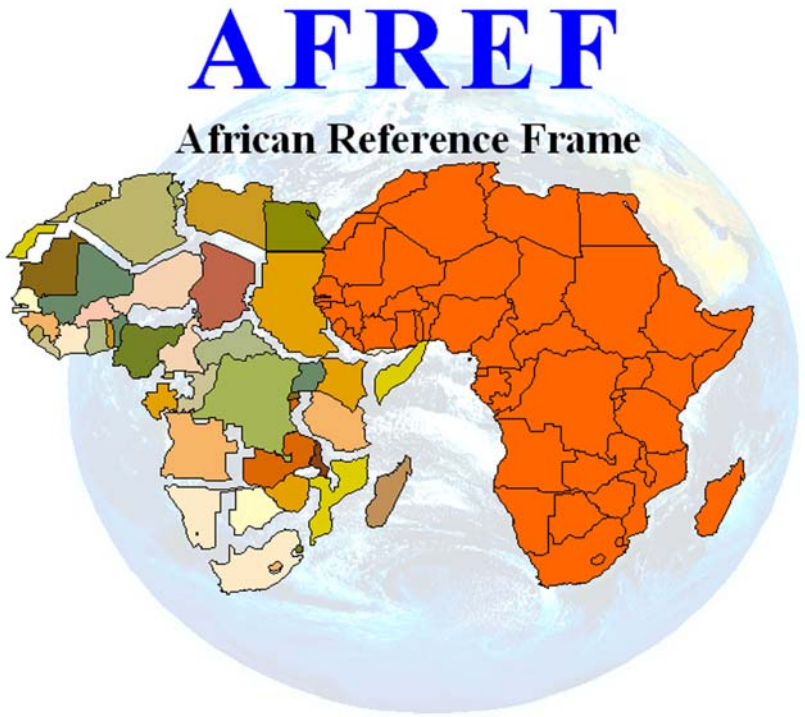
AFREF

R.M.S. Fernandes

AFREF

AFRICAN REFERENCE FRAME



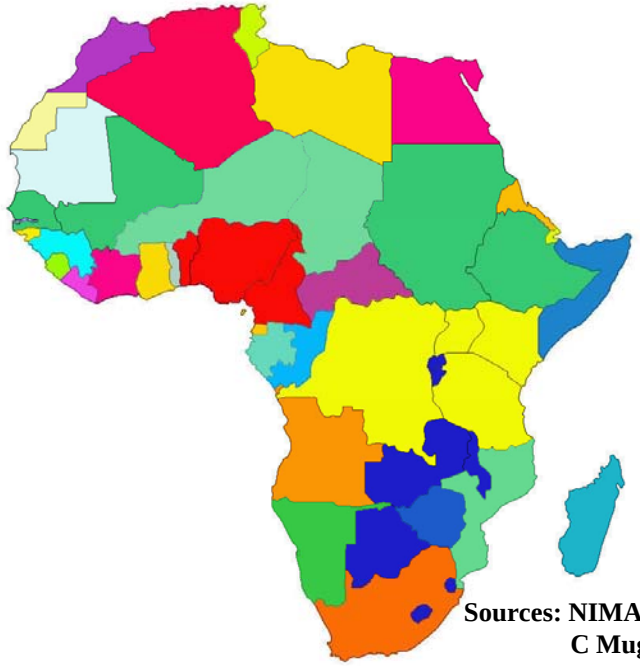
AFREF is an effort carried out by the international community, in particular the African countries, to establish a continental reference system, consistent and homogeneous with the global reference system (ITRS) as a basis for the national reference networks.

Datums* in Africa

A legacy of the Colonial era – datums based upon ellipsoids determined by European geodesists.

Classical approach used: astronomically-defined origin; ellipsoid from Europe; classical triangulation.

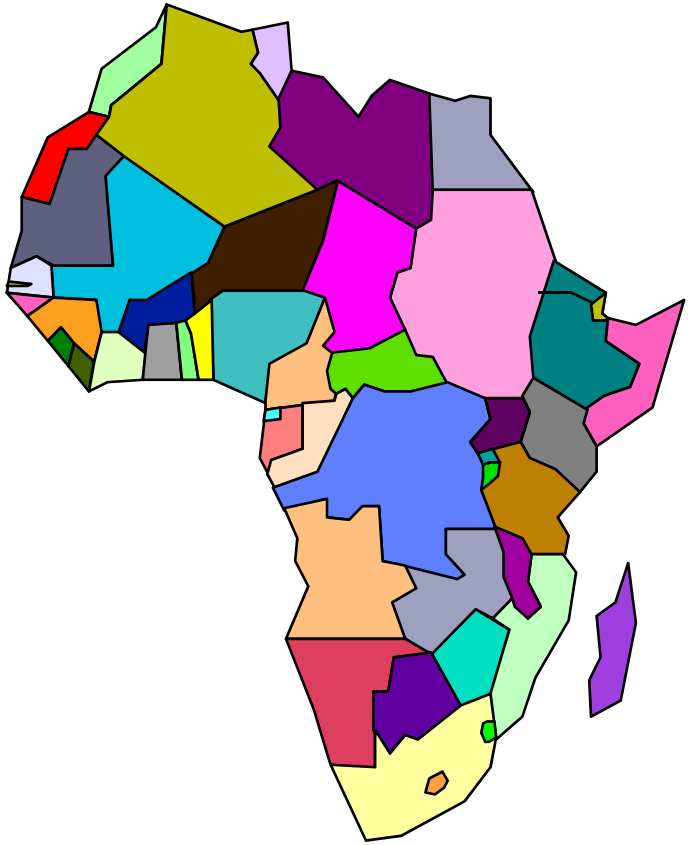
Many so-called “datums” are just re-computations of all or part of existing networks, using the same initial point [e.g. the Arc 1950, Arc 1960, Circuit datums].



Sources: NIMA TR8350.2
C Mugnier (PE&RS)
EPSG Database

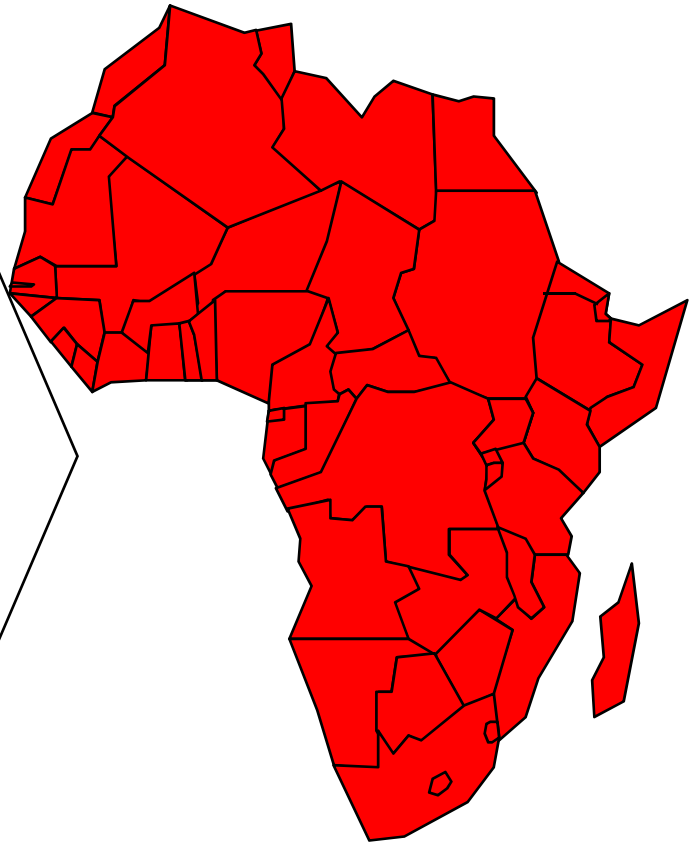
Way to go...

