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Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
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PD/PI Name:	Meghan Miller, Principal Investigator Karl F Feaux, Co-Principal Investigator Glen S Mattioli, Co-Principal Investigator Guoquan Wang, Co-Principal Investigator
Recipient Organization:	UNAVCO, Inc.
Project/Grant Period:	09/15/2010 - 08/31/2017
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Submitting Official (if other than PD\PI):	Glen S Mattioli Co-Principal Investigator
Submission Date:	08/25/2016
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	Glen S Mattioli

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,

2015 to August 31, 2016. 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 Karl Feaux, Glen Mattioli, and Guoquan Wang. 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 21, 2015, April 5, 2016 and June 16, 2016 to the COCONet NSF-EAR-IF Program Officer, Mr. Russ Kelz. Also included in this annual report is a brief summary of activities completed in FY2016-Q4, which also will be submitted as a quarterly report by September 15, 2016.

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 transferred 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.

Lastly, 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.

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

Major Activities:

FY2016-Q1:

- Two new cGPS-Met stations were installed in FY2016-Q1 - Los Roques, Venezuela (CN42) and Providenciales (CN53). The total number of new, refurbished, or co-located stations installed to date is 76. **There are 7 remaining stations to be installed as part of the COCONet siting plan.**
- Maintenance work was completed at a number of stations, including:
 - Honduras: Receiver and met pack replacements at CN18, CN21 and ROA0.
 - Nicaragua: Cellular data communications installation at CN22 and router repair at CN29.
 - St. Lucia: New receiver and equipment enclosure installed at CN04; antenna repaired at CN47.
 - Antigua: Receiver replaced, and data communications restored at BGGY.
 - Montserrat: Communications overhaul along with maintenance tasks for NWBL, GERD, TRNT, OLVN, AIRS, and RCHY (these stations were part of CALIPSO and are now being maintained through COCONet).
 - Colombia: New antenna and mount installed at SAN0 on San Andres Island.

FY2016-Q2:

- The current COCONet siting plan calls for 54 new stations, 5 new stations associated with tide gauge installations, and 29 refurbished stations (equipment was sent to five additional existing stations last quarter, increasing the refurbished count to 29) for a total of 88 new and refurbished stations, and at least 62 existing stations to be incorporated into the COCONet data archive.
- **The total number of new, refurbished, or co-located stations installed to date is 81. There are 7 remaining stations to be installed as part of the COCONet siting plan; 3 new stations and 4 refurbished stations.**

- Maintenance work was completed at a number of stations, including:

- **Haiti**

CN09 - New LS300 cell modem, enclosure, and LNA ready to ship via diplomatic pouch.

JME2 - New LS300 cell modem, enclosure, and LNA ready to ship via diplomatic pouch.

- **Bahamas**

CN15 - New public IP address assigned to Trimble NetR9 receiver.

CN13 – New LS300 cellular modem configured for VPN.

- **Honduras**

CN18 - BGAN repaired. Site is now online.

- **Panama**

CN20 - Cisco RVO42 reconfigured at STRI.

TGPM - Cisco RVO42 reconfigured at STRI.

- **Nicaragua**

CN22 - Installed LS300 cell modem and removed faulty radio. New LNA ready to ship.

CN29 - Installed LNA. New LS300 cell modem ready to ship.

- **Trinidad**

CN45 - New ISP chip installed. Data are flowing.

- **Cayman Islands**

GCFS - Data are being pulled from Cayman Island's Department of Surveying.

- **Costa Rica**

QSEC – Data communications restored.

- **Montserrat**

RDON - Radome, Trimble NetR9, Met pack, and cables shipped.

TRNT - Met pack and cables shipped.

RCHY- Data communications/power equipment shipped to MVO.

- **Antigua**

BGGY- Replaced NetR9 due to Ethernet failure.

- **Dominican Republic**

CN27 - RV90 cellular modem replaced by local contact.

FY2016-Q3:

- The current COCONet siting plan calls for 54 new stations, 5 new stations associated with tide gauge installations, and 27 refurbished stations (eliminated CAYS and MALP in FY2016-Q3) for a total of 86 new and refurbished stations, and at least 63 existing “contributed” stations to be incorporated into the COCONet data archive.
- **The total number of new, refurbished, or co-located stations installed to date**

is 81. There are 5 remaining stations to be installed as part of the revised and updated COCONet siting plan, which includes 3 new stations and 2 refurbished stations.

