



GETSI 2016 Annual Report - UNAVCO

Collaborative Research: Geodesy curriculum for the 21st century-- Innovative science for addressing societally critical issues

Project Period: 07/01/2013-06/30/2017 (original end date 6/30/16 extended to 2017)

Reporting Period: 07/01/2015-06/30/2016

Principal Investigators: Meghan Miller (PI), Donna Charlevoix (Co-PI), Beth Pratt-Sitaula (CoPI)

Sponsor: NSF DUE-TUES

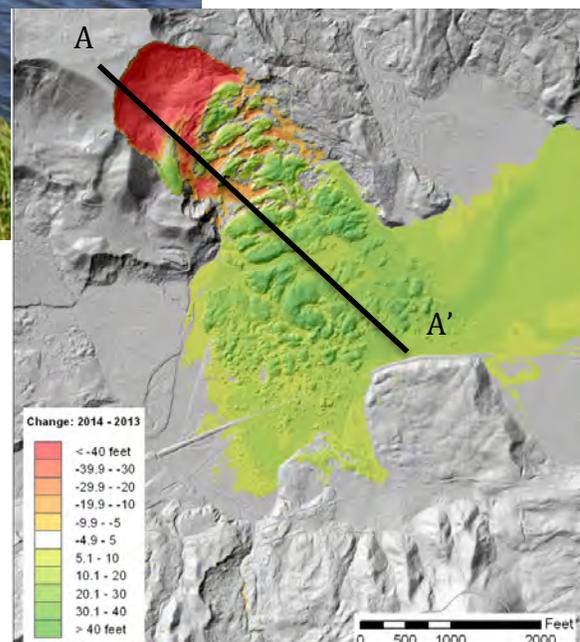
Award ID: 1245025

Collaborators: Bruce Douglas (Indiana University), Rebecca Walker (Mt San Antonio College)



Animation on measuring ground water change with GPS that was made to support the "Measuring Water Resources" module.

Lidar image of Oso Washington Landslide showing surface elevation changes as part of the "Surface Process Hazards" module.



Accomplishments

What are the major goals of the project?

Recent technological innovations in geodesy (the measurement of the size, shape, and mass distribution on Earth and changes over time) have allowed a wide range of advances in our understanding of Earth processes on topics critical to society such as natural hazard mitigation, climate change, and water resource management. Undergraduate teaching resources have not kept pace. GETSI (GEodetic Tools for Societal Issues) is a curriculum development and dissemination project to increase the representation of geodetic data use by both introductory and majors-level undergraduate students. GETSI is partnered with the SERC (Science Education Resources Center) InTeGrate project (Interdisciplinary Teaching about Earth for a Sustainable Future) for curriculum design, assessment, and evaluation. The project will produce four modules that encompass about two weeks of class time each – two at the introductory level and two at the majors' level.

Overarching Objectives

1. Improve geoscience (particularly geodetic) knowledge base of undergraduate students both for general science literacy (introductory) and future science workforce (majors-level).
2. Improve effectiveness of teaching resources and pedagogy employed by faculty members teaching geodesy, geoscience, and allied sciences.

TUES Type 1 Outputs

1. Development, testing, revision, and dissemination of five curricular modules featuring geodesy data investigations on societally important topics which support Earth science and quantitative literacy at both introductory and majors' levels in diverse academic settings.
2. Developers' manual to facilitate future integration of geodesy and other data into teaching materials.
3. Support for faculty in integrating curriculum into courses

TUES Type 1 Outcomes

1. Students:
 - a. Are able to apply authentic geodetic data and quantitative reasoning to addressing critical societal issues
 - b. Have improved understanding of nature and methods of science
 - c. Gain better understanding of relevant geoscience and climate literacies and the ability to apply them to critical resource, hazard, and environmental issues
2. Faculty
 - a. Adopt developed geodesy curriculum modules
 - b. Include more connections between authentic data and addressing of critical societal issues
 - c. Increase use of promising pedagogical practices in STEM education
 - d. Use systematic assessment of student learning

What was accomplished under these goals?