Non-uniform systems



GNSS stations + ITRS

Uniform system



- **GNSS stations will realize and maintain AFREF**
- **AFREF will be based on ITRS**

AFREF

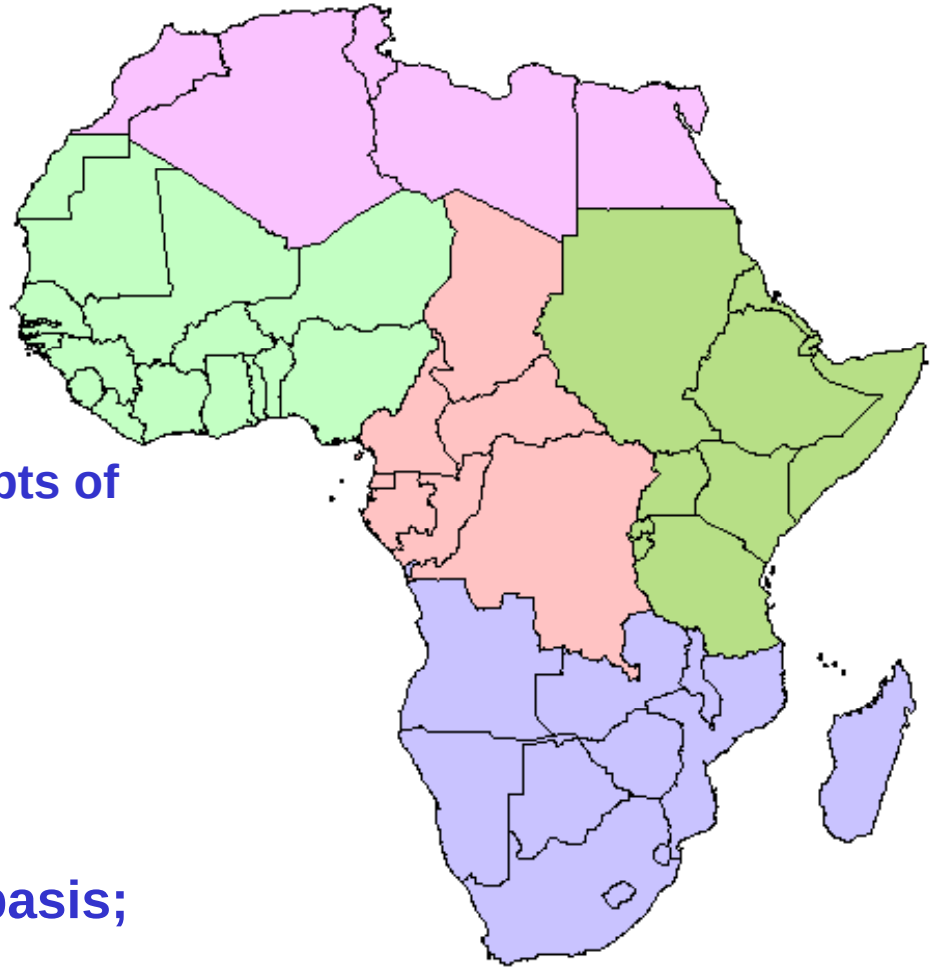
OTHER GOALS

- To realize a unified vertical datum and to support efforts to establish a precise African geoid.

- To determine the relationship between the existing national reference frames and the new system (and ITRS) in order to preserve legacy information of the existing frames.

- To provide a sustainable development environment for technology transfer so that these activities will enhance the national networks and other GNSS related applications.

Organizational Principles



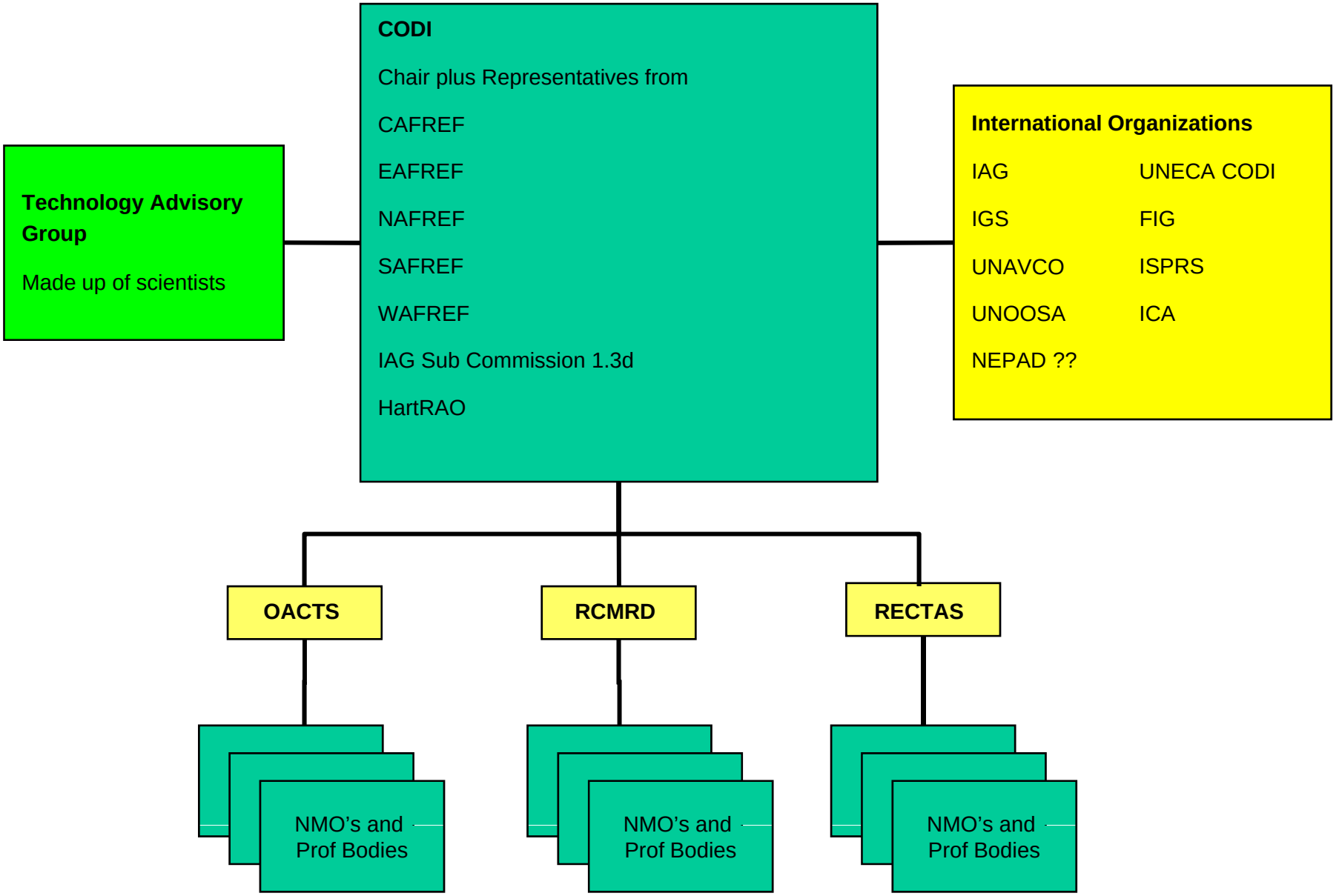
The structure reflects the broad concepts of AFREF that:

It is to be designed, managed and executed from within Africa;

It is to be organized on a regional basis;

It is to be executed at the national level

Organizational Structure



Institutional Acceptance

UN ECA CODI (Committee on Development information)

Have adopted the Windhoek Declaration

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

IAG (International Association of Geodesy)

Have created structures to coordinate project and provide technical assistance expertise

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.

AFREF08
First AFREF solution – Study Case

- Set of coordinate positions for a number of GNSS stations distributed by the entire African continent

- AFREF08 is referred to ITRF2005 for a certain epoch. Consequently, the coordinates will not change with time‡
  - Reference epoch is 01 May 2008 using one week of data – GPSweek 1477
  - a second solution was computed for GPSweek 1478 for comparison and evaluation of reference solution.

‡ *this will be further discussed in this presentation…*

Roadmap for the AFREF08 solution

1. Selection of the AFREF stations

What was (and will be?) an AFREF08 station?

- **Continuously operating**
  - ***No end of operation foreseen***
- **Reliable Internet access**
  - ***Data transfer after few hours of acquisition***
- **Data Publicly available**
  - ***No restrictions to data distribution***
- **Installation according to IGS standards**
  - ***stable monument, self-centering mounting device, equipment recognized, any local ties very well determined, etc...***
- **Uniform Distribution as good as possible**
  - ***Current objective: no more than 1000Km between AFREF core stations***

How to implement the network?

