

GLOBAL GEOCENTRIC COORDINATE SYSTEM

Global Navigation Satellite System



GLOBAL GEOCENTRIC COORDINATE SYSTEM of the RUSSIAN FEDERATION

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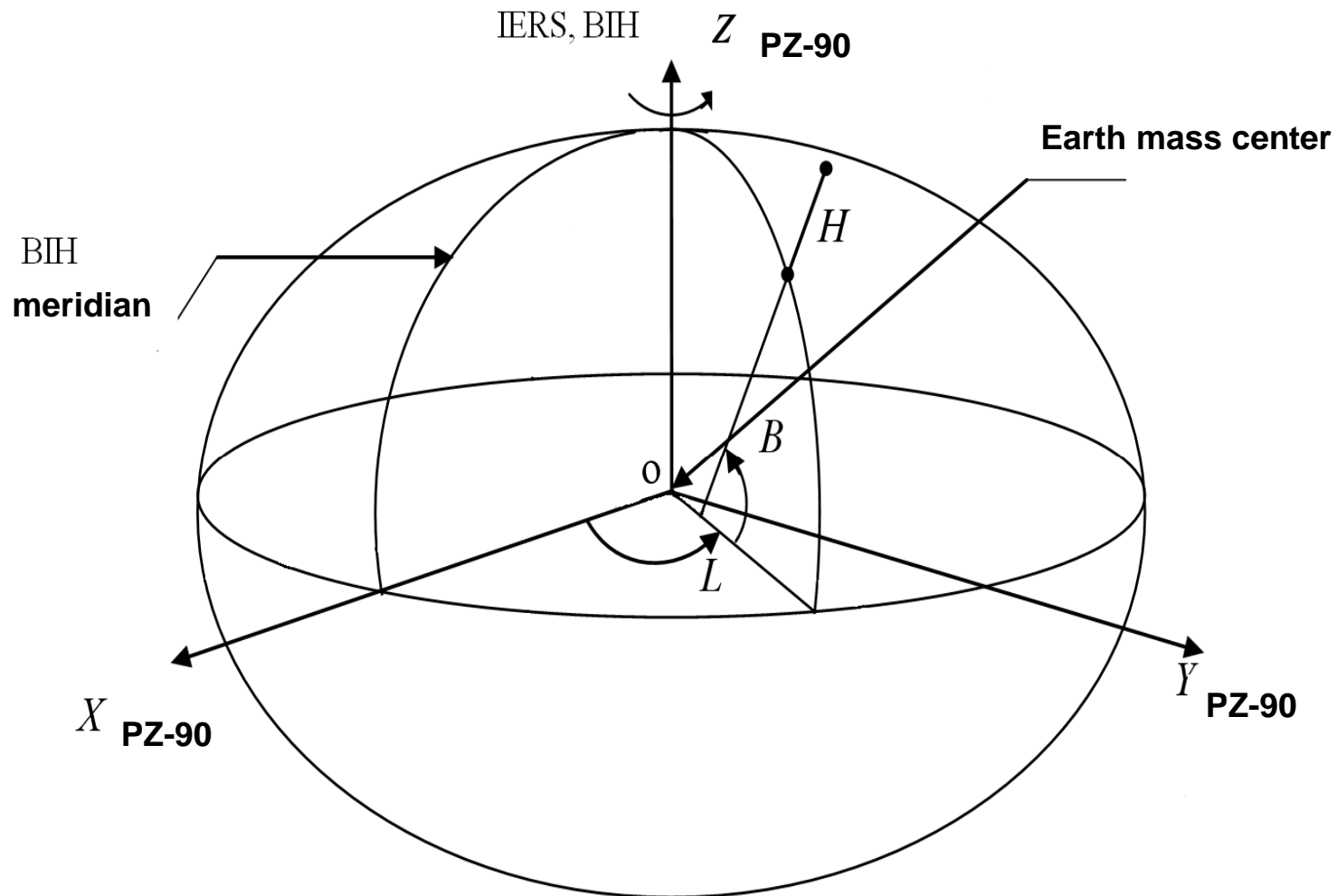
INTRODUCTION

Coordinate system PZ-90 is the earth coordinate system. The definition of this coordinate system meets the criteria outlined in the PZ-90:

- it is geocentric, the center of mass is determined for the entire Earth, including oceans and atmosphere;
- size corresponds to the current state of knowledge about the values of the speed of light, geocentric gravitational constant, and the precision of satellite laser ranging;
- orientation corresponds to the recommendations of the International Earth Rotation Service (IERS) and the International Bureau of time (BIH);
- time evolution in orientation will not create a residual global rotation with respect to the Earth's crust (the zero rate of rotation relative to ITRF2000);
- It is fixed on the Earth surface by the points of space geodetic network
- PZ-90 is a geodesic basis for GLONASS system and is used to provide satellite orbital flights and navigation solutions. Users receive directly PZ-90 from GLONASS.