Major Activities

Significant headway was made on Outputs #1 and #3 and Output #2 was completed.

More details, including website use so far, are included in the Appendix “Year Three Evaluation Report” by the Science Education Resource Center (SERC).

Output #1: The Year 1 modules (*Ice Mass and Sea Level Changes* [intro] and *Imaging Active Tectonics with InSAR and LiDAR* [majors]) were finished and published online. The Year 2 modules (*Surface Process Hazards* [intro] and *Measuring Water Resources with GPS, Gravity, and Traditional Methods* [majors]) and the fifth module added with supplemental funding (*GPS, Strain, and Earthquakes* [majors]) all passed the Materials Development Rubric and were tested in 2-3 classrooms. Final revisions are underway and all three modules will be published later in 2016. An animation “Measuring Drought: A GPS Network Offers A New Perspective”

(<https://www.youtube.com/watch?v=5Bzt374u5aU&index=2&list=PLzmugeDoplFOot41MIBBZiLYBCB0M-p1P>) was developed in collaboration with community member, Adrian Borsa, to support learning in the *Measuring Water Resources with GPS, Gravity, and Traditional Methods* module.

Output #2: The “Developers Manual” was written and published online (<http://serc.carleton.edu/getsi/develop/index.html>).

Output #3: GETSI is ramping up more faculty professional development to facilitate integration of teaching materials into courses. In the past year we: 1) engaged in outreach in poster sessions and from the UNAVCO and NAGT booths at both GSA and AGU; 2) held a short course with 12 attendees at the UNAVCO Science Workshop (March 2016); 3) participated in a joint webinar with the InTeGrate project (March 2016) with 47 participants; 4) sent announcements via websites and listservs of UNAVCO and partner organizations; and 5) scheduled and initiated planning for 3 more short courses (2 GSA September 2016 and 1 AGU December 2016) and 1-2 more joint webinars with InTeGrate.

Opportunities for training and professional development?

GETSI materials authors receive professional development related to pedagogical best practices for geoscience teaching. Participants in webinars and short courses receive professional development related to both pedagogy and geodesy content.

How have results been disseminated to communities of interest?

As described above in Major Activities Output #3, modules have been disseminated via a short course, webinar, conference booths, conference presentations, listservs, and websites. GETSI is also featured on the UNAVCO website as a major project (<http://www.unavco.org/projects/projects.html#Major>) giving it prominence beyond just the Educational section, which tends to be limited to a smaller subset of the UNAVCO community.

Plan for next reporting period?

During the next reporting period, the remaining three modules will be revised and published. We will conduct dissemination and professional development short courses in conjunction with the 2016 GSA Annual Meeting 2016 AGU Annual Meeting. GETSI modules will also be featured in InTeGrate dissemination webinars. Module users (meta-pilot-testers) will be recruited to give feedback on how they actually adapted or adopted the materials, to inform our research into how developed materials are actually implemented and future short courses. We also plan to write a short news article for EOS or *In the Trenches* and continue to disseminate at meeting booths and presentations and through partner organizations of NAGT and InTeGrate.

Products

Conference Papers and Presentations

Title: Use of geodetic data in the introductory geoscience classroom: components of the GETSI project's Ice Mass and Sea Level Changes module

Conference: Geological Society of America Annual Meeting 2015

Authors: Becca Walker, Leigh Stearns, Beth Pratt-Sitaula

Title: Undergraduate teaching modules featuring geodesy data applied to critical social topics (GETSI: GEodetic Tools for Societal Issues) [invited]

Conference: American Geophysical Union Annual Meeting 2015

Authors: Beth Pratt-Sitaula, Becca Walker, Bruce Douglas, Donna Charlevoix, Meghan Miller

Websites

GETSI Project Site: <http://serc.carleton.edu/gets/index.html>

This is the GETSI project website. It gives background information on the project and is the primary publication site of the teaching modules when they are complete. Development workspaces allow for internal project notes and draft module text.

