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PAGES 89–104

Focused Study of Interweaving Hazards Across the Caribbean

PAGES 89–90

The Caribbean is a region of lush vegetation, beaches, active volcanoes, and significant mountain ranges, all of which create a natural aesthetic that is recognized globally. Yet these very same features, molded through geological, oceanic, and atmospheric processes, also pose natural hazards for the developing countries in the Caribbean. The rise in population density, migration to coastal areas, and substandard building practices, combined with the threat of natural hazards, put the region's human population at risk for particularly devastating disasters. These demographic and social characteristics exist against a backdrop of the threat of an evolving climate, which produces a more vigorous hurricane environment and a rising average sea level.

The 12 January 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. Prompted by these and other events, a new National Science Foundation (NSF)–funded initiative known as the Continuously Operating Caribbean Observation Network (COCONet), which commits roughly $7 million over 5 years to a collaborative natural hazard research team, was formed in 2010. This team includes researchers from UNAVCO, Purdue University, University of Puerto Rico at Mayagüez, and the University Corporation for Atmospheric Research (UCAR).

COCONet Infrastructure

COCONet will enhance geodetic research infrastructure in the region surrounding the Caribbean plate to support a broad range of process-oriented geoscience investigations with direct relevance to geohazards. COCONet will allow for more in-depth topical geophysics studies and will 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 (managed by various institutions committed to free and open data access) that are already or will soon be in operation (see Figure 1). In addition to raw data, products will include estimates of column-integrated tropospheric water vapor, time series of daily positions and component velocities for each station (used to quantify tectonic changes in the region), 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.

Research Objectives in Tectonics

The large oceanic extent of the Caribbean and the presence of many offshore active faults make the Caribbean region a source and a recipient of tsunamis. 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 the following: What are the kinematics, boundaries, and rigidity of the Caribbean plate? What reference frame is appropriate for tectonic studies? More targeted areas of investigation will include the mechanisms of stress release at convergent boundaries and interplate coupling along the leading and trailing edges of the Caribbean plate. Broader issues include the question of how strain is partitioned at convergent margins and how stress is transferred across plate boundaries.

Investigations of Climate and Weather

COCONet will also address key processes in the Caribbean region tied to

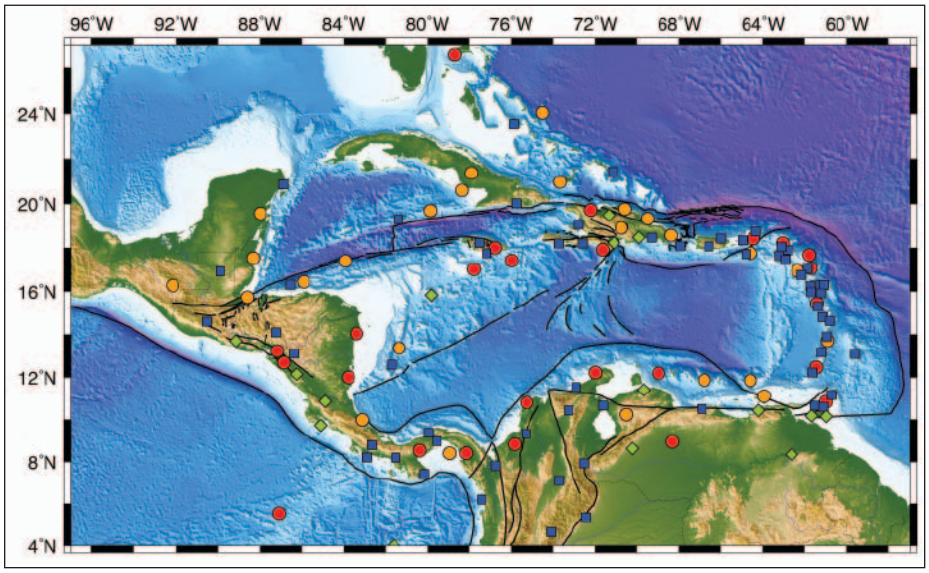

*Fig. 1. New Continuously Operating Caribbean Observation Network (COCONet) sites defined during the February 2011 meeting (*n *= 25) are shown as red circles. COCONet sites defined during the June 2011 meeting (*n *= 25) are shown as orange circles. Existing or planned sites (*n *= 62) to be included in the COCONet archive are shown as blue squares. Existing sites to be upgraded (n = 15) are shown as green diamonds. Bathymetry and topography are from ETOPO1, a 1-arc-min global relief model of the Earth's surface. Faults and block boundaries are shown as black lines.*

ocean-atmosphere coupling, transport of moisture, and precipitation. Better observations are critical to improving initialization of numerical weather prediction systems and to assessing model skills 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 midlatitudes; and data collected from small and large landmasses will reveal the interactions among the ocean, land, and atmosphere.

COCONet observations will address the following key questions: 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 do land heating and island topography influence moisture transport and precipitation?

The most obvious weather hazard that affects the Caribbean region is hurricanes. Thus, an aim of COCONet will be to determine how continuous and reliable estimates of precipitable water vapor, derived from the COCONet cGNSS data with a temporal resolution of 15 minutes or less, can be applied to better understand how latent heat release in convective towers within the atmosphere along with synoptic-scale moisture transport can fuel the evolution of tropical storms.

Capacity Development

Three broad themes for capacity development have been identified to help ensure the success of COCONet. The first theme is the need for COCONet to effectively complement and extend regional geodetic infrastructure and technical capabilities while simultaneously promoting open data policies. Regional partners will play leading roles in transforming data obtained through COCONet into concrete benefits for hazard mitigation and scientific advancement.

The second theme 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, students, teachers, surveyors, emergency managers, and policy and decision makers have all been identified as key audiences for COCONet's outreach.

The third theme is the need for bidirectional scientific partnerships to nurture a new generation of researchers in the region to ensure that knowledge flows in multiple directions—from and among Caribbean nations as well as among 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, all of which include partners from across the Americas.

Initial and Future Steps

Two workshops were organized in the first year of the project. The first was held in early February 2011 in Puerto Rico. More than 100 scientists representing 25 countries attended. Outcomes included a refined set of science goals and a prioritization of initial site installations. The workshop report and NSF proposal can be found online (http://www.unavco.org/community/meetings-events/2011/coconet/agenda.html). A second workshop was held in Port of Spain, Trinidad, in June 2011. This meeting allowed for a further refinement of the site development plan and identification of new, refurbished, and existing cGNSS sites that will make up COCONet (Figure 1).

COCONet, now in its initial implementation and build-out phase, represents an excellent opportunity for scientists, both those already working in the region and new investigators, to leverage COCONet data and products. Investigators are encouraged to contact UNAVCO, UCAR, the COCONet organizing committee, or the authors of this report for additional information.

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