

The Africa Reference Frame Project – AFREF & South Africa's TrigNet System

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International Committee on GNSS
Pasadena, California
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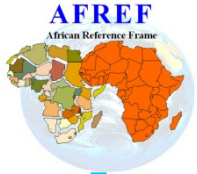


The Africa Reference Frame Project – AFREF



Overview

- **Background**
- **Rationale**
- **Objectives**
- **Institutional acceptance**
- **Structure**
- **Progress**
- **Present situation**
- **Comments and concerns**
- **Conclusion**



Background

- **Fundamental point of departure for projects, services or products requiring geo-spatial information is a uniform & reliable co-ordinate reference frame.**
- **Over 50 countries in Africa each with their own geodetic reference system and frame and some with 2 or more systems.**
- **Although there are many areas of conflict there are also areas where peace has been restored and require a lot of development.**
- **It is known that many private commercial enterprises are setting up their own reference frames particularly in the oil and mining industries.**
- **AFREF is, therefore, an African initiative to unify the geodetic reference frames of Africa based on the ITRF through a network of GNSS base stations at a spacing such users will be at most within ~1000 km of a base station.**



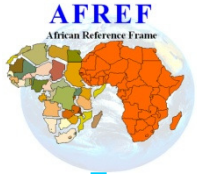
Rationale

- **Surveying & Mapping**
- **Security**
 - Unique international boundary definition
- **Science**
 - Atmospheric research
 - Geophysics research
- **Disaster mitigation**
 - 59% of disasters in Africa are hydro-meteorological in nature
 - drought and flooding (climate monitoring & weather prediction)
- **Infrastructure planning & development**
- **Gap in global coverage & contribution to Global Geodetic Observing System (GGOS) part of GEO etc**



Objectives of AFREF 1

- To determine a continental reference system for Africa consistent and homogeneous with the global reference frame of the ITRF as a basis for national 3-d reference networks.
- To realize a unified vertical datum and to support efforts to establish a precise African geoid.
- To establish continuous, permanent GNSS base stations at a spacing such that the users will be within 1000km of a base station and that data is freely available to all nations.
- Understand the necessary geodetic requirements of participating national and international agencies.



Objectives of AFREF 2

- To determine the relationship between the existing national reference frames and the ITRF to preserve legacy information based on existing frames.
- To provide a sustainable development environment for technology transfer so that these activities will enhance the national networks and other applications.
- Assist in establishing in-country expertise for implementation , operation, processing and analysis of modern geodetic techniques, primarily GNSS.



Structure 1

The structure reflects the broad concepts of AFREF that:

- It is to be designed, managed and executed from within African;**
- It is to be organized on a regional basis;**
- It is to be executed at the national level; and**
- Technical expertise and support will come from the international geodetic community such as IAG, IGS etc.**

