

COCONet EAR 1042906/9 Quarterly Report

March 2016 - May 2016 (PY2016-Q3)

SUMMARY

This quarterly report covers COCONet project (EAR-1042906/EAR-1042909) activities for the time period from December 1, 2015 to May 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. 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. This project is currently in a grantee-approved No Cost Extension (NCE) through August 31, 2016.

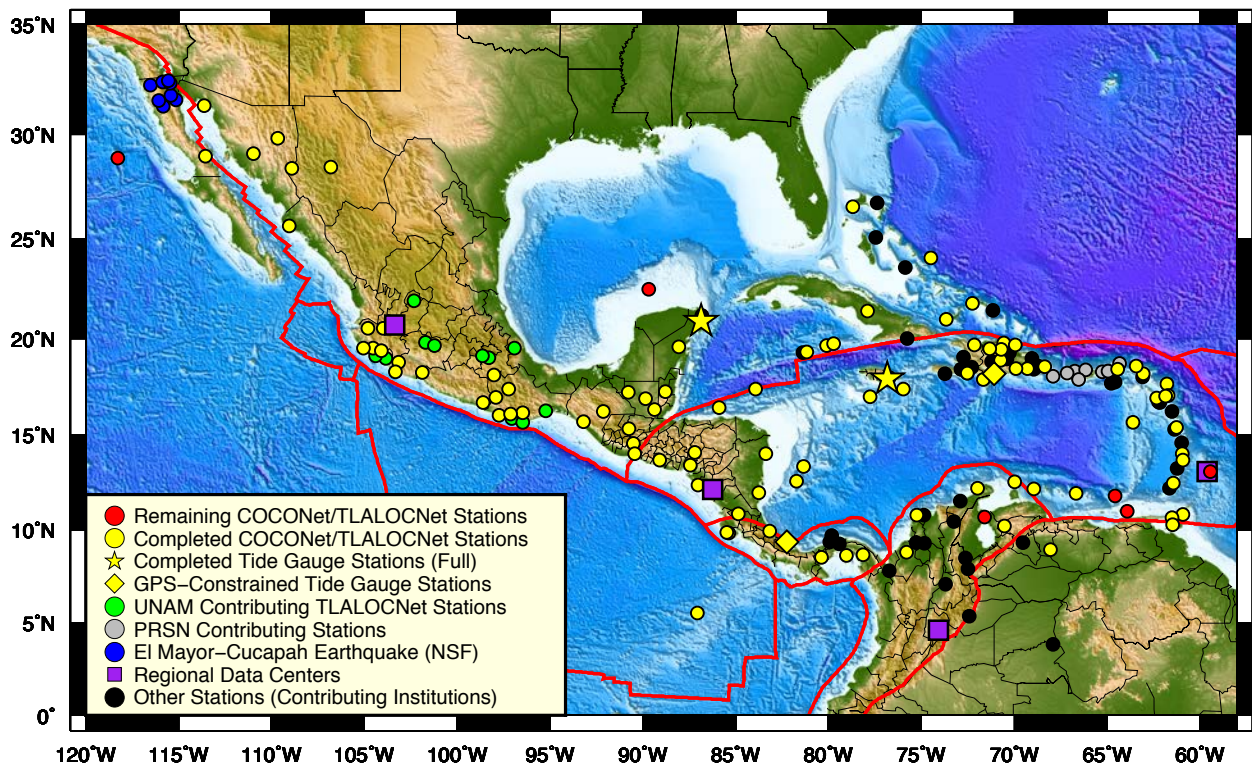


Figure 1. The current combined COCONet and TLALOCNet siting plan. Yellow dots represent the 81 completed COCONet stations (new and refurbished) and 23 completed stations from the TLALOCNet network. Red dots represent the 5 remaining, planned COCONet stations (new and refurbished), and 1 planned TLALOCNet station. The yellow stars represent the completed, full-tide gauge locations (with 2 additional GPS sites per location). The yellow diamonds represent existing tide gauge stations where 1 GPS station was added to constrain the motion of the pier. The existing “contributing” GPS stations ($n=55$), which either already are or soon to be delivering data to the COCONet archive, are shown as black dots. Contributing stations from the Puerto Rico Seismic Network are shown in gray ($n=8$). The four regional data centers or mirrors are shown as purple squares (Mexico - TLALOCNet, and Nicaragua, Colombia, and Barbados - COCONet).

