COCONet EAR 1042906/9 Quarterly Report

September 2013 - November 2013 (FY2014-Q1)

SUMMARY

This quarterly report covers COCONet project (EAR-1042906/EAR-1042909) activities for the time period from September 1, 2013 to November 30, 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, 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.

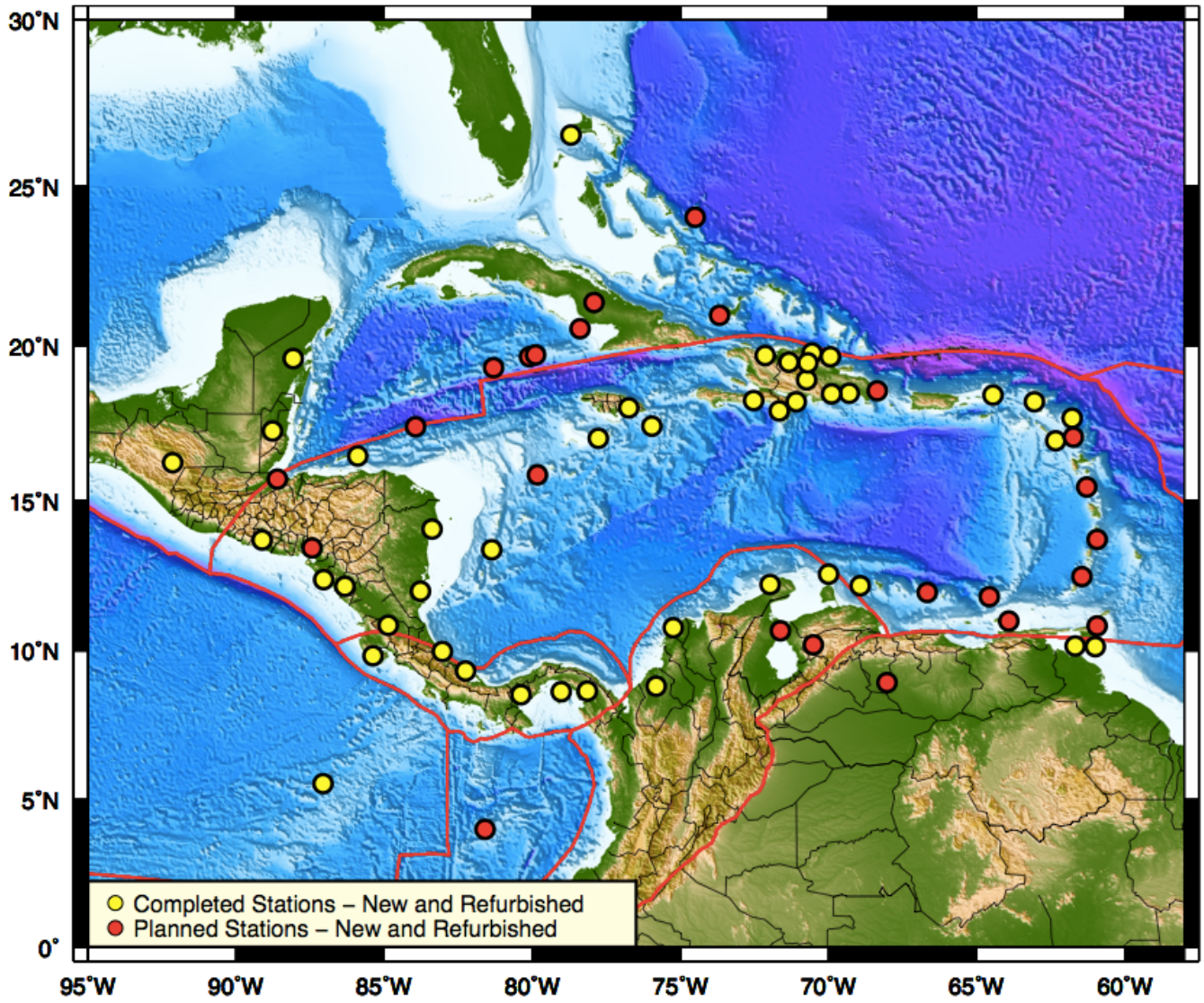

Figure 1. The current COCONet siting plan. Yellow dots represent the 44 completed COCONet stations (new and refurbished) and red dots represent the 24 planned stations (new and refurbished). The four refurbished REMOS stations in Venezuela have been removed. The existing stations (61+), which deliver data to the COCONet archive and the 8 additional cGPS stations (locations TBD) associated with the tide gauge installations are not shown in this map.

