Processing strategies for AFREF African Reference Frame

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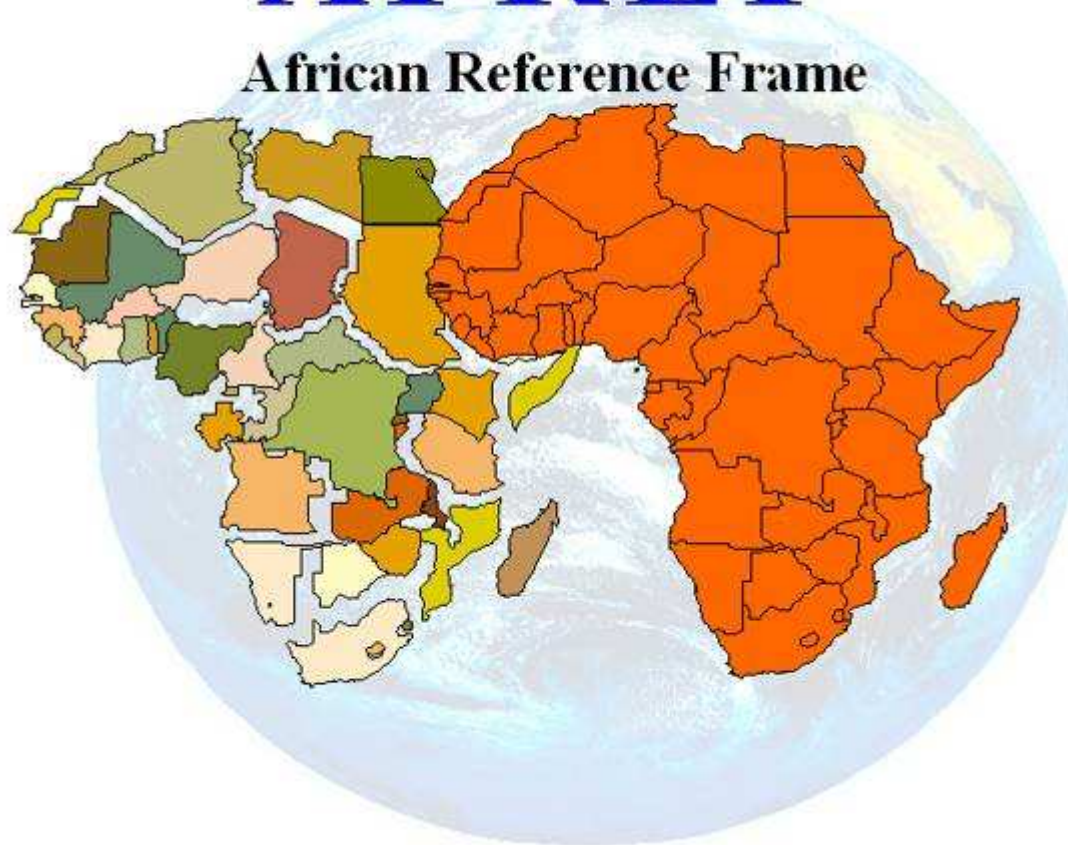
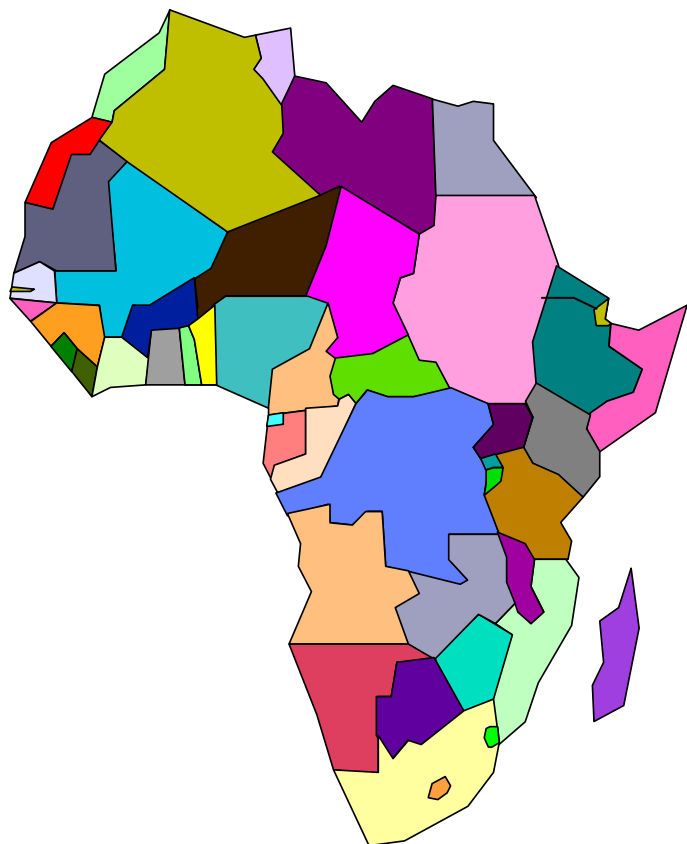**Consequences of using reference systems that are not consistent !**

