

## **Резюмета на публикации**

**Dimitrov, N., Georgiev, I., Danchev, P. (2020). Refraction correction in precise leveling observations for national leveling network first order. *Geodesy and Cartography*, 46(4), 159-162. <https://doi.org/10.3846/gac.2020.11555>**

### **Abstract.**

The paper deals with some problems when applying a correction to reduce the effect of vertical refraction in precise leveling observation. An example for calculating the refraction correction for one first order leveling line with length of 109 km in Bulgaria is given. Comparison between the obtained errors before and after applying refraction correction has been made. The results show that is important to measure the temperatures simultaneously with the leveling by aspiration thermometer with an accuracy of  $\pm 0.1$  °C. It is recommended to make experimental research and to adopt appropriate for Bulgaria model for taking into account the influence of vertical refraction.

**Dimitrov N, I. Georgiev, Nakov R. Monitoring of geodynamic processes in the area around Sofia. SGEM, Volume 20, Book 2.2, 20th International Multidisciplinary Scientific GeoConference (SGEM 2020) 18-24 August, Albena, Bulgaria, 2020, ISBN:978-619-7603-07-1, ISSN:1314-2704, DOI:10.5593/sgem2020/2.2/s09.010, p 79-86.**

### **ABSTRACT**

The study of recent crustal movements is one of the priority areas of the Earth sciences. Geodetic methods occupy a particularly important place in the general complex of measurements and investigations of crustal movements because they provide quantitative information on the condition and development of geodynamic processes. The paper outlines the newly accepted project with main goal monitoring the geodynamic processes in the area of Sofia. This goal will achieve by periodic GNSS measurements over the Sofia geodynamic network and using data from continuously operating reference stations from National GNSS Network. The study will give estimates of the recent crustal movements in the area; active strain and strain rate and correlation between the crust movements, seismic events and tectonic structures. DInSAR method, based on interferometric images, will also apply to obtain independent estimates of the crustal movements from RSA data. The paper summarizes the geodetic, geological and seismotectonic information about the territory around Sofia obtained up to now. A description of the existing geodynamic geodetic network in the studied area is given and main characteristics of the geological setting are made. The data show the presence of active faults in the area that need to be investigate. The research project can be seen as a new stage in the study of an area with a clear seismic hazard. It is propose to develop current issues related to the joint interpretation of geodetic, geological and seismotectonic information for the assessment of recent geodynamic processes. The expected results will be a contribution to the assessment of natural risk and seismic hazard in the studied area.

**Dimitrov N., Georgiev I., Atanasova M., Ivamov A. Monitoring of the landslide processes at the "Dalgiya Yar" landslide. Conference, Section Geodesy and Mine Surveying, Volume 20, Book 2.2, 20th International Multidisciplinary Scientific GeoConference (SGEM 2020) 18-24 August, Albena, Bulgaria, 2020, ISBN:978-619-7603-07-1, ISSN:1314-2704, DOI:10.5593/sgem2020/2.2/s09.011, p 87-94.**

### **ABSTRACT**

The study of landslides is of particular importance because they can lead to great material damage. The region of the Bulgarian northern Black Sea coast is affected by many landslides and it is important to monitor motions of the major landslides in this area. The paper outline deformation analysis of the landslide processes in the area of “Dalgiya yar”. It is a landslide circus from the Varna landslide region that covers several active landslides, whose boundaries are overlapping and for that reason are difficult to differentiate. For some of the landslides located in this area, a smaller landslide could be delineated inside them. For this study we used data from two epochs measurements - in 2013 by classical and in 2018 by GNSS, provided by Ministry of Regional Development and Public Works and new GNSS measurements performed in 2019 year of the geodetic network in the “Dalgiya Yar” landslide. The coordinates obtained by processing of the last GNSS measurements along with coordinates from first two epochs are processed together to solve for point’s velocities of the established geodetic control network. Strain rates, crustal dynamic parameters and point’s velocities of the network are obtained. The horizontal motions of the landslide vary from 13 mm/y to 46 mm/y. Separately, the landslide movements are estimated by D-iNsar technics using images produced by Sentinel-1. Comparison of the results from both methods shows a good agreement. The results contribute to obtain reliable information about the origin and dynamics of the landslide movement process as well as the assessment of the resulting hazards for the population and the infrastructure. As a whole, the results unambiguously show the necessity to permanently monitor the landslide and the same is valid for most of the North Black Sea landslides.

