EarthScope's Efforts: Opportunities, Challenges, and Solutions in Geodesy Education and Workforce Development

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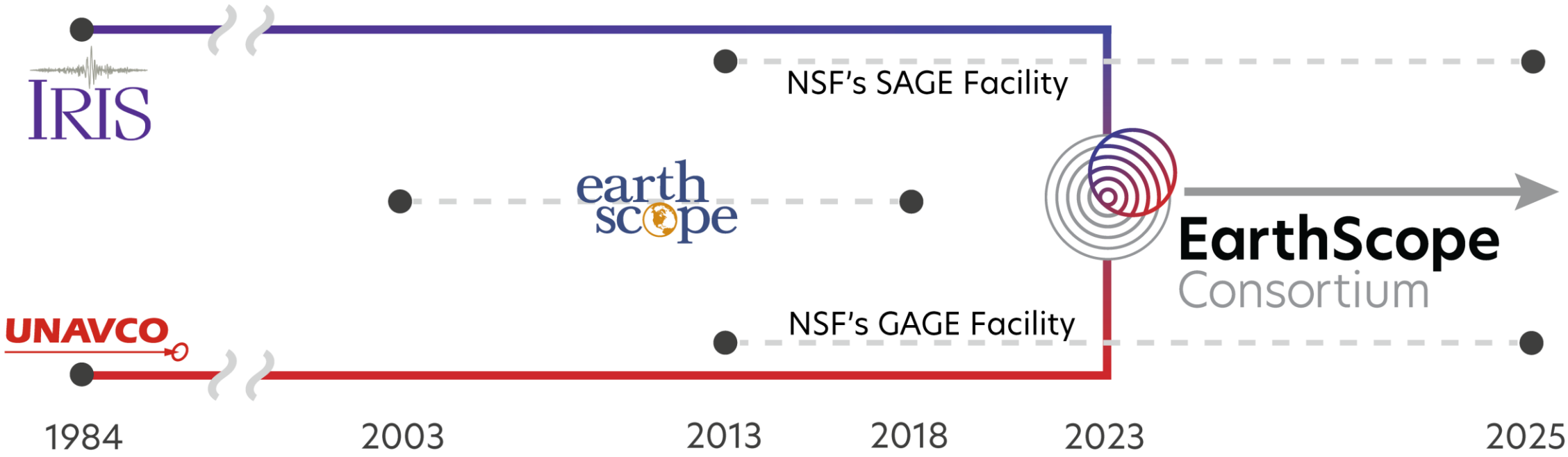
CGSIC - Surveying, Mapping, and Geosciences Subcommittee
September 11, 2023

What is EarthScope Consortium?



US National Science Foundation (NSF) facilities support research and education.

- GAGE – **Geodetic** Facility for the Advancement of Geoscience
- SAGE – Seismological Facility for the Advancement of Geoscience

Mission statement

EarthScope Consortium is a non-profit university consortium dedicated to transforming global geophysical research and education.

Our vision is an engaged society, resilient to geohazards, informed by geophysical discovery and collaboration.

