A Progress Report on The AFREF Project and It's Potential to Support Development in Africa

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Space Geodesy Workshop

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Overview

- Background
- Rationale
- Objectives
- Progress
- Institutional acceptance
- Structure
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- Way Forward
- 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 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 own reference frames particularly in the oil industry.**
- **AFREF is, therefore, an African initiative to unify reference frames based on the ITRF through network of GPS base stations at spacing such the 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 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.

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.

Progress to Date 1

- **Cape Town March 2000:**
  - **Global Spatial Data Infrastructure (GSDI)**
  - **Need expressed for unified reference frame**
- **Tunisia May 2000:**
  - **Meeting held to North African co-ordinate systems**
  - **6 countries attended**
- **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**
  - **Meeting requested that project go under IAG banner**

Progress to Date 2

- **Lusaka July 2002**
  - **UNOOSA / USA sponsored series of workshops on Use and Applications of GNSS:**
  - **Large number of African countries represented**
  - **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 CODI also present**
  - **Prepared what has become known as “Windhoek Declaration”**

Progress to Date 3

- **Addis Ababa August 2004:**
  - **UNECA CODI Accepted "Windhoek Declaration"**
  - **Established a Working Group on AFREF**
  - **Nominated a Steering Committee**
- **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**
  - **4 days including visits**
  - **~40 delegates and 15 presenters**

Progress to Date 4

- **Nairobi August 2007:**
  - **Technical Workshop**
  - **Organized by RCMRD in conjunction with the University of Lisbon, the University of Beira-Interior (Portugal) and Hart RAO**
  - **Attended by representatives from 8 countries mainly from East Africa**
  - **Dealt with GNSS reference stations and processing of GNSS data**
- **Nigeria September 2007**
  - **AFREF stakeholders forum**

Institutional Acceptance 1

- **UN ECA CODI (Committee on Development information)**
  - Have adopted the Windhoek Declaration
  - Have accepted the importance of AFREF
  - Created a Working Group to deal specifically with AFREF
- **UN OOSA (UN Office for Outer Space Affairs)**
  - Have recognized importance of AFREF for variety of applications
  - Supported the Cape Town workshop
- **IAG (International Association of Geodesy)**
  - Have recognized importance of AFREF and have committed support
  - Have created structures to co-ordinate project and provide technical assistance expertise
  - Supported the Cape Town workshop

Institutional Acceptance 2

- IGS (International GNSS Service)
  - Has strong commitment to support AFREF
  - Supported the Cape Town workshop
- FIG (International Federation of Surveyors)
  - Sponsored workshops in Cairo and Accra
- UNAVCO (University NAVSTAR Consortium Incorporated)
  - Have strongly supported the project
  - Supported the Cape Town workshop
- NEPAD (New Partnership for Africa's Development)
  - Political acceptance
  - Access to funding possibly easier

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

IGS

UNAVCO

UNOOSA

NEPAD ??

UNECA CODI

FIG

ISPRS

ICA

OACTS

NMO's and Prof Bodies

RCMRD

NMO's and Prof Bodies

RECTAS

NMO's and Prof Bodies

Present situation 1

- Up to about 2005 there were about 15 IGS stations in Africa
  - CDDIS gave about 30 stations
    - Some of these in clusters
    - Some not operational
    - Some appear to be experimental eg GLONASS only with very little data
- There were 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 44 continuous base stations.
- There are a number of contractors setting up own local systems such as in oil industry.

