GPS Analysis Strategies to Minimize the Error Contribution to Geodetic GPS Determination

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XXIV FIG International Congress 2010 – Facing the Challenges – Building the Capacity

Sydney Convention & Exhibition Center, 11 – 16 April 2010

Overview

- The purpose of *IPGSN*

- Status of *IPGSN*

- GPS analysis strategies

- Comparison of troposphere modelling and implications to the determination of precise station coordinates (*height component*)

- Summary

The purpose of IPGSN

➢ to maintain a geodetic reference frame over Indonesia region with dynamics seismic activity

➢ supports a wide range of scientific applications:
  – geodynamics,
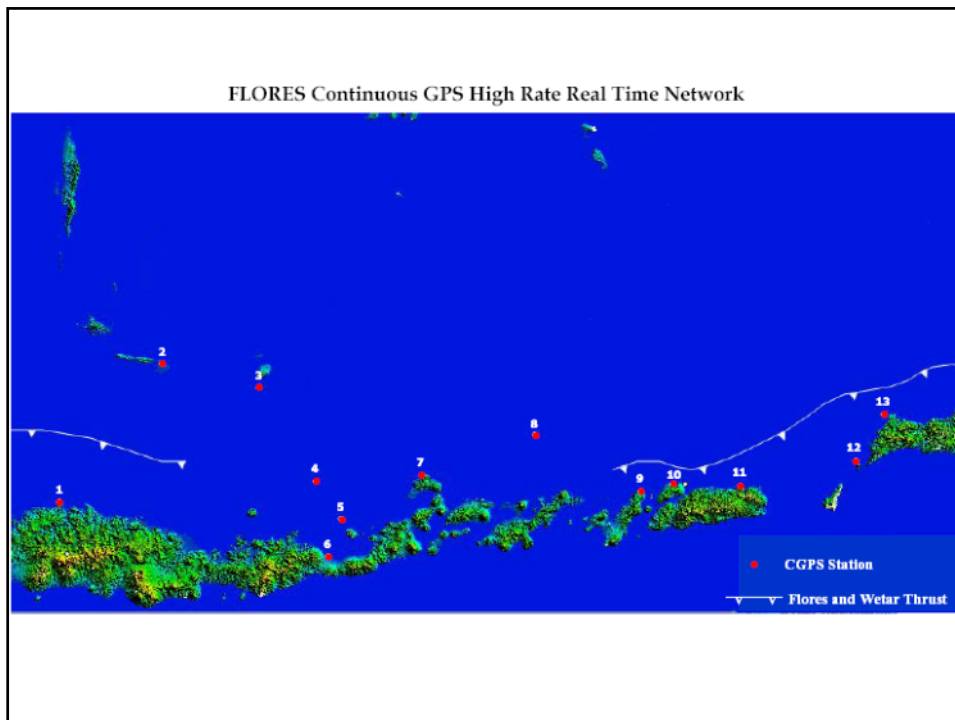 – sea level monitoring,
  – atmospheric study

The Present Status of IPGSN and its Development
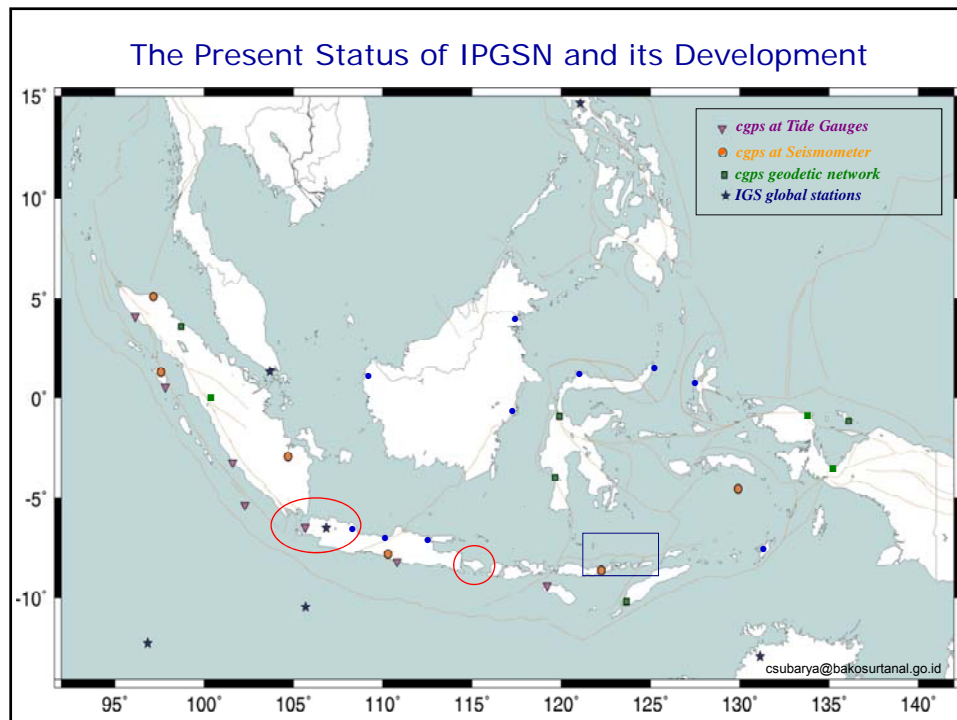
West Java Continuous GPS Real Time Network

