

COOPERATION ON GPS METEOROLOGY BETWEEN THE UNITED STATES AND CUBA

BY RICHARD ANTHES, ALAN ROBOCK, JUAN CARLOS ANTUÑA-MARRERO,
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Abstract

In May 2014 a team of atmospheric and geodetic scientists from UNAVCO and the University Corporation for Atmospheric Research (UCAR) sent and helped set up a global positioning system (GPS) receiver to measure atmospheric water vapor at the Grupo de Óptica Atmosférica de Camagüey (GOAC) at the Camagüey Meteorological Center in Camagüey, Cuba. The GPS receiver immediately began to produce observations of precipitable water, which are being shared with the international meteorological community. Obtaining permission from both sides to send a highly sensitive instrument from the United States to Cuba was not easy. This paper describes the series of events that led to this achievement, beginning with a North Atlantic Treaty Organization (NATO) workshop in Rome, Italy, in 1994 in which Alan Robock met a young Cuban scientist named Juan Carlos Antuña and accepted him as a graduate student at the University of Maryland, College Park. The GPS meteorology connection began with a March 2007 visit of a delegation from the United States headed by then American Meteorological Society (AMS) President Richard Anthes to Havana, Cuba, at the invitation of the Cuban Meteorological Society president, Andrés Planas. These two threads led to this remarkable cooperation between Cuban and U.S. scientists. Several visits to Cuba beginning in 2010 by Robock, who met former President of Cuba Fidel Castro and the science advisor to the president of Cuba, played a significant role. This is another instance (the visit of the AMS delegation to China in 1974 was a prime example) of how communication and visits between meteorologists in countries that are at odds on many other issues can lead to lasting collaborations that benefit both countries as well as the international community.

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The events leading to the installation of a U.S. GPS receiver to measure precipitable water in Camagüey, Cuba, and the related collaboration of U.S. and Cuban scientists are described.

COOPERATION ON GPS METEOROLOGY BETWEEN THE UNITED STATES AND CUBA.

It is a truism that the atmosphere does not recognize geographic or political borders, and because of this, there has often been cooperation between meteorologists in countries that disagree on many other issues. A prime example of this cooperation was the visit of the American Meteorological Society (AMS) delegation to China in April and May 1974 (Kellogg et al. 1974).

Interactions between Cuba and the United States have been minimal in most respects since 1959 and the U.S. embargo of Cuba that began 19 October 1960. The embargo, which continues today, is a commercial, economic, and financial embargo—it prohibits all exports to Cuba except for some food and medicine. Cuba is a member of the World Meteorological Organization, through its Instituto de Meteorología (INSMET). INSMET is a government organization that carries out many of the functions of the National Oceanic and Atmospheric Administration's (NOAA) Office of Oceanic and Atmospheric Research and the National Weather Service (NWS).

Travel of U.S. citizens to Cuba and of Cubans to the United States has also been severely restricted since 1960. The economic embargo forbids the spending of money in Cuba by U.S. citizens without a license from the U.S. Department of the Treasury. However, there is a general license in effect for people in certain categories, including diplomats, journalists, and academics. This means that U.S. university scientists are free to travel to Cuba, as long as they work on academic pursuits during the visit, with the intention to produce scientific publications. This license has allowed the U.S. authors of this article to travel to Cuba several times. But the existence of the general license is not widely known. As a result, scientific

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GENERAL LICENSE FOR U.S. SCIENTISTS TO COOPERATE WITH CUBAN SCIENTISTS

U.S. Department of the Treasury rules for cooperation with Cuba may be found online (www.treasury.gov/resource-center/sanctions/Programs/pages/cuba.aspx). Specifically, the relevant portion of the general license for scientists is that the general license includes the following:

“E. Full-time professionals conducting professional research or attending certain professional meetings

