IAG REPORT

GEODETIC RESEARCH ACTIVITIES IN GREECE

FOR THE PERIOD 2015-2018

Edited by

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Contributions by:

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- *School of Rural and Surveying Engineering, Department of Topography, National Technical University of Athens (NTUA)*
- *Laboratory of Geodesy and Geomatics, Department of Civil Engineering, Aristotle University of Thessaloniki (AUTh)*
- *Laboratory of Geodesy and Geodetic Applications, Department of Civil Engineering, University of Patras*
- *Laboratory of Geodesy and Geomatics Engineering, (GeoMatLab), School of Mineral Resources Engineering, Technical University of Crete*
- *Laboratory of Geodesy and Surveying, Department of Surveying and Geoinformatics Engineering, University of West Attica*
- *Hellenic Military Geographical Service (HMGS)*
- *Institute of Geodynamics, National Observatory of Athens (NOANET)*
- *Hellenic Cadastre*

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FOREWORD

This report was prepared as part of the national report of the Committee of Geodesy and Geophysics of Greece, on the occasion of the 28th General Assembly of the International Union of Geodesy and Geophysics (IUGG) which will be held in Montreal, Canada, July 8 – July 18, 2019.

The report presents the geodetic activities and the progress achieved in Geodesy by Greek Universities, Research Institutions and National Agencies for the period 2015-2018. All the Geodesy related research studies and contributions to national and international scientific projects, working groups and editorial boards lay mainly within the scope of the four Commissions of the International Association of Geodesy (IAG) according to its current structure (Commission 1: Reference Frames, Commission 2: Gravity Field, Commission 3: Earth Rotation and Geodynamics, Commission 4: Positioning and Applications).

As it is expected, research work does not necessarily cover the aims and goals of one Commission only, but covers broader and combined subjects. Moreover, given that nowadays Geodesy, both in terms of theoretical developments and practical applications, is cooperating widely with other geosciences, it is evident that in some cases the research results presented may not be strictly geodetic. This is in the sense that Geodesy offers the fundamental and basic breadboard, so that its products can then be used in other scientific applications and/or through other data and product manipulation and processing tools. Such examples of interdisciplinary research are the use of GNSS products in geo-information, remote sensing and photogrammetric applications, the incorporation of geoid models within oceanographic, hydrological, engineering and geodynamic studies and the exploitation of geodetic methods and databases to the prevention and mitigation of natural hazards.

The content of the report is divided in nine main sections with each section being entitled with the name of the corresponding university institute or agency. The contribution of each institute or individual scientist is reported based on the material they provided along with the respective list of literature. An attempt was made to slightly homogenize the material provided by the respective contributors. Therefore, the text and, in general, the style of each sub-report, have been maintained in the subsequent sections.

I take the opportunity to express my sincere thanks to all colleagues working at University Departments, Research Institutions and National Agencies for their contributions, extensive lists of publications and other relevant material provided for the compilation of this report.

Thessaloniki, November 2018

Prof. Ilias N. Tziavos
Aristotle University of Thessaloniki

1. School of Rural and Surveying Engineering, Department of Geodesy and Surveying, Aristotle University of Thessaloniki (AUTh)

1.1 Laboratory of Gravity Field Research and Applications (GravLab)

Prof. I.N. Tziavos, Assoc. Prof. G.S. Vergos, Ass. Prof. V.N. Grigoriadis

Main research activities

During the last four years the main research activities of GravLab have been directed to the continuous evaluation of satellite only and combined Global Geopotential Models (GGMs) from GOCE and GRACE using GNSS/Leveling, land and marine gravity data. Research work has been also performed for the evaluation of potential values for the Hellenic region towards height system unification and the realization of the IHRS through the IHRF. Local combination schemes have been examined employing available land and marine gravity data, GGMs and global digital topography models for the topographic effects. In terms of the marine environment, GravLab has continued the exploitation of satellite altimetry data, focusing on the recent SAR and SARin observations. Therefore, Cryosat-2 and Sentinel 3a/3b have been used to model the mean sea surface, regional geoid and mean dynamic ocean topography determination. Extensive work has been performed in the direction of using GRACE data for monitoring water mass variations. Finally, extensive field work has been carried out in sea bottom mapping in coastal areas.

Positions held during the reporting period

During the reporting period, Prof. Tziavos has been a member of the Editorial Board of Journal of Geodesy. Assoc. Professor Vergos has been the Director of the Central Bureau of IAG's the International Gravity Field Service and a member of IAG's Committee on the Essential Geodetic Variables.

Research projects during the reporting period

The main research project of GravLab during the last for years have been:

- "Height System Unification, Dynamic Ocean Topography and gravity field determination with GOCE Global Geopotential Models employing stochastic methods and heterogeneous data sources – GOCE+++", funded by the European Space Agency within the ESA/PRODEX program.
- "GOCE for height system unification and dynamic ocean topography determination in the Mediterranean Sea – GOCEMed", funded by DAAD and the Greek National Scholarships Foundation.

References for the reporting period:

The complete list of publications by GravLab can be found in the Laboratory webpage http://gravlab.topo.auth.gr. A short list of recent and representative publications is as follows:

Andritsanos V, Arabatzi O, Gianniou M, Pagounis V, Tziavos IN, Vergos G, Zacharis E (2015) Comparison of Various GPS Processing Solutions toward an Efficient Validation of the Hellenic Vertical Network: The ELEVATION Project. J Surv Eng 10.1061/ (ASCE) SU.1943-5428.0000164, 04015007.

Barzaghi R, Carrion D, Vergos GS, Tziavos IN, Grigoriadis VN, Natsiopoulos DA, Bruinsma S, et al (2018) GEOMED2: High-Resolution Geoid of the Mediterranean. In: International Association of Geodesy Symposia. Springer, Berlin, Heidelberg. doi: 10.1007/1345_2018_33.

Grigoriadis VN, Tziavos, IN, Tsokas GN, Stampolidis A (2016) Gravity data inversion for Moho depth modeling in the Hellenic area. Pure and Applied Geophysics, 173(4): 1223-1241. doi: 10.1007/s00024-015-1174-y

Mertikas SP, Zhou X, Qiao F, Daskalakis A, Lin M, Peng H, Tziavos IN, Vergos GS, Tripolitsiotis A, FrantzisX (2016) First preliminary results for the absolute calibration of the Chinese HY-2 altimetric mission using the CRS1 calibration facilities in West Crete, Greece. Adv Space Res 57(1): 78-95.

Tziavos IN, Vergos GS, Grigoriadis VN, Tzanou EA, Natsiopoulos DA (2015) Validation of GOCE/GRACE satellite only and combined global geopotential models over Greece, in the frame of the GOCESeaComb Project. In: Rizos C and Willis P (eds) IAG 150 Years, IAG Symposia vol. 143, Springer, pp. 297-304. doi: 10.1007/1345_2015_160.