EarthScope Primary Activities

GAGE
SAGE
Operated by EarthScope Consortium

Data -- Archiving, processing, software, visualizations

Engagement -- Teaching resources, internships, technical short courses, DEIA

Instrumentation -- Networks, PI support, RAPID responses, seismic, geodetic

earthscope.org

Seismology support

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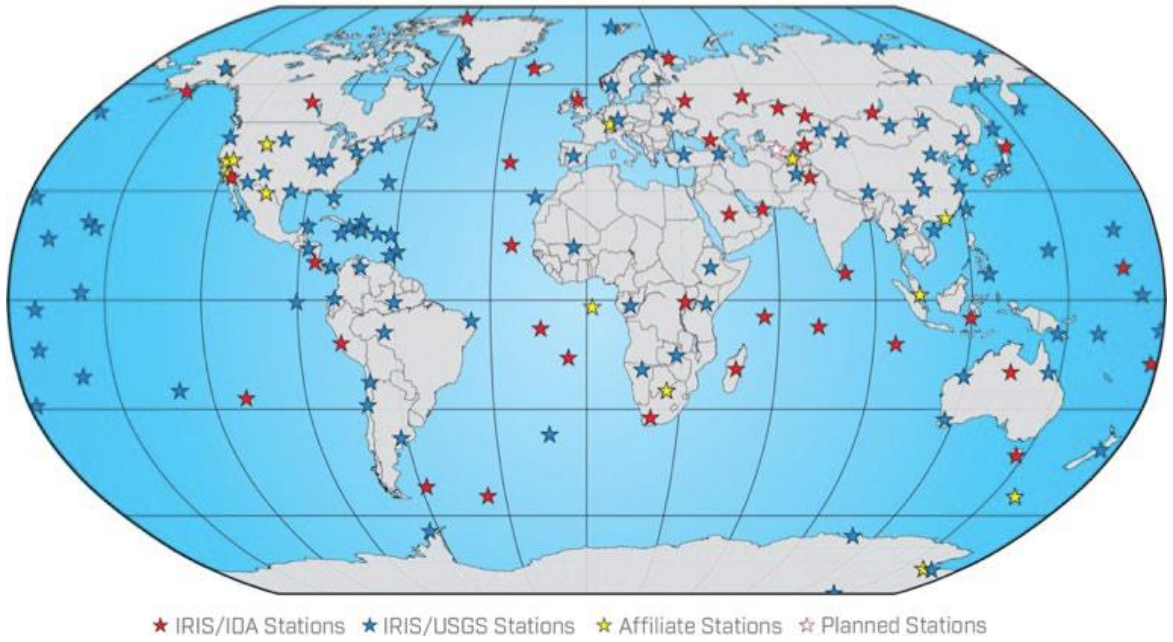
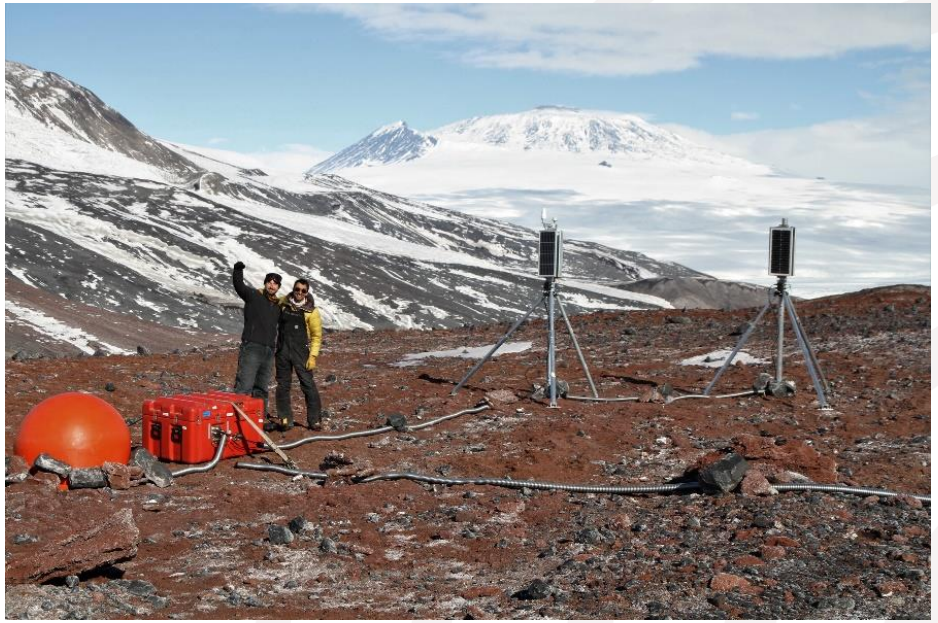
- **Data archiving**: raw seismic and derived products
- **Global Seismographic Network**
- **Portable instrumentation services**: seismometers, active-source support, magnetotelluric, ground penetrating radar



