**SUMMARY**

This quarterly report covers the COCONet project (EAR-1042906/EAR-1042909) activities for the time period December 2011 - February 2012. The COCONet grant was awarded to UNAVCO on September 14, 2010 and a collaborative grant (EAR-1042909) awarded to J. Braun, University Corporation for Atmospheric Research. The project is under the direction of M. Meghan Miller, Eric Calais, Guoquan Wang, John Braun, Glen Mattioli, and Karl Feaux.

Most of the effort during this reporting period included reconnaissance and installation activities related to the siting plan developed at the Port of Spain siting meeting in June 2011. Specifically, reconnaissance activities in Colombia and installations in Nicaragua were the field highlights during the last quarter. COCONet engineers and UNAVCO Project Support staff coordinated with US State Department officials to utilize the “diplomatic pouch”, which is a means of expediting equipment to US embassies abroad, alleviating the need to donate government-owned equipment. Barrett Friesen presented a COCONet poster at the AGU Fall Meeting in San Francisco, CA as well as the UNAVCO Science Workshop in Boulder, CO. The poster included construction status, science objectives, and acknowledgments of the COCONet partner organizations. UNAVCO engineering personnel have performed site reconnaissance at 50 locations in 24 countries, submitted land use permits for 39 sites, permits accepted for 27 sites, and currently have thirteen stations installed (Figure 1).

![Figure 1. The final COCONet siting plan, the result of siting meetings in Puerto Rico and Trinidad. Green dots represent new (50) or refurbished stations (15), red dots represent existing stations (61), and the blue triangle represents one alternate site on Sombrero Island. Large green dots represent the thirteen completed COCONet stations to date.](image-url)
COCONet FY2012-Q2 Report

**COCONet Highlight: Colombia Reconnaissance Completed**

During the period December 4-12, 2011, Kyle Bohnenstiehl (UNAVCO) and Dr. Hector Mora of the Colombian Geological Survey (formerly INGEOMINAS), completed reconnaissance of four new COCONet sites in Colombia, including Galerazamba, Monteria, Providencia Island, and Puerto Bolivar. All of the sites had been prescreened by Dr. Mora and were found to be of excellent quality.

Galerazamba is located at an active salt evaporation mine, between Cartagena and Barranquilla, and is within 50 meters of the ocean in limestone/coral bedrock and has excellent security and cell phone communications. Monteria Airport will host the designated site, which will be constructed using a hand-augured hybrid short-drilled braced monument. Bedrock is not exposed so siting was concentrated in areas that had excellent data communications, access, and security. Providencia Island creates the opportunity to have a site well out into the Caribbean Sea on a unique volcanic island. A private landowner on the island generously agreed to host the site for COCONet. The fourth site will be located at the Puerto Bolivar airport, operated by the Cerrejon Mining Group. Puerto Bolivar serves as an ocean shipping point for one of the largest coal mines in the world, located 170 Km south by rail from the site. The site provides excellent bedrock, security, and cell phone data communications.

Despite severe rains, the trip was a great success. In addition to the reconnaissance completed, UNAVCO now has a better understanding of the logistics involved in working in Colombia. New relationships were formed with landowners and old relationships were rekindled. Three of the four new sites in Colombia have been permitted. The equipment is currently being staged for shipment to Colombia and installation will begin later this spring. The Colombian Geological Survey/GEORED will provide logistical support during the installations. In addition, five other existing GPS stations in Colombia, part of Dr. Mora’s GEORED, will be included as existing stations within the COCONet framework.
Figure 2. Dr. Mora examines a rock outcrop near Puerto Bolivar, Colombia.

**FIELD OPERATIONS SUMMARY**

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

- COCONet field engineer installed three new GPS stations in Nicaragua near Poneloya, Bluefield and Puerto Cabezas. COCONet field engineers built a short drilled braced monument in a competent rock outcrop at Poneloya. The Bluefield and Puerto Cabezas stations have rooftop monuments due to the lack of rock in the vicinity and security concerns.
- UNAVCO field engineers upgraded three existing stations (refurbished stations) to COCONet standards, including MANA in Nicaragua, GRZA and VERA in Costa Rica. Trimble NetR9 GPS receivers and Vaisala WXT520 meteorological instruments were installed to complete the upgrades. Trimble Zephyr Geodetic 2 antennas were provided, although not installed, in order to preserve the GPS time series. These GPS antennas can be used as spares in case of GPS antenna failures in the future.
- UNAVCO completed on-site maintenance at CN15 on Grand Bahama Island to restore the station after flood damage from Hurricane Irene. Storm surges from powerful hurricanes are
likely to cause as much damage as high wind for stations that are situated near the coast or in low lying areas.

