GETSI 2015 Annual Report

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

**Project Period:** 07/01/2013-06/30/2016  
**Reporting Period:** 07/01/2014-06/30/2015  
**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)

*Two visualizations made in conjunction with GETSI project Year 2 – Visible Earthquake InSAR tool and GPS-glaciers animation*

![Image of visualizations](image1.png)

![Image of glaciers](image2.png)
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 four 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. The Year 1 modules (Ice Mass and Sea Level Changes [intro] and Imagine Active Tectonics with InSAR and LiDAR [majors]), which were initiated in the previous year, underwent the majority of their writing. Both passed the GETSI Materials Development Rubric and were classroom tested in 2 or 3 courses. Revision work has start on Ice Mass and Sea Level Changes.

The Year 2 modules (Surface Process Hazards [intro] and Water Resource Geodesy [majors]) were initiated at the April 17-19 GETSI Materials Development Workshop. Both modules have passed the first checkpoint of having a completed detailed outline, unit learning goals, summative assessment plan, and data preparation plan.

More details about these module development activities are included in the attached “Year Two Evaluation Report” by the Science Education Resource Center (SERC).

GETSI also received supplementary funding to modify an existing beta-version module that had previously been developed by UNAVCO and community members - Infinitesimal strain analysis using GPS data. Revisions are underway to align the module with the GETSI Materials Development Rubric and initiate classroom testing and student work assessment.

An animation and interactive InSAR tool were initiated at the end of Year 1 were completed in the first part of Year 2. The animation “Using GPS to measure glacial ice mass loss” is a key element of Ice Mass and Sea Level Changes Unit 4 and is published to the UNAVCO YouTube channel. “Visible Earthquake” InSAR modeling tool is a key element of Imagine Active Tectonics Units 3 & 4. GETSI has begun planning for another animation that would feature how GPS data can be used to better understand groundwater loss from the California drought that would be used as part of the Water Resource Geodesy module.

Opportunities for training and professional development?

GETSI materials authors receive professional development related to pedagogical best practices for geoscience teaching. They received this professional development during three preparatory webinars and the April GETSI Materials Development Workshop (http://serc.carleton.edu/getsi/meetings/index.html).

Professional development for other geoscience faculty members to adopt GETSI modules will be done during Year 3, but the groundwork was laid in Year 2 by applying to do two GSA short courses and participate in InTeGrate dissemination webinars.

How have results been disseminated to communities of interest?

As the modules are still very much in development, GETSI does not yet have “results” in the form of final published modules. However, we have worked to inform interested parties about the project’s existence. Two GETSI materials authors gave talks at the 2014 AGU annual meeting. Elements of GETSI modules (in particular the Visible Earthquake InSAR Tool) were featured in an NAGT Cutting Edge Virtual Workshop “Student Learning About Critical Earth Issues Through the Use of Large Online Digital Data Sets”. 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 two Year 1 modules will be revised and published. The Year 2 modules and the supplemental-funding module will be completed, tested, and have revisions at least started. We will collaborate on the production of an animation featuring GPS data about the California drought. We will conduct dissemination and professional development short courses in conjunction with the 2015 GSA Annual Meeting and UNAVCO 2016 Science Workshop. Year 1 GETSI modules will also be featured in InTeGrate dissemination webinars.

**Products**

**Conference Papers and Presentations**

Title: GEodesy Tools for Societal Issues (GETSI): Undergraduate curricular modules that feature geodetic data applied to critical social topics  
Conference: American Geophysical Union Annual Meeting 2014  
Authors: Bruce James Douglas, Beth Pratt-Sitaula, Becca Walker, Meghan Miller and Donna Charlevoix

Title: Using geodetic data to each about changes in ice mass and sea level in introductory courses  
Conference: American Geophysical Union Annual Meeting 2014  
Authors: Leigh Stearns, Becca Walker, and Beth Pratt-Sitaula

**Websites**

GETSI Project Site: http://serc.carleton.edu/gesi/index.html  
This is the GETSI project website. It gives background information on the project and will be 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.

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.

Gareth Funning  UC Riverside  Faculty  1 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 will pay him a total of $7500 stipend over ~15 month period for work on module development and revision.

Leigh Stearns  Univ. of Kansas  Faculty  1 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 will pay her a total of $7500 stipend over ~15 month period for work on module development and revision.

Eric Small  Univ. of Colorado  Faculty  0 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  0 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.

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.

Type: Industrial/Commercial
Name: 3-Point Science
Location: Canada
Contribution: Technical support
Details: One co-owner of 3-Point Science has previously participated in the beta-level development of an interactive InSAR Tool which allows users to better understand how an interferogram relates to fault motion. UNAVCO and GETSI are sub-contracting with 3-Point Science to further development of this tool for incorporation into the module "Imaging Active Tectonics".

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.
Appendix – Report from External Evaluator

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

Executive Summary

The second year of the GETSI Geodesy Tools for Societal Issues project focused on materials development and piloting of the Year One modules (an introductory-level and a majors-level module). Year One teams have made progress toward Output Goals # 1 and # 3 (see Figure 1 for this Logic Model). All Year One module authors piloted during this past academic year. Despite the inherent challenges of faculty working together on curriculum for the first time, the module authors are satisfied with their experience thus far and excited about the materials they have created. The Year One teams appear on track toward being able to demonstrate student outcomes in the next year. In addition, plans are underway to include the Year One modules (when revised and published) in dissemination strategies through professional society meetings and collaborative webinars with the InTeGrate project. These plans should support the project in making progress toward the faculty outcomes. In addition, the development process began for two new modules (an introductory-level and a majors-level module). Both new authors for Year Two teams reported an understanding of the materials development process and an eagerness to develop the materials.