AFREF

AFREF

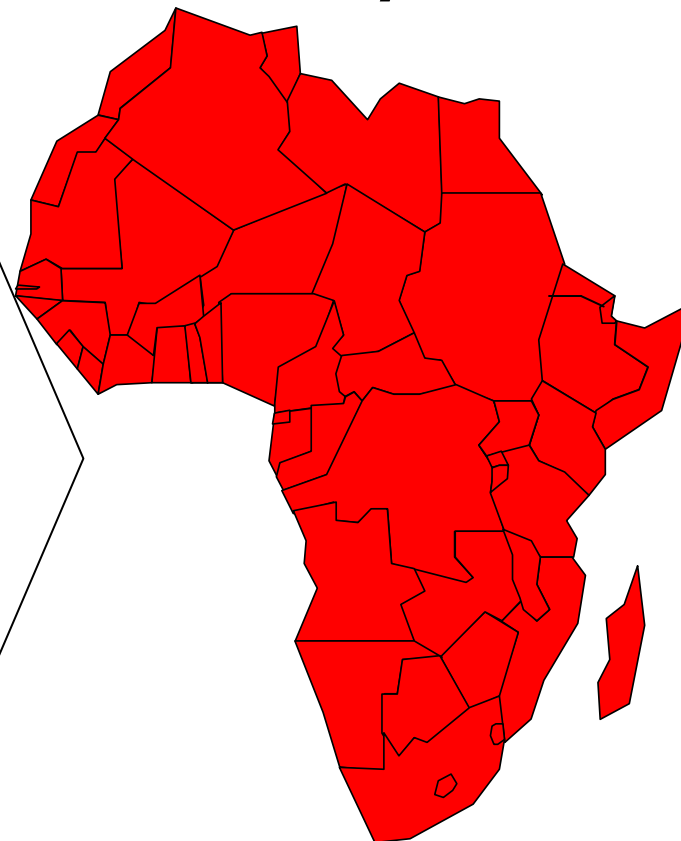**African Reference Frame**

African initiative to unify the different datums

Way to go...

Non-uniform systems

Uniform system

GNSS
stations
+
ITRS

- GNSS stations will realize and maintain AFREF

- AFREF will be based on ITRF2005

AFREF08
First AFREF solution

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

    • *plus some few stations in other continents that will allow one to connect to other continental reference frames (e.g., EUREF [Europe], SIRGAS (South America).*

• AFREF08 will be referred to ITRF2005 for a certain epoch. Consequently, the coordinates will not change with time[‡]

    • Reference epoch initially planned was 01 January 2008, but possibly it will be postponed to 01 March 2008 in order to allow the interested organizations to reply to a *Call for Participation* to be announced during next month.

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

Relation with IGS

- IGS stations will be the backbone of the AFREF08 realization by providing the link to ITRF2005

Roadmap for the AFREF08 solution

1. **Selection of the AFREF stations**

   What 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, any local ties very well determined, etc...*