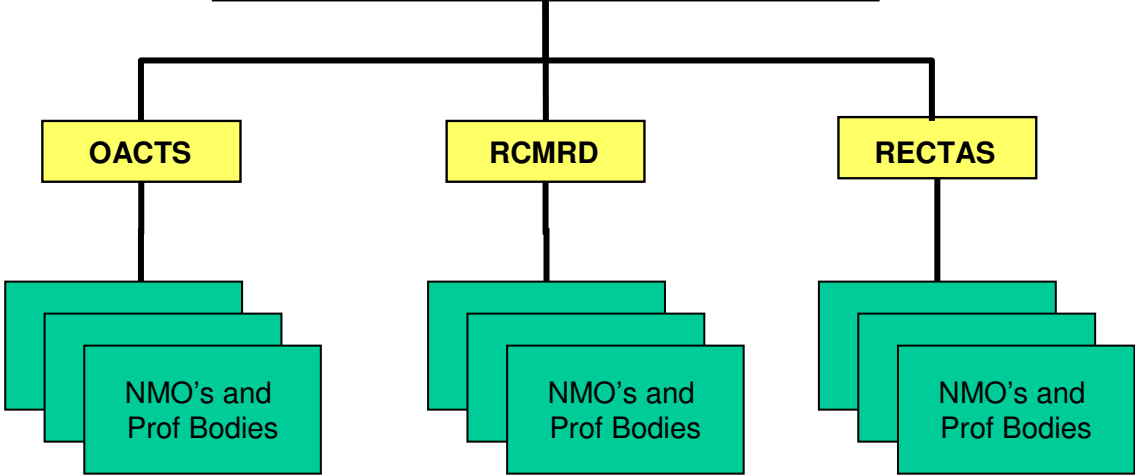


Structure 2

Technology Advisory Group
Made up of scientists from Africa

CODI
Chair plus Representatives from
CAFREF
EAFREF
NAFREF
SAFREF
WAFREF
IAG Sub Commission 1.3d
HartRAO

International Organizations
IAG UNECA CODI
IGS FIG
UNAVCO ISPRS
UNOOSA ICA
NEPAD ??





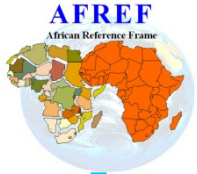
Progress to Date 1

- **Cape Town March 2001:**
 - to gauge level of interest among NMO's in region
 - 8 countries attended and supported project
 - IAG/IGS, EUREF, NIMA supported project
- **Lusaka July 2002**
 - UNOOSA / USA sponsored series of workshops on Use and Applications of GNSS
 - One of the outcomes was recommendation to
 - Establish a continental reference for Africa or AFREF consistent with ITRF
- **Windhoek Dec 2002**
 - 8 Southern and East African countries represented
 - Representative from UN ECA CODIST also present
 - Prepared what has become known as “Windhoek Declaration”



Progress to Date 2

- **Addis Ababa August 2004:**
 - **UNECA CODI-ST Accepted “Windhoek Declaration”**
- **Other meetings**
 - **Nairobi October 2004**
 - **Cairo April 2005 FIG Working Week**
 - **Accra March 2006 FIG Regional Conference**
- **Cape Town July 2006:**
 - **Technical Workshop**
 - **Co-sponsored by 6 organizations incl. IAG, UNAVCO, UNOOSA**
 - **~40 delegates and 15 presenters**



Progress to Date 3

- **Nairobi August 2007 and August 2008:**
 - Technical Workshops
 - Organized by RCMRD in conjunction with the University of Lisbon, the University of Beira-Interior (Portugal) and Hart RAO
 - Dealt with GNSS reference stations and processing of GNSS data
- **Johannesburg June 2008:**
 - Joint meeting to discuss co-operative efforts between:
 - AFREF (Geodesy)
 - Africa Array (Geophysics)
 - IHY (Space physics)
 - AMMA-GPS (Meteorology)
 - Very successful meeting



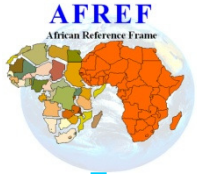
Institutional Acceptance 1

- **UN ECA CODIST (Committee on Development Information, Science & Technology)**
 - Have adopted the Windhoek Declaration
 - Created a Working Group to deal specifically with AFREF
- **UN OOSA (UN Office for Outer Space Affairs)**
 - Have recognized the importance of AFREF for variety of applications
 - Supported travel for June 2008 workshop
- **IAG (International Association of Geodesy)**
 - Have created structures to co-ordinate the project and provide technical assistance and expertise



Institutional Acceptance 2

- **IGS (International GNSS Service)**
 - Has strong commitment to support AFREF
- **FIG (International Federation of Surveyors)**
 - Sponsored workshops in Cairo and Accra
- **UNAVCO (University NAVSTAR Consortium Inc.)**
 - Have strongly supported the project through travel support.