Participants

Individuals

Meghan Miller UNAVCO PI 0 Months

As the UNAVCO President Miller is responsible for coordination with the science community and the successful accomplishment of the work. She is paid entirely out of indirect as her work is for the proportional benefit of all awards; thus she does not draw salary on this grant.

Donna Charlevoix UNAVCO Co-PI 0 Months

As the Director of UNAVCO's Education and Community Engagement, Charlevoix is also responsible for coordination with the science community and the successful

accomplishment of the work. Her salary is covered through the NSF GAGE Facility Cooperative Agreement.

Beth Pratt-Sitaula UNAVCO Co-PI 2 Months
A UNAVCO Educational Specialist, Pratt-Sitaula serves as the GETSI facilitator in charge of project logistics and communication. She coordinates between UNAVCO, the authors, technical experts, beta-testers, SERC, NAGT, and related organizations. She leads dissemination (meeting presentations, journal papers, articles, website content, webinars) and will ultimately write the geodesy curriculum developer's manual. Pratt-Sitaula's funding to work on GETSI is entirely from the GETSI grant (NSF Tues).

Austin Madson UNAVCO Student 2 Months
Madson was a UNAVCO Summer Internship Program (USIP) intern in summer 2015. He worked on data processing and map generation in support of the "Water Resources" and "Surface Process Hazards" module. He was paid primarily through the USIP program, which is funded by NSF GAGE Facility, with some additional funds from GETSI grant for follow participation.

Gareth Funning UC Riverside Faculty 0 Month
Funning is serving as module co-author with collaborator Bruce Douglas (Indiana University) on the majors-level module "Imaging Active Tectonics". His full time job is as a faculty member at UC Riverside. GETSI paid him a total of \$7500 stipend over ~18 month period for work on module development and revision.

Leigh Stearns Univ. of Kansas Faculty 0 Month
Stearns is serving as module co-author with collaborator Becca Walker (Mt San Antonio College) on the introductory level module "Ice and Sea Level Changes". Her full time job is as a faculty member at University of Kansas. GETSI paid him a total of \$7500 stipend over ~18 month period for work on module development and revision.

Eric Small Univ. of Colorado Faculty 1 Month
Small is serving as module co-author with collaborator Bruce Douglas (Indiana University) on the majors-level module *Water Resource Geodesy*. His full time job is as a faculty member at University of Colorado. GETSI will pay him a total of \$7500 stipend over ~15 month period for work on module development and revision.

Sarah Hall Coll. of the Atlantic Faculty 1 Month
Hall is serving as module co-author with collaborator Becca Walker (Mt San Antonio College) on the introductory level module *Surface Process Hazards*. Her full time job is as a faculty member at College of the Atlantic. GETSI will pay her a total of \$7500 stipend over ~15 month period for work on module development and revision.

Jenda Johnson Volcano Video Productions 0 month
Johnson produced the animation about GPS and ice mass loss, in collaboration with Stearns, Walker, and Pratt-Sitaula. She was paid through another budget within UNAVCO.

Ellen Iverson SERC 1 month
Iverson is the lead assessment consultant and external evaluator for the GETSI project. She is paid by SERC (Science Education Resources Center) via an subaward from this NSF TUES project.

Stuart Birnbaum SERC 0 month
Birnbaum is the assessment consultant for the majors-level modules. He is paid by SERC (Science Education Resources Center) via a subaward from this NSF TUES project.

Kristin O'Connell SERC 1 month
O'Connell is the webmaster for the GETSI project. She supports any team needs related to the SERC-hosted GETSI website and all issues related to submission of student data for assessment review. She is paid by SERC (Science Education Resources Center) via an subaward from this NSF TUES project.

Organizations

Type: Academic Institution

Name: SERC (Science Education Resource Center)

Location: Northfield, MN

Contribution: Assessment and evaluation; dissemination

Details: SERC is providing assessment design, external evaluation, and project dissemination through a designated subaward. GETSI module design and assessment are following the model of SERC's InTeGrate project. Modules are being reviewed by expert assessment consultants and student data will be collected using the InTeGrate collection system. SERC is also hosting the GETSI website and providing content management assistance for the site and webinars. As needed, GETSI announcements go out through SERC channels to the wider geoscience community. Ellen Iverson, a SERC assessment specialist, is providing external evaluation of the GETSI project (see report in Significant Results section).