- UNAVCO field teams completed site reconnaissance at 17 locations in nine countries during the last three months. Site reconnaissance has mostly been completed, with the exception of sites in Venezuela, Mexico, and Cuba.
- Permits were finalized for three out of four sites in Colombia, seven sites in the Dominican Republic, and the Pearl Island site in Panama.

Table 1. COCONet Status: Tasks completed to date and in FY2012-Q2.

<table>
<thead>
<tr>
<th></th>
<th>Cumulative</th>
<th>Since Previous Quarter</th>
<th>Details From Current Quarter</th>
</tr>
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<tbody>
<tr>
<td>Station Recons</td>
<td>50</td>
<td>17</td>
<td>Colombia, Bahamas, Mexico, Carriacou, Dominica, Trinidad, Haiti, Costa Rica</td>
</tr>
<tr>
<td>Permits Submitted</td>
<td>39</td>
<td>24</td>
<td>Nicaragua, Colombia, Dominican Republic, Trinidad, Bahamas, Costa Rica, Haiti, Honduras</td>
</tr>
<tr>
<td>Permits Accepted</td>
<td>27</td>
<td>17</td>
<td>Nicaragua, Colombia, Dominican Republic, Trinidad, Costa Rica, El Salvador</td>
</tr>
<tr>
<td>Stations Installed/Refurbished</td>
<td>13</td>
<td>6</td>
<td>Nicaragua, Costa Rica</td>
</tr>
<tr>
<td>Data Flow</td>
<td>9</td>
<td>6</td>
<td>2 in Jamaica, 2 in Nicaragua to be upgraded to continuous comms</td>
</tr>
<tr>
<td>Maintenance Visits</td>
<td>1</td>
<td>1</td>
<td>Grand Bahama</td>
</tr>
<tr>
<td>Next Quarter Projection</td>
<td>Recons: 9, Permits Submit: 9, Installs: 6, Refurbishments: 6</td>
<td></td>
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</tr>
</tbody>
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**DATA SUMMARY**

The Port-of-Spain planning meeting resulted in 50 target locations for new stations, 15 targets for refurbished stations, and 61 existing stations for integration into the COCONet network. The COCONet data plan calls for 10 stations to provide high-rate real-time GPS data streams. COCONet is currently downloading 15-second data and processing daily time series from eight of the 13 new and refurbished COCONet stations. Processing of station data by the PBO GPS Analysis Centers is yielding high-quality time series. Table 2 shows the current data summary for stations identified as belonging to the COCONet network:
Table 2. COCONet Data Summary.

<table>
<thead>
<tr>
<th></th>
<th>New Stations</th>
<th>Refurbished Stations</th>
<th>Existing Stations</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard data archived at UNAVCO</td>
<td>6 of 10 stations installed currently archiving 15-sec data</td>
<td>2 of 3 refurbished stations currently archiving data</td>
<td>UNAVCO has received data from 21 existing stations. 14 currently online and operational.</td>
<td>CN10, CN11, CN22, CN29, GRZA not currently online – plan in place to repair or install data communications</td>
</tr>
<tr>
<td>Stations Streaming 1-Hz Data</td>
<td>(3) CN15, CN40, ISCO</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**Budget and Schedule**

The COCONet project uses earned value to manage construction. The baseline was refined after the Trinidad siting meeting and now includes a revised budget and schedule to reflect changes to the siting plan.

The revised schedule includes a total of 50 new station installations, 15 refurbished stations, and 61 existing stations to be included in COCONet data products. Refurbished stations are defined as stations that were operational in the past, 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. The installation schedule was extended to four years, given the delay in starting the field component of the project needed to refine the siting plan in light of new information that was not available at the time the proposal was developed.

Project spending in FY2012-Q2 is within eight percent of the current spending plan with over $1.4M spent to date (Figure 3). One reason for the discrepancy between the actual and budgeted expenses is that the Purdue subaward has not yet been invoiced. Field crews concentrated on reconnaissance and permitting efforts and stayed ahead of scheduled reconnaissance. As agreements with host institutions are put into place, the next three months should see a spike in station installations.

