GLOBAL GEOCENTRIC COORDINATE SYSTEM

Global Navigation Satellite System

**GLOBAL GEOCENTRIC COORDINATE SYSTEM
of the RUSSIAN FEDERATION**

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**November 7, 2012
WG D – Reference Frames, Timing and Applications**

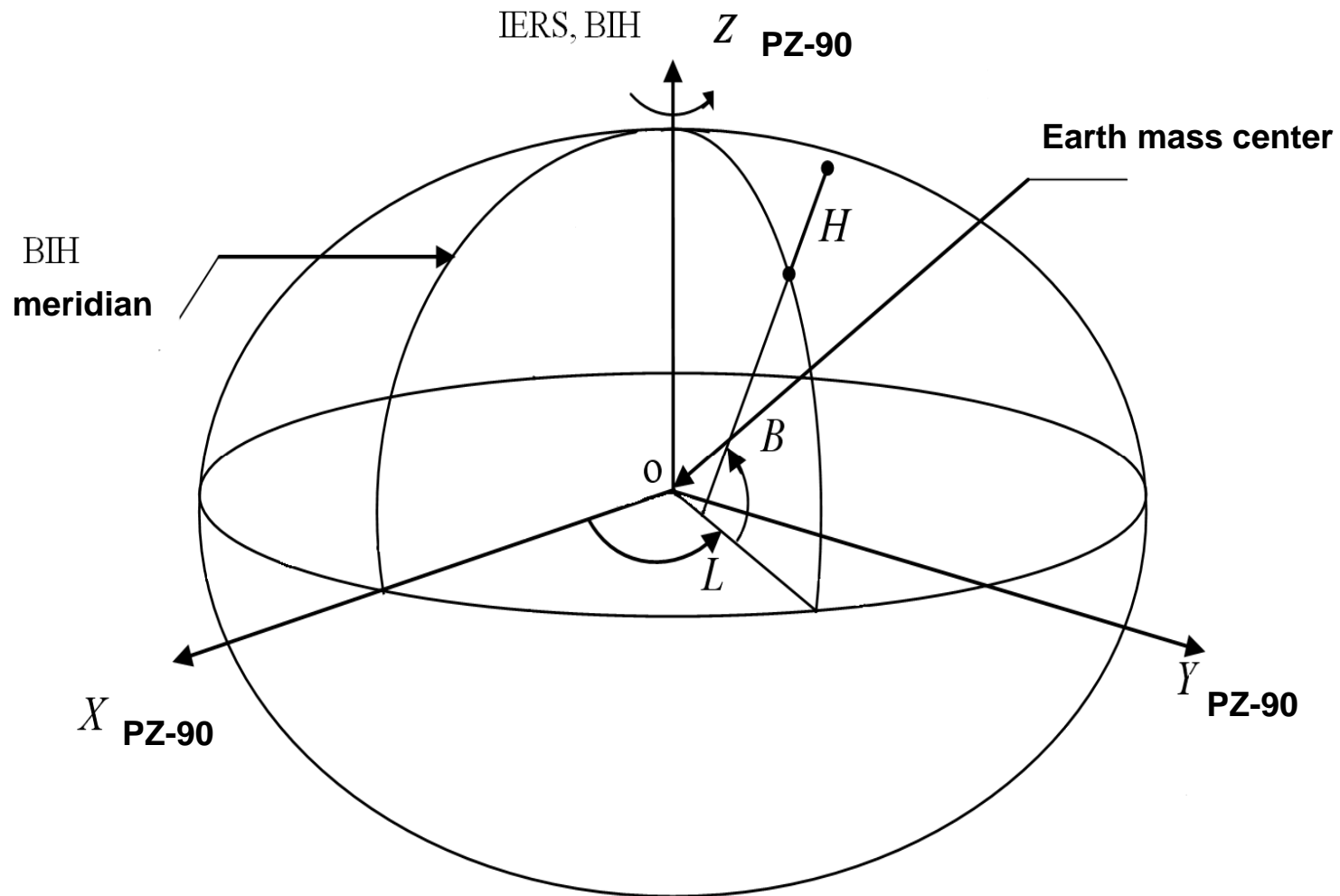# GLOBAL GEOCENTRIC COORDINATE SYSTEM

INTRODUCTION

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

- 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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HISTORY (1)

The 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 GEO-IK (1985-1989.), GLONASS, ETALON and gravity data on land and the oceans derived from altimetry GEO-IK. In the derivation of the PZ-90, except for the coordinate system, the reference ellipsoid parameters and the model parameters and the gravitational field of the Earth were refined. Such kinds of GEO-IK measurements were used (photo, Doppler, radio and laser ranging, altimetry) and 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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HISTORY (2)