- Maintenance work was completed at a number of stations, including:
 1. CN22
 1. Cellular modem was updated.
 2. GPS antenna LNA swapped (preventative maintenance).
 2. CN29
 1. Installed LS300 cell modem.
 2. Co-located with INETER seismometer.
 3. CN30
 1. Installed LS300 cell modem.
 2. Station co-located with INETER seismometer.
 3. Installed new met station.
 4. GPS antenna LNA swapped (preventative maintenance)
 4. CN53: New AC timer sent to improve performance of DLS modem.
 5. Telica cGPS Network (added to COCONet activities with approval by NSF)
 1. TECF: Installed new GPS receiver.
 2. TELN: Installed new GPS receiver.
 3. JCFI: Installed new GPS receiver.
 4. POLS: Installed new GPS receiver.
 5. POLI: Installed LS300 modem.
 6. QUEN: Repaired station, now online (hit by lightning).
 7. LEME: Installed new GPS receiver.
 8. HERH: Installed new GPS receiver.
 9. HOYN: Campaign site position occupied.
 10. SALN: Campaign site position occupied.
 11. CALV: Campaign site position occupied.
 6. RDMA
 1. Added contributing station. Now archiving and processing data.
 7. VRAI
 1. Site visited by Dr. Marino Protti to fix data communications issues.
 8. RDON
 1. Installation of GPS equipment to repair station that was hit by lighting.
 9. TEG2
 1. UPI student visited to resolve data communications problems at the station.
 10. Haiti
 1. CN09: Equipment currently in customs.
 2. JME2: Equipment currently in customs.

FY2016-Q4:

- The current COCONet siting plan calls for 54 new stations, 5 new stations associated with tide gauge installations, and 26 refurbished stations for a total of 85 new and refurbished stations. The BAYS station was dropped from the construction plan in FY2016-Q4. Currently, 55 active existing “contributed” stations are incorporated into the COCONet data archive.
- **The total number of new and refurbished cGPS stations installed to date is 83 (See COCONet_EAR1042906_FY2016_an_rpt_figs.pdf - Figure 1).**
 - Accordingly, there are 2 remaining stations to be installed as part of the revised and updated COCONet siting plan, which includes 1 new station and 1 refurbished station.**
- Maintenance work was also completed at a number of stations last quarter,

including:

1. CN01
 1. Faulty Ethernet cable was replaced.
1. CN09
 1. Installed new equipment enclosure.
 2. Installed new LS300 cell modem.
 3. GPS antenna LNA swapped (preventative maintenance).
1. CN13
 1. Installed new LS300 cell modem at station.
1. CN17
 1. Equipment enclosures built and tested. This is a custom enclosure designed for remote islands with a highly corrosive environment. Additionally, the enclosures will house a bank of batteries need to operate a VSAT.
 2. JME2
 1. Installed new equipment enclosure.
 2. Installed new LS300 cell modem.
 3. GPS antenna LNA swapped (preventative maintenance).

Specific Objectives:

Significant Results:

In FY2016, the COCONet project focused mainly on operations and maintenance activities for the installed stations, while continuing to make progress in the construction of the few remaining stations. One significant result in FY2016 was the upgrade of cGPS-Met stations in Haiti to become standardized COCONet stations. Another key result in FY2016 was the planning, execution, and reporting of the fourth COCONet community workshop that was held in the Dominican Republic from 3-5 May 2016.

Seventy-eight participants from 28 countries representing over 40 institutions in the region contributed to the workshop plenary talks, breakout discussions, and poster presentations (See COCONet_EAR1042906_FY2016_an_rpt_figs.pdf - Figure 2). The talks and breakout sessions focused on science, long-term sustainability, and capacity building in the region. The workshop organizing committee met at the close of the workshop and evaluated their impressions as well as feedback from participants. The workshop was deemed very successful, with significant positive interactions among UNAVCO staff, regional partners, other key stakeholders, and the NSF representative. In August 2016, UNAVCO submitted the final COCONet workshop report, as required by the National Science Foundation. The report will be posted on the COCONet [publication page](#). All previous workshop reports, other reports, and newsletters also are available on this page.

A press release pertaining to the workshop in [English](#) and [Spanish](#) was prepared and disseminated to the local media in the Dominican Republic. Special thanks goes to Dr. Alex Holsteinson for his help with organizing the workshop, preparing the press releases, and communicating with the local community in the Dominican Republic.