“I. Professional research. Full-time professionals are authorized to engage in Cuba travel-related transactions and such additional transactions that are directly incident to conducting professional research in their professional areas pursuant to § 515.564(a)(1) of the Regulations, provided that their research (1) is of a noncommercial academic nature; (2) comprises a full work schedule in Cuba; (3) has a substantial likelihood of public dissemination; and (4) does not fall within certain categories listed in § 515.564(c)-(e).”

interactions between the two countries, which are generally apolitical in nature, have been rare. As described in a recent *Science* editorial, “The official relationship between Cuba and the United States has been frozen for over half a century, restricting scientific cooperation in many fields” (Fink et al. 2014 and related letter Antuña-Marrero et al. 2014). See the sidebar for a brief discussion of the general license.

An exception to the rule has been the cooperation between Cuban and U.S. meteorologists in the respective national weather services (the NWS in the United States and INSMET in Cuba) on tropical cyclone forecasting. Since the days of the Jesuit priest Father Benito Viñes (Ramos Guadalupe¹ 2014), Cuban meteorologists have been leaders in forecasting Atlantic hurricanes, and have shared their forecasts and research methods freely with the United States. Even with the restrictions on discourse between the two countries, hurricane forecasters in Havana, Cuba, and Miami, Florida, freely share their data and forecasts, and hold frequent telephone conferences when tropical storms threaten the region.² The National Hurricane Center frequently flies its hurricane hunter aircraft over Cuba when the island is threatened by approaching storms.

However, aside from the cooperation between operational forecasters, interactions between U.S.

and Cuban research meteorologists over the past 60 years have been rare. It therefore seemed like somewhat of a miracle when in May 2014 a team of atmospheric and geodetic scientists from UNAVCO and the University Corporation for Atmospheric Research (UCAR) sent and helped set up a global positioning system (GPS) receiver to measure atmospheric water vapor at the Grupo de Óptica Atmosférica de Camagüey (GOAC) at the Camagüey Meteorological Center in Camagüey, Cuba. GOAC (www.goac.cu) is part of INSMET (Antuña-Marrero et al. 2012). The GPS receiver immediately began to produce observations that can be used to estimate precipitable water (Fig. 1).

Even with slowly thawing political relations between the two countries, with the embargo still in full force, and the strict International Traffic in Arms Regulations (ITAR), how could scientists in the United States send any technical equipment to Cuba, much less sensitive instrumentation involving GPS technology?

This success story in scientific cooperation has several threads dating back over two decades. It was not a result of anyone’s long-range strategic plan nor a piece of some larger diplomatic strategy to bring about a rapprochement between the two countries. Instead, like many international success stories, it resulted from individuals from both countries who over the years found common interests and developed mutual trust and were willing to work hard on overcoming the bureaucratic and political restrictions on both sides. It also involved a lot of luck and serendipity.

We begin the story with a workshop held 20 years ago at a North Atlantic Treaty Organization (NATO) Advanced Research Workshop on “The Effects of the Mount Pinatubo Eruption on the Atmosphere and Climate,” Rome, Italy, 26–30 September 1994. Here, Alan Robock (then at the University of Maryland) met Juan Carlos Antuña-Marrero (research scientist at INSMET). Antuña-Marrero had contacted Robock by e-mail expressing his desire to attend the University of Maryland as a graduate student working on observing

¹ Luis E. Ramos Guadalupe is the director of the Historical Heritage Section of the Academia de Ciencias de Cuba (Cuban Academy of Sciences). Oswaldo García translated his biography of Father Benito Viñes into English, which was another result of the 2007 visits described in this paper. This biography (Ramos Guadalupe 2014) is available from the AMS.

