"GOAC: Contributing to TEMPO"

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TEMPO Science Team Meeting

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DEMONSTRATING THE POTENTIAL FOR FIRST-CLASS RESEARCH IN UNDERDEVELOPED COUNTRIES

Research on Stratospheric Aerosols and Cirrus Clouds Optical Properties, and Radiative Effects in Cuba (1988–2010)

BY JUAN CARLOS ANTUÑA MARRERO, RENÉ ESTEVAN ARREDONDO, AND BORIS BARJA GONZÁLEZ

A strong research team developed in Camagüey, Cuba, by pursuing clear and precisely defined capacity building and research goals with the help of international cooperation.

INITIAL STAGE: COOPERATION WITH THE SOVIET UNION (1988–91). From the early 1980s to the early 1990s, the Camagüey Meteorological Center (CMC) was the experimental site for the Joint Cuban–Soviet Laboratory for Tropical Meteorology. CMC (21.4°N, 77.9°W) belongs to the Cuban Meteorological Institute [Instituto de Meteorología de Cuba (INSMET)], located in the city of Camagüey, about 500 km east of Havana. The site was equipped with aerological sounding, meteorological radar, as well as a network of six surface meteorological stations. Soviet and Cuban scientists jointly conducted cloud seeding experiments and associated research during that period (Medveded et al. 1986).

By the end of 1988, a Maket-2 lidar station for stratospheric aerosol (SA) measurements was installed at CMC (Fig. 1), which was afterward known as the Camagüey Lidar Station (CLS). The main parameters of the instruments appear in Table 1. The Soviet team in charge of the lidar was led by Professor Sergey Khmelevtsov, from the Institute of Experimental Meteorology (IEM), Obninsk, Russia. IEM sent engineers and physicists to Camagüey, Cuba, at the end of 1988 and early 1989 to set up the lidar and to share knowledge

FIG. 1. Maket-1 lidar system installed at Camagüey in 1988.

Brief History:

1988 -1997
Soviet LD-2 Stratospheric Lidar Installed & operated at Camagüey, Cuba

Bull. Amer. Meteor.
http://dx.doi.org/10.1175/BAMS-D-11-00149.1

Describes history of *GOAC* (CLS-Camagüey Lidar Station).

GOAC Philosophy:
Full cycle research

- Measurement-QC
- Interpretation
- Application for Atmospheric Research

http://www.goac.cu

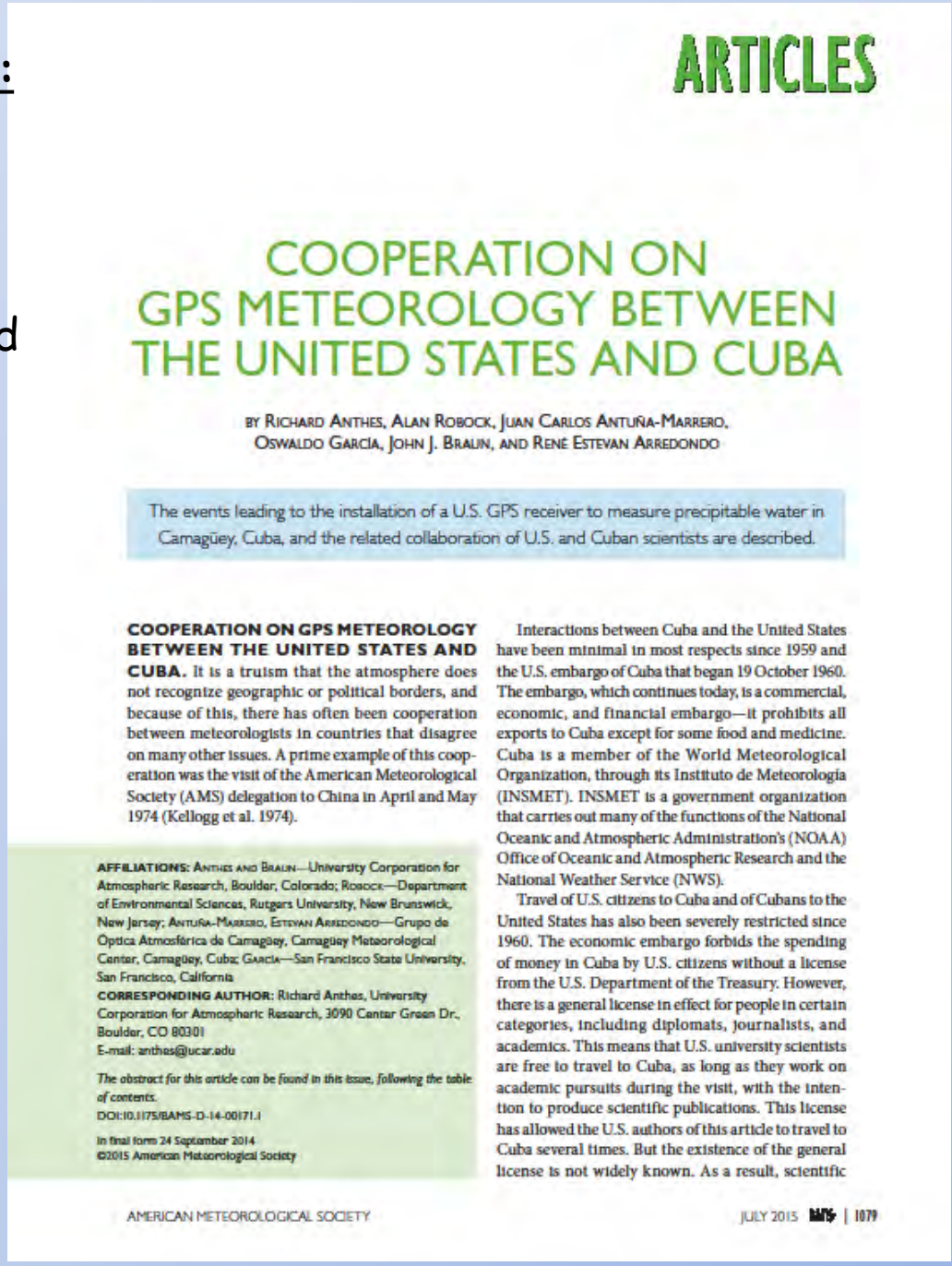
Part of the Camagüey Meteorological Center
Belongs to the INSMET (Cuban Meteorological Institute)

