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.10 **e-mail: afref@rcmrd.org** **January 2010**

Introduction

The purpose of this newsletter is to create 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 for Africa and the national and regional reference networks. When fully implemented, it will consist of a network of continuous, permanent GPS stations such that a user anywhere in Africa would have free access to the generated data.

I am pleased to welcome you to read the tenth edition of the AFREF newsletter. I also take the opportunity to thank Dr Lazarus M. Ojigi of Space Applications Department, National Space Research & Development Agency (NASRDA), Abuja, Nigeria for contribution on 'The Role of Orthometric Heights Baseline in Validating the EGM08 for Africa' and Mr. Barde Jatau and Mr. Olaide Onabajo for contributing the report on Acquisition and Installation of OSGOF AFREF CORS stations in Nigeria.

In this issue we report on the AFREF Experts Group Meeting Held at Ile-Ife, Nigeria on 9-11 February 2010 on determining the Optimum Locations of Permanent GNSS Stations for first AFREF Computation.

We also like to encourage you to contribute articles to this newsletter. Any articles on GNSS, new base station installation, GNSS networks establishments in African countries, experiences etc are welcome. Lets encourage each other implement AFREF by letting others know what your are doing.

Also log on to the AFREF website, http://geoinfo.uneca.org/afref/ for more information on AFREF and more important, invitation for call for participation. The call for participation paper is downloadable from the site.

Muya Kamamia
AFREF Secretariat
Regional Centre for Mapping of Resources for Development (RCMRD)
P.O.Box 632-00618 Ruaraka, Nairobi
Kenya
Tel:+254-20-8560227/8561775;
Fax:254-20-8561673
E-mail-farah@rcmrd.org, muyack@rcmrd.org

Report on the AFREF Experts Group Meeting Held at Ile-Ife, Nigeria on 9-11 February 2010 on determining the Optimum Locations of Permanent GNSS Stations for first Computation

The main aim of the workshop was to enhance regional and national expertise for implementation, operations, processing and analyses of modern geodetic techniques. The formal objectives were:

- Present, discuss and adopt the correct methodologies for the future computing of transformation parameters
- Determine minimum density of stations to enable first computation of Africa's reference frame
- Review the locations of existing stations
- Determine gaps and optimum location of stations pledged by Ordnance Survey
- Review alternative computation methods and develop guidelines for the computations
- Agree on work programme and timeline for the first official computation.

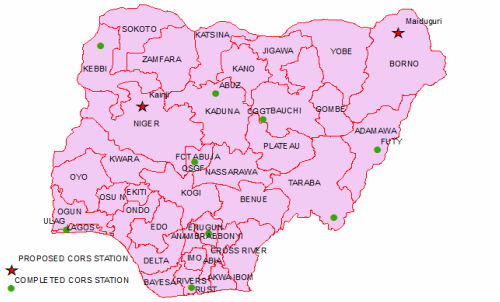
The meeting also made recommendations on actions required to guide member States efforts in the refining of the transformation parameters from the different geodetic reference figures of the Earth, datum and co-ordinate systems in Africa to a same common reference system.

The meeting was attended by high-level experts selected from academia, research institutions, government, the private sector and other regional and international organizations. ECA organised and supported the all costs of the meeting.

Acquisition and Installation of OSGOF AFREF CORS station

The Federal Government of Nigeria through the Office of the Surveyor- General of the Federation (OSGOF) acquired eight (8No.) state of the art Global Navigation Satellite System (GNSS) equipment from Trimble. The office made a laudable landmark by installing the first ever Continuously Operating Reference Station (CORS) in the country on the 7th August, 2009 on top of the office complex at Garki II, Abuja.
Owing to the importance of these stations and the effort to realize a good geometrical Networks of CORS stations covering the entire country, the Federal Government through the Office of the

Surveyor-General of the Federation has completed arrangement to install additional two (No 2) CORS stations in the Borno (Maiduguri) and Niger (Kainji). The Data from these CORS stations, when fully operational, will be useful for Geodetic, Meteorological and Hydrological applications and hence aid in National and International decision making.



Map of Nigeria showing AFREF CORS Stations

OSGOF AFREF Stations Vision

OSGOF's vision which is in line with ITRF/AFREF vision is to ensure that GNSS data of high integrity permeate every aspect of society and will be available in the form and when required to aid decision making with minimal pre-processing.

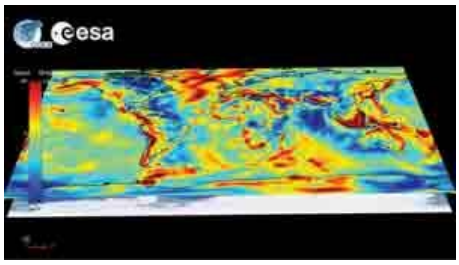
OSGOF AFREF receiver and Antenna

Nigerian AFREF Data Centre (OSGF CORS Station)

The Nigerian AFREF Data Centre is located at the Office of the Surveyor-General of the Federation, HQT Abuja (OSGF CORS station). The Data Centre consist of the 12U Rack which houses the NET R8 receiver, the hp window 7 pro Server which is the latest product in the market, consisting of eight removable hard disc each having 500GB storage space and the Cisco 1800 series. Also in the data centre are the internet server and the Desktop computer.