² The NWS National Hurricane Center in Miami is a World Meteorological Organization–designated Regional Specialized Meteorological Center (WMO RSMC) for hurricane forecasts. This RSMC, as part of its regional responsibility, coordinates hurricane forecasts with Caribbean meteorological services.

the stratosphere after volcanic eruptions. Like most other graduate programs, Maryland requires scores from the Graduate Record Exam (GRE) and Test of English as a Foreign Language (TOEFL), but GRE and TOEFL exams are not offered in Cuba. As a result of their personal meeting, Robock vouched for Antuña-Marrero, and Maryland made an exception, offering him admission to the graduate program with a research assistantship, supported by a National Aeronautics and Space Administration (NASA) grant.

It took a full semester for Robock to get the U.S. Department of the Treasury to agree to pay Antuña-Marrero as a graduate research assistant under his NASA grant, so Antuña-Marrero did not arrive in Maryland until January 1996. There had been an unusual 50-cm snowfall the day before, and when Antuña-Marrero arrived, he saw snow for the first time in his life. The next day, as Robock's houseguest, he shoveled snow for the first time.

In 1998 Antuña-Marrero received his master of science degree from the University of Maryland working on lidar and satellite observations of stratospheric aerosols for use in climate modeling. Three years later (6–8 March 2001), Robock and Antuña-Marrero organized the First Workshop on Lidar Measurements in Latin America, in Camagüey. In 2002 Antuña-Marrero earned his doctor of philosophy (Ph.D.) from Rutgers University working with Robock. His dissertation title was "Comparison of SAGE II and lidar stratospheric aerosol extinction datasets after the Mt. Pinatubo eruption." Antuña-Marrero then returned to Camagüey to continue his meteorological research.

A second thread of this story begins in July 2003 when Oswaldo García, professor of Meteorology, then chair of the Geosciences Department, now the Department of Earth and Climate Sciences, at San Francisco State University (SFSU), met Mayra Santana, then working for INSMET, at the Sixth International Conference on School and Popular Meteorological and Oceanographic Education that was held in Madrid, Spain. García was born in Havana in 1947. His interest in meteorology was sparked as a small child by the spectacle of the "nortes," the local name for the occasional cold-air outbreaks from North

America during the winter. Nortes interrupt the placid trade winds that characterize the climate of Havana and generate huge waves that crash over the city's iconic Malecón seawall. García immigrated to the United States as a 13-year-old with his family after the Cuban Revolution and continued to pursue his interest in meteorology. He received his Ph.D. from the Atmospheric Science Department at the University at Albany, State University of New York; did postdoctoral work at the University of Hawaii at Mānoa; and worked at the NOAA/Environmental Research Laboratories in Boulder, Colorado, before joining the faculty at SFSU.

The 2003 meeting in Madrid led to an invitation for García to attend the III Congress of the Cuban Meteorological Society in December 2005 in Havana. At this meeting, García's first trip back to Cuba since he left in 1961, he made a presentation describing SFSU's outreach efforts to increase interest in meteorology as a career among underrepresented minorities and took the opportunity to meet with many Cuban meteorologists. During this visit he was impressed by the eagerness of Cuban meteorologists to learn more about their American counterparts and made a commitment to help increase the meteorological collaborations between the two countries.

The third and final thread in the story was also developing at about this time. A heterogeneous network of GPS stations in the Caribbean was taking shape, primarily focusing on the use of GPS for surveying and solid earth science applications. John Braun, a scientist at UCAR who had a close relationship with scientists and engineers at UNAVCO, received funding from the National Science Foundation (NSF) to install a small network

