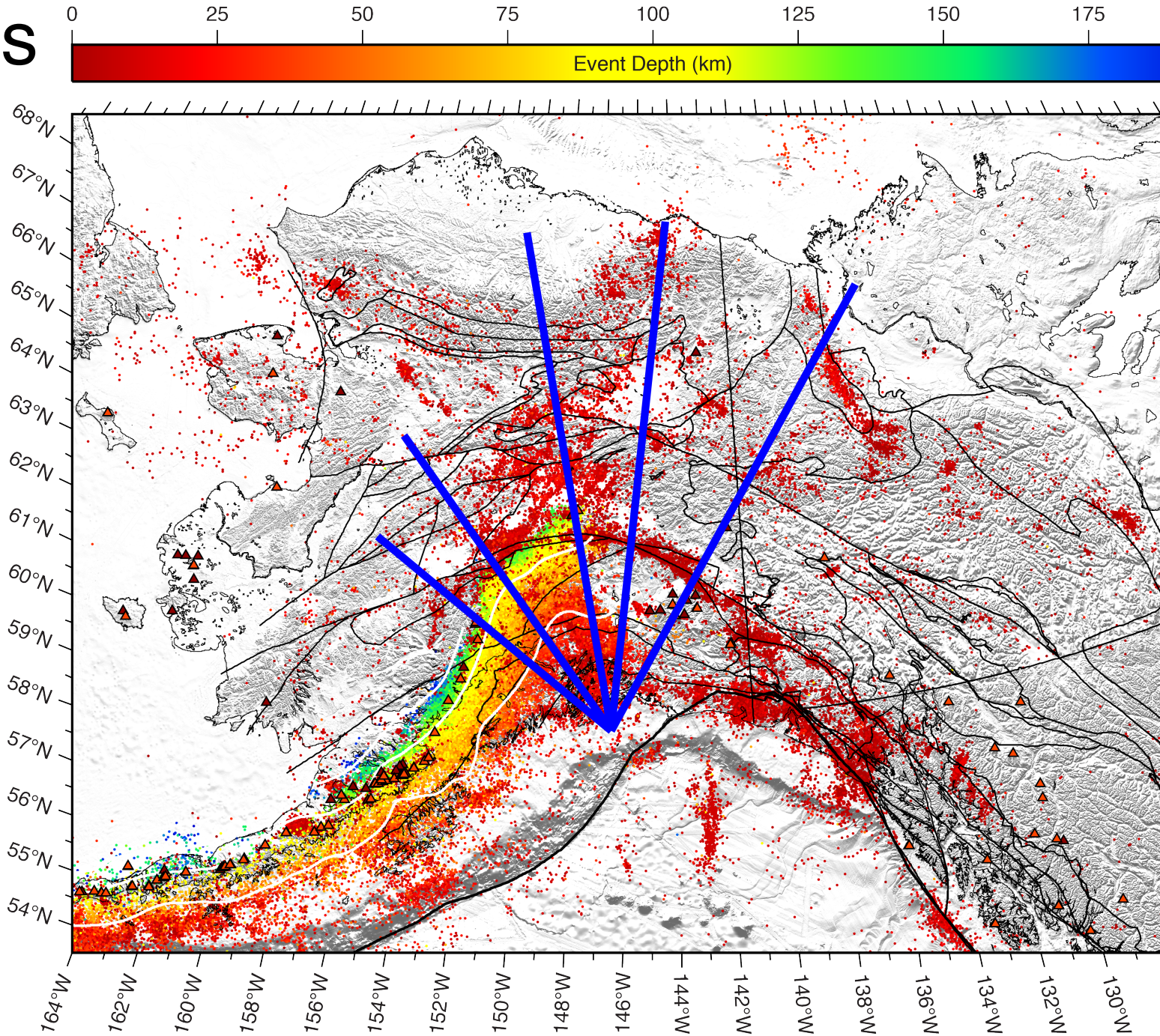
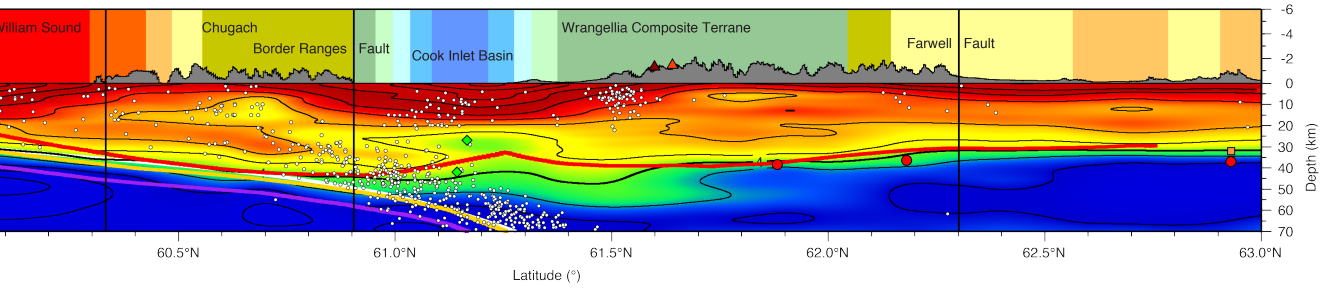
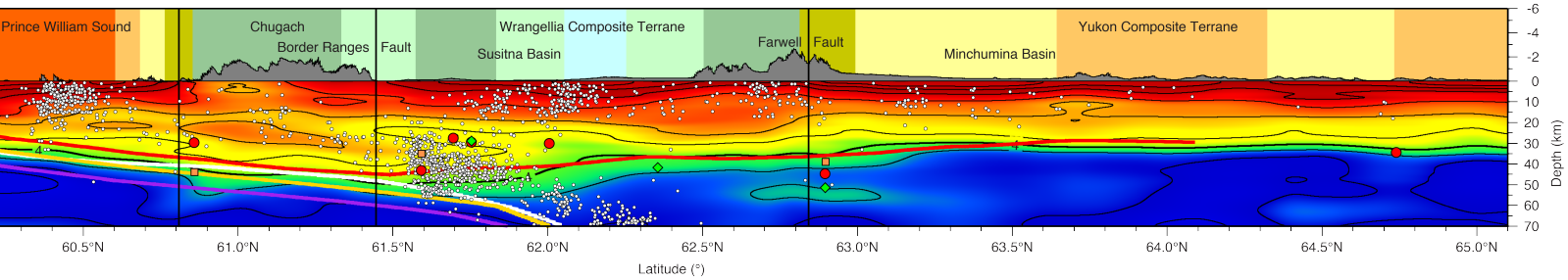


