State Geodetic Network of the Russian Federation

The structure of State Geodetic Networks

- Horizontal Control Networks
- Leveling Networks
- GNSS Networks

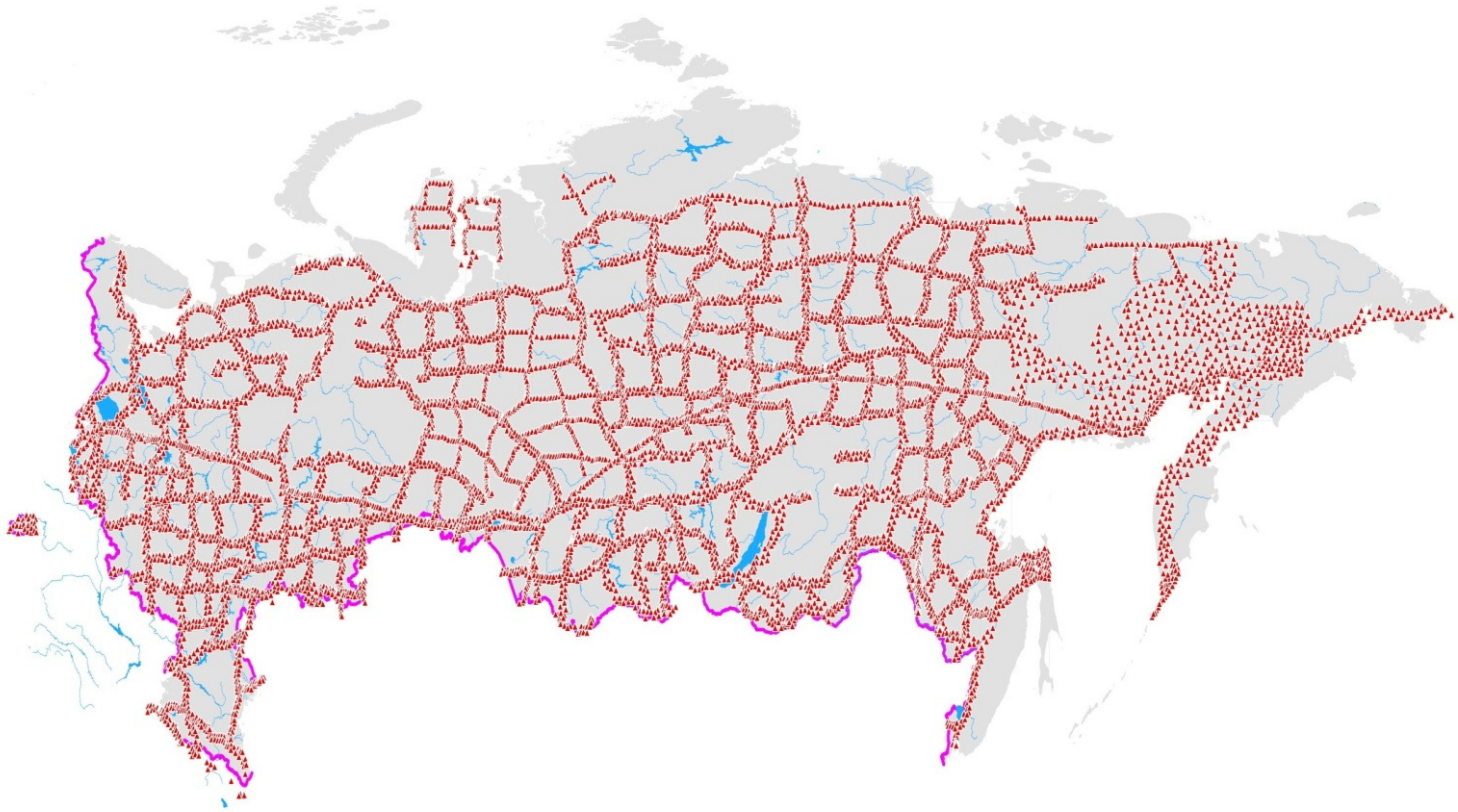
ЦНИИГАиК

Horizontal Control Networks

At present, the State Geodetic Nets of the 1 – 4 classes form the base for the coordinate system SK-95

The total amount of geodetic points in these nets exceeds **300 000**

Horizontal Control Networks



The map of the State Horizontal Network of the 1st class

Horizontal Control Networks

The SK-95 coordinate system has been created in two steps:

• common adjustment of angle and linear measurements in the nets of the 1st and the 2nd classes, made under the direction G.N. Efimov

•integration and common adjustment of the terrestrial, the Space Geodetic Network and the Doppler Geodetic Network

As a result, the homogeneous geodetic construction was obtained covering the whole territory of the former USSR. The average distance between the geodetic points is about 15 km.

