ANALYSIS OF THE EARTH'S CENTER OF MASS PERIODICAL MOVEMENTS

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In 2009 INASAN (ina) Doris Analysis Center installed new version GIPSY-OASIS II software developed by JPL with updated DORIS part of GIPSY developed by IGN/JPL (Linux version 5.0). This software was ported on the new PC computer with the new Linux distributive (Ubuntu 9.04).

List of INASAN products provided to the IDS (February 2010)

Product	Latest version	Span
Sinex weekly free network solutions	inawd06	1992.8 - 2010.0
Geocenter	Ina05wd01	1992.8 - 2010.0
EOP-series	ina07wd01	1992.8 - 2010.0
STCD-series	ina07wd01	1993.0 - 2007.6

In 2009 INASAN AC fully reprocessed all DORIS data for 1993.0-2010.0 with the new software and new models

Old models:

1) elevation cutoff angle = 15 degrees

2) the gravity field is GGM01C (120x120)

3) solar radiation pressure coefficients were estimated

4) Lanyi tropospheric mapping function was used

5) atmospheric density model DTM94 as a priori

6) estimating atmospheric drag every 6 hrs for SPOT's and every 24 hrs for TOPEX

7) polar motion rates were estimated

New models:

1) elevation cutoff angle = 15 degrees and data downweigthing at low elevation were applied

2) the gravity field is GGM02C (120x120)

3) fixing daily coefficients for solar radiation pressure models

4) Niell tropospheric mapping function was used

5) atmospheric density model DTM2000 as a priori

6) estimating atmospheric drag every 1 hr

7) polar motion rates were not estimated

Studies of geocenter movements

1) The linear regression analysis (LRA)

$$J(t) = a_0 + b_0 t + A_0 \sin\left(\frac{2\pi}{T}(t - t_0) + \varphi_0\right),$$

$A_0 -$ amplitude of the signal

$T -$ period of the signal (in years)

$\varphi_0 -$ initial phase of the signal

$a_0 -$ offset

$b_0 -$ trend

$t_0 -$ initial time (1st January)

$t -$ time

Comparison INA geocenter times series (old-ina05wd01 and new-ina10wd01) with IGN geocenter times series

AC	Time series	Span	Tx				Ty				Tz			
			Annual		Semiannual		Annual		Semiannual		Annual		Semiannual	
			A1 (mm)	Phi (deg)	A2 (mm)	Phi (deg)	A1 (mm)	Phi (deg)	A2 (mm)	Phi (deg)	A1 (mm)	Phi (deg)	A2 (mm)	Phi (deg)
IGN	ign09wd01	1993.0-2010.0	5.6 0.2	106.9 3.9	5.5 0.3	358.6 3.3	4.7 0.04	319.4 6.7	7.6 0.3	350.9 3.4	2.2 0.9	289.7 47.0	33.5 1.4	357.9 2.5
INA	ina05wd01	1993.0-2010.0	6.8 0.3	110.3 5.0	0.5 0.4	270.4 57.4	5.4 3.3	317.7 6.7	9.4 0.4	353.2 3.1	27.2 1.0	291.1 5.0	6.3 0.5	303.8 23.0
INA	ina10wd01	1993.0-2010.0	4.7 0.4	100.2 6.4	5.6 0.4	350.6 5.3	4.6 0.2	307.4 17.5	11.4 0.8	347.2 6.0	6.2 2.9	261.8 19.8	30.2 2.1	351.3 5.5

2) Dynamic regression modeling (DRM method)

- **Trend-stability estimation**
- **Estimation and removal of trend component**
- **Estimation of harmonic components (spectral and wavelet analysis)**
- **Development GARCH model for the residuals from previous step**
- **Application of Kalman's filter**

Comparison of geocenter motion variations by LRA and DRM methods for ina05wd01 time series (1993.0-2009.0)

Method	Harmonics periods (years)	Tx Annual	Semian.	Ty Annual	Semian.	Tz Annual	Semian.
LRA	0.5; 1	6.7	3.6	5.5	9.3	28.9	9.8
DRM	0.15; ~0.5; ~1; ~2; ~3; ~5	5.9	2.1	6.1	1.1	24.2	11.1

