

System of Geodetic Parameters

“Parametry Zemli 1990”

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

Brief Description

“Parametry Zemli 1990”^{*} is a system of geodetic parameters including fundamental geodetic constants, the Earth ellipsoid parameters, the Earth gravity field parameters, the geocentric coordinate system, and the transformation parameters to other reference systems. The PZ-90.11 is the state geocentric coordinate system introduced by the Russian Federation Government Decree 1463 of December 28, 2012, and has been used for geodetic support of orbital missions and navigation since January 15, 2014. The PZ-90 Coordinate System is a basis for geodetic support of the GLObal NAVigation Satellite System (GLONASS).

Definition of Frame

- **Origin:** Earth’s center of mass being defined for the whole Earth including oceans and atmosphere.
 - **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.
 - **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.
- PZ-90.11 is agreed with ITRF2008.

^{*} In English “The Earth Parameters 1990”.

Coordinate System: Orthogonal Cartesian Coordinates (X, Y, Z). The PZ-90 Coordinate System origin also serves as the geometric center of the PZ-90 ellipsoid and the Z-axis is its minor axis. The geodetic coordinates (latitude, longitude, height) are computed using this PZ-90 Earth's ellipsoid.

Defining Parameters: PZ-90 is defined by four fundamental parameters: the semi-major axis, the flattening factor of the Earth ellipsoid, gravitational constant (mass of Earth's atmosphere included), and the angular velocity of the Earth.

Parameter	Notation	Unit	Value
Semi-major Axis	a	m	6 378 136.0
Flattening Factor of the Earth Ellipsoid	α	–	1/298.25784
Gravitational Constant (Mass of Earth's Atmosphere Included)	fM	m^3/s^2	$398\,600.4418 \times 10^9$
Angular Velocity of the Earth	ω	rad/s	$7.292\,115 \times 10^{-5}$

References: “Parametry Zemli 1990” (PZ-90.11): Reference document. – Moscow: Military Topographic Department of the General Staff of Armed Forces of the Russian Federation, 2014, 52 p.

http://eng.mil.ru/files/PZ-90.11_final-v8.pdf (English version)

<http://structure.mil.ru/files/pz-90.pdf> (Russian version)

Relationship with other reference systems: Transformation parameters of reference systems are obtained based on the differences between the coordinates of the same sites, defined in both systems.

Transformation Parameters: Transformation parameters and their root-mean-square errors for PZ-90, PZ-90.02, PZ-90.11, WGS 84 (G1150), ITRF2008 and ITRF2014.

#	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
4	PZ-90.11	ITRF2014	-0.0053 ± 0.0020	-0.0040 ± 0.0020	-0.0032 ± 0.0020	+0.035 ± 0.073	-0.087 ± 0.073	+0.036 ± 0.090	-0.0000 ± 0.0001	2010.0

Notes: PZ-90 is the GLONASS geodetic basis. The PZ-90 Coordinate System is also used for orbital mission support and navigation. From the GLONASS satellites, users directly receive coordinates in PZ-90 and time in the GLONASS time scale.

Future Plans: The new version of “Parametry Zemli 1990” Coordinate System (PZ-90.11) is adopted in the Russian Federation. It has been implemented into GLONASS geodetic support. The PZ-90.11 monitoring is to be provided and user access is to be granted to the coordinates of a number of the PZ-90.11 sites based on the monitoring results.