UNAVCO Annual Report

MRI-R2: Acquisition of GPS Equipment for Africa Array

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Principal Investigator: Miller, M. Meghan .

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Organization: UNAVCO, Inc.

Project Participants

Meghan M. Miller, UNAVCO

Charles Meertens, UNAVCO

Andrew Nyblade, Penn State University

Eric Calais, Purdue University

RESEARCH AND EDUCATION ACTIVITIES AND FINDINGS

UNAVCO and AfricaArray (AA) have partnered to create a multidisciplinary research network for the boarder Earth science community by expanding of the AfricaArray seismic network with continuous Global Positioning System (CGPS) instruments fitted with meteorological (met) sensors funded through this project funded by NSF ARRA EAR MRI and the 30% cost-share provided by the three AA founding partners - The Council for Geoscience -aka the South Africa Geological Survey (Pretoria), The University of the Witwatersrand – aka Wits (Johannesburg), and The Pennsylvania State University (University Park). The CGPS/met instrumentation in this distributed observing system will be major leap forward for geodetic infrastructure in Africa that will serve the science needs of a broad range of Earth scientists with interests in plate boundary tectonics and the rifting cycle, geodetic applications, hydrology, and climate change.

With funding from this project CGPS/met instruments will be added to 15 existing AA seismic stations and installed at 5 new stations across eastern, southern and western Africa (Figure 1), forming a 20-station multidisciplinary community facility that will provide continuous high-quality data sets and support unique educational programs serving both American and African students.

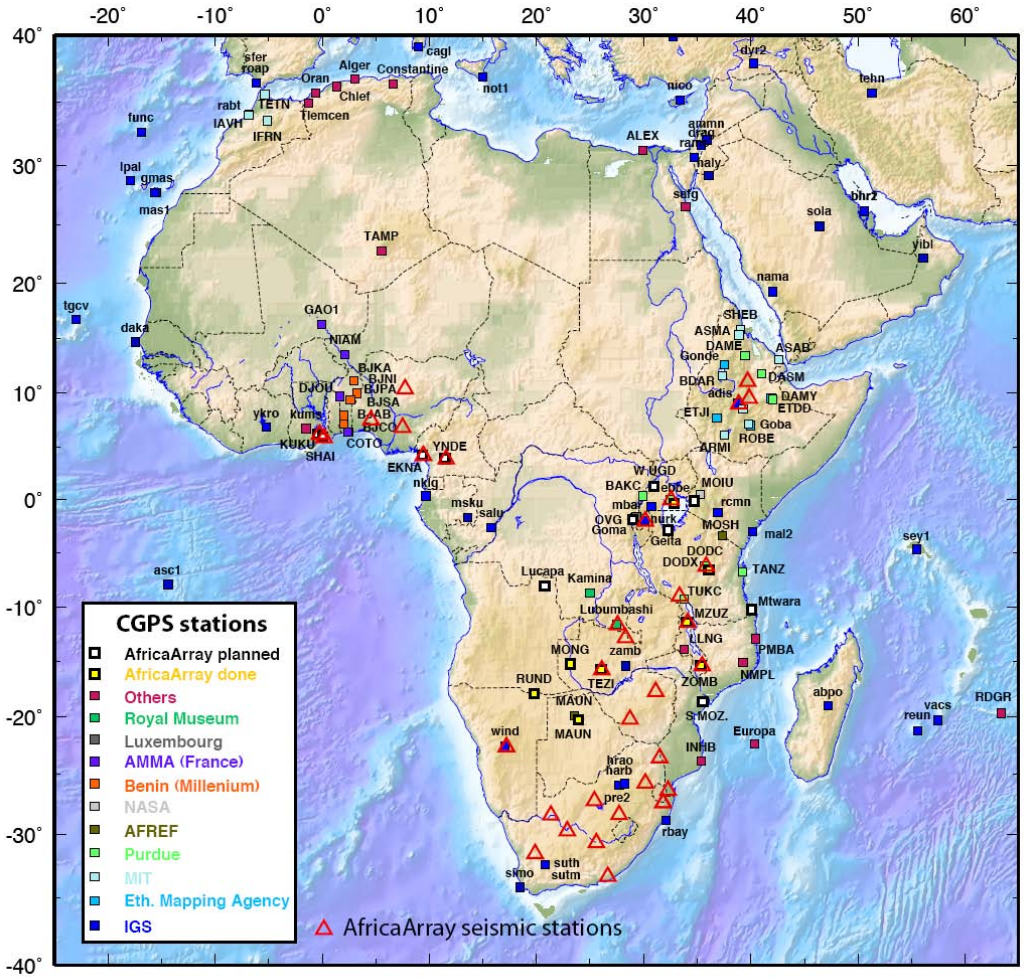

Figure 1. Map showing location of AfricaArray seismic stations, broadband seismic stations operated by other organizations, and proposed CGPS stations where instrumentation requested in this proposal will be installed. Details and status of GPS stations in Africa are given in Table 1.

The Africa Array (AA) seismic network now consists of 38 broadband stations in 15 countries Beginning in August of 2010, continuously operating GPS and weather stations were added to 8 of these stations and 5 more will be installed in January 2011. These sites are marked with red circles in Figure 1 and listed in Table 1.

In 2010 UNAVCO purchased 21 geodetic-quality Trimble NetR8 GPS receivers and all necessary ancillary equipment. This included 21 Vaisala WX520 automated meteorological stations. Twenty instruments will be installed and one is a spare to allow for in the field swapping in the event of instrument failures. We note that 4 additional systems that are owned by PSU will be dedicated to this project and will provide data for AA, in addition to 3 other GPS stations already running in the D.R. Congo and Tanzania equipped with NetRs GPS receivers provided by the Royal Museum for Central Africa in Belgium.