Vergos GS, Erol B, Natsiopoulos DA, Grigoriadis VN, Işık MS, Tziavos IN (2018) Preliminary results of GOCE-based height system unification between Greece and Turkey over marine and land areas. Acta Geod Geophys 53(1): 61-79. https://doi.org/10.1007/s40328-017-0204-x.

Conference Presentations

Participation to all main geodetic and related to geodesy international meetings. An extensive list of the more than 65 GravLab presentations can be found in http://gravlab.topo.auth.gr.

Prof. D. Tsoulis – GravLab

Main research activities

- Chair of ICCT/IAG's Joint Study Group 0.11 on Multiresolutional aspects of potential field theory (affiliation with IAG Commissions 2, 3 and GGOS, 2015-2019)
- Consortium member of IAG's GGOS as designated representative of ICCT (2015-2019)
- Associate Editor, Geophysical Prospecting (keyword: Potential Field Theory)
- Editor, Journal of Geodetic Science
- Editor, Journal of Geodesy and Geoinformatics
- Editor, AIMS Geosciences

References for the reporting period:

Tenzer R, Chen W, Tsoulis D, Bagherbandi M, Sjoberg L, Novak P, Jin S (2015) Analysis of the refined CRUST 1.0 crustal model and its gravity field, Surveys in Geophysics, 36(1), pp 139-165

Papanikolaou T, Tsoulis D (2016) Assessment of numerical integration methods in the context of low Earth orbits and inter-satellite observation analysis, Acta Geodaetica et Geophysica, 51(4), pp 619-641

Patlakis K, Tsoulis D (2016) Assessment of the recently released GOCE-based models in terms of spectral and spatial resolution, IAG Symposia Series, Volume 143, 150th Anniversary of IAG, 331-338 pp, Springer

Tsoulis D (2016) Reference and Time Systems, Ziti Editions, Thessaloniki, 352 pp (in Greek), ISBN 978-960-456-445-3

Hornig A, Kazantzidis A, Chaturvedi N, Fritsch D, Tsoulis D (2017) Time-synchronization impact on the performance of the distributed ground station network service for tracking cubesats and further signal sources, Proceedings of the International Astronautical Congress, IAC 8, 4829-4943 pp

1.2 Laboratory of Geodetic Methods and Satellite Applications (SatLab)

Prof. D. Rossikopoulos, Prof. A Fotiou, Prof. C. Pikridas

Main research activities

During the last 10 years, the AUTH Satellite Methods and Geodetic Applications Lab has participated in more than 10 funded research projects, providing scientific expertise and services to the above scientific areas. AUTH Lab has a critical mass of good quality research in several areas with more than 70 scientific publications and papers in national and international journals and conferences over the last 5 years.

Lab Members are participating as Leader and cooperative partners at several Research Projects supported from National and European funds such as, Hellenic Plate Observing System, Interreg-BeRTISS, Monitoring of HeXaGoN GNSS Network etc.

References for the reporting period:

Bitharis S, Papadopoulos N, Pikridas C, Fotiou A, Rossikopoulos D, Kagiadakis V (2018) Assessing a new velocity field in Greece towards a new semi-kinematic datum. Survey Review, DOI: 10.1080/00396265.2018.1479937.

Rossikopoulos D (2018): Residual Analysis and Detection of Outliers in Mixed Linear Models. In: (D. Rossikopoulos and A. Fotiou (eds.): Quod erat demonstrandum. In quest of the ultimate geodetic insight. Special issue for professor emeritus A. Dermanis. AUTh.- School of Rural and Surveying Engineering.

Bitharis S, Fotiou A, Pikridas C, Rossikopoulos D (2018) A new velocity field of Greece based on seven years (2008–2014) continuously operating GPS station data. In: Freymueller J.T., Sánchez L. (eds) International Symposium on Earth and Environmental Sciences for Future Generations. International Association of Geodesy Symposia, vol. 147. Springer, Cham.

Haralambous H, Oikonomou C, Pikridas C, Guerova G, Dimitrova T, Lagouvardos K, Kotroni V, Tymvios F (2018) BeRTISS project: Balkan-Mediterranean real-time severe weather service. Proceedings of SPIE - The International Society for Optical Engineering. doi: 10.1117/12.2324129.

Bitharis S, Ampatzidis D, Pikridas C, Fotiou A, Rossikopoulos D, Schuh H (2017) The Role of GNSS Vertical Velocities to Correct Estimates of Sea Level Rise from Tide Gauge Measurements in Greece. Marine Geodesy, Vol 60, No 2.

Rossikopoulos D, Fotiou A, Pikridas C, Bitharis S (2016) Models and Techniques in Geodetic Monitoring of Tectonic Deformations in Greece. Bulletin of the Geological Society of Greece, vol. L, 2016. Proceedings of the 14th Intern. Conference, Thessaloniki, May 2016.

Pikridas C (2015) The use of GNSS tropospheric products for climate monitoring. A case study in the area of Ioannina North-Western Greece. South-Eastern European Journal of Earth Observation and Geomatics, vol.4, pp.81-90. ISSN: 2241-1224.

Prof. C. Kotsakis – SatLab

Main research activities

Prof. C. Kotsakis' research activity during the last four years was mainly focused on operational aspects of geodetic reference frames and their impact in geodetic network analysis and Earth monitoring applications. A number of significant publications and conference presentations have resulted from his work, and the major scientific findings have been reported in detail in three journal papers, five peer-reviewed proceedings papers, and four book chapters.

References (indicative list). Full list of publications can be found in http://users.auth.gr/kotsaki

Kotsakis C. (2018a) Datum definition and minimal constraints. Encyclopedia of Geodesy, doi: 10.1007/978-3-319-02370-0_92-1.

Kotsakis C. (2018b) Nonlinear geospatial frame transformations in the presence of noisy data. Mathematical Geosciences, doi: 10.1007/s11004-018-9742-1.

Chatzinikos M., Kotsakis C. (2018) Noise filtering augmentation of the Helmert transformation for the mapping of GNSS-derived position time series to a target frame. IAG Symposia Series, Springer-Verlag, vol. 147, pp. 277-283.

Aslanidis N., Kotsakis C. (2018) Evaluation of NRTK-based heighting techniques from different continuously operating GNSS reference networks in Greece. IAG Symposia Series, Springer-Verlag Berlin Heidelberg, vol. 148, accepted for publication.

Kotsakis C., Chatzinikos M. (2017a) Rank defect analysis and the realization of proper singularity in normal equations of geodetic networks. Journal of Geodesy, vol. 91, no. 6, pp. 627-652.

Kotsakis C., M. Chatzinikos (2017c) Weekly TRF realization from non-singular input NEQ and related distorting effects in minimally constrained solutions. Presented at the EGU General Assembly, Vienna, Austria, April 23-28, 2017.