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.

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

- 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
 - a. Cellular modem was updated.
 - b. GPS antenna LNA swapped (preventative maintenance).
 2. CN29
 - a. Installed LS300 cell modem.
 - b. Co-located with INETER seismometer.
 3. CN30
 - a. Installed LS300 cell modem.
 - b. Station co-located with INETER seismometer.
 - c. Installed new met station.
 - d. 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)
 - a. TECF: Installed new GPS receiver.
 - b. TELN: Installed new GPS receiver.
 - c. JCFI: Installed new GPS receiver.
 - d. POLS: Installed new GPS receiver.
 - e. POLI: Installed LS300 modem.
 - f. QUEN: Repaired station, now online (hit by lightning).
 - g. LEME: Installed new GPS receiver.
 - h. HERH: Installed new GPS receiver.
 - i. HOYN: Campaign site position occupied.
 - j. SALN: Campaign site position occupied.
 - k. CALV: Campaign site position occupied.
 6. RDMA
 - a. Added contributing station. Now archiving and processing data.

7. VRAI
 - a. Site visited by Dr. Marino Protti to fix data communications issues.
 8. RDON
 - a. Installation of GPS equipment to repair station that was hit by lightning.
 9. TEG2
 - a. UPI student visited to resolve data communications problems at the station.
 10. Haiti
 - a. CN09: Equipment currently in customs.
 - b. JME2: Equipment currently in customs.
- UNAVCO currently archives 144 COCONet-designated cGPS stations. 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 two distinct groupings of COCONet sites: 1) **COCONetCore (56)**, 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 (63)**, 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.
 - During this reporting period, 79.0% of all 144 stations delivered data to the DAI, including data from **96%** of the **COCONetCore** and **76%** of the **COCONetRefurb** stations.
 - Currently, **56** 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 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.
 - The COCONet Regional Data Centers at INETER (Nicaragua), CIMH (Barbados), and SGC (Colombia) continue operations using the Dataworks for GNSS software developed at UNAVCO in part with funding from COCONet (this award) as well as other sources.
 - The Regional Mirror Data Centers at INETER and CIMH are reporting 140 COCONet stations available for metadata queries and data downloads; this includes 6 inactive or retired stations.
 - The full Regional Data Center at SGC is reporting the same 140 COCONet stations plus 1 additional local station available for metadata queries and data downloads.
 - Including open commitments, the COCONet expenditures are now over \$5.84M through May 2016. A plan has been developed to spend the remaining funds, guided by oversight from COCONet Working Group, and focused on completing the remaining scope as per the award and supplements. In the last quarter, \$129.9K was spent with \$191K remaining in the award at the time of this submission.

COCONet field activities this quarter are summarized in Table 1 below.

	Cumulative	Since Previous Quarter	Details From Current Quarter
Station Recons	85 (removed two refurbished stations from the siting list in FY2016-Q3)	0	All recons completed, except for 1 Gulf of Mexico station. Removed CAYS and MALP from refurbished list, based on guidance from the Pls.
Stations Installed New/ Refurbished	56 new 25 refurbished	0	New: none Refurbished: none
Maintenance Visits	94	18	CN22, CN29, CN30, CN53, VRAI, RDON, TEG2, TECF, TELN, JCFI, POLS, POL1, QUEN, LEME, HERH, HOYN, SALN, CALV

Table 1. COCONet Status: Tasks completed to date and in FY2016-Q3.

Work planned for FY2016-Q4 includes:

- Haiti maintenance – installation of new equipment enclosures in July.
- Two remaining stations in Venezuela scheduled for installation in June/July.
- Mexico station installation CN17 scheduled for installation in September.

OUTREACH

Fourth COCONet Workshop in Dominican Republic

The fourth COCONet Workshop 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 (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. Significant progress on the workshop report has already been made by the workshop organizing committee. We anticipate that the workshop report will soon be completed within 2 months. 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.

