COCONet EAR 1042906/9 Quarterly Report

March 2014 - May 2014 (FY2014-Q3)

SUMMARY

This quarterly report covers COCONet project (EAR-1042906/EAR-1042909) activities for the time period from March 1, 2014 to May 30, 2014. 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. Dr. Glen Mattioli is acting as Project Director in his role as Director of Geodetic Infrastructure at UNAVCO and Dr. John Braun is the UCAR PI.

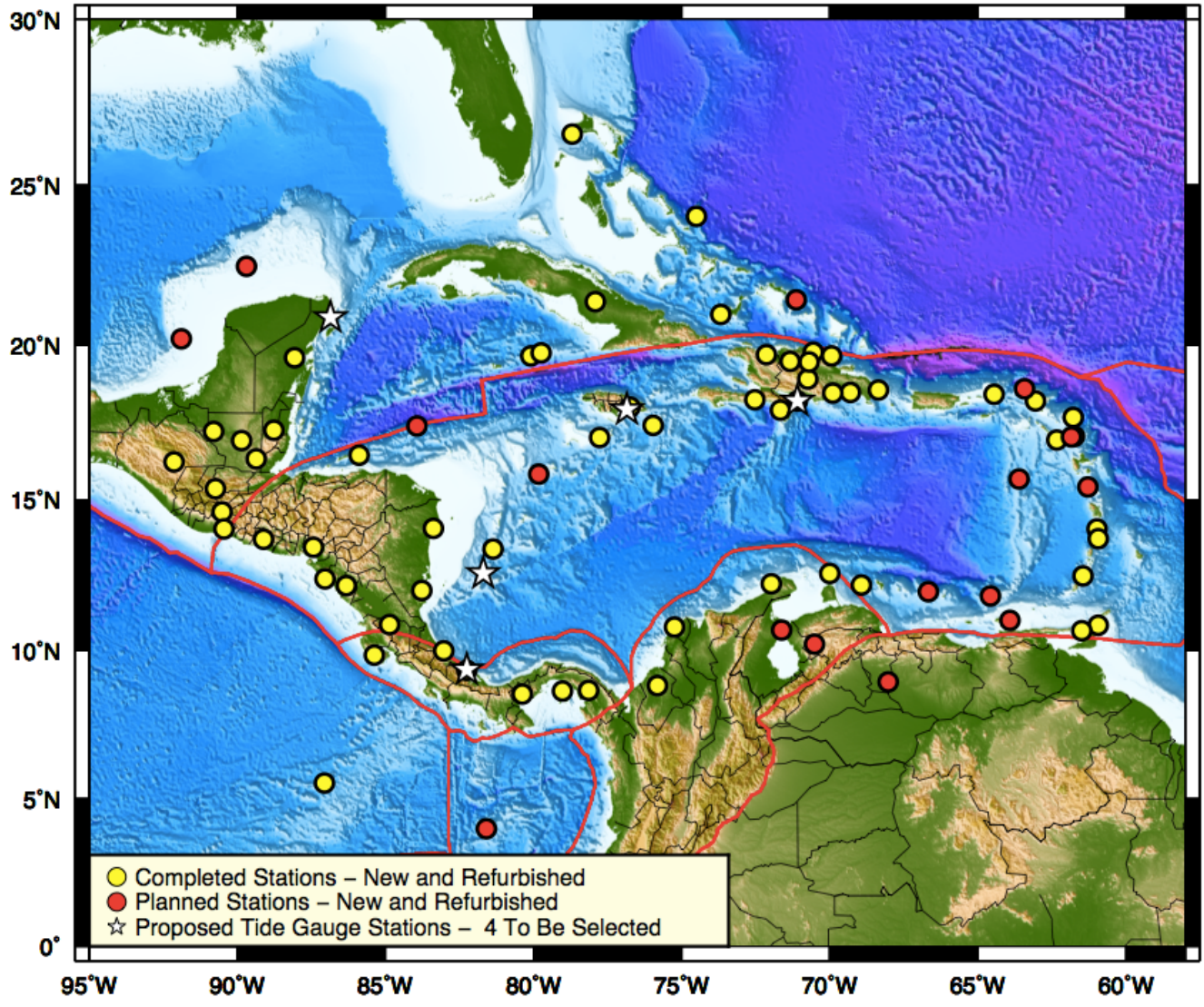

Figure 1. The current COCONet siting plan. Yellow dots represent the 60 completed COCONet stations (new and refurbished) and red dots represent the 17 remaining planned stations (new and refurbished). The white stars represent the proposed tide gauge locations (with 2 additional GPS sites per location). The existing "contributing" GPS stations (n=61+), which either already or are soon to be delivering data to the COCONet archive, are not shown in this map.