Kotsakis C., Vatalis A., Sanso F. (2017) The Helmert transformation approach in network densification revisited. IAG Symposia Series, Springer-Verlag Berlin Heidelberg, vol. 146, pp. 3-10.

Chatzinikos M., Kotsakis C. (2017a) Appraisal of the Hellenic Geodetic Reference System 1987 based on backward-transformed ITRF coordinates using a national velocity model. Survey Review, vol. 49, no. 356, pp. 386-398.

Chatzinikos M., Kotsakis C. (2017b) Weighted vs. un-weighted MCs for the datum definition in regional networks. IAG Symposia Series, Springer-Verlag Berlin Heidelberg, vol. 146, pp. 161-170.

Kotsakis C. (2016a) Reference station weighting and frame optimality in minimally constrained networks. IAG Symposia Series, Springer-Verlag Berlin Heidelberg, vol. 142, pp. 221-226.

Kotsakis C., M. Chatzinikos (2016) Unconstrained NEQ with full rank in GNSS networks: genuine problem or trivial nuisance for frame realization? Presented at the Annual EUREF Symposium of the IAG Reference Frame Sub-Commission for Europe, Donostia - San Sebastian, Spain, May 25-27, 2016.

Kotsakis C., Chatzinikos M. (2015) Assessment of weighted and unweighted inner constraints on multi-session solutions for estimating station velocities in regional GNSS networks. Presented at the IUGG 26th General Assembly, Prague, Czech Republic, June 22 - July 2, 2015.

Chatzinikos M., Stefanidou E., Kotsakis C. (2015) Spatial analysis of the interaction between a heterogeneous velocity field and a static GNSS-based reference frame: a Greek case study. Presented at the IUGG 26th General Assembly, Prague, Czech Republic, June 22 - July 2, 2015.

Prof. Emeritus A. Dermanis

Dermanis A (2015) Problems in parameter estimation with nonlinear models. In: Arvanitis A, Basbas S, Lafazani P, Papadopoulou M, Paraschakis I, Rossikopulos D (eds), *Cartographies of Mind, Soul and Knowledge*. Special issue for Emeritus Professor Myron Myridis. Publication of the SRSE, AUTh, pp. 117-133.

Dermanis A (2015) Determination of transformation parameters between two reference systems without common points. Three application examples from digital terrain models, laser scanning and GNSS seismology. In: Fotiou A, Paraschakis I, Rossikopoulos D (Eds), Measuring and Mapping the Earth. Special issue for Professor Emeritus Christogeorgis Kaltsikis. Publication of the SRSE, AUTh, 2015, pp. 100-114.

Dermanis A (2016) Global Reference Systems: Theory and Open Questions. Invited paper at the Academia dei Lincei Session, VIII Hotine-Marussi Symposium on Mathematical Geodesy, Rome, 17–21 June, 2013. In: Sneeuw N., Novák P., Crespi M., Sansò F. (Eds.): VIII Hotine-Marussi Symposium on Mathematical Geodesy, IAG Symposia, Volume 142, pp. 9-16. Springer International Publishing Switzerland.

Chatzinikos M and Dermanis A (2017) A study on the impact of reference frame implementation strategy on GNSS time series for regional network analysis. REFAG2014, Kirchberg, Luxembourg, October 13–17, 2014. In: van Dam, Tonie (Ed.), 2017. REFAG 2014 - Proceedings of the Symposium on Reference Frames for Applications in Geosciences. IAG Symposia 146, pp. 11-20, Springer-Verlag Berlin Heidelberg.

Dermanis A (2017) Fitting analytical surfaces to points: General approaches and applications to ellipsoid fitting. In: Fotiou A, Georgoula O, Papadopoulou M, Rossikopoulos D, Spatalas S (eds.), *Living with GIS*. Volume in Memory of Professor Yannis Paraschakis. Publication of the SRSE, AUTh, pp. 81-106.

Chatzinikos M and Dermanis A (2017) A coordinate-invariant model for deforming geodetic networks: understanding rank deficiencies, non-estimability of parameters, and the effect of the choice of minimal constraints. Journal of Geodesy, 91, 375–396

Chatzinikos M and Dermanis A (2017) Interpretation of numerically detected rank defects in GNSS data analysis problems in terms of deficiencies in reference system definition. GPS Solutions, 21; 1239–1250.

Benedetti E, Dermanis A, Crespi M (2017) On the feasibility to integrate low-cost MEMS accelerometers and GNSS receivers. Advances in Space Research, 59, 2764-2778.

Dermanis A and Sansò F (2018) Different equivalent approaches to the geodetic reference system. Rendiconti della Accademia dei Lincei, Scienze fisiche e naturali, 29 (Suppl 1):S11–S22.

Dermanis A (2018) Theory and Realization of Reference Systems. 128 pages. In: W. Freeden, R. Rummel (Eds.), Handbuch der Geodäsie, volume "Mathematical Geodesy/Mathematische Geodäsie". Springer Verlag, Heidelberg, Berlin.

Dermanis A (2018) Geodetic methods for monitoring crustal motion and deformation. 72 pages. In: W. Freeden, R. Rummel (Eds.), Handbuch der Geodäsie, volume "Mathematical Geodesy/Mathematische Geodäsie". Springer Verlag, Heidelberg, Berlin (in print).

Prof. Emeritus D. Arabelos and Prof. Emeritus M.E. Contadakis

Prof. Contadakis has been a member of the Editorial Board of the International Journal "Earth System Science Data" of Copernicus Organization (2009-2017)

Main research activities

In the period 2015-2019 we continue the previous scientific activity i.e. the study of the variations of different physical parameters of the Geosphere in relation to the seismic activity, in order to identify earthquake's pre-cursory phenomena. In particular, our research focuses on three areas:

1) Direct estimation of the lower Ionosphere variations analyzing the T(otal)E(lectron)C(ontent) estimations of GLONASS and GPS networks.
2) Indirect estimation of the lower Ionosphere variations by analyzing the disturbances on the LF/VLF electromagnetic wave transmission induced by the disturbed lower Ionosphere.
3) Tidal triggering effect on earthquake occurrence.

In this investigation apart of our group and Prof. T.D. Xenos and Mr. C. Skeberis from the Department of Telecommunication of AUTh, contribute researchers from: University of Bari, Italy (Prof. P.F. Biagi, leader of the network); Department of Engineering of Enterprise, University of Tor Vergata, Italy; National Institute of Earth's Physics, Seismological Department, Bucharest, Romania; Austrian Academy of Sciences, Austria; Canakkale Onsekiz Mart University, Department of Geophysics, Turkey; Institute of Physics of the Earth, National Academy of Sciences, Moscow, Russia.