Active way

Install stations to densify the AFREF network

which can also be used for other applications

Passive way

Classify stations already installed in the framework of other projects as AFREF stations

necessary cooperation/support with these projects

Interaction with other applications needed

Site distribution

Political constraints

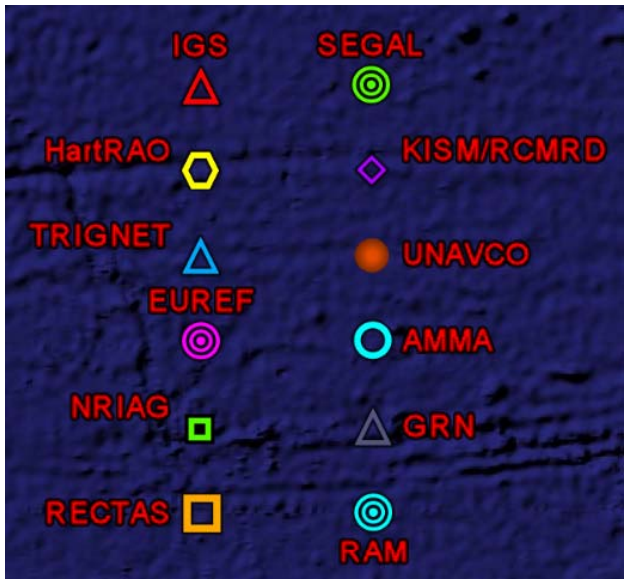
- 61 Territories
  - Largest:
    - Sudan (2 505 810 Km²)
  - Smallest:
    - Melilla, Spain (12 Km²)
    - Gambia (11 300 Km²)

Every territory (definitively, every country) should have a station part of AFREF

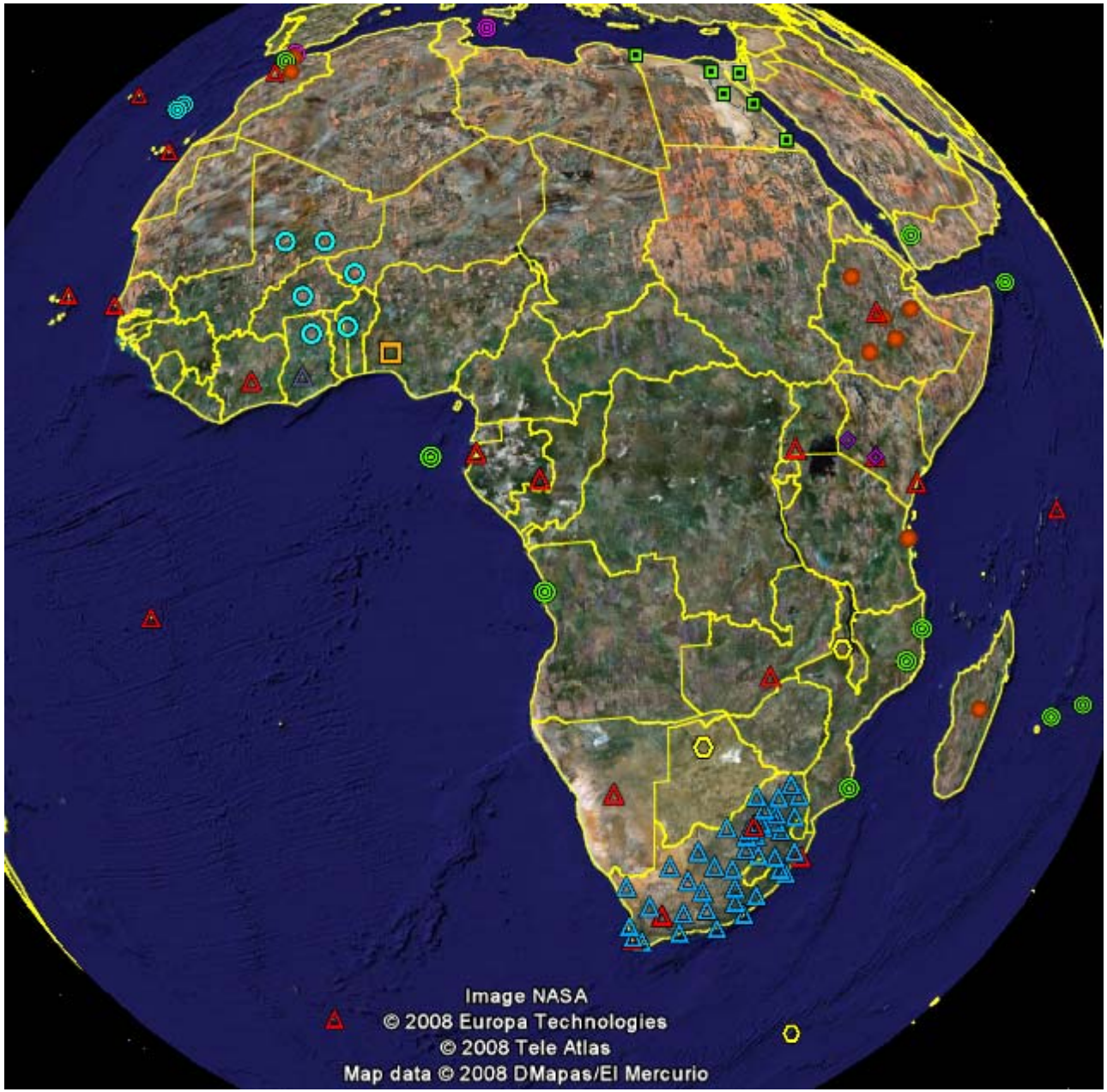
Current Situation

Survey of CGPS sites:

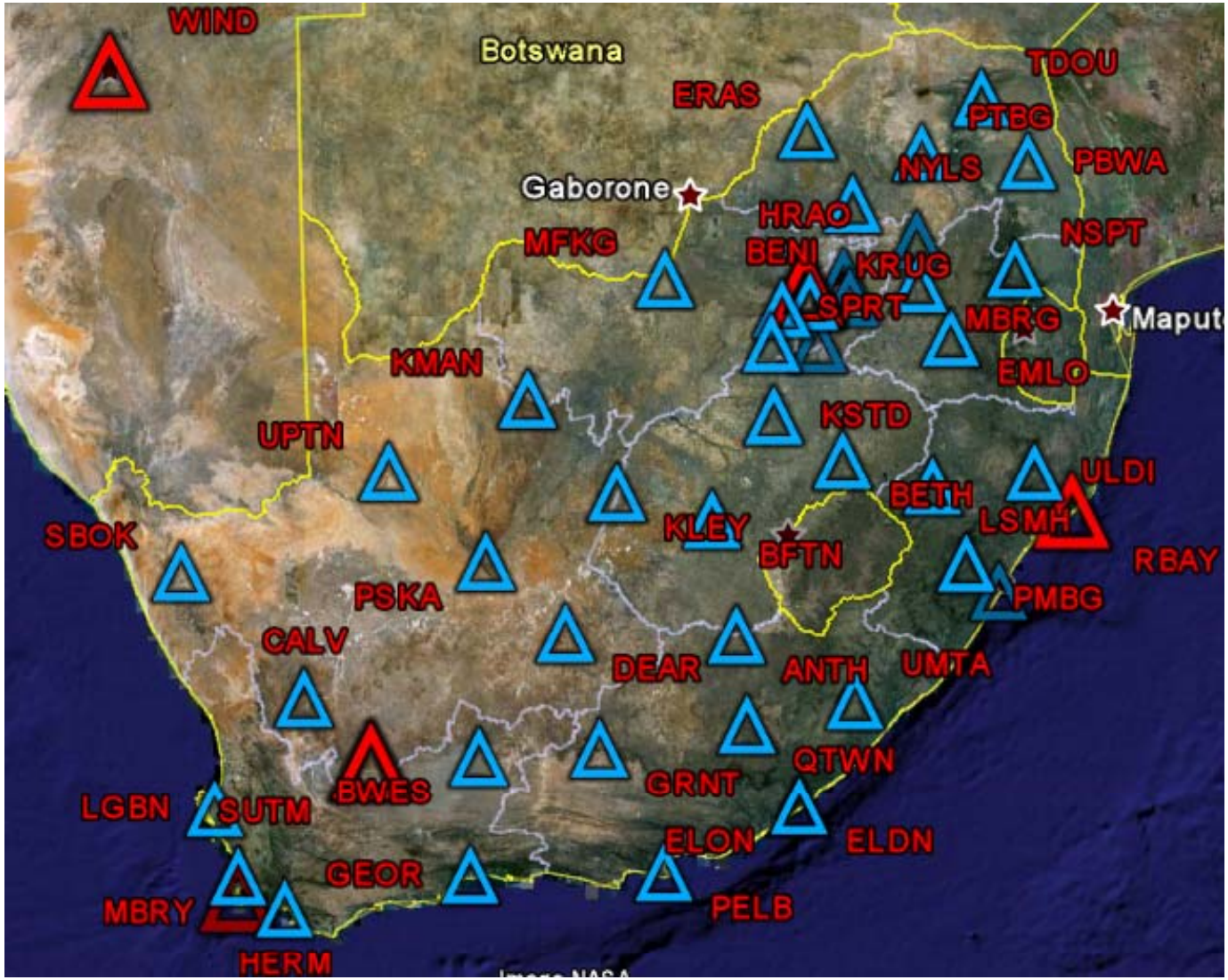
101



Note:
Many stations belong to more than one network.