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Definition of the axes origins:

- ; Origin - center of mass of the Earth
- ; The Z-axis is directed towards the Earth's poles conditionally as defined recommendations of the International Earth Rotation Service (IERS) and the International Bureau of time (BIH)
- ; The X axis is directed to the point of intersection of the equator and the prime meridian established by the International Bureau of the time (BIH)
- ; The Y-axis completes the system to the right

Origin of PZ-90 also serves as the geometric center of common terrestrial ellipsoid PZ-90 and Z-axis is the axis of the ellipsoid of rotation

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PZ-90 was created in composition of the Earth geodetic parameters system «Earth parameters» in 1990 using dynamic method of satellite geodesy from joint equalization of the observations of geodetic satellites GEOIK (1985-1989), GLONASS, ETALON and gravity data on land and the oceans derived from altimetry GEOIK. In the derivation of the PZ-90, except for the coordinate system, to refine the reference ellipsoid parameters and the model parameters and the gravitational field of the Earth. Such kinds of GEOIK measurements were used (photo, Doppler, radio and laser ranging, altimetry) together with global gravimetric catalogue. Coordinate system PZ-90 is fixed by globally located points of space geodetic network. A number of GLONASS ground control points are identified in the coordinate system PZ-90 and combined with the items of space geodetic system.

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A modification of PZ-90 was made in 2005 and was named PZ-90.02.

In 2007 it was commissioned. State geocentric reference system "Parameters of the Earth 1990" in the version of PZ-90.02 is called PZ-90.02.

The following table shows the name, date of creation, the age and accuracy characteristics of the implementation of the system of coordinates

name	Date of creation	datum	The accuracy of the geocentric position of points	The accuracy of the relative position of points
PZ-90	1990	-	1 ó 2	(0,3 ó 0,5) / 2000
PZ-90.02	2005	2002.0	0,3 ó 0,5	(0,02 ó 0,03) / 2000

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Methodology of PZ-90.02

PZ-90.02 was obtained by using a dynamic method of space geodesy in joint equalization across GEOIK measurement information and the results of high-precision coordinate determination on the points of space geodetic network using GLONASS/GPS equipment.

There were two stages of PZ-90.02 development

The timescale of the first stage is 1997-1999. Based on the improved methods and technologies of the Earth geodetic parameters a joint processing of GEOIK measuring data was made. The coordinate system and the Earth gravitation field parameters were specified.

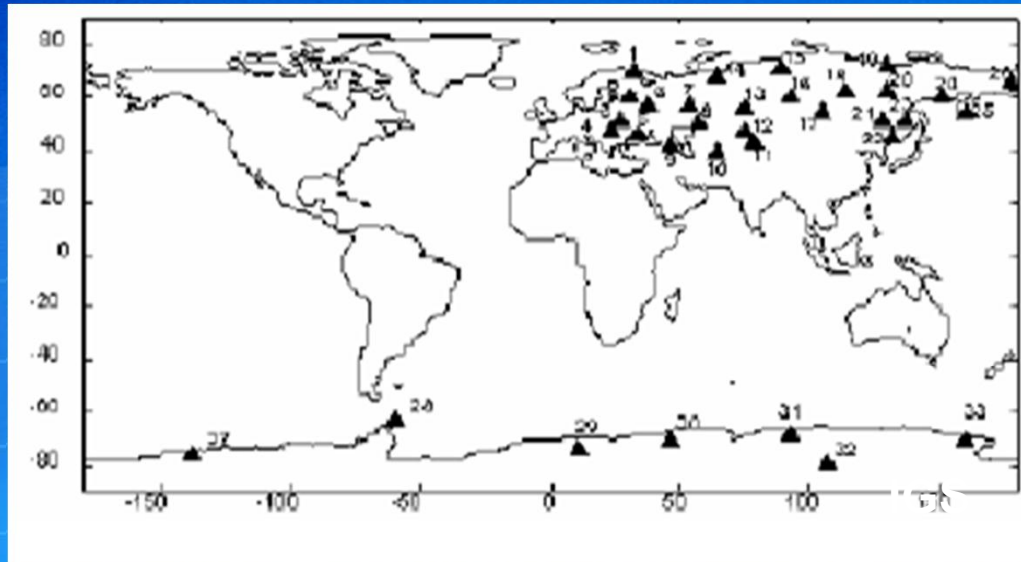
During the second stage (2000-2004) the space geodetic network measurements with user GLONASS/GPS equipment were executed in processing .