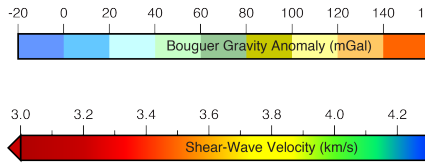
Earthquake Center

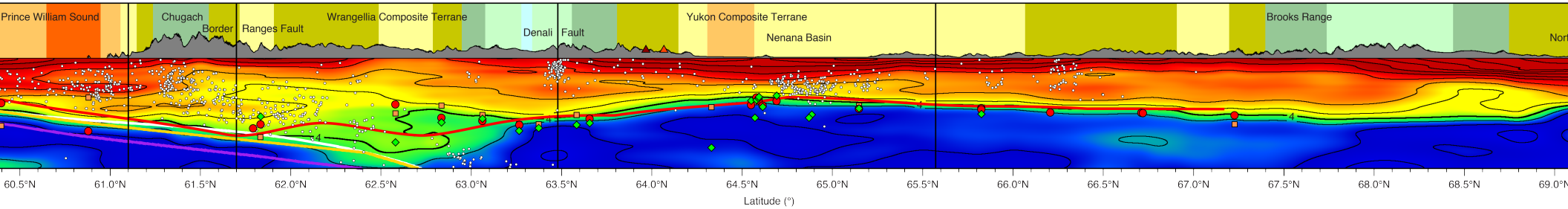
Vs Cross-Sec

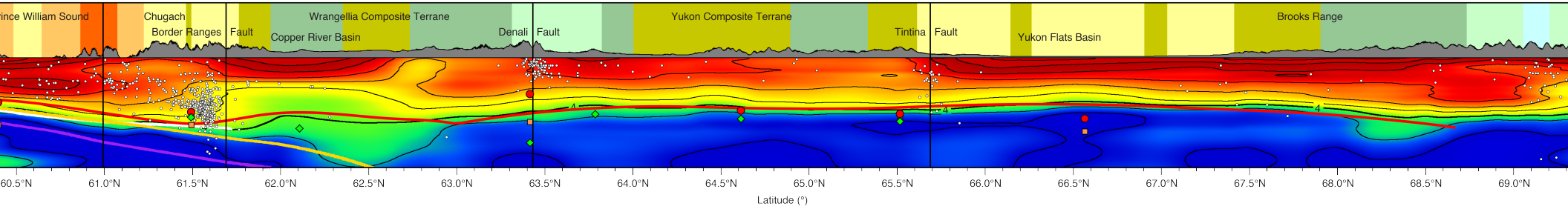
Ward & Lin (i

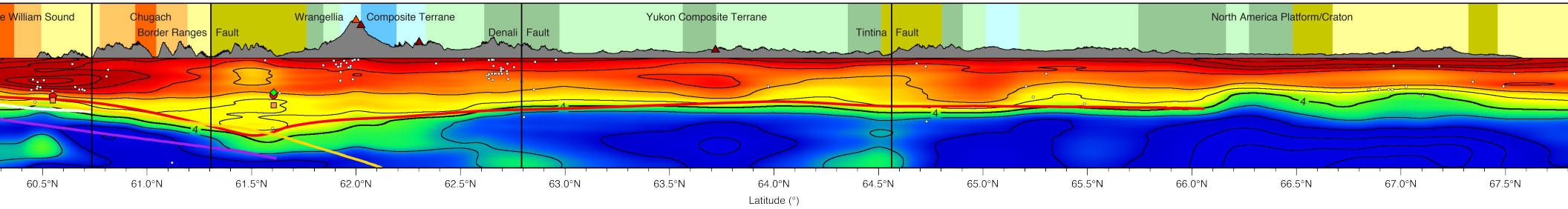










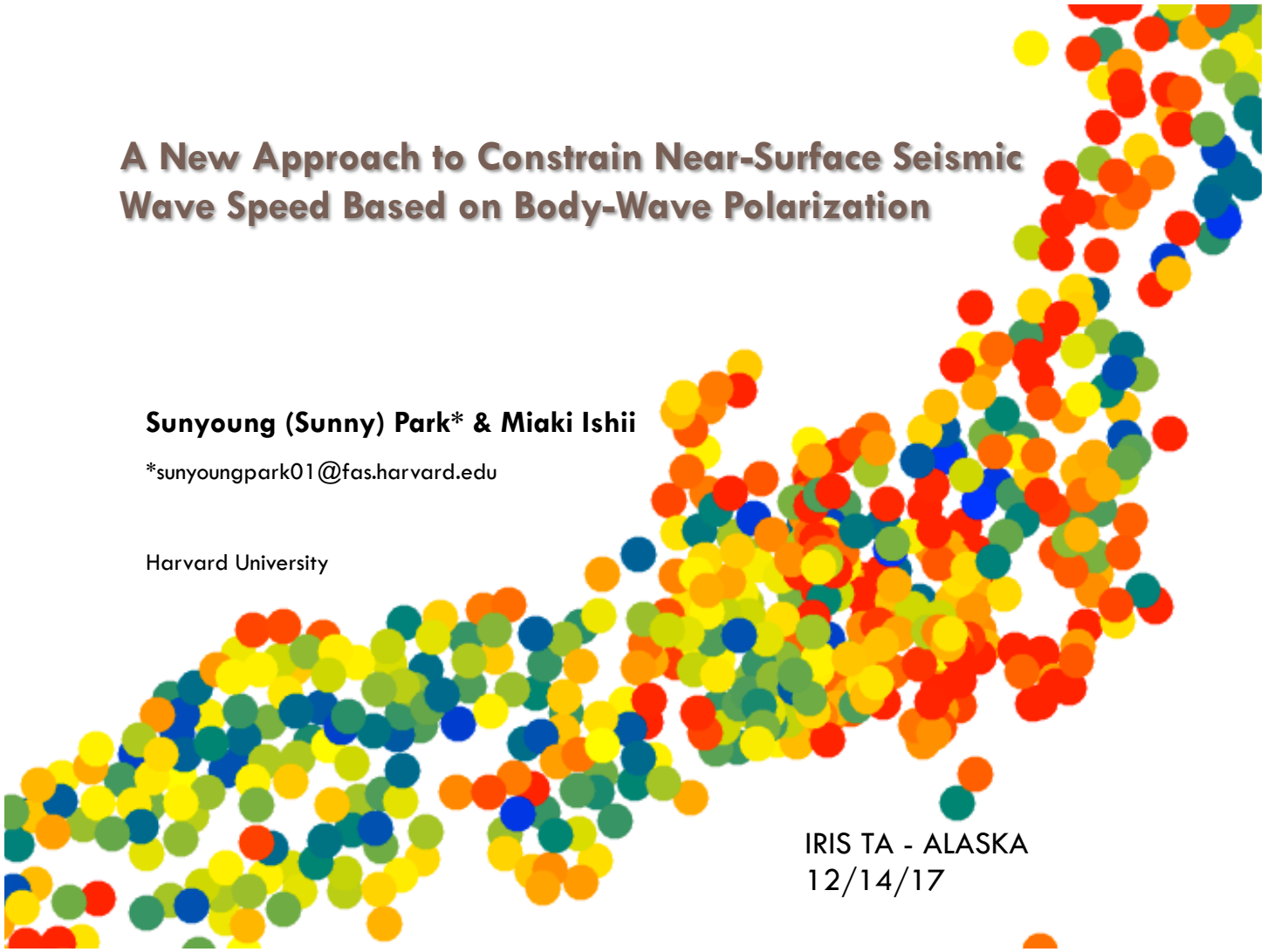


A New Approach to Constrain Near-Surface Seismic Wave Speed Based on Body-Wave Polarization

