



GETSI 2014 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: 07/01/2013-06/30/2014

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Sponsor: NSF DUE-TUES

Award ID: 1245025

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



GETSI Team during the February 2014 Materials Development Workshop.

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

We gathered community input through surveys and charettes, launched the project website (<http://serc.carleton.edu/gets/index.html>), started the development of the first two curricular modules, and laid the groundwork for student data collection in Year 2.

We conducted a survey at Geological Society of America (GSA) and American Geophysical Union (AGU) annual meetings that reached 63 undergraduate geoscience educators. Two charette webinars, *Applying Geodesy Data to Societally Important Questions in Undergraduate Courses*, were held January 10 and 31st (<http://serc.carleton.edu/gets/workshops/charette/index.html>) to gain additional input from community members and to provide professional development regarding existing geodesy teaching resources for undergraduate courses. A total of 25 geoscience community members participated. Another 12 people participated in a Special Topic Session on Undergraduate Geodesy Curriculum at the UNAVCO Science Workshop May 4, 2014.

The GETSI website was launched in November 2013 using the Content Management System and basic design structure from SERC/InTeGrate (<http://serc.carleton.edu/index.html>; <http://serc.carleton.edu/integrate/index.html>).

In November and December, topics for both the majors-level (Imaging Active Tectonics with InSAR and LiDAR) and introductory (Changing Ice and Sea Level) were selected; co-authors for both modules were recruited. The Year 1 Materials Development Workshop was held February 21-23, 2014 with all the GETSI PIs, the two co-authors, two SERC assessment staff, and other UNAVCO staff. Since then authors have been working to further development of both modules.

The basic students data input forms and assessment have largely been developed based on minor modifications from the InTeGrate Project format.

We have also begun working on visualizations and interactive data tools to support module learning. An InSAR Tool is under development (with joint funding from other parts of UNAVCO), which will help students better understand how InSAR interferograms work (beta version at: <http://earthquake.visiblegeology.com/>). We are also working with a ge-animator to make a short animation showing how GPS stations adjacent to ice sheets measure rebound as the ice melts. Although these were initiated during the Year 1 period, the majority of this work will be done during Year 2.

Significant Results

Feedback from both surveys and charettes suggested broadly similar advice from geoscience teaching community members on what they would like to see from the GETSI project. Plate tectonics and hazards topics were the most popular topics but both climate change and water resources also had strong support. The types of resources most desired were data sets, lab/class activities, and animations/visualizations.

Community Input Surveys

A total of 63 geoscience community members filled out a Faculty Input Survey during GSA and AGU annual meetings in 2012 and 2013. A broad range of faculty participated from 2-year colleges to PhD-granting universities (Figure 1). On a 5-point scale from 1 (what is geodesy?) to 5 (I'm a geodesist) the average respondent came in at 3.0 (somewhat familiar with geodesy) indicating that responses were largely from "typical" geoscience faculty and not expert geophysicists. On average ~70% of the respondents taught introductory level courses and ~70% taught majors-level courses. Plate tectonic motion and hazards (earthquakes, landslides, and volcanoes) were the most popular topics with 90% or more respondents being interested (55-70% highly interested) (Table 1). Climate change-related topics of ice mass and sea level changes also had ~90% of respondent being interested but more evenly split between high and some interest. Water resources were lower, but still had ~70% interest (~25% highly interested). For types of teaching resources desired, respondents strongly selected data sets, activities, and visualizations as most likely to use (Table 2). However all types of resources had at least 70% likely to use levels (most or somewhat likely to use). Instructors at 2-year colleges were more evenly interested in all the topics and they also gave higher likelihood of using assessment instruments (the lowest valued teaching resources by the group as a whole).