Key outcomes or Other achievements:

FY2016-Q1

To date, UNAVCO engineering personnel have performed site reconnaissance at 81 locations, submitted land use permits for 81 sites, received permits for 79 sites, and currently have 76 stations installed. Key accomplishments in the last quarter were the installation of the COCONet cGPS-Met stations on Los Roques, Venezuela (CN42) and Providenciales (CN53), an island that is part of Turks and Caicos. COCONet station maintenance was also completed.

FY2016-Q2

To date, UNAVCO engineering personnel have completed the installation of 81 cGPS-

Met stations in the Caribbean region. Key accomplishments in the last quarter were the preparation for the Nicaragua maintenance trip and the submission (and funding) of the proposal for the fourth COCONet Community Workshop that will be held in Punta Cana, Dominican Republic.

FY2016-Q3

To date, UNAVCO engineering personnel have completed the installation of 81 cGPS-Met stations across the Caribbean region. Key accomplishments in the last quarter included the Nicaragua maintenance trip and the successful completion of the fourth COCONet Community Workshop held in Punta Cana, Dominican Republic.

FY2016-Q4

To date, UNAVCO engineering personnel have completed the installation of 83 cGPS-Met stations across the Caribbean region. Key accomplishments in the last quarter included a Haiti maintenance trip and the completion of two new cGPS-Met stations in Venezuela. In Haiti, Engineer Mike Fend upgraded the equipment enclosures and power systems for stations CN09 (Cap Haitian) and JME2 (Jacmel). The GPS antenna LNA was replaced at both stations as preventative maintenance. In Venezuela, COCONet collaborator Dr. Franck Audemard of Fundación Venezolana de Investigaciones Sismológicas (FUNVISIS) and his team installed cGPS-Met stations CN43 (Isla La Blanquilla) and CN44 (Margarita Island – See COCONet_EAR1042906_FY2016_an_rpt_figs.pdf - Figure 3).

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

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:

COCONet Fellows Advance Research and Outreach

COCONet has supported nine fellows for graduate research within the COCONet footprint. Four COCONet Fellows have completed their doctoral degrees and moved to postdoctoral or faculty positions at other research institutions. Five are pursuing their doctoral degrees at U.S. universities and have received their last year of funding through the COCONet Fellowship program. All of the COCONet Fellows have been very successful in advancing research, outreach, and community engagement within the COCONet footprint. Some of the accomplishments from the COCONet Fellows in FY2016-Q3 include:

- Teddy Allen presented his latest research at the 4th COCONet Workshop in the Dominican Republic in May 2016.
- Roby Douilly graduated from Purdue University with a doctoral degree in Geophysics and Seismology in May 2016 (Figure 3). He has a post-doctoral position at the University of California, Riverside with David Oglesby.
- Steeve Symithe graduated from Purdue University with a doctoral degree in Geophysics and Seismology in April 2016 (See COCONet_EAR1042906_FY2016_an_rpt_figs.pdf - Figure 4). He will return to Haiti as a new faculty member at the University of Haiti.
- Ophelia George, at the University of South Florida, plans to complete her doctoral degree in Geology in 2016. She has been analyzing seismic, geodetic and InSAR imagery from Dominica to create a volcanic hazard map for the island. She presented her latest research at the Fourth COCONet Workshop in the Dominican Republic in May 2016.
- Vanshan Wright, at Southern Methodist University, is studying fault dynamics in Jamaica. He presented his latest results at the Fourth COCONet Workshop in the Dominican Republic in May 2016.

Regional Data Centers

In FY2015, UNAVCO staff delivered the Regional Data Center systems to Barbados, Nicaragua, and Colombia. Each system consists of a virtual machine (VM) that has been provisioned with the Linux operating system and systems software including web server, web application server, ftp server, Java, Perl, Python, Dataworks, and MySQL, plus the GSAC database, GSAC software, and required synchronization scripts. The following two COCONet mirror centers and data centers are considered operational:

Caribbean Institute for Meteorology and Hydrology – The [Caribbean Institute for Meteorology and Hydrology](#) (CIMH) received a grant to develop a mirror data center to host and serve COCONet data and metadata from UNAVCO and serve as a geodetic seamless archive center through web services ([GSAC-WS](#)). CIMH, headquartered in Husbands, St. James, Barbados will serve the eastern circum-Caribbean region. Dr. Andrea M. Sealy is the principal investigator for the mirror data center award. CIMH is a Regional Meteorological Training Centre for the World Meteorological Organization (WMO) and part of the Caribbean Meteorological Organization (representing 16 countries in the Caribbean). The institute is well placed to serve as a mirror data center and to expand collaborations and integration of geodetic data for atmospheric and solid Earth sciences applications.