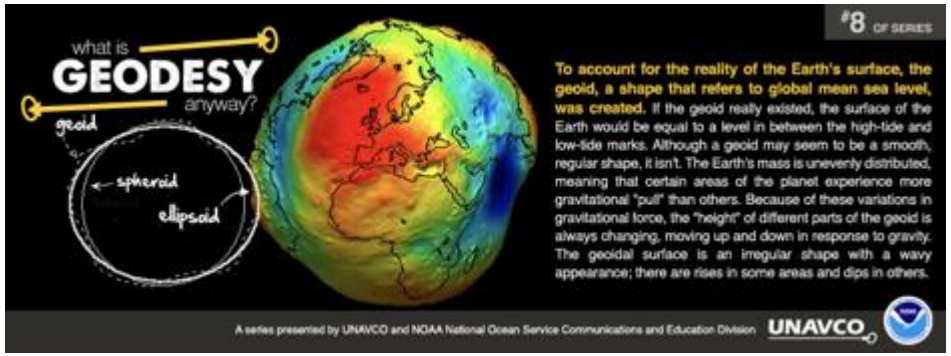


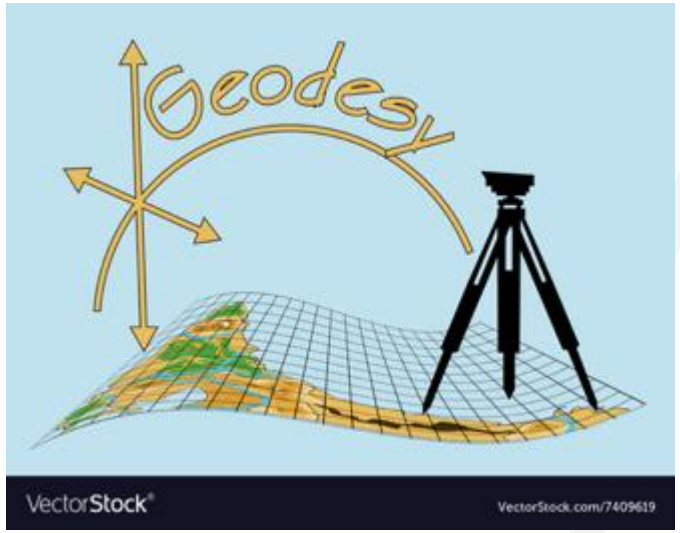
Geodesy support

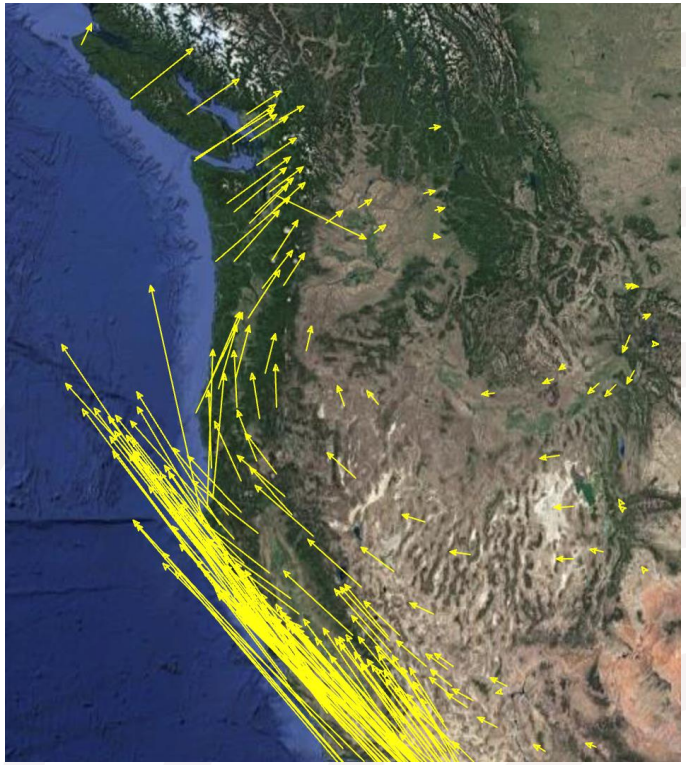
- **Data archiving**: GNSS, borehole strain/etc., SAR
- **Network of the Americas** operation (GNSS and borehole)
- **NASA Global GNSS Network** support
- **Portable instrumentation services**: GNSS, terrestrial laser scanning, UAV structure from motion

What is Geodesy?

The science of where things are, where they have been, and where they are going







EarthScope Engagement

- Responsive to geoscience community and societal needs
- Collaborate with geoscience community and amplify expertise

- Specific activities
  - Technical short courses
  - K-12 teaching resources and workshops
  - Undergraduate teaching resources and workshops
  - Internship programs
  - DEIA activities and integration

Technical Short Courses

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SHORT COURSES

2023 Multi-GNSS Precise Point Positioning and PRIDE PPP-AR Short Course

DATE(S): SEPTEMBER 25 & 27, 2023
LOCATION: VIRTUAL

This course will explore the latest concepts in high-precision multi-GNSS PPP processing and undifferenced ambiguity resolution techniques. Participants will learn how to apply these theories to a range of scientific and engineering projects using the open-source PRIDE PPP-AR software.

SHORT COURSES

2023 InSAR Processing and Theory with GMTSAR Short Course

DATE(S): JULY 25 - 29, 2023
LOCATION: VIRTUAL

This course will cover the theory and application of repeat-pass synthetic aperture radar interferometry (InSAR) using the software GMTSAR. Lectures and exercises will be given to teach the basic theoretical aspects of InSAR.

SHORT COURSES

2023 GNSS Interferometric Reflectometry Short Course

DATE(S): MAY 2-5, 2023
LOCATION: VIRTUAL

GNSS-IR is a method for estimating environmental parameters using data from geodetic-quality GNSS sites. It is used to measure changing conditions below a GNSS antenna such as snow depth, soil moisture, and water levels.

Responding to community requests and leveraging community expertise since 2005

- Graduate students, researchers
- Pre-COVID – in-person and hybrid - ~250 people/year
- Since 2020 – virtual - ~800 people/year

Skills Building

1. Linux & Generic Mapping Tool
2. Seismic Analysis Code (SAC)
3. SAGE Data Management Center
4. Seismic waveform modeling
5. Python and seismic libraries
6. Jupyter notebooks

- 12-week summer virtual course
- Undergrads/graduate students
- ~140 participants complete per year

GNSS module added 2022

Module 7 (BONUS) – Accessing and exploring GNSS data, interpreting GNSS plots, creating plots of GNSS station motion over time, removing the linear trend from GNSS data, examination of residuals and exploring GNSS time series for signals of earth processes.