Present situation 2

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

- Algeria
- Angola
- Benin
- Botswana
- Cameroon
- Egypt
- Ethiopia
- Ghana
- Kenya
- Lesotho
- Malawi
- Moroco
- Mozambique
- Namibia
- Nigeria
- Rwanda
- South Africa
- Swaziland
- Tanzania
- Tunisia
- Uganda
- Zambia

AFREF
African Reference Frame

Present situation 3

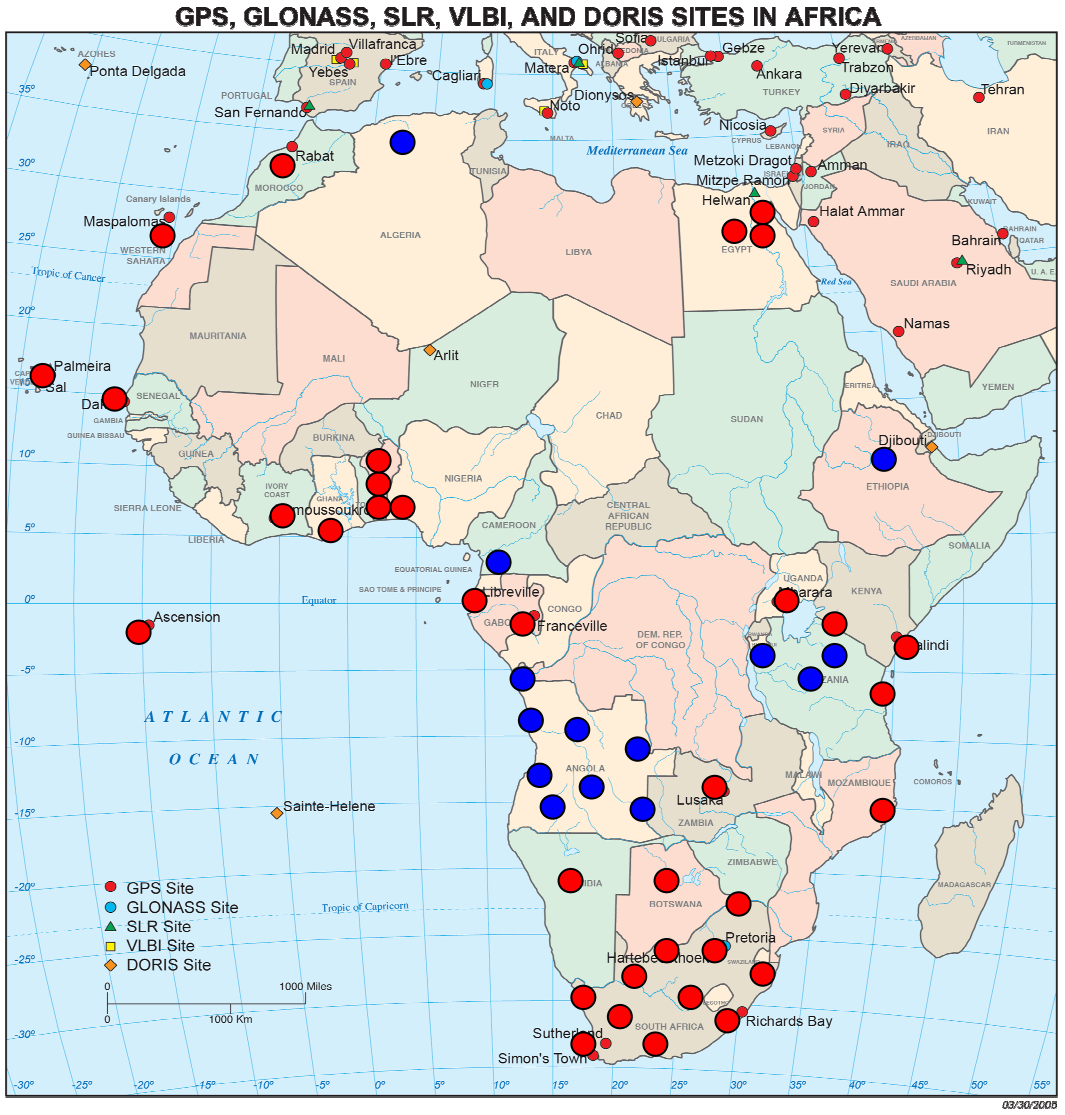
Installed and operational IGS stations ~2005

Present situation 4

Some known installed and planned GNNS station Sept 2007

(Not all stations shown for clarity)