Instituto Nicaraguense De Estudios Territoriales – The [Nicaraguan Institute for Terrestrial Studies](#) (Instituto Nicaraguense De Estudios Territoriales, INETER) received a grant to develop a mirror data center to host and serve COCONet data and metadata from UNAVCO and serve as a geodetic seamless archive center through web services ([GSAC-WS](#)). INETER, headquartered in Managua, Nicaragua will serve the western circum-Caribbean region. Dr. Jose Armando Saballos is the principal investigator for the mirror data center award. INETER provides research, data, education, and support for all hazards in Nicaragua, especially volcanic unrest, earthquakes, and severe weather. Their diverse talents in all fields of geoscience research and observations and their established data services make the INETER an excellent site for a mirror data center.

Colombian Geological Survey – The [Colombian Geological Survey](#), Center for Processing and Analysis of Geodetic Data received a grant to develop a regional data center (RDC) headquartered in Bogota, Colombia and serve the entire circum-Caribbean community. The RDC functions as a mirror for COCONet data and metadata with capabilities for local data and metadata management, such as downloading stations and archiving GNSS data. Dr. Hector Mora-Paez serves as the principal investigator for the RDC award. Dr. Mora-Paez directs the GNSS [GEORED](#) Project at the Colombian Geological Survey. The project, the institution, and the investigators are well suited to host a regional data center with capabilities to support longer-term integration and dissemination of geodetic data for research and broader impacts.

In FY2016, UNAVCO continued to provide hardware, software, and technical support to operate these sites. The centers provided open access to data, data integration, high impact research and graduate-level training in the Earth sciences in the circum-Caribbean region where there is a significant need for more expertise and study to meet immediate concerns and provide longer-term benefits to the COCONet community.

Training

Training of local engineers and technicians is an important part of the success of COCONet. In FY2016, UNAVCO field engineers worked with a number of local operators in the construction and maintenance of the cGPS-Met stations. A few of the more noteworthy training activities include engineers and technicians from La Fundación Venezolana de Investigaciones Sismológicas (FUNVISIS), Centre National de l'Information Géo-Spatiale (CNIGS), Universidad Politécnica de Ingeniería (UPI), the Bahamas Department of Meteorology, Instituto Nicaraguense de Estudios Territoriales Intra-Americas Studies of Climate Processes (INETER), and the Montserrat Volcano Observatory (MVO).

During the last day of the 4th COCONet Community Workshop in Punta Cana, Dominican Republic, UNAVCO provided an optional training session on Dataworks for GNSS. Dataworks for GNSS is the UNAVCO-developed software system consisting of open-source software modules that can be employed by regional GNSS managers for small networks for data and metadata management.

Thirty-one people attended the Dataworks software training (See COCONet_EAR1042906_FY2016_an_rpt_figs.pdf - Figure 5). The major components of Dataworks, including the database, GSAC, receiver download, metadata management, and

mirroring scripts were presented at an introductory level with more detailed presentation of selected topics. Systems level topics including preparing a Linux server, software installation, metrics, and security were presented, as was starting up an Amazon Elastic Compute instance and installing the Dataworks Amazon Machine Image. Dataworks software, server, and installation manuals were provided as PDF files on a thumb drive to each participant.

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

UNAVCO Science Snapshot

A UNAVCO Science Snapshot was posted in September about the Symithe et al paper, "[GPS Defines Caribbean Plate in Motion](#)", 30 September 2015.

New Email List Serve for the COCONet Community

In FY2016-Q4, a new and improved COCONet mailing list was developed, coconet-all@unavco.org. This list will be used primarily for announcements relevant to the COCONet community. Pertinent announcements will be sent to this moderated list to share. To subscribe or unsubscribe, please contact Linda Rowan, rowan@unavco.org. Note that the old list, coconet-alert@unavco.org is gone and no emails can be exchanged using that email.

New COCONet Facebook Group

UNAVCO has started a [COCONet Facebook Group](#) on which any group member can post. Note that this is a public group, meaning users have to join to post but the page can be seen by anyone. This page is another way for the community to share science, technology and appropriate information that may be of interest to others within the COCONet community and to the broader public.