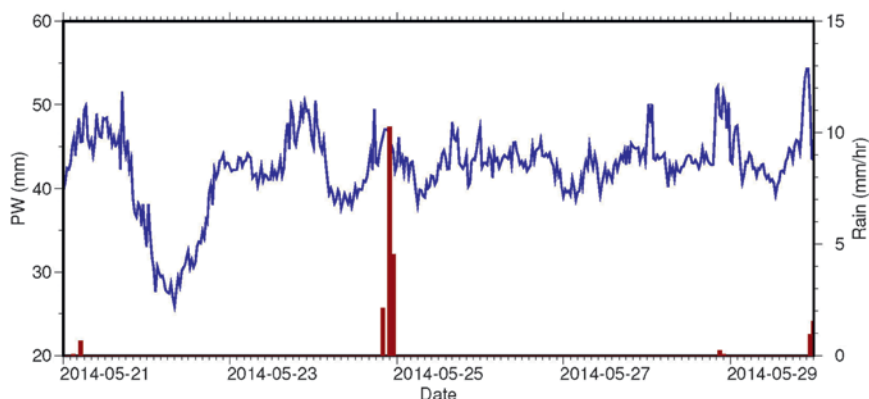


FIG. 1. Time series (21–29 May 2014) of precipitable water (PW; mm) at INSMET site in Camagüey, as measured by the GPS receiver. Also shown is the rainfall (red bars) collected from the Vaisala WXT collocated with the GPS. The time series starts on 21 May 2014, the first full day of data collected from the GPS station.

of ground-based GPS stations in the Caribbean for atmospheric applications.

A few months after García's trip to Havana, on 18 April 2006, San Francisco State University hosted a meeting of UCAR's University Relations Committee. García had met Rick Anthes, president of UCAR, two years earlier in Boulder during a meeting of the UCAR Academic Affiliates and they became good friends and colleagues. Robock was also at the 18 April meeting. During dinner, García and Anthes discussed the possibilities of scientific collaboration with Cuba and begin making plans for the visit of a UCAR–SFSU delegation to visit Cuba at the earliest opportunity.

The opportunity came sooner than expected, when Anthes was elected president of the AMS in late 2006, to serve in 2007. García put him in touch with the president of the Cuban Meteorological Society (SOMETCUBA), Andrés Planas, who invited him to visit Cuba to discuss possible collaborations between the two societies and the UCAR and Cuban scientific communities. This led to a visit on 27–30 March 2007 by Anthes, García, Karyn Sawyer [director of UCAR's Joint Office for Science Support (JOSS)], and Tim Spangler [director of UCAR's Cooperative Program for Operational Meteorology Education and Training (COMET)]. During meetings with SOMETCUBA and INSMET, the delegation discussed

several potential joint research projects with their Cuban hosts (Figs. 2 and 3). On the afternoon of 28 March, the UCAR delegation visited the INSMET headquarters in Casablanca, across the bay from Havana, and one of numerous topics discussed was the possibility of installing a ground-based GPS receiver in Cuba. Braun had asked Anthes to bring this opportunity to the attention of INSMET leadership (Fig. 4). According to Anthes's summary of the meeting, written shortly after the visit:

Rick Anthes invited Tomás Gutierrez (INSMET Director) and collaborators to write a paper for the *Bulletin of the American Meteorological Society (BAMS)*, focused on the present state of meteorology in Cuba. He then presented INSMET with a book on the use of GPS for obtaining precipitable water estimates, and urged Dr. Gutierrez to consider John Braun's invitation to set up a GPS station in Havana that would help expand SuomiNet (Ware et al. 2000) into the Caribbean. Drs. Gutierrez and Mario Carnesoltas led the visitors on a tour of INSMET's facilities and viewed UCAR's website. Dr. Gutierrez showed strong interest in obtaining real-time precipitable water vapor information for the Caribbean basin and agreed to consider the possible deployment of a GPS station at INSMET's headquarters.

The presence of García during this first meeting was an essential part of its success. He not only acted as chief translator and active participant in all the discussions throughout the meetings, but his being a native Cuban helped in building an open and trusting relationship between the two sides.

In a completely independent event, two weeks before the UCAR–SFSU visit to Havana, Robock had visited Camagüey on 11–14 March 2007 to discuss continued collaboration with Antuña-Marrero and also visited Havana and INSMET. During his visit, Robock made Antuña-Marrero aware of UCAR's upcoming visit to Cuba to explore scientific cooperation, and a few months later, during August 2007, Antuña-Marrero wrote to Anthes expressing his interest in establishing cooperation and setting up the preliminary basis for future contacts.