Sunyoung (Sunny) Park* & Miaki Ishii

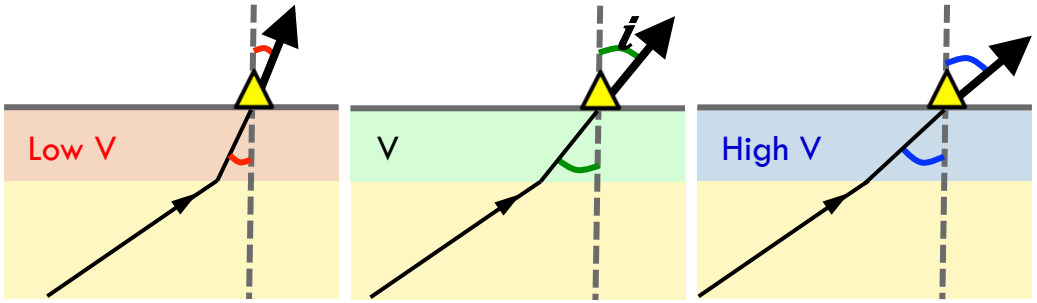
*sunyoungpark01@fas.harvard.edu

Harvard University

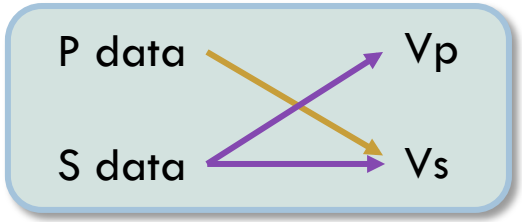


IRIS TA - ALASKA
12/14/17

Polarization Analysis

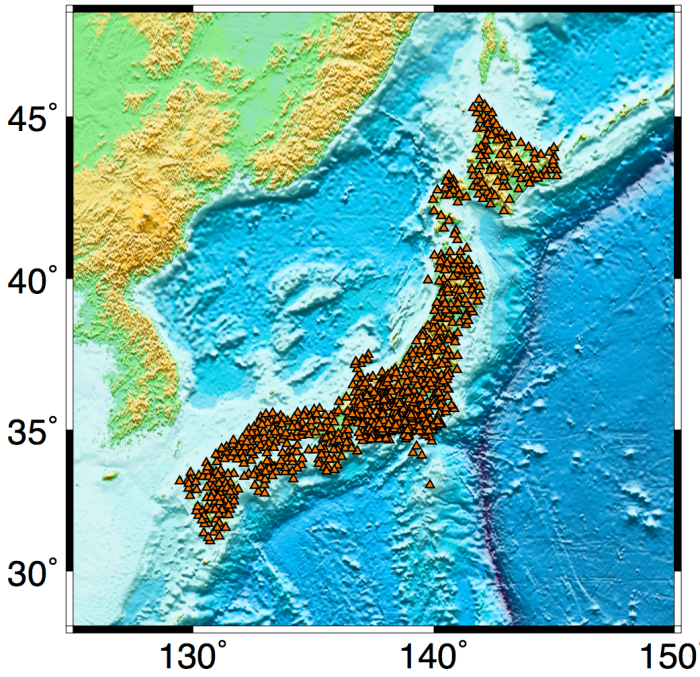


P and S polarizations → Near-surface Vp and Vs

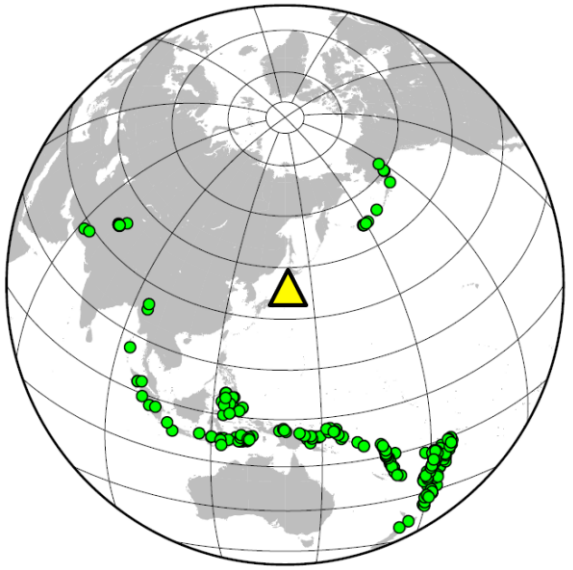


- P not sensitive to Vp
- Highest frequency information on Vs

Application to the Hi-net Data

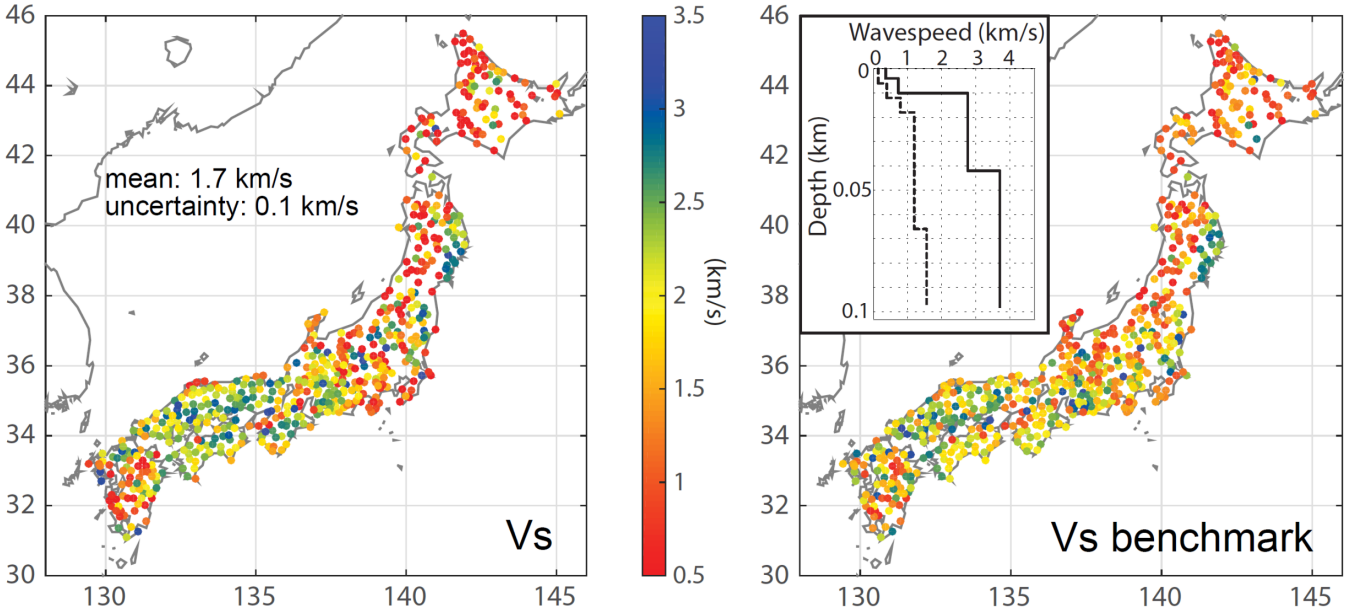


- Hi-net (>700 stations)
  - Dense coverage
  - Benchmark data



- Earthquakes (~250 events)
  - Teleseismic (30° to 90°)
  - Intermediate & deep (depth ≥ 60 km)
  - 2004/01 to 2016/04
  - Mw ≥ 6

Near-Surface Vs

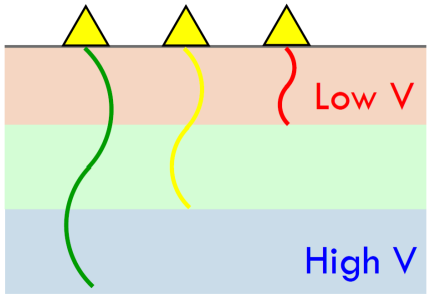


- Resolves Vs at ~100-m depth
- Correlation with topography, geology, and volcanoes