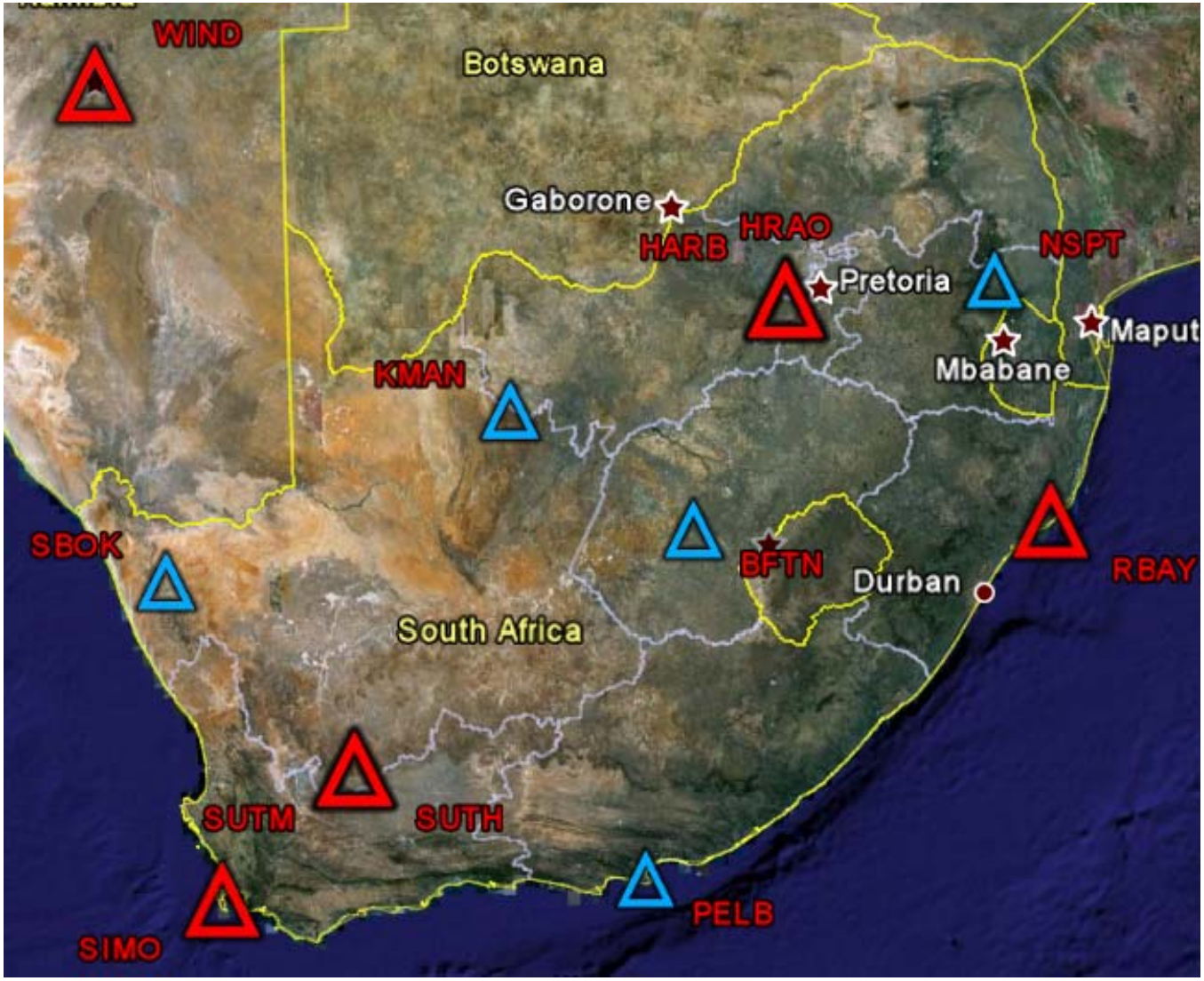


South Africa
Trignet + IGS



Too many fiducial stations at continental scale...