References for the reporting period:

A short list of some representative publications for the reporting period is as follows:

Arabelos DN, Contadakis ME, Vergos GS, Spatalas S (2016) Variation of the Earth tide-seismicity compliance parameter during the recent seismic activity in Fthiotida, central Greece, Annals of Geophysics, 59, 1, S0102.

Contadakis ME, Arabelos DN, Vergos GS, Spatalas SD, Skordilis M (2015) TEC variations over the Mediterranean before and during the strong earthquake (M = 6.5) of 12th October 2013 in Crete, Greece. Physics and Chemistry of the Earth 85: 9-16. Elsevier Ltd.

Contadakis ME, Arabelos DN, Vergos GS (2017) Testing the recent Santorini seismic activity for possible tidal triggering effect. Bulletin of the Geological Society of Greece 51: 1-17.

Skeberis C, Zaharis ZD, Xenos TD, Spatalas SD, Arabelos DN, Contadakis ME (2015), Time–frequency analysis of VLF for seismic-ionospheric precursor detection: Evaluation of Zhao-Atlas-Marks and Hilbert-Huang Transforms. Physics and Chemistry of the Earth 85: 174-184.Elsevier Ltd.

Skeberis C, Zaharis ZD, Xenos TD, Spatalas SD, Arabelos DN, Contadakis ME (2015), Time–frequency analysis of VLF for seismic-ionospheric precursor detection: Evaluation of Zhao-Atlas-Marks and Hilbert-Huang Transforms, Physics and Chemistry of the Earth 85: 174-184. Elsevier Ltd.

Vergos GS, Arabelos DN, Contadakis ME (2015), Evidence for tidal triggering on the earthquakes of the Hellenic Arc, Greece. Physics and Chemistry of the Earth 85: 210-215. Elsevier Ltd.

2. School of Rural and Surveying Engineering, National Technical University of Athens (NTUA)

2.1 Department of Topography

Commission 1: Reference Frames

During the period 2015-2018 research work has been carried out on satellite Geodesy, crustal geodynamics, earthquakes, gravimetry and Synthetic Aperture Radar. Indicative specific research activities of the members from the Laboratories of Dionysos Satellite Observatory (DSO) and Laboratory of Higher Geodesy (HGL) are given in the following.

Katsikaris *D. (2018) Study and software implementation of the IAU 2000/2006 Conventions on reference systems. MSc Thesis, NTUA (in Greek)*

Panou G., Korakitis R. and Delikaraoglou D. (2018) "*Cartesian to geodetic coordinates' conversion by an iterative geometrical method"*. Dedicated volume in honor of Professor Emeritus A. Dermanis, Ziti editions, Thessaloniki, Greece , pp 274-281.

Panou G. and Korakitis R., (2017) *Geodesic equations and their numerical solutions in geodetic and Cartesian coordinates on an oblate spheroid* J Geodetic Science 7, p.31–42

Panou G., Korakitis R. and Delikaraoglou D. (2016) "*Triaxial coordinate systems and their geometrical interpretation"*. In: Fotiou A., Paraschakis I. and Rossikopoulos D. (Eds.), *Measuring and Mapping the Earth*: Dedicated volume in honor of Professor Emeritus C. Kaltsikis, Ziti editions, Thessaloniki, Greece, pp. 126–135.

Commission 2: Gravity Field

In this area, the activity was focused on using geometrical and physical properties of the gravity potential in several applications. Relevant publications are as follows:

Manoussakis, G. & Korakitis, R. (2018) "*Surface theory and third order partial derivatives of the normal gravity potential"*, IAG Symposia Series, IX Marussi-Hotine Symposium, Rome 2018 (presented and submitted for publication).

Manoussakis, G., Korakitis, R. & Milas, P. (2017) "*Gravimetric estimation of the Eötvös matrix components"*, Contributions to Geophysics and Geodesy, 47/1, p.53–68.

Manoussakis, G., Milas P. & Korakitis, R. (2017) "*Estimation of the deflection of the vertical using local gravity measurements"*, EGU General Assembly 2017, Session G1.1 ("Recent Developments in Geodetic Theory"), EGU2017, Vienna.

Delikaraoglou D. and E.G. Bousias-Alexakis (2016) Foreseeable Geometry Improvements from Future Global Navigation Flower Constellation Systems. In "*Measuring and mapping the Earth*", Eds. A. Fotiou, I. Paraschakis, and D. Rossikopoulos, pp. 136–147.

Panou, G. & Korakitis, R. (2016) "*The linearized fixed gravimetric boundary value problem and its solution in spheroidal approximation"*. International Symposium on Earth and Environmental Sciences for Future Generations. International Association of Geodesy Symposia, vol 147. p. 33-37, Springer, Cham.

Panou G. (2015) "*The gravimetric boundary value problem in spheroidal approximation and its role in the height datum problem*", 26th International Union of Geodesy and Geophysics, General Assembly, June 22 - July 2, Prague, Czech Republic

Manoussakis, G. and D Delikaraoglou (2015) Initial Study of Normal Isocurvature Surfaces and Their Relation to Partial Derivatives of Plumb Line Curvature *Journal of Basic and Applied Physics, ISSN:2304-9340 (Print), -9332 (Online)* 4: 2. , pp. 12-19, May.

Manoussakis, G. & Korakitis, R. (2015) "*Refinement of the normal Eötvös matrix and its influence on the estimation of the deflections of the vertical*", Contributions to Geophysics and Geodesy, 45/2, p.93–109.

Commission 3: Earth Rotation and Geodynamics

The laboratories DSO and HGL follow all the up-to-date techniques in GNSS processing, modelling of tectonic motion, and strain calculation as well as improving and archiving all available data and results is one of the constant tasks of the laboratories.

Melis, N., Paradissi, D., Drakatos, G., Marinou, A., Anastasiou, D., Alatza, S., Zacharis, V., Papanikolaou, X., Kalogeras, I., Chouliaras, G., Evangelidis, C. And K. Makropoulos, 2015. "Multiparametric warning systems: Near real-time capabilities in South Aegean region." Int. Workshop on the Volcanic and Geodynamic field of south Aegean, 20-22 May, 2015, Greece.

A. Marinou, Athanassios Ganas Kalliopi Papazissi and Demitris Paradissis, Geodetic evidence for E-W crustal block boundary along the Kaparelli fault (south Viotia region, central Greece)", *Annals of Geophysisc , 58, 2, 2015, S0219.*

Alatza S., I. Papoutsis, D. Paradissis (2015) Monitoring ground motion in Amorgos Island, Greece with Persistent Scatterer Interferometry, , The Volcanic and Geodynamic Field of the South Aegean, Int. Workshop, 20-22 May 2015 , Santorini, Greece.