COCONet in the News

[Ground shakes expose faraway earthquake hot spots](#), 8 January 2016, Thomas Sumner, *Science News*

Eleventh Session of the Intergovernmental Oceanographic Commission (IOC) Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions

Representing COCONet, Co-PI Karl Feaux attended this meeting on Tsunami and Coastal hazards on April 5-7, 2016 in Cartagena de Indias, Colombia. The meeting was attended by 70 participants from 18 Caribbean countries and territories and 3 observer organizations: Puerto Rico Seismic Network ([PRSN](#)), [UNAVCO](#), and the World Meteorological Organization (WMO). Karl Feaux represented UNAVCO and gave a brief presentation, which introduced the participants to UNAVCO, the Plate Boundary Observatory, and provided an update on the COCONet and TLALOCNet projects. The primary interest of the participants at this meeting was related to the COCONet tide gauge installations and stations capable of high rate data realtime data distribution.

Other Outreach Activities

COCONet Fellow, Hans Lechner, attended the annual Fall Meeting of the American Geophysical Union, 2015. He helped to organize and is co-chairing a public affairs session on *Volcanic Hazards: Translating Research and Monitoring into Improved Communication, Preparedness and Response*. The session will include a presentation by his colleagues at Michigan Tech about working with emergency managers and the local community around Pacaya Volcano in Guatemala. Some of this work has been supported through a Geoscientists Without Borders grant. He gave a presentation, Lechner, H.N., Waite, G.P., Escobar-Wolf, R., Lopez-Hetland, B., *Elastic modeling of the Pacaya volcanic complex: a 2009-2015 campaign-GPS*

deformation history at the AGU meeting as well.

Publications

Several papers related to COCONet were published or submitted, including the following:

Chaves, E.J. and Schwartz, S.Y. (2016), Monitoring transient changes within overpressured regions of subduction zones using ambient seismic noise. *Science Advances*, 2(1). doi: 10.1126/sciadv.1501289.

Ellis, A. P., DeMets, C., Briole, P., Molina, E., Flores, O., Rivera, J., Lasserre, C., Lyon-Caen, H., Lord, N. (2015), Geodetic slip solutions for the Mw= 7.4 Champerico (Guatemala) earthquake of 2012 November 7 and its postseismic deformation. *Geophysical Journal International*, 201(2), 856-868. doi: <http://dx.doi.org/10.1093/gji/ggu484> .

Yang, L., et al. (2016), GPS geodetic infrastructure for natural hazards study in the Puerto Rico and Virgin Islands region, *Natural Hazards*, pp 1-25, DOI: [10.1007/s11069-016-2344-7](https://doi.org/10.1007/s11069-016-2344-7)

Symithe, S. and Calais, E. (2016), Present-day shortening in Southern Haiti from GPS measurements and implications for seismic hazard, *Tectonophysics*, v679, p. 117-124, DOI: [10.1016/j.tecto.2016.04.034](https://doi.org/10.1016/j.tecto.2016.04.034)

Alfaro, E.J and Hidalgo. H.G. (2016), Climate of an oceanic island in the Eastern Pacific: Isla del Coco, Costa Rica, Central America, Eric J. Alfaro and Hugo G. Hidalgo, *Rev. Biol. Trop.* (Int. J. Trop. Biol. ISSN-0034-7744) Vol. 64 (Suppl. 1): S59-S74, DOI: [10.15517/rbt.v64i1.23411](https://doi.org/10.15517/rbt.v64i1.23411)

Calais, E., Symithe, S., Mercier de Lepinay, B., Prepetit, C. (2016), Plate boundary segmentation in the northeastern Caribbean from geodetic measurements and Neogene geological observations, *Geoscience*, Vol. 348, p. 42-51, DOI: [10.1016/j.crte.2015.10.007](https://doi.org/10.1016/j.crte.2015.10.007)

H. Geirsson et al. (2015), The 2012 August 27 Mw7. 3 El Salvador earthquake: expression of weak coupling on the Middle America subduction zone, H. Geirsson et al., *Geophys. J. Int.*, 202 (3): 1677-1689, DOI: [10.1093/gji/ggv244](https://doi.org/10.1093/gji/ggv244)

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

The plan for FY2017 is to finish the construction of the final two COCONet cGPS-Met stations, CN17 (new), in the Gulf of Mexico and MARA (refurbished) in Venezuela. With the help of COCONet partners in the region, COCONet management will continue to maintain the stations with limited resources. However, maintaining the data communications at each station is the highest priority for the network in FY2017-FY2018.