The Data centre is powered with the commercial power supply and solar system to forestall power interruption at the centre.

More accurate Geoid from Satellite Gravimetry



Following the launch and in-orbit testing of the most sophisticated gravity mission ever built, ESA's GOCE satellite is now in "measurement mode", mapping tiny variations in Earth's gravity in unprecedented detail. The "Gravity field and steady-state Ocean Circulation Explorer" (GOCE) satellite was launched on 17 March from northern Russia. The data now being received will lead to a better understanding of Earth's gravity, which is important for understanding how our planet works. It is often assumed that gravity exerts an equal force everywhere on Earth. However, owing to factors such as the rotation of the planet, the effects of mountains and ocean trenches, and density variations in Earth's interior, this fundamental force is not quite the same all over. Over two six-month uninterrupted periods, GOCE will map these subtle variations with extreme detail and accuracy. This will result in a unique model of the geoid – the surface of an ideal global ocean at rest. A precise knowledge of the geoid is crucial for accurate measurement of ocean circulation and sea-level change, both of which are influenced by climate. In addition, by providing a global reference to compare heights anywhere in the world, the GOCE-derived geoid will be used for practical applications in areas such as surveying and leveling. Contact ESA, www.esa.int

The Role of Orthometric Heights Baseline in Validating the EGM08 for Africa

Introduction

Precise geoid modelling for African countries is imperative and crucial to the substance of earth surface/science research and infrastructural developments in all its towns and cities. Geoid modeling is the representation of the geoid with respect to a reference ellipsoid. The separation between the geoid and the reference ellipsoid is the geoid height (*N*). The reliability of the geoid

model will depend on the accuracy and horizontal resolution (spacing) of the geoid heights. The development and analysis of an accurate geoid model encompasses four (4) essential elements: *Theory*, *Data*, *Coding and Processing*, and *Validation* (*http://www.nrcan.gc.ca*). The African Geodetic Reference Frame (AFREF) Project will be adjudged most successful at the end of the day if it is able to deliver a common vertical reference datum and geoid for Africa. However, this feat is not without some notable challenges, which could be surmounted, if there is total commitment and cooperation among the stakeholders.

The determination of a national or local geoid would traditionally require elevation data from three basic methods, namely *gravimetric*, *ellipsoidal* and *orthometric* heights. The determination of geoidal separation or undulation (*N*) from the combinations of *gravimetric and ellipsoidal (WGS84)*, or *orthometric and ellipsoidal (WGS84)*, or *the three* for the development of national and continental geoid model for Africa has been a great and difficult task. Reasons that can be adduced for this difficulty include, none availability of relevant data, incomplete data and unorganized databases, non-homogeneous data format, different data standards, accuracy and integrity, poor economic and strategic organizations to implement national vertical datum, etc.

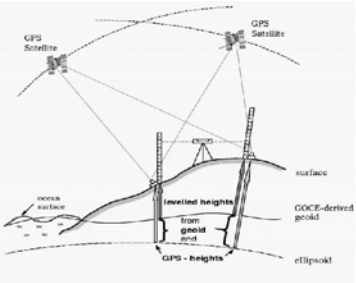


Figure 1: The concept of orthometric height (leveled heights) and ellipsoidal heights (GPS heights) at terrain points with precise geoid heights (Gravimetric/GOCE-derived) about the same adopted reference ellipsoid. (*Source: Johannessen et al, 2003*)

However, on the availability of gravity data for Africa, Merry (2003) reported that continuous coverage over the oceans was available from satellite altimetry data, while on the land there were large blank areas and other areas where the coverage was sparse (figure 2); but recommended that concerted effort be made to fill these gaps, possibly with the aid of airborne gravimetry.

While we wait for the Africa Geoid Project to be concluded, the Global Geoid Model 2008 (EGM08) has a lot of improvement over that of EGM96, which could be adopted as a first approximation for African countries upon validation by the use of baseline orthometric level lines across various regions. A comparison of the EGM08 geoid models to leveled orthometric heights on well conditioned baselines and GPS adjusted ellipsoidal heights on Bench marks (BMs) across the countries of Africa will generate a good basis for geoid integrity test in the sub-regions and countries of Africa.

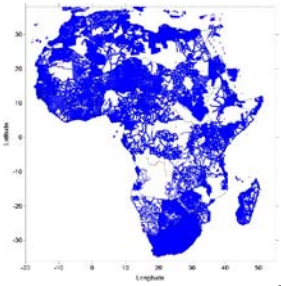


Figure 2: Gravity Data Coverage in Africa (Source: Merry, 2003).