- **Installed**
- **Planned**



Concerns & Comments 1

- **Funding for infrastructure**
  - Would appear to be funds available but how does one access such funds? (eg NASA)
  - Everyone wants ot participate but not open wallets
  - Seem to be able to get money for workshops etc
  - Need to prepare list of possible that meet certain criteria
- **Political Buy-in**
  - Get AFREF recognised as NEPAD project
  - May facilitate fund raising
- **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 & Comments 2

- **Don't loose 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.**
- **IGS & AFREF**
  - **Supported various workshop**
  - **Assisted with preparation of CfP**
  - **Obtained financial support from UNAVCO for Cape Town Workshop July 2006**
  - **Highlight importance of AFREF at every opportunity**
- **Future IGS involvement**
  - **Point of contact with "assisting agencies" – both technical and financial**

Way Forward

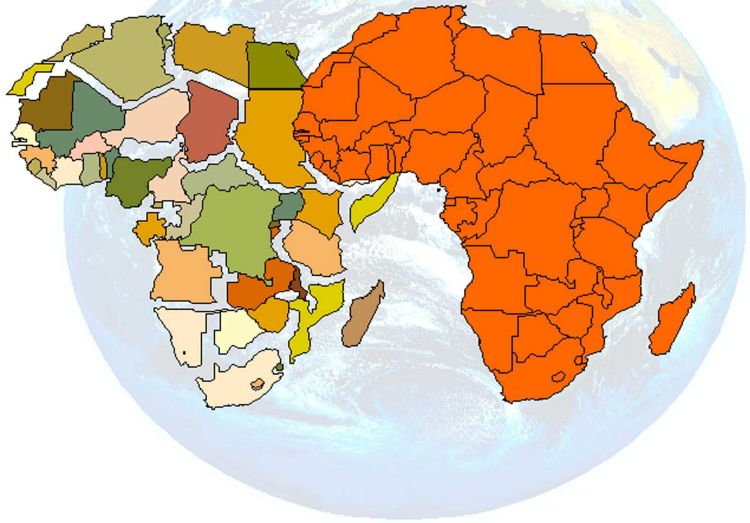
- **Publicity and Political Support:**
  - **Convince NMO's, Govts and International Agencies of importance AFREF – NEPAD's political clout**
  - **Can't plan or do things unless you know where you are!!**
- **Steering Committee has prepared "Call for Participation" which has been distributed to:**
  - **African National Mapping Organizations (NMO's)**
  - **International Organisations**
  - **Funding agencies**
  - **Appropriate equipment maunfacturers and vendors**
    - **Leica & Trimble have donated receivers**
- **Effort to go into getting commitment from NMO's and other role players.**

Conclusion

- **AFREF is an essential element for Africa's Development.**
- **Apart from the geodetic aspects, the AFREF infrastructure of permanent GNSS base stations has enormous potential for scientific research.**
- **The project is starting to gain momentum but needs co-ordination of effort.**