- Would like to expand to full GNSS Skills Building course
- Need funding and partners

K-12 Teaching Resources

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Volcano Monitoring with GPS: Westdahl Volcano Alaska

Maite Agopian (EarthScope Project National Office Fairbanks) and Beth Pratt-Sitaula (EarthScope Consortium)

Author Profiles

EarthScope Consortium

▶ This activity is part of the On the Cutting Edge Exemplary Teaching Activities collection

Detecting Cascadia's changing shape with GPS | Lessons on Plate Tectonics

Nancy West (UNAVCO), Shelley Olds (EarthScope Consortium), & David Thesenga (Alexander Dawson School)

Author Profile

EarthScope Consortium

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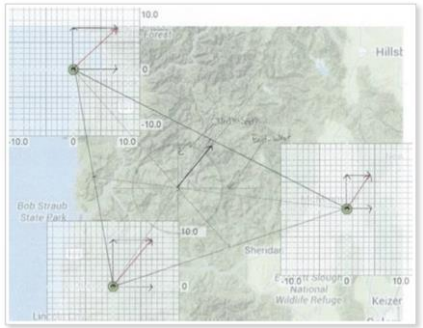


Exploring California's Plate Motion and Deformation with GPS | Lessons on Plate Tectonics

Roger Groom (Mt. Tabor Middle School), Andy Newman (Georgia Institute of Technology), Shelley Olds (EarthScope Consortium), Cate Fox-Lent (UNAVCO), Nancy West (Quarter Dome Consulting), & David Thesenga (Alexander Dawson School)

Author Profile

EarthScope Consortium

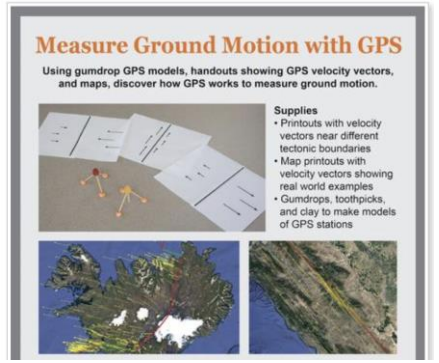
Measuring Ground Motion with GPS: How GPS Works

Shelley Olds (EarthScope Consortium), Daniel Zietlow (UNAVCO), & David Thesanga (Alexander Dawson School)

Author Profile

EarthScope Consortium

▶ This activity is part of the On the Cutting Edge Exemplary Teaching Activities collection



Also teacher workshops at National Science Teaching Association conference

Online tools

GPS Velocity Viewer

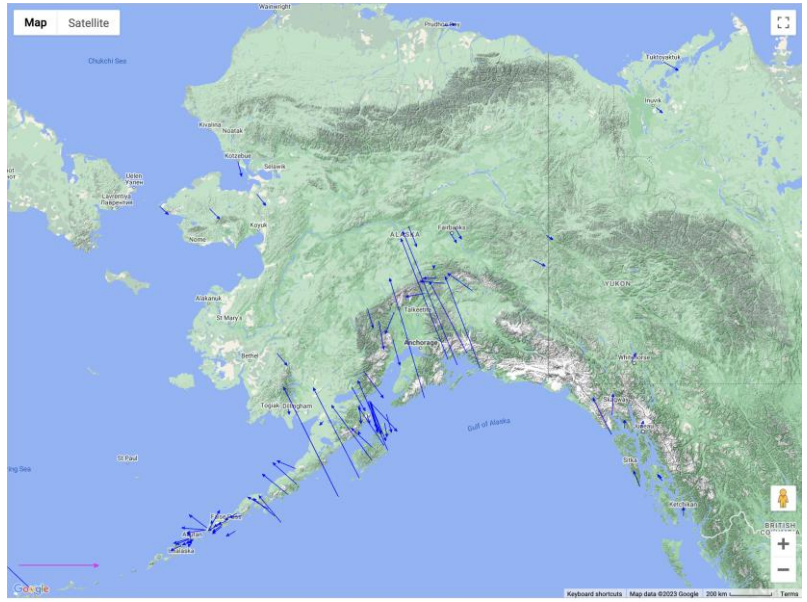


Plate Motion Calculator

Before using, please see: **Overview** **Models** **Usage** **Notes** **References**

Enter latitude and longitude coordinates (and optionally other selections)

Latitude:	**degrees North** **minutes North** **seconds North** E.g. enter the latitude as **–56.25** degrees or **–56** degrees **15** minutes for **56 degrees 15 minutes South**.
Longitude:	**degrees East** **minutes East** **seconds East** E.g. enter the longitude as **–102.5** degrees or **–102** degrees **30** minutes for **102 degrees 30 minutes West**.
Height:	**height (meters)** ***optional*** WGS-84 height of geographic coordinate (default = 0 meters)

