National Report of Greece to the International Union of Geodesy and Geophysics 2019-2022

Contributions in

Geodesy (Part 1)

Geomagnetism and Aeronomy (Part 2)

Prepared for the

XXIII General Assembly of the

International Union of Geodesy and Geophysics (IUGG)

in Berlin, Germany, June 30 – July 11, 2003

Athens, June 2023

The National Report of Greece to the International Union of Geodesy and Geophysics for the period 2019-2022 comprises two parts:

Geodesy (Report to IAG, Part 1)

and Geomagnetism and Aeronomy (Report to IAGA, Part 2)

Part 1

IAG REPORT

GEODETIC RESEARCH ACTIVITIES IN GREECE

FOR THE PERIOD 2019-2023

Edited by

Ilias N. Tziavos
IAG National Correspondent

Contributions by:

- *School of Rural and Surveying Engineering, Department of Geodesy and Surveying, Aristotle University of Thessaloniki (AUTh)*
- *School of Rural and Surveying Engineering, National Technical University of Athens (NTUA) Laboratory of Geodesy*
- *University of Patras, Department of Civil Engineering, Geodesy Lab*
- *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*
- *Department of Surveying and Geoinformatics Engineering of the School of Engineering of the International Hellenic University*
- *Hellenic Military Geographical Service (HMGS)*
- *Institute of Geodynamics, National Observatory of Athens (NOANET)*
- *Hellenic Cadastre*

June 2023

CONTENTS

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 Berlin, Germany, July 11-20, 2023.

The report presents the geodetic activities and the progress achieved in Geodesy by Greek Universities, Research Institutions and National Agencies for the period 2019-2023. 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 background, so that its products can then be used in other scientific applications and/or through other databases and processing tools. Such examples of interdisciplinary research are the use of GNSS, and satellite in general, products in geo-information and remote sensing 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, June 2023

Prof. Emeritus 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, Prof. D. Tsoulis, Prof. G.S. Vergos, Assoc. Prof. V.N. Grigoriadis

Main research activities

During the last four years the main research activities of GravLab have been directed to modeling the Earth's gravity at local and regional scales, the evaluation of potential values for the Hellenic region towards height system unification and the realization of the IHRS through the IHRF. GravLab members have participated in the Colorado geoid experiment for the determination of the geoid and the intercomparison of geoid determination methodologies within the activities of IAG's Joint Working Group 2.2.2 "The 1 cm geoid experiment". Moreover, GravLab has continued the exploitation of GOCE gradiometric observations for local and regional gravity field recovery, working on the data pre-processing and filtering and their downward continuation and combination with local data. Additionally, work on theoretical and computational aspects on potential fields has been carried out, including algorithms for the evaluation of potential harmonic coefficients of a polyhedral source and estimation procedures for third order potential derivatives. Within the frame of related projects, extensive gravity campaigns have been carried out towards filling the gaps in existing databases over Northern Greece as well as towards the modernization of the Greek Gravity Reference System. Finally, extensive work has been performed in the direction of using GRACE and GRACE/FO data for monitoring water mass variations and studying vertical deformations.

Positions held during the reporting period

During the reporting period, GravLab members held the following positions:

Prof. Tziavos has been a member of the Editorial Board of Journal of Geodesy and since October 2022 is a Professor Emeritus of the Aristotle University of Thessaloniki.

Prof. Tsoulis has been:

- Chair of ICCT/IAG's JSG T.28: Forward gravity field modelling of known mass distributions.
- Consortium member of IAG's GGOS as designated representative of ICCT.
- Associate Editor, Geophysical Prospecting (keyword: Potential Field Theory).
- Editor, Journal of Geodetic Science.
- Corresponding member, Geodetic Commission (DGK), Bavarian Academy of Sciences.

Prof. Vergos has been:

- Director of the Central Bureau of IAG's International Gravity Field Service
- Chair of IAG Commission 2 SC 2.2: Geoid, Physical Height Systems and vertical datum unification.
- Member of IAG's Committee on the Essential Geodetic Variables.
- Editor in IAG Symposia Proceedings.
- Guest Editor in Journal of Geodesy.
- Guest Editor in Remote Sensing.

Assoc. Prof. Grigoriadis has been:

- Member of IAG JWG 2.2.2: The 1 cm geoid experiment
- Vice-chair of JWG 2.2.1: Error assessment of the 1 cm geoid experiment
- Member of JSG T.37: Theory and methods related to the combination of high-resolution topographic/bathymetric models in geodesy

Research projects during the reporting period

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

- «Geoid and Gravity Field Modelling by GOCE Satellite Gradients and Terrestrial Data – GeoGravGOCE» project, funded by the HFRI(ELIDEK)/GSRT. Duration: 23/12/2019 – 22/12/2021.
- «Modernization of the Hellenic Gravity Network – ModernGravNet» project, funded by the HFRI(ELIDEK)/GSRT. Duration: 23/12/2019 – 22/06/2022.
- EaRth Observation Tools for the promotion of DigITal Economy – Erodite» project, funded in the frame of the H2020 Erasmus+ (Erasmus+) in the frame of the EAC/A02/2019 call EAC/A02/2019. Duration: 01/2021 – 01/2024.

- "Generation and strengthening of network differential positioning services through continuously operating reference stations for land and airborne applications – GeoNetGNSS» project, funded by the European Union and National Funds through the RCM OP (KEPA/ANEM) in the frame of the action Innovation Investment Plans. Duration: 10/2021 – 10/2023.

References for the reporting period:

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

Grigoriadis VN, Vergos GS, Barzaghi R, Carrion D, Koç Ö (2021) Collocation and FFT-based geoid estimation within the Colorado 1 cm geoid experiment. J Geod 95(52). https://doi.org/10.1007/s00190-021-01507-7.

Goyal R, Featherstone WE, Tsoulis D, Dikshit O (2020) Efficient spatial-spectral computation of local planar gravimetric terrain corrections from high-resolution digital elevation models, Geophys. J. Int., 221(3), pp 1820-1831. https://doi.org/10.1093/gji/ggaa107.

Jamet O, Tsoulis D (2020) A line integral approach for the computation of the potential harmonic coefficients of a constant density polyhedron, J Geod, 94(3), 30. https://doi.org/10.1007/s00190-020-01358-8.

Mamagianou E, Pitenis E, Natsiopoulos DA, Vergos GS, Tziavos IN (2022) GeoGravGOCE: A standalone MATLAB GUI for processing GOCE satellite gradient data. Computers and Geosciences 166,105184. https://doi.org/10.1016/j.cageo.2022.105184.

Natsiopoulos DA, Mamagiannou EG, Pitenis EA, Vergos GS, Tziavos IN (2023) GOCE Downward Continuation to the Earth's Surface and Improvements to Local Geoid Modeling by FFT and LSC. Remote Sensing 15(4):991. https://doi.org/10.3390/rs15040991.

Piretzidis D, Sideris MG, Tsoulis D (2019) Comparison of Criteria for the Identification of Correlated Orders in GRACE Spherical Harmonic Coefficients. In: Novák P., Crespi M., Sneeuw N., Sansò F. (eds) IX Hotine-Marussi Symposium on Mathematical Geodesy. International Association of Geodesy Symposia, vol 151. Springer, Cham. https://doi.org/10.1007/1345_2019_83.

Pitenis E, Mamagianou E, Natsiopoulos DA, Vergos GS, Tziavos IN, Grigoriadis VN, Sideris MG (2022) FIR, IIR and Wavelet Algorithms for the Rigorous Filtering of GOCE SGG Data to the GOCE MBW. Remote Sensing 14(13),3024. https://doi.org/10.3390/rs14133024.