FIG. 2. Oswaldo García, Mayra Santana (INSMET), Rick Anthes, Karyn Sawyer, Mario Carnesoltas, and Mirella and Andrés Planas on the roof of the INSMET site in Casablanca, Havana, 28 Mar 2007. (Photo by Rick Anthes.)

Soon after the March visit, SOMETCUBA President Andrés Planas invited Anthes to give the keynote talk at the V Congress of the Cuban Meteorological Society. Anthes and his wife, Susan, visited Havana on 1–5 December 2007. García had planned to accompany them but had difficulties obtaining his visa. As the days to departure from Miami counted down, García optimistically expected the visa to arrive at any moment and even traveled from San Francisco, California, to Miami at his own expense the day before the scheduled flight to Havana. But in the end his visa did not arrive, and Rick and Susan Anthes, neither of whom speak Spanish, went to Havana anyway. The venue of the V Congress of the Cuban Meteorological Society was held in El Capitolio (National Capitol Building; Fig. 5). Despite not having García as a translator, Anthes had further discussions with INSMET about putting a ground-based GPS receiver at the INSMET weather observatory in Casablanca. It was clear that the Cuban scientists were still interested in this instrument and its observations, as well as collaborations with the United States, but only slight progress had been made since March.

Over the next two years, García continued to work quietly with both sides to keep the GPS meteorology idea alive. On 1–3 December 2009, García and Braun visited Cuba and continued discussions of putting a ground-based GPS receiver in Cuba. The discussions between Braun and Mario Carnesoltas held during this meeting helped clarify some technical questions and gave both sides a better understanding of the many hurdles, both technical and bureaucratic, that needed to be overcome before this project came to fruition.

On 12 January 2010, a magnitude 7.0 (Mw) earthquake occurred near Leogane, Haiti, killing at least 100,000 people and highlighting the susceptibility of the Caribbean to a

range of geohazard events. In response to this catastrophe, the NSF funded the Continuously Operating Caribbean GPS Observational Network (COCONet) project. The aim of this infrastructure project is to develop a large-scale network of geodetic and



FIG. 3. Tim Spangler (director of COMET, UCAR), Luis E. Ramos Guadalupe, and Rick Anthes in front of SOMETCUBA headquarters 28 Mar 2007. (Photo by Rick Anthes.)



FIG. 4. Anthes demonstrating SuomiNet, a network of GPS receivers operating in the United States, at INSMET, Casablanca, Mar 2007. Behind Anthes are (left to right) Oswaldo García, Jesus Dole [head of Information Technology (IT) at INSMET], Daniel Martinez (head of Physics within the Atmosphere Department of INSMET), and Mario Carnesoltas. (Photo by Tim Spangler.)



FIG. 5. Salon de los Pasos Perdidos, inside El Capitolio in Havana, venue of the V Congress of the Cuban Meteorological Society, 4 Dec 2007. (Photo by Rick Anthes.)

atmospheric infrastructure in the Caribbean that will form the backbone for a broad range of geoscience and atmospheric investigations and enable research on process-oriented science questions with direct relevance to geohazards (Braun et al. 2012). The significance of this project was that it created momentum in the Caribbean region for an international observational network to support geohazard research with

change to give a talk on his work. After arriving for his 14 September visit, Robock, now at Rutgers University, was asked if he minded that the comandante attend his talk. Robock agreed and Castro not only attended the talk, but participated vigorously in the discussion (Fig. 6). On this visit Robock also met Castro's son, Fidel Castro Diaz-Balart, who is science advisor to the president of Cuba, and is shown with

Robock, Antuña-Marrero, and Gutierrez at the Hotel Nacional in Fig. 7.