To date, UNAVCO engineering personnel have performed site reconnaissance at 79 locations in 26 countries, submitted land use permits for 75 sites, received permits for 73 sites, and currently have 60 stations installed (Figure 1, yellow dots).

Key accomplishments in the last quarter were the installation of the COCONet station in Camaguey, Cuba (See Field Highlight below) and the purchase of equipment related to the tide gauge stations (See Tide Gauge Station Update). The GPS-Met station installation in Cuba is a significant development not only for the COCONet project, but also in terms of scientific collaboration between the US and Cuba in general (see for example the recent editorial in *Science*, published on the 6th of June 2014 (VOL 344 Issue 6188 p.1065)). The purchase of hardware for the tide gauge stations will allow engineers to test these systems in-house before deployment in Mexico and Jamaica in late FY2014 and early FY2015. In April, the COCONet Working Group, led by Dr. John Braun, held a teleconference in which a number of important siting decisions were made (See Working Group Meeting Update).

Working Group Meeting Update

On April 1, 2014, UCAR PI and COCONet Working Group chair, Dr. John Braun led a teleconference for the COCONet Working Group. Other meeting attendees were Andrea Sealy, Omar Perez, Glen Mattioli, Jim Normandeau, Karl Feaux, and Linda Rowan. A number of operational updates were discussed and the group approved the following changes to the siting plan:

- The new Guatemala station will be removed from the plan. In its place, COCONet will provide meteorological instruments at six existing stations, and obtain free and open access to all stations in the Guatemalan cGPS network.
- New station at Sombrero Island was added.
- Two new stations in the Gulf of Mexico (Islands owned by Mexico) were added.

The updated siting plan now calls for 53 new stations, 24 refurbished stations, two new tide gauge installations and the installation of GPS instruments at two existing tide gauge stations in the region. Data from at least 61 existing stations will also be included in the COCONet data flow system.

Field Highlight: Cuba Installation

In collaboration with the Grupo de Óptica Atmosférica de Camagüey, Jim Normandeau (UNAVCO) and PI Dr. John Braun (UCAR) traveled to Camaguey, Cuba to install COCONet station CN16. This historic scientific instrument installation was seven years in the making; a process that began in December 2007 when Dr. Richard Anthes (UCAR) first visited Cuba and began discussions with officials from the Cuban Meteorological Institute (INSMET) about installing a ground-based GPS receiver at their institution in Camagüey. In 2011, the COCONet Siting Committee made a commitment to provide instrumentation for a cGPS-Met station in Camagüey, assuming all appropriate official government approvals could be

obtained. In 2012, Dr. Alan Robock, part of an AAAS delegation visit to Havana to enhance scientific cooperation, met with Dr. Fidel Castro Diaz-Balart urging the approval of the GPS installation in Camagüey. A number of bureaucratic hurdles had to be overcome, including convincing the Cuban military that the proposed new cGPS station posed no security threat, receiving a Cuban GPS import license (granted in October 2012), and receiving an export license from the US Department of Commerce (granted in April 2013). Before shipping the equipment, one final approval was required by the Cuban Customs Department. The GPS and surface meteorological instruments and ancillary equipment eventually arrived in Havana and cleared customs in April 2014.

Using photographs from other COCONet installations, our Cuban partners immediately began the work of installing the station hardware. When COCONet team arrived, the station was already 95% built, which allowed more time for training, discussions about future collaborations, and other outreach activities. Data from the cGPS-Met station will be uploaded hourly to the UNAVCO archive.

Figure 2. René Estevan Arredondo, Juan Carlos Antuna Sanchez and Nelson Díaz Spencer finalize the installation of the GPS antenna in Camagüey, Cuba.

