The Helio-Geodynamic Testing Ground Area “Simeiz–Katsiveli”: Some Results of the Observation Analysis

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Abstract We summarize briefly the status of our 22-m radio telescope as an IVS Network Station. Solving the problem of forecasting catastrophic natural and man-made phenomena in the Crimean peninsula it is connected with the organization of the complex network of local observations of helio-geodynamic testing areas. We show some results of this polygon “Simeiz–Katsiveli”. The aim is to show that the polygon operates as an international Center of Earth data parameters.

1 General Information

In 1994, RT-22 expanded its international cooperation in the field of very long baseline radio interferometry in geodetic programs (Figure 1). NASA, MAO NASU, IPA RAS, and SRI RAS created a new generation VLBI station—the Simeiz VLBI station. Based on RT-22 and stations of space geodesy and geodynamics, the geodynamic “Simeiz–Katsiveli” area was created, which includes three complementary observing technologies (VLBI, SLR, and GNSS).

The Simeiz geodynamics area consists of the radio telescope RT-22, two satellite laser ranging stations, a permanent GPS receiver, and a tide gauge.

Parameters of the 22-meter radio telescope are presented in Table 1.

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2 Activities during the Past Two Years and Current Status

During the last two years the Space Geodesy and Geodynamics stations regularly participated in the international network programs of the IVS, the International GNSS Service (IGS), and the International Laser Ranging Service (ILRS).

During the period 1 January 2015 through 31 December 2016, the Simeiz VLBI station participated in seventeen 24-hour geodetic sessions. Simeiz regularly participated in the EUROPE and T2 series of the geodetic VLBI sessions.

Effects of Global Geodynamic Processes on Climate Characteristics of Crimea

In recent decades, geodynamics has become an area of intensive international scientific research, including plate tectonics on global and regional scales, i.e., studies of the movements of the earth’s crust as well as the study of the rotation of the Earth and other phenomena, such as tides. In addition, research was done to deepen our knowledge of the gravitational and magnetic fields of the Earth. A common requirement for these studies is the need to create an accurately defined reference system (or systems), with respect to which all observations could be conducted and within which it is possible to formulate theories and models of the dynamics of the Earth. With regard to measurements on the surface, all modern methods (VLBI, SLR, and GNSS) determine the parameters of the Earth’s rotation relative to three different coordinate systems. These co-

Fig. 1 Simeiz VLBI station.

Table 1 The antenna parameters of the Simeiz VLBI station.

Diameter D	22 m
Surface tolerance (root mean square)	0.25 mm
Wavelength limit	2 mm
Feed System	Cassegrain system or primary focus
Focal length F	9.525 m
Focal ratio F/D	0.43
Effective focal length for Cassegrain system	134.5 m
Mount type	Azimuth-Elevation
Pointing accuracy	10 arcseconds
Maximum rotation rate	1.5 degrees/second
Maximum tracking rate	150 arcseconds/second
Working range in Azimuth (0 to South)	-270 ± 270 degrees
in Elevation	0 – 85 degrees

ordinate systems are differently sensitive to different parameters. Therefore, in order to separate the various effects in the rotation of the Earth, all three measurement methods must be supported. Improvement of the technical level of the equipment will ensure the contribution of these methods to the solution of geodynamical problems from the point of view of three levels of accuracy: decimeter, centimeter, and millimeter.

As shown by our analysis of satellite data, the connection of local climatic and geophysical characteristics with the rotation of the Earth is beyond doubt. However, its impact on the economically important points of the Crimean peninsula (e.g., due to the diversity of the terrain, man-made conditions) should be monitored by regular terrestrial and space observations. Against the background of stable oscillations, abrupt changes and deviations from the stationary state can serve as a signal for environmentally unfavorable events. In our work [1] it was shown that the moment of occurrence of these events and localization in space can be detected by means of wavelet analysis. The results obtained by us stimulate the further development of the idea of creating a single helio-geodynamic system of the Crimean peninsula in the general system of observations of the planet Earth.

Solving the problem of forecasting catastrophic natural and man-made phenomena in the Crimea it is connected with the organization of complex observations in a network of local geodynamic polygons. In the spectrum of the time-frequency wavelet analysis of satellite data on an insolation incident on the Earth's surface at the point of the Kara-Dag in the period from 1983.5 to 2005.5, geodynamic effects of regular oscillations and, since 1999, an oscillation of unknown nature were found.

An accelerated increase of the surface temperature of the earth was detected in "Nikitsky Botanical Garden" after 1988. Based on the analysis of ground measurements of temperature in the air at 2 m height and at the earth's surface for the period from 1930 to 2014, we discuss possible causes of the acceleration.

The International Terrestrial Reference Frame (ITRF) is a set of points with their three-dimensional Cartesian coordinates which realize an ideal reference system. However, in the face of increasing opportunities for observation, as well as taking into account social and scientific goals, it is necessary to support spatio-temporal reference systems for monitoring global changes and for accurate navigation in space that must correspond to the required level of accuracy, guaranteeing a solid basis for measuring the effects of global changes and for high-precision navigation near the Earth and in deep space. The contribution of various scientific organizations that study problems in geodetic, astronomical, and space sciences allows the organization of complex interdisciplinary support of reference systems. This coordinated approach allows for a deeper understanding of the Earth as an integrated system.

The quasi inertial reference frame DTRF, determined by the DGFI (Deutsches Geodätisches Forschungsinstitut), includes corrections to deformations of the Earth, computed using homogeneous geophysical models for the "Ocean", "Atmosphere", and "Hydrology." An analysis of the three time series of corrections to the Earth deformations of the Simeiz station, calculated by the Atmosphere model for the period 1980–2014, revealed a significant fluctuation with a period of 1 year in the eastern and vertical components of the sea. The parameters of this oscillation for each component of the corrections are stable to a change in the order of n of the sinusoidal model. In addition to the annual wave, the model for n = 2 and n = 3 contains oscillations with periods of about 370, 353, and 182 days.

In the northern component, there are no continuous periodic oscillations in the frequency interval under consideration.

As a result, we can assume that the generation of periodic oscillations in the frequency range under consideration is related to the dynamics of the motion of the Moon and the Earth around the Sun.

3 Future Plans

Our plans for the coming years are to

- put into operation the VLBI Data Acquisition System DBBC,
- upgrade the laser of SLR Simeiz-1873 station, and
- set up a new GPS station near Simeiz VLBI station.

References

1. Volvach A.E., Kurbasova G.S., "The Simeiz Fundamental Geodynamics Area", in *International VLBI Service for Geodesy and Astrometry 2013 Annual Report*, edited by K. D. Baver, D. Behrend, and K. L. Armstrong, NASA/TP-2014-217522, p. 160–163, 2014.