Romeshkani M, Sharifi MA, Tsoulis D (2021) Estimation of gravitational curvature through a deterministic approach and spectral combination of space-borne second-order gravitational potential derivatives, Geophys. J. Int., 224(2), pp 825-842. https://doi.org/10.1093/gji/ggaa466.

Romeshkani M, Sharifi MA, Tsoulis D (2020) Joint estimation of gravity anomalies using second and third order potential derivatives, Geophys J. Int., 220(2), pp 1197-1207. https://doi.org/10.1093/gji/ggz517.

Sánchez L, Ågren J, Huang J, Wang YM, Mäkinen J, Pail R, Barzaghi R, Vergos GS, Ahlgren K, Liu Q (2021) Strategy for the realisation of the International Height Reference System (IHRS). J Geod 95(33). https://doi.org/10.1007/s00190-021-01481-0.

Tsoulis D, Gavriilidou G (2021) A computational review of the line integral analytical formulation of the polyhedral gravity signal. Geophys. Prospect., 69(8-9):1745-1760. https://doi.org/10.1111/1365-2478.13134.

Tsoulis D, Moukoulis C (2019) Processing aspects of level 2 GOCE gradiometer data for regional applications, Geophys. J. Int., 216(2), pp 1116-1131. https://doi.org/10.1093/gji/ggy485.

Tziavos IN (2020) Gravity and geoid in the Mediterranean Sea: The GEOMED project. Rend Fis Acc Lincei. https://doi.org/10.1007/s12210-020-00880-3.

Vu DT, Bruinsma S, Bonvalot S, Remy D, Vergos GS (2020) A Quasigeoid-Derived Transformation Model Accounting for Land Subsidence in the Mekong Delta Towards Height System Unification in Vietnam. Remote Sensing 12(5), 817. https://doi.org/10.3390/rs12050817.

Wang, Y.M., Sánchez, L., Ågren, J. et al. Colorado geoid computation experiment: overview and summary. J Geod 95, 127 (2021). https://doi.org/10.1007/s00190-021-01567-9.

Yang M, Hirt C, Wu B, Deng XL, Tsoulis D, Feng W, Wang CQ, Zhong M (2022) Residual Terrain Modelling: The Harmonic Correction for Geoid Heights. Surv Geophys (2022). https://doi.org/10.1007/s10712-022-09694-4.

1.2 Laboratory of Geodetic Methods and Satellite Applications (SatLab)

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

Main research activities

During the last 4 years, the AUTH Satellite Methods and Geodetic Applications Lab has participated in 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 scientific publications and papers in national and international journals and conferences over the last 4 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 (https://www.helpos.gr/), Monitoring of HeXaGoN GNSS Network and EaRth Observation Tools for the promotion of DigITal Economy – Erodite (https://www.erodite.info/). In addition, the GNSS_QC research team is participating to EUREF Technical Working Group on the creation of a European Dense Velocity model.

References for the reporting period:

A selected list of the recent publications is as follows:

Karolos I-A., Bitharis S., Tsioukas V., Pikridas C., Kontogiannis S., Gkamas T., Zinas N.: *Proposed 4.0 Industrial Management System for daily operations that poses point cloud assets with annotated real-time sensory measurements and utilizes unsupervised alert logic.* FIG Peer Review Journal [Link]

Lazos, I., Sboras, S., Chousianitis, K., Kondopoulou, D., Pikridas, C., Bitharis, S., & Pavlides, S. (2022). *Temporal evolution of crustal rotation in the Aegean region based on primary geodetically-derived results and palaeomagnetism*. Acta Geodaetica et Geophysica, 1-18. https://doi.org/10.1007/s40328-022-00379-3

Karakostas, V., Papazachos, C., Papadimitriou, E., Foumelis, M., Kiratzi, A., Pikridas, C., Kostoglou, A., Kkallas, C., Chatzis, N., Bitharis, **S.**, Chatzipetros, A., Fotiou, A., Ventouzi, C., Karagianni, E., Bonatis, P., Kourouklas, C., Paradisopoulou, P., Scordilis, E., Vamvakaris, D., Grendas, I., Kementzetzidou, D., Panou, A., Karakaisis, G., Karagianni, I., Hatzidimitriou, P., & Galanis, O. (2021). *The March 2021 Tyrnavos, central Greece, doublet (Mw6.3 and Mw6.0): Aftershock relocation, faulting details, coseismic slip and deformation*. Bulletin of the Geological Society of Greece, 58, 131-178. https://doi.org/10.12681/bgsg.27237

Chatzipetros, A., Pavlides, S., Foumelis, M., Sboras, S., Galanakis, D., Pikridas, C., Bitharis, **S.**, Kremastas, E., Chatziioannou, A., & Papaioannou, I. (2021). *The northern Thessaly strong earthquakes of March 3 and 4, 2021, and their neotectonic setting*. Bulletin of the Geological Society of Greece, 58, 222-255. https://doi.org/10.12681/bgsg.27225

Lazos I., Sboras S., Chousianitis K.**,** Bitharis S., Mouzakiotis E., Karastathis V., Pikridas C., Fotiou A., Galanakis D: *Crustal deformation analysis of Thessaly (central Greece) before the March 2021 earthquake sequence near Elassona-Tyrnavos (northern Thessaly)*. Acta Geodynamica et Geomaterialia., 18, No. 3(203), 379–385, 2021. https://doi.org/10.13168/agg.2021.0026

Sboras S., Lazos I., Bitharis S., Pikridas C., Galanakis D., Fotiou A., Chatzipetros A., Pavlides S. (2021): *Source modelling and stress transfer scenarios of the October 30, 2020 Samos earthquake: Seismotectonic implications*. Turkish J. Earth Sci, (2021) 30: 699-717. https://doi.org/10.3906/yer-2107-25

Lazos I., Chatzipetros A., Pavlides S., Pikridas C, Bitharis S. (2020): *Tectonic crustal deformation of Corinth Gulf, Greece, based on primary geodetic data*. Acta Geodynamica et Geomaterialia., 17, No. 4 (200), 413–426, 2020. https://doi.org/10.13168/agg.2020.0030

Pikridas C., Bitharis S., Katsougiannopoulos S., Spanakaki, K., Karolos, I.-A. (2019). *Study of TEC variations using permanent stations GNSS data in relation with seismic events. Application on Samothrace earthquake of 24 May 2014*. Geodesy and Cartography, 45(3), 137-146. https://doi.org/10.3846/gac.2019.10246

Bitharis S., Papadopoulos N., Pikridas C., Fotiou A., Rossikopoulos D., Kagiadakis V. (2019) *Assessing a new velocity field in Greece towards a new semi-kinematic datum*, Survey Review, 51:368, 450-459, https://doi.org/10.1080/00396265.2018.1479937

Oikonomou C., Tymvios F., Pikridas C., Bitharis S., Balidakis K., Michaelides S., Haralambous H., Charalambous D. (2018). *Tropospheric delay performance for GNSS integrated water vapor estimation by using GPT2w model, ECMWF's IFS operational model and in situ meteorological data*. Adv. Geosci., 45, 363-375, https://doi.org/10.5194/adgeo-45-363-2018.

Prof. Emeritus A. Dermanis

References for the reporting period:

Dermanis A, 2020: Geodetic Methods for Monitoring Crustal Motion and Deformation, 71 pages. In: W. Freeden and R. Rumel, eds. (2020): Handbuch der Geodäsie: Mathematische Geodasie / Mathematical Geodesy, Vol. 1., 625-695.