OPERATIONS SUMMARY

A number of planning, operational, and logistical tasks were completed during the last quarter including:

New stations installed:

- Carriacou, Grenada – CN46
- Honduras – CN21
- Cuba – CN16
- Changed designation of TTUW from refurbished to new station

Stations refurbished or upgraded:

- UNAVCO Engineer Ellie Boyce traveled to Guatemala to train local collaborators on installation techniques for the Vaisala meteorological instruments. These instruments will be collocated at six existing stations (GUAT, TAXI, CHIS, ELEN, NARA, POPT) within the Guatemalan IGN network. The installation of an automated data flow for the stations is currently in-progress. Data are currently available on the IGN ftp server.
- Two cGPS-Met stations in the Cayman Islands were upgraded with Vaisala meteorological instruments.

Maintenance trips:

- UNAVCO Engineer Kory Dausz visited stations CN29 and CN30 in Honduras to troubleshoot interference issues, repair communications links and to replace a faulty receiver. Both stations are online and in good health.
- UNAVCO engineer, John Sandru, traveled to the Dominican Republic to repair CN06, CN08 and CN27. New cellular modems were installed at each site and the stations are currently online. John also visited 3 stations (LVEG, SROD and BARA) to replace non-operational meteorological instruments, which had been removed by the local collaborators.
- The COCONet station on Roatan Island, Honduras was visited for general troubleshooting (station was offline) and to formalize the MOU with the Airport Authority. A cellular modem was installed which provided data communications for the station.

Work planned for FY2014-Q4 includes:

- Honduras – Installation on Swan Island, maintenance trip to ROA1 and CN21
- Venezuela – Begin installation of 6 cGPS stations
- Sombrero Island, Anguilla – Installation of new cGPS-Met station
- Aruba – Maintenance trip to repair cellular connection
- Antigua – Installation of CN01 and upgrade of BGGY station
- Mexico – Recon for two new cGPS sites in the Gulf of Mexico
- Dominica – Installation of CN48

Additional details related to COCONet field activities this quarter may be found in Table 1 below.

	Cumulative	Since Previous Quarter	Details From Current Quarter
Station Recons	79	9	Remaining: (6) two Gulf of Mexico stations, plus two tide gauge locations (two GPS at each tide station)
Permits Submitted	75	5	
Permits Accepted	73	6	
Stations Installed New / Refurbished	41 new 19 refurbished	4 new 7 refurbished	New: CN46 (Carriacou), CN16 (Cuba) CN21(Honduras), TTUW (Trinidad) Refurbished: 6 Guatemala stations (GUAT, TAXI, CHIS, ELEN, NARA, POPT), 2 Cayman Island stations
Maintenance Visits	33	9	Nine stations visited in the Dominican Republic and Honduras.

Table 1. COCONet Status: Tasks completed to date and in FY2014-Q3.

TIDE GAUGE NETWORK

UNAVCO began in-house testing and system integration of Sutron Inc. tide gauge instrumentation, including a radar water level recorder and pressure sensor backup. Arrangements for GOES 5-minute satellite telemetry for the tide data have been coordinated with NOAA and host institutions.

In May 2013, a UNAVCO engineer made a reconnaissance trip to a proposed site at Puerto Morelos, Mexico operated by Ciencias del Mar (UNAM). This site was ideal for both logistical, support and pre-existing facilities. UNAVCO has established Enrique Cabral as the main point of contact between UNAVCO and the Tide Gauge Institute at Geophysica-UNAM (headed by Jorge Zavala) and is developing the required MOU for the installation and continued operations and maintenance. UNAVCO intends to install this site in late-Summer 2014. In April 2014, a site reconnaissance was completed for Port Royal, Jamaica. An MOU and statement of work has been submitted to Jamaica Meteorological Services for review. The Jamaican Meteorological Services would provide customs and installation assistance, long-term tide gauge maintenance as well as land-use permission with the Jamaican Coast Guard. Lastly, a reconnaissance visit was completed for the upgrade station at Barahona, Dominican Republic. Arrangements for this GPS installation at the existing, functioning tide gauge are ongoing in coordination with the Dominican Republic Meteorological Office (ONAMET).

Additional reconnaissance trips are scheduled for Puerto Morelos, Mexico and Kingston, Jamaica. In-country organizations have agreed to provide installation assistance and long-term support at both locations. Additional discussions are ongoing regarding the final location of the two additional upgrade stations.