Sun photometer operated jointly by GOAC & GOA-UVA (Universidad Valladolid, España) contributing from 2008 to AERONET (NASA).

GPS for Water Vapor Measurements:

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.

Obtaining permission from both sides to send a highly sensitive instrument from the United States to Cuba was not easy.



ARTICLES

COOPERATION ON GPS METEOROLOGY BETWEEN THE UNITED STATES AND CUBA

BY RICHARD ANTHES, ALAN ROBOCK, JUAN CARLOS ANTUÑA-MARRERO, OSWALDO GARCIA, JOHN J. BRALIN, AND RENÉ ESTEVAN ARREDONDO

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).

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The abstract for this article can be found in this issue, following the table of contents.
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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

Solar Radiation Data Rescue at Camagüey, Cuba

BY JUAN CARLOS ANTUÑA, ARAMIS FONTE, RENÉ ESTEVAN, BORIS BARJA, ROBERTO ACEA, AND JUAN CARLOS ANTUÑA JR.

Although global-scale digitized climate information is abundant, in some countries a considerable amount of information remains in paper records. These valuable records are at risk of being lost forever. Several ongoing efforts are preserving data at risk of deterioration by digitizing them into computer-compatible form for easy access. In a 2004 *Bulletin* article, Page et al. described the following main challenges in such data rescue projects: decaying paper records, missing data (because of damage by improper storage, natural disasters, station operations suspensions, etc.), lack of funds, and the use of obsolete technologies. Although that particular article addressed the situation in Southeast Asia and the South Pacific, the challenges are common to the entire world.

Here we describe the ongoing project for rescuing the solar radiation measurements dataset collected at Camagüey, Cuba. The data have been collected over a period of more than 30 years. Like many of the current meteorological and climatic records in Cuba, these data are only stored on paper, which inhibits various applications. For instance, the need to update procedures for information analysis was one of the barriers to the development of solar energy applications identified by the Cuban report to the Solar and Wind Resource Assessment.

Because of the lack of funding for computer equipment, we have developed a low-cost data rescue design. It is based mainly on using old, out-of-service PCs and involves key-entering software in FORTRAN running under MS-DOS, though the use of state-of-the-art PCs is also possible. Engaging the complete research cycle is fundamental to Cuban science philosophy, and thus to the Camagüey Lidar Station team, so we have also gone further than just rescuing the original observations. The project also has involved developing the software for processing the observations, controlling quality, and improving the original manual processing.

TABLE 1. Instruments used at Camagüey Meteorological Center for solar radiation measurements.

Instrument models
Actinometer M-3
Pyranometer M-80-M, M-115-M
Balanzometer M-10-M
Galvanometer GSA-1MA, GSA-1MB

Usually, meteorological data-rescue projects in less developed countries have been led and supported by international organizations and/or institutions from developed countries. The main reason for this is the lack of funding in the less-developed countries and sometimes a lack of local "know how." In this case, we demonstrate an alternative approach with very few material resources, optimizing both the local technical expertise and scarce material resources.