The accuracy of geodetic point coordinates in the SK-95 system is the following:

•Root-mean-square (RMS) error of relative positions of the adjacent points is equal to 2-4 cm;

•RMS error of relative positions of points at distances over 1000 km is equal to 0.5 – 0.6 m

Horizontal Control Networks

The comparison of SK-95 and ITRS coordinate systems :

- RMS error of the relative positions of adjacent points is < 5 cm
- RMS error of relative positions of the points at distances more then 1000 km is equal to 0.2-0.4 m
- maximum errors of relative positions of points are equal to 60 -70 cm.

State Leveling Networks

The system of normal heights in the territory of Russia is maintained by the networks of high-precision geometric leveling of the I-st and II-nd classes.

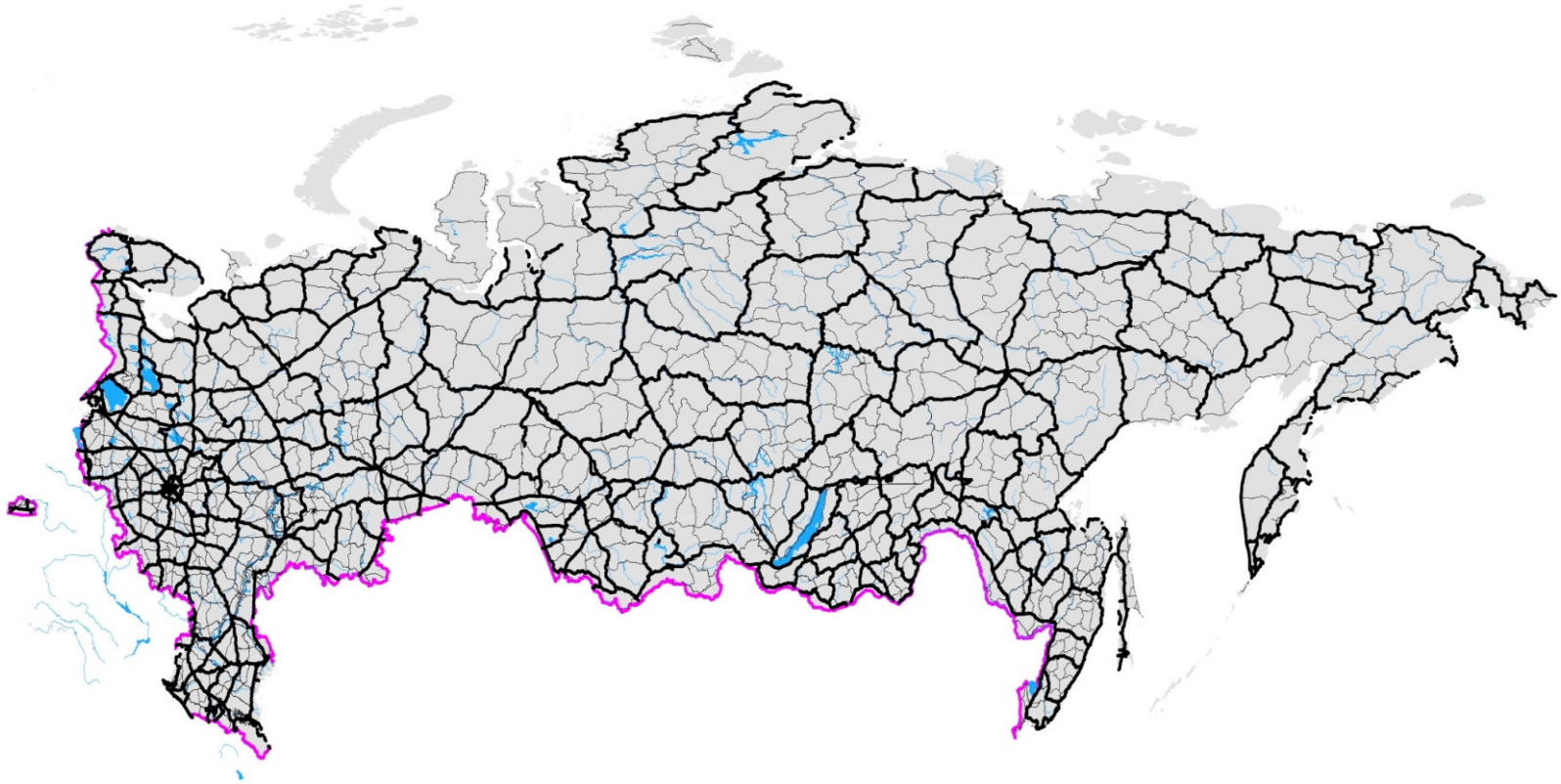
The high-precision networks compose about 1000 closed-loop configurations. The total length of leveling lines is near 400,000 km. The network adjustment was based on the Kronshtadt tide gauge, which has been the reference zero height point since 1873.