The September 2013 floods across the Front Range in Colorado impacted the COCONet project in a number of ways. Nearly all COCONet engineers and project managers were negatively affected, resulting in damage to their homes, which in several cases required relocation of their families. This event, combined with the reduction in force related to the reduced funding at the initiation of the GAGE Facility Cooperative Agreement and the partial government shutdown from October 1 through 17, caused most field operations at UNAVCO to be significantly reduced during the previous quarter.

Despite the fact that there were no new COCONet installations and field work was significantly reduced in the last three months, logistical, ongoing maintenance, and tide gauge network planning occurred. Also, UNAVCO completed the review of the applications and announced the initial COCONet regional data center and two regional data mirrors (See Education, Outreach, and Community Engagement). UNAVCO field engineers focused on maintenance activities in Mexico as well as permitting and logistics efforts for upcoming work in Cuba, Jamaica, Colombia, Venezuela, and St. Lucia.

One important development in FY14Q1 was the acknowledgement by our main Venezuelan partner at Simon Bolivar University that the institution was no longer interested in maintaining the 4 existing stations in Venezuela that they operated and which were scheduled for upgrades as part of COCONet. This development will not affect the installation schedule for the five new stations in Venezuela. The COCONet Working Group, however, will meet in the next quarter to decide where the resources for the planned four stations should be reallocated to meet COCONet science objectives.

To date, UNAVCO engineering personnel have performed site reconnaissance at 63 locations in 25 countries, submitted land use permits for 59 sites, received permits for 58 sites, and currently have 44 stations installed (Figure 1, yellow dots).

COCONET HIGHLIGHT: TIDE GAUGE PROGRESS

Progress on the additional scope for the tide gauge installations has been slow. Co-PI and Project Director Mattioli has now assigned this critical task to Mr. Tim Dittmann for his project management and oversight. Mr. Dittmann is the PBO Eastern Region Manager and recently completed the installation of the six Eastern PBO sites and the upgrades to the five PBO sites that comprise the PBO Multi-monument change order. Mr. Dave Mencin, PBO BSM Operations Manager, will remain on the COCONet tide gauge team to assist Mr. Dittmann.

UNAVCO staff have begun discussions with several experts in the field of GPS constrained tide gauges and sea-level monitoring, including Ms. Christa G. von Hillebrandt (NOAA), Dr. Giovanni Sella (NOAA), Dr. Kristine Larson (CU), Dr. Mark Merrifield (U of HI) and Mr. Doug Wilson (Caribbean Wind LLC). Through these discussions, UNAVCO has been able to develop specific designs for station engineering, including instrumentation and integration, and determine the needs and current assets of the complex sea-level monitoring community.

One type of instrumentation for accurate sea level monitoring is an acoustic radar sensor with a pressure sensor backup, all telemetered through GOES satellites. GOES is critical for the IOC (Sea Level Monitoring Facility) / Caribbean Tsunami warning systems and thus provides significant value-add at a relatively low cost. UNAVCO will also transmit/archive tide data through Boulder concurrent with the co-located GPS data stream. Three vendors of these instruments and loggers have been identified and UNAVCO intends to complete the purchasing process by the end of FY2014-Q2.

The ability to provide required maintenance is a critical factor in the success of a tide gauge network. For this reason, UNAVCO will consider reconnaissance at easily accessible locations for the new and/or upgraded tide gauge sites, including the Yucatan Peninsula in Mexico, Jamaica, Dominican Republic, Costa Rica, and Panama. The upgrades will consist of adding GPS (on-pier and on-land) to existing, functioning tide gauge stations. These locations will fill the need for the Caribbean tide gauge network, have excellent in-country contacts for long-term support, and will require lower travel costs. The COCONet Working Group will be consulted for approval of the station siting and construction plan as early as possible in 2014.

Figure 2. One of the proposed tide gauge locations, near Puerto Morales, Mexico.

OPERATIONS SUMMARY

Although no new COCONet stations were installed, a number of planning, operational, and logistics tasks were completed during the last quarter, including:

- A maintenance visit was made to CN24 in Felipe Carrillo Puerto, Mexico. The COCONet field engineer installed a VPN router to allow data downloading from the station. Training was provided to a local collaborator who will be installing a similar VPN router at CN25.
- Andre Bassett began planning logistics for the trip to Haiti scheduled for January 2014. The purpose of this trip is to upgrade the cellular modems in order to get two stations in Haiti online.
- Shipping was completed for maintenance and station installation activities in the Dominican Republic. The equipment arrived in country, but is still undergoing the customs clearance process.
- An MOU was signed between UNAVCO and the Ministry of Physical Development in St. Lucia. This will allow the construction of the COCONet station on the south end of St. Lucia, an important atmospheric target for COCONet.
- The MOU between UNAVCO and the Smithsonian Tropical Research Institute (Panama) was finalized this quarter. This MOU permits the site located at Bocas del Toro, Panama and provides access to their Internet connection, which will allow COCONet to remove the BGAN terminal currently located at CN20.
- Equipment was shipped to Honduras for the COCONet installation in San Lorenzo. The equipment is currently in Honduran Customs waiting for clearance.
- COCONet assembled and tested equipment for shipment to Carriacou. This installation will be completed with collaboration and coordination with the University of the West Indies - Seismic Research Center.

