10 Years of Geodetic Experiments at the Simeiz VLBI Station

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Abstract

This report gives an overview about the geodetic VLBI activities during 10 years at the Simeiz station. The positions of the points in the fundamental geodynamics area “Simeiz-Katsively” have been determined by special GPS survey campaign. It also summarizes the seasonal and long-term variability of the Black Sea level near Yalta and Katsively.

1. Introduction

The 22-m radiotelescope of the Crimean Astrophysical Observatory participated in the very first intercontinental very long baseline interferometric (VLBI) observations in September 1969 under astrophysical programs. The early narrow-band VLBI observations provided decameter accuracy and were not useful for geodynamics applications. The telescope was upgraded in 1994: a Mark IIIA data acquisition terminal and a dual-frequency horn were loaned from NASA/GSFC, dual band S/X receivers were supplied by the Institute of Applied Astronomy in Saint-Petersburg, Russia, a CH-70 hydrogen maser was supplied by the Institute of Space Research in Moscow. Interferometric fringes were obtained in the first test carried out on June 20, 1994. This upgrade enabled the station to join international observing campaigns under both astrophysical and geodynamics programs.

2. Measurements of Motion of Simeiz Station Using VLBI.

All available dual-band geodetic Mark III VLBI observations for 21 years, from 1979.59 till 2000.72 were used in the analysis: 3 058 sessions, **3 005 651** observations including 36 successful sessions with participation of the station Simeiz for 6 years: 1994.48–2000.36 with **19 631** good measurements of group delays.

Estimates of the horizontal velocity of the station Simeiz were calculated using VLBI observations carried out under geodynamics programs during the years 1994-2000. The complete set of 3 million VLBI observations has been analyzed and it was found that the station moves with respect to the Eurasian tectonic plate considered as rigid with a rate of 2.8 ± 0.9 mm/yr in a North-North-East direction. Results are presented in Table 1 (azimuth is measured from North). The details of the analysis are stated in the paper of Petrov et al., 2001.

Estimates of the velocity of the radioastronomical station Simeiz were obtained using VLBI observations carried out under geodynamics programs during the years 1994-2004 using Occam 5.1 for data analysis (Volvach, Sokolova, Shabalina, 2004). Figure 1 show the time series of topocentric coordinates of Simeiz.

3. The Fundamental Geodynamics Area “Simeiz-Katsively”

The fundamental geodynamics area “Simeiz-Katsively” is situated on the coast of the Black Sea near the village of Simeiz 20 km west of the city of Yalta in Ukraine. It consists of two satellite

Table 1. Residual station velocities with respect to the Eurasian plate.

Station	Up (mm/yr)	East (mm/yr)	North (mm/yr)	Corr E-N	Hor. Rate (mm/yr)	Azimuth Deg	D
DSS65	2.1 ± 1.5	-0.1 ± 0.2	0.0 ± 0.1	0.86	0.1 ± 0.2	271±51	h
EFLSBERG	-0.5 ± 0.8	0.5 ± 0.3	-0.4 ± 0.2	0.03	0.7 ± 0.2	132±22	h
MATERA	1.1 ± 0.9	0.9 ± 0.4	4.9 ± 0.4	0.30	5.0 ± 0.5	11±5	f
MEDICINA	-3.1 ± 0.8	1.7 ± 0.4	2.0 ± 0.4	0.11	2.6 ± 0.4	40±8	f
NOTO	0.6 ± 1.0	-1.0 ± 0.5	5.0 ± 0.4	0.30	5.1 ± 0.4	349±6	f
NYALES20	5.8 ± 1.5	0.0 ± 0.0	0.0 ± 0.0	-0.92	0.0 ± 0.0	350±65	h
ONSALA60	3.3 ± 0.6	-1.0 ± 0.4	-0.8 ± 0.4	-0.11	1.3 ± 0.3	229 ± 17	f
WETTZELL	-0.0 ± 0.1	-0.3 ± 0.2	0.4 ± 0.2	-0.04	0.5 ± 0.2	322± 25	hv
SIMEIZ	2.7 ± 3.0	1.3 ± 0.7	2.5 ± 0.9	**0.07**	**2.8 ± 0.9**	**27 ± 15**	f

The last column contains status of the station: free (f), defining for horizontal motion (h), defining for both horizontal and vertical motion (hv).

laser ranging stations, a permanent GPS receiver, a sea level gauge and the radiotelescope RT-22. All these components are located within 3 km (Figure 2).

The reference point of the antenna is the point of projection of the azimuthal axis onto the elevation axis. The coordinates of this point are determined in analysis of the observations. However, this point may move with respect to the local area where the radiotelescope is located.

Positions of both horizontal and azimuthal axis were also carefully measured with precision of $2''$ during a special first GPS survey campaign in 1995 (Bolotin et al., 1995). One of the conclusions of the surveying campaign was that *"a more detailed study of the complete dataset gives us grounds to believe that the azimuthal axis draws a cone in space and has smooth random wobbles when the antenna moves on azimuth. Nevertheless, the total effect does not exceed ±1 mm"*.

The time series of the deviation of the azimuthal axis with respect to the local plumb line as a function of time is presented in the paper by Petrov et.al., 2001. The inclination angle is increasing with a rate $2''.6$ per year in the direction of azimuth 296 deg and we believe that the antenna is leaning like the Pisa tower.