A month later, in October 2010 at the annual UCAR meetings in Boulder, Robock described his trip to Cuba and his meeting with Fidel Castro to Anthes and García, who mentioned that they had been trying for three years to send a GPS receiver to Cuba. Robock met with Braun and agreed to help. Robock made Antuña-Marrero aware of the COCONet interest in installing a GPS receiver in Cuba, establishing contact between himself, Braun, and García. Antuña-Marrero expressed the GOAC interest of having access to GPS technology to continue the building of state-of-the-art



FIG. 6. Fidel Castro making a point to Alan Robock, 14 Sep 2010, in Havana. (Photo taken by Fidel Castro's photographer, signed by Fidel Castro, and presented to Alan Robock after his lecture.)

instrumental research capacities locally at Camagüey. It was at this time that the effort to establish a GPS receiver in Cuba shifted from Havana to Camagüey, largely because of Antuña-Marrero's and GOAC's strong interest and efforts on the Cuba side.

The week after Robock returned from the trip to Cuba, he received a phone call from the Cuban ambassador to the United States, Jorge Bolaños, who told him how happy Fidel Castro was with his visit, and invited him to lunch at the United Nations that week. Robock could not make that engagement, but the week after the October UCAR meeting, he accepted Bolaños's invitation to visit him in Washington, D.C. At that meeting, among other things, Robock asked Bolaños for help in arranging for the GPS to be installed in Cuba.

Meanwhile, the COCONet project was moving forward and on 3 and 4 February 2011 the COCONet Workshop for Community, Science, Station Siting, and Capacity Building was held in Puerto Rico. Juan Carlos Antuña-Marrero was invited to attend the meeting and had his trip supported by UNAVCO using the Office of Foreign Assets Control (OFAC) general license. Antuña-Marrero flew from Cuba to Panama but was not allowed to board the plane to Puerto Rico. He had previously applied to travel to NASA's Goddard Space Flight Center (GSFC) for an extended visit and there was a snafu in his passport and visa status. Antuña-Marrero had to return to Cuba on the next plane. Despite the travel problems, Antuña-Marrero was able to communicate to the workshop participants his continued interest and desire to participate in the project. At this point, the newly created COCONet siting committee made a commitment to provide instrumentation for Camagüey, assuming all logistical paperwork was approved.

Antuña-Marrero eventually resolved the issues with his passport and visa and was able to travel to GSFC for a visit there, under the Yoram Kaufman Visiting Fellowships Program, from 12 March to



FIG. 7. Juan Carlos Antuña-Marrero, Alan Robock, Fidel Castro Diaz-Balart (son of Fidel Castro and science advisor to the president of Cuba), and Tomás Gutierrez (director of INSMET) at the Hotel Nacional in Havana, 15 Sep 2010. (Photo by Alan Robock.)

30 April 2011. Because of bureaucratic obstacles on the Cuban side, the visit, planned for five months, was reduced to seven weeks. The leadership and decisive support from NASA and the University of Maryland, Baltimore County, through the Goddard Earth Sciences and Technology (GEST) Center Visiting Fellows Program (Raymond Hoff, director) and the office of Maryland Senator Barbara Mikulski, made possible the first extended visit of a Cuban scientist to a NASA facility that we know of.³ (Robock had once arranged for Antuña-Marrero to visit NASA GSFC while a student at the University of Maryland, College Park, to attend a seminar on lidar observations of the stratosphere.) The visit was conducted under the guidance of and with scientific support from Dr. Loraine Remer and granted Antuña-Marrero the opportunity to learn about the advanced capabilities of the Moderate Resolution Imaging Spectroradiometer (MODIS) aerosols dataset and ongoing NASA aerosol research. While at GSFC, Antuña-Marrero was free to travel within the United States and on 21–23 April 2011 he visited Boulder, spending time with the Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC) and UNAVCO and staying

³ The sponsorship of this visit was made possible by a relaxation of the rules of academic interactions between the United States and Cuba by President Barack Obama in January 2011. The modified general license allowed “sponsorship, including the payment of a stipend or a salary, of a Cuban scholar to teach or engage in other scholarly activity at the sponsoring U.S. academic institution” [76 Fed. Reg. 19 (28 Jan 2011), Rules and Regulations].

at Braun's house. Logistics of his visit to UCAR were complicated, as there were many limitations put on what UCAR staff could do for him during his visit (by the U.S. Department of State and UCAR's attorney). Most of the discussions were on putting a GPS receiver at the INSMET weather station in Camagüey. A key outcome of this visit was a signed memorandum of understanding between UCAR, INSMET/GOAC, and UNAVCO to pursue collaborative research.