Work planned for FY2014-Q2 includes:

- PBO AK Region Field Engineer Ellie Boyce will install meteorological instruments at six existing sites in Guatemala. This will provide data from the IGN network in Guatemala to the COCONet community.
- Three meteorological instruments will be installed at existing CORS stations in the Cayman Islands.

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	63	0	
Permits Submitted	61	0	
Permits Accepted	58	2	St. Lucia (Ministry of Physical Development), Smithsonian Tropical Research Institute (Panama)
Stations Installed New / Refurbished	34 new 10 refurbished	0 new 0 refurbished	
Maintenance Visits	20	1	Mexico

Table 1. COCONet Status: Tasks completed to date and in FY2014-Q1.

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) has rejected the location of three new stations (St. Croix, Cayman Islands, Guanaja) and approved the addition of 2 new (Aruba, Panama-Bocas Island) and 8 refurbished stations to the plan. Also, one of the planned refurbished stations, GOV1, was determined to be unsuitable for construction. Consequently a new station GOV2 was built in its place. Four of the refurbished stations in Venezuela were removed from the Trinidad siting plan. At this time, the current siting plan calls for 50 new stations, 18 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 (includes new, refurbished, and existing stations). 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. At the time of this report, Level 2 GPS products are available from 80 COCONet stations (includes new, refurbished, and existing stations). Note: data products may not be available from all stations installed at the time of this report due to unresolved communication issues or other reasons, such as the station being recently built and the data not yet being available for archiving or analysis. A comprehensive data re-processing effort by the PBO ACs/ACC, designed to produce IGS08 solutions for all PBO, COCONET and affiliated network stations back through 1996, continued this period and we expect that new Level 2 data products will become available for all available COCONet stations with historic time series sometime during the next quarter.

Currently, 25 COCONet stations are 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). This exceeds a project goal outlined in the project proposal, which called for at least 10 stations to deliver high-rate, low-latency data in real-time.

BUDGET AND SCHEDULE

The current schedule includes at least 50 new station installations, 18 refurbished stations, and contribution of data from at least 61 existing stations. Refurbished stations are defined as stations that are operated by a regional partner and were working previously, but now require some equipment upgrades to become compatible with COCONet standards. Existing stations are assumed to require no additional hardware to be compatible with the COCONet network and therefore can provide data directly to the COCONet project at minimal additional cost (for data archiving and processing). The installation schedule was extended to four years, given the delay in starting the field component of the project, because of the need to refine the siting plan in light of new information that was not available at the time that the proposal was developed and submitted to NSF in 2010.

The project has been running slightly behind schedule in station installations (Figure 3). This situation was compounded in FY2014-Q1 by the Colorado floods, reduction in force, and the partial government shutdown. Significant progress was made in project logistics and planning, however, which will put the project in a good position to get back on track early in the next year. The projection for the next quarter is to install or upgrade at least 7 new/refurbished stations.

COCONet expenditures are over $3.6M through the end of November 2013, giving the project a slight budget under run to date. This budget variance is consistent with the corresponding schedule variance. There are a number of financial commitments that will hit the books in the next few quarters, including the costs associated with the COCONet Graduate Fellowships and the implementation of the regional data center and regional data mirrors. Also, some of the expensive sites in Venezuela, Swan Island, and Cuba, which were originally scheduled for this quarter, have been delayed.

