

State Space Corporation ROSCOSMOS
INFORMATION AND ANALYSIS CENTER FOR POSITIONING, NAVIGATION AND TIMING
(IAC PNT) CENTRAL RESEARCH INSTITUTE FOR MACHINE BUILDING, FEDERAL STATE
UNITARY ENTERPRISE (FGUP TSNIIMASH)

Accuracy Assessment of PZ-90.11 Reference Frame Based on Orbital Data Processing of GLONASS Ephemeris

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The PZ-90.11 is the national Coordinate System

- introduced by the Russian Federation Government Decree 1463 of December 28, 2012, and
- used for geodetic support of orbital missions and navigation from January 15, 2014.
- The PZ-90 Coordinate System is a basis for geodetic support of the GLObal Navigation Satellite System (GLONASS).



System of Geodetic Parameters “Parametry Zemli 1990” * PZ-90.11

Responsible Organization: Ministry of Defense of the Russian Federation

Abbreviated Frame Name: PZ-90

Associated TRS: PZ-90

Coverage of Frame: Global

Type of Frame: 3-Dimensional orthogonal

Last Version: PZ-90.11

Reference Epoch: 2010.0

* In Russian “Earth Parameters 1990”





Definition of PZ-90.11 Reference Frame

- **Origin:** Earth's center of mass being defined for the whole Earth including oceans and atmosphere.
- **Scale:** Conforms to the current state of knowledge of the speed of light, the geocentric gravitational constant as well as to the precision of the satellite laser ranging instruments.
- **Orientation:** Conforms to the Recommendations of BIH.
- **Evolution:** Zero rotation rate with respect to the ITRF2008.
- **Axes:**
 - Z-axis is directed to the Conventional Reference Pole that was defined by the International Earth Rotation and Reference Systems Service (IERS) and Bureau International de l'Heure (BIH);
 - X-axis is directed to the intersection point of the equatorial plane and the Zero Meridian defined by BIH;
 - Y-axis completes a right-handed system.

PZ-90.11 is agreed with ITRF2008.

32.0° N 55° E
48.37° N 37° E
48.1° N 54° E
32.0° N 48.1° E

55° 54' 44" N, 37° 48' 29" E

55° 54' 44" N, 37° 48' 29" E

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INFORMATION AND ANALYSIS CENTER FOR POSITIONING, NAVIGATION AND TIMING

55° 47' 01" N, 37° 37' 50" E



- MAIN
- GLONASS SCC
- GLONASS
- GPS
- NEWS**
- ARCHIVE
- GUIDE
- FEEDBACK
- ABOUT IAC

UTC+3: 17:43:44

08.04.2014

THE TRANSITION TO USING THE TERRESTRIAL GEOCENTRIC COORDINATE SYSTEM "PARAMETRY ZEMLI 1990" (PZ-90.11) IN OPERATING THE GLOBAL NAVIGATION SATELLITE SYSTEM (GLONASS) HAS BEEN IMPLEMENTED

In fulfillment of the Russian Government Resolution № 1463 of December 28, 2012 "On the Common National Geodetic Coordinate Systems" starting from 3:00 pm on December 31, 2013 the transition to using the terrestrial geocentric coordinate system "Parametry Zemli 1990" (PZ-90.11) in operating the GLObal NAVigation Satellite System (GLONASS) has been implemented.

The fundamental geodetic constants as well as the Earth's ellipsoid parameters used in PZ-90.11 are provided in the Annex to the above mentioned Resolution.

The updated version of the GLONASS ICD (edition 5.1 of 2008) is published at www.spacecorp.ru/directions/glonass/control_document

Source: www.spacecorp.ru/directions/glonass/control_document

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32.0° N 55° E
48.37° N 37° E
48.1° N 54° E
32.0° N 48.1° E

Transformation of spatial Cartesian coordinates from system 1 to system 2 is made by the equation

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_2 = (1+m) \begin{pmatrix} 1 & +\omega_z & -\omega_y \\ -\omega_z & 1 & +\omega_x \\ +\omega_y & -\omega_x & 1 \end{pmatrix} \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_1 + \begin{pmatrix} \Delta X \\ \Delta Y \\ \Delta Z \end{pmatrix} \quad (\text{A.4.1})$$

where $\Delta X, \Delta Y, \Delta Z$ – linear transformation elements for translating reference system 1 to system 2, m;

$\omega_x, \omega_y, \omega_z$ – angular transformation elements for translating reference system 1 to system 2, rad;

m – scale transformation element for translating reference system 1 to system 2.