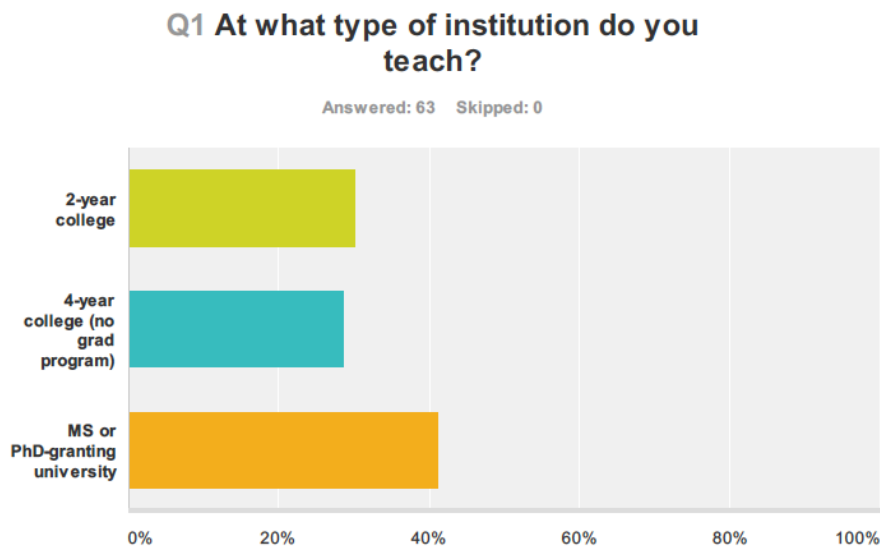


Figure 1. Types of institutions taught at by survey respondents.

Table 1. Geodetic topics of interest for survey respondents.

	High interest	Some interest	No interest	Total
Tectonic plate motion and/or structural deformation from GPS	69.35% 43	27.42% 17	3.23% 2	62
Earthquake hazard from GPS, tiltmeters, LiDAR, or radar	68.85% 42	24.59% 15	6.56% 4	61
Glacial ice loss using gravity, GPS, or radar	40.68% 24	45.76% 27	13.56% 8	59
Change in ground water reservoirs using gravity or GPS	27.59% 16	44.83% 26	27.59% 16	58
Change in sea level using satellite altimetry	49.18% 30	44.26% 27	6.56% 4	61
Monitoring surface water flow using radar	25% 14	44.64% 25	30.36% 17	56
Landslide/geomorphology study using LiDAR, radar, or GPS	61.02% 36	30.51% 18	8.47% 5	59
Volcanic hazard analysis using GPS, radar, or tiltmeters	55.93% 33	32.20% 19	11.86% 7	59

Table 2. Likelihood of using Types of teaching resources interest for survey respondents.

	Most likely to use	Somewhat likely to use	Not likely to use	Total
Instructor notes on background science content	51.67% 31	38.33% 23	10% 6	60
Data sets specially prepared for student use	83.87% 52	12.90% 8	3.23% 2	62
Accessible data portals that are also used by researchers	43.10% 25	44.83% 26	12.07% 7	58
Laboratory or classroom activities	80% 48	18.33% 11	1.67% 1	60
Homework assignments	33.33% 20	51.67% 31	15% 9	60
Presentations or slide sets	54.10% 33	32.79% 20	13.11% 8	61
Animations of other visualizations	74.19% 46	22.58% 14	3.23% 2	62
Assessment tools (rubrics, grading criteria, etc.)	42.37% 25	30.51% 18	27.12% 16	59

Charettes

More than 50 people registered for the two charette-webinars in January 2014 and a total of 25 actually participated. They came from broadly similar distribution of institutions as the survey but with about 13% non-academic institutions also participating (ex. government and industry) (Figure 2). Knowledge of geodesy was also somewhat higher at 4 out of 5 for the second webinar (question accidentally omitted from the registration for the first webinar). During the discussion section of the webinar, participants were asked to indicate by a show of “hands” which teaching topics most interested them. The results were more sub-equal than on the surveys with hazard/tectonics coming in at 64%, climate change 68%, and water resources at 52%. The same three types of teaching materials –

data sets, activities, and visualizations also ranked highest. The discussion in both webinars centered for some time on the relative value of “canned data sets” vs “researcher-grade data portals”. Although the general advice was that the former was best for introductory and the latter best for majors, there was fairly strong support for researcher-grade data portals for everyone if technically feasible and not too cumbersome. Between both webinars only one participant indicated an issue with computer access for students. In general people were strongly in favor of computer use, certainly at home but also in classroom and lab exercises. There was also strong urging for modules to actually be a series of “modulettes” so that an instructor would not have to commit to a full two weeks to use components of the module materials.