Type: Other Nonprofits

Name: National Association of Geoscience Teachers (NAGT)

Location: Northfield, MN

Contribution: Collaborative Research

Details: NAGT is collaborating with GETSI on dissemination. For example, as part of publicizing GETSI webinars, announcements went out on NAGT listservs.

Impacts

What is the impact on the principle discipline?

Geodesy encompasses an increasingly important set of geoscience methods for better understanding earth processes. Its scope has greatly increased from early applications of surveying and tectonic plate motions to include critical insights into natural hazards (ex. earthquake, volcanoes, landslides), climate change (ex. ice mass and sea level change), and water resources (ex. ground water storage and change). However, the field remains fairly technical and access to some data sets is limited. Therefore undergraduate students are seldom given the chance to analyze geodesy data. This is a critical omission for a toolbox of techniques needed for the next generation of science literate citizens and geoscience workforce members. GETSI is working to address part of this gap through the development

and dissemination of high quality teaching modules for both introductory and majors-level courses that feature geodesy data analysis.

What is the impact on society beyond science and technology?

As our global population continues to increase, living in ever more marginal lands with ever-increasing temperatures and decreasing water resources, our ability to mitigate effectively for natural hazards, respond to climate changes, and manage our common resources becomes ever more critical. The GETSI project is rooting the study of earth science through the lens of societally important questions. The aim is to increase students' (future citizens') ability to analyze and address these challenges.

Changes/Problems

Actual or Anticipated problems or delays and actions or plans to resolve them

The final publication of the last three modules will be a little later than originally hoped, but they are still on track for completion in 2016. No new actions or plans are needed to resolve the delay. We are proceeding with the original plan but on a somewhat extended schedule.

Appendix – Report from External Evaluator

Year Three Evaluation Report Prepared for GETSI by Ellen Iverson, Director of Evaluation Science Education Resource Center (SERC) at Carleton College

Summary

The third year of the GETSI Geodesy Tools for Societal Issues project focused on the publishing of the year one team’s two modules: 1) Ice mass and seal level changes and 2) Imaging active tectonics with LiDAR and InSAR. The year one teams demonstrated completion of output goals #1 and #3 (see Figure 1 for this Logic Model). In addition, the website and dissemination activities appear to be reaching faculty and these faculty report intended use of geodesy curriculum modules (outcome goal #2).

In addition, the year two teams passed the materials review process for their three modules : 1) Surface Process Hazards, 2) Measuring Water Resources with GPS, Gravity, and Traditional Methods, and 3) GPS, Strain, and Earthquakes. These modules were piloted in courses were piloted in 8 courses, involving over 140 enrolled students, thus making strong progress toward output goals # 1 and # 3 (see Figure 1 for this Logic Model).