**Atanasova M., Dimitrov N., Nikolov H. Study on the geodynamic processes for the area of the Southwest Bulgaria using Insar data. SGEM, Volume 20, ISSUE 2.1, 20th International Multidisciplinary Scientific GeoConference (SGEM 2020) 18-24 August, Albena, Bulgaria, 2020, ISBN:978-619-7603-06-4, ISSN:1314-2704, DOI:10.5593/sgem2020/2.1/s08.074, p 573-580.**

## **ABSTRACT**

Geodynamic processes and seismic activity are considered to be the prime driver of horizontal and vertical movements of the Earth's crust in the Balkan Peninsula. One proven method for continuous monitoring of ground deformations is the use of data from active radar remote sensing. These data are the basis for the creation of interferometric images (IFIs) for quantitatively assessment the recorded ground movements of the Earths’ surface within a fixed time interval. For this research a set of IFIs were created for areas of Sofia.

The main objective of this research is monitoring of the ongoing geodynamic processes by complementary use of SAR and GNSS data. GNSS data from permanent and local geodetic networks are used for validation of the SAR derived information concerning the study area. The study will give reliable data for ongoing risky geo-processes for the region of the Southwest Bulgaria.

Landslides are one of the main geological hazards that can cause critical damage to the infrastructure in an area and can result in serious risks to the people’s safety there. Maps of active, stabilized and potential landslides in Southwest Bulgaria provided by the national landslide register part of the GIS maintained by Ministry of Regional Development and Public Works (MRDPW) are used. For mapping the deformations in the studied region interferometric images were produced at 4 intervals. The results obtained from this study are used for the further development of the methodology for monitoring the risk of geo-processes by combining data from different sources.

**Ivanov A., I. Georgiev, N. Dimitrov. Analysis of sea level data at Varna and Burgas tide gauge stations. SGEM, Volume 20, Book 2.2, 20th International Multidisciplinary Scientific GeoConference (SGEM 2020) 18-24 August, Albena, Bulgaria, 2020, ISBN:978-619-7603-07-1, ISSN:1314-2704, DOI:10.5593/sgem2020/2.2/s09.001, p 3-10.**

## **ABSTRACT**

There is observational evidence that the global sea levels are rising and increasing the risk to coastal communities from floods and erosion. Interest in marine sea level research is dictated not only by forecasting cataclysms and sea level rising, but also in connection with interdisciplinary studies exploring the causes of this change.

This article outlines time series analysis of tide gauge data to solve for short and long term sea level variations at the Varna and Burgas tide gauge stations. The data covered the period 1928 – 2019 for Varna, and 1928 – 2017 for tide gauge station Burgas. Data include values from both analogue and radar measurements corrected for subsidence of the tide gauge staff. Regression model is applied analyzing monthly sea level data for computing mean sea level, trend, annual, semiannual and decadal variations.

The analysis of tide gauge data from two stations indicates annual and decadal variations of mean sea level. Radar tide gauge data includes hourly values for period May 2013 – December 2019 (st. Varna ) and June 2013– April 2017 (st. Burgas).

This observation period is sufficient for separation long from short term tidal constituents. Least-squares harmonic analysis was used to solve for amplitudes and phases of tidal constituents. The method is based on the theory that observed data series can be presented by sum of components with a previously known frequencies stable in time. Over 60 statistically significant short term tidal constituents are obtained from both tide gauge stations. The annual and semiannual tidal amplitudes and phases, estimated with harmonic analysis and regression model ~~and~~ are compared for stations Varna and Burgas

**N. Dimitrov, P. Danchev P. Georgiev I. (2021). Refraction Correction for Connection of the National Leveling Network First Order to Tide Gauge Station Varna. Conference Proceedings, 11th Congress of the Balkan Geophysical Society, Oct 2021, Volume 2021, p.1 - 5. DOI: 10.3997/2214-4609.202149BGS29**