Alatza S., A. Marinou, D. Anastasiou, X. Papanikolaou, D. Paradissis (2015) Tectonic field and deformation in Chalkidiki area, Greece, , EGU General Assembly 2015

Alatza S., P. Elias, P. Briole, D. Paradissis, (2017) Analysis of the Ms=6.2, June 15, 1995 earthquake (Greece): Data, products and preliminary results, 22-26 September CRL School 2017, Nafpaktos, Greece

Alatza S., P. Elias, P. Briole, D. Paradissis (2017) ,Modeling co-seismic deformation of the Ms=6.2 June 15, 1995 Aigion earthquake (Greece) based on SAR interferometry, MDIS-Form@ter, Clermont-Ferrand, Besse-en-Chandesse,16-20 October 2017.

Howell A., K. Palamartchouk, X, Papanikolaou, D, Paradissis, C, Raptakis, A, Copley, P. England, J. Jackson (2017) "The 2008 Methoni earthquake sequence: The relationship between the earthquake cycle on the subduction interface and coastal uplift in SW Greece", (2017), Geophysical Journal International 208(3):1592-1610, DOI10.1093/gji/ggw462

Alatza S., I. Papoutsis, D. Paradissis, C. Kontoes (2019) Multi-temporal InSAR analysis for monitoring ground deformation in Amorgos island, Greece, 4th Joint International Symposium on Deformation Monitoring (JISDM 2019), May 15-17, 2019, Athens, Greece.

Commission 4: Positioning and Applications

The Laboratory of General Geodesy (GGL) pursues basic and applied geodetic research in the areas of technical and industrial geodesy, detection of small scale deformations, geodetic metrology, indoors positioning and location.

Pelecanos A. , D. Skarlatos, G. Pantazis (2018) Finite element analysis of the monitored long-term settlement behaviour of Kouris earth dam in Cyprus". Presentation on the " *9th European Conference on Numerical Methods in Geotechnical Engineering",* Porto, Portugal, 25-27 June.

Moropoulou A., Karoglou M., Agapakis I., Mouzakis C., Asimakopoulos S., Pantazis G., Lambrou E.(2018) "Holy Selphuchre Monitoring System". Presentation on the "1st International Conference on "Transdisciplinary Multispectral Modeling and Cooperation for the Preservation of Cultural Heritage (TMM_CH) ", Athens, October.

Alevizakou EG, G. Pantazis (2017) "A Comparative Evaluation of Various Models for Prediction of Displacements" Applied Geomatics, DOI: 10.1007/s12518-017-0189-8.

Arabatzi O., N Kouvas, V. Pagounis, M. Tsakiri, (2017) A test facility for verification of length measurements. In: *Proc. Int. Symposium GEOMAT 2017*, 15-16 November, Iasi, Romania

Tsakiri M, A. Sioulis, G. Piniotis (2017) Compliance of low-cost, single-frequency GNSS receivers to standards consistent with ISO for control surveying. Int. J. Metrol. Qual. Eng. 8, 11, doi.org/10.1051/ijmqe/2017006.

Marinos V. P., G. K. Prountzopoulos, P. Asteriou, G. Papathanassiou, T. Kaklis, G.Pantazis*, E. Lambrou, N. Grendas, E. Karantanellis, . Pavlidis (2017)* "Beyond the boundaries of feasible engineering geological solutions: stability considerations of the spectacular Red Beach cliffs on Santorini Island, Greece". Environmental Earth Sciences, Issue 15/2017, August.

Kealy A., Goel S., Gikas V., Retscher G., Toth C., Brzezinska D., Lohani B. (2017) “Cooperative Localization of Unmanned Aerial Systems Using Low Cost GNSS and MEMS Inertial Sensors”, Journal of Surveying Engineering, Vol. 143(4), doi.org/10.1061/(ASCE)SU.1943-5428.0000230

Retscher G., Hofer H., Kealy A., Gikas V., Ettlinger A., Obex F. (2017) “Constrained Differential Wi-Fi and UWB Measurements for Indoor Cooperative User Localization”, IAG-IASPEI Scientific Assembly, Kobe, Japan, July 31 – Aug. 4

Pantazis G. (2017) The astronomical orientation of ancient greek theatres in relation with the topography and greek mythology " Civil Engineering and Architecture, 5(5): 185-192, *2017*, DOI: 10.13189/cea.2017.050504

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3. Laboratory of Geodesy and Geomatics, Department of Civil Engineering, AUTh

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4. Laboratory of Geodesy and Geodetic Applications, Department of Civil Engineering, University of Patras (Director: Prof. S. Stiros)

Research activities of this scientific group focus on (a) Geodynamics including (a) Seismotectonics and Volcanology, (b) Deformation monitoring (c) Noise in instruments and Metrology and (c) Numerical network adjustments-inversion of geodetic data. The scientific results of the group for 2015-2108 are summarized among others in the following papers.

Saltogianni, V., Moschas, F., Stiros, S., The 2014 Cephalonia Earthquakes: Finite Fault Modeling, Fault Segmentation, Shear and Thrusting at the NW Aegean Arc (Greece), *Pure and Applied Geophysics*, 2018, doi: 10.1007/s00024-018-1938-2

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5. Laboratory of Geodesy and Geomatics Engineering, (GeoMatLab), School of Mineral Resources Engineering, Technical University of Crete

Prof. Stelios P. Mertikas, www.geomatlab.tuc.gr

During the period 2015 – 2018 the main research activities of GeoMatLab are focused mainly on Satellite Altimetry Calibration/Validation (Cal/Val) and GNSS atmospheric and deformation monitoring.

The Gavdos/Crete Permanent Facility for Altimetry Calibration has been continuously operating and providing absolute altimeter biases for more than 15 years. It is in located in western Crete, Greece. It is such a Cal/Val infrastructure where calibration of satellite altimeters takes place making use of several of the calibration techniques (i.e., absolute indirect, relative direct Cal/Val), both at sea as well as on land using a prototype microwave transponder. This facility was originally built up in 2001 to calibrate the Jason satellite altimeters, but it eventually has contributed throughout its many years of operation into calibrating all international altimeters, such as those from the European Space Agency, as well as American, French, Chinese, and Indian satellites.

It includes a major set of permanent Cal/Val sites and prototype scientific equipment at various locations in Crete and Gavdos. At present, this infrastructure includes 17 permanent Global Navigation Satellite System stations, 8 tide gauges, 6 meteorological systems, several communication links, one microwave transponder and a central facility for data archiving and processing, and also to remotely control all field units. The PFAC allows calibration of satellite altimeters over ascending and descending passes, and it also permits multi-mission calibration at crossover locations and over land and water at the same time. At the same locale, connection and cross-comparison of various altimeters can be made using the same orbits, conditions, and settings by employing diverse methods and instrumentations on the ground (sea surface and transponder) for absolute assessment.

All international altimetry missions (i.e., Sentinel-3 and CryoSat-2 (European), Jason series (American-French), HY-2 (Chinese), and SARAL/AltiKa (Indian-French) have been calibrated at this facility with sea-surface techniques as of 2004.