#	From	To	ΔX (m)	ΔY (m)	ΔZ (m)	ω_x (mas)	ω_y (mas)	ω_z (mas)	m (10^{-6})	Epoch
1	PZ-90	PZ-90.02	-1.07 ± 0.10	-0.03 ± 0.10	+0.02 ± 0.10	0	0	-130 ± 10	-0.220 ± 0.020	2002.0
2	WGS 84 (G1150)	PZ-90.02	+0.36 ± 0.10	-0.08 ± 0.10	-0.18 ± 0.10	0	0	0	0	2002.0
3	PZ-90.11	ITRF2008	-0.003 ± 0.002	-0.001 ± 0.002	+0.000 ± 0.002	+0.019 ± 0.072	-0.042 ± 0.073	+0.002 ± 0.090	-0.000 ± 0.0003	2010.0

PZ-90.11 Accuracy Parameters

#	Parameter	Accuracy
1	Earth's Center of Mass	0.050 m
2	Alignment of the Axes	0.001"
3	Relative Position of the Sites	0.005-0.010 m



- The estimation based on daily solutions.
- Orbital method was applied for transformation parameter determination.
- GLONASS broadcast ephemeris was used.
- The data were obtained from GNSS receivers globally located on the Earth. Total number of sites is from 750 to 1150.



РОСКОСМОС



ЦНИИМАШ
TSNIIMASH



ИАЦ



The same investigation was done by:

- Vladimir V. Mitrikas, Sergey G. Revnivykh, Evgeniy V. Bykhanov
- WGS84/PZ90 Transformation Parameters Determination Based On Laser And Ephemeris Long-Term GLONASS Orbital Data Processing
- Proceedings of the 11th International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GPS 1998)
- September 15 - 18, 1998
- Nashville, TN