Dermanis A, 2020: Theory and Realization of Reference Systems, 127 pages. In: W. Freeden and R. Rumel, eds. (2020): Handbuch der Geodäsie: Mathematische Geodasie / Mathematical Geodesy, Vol. 1., 697-823.

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

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 precursory phenomena. In particular, our research focuses on three areas:

1) Direct estimation of the lower Ionosphere variations analysing the T(otal)E(lectron)C(ontent) estimations of GLONASS and GPS networks.
2) Indirect estimation of the lower Ionosphere variations by analysing the disturbances on the LF/VLF electromagnetic wave transmission induced by the disturbed lower Ionosphere.
3) Tidal triggering effect on earthquake occurrence. Researchers from other institutes have been collaborating with our group to this investigation, i.e.: Prof. T.D. Xenos and Dr. C. Skeberis from the Department of Telecommunication of AUTh, and Prof. E.M. Scordilis from the Department of Geodynamics of AUTh; Prof. P.F. Biagi, leader of the network, University of Bari, Italy; 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:

Arabelos DN, Contadakis, Micheal E.; Vergos GS, Skeberis C, Xenos TD, Spatalas S, (2020). Variation of some planetary seismic hazard indices on the occasion of Lefkada, Greece, earthquake of 17 November, 2015, ANNALS OF GEOPHYSICS, Vol. 63, No. 5, p.547, 2020

Contadakis ME, Arabelos DN, Vergos GS, Skeberis C, Xenos T, Biagi PF, Scordilis EM (2020). Ionospheric turbulence from TEC variations and VLF/LF transmitter signal observations before and during the destructive seismic activity of August and October 2016 in Central Italy, ANNALS OF GEOPHYSICS, Vol. 63, No. 5, p.546, 2020

Contadakis ME, Vallianatos F, Spatalas S, Scordilis EM (2020). Lower Ionospheric turbulence variations during the intense tectonic activity in Eastern Aegean area, ANNALS OF GEOPHYSICS, Vol. 63, No. 5, p.544, 2020

Arabelos DN, Contadakis ME, Vergos GS, Scordilis EM (2019). Lower Ionospheric Turbulence Variations during the Intense Tectonic Activity of October, 2018 at Zakynthos Area, Greece, Open Journal of Earthquake Research, Vol. 8, p. 255-266, 2019

Arabelos DN, Contadakis ME, Scordilis EM (2019). Lower Ionospheric turbulence variations during the recent activity of Etna's Volcano, Sicily, in December 2018, Bulletin of the Geological Society of Greece, 2019, Vol. 55, No. 1, p.19-33

Biagi PF, Colella R, Schiavulli L, Ermini, A, Boudjada M, Eichelberger H, Schwingenschuh K, Katzis K, Contadakis ME, Skeberis C, Moldovan IA, Bezzeghoud M (2019). The INFREP Network: Present Situation and Recent Results, Open Journal of Earthquake Research, Vol. 8, p. 101-115, 2019

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

Research activity during the last four years (2019-2022) was mainly focused on:
Commission1: Reference Frames
Commission 3: Earth Rotation and Geodynamics
Commission 4: Positioning and Applications

I -- Scientific Conference Organization

4th Joint International Symposium on Deformation Monitoring, (2019) Athens FIG / IAG / ISPRS, May 15-17
http://jisdm2019.survey.ntua.gr/

II -- Editor in Special Issues

Retscher G., Masiero A., Goel S., Gikas V. (2022) "*New Advances in Indoor Navigation*" Geomatics, MDPI (in progress)
https://www.mdpi.com/journal/geomatics/special_issues/new_advances_Indoor_navigation

Retscher G., Krejcar O., Gikas V., Kačmařík M. (2021) "*Advances in Localization and Navigation (GIS Ostrava 2021)*", ISPRS International Journal of Geo-Information
https://www.mdpi.com/journal/ijgi/special_issues/GIS_Ostrava_2021

Paziewski J.D., Kealy A., Gikas V., Geng J. (2021) "*Recent Advances in Ubiquitous Positioning Systems for Mobility Applications*", Measurement Science and Technology, Meas. Sci. Technol., 32(9)
https://iopscience.iop.org/article/10.1088/1361-6501/ac0186

Gikas V., Schwieger V., Zhang L. (2021) "*Editorial to the Special Issue: Deformation Monitoring*", Applied Geomatics 13 (1), 1-2 *https://link.springer.com/journal/12518/volumes-and-issues/13-1/supplement*

III – Book Chapters

Retscher G., Kealy A., Gikas V., Gabela J., Goel S., Li Y, Masiero A., Toth C.K., Perakis H., Błaszczak-Bąk W., Koppanyi Z., Grejner-Brzezinska D. (2020) "*A Benchmarking Measurement Campaign to Support Ubiquitous Localization in GNSS Denied and Indoor Environments*" In: Int. Ass. of Geod. Symp. Springer, Berlin, Heidelberg. *https://doi.org/10.1007/1345_2020_102*

Piniotis G., Gikas V. (2020) "*Experimental Assessment of a Ground-Based Radar Interferometer (GBRI) for the Determination of the Oscillation Parameters of Large-scale Engineering Structures*", Τιμητικός – συλλεκτικός Τόμος στη μνήμη Ευαγγελίας Λάμπρου, Πολυτεχνειούπολη Ζωγράφου, Αθήνα, 2020

Gikas V., Retscher G., Kealy A. (2019) "Collaborative Positioning for Urban Intelligent Transportation Systems (ITS) and Personal Mobility (PM): Challenges and Perspectives" in Mobility Patterns, Big Data and Transport Analytics, Elevier Inc., https://doi.org/10.1016/B978-0-12

Dovis, F., Ruotsalainen, L., Toledo-Moreo, R., Kassas, Z.Z.M., Gikas, V. (2020) "*Recent Advancements on the Use of Global Navigation Satellite System-Based Positioning for Intelligent Transport Systems*", IEEE Intelligent Transportation Systems Magazine, 2020, 12(3), pp. 6–9, 9146601 *https://ieeexplore.ieee.org/document/9146601*

Gikas, V., Retscher, G., Kahmen, H., Neuner, H., Rizos, C. (2020) "*Editorial to the Special Edition of the JAG on Deformation Monitoring*", Journal of Applied Geodesy, 2020,14 (2), 119-119
https://www.degruyter.com/journal/key/jag/14/2/html

Gikas V., Pantazis G., Tsakiri M. (2019) "*Selected Papers from 4th Joint International Symposium on Deformation Monitoring (JISDM 2019)*", SENSORS, MDPI
https://www.mdpi.com/journal/sensors/special_issues/JISDM2019 812970-8.00015-4, pp381–414

IV – Journal Publications

Mpimis A., Kapsis T., Panagopoulos A.D., Gikas V., (2022) "*Cooperative D-GNSS Aided with Multi Attribute Decision Making Module: A Rigorous Comparative Analysis*", Future Internet, 14(195), MDPI, 1–17

Papathanasopoulou V., Spyropoulou I., Perakis H., Gikas V., Andrikopoulou E. (2022) "*A Data-driven Model for Pedestrian Behavior Classification and Trajectory Prediction*", IEEE Open Journal of Intelligent Transportation Systems, 3, 328–339

Filograno M.L., Piniotis G., Gikas V., Papavasileiou V., Gantes C.J. ,Kandyla M., Riziotis C. (2022) "*Comparative Assessment and Experimental Validation of a Prototype Phase-Optical Time-Domain Reflectometer for Distributed Structural Health Monitoring*", Journal of Sensors, 1–23