In 2015, a permanent Sentinel-3 altimeter site of the European Space Agency has been established in western Crete for calibrating both Sentinel-3A and Sentinel-3B at the same location. This facility, named the CDN1 Cal/Val site, is able to calibrate other altimeters as well, and particularly the baseline/reference missions of Jason (i.e., Jason-2, Jason-3, and Jason-CS/Sentinel-6). It has been picked to be a triple crossover point between Sentinel-3A, -3B, and Jason; actually, it is a quadruple crossover place, as it is also only 2 km away from the ground track of SARAL/AltiKa (previously of Envisat).

Professor Mertikas has become a member of the Mission Advisory Group in the European Space Agency that will take the lead in advising the Agency on the Sentinel-6/Jason-CS Mission until the end of post-launch Switch-On and in Orbit Verification (planned for 2020).

An International Review Workshop on Satellite Altimetry Cal/Val Activities and Applications has been held in Chania, Crete, Greece, 23-26 April 2018.

A list of recent and representative publications is given below. A complete list can be found in:
www.geomatlab.tuc.gr

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Lei Yang, Xinghua Zhou, S. P. Mertikas, Lin Zhuc, Long Yang, Ning Lei, (2017) "First Calibration Results of Jason-2 and SARAL/AltiKa Satellite Altimeters from the Qianli Yan Permanent Cal/Val Facilities, China", Advances in Space Research, doi:101016/j.asr.2017.02.044.

Mertikas, S. P. (2016). "Introduction to Geodesy, Satellite Positioning and Altimetry", Klidarithmos Publishing House, Athens, ISBN: 978-960-461-721-0, http://www.klidarithmos.gr/eisagogi-sth (In Greek)

Mertikas S. C. Donlon, C. Mavrocordatos, P. Femenias , T. Parrinello, I. N. Tziavos, N. Picot , J.-D. Desjonqueres, O.-B. Andersen, "A Fiducial Reference Measurement Site for Establishing Absolute Heights for Satellite Altimetry in Crete, Greece", International Symposium of Gravity, Geoid and Height Systems, "GGHS-2016", Thessaloniki, Greece, 19-23 September 2016, [Abstract, Paper]

Mertikas S.P, C. Donlon, C. Mavrocordatos, B. Bojkov, P. Femenias, T. Parrinelo, N. Picot, J.D. Desjonqueres, O.B. Andersen, "A Fiducial Reference Site for Satellite Altimetry in Crete, Greece", ESA Living Planer Symposium, 9-13 May 2016, Praque, Czech Republic, [Abstract, Paper]

Mertikas S., C. Donlon, C. Mavrocordatos, I.N. Tziavos, D. Galanakis, G. Vergos, O.B. Andersen, A. Tripolitsiotis, X. Frantzis, M. Lin, F. Qiao, "Gavdos/West Crete Cal-Val site: Over a decade calibrations for Jason series, SARAL/AltiKa, CryoSat-2, Sentinel-3 and HY-2 altimeter satellites", ESA Living Planer Symposium 2016, Praque, Czech Republic, 9-13 May 2016.[Abstract, Paper]

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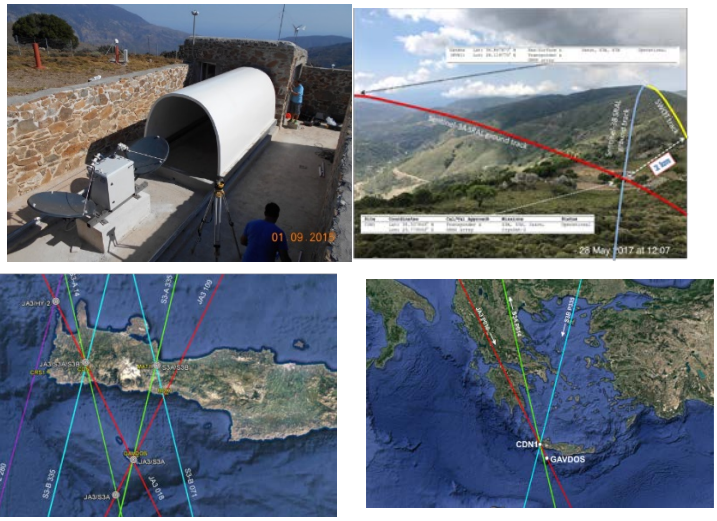
Mertikas S.P., X. Zhou, F. Qiao, A. Daskalakis, M. Lin, H. Peng, I.N. Tziavos, G.S. Vergos, A. Tripolitsiotis, X. Frantzis (2015). "First preliminary results for the absolute calibration of the Chinese HY-2 altimetric mission using the CRS1 calibration facilities in West Crete, Greece", Advances in Space Research, Elsevier. DOI: 10.1016/j.asr.2015.10.016.

Mertikas S.P., A. Daskalakis, I.N. Tziavos, G. Vergos, X. Frantzis, A. Tripolitsiotis (2015). "First calibration results for the SARAL/AltiKa altimetric mission using the Gavdos permanent facilities", Marine Geodesy, 38, S1, 249-259, 2015, DOI: 10.1080/01490419.2015.1030052.



The sea-surface (Gavdos, CRS1, RDK1) and transponder (CDN1) Cal/Val sites of the Permanent Altimetry Calibration Facility along with the Operations Control Center at the Technical University of Crete in western Crete, Greece. The multi-mission, diverse Cal/Val service is illustrated by the ground-tracks of existing (Jason-3, Sentinel-3A, Sentinel-3B, and HY-2A), as well as future satellite altimetry missions. The CryoSat-2 satellite is also calibrated using either the CDN1 Cal/Val transponder site or the Gavdos Cal/Val site with sea-surface techniques.

6. Laboratory of Geodesy and Surveying, Department of Surveying and Geoinformatics Engineering, University of West Attica, Athens, Greece

Prof. V. Pagounis, Assoc. Prof. V. D. Andritsanos, Assoc. Prof. M. Gianniou

The laboratory of Geodesy and Surveying of the Department of Surveying and Geoinformatics Engineering (University of West Attica, Athens) is equipped with modern geodetic instruments such as total stations (robotic and image stations), GNSS geodetic receivers, a gravimeter of relative measurements, a TOF laser scanner and a single beam echo sounder. A permanent GPS reference station is working since 2010, with a logging interval of 15 sec., providing accurate position data for educational and research purposes. In addition, two tide gauges are operational in Isthmos Canal (Peloponnesus – Central Greece) since 2014 and provide local sea surface measurements every 10 sec. A permanent meteorological station is working since 2017, in conjunction with the GPS station (http://labgeo.tg.teiath.gr), providing 24h meteorological data. The access to the GPS as well as to the meteorological station data is free for educational and research purposes. Three gravity campaigns across Attica region were organized since 2016 and, approximately, 50 gravity benchmarks, among them the calibration line of Parnitha Mountain, were measured.