Bali Continuous GPS Real Time Network
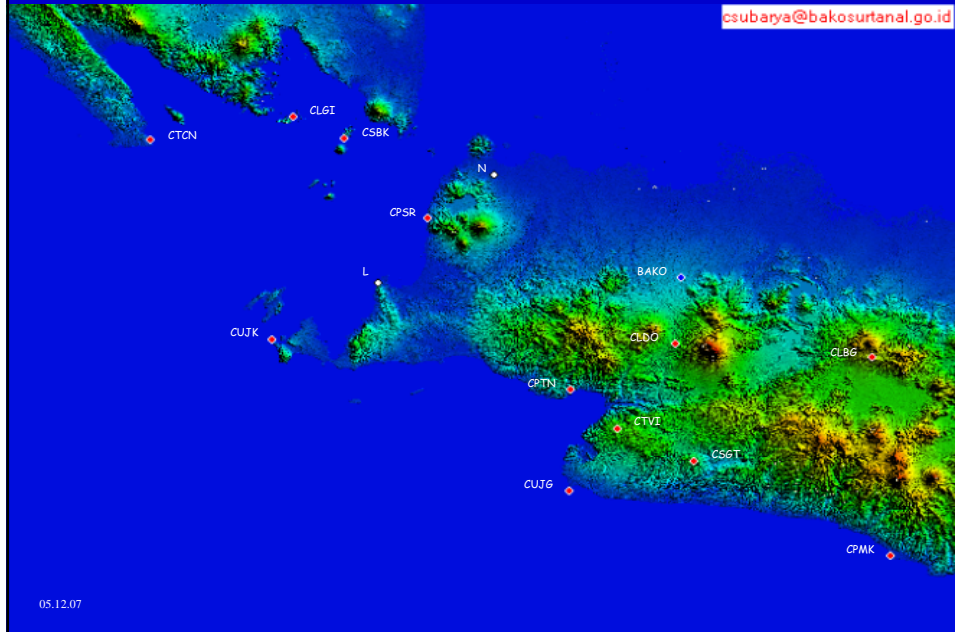
FLORES Continuous GPS High Rate Real Time Network
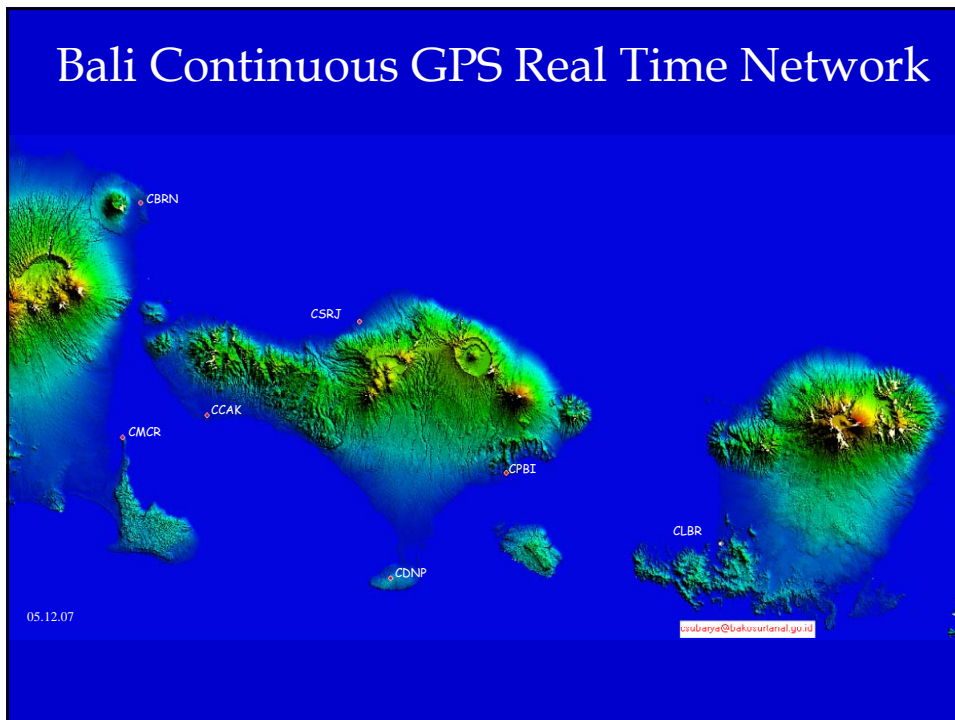
Strategy of cGPS Data Processing and Analysis