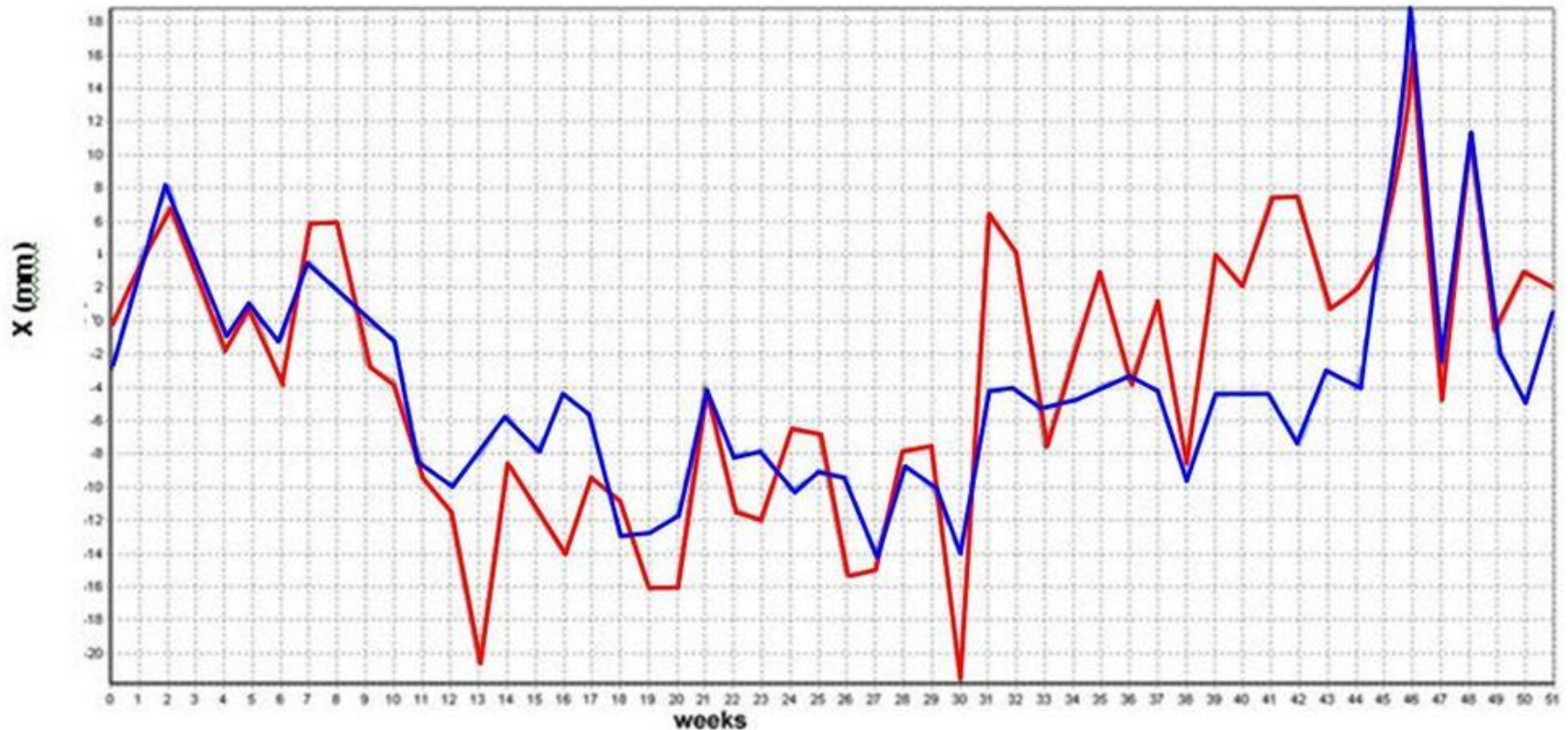# DRM forecasting model of the weekly geocenter positions for 2008 (X)

Fig.1. X geocenter coordinate, evaluated at INA DORIS Analysis center (red line) and simulated by the model (blue line) for the 2008 year.