Retscher R., Gabela J., Gikas V. (2022) "*PBeL – Problem Based (e-)Learning of LBS in Online Teaching for Geomatics Students*", GEOMATICS, MDPI, 1, 1–29

Pagounis V., Merlemis N., Anastasiou D., Arabatzi O., Zacharis V., Tsakiri M. (2022). Compact testing of total station instruments using folded optics. Journal of Applied Engineering sciences. Vol. 12(25), issue 1/2022, Art.No 331 pp.71-76 DOI: 10.2478/jaes-2022-0011

Panou, G., & Korakitis, R. (2022). Cartesian to geodetic coordinates conversion on a triaxial ellipsoid using the bisection method. Journal of Geodesy, 96(10), 66. https://doi.org/10.1007/s00190-022-01650-9

Masiero A., Toth C., Gabela J., Retscher G., Kealy A., Perakis H., Gikas V., Grejner-Brzezinska D. (2021) "*Experimental Assessment of UWB and Vision-based Car Cooperative Positioning System*", Remote Sensing, 13(23)

Themistocleous, K., Danezis, C., Gikas, V (2021) "*Monitoring Ground Deformation of Cultural Heritage Sites Using SAR and Geodetic Techniques: The Case Study of Choirokoitia*", Cyprus, Applied Geomatics, 13(1), 37–49

Panou, G., & Agatza-Balodimou, A.-M. (2021). Direct and Indirect Estimation of the Variance–Covariance Matrix of the Parameters of a Fitted Ellipse and a Triaxial Ellipsoid. Journal of Surveying Engineering, 147(1). https://doi.org/10.1061/(ASCE)SU.1943-5428.0000342

Panou, G., & Korakitis, R. (2021). Analytical and numerical methods of converting Cartesian to ellipsoidal coordinates. Journal of Geodetic Science, 11(1), 111–121. https://doi.org/10.1515/jogs-2020-0126

Retscher, G., Kealy, A., Gabela, J., Li, Y., Goel, S., Toth, C. K., Masiero, A., Błaszczak-Bąk, W., Gikas, V., Perakis, H., Koppanyi, Z., & Grejner-Brzezinska, D. (2020) "*A Benchmarking Measurement Campaign in GNSS-Denied/Challenged Indoor/Outdoor and Transitional Environments*", Journal of Applied Geodesy, 14(2), 215–229 *doi: https://doi.org/10.1515/jag-2019-0031*

Panou, G., & Korakitis, R. (2020). The direct geodesic problem and an approximate analytical solution in Cartesian coordinates on a triaxial ellipsoid. Journal of Applied Geodesy, 14(2), 205–213. https://doi.org/10.1515/jag-2019-0066

Panou, G., Korakitis, R., & Pantazis, G. (2020). Fitting a triaxial ellipsoid to a geoid model. Journal of Geodetic Science, 10(1), 69–82. https://doi.org/10.1515/jogs-2020-0105

Panou G., Mintourakis I., Paradissis D., Korakitis R., & Balodimos D.-D., (2020). Rectangular harmonic analysis applied to a regional gravity field. In: Measurements routes. Dedicated volume in honor of Professor E. Lambrou, Ziti editions, Thessaloniki, Greece, pp. 79-88.

Gabela J., Retscher G., Goel S., Perakis H., Masiero A., Gikas V., Toth C., Kealy A., Koppányi Z., Błaszczak-Bak W., Li Y. and Grejner-Brzezinska D. (2019) "*Experimental Evaluation of a UWB based Cooperative Positioning System for Pedestrians in GNSS Denied Environments*", Sensors, 19(23), 25 pgs.

Retscher G., Gikas V., Hoffer H., Perakis H, Kealy A. (2019) "*Range Validation of UWB and Wi-Fi for Integrated Indoor Positioning*", Applied Geomatics, 11, 187–195

Panou, G. (2019). Cartesian to geodetic coordinates conversion on an oblate spheroid using the bisection method. Computers & Geosciences, 133, 104308. https://doi.org/10.1016/j.cageo.2019.104308

Panou, G., & Korakitis, R. (2019). Geodesic equations and their numerical solution in Cartesian coordinates on a triaxial ellipsoid. Journal of Geodetic Science, 9(1), 1–12. https://doi.org/10.1515/jogs-2019-0001

Mintourakis, I., Panou, G., & Paradissis, D. (2019). Evaluation of ocean circulation models in the computation of the mean dynamic topography for geodetic applications. Case study in the Greek seas. Journal of Geodetic Science, 9(1), 154–173. https://doi.org/10.1515/jogs-2019-0015

V -- Conference Papers

Kealy A., Retscher G., Gabela J., Li Y., Goel S., Toth C., Masiero A., Blaszczak-Bak, W., Gikas V., Perakis H., Koppanyi Z., Grejner-Brezezinska D. (2019) "A Benchmarking Measurement Campaign in GNSS-denied/challenged Indoor/Outdoor and Transitional Environments", FIG Working Week, Hanoi, Vietnam, April 22–26 [ΠΛΗΡΗΣ ΚΡΙΣΗ ΑΡΘΡΟΥ]

Gikas V., Mpimis A., Piniotis G., Perakis H., Papadimitriou H., Drimeris K., Sotiriou P. (2019) "Long-term monitoring of the Tall Piers of a Girder Bridge Using a Network of Digital Inclinometers: First Results

and Perspectives for Future Analyses", 4th Joint Int. Symp. on Deformation Monitoring, Athens, Greece, May 15–17

Yigit C.O., Dindar A.A., El-Mowafy A., Bezcioglu M., Gikas V. (2019) "Investigating the Ability of High-rate GNSS-PPP for Determining the Vibration Modes of Engineering Structures: Small Scale Model Experiment", 4th Joint Int. Symp. on Deformation Monitoring, Athens, Greece, May 15–17

Filograno M.L., Piniotis G., Gikas V., Papavassiliou V., Gantes C., Kandyla M., Riziotis C. (2019) "Experimental Validation of a Prototype Photonic Phase Optical Time Domain Reflectometer for SHM in Large-scale Infrastructures", 4th Joint Int. Symp. on Deformation Monitoring, Athens, Greece, May 15–17

Themistocleous K., Danezis C., Mendonidis E., Gikas V. (2019) " Monitoring Ground Deformation of Cultural Heritage Sites Using SAR and Geodetic Techniques: The Case Study of Choirokoitia, Cyprus", 4th Joint Int. Symp. on Deformation Monitoring, Athens, Greece, May 15–17 [ΠΛΗΡΗΣ ΚΡΙΣΗ ΑΡΘΡΟΥ]

Anastasiou D., Ganas A, Legrand J., Bruyninx C., Papanikolaou X., Tsironi V., Kapetanidis V. (2019). Tectonic Strain distribution over Europe from EPN data. EGU General Assembly 2019, Geophysical Research Abstracts, Vol. 21, EGU2019-17744-1

Anastasiou D., Papanikolaou X., Kapetanidis V., Tsironi V., Ganas A. and Paradissis D. (2019). STRAINTOOL - Improving the mapping of tectonic strain in Eurasia. 12th HSTAM International Congress on Mechanics, Thessaloniki, Greece, 22-25 September

Andrikopoulou E., Spyropoulou I., Perakis H., Gikas V. (2020) "Exploring Contributory Parameters of Pedestrian Movement Using Low Cost GNSS Receiver Data", Proc. of 8th Transport Research Arena TRA, April 27-30, 2020, Helsinki, Finland

Athanasios Iliodromitis, Georgios Pantazis, Vassilios Vescoukis, Evangelia Lambrou (2019). "A methodology for WSN deployment in 2D large-scale constraining environments, using computational geometry algorithms". 4th Joint Int. Symp. on Deformation Monitoring, Athens, Greece, May 15–17.