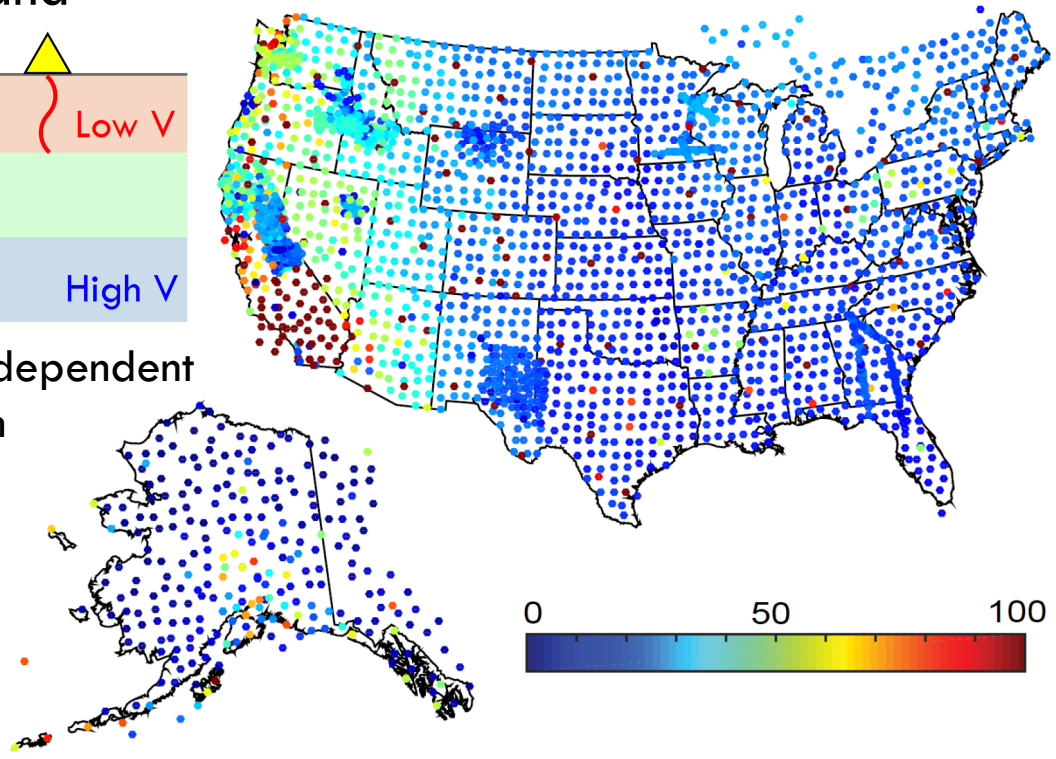
Park & Ishii, *in review*

Application to the U.S. Data

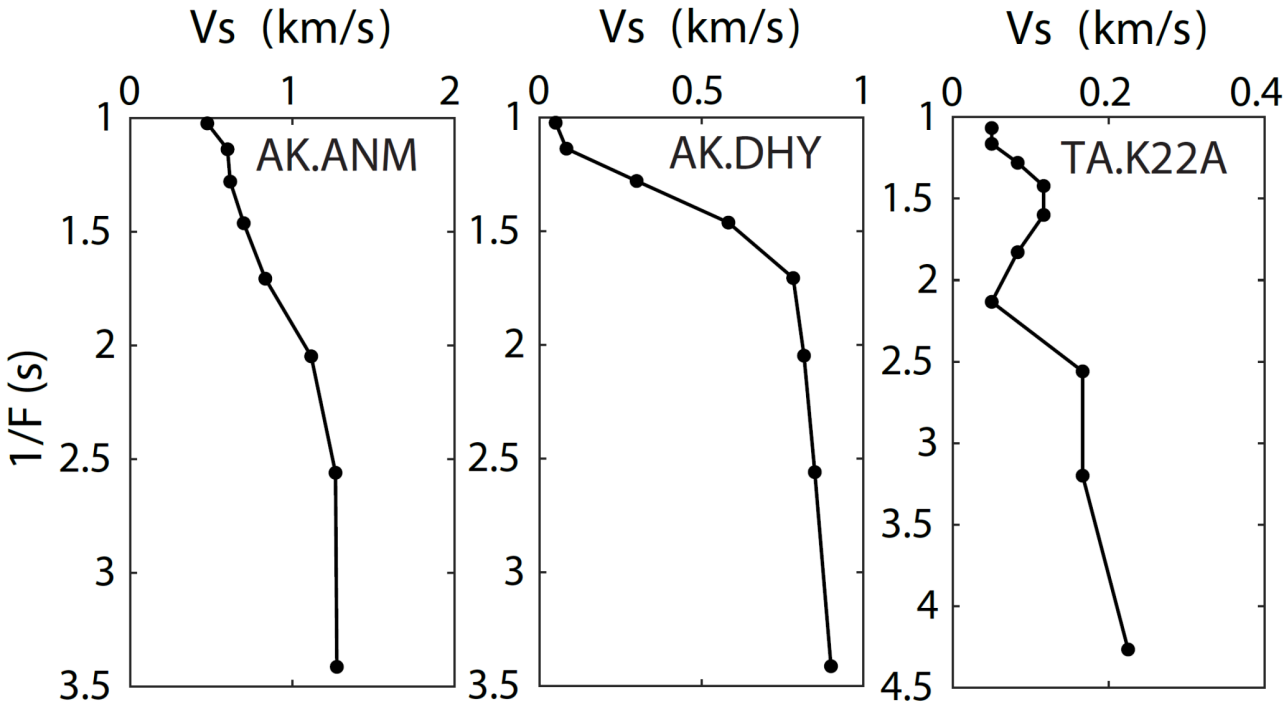
- broadband



Frequency-dependent polarization



Toward a depth dependent model



Conclusions

- A new approach to constrain near-surface seismic structure
  - Single station
  - Non-invasive & Computation-efficient
  - Detection of instrument response issues
  - P-wave polarization → Vs (high frequency)

- Hi-net
  - Estimates ~ Well measurements
  - Correlation with geology, topography, and the volcanoes

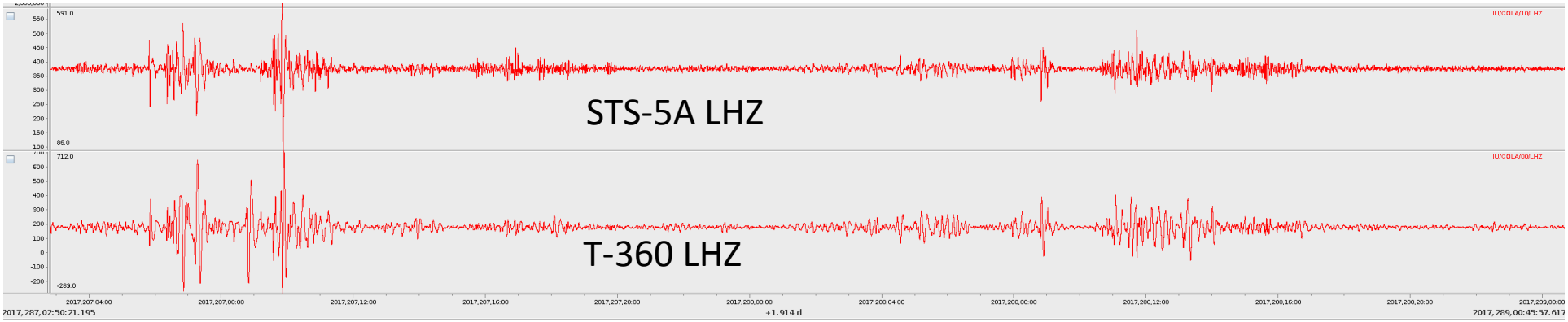
- U.S. stations
  - Frequency dependence → Depth varying V

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

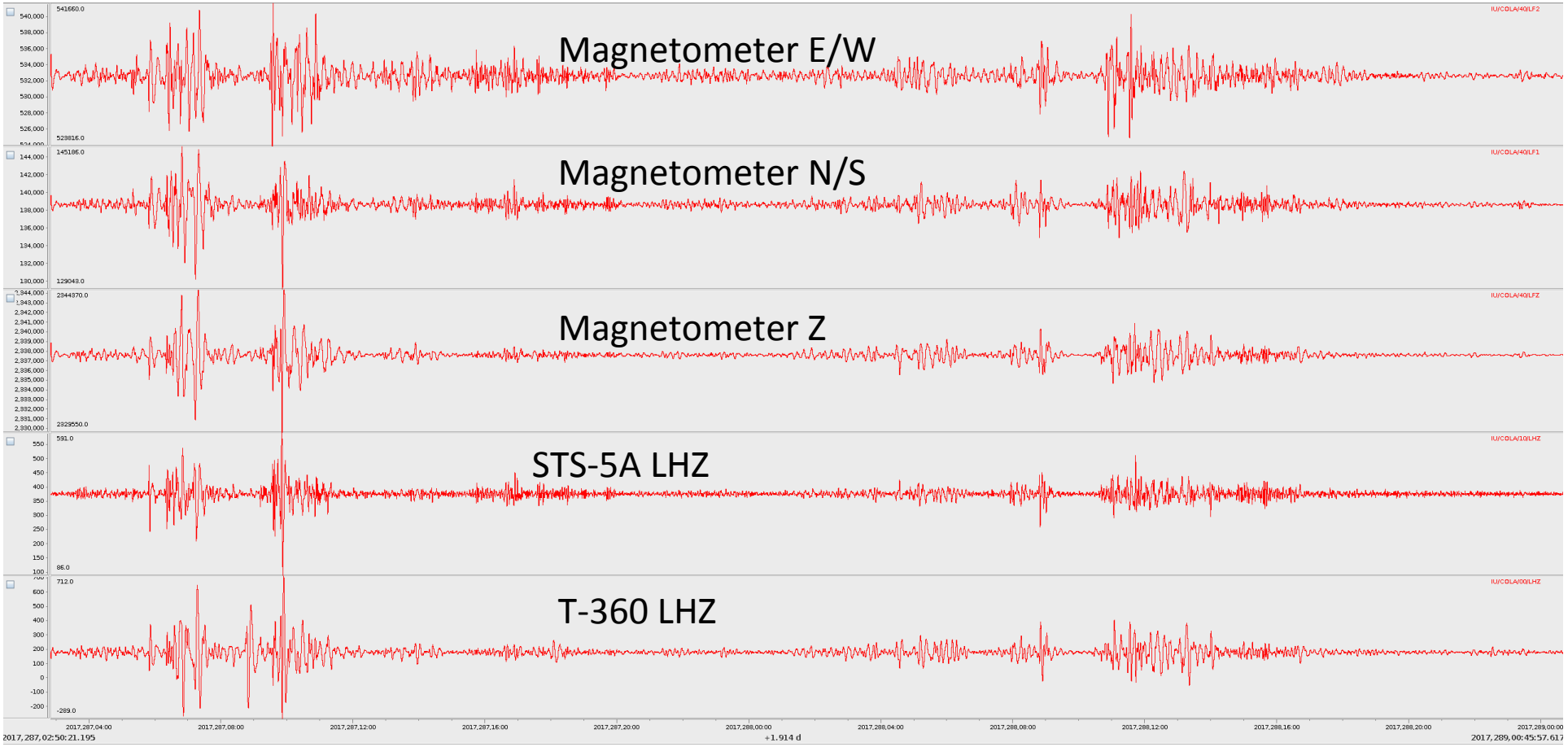
Signals Recoded on the GSN station COLA (Fairbanks, Alaska)

