Preview of Award 1042906 - Annual Project Report

Cover

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Accomplishments

*** What are the major goals of the project?**

This annual report covers COCONet project (EAR-1042906/EAR-1042909) activities for the time period from September 1, 2012 to May 31, 2013. COCONet is a Collaborative Research project between UNAVCO (EAR-1042906) and University Corporation for Atmospheric Research (UCAR) (EAR-1042909) awarded on September 14, 2010. The project is under the direction of M. Meghan Miller, as PI, with Co-PIs Guoquan Wang, Glen Mattioli, and Karl Feaux. Glen Mattioli is acting as Project Director in his role as Director of Geodetic Infrastructure at UNAVCO and John Braun is the UCAR PI. This document is a roll-up of the quarterly reports previously submitted by email on December 14, 2012, March 16, 2013, and June 18, 2013 to the COCONet NSF-EAR-IF Program Officer, Mr. Russ Kelz.

Major Goals for COCONet (modified from Braun et al., 2012, Eos feature article)

The Caribbean is a region of lush vegetation, beaches, active volcanoes, and significant mountain ranges; an environment that was created through geological, oceanic, and atmospheric processes, which also pose natural hazards for the developing countries in the Caribbean. The rise in population density, migration to coastal areas, and sub-standard building practices make the threat of natural hazards particularly devastating for the region. These demographic and social characteristics are taking place against a backdrop of the threat of an evolving climate, which produces a more vigorous hurricane environment and rising mean sea-level. The January 12, 2010 earthquake in Haiti and Hurricane Ike (2008) both caused widespread destruction and loss of life, illustrating the need for a scientific focus on the underlying natural hazards of

the Caribbean. This report highlights a new National Science Foundation funded initiative termed COCONet (Continuously Operating Caribbean Observation Network), which commits ~$7M over five years to a collaborative natural hazard research team including UNAVCO, University of Houston, and the University Corporation for Atmospheric Research (UCAR).

COCONet will infuse geodetic infrastructure into the Caribbean to support a broad range of process-oriented geoscience investigations with direct relevance to geohazards. COCONet will allow for more focused topical geophysics studies and will also be a focal point for leveraging regional infrastructure for international partnerships and capacity building.

COCONet will install 50 new continuous Global Navigation Satellite System (cGNSS) and meteorology stations in the Caribbean and Central America, refurbish an additional 15 stations, and archive data from 62 cGNSS stations that are already or will soon be in operation (Figure 1) by various institutions committed to free and open data access. In addition to raw data, products will include estimates of column integrated tropospheric water vapor, time series of daily positions and component velocities, and high-rate low-latency data from a subset of stations. Data and products will be provided through UNAVCO or in collaboration with a regional center.

The large oceanic extent of the Caribbean and the presence of many offshore active faults make the region a source and a recipient of tsunamis. The Central America and Lesser Antilles subduction zones are associated with explosive volcanoes that pose a direct threat to large population centers. Much of the region's tectonic context is still relatively poorly constrained, and local risk is not yet quantified. Only a few of the active plate boundary faults have well-determined geodetic slip rates and some key structures are not even considered in current hazard assessments.

Some key tectonic questions that COCONet will address include: What are kinematics, boundaries, and rigidity of the Caribbean plate? What reference frame is appropriate for tectonic studies? More targeted questions include mechanisms of stress release at convergent boundaries and interplate coupling along the leading and trailing edges of the Caribbean plate. Broader questions include how is strain partitioned at convergent margins and how is stress transfered across plate boundaries?

COCONet will also address key processes in the Caribbean region tied to ocean-atmosphere coupling, transport of moisture, and precipitation. Better observations are critical for improved initialization of numerical weather prediction systems and to assess model skill related to precipitation and latent heat transport. The distribution of stations across the Caribbean basin will allow large and small-scale processes to be studied: stations along the boundary of the Caribbean sea will be important for regional moisture studies; North-South transects, on both the eastern and western edges, will measure differences in moisture transport from low level jets into the mid-latitudes; and data collected from small and large landmasses will reveal the interaction between the ocean, land, and atmosphere.

COCONet observations will address key questions including: What are the sources and predictability of climate anomalies in the Caribbean? Are convective parameterizations, originally derived from western Pacific data sets, applicable to a Caribbean atmosphere? How does land heating and island topography influence moisture transport and precipitation?

The most obvious weather hazard that affects the Caribbean region is hurricanes. An emphasis of COCONet will be in determining how continuous and reliable estimates of precipitable water vapor, with temporal resolution of 15 minutes or less, can be applied in understanding of latent heat release in convective towers and synoptic scale moisture transport can fuel the evolution of tropical storms.

Lastly, three broad themes for capacity development have been identified to help ensure the success of COCONet. The first is the need for COCONet to effectively complement and extend regional geodetic infrastructure, and technical capabilities while simultaneously promoting open data policies. COCONet regional partners will play leading roles in transforming data obtained through COCONet investment into concrete benefits for hazards mitigation and scientific advancement. The second is the need to bridge the gap between scientific understanding and the application of that knowledge for public benefit. As COCONet advances science, it should also be used to improve public use of the acquired knowledge. Therefore, primary-school students, teachers, surveyors, emergency managers, policy and decision makers have all been identified as key audiences for COCONet outreach. The third theme is the need for bidirectional scientific partnerships to nurture a new

generation of researchers in the region to assure knowledge flow in multiple directions – from and among Caribbean nations as well as between all of the project's international stakeholders. Mechanisms for promoting intellectual exchange include traditional opportunities such as encouraging advanced training or graduate school for Caribbean students as well as fostering the development of Caribbean training centers, bidirectional science exchanges, and field campaigns, which include partners from across the Americas.

*** What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities:

Third Quarter Report

Field Operations Summary

In addition to the CN02 station installation, the following field operation milestones were completed during the last three months:

- US State Department issued an export license for installation of UNAVCO GPS equipment in Cuba. The installation will occur as soon as final pre-clearance with Cuban customs officials is finalized.
- In May, Jim Normandeau completed the COCONet upgrade at Roatan in Honduras (ROA0).
- Reconnaissance activities were initiated for 2 tide gauge locations in Anguilla and the Yucatan Peninsula in Mexico (see additional information below).
- In late May-early June, UNAVCO field engineers Abe Morrison and Mike Fend completed the installation of COCONet station CN19 in Aruba
  Tide Gauge reconnaissance report:

  As part of a supplement approved for this award on 7/31/2012, UNAVCO was authorized to locate, permit and install two (2) cGPS-constrained sea-level tide gauges and augment two (2) existing sea-level tide gauges with cGPS in Caribbean region. UNAVCO has initiated contact with the University of Colorado, University of Hawaii, NOAA and commercial specialists to validate the design and location of these sea-level tide gauges and will bring this to the COCONet Working Group for recommendations in the next quarter. In addition UNAVCO has performed two reconnaissance activities of existing tide gauges during the course of normal COCONet operations in Cancun Mexico and Anguilla.