The positions of the points in the geodynamics test area "Simeiz-Katsively" have been determined by special second GPS survey campaign by the Main Astronomical Observatory in October 2001 and third GPS survey campaign in August 2004. Results are presented in Table 2.

4. The Black Sea Level.

The 22-m radiotelescope RT-22 is located 80 m from the edge of the Black Sea. Yalta level gauge is located near Yalta 20 km east of RT-22. The level varied insignificantly from January to March. Then its prompt growth till May begins. Then the growth is slowed down and in June there comes a maximum. After July there is a fast fall up to the minimal size observable in October. Since October till November the seasonal level varies poorly. In the period since November till December the fast growth of a level which is slowed down in the period December - January is again observed.

The analysis of sea level changes of the Black Sea is carried out depending on solar activity and

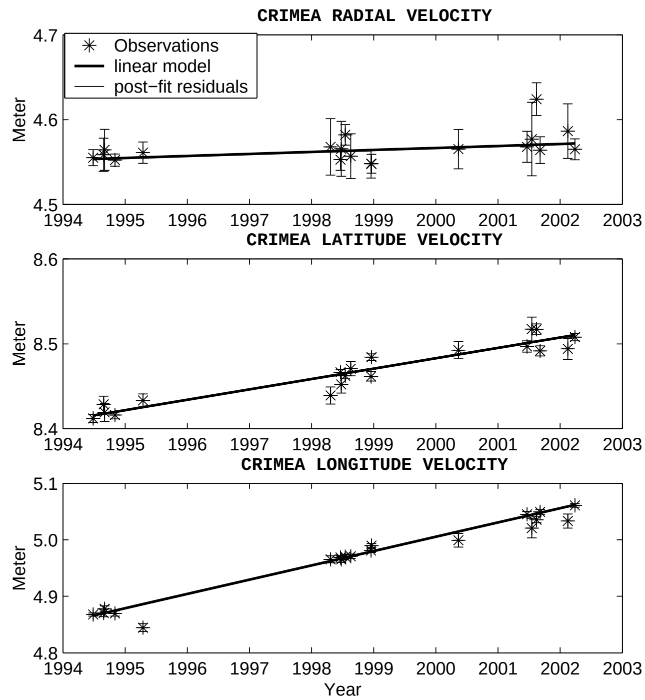

Figure 1. Crimea velocities: radial (top), latitude (middle) and longitude (bottom).

Table 2. Final solution for coordinates of points in the area "Simeiz-Katsively".

Station	X, m	RMS, m	Y, m	RMS, m	Z, m	RMS, m
KTHI	3785378.6041	0.0004	2551165.3915	0.0003	4439717.4172	0.0004
KTLR	3785923.9017	0.0005	2550781.8054	0.0003	4439471.6117	0.0004
KTRT	3785160.8761	0.0004	2551262.2573	0.0002	4439789.8357	0.0004
SIME	3783746.4067	0.0000	2551362.7445	0.0000	4441445.1801	0.0000
CRAO	3783897.2187	0.0006	2551404.3953	0.0004	4441264.2859	0.0006
SIMI	3783887.4552	0.0004	2551403.5454	0.0003	4441266.8603	0.0005
KTE2	3785236.0690	0.0477	2551188.5462	0.0308	4439784.2244	0.0531
KTE1	3785206.0519	0.0345	2551216.1368	0.0240	4439790.8836	0.0426

geophysical conditions using the data of monthly observations of a level of the Black Sea in item. Katsively for the period from 1992 to 2004. The data cover the period of a phase of recession 22 and 23 cycles of solar activity. The long data of measurements of a sea level allow to look for possible influences of solar activity and geophysical conditions on observable changes of the sea level. The long-term changes are shown as regular trend as constant increase of a sea level from 1992 up to 2000, with gradual recession by 2004. The short-term changes are shown as seasonal variations of increase of a sea level from January to middle of the year and their subsequent recession by the end of the year. The amplitude of seasonal variations also varies from year to year. Such character of change of a level of the Black Sea allows to assume an opportunity of joint influence on a sea

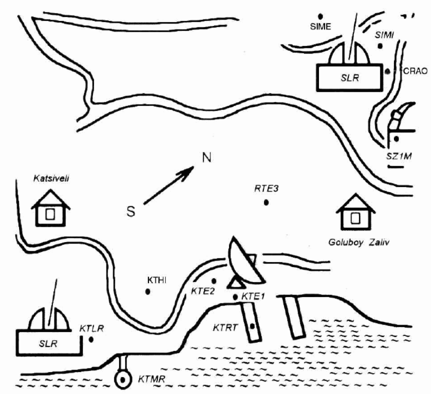

Figure 2. The geodynamics area “Simeiz-Katsively”.

level of the most various factors connected with solar activity and geophysical conditions during realization of measurements.

5. Future Plans

The VLBI activities in 2005 at “Simeiz-Katsively” area will consist of: (1) carrying out modernization of sites VLBI (Mark 5B system), SLR-1 and SLR-2 with the purpose to increase their level of equipment according to the international standards; (2) realization of observations on sites VLBI and SLR for maintenance in territory of Crimea the International Terrestrial Reference Frame (ITRF) and high-precision connection (at a level of several millimeters) permanent GPS stations of the network to ITRF; (3) creation of the prototype of a system of monitoring of geodynamic phenomena of mountain region of Crimea and geotectonic of the Black Sea basin.

6. Acknowledgment

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