

METHODICAL FUNDAMENTALS OF CREATION OF PERMANENT GPS NETWORKS

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Nowadays measurement of geodynamic movements of a terrestrial surface is carried out mainly by methods of a satellite geodesy. Permanent network GPS of points existing now is based on the regulation, that geodynamic movements represent the directed monotonous displacements of tectonic plates with speeds, measured first tens centimeters per one year. Obtaining of the authentic data on character of geodynamic movements is caused by parameters of a permanent geodetic network with which help vectors of displacement of geodetic points are fixed. Alongside with step-type behavior of measurements, the major characteristic of a geodetic network is conformity of quantity and density of points of supervision, to character of block divisibility of an earth's crust of the investigated region. Proceeding from traditional representations, displacement in the space of each detached block of the Terrestrial surface should be fixed not less, than by three GPS by points of supervision. The surface of the European Continent is divided into blocks according to six azimuths (0° , 17° , 35° , 45° , 62° , 77°), and the scale of divisibility of an earth's crust blocks is multiple 140X140 km, towards reduction of the sizes, it is accordingly 70X70 km, 35X35 km, 18X18 km, 8X8 km, 4X4 km, 2X2 km etc. [4]. Proceeding from this, for the account of the character of displacement of all blocks in case of activation of any azimuth of block divisibility of lithosphere the surface of the Earth with the area 1000X1000 km should be covered with a network from 4,5 million GPS of points . Supposing overlapping of any part of points , it is possible to speak about 1 million GPS of points on a site of a surface of the Earth 1000X1000 km. If such density of permanent network GPS of points it is not achieved, reliability of received data on geodynamic movements can not have an authentic quantitative estimation. It is connected, for example, with the fact according to long-term supervision in aseismic unit of crossing Main Black Sea (an azimuth 45°) and Odessa-Sivash neotectonic zones (an azimuth 90°) on adjacent blocks with the sizes 2x2 Km of one azimuth of orientation were fixed reversive movements of one block concerning another with amplitude not less than 30 sm for 3 days [7]. The same results were received in aseismic area of Urals [1]. For fixing short term geodeformation the mobile complete set of the GPS-equipment of a geodetic class of the firm Trimble Navigation was used. The characteristic of GPS system and the used equipment is briefly given in works [2,3]. Required accuracy of definition of coordinates provided the technology of differential GPS when simultaneously work 2 or more receivers installed on different points, limiting measured piece. In this case one receiver is considered a basic one (motionless), and the others - determined (moving). Simultaneous work of a minimum of two receivers allows to define the size of ionosphere and the troposphere amendment compensating distortion of satellite radio signals at their passage through an ionosphere and troposphere of the Earth. The main operating condition in a mode of differential GPS is maintenance of simultaneous reception of signals from the same satellites by both

receivers. In the given researches 4 and more receivers Trimble conducting simultaneous work on researched intervals took part. At the subsequent paired processing it provides measurement of displacement and deformations simultaneously on 6 and more pieces on the site. The results, which are given out through discrete intervals, represented the average values of displacement for this time interval. Provision of high accuracy of definition of displacement with GPS-technologies proved to be true on the special bases equipped with stationary points with known coordinates. Data processing of field measurements is carried out with the use of packages of firm software GP Survey and TG Office, of the program complex Gamit used at processing of measurements of global GPS-networks. By results of processing the received data vectors between points and their components (length of a vector, excess, components the North - south and the West - east) are calculated. On changes of sizes a component of vectors sizes of displacement and deformations of the appropriate intervals in horizontal and vertical planes and their amplitudes are defined. In more detail a measurement technique of – short term displacement and deformations with the use of GPS equipment of a geodetic class, and also a technique of processing and interpretation of results of measurements are given in the work [4] (Fig1). The first measurements of high-frequency geodeformations were executed in 2000. The experimental object is 17 kilometers from the city of Surgut on crossing of the main oil pipeline with local tectonic infringement (an azimuth 0°).