The research areas of the laboratory are accurate positioning and applications, geodetic reference systems, gravimetry, altimetry, heterogeneous data combination in local and regional geoid and DOT modeling and deformation monitoring.

The current geodetic research project of the laboratory of Geodesy and Surveying is:

Partner - IKYDA2016: «GOCE for height system unification and dynamic ocean topography determination in the Mediterranean Sea – GOCEMed», funded by DAAD and NSF – Main investigator: G. Vergos – Aristotle University of Thessaloniki.

A list of publications of the members of the Laboratory of Geodesy and Surveying for the period 2015 – 2018 follows:

Andritsanos, V. D., M. Gianniou and D. I. Vassilaki (2015): Effect of the transformation between Global and National Geodetic Reference Systems on GCPs and CPs accuracy. Presented at the 35th EARSeL Symposium – European Remote Sensing: Progress, Challenges and Opportunities, Stockholm, Sweden, June 15-18. To appear in the Proceedings.

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http://dx.doi.org/10.1061/(ASCE)SU.1943-5428.0000164

Vergos, G.S., V.D. Andritsanos, V.N. Grigoriadis, V. Pagounis and I.N. Tziavos (2016): Evaluation of GOCE/GRACE GGMs over Attica and Thessaloniki, Greece, and Wo determination for Height System Unification. International Association of Geodesy Symposia vol. 144, pp. 101 - 109, Springer editions, http://dx.doi.org/10.1007/1345_2015_53

Pagounis V., M. Tsakiri, V. Zacharis, V. D. Andritsanos and M. Tsiardaki (2016): Detection of geometric changes for an historical theatre by comparing surveying data of different chronological periods. Journal of

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Andritsanos, V. D., O. Arabatzi, V. Pagounis and M. Tsakiri (2017): Quality control of height benchmarks in Attica, Greece, combining GOCE/GRACE satellite data, global geopotential models and detailed terrain information. Presented at the 1st Joint Commission 2 and IGFS Symposium, September 19 – 23, Thessaloniki. International Association of Geodesy Symposia. Springer eds. https://doi.org/10.1007/1345_2017_7

Andritsanos V. D. and I. N. Tziavos (2017): Spectral analysis and validation of Multiple Input / Multiple Output DOT estimation in the Eastern Mediterranean Sea. Presented at the 1st Joint Commission 2 and IGFS Symposium, September 19 – 23, Thessaloniki. International Association of Geodesy Symposia. Springer eds. https://doi.org/10.1007/1345_2017_10

Andritsanos, V. D. and I. N. Tziavos (2018): Spectral considerations of MIMOS theory in gravity and geoid modelling through the assimilation of satellite-based geopotential models. Presented at the International Symposium "Gravity, Geoid and Height Systems - 2nd Joint Meeting of the IGFS and IAG Commission 2", September 19 – 21, 2018, Copenhagen, Denmark.

Andritsanos, V. D. and I. N. Tziavos (2018): Central Mediterranean DOT estimation through spectral combination of altimetric, surface and satellite gravity data. Presented at the International Symposium "Gravity, Geoid and Height Systems - 2nd Joint Meeting of the IGFS and IAG Commission 2", September 19 – 21, 2018, Copenhagen, Denmark.

7. Hellenic Military Geographical Service's (HMGS) report to IAG

7.1 Reference Systems

a. Realization GGRS in remote islands

HMGS connected the triangulation network of the islands Megisti, Ro and Stroggyli, to the IGS network. These islands are far away from Greece's mainland and their triangulation network was connected to the national network through Doppler measurements in 1985. The above mentioned re-connection was compulsory in order to assure the absolute position in a global reference system and increase the accuracy of the appropriate transformations.

Five points were surveyed by GNSS receivers and they were referenced to the IGS network through twelve IGS stations. In order to assist data processing eight more EPN stations were used. Also, there GPS observations were used from other two GPS receivers on two pillars in Rhodes and Crete. Furthermore, GPS observations from other six points of the HEPOS network were also used. The reference frame employed was ITRF2008, as it was materialized from the IGS stations.

After that, a 3-parameter translation was computed giving low accuracy, suitable for cartographic and navigation purposes. In order to achieve better accuracy a Helmert 7-parameter transformation was computed between the reference systems of ITRF2008 and GGRS87 as it is materialized in the three islands.

GNSS stations in islands Megisti and Ro.

Publications:

1. *HMGS internal report*.

2. Common announcement by HMGS, National Cadastre & Mapping Agency and National Technical University of Athens about the GGRS87 materialization in Katellorizo island complex, December 2015.

b. Towards the establishment of a new GNSS Reference Frame

The last years HMGS is holding a continuous campaign in Greece establishing a new reference frame using existing triangulation pillars. It will be a local realization of ITRF2008 referenced by IGS permanent stations around Greek territory.

The network will be categorized into two major classes A and B. Class A points are referenced from the IGS permanent stations and class B points from Class A network points. Other classes (C and D) will be used for densification and other points (e.g. spirit levelling pillars).

c. Assessing a new velocity field in Greece

HMGS in cooperation with the Aristotle University of Thessaloniki (AUT) has combined data from different GNSS campaigns held in Greece in a common coordinate system using Helmert transformation in each measurement epoch.

The aforementioned combination led to the usage assessment of the periodically updated velocity field computed by AUT. Implementation of the velocity field improves more than 60% the fitting compatibility between the different reference frames.

Materialization of the new reference frame until 2018.

Publications:

1. Bitharis S., Papadopoulos N., Pikridas C., Fotiou A., Rossikipoulos D. Kagiadakis V., *Assesing a new velocity field in Greece by combining GNSS campaigns towards the establishment of a new Reference Frame*, Poster presentation in EUREF 2017 Symposium, Wroclaw, Poland, May 2017

2. Bitharis S., Papadopoulos N., Pikridas C., Fotiou A., Rossikipoulos D. Kagiadakis V., *Assesing a new velocity field in Greece towards a new semi-kinematic datum*, Survey Review, DOI: 10.1080/00396265.2018.1479937

7.2 Gravity Field

HMSG continues to hold a campaign of gravity measurements on triangulation and levelling pillars where GPS observations exist, in order to establish a dense geodynamic network.

During 2015 – 2018, 160 pillars were measured in the regions of Thrace, Macedonia, Thessaly and Epirus. Gravity measurements were held with Scintrex CG-5 and LaCoste & Romberg (model D-107) gravity meters and they were referenced to the National Gravimetric Network.

Also, in 2018 gravity measurements were held on densification points in cooperation with Aristotle University of Thessaloniki in the regions of Macedonia and Epirus. The aforementioned campaign, in combination with the existing geodynamic network will lead to a more accurate gravimetric geoid model of Greece.