Other photographs from the workshop are posted on UNAVCO's smugmug account, under [Meetings/2016-COCONet-Community](#).



Figure 2. Participants in the 2016 COCONet Community Workshop: Results, Sustainability & Capacity Building. 79 participants, 28 countries, more than 40 institutions, more than 100 observing sites. Punta Cana, Dominican Republic. (Photo/Beth Bartel)

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*

Recent Publications/Submissions

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

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

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, February 2016, DOI: [10.15517/rbt.v64i1.23411](https://doi.org/10.15517/rbt.v64i1.23411)

Plate boundary segmentation in the northeastern Caribbean from geodetic measurements and Neogene geological observations, E. Calais, S. Symithe, B. Mercier de Lepinay, C. Prepetit, *C.R. Geoscience*, 348 (2016) 42-51, DOI: [10.1016/j.crte.2015.10.007](https://doi.org/10.1016/j.crte.2015.10.007), available online in December 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.* (September, 2015) 202 (3): 1677-1689, DOI: [10.1093/gji/ggv244](https://doi.org/10.1093/gji/ggv244)

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 Fourth 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.
- Steve Symithe graduated from Purdue University with a doctoral degree in Geophysics and Seismology in April 2016 (Figure 3). He will return to Haiti as a new faculty member at the University of Haiti.



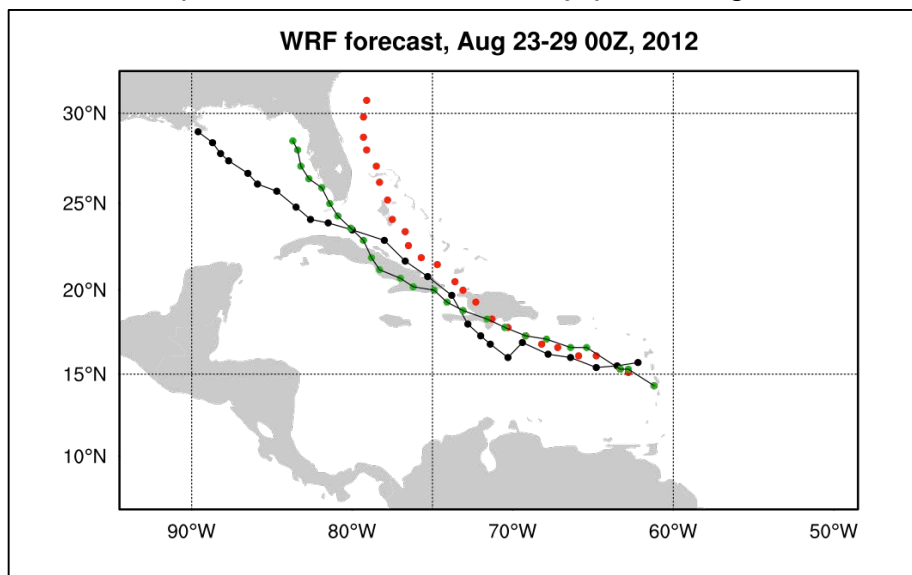
Figure 3. COCONet Fellows from Haiti, Steve Symithe and Roby Douilly, at Purdue University commencement, where their doctoral degrees in Geophysics and Seismology were recently conferred. Also pictured (center) is Prof. A. Freed, who acted as their local mentor after their PhD advisor, Prof. E. Calais, left Purdue, first for a position at the UN and then for a new faculty position in Paris, France.

- 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.

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.

UCAR continues to use Hurricane Isaac in 2012 as an illustrative case study examining the benefit of GPS PWV data to improve hurricane forecasts. Preliminary results from this activity were presented at the COCONet Workshop in early May 2016 in Punta Cana, Dominican Republic. The assimilation of GPS PWV data has made a significant positive impact on the track forecast of Isaac (2012). UCAR has successfully modified the Gridpoint Statistical Interpolation (GSI) data assimilation system, currently used operationally by the National Center for Environmental Prediction (NCEP) to ingest COCONet PWV products into the assimilation system. An updated figure to the presentation given in Punta Cana is shown below. The forecast improvement is obtained through the assimilation of PWV data as well as from the computation of a flow dependent error covariance that was used within the data assimilation process. UCAR is currently performing a detailed evaluation of the assimilation



run to quantify and explain how the PWV assimilation improved the forecast track.