Supporting Files

Filename	Description	Uploaded By	Uploaded On
COCONet_EAR1042906_FY2016_an_rpt_figs_opt.pdf	COCONet FY2016 Annual Report Figures	Glen Mattioli	08/25/2016

Products

Books

Book Chapters

Inventions

Journals or Juried Conference Papers

Licenses

Other Conference Presentations / Papers

Other Products

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

FY2016 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 (now the COCONet working group) refined the siting plan based on the actual suitability of the location for a cGPS-Met station. At this time, the siting plan calls for 54 new stations, 5 new stations associated with tide gauge installations, and 26 refurbished stations for a total of 85 new and refurbished stations. The COCONet data plan also called 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. 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 (ACs) in collaboration with the Analysis Center Coordinator (ACC), and are identical in format to corresponding PBO data products.

UNAVCO currently archives 147 COCONet-designated cGPS stations, including some that are no longer active and thus are not providing new data to the UNAVCO archive. This group includes those that are new and refurbished as well as contributing stations from other networks (*i.e.* COCONet regional partners). The UNAVCO Data Archive Interface (DAI) (<http://www.unavco.org/data/gps-gnss/data-access-methods/dai2/app/dai2.html#>) now has three distinct groupings of COCONet sites: 1) **COCONetCore (58)**, which includes all the sites that UNAVCO has installed and currently maintains; 2) **COCONetRefurb (25)**, which includes all the existing sites operated by collaboration institutions that UNAVCO has upgraded with equipment and currently maintains; and 3) **COCONetPartner (64)**, which includes stations that UNAVCO does not operate, but whose data have been contributed by various regional partners. One additional contributing station was added last quarter.

The recent performance of the network data is summarized below:

In the COCONetCore grouping, 54 of 56 active stations (96%) returned 1 or more files during the period 1-Jun-2016 to 10-Aug-2016 (The count of 56 excludes 1 pending station, CN49, and another recently constructed station in Venezuela, CN43).

In the COCONet Refurbished grouping, 20 of 24 active stations (83%) returned 1 or more files during the period 1-Jun-2016 to 10-Aug-2016 (The count of 24 excludes POPT due to its retired status).

In the COCONetPartner grouping, 41 of 55 active stations (75%) returned 1 or more files during the period 1-Jun-2016 to 10-Aug-2016 (The count of 55 includes the new station RDMC and excludes 9 retired stations).

Currently, **49** COCONet stations are configured to deliver high-rate, low-latency (1 Hz, < 2 s) data streams in real-time to UNAVCO via the Networked Transport of RTCM via Internet Protocol (NTRIP). This number has been reduced from last quarter to remove some stations with poorly performing data communications, which were deemed unable to support real-time data streaming. The remaining 49 real-time stations, however, greatly exceeds project goals, as outlined in the original proposal, which called for at least 10 stations to deliver high-rate, low-latency data in real-time.

Other Publications

Patents

Technologies or Techniques

Thesis/Dissertations

Websites

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

UNAVCO Main Website

<http://www.unavco.org>

UNAVCO, Inc. main website. All reports, personnel, data, status, etc. are provided to the public through this website. Also included are Science and Technical Snapshots and links to other major projects including COCONet and TLALOCNet.

Participants/Organizations

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Miller, Meghan	PD/PI	0
Feaux, Karl	Co PD/PI	2
Mattioli, Glen	Co PD/PI	2
Wang, Guoquan	Co PD/PI	0

Full details of individuals who have worked on the project:

Meghan Miller

Email: [Meghan@unavco.org](mailto: Meghan@unavco.org)

Most Senior Project Role: PD/PI

Nearest Person Month Worked: 0

Contribution to the Project: UNAVCO, Inc. President. Directly supervises the Director of Geodetic Infrastructure, Co-PI Mattioli, who is acting as the COCONet Project Director.

Funding Support: GAGE Facility Cooperative Agreement with NSF.

International Collaboration: No

International Travel: No

Karl F Feaux

Email: [feaux@unavco.org](mailto: feaux@unavco.org)

Most Senior Project Role: Co PD/PI

Nearest Person Month Worked: 2

Contribution to the Project: Co-PI Feaux is responsible for network operations and oversight. He prepares quarterly reports for review by GI Director and Co-PI Mattioli to review. He chaired the COCONet 4th workshop organizing committee.