Publications:

HMGS internal report.

8. The GNSS National Network of the Institute of Geodynamics, National Observatory of Athens (NOANET)

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Dr Athanassios Ganas , Research Director, aganas@noa.gr

8.1 Permanent GNSS stations and telemetry

The National Observatory of Athens operates the NOANET, which is a continuously operating GNSS network in Greece for regional studies in seismology and geodynamics. The NOANET is a real-time, high-rate GNSS network aiming to support both Greek and International geophysical research employing GNSS to measure coseismic, postseismic, and interseismic deformation across major fault zones; plate motion and crustal deformation at plate boundaries in the eastern Mediterranean and volcano deformation along the south Aegean Volcanic Arc. The NOANET network has been operating since 2006 following the EUREF (Regional Reference Frame Sub-Commission for Europe) Permanent Network standards. Since the mission of NOANET is primarily to monitor and quantify crustal deformation in Greece, the location of each permanent station was carefully selected in order that both geological and seismotectonic criteria are fulfilled. The stability of the points was always an important issue during the network design. Accordingly, all station antennas are installed on bedrock either directly with pillars/steel tripods or indirectly with steel masts on building roofs. The network as of October 2018 comprises 24 stations, which are connected to the main server in Athens via the Internet or via the leased telephone lines and have 2-weeks power autonomy. All stations are equipped with dual-frequency GPS receivers. The station location is shown in Figure 1. Our stations collect data every 1 s and transmit them to Athens on the hour (hourly files). 5 Hz (0.2 s) data are also collected on the ring buffer and remain available for manual download for a period of 48 hours. Data archiving is performed in two modes: a) 1-s raw data of each station are archived in hourly intervals and b) daily data for each station are archived in 30-s sampling rates. The network server in Athens is collecting data in automatic mode and a daily file is created at mid-night by sub-sampling the hourly observations every 30-s intervals. This file is converted to RINEX format and delivered to the NOA Web Server where it is available for immediate download.

8.2 Hardware and software

NOA operates a mixed pool of receivers (Leica, Astech, Trimble, Topcon) and antennas for permanent GPS/GNSS observations (see Table 2 for details of geodetic equipment). The data acquisition software is Leica Spider. We currently use a real-time quality processing using the Leica SpiderQC v.4.1 software. The GNSS data are distributed via the Internet in the form of daily files, sub-sampled at 30-s. Following a successful collaboration with UNAVCO the GSAC Web Service was implemented. The GSAC (Geodesy Seamless Archive Centers) is UNAVCO's software system that powers geodesy data repositories with a web service. Additionally, the GLASS (Geodetic Linking Advanced Software System) software, which is an integrated software package deployed in a GNSS infrastructure to manage data and metadata, is also installed. Developed from the original GSAC concept, GLASS is an open source platform under Creative Commons licensing. Currently we process 30-s GPS data from permanent GNSS stations in Greece using the GAMIT/GLOBK software. All data are processed in 24-h sessions in a three step distributed approach, which is based on the “quasi-observation” theory and the reference frame is not defined until the last step of the analysis, where we realize a common reference frame applying generalized constraints while estimating a seven-parameter Helmert transformation (three network rotations, three network translations and one scaling parameter), aligning each individual daily solution to the 2014 realization of the International Terrestrial Reference Frame. We also process many IGS stations together with the NOANET and the Greek stations in order to optimize the network internal constraints. The final products are time series along with horizontal and vertical velocities. To ensure reliable velocity results we perform outlier editing and modeling of the first-order features of the time series, while temporally correlated noise is taken into account.

Figure 1. Relief map of Greece with locations of the permanent GNSS stations of NOANET

8.3 Network Funding

EPOS-IP: This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement N° 676564, 2015-2019 https://epos-ip.org/
EYDAP SA project "Monitoring ground motions in Evinos Dam region by use of SAR interferometry", 2017 (Principal Investigator: A. Ganas)
ESA project "Integrating SAR interferometry and GNSS for studying tectonic processes in Indonesia", 2015-2018
ASPIDA GSRT project 2013-2015 http://aspida.gein.noa.gr/
RASOR FP7 project 2013-2016 http://www.rasor-project.eu/
HELPOS (The hEllenic Research infrastructure within the EPOS project) - MIS 5002697

8.4 Websites – Portals

GLASS node at NOA (Geodetic Linking Advanced Software System) http://glass.unice.fr:8080/gnss-data-gateway/#/site
GSAC node at NOA (Geodetic Seamless Archive Center) http://194.177.194.238:8080/noanetgsac/

8.5 Publications in Peer-reviewed SCI Journals (2015-2018)

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Melgar, D., Crowell, B. W., Geng, J., Allen, R. M., Bock, Y., Riquelme, S., Hill, E. M., Protti, M., Ganas, A., 2015. Earthquake magnitude calculation without saturation from the scaling of peak ground displacement, Geophysical Research Letters, 42, 5197-5205.

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9. Hellenic Cadastre

Geodetic Activities for the period 2015-2018

In 2018 a new public entity under the name "Hellenic Cadastre" replaced the “National Cadastre and Mapping Agency S.A.”. The new entity, which is supervised by the Minister of Environment and Energy, undertook the responsibility for the development and operation of the National Cadastre of Greece. The main geodetic activities of the Hellenic Cadastre are related to the operation of the national RTK network HEPOS (Hellenic Positioning System) and the maintenance of HEPOS’ geodetic reference frame HTRS07 (Hellenic Terrestrial Reference Frame 2007), which is the official realization of ETRS89 in Greece. In this context, the main activities of the Hellenic Cadastre in the period 2015-2018 have been:

- Monitoring of the coordinates of HEPOS stations
- Estimation of tectonic station velocities
- Estimation of crustal deformations induced by strong earthquakes (the 2014 North Aegean trough earthquake, the 2015 Lefkada earthquake, the 2017 Lesvos earthquake and the 2017 Kos-Bodrum, SE Aegean Sea earthquake)
- Assessment of crustal deformations associated with the 2011-2012 unrest of the Santorini volcano, Aegean Sea.
- Cooperation with EUREF towards a solution for maintaining ETRS89 in presence of strong tectonic activity.
- Participation in the EUREF Working Groups “Deformation Models” and “European Dense Velocities” for the determination of a dense European tectonic velocity field and the consideration of a deformation model in the maintenance and use of national realizations of the ETRS89.

Publications

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Taymaz T., V. Saltogianni, S. Yolsal-Çevikbilen, M. Gianniou, T. Öcalan, T. Eken, and S. Stiros (2018): “The 2017 Lesvos (Greece) Mw6.3 earthquake: Normal faulting in the Aegean Sea”, *Geophysical Research Abstracts,* Vol. 20, EGU2018-5346, 2018.

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