Second Quarter Report

Field Operations Summary

During the last three months, the following field operation milestones were completed:

- In February, field engineer John Sandru completed maintenance visits at CN07, CN06, CN08, and CN27 in the Dominican Republic and upgraded an additional four stations (BARA, SROD, SPED, LVEG) to COCONet standards.
- In February, field engineers Abe Morrison and Michael Fend completed the COCONet installation at Virgin Gorda (CN03).
- In late February-early March, field engineers Kyle Bohnenstiehl and Max Enders completed three installations in Panama (CN20, CN34, and CN28) and maintenance at CN33.
- In late-February, COCONet engineers conducted station maintenance in Jamaica (Morant Cay).

First Quarter Report

Field Operations Summary

During the last three months, the following field operation milestones were completed:

- In early September, Sarah Doelger completed the installation of CN35 on Providencia Island, Colombia.
- In October, UNAVCO engineer John Sandru and Luis Salazar Tlaczani from the Institute of Geophysics, University National Autonomous, Mexico (UNAM) installed two new sites (CN24 and CN25) in Mexico. CN24 is located in Felipe Carrillo Puerto, Quintana Roo and CN25 is in Comitan De Dominguez, Chiapas. Both sites are rooftop monuments on buildings owned and operated by the Mexican Metrological Observatory.
- In October, Víctor González and Marin Protti (Observatorio Vulcanológico y Sismológico de Costa Rica, Universidad Nacional,) completed the construction and installation of one more COCONet CGPS station. The station name is Reserva Veragua Rainforest (VRAI), located in the northeast part of Costa Rica.
- COCONet engineers conducted station maintenance in Jamaica (Kingston, Pedro Caye, Morant Caye) and Nicaragua (Poneloya, Puerto Cabezas, Bluefields).

Specific Objectives: See above.

Significant Results: **Third Quarter Report**

COCONet Highlight: New Station Installed in Anguilla

In May of 2013, UNAVCO Field Engineers John Sandru and Mike Fend traveled to Anguilla to install a new COCONet station (CN02) near the Anguilla Wallblake Airport. With assistance from the Anguillan government, UNAVCO installed a continuous GPS/MET station on the island, which is one of the most northerly of the Leeward Islands in the Lesser Antilles, lying east of Puerto Rico and the Virgin Islands, and directly north of Saint Martin. The main island of Anguilla is approximately 16 miles (26 km) long by 3 miles (5 km) wide at its widest point. This is the most northeastern COCONet site to be installed. The Anegada Passage, separates Anguilla from the British Virgin Islands. The 40-mile-wide (65 km) channel connects the Atlantic Ocean with the Caribbean Sea. This site will provide important GPS/Met observations to test tectonic models of the opening of the Anegada Passage and to refine models for secular motion of the Caribbean plate as well as generating new and potentially leveraging observations related to hurricanes and tropical storms that initiate in the Atlantic Ocean and transit into the Caribbean Sea.

Second Quarter Report

COCONet Highlight: Dominican Republic Installations

In January of 2013, UNAVCO engineer John Sandru traveled to the Dominican Republic to install state of the art GPS equipment at four existing continuous GPS stations operated by the General Council of the Judiciary (Jurisdiccion Inmobiliaria). This equipment included a Trimble NetR9 receiver, Trimble choke ring antenna, and a Vaisala WXT520 meteorological instrument at each station. Additionally, each receiver was upgraded to provide RTK service to the island's professional land surveyor community. This endeavour brings the total number of refurbished stations that

COCONET has upgraded throughout the region to nine.

First Quarter Report

COCONet Highlight: COCONet Data and Research Workshop

The third COCONet workshop, held in Tulum, Mexico (October 24-26, 2012), was sponsored by the National Science Foundation and hosted by the National Autonomous University of Mexico (UNAM) and UNAVCO. The meeting was attended by 84 participants, representing 45 institutions from 19 countries (Figure 2). This third COCONet workshop focused primarily on long-term operations and maintenance for GPS stations installed in the Caribbean, GPS data processing, higher-level data products generation, and real-time GPS data distribution for enhanced science and broader societal benefits. Significant science advances and societal benefits that COCONet in its nascent stages has already accomplished were presented. In addition, there were presentations about the future potential and long-term sustainability of the network and the data. Plans were initiated to establish regional data centers for data archival and/or analysis/products to advance not only regional capacity, but the regional use and impact of the data. A key result of the meeting was identifying several institutions that could potentially host a regional data center. Representatives from these institutions will be involved in a smaller meeting in the next 3-6 months to further develop plans for regional data centers. Other key objectives of the meeting were to explore new research and data product opportunities and to layout future goals and expanding directions for COCONet. There was great enthusiasm and energy at the workshop from all of the participants for developing regional data centers, plus advancing the research and education opportunities, the science and engineering workforce capacity, the international partnerships, and the societal benefits from COCONet. A draft of the 3rd workshop report has been prepared and is being reviewed by G. Mattioli; we anticipate that the final report will be completed before the end of December 2012.

COCONet Highlight: Nicoya Earthquake

On Wednesday, September 5, 2012, at 14:42:07 UTC, a magnitude 7.6 earthquake struck roughly 40 km (25 miles) below the surface of the Earth, 10 km (6.2 miles) ESE of the city of Nicoya, Costa Rica. This earthquake occurred beneath the Nicoya Peninsula of Costa Rica as the result of thrust faulting on the plate interface between the subducting Cocos and overriding Caribbean plates. At this latitude, the Cocos plate moves north-northeast with respect to the Caribbean plate at approximately 77 mm/yr, and subducts beneath Central America at the Middle America Trench, as determined by GPS observations supported by UNAVCO and the COCONet project. Preliminary estimates show that approximately 3 meters of slip occurred on the interface between the two plates (*e.g.* Lujia and Newman, September 2012, personal communications). Two COCONet stations in Costa Rica, QSEC and VERA, were used in the analysis and UNAVCO engineers assisted NSF funded PIs (Dr. Andrew Newman, Dr. Timothy Dixon) and regional scientists (Dr. Marino Protti, OVSICORI) to ensure that COCONet and other stations in the region were returning data after the earthquake. UNAVCO support was part of a NSF RAPID award as well as part of COCONet O&M. High-rate (5Hz) data from some stations, including COCONet station QSEC, were processed to produce baseline estimates relative to the station VERA (Figure 3).