Anastasios-Grammatas Kampouris, Evangelia Lambrou, Georgios Pantazis (2019). "Investigation of the dependence between digital height readings and the meteorological parameters by using a stand-alone set up and repeatable short term measurements". 4th Joint Int. Symp. on Deformation Monitoring, Athens, Greece, May 15–17

Georgios Pantazis, Dimitrios Skarlatos, Loizos Pelecanos (2019), "Long-term geodetic monitoring of seasonal deformations of earth dams and relevant finite element verification". 4th Joint Int. Symp. on Deformation Monitoring, Athens, Greece, May 15–17.

Antonia Moropoulou, Andreas Georgopoulos, Evangelia Lambrou, George Pantazis, Sofia Soile, Sevasti Tapeinaki, Elisavet Tsilimantou, Kyriakos Lampropoulos (2019). "Multispectral monitoring of the successive phases of the Holy Aedicule rehabilitation". 4th Joint Int. Symp. on Deformation Monitoring, Athens, Greece, May 15–17.

Masiero A., Perakis H., Gabela J., Toth C., Gikas V., Retscher G., Goel S., Kealy A., Koppányi Z., Błaszczak-Bak W., Li Y., Grejner-Brzezinska D.G. (2020) Indoor navigation and mapping: Performance analysis of UWB-based platform positioning International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives, 43(B1), pp. 549–555

Retscher G., Li Y., Kealy A., Gikas V. (2020) The need and challenges for ubiquitous Positioning, Navigation and Timing (PNT) using Wi-Fi, FIG Working Week, June 20 –21

Borlenghi, P., Piniotis, G., Perakis, H., Gikas, V., & Gentile, C. (2020) Measuring the dynamic displacements of bridges using geophone data: application and validation on a lively footbridge EURODYN, pp 4687–4695, Nov. 23–26

Anastasiou D., Avgeri T., Iliodromitis A., Pagounis V., Tsakiri M. (2020) 3D Virtual Models for an Early Education Serious Gaming Application. The International Archives of the Photogrammetry,

Remote Sensing and Spatial Information Sciences, Volume XLIV-4/W1-2020, 2020, 3D GeoInfo 2020 and BIM GIS Integration Workshop, virtual/online event 7-9 September DOI: 10.5194/isprs-archives-XLIV-4-W1-2020-3-2020

Anastasiou D., Baxevanidi E., Gianniou M., Andritsanos V. and Pagounis V. (2020), 3D digital tools for the development and promotion of religious heritage tourism. FIG Working Week 2020 in Amsterdam, Netherlands, 10-14 May.

Stratakos I., Sotiriou P., Perakis H., Gikas V., Spiliotakopoulos K., Pelekoudas D. (2021) Design and Testing of a Fuel Consumption Eco-Driving Coach System for Truck Drivers based on Geolocation and BI Technologies, GIS Ostrava 2021 – Advances in Localization and Navigation, March 17–19

Mpimis T., Sotiriou P., Gikas V. (2021) Addressing the potential of GNSS moving base station technique for vehicular C-ITS applications: preliminary tests and results, GIS Ostrava 2021 – Advances in Localization and Navigation, March 17–19

Papathanasopoulou V., Spyropoulou I., Perakis H., Gikas V, Andrikopoulou E. (2021) Classification of pedestrian behavior using real trajectory data, 7th International IEEE Conference on Models and Technologies for Intelligent Transportation Systems (MT-ITS), 16– 17 June

Gikas V., Spiliotakopoulos K., Stratakos I., Sotiriou P., Perakis H., Pelekoudas D. (2021) Development of a prototype, self-trained truck driver coaching system based on geolocation, IoT and BI: Preliminary results and analyses, 2021 7th International IEEE Conference on Models and Technologies for Intelligent Transportation Systems (MT-ITS), 16– 17 June

Stratakos I., Perakis H., Sotiriou P., Gikas V., Spiliotakopoulos K. (2021) Performance evaluation of a purpose-built, low-cost, multi-sensor platform for supporting a truck driver coaching system, FIG Working Week, 21 - 25 June 2021

Retscher G., Gikas V., Gerike R. (2021) Curricula Enrichment for Sri Lankan Universities Delivered Through the Application of Location-based Services to Intelligent Transport Systems (10865), FIG e-Working Week, June 21-25, 2021

Bouloukou M.P., Masiero A., Vettore A., Gikas V. (2021) UAV UWB Positioning Close to Building Facades: A Case Study "XXIVth ISPRS Congress, July 4-10, 2021 (June 6-10, 2022) - Nice, FRANCE

Masiero A., Dabove P., Di Pietra V., Piragnolo M., Vettore., Cucchiaro S., Guarnieri A., Tarolli P., Toth C., Gikas V., Perakis H., Chiang K-W., Ruotsalainen L., Goel S., Gabela J. (2021) A case study of pedestrian positioning with UWB and UAV cameras, XXIVth ISPRS Congress, July 4-10, 2021 (June 6-10, 2022) - Nice, FRANCE

Masiero A., Dabove P., Di Pietra V., Piragnolo M., Vettore A., Guarnieri A., Toth C., Gikas V., Perakis H., Chiang K.W., Ruotsalainen L.M., Goel S., Gabela J. (2022) A comparison between UWB and laser-based pedestrian tracking, XXIVth ISPRS Congress, July 4-10, 2021 (June 6-10, 2022) - Nice, FRANCE

Stratakos I., Perakis H., Sotiriou P., Gikas V., Pelekoudas D., Spiliotakopoulos K., Mpimis T. (2021) Truck Driver Behavior Extraction Using BI, Geo-location and IoT Technologies, 10th International Congress on Transportation Research, September 2nd - 3rd 2021, Rhodes, Greece

Papathanasopoulou V., Spyropoulou I., Perakis H., Gikas V. (2021) Data-driven pedestrian modeling: Analysis of pedestrian behavior under various conditions, 10th International Congress on Transportation Research, September 2nd - 3rd 2021, Rhodes, Greece

Haxhi A., Perakis H., Gikas V., Fafoutellis P., Mantouka E., Vlahogianni E.I., Pnevmatikou A., Fortsakis P. (2021) Towards Smartphone-based enhanced GNSS positioning for Eco Driving ITS services, 10th International Congress on Transportation Research, September 2nd - 3rd 2021, Rhodes, Greece

Fafoutellis P., Mantouka E., Vlahogianni E.I., Haxhi A., Perakis H., Gikas V., Pnevmatikou A., Fortsakis P. (2021) What is the Impact of Driving Behavior on Fuel Efficiency? Theoretical Aspects and Empirical Evidence, 10th International Congress on Transportation Research, September 2nd - 3rd 2021, Rhodes, Greece

Anastasiou D., Zacharis V., Pagounis V., Tsakiri M. (2021). An interactive virtual environment for teaching total station surveying. FIG e-Working Week 2021. Smart surveyors for land and watermanagement. Challenges in a new reality. 20 - 25 June

Piniotis G., Gikas V. (2022) Experimental Assessment of the Accuracy of a Ground-Based Radar Interferometer (GBRI) in a fully controlled laboratory environment, 5th Joint Int. Symp. on Deformation Monitoring, 20-22 June, Valencia, Spain

Piniotis G., Gikas V. (2022) Steel bridge structural damage detection using Ground-Based Radar Interferometry (GBRI) vibration measurements and deep learning Convolutional Neural Networks, 5th Joint Int. Symp. on Deformation Monitoring, 20-22 June, Valencia, Spain