We believe such low-cost projects in less-developed countries can complement the internationally supported data rescue projects that use state-of-the-art technology.

SOLAR RADIATION MEASUREMENTS.

Measurements at Camagüey Meteorological Station (21.4°N, 77.9°W, 122 m ASL) began in 1966. The manually operated Yanishevsky actinometric instrumentation was provided by the Hydrometeorological Service of the former Soviet Union. Sensors from this station type operate based on the thermoelectric principle. Similar instruments (see Table 1) have collected valuable broadband solar radiation datasets in other

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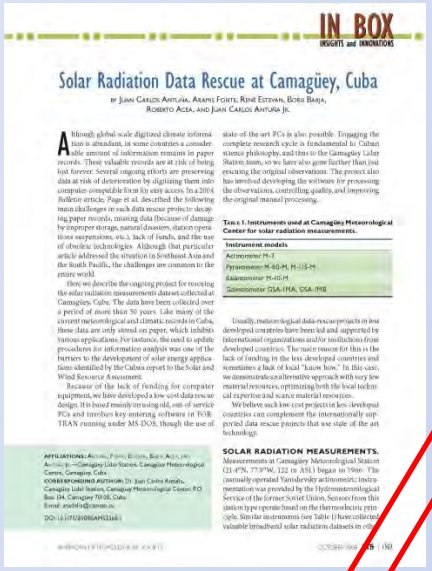
First publication ever by Cuban scientists in BAMS.

Evolution:

Solar Radiation Diagnostic Service

Data Rescue


IN BOX
INSIGHTS and INNOVATIONS

Solar Radiation Data Rescue at Camagüey, Cuba

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Rescued:

Camagüey: 1970 -2014
Jovellanos: 2010-2014
La Fe: 2012-2014
Topes Collantes:2011-2014
Casablanca: ---

Solar Radiation Climatology for Camagüey 1981-2010

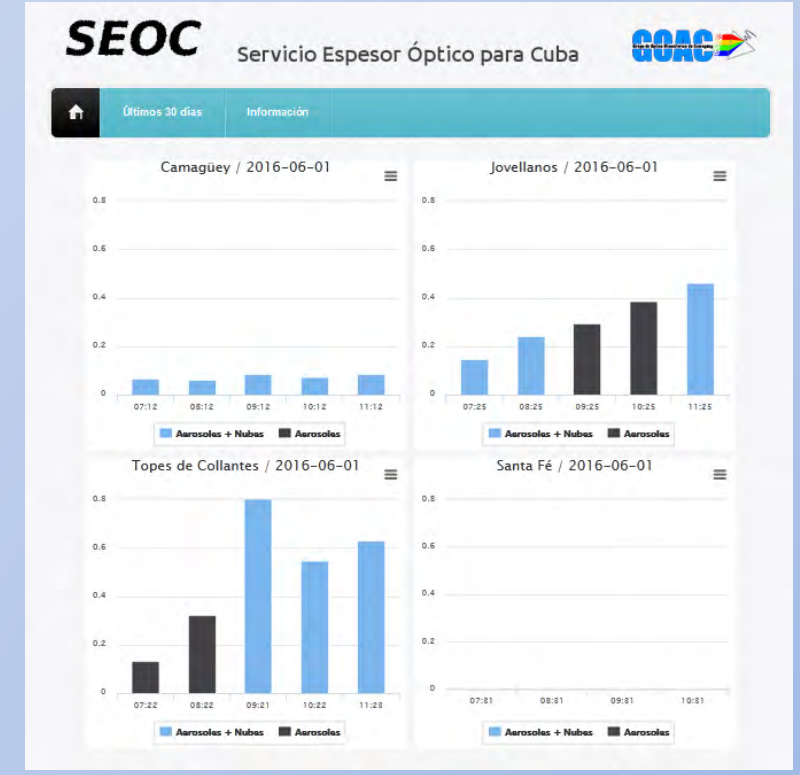
GOAC Online Services:

Solar Radiation Diagnostic Service for Cuba

http://www.goac.cu/actino/

Broadband Optical Depth Service for Cuba (Aerosol & aerosol+cloud)

http://www.goac.cu/seoc/



Real time Meteorological Information for Camagüey (From GPS Met/Station)

http://www.goac.cu/met/index.php

INSMET

Muchas Gracias.

GOAC

Grupo de Óptica Atmosférica de Camagüey