Key outcomes or Other achievements:

Third Quarter Report

Most of the effort during this reporting period included reconnaissance, permitting, installation and maintenance activities related to the siting plan developed at the June 2011 Port of Spain siting meeting and four siting committee meetings held during the past two years. Specifically, refurbishment of the Roatan station, located on an offshore island of Honduras and new station installations in Panama and Anguilla were among the operations highlights during the last quarter. UNAVCO engineering personnel have performed site reconnaissance at 63 locations in 25 countries, submitted land use permits for 56 sites, received permits for 53 sites, and currently have 40 stations installed (Figure 1, yellow dots).

The Spanish version of the final report for the COCONet Data and Research Workshop, which was held in Tulum, Mexico October 24-26, 2012, was posted to the COCONet website and can be viewed at: http://coconet.unavco.org/lib/downloads/COCONet-3-Espanol.pdf. The completion of this document was a critical COCONet project milestone. Efforts are now underway to address the concerns and suggestions provided by the COCONet 3rd workshop participants.

In April 2013, Dr. Franck Audemar (La Fundación Venezolana de Investigaciones Sismológicas) and Dr. Omar Perez (Simon Bolivar University) met with UNAVCO staff and Dr. Roger Bilham (University of Colorado) in Boulder, CO to discuss issues related to the upcoming reconnaissance of four refurbished stations and the installation of 5 new stations in Venezuela. Topics for discussion included shipping of equipment to Venezuela, safety considerations related to planned fieldwork, and logistics. In addition, photos from Aves Island were reviewed in detail to assess a potential location and monument type were prior to future reconnaissance at this critical location, which is 210 km west of the Leeward Islands in the Caribbean. This site is critical for both the solid Earth and atmospheric science objectives of COCONet.

Second Quarter Report

Most of the effort during this reporting period included reconnaissance, permitting, installation and maintenance activities related to the siting plan developed at the Port of Spain siting meeting in June 2011 and four siting committee meetings held during the past 21 months. Specifically, installations of refurbished stations in the Dominican Republic, station installations in Panama and the British Virgin Islands, and maintenance work in Jamaica were the operations highlights during the last quarter. UNAVCO engineering personnel have performed site reconnaissance at 59 locations in 25 countries, submitted land use permits for 56 sites, permits accepted for 53 sites, and currently have 37 stations installed (Figure 1, red dots).

The final report for the COCONet Data and Research Workshop, which was held in Tulum, Mexico October 24-26, 2012, was submitted to the National Science Foundation in early February 2013 and was posted to the COCONet website simultaneously and can be viewed at: http://coconet.unavco.org/lib/downloads/COCONet-Tulum-Report.pdf. The completion of this document was a critical COCONet project milestone. Efforts are now underway to address the concerns and suggestions provided by the COCONet 3rd workshop participants.

The COCONet management team pursued hiring two replacement engineers during the last three months. Michael Fend, who worked as an intern for the Plate Boundary Observatory in Alaska, was hired as a COCONet field engineer in February 2013. In his short time working at UNAVCO, Michael has already made contributions to the project, including fieldwork during the installation of the COCONet station in Virgin Gorda, British Virgin Islands. The search for the second field engineer is still in-progress. Field engineers from throughout UNAVCO have been used to support various aspects of the project. Engineer John Sandru, hired in the summer of 2012, continues to provide excellent support to the COCONet project. Jim Normandeau, the UNAVCO Project Manager responsible to support NSF-EAR projects as the head of the Engineering Support, GLC, and Global Networks group within the Geodetic Infrastructure directorate, has been named the Engineering Project Manager for the COCONet project is now dedicating ~30% of his effort to this project.

First Quarter Report

Most of the effort during this reporting period included reconnaissance, permitting, installation and maintenance activities related to the siting plan developed at the Port of Spain siting meeting in June 2011 and four siting committee meetings held during the past 18 months. Specifically, permitting in the Dominican Republic, station installations in Mexico and Colombia, and maintenance work in Jamaica and Nicaragua were the operations highlights during the last quarter. UNAVCO engineering personnel have performed site reconnaissance at 59 locations in 25 countries, submitted land use permits for 49 sites, permits accepted for 39 sites, and currently have 29 stations installed (Figure 1, red dots).

Dr. Alberto Lopez from the University of Puerto Rico, Mayaguez led planning efforts for the COCONet Data and Research Workshop which was held in Tulum, Mexico October 24-26, 2012 (See COCONet Highlight). This meeting was a critical project milestone, which was completed in FY2013-Q1.

Two significant geophysical events were captured by COCONet infrastructure during the period of performance of this report. A large Mw7.6 earthquake struck the Nicoya Peninsula in Costa Rica on September 5, 2012. For this earthquake, high-rate (1Hz) GPS observations were used to generate a geodetically determined finite fault model and coseismic displacementgram (See COCONet Highlight). Also, Hurricane Sandy, a particularly destructive hurricane for the eastern coast of the U.S., passed close to COCONet stations in Jamaica and the Bahamas before reaching the U.S. (See UCAR Update).

*** What opportunities for training and professional development has the project provided?**

Education and Community Engagement

The COCONet project continues to expand and advance outreach activities to achieve the objectives of the project and ensure the broader impacts to science and society. Key highlights of ongoing and new activities related directly to outreach and community engagement include the following:

- Completion of two successful Pan American Advanced Studies Institute (PASI) short courses involving COCONet facilities, data, and partners. The May 2013 PASI in Leon, Nicaragua, covered Magma-Tectonic Interactions in the Americas. The June 2013 PASI in Cartagena, Colombia, covered Atmospheric Processes in Latin America and the Caribbean: Observations, Analysis, and Impacts (see UCAR report below). Both short courses were oversubscribed and

included researchers from more than 10 different countries. The atmospheric course was able to leverage virtual meeting services and accessible online content to allow additional researchers who could not attend the course in person to participate in segments of the course. Both courses will be archived online at the COCONet website in the near future and interested researchers can access the training on their own time.