## **Resume**

The paper outlines some problems when applying refraction correction in order to reduce the effect of vertical atmospheric refraction in precise leveling observation. An example for calculating the refraction correction for a leveling line that connect the National Leveling Network first order to tide gauge station Varna is given. The estimation is using the model described in new Instruction № RD-02-20-1 of 15 January 2021 for the Establishment and Maintenance of the National Leveling Network. The results show that that the refraction correction is commensurable with correction for rod scale and must be applied for each set-up, appropriate weather conditions when the air temperature changed slightly throughout the day is better to be chosen. The applying of the refraction correction does not eliminate the requirements related with the maximum length of sight, minimum high of sight, balancing of the length of sights, and the choice of appropriate weather conditions.

**Dimitrov N., R. Nakov. (2021). Supplementary measurements in the Sofia Geodynamic Network. Significance for contemporary local and regional geodynamics. Review of the Bulgarian Geological Society, 82, 3, 239–241; <https://doi.org/10.52215/rev.bgs.2021.82.3.239>**

**Abstract.** The supplementary results are in agreement with previously obtained data that show southern motion of the stations with increasing velocities from north to south. They supplement the network in areas with missing data, but provide also new more accurate data at a local level. The velocities are from about 1.5mm/y of the northern most station to slightly over 3mm in the southern most station. They are significant for the interpretation of the present-day geodynamics and may be used as well as for the evaluation of the geological hazards.

**Atanasova M., Nikolov H., Georgiev I, Vassilev K, Dimitrov N, Ivanov A. Creating a thematic geodatabase for monitoring the landslide processes of the landslide circus “dalgia yar”. 7th World Multidisciplinary Earth Sciences Symposium 7-11 September 2020 – Prague (Czech Republic), IOP Conference Series: Earth and Environmental Science, 2021. Vol. 906. 1. 1-12.**

**Abstract.** Impact on the process of landslide origin and activation is result of many factors both endogenous and exogenous. The purpose of this study is to provide possibility for analysis and assessment of the geo-processes in the "Dalgia yar" landslide located at Northern Black Sea coast of Bulgaria in order to prevent risks and disasters of natural and anthropogenic origin. An important stage was to seamlessly include data from different sources such as geodetic measurements, satellite SAR (Synthetic-aperture radar) data as well as geological and geophysical data. The established geodatabase structures the collected information on dangerous geo-processes in the mentioned area and introduces them into the GIS (Geographic information system) environment. Its purpose is to facilitate the analysis of the available geological data for this landslide and to integrate them with results of measurements from regular monitoring. Interferometric images (IFIs), data from permanent GNSS (Global Navigation Satellite Systems) stations and from local geodynamic GNSS network, geological, seismic and geophysical data, updated geological maps and maps of the risk of landslide processes are included in the database. The IFIs have been produced using well established procedure for processing large number of Sentinel-1 SAR data of the purposely created local archive. Other key element used to improve the final results of SAR data processing and important part of the geodatabase is the precise Digital Elevation Model (DEM), which is much better in terms of horizontal and vertical resolutions than the open accessed ones (SRTM). The coordinates and velocities of the GNSS points are obtained from adjustment and analysis of two epoch measurements of the geodynamic control network of landslides "Dalgia yar". Since the area has complex geological structure, small scale maps reflecting the geological and geophysical hazards are integral part of the geodatabase. Having all this information the analysis concerning the ongoing geodynamical processes in the study area is significantly improved and more reliable information is produced for better regional planning by the local authorities and residents.

**Dimitrov N., I. Georgiev, P. Danchev. Velocity Field in Southwest Bulgaria Obtained from GNSS Data. Proceedings of 21th International Multidisciplinary Scientific GeoConference SGEM 2021, 21, 2.1, International Multidisciplinary Scientific GeoConference, 2022, ISSN:1314-2704, DOI:10.5593/sgem2021/2.1/s09.57, 459-465.**

## **ABSTRACT**

The region of southwest Bulgaria is characterized by a large number of fault structures, and the presence of tectonic and seismic activity, thus predetermines the development of dangerous geodynamic processes.