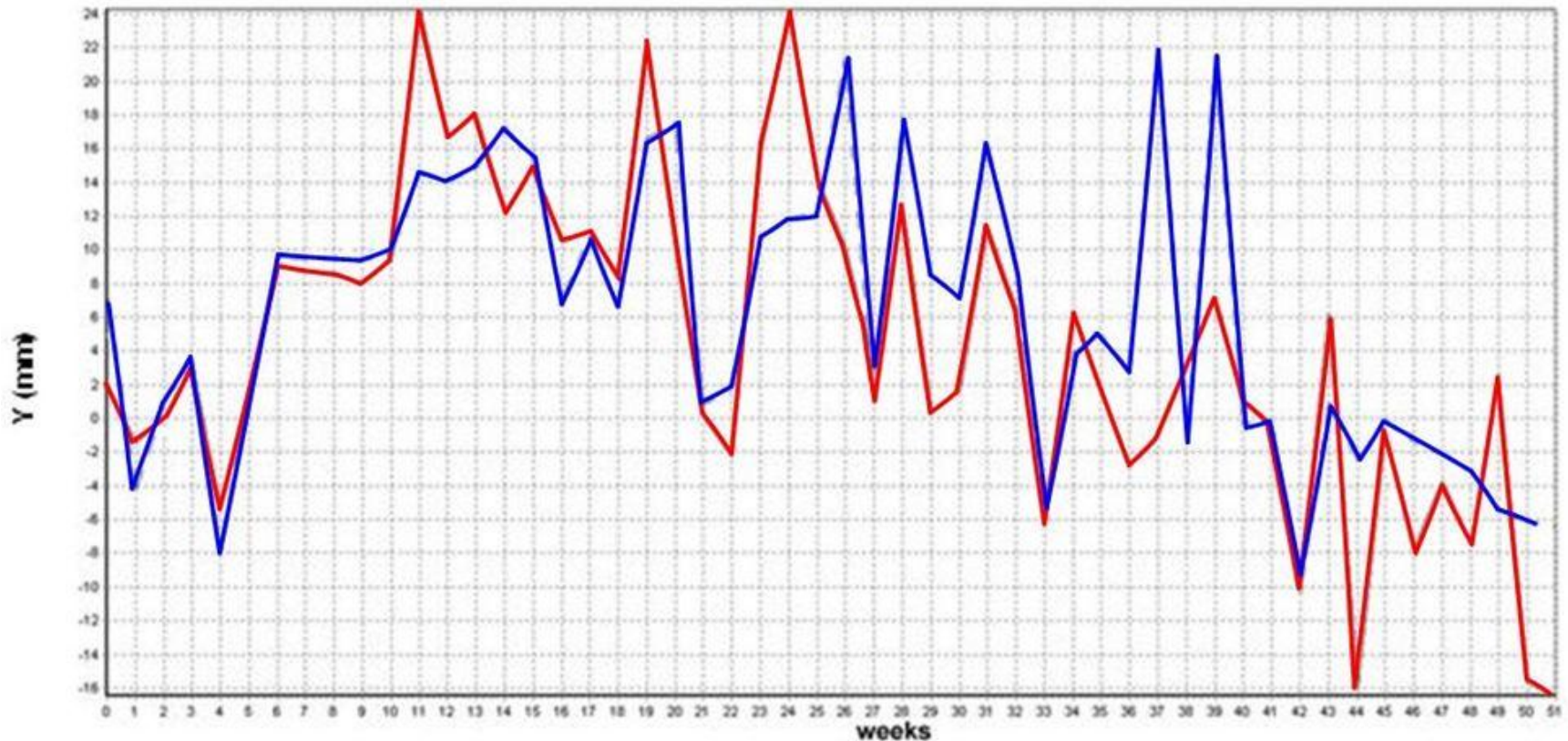# DRM forecasting model of the weekly geocenter positions for 2008 (Y)

Fig. 2. Y geocenter coordinate, evaluated at INA DORIS Analysis center (red line) and simulated by the model (blue line) for the 2008 year.