The leveling networks of Russia was developed by creation of new leveling lines and updating the existing ones. This allowed to build up the density of points of leveling networks of Russia, maintain of the height system at a modern level with account for to changes of physical surface of the Earth.

The length of loops (polygons) in the European part of Russia is varying from 190 km to 2600 km at average length of perimeter equal to 980 km.

The length of polygons in Siberia and the Far East is varying from 400 km to 4700 km at average length of perimeter equal to 2200 km.

State Leveling Networks



Map of the leveling lines of 1st and the 2nd classes

GNSS Networks

At present, in Russia the geodetic networks of new generation have been created and are being developed.

The Fundamental Astro-Geodetic Net (FAGS) presents the first level of accuracy.

FAGS points are located at distance of 650 – 1000 km from each other. The FAGS net includes:

- all IGS points located on Russian territory;
- VLBI points of the Russian Academy of Science;
- points of the Russian State Service of Time, Frequency and Determination of the Earth Rotation Parameters;
- points of Russian system of differential correction and monitoring (ROSCOSMOS).

GNSS Networks

The FAGS points allow to realize the geocentric coordinate system, as part of the general task of defining and supporting the coordinate-and-time system for the Russian Federation.

At present not all points of FAGS perform permanent GPS/GLONASS observations. By the end of 2010 the continuous observations are being made at 33 points, and at 16 more points the observations are done from time to time.

There are the other two levels of modern geodetic nets:

•high precision geodetic net (VGS);

•first order satellite geodetic net (SGS-1).

The VGS and SGS-1 nets are assigned to spread and densify the united geocentric coordinate system over the territory of Russia.

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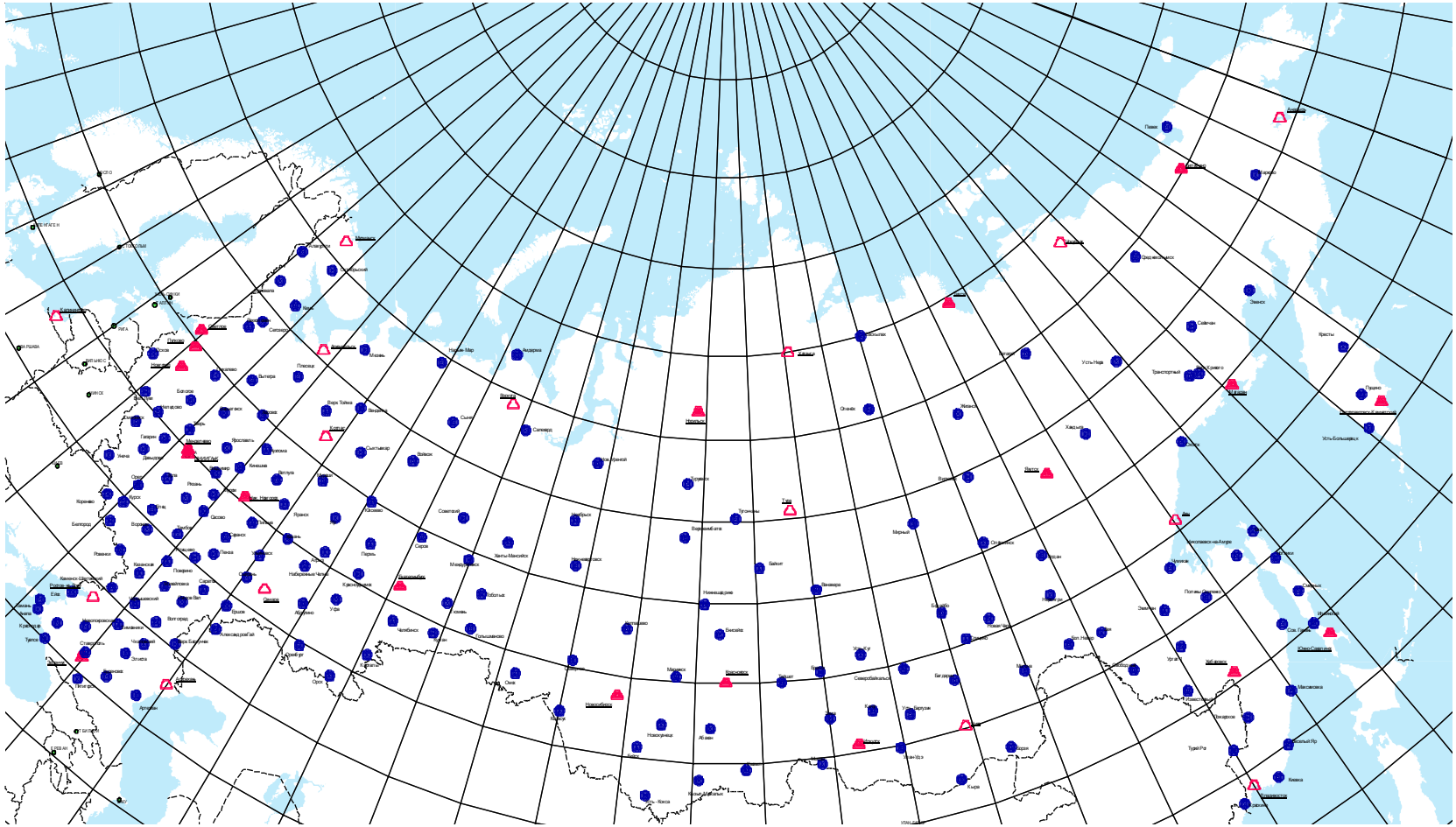
GNSS Networks