Gartner G., Binn A., Retscher G., Gabela J., Gikas V., Schmidt M., Wang W. (2022) “From project-based to problem-based learning in engineering disciplines: enhancing Cartography and Geomatics education”, 8th Int. Conf. on Higher Education Advances (HEAd’22), July 14-17, Valecia, Spain

Gabela J, Retscher R, Gartner G, Binn A, Gikas V., Spyropoulou I., Gerike R., Ratnayake R, Buddhika A., Perera L., Kalansooriya P., Pradeep R., Hewawasam C., Dammalage T., Abeyratne V. (2022) Overview of the PBL in geodesy, geoinformatics and transport engineering education, FIG Congress 2022 Sept. 11-15, Warsaw, Poland

Mpimis T., Perakis H., Gikas V., Kapsis T., Guod Y., Joswige N., Panagopoulos A., Dovis F., Ruotsalainen L., Papamichail I. (2022) "RobPos4VApp: Low-cost Cooperative DGNSS-based Positioning in Connected Vehicle Applications", Positioning and Navigation for Intelligent Transportation Systems, POSNAV 2022, Nov 3-4, Berlin, Germany

Perakis H., Gikas V. (2022) "Two-Way Ranging for Indoor Collaborative Multi-Agent Positioning", Positioning and Navigation for Intelligent Transportation Systems, POSNAV 2022, Nov 3-4, Berlin, Germany

Haxhi A., Perakis H., Mpimis T., Gikas V. (2022) "Testing of a Combined Hatch Filter/RAIM Algorithm for SPP Smartphone Kinematic Positioning in GNSS Harsh Environments", Positioning and Navigation for Intelligent Transportation Systems, POSNAV 2022, Nov 3-4, Berlin, Germany

Retscher G., Gerike R., Gabela J, Heidegger F., Gartner G., Binn A., Gikas V., Spyropoulou I., Ratnayake R., Buddhika Jayasinghe A., Perera L., Kalassooriya P., Pradeep P., Hewawasam C., Dammalage T., Abeyratne V. (2022) "Education on Location-Based Services for Intelligent Transport Systems as the Basis for Interdisciplinary Innovation in Transport", Positioning and Navigation for Intelligent Transportation Systems, POSNAV 2022, Nov 3-4, Berlin, Germany

Kapsis T. T., Mpimis T, Panagopoulos A. D., and Gikas. V. (2022) "Positioning Enhancement using Low Cost GNSS Receivers Data Exchange in Critical Intelligent Transport Systems", PACET: "PAnhellenic Conference on Electronics and Telecommunications", Tripolis, Greece, 2-3 Dec.

Krei V., J. Galanis, V. Zacharis, M. Tsakiri (2022) S-Wave detection using GNSS permanent station data: A case study of 2019-07-06 M 7.1 Ridgecrest Earthquake Sequence, S. California and 2018-11-30 M 7.1 Point MacKenzie, Alaska". Proc. 5th Joint International Symposium on Deformation Monitoring (JISDM 2022) April 6-8, 2022, València, Spain.

Zacharis V., M. Tsichlaki, X. Papanikolaou, M. Tsakiri (2022) Validating DORIS Meteo Data. Proc. 2022 International DORIS Service IDS Workshop, 31 Oct. -3 Nov., Venice, Italy

Papanikolaou X., V. Zacharis, M. Tsichlaki, S.Nahmani, A.Pollet, V M. Tsakiri, J.Galanis (2022) Development of an in-house DORIS processing software. Proc. 2022 International DORIS Service IDS Workshop, 31 Oct. -3 Nov., Venice, Italy

Anastasiou A., X.Papanikolaoy, M.Tsakiri, S.Lalehos (2022) Development of a monitoring platform for permanent GNSS stations analysis in the region of the EnCeladus Hellenic Supersite, preliminary results. Proc. 16th International Congress of the Geological Society of Greece, 17-19 October, 2022, Patras, Greece

Papanikolaou X. M. Tsakiri, S. Nahmani, A. Pollet (2022) Designing a DORIS processing software for orbit determination and estimation of geodetic parameters. Proc. IAG International Symposium on Reference Frames for Applications in Geosciences (REFAG 2022), October 17-20, 2022, Thessaloniki, Greece.

Anastasiou D., X. Papanikolaou, M. Tsakiri (2022) On the stability of regional reference frames in Greece using GNSS permanent stations. Proc. IAG International Symposium on Reference Frames for Applications in Geosciences (REFAG 2022), October 17-20, 2022, Thessaloniki, Greece.

Aspioti K., Anastasiou D., Gianniou M., Andritsanos A. and Pagounis V. (2022). Velocity and strain field estimation from episodic GNSS campaigns (2012-2021) for the region of Attica, Greece. Reference Frames for applications in Geosciences, 17-20 October 2022, Thessaloniki, Greece

Panou, G. & Korakitis, R. (2022). Rectangular polynomial analysis applied to a local gravity field. X Hotine-Marussi Symposium, 13-17 June, Milano, Italy

Panou, G. & Korakitis, R. (2022). Modelling the local gravity field by rectangular harmonics with numerical validations, EGU General Assembly 2022, Vienna, Austria, 23–27 May 2022, EGU22-1880, https://doi.org/10.5194/egusphere-egu22-1880.

3. Patras University, Dept of Civil Engineering, Geodesy Lab (head: Prof S. Stiros)

During the last intra-congress period, the main focus of our research in Geodynamics was the quality of proposed (underground) seismic fault models which are derived from analysis of displacement vectors of permanent GNSS stations.

Seismic fault models are of two types: (a) Uniform slip models which correspond to one or more planar faults with uniform slip along them. Each fault defined by 9 variables and these models reflect a simplification of the seismic rupture. (b) Variable slip models which assume slip variable in each seismic fault surface and are described by tens or hundreds of variables.

Solution for the variables which define a seismic fault model corresponds to solution of a system of highly non-linear equations. In most cases this system is under-determined, i.e., it corresponds to fewer observation equations corresponding to GNSS displacement vectors than the number of unknowns. In addition, no approximate values for most unknown variables are usually known, while the signal-to noise ratio (SNR) of observations is usually very low. As a consequence, no formal network adjustment techniques for fault models are possible.

For this reason, the solution ("inversion") of fault models is based on numerical techniques, mostly on Monte Carlo-based techniques. In this approach, an algorithm searches within a "search space" for a solution which offers the best fit with observations ("minimized cost function"). Unfortunately, using this approach, no unique solution is possible since numerous solutions can minimize the cost function, while the solution depends on the initial guess of the values of unknown variables.

Our contribution to overcome this problem was in two directions:

1. New efficient inversion (adjustment) algorithm

A new inversion algorithm which approximates the search space with a gridded hyper-space was proposed. This new algorithm, known as TOPological INVersion (TOPINV) algorithm, "scans" the whole of the search space (exhaustive searches of a hyperspace approximated by a N-dimensional grid, N≥9), identifies all solutions which minimize the cost function and can pick the optimal solution. This algorithm is functional for at least up to 18 unknown variables, but is computationally very expensive.

To overcome this problem, the TOPINV algorithm was implemented in GPUs which permit parallel processing even in common computers. A problem that was solved is that GPUs are typically compatible with 3-D spaces, and certain transformations were necessary in order to adapt hyperspaces (spaces higher than in 3 dimensions) in GPUs.

The results of this research are summarized in the following publication:

Venetis, I., Saltogianni, V., Stiros, S., Gallopoulos, E. (2020). Multi-variable inversion using exhaustive grid search and high-performance GPU processing: A new perspective, *Geophys J Int*, doi: 10.1093/gji/ggaa042

2. Quality of variable slip models

Variable slip models correspond to highly under-determined observations systems, their quality cannot be easily assessed and correspond to non-unique solutions; for example, even for major earthquakes very different variable slip fault models have been proposed.