- Improvements and updates to the COCONet webpage, such as new or revised content to the main subpages of Project Management, COCONet Science, People & Partnerships, Reports & Publications, Data, and Events & Meetings to keep the community and the public informed of COCONet activities and opportunities.
- Continued development and expanding use of the COCONet Facebook page.
- Distribution of the monthly newsletter to inform COCONet partners, collaborators, and other stakeholders of actions, advances, and opportunities. Initial feedback on the newsletter has been positive.
- COCONet partners organized a well-attended full day session on COCONet research at the AGU Meeting of the Americas in Cancun, Mexico in May 2013. In addition, COCONet sponsored 8 students to present their COCONet-related research at AGU-MOA.
- COCONet support for Research Experiences in Solid Earth Science for Students (RESESS) intern Rachel Medina for the summer semester of 2013 will allow her to learn more about processing GPS data while conducting research on the apparent large vertical displacement at Soufriere Hills Volcano, Montserrat after a major dome collapse in 2003. Rachel will work with Dr. Glen Mattioli and Dr. John Braun (research advisors) plus Dr. Norgaard Rolf (RESESS Writing Workshop Instructor), Dr. Aisha Morris (RESESS Director), and Dr. Linda Rowan (writing mentor).
- Development of a prestigious COCONet Fellowship Award that will support two graduate students to conduct research toward an advanced degree at a U.S. institution using COCONet resources starting as early as August 2013. The fellowships will help to develop the next generation of geodesists with a focus on building human capacity among the more than 30 nations that are part of the COCONet community.
- COCONet Working Group 4: Community Engagement and Outreach has been organized and approved by the COCONet Steering Committee. The volunteer members of Working Group 4 include Franck Audemard, Venezuelan Foundation for Seismological Research, Carlos Fuller, Caribbean Community Climate Change Centre, Leslie Jason Hodge, Department of Lands and Surveys, Anguilla, Peter Dare, University of New Brunswick and Daniel Lao Davila, Oklahoma State University. The Working Group will promote COCONet in scientific and non-scientific communities.
- Another key action item of the third workshop report was establishment of four working groups to advance some specific recommendations. The new *stakeholder management* page on the COCONet website lists the groups (Data Networks, Regional Data Centers, Scientific Training and Community Engagement and Outreach) and their goals. A UNAVCO staff member will act as a liaison to each of these groups. Additional volunteers are needed for each group and the groups are already beginning to work on their specific objectives.

The following publications and associated presentations at national and international meetings were completed:

Feaux, K. F. and Normandeau, J., J. J. Braun, E. Calais, K. Dausz, B.T. Friesen, G.S. Mattioli, M. M. Miller, E. Seider, and G. Wang (2012), COCONet (Continuously Operating Caribbean GPS Observational Network): Network Status and Project Highlights, Abstract T41A-2556 presented at 2012 Fall Meeting, AGU, San Francisco, Calif., 3-7 Dec.

Puskas, C. M., D.A. Phillips, G.S. Mattioli, C.M. Meertens, T. Herring, M.H. Murray, T. Melbourne, F.M. Boler, G. Blewitt, K. Larson, K. Feaux, J. Braun, E.E. Small (2012), UNAVCO Enhanced data products for the EarthScope Plate Boundary Observatory, COCONet, and other regional networks, Abstract G23B-0916 presented at 2012 Fall Meeting, AGU, San Francisco, Calif., 3-7 Dec.

Miller, J.A., G.S. Mattioli, and S.A. James, 2012, 2011-2012 Campaign GPS Geodetic Monitoring of Surface Deformation, Dominica, Lesser Antilles, Abstract G41A-0892 presented at 2012 Fall Meeting, AGU, San Francisco, Calif., 3-7 Dec. 2012.

Braun, J. J., T. Van Hove, The Application of COCONet to Determine Water Vapor Variability in the Caribbean; Poster, 93 Annual AMS Meeting, Austin, TX, AMS, Jan 8, 2013.

Braun, J.J., T.M. Van Hove (2012), The Application of COCONet to Determine Water Vapor Variability in the Caribbean (Invited), Abstract A53S-06 presented at 2012 Fall Meeting, AGU, San Francisco, Calif., 3-7 Dec.

Medina, R.B., G.S. Mattioli, and J.J. Braun, 2012, An Analysis of GPS and Remote Sensing Data of Soufrière Hills Volcano, Montserrat, during the July 2003 Dome Collapse: Implications for Detection of Ash Plumes and Vertical Deformation, Abstract V33E-07 presented at 2012 Fall Meeting, AGU, San Francisco, Calif., 3-7 Dec. 2012.

The following publications, presentations, and/or meetings were either completed, submitted, or accepted for publication in FY2013-Q1:

Mattioli, G. S., J. J. Braun, E. Calais, K. Dausz, K. Feaux, B. T. Friesen, M. M Miller, J. Normandeau, E. Seider, and G. Wang, 2012, COCONet (Continuously Operating Caribbean GPS Observational Network): Goals, Network Status, Revised Scope, and Project Highlights, SIRGAS2012, Abstracts and Program SIRGAS Annual Mtg., Concepcion, Chile, Oct. 2012.

Braun, J. J., K. Feaux, B. Friesen, G.S. Mattioli, M. M. Miller, J. Normandeau, E. Seider, and G. Wang, 2012, COCOnet (Continuously Operating Caribbean GPS Observational Network): Infrastructure Enhancements To Improve Sea Level Monitoring, Paper No. 212178, Geological Society of America Abstracts with Programs. Vol. 44, No. 7, p.229.

Protti, M., V. Gonzalez, J. Freymueller, S. Doelger, 2012, Isla del Coco, on Cocos Plate, converges with Isla de San Andrés, on the Caribbean Plate, at 78mm/yr, Rev. Biol. Trop. (Int. J. Trop. Biol. ISSN-0034-7744) Vol. 60 (Suppl. 3): 33-41.

* How have the results been disseminated to communities of interest?

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The following student presentations (with student authors underlined below) at the AGU Meeting of the Americas in May 2013 were supported in part by COCONet resources in FY2013-Q3:

A model of short-term surface deformation of Soufriere Hills Volcano, Montserrat, constrained by GPS geodesy, Erin E. McPherson; Glen S. Mattioli

Updated velocity field for the Caribbean plate from COCONet GPS observations, *Jamie A. Miller; Glen S. Mattioli; Pamela E. Jansma*

On the motion of the Caribbean relative to South-America: New results from GPS geodesy 1999-2012, *Roberto De La Rosa; Julio Marquez; Mizael Bravo; Yuleika Madriz; David Mencin; Steven G. Wesnousky; Peter H. Molnar; Roger Bilham; Omar J. Perez*

Asymmetrical and heterogeneous elasto-static deformation along the El Pilar Fault in Northeastern Venezuela, *Carlos Reinoza; François Jouanne; Franck A. Audemard; Christian Beck*

Coseismic Coastal Uplift from the 2012 Mw7.6 Nicoya Earthquake, Costa Rica: Implications of Megathrust Rupture for Fore Arc Morphotectonics, *Jeffrey Marshall; Shawn Morrish; Andrew V. Newman; Marino Protti*