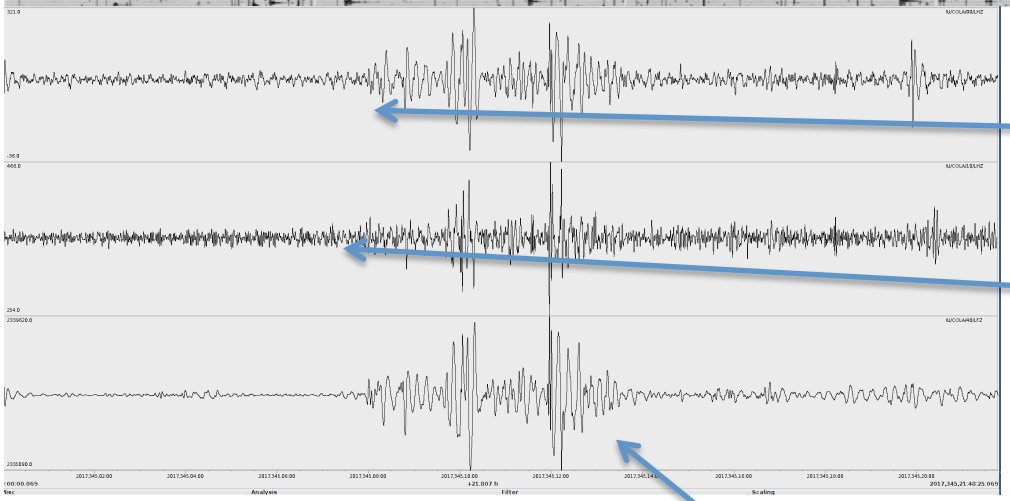


2 days (band-passed 100-1000 s)

USGS science for a changing world

IRIS





T-360 LHZ

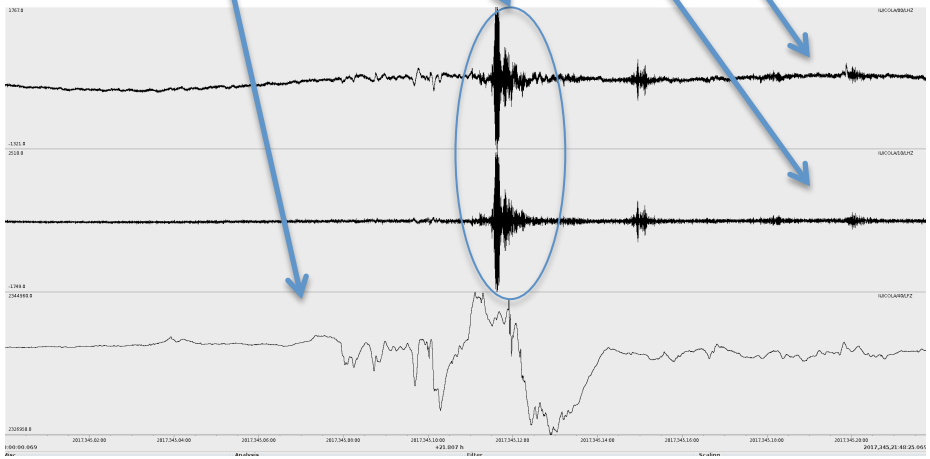
STS-5A LHZ

Band-pass (100 - 1000 s)

Magnetometer LFZ

M 5.6
Tonga
EQ

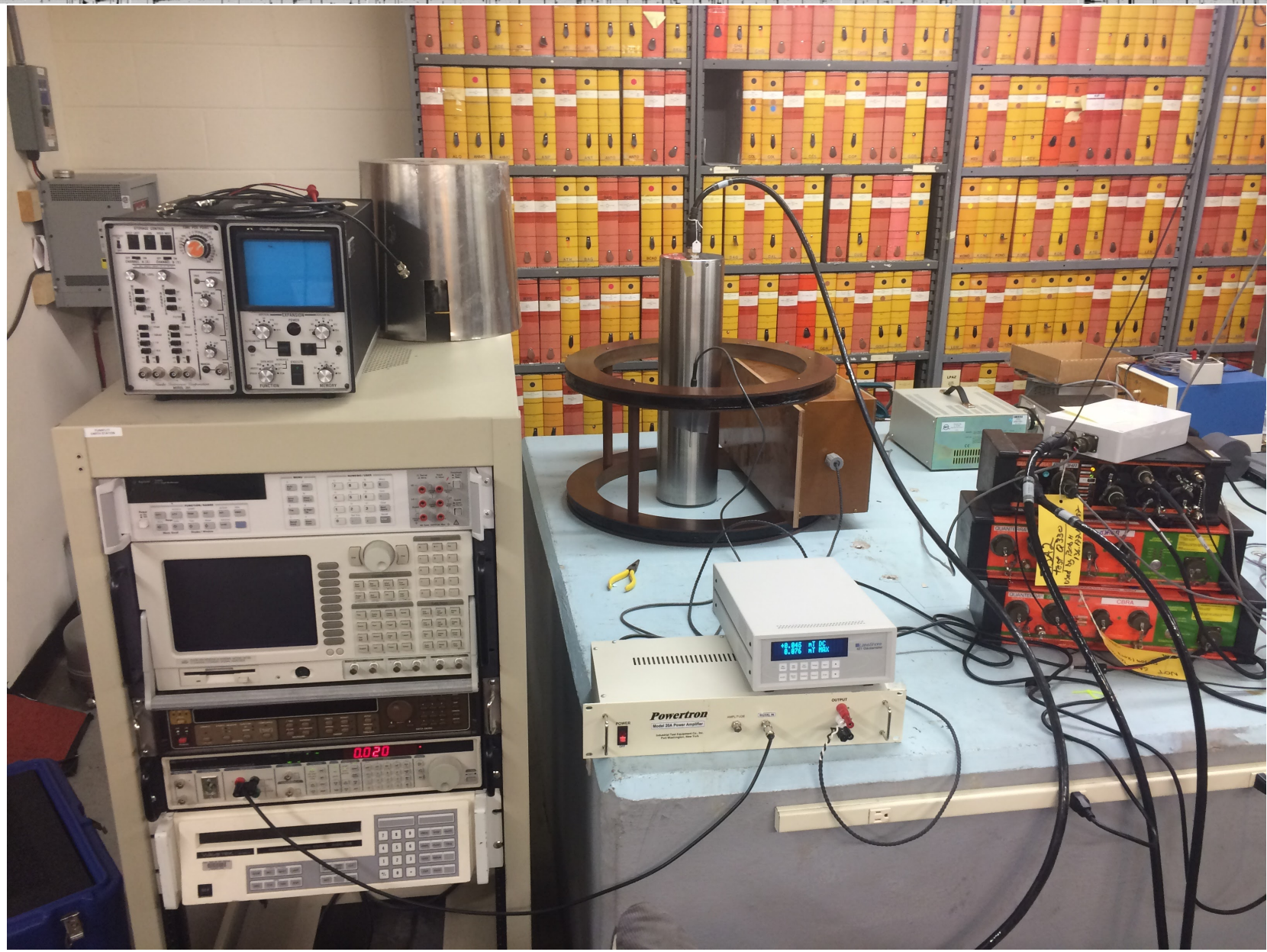
December 11, 2017 COLA data 21 hour time windows different filters.



Low-pass (10 s)

USGS
science for a changing world

IRIS



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:

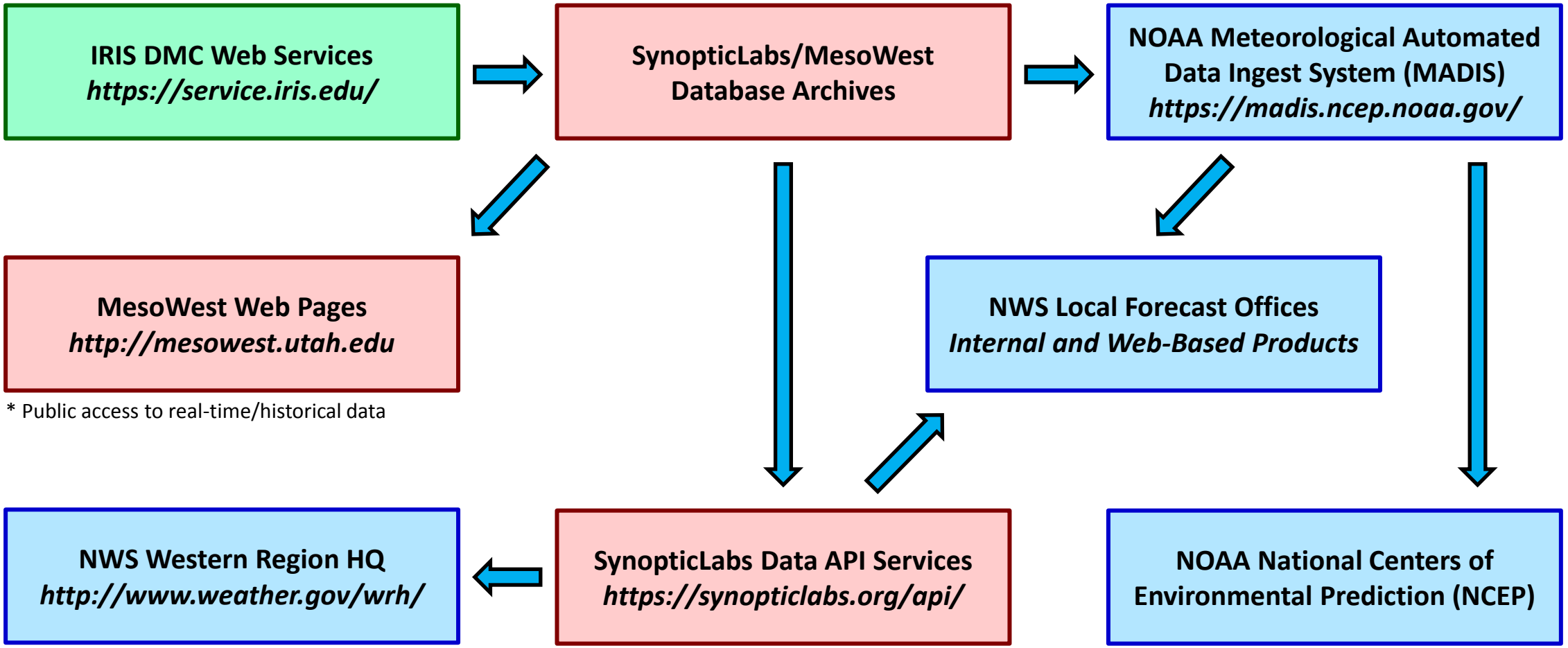
The National Weather Service and MesoWest have several web-based products where the Alaska TA data can be viewed. On the left is an interactive map available from the National Weather Service which shows the deployed Alaska TA stations. The two images on the right show data in tabular format for the 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.

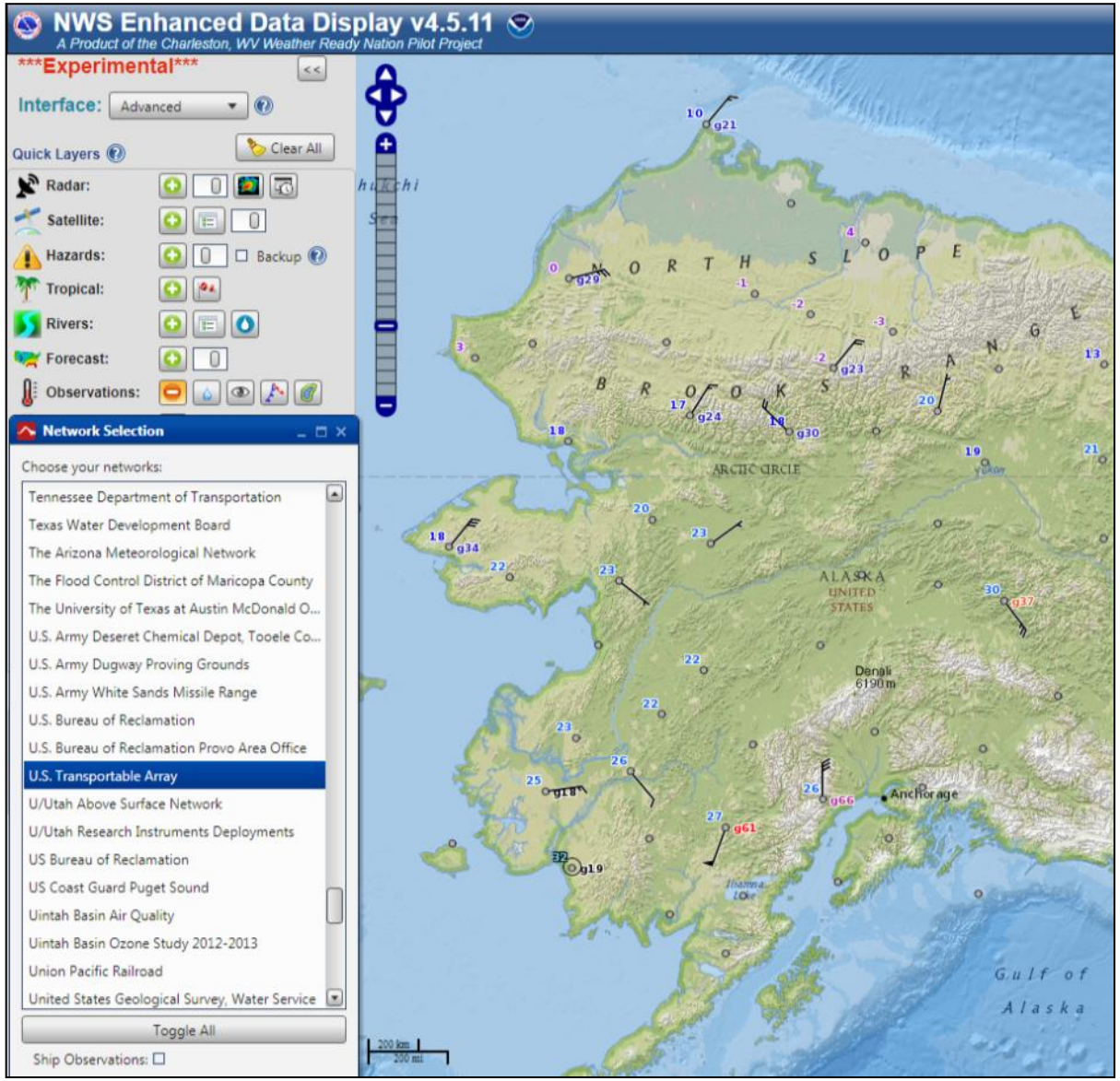
Real-Time ATA Data Flow to NOAA/NWS

- Starting from IRIS DMC, TA 1 Hz weather data (Setra 278 pressure and Vaisala WXT520 sensors) are accessed in real-time 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.