This article discusses the estimates of modern movements of the earth's crust obtained from periodic geodetic measurements. They describe the total effect of fast and slow horizontal and vertical movements. Obtaining such estimates, on the order of mm/y, requires determining the coordinates of the points of the geodynamic geodetic networks with millimeter accuracy. Achieving such accuracy is possible only with the help of modern satellite geodetic technologies.

GNSS data from five continuously operating reference stations belonging to National GNSS network is used in this research. The raw GNSS measurements for three-year-and-a-half period are processed. Time series with coordinates and mean square errors (north, east and up) and time series with the residuals from multi-year solution are estimated. The time series show very good quality of the solution (the values of nrms are smaller than 0.70).

The results for velocities of EPN Densification network, National GPS Network and Geodynamic GPS network around Sofia and Southwest Bulgaria are combined to obtain velocities field in Southwest Bulgaria derived from GNSS measurements. The newly acquired velocity field confirms that the general tendency of movement of the points in the region of Southwest Bulgaria is in the southern direction with respect to stable Eurasia, as a general tendency the velocities increase from North to South. This pattern is in agreement with the extensive movement of southern Bulgaria and northern Greece. The obtained velocity field can be used for further detailed geodynamic and geological investigations of the fault structures in the region.

**Dimitrov N., Atanasova M., Georgiev I. Processing and Analysis of CORS GNSS Data for The Study of Landslides In The Northern Black Sea Coast. Proceedings of 21th International Multidisciplinary Scientific GeoConference SGEM 2021, 21, 2.1, International Multidisciplinary Scientific GeoConference, 2021, ISSN:1314-2704, DOI:10.5593/sgem2021/2.1/s09.51, 411-417.**

## **ABSTRACT**

The Bulgarian northern Black Sea coast is affected by many landslides. Several geodynamic networks have been built to study landslide processes in the northern Black Sea coast. Landslide research is important, as these phenomena can lead to great material damage. Their destructive impact on buildings, engineering structures and disturbances in the resilience of the earth's crust causes enormous economic, environmental, social and other damage, and often takes human lives.

A modern tool for monitoring landslides is the application of GNSS measurements, which has an advantage over conventional measurement methods. GNSS data from six continuously operating reference stations from National GNSS network for three years and a half period are

processed and analyzed. Time series with coordinates and mean square errors (north, east and up) are obtained. Time series with the residuals from multi-year solution are obtained too. The time series show the very good quality of the solution (the values of nrms are between 0.60 and 0.80).

In this study long-term processing of data from continuously operating reference stations (CORS) is performed, to obtain the coordinates and velocities of the stations, because this also affects the local networks built for the study of landslides.

The velocities of the points from the National GNSS network in the northern Black Sea region are relatively small, less than 1 mm/year. To obtain the movements of the points from the local geodynamic networks, it is necessary to process their GNSS measurements together with the GNSS measurements from the continuously operating reference stations from National GNSS network but the velocities of the station must be taken in to account, as done in this study. This allows to determine whether the measured points are located in the landslide or outside it and thus to accurately determine landslide boundaries.

**Dimitrov N, Nakov R. Recent GPS results on the geodynamics of the area around Sofia (Central-Western Bulgaria). Списание на Българското геологическо дружество, 3, 81, 2020, ISSN:0007-3938, 241-243.**

#### **Abstract.**

The paper outlines recent results from estimation of 23 years GPS measurements on the geodynamic network around Sofia. The obtained result, clearly provide new more accurate GPS geodynamic data on the considered area. All velocities clearly exceed 1.5 - 2 mm/y reaching up to 3 - 4 mm/y. As a general tendency the velocities tend to increase from North to South. According to the new results analysis of geological processes is given. The newly acquired velocities from three campaigns 1997, 2000 and 2020 years confirm that the general tendency of movement of the stations in the region of Central West Bulgaria is in the south direction with respect to stable Eurasia. The velocities tend to increase from north to south. This pattern is in agreement with the extensive movement of southern Bulgaria and northern Greece. The new results provide much better accuracy, reliability and local details.