A. INPUTS

<table>
<thead>
<tr>
<th>NSF Funding</th>
<th>UNAVCO</th>
<th>TUES partner colleges, universities, and faculty</th>
<th>SERC</th>
<th>NAGT</th>
<th>Geodesy community</th>
<th>Earth science teaching community feedback</th>
</tr>
</thead>
</table>

B. 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.

C. TUES TYPE 1 OUTPUTS

1. Development, testing, revision, and dissemination of four curricular modules featuring geodesy data investigations 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.

D. 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 (Table 1) 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 (e.g., Froyd, 2008)
   d. Use systematic assessment of student learning

E. LONG TERM OUTPUTS

1. Development, testing, revision, and publication of a larger collection of curricular modules featuring geodesy.

2. Support faculty in integrating curriculum into diverse institutions and course settings across the USA.

Figure 1 GETSI Logic Model
Year 1 Teams

Both Year One teams (Ice Mass and Sea Level Changes team and the Imagine Active Tectonics with InSAR and LiDAR team) completed development in time to pilot their modules by the end of the 2015 academic year. Both modules passed the materials rubric after revisions to meet the assessment items on the rubric. While not required to pass the rubric, both modules were asked to add more explicit metacognition strategies.

The Ice Mass and Sea Level Changes completed its first pilot in the Fall of 2014 and the second pilot was recently completed (5/12/15). In addition, a beta-tester will complete a pilot of the materials this summer. This will provide three different environments for evaluating the curriculum. The Imagine Active Tectonics with InSAR and LiDAR also piloted this spring in both author classrooms and a beta-tester classroom. Assessments of student work is being collected from all pilot classrooms for analysis this summer. The analysis of the student work will inform the revision plan for both modules.

All four module authors completed a reflection following the materials development phase. Authors are excited about the materials they developed and were eager to try them in the classroom. Managing development timelines with competing academic and research schedules was a challenge reported by authors. Several of the authors noted the importance of discussing differing work styles up front. One author commented on the difficulty of holding each other accountable for deadlines because they did not know each other very well. Another author commented that second face-to-face meeting for materials development may have alleviated the timeline challenges. The materials rubric was identified as helpful at the onset of the development process in developing the outline and plan. Authors also found it a useful tool to ensure that they had not neglected any key aspects. Some authors did find it a little overwhelming and too involved to keep it in mind during development.

Year 2 Materials Development Meetings

Pre-meeting Webinars

Prior to the face-to-face materials development meeting (held April 17-19), the primary project facilitator led three webinars team members: 1) GETSI Overview and Guiding Principles (February 27) (all team members and assessment consultants participated), 2) Development Approach (March 13), and 3) Learning Outcomes (March 20) (the last two were aimed at the new authors). The goals of these webinars were to give participants an introduction so that they would be better prepared to move forward on curriculum design at the face-to-face team meeting in April.

Face-to-Face Team Meeting

On April 17-19 at a face-to-face at the UNAVCO office in Boulder, the two module author teams: 1) Surface Process Hazards, and 2) Water Resources and Geodesy met to begin work on the curriculum. A third team (GPS, Strain, and Earthquakes) will be on a different timeline. The meeting included the assessment consultants and was led by the primary project facilitator.

Like the February 2014 meeting, the goals of the meeting were for participants to:
• Get to know team members and establish working relationships with team members, the assessment consultants, and the project lead
• Explore the materials development process and become comfortable with the Content Management System (CMS)
• Review potential geodesy data types and sources related to their module
• Sketch out their module content, components, and document their plan on the CMS
• Create a workplan, timeline, and communications plan

The evaluation of the meeting was accomplished through end-of-day roadchecks and end-of-meeting survey. In addition, the module outlines, workplans, timeline, and communication plans from both teams on the CMS serve as documented artifacts for meeting the intended goals.

Two roadchecks were administered online during the meeting. Both roadchecks indicated that participants (n=5 for both) were satisfied with the meeting at that time with overall satisfaction ratings of 9.6 (out of 10) for Roadcheck 1 and 9.0 (out of 10) for Roadcheck 2.

The roadchecks highlighted that participants were comfortable asking questions and that their voices were being heard as exemplified by this characteristic quote:

“The setting was open to contributions and time was given to respond to questions in a thoughtful and considerate manner”

The primary challenge was needing enough time to work on their modules. One participant noted that it was difficult to learn from watching PowerPoint slides and that they would look forward to other modes of learning.

Three participants completed the end of workshop survey. The overall satisfaction of participants for the meeting was 9.0 (out of 10) indicating that all were very satisfied with their meeting experience. The comments highlighted their satisfaction, for example:

“I would like to complement the conveners on running a smooth and balanced meeting. Flexibility to accommodate weather related travel delays meant that the meeting proceeding without any awkwardness or feeling of the need to rush to meet the original schedule.”

The participants agreed that each of the workshop goals were met. Managing the timeline in order to complete the curriculum surfaced as the main concern. One participant suggested that the PowerPoint presentations were not necessary because the pre-workshop webinars had so completely covered the material. Constructing the sharing/reporting outs between the two teams could also have been more useful. One participant suggested that in the future each team should focus their report on a key question where group response would be useful.