Our contribution was the investigation of the stability of variable slip fault models these models as a function of the noise in data and of the distribution of observation stations (measurement configuration). This analysis was based on synthetic data.

There was selected a representative reference fault model and an associated set of reference GNSS slip-vectors.

(i) In order to investigate the impact of noise in observations in the fault model, ten different sets of slip vectors were produced adding noise of different levels to the reference values. It was found that the increase of the observations noise led to instability of the fault models, especially away from the fault. The amplitude of the slip was found very sensitive to measurement noise.

(ii) In order to investigate the impact of the configuration of observation stations in the fault model, different observational systems were examined. It was found that stations above a fault tend to show spurious stress concentration on the fault surface.

The results of this research are summarized in the following publication:

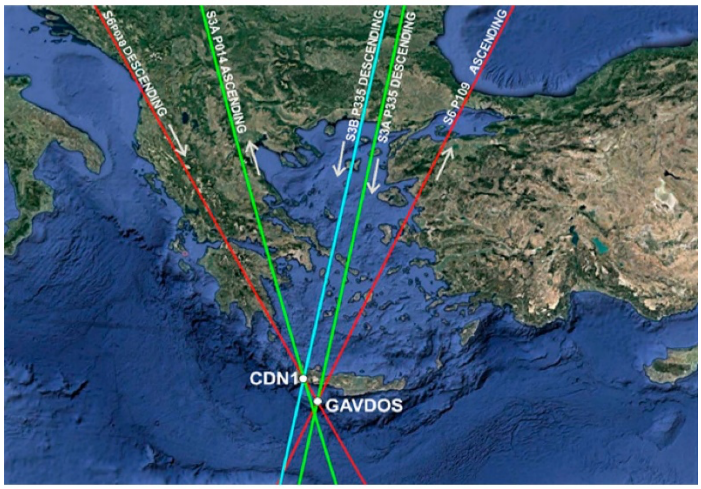
Leivadas-Stathakopoulos I, Biliani I, Stiros S, Observations noise and stability of geodetic variable slip fault models, *Geophys. J. Int*, 2022, 228, 826–838 doi: 10.1093/gji/ggab377

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

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

During the period 2019 – 2022 research activities of GeoMatLab are focused primarily on Satellite Altimetry Calibration/Validation (Cal/Val), sea level determination, GNSS atmospheric and deformation monitoring, and remote sensing.

A ground reference infrastructure has been established in Gavdos and Crete has been continuously operating and providing absolute altimeter biases for more than 20 years. The European Space Agency recognized it in 2018 as the ESA Permanent Facility for Altimetry Calibration (ESA-PFAC). It consists of several calibration/validation sites spread over Western Crete and Gavdos islands. 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.



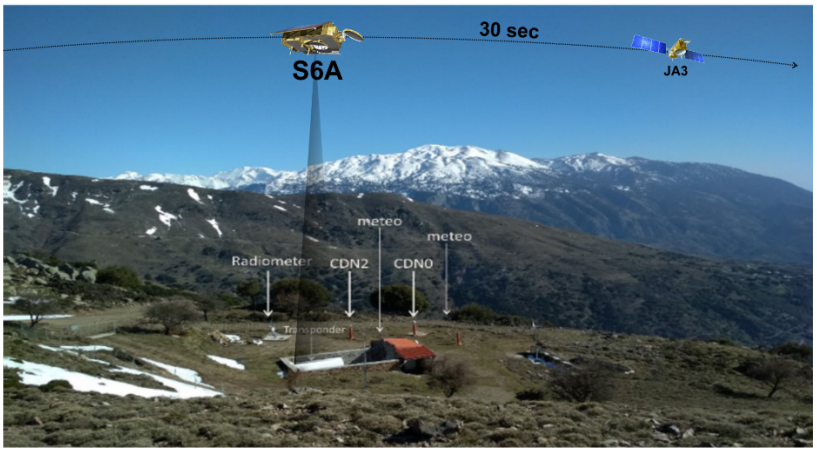


Figure 1: The two permanent transponder Calibration/Validation sites up on the mountains of west Crete (CDN1 Cal/Val site) and in Gavdos island (GVD1 Cal/Val site).

It includes a major set of permanent sea-surface Cal/Val sites and prototype scientific equipment (microwave transponders) at various locations in Crete and Gavdos. At present, this infrastructure includes 17 permanent Global Navigation Satellite System stations, 10 tide gauges, 7 meteorological systems, several communication links, two microwave transponders and a central facility for data archiving, processing, and for remotely controlling all field units. The ESA-PFAC allows calibration of satellite altimeters over ascending and descending passes and permits multi-mission calibration at crossover locations over land and sea-surface simultaneously. 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, settings, and instrumentations on the ground (sea surface and transponder) for absolute assessment.

All international altimetry missions (i.e., Sentinel-6 MF, Sentinel-3A/B and CryoSat-2 (European), Jason series (American-French), HY-2 (Chinese), and SARAL/AltiKa (Indian-French) have been calibrated at this facility as of 2004.

A new transponder site on Gavdos island was established in 2021 dedicated primarily for the operational altimeter of Sentinel-6 and Sentinel-3 with range and sigma-naught calibration. This facility is called GVD1 transponder Cal/Val site. The measurements and results of these two transponder facilities are analyzed and evaluated by a team of 15 people with representatives from the Technical University of Crete, the European Space Agency, the Eumesat in Germany, the French Space Agency (CNES), the Jet Propulsion Laboratory (NASA), the US National Oceanic and Atmospheric Administration (NOAA), and ESA collaborators from France, Spain, Italy and Germany.

Also, a new sea-surface Cal/Val site, called “SUG1”, has been established at the southwest coast of Crete. It supports calibration of the same Sentinel-3A, Sentinel-3B, Sentinel-6 and CryoSat, and HY-2B and HY-2C.

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

References for the reporting period (2019-2022)

Mertikas, S.P.; Lin, M.; Piretzidis, D.; Kokolakis, C.; Donlon, C.; Ma, C.; Zhang, Y.; Jia, Y.; Mu, B.; Frantzis, X.; Tripolitsiotis, A.; Yang, L. (2023). Absolute Calibration of the Chinese HY-2B Altimetric Mission with Fiducial Reference Measurement Standards. Remote Sens. 2023, 15, 1393. https://doi.org/10.3390/rs15051393

Kokolakis, C.; Piretzidis, D.; Mertikas, S.P. (2022). Impact of satellite attitude on altimetry calibration with microwave transponders. Remote Sensing, https://doi.org/10.3390/rs14246369

Mertikas, S.P.; Donlon, C.; Mavrocordatos, C.; Piretzidis, D.; Kokolakis, C.; Cullen, R.; Matsakis, D.; Borde, F.; Fornari, M.; Boy, F.; Tripolitsiotis, A.; Guinle, T.; Frantzis, X.; Duesmann, B. (2022). Performance evaluation of the CDN1 altimetry Cal/Val transponder to internal and external constituents of uncertainty. Advances in Space Research, https://doi.org/10.1016/j.asr.2022.07.001.

