AFRICAN GEODETIC REFERENCE FRAME (AFREF)-NEWSLETTER

Secretariat: Regional Centre for Mapping of Resources for Development (RCMRD)

P.O.Box 632-00618, Ruaraka Nairobi, Kenya. Tel: +254-20-8560227/8561775Fax:254-20-8561673

AFREF News Letter No.17 **e-mail: afref@rcmrd.org** **January 2015**

Introduction

The purpose of this newsletter is to inform AFREF stakeholders the status of the establishment of AFREF within the African countries. It also creates a forum for discussions and exchange of information and experiences in the implementation of AFREF.

The objective of the AFREF initiative is to unify and modernize the geodetic reference frame in Africa. The initiative encourages African governments through their national Mapping Agencies to modernise their geodetic networks using modern GNSS technologies. This will involve establishing of a network of CORS that will provide a variety of services including DGPS/RTK correction and supporting various applications such as mapping, engineering, cadastral, weather, geodynamics etc. When fully implemented, it will consist of a network of continuous, permanent GNSS stations such that a user anywhere in Africa would have access to the generated data.

African countries particularly through their national mapping organisations are encouraged to at least establish one CORS and disseminate the GNSS data to AFREF data holding centre.
Other national and international organisations establishing CORS in the continent for various applications such as research on earth sciences are encouraged to disseminate GNSS data to AFREF data holding centres.
GNSS data from AFREF CORS is currently being archived at AFREF Operational Data Centre,(AODC) , http://www.afrefdata.org/ currently being hosted by National Geo Information (NGI) agency in South Africa. You may check the current status.

RCMRD has established on her website under projects, an AFREF data centre, www.rcmrd.org/index.php/afref-data-centre where previous AFREF newsletters are archived and other major AFREF documents including call for participation document.
In this newsletter, we make report on Expert Group Meeting on African Geodetic Reference Frame (AFREF) during UN GGIM meeting in in December 2014 in Tunis Tunisia, Donated GPS receivers for AFREF by Ordinance Survey UK, Determination of ITRF2008 Coordinates for Burkina Faso, Less than Ten Centimeter Real-Time GNSS Positioning Accuracy standalone receivers, Precise Point Positioning (PPP) GNSS data processing.

Muya Kamamia, LS(K), MISK(K)
AFREF Secretariat, RCMRD
P.O.Box 632-00618 Ruaraka, Nairobi, Kenya
Tel. : +254-20-2680748/2680722
E-mail; muyack@rcmrd.org muyack@yahoo.com.

Expert Group Meeting on African Geodetic Reference Frame (AFREF) Adapts first AFREF Coordinates

The Expert Group Meeting on AFREF was held on 08-09 December 2014 in Tunis, Tunisia during United Nations initiative on Global Geospatial Information Management (UN-GGIM) meeting. The main aim of the meeting was to provide the steering committee members a formal opportunity to review and assess AFREF current status and its future development. Dr. Hussein Farah, the Director General of RCMRD who is also the Chair of CODIST-GEO Working Group on AFREF gave a brief status report and future development of AFREF. The following items were also discussed.

The meeting adopted AFREF management structure proposed during the Steering Committee meeting in 2012 at RCMRD. The new management structure was proposed to be aligned with the AU steering machinery comprising of

- Joint Secretariat administered by AU Department of Human Resources, Science and Technology (AU/HRST) and ECA's ICT, Science and Technology Division (ECA/ISTD)
- Technical Advisory Working Group (current CODIST-Geo Working Group on AFREF)
- AFREF Scientific Advisory Working Group (current Science and Technology Advisory Group)

The meeting discussed and formally agreed on the revamping of the AFREF management structure, but ensuring that it fits into the UN-GGIM: Africa operative mechanism. The participants further tasked ECA, AUC and RCMRD to work out the organogram diagram of the management structure to highlight both the political side as well as the operational and technical elements. The organogram diagram should show how the technical side fits into UN-GGIM: Africa and its linked to GGRF.

The meeting discussed and agreed that there is a need for a Network Coordinator and the terms of reference should be developed for the preparation of a Call for participation to appoint a suitable agency to fill that role. ECA, AUC and RCMRD were requested review and identify where the Coordinator should be stationed.

Presentations on Global Geodetic Reference Frame (GGF) and first AFREF computations were then presented.

Presentations on GGTF was done by Mr. Zuheir Altamimi who highlighted the rationale and achievements of GGRF to date including the formulation of the WG TOR, elaboration of the Concept Note on GGRF, organization of a briefing Sessions of UN diplomatic missions in New York and adoption of the draft resolution by the UN-GGIM CE in August 2014. The resolution will be submitted to the United Nations General Assembly in early 2015. The meeting further recommended that the ISC should pass a resolution through UN-GGIM:Africa urging member States to fully support and participate in the GGRF.