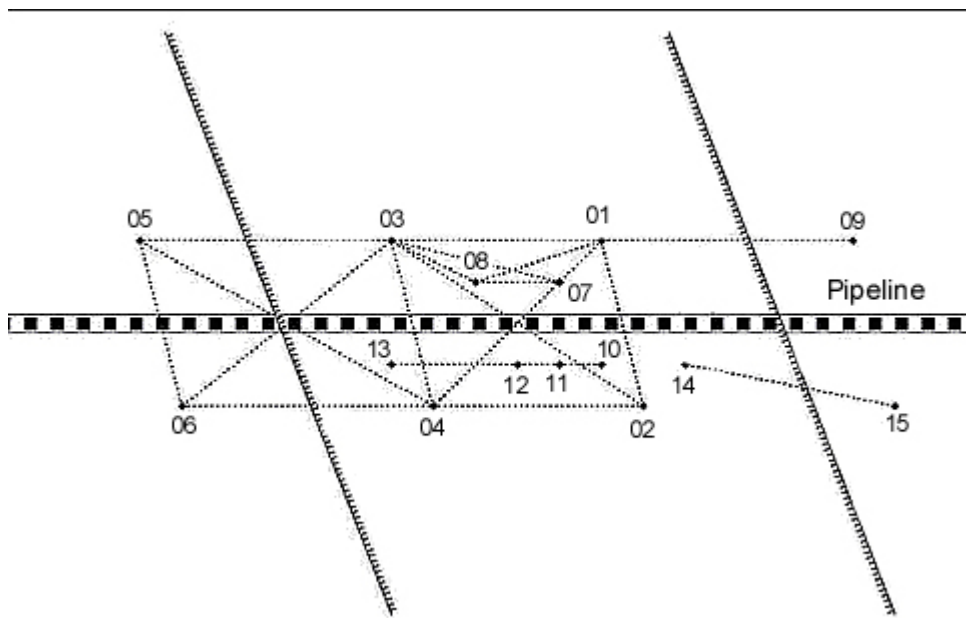


Fig. 1. The Circuit of the permanent geodetic network created for studying of high-frequency geodeformations on a site of a gas main, subjected to failures of a geodynamic nature according to the work [1]

Dynamics of displacement and deformations was investigated by methods of a satellite geodesy according to specially developed technique. Mutual vertical and horizontal displacement of points of the special observant station equipped on a researched site were directly measured. The observant station represented a system of the points fixed on the district with the help of stability metal reference points which application provides an opportunity of recurrence of the experiment. In total 15 points of supervision were equipped on the object. In addition control

series of supervision were made in a untouched file of rocks outside a zone of influence of tectonic infringement. Thus, the observed system of the points fixed on the district by reference points, covered a zone of a break which under assumptions and the data of previous experiments, should have the greatest activity. In total within 7 days six working series of continuous measurements of sizes of short term deformations of tectonic trench zones and 2 control series of supervision in an untouched file were carried out on the object. Duration of continuous series of measurements made on different reference points of observant station was from 16 till 30 hours. At cameral processing of the results of measurements accuracy of definition of lengths of lines and exceeding between reference points as on parameters of quality of reception of vectors in geocentric to system of coordinates was estimated, and by calculation is of nonviscous short circuits of the closed contours. Thus it was determined, that mistakes of short circuit do not exceed sizes of 1 mm in a horizontal plane and 2 mm in a vertical plane. As a result of the executed experimental work good enough correlation of results of measurements with the data of previous researches, was received, and efficiency of application of complexes of a satellite geodesy was proved as means of contactless research and the control of the influence of dynamically intense zones for pipelines by continuous supervision over displacement and deformations of a terrestrial surface. It is determined that the absolute size of horizontal deformations during works made 35-57 mm. For vertical deformations 86 - 108 mm displacement are measured (Fig 2,3). Displacement occurred during time intervals from 20 to 85 minutes.