South Africa
Trignet + IGS

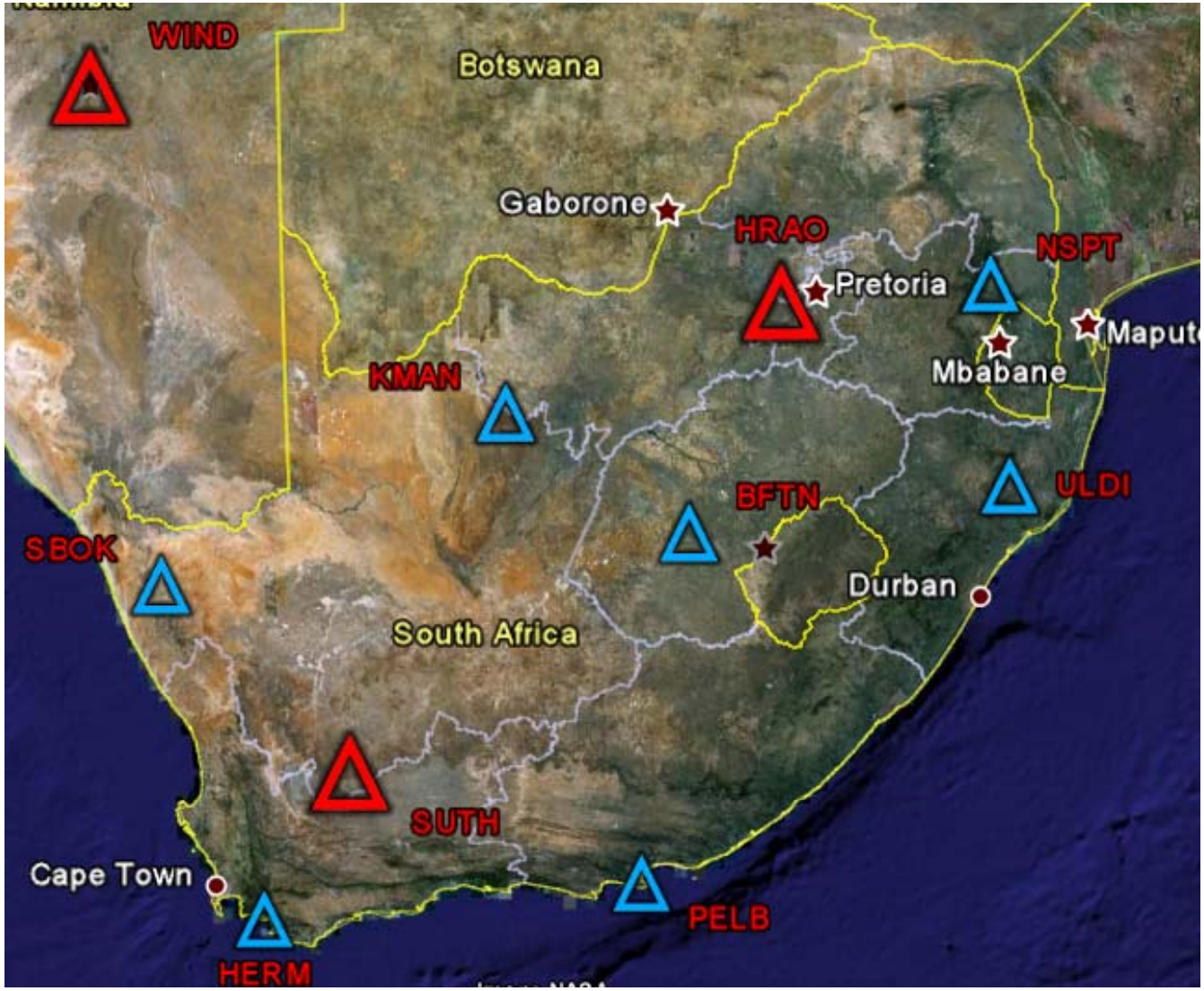


HRAO+HARB and SUTM+SUTH

RBAY not available

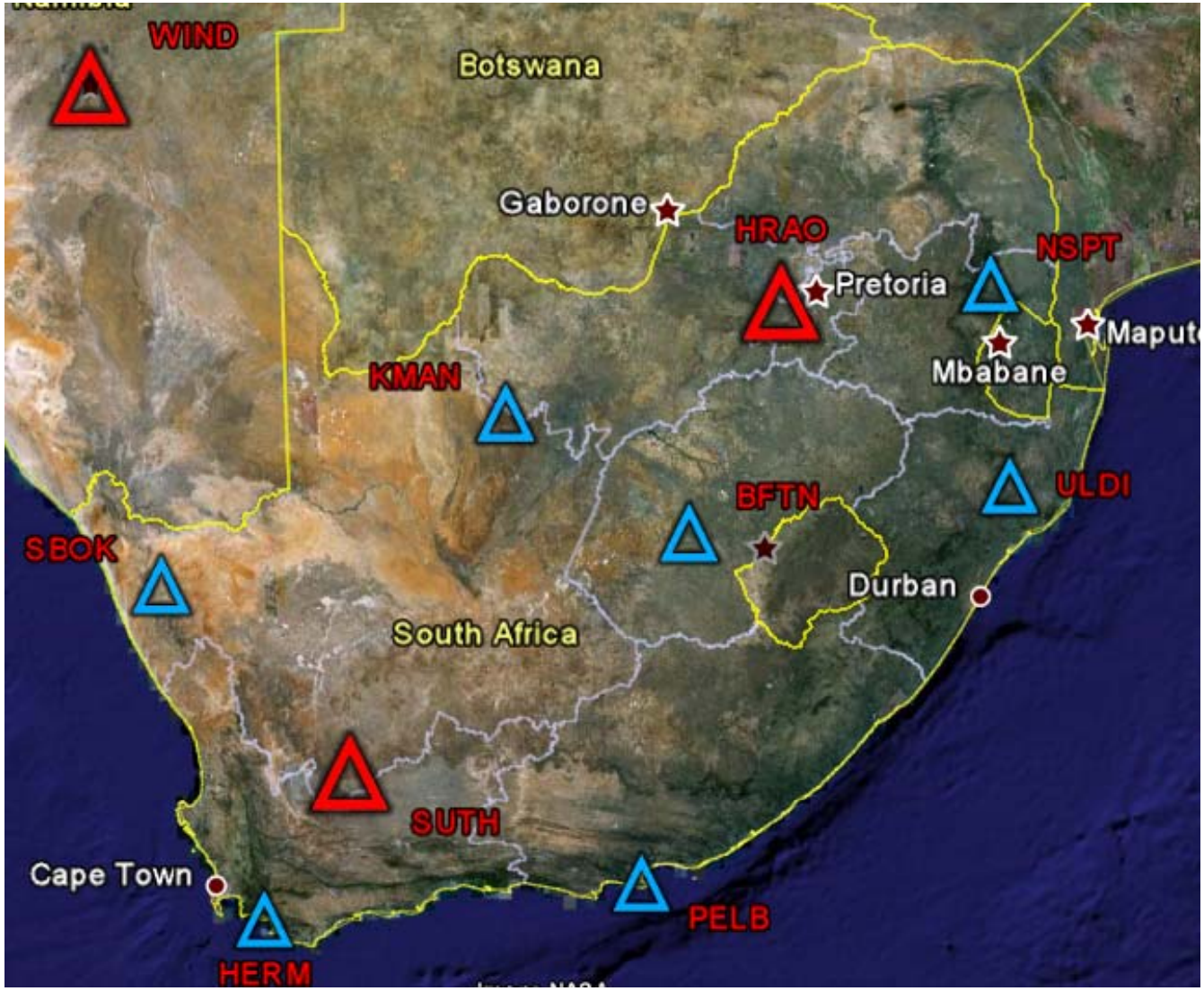
SIMO is problematic

South Africa
Trignet + IGS



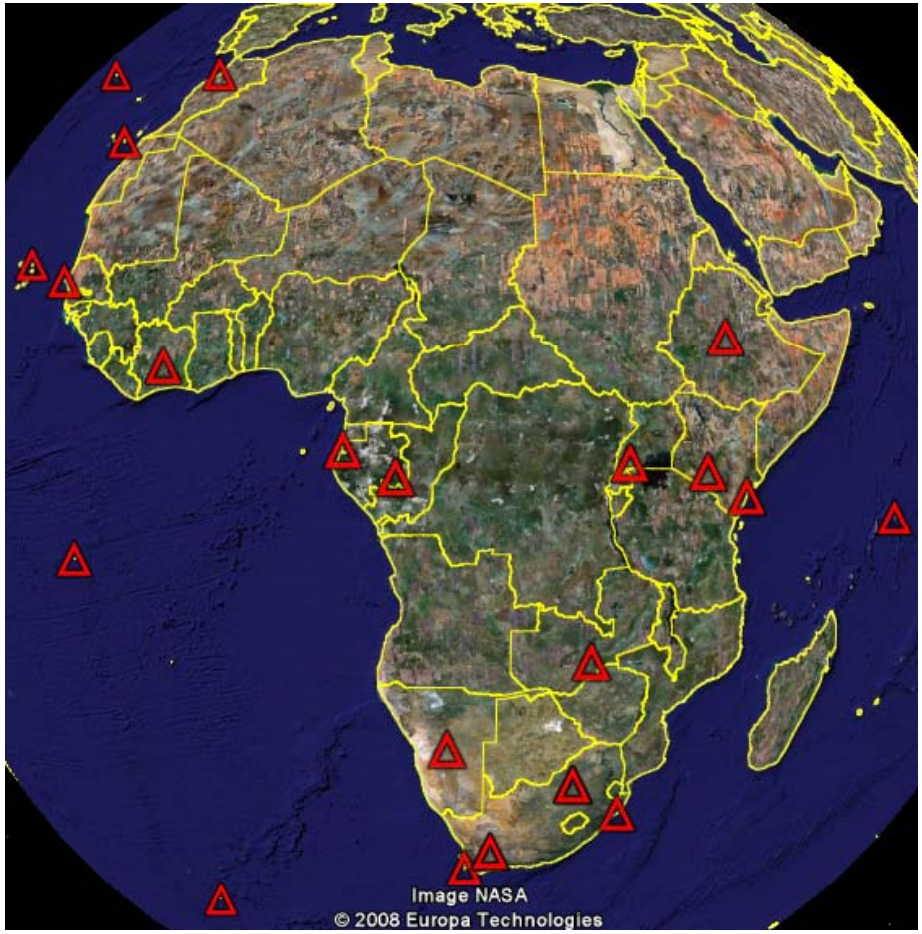
Final selection of stations to be processed.

South Africa
Trignet + IGS

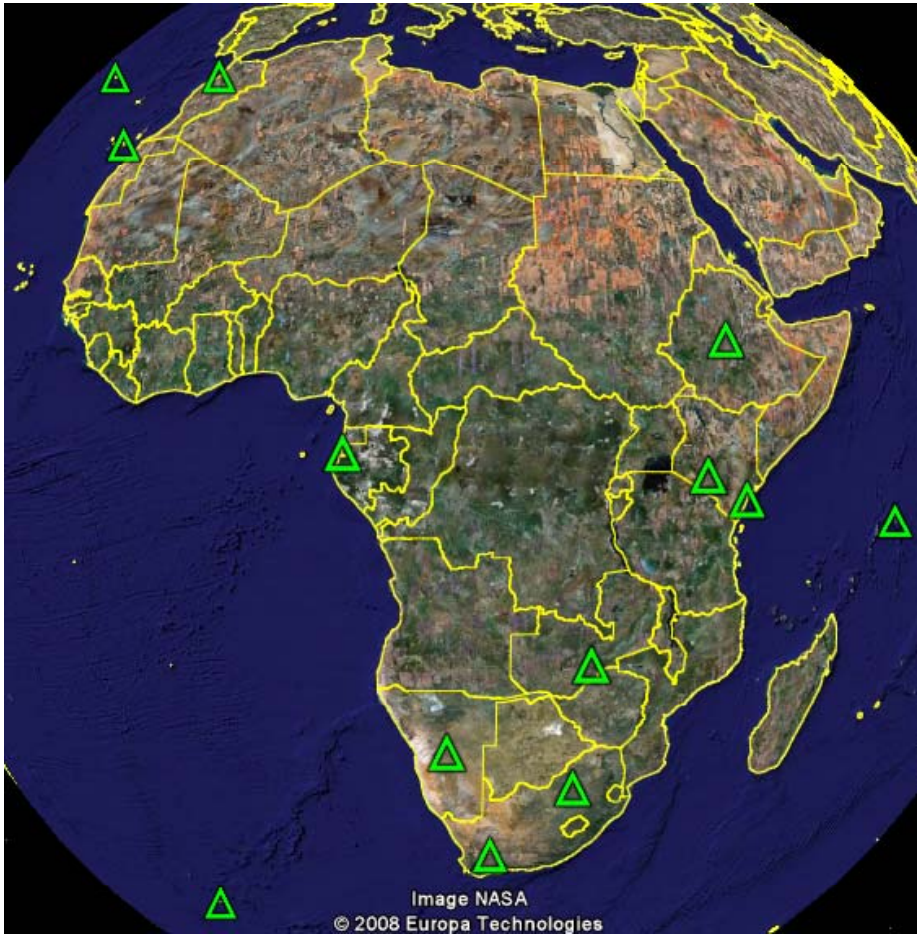


Final selection of stations to be processed.