Geoid Height Calculator

Coordinates (Latitude, Longitude, Elevation)

```
16.7408514345,-62.2138562081,82.2349
-31.2084545,-69.6365451,2419.1
34.4080925890291,-119.371255097653,162.510695808945
7.93227598779977,-72.5128133627576,321.150292529708
18.3074397892122,-65.282515096517,-30.3937790609993
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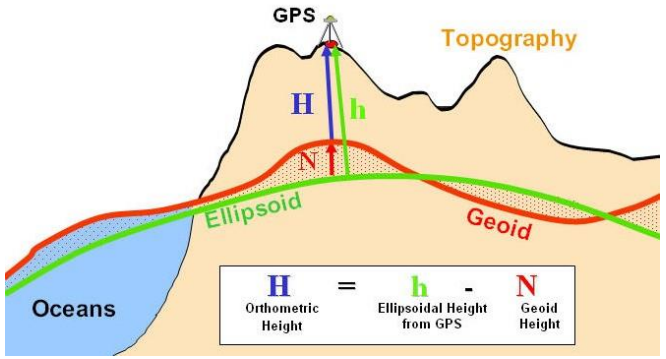
Submit



Undergraduate Resources

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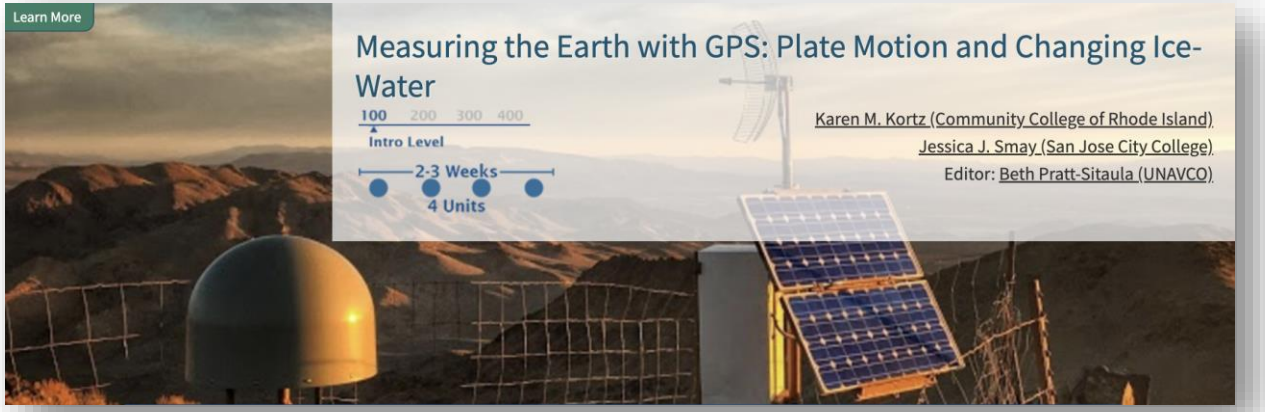

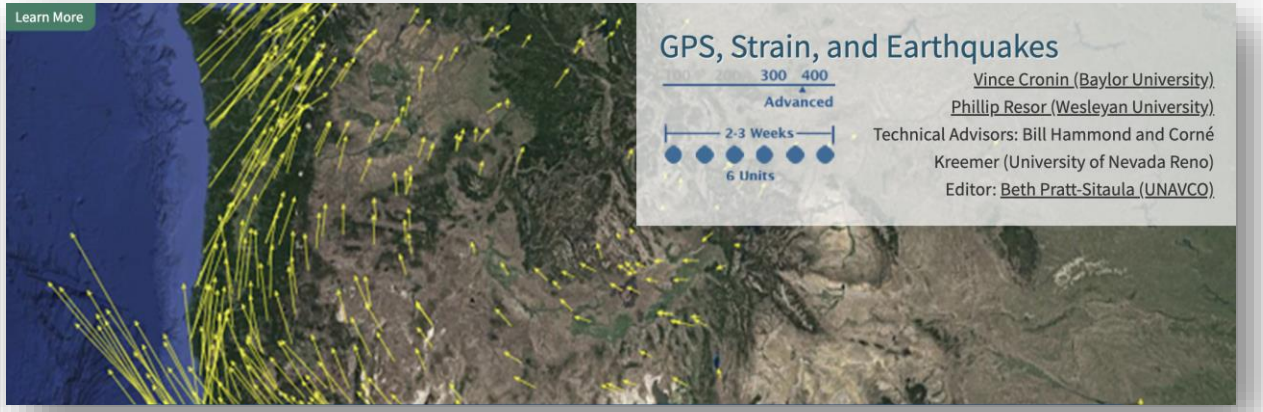

Solving societal challenges

Increasing student STEM engagement

Complementary paths to improvement

Measuring Water Resources with GPS, Gravity, and Traditional Methods

100 200 300 400

Intermediate-Advanced

2-3 Weeks

4 Units

Bruce Douglas (Indiana University-Bloomington)
Eric Small (University of Colorado at Boulder)