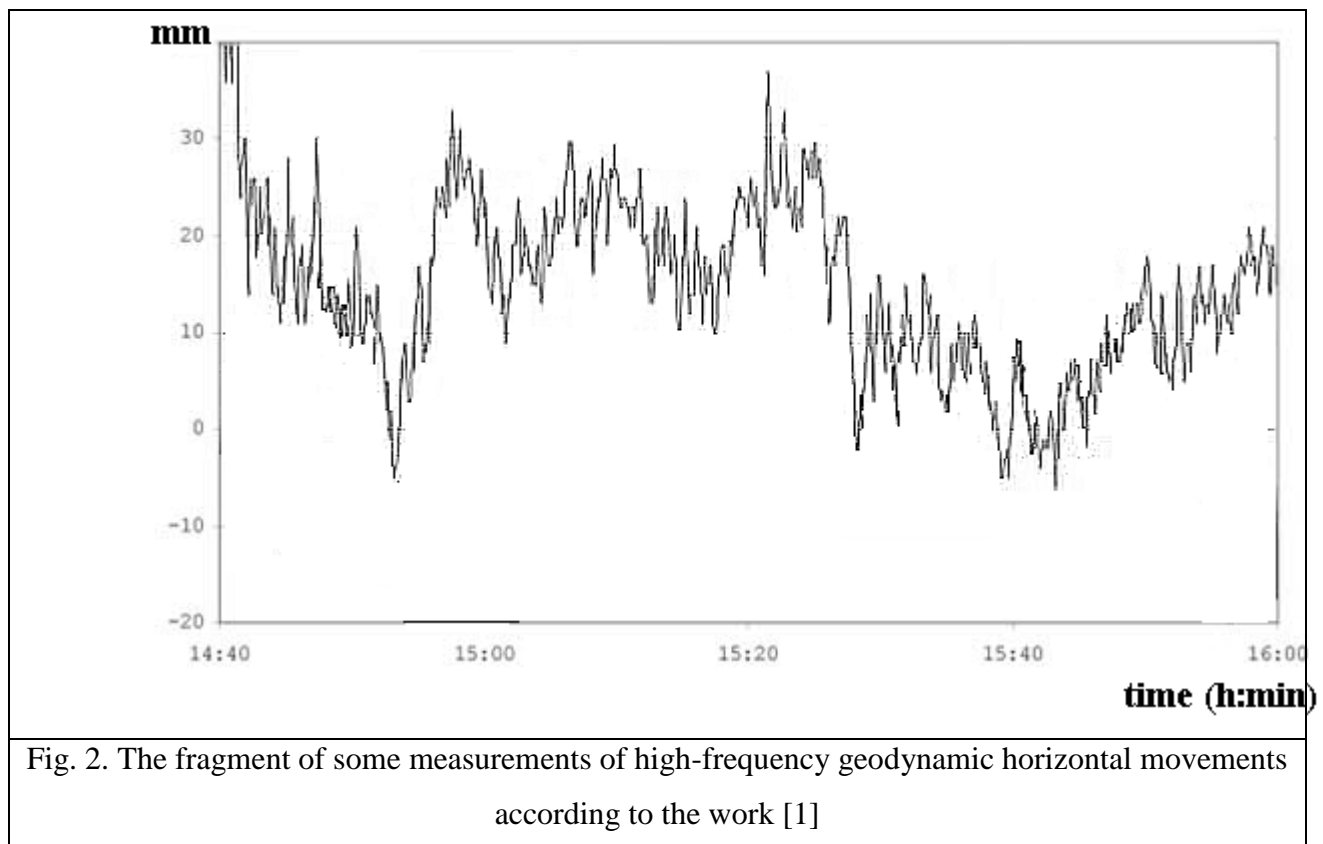