Geomorphologic Features and Age Estimation of Submarine Landslides in the Southwestern Colombian Caribbean, *Javier Idarraga Garcia; Carlos A. Vargas-Jimenez*

Flexural Thickness Variations of the Maracaibo Block, *Mariano S. Arnaiz-Rodriguez; Franck A. Audemard*

Passive Tomography of the Caribbean Using Surface Waves Extracted from Ambient Noise, *Francisco J. Hernandez; Alberto M. Lopez; Eugenio Asencio*

The Contributions of Seismogeodesy to Earthquake and Tsunami Early Warning *Diego Melgar; Brendan W. Crowell; Jianghui Geng; Yehuda Bock; Jennifer S. Haase*

The following additional presentations (presenters in bold; student authors are underlined) were completed in FY2013-Q3:

Geological Society of America Southeastern Section March 2013

COCONet (Continuously Operating Caribbean GPS Observational Network): Status of the Network to Support Geodetic and Atmospheric Investigations and Sea Level Monitoring, *J. J. Braun, Eric Calais, Karl Feaux, **Glen Mattioli**, M. Meghan Miller, J. Normandeau, John Sandru and Guoquan Wang*

European Geosciences Union Meeting April 2013

UNAVCO GPS High-Rate and Real-Time Products and Services: Building a Next Generation Geodetic Network, ***David Mencin**, Charles Meertens, Glen Mattioli, Karl Feaux, Sara Looney, Charles Sievers, and Ken Austin*

AGU Meeting of the Americas May 2013

Co-seismic deformation of the August 27, 2012 Mw 7.3 El Salvador and September 5, 2012 Mw 7.6 Costa Rica earthquakes, ***Halldor Geirsson**; Peter C. La Femina; Charles DeMets; Glen S. Mattioli; Douglas Antonio Hernández*

A Stable Reference Frame for Landslides Study in the Puerto Rico and Virgin Islands Region, ***Guoquan Wang***

COCONet (Continuously Operating Caribbean GPS Observational Network) - A multihazard GPS/Met observatory: Enhancing geodetic infrastructure and the scientific community in the Caribbean, ***Karl Feaux**; John J. Braun; Eric Calais; Glen S. Mattioli; M Meghan M. Miller; James Normandeau; John Sandru; Guoquan Wang*

Early implications of the COCONet GPS velocity field for studies of plate and microplate motions in the Caribbean, ***Charles DeMets***

GPS-derived slip rates of active faults in eastern Venezuela, along the southeastern Caribbean PBZ, ***Franck A. Audemard**; Christian Beck; Francois Jouanne; Carlos E. Reinoza*

Co- and Post-seismic deformation after the 2012 Mw 7.6 Costa Rica Earthquake from Continuous GPS observations, ***Rocco Malservisi**; Timothy H. Dixon; Marino Protti; Victor Gonzales; Susan Y. Schwartz; Andrew V. Newman; Stephen R. McNutt*

Isla del Coco, on Cocos Plate, Converges with Isla de San Andrés, on the Caribbean Plate, at 78 mm/yr, ***Marino Protti**; Victor M. Gonzalez; Jeffrey T. Freymueller; Sarah Doelger*

COCONet Atmospheric Data Products: An Initial Assessment, ***John J. Braun**; Teresa M. Van Hove; Glen S. Mattioli; Karl Feaux; James Normandeau*

The UNAVCO role in planning, building, and maintaining geodetic infrastructure across the Americas: update on PBO, COCONet, and TLALOCNet, ***Glen S. Mattioli**; John J. Braun; Enrique Cabral; Eric Calais; Charles DeMets; Karl Feaux; David Mencin; M Meghan M. Miller; James Normandeau; Yolande Serra; Guoquan Wang*

An update on UNAVCO/COCONet High Frequency Real-Time Products: Towards a next generation multi-hazard network, ***David Mencin**; Glen S. Mattioli; Karl Feaux; Sara Looney; Charles Sievers; Charles M. Meertens*

Seventeen Years of Geodynamic Monitoring of a Seismic Gap that was Partially Filled by the Nicoya, Costa Rica, Mw=7.6 Earthquake of September 5th, 2012, ***Marino Protti**; Victor M. Gonzalez; Susan Y. Schwartz; Timothy H. Dixon; Andrew V. Newman; Paul Lundgren; Yoshi-Yuki Kaneda; Teruyuki Kato*

Static and Dynamic Rupture-History of the Nicoya (Mw=7.6) Earthquake, Costa Rica: An approach using high frequency rate GPS and seismological recordings in the near field, ***Victor Gonzales Salas**; Marino Protti; Esteban J. Chaves Sibaja; Floribeth Vega; Walter Jimenez*

Slow Slip Event and Interseismic Strain Accumulation in the Nicoya Peninsula, Costa Rica, ***Yan Jiang**; Robert McCaffrey; Timothy H. Dixon; Shimon Wdowinski; Marino Protti; Victor M. Gonzalez*

Source rupture process of the 5 September 2012 Costa Rica Mw=7.6 thrust event from joint inversion of high-rate GPS, strong motion, and teleseismic P wave data, ***Thorne Lay***; *Han Yue; Luis A. Rivera; Susan Y. Schwartz; Marino Protti*

Delineating and Defining the Boundaries of an Active Landslide in the Rainforest of Puerto Rico Using a Combination of Airborne and Terrestrial LIDAR Data, ***Guoquan Wang***; *James Joyce; David A. Phillips; Ramesh L. Shrestha; William E. Carter*

*** What do you plan to do during the next reporting period to accomplish the goals?**

Continue with project plan as per revision to scope and budget as submitted to NSF in April 2013 and approved by NSF in June 2013.

Supporting Files

Filename	Description	Uploaded By	Uploaded On
COCONet_EAR1042906_FY2013_an_rpt_figs.pdf	COCONet Figures and Tables	Glen Mattioli	07/23/2013

Products

Journals
Nothing to report.

Books
Nothing to report.

Book Chapters
Nothing to report.

Thesis/Dissertations
Nothing to report.

Conference Papers and Presentations
Nothing to report.

Other Publications
Nothing to report.

Technologies or Techniques
Nothing to report.

Patents
Nothing to report.

Inventions
Nothing to report.

Licenses
Nothing to report.

Websites

Title: COCONet: Continuously Operating Caribbean GPS Observational Network

URL: http://coconet.unavco.org/coconet.html

Description: COCONet main website. All reports, personnel, data, status, etc. are provided to the public through this website.