As a result:

- ; satellite GEOIK measurements obtained during 1985 – 1999 from all points of the space geodetic network were processed.
- ; GLONASS/GPS measurements from all points of the space geodetic network were processed.
- ; System PZ-90.02 is extended to 14 points of IGS network, located in Russia.

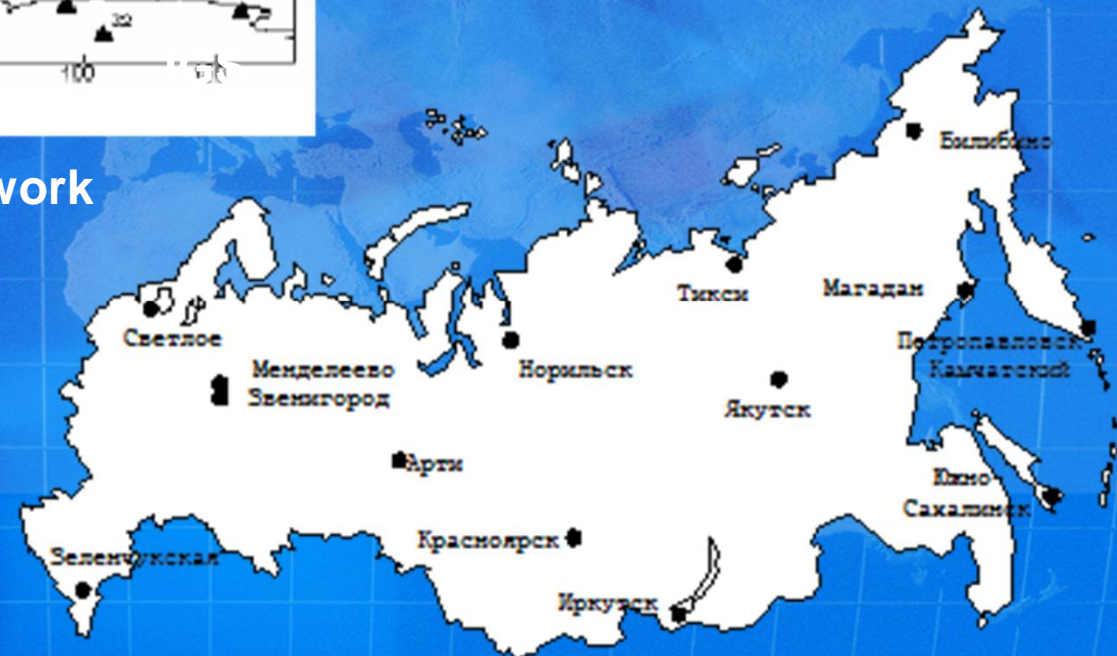
The results are used to monitor and assess the accuracy of the coordinate system.

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Points of IGS network
hosted in Russia

Points of space geodetic network



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Transformation system PZ-90.02 with other systems

Element values of transformation for coordinate system were obtained by the difference between the coordinates of similar points identified in both systems. The table shows the element values of transformation and their standard errors for systems PZ-90, PZ-90.02, WGS-84 (1984) and ITRF-2000.

/			$\Delta X,$	$\Delta Y,$	$\Delta Z,$	$(\omega_x,$ $\cdot 10^3)$	$(\omega_y,$ $\cdot 10^3)$	$(\omega_z,$ $\cdot 10^3)$	$m \cdot 10^6$
1	-90	-90.02	-1,07 $\pm 0,1$	-0,03 $\pm 0,1$	+0,02 $\pm 0,1$	0	0	-130 \pm 10	-0,22 $\pm 0,02$
2	WGS-84	-90	+1,10 $\pm 0,2$	+0,30 $\pm 0,2$	+0,90 \pm 0, 3	0	0	+200 \pm 20	+0,12 \pm 0,0 6
3	ITRF-2000	-90.02	+0,36 $\pm 0,1$	-0,08 $\pm 0,1$	-0,18 $\pm 0,1$	0	0	0	0

Elements for transforming the coordinate system WGS-84-PZ-90, presented in the table are referenced to epoch 01.01.1990, the elements for transforming the coordinate system PZ-90.02-ITRF-2000 are referenced to epoch 01.01.2002, and coincide with the elements of transformation PZ-90.02-WGS-84 (G1150).

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FUTURE PLANS

Currently, Ministry of Defense of RF has prepared a new draft version of PZ-90 - PZ-90.11 (epoch 2010.0). Only geocentric coordinate system PZ-90.02 was specified. The measurements from GLONASS/GPS points of space geodetic network, IGS network stations located in Russia, and global Doppler measurements from DORIS were used to obtain PZ-90.11.

According to preliminary estimates, the error (root mean square) of PZ-90.11 origin position relatively to the center of mass of the Earth is characterized by 0.05 m, and angular error 0.001 angular seconds. The error of the mutual position of the points of space geodetic network is 0.005 - 0.01 m based on distance about 4000 km.