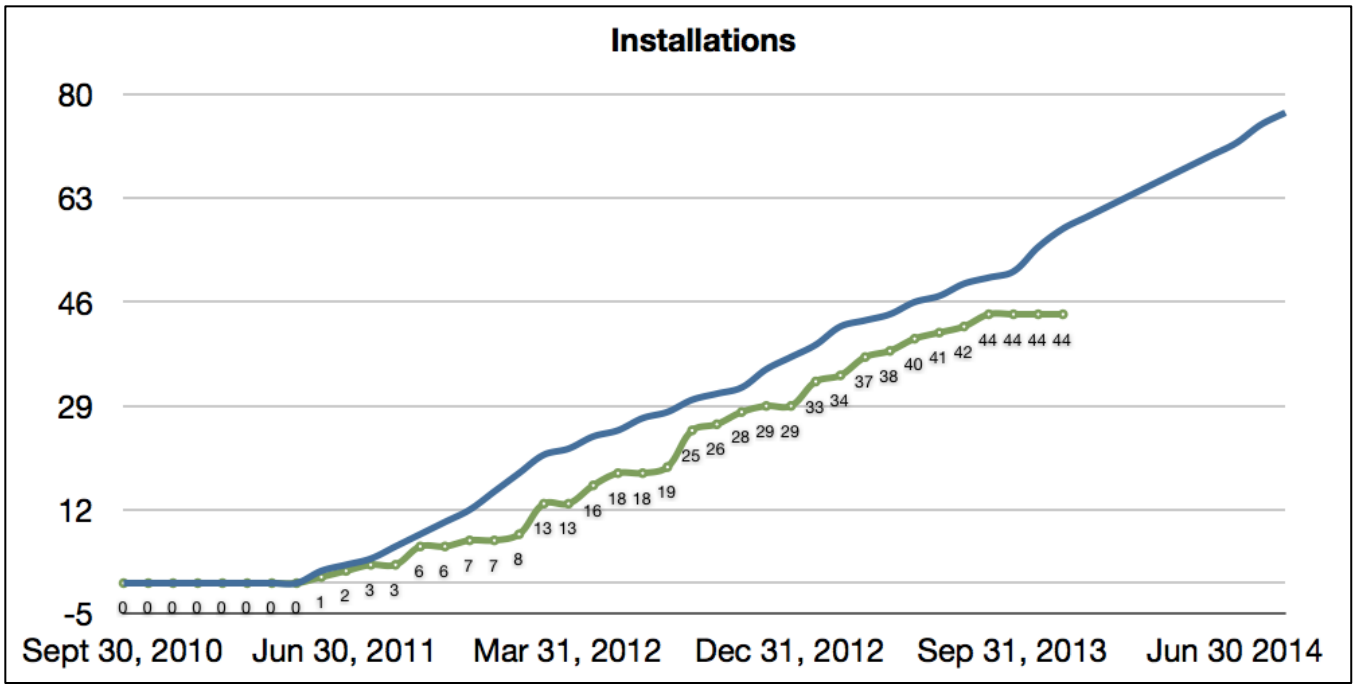

Figure 3. COCONet Installations: Plan (blue line) vs. Actual (green line).

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. One major highlight for the last quarter involved the selection of the host institutions for the Regional Mirror Data Centers and the more advanced Regional Data Center. Each institution selected will be eligible for up to two years of funding. Each institution will receive all required hardware and software from UNAVCO. The selection process was competitive and based on standard NSF guidelines for proposal evaluation based on Intrinsic Merit and Broader Impacts. UNAVCO staff (not including any member of the PI team) and external panelists from the COCONet region reviewed the proposals. Final recommendations by the selection panel were reviewed and accepted by the chair of the COCONet Working Group and the PI team.

The following host institutions were selected:

Mirror Data Center Sites

Caribbean Institute for Meteorology and Hydrology – The Caribbean Institute for Meteorology and Hydrology (CIMH) will receive 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) will receive 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.

Regional Data Center

Colombian Geological Survey – The Colombian Geological Survey, Center for Processing and Analysis of Geodetic Data will receive 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 will serve 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.

UNAVCO will provide hardware, software, installation, and training as needed to develop these sites. The centers will support 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. The benefits include but are not limited to, educational advancement; professional workforce development; hazards preparedness, response and mitigation; development and planning; and understanding and living with Earth processes.

These new COCONet regional centers should be fully functional in the near future. After a review of the success of the centers, support for additional data centers, contingent on available funding, will be considered in 2014.

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. In an effort to make COCONet met data more widely available to the global atmospheric science and numerical weather modeling communities, COCONet data and derived data products are now being incorporated into the World Meteorological Organization's (WMO) Global Telecommunications System (GTS). The COSMIC group at UCAR has the ability to create 'BUFR' files, which would include PI Braun's estimates of PWV and temporally averaged surface met data (over the same epoch as the PWV), for delivery to the WMO GTS. Braun is currently in negotiations with appropriate NOAA staff to provide PWV products for all COCONet sites.