Parameter	Description
GPS Software	GAMIT 10.35 (King and Bock, 2006) for GPS observations processing
Stations	Grouping into 50 stations sub-networks
Data	Double-differenced phase and code pseudo-range observations
Sessions and sampling	24-hour session, sampling interval (data cleaning 30s)
Elevation cut-off angle	10°
Ionosphere refraction	Ionosphere-free linear combination LC
Troposphere refraction	A priori zenith delays from Saastamoinen (1973) model, using a standard atmosphere, mapped with the GMF mapping functions; zenith wet delays estimated as a piece-wise linear model with 1-h nodes
Antenna PCV	IGS absolute phase center correction (igs05_1525_plus.atx)
Earth orientation	IERS bulletin B
Earth and polar tide	IERS2003
Ocean tide loading	Computed using FES2004
Gravity model	EGM96
Station positions	Free-network approach. A priori values is based on ITRF2005 epoch 2000.0
Orbits	Adjusted (relaxed orbit strategy). A priori values from IGS precise orbits
Reference Frame	ITRF2005 epoch 2000.0 datum
Combination strategy	The global GPS sub-network solutions are combined into daily and weekly solutions, and aligned to the ITRF2005 using the minimum constraint approach implemented in the GLOBK software.

Troposphere Modeling

$$\Delta L(e) = \Delta L_h^{z} \cdot mf_h(e) + \Delta L_w^{z} \cdot mf_w(e)$$

ΔL **Troposphere Total Delay**

ΔL_h^{z} **Zenith Hydrostatic Delay**

ΔL_w^{z} **Zenith Wet Delay**

e   **Zenith angle**

mf_h **hydrostatic mapping function**

mf_w **wet mapping function**

Troposphere Modeling

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Mapping functions:

- **Global Mapping Functions (GMF)**

Hydrostatic a priori delays:

- **Global Pressure and Temperature (GPT) model**
- **Zenith delays from ECMWF weather model data**

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cGPS Coordinates Time Series in ITRF2005

$$y(t_i) = a + bt_i + c\sin(2\pi t_i) + d\cos(2\pi t_i) + e\sin(4\pi t_i) + f\cos(4\pi t_i)$$
$$+ \sum_{j=1}^{n_g} g_j H(t_i - T_{gj}) + v_i$$

Case studies:

- **cGPS stations at various monument types and locations**
- **1.8 – 5 years continuously data period**
- **daily vs weekly solutions**
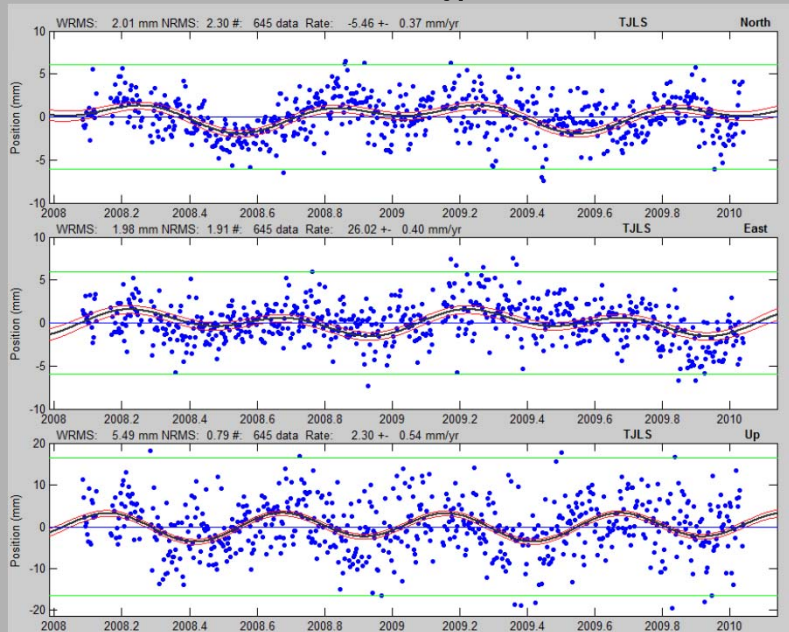- **coordinates time series by using GG-Matlab (Herring, 2003)**