Figure 4. The best track of Hurricane Isaac (2012) is shown in black. A WRF forecast without the use of GPS PWV is shown in red. The forecast after a 24-hour cycling data assimilation process is shown in green. Assimilation of the GPS PWV data show significant positive impact on the six-day storm track.

UCAR/COSMIC is also conducting an evaluation of the 15 hurricanes in the Atlantic Basin between 2010 and 2015 to quantitatively assess which storms were the most poorly forecast. An example of both good (Hurricane Rafael – 2012) and bad (Hurricane Joaquin – 2015) track forecasts from the GFS model are shown below.

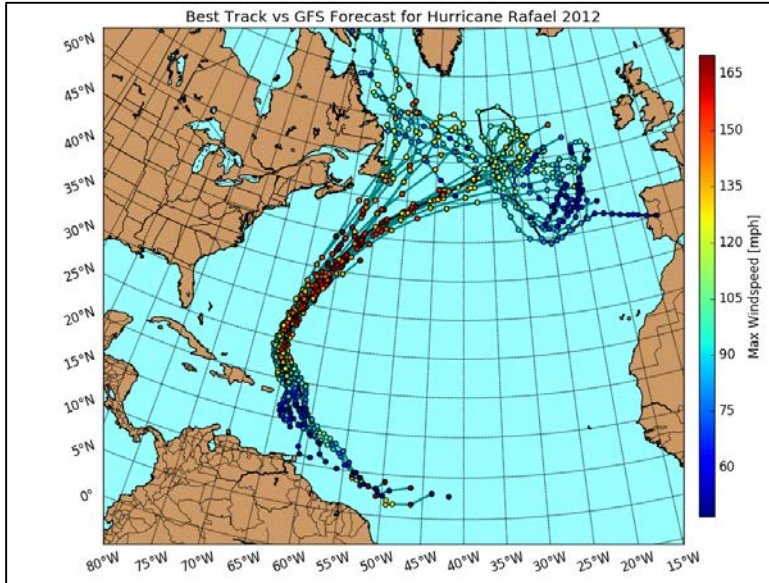


Figure 5. GFS track and windspeed forecasts for Hurricane Rafael (2012). The National Hurricane Center (NHC) best track estimate is also shown in black.

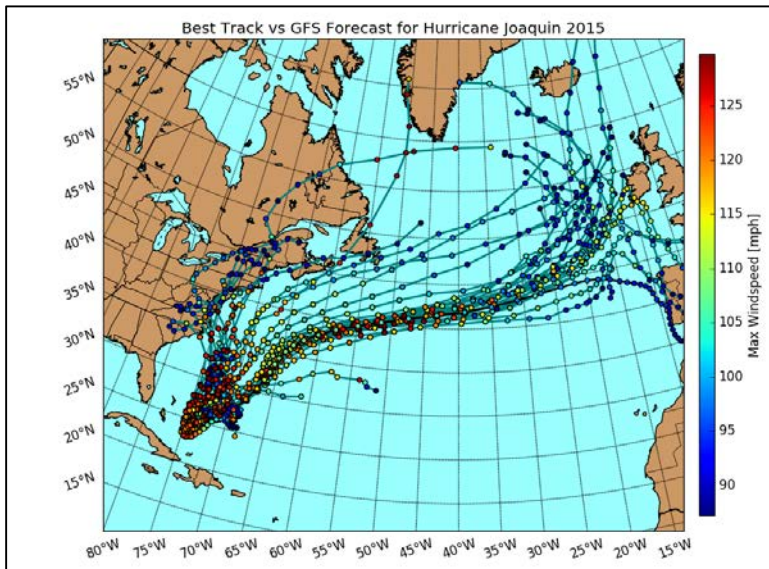


Figure 6. Similar to Figure 5, but for Hurricane Joaquin (2015).

PROJECT CONCERNS

Support for Continued Operations and Maintenance: We currently estimate that at that planned project completion date (the grantee-approved NCE ends on August 31, 2016), approximately \$100K will remain. 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 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.