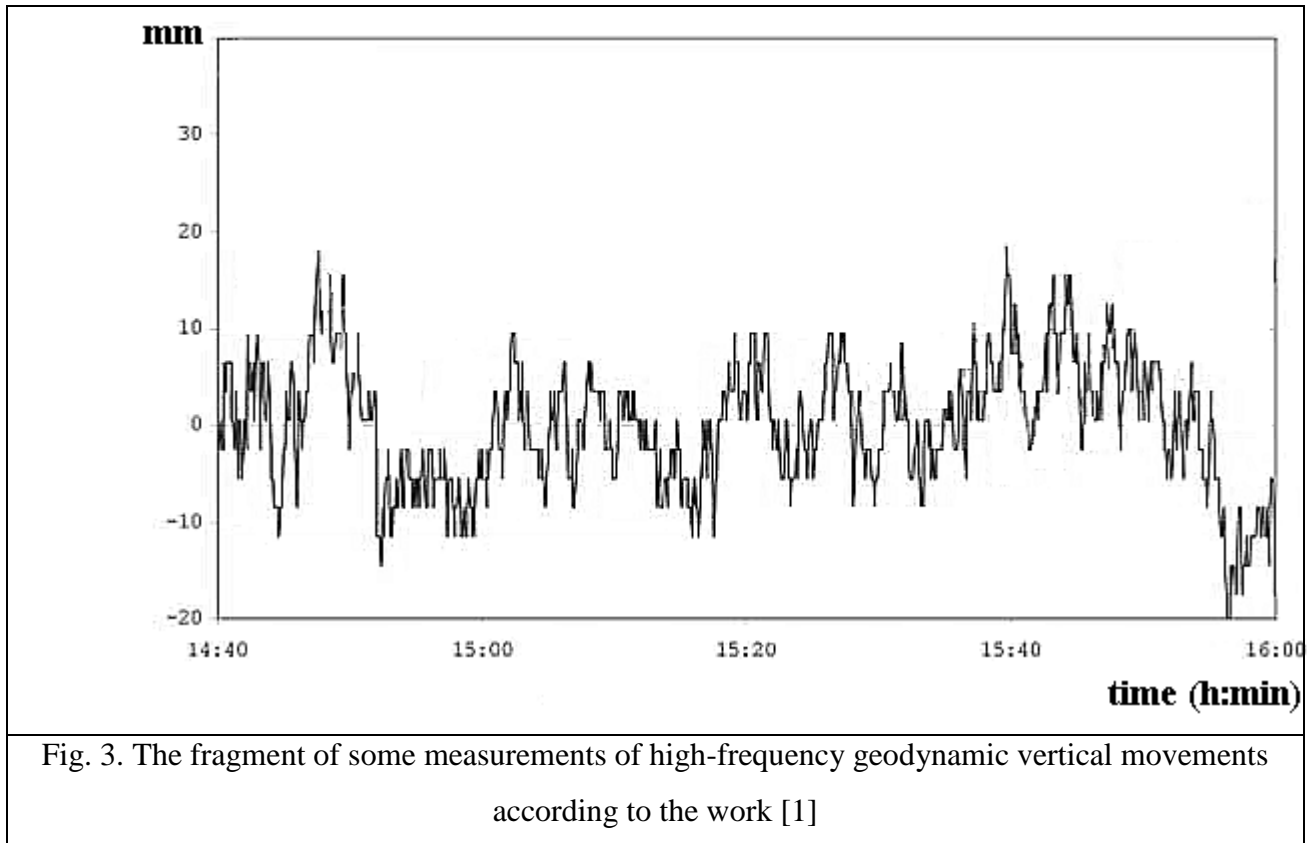