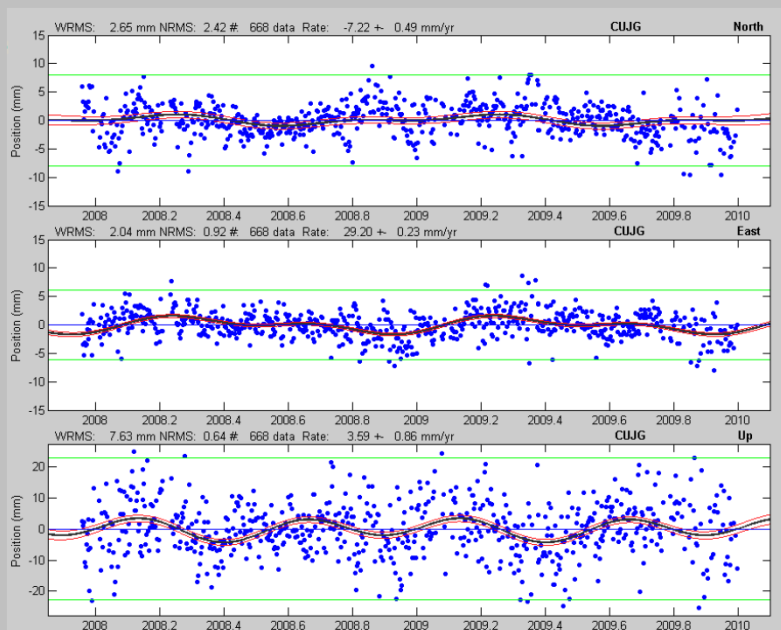**Daily Solution of CLBG at Lembang-Bandung on "brace monument type"**
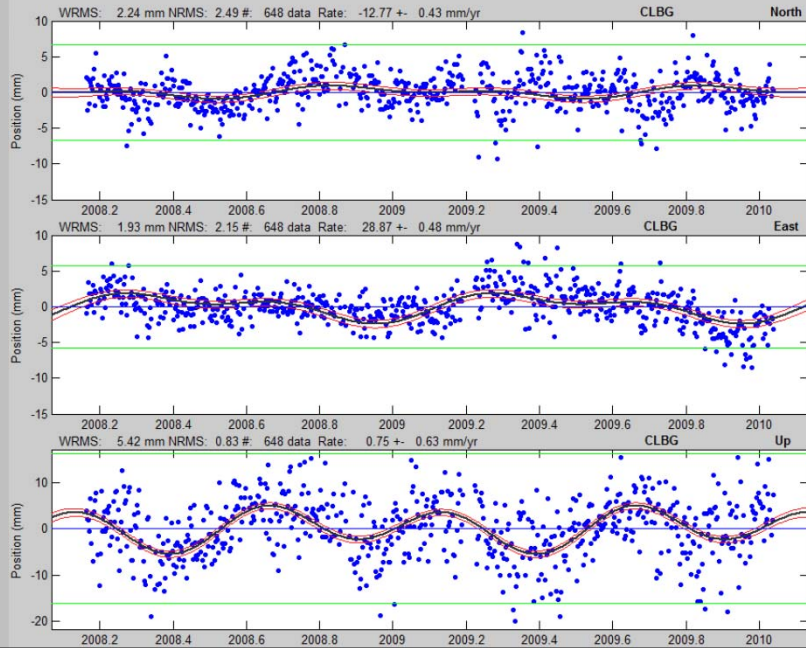
Daily Solution of KOEP at Timor Island on "top of concrete roof monument type"
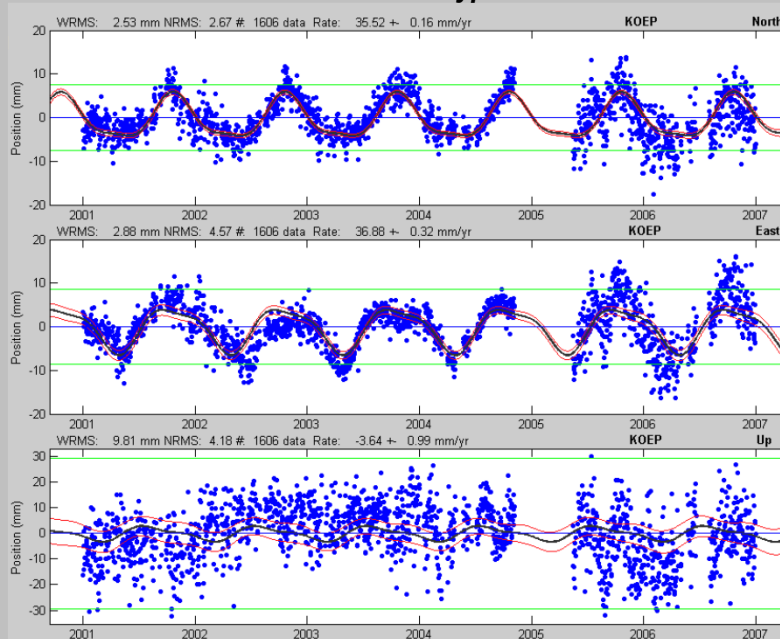
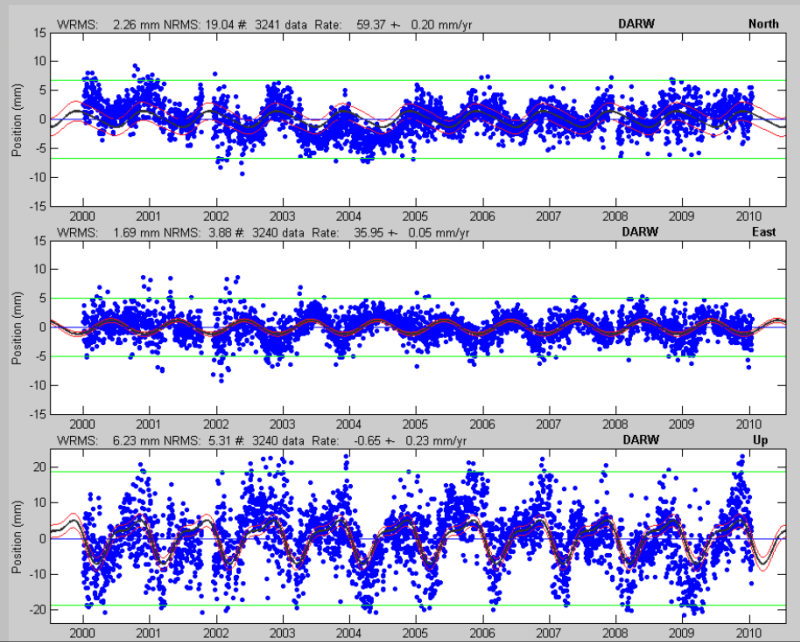Daily Solution of TJLS at Sunda Strait on "tide gauge station monument type"