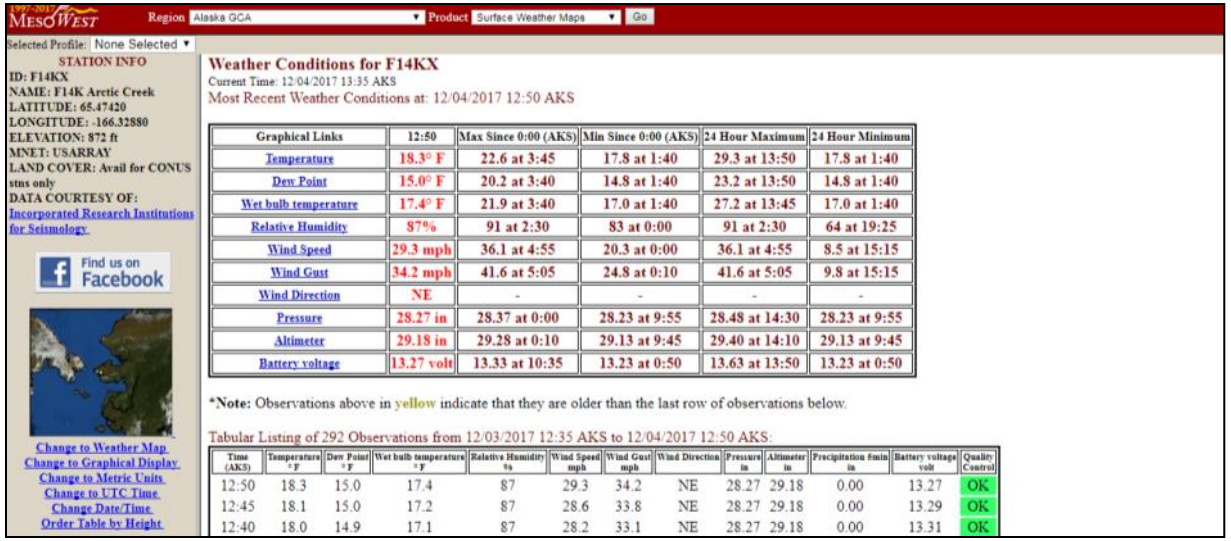


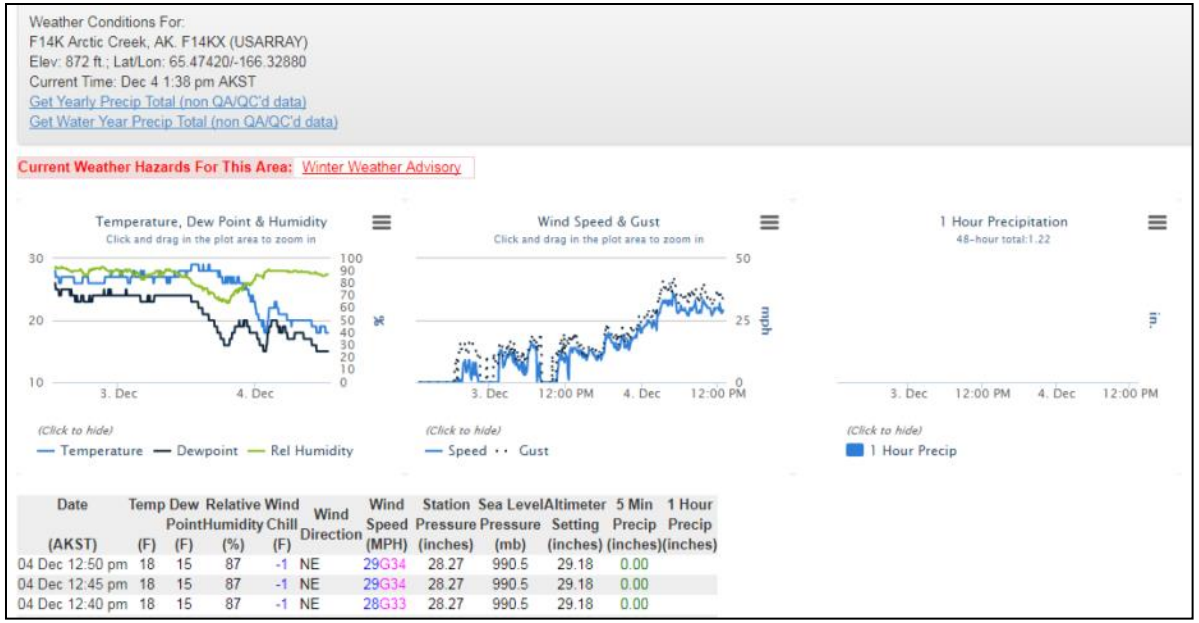
Real-Time ATA Data in NOAA/NWS and MesoWest

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



http://mesowest.utah.edu/cgi-bin/droman/meso_base_dyn.cgi?stn=F14KX



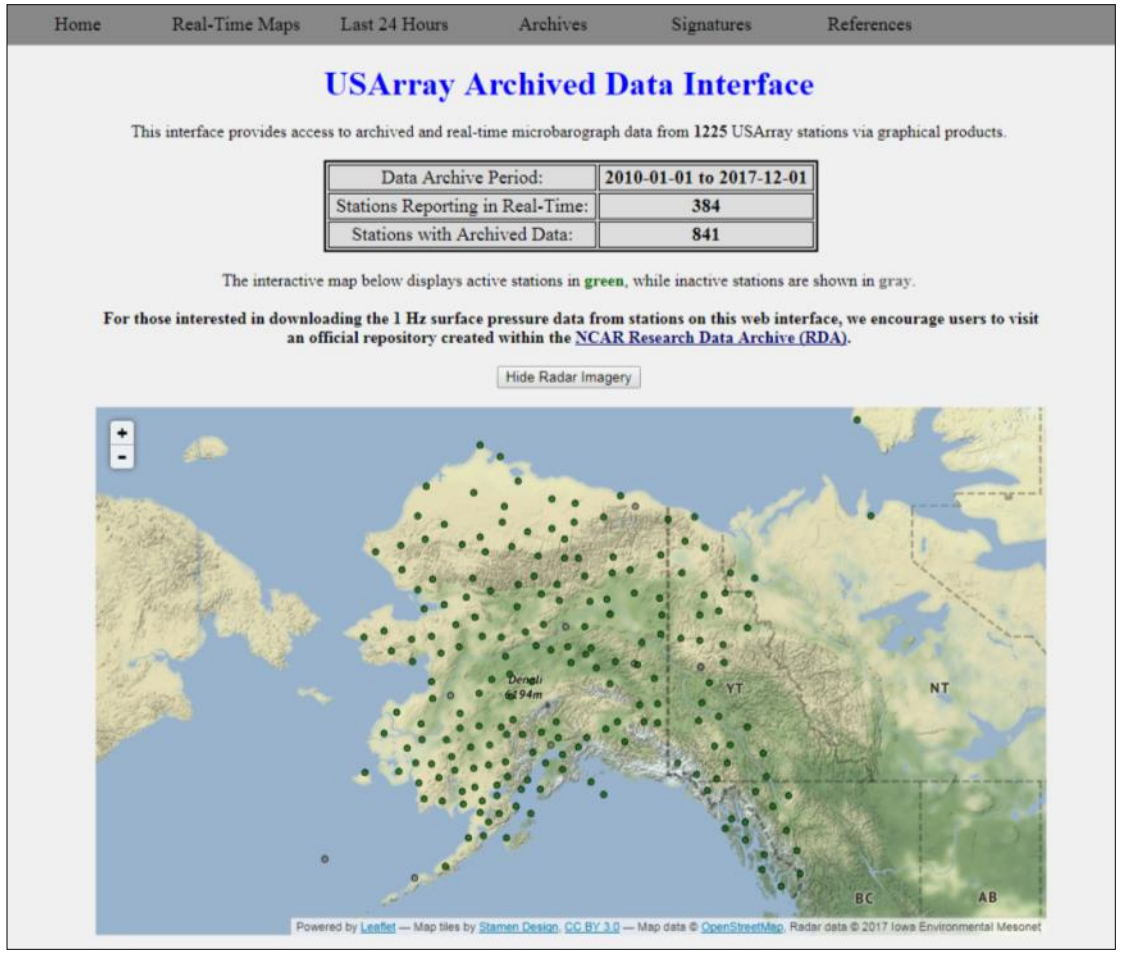


http://www.wrh.noaa.gov/mesowest/getobext.php?sid=F14KX

Atmospheric Community – 1 Hz TA Pressure Data Access

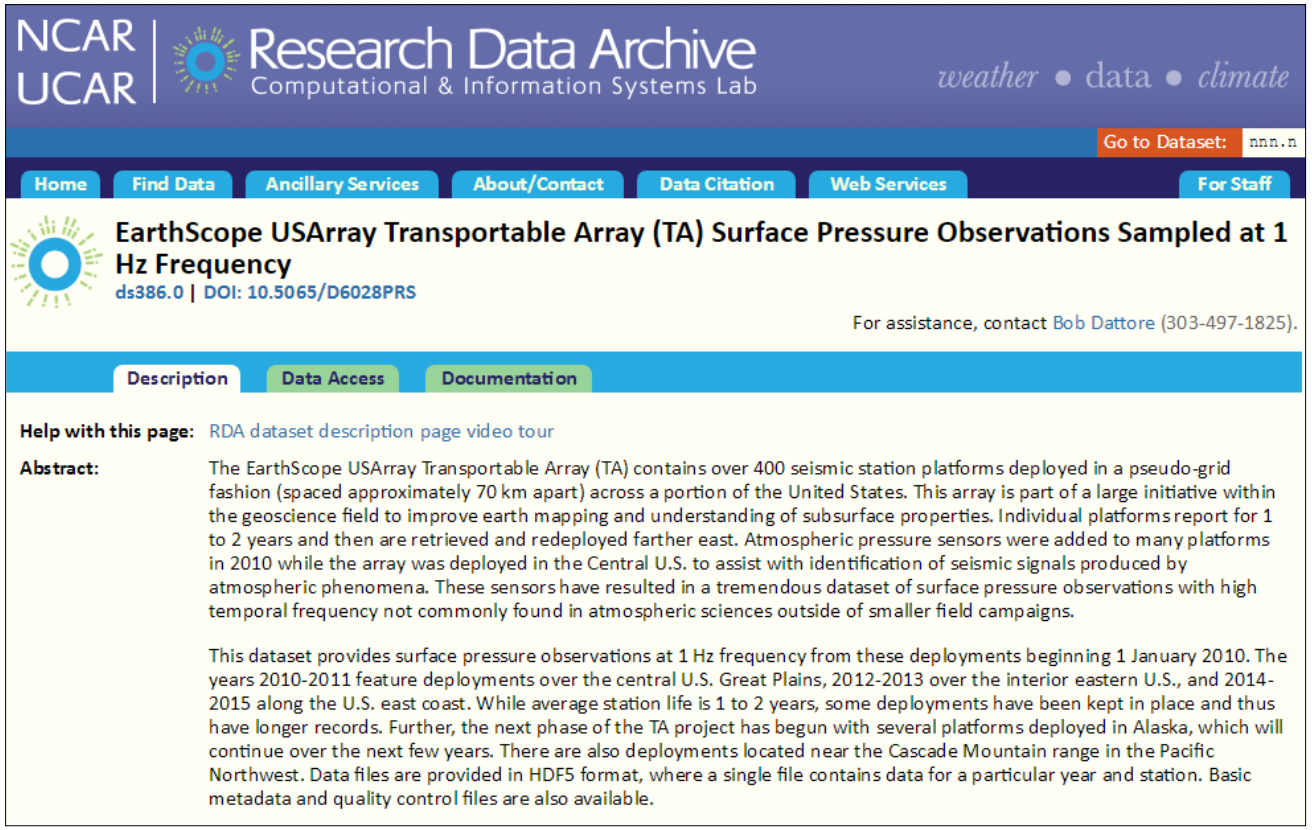
- 2013-2017 NSF Project Task: Improved Access to TA 1 Hz pressure data to Atmospheric Science Research Community