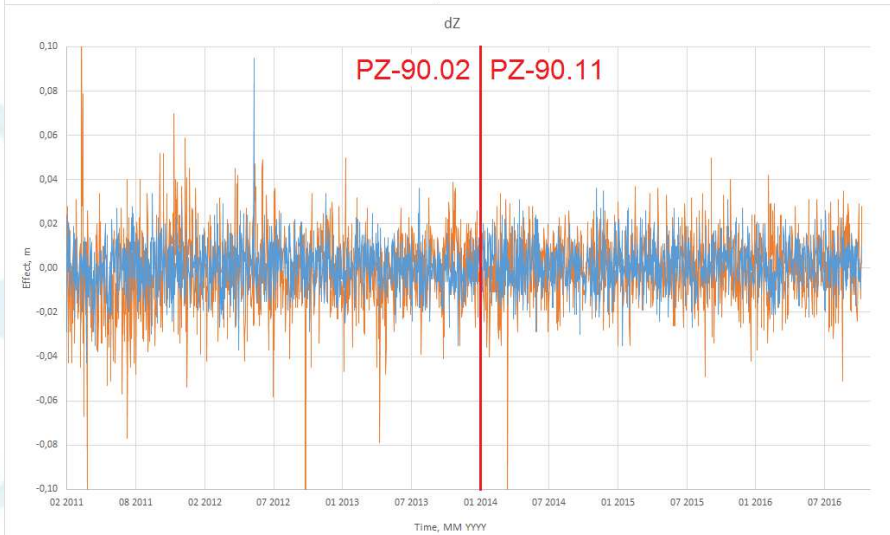
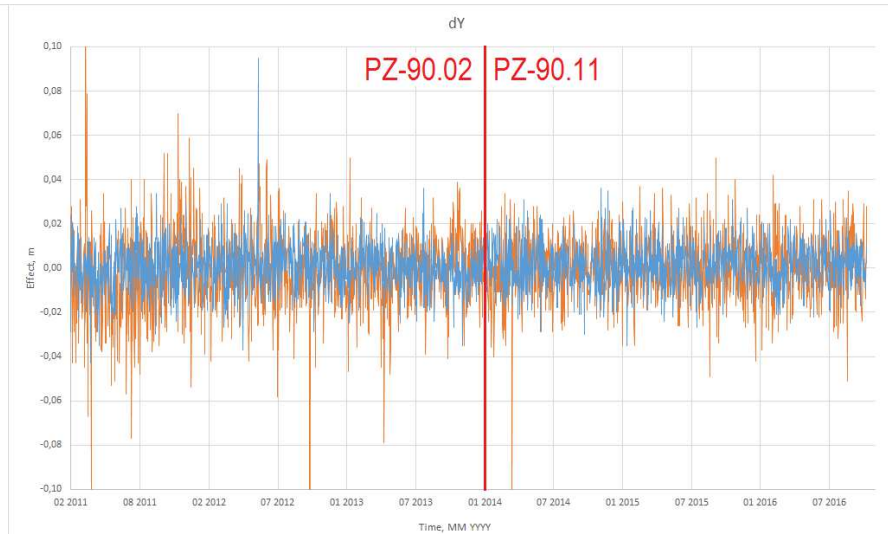
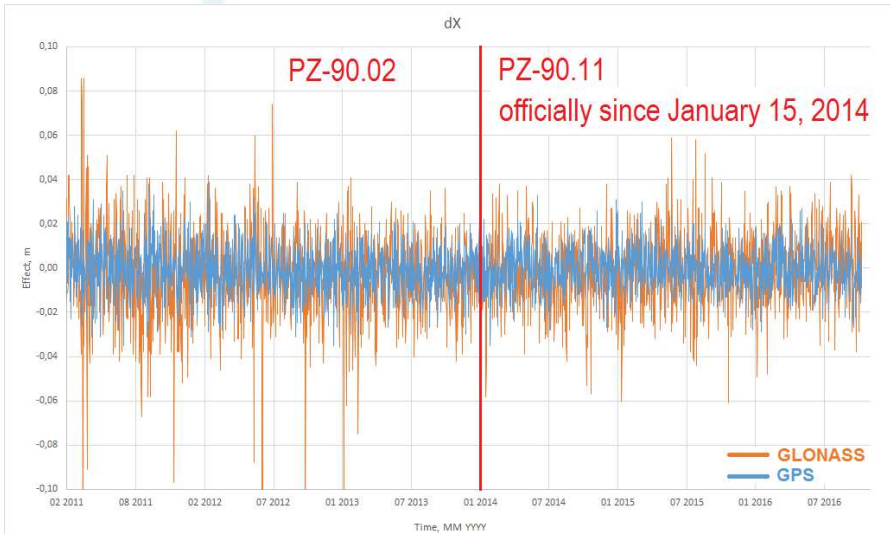
WGS84/PZ90 Transformation Parameters Determination Based On Laser And Ephemeris Long-Term GLONASS Orbital Data Processing

Vladimir V. Mitrikas, Sergey G. Revnivykh, *GEO-ZUP Company*.

Evgeniy V. Bykhanov, *Institute of Military Forces*.



Earth's Center of Mass



Reference Frame	RMS				Tolerance, m
	ΔX , m	ΔY , m	ΔZ , m	Origin, m	
PZ-90.02	0,027	0,030	0,095	0,104	> 0,05
PZ-90.11	0,017	0,014	0,053	0,057	≈ 0,05
WGS84	0,009	0,009	0,041	0,043	< 0,05