Funding Support: This award and the GAGE Facility Cooperative Agreement with NSF.

International Collaboration: No

International Travel: Yes, Colombia - 0 years, 0 months, 7 days; Costa Rica - 0 years, 0 months, 5 days; Dominican

Republic - 0 years, 0 months, 5 days

Glen S Mattioli

Email: gmattioli@uta.edu

Most Senior Project Role: Co PD/PI

Nearest Person Month Worked: 2

Contribution to the Project: Director of Geodetic Infrastructure and Project Director for COCONet. Reviewed and edited original proposal. Reviews, edits, and amends all quarterly and annual reports. He directly supervises Co-PI Feaux and reports directly to PI Miller, President of UNAVCO, Inc. He co-wrote the COCONet 4th workshop proposal and final report to NSF.

Funding Support: This award and the GAGE Facility Cooperative Agreement with NSF.

International Collaboration: No

International Travel: Yes, Dominican Republic - 0 years, 0 months, 5 days

Guoquan Wang

Email: gwang@uh.edu

Most Senior Project Role: Co PD/PI

Nearest Person Month Worked: 0

Contribution to the Project: Co-PI on original proposal to NSF. Reviewed text of proposal and also reviews quarterly reports.

Funding Support: Other University of Houston and NSF awards.

International Collaboration: No

International Travel: No

What other organizations have been involved as partners?

Nothing to report.

What other collaborators or contacts have been involved?

UNAVCO, Inc. manages the construction and operations/maintenance of the COCONet network. However, a number of key partner organizations have advised the project and/or assisted with the construction and maintenance of the COCONet stations, including:

University of Puerto Rico Mayagüez

Grupo de Óptica Atmosférica de Camagüey (GOAC)

Universidad Nacional Pedro Henriquez Ureña (UNPHU)

University of Wisconsin - Madison

Caribbean Institute for Meteorology and Hydrology

Georgia Institute of Technology

Antigua & Barbuda Meteorological Services

Global Mtrix Engineering Puerto Rico - Dominican Republic

Institute of Meteorology, Havana Cuba

University at Albany

Universidad Nacional de Colombia

Caribbean Institute for Meteorology and Hydrology (CIMH)

Universidad Nacional de Colombia

Universidad Nacional Autónoma de México

Universidade do Estado do Amazonas

Ecole Normale Supérieure

University of California, Santa Cruz

Meteorological Department, Curaçao

Observatorio Sismológico Politécnico Loyola

Centre National de l'Information Géo-Spatiale (CNIGS)

Oficina Nacional de Meteorología (ONAMET)

Global Geodetic Observing System, University of Texas at Austin

Instituto Sismológico Universitario (ISU-UASD)

University of the West Indies, Mona

Servicio Geologico Colombiano

Government of Anguilla

Seismic Research Centre, University of the West Indies

Department of Meteorology Aruba

Instituto Hondureño de Ciencias de la Tierra/UNAH

Merramientas Operacionales, Cuba

Simon Bolivar University

University of South Florida

La Fundación Venezolana de Investigaciones Sismológicas (Funvisis)

The International Research Institute for Climate and Society

Jurisdiccion Inmobiliaria

Purdue University

Universidad Politécnica de Ingeniería (UPI)

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, which was selected for funding with a start date of September 1, 2013. The overall goal was 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 proposed new cGPS stations at locations of high scientific value in Mexico and adjacent islands, in parallel with the upgrade of existing cGPS stations previously established by NSF-funded collaborations. The resulting 25 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). This \$2.14M 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?

See discussion above related to COCONet Science Fellows and training for RDC operators.

What is the impact on physical resources that form infrastructure?

See discussion related cGPS/Met station installation, operations, and maintenance.

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 continues to develop capacity with its circum-Caribbean partners for the installation and maintenance of cGPS/Met infrastructure.

What is the impact on society beyond science and technology?

In FY2016, the COCONet project continued to build a sense of community through workshops, working groups, free and open data access, COCONet social media and website, and the COCONet Science Fellowship program.

Changes/Problems

Changes in approach and reason for change

Nothing to report.