All GPS and met electronics were tested and configured in-house at UNAVCO. In addition, the power, cabling, and enclosure equipment were assembled and the complete systems prepared and shipped to staging areas in Africa.

UNAVCO provided onsite engineer support for the installation of the first 6 GPS/met stations. Two AA technicians from the University of the Witwatersrand and the Council for Geoscineces and one AA Penn State graduate student from Uganda participated in this initial field trip and were trained in all GPS station installation methods (Figure 2 and training section below for details).

Figure 2. The primary August 2010 field team of Zibusisu Gumede, Sarah Doelger, and Robert Kometsi (left to right).

These individuals are subsequently responsible for all future installations and training of any additional technical personnel

In total, 8 stations were installed in 2010 at pre-existing seismic stations including: Dodoma, Tanzania; Rundu, Namibia; Maun, Botswana; Itezi-Tezi and Mongu (Figure 3), Zambia; Zomba and Mzuzu, Malawi; and Entebbe, Uganda. Dodoma and Entebbe sites may be moved if data access from pre-existing sites proves to be reliable. Note that the 4-character station ID MAUN may change pending resolution of a naming conflict.

Two stations each are planned for Ghana and Cameroon and one in Angola beginning early 2011. The remaining GPS equipment will be shipped as necessary from the UNAVCO warehouse.

Data is being collected manually from five of the GPS stations at ~3-6 months service intervals and is then promptly transferred to UNAVCO where it is archived and made available on the public. An internet connection was recently provided for the Maun, Botswana site and UNAVCO is able to pull daily data from the GPS receiver.

Historically, GPS stations throughout Africa have suffered from vandalism and neglect. Poor site security coupled with site/data access difficulties have left a number of current African GPS stations in declining condition or out of use entirely. To help improve security, all existing AA GPS stations were installed on the rooftops of concrete buildings (AA seismic vaults or buildings adjacent to the vaults). The receivers were placed in the closest possible rooms within each building.

Figure 3. The GPS station with meteorological sensor in Mongu, Zambia. The equipment is installed on the roof of the Zambian National Meteorological Survey.

Additionally, in mid 2011, it is expected that a UNAVCO engineer will return to the stations in Zambia and Malawi to install telemetry systems for some of the GPS equipment. These will likely be cellular communications systems. This trip will also serve as training for one or two AA collaborators who will learn to configure and install the telemetry equipment independently at other sites.

Table 1. The status and current plans for 2011 field work.

LOCATION	INSTALL DATE	4-CHAR ID
Rundu, Namibia	Aug. 2010	RUND
Maun, Botswana	Aug. 2010	MAUN
Itezi-Tezi, Zambia	Aug. 2010	TEZI
Mongu, Zambia	Aug. 2010	MONG
Mzuzu, Malawi	Aug. 2010	MZUZ
Zomba, Malawi	Aug. 2010	ZOMB
Entebbe, Uganda	Sept. 2010	ETBE
Dodoma, Tanzania	Sept. 2010	DODM
Kukurantumi, Ghana	Jan. 2011	KUKU
Shai Hills, Ghana	Jan. 2011	SHAI
Ekona, Cameroon	Jan. 2011	EKNA
Yaounde, Cameroon	Jan. 2011	YNDE
Lucapa, Angola	Jan. 2011	TBD
Geita, Tanzania	2011	TBD
Mtwara, Tanzania	2011	TBD
Goma, D. R. Congo	2011	TBD
South central Mozambique	2011	TBD
Western Uganda	2011	TBD
Western Kenya	2011	TBD

TRAINING AND DEVELOPMENT

Zibusisu Gumede (University of Witwatersrand, South Africa) and Robert Kometsi, (Council for Geosciences, South Africa) accompanied UNAVCO engineer Sarah Doelger for the six installations in Botswana, Namibia, Zambia, and Malawi in August (Figure 4). They actively participated in the construction of each site and learned configuration and trouble shooting methods for the GPS receivers/weather stations.

AA PhD candidate Fred Tugume joined the field team for both installations in Malawi. Immediately thereafter, he independently installed the Dodoma and Entebbe stations in Tanzania and Uganda, respectively.

Zibusisu Gumede will be the primary person responsible for organizing all future installations and is equipped to train any other AA technical collaborators. He is also responsible for coordinating data access at the manual download GPS sites.

On site collaborators at many of the GPS stations include meteorologists and geophysicists with interests in the data. In particular, many of the former previously relied on older, more cumbersome, weather instruments. These scientists were instructed in GPS receiver operation and met data processing for their own use.

Figure 4. Left - Robert Kometsi installs the meteorological sensor on top of the seismic vault at Itexi-Tezi, Zamiba. **Right** - Winstone Kapanje (left), a local collaborator with the Geologic Survey of Malawi in Zomba, Fred Tugume, and others help to install the GPS antenna on the roof of the Survey office building.

OUTREACH ACTIVITIES

Collaboration is the hallmark of the Africa Array project. Many participants from public and private institutions throughout Africa are dedicated to building AA's capacity. Technicians onsite have been trained to separate the GPS and weather data so that the weather observations are available immediately to the local met services.

Partnerships and collaborators. The data will be used in the future to train African scientists. Through open data access, all partners and collaborators have access to the data once it reaches the UNAVCO archive. Already, the AFREF data center is accessing the data and redistributing it through their web portal.