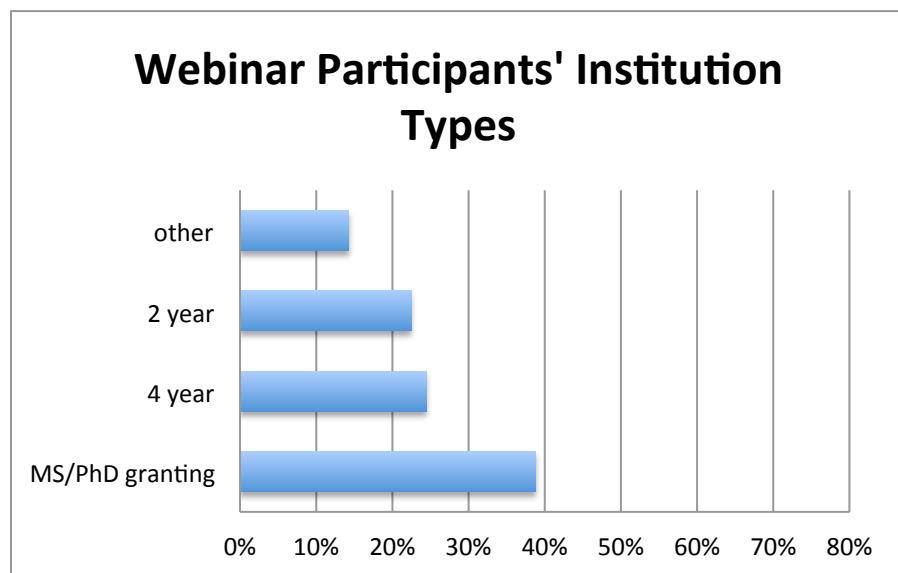


Figure 2. Types of institutions taught at by charette webinar participants.

Conclusions

The GETSI project is using the input from the surveys and charettes to help shape the modules being developed. Overall the results were in keeping with initial input sought during the proposal-writing phase. The Year 1 module topics include one each of hazards and climate change, since those were the most highly desired. Year 2 will most likely have a water resources module and perhaps another hazard-related one on something besides earthquakes. We are putting maximum effort into the types of resources recommended by community members (including procuring outside funds for visualizations). Although certain resources (teaching notes, assessments) were lower rated, GETSI will still be including these in order to produce a complete product and to be in keeping with best practices for educational materials and to maintain standard format with the InTeGrate project.

Opportunities for training and professional development?

Professional development was conducted for both GETSI personnel and other geoscience teaching community members. In preparation for the February 2014 Materials Development Workshop, the GETSI PIs and co-authors participated in three webinars,

which introduced them to the GETSI/InTeGrate guiding design principles. Further professional development occurred during the workshop itself. Topics ranging from Learning Outcomes and Module Design to Aligning Assessments and Instructional Strategies (<http://serc.carleton.edu/getsi/meetings/index.html>).

Community participants in the two *Applying Geodesy* webinars received an overview of what geodesy is, were informed of existing resources for teaching with geodesy data, and gave input for future GETSI resources that they would particularly value. The first two activities were professional development in nature since many of the attendees were not fully aware of what geodesy entailed and did not know of the existing teaching resources.

How have results been disseminated to communities of interest?

As the project is just finishing its first year, 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. The commencement of the GETSI project was announced through email and website channels of UNAVCO, SERC, NAGT (National Association of Geoscience Teachers), IRIS (Integrated Research Institutes for Seismology) and PI personal contacts. The project scope and goals were also described in presentations at the AGU annual meeting (December 2013) and the UNAVCO Science Workshop (March 2014). 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 first two modules will be finished, tested, revised, and published. This will include animations/visualizations for both modules and a student summer intern working on processing of necessary data sets. The second set of two modules will be initiated in spring 2015 through webinars and materials development workshop anticipated to be very similar to the ones held in 2014.

Products

Conference Papers and Presentations

Title: Innovations in making EarthScope science and data accessible

Conference: American Geophysical Union Annual Meeting 2013

Authors: Beth Pratt-Sitaula, Robert Butler, Jill Whitman, Frank Granshaw, Robert Lillie, Nancee Hunter, Vince Cronin, Phillip Resor, Shelley Olds, Meghan Miller, Rebecca Walker, Bruce Douglas

GETSI Project: GEodesy Tools for Societal Issues – An initiative to create teaching modules for undergraduates based on the application of geodetic data sets

Conference: UNAVCO Science Workshop 2014

Authors: Bruce Douglas, Beth Pratt-Sitaula, Becca Walker, 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 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.

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.

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 SERC Annual Report in Appendix 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 One Evaluation Report Prepared for GETSI by Ellen Iverson, Director of Evaluation Science Education Resource Center (SERC) at Carleton College

Executive Summary

The GETSI Geodesy Tools for Societal Issues project shows promise in both engaging the broader community early in their project and in the early stages of developing strong curriculum with geodetic data. The webinars for the broader community, which were well received, helped participants to become more aware of existing geodetic education resources as well as allowed input into the future resources. The materials development team webinars and face-to-face meeting initiated the development of the curriculum with evidence of strong plans, outlines, and initial materials. In addition, embedding an evaluative stance into the agenda and development process proved a powerful way to engage the teams productively with early indications of high quality materials aligned well to the community's needs.