**Dimitrov N., R. Nakov. Strain Accumulation in Southwest Bulgaria Derived From GNSS Measurements. Proceedings of 21th International Multidisciplinary Scientific GeoConference SGEM 2021, 21, 2.1, International Multidisciplinary Scientific GeoConference, 2021, ISSN:1314-2704, DOI:10.5593/sgem2021/2.1/s09.53, 427-433.**

#### **ABSTRACT**

Globally, modern crustal movements are being studied as a priority, a large number of projects are being developed and significant funds are being allocated for the development of research in this field of science. Due to the social importance of the problem, the need to obtain geodetic data on the current activity of the earth's crust is realized.

This article examines the study of the temporal movements of the earth's crust and the accumulated stresses in a geologically and seismically active region with the presence of many fault structures. The region around Sofia and southwest Bulgaria is distinguished by many fault structures, and the presence of tectonic and seismic activity, thus implies the emergence of dangerous geodynamic processes.

A geodynamic GPS network has been built in the region to study the geodynamic processes. Campaigns with GNSS measurements have been performed for more than 23 years. GNSS data

acquired from periodic geodetic measurements between 1997 and 2020 are analyzed to obtain the strain rate field for southwestern Bulgaria.

The newly acquired strain rate field show dominating N-S extension and the deformation is not uniformly distributed over the studied area. Some important conclusions have been made about the behaviour of the fault structures. The result for strain rate field confirms that the movement of the points in the region of Southwest Bulgaria is in the southern direction relative to stable Eurasia. This extensive movement of southern Bulgaria and northern Greece is confirmed. Due to the long period of measurements the results are highly reliable and can be used for detailed geodynamic and geological study of the fault structures in the region and evaluation of the seismic hazard.

**Atanasova-Zlatareva, M.; Nikolov, H. and Dimitrov, N. (2021). Study on Ground Motions in Southwest Bulgaria based on in-Situ and Satellite Data. In Proceedings of the 7th International Conference on Geographical Information Systems Theory, Applications and Management - Volume 1: GISTAM, ISBN 978-989-758-503-6, pages 157-164. DOI: 10.5220/0010503101570164**

**Abstract:**

In the last decades data from satellites are being used more frequently to study the ground movements. This fact is evidenced by the increased number of research papers and projects using freely provided data by space agencies such as ESA (European Space Agency) and JAXA (Japan Aerospace Exploration Agency) and increased revisiting time of the new instruments on-board satellites. Other reason for this increase are the latest developments in processing methods such as PSI (Persistent Scatterer Interferometry) and even increasing number of cloud processing options provided by universities and research centres. Nevertheless the information obtained by this manner has some drawbacks for example moderate spatial resolution. This is why in-situ data from precise GNSS (Global Navigation Satellite System) measurements are essential. In this study the authors used both kinds of data to study one of the regions of Bulgaria which is recognized to be highly prone to seismic and geological hazards namely the Southwest region. For this research two sources of data have been used – SAR (Synthetic Aperture Radar) data from Sentinel-1 mission of ESA and in-situ acquired contemporary and older GPS (Global Positioning System) data. As a result of SAR data processing produced were interferometric images from ascending and descending orbits to decrease the effect of the mountainous topography, while the results from the GNSS measurements were used for verification.

**Dimitrov N, Nakov R. (2022). GPS Results from Long Time Monitoring of Geodynamic Processes in South-Western Bulgaria. Applied Sciences. 2022; 12(5):2682. <https://doi.org/10.3390/app12052682>**

**Abstract:** Monitoring of geodynamic processes by modern GNSS technics in the area of Sofia and south western Bulgaria continues already for 25 years. To study the modern crustal movements in the area Global Positioning System (GPS) data acquired between 1996 and 2021 are analyzed to obtain the velocity field for south western Bulgaria. For a span period of almost 25 years the monitoring has covered 28 stations. They have been measured in different years and in different number of campaigns. Despite the different number of the measurements the obtained results are quite homogeneous in the different localities of the studied area and show clear uniform tendencies. All velocities are in southern direction. They are in the limits of 1.5 mm/year up to slightly over 3 mm/year, almost reaching 4 mm/year. The velocities of the stations tend to increase from north (stations around Sofia), passing through an intermediate locality (between Sofia and Kyustendil-Pazardhik), clearly increasing in the southernmost part

of the country (around Gotse Delchev). This velocity field motivates N-S expressed extension with increasing rates from North to South. The difference in the velocity rates tends to change along geologically suggested active fault zones. The obtained results in a general way confirm previously data, but with much better accuracy and details at local level. This way both the repeatedly measurements and extension of the geodynamic network prove to be a powerful tool for better understanding of the present-day geodynamics.