   - **Uniform Distribution as good as possible**
     - *Current objective: no more than 1000Km between AFREF core stations*
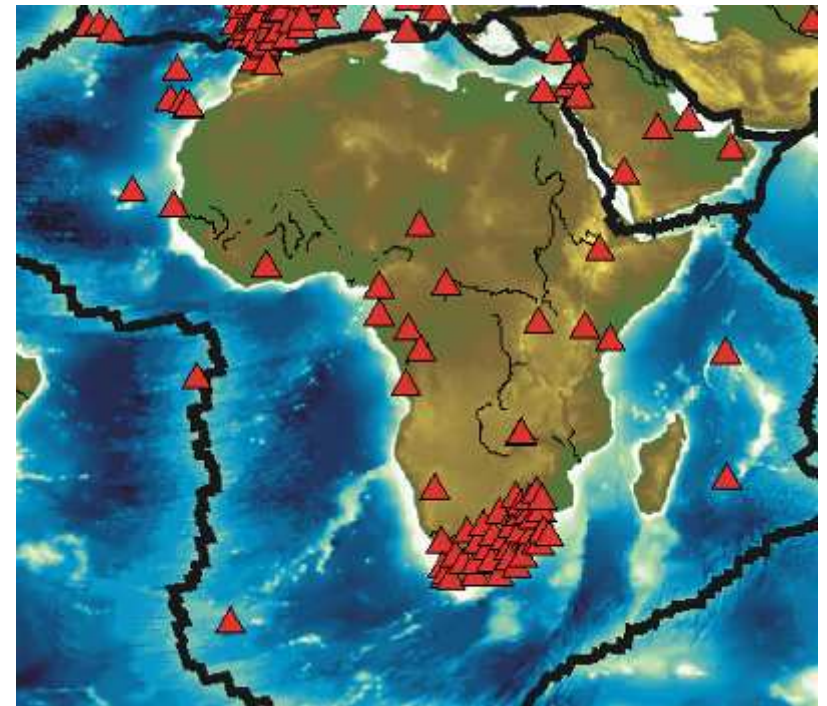
Example: South Africa
IGS + TRIGNET network
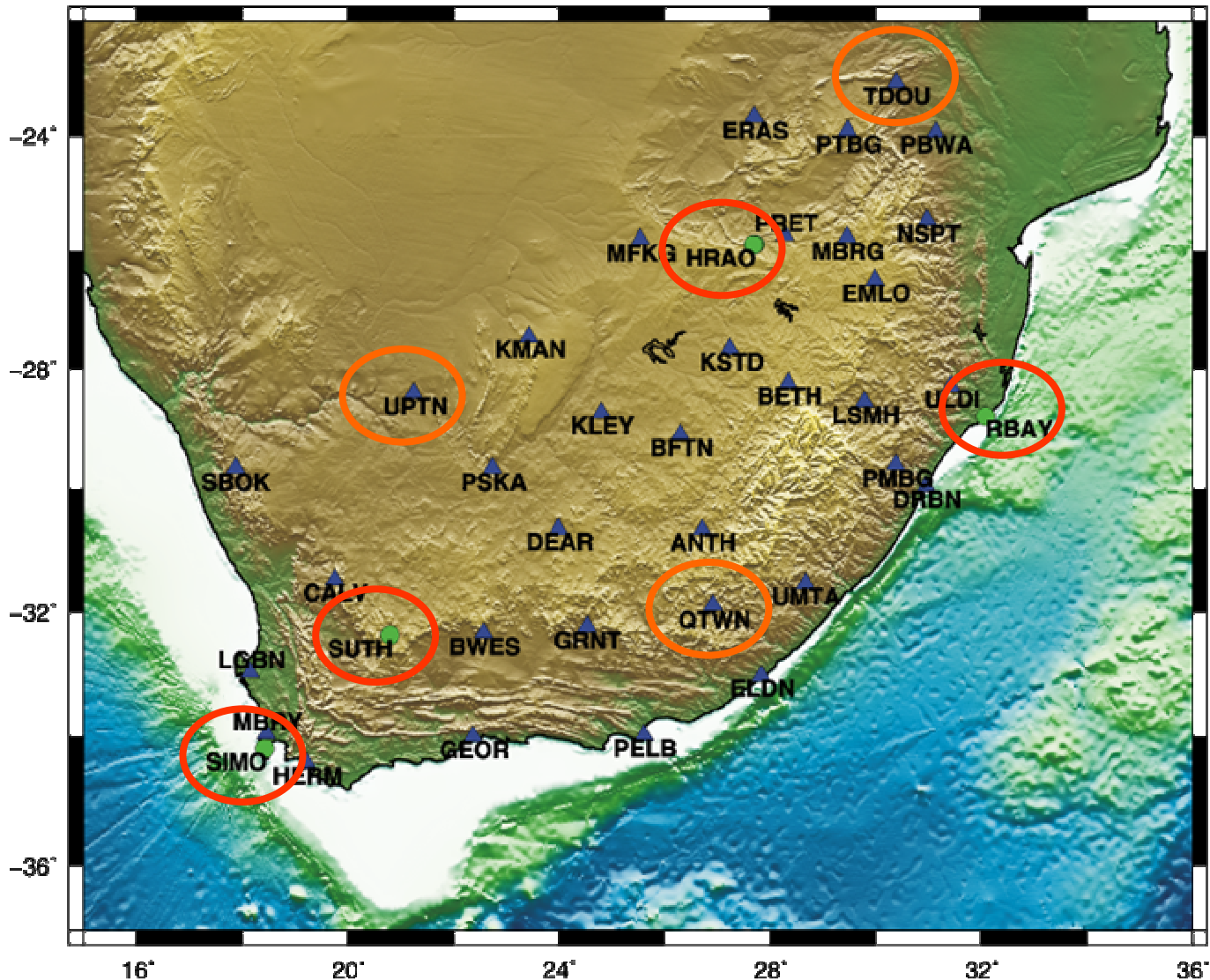
IGS stations