Engaging the Broader Community

As part of an effort to gather inputs and concerns from the broader community of potential "non-geodetic" adopters early in the project, Dr. Beth Pratt-Sitaula, the primary project facilitator developed a webinar entitled, Applying Geodesy Data to Societally Important Questions in Undergraduate Courses. The webinar was broadly advertised throughout the geoscience education community via the National Association of Geoscience Teachers (NAGT) communications, geo-related news feeds, and as a news item on the SERC website. The initial advertisement for the January 10th webinar received 25 applications so an additional date on January 31st was added. By dividing the participants between two dates, more interaction and virtual dialogue could be fostered with a smaller set of participants. Evaluation of these webinars was facilitated through a short online survey (10 respondents across the two webinars). Those who responded to the survey reported high satisfaction with the webinar (8.9 out of 10). Participants valued the opportunity to hear about existing geodesy resources, the plans for future resources, and the ability to ask questions and give input. These quotes characterize participants' perceptions of the webinar:

"It is the first time that I attend this type of seminar. Even I have experience in geodesy, to see that efforts that you are doing to disseminate the information is very valuable."

"Overall, the webinar as a whole was pretty valuable because it alerted me to existing resources that I can use in my classrooms, as well as allow for input in the early stages of development of future resources."

Year 1 Materials Development Meetings

Pre-meeting Webinars

Prior to the face-to-face materials development meeting (held February 21-23), the primary project facilitator led three webinars for all team members: 1) Introduction to the

GETSI InTeGrate Development Model (January 17), 2) Guiding Principles for Module Design (January 24), and 3) GETSI-InTeGrate Development Approach and Learning Outcomes (February 14). 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 February. The webinars provided an overview of the relationship between the GETSI project and the InTeGrate STEP Center, an overview of the GETSI guiding principles, an introduction to the GETSI development website, an introduction to the GETSI materials development rubric which included specifics on designing strong learning goals, and an introduction to the goals of the face-to-face meeting.

Face-to-Face Team Meeting

On February 21-23 at a face-to-face at the UNAVCO office in Boulder, the two module author teams: 1) *Ice mass and sea level changes*, and 2) *Imaging Active Tectonics with InSAR and LiDAR* met to begin work on the curriculum. The meeting included the assessment consultants and was led by the primary project facilitator.

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 were satisfied with the meeting at that time with overall satisfaction ratings of 9.5 (out of 10) for roadcheck 1 and 9.7 (out of 10) for roadcheck 2.

The roadchecks highlighted that the agenda allowed for the appropriate interspersing of content with work time and that this made for focused and productive days. The pre-meeting webinars proved to be effective in laying the groundwork for the working meeting. One participant noted, "Preparation for meeting was thorough and provided sufficient information that ensured the meeting was able to move along at an efficient pace which also left time for digressions that allowed for immediate addressing of topics or concepts that did arise that generated questions."

The overall satisfaction of participants for the meeting was 9.75 (out of 10) indicating that all were very satisfied with their meeting experience. Write-in comments reflected participants' satisfaction with the way the meeting had been structured and the content provided. One participant added, "I thought this was a great meeting. I was worried that I

would be overwhelmed by pedagogy-jargon or intimidated by the big picture task, but that was not the case. I feel that we got a lot done in a short amount of time.”

One area of concern going forward centered on the materials development rubric and aspects of the rubric. Participants noted that fulfilling the rubric criterion for the module development would require attention and an iterative process. One participant questioned to what extent systems thinking should be a central guiding principle for the module.

GETSI Materials Development Rubric – Embedded Evaluation Process

Part of the GETSI project plan was to make use of the InTeGrate model for materials development which includes an embedded evaluation development process guided by a rubric and a pilot process that includes the collection of student assessment data. The GETSI rubric assists curriculum developers as they prepare materials by embedding criteria for the project guiding principles and evidence-based teaching practice (including learning goals, assessment, resources, instructional strategies, and alignment of these curricular aspects). The rubric guides a checkpoint process in which an assessment consultant and the primary project facilitator ensure that the materials being developed will pass the rubric before pilot testing. The elements of the rubric also served as a guide for the agenda for the materials development meeting. Aligning the meeting development agenda and the process proved to be a powerful way to move new teams forward efficiently and ensuring an evaluative and evidence-based practice stance from the beginning.

Module Progress to Date

Both teams completed module outlines, workplans, timeline, and communication plans at the meeting or shortly following the meeting. The **Ice mass and sea level changes** team will meet their timeline of Checkpoint 2 this month, which will keep them on schedule for a fall pilot. The **Imaging active tectonics with InSAR and LiDAR** is on a later schedule of piloting in early 2015.