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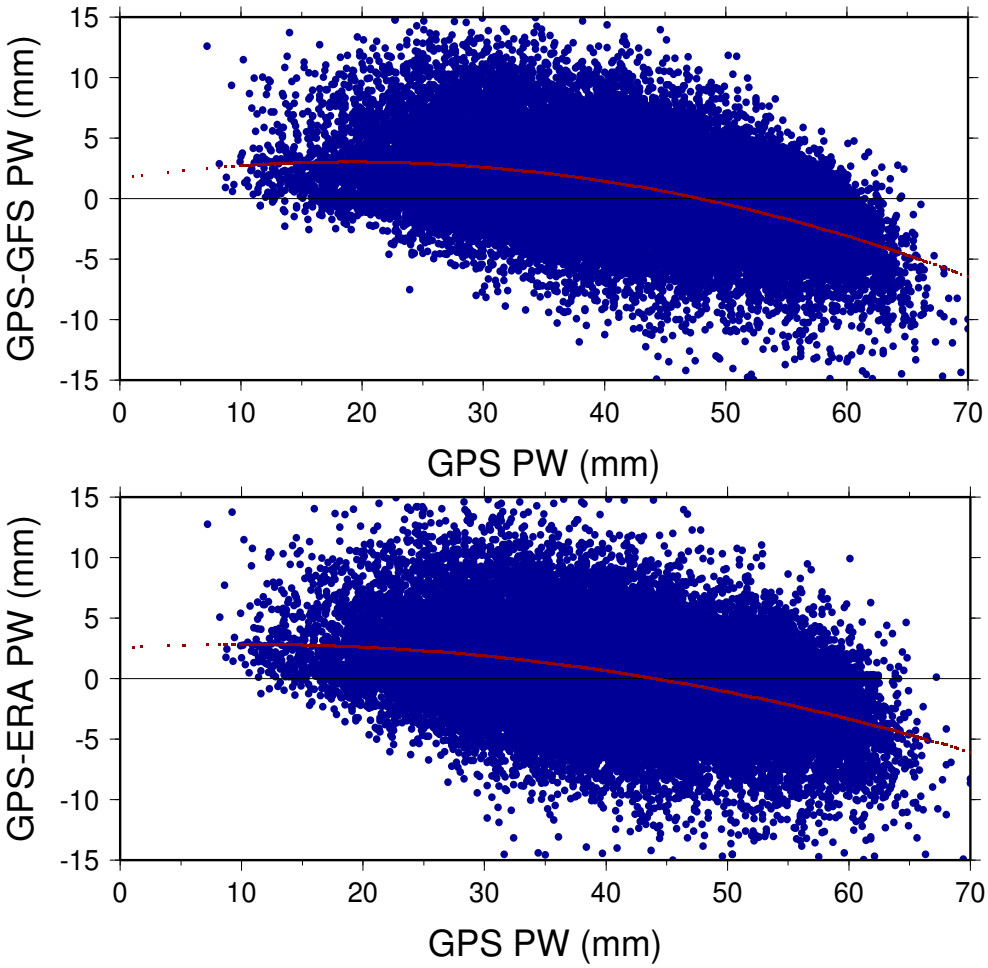

Figure 4: Differences in PWV for COCONet GPS data and GFS analysis fields (top) and ERA-Interim (bottom) computed as a function of total PWV.

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. This task is currently on hold within the NWS until January 7, 2014.

COCONet data products are being evaluated against global analysis and reanalysis systems. As an example, Precipitable Water Vapor (PWV) analysis fields from the Global Forecast System (GFS) model at NOAA and reanalysis fields from the ERA-Interim project at the European Center for Medium Range Weather Forecasting (ECMWF) Center were compared against COCONet derived Precipitable Water Vapor Estimates (see Figure 4). These comparisons indicate that both of these gridded products are biased slightly wet with respect to GPS derived PWV for amounts less than 50 mm. This bias changes (so that the GPS PWV is slightly moist with respect to the analysis/reanalysis products) for PWV amounts greater than 50 mm. In general, the ERA-Interim products have a slightly smaller bias and lower diurnal error than GFS.

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 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.

PROJECT CONCERNS

Project Staffing – The newest GAGE budget required a reduction in staffing from proposed levels, including four field engineers and other key support staff. These engineering resources will no longer be available for the COCONet project. Other GAGE field engineering resources will be less available for work on COCONet activities. **Risk mitigation**: Recognition that with a reduced staff, priorities must be set and managed. The GAGE Geodetic Infrastructure Director will set and manage these priorities. When UNAVCO staff members, normally assigned to other projects are used to support COCONet installations or site operations and maintenance, their time, travel, and field expenses are charged directly to the COCONet award.

Project control: Much of the remaining work, especially in the West Indies, Venezuela, and Cuba relies heavily on local collaborators. **Risk mitigation**: COCONet management will make these stations a priority in the next quarter. Collaborations will be developed and strengthened in order to continue to make progress in the installation of these stations.