IGS
Problems with network maintenance

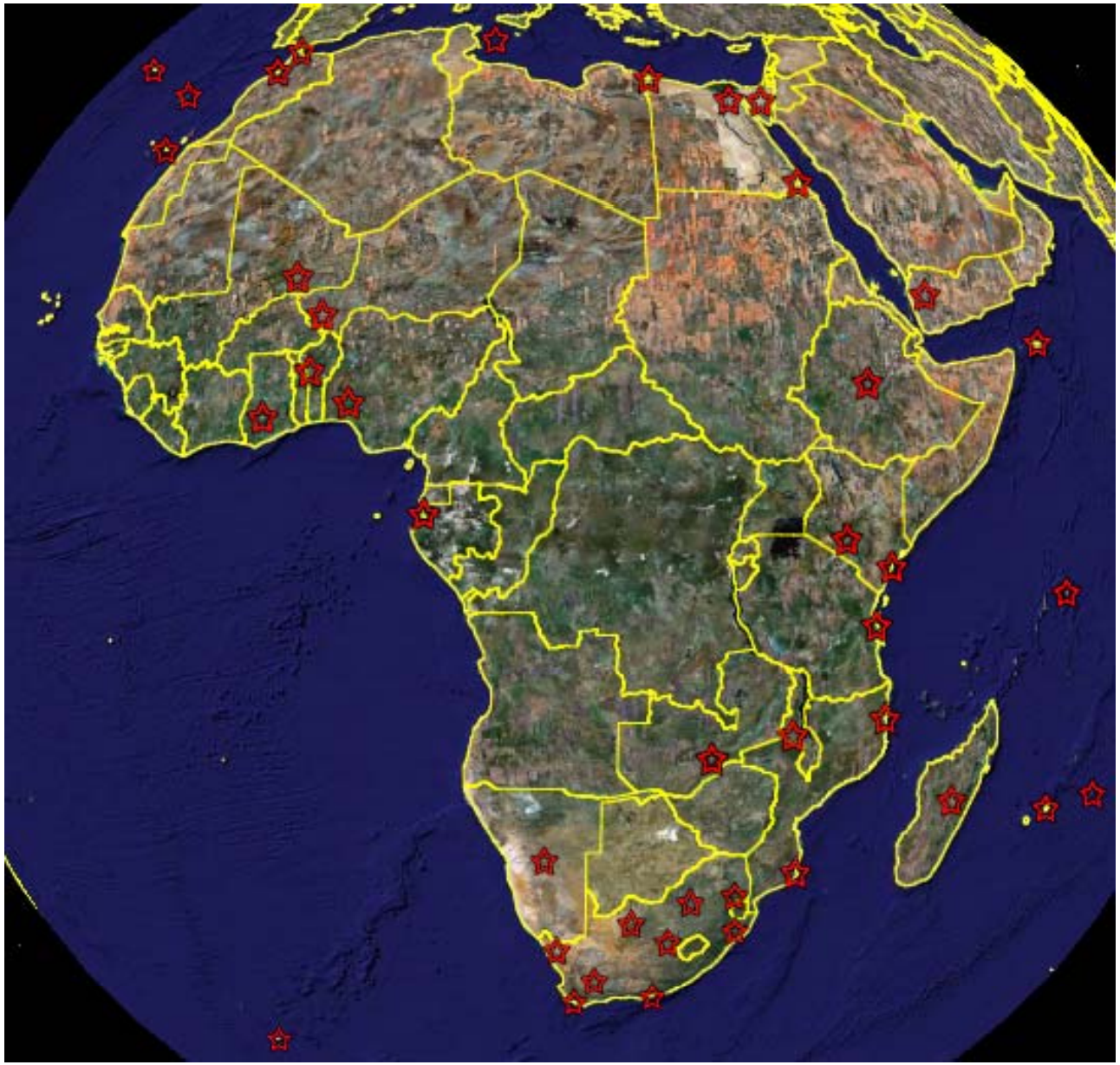


23 stations officially part of IGS network



Only 13 stations with available data for the desired period

“Final” Selection



Position solutions was computed for a total of 37 stations.

Roadmap for the AFREF08 solution

2. Processing methodology to compute AFREF08

- 2 Independent Solutions using 2 Different Software Packages
  - *RCMRD (Kenya) with collaboration of IDL (Portugal) is using GIPSY*
  - *HartRAO (South Africa) is using GAMIT*

- 2 Different Mapping approaches to align to ITRF2005
  - RCMRD/IDL will use a global set of reference mapping stations
  - HartRAO will use a regional set of reference mapping stations

- Unique combined solution
  - Dedicated scripts based on GIPSY tools
  - Differences will allow us to detect errors due to software packages/models used.

AFREF08 Results

Comparison Global / Regional mapping

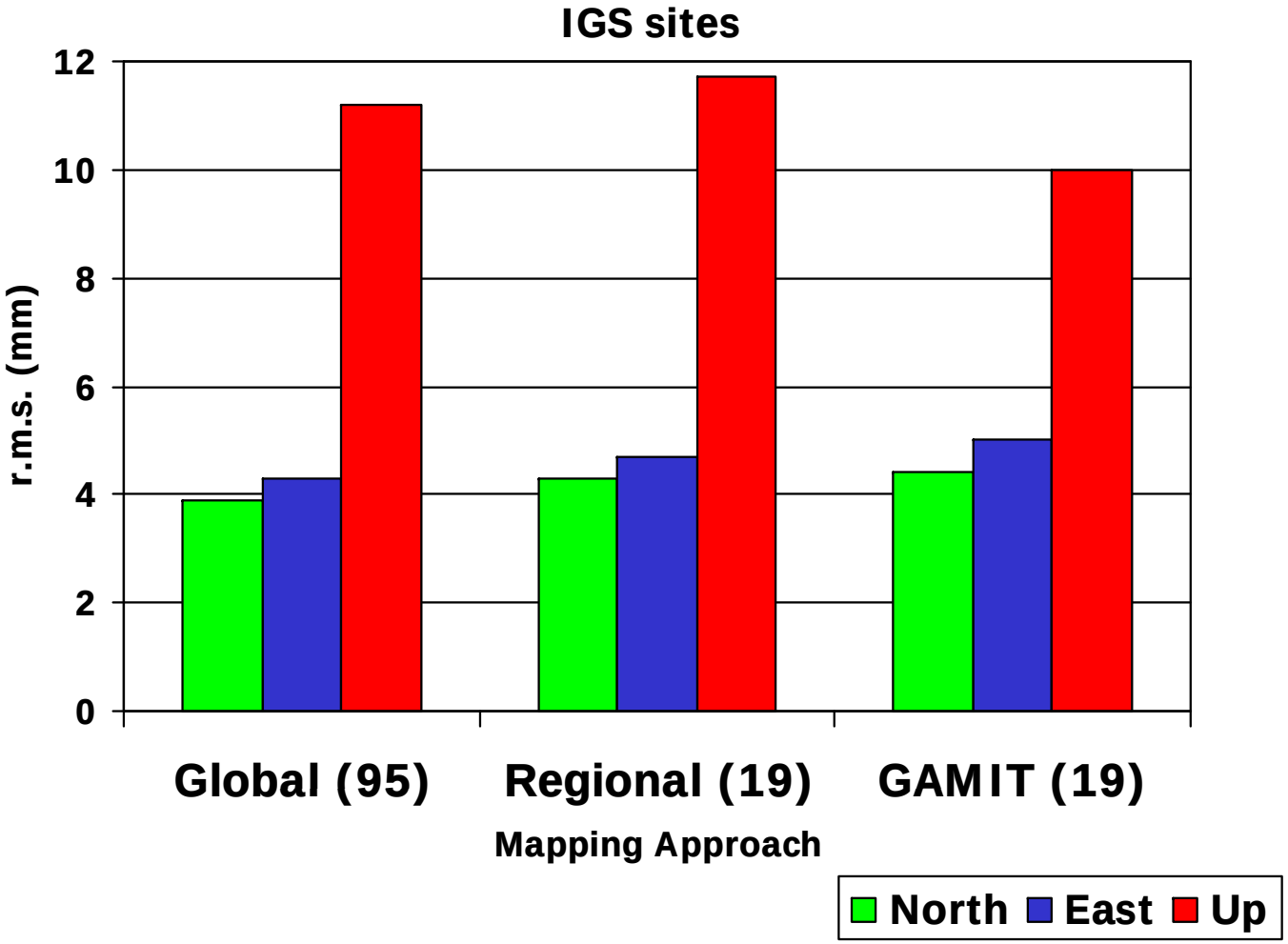
daily mapping

Solution 1..n

GIPSY tools

Global parameters (Dedicated Network)