**Mila Atanasova-Zlatareva, Hristo Nikolov, Ivan GEORGIEV, Nikolay DIMITROV, Anton IVANOV. Studying the Landslide Processes at "dalgiya Yar" Landslide Circus by Combined Use of GNSS and InSAR (10656). Proceedings FIG Working Week 2020 Smart surveyors for land and water management Amsterdam, the Netherlands, 10–14 May 2020, FIGNET, 2020, ISBN:978-87-92853-93-6, ISSN:2307-4086, pp. 1-14**

## **SUMMARY**

The main objective of this research is monitoring the ongoing landslide processes by complementary use of SAR and GNSS data. It will be achieved by means of proved methodology for continuous monitoring of landslide areas by integrating information from interferometric images and GNSS data from permanent and local geodetic networks. The study will give reliable data for ongoing risky geo-processes for the region of the Northeastern Bulgaria, known with several large active landslides.

These results are important for understanding the origin and dynamics of landslide processes as well as assessing the resulting hazards. Local archive with Sentinel-1A/B images for this region is created and interferograms are produced. Raster heat map based on displacement values from interferograms was made. The area of interest of this study is "Dalgiya yar" - a landslide circus in which concentration of ground deformations has been observed.

When geodynamic networks are used to study landslide processes several types of surveying points are used – ones fixed on geologically stable terrain, others located inside the landslide. For stable points located in the non-deformable zone of the landslide used were stations of permanent GNSS network NIGGG. New established network in and around the landslide area "Dalgiya yar" – “Fara” consists of a total of 30 stabilized points.

In the geodynamic network "Dalgiya yar" are included all old 6 points that were discovered on the ground from the network used to track deformations along the road. A preliminary study, based on data provided by Ministry of Regional Development and Public Works of the landslide processes in the road I-9. Analysis of horizontal and vertical deformations for the period 2013 - 2018 along the road I-9 the last cycle of June 2019yr.

**Dimitrov N., P. Danchev, I. Georgiev (2019) Investigation of the impact of atmospheric refraction on precision leveling measurements. Bulgarian Geophysical Journal, 2019, Vol. 42, pp28-36, ISSN 1311-753X. DOI: 10.34975/bgj-2019.42.3**

## **Abstract.**

The effect of atmospheric refraction on the results of precise leveling measurements is investigated. This study is based on level measurements for 30 km line provided by Geodesy, Cartography and Cadastre Agency. The results show that refraction's impact is not eliminated with one and the same positive and negative differences of elevation. The correction must be applied for each instrument set-up. Largest values of refraction are observed in the leveling



distances with highest terrain slope. The error caused by refraction is a significant systematic error in the leveling measurements and it is mandatory to be applied.

**Ivanov, A., I. Georgiev, N. Dimitrov (2019) Analysis of monthly sea level data from Varna tide gauge station. Bulgarian Geophysical Journal, 2019, Vol. 42, pp77-82, ISSN 1311-753X. DOI: 10.34975/bgj-2019.42.7**

#### **Abstract.**

Climate changes and global warming are assumed for main reasons of constant sea level rise. Survey methods such as altimetric measurements are essential for determining global processes related to sea level change, but the regional and local changes are also important. In this paper regional sea level changes at tide gauge station Varna at Black sea coast is analyzed. Single spectrum analysis is carried out for monthly sea level data for period 1929-2019. The sea level trend, long term tidal constituents, amplitudes and phases are estimated. The results clearly indicate positive mean sea level trend with value of  $1.2 \pm 0.1 \text{ mm/yr}$ .