Other Products

Product Type: Data and Research Materials (e.g. Cell lines, DNA probes, Animal models)

Description: **Third Quarter Report**

Data Summary

The Port-of-Spain, Trinidad planning meeting resulted in 50 target locations for new stations, 15 targets for refurbished stations, and at least 61 existing stations for integration into the COCONet network. Since the Port-of-Spain workshop, the COCONet siting committee has rejected the location of three new stations (St. Croix, Cayman Islands, Guanaja) and approved the addition of 2 new or refurbished sites (Aruba, Panama-Bocas Island) and 7 refurbished stations to the plan. At this time, the current siting plan calls for 49 new stations, 22 refurbished stations and at least 61 existing stations to be incorporated into the COCONet data archive. The COCONet data plan also calls for at least 10 stations to provide high-rate, low-latency (1 Hz, <1 ms) or real-time GPS data streams.

UNAVCO currently provides a suite of geodetic data products from COCONet GPS stations. COCONet stations are mostly configured for 15-second hourly downloads, with some exceptions for sites that have BGAN satellite data communications infrastructure in place.

Level 1 GPS data products include quality checked RINEX files. At the time of this report, Level 1 GPS data are available from 85 COCONet stations (Table 1-Data Flow). Level 2 GPS data products include station position solutions, station position time series, station position velocity estimates, and tropospheric delay parameters. Level 2 products are produced by the Plate Boundary Observatory (PBO) Analysis Centers (AC's) and Analysis Center Coordinator (ACC), and are identical in format to corresponding PBO data products. At the time of this report, Level 2 GPS products are available from 83 COCONet stations. Note: data products may not be available from all stations installed at the time of this report due to communication issues or other reasons, such as the station being recently built and the data not yet being available for archiving or analysis.

Seven stations are currently configured to deliver high-rate, low-latency (1 Hz, < 2 s) data streams in real-time via the Networked Transport of RTCM via Internet Protocol (NTRIP). These data and derived data products are now being incorporated into the World Meteorological Organization's (WMO) Global Telecommunications System (GTS).

Second Quarter Report

Data Summary

The Port-of-Spain, Trinidad planning meeting resulted in 50 target locations for new stations, 15 targets for refurbished stations, and 61 existing stations for integration into

the COCONet network. Since the Port-of-Spain workshop, the COCONet siting committee has rejected the location of four new stations (St. Croix, Cayman Islands, Guanaja, and Punta Cana) and approved the addition of 6 refurbished stations to the plan. In the last quarter, the COCONet Siting Committee approved two additional sites (Aruba and Panama). At this time, the current siting plan calls for 48 new stations, 21 refurbished stations and at least 61 existing stations to be incorporated into the COCONet data archive. The COCONet data plan also calls for at least 10 stations to provide high-rate, low-latency (1 Hz, <1 ms) or real-time GPS data streams.

UNAVCO currently provides a suite of geodetic data products from COCONet GPS stations. COCONet stations are mostly configured for 15-second hourly downloads, with some exceptions for sites that have BGAN satellite data communications infrastructure in place.

Level 0 and 1 GPS data products include quality checked RINEX files from all stations and real-time data from a subset of 7 stations. Level 2 GPS data products include station position solutions, station position time series, station position velocity estimates, and tropospheric delay parameters. These Level 2 products are produced by the Plate Boundary Observatory (PBO) Analysis Centers (AC's) and Analysis Center Coordinator (ACC), and are identical in format to their corresponding PBO data products. At the time of this report, Level 2 products are available from 72 (33 of the 37 completed new/refurbished and 39 existing stations); data products may not be available due to station communication issues or other reasons, such as the station being recently built. Table 2 below shows the current data summary for stations identified as belonging to the COCONet network. Seven stations are configured to deliver high-rate, low-latency (1 Hz, <1 ms) data streams in real-time via the Networked Transport of RTCM via Internet Protocol (NTRIP).

First Quarter Report

Data Summary

The Port-of-Spain planning meeting resulted in 50 target locations for new stations, 15 targets for refurbished stations, and 61 existing stations for integration into the COCONet network. Since the Port-of-Spain workshop, the COCONet siting committee has rejected the location of four new stations (St. Croix, Cayman Islands, Guanaja, Punta Cana) and approved the addition of 6 refurbished stations to the plan. The current siting plan calls for 46 new stations, 21 refurbished stations and at least 61 existing stations to be incorporated into the COCONet data archive. The COCONet data plan also calls for at least 10 stations to provide high-rate real-time GPS data streams.

COCONet is currently downloading mostly 15-second data (with some exceptions for BGAN sites) and processing daily position estimate from 26 of the 29 new and refurbished COCONet stations through the Plate Boundary Observatory (PBO) analysis centers. Data from 39 existing stations in the region are being archived.

Processing of station data by the PBO GPS Analysis Centers is yielding high-quality time series. Table 2 shows the current data summary for stations identified as belonging to the COCONet network. See the discussion above related to the current status of PBO AC data processing and the plans for RT-GPS ingest and analysis at UNAVCO

Supporting Files
Other:

Filename	Description	Uploaded By	Uploaded On
COCONet_EAR1042906_publications.pdf	COCONet publications in FY2013.	Glen Mattioli	07/23/2013

Participants

Research Experience for Undergraduates (REU) funding

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Meghan Miller	PD/PI	
Glen S Mattioli	Co PD/PI	
Guoquan Wang	Co PD/PI	
Karl F Feaux	Co PD/PI	

What other organizations have been involved as partners?
Nothing to report.

Have other collaborators or contacts been involved? N

Impacts

What is the impact on the development of the principal discipline(s) of the project?

COCONet was the impetus for the development of TLALOCNet - another multihazard cGPS/Met network in Mexico. UNAVCO submitted an MRI proposal in February 2013 to request funding to develop a combined atmospheric and tectonic cGPS-MET network in Mexico, named TLALOCNet, for interrogation of climate, atmosphere, the earthquake cycle, and tectonic processes of Mexico and environs. TLALOCNet will span all of Mexico and link existing GPS infrastructure in North America and the Caribbean. We propose six new cGPS stations at locations of high scientific value in Mexico and adjacent islands, in parallel with the of upgrade 18 cGPS stations previously established by NSF-funded collaborations. The resulting 24 stations will operate to the high standard of the EarthScope Plate Boundary Observatory (PBO) and the Continuously Operating Caribbean GPS Observational Network (COCONet), and complement additional cGPS-MET stations to be installed by our Mexican partners, including National Meteorological Service (SMN) and the Universidad Nacional Autonoma de Mexico (UNAM) over the next three years. This $1.5M request to the NSF MRI program, which builds on decades of NSF investments in Mexico and is supported by several years of preparation, community workshops, and planning by multiple institutions and individuals, is tailored to achieve the highest and broadest impact for the most efficient and appropriate investment. TLALOCNet is greatly leveraged Mexico's formal cost-share of $643K (13 stations) and SMN's anticipated further substantial investment in cGPS-MET across Mexico. Collectively, the developed infrastructure and capabilities will provide the basis for a unique class of interdisciplinary observations and science applications that meet the criteria for MRI instrument development. Design and construction rely on design work and engineered solutions for system integration. Risks associated with development of the unique observing system will be managed by benchmarking against established scope

and schedule, in close coordination with the sponsor and the scientifically diverse user community.