On 28 and 29 June 2011, Antuña-Marrero was able to attend the COCONet Network Operators Meeting in Port-of-Spain, Trinidad, where he reiterated the commitment by his research group to participate in COCONet. He was befriended by a number of Latin American scientists at the conference who assured him of their support within the broader COCONet community.

Over the U.S. Thanksgiving holiday (22–25 November 2011), Rick Anthes and his wife, Susan, John Braun, and a professor from San Francisco State University, Andrew Oliphant, visited Antuña-Marrero in Camagüey to tour his research facility and discuss the siting of a GPS receiver. The Camagüey chapter of SOMETCUBA (President René Estevan Arredondo) hosted the visit (www.goac.cu/sometcuba/act_vams.php). García had planned to accompany them, but once again his visa did not arrive on time and at the last minute he had to cancel. After their meetings in Camagüey, the Anthes, Braun, and Oliphant rented a car and drove to Ciego de Ávila, Cienfuegos, and then to Havana for meetings with INSMET and SOMETCUBA. On this trip, it was learned that progress was being made on getting Cuban authority approvals for a GPS receiver sent to Camagüey.

Three weeks later on 12–16 December 2011, Robock was part of an American Association for the Advancement of Science (AAAS) delegation visit to Havana to enhance scientific cooperation (Antuña et al. 2012). During the visit, he met again with Fidel Castro Díaz-Balart and urged the approval of the GPS installation in Camagüey. Robock emphasized that there were no security concerns for Cuba with the installation. Dr. Castro responded that while he knew that, the Cuban military would need to be convinced. Anne Thompson [president of the Atmospheric Sciences Section of the American Geophysical Union (AGU)] and Robock (past president of the Atmospheric Sciences Section of AGU) continued discussions on U.S.–Cuba scientific collaboration with Antuña-Marrero, and made plans to have him attend the 2012 AGU Fall Meeting.

During the AAAS visit, Tomás Gutierrez instructed Armando Muñoz, who was in charge of all

the required paperwork to be conducted in Havana, to work with Antuña-Marrero. Muñoz played a key role in the process of getting the approvals from all of the involved Cuban institutions. He demonstrated professionalism and persistence in complying with each one of the formality procedures requested by the several Cuban institutions that were required to approve the import of the instrument. In some cases, he had to draft more than one version of the same document, each time getting the signatures and approval stamps of the required officers.

Muñoz's efforts succeeded and on 23 October 2012, Cuba granted a Cuban GPS import license, valid until 23 April 2013 (the import license was later renewed on 8 April 2013 and was valid until 8 October 2013).

At the December 2012 AGU meeting in San Francisco an informal meeting attended by Robock, Antuña-Marrero, Braun, and UNAVCO (UNAVCO President Meghan Miller, Glen Mattioli, Karl Feaux, and Jim Normandeau) was held to discuss logistical constraints in exporting equipment from the United States to Cuba. UNAVCO agreed to take the lead in applying for an export license. This process was tedious, with multiple resubmittals and clarifications, but eventually, on 6 June 2013, the U.S. Department of Commerce approved an export license for UNAVCO to ship a GPS receiver to Camagüey, leading to the establishment of the station as part of the broader COCONet project.