Summarizing:
Relation with IGS and National Networks

All IGS stations in Africa will be AFREF08 stations but not all AFREF stations will be IGS stations

All AFREF08 stations will contribute to realize the various national reference frames but not all national GNSS stations will be AFREF08 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) will use GIPSY*

  - *HartRAO (South Africa) will use 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.**

Software
GIPSY & GAMIT

GIPSY (undifferenced data)

   Precise Point Positioning strategy

- Each site individually processed
- JPL orbits + clock corrections
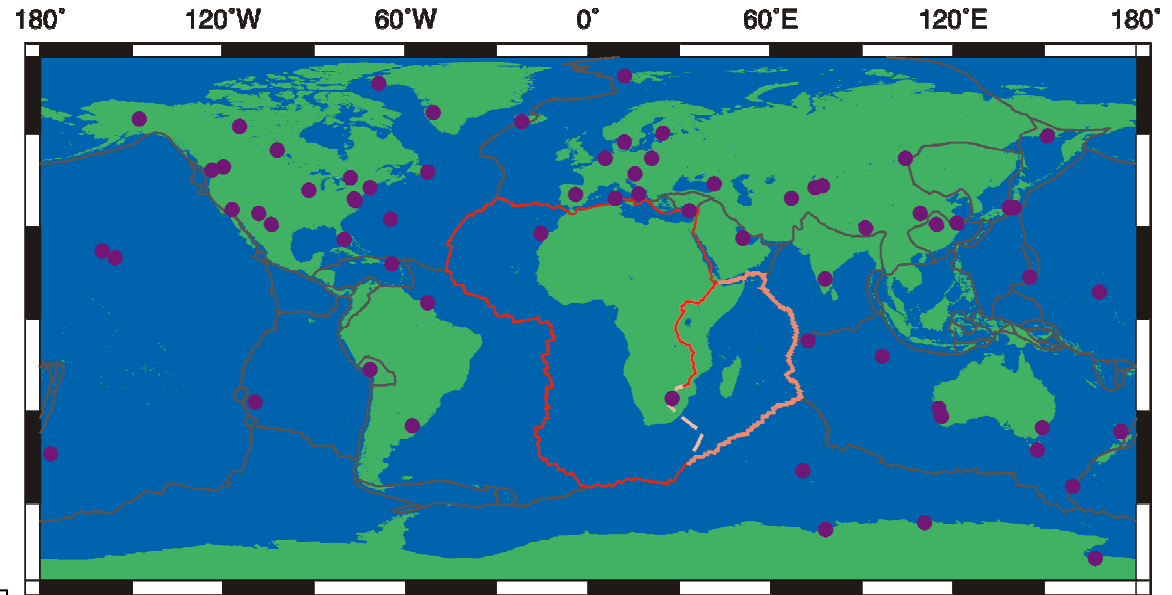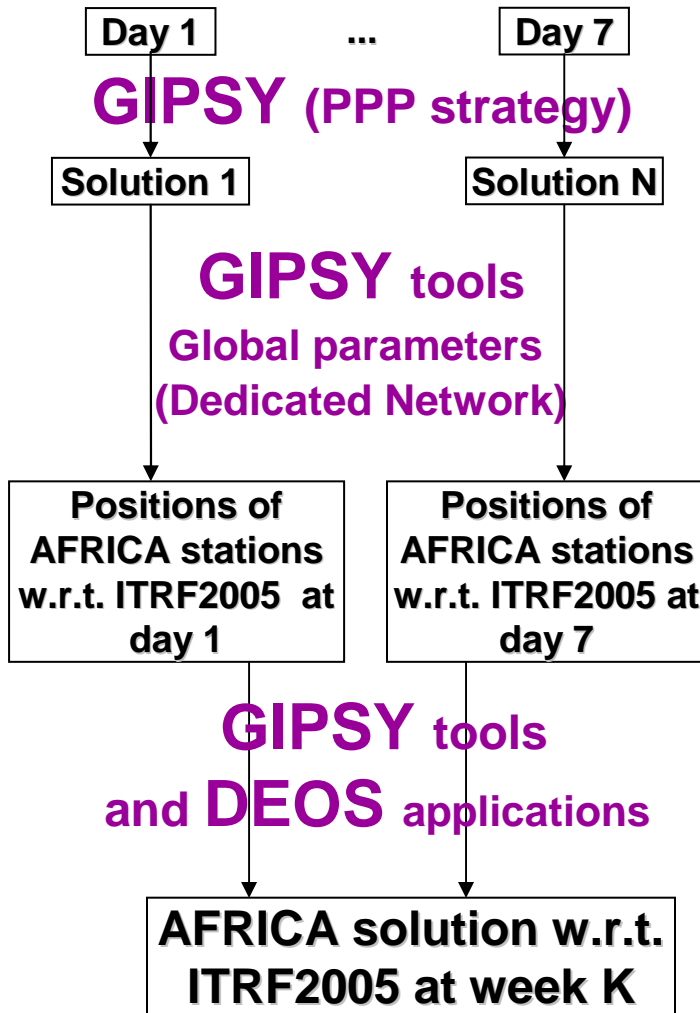- Use of *ambizap* algorithm to solve for ambiguities