Dr Zuheir Altamimi (IGN, France) also made presentations on different ways of realizing regional reference frames, fully consistent with the International Terrestrial Reference Frame (ITRF) and made proposals on general guidelines on how to optimally realize a regional reference frame using IGS data and products and its rigorous alignment to the ITRF.

Mr. Richard Wonnacott presented the interim results of independent solutions being developed by various African scientific teams including HartRAO(South Africa, Ardhi University(Tanzania), Directorate of Surveys and Mapping of Tanzania, and SEGAL (University of Beira Interior Portugal).

Other issue discussed is the Data Policy, Partnership and Capacity building. For full report please check on www.rcmrd.org/index.php/afref-data-centre

Determination of ITRF2008 Coordinates for Burkina Faso

The Institute of Physical Geodesy of Technische Universität Darmstadt (IPGD) carried out the data evaluation and determination of International Terrestrial Reference Frame 2008 (ITRF2008) coordinates for the Continuously Operating Reference Station (CORS) network in Burkina Faso.

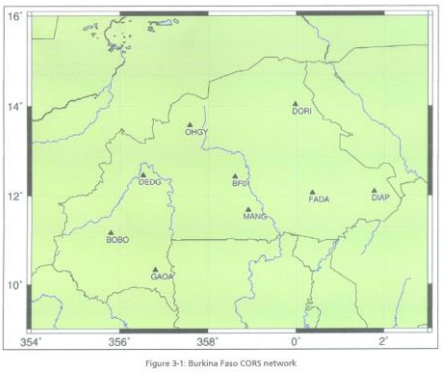


Figure 3-1: Burkina Faso CORS network

These coordinates constituted the determination of the New Burkina Faso Geodetic Datum (NBFGD). The work was carried out as sub-contract to Trimble Europe B.V. as the prime contractor under the Millennium Challenge Account (MCA) Burkina Faso Contract No. 140/ltp18/MrAt03/GD/1 02 01.

The determination of the NBFGD was based on the evaluation of a period of three weeks of GNSS data (GPS+GlONASS) from CORS in Burkina Faso. The overall aim was to achieve the most accurate coordinates of the CORS monuments in ITRF2008 so that the NBFGD would have updated ITRF surface
To achieve the above-mentioned objective, data evaluation was carried out. The figure below shows Burkina Faso CORS Network. For more information on this project, please contact the above-mentioned resource person

Donated GPS receivers for AFREF by Ordinance Survey United Kingdom(UK)

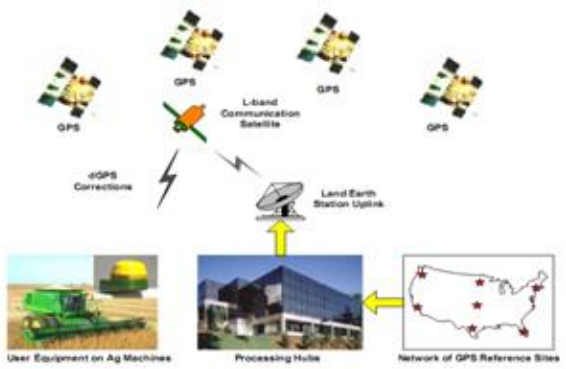
Ordinance Survey (UK) donated 77 used GPS receivers have been received by RCMRD, the current chairing organisation on AFREF.

The equipment shall be distributed to African countries as recommended by the AFREF steering Committee

Less than Ten Centimeter Real-Time GNSS Positioning Accuracy standalone receivers

Standalone GNSS receiver systems with less than six centimetres accuracy in real time positioning accuracy and with global coverage have been available for some time now, but have we been using them our continent?

They are very suitable for those requiring hire accuracy solutions in real time and are in areas with no CORS providing RTK corrections.



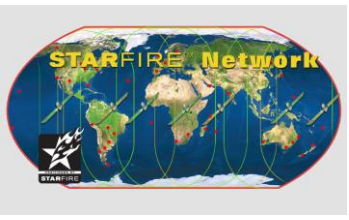
The receiver systems receive RTK corrections from Global Navigation Satellite System (GNSS) Satellite Based Augmentation Systems (SBAS). An augmentation is a method of improving or "augmenting" the navigation system's performances including integrity, continuity, accuracy and availability.

Such Satellite Based Augmentation Systems (SBAS) have a global coverage through the use of geostationary L-band satellites which broadcast the augmentation information.

The ground infrastructure includes a network of Continuously Operating Reference GNSS Stations (CORS) and GNSS data Processing Facility. The processing facility computes integrity, corrections and GEO ranging data forming the SBAS signal-in-space (SIS). The SBAS GEO satellites relay the SIS to the SBAS users which determine their position and time information. For this, they use measurements and satellite positions both from the primary GNSS constellation(s) and the SBAS GEO satellites and apply the SBAS correction data and its integrity to the user.