What is the impact on other disciplines?
Nothing to report.

What is the impact on the development of human resources?

Introduction and Overview from COCONet Third Workshop, Tulum, Mexico

The third COCONet workshop, held in Tulum, Mexico (October 24-26, 2012), was sponsored by the National Science Foundation and hosted by the National Autonomous University of Mexico (UNAM) and UNAVCO. The Tulum meeting included 84 participants, representing 45 institutions from 19 countries. This report details the activities and outcomes of the workshop. Appendix A lists the 3rd workshop organizing committee, Appendix B contains the workshop agenda, and Appendix C provides a list of workshop participants.

The original COCONet proposal envisioned supporting two workshops over the planned project life of three years. The original time-line for COCONet was expanded to five years 2011 and the end date for the project is now August 31, 2015. The original plan to hold a project kickoff meeting in year one and a network operators meeting in year three was expanded to a total of three workshops. Additional funding was provided by NSF to expand participation in the first COCONet workshop, and funds were reallocated from the project budget to expand participation in the third workshop. During the first workshop, held in San Juan, Puerto Rico (February 3-4, 2011), participants developed an initial community plan that refined the overarching science goals for the proposed integrated multi-disciplinary network, reviewed the original GPS station siting plan, developed a consensus list of existing high-quality cGPS stations in the Caribbean for possible inclusion into the COCONet archiving and data processing scheme, and defined and prioritized additional science experiments, which could capitalize on the NSF investment in the pan-Caribbean infrastructure of COCONet.

The second workshop, held in Port-of-Spain, Trinidad, Republic of Trinidad and Tobago (June 28-29, 2011) brought together Caribbean network operators to evaluate and select existing and new stations to meet the COCONet science goals and to begin planning for pan-Caribbean capacity building with a focus on data collection, processing and archiving. GPS network operators identified numerous existing stations in the Lesser Antilles and Venezuela, which were not previously known by the larger geodetic community or UNAVCO staff; developed a first-order siting plan for new stations; clarified the need for a follow-on siting meeting to identify and finalize existing and new station locations. In addition, both Caribbean and US investigators requested that the COCONet management team consider a refurbishment option for some set of regional GPS stations of geodetic quality, which require equipment upgrades to be at COCONet standards.

This third COCONet workshop focused primarily on longer-term operations and maintenance for GPS stations installed in the Caribbean, GPS data processing, generation of higher-level data products, and real-time GPS data distribution for enhanced science and broader societal benefits. Several examples of recent scientific advances and societal benefits arising from the nascent stages of COCONet were presented by invited speakers. In addition, there were presentations about the future, potential, and long-term sustainability of COCONet data and the COCONet user community. Plans to establish regional data centers (RDC) for raw data archival, basic data analysis, and enhanced data products were proposed and discussed during several breakout sessions. An overarching goal of any COCONet RDC is to advance not only regional capacity, but to further enhance regional use and impact of COCONet data. A key result of the Tulum meeting was identification of several institutions, which could host a regional data center. Representatives from these institutions will be invited to a smaller meeting, likely to be hosted at UNAVCO headquarters in Boulder, CO, in the next 3-6 months to develop further the technical requirements and implementation plans for COCONet RDCs. Other key objectives of the meeting were to explore new research opportunities and data products and to map out future goals and expanding directions for COCONet. There was great enthusiasm and energy at the workshop from all of the participants to develop regional data centers, to advance COCONet research and educational opportunities, to enhance regional science and engineering workforce capacity, to improve and strengthen international partnerships, and to promulgate the societal benefits arising from COCONet.

What is the impact on physical resources that form infrastructure?

COCONet Siting and Station Construction Status: Tulum Workshop

The Tulum workshop provided an opportunity for participants to learn more about the status of reconnaissance, permitting, and station installations for COCONet. The five-year project plan, which was developed after the Trinidad meeting, includes four years (FY2011-FY2014) of station construction activities and one year (FY2015) of operations and maintenance (Figure 1). The siting plan that was developed at the Trinidad meeting consisted of 50 new stations, 15 refurbished stations, and at least 61 existing stations from the region to be incorporated into the COCONet archive and processing. The COCONet Siting Committee, which was formed in August 2011 as a recommendation from the Trinidad meeting, has approved removal of four new stations from consideration, while recommending additional investment in refurbishing existing stations in the region. The siting session at the Tulum workshop was productive, resulting in clarification of the status of the existing COCONet station in Honduras (TEG2) and the elimination of three existing stations for consideration from the Trinidad siting plan. The revised plan now consists of 46 new stations, 21 refurbished stations, and 77 existing stations to be incorporated into the COCONet data archive and processing.

The COCONet project is entering its third year of construction and significant progress has been made in reconnaissance, permitting, and station installations (new and refurbished). Overall, the project is ahead of schedule in reconnaissance and permitting and slightly behind schedule in station installations. For the 67 new and refurbished stations, the project has completed 57 reconnaissance visits, accepted 37 permits, and installed 28 stations (Figure 2). Data from 45 existing regional stations have been delivered to the COCONet archive (Figure 3). With the progress made to date, the COCONet project is in a good position to meet the four-year construction goals on-schedule and within budget.

What is the impact on institutional resources that form infrastructure?
Nothing to report.

What is the impact on information resources that form infrastructure?
Nothing to report.

What is the impact on technology transfer?

COCONet has developed capacity with its cicum-Caribbean partners for the installation and maintenance of cGPS/Met infrastructure.

What is the impact on society beyond science and technology?

Building of the COCONet community through workshops, working groups, free and open data access, COCONet social media and website, and the COCONet Science Fellowship program.