However, the U.S. approval of the export license did not end the bureaucratic process. On 9 October 2013, Antuña-Marrero wrote to Robock:

Dear Alan:

We are now dealing with the Agency in Charge of the Import. Having all the official documents in their hands (because it is an import from the US) they are requesting additional approval letters from the Foreign Affairs Offices of the Ministry of Sciences, the Ministry of Commerce and International Cooperation.

Interviews have already been requested with the people in charge of those offices to hand them letters (signed by Tomás) explaining why their letters are required and handing then copies of all the official documents. Then we should wait from then to produce the letters to be back to the Import Agency.

Regards, Juan Carlos

FIG. 8. Group in front of GOAC in Camagüey 23 Nov 2011. Back row from left to right: Dositeo García Bargados, director of the Camagüey Meteorological Center (CMC), Juan Carlos Antuña-Marrero (GOAC), Karel Agüero Rodríguez (Forecast Department, CMC, and member of SOMETCUBA board), Carlos E. Hernández Bruneta (GOAC and member of SOMETCUBA board), Iomaris Pérez Abraham (Clima Department, CMC, and member of the SOMETCUBA board), John Braun (UCAR COSMIC), and Rick Anthes (UCAR president and AMS president). In front, from left to right: René Estevan Arredondo (director of GOAC and president of the Camagüey chapter of SOMETCUBA), Boris Barja González (GOAC and member of SOMETCUBA board), and Andrew Oliphant (professor of geography, San Francisco State University). (Photo by Rick Anthes.)



But on 22 November, Cuba renewed the GPS import license for the third time until 22 May 2014, and on 10 January 2014 Antuña-Marrero announced that the GPS import permission for Cuba had finally been granted by all the different authorities. All the necessary approval documents were provided by the Import Agency to Cuban Customs, paying the way for UNAVCO to ship the GPS receiver from Boulder to Havana in April via DHL Express, where it cleared customs and was then moved from Havana to Camagüey.

After the GPS receiver arrived in Camagüey, GOAC personnel led by its director, René Estevan Arredondo, conducted the refurbishing of the GOAC instruments site, setting up electrical and network connections for the GPS receiver and the associated automatic weather station. Both instruments plus a camera (for remotely monitoring the

instrument's status and its security) were installed in advance of the arrival of the UCAR–UNAVCO team (Fig. 8).



FIG. 9. Group on roof of GOAC's instrument site in Camagüey after installation of the GPS receiver (white domed instrument, center). In front: Braun (UCAR COSMIC). Behind Braun, left to right: Nelson Díaz Spencer (GOAC), Jorge Rosas Santana (GOAC), Jim Normandeau (UNAVCO), Iralmis Yipsy Platero Morejón (GOAC), René Estevan Arredondo (director, GOAC), Juan Carlos Antuña-Sánchez (GOAC), Frank García Parrado (GOAC), Albert Rodríguez Vega (Clima Department, CMC, Ph.D. student, GOAC), and Juan Carlos Antuña-Marrero (GOAC). (Photo by John Braun.)

With the instrument and site prepared, Braun and Jim Normandeau (a UNAVCO field engineer) traveled to Camagüey during 19–25 May 2014 to help install the GPS receiver and get it running properly (Fig. 9). The first successful observations were made during this trip, and on 22 May 2014 Antuña-Marrero wrote:

Dear Alan, Rick and Oswaldo:

The GPS has been installed and it is running taking measurements. There is only one pending thing that Jim will do at UNAVCO (setting up an IP address) for finishing the real time transfer of the measurements.

Our team had a very fruitful exchange with John and Jim and Rene. I think that we will be able to keep it running and the data flowing to UNAVCO. We also learned how to get the meteorological data on real time for future local uses.

We have enjoyed the visit of John and Jim both in the professional and personal sides.

Best Regards

Juan Carlos

With the successful establishment of the GPS receiver in Camagüey and the joining of Cuba into the international COCONet research network, this story ends. But the collaborations, friendships, and collegial relationships established since 1994 leading to this milestone will go on for many years.

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