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. After a number of changes approved by the COCONet Siting Committee and COCONet Working Group (see http://coconet.unavco.org/project-management/project-management.html), the current siting plan calls for 53 new stations, 24 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 archives 102 cGPS stations, which are designated as COCONet stations. The stations are new, refurbished or contributing stations from other networks. During this reporting period, 86% of the stations delivered data to the archive. Additionally, there are currently 31 COCONet stations delivering high-rate, low-latency (1 Hz, < 2 s) data streams in real-time via the Networked Transport of RTCM via Internet Protocol (NTRIP). This exceeds a project goal outlined in the project proposal. Note: The number (31) is less than the number reported for the last quarter. There were a number of stations configured to stream high rate data that had not yet delivered data. The new number reflects the number of stations actually producing high rate data streams.

BUDGET AND SCHEDULE

While the project has been running slightly behind the schedule for station installations (based on the August 2012 rebaseline), the original installation goal of COCONet (50 new stations) has been met (Figure 3). In addition, the project is also close to completing the goal of 50 new and 15 refurbished (from the Trindad Siting Plan). In FY2014-Q3, significant progress was made in station installations, with 11 new and refurbished installations completed as well as progress in tide gauge station reconnaissance, logistics and planning. The projection for the next quarter is to install or upgrade at least 6 new/refurbished stations. The current construction estimate for the end of FY2014 will be 66 new/refurbished stations, including 1 tide gauge station in Puerto Morelos, Mexico.

Including open commitments, the COCONet expenditures are now over $4.3M through the end of April 2014, giving the project a slight budget under run to date. The cost variance (8.8%) is consistent with the schedule variance. With most of the site permits obtained, the riskiest part of the construction project is now coming to an end. Remaining station installations are expected to continue into FY2015, but by then, COCONet management will be able to focus on Venezuela, including Aves Island, along with the tide gauge installations.

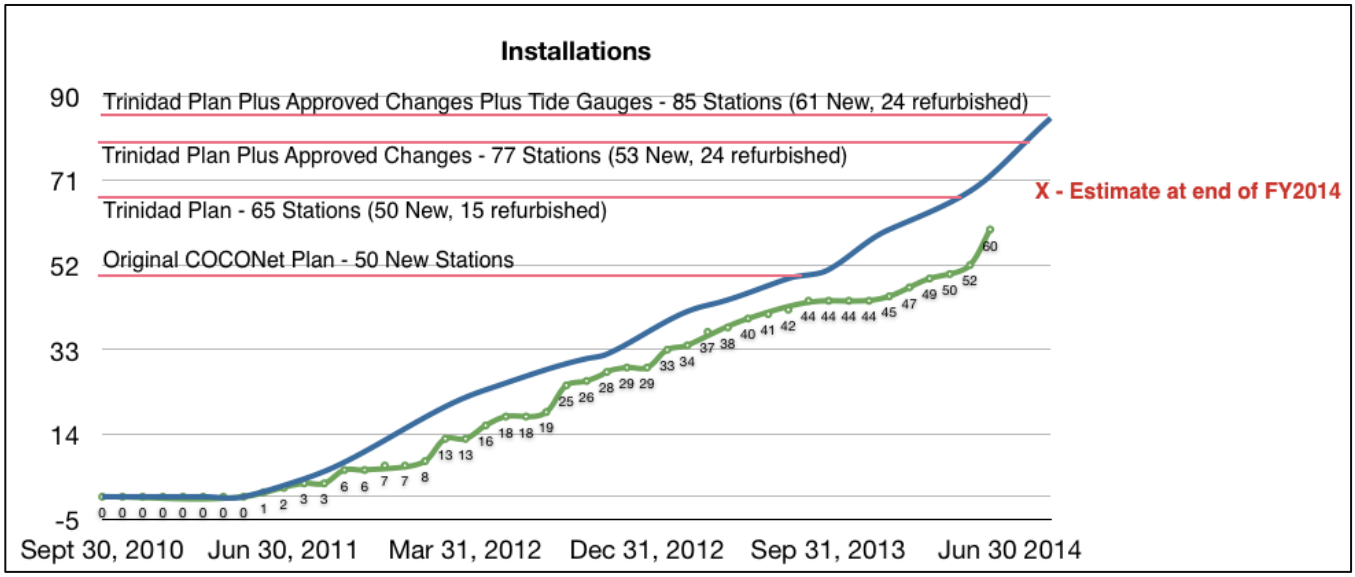

Figure 3. COCONet Installations: Plan (blue line) vs. Actual (green line).

EDUCATION, OUTREACH, 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.