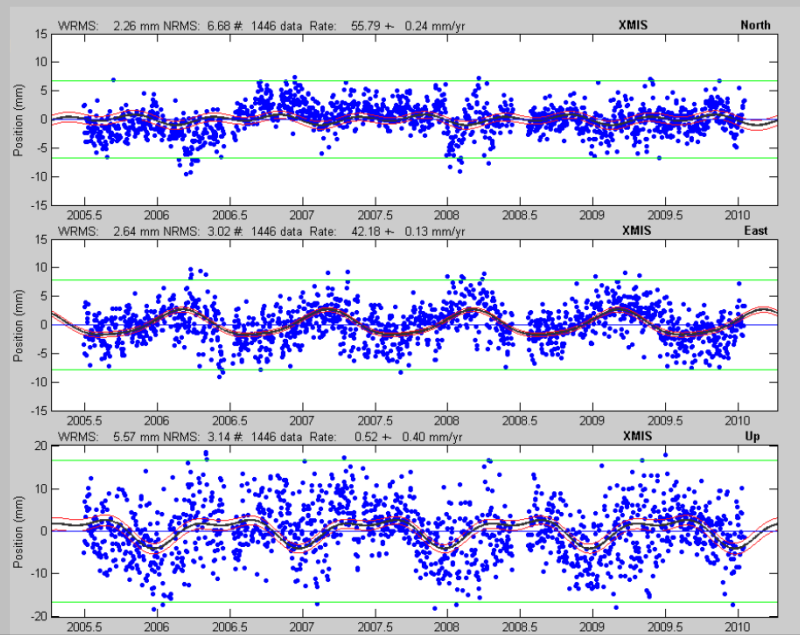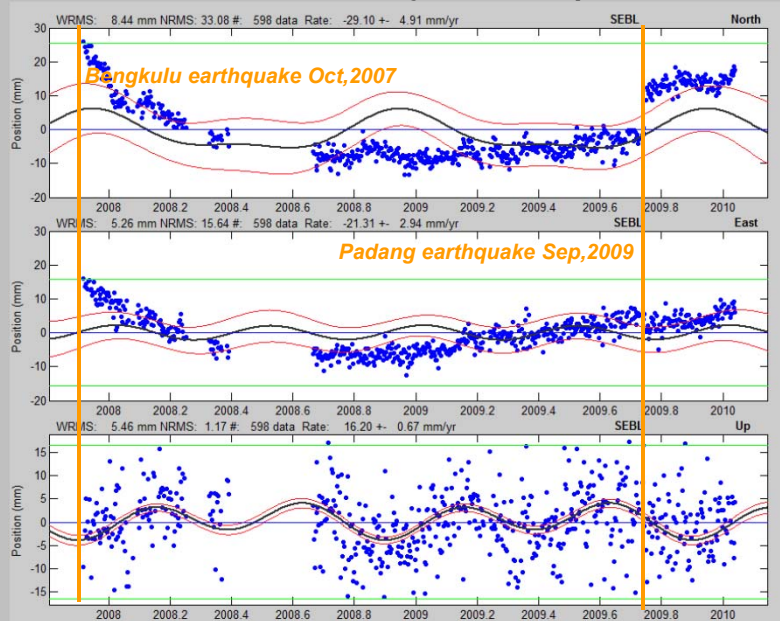Weekly Solution of CUJG at Southern Java on "3m concrete station monument type"