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 the 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 – 2 м	(0,3 – 0,5) м / 2000 км
PZ-90.02	2005	2002.0	0,3 – 0,5 м	(0,02 – 0,03) м / 2000 км

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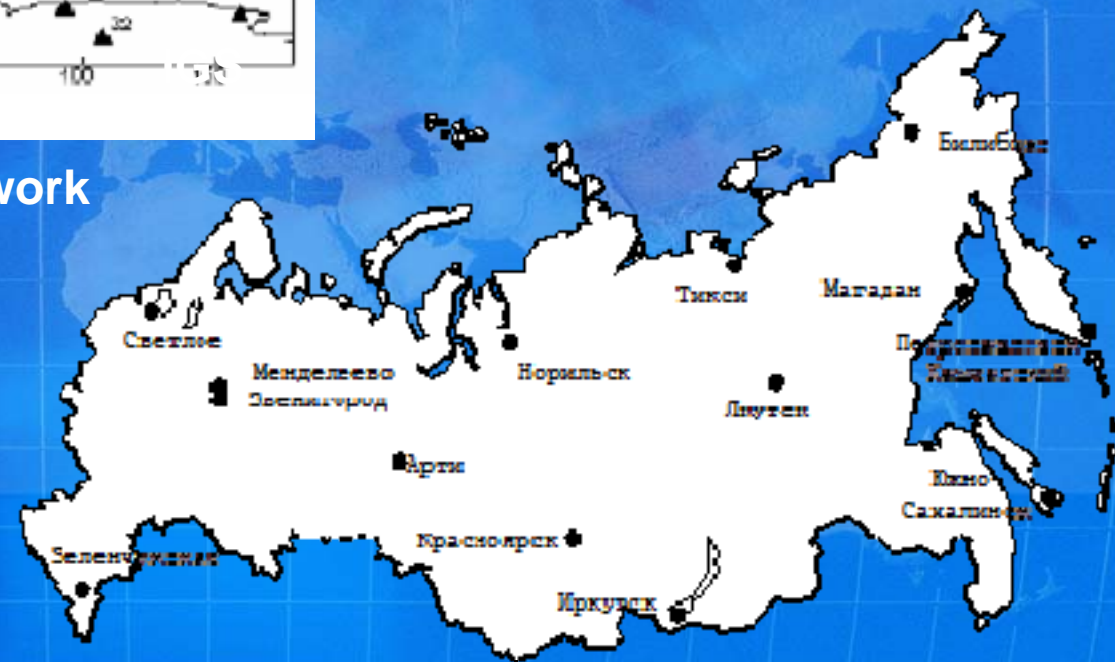
The results are used to monitor and assess the accuracy of the coordinate system.

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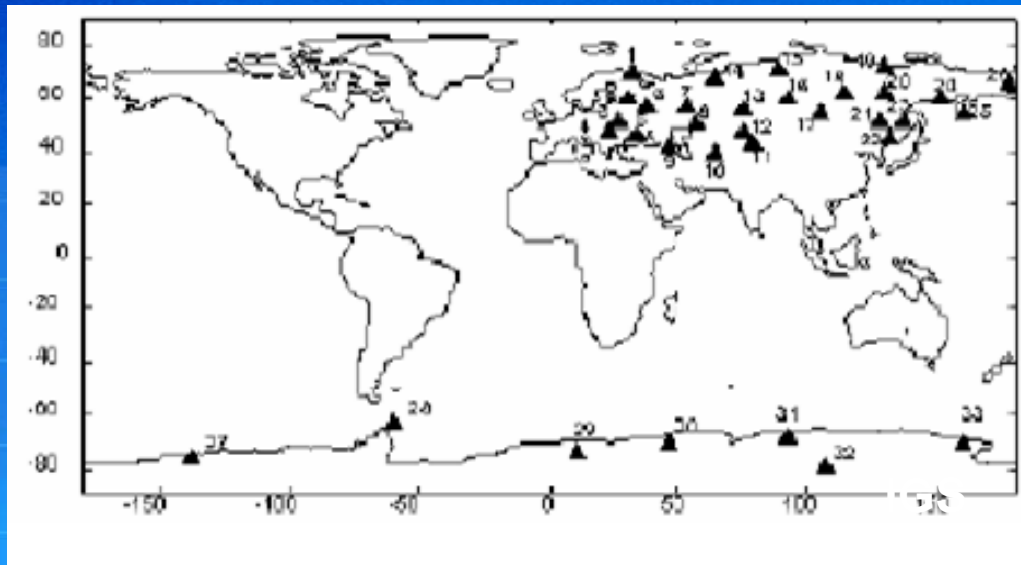
Points of IGS network hosted in Russia

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.