Present situation 1

- **There are about 20 IGS stations in Africa**
 - **CDDIS gives about 30 stations**
 - **Some of these in clusters**
 - **Some not operational**
 - **Some appear to be experimental eg GLONASS only with very little data**

- **There are others which have been installed at academic institutions or airports but are not registered as IGS stations.**
 - **Many of these stations need little or no upgrade to meet IGS standards.**
 - **South Africa has network of 49 continuous base stations.**

- **There are a number of contractors setting up own local systems such as in oil and mining industry .**



Present situation 2

Number of activities underway to install permanent base stations or move towards ITRF

Algeria

Benin

Cameroon

Ethiopia

Kenya

Malawi

Mozambique

Nigeria

South Africa

Tanzania

Uganda

Angola

Botswana

Egypt

Ghana

Lesotho

Moroco

Namibia

Rwanda

Swaziland

Tunisia

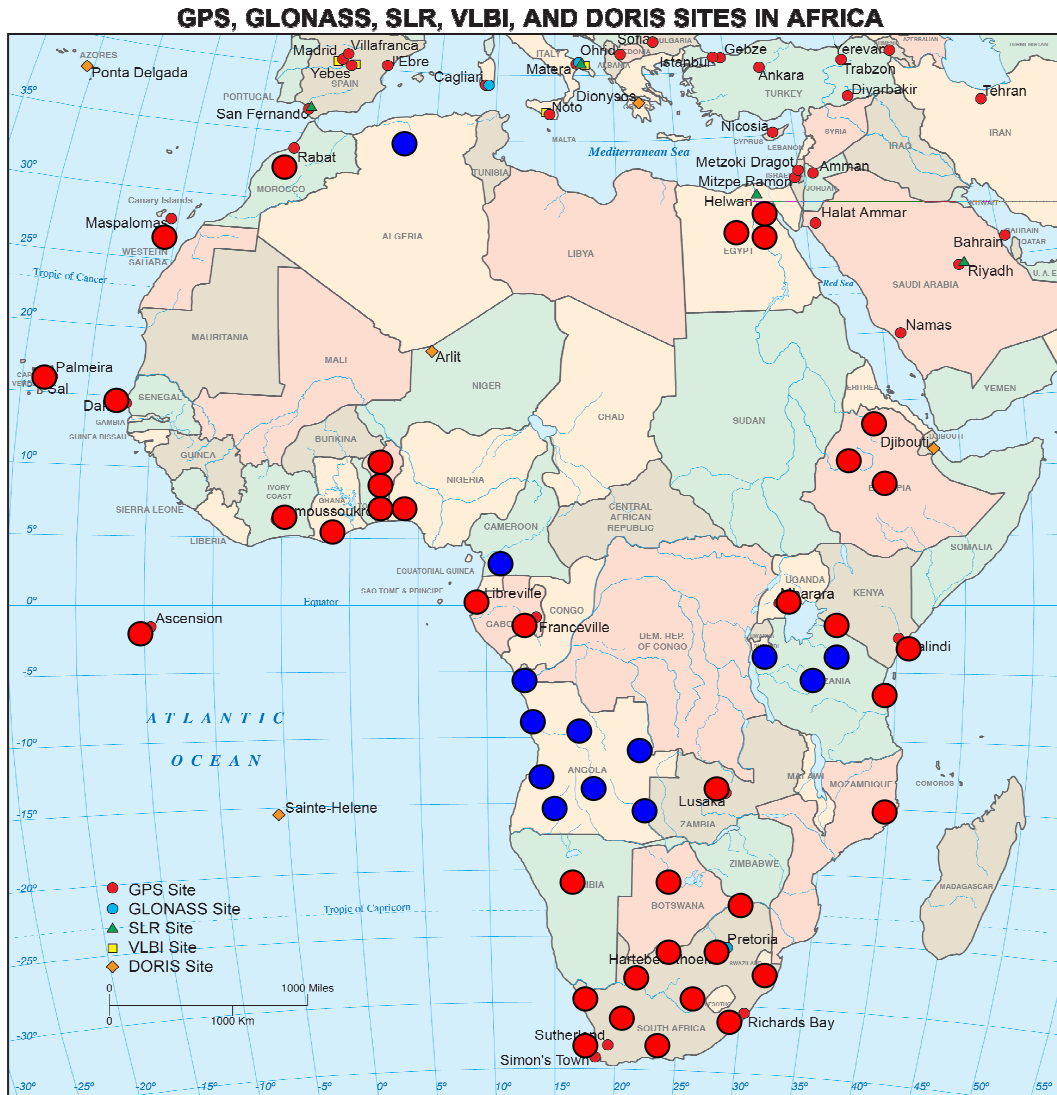
Zambia



Present situation 4

Some known installed and planned GNSS station June 2008
(Not all stations shown for clarity)