Daily Solution of DARW IGS Station at Darwin-Australia

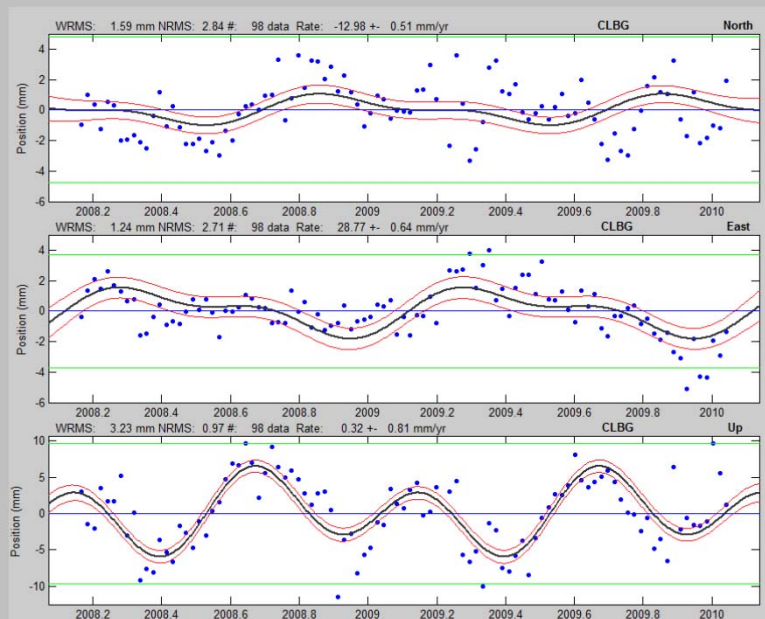*Daily Solution of XMIS IGS Station at Christmas Is. -Australia*
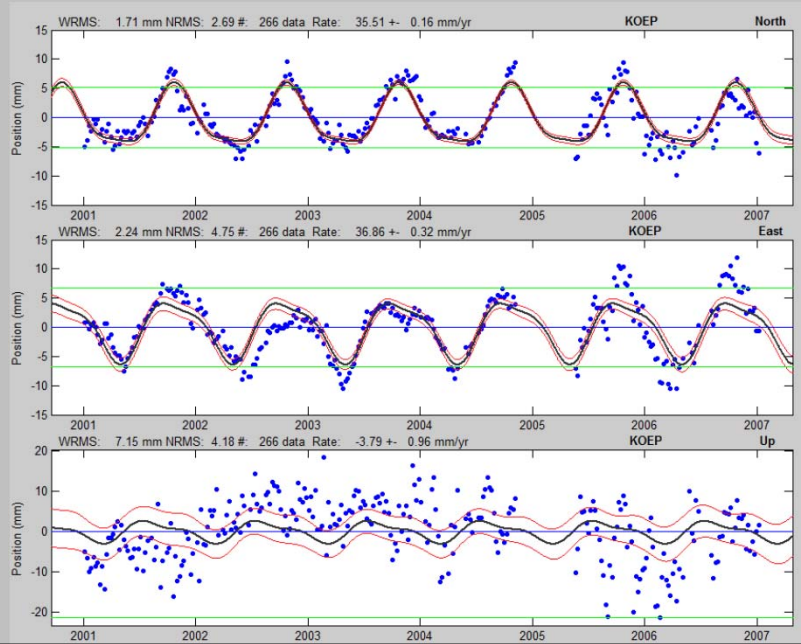