COCONet Fellowships

The COCONet project will provide a second year of funding to the five students who were awarded the COCONet Graduate Fellowships in 2013. In addition, the project will fund a second round of graduate research fellowships starting in August or September of 2014. The new COCONet Graduate Fellowships will provide two individual awards between $5,000 and $10,000 per year for a maximum of 2 years to support solid Earth or atmospheric science graduate research projects conducted at a U.S. institution of higher education. The research projects must be within the COCONet footprint or directly use data from the COCONet GPS stations and/or meteorological sensors.

Regional Data Centers

UNAVCO Contracts staff worked to finalize the formal agreements between UNAVCO and each of the Regional and Regional Mirror Data Centers (SGC in Colombia, and CIMH in Barbados and INETER in Nicaragua) and to finalize the statements of work and budgets related to the data center. The agreements were signed by SGC and are ready to be signed by the other parties. The purchase of the computer server hardware has been delayed until the agreements are signed. In the meantime, progress continues on software components that will make up the data centers. In addition, to test the various components of the Regional Mirror Data Centers software without the intended hardware in-house, UNAVCO has proceeded with configuring a virtual machine (VM). This VM has been provisioned with the Linux operating system and systems software including web server, web application server, ftp server, Java, Perl, Python, and MySQL, plus the GSAC database, GSAC software, and synchronization scripts required. The configuration and testing of the components is ongoing.

UNAVCO staff participated in a GSAC Workshop hosted by the University of Beira Interior, Covilha, Portugal, and attended by the eight European Data Centers utilizing the GSAC system as well as representatives from other European Data Centers contemplating using GSAC. The viewpoints of the participants, especially with regard to data access and useful metadata elements, were relevant to the COCONet Regional Data Centers since GSAC is a primary software component included in the COCONet RDC/RM package.

Meetings and Conferences

Ninth 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 May 13-15, 2014 in St Thomas, USVI. Karl gave a brief presentation, which introduced the participants to UNAVCO, the Plate Boundary Observatory, and provided an update on the COCONet and TLALOCNet projects. Co-PI Feaux also promoted the Fellowship opportunities available within COCONet. The primary interest of the participants at this meeting was related to the COCONet siting plan for the planned tide gauge installations. Karl provided clarification to the group about the plan and proposed locations for the tide gauge instruments within the COCONet footprint.

UNAVCO Science Workshop 2014

Two of the COCONet fellows (Ophelia George – University of South Florida, Esteban Chavez – University of California, Santa Cruz) attended the UNAVCO Science Workshop in March of 2014. COCONet management also invited two Venezuelan students (Yuleika Madriz, Simon Bolivar University and Ricardo Lopez, FUNVISIS) to attend the workshop. Attendance at this workshop allowed the students to interact with a broad range of researchers and provided an opportunity to share their research progress.

Dr. Sarah Stamps presented a talk at the *UNAVCO Science Workshop 2014* on her community engagement, outreach efforts, and deeply personal experiences related to the human impacts of the devastating January 12, 2010, Mw 7.0 earthquake (Stamps et al., 2014).

EGU General Assembly 2014

Dr. Glen Mattioli presented a talk (Mattioli et al., 2014) outlining the scope and science objectives of COCONet and the research results of Dr. Jamie Miller, a recent Ph.D. graduate from the Department of Earth and Environmental Sciences at the University of Texas at Arlington (Miller, 2014). Dr. Miller's dissertation included new campaign GPS observations from 2012 and 2013 on Dominica and new GPS observations made in concert with PSU Ph.D. candidate and COCONet Science Fellow, Mr. Halldor Geirsson and UNAVCO staff in 2013 and 2014 in Nicaragua. The principal conclusion of one of the chapters in Dr. Miller's dissertation was the clear demonstration (>99% confidence) that the Caribbean plate was comprised of two major blocks, with likely deformation between the *western* and *eastern* blocks being taken up either along the Hess Escarpment (~2-3 mm/yr) or the Beata Ridge (~1 mm/yr). This

conclusion was supported by the analysis of new COCONet cGPS data and ties to campaign GPS measurements that PI Mattioli and his students and colleagues have being making since the late 1990's in Central America and the Eastern Caribbean. This new kinematic model for the Caribbean is at variance with previous models that have concluded that there is only a single Caribbean plate (*e.g.* DeMets et al., 2000, GRL; DeMets et al., 2007, GSA Special Paper).