Research Project Website: http://meso1.chpc.utah.edu/usarray/



- 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

NCAR Official Research Data Archive: http://dx.doi.org/10.5065/D6028PRS



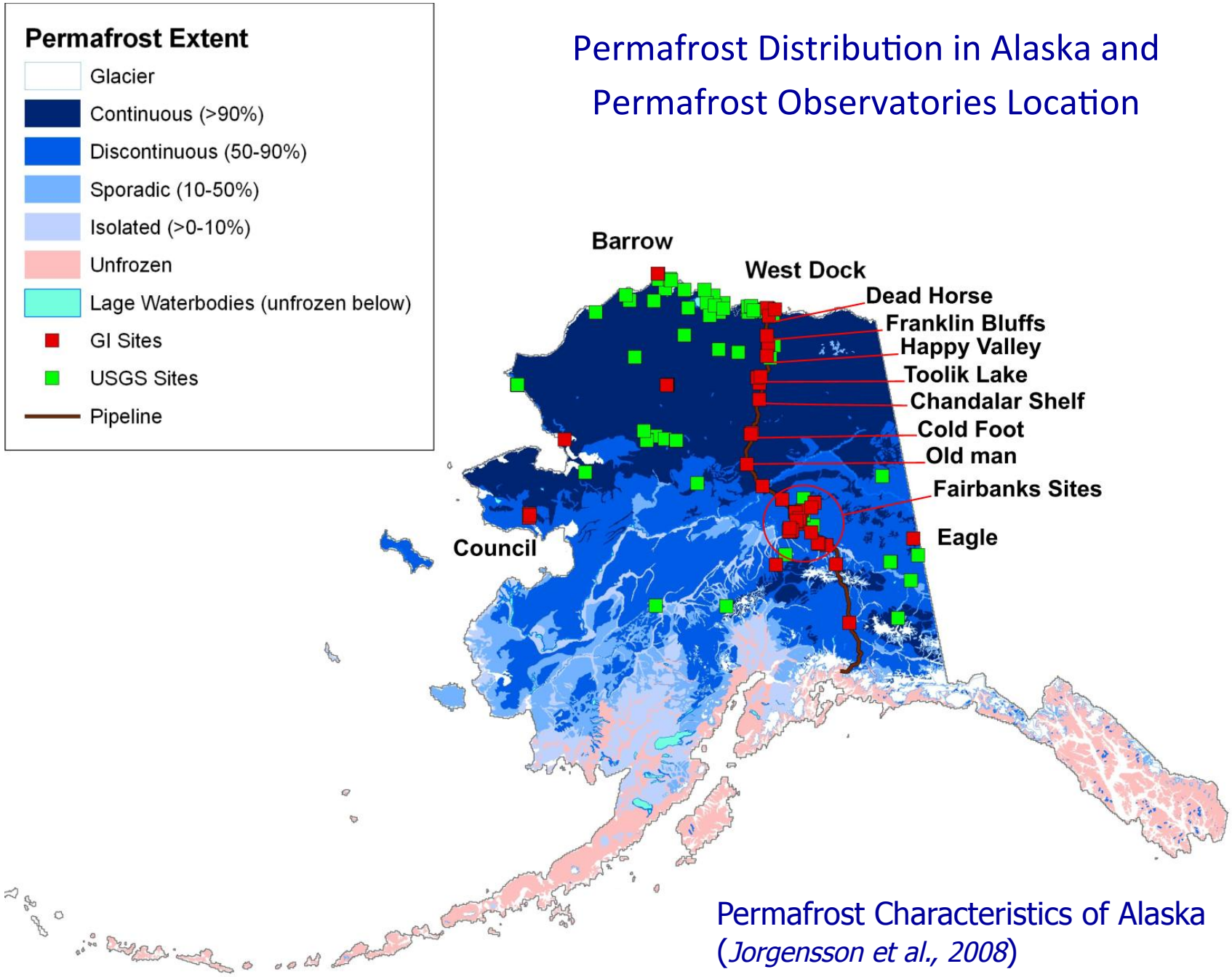
- Presently contains 1 Hz pressure data from 1 Jan 2010 - 31 Dec 2015
- Plan to extend archive to 31 Dec 2017 upon completion and review of 2017 dataset

Augmentation of the USArray sites with temperature profilers

Dmitry Nicolsky, Alexander Kholodov, and
Vladimir Romanovsky

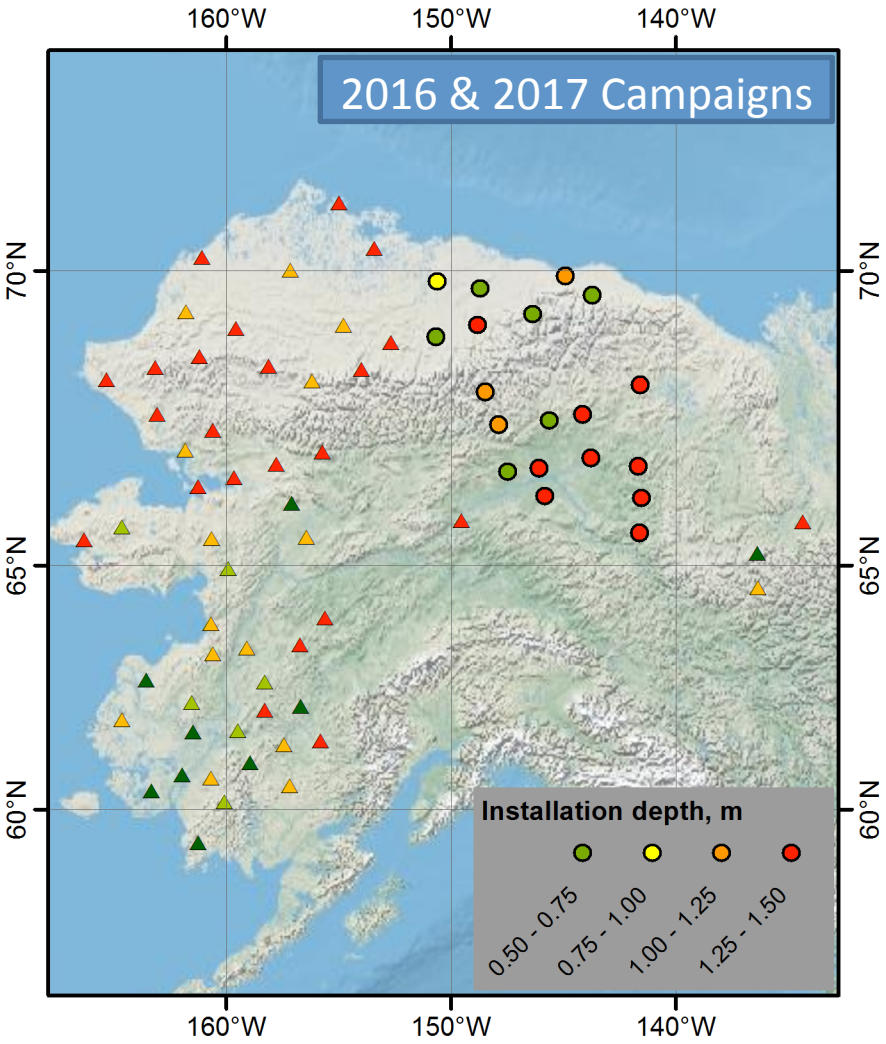
University of Alaska Fairbanks, Geophysical Institute
December, 2017

Permafrost Distribution in Alaska and Permafrost Observatories Location



Permafrost Characteristics of Alaska (*Jorgensson et al., 2008*)

Augmentation of the USArray sites with temperature profilers



PIs: Nicolsky, Romanovsky, and Kholodov

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