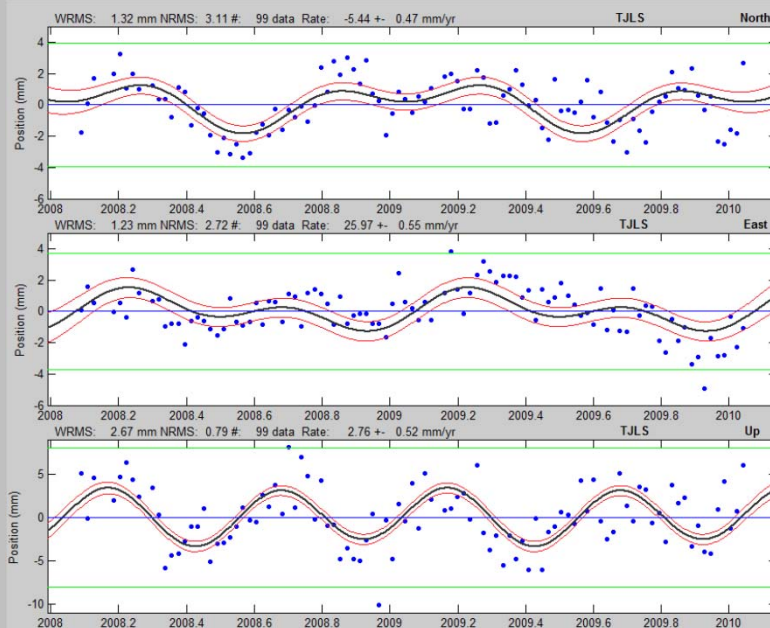Daily Solution of SEBL at Bengkulu-Sumatra on tide gauge station, influenced by two earthquakes

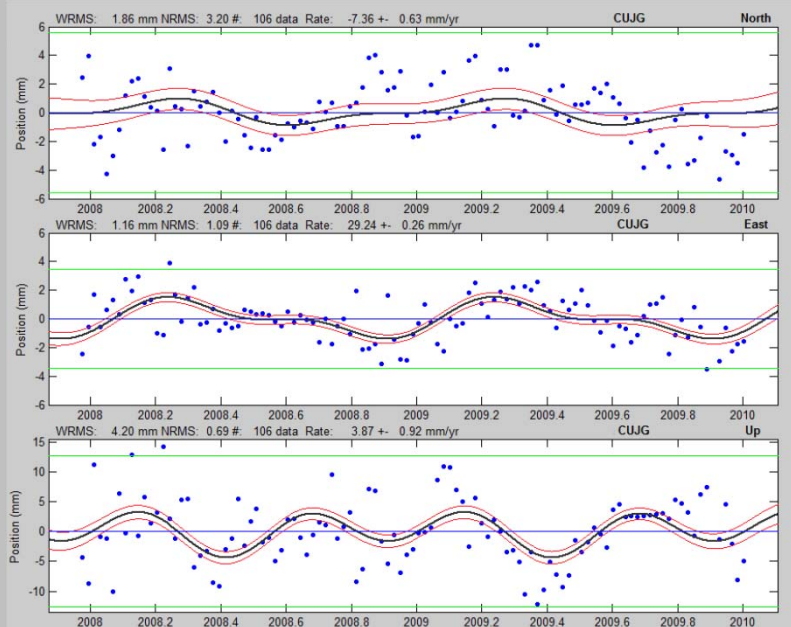Weekly Solution of CLBG at Lembang-Bandung on "brace monument type"