Map of FAGS and VGS points

GNSS Networks

•Adjacent points of VGS net are placed at a distance of 150-300 km from each other. At present the VGS consists of several hundred points.

•Adjacent points of SGS-1 net are located at a distance of 20-30 km from each other. The active work is now being performed to create new fragments of SGS-1. Now there are about two thousand points of SGS-1. It is planned to increase this amount by several times in the near future.

•Each point of FAGS and VGS is connected by geodetic measurements with two points of traditional astro-geodetic net, and also with two points of the main vertical system. About one third of SGS-1 points are too connected to astro-geodetic net. Thus, it is possible to perform the geodetic connection of geocentric coordinate system with the current implementation of the State SK-95 system, and also with the current implementation of the Baltic system of normal heights.

Program of developing the State Coordinate System

Perspective development of the system of spatial coordinates in Russia includes the following steps:

•extension of the common geocentric coordinate system to the points of FAGS, VGS, and SGS-1;

•accumulation of time spans of satellite observations to estimate and output the changes in point positions;

•creation of detailed models of movements of the Earth crust blocks on Russian territory with account of the information on geological structures and tectonic processes;

•qualitative modernization of the SK-95 Horizontal Datum in order to gradually transform it to the system of spatial coordinates.

Modernization of the SK-95 State coordinate system

•Modernization of the SK-95 Horizontal Datum provides performing re-adjustment of linear and angle measurements made at the points of the State geodetic network, in relation to the points of FAGS, VGS, SGS-1. As a result we are able to keep precision characteristics of mutual position of relative points of geodetic nets and provide exclusion of systematic deformation of the SK-95 system.

•For the whole territory of Russia we will set the common transformation parameters between modernized SK-95 system and the accepted realization of geocentric coordinate system.

•Thus, it will be created the background for introducing the common technology of updating and developing the SK-95 coordinate system, as well as for providing the precise values for heights above Krasovsky ellipsoid at the points of horizontal networks.

Modernization of the Vertical system of normal heights

The height modernization provides:

- changing the locations of high precision leveling polygons in order to use the points of FAGS and VGS as knot (junction) points as much as possible
- developing of models of heights' change with time, and use them for creating vertical systems for different epochs
- coordinating the timeline of repeat leveling with measured height changes in certain regions
- merging the Russian leveling networks with the leveling networks of neighboring countries

Unification of national height systems of different countries to solve scientific and practical tasks

Unification of the Russian 1st class leveling network with the west and central European height networks.

•According to the agreements on cooperation between TsNIIGAiK (Russia), BKG (Germany) and FGI (Finland), the parties have been performing works on unification of base leveling nets since 2008.

•The main purpose of such unification is to create the unified height system for the whole territory of Europe.