Positions of AFRICA stations w.r.t. ITRF2005* at day 1..n



AFREF08 Results
Weekly Combination

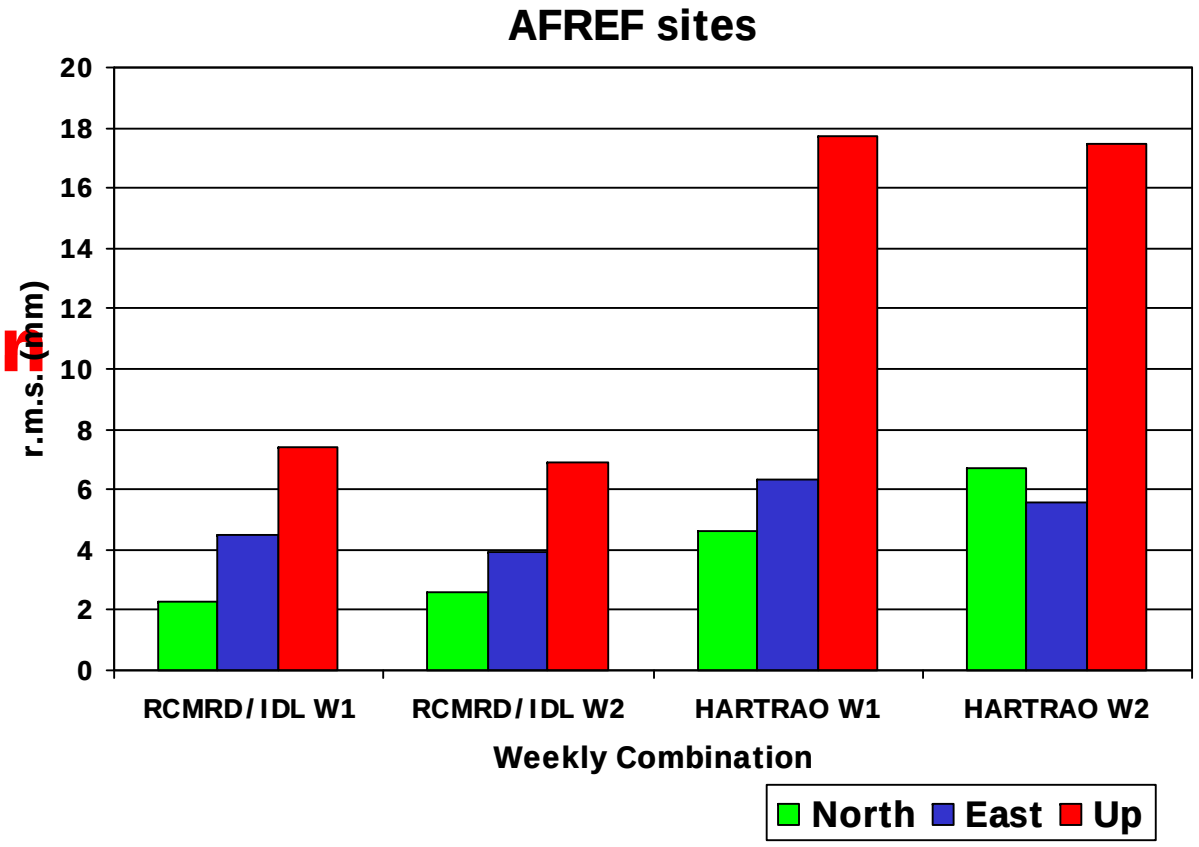
week combination

Positions of AFREF stations w.r.t. ITRF2005 at day 1

Positions of AFREF stations w.r.t. ITRF2005 at day 7

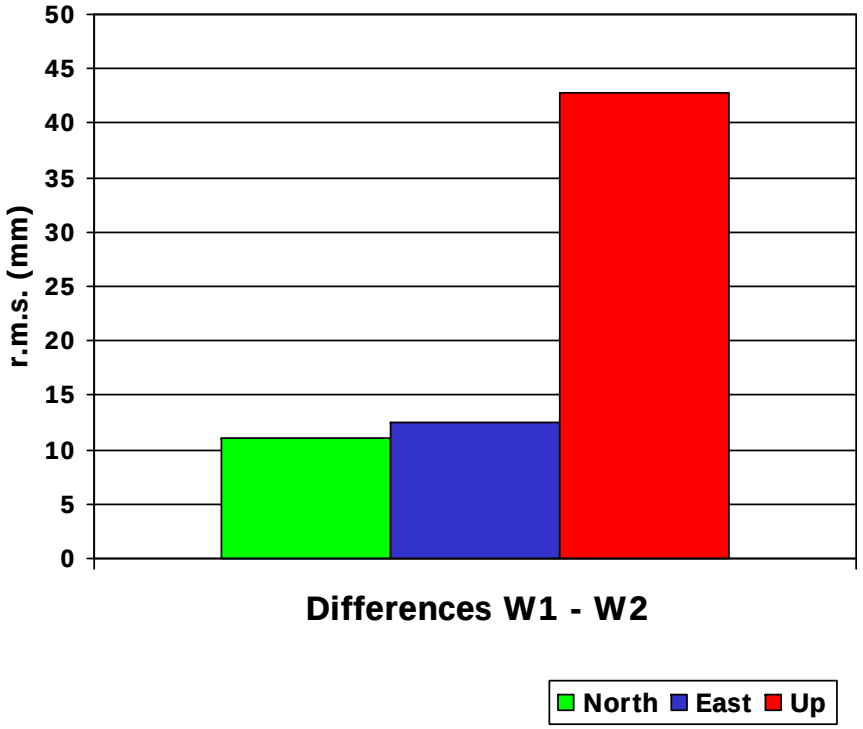
GIPSY tools and SEGAL applications

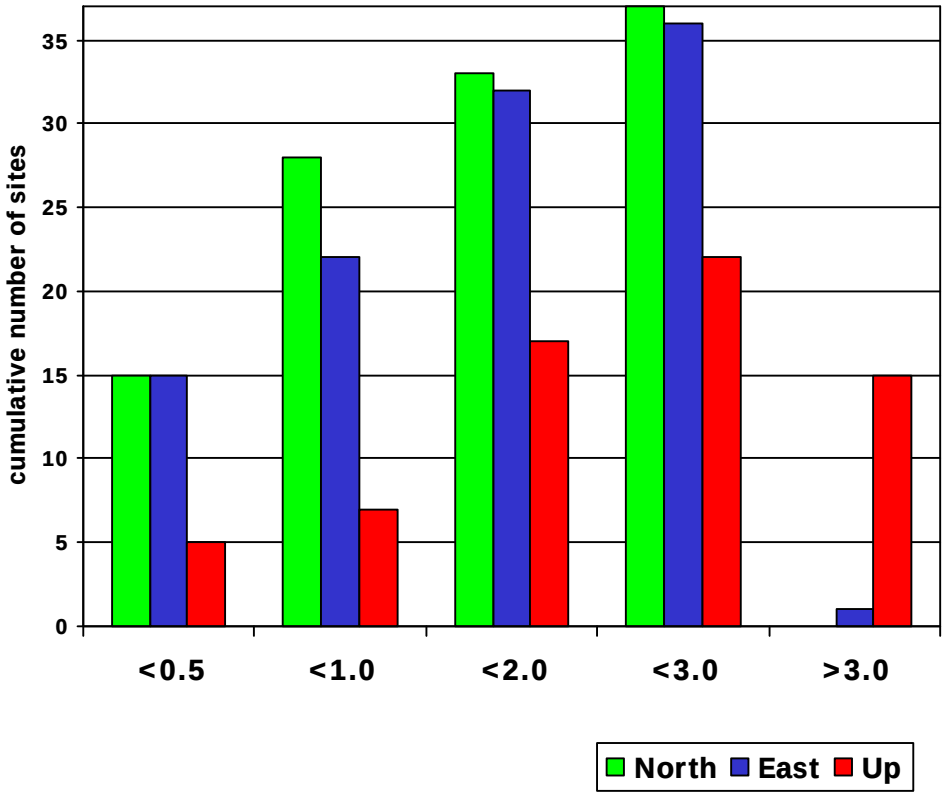
AFREF solution w.r.t. ITRF2005 at week K