Fig. 2. The fragment of some measurements of high-frequency geodynamic horizontal movements according to the work [1]



There is a set of indirect acknowledgement of that such fine - block structures are mobile and really are subjected to intensive geo-deformations [5]. An indirect sign of occurrence of intensive high-frequency geodeformations can be the given fixings of time and a place of failures of gas networks. It is determined, that up to 80-90 % of failures on city gas networks of Public Limited Company " Odessagas " (monograph) and on main gas mains of Public Limited Company" Gazprom " [1] is provoked by geodynamic processes. We shall consider results of long-term supervisions which are conducted in Odessa. Here length of gas networks is more than 4 thousand km in the area of 400 km² I. In view of frequency of joints which are places of failures of gas mains, the spatial sanction of a network of supervision over geodeformations is not worse, than 50 m. As an example we shall consider the Indirect displays of geodeformations reflecting localness of their display in space. Within the framework of definition of geodynamics as a science studying movements and deformations, occurring in the earth's crust, cloaks and a nucleus, and their reasons [5] we shall consider in a complex the mechanism of excitation of intensive geodeformations by global processes and formation of fast mixtures of a surface of the Earth, indirectly identified on anomalies of existential distribution of failures of gas mains, for example in Odessa. The transfer mechanism of the processes occurring in Terrestrial bowels is plate tectonics. Movements of plates will be coordinated to concepts of spreading and correspond to geodeformations with the expressed horizontal component. The regulations about volume in this case are postulated, that not deep earthquakes in area of middle oceanic ridge in the Atlantic Ocean are indicators of activization of spreading. Also it is postulated, that the horizontal type of reversive movements should be associated with failures follows understand as with breakdown of gas mains in places of their outlet from the ground. Such sites of pipes are subject to the explosive deformations formed by movements of structures to which gas pipes are supplied. The

time interval (the end of January, 2003), when spreading in Northern Atlantic in the area of Iceland became more active, was determined. (Table)

Table 1. Seismic displays in the areas of Middle Ocean Ridge of the Atlantic Ocean in the period from 28.01.03 till 07.02.03

Data	Latitude.	Longitude	H (km)	M
2003/01/27 06:01:34.4	59.261°	-30.179°	10 km	4.3
2003/01/27 06:08:48.4	59.719°	-30.078°	10 km	4.5
2003/01/27 06:19:17.9	59.401°	-30.38°	10 km	4.4
2003/02/01 15:45:05.4	57.496°	-33.264°	10 km	4.9
2003/02/01 18:47:52.3	57.522°	-33.353°	10 km	5.6
2003/02/01 20:35:22.6	57.357°	-33.115°	10 km	4.6
2003/02/01 21:10:54.6	57.378°	-33.295°	10 km	5.1
2003/02/01 21:42:42.3	57.593°	-33.817°	10 km	4.5
2003/02/02 17:00:28.4	57.332°	-33.411°	10 km	4.8
2003/02/02 17:32:41.5	57.429°	-33.494°	10 km	5.0

It is possible to accept, that spreading became more active on January, 27 and February, 1-2. Two stages of activization of spreading were divided with a time interval close to one week. Between spreading on January, 27 and horizontal displacement in Odessa on January, 31 3,5 days have passed, as approximately after spreading on the first and the second of February, and horizontal displacements in Odessa on February, 4. Proceeding from definition of geodynamics in edition [5] we have decided to find out the reasons of the occurred geodeformations. On fig. 4 changes of duration of a day (BULLETIN B (IAU 2000), IERS Annual Report) in comparison with reference (ms) (after removal of a harmonic with the period of 14,2 days) are shown. It is possible to see, that o the whole parameter D at the end of January - the beginning of February has a minimum. The maximal gradients of reduction of parameter D are fixed in dates of spreading on January, 27 and February, 1 2003. Infringement of the general tendency and growth of parameter D is fixed on January, 31 and February, 4, 2003.