Changes

Changes in approach and reason for change

Submitted and already approved by NSF in June 2013

Justification for Changes in Objective or Scope: Above in the Proposed Changes in Objectives or Scope section, we outlined the proposed revised budget for the COCONet award for the remainder of FY2013, FY2014, and FY2015. The revisions are primarily related to the final siting plan, the distribution of new versus refurbished sites, pace of work for the installation phase of COCONet. The budget of the budget has now shifted from years one and two to year three. Additional changes reflect broad community input obtained through polling the participants of the three COCONet workshops funded by NSF. In addition, after 2.5 years of progress on the COCONet project, actual costs allow us to better condition our budget for future spending in key areas such as travel and telecommunications. The largest and most significant change is related to

the defunding the Purdue subaward of $400K. Revised plan and justification for change to the subaward to Purdue University from UNAVCO is outlined below. 1) Working Group Travel: The third COCONet workshop report recommend the development of community-based working groups to guide and advise the COCONet PIs and UNAVCO staff. Four working groups were proposed as an outgrowth of the COCONet 3rd workshop held in Tulum, Mexico in late October 2012. These groups consist of a UNAVCO technical lead and three or four members from COCONet stakeholder institutions or international partners. The $75K will support at least one face-to-face meeting for each of the four working groups in FY2014 and FY2015, perhaps in concert with another annual meeting like AGU or GSA. 2) COCONet Graduate Student Fellowship: The Purdue subaward was developed to support MS or PhD students from the Caribbean region to work on COCONet-related science and use data from COCONet. With the departure of former COCONet Co-PI Dr. Eric Calais to France, the COCONet project no longer has direct support for graduate research. The $162K budgeted here is envisioned to support at least two graduate students for two years to pursue research related to either solid Earth or atmospheric science projects within the COCONet footprint or directly using data from the COCONet cGPS-met sensors. Ideally, one student will focus on each of the two primary target science areas outlined in the COCONet proposal. Students would be awarded a "COCONet Graduate Fellowship," which will include funding in the form of a living stipend and support to defray the cost of tuition as well as modest support for research. We envision establishing a committee that will include COCONet PIs and as well as other community members to help select the students who will receive these awards, while avoiding any conflicts of interest. Applicants will submit an application outlining their research plan relative to COCONet objectives, a brief statement of support from their MS or PhD thesis or dissertation advisor, three references, and complete university transcripts. 3) PASI Video and Student Support: The $30K and $20K, respectively are budgeted to support the upcoming Atmospheric Science PASI led by J. Braun and the Tectonic-Magmatic Interactions PASI led by P. LaFemina. The $30K will allow filming of the PASI lectures delivered during these important events, which then would be provided to the entire COCONet community through the COCONet website. The $20K budgeted for PASI students will allow two additional students, which could not be supported by the NSF PASI funds directly awarded to UCAR and PSU, to attend the PASI conferences in Bogota, Colombia and Leon, Nicaragua in May 2013. 4) Visiting Engineer: The $39K budgeted in this category is to support 1-2 field or data engineers per year from COCONet stakeholders or institutional partners to come to UNAVCO headquarters in years FY2014 and FY2015 to work closely with UNAVCO staff to improve technical skills, with a focus on network operations and monitoring with a view to the long-term viability of the COCONet cGPS-met observations. The goal of this training will be to improve these individual's technical skills such that they can work independently across the COCONet region to troubleshoot and repair COCONet sensors or components in the proposed COCONet Regional Data Centers. The funds will be used to support travel, housing, and per diem while the visiting engineer or technician is in residence in Boulder, CO. We anticipate that the visiting engineer or data technician will be residence at UNAVCO for 10 days to 2 weeks. 5) Student Meeting Support: The $25K budgeted in this category will be used to support undergraduate and graduate students attending and presenting a paper at a national or international meeting, for example at AGU, GSA, EUG, or the Meeting of the Americas. Student support will be limited to $2K per meeting and each student will be eligible to receive only one travel grant through COCONet. Accepted abstracts to the meeting are required to be submitted, together with a brief statement of need and confirmation from the student's advisor certifying that the student is in good standing at their respective institution and further outlining what the expected value that the student will gain through attendance at this meeting with COCONet support. Students at US or any COCONet stakeholder institution or partner country would be eligible to apply and receive one-time funding.

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

Proposed Changes in Objective or Scope:

UNAVCO Revised Budget Justification and Impact Statement

COCONet (Continuously Operating Caribbean GPS Observational Network) An Infrastructure Proposal for a Multi-hazard Tectonic and Weather Observatory

Award Period: September 1, 2010 - August 31, 2015

Revised March 27, 2013 for the period March 1, 2013 to August 31, 2015

Significant changes and Budget Impact

Changes to the original 2010 Budget Justification that result from the proposed rebaseline of March 2013 are outlined below. Significant changes include: 1) the addition of modest support for the Project Director, G. Mattioli, at 0.3 calendar months/year; 2) placement of costs associated with K. Feaux's Project Management from the Other Professionals category to

Senior Personnel to reflect his appointment as Co-PI; 3) inclusion of revised scope to install two platinum-grade tide gauge sites within the COCONet footprint for sea level monitoring and for tsunami hazard mitigation; 4) a revised plan to rescope the remaining $350K of unused funds originally budgeted for a subaward from UNAVCO to Purdue University - a separate, detailed justification for this was presented to the NSF previously. The revised plan includes: a) funding for at least 2 COCONet Science Fellows, with one focused on solid Earth and the other focused on atmospheric processes, the selection of which will be completed through a community-wide, open competition; b) support for funding face to face meetings in FY2014 and FY2015 for the four newly constituted COCONet working groups; c) modest additional funding to allow additional community participation for the two COCONet-related PASIs, which occur in May 2013; and d) funding to support enhanced skills development through a visitor program at UNAVCO in Boulder for COCONet regional partner or stakeholder staff engineers or technicians; 5) a revision of expected costs for field engineering travel, equipment and material shipments, and data communications for the new and refurbished COCONet sites, which is consistent with the current installation schedule and approved siting plan; and 6) the allotment of $100K for 1-2 regional data centers, as per the recommendations from the COCONet 3rd Workshop report. In summary, the total budget plan as proposed here is $20K less than the original budget of $5.986M submitted in 2010. Please note that this revised budget reflects actual costs from September 1, 2010 to February 28, 2013 and proposed changes from March 1, 2013 (final 6 months of third award year) to August 31, 2015. Accordingly, the revised budget reflects plans for the next 2.5 years, but the annual and cumulative 1030 Budget Forms, as well as the differences between the originally submitted and the current proposed revised budget have been included for all five years for completeness and clarity.

Changes that have a significant impact on expenditures

See above.

Significant changes in use or care of human subjects
Nothing to report.

Significant changes in use or care of vertebrate animals
Nothing to report.

Significant changes in use or care of biohazards
Nothing to report.