The Role of Baseline Orthometric Heights

The role of the baseline orthometric heights in the validation of EGM08 include, to check the deviation of vertical, estimate the agreement of the geopotential model on the adopted geoid model and the orthometric baselines, the computation of the long wavelength component of height anomalies from the EGM08 geopotential model, and the re-computation of the absolute difference in heights for selected sites. Modeling the difference between gravimetric and GPS/levelling geoids will improve the geoid height determination accuracy at a point observed and, thus, help determination of orthometric heights from GPS observations. (Seker and Yildirim, 2007). This approach is imperative as a starting point, while political negotiations are initiated to secure the medium and long-term economic support and political will power of African Nations and Leaders for a complete and total high resolution airborne gravimetric survey of Africa, which should provide the most synoptic coverage and timeliness advantage in the determination of national and continental geoid in tandem with the on-going AFREF Continuous Operating Reference Stations (CORS) Project. The validation of the current global geoid model in various countries of Africa by host mapping agencies and organizations will go along way in awakening national survey and mapping consciousness in the area of vertical datum surveys. The arrival of new methodologies in height determination via satellites and airborne imagery technology should not erode the classical approaches that could be used from time to time in ascertaining the validity and certainty of the

newer methods. The national mapping agencies in African countries should be proactive in this direction, because Africa as a continent is endowed with rich human and material resources; hence should take the driving seat of her destiny.

Suggestion

i. The Mapping Agencies in African Countries should take the task of accurate and reliable vertical datum and geoid determination for their countries and Africa very seriously.

ii. The African Geoid Project being handled by Commission II (Gravity Field Commission) of the International Association of Geodesy (IAG) should be pursed to a logical conclusion.

iii. The African Union Governments should collectively see the African Geoid Project as a positive paradigm for sustainable development in Africa, and give it full economic and political support.

References

Johannessen, J. A, Balmino, Le Provost, G. C., Rummel, R., Sabadini, R., Sünkel, H., Tscherning, C. C., Visser, P., Woodworth, P., Hughes, C. W., Legrand, P., Sneeuw, N., Perosanz, F., Aguirre-Martinez, Rebhan, H., and Drinkwater, M. R. (2003).T*he European Gravity Field and Steady-State Ocean Circulation Explorer Satellite Mission: Its Impact on Geophysics. Kluwer Academic Publishers. Surveys in Geophysics* **24:** 339–386, 2003.

Seker, Z. D., and Yildirim, A. (2007). Orthometric Height Derivation from GPS Observations. FIG XXII International Congress Washington, D.C. USA, April 19-26 2002.

Merry, L. C (2003). The African Geoid Project and Its Relevance to the Unification of African Vertical Reference Frames. 2nd FIG Regional Conference Marrakech, Morocco, December 2-5, 2003

National Resources Canada *Height Reference System Modernization: Geoid Modelling - Public Models.* Canadian Spatial Reference System**.** http://www.nrcan.gc.ca. For more info, contact Dr Lazarus M. Ojigi at *lmojigi@yahoo.com*, *lmojigi@futminna.edu.ng*

Training Opportunities on Satellite Navigation Science and Technology for Africans

5th Annual AFREF & GNSS Data Processing Course, 24th August to 3rd September 2010, RCMRD, Nairobi, Kenya

RCMRD in conjunction with the Center of Geophysics of the University of Lisbon, Portugal and HARTRAO South Africa have been conducting an annual course on African Reference Frame (AFREF) and Global Navigation Satellite System (GNSS) Data Processing at RCMRD offices in Nairobi Kenya annually since 2006. This year, the course will be held on 24th August to 3rd September 2010. The Objectives of the course is to provide technical skills in the installation of GNSS base stations, data handling, dissemination and processing towards AFREF realization. The content includes the following;

- Introduction to Global Navigation Satellite System (GNSS)
- Reference systems, datum, datum transformations and coordinate systems
- IGS data and products
- AFREF concepts and progress
- Establishment of Continuously Operating Reference GNSS Stations
- Practical field works on Static GNSS surveys
- GNSS data post processing
- On line GNSS Data processing

Second Workshop on Satellite Navigation Science and Technology for Africa, 6 - 24 April 2010, Miramare, Trieste, Italy

The Abdus Salam International Centre for Theoretical Physics, in co-operation with the Boston College of the United States, is organizing a Second Workshop on Satellite Navigation Science and Technology for Africa from 6 to 24 April 2010, under the framework of the cooperation MOU signed by the two institutions. It will be directed by Professors P. H. Doherty (Boston College, USA), and S. M. Radicella (ICTP, Trieste, Italy). The first workshop successfully took place in 2009. The deadline for application was 1st December 2009 but you may check on the following address and website by the end of the year for the third workshop. smr2135@ictp.it and http://www.ictp.it/