- Installed
- Planned





Concerns 1

- **Funding**
 - Would appear to be funds available but how does one access such funds?
 - Seem to be able to get money for workshops etc
 - Manufacturers willing to donate equipment
 - Difficult to get money for long term running costs
- **Political Buy-in**
 - Get AFREF recognised by African political leaders
- **Co-ordination of efforts**
 - There are a number of groups installing or are prepared to install
 - Lack of information on these initiatives
 - Result in duplication of effort



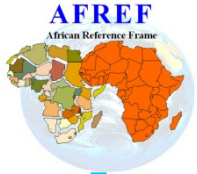
Concerns 2

- **Internet in Africa**

- **Africa's population :** ~1 bn
- **Percentage of population with access to Internet :** ~3.6%
- **Average Connection speed:** 56 kbps
- **Reliability :** Poor
- **Routing:** Indirect
- **Cost of bandwidth in Africa vs. US:** 1000 greater
- **Yearly increase in internet speed worldwide:** 30%
- **Africa's connectivity :** 10-20 years behind
- **Forecast :** The gap is widening

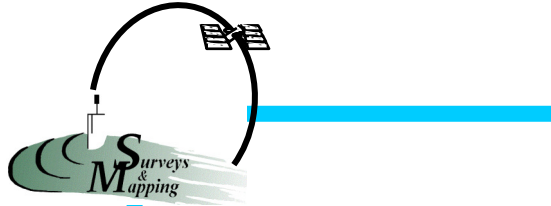
Extracted from:

symmetry - September 2008 - Mapping the Digital Divide - Les Cottrell
www.symmetrymagazine.org (Volume 5 Issue 4)

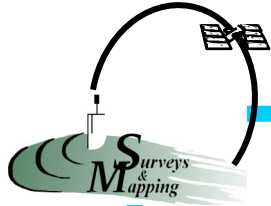


Comments

- **Don't lose sight of aims & objectives of AFREF**
 - Groups installing for specific scientific reasons in name of AFREF but not keeping primary objectives of AFREF in mind.
 - NMO's excluded or superficially included.
 - AFREF is a project to be managed and executed by African NMOs and Universities with International assistance
- **IGS**
 - Supported various workshop
 - Assisted with preparation of CfP
 - Obtained financial support from UNAVCO for Cape Town Workshop July 2006 and other travel
 - Highlight importance of AFREF at every opportunity
 - Point of contact with “assisting agencies” – both technical and financial

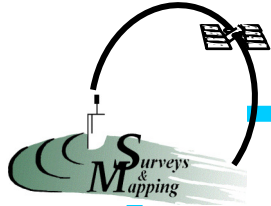


TrigNet – South Africa’s Network of Permanent GNSS Base Stations



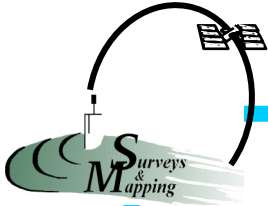
Overview

- **Background**
- **Distribution**
- **Services offered**
- **International project participation**
- **Non-positioning applications**