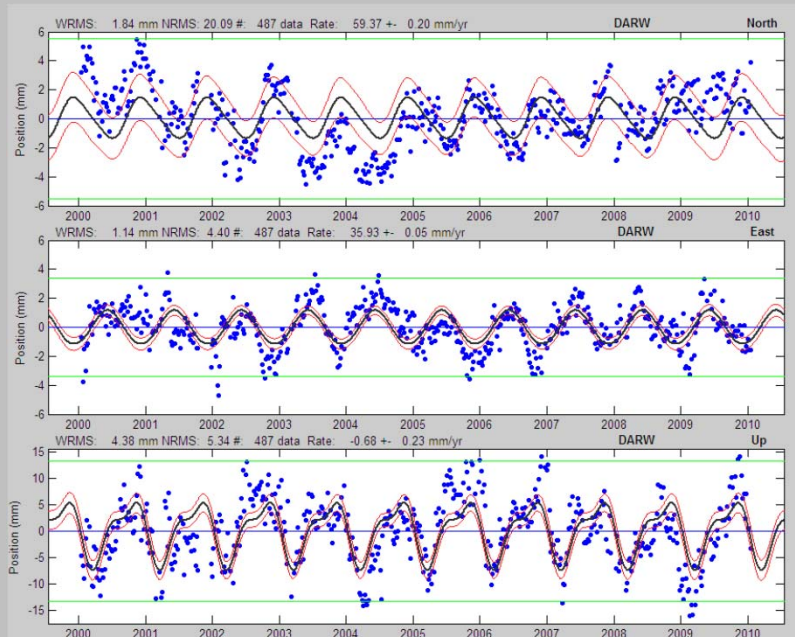*Weekly Solution of KOEP at Timor Island on "top of concrete roof monument type"*

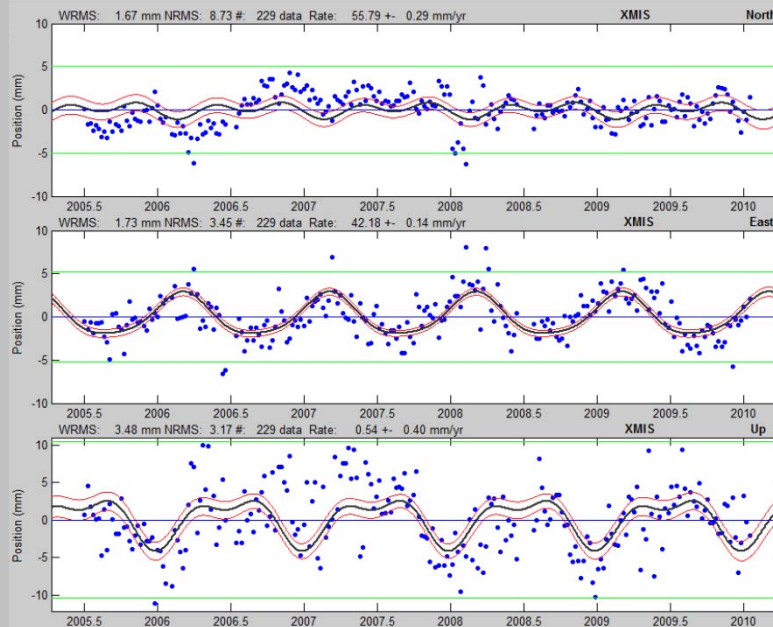*Weekly Solution of TJLS at Sunda Strait on "tide gauge station monument type"*

Weekly Solution of CUJG at Southern Java on "3m concrete station monument type"

Weekly Solution of DARW IGS Station at Darwin-Australia

Weekly Solution of XMIS IGS Station at Christmas Island

Summary

- **Long-term differences** between daily and weekly solution of GMF/GPT and GMF/ECMWF are in general

  - on the millimeter level for the horizontal component

  - factor 3 of horizontal precision for the station heights (up to 2 mm for a few stations)

- There is a clear that weekly solution is more robust solutions compare with daily solution on the sub-millimeter level

- Further studies need to be done to apply VMF1/ECMWF by incorporated meteorological surface measurement to expect better level precision on the height component.

GPS = *Great Places to Smoke*