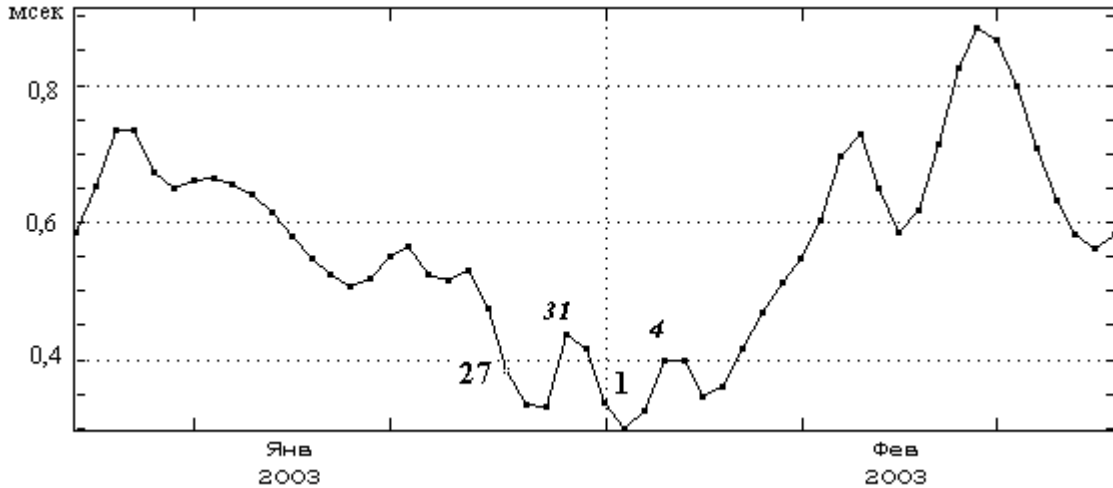


Fig. 4. Change in time of parameter D (BULLETIN B (IAU 2000), IERS Annual Report) after removal of a harmonic with the period of 14,2 days

Thus it is proved, that the process cyclic spreading alternated by horizontal movements of the earth's Crust is formed by features of rotation of the Earth about the axis in this period. In Odessa abnormal growth of intensity of horizontal displacements was observed on January, 31 and February, 4. These two days 5 failures took place, in both cases in a time interval duration no more than 90 minutes. Duration of geodeformation process for 60 minutes corresponds to the time scale of displacement determined by geodetic methods [1]. We shall remind, that displacements occurred during time intervals from 20 about 85 minutes. Intensive repeated geodeformations were located in limits with the sizes 1x1 km, in which borders "Vorontsov Palace", Odessa Opera Theatre and "Vorontsov" library fig. 5,6.

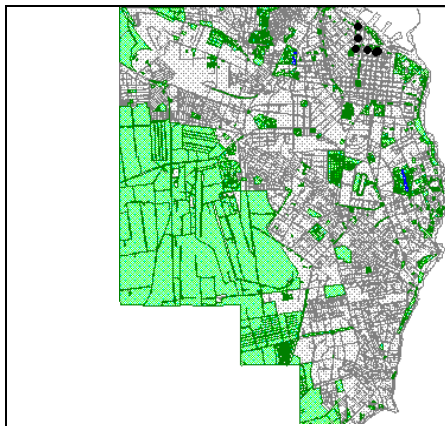


Fig. 5. The map of places of failures of gas mains (black point) of Public Limited Company "Odessagas " in places of an outlet from the ground, January, 31, 2003

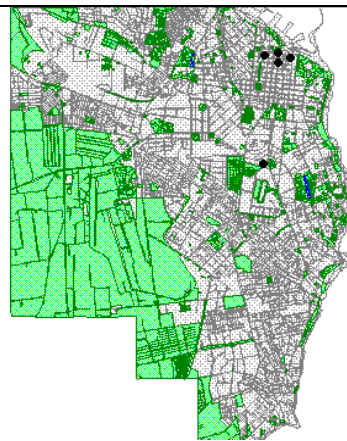


Fig. 6. The map of places of failures of gas mains (black point) of Public Limited Company "Odessagas " in places of an outlet from the ground, February, 4 2003