Editor: Beth Pratt-Sitaula (UNAVCO)

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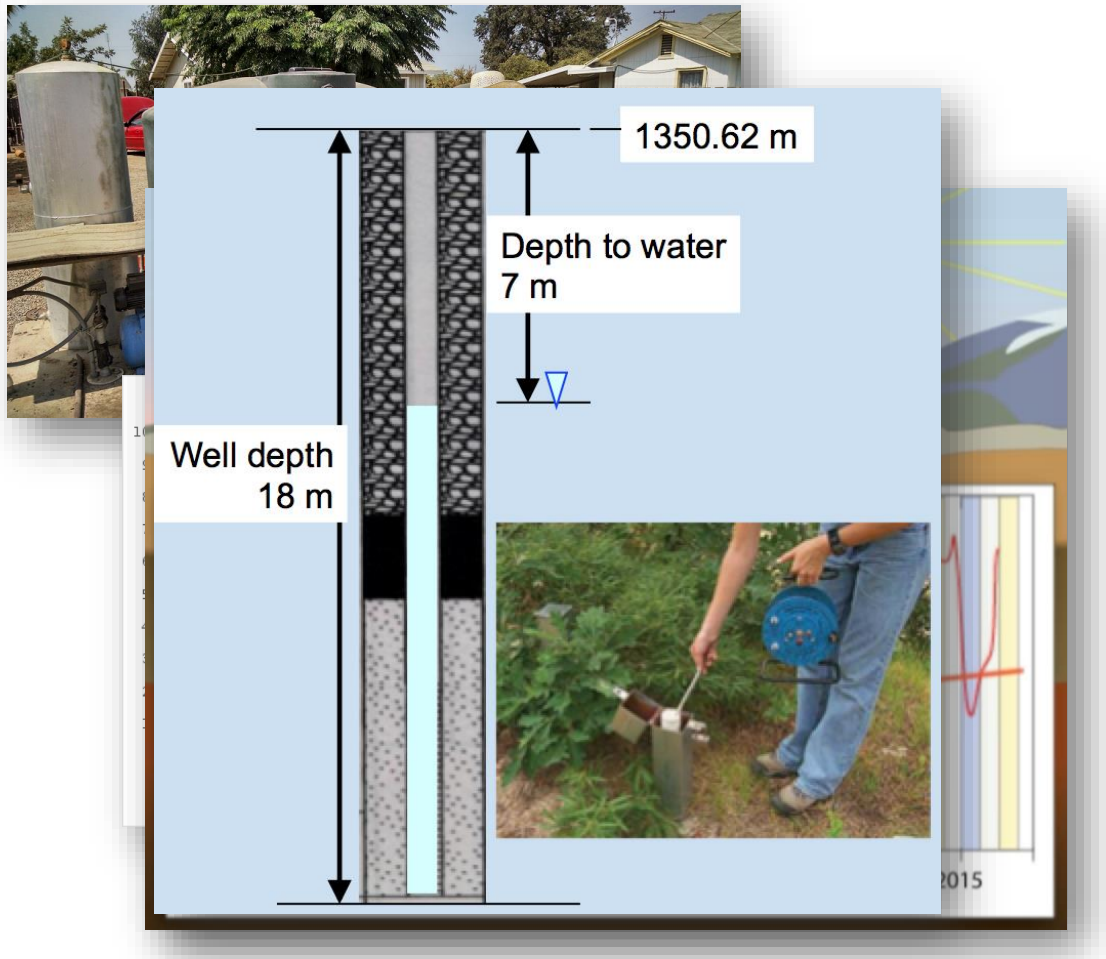


Images: Circle of Blue, NOAA, USGS, EarthScope

Instructor learning

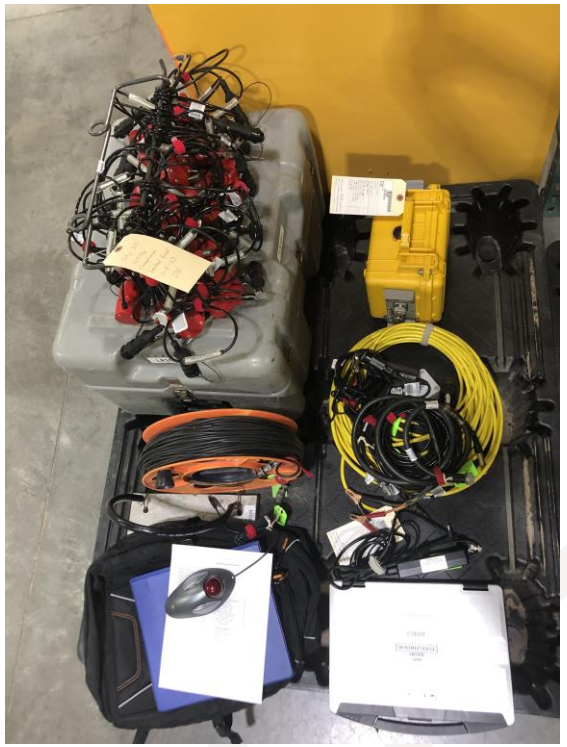
Short courses for geophysics and geodetic teaching

Join teaching-geophysics@earthscope.org for announcements

Loan instruments available for education

Ground penetrating radar (GPR)

GPS survey kits



Exploration seismometer

EarthScope Field Education page

- Other EarthScope instruments - TLS, SfM, UAS, DAS, magnetotellurics, other seismometers
- EarthScope instruments – shipping cost only (education waivers available for low-resource institutions)
- Electrical resistivity, gravimeters – available for rent from community partners

Student Internships

Four programs - 32 students in 2023

- **Geo-Launchpad** Program (GLP)