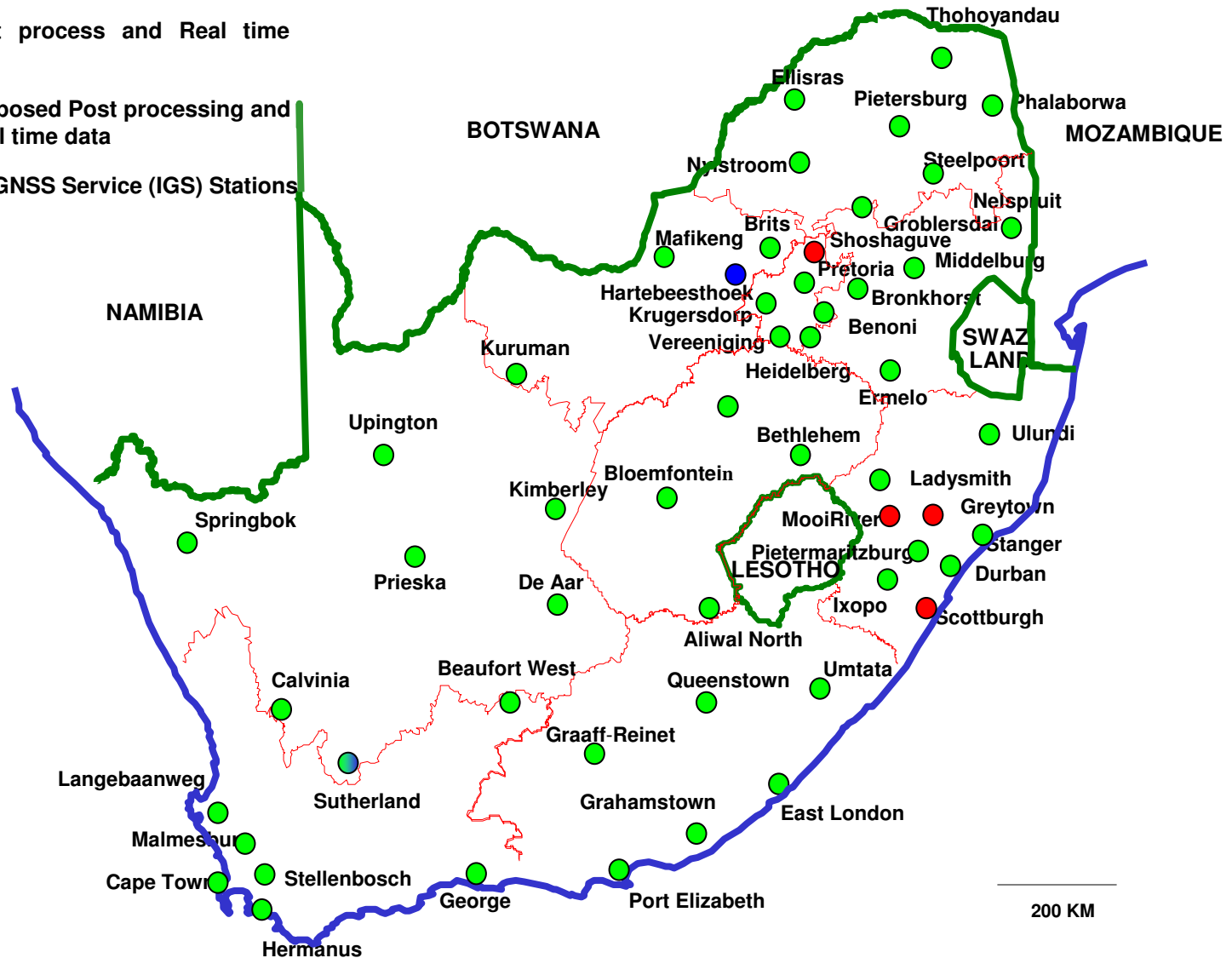
Background

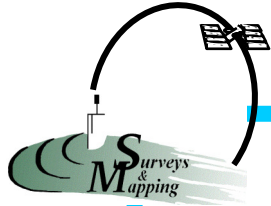
- **The Chief Directorate Surveys and Mapping is mandated to establish and maintain a National Control Survey Network.**
- **Currently have ~58000 passive control points throughout the country.**
- **Commenced with the installation of network permanent GNSS base stations in 1999.**
- **Currently have 49 stations continuously feeding 1 sec dual frequency data to a central control centre near Cape Town.**
- **Of the 49 stations 12 are providing GPS/GLONASS data and the rest GPS only.**



Distribution at Nov 2008

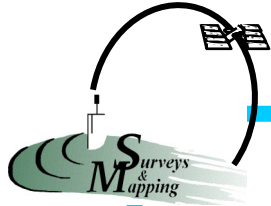
- Post process and Real time data
- Proposed Post processing and Real time data
- Int GNSS Service (IGS) Stations





