Present-Day Strain Field of Africa derived from the GNSS Velocity Field

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Tectonic Framework – Africa

Two major tectonic plates:
Nubia
Somalia
plus some small blocks:
Victoria
Rovuma
Lwandle (?)

after Stamps et al., 2008
Stress map of Africa

World Stress Map (1:5,000,000) of the IUGG - ILP Project

CORS GNSS stations – Africa

With more than 10 years of observations

28 sites
GNSS stations – Africa

With more than 05 years of observations

70 sites

GNSS stations – Africa

With more than 03 years of observations

116 sites
GNSS stations – Africa

Processed data 2012

Oct Nov Dec
All Year

Time-Series
Secular Motion

Hopefully connection station and plate is rigid!
Analysis Methodology

GIPSY

Stations

Day 1  ...  Day n

GIPSY (PPP strategy)

Solution 1  Solution 7

GIPSY tools
Global parameters
(Dedicated Mapping)

Positions of stations w.r.t.
ITRF2008 at day 1

Positions of stations w.r.t.
ITRF2008 at day n

Solution
day 1

ITRF2008

... velocity field
w.r.t. ITRF2008

Solution
day n

ITRF2008

HECTOR – Time-Series Analysis

available at: http://segal.ubi.pt/hector/

Computation of:
- Secular Trend
- Seasonal Signals
- Jumps
- Power-law errors
- Spectrum Index

Description

Hector is a software package that can be used to estimate the linear trend in time-series with temporal correlated noise. Trend estimation is a common task in geophysical research where one is interested in phenomena such as the increase in temperature, sea level and position over time. It is well known that in most geophysical time-series the noise is correlated in time and this has a significant influence on the accuracy by which the linear trend can be estimated. Therefore, the use of a computer program such as Hector is advisable.

Hector assumes that the user knows what type of temporal correlated noise exist in the observations and estimates both the linear trend and the parameters of the chosen noise model using the Maximum Likelihood Estimation (MLE) method.

How to cite Hector

If you find the Hector program useful, please cite it in your work as:

Time-Series examples

FIG 2013, Abuja, 07 May 2013

- Site SBOK
  - Trend: 10.69 ± 0.34 m/year

- Site MSAR
  - Trend: 17.88 ± 0.23 m/year

Time-Series examples

FIG 2013, Abuja, 07 May 2013

- Site ALEX
  - Trend: 0.30 ± 0.20 m/year

- Site ALX2
  - Trend: 2.89 ± 0.09 m/year
Time-Series examples – Africa Array

Angular Velocities

Used Sites
- NUBI: 25
- SMLA: 07
- VICT: 05

Based on stations with more than 3.5 yrs of observations (with the exception of Victoria where sites with the threshold value was 2.5 yr)

Fernandes et al.  
GJI, 2013
Victoria Block

Location of the rotation poles for Nubia-Victoria and Victoria-Somalia plate pairs. Small black stars indicate the determinations made by Stamps et al. (2008). Relative motions represented by dark grey vectors along the Nubia-Victoria plate boundary are referred to fixed Nubia, while relative motions along the Victoria-Somalia plate boundary are relative to fixed Victoria.

Velocity Field wrt NUBI

For stations with more than 3.0 yr

116 sites
Ibero-Maghreb region
Oblique convergence along the plate boundary

GPS results in North Africa: Yellow: Koulali et al., 2011; Red: Fernandes et al., 2007; Black: Anzidei et al., 2001; Blue: Serpelloni et al., 2007.

Meghraoui & Pondrelli, 2012

Southern Africa
Stability of Nubian plate

Westard Motions in Cape Region
Noiser solutions in Joburg area (human/mining?)

Definition of plate boundary
Comments on GNSS data

Lack of stations in some areas...
- Sahara (from Mauritania to Sudan)
- West Africa (Senegal, Guinea)
- Central Africa (CAR, DRC)
- North Africa (Libya, Tunisia)

Access to data in many countries
(e.g., Algeria, Angola)

Confidence on the solutions
- Still need to distinguish between signal and noise
- Some stations show significant data gaps to allow us a robust velocity model

Open Questions on results

Internal plate deformation ?

Important local effects ?

East African Rift block composition ?

Ibero-Maghreb (EURA-NUBI) plate boundary ?

And more and more questions...
(directly correlated with more and more data)
Questions?