The elements of transformation and errors (root mean square) are defined for systems PZ-90.02, PZ-90.11 and ITRF-2008.

The meridian position, the linear scale and the system origin of PZ-90.11 are agreed with ITRF-2008 to epoch 2010.0.

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/			$\Delta X,$	$\Delta Y,$	$\Delta Z,$	$(\dot{\omega}_X, \cdot 10^3)$	$(\dot{\omega}_Y, \cdot 10^3)$	$(\dot{\omega}_Z, \cdot 10^3)$	$m \cdot 10^6$
1	-90.02	-90.11	-0,373 $\pm 0,027$	+0,186 $\pm 0,056$	+0,202 $\pm 0,033$	-2,30 $\pm 2,11$	+3,54 $\pm 0,87$	-4,21 $\pm 0,82$	-0,008 $\pm 0,004$
2	ITRF-2008	-90.11	-0,003 $\pm 0,002$	-0,001 $\pm 0,002$	+0,000 $\pm 0,002$	+0,019 $\pm 0,072$	-0,042 $\pm 0,073$	+0,002 $\pm 0,090$	-0,000 $\pm 0,000$ 3

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FUTURE PLANS (2)

In 2011 ROSREESTR of RF (responsible for geodesy and cartography) created a new geodetic coordinate system which is used for regional GLONASS application .

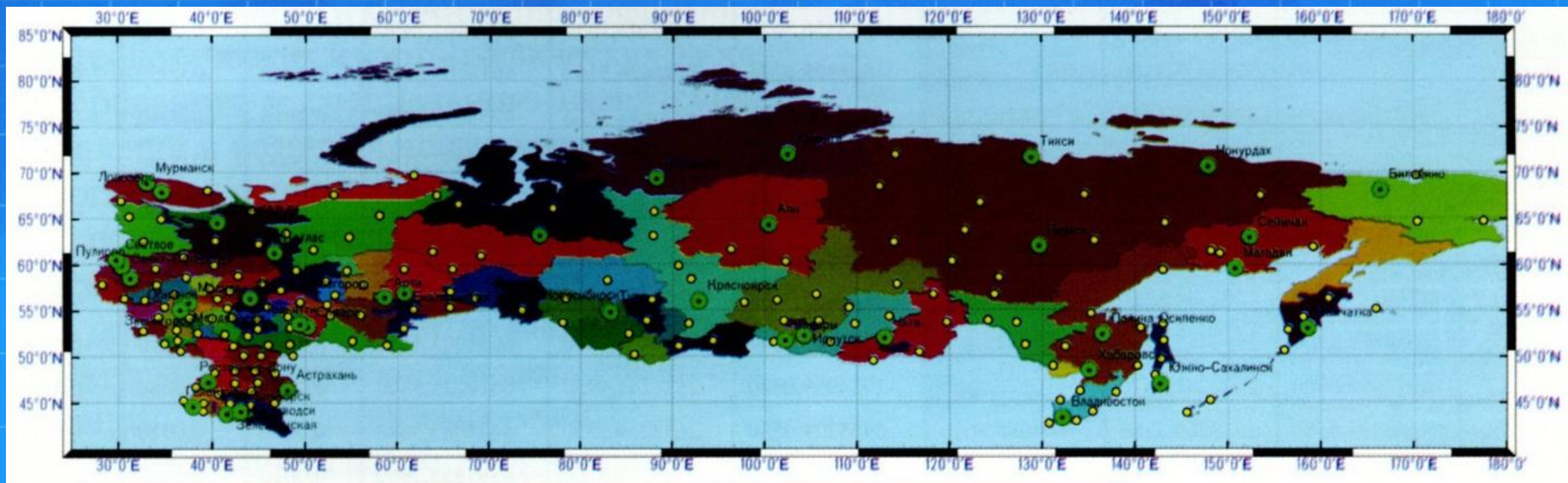
This geodetic coordinate system is fixed by points of the state geodetic network (StGN).

According to the «Main statements on SGN of RF» the StGN includes:

- Fundamental astronomic - geodetic points (50 points);
- Points of high-precision geodetic network (300 points);
- Points of satellite geodetic network of 1st class (SGN-1 - about 4000 points).

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Arrangement map of
Fundamental astronomic - geodetic points and
Points of high-precision satellite geodetic network (SGN-1)



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FUTURE PLANS (3)

Presently the parameters of the PZ-90.11 and new geodetic coordinate system of RF (including the coordinates of the points SGN and StGN) are under agreement process.

The possibility of free access to the coordinates of SGN and StGN points located on Russian territory is under consideration.

It is supposed to clarify and revise the PZ-90 each 5 years.

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Thank You for attention!

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