**Dimitrov, N., Georgiev, I., Ivanov, A. (2020) Global geodetic parameters obtained from 14 years Lageos 1 Satellite Laser Ranging, EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-15816, <https://doi.org/10.5194/egusphere-egu2020-15816>, 2020**

Abstract. Satellite Laser Ranging (SLR) data of the geodynamic satellite Lageos-1 (LAsER GEODynamics Satellite) for the period January 2000 - June 2013 are processed and analysed through sequential estimation to obtain multiyear solution for global geodetic parameters - coordinates and velocities of 37 stations located on the main tectonic plates. The analysis is carried out with the Satellite Laser Ranging Processor (SLRP) software, version 4.3, developed in the Department Geodesy of the National Institute of Geophysics, Geodesy and Geography at Bulgarian Academy of Sciences. The software consists of two main programs – orbit determination and parameter estimation modules. Total number of 202 447 measurements are processed and analysed by monthly batches. Arc dependent parameters, geogravitational parameter - GM, Earth Orientation Parameters (pole coordinates and length of the day - LOD), along track and solar radiation pressure coefficients are obtained from monthly solutions. The weighted root mean squares of the monthly station coordinates solution are between 2 and 16 mm. The analysis of monthly GM time series reveal value of the secular trend  $\dot{G}/G = -3.31 \cdot 10^{-13} \text{ yr}^{-1}$ . The results obtained contribute to the monitoring of recent tectonics of the major continental plates and global geodynamic parameters.

Dimitrov N. Accuracy and error sources in RTK Measurements. Proceeding XXXI International Symposium On “Modern Technologies, Education and Professional Practice in Geodesy and Related Fields” 03-05 November 2021, Sofia, Bulgaria, CD, 2021, ISSN:2367-6051, 1-7

#### **ABSTRACT**

Positioning with Global Navigation Satellite Systems (GNSS) is a rapidly evolving environment. Improvements in receiver hardware and software, increased wireless communication capabilities, new signals and additional satellite systems make positioning much easier, faster and more accurate. in real time, and will probably be even more developed in the near future. The publication analyzes the sources of errors in real-time GNSS measurements. The possible sources of ionospheric and troposphere errors are systematized. The influence of the field conditions on the accuracy of the measurements is described.

Guidelines for best practices in field measurements are provided to obtain reliable real-time measurement results.

Dimitrov N. (2022). Scientific project for monitoring of geodynamic processes in Sofia. Coordinates, Volume XVIII, issue 6, Thomson Press (India), 2022, ISSN:0973-2136.

### **Summary**

The paper outlines the newly accepted project with main goal monitoring the geodynamic processes in the area of Sofia. This goal will achieve by periodic GNSS measurements over the Sofia geodynamic network. Preliminary results have already been obtained. The newly acquired velocities confirm that the general tendency of movement of the stations is in the south direction with respect to stable Eurasia. The velocities tend to increase from north to south. This pattern is in agreement with the extensive movement of southern Bulgaria and northern Greece. The new results provide much better accuracy, reliability and local details.

**Milev, G., K. Vassileva, N. Dimitrov. Sofia CERGOP-2 Progress Report of Bulgaria. Reports on Geodesy, Warsaw University of Technology, No 4(71), 2004, 201-207. ISSN 0867-3179, ISBN 83-85287-70-1.**

### **ABSTRACT**

The works carried out during the time between the Nice and Sofia Conferences have been presented. They mainly concern the forthcoming installation of the antennas of the two permanent stations, combined processing of two campaigns – BULREF'03 and BULREF'93. Results from test measurements at the selected antenna places, from the processing of the GPS data for the Balkan Peninsula stations and other specific activities related to the Work Package 10.7 (WP 10.7) have been outlined.

**Milev G., Vassileva K., Becker M., Valev G., Dimitrov, N. (2006) Final CERGOP-2 report of Bulgaria, Reports on Geodesy, Warsaw University of Technology, No 3(78), 2006, 287-302, ISSN 0867-3179.**

### **ABSTRACT**

The scope of the works accomplished within the project has been presented. The particularities on the implementation of the Bulgarian activities in comparison with the activities of the other countries and Work Packages have been outlined. The main points on the organization of the works with short information have been given and the operation of the two Bulgarian permanent stations has been outlined as well. A special attention has been paid to the processing, analysis, investigation and interpretation of the Bulgarian and Balkan Peninsula GPS data. The results from the absolute gravity measurements (a network of absolute gravity stations, connection to the national basic gravity network etc.) have been presented as well. The structure and contents of the monograph "Geodynamics of the Balkan Peninsula" has been given. Respective conclusions and generalizations have been drawn and possibilities for using of the project results in the frame of the country and in Europe have been presented.