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

Support for Continued Operations and Maintenance: We currently estimate that approximately \$119K will remain at the end of August 2016. With these residual funds along with limited bridge funding allocated for COCONet for next year as Supplemental Funding of \$94K to the GAGE Facility Cooperative Agreement (YR4), there is a risk that some COCONet stations will have reduced support for operations and maintenance in FY2017. The funding and therefore O&M outlook for FY2018 also remains highly uncertain. **Risk mitigation:** Continue to closely monitor project expenses and reduce costs to support only a bare bones maintenance and operations program moving forward. Also, work with our partners in the Caribbean who can be relied upon to perform some of the station maintenance activities.

Changes that have a significant impact on expenditures

Proposed Changes in Objective or Scope

The following revised budget justification and impact statement was part of a change order approved by the NSF in March, 2013. In FY2016, with the completion of PASI workshops, regional data centers, COCONet Fellowships, and the Fourth Community workshop, the COCONet project has completed all of the goals outlined in the revised budget justification.

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.

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.

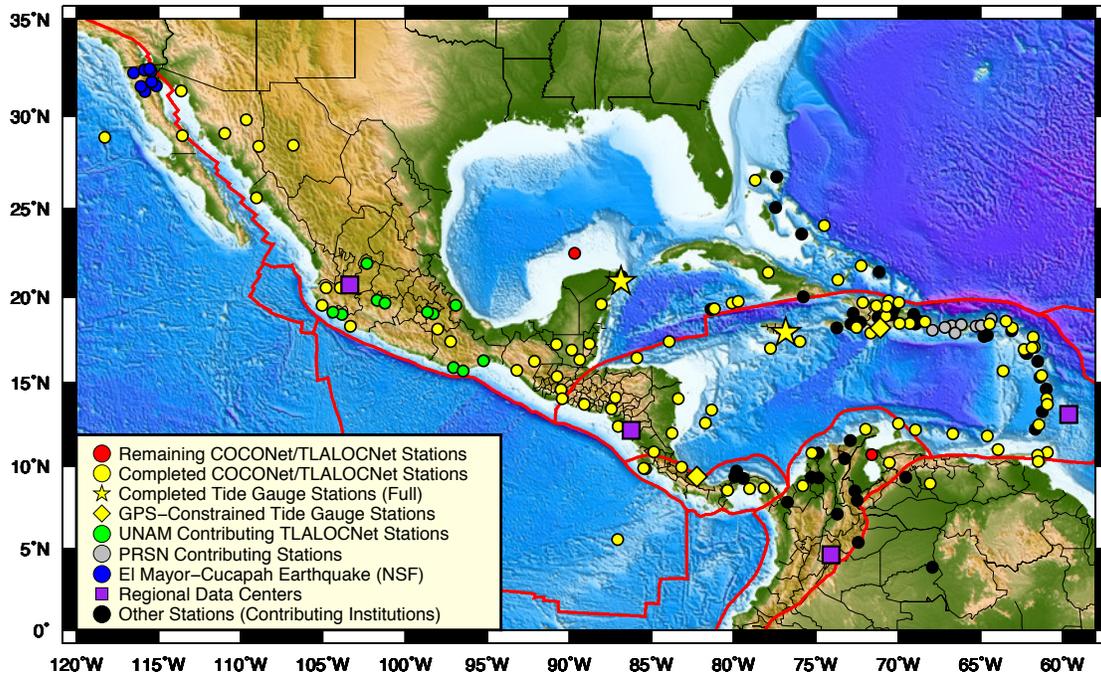


Figure 1. The current combined COCONet and TLALOCNet siting plan as of August 25, 2016.



Figure 2. Participants from the 4thCOCONet Community Workshop held in the Dominican Republic, May 3-5, 2016.



Figure 3. Installation of cGPS-Met station CN44 at Parque Nacional La Sierra-Cerro Copey, Isla de Margarita, Venezuela, with Ricardo Jose López Rubio, Carlos Reinoza Gómez, and Dr. Franck Audemard (Photo courtesy of FUNVISIS).



Figure 4. COCONet Fellows from Haiti, Steeve Symithe and Roby Douilly, at Purdue University commencement, where their doctoral degrees in Geophysics and Seismology were recently conferred. Also pictured (center) is Prof. A. Freed, who acted as their local mentor after their PhD advisor, Prof. E. Calais, left Purdue, first for a position at the UN, and then for a new faculty position in Paris, France.



Figure 5. UNAVCO software engineer S. Wier conducting Dataworks training on the 3rd afternoon of the 4th COCONet Community Workshop.