AFREF08 Results

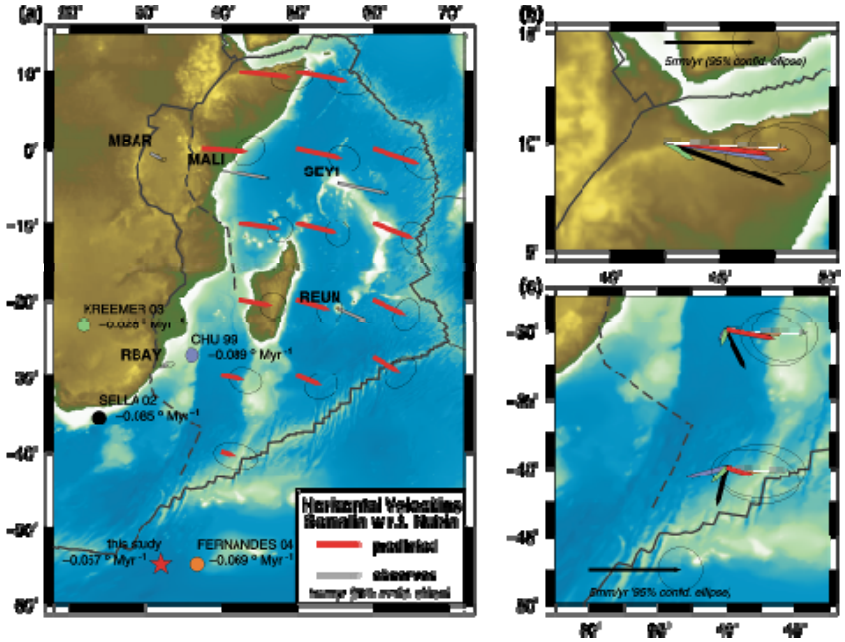
Comparison between the 2 weekly solutions



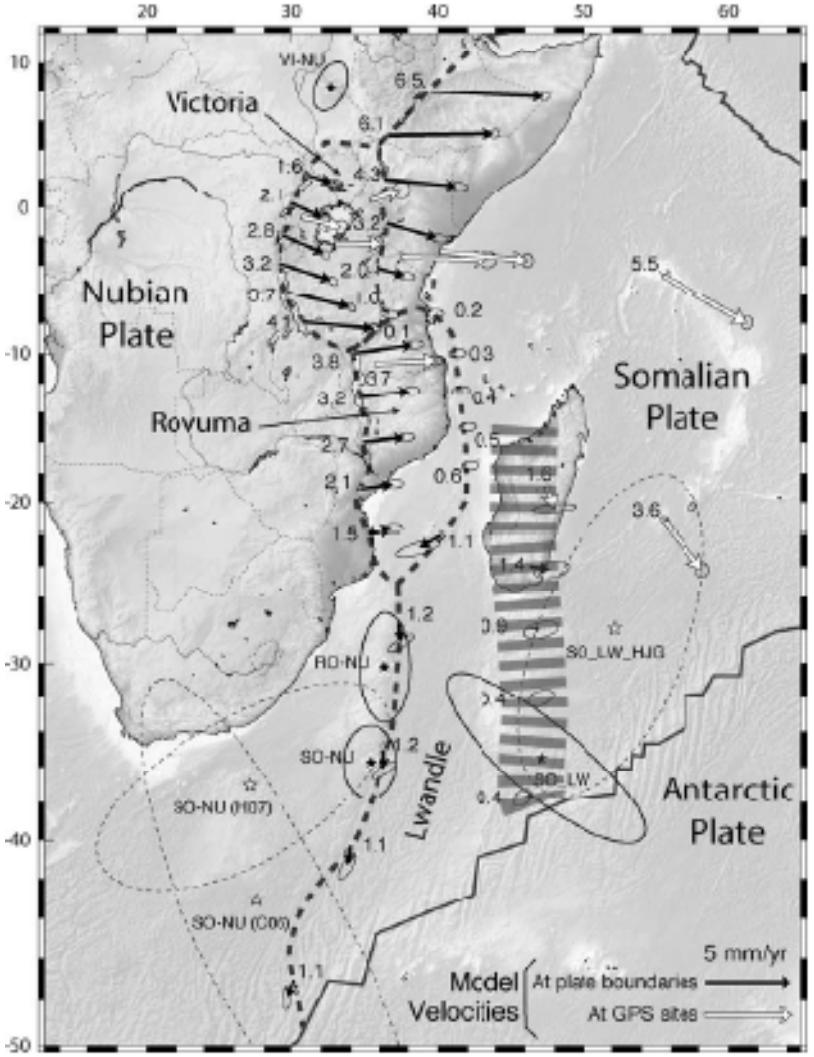


The role of tectonics….

Africa contains two major tectonic plates (Nubia and Somalia) plus some few minor tectonic blocks (e.g. Victoria)



in *Fernandes et al. [2004]*

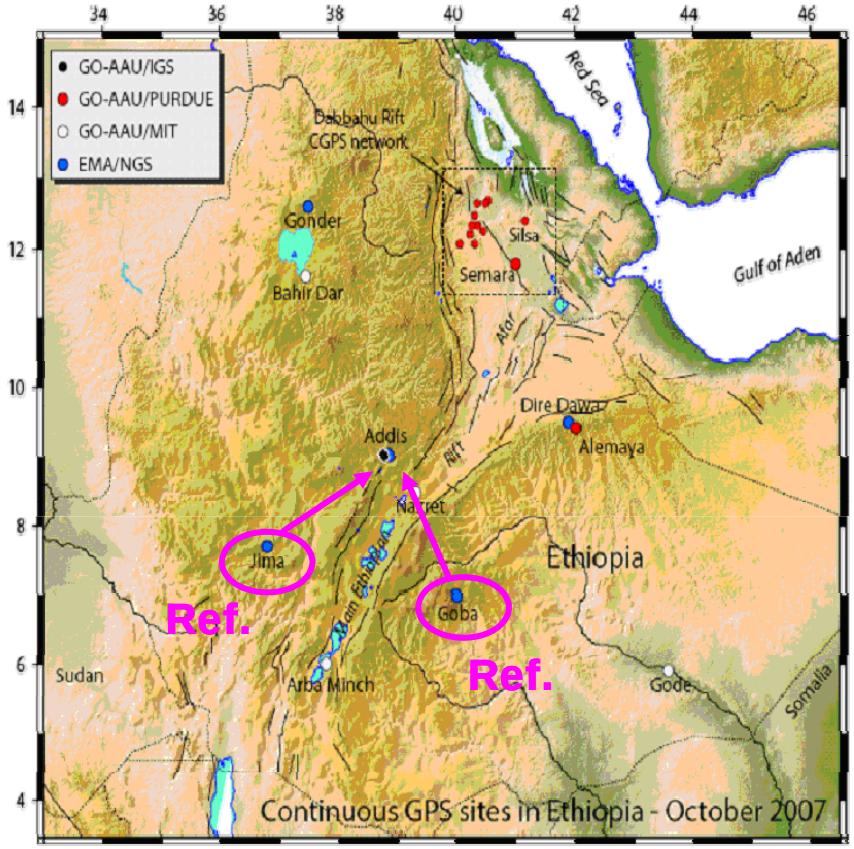


in *Stamps et al. [2008]*

Example: Ethiopia case

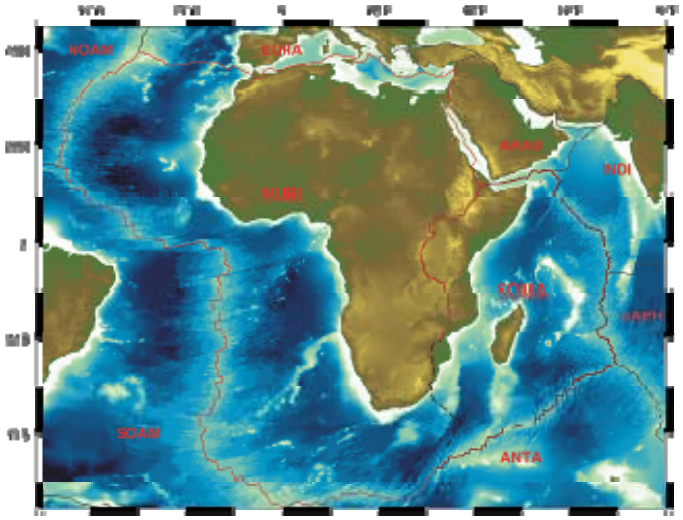
Stations located on the opposite sides of the East African Rift will move apart about 6-7 mm/yr

This is a significant change in the relative positions that must be taken into account if someone decides to use stations located on both sides to further densify the network using data collected in the future



Internal consistency of AFREF08

AFREF08 will be linked to the Nubian plate
➔ Stations located in this plate will be stationary (no motion).



Reference stations located on other tectonic blocks will have a differential motion with respect to Nubia that should be taken into account when these stations are used for densification purposes.

$$X(t) = X(t0) + V \cdot t$$

t – sometime in future
t0 – reference epoch (01 May 2008)

After the computation of the position of a new station at an epoch t, the angular velocity model must be applied backwards in order to compute the position of this station at epoch t0 (01 March 2008).

This is only necessary for stations not located on Nubia.

And the effort will continue…

THANK YOU…