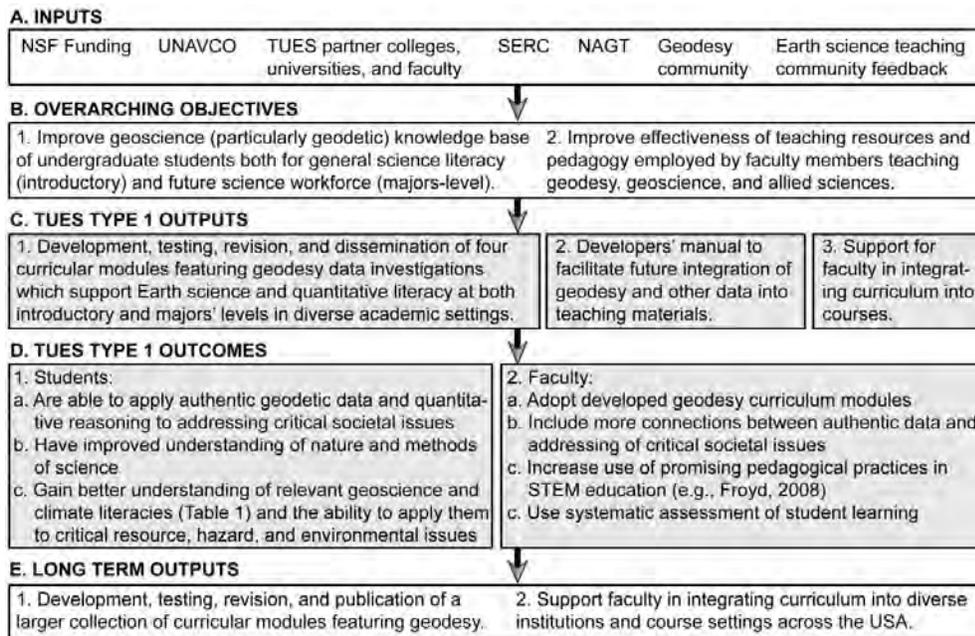


Figure 1 GETSI Logic Model

Year 1 Teams

The Year one teams revised their materials based on their teaching experiences and an analysis of student learning outcomes with the pilots to the materials in 6 courses, involving over 110 students. For the Ice mass and sea level changes module, faculty (module authors and tester) were pleased with demonstrated student outcomes related to being able to interpret and describe climate graphs as well as making rate of change calculations and using multiple data sets to make predictions about changes in Greenland's ice mass. For the Imaging active tectonics with LiDAR and InSAR, faculty (module authors and tester) reported that students demonstrated a more nuanced understanding of faults, faulting, and changes to near-surface environments that impact humans. Faculty reported some difficulties with students understanding the final module exercise where students are asked to synthesize and apply their earlier knowledge gained from analysis related to LiDAR and InSAR. This module was revised to respond to the teaching and student learning challenges from the pilot prior to being made available on the website.

The two modules were published on the website in the Fall of 2015:

http://serc.carleton.edu/getsi/teaching_materials/ice_sealevel/index.html

http://serc.carleton.edu/getsi/teaching_materials/imaging_active_tectonics/index.html

In the short amount of time the modules have been publicly available, over 1300 website users have made over 7200 pageviews. Additionally, the modules have teaching materials (e.g., answer keys) which require the PI to grant access to the specific user based on teaching credentials. The instructor only materials have been requested by 15 faculty. Of these faculty over half (8 of 15) identified a specific course in the spring or summer of 2016 where they planned to incorporate the materials. Across these 8 reported courses, nearly 200 enrolled students would have been impacted. In addition, one faculty member reported the use of a module an example of reflective seismology for a teacher workshop in a NSTA short course. The Ice Mass and Sea Level Changes was featured in an InTeGrate sponsored webinar: Using Data to Teach About Societally Important Questions held on March 23rd. For this webinar, 82 people registered and of those 39 participated in the webinar. Additional dissemination is being planned for the Fall of 2016.

Year 2 Teams

The three module author teams: 1) Surface Process Hazards, and 2) Water Resources and Geodesy, and 3) GPS, Strain, and Earthquakes passed the Materials Development rubric after minor revisions to address assessment and measurement items and/or students ability to address interdisciplinary problems. All modules piloted or are currently piloting the materials in in 8 courses, involving over 140 enrolled students.

For the two pilots that are complete for Measuring Water Resources with GPS, Gravity, and Traditional Methods, faculty (author and tester) reported a challenge in "balancing the volume of material produced with what can actually be accomplished in class." This challenge made the units feel rushed at times to faculty. Overall faculty piloting the materials were pleased with what students learned. As one module author stated, "some revisions are certainly needed...but I think the material is really great for Earth science students. It makes them scratch their heads and analyze real data as related to a very clear societal problem."

All three modules appear on track to complete pilots by June of 2016. Materials will be revised over the summer in response to faculty teaching experiences and analysis of student outcomes. All these modules appear on track for being published in the Fall of 2016.