GAMIT (double differences)

   Free Network strategy

- All station positions estimated in one inversion
- A-priori IGS orbits (adjusted)

Methodology GIPSY

solution

| Day 1 | ... | Day 7 |

GIPSY (PPP strategy)

| Solution 1 | | Solution N |

GIPSY tools

**Global parameters
(Dedicated Network)**

| Positions of AFRICA stations w.r.t. ITRF2005 at day 1 | Positions of AFRICA stations w.r.t. ITRF2005 at day 7 |

GIPSY tools
and **DEOS** applications

**AFRICA solution w.r.t.
ITRF2005 at week K**

1 + 1 Weeks
**2nd week will be used
to confirm the results internally
by each Analysis Center...**

Pause

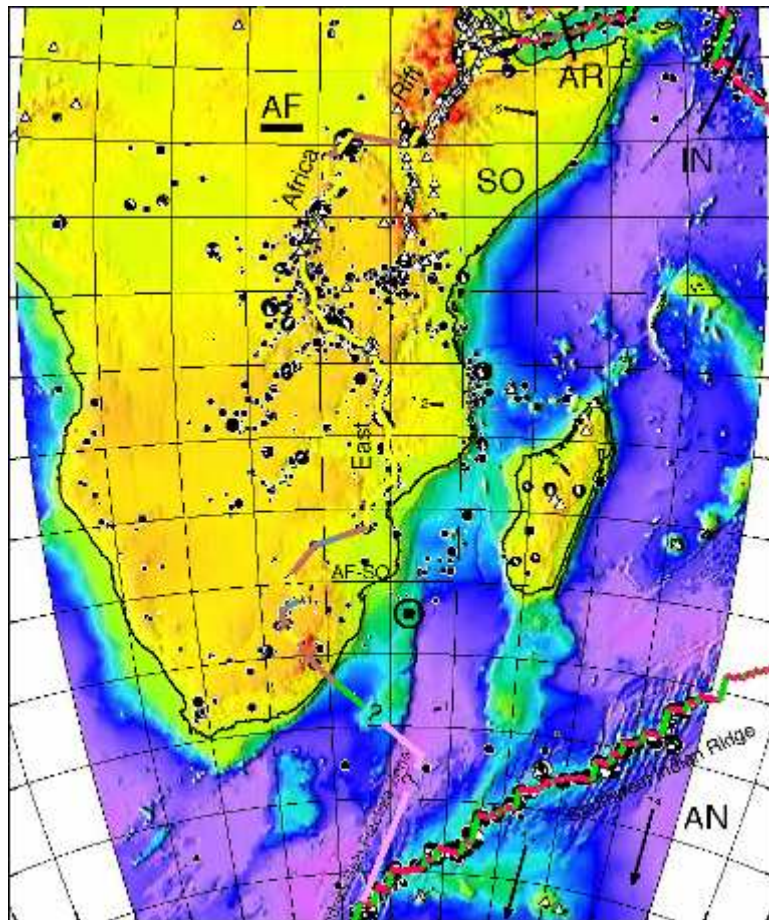**Recent studies have proved that the audience tends to lose their concentration after some minutes.**
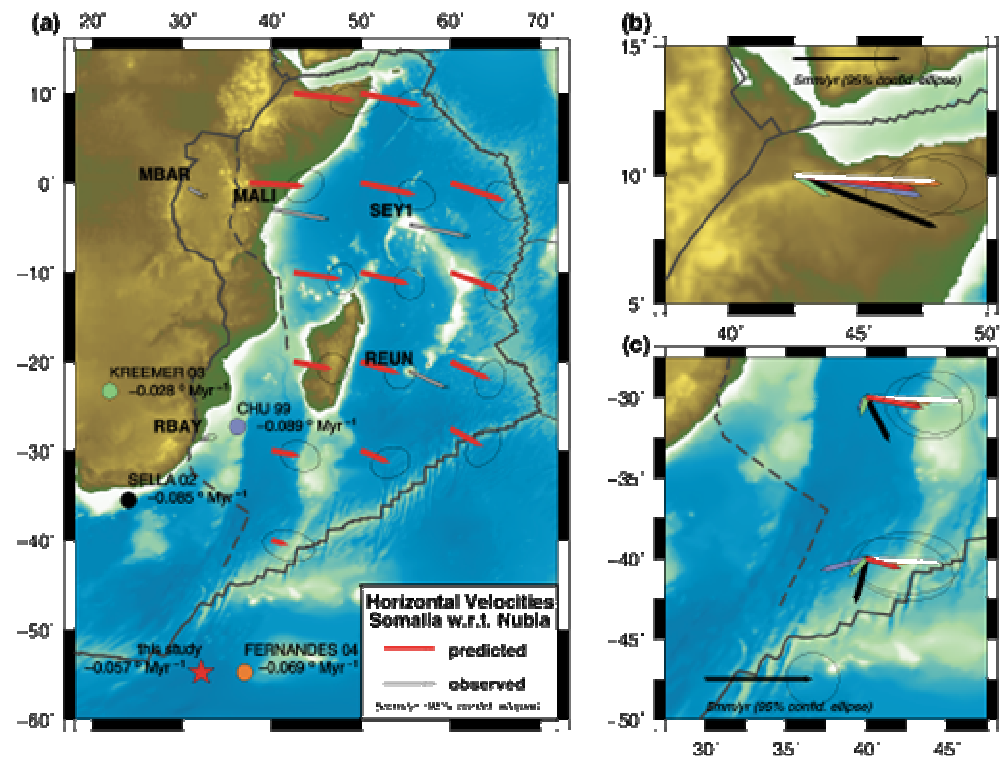
Therefore, let's do a pause.

Pause done.

The role of tectonics….