The augmentation information provided by SBAS covers corrections and integrity for satellite position errors, satellite clock – time - errors and errors induced by the estimation of the delay of the signal while crossing the ionosphere. For the errors induced by the estimation of the delay caused by the troposphere and its integrity, the user applies a tropospheric delay model. Such augmentation information is normally provided via subscription.

There are two main such systems currently in the world includes **Starfire** and **TerraStar**



The Starfire is owned by NavCom Technology, Inc.,USA, a John Deere Company, is a leading provider of advanced GNSS products for OEMs, VARs

and system integrators needing high performance RTK systems, global five centimeter level GPS satellite corrections, geodetic quality GNSS receivers, wireless communication products and engineering consulting in the areas of precise positioning, wireless communications and robotics.

Starfire service is available via their geostationary satellite and also over the internet via NTRIP. StarFire™ utilizes a network of more than 40 GNSS reference stations around the world to compute GNSS satellite orbit and clock corrections. The StarFire™ global subscription service provides real-time accuracy typically better than 5cm.

The service is supported by Microsurvey FieldGenius and Calrson Ce field softwares.

To use this service, the user must procure Navcom receivers and subscribe to the services. For more info please check their site; http://www.navcomtech.com/navcom_en_US/

TerraStar owns, operates, maintains and controls its Global network of GNSS reference stations and the associated infrastructure to ensure maximum operational reliability of its augmentation services for land precise positioning. This gives TerraStar full control and the ability to respond rapidly to customer requirements and advances in technology.

TerraStar works closely with GNSS receiver manufacturing partners to bring fully integrated capability to the widest group of users and spectrum of applications including Altus Positioning Systems, NovAtel Inc., Septentrio Satellite Navigation and Leica Geosystems These companies provide TerraStar integrated receivers for a range of users and applications, from portable pole mounted survey to vehicle mounted and OEM embedded systems. Some Chinese GNSS receivers manufacturers using Novatel and Sepentrio board could also producing TerraStar supported GNSS receiver systems. All Leica and Geomax GNSS receiver use Novatel boards.

TerraStar operates, maintains and controls own network of over 80 GNSS reference stations to ensure maximum operational reliability.
TERRASTAR-D is the precise positioning service designed to deliver less than 10cm level positioning accuracy globally. The service is based around Precise Point Positioning (PPP) - a technique.

TerraStar services are available via subscription and can be purchased through e-Commerce System.

TerraStar receivers are also supported Microsurvey FieldGenius and Calrson Ce Field software. For information on TerraStar, please check their website at http://www.terrastar.net/

Precise Point Positioning (PPP) GNSS data processing

Precise point positioning (PPP) is a method that performs precise position determination using a single GPS receiver. This positioning approach arose from the advent of widely available precise GPS orbit and clock data products with centimeter accuracy. These data can be applied to substantially reduce the errors in GPS satellite orbits and clocks, two of the most significant error sources in GPS positioning. Combining precise satellite positions and clocks with a dual-frequency GPS receiver, PPP is able to provide position solutions at centimeter to decimeter level, which is appealing to many applications. PPP is different from double-difference RTK (real-time kinematic) positioning that requires access to observations from one or more base stations with known coordinates. The word "precise" is also used to distinguish it from the conventional point positioning techniques that use only code or phase-smoothed code as the principal observable for position determination. The following are some software available for Precise Point Positioning (PPP);

GIPSY-OASIS, or GIPSY: the GNSS-Inferred Positioning System and Orbit Analysis Simulation Software package, developed by the Jet Propulsion Laboratory (JPL), and maintained by the Orbiter and Radio Metric Systems (ORMS) group. https://gipsy-oasis.jpl.nasa.gov/

NRCan PPP: Global GPS post-processing service, developed by Natural Resources Canada. http://www.nrcan.gc.ca/earth-sciences/geomatics/geodetic-reference-systems/tools-applications/10925

MagicGNSS: GNSS Orbit Determination and Precise Positioning software developed by GMV, Spain. http://magicgnss.gmv.com/

Bernese Software: GPS/GLONASS post processing package developed by Astronomical and the Physical Institutes of the University of Bern, Switzerland. http://www.bernese.unibe.ch/

GAPS : The University of New Brunswick (UNB) developed the GPS Analysis and Positioning Software (GAPS).

gLAB Software: ESA/UPC GNSS-Lab Tool suite (gLAB) is an interactive software package for GNSS data processing and analysis, including Precise Positioning. www.gage.es

Navigation Package for Earth Observation Satellites (NAPEOS): software system for GNSS data processing and Multi-satellite high precision orbit determination developed and maintained by the European Space Operations Centre (ESOC) of the European Space Agency (ESA). http://www.positim.com/