On January, 31 horizontal displacements began at 08 10 minutes and proceeded till 09 40 minutes (time Greenwich) . That is in the specified time interval failures occurred exclusively in

the places of an outlet of gas mains from the ground. On February, 4 the situation repeated. Horizontal displacements were fixed for 55 minutes from 08 45 minutes till 09 20 minutes. The analysis of a geodynamic situation during intensive geodynamic movements with the expressed horizontal component shows, that in conditions of intensive plate movements connected to global processes, reflected in parameters of rotation of the Earth, within the limits of active neotectonic zone - unit of crossing neotectonic breaks belonging to different directions of block divisibility of lithosphere active geodeformation processes were fixed within the limits of a local zone, making 0,25 % from the observed area. Duration of fixed geodeformations does not exceed 90 minutes that does not exceed 2 % from the time of supervision. High-frequency displacement by duration of 90 and 55 minutes on January, 31 and February 4 approximately coincided with a minimum and a maximum of parameter D that corresponds to a maximum and a minimum of angular speed of the Earth rotation (Fig. 7).

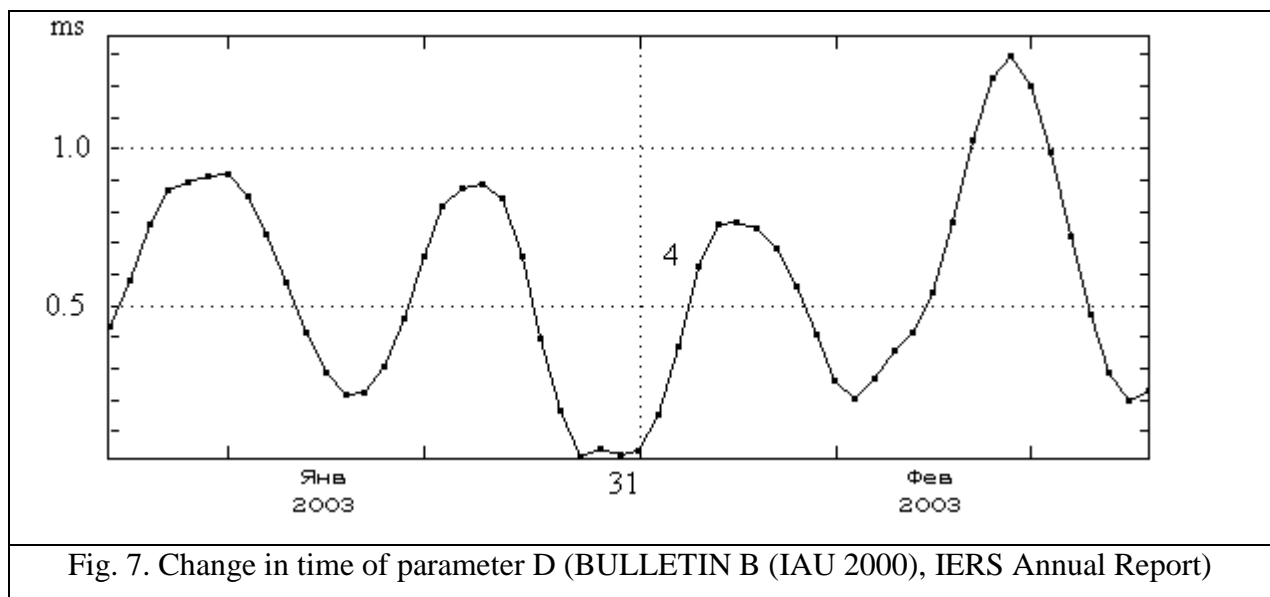


Fig. 7. Change in time of parameter D (BULLETIN B (IAU 2000), IERS Annual Report)

Conclusions: the Sanction on space of the modern permanent geodetic networks used for fixing of geodeformations, does not completely allow to receive an estimation of fast high frequency reversive movements of the Earth surface.

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