Community college – pre-research skills building

- **U**ndergraduate **R**esearch **I**nternships in **SE**ismology (URISE)
- **R**esearch **E**xperiences in **S**olid **E**arth **S**cience for **S**tudents (RESESS)

Undergraduate research

- **Student Careers Program**

Undergrad/grad - work experience

Student Internships

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Community supporting activities

- Led Anti-harassment/discrimination training for ~100 students in other NSF-funded internships

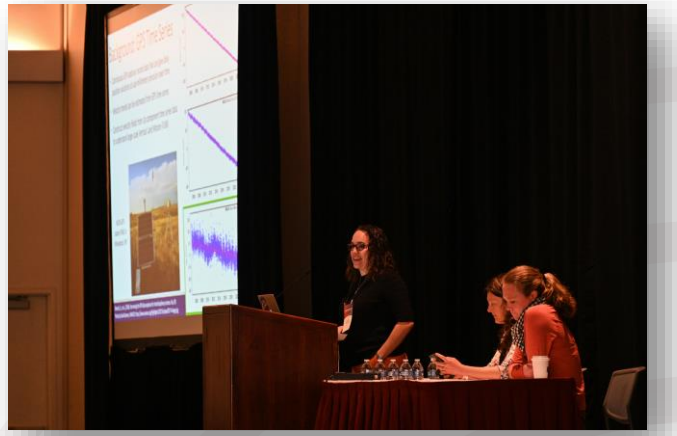
- Mentoring skills workshops for faculty

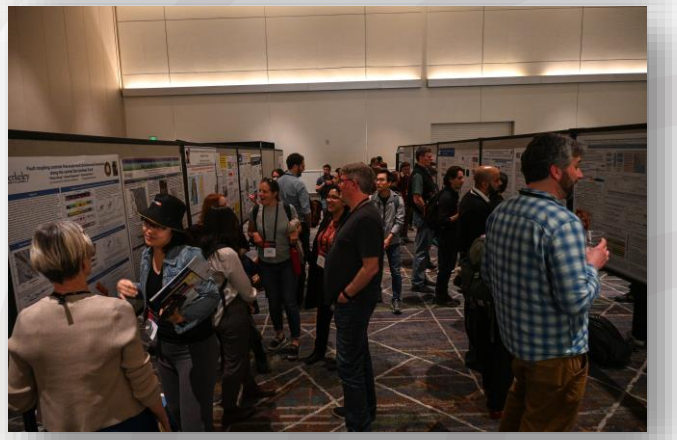
Accessibility & broadening participation

- Working with students from marginalized groups
- Internships aimed at broadening participation
- Collaborating with accessible field course (GeoSPACE)

Community meetings/conferences

- GAGE/SAGE Community Workshop - ~310 people in 2023