EZSurv: software for GNSS data post processing. In addition to PPP processing in both Static and Kinematic data, it's also does baseline processing in all automatically. It uses both RINEX data format and a variety of other receiver native data formats including Altus-PS, Ashtech™ProMax500, CHC Navigation, Hemisphere GNSS, Javad, Kolida, NavCom, Novatel, Pentax, Septentrio, South GNSS, Stonex, Topcon and Unistrong. It also allows automatic download of worldwide CORS GNSS data during processing. www.effigis.com

All the aforementioned PPP SW require the availability of precise reference satellite orbit and clock products, normally computed using a network of GNSS reference stations distributed worldwide. The International GNSS Service (IGS) uses its global network to compute orbit and clock products used by several of the PPP providers. In fact, some of the central processing facilities that collaborate with IGS in the computation of these products are the same as the ones listed above; JPL, ESOC, NRCan, CODE (Bern University).

Among these institutions, some of them offer online processing whereby one is required to submit RINEX observation files and the data will be processed and then the PPP solution is

obtained and sent back. Some of these free online services includes;

GAPS: available as an online post-processing engine via their webpage. Static as well as kinematic processing is possible. They accept an observation file in the RINEX 2.10 or 2.11 formats with GPS data. IGS orbits and clocks necessary for processing the observations are automatically retrieved from one of the IGS global data centers.

magicPPP: processing static and kinematic GPS and GLONASS real-time data in RINEX format. Only dual-frequency PPP is supported. Real-time GPS and GLONASS orbits and clocks needed by PPP are generated internally (magicODTS). Rapid and final GPS orbits and clocks from IGS are also used, if available.

Automatic Precise Positioning Service (APPS): using GIPSY software, APPS supports input in RINEX 2.10, RINEX 2.11 files and GIPSY TDP files to process static and kinematic GPS real-time data. http://apps.gdgps.net/

NRCan PPP: provides post-processed position estimates from GPS observation files submitted by the user in RINEX format. Single station position estimates are computed for users operating in static or kinematic modes using precise GPS orbits and clocks from IGS global data centers.

Workshops and Training announcements

Training on AFREF and Processing of Global Navigation Satellite System (GNSS) Data

Training on African Geodetic Reference Frame (AFREF) and Processing of Global Navigation Satellite System (GNSS) workshop is scheduled from 6th to 10th July 2015 at Regional Centre of Resources for Development for Resources (RCMRD), Nairobi, Kenya. This is an annual training held at RCMRD.

Here blow is 2014 AFREF participants drawn from Botswana(1), Burundi(1), Ethiopia(3), Kenya(7), Lesotho(1), Namibia(2), South Sudan(1), Sudan(6), Swaziland(1), Uganda(1), Tanzania(1), Rwanda(1)

The main objective of the course is to build the required technical capacity to implement and operate the Africa Reference Frame (AFREF) project. It is designed to provide practical skills in setting up Continuous Operating GNSS Reference Stations (CORS), processing of GNSS data and operationalization of AFREF project at national level. The topics to be covered will include GNSS technology, CORS instruments and set up, observation requirements and planning, CORS geodetic network design, reference systems and coordinate systems and GNSS data processing.

For more information and application, please visit our website, for more information www.rcmrd.org or contact muyack@rcmrd.org

United Nations Office for Outer Space Affairs Meetings and Workshops for 2015 related to GNSS technologies

1-The United Nations/Russian Federation Workshop on the Applications of Global Navigation Satellite Systems (GNSS) is to be organized by the Office for Outer Space Affairs in cooperation with the Russian Federal Space Agency (Roscosmos), the Reshetnev Information Satellite Systems Joint Stock Company of the Russian Federation, and the International Committee on Global Navigation Satellite Systems (ICG). The workshop will be hosted by the Reshetnev Information Satellite Systems Joint Stock Company and will be held in Krasnoyarsk, Russian Federation, from 18 to 22 May 2015. The detailed information about the Workshop is available on the website of the Office for Outer Space Affairs at: http://www.unoosa.org/oosa/en/SAP/gnss/index.html.
Please note that an on-line application form is available on the website of the Office for Outer Space Affairs at the following address:
https://register.unoosa.org/civicrm/event/register?reset=1&id=31

2-The United Nations International Meeting on Global Navigation Satellite Systems is scheduled to take place from 14 to 18 December 2015 in Vienna, Austria. This International Meeting will mark the growth and results the International Committee on Global Navigation Satellite Systems has experienced since its establishment in 2005.The Meeting will also build on the achievements of past international meetings and regional workshops on the applications of GNSS in order to review the status of follow-up projects and initiatives and to consider the kind of support that could be provided by ICG for the benefit of all.