54.1
37.0
55.0
32.0
E
48.32
48.1
32.0
N
55.0
37.0
54.1



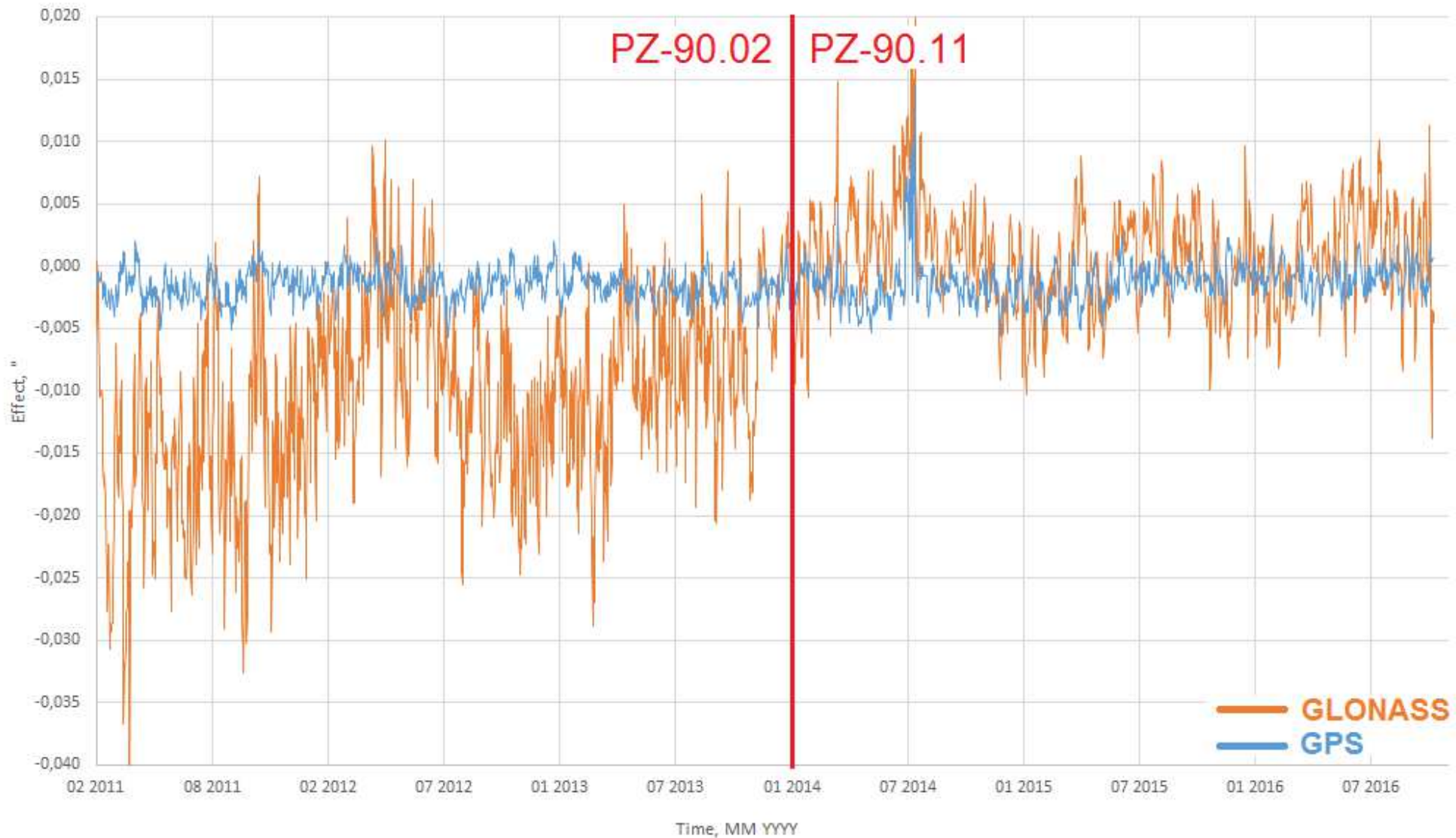
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54.1
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48.1
32.0
N
55.0
37.0
54.1

Wz

PZ-90.02 PZ-90.11



GLONASS
GPS

Alignment of the Axes



Reference Frame	RMS		
	Wx, "	Wy, "	Wz, "
PZ-90.02	0,0016	0,0018	0,0085
PZ-90.11	0,0008	0,0010	0,0042
WGS84	0,0009	0,0011	0,0016



Thank you!