- Travel support for ~70 students/post-docs
- Feature early career researchers
- Talks, posters, short courses

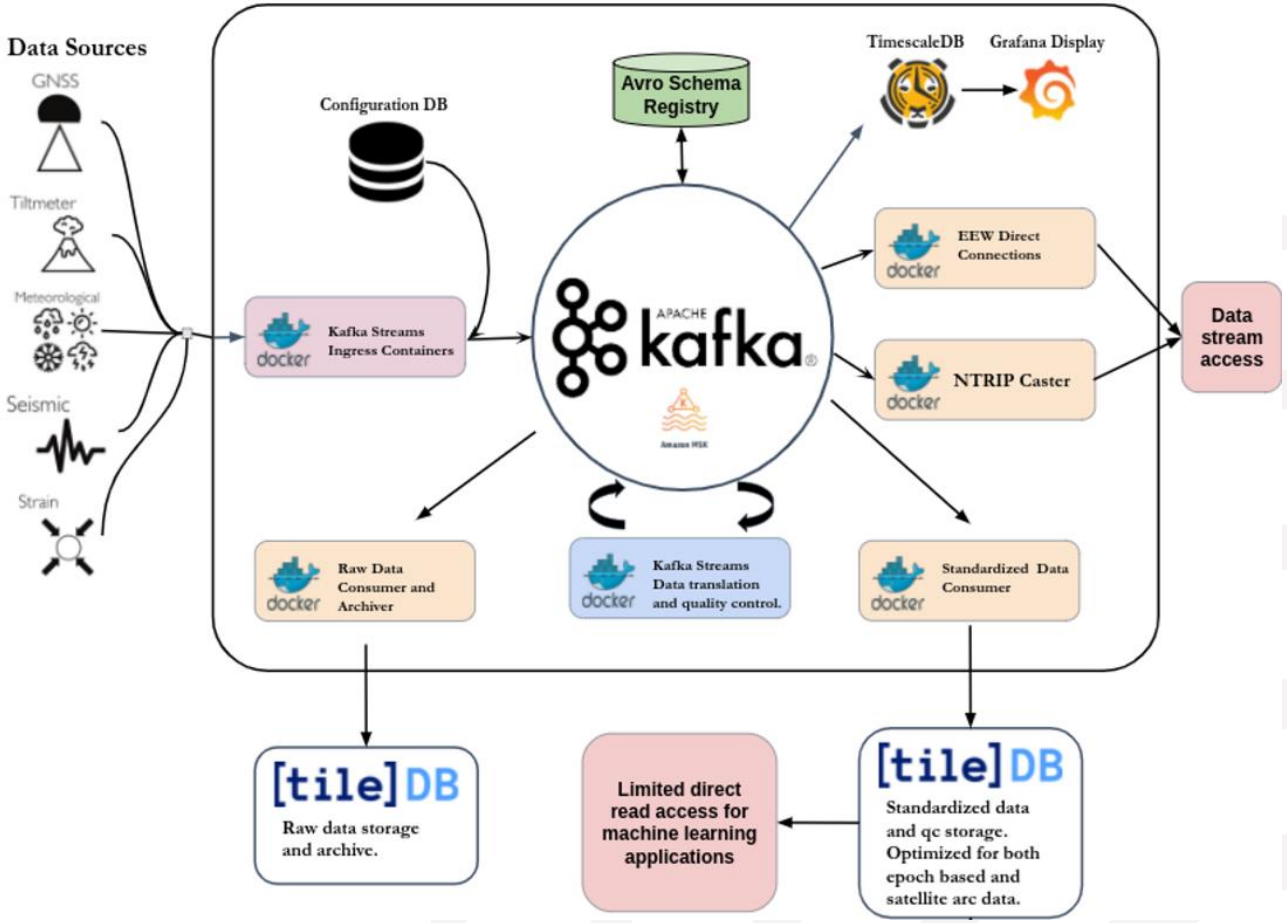




Data to the cloud

Common Cloud Platform for all data systems is under development

- Replacing Seattle and Boulder data centers
- Increased file format flexibility, performance, reliability
- Ease of access for cloud computing applications



Common Sensors

Urgent needs in geodesy

- US lacks enough geodesists
- Many discussions with faculty/government
  - Training/certificate program in geodesy
  - How can the GAGE facility help
- No specific plans at the moment
  Couple proposals were not funded
- Still very open to suggestions/partners on how facility can support
- Expand beyond traditional tectonics applications

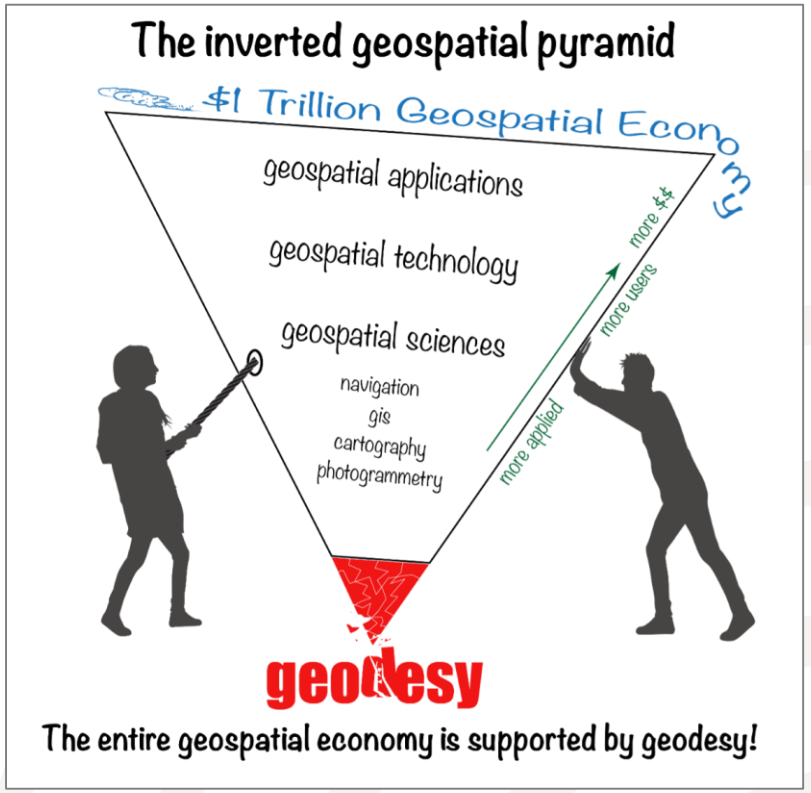


Image: Dana Caccamise I

Questions