UCAR UPDATE

The UCAR/COSMIC program is participating in COCONet under support from NSF grant (EAR-1042909). UCAR/COSMIC produces continuous estimates of atmospheric precipitable water vapor (PW) using a heterogeneous network of GNSS stations, including those stations that are part of COCONet. These data are produced and distributed through the Suominet (www.suominet.ucar.edu) web portal as well as with the local data management (LDM) system. As of May 30, 2014, UCAR/COSMIC is attempting to analyze data in real-time from more than 70 stations within the COCONet domain. Typically, data are available for real-time analysis from approximately half of these stations. UCAR/COSMIC is also collaborating with researchers (Yolande Serra from the University of Arizona and Dave Adams from the Universidad Nacional Autónoma de México (UNAM)) on the analysis of GPS data collected from a field project in 2013 to observe the North American Monsoon in Northern Mexico (Adams et al., 2014). UCAR/COSMIC is providing GPS derived PW from ten stations deployed from June through October 2013 to support the research of monsoon related precipitation in the region.

UCAR/COSMIC continues to pursue a mechanism to deliver COCONet data to the Global Telecommunications System (GTS). An open ticket within the National Weather Service (NWS) Telecommunications Operations Center (TOC) has been created to push COCONet surface observations from the WXT-520 surface meteorology instruments onto the GTS in XML format. Currently, we are waiting for final approval from the NOAA network operations (Net/Ops) group to exchange computer key information and begin testing of data transmission to the NWS. We expect that this task will be finished the next month month and be operational for the majority of the upcoming hurricane season.

As an example of how COCONet data products are now starting to be used within the broader research community, Dr. Ana-Maria Duran-Quesada from the University of Costa Rica has provided an update on a collaboration with UCAR to understand sources of precipitation in the region. Dr. Duran-Quesada has used precipitation data from Cocos Island to compute the diurnal cycle of precipitation on the island and compute a climatology of moisture sources for the island and relate those sources to ocean salinity measurements. These results are now being compiled into a manuscript with an emphasis on how COCONet data products might be used more broadly in Costa Rica.

COCONET-RELATED PUBLICATIONS (FY14Q3 ONLY)

Adams, Dave, K., C. Minjarez, Y. Serra, A. Quintanar, L. Alatorre, A. Granados, E. Vazquez, **J. Braun**, 2014, Mexican GPS Tracks Convection from North American Monsoon, EOS Trans. AGU, DOI:10.1002/2014EO070001.

^Elsworth, D, R. Foroozan, J. Taron, **G.S. Mattioli**, and Barry Voight, 2014, Geodetic Imaging of Magma Migration at Soufrière Hills Volcano 1995-2008, *Chapter 12: The Eruption of Soufiere Hills Volcano, 15 years on*, (G. Wadge, ed.), Geological Society, London, Memoirs 2014, v.39; p219-227, doi: 10.1144/M39.12.

***Mattioli, G.S.**, J. Miller, C. DeMets, and P. Jansma, 2014, Rigidity and definition of Caribbean plate motion from COCONet and campaign GPS observations, EGU General Assembly 2014 (14546): GD6.6/GMPV25/TS7.12, Vienna, Austria, April 2014.

^Odbert, H.M., G.A. Ryan, **G.S. Mattioli**, S. Hautmann, J. Gottsmann, N. Fournier, R. Herd, and A. Linde, 2014, Volcano geodesy at Soufrière Hills Volcano: a review, *Chapter 11: The Eruption of Soufiere Hills Volcano, 15 years on*, (G. Wadge, ed.), Geological Society, London, Memoirs 2014, v.39; p195-217, doi: 10.1144/M39.11.

Stamps, D.S., D.J. Charlevoix, E. Calais, A. Freed, E. Chaussard, and **G.S. Mattioli**, 2014, Education and Community Engagement in Response to the 2010 Haiti Earthquake from a Young Investigator's Perspective, 2014 UNAVCO Science Workshop, Broomfield, CO, March 4-6, 2014.

---

*Travel to EGU meeting directly supported by COCONet award
^Uses data from cGPS sites that are now supported in part by COCONet award
COCONet PIs shown in **bold**

PROJECT CONCERNS

Project control: Much of the remaining work, especially in the West Indies and Venezuela relies heavily on local collaborators. **Risk mitigation**: With other components of the project now winding down, COCONet management and field engineering staff will focus on these stations in the next quarter.