**Milev G., Vassileva K., Dimitrov N. (2006) Sofia CERGOP-2 progress report of Bulgaria Reports on Geodesy 4(79), 253-258, ISSN 0867-3179.**

## **ABSTRACT**

The works carried out during the time between the Nice and Sofia Conferences have been presented. They mainly concern the forthcoming installation of the antennas of the two permanent stations, combined processing of two campaigns – BULREF'03 and BULREF'93. Results from test measurements at the selected antenna places, from the processing of the GPS data for the Balkan Peninsula stations and other specific activities related to the Work Package 10.7 (WP 10.7) have been outlined.

**Milev G., Vassileva K., Dimitrov N. (2006) Bulgarian geodynamics CERGOP-2 activities - Vienna progress report Reports on Geodesy 4(79) pp 269-276, ISSN 0867-3179.**

### **Abstract**

The investigations and activities accomplished during the second year of the CERGOP-2 project implementation have been generalized. Moreover it is emphasized on the results not presented at the previous conferences of the project up-to-now or related to it. Processing, comparison and analysis of the GPS campaigns (BULREF'93 – BULREF'03/CEGRN'03), of data from the permanent stations located on the Balkan Peninsula and of CEGRN, EUREF and other stations have been accomplished. The organisation and results from the activity of the Balkan's partners participating in the project realization have been presented. Respective suggestions, main aspects of the follow-up investigations and conclusion have been outlined.

**Milev G., Vassileva K., Becker M., Valev G., Dimitrov, N. (2006) Final CERGOP-2 report of Bulgaria Reports on Geodesy 4(79) pp 289-304, ISSN 0867-3179.**

## **ABSTRACT**

The scope of the works accomplished within the project has been presented. The particularities on the implementation of the Bulgarian activities in comparison with the activities of the other countries and Work Packages have been outlined. The main points on the organization of the works with short information have been given and the operation of the two Bulgarian permanent stations has been outlined as well. A special attention has been paid to the processing, analysis, investigation and interpretation of the Bulgarian and Balkan Peninsula GPS data. The results from the absolute gravity measurements (a network of absolute gravity stations, connection to the national basic gravity network etc.) have been presented as well. The structure and contents of the monograph "Geodynamics of the Balkan Peninsula" has been given. Respective conclusions and generalizations have been drawn and possibilities for using of the project results in the frame of the country and in Europe have been presented.

**Milev G., K. Vassileva, M. Becker, N. Dimitrov. (2006). Geodetic measurements and investigations on the territory of Bulgaria within the CERGOP project. Balkan Peninsula monograph, Reports on Geodesy, Warsaw University of Technology, No 5(80), 2006, 213-220, ISSN 0867-3179.**

### **Introduction**

The territory of Bulgaria is studied within the CERGOP project as a part of the Balkan Peninsula and as a specific geodynamic region by geodetic means from 1996 (Milev et al, 2002; Milev et al, 2003). EUREF and CERGOP stations were included in four GPS CEGRN campaigns - 1996, 1997, 2003 and 2005. In the second stage of the project – CERGOP-2 the country participates

as a full contractor and it is responsible for the implementation of the Work Package 10.7 – Geodynamics of the Balkan Peninsula (Milev et al., 2004). GPS data from all campaigns were processed compared and analyzed and published. Two permanent GNSS stations have been established and operated on the territory of Bulgaria. The main results obtained – coordinates and velocities concerning the territory of Bulgaria are analyzed from geodynamic point of view and some conclusions and suggestions have been drawn. The activities accomplished with respect to the establishment of the National Gravity System presented in more detail in sections 4.3.10 and 4.3.11 are related to the implementation of CERGOP-2 project. Moreover an integration of CERGOP-2 activities with activities on other international projects on the territory of Bulgaria like EUREF, European Combined Geodetic Network (ECGN), Unified European Gravity Network 2002 (UEGN02) has been implemented.