№ п/п	Из системы	В систему	ΔX, м	ΔY, м	ΔZ, м	$(\omega_X,$ угл.с$)$ $\cdot 10^3$	$(\omega_Y,$ угл.с$)$ $\cdot 10^3$	$(\omega_Z,$ угл.с$)$ $\cdot 10^3$	$m \cdot 10^6$
1	ПЗ-90	ПЗ-90.02	−1,07 ±0,1	−0,03 ±0,1	+0,02 ±0,1	0	0	−130±10	−0,22 ±0,02
2	WGS-84	ПЗ-90	+1,10 ±0,2	+0,30 ±0,2	+0,90±0,3	0	0	+200±20	+0,12±0,06
3	ITRF-2000	ПЗ-90.02	+0,36 ±0,1	−0,08 ±0,1	−0,18 ±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 (1)

Currently, Ministry of Defense of RF has prepared the new draft version of the 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, 90.11 and ITRF-2008.

The meridian position, the linear scale and the system origin of PZ-90.11 are agreed with ITRF2008 to epoch 2010.0.

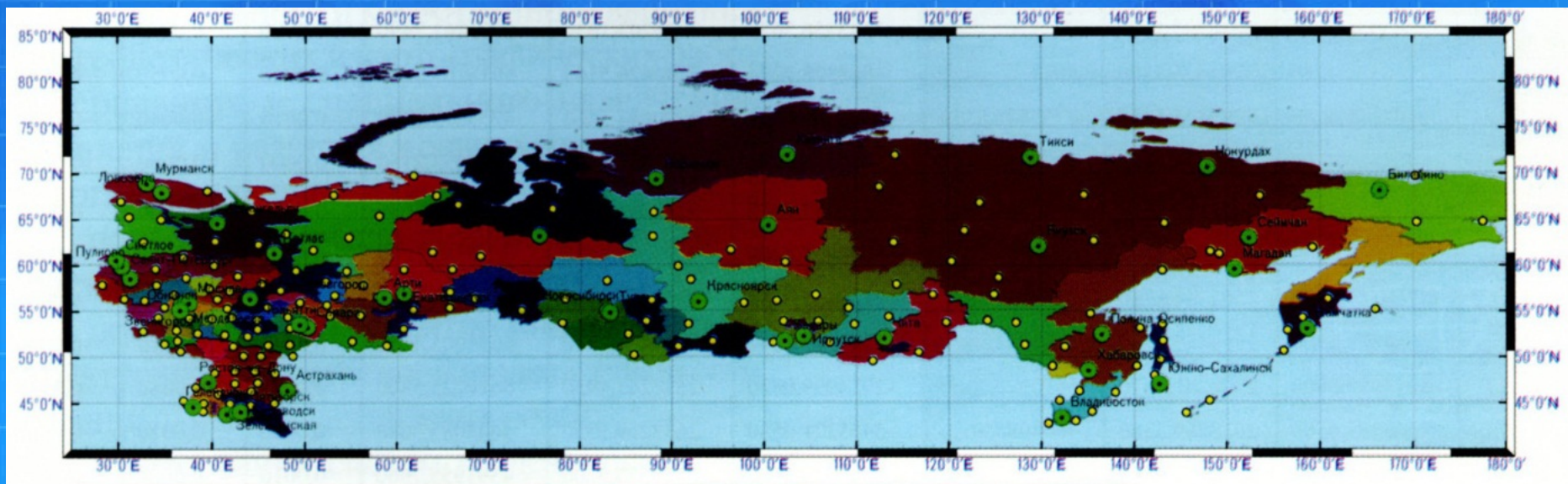# GLOBAL GEOCENTRIC COORDINATE SYSTEM

FUTURE PLANS (2)

№ п/п	Из системы	В систему	ΔX, м	ΔY, м	ΔZ, м	$(\omega_X,$угл.с$)$ $\cdot 10^3$	$(\omega_Y,$ угл.с$)$ $\cdot 10^3$	$(\omega_Z,$ угл.с$)$ $\cdot 10^3$	$m \cdot 10^6$
1	ПЗ-90.02	ПЗ-90.11	−0,373 ±0,027	+0,186 ±0,056	+0,202 ±0,033	−2,30 ±2,11	+3,54 ±0,87	−4,21 ±0,82	−0,008 ±0,004
2	ITRF-2008	ПЗ-90.11	−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

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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 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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