AFREF

African Reference Frame



THANK YOU

http://geoinfo.uneca.org/afref

Extra Slides

Practicalities 1

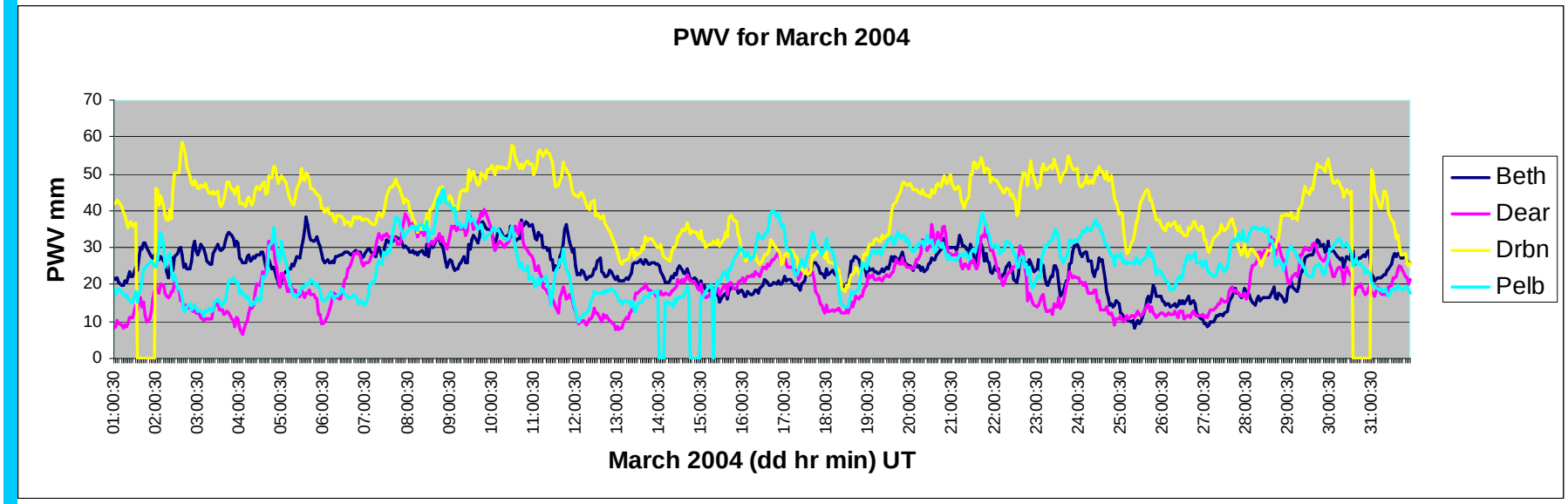
- **Capacity**
  - **Workshops**
    - **Cape Town Workshop cost ~$55000 excluding contribution from home organizations of presenters (~40 delegates & 15 presenters)**
  - **Distance learning???**
- **Telecommunication**
  - **Wide range of telecom technologies**
  - **Variable monthly costs ~$30 (internet) - $300 (diginet)**
  - **Reliability questionable**
- **Power**
  - **Range of power sources**
    - **National power grid**
    - **Solar power**
    - **Wind power**
    - **Diesel generation (ie local generator)**
  - **Reliability questionable**

Practicalities 2

- **Cost**
  - **Permanent Stations**
    - **Capital**
      - **Receivers, antennas and peripheral equipment** **~$ 30000/station**
      - **Control station hardware plus software** **~$ 125000/centre**
    - **Running costs**
      - **Telecommunications 50 stations at average $165/ station/ month** **~$100000 / year**
      - **Ongoing maintenance** **~$ 50000 / year**
        - » **Total estimated running costs** **~$150000 / year**
    - **Redundancy of equipment ??????**
    - **The above excludes cost of any human resources**
  - **Workshops**
    - **~$55000/ workshop of 40 delegates**
  - **Publications**
    - **Reports, handbooks etc 2500 documents @ ~$8each ~$ 20000 per publication**

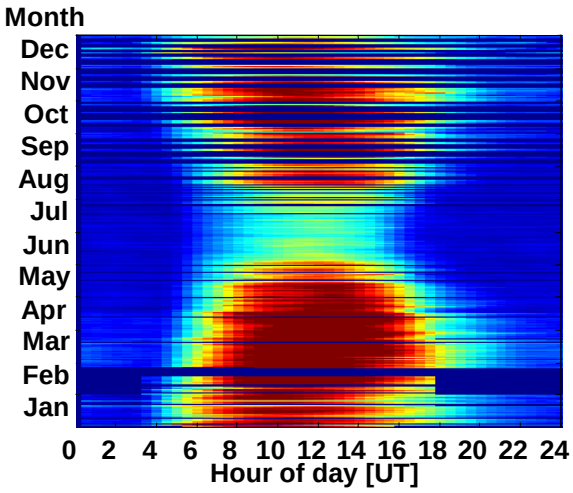
Scientific Applications 1

- **Atmospheric research**
  - **Climate & Weather**
    - **Estimation of precipitable water vapour from network of GNSS stations in South Africa**