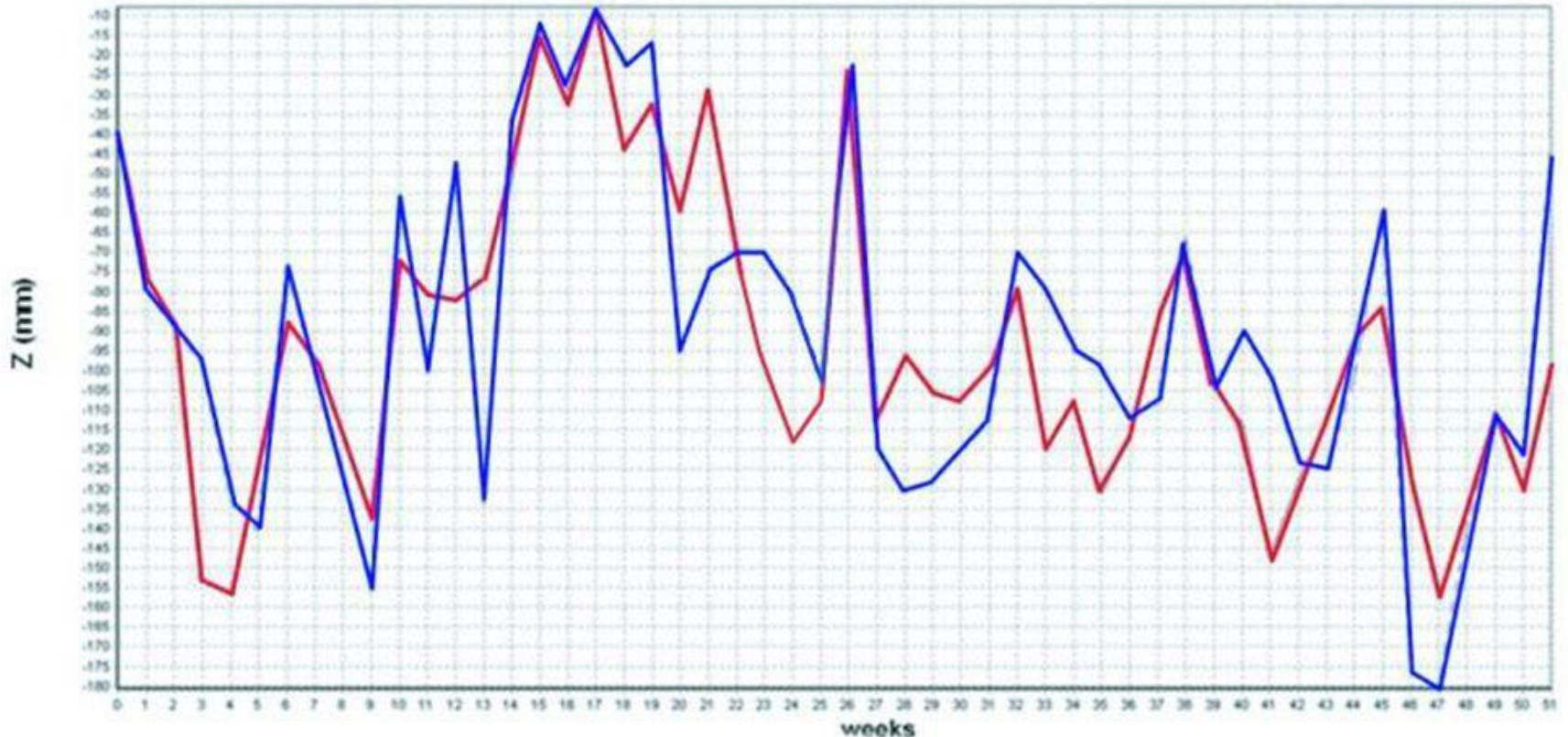# DRM forecasting model of the weekly geocenter positions for 2008 (Z)

Fig. 3. Z geocenter coordinate, evaluated at INA DORIS Analysis center (red line) and simulated by the model (blue line) for the 2008 year.

Forecasting results

Time interval (weeks)	Correlation coefficient			RMS (mm)		
	X	Y	Z	X	Y	Z
First 10 weeks	0.852	0.949	0.815	2.24	2.26	12.92
52 (whole year)	0.786	0.766	0.802	7.01	7.52	29.13

Conclusions

- **There is good agreement between LRA and DRM models used for studies of geocenter motion.**

- **The first attempt to develop a mathematical model of the geocenter motion with DRM approach has been made.**

- **DRM model may be used for predictions during the next 10 weeks.**

- **It is planned to investigate with DRM model SLR and GPS time series of geocenter motion.**