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


in *Bird [2003]*

in *Fernandes et al. [2004]*

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

Continuous GPS sites in Ethiopia - October 2007
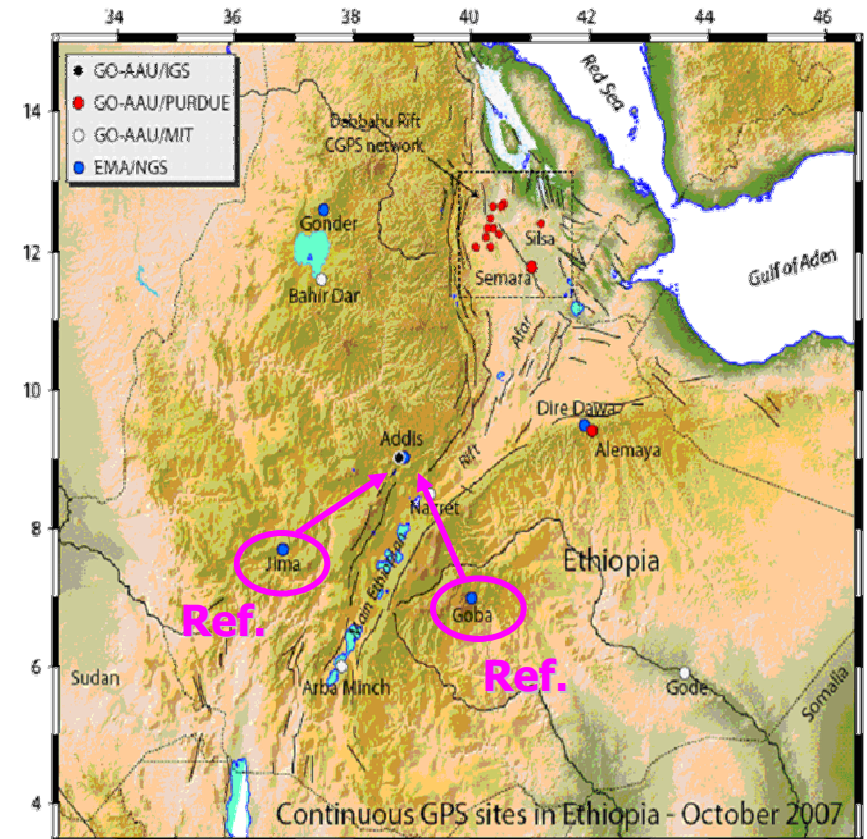
Internal consistency of AFREF08

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

Reference stations located on the 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 . t

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.
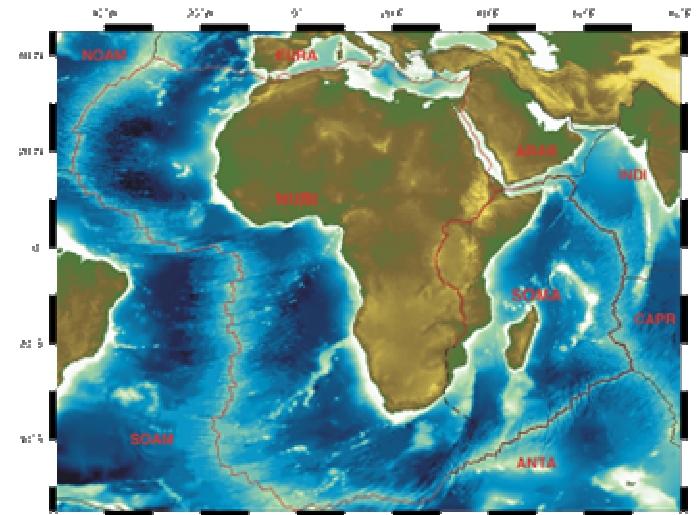
Summary

AFREF08 will be estimated using a consistent set of stations distributed by the entire continent (plus some stations located in neighborhood regions).

Almost all available CORS stations in Africa will be part of the AFREF08 solution (the few exceptions are due to good reasons [e.g., Trignet]).

The coordinate positions will be computed by combining 2 independent solutions using 2 different software packages.

AFREF08 will be formed by a set of coordinates linked to ITRF2005 at a certain epoch (01 March 2008) together with an angular velocity model that will express the relative motions of the existing tectonic blocks in the continent with respect to the Nubian plate.

Future
Maintenance of the AFREF network

- **Data Centers**
  - *2 (at most 3) Data Centers will be sufficient*

- **Analysis Centers – Maintenance of the Reference Frame**
  - *It will desirable that more groups will produce individual solutions based also on other software packages (namely, Bernese)*
  - *An approach similar to EUREF must be followed (why to reinvent the wheel?): distributed computation of overlapping networks*

- **Combination Center**
  - *Production of combined weekly solution ensuring the quality of the AFREF products (station data and positions) and their dissemination.*

New AFREF babies...

Pemba, Mozambique

borned 08 November 2007

New AFREF babies...

Inhambane, Mozambique

borned 11 November 2007