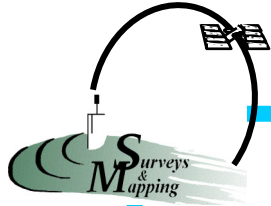
Products

- **Post Processing RINEX Data**
 - 1 sec L1, L2 Daily and hourly files
 - 5 sec L1 only Daily and hourly files
 - 30 sec L1, L2 Daily files
 - Customized RINEX files
- **Real Time RTCM Data**
 - DGPS via NTRIP country wide (VRS Network solution)
 - RTK via NTRIP
 - Single base from all stations
 - VRS Network solution from three clusters
 - Gauteng
 - KwaZulu Natal
 - Western Cape
- **All data and services are free of charge!!!!!!**



International Projects

- **International GNSS Service Real Time Working Group (IGS RTWG)**
 - Trying to establish whether or not a Global Real Time service is feasible
- **International GLONASS Service (IGLOS)**
 - Tracking of GLONASS satellites for orbit estimation and integration of data into IGS framework
- **Constellation Observing System for Meteorology, Ionosphere & Climate (COSMIC)**
 - GPS/MET research - meteorological data collection, using the Global Positioning System



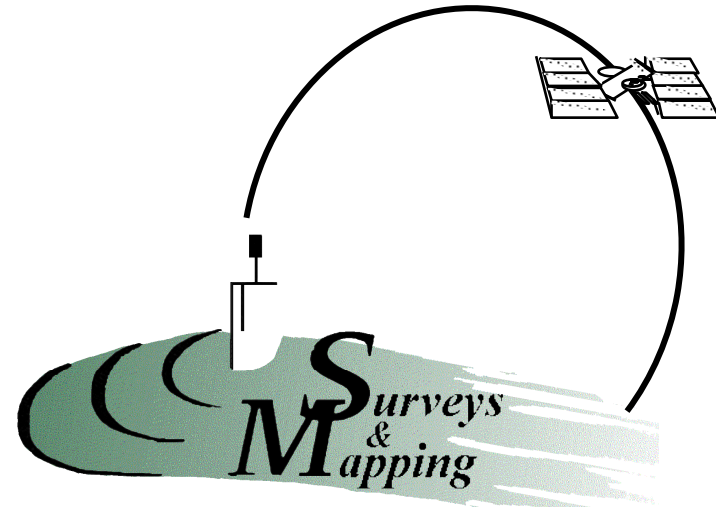
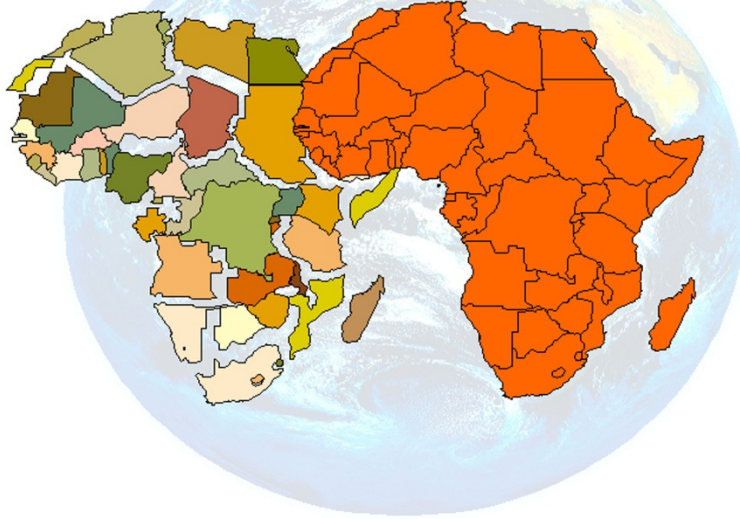
Non-Positioning Applications

TrigNet data has been used for:

- **Geophysics**
 - Plate tectonics
 - Geo-hydrology
- **Space weather**
 - Ionosphere mapping
- **Meteorology**
 - Weather forecasting
 - Climate monitoring

AFREF

African Reference Frame



THANK YOU

<http://geoinfo.uneca.org/afref>

<http://www.trignet.co.za>