Earned value management (EVM) techniques were applied to the construction and field operations components of the project (removing education and outreach, participant support, and subawards). Using EVM (Figure 4), the construction/field operations component of the
project is shown to be slightly behind schedule (3% negative schedule variance) and slightly under budget (2% positive cost variance). We expect to be on or ahead of schedule by June 1, 2012 based on current plans for reconnaissance, permitting, and installation.

Figure 3. Total project actual costs vs. budget.

Figure 4. COCONet Earned Value Management – Field Operations
UCAR UPDATE

The UCAR/COSMIC program is participating in COCONet under support from NSF grant (EAR-1042909). UCAR 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 to automatically distribute data through the internet to stream subscribers.

Outside of routine analysis, COCONet-related UCAR activities during the FY2012-Q2 time period (January – March, 2012) were focused on the initial planning of a short course on COCONet atmospheric science. UCAR is seeking support for this short course through the NSF Pan American Advanced Studies Institutes (PASI). This workshop is tentatively planned for May or June of 2013, with a possible location of Cartagena, Colombia. We expect that the course will have both theoretical and technical elements designed to address a number of important topics relevant to the region. The scientific focus will address global tele-connections of large-scale climate signals (El-Nino Southern Oscillation, North Atlantic Oscillation, and Amazonian convection), moisture fluxes in the Inter-American Seas, monsoon systems in the Americas, tropical storms and hurricanes. More technical topics will include an overview of atmospheric remote sensing with GNSS, the introduction of existing and planned cGNSS networks in the Americas, accessing cGNSS data streams, numerical weather prediction, and atmospheric analysis and reanalysis projects. The course will also include a research colloquium where both students and lecturers will have the opportunity to present current or planned research topics related to atmospheric processes in the Americas.

A brief report (Braun et al., 2012) regarding COCONet was published in FY2012-Q2. This report serves as an announcement of the project to the broader earth science community, summarizes its goals, gives an activities update, and lists data and products that will be available to the broader research community.

Cuba site update: The approval process for a COCONet installation in Cuba appears to still be under review by the Cuban government (see report FY2012-Q1 report). Our potential collaborator in Camaguey Cuba, Dr. Juan Carlos Antuna, indicates that a decision on his request to form collaboration is still under review. Progress updates will be provided when available.

EDUCATION AND OUTREACH HIGHLIGHT: SPECIAL TOPICS SESSION AT UNAVCO SCIENCE WORKSHOP

On March 1, 2012, John Braun, Glen Mattioli, and Karl Feaux led a special topics session related to COCONet at the UNAVCO Science Workshop in Boulder, CO. The session was well attended by both geodetic and atmospheric researchers interested in the COCONet project. After a brief introduction of the project science goals and a construction status report, three main topics were discussed: Capacity building and outreach opportunities, building a backup data communications system using the BGAN technology, and post-installation engagement from the COCONet partners. During the discussions, a number of excellent suggestions were made including:

1) UNAVCO should investigate funding mechanisms for the development of a stand-alone data archiving/access software package that could be used by interested Caribbean institutions to establish disseminated COCONet regional data archives.

2) UNAVCO should plan another meeting for international partners in the region, preferably by Fall 2012.

3) UNAVCO should establish programs that promote involvement of students from the Caribbean region, including engineer exchange programs. The Plate Boundary Observatory could be used as a laboratory for training field technicians from the region.

4) A digital quarterly COCONet newsletter should be developed and distributed electronically to interested parties.

PROJECT CONCERNS

Relationship building between UNAVCO and host institutions in the Caribbean region continues to be an ongoing challenge for the project. For example, there were only a few representatives from COCONet partner institutions attending the UNAVCO Science Workshop. Looking forward to the operations and maintenance phase, strong partners are critical to the long-term success of the project. **Mitigation:** UNAVCO staff will continue to attend and present at regional meetings. To develop partnerships within the atmospheric community, Karl Feaux and John Braun will be attending the 30th Conference on Hurricanes and Tropical Meteorology in mid-April at Ponte Vedra Beach, FL. As discussed in the special topics session at the UNAVCO Science Workshop, UNAVCO and its partners must secure resources to host workshops and provide training opportunities for our collaborators in the region.

Project staffing is also a slight concern for the project. The three-person COCONet field team has spent a significant amount of their time on the road in the last year, trying to complete the reconnaissance effort. There is some concern that the current level of effort is not sustainable in the long-term. **Mitigation:** With Jim Normandeau taking over the management of the field staff, UNAVCO Facility engineers will be able to provide some relief for COCONet engineers, without budget impact.