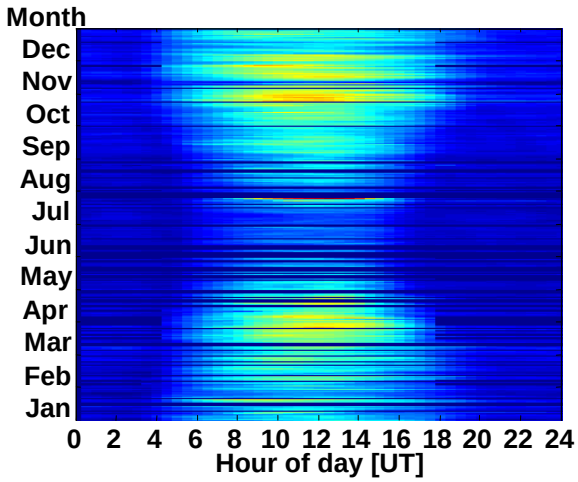


Scientific Applications 2

- **Atmospheric research**
  - **Space weather**
    - **Ionospheric mapping of variation of annual TEC over South Africa from network of GNSS base stations**



2002

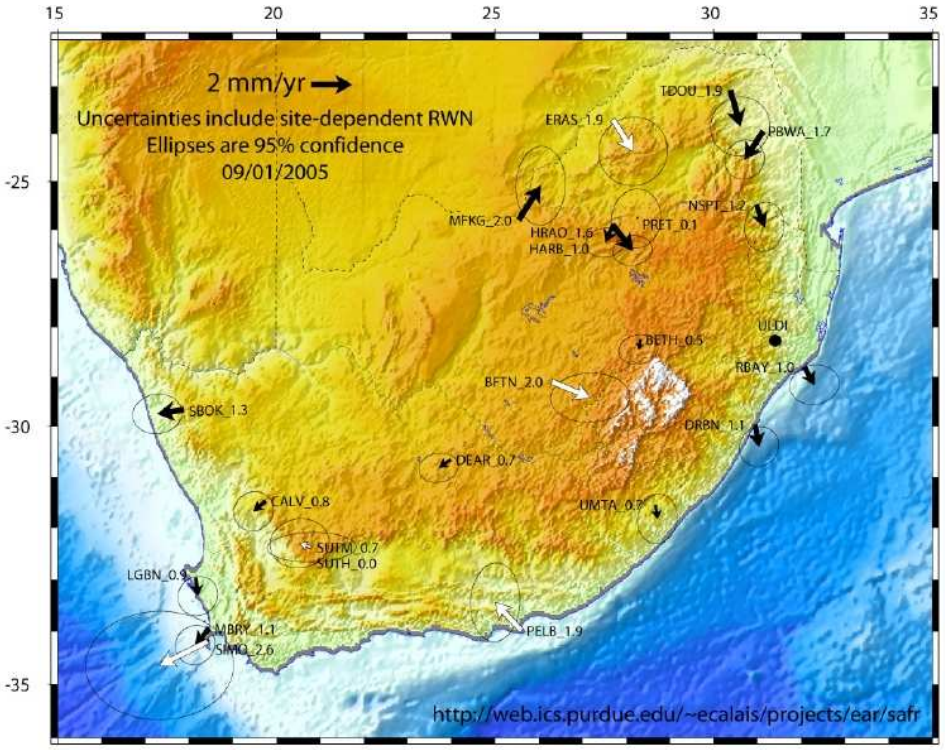


2004

Thanks to B Opperman of Hermanus Magnetic Observatory for plots

Scientific Applications 3

- **Geophysics research**
  - **Plate motions**
    - **Plate motion estimates in South Africa from network of GNSS base stations**



C.J.H. Hartnady, E. Calais & R. Wonnacott (2007): "ITRF2000 velocity field from the South African TrigNet GPS array and the African GNSS network: Implications for Nubia-(Rovuma-Lwandle-)Somalia plate motions" East African Rift Conference, Kampala