Yang, L.; Lin, L.; Fan, L.; Liu, N.; Huang, L.; Xu, Y.; Mertikas, S.P.; Jia, Y.; Lin, M. (2022). Satellite Altimetry: Achievements and Future Trends by a Scientometrics Analysis. Remote Sens. 2022, 14, 3332. https://doi.org/10.3390/rs14143332

Yang, L.; Lin, M.; Ma, C.; Mertikas, S.P.; Hu, W.; Wang, Z.; Mu, B.; Zhou, X. (2022). Monitoring the Performance of HY-2B and Jason-2/3 Sea Surface Height via the China Altimetry Calibration Cooperation Plan. IEEE Transactions on Geoscience and Remote Sensing, vol. 60, pp. 1-13, 2022, Art no. 1002013, https://doi.org/10.1109/TGRS.2022.3153631.

International Altimetry Team (2021). Altimetry for the future: Building on 25 years of progress. Advances in Space Research, 68(2), 319-363, https://doi.org/10.1016/j.asr.2021.01.022.

Mertikas, S.P.; Donlon, C.; Matsakis, D.; Mavrocordatos, C.; Altamimi, Z.; Kokolakis, C.; Tripolitsiotis, A. (2021). Fiducial reference systems for time and coordinates in satellite altimetry. Advances in Space Research, 68(2):1140-1160. https://doi.org/10.1016/j.asr.2020.05.014.

Mertikas, S.; Partsinevelos, P.; Tripolitsiotis, A.; Kokolakis, C.; Petrakis, G.; Frantzis, X. (2020). Validation of Sentinel-3 OLCI Integrated Water Vapor Products Using Regional GNSS Measurements in Crete, Greece. Remote Sens. 2020, 12, 2606, https://doi.org/10.3390/rs12162606.

Mertikas, S.; Tripolitsiotis, A.; Donlon, C.; Mavrocordatos, C.; Féménias, P.; Borde, F.; Frantzis, X.; Kokolakis, C.; Guinle, T.; Vergos, G.; Tziavos, I.N.; Cullen, R. (2020) The ESA Permanent Facility for Altimetry Calibration: Monitoring Performance of Radar Altimeters for Sentinel-3A, Sentinel-3B and Jason-3 Using Transponder and Sea-Surface Calibrations with FRM Standards. Remote Sens. 2020, 12, 2642, https://doi.org/10.3390/rs12162642.

Saltogianni, V.; Mouslopoulou, V.; Oncken, O.; Nicol, A.; Gianniou, M.; Mertikas, S. (2020). Elastic Fault Interactions and Earthquake Rupture Along the Southern Hellenic Subduction Plate Interface Zone in Greece. Geophysical Research Letters 47, https://doi.org/10.1029/2019GL086604

Yang, L.; Xu, Y.; Zhou, X.; Zhu, L.; Jiang, Q.; Sun, H.; Chen, G.; Wang, P.; Mertikas, S.P.; Fu, Y.; Tang, Q.; Yu, F. (2020). Calibration of an Airborne Interferometric Radar Altimeter over the Qingdao Coast Sea, China. *Remote Sens.* 2020, *12*, 1651. https://doi.org/10.3390/rs12101651

Mertikas, S P., Donlon, C.; Cullen, R; Tripolitsiotis (2020), A. Scientific and operational roadmap for fiducial reference measurements in satellite altimetry calibration & validation, International Association of Geodesy Symposia, 150, pp. 105 - 109, https://doi.org /10.1007/1345_2019_61.

Mertikas, S.P., Kokolakis, C. (2020). Satellite Altimetry in Earth Geophysics. In: Gupta, H. (eds) Encyclopedia of Solid Earth Geophysics. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-10475-7_246-1

Mertikas, S.P.; Partsinevelos, P.; Mavrocordatos, C.; Maximenko, N.A. (2020). Chapter 3-Environmental applications of remote sensing. Pollution Assessment for Sustainable Practices in Applied Sciences and Engineering, Editors: Mohamed, A-M.; Paleologos, E., Howari, F-M. 107-163, https://doi.org/10.1016/B978-0-12-809582-9.00003-7

Mertikas, S.P.; Donlon, C.; Femenias, P.; Cullen, R.; Galanakis, D.; Frantzis, X., Tripolitsiotis, A. (2020) Fiducial Reference Measurements for Satellite Altimetry Calibration: The Constituents. In: Mertikas, S., Pail, R. (eds) Fiducial Reference Measurements for Altimetry. International Association of Geodesy Symposia, vol 150. Springer, Cham. https://doi.org/10.1007/1345_2019_56

Mertikas, S.; Donlon, C.; Vuilleumier, P; Cullen, R.; Féménias, P.; Tripolitsiotis, A. (2019) An Action Plan towards Fiducial Reference Measurements for Satellite Altimetry. Remote Sensing, 11(17), 1993, https://doi.org/10.3390/rs11171993.

Mertikas, S.P. (2019). Geodesy, Ground Positioning, and Levelling. In: Gupta, H. (eds) Encyclopedia of Solid Earth Geophysics. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-10475-7_178-1

5. 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

Commission 2: Gravity Field

The research areas of the Laboratory of Geodesy and Surveying at the Department of Surveying and Geoinformatics Engineering (University of West Attica, Athens) include gravimetry, altimetry, heterogeneous data combination in local and regional geoid and Dynamic Ocean Topography modeling and deformation monitoring. For these purposes the Laboratory is equipped with modern geodetic instruments such as GNSS geodetic receivers, geodetic levels, a gravimeter of relative measurements, and a single beam echo sounder. In addition, two tide gauges are operational in Isthmos Canal (Peloponnesus – Central Greece) since 2014 and provide local sea surface measurements every 10 sec. Gravity campaigns across Attica region were organized since 2016 and, approximately, 200 gravity benchmarks, among them the calibration line of Parnitha Mountain, were measured. A PhD work is in progress entitled "Applications of artificial intelligence in gravity Field estimations".

Current geodetic research project

Partner in **"ModernGravNet**: **Modernization of the Hellenic Gravity Network"**, funded by Hellenic Foundation for Research and Innovation (H.F.R.I.) under the "First Call for H.F.R.I. Research Projects to support Faculty members and researchers and the procurement of high-cost research equipment grant" (Project Number: 1550) – Main investigator: V. Grigoriadis – Aristotle University of Thessaloniki.

Publications

Grigoriadis, V. N., V. D. Andritsanos and D. Natsiopoulos (2022): Validation of the Hellenic gravity network in the frame of the ModernGravNet project. Presented at the 2021 Scientific Assembly of the International Association of Geodesy "Geodesy for a Sunstainable Earth", June 28th – July 2nd, Beijing, China. Accepted for publication at the International Association of Geodesy Symposia Series. Springer eds.

Grigoriadis, V.N., V.D. Andritsanos and D. Natsiopoulos (2022): Investigation of different geoid computation techniques in the frame of the ModernGravNet project. Presented at the 2022 European Geophysical Union General Assembly, May 23rd – 27th, Vienna, Austria.

Andritsanos, V.D., V.N. Grigoriadis, D. Natsiopoulos and G.S. Vergos (2022): Zero-height geopotential level WoLVD estimation for the homogenization and modernization of the Vertical Datum of Greece. Presented at the 2022 European Geophysical Union General Assembly, May 23rd – 27th, Vienna, Austria.

Commission 3: Earth Rotation and Geodynamics

The research areas of the Laboratory of Geodesy and Surveying at the Department of Surveying and Geoinformatics Engineering (University of West Attica, Athens) include geodetic reference frames and tectonic geodesy. For these purposes the Laboratory is equipped with modern geodetic GNSS receivers, a permanent GPS reference station operating since 2010 and licenses for the Bernese, GAMIT and GipsyX software packages. The Laboratory is collaborating with many institutions in Greece and abroad. A PhD work is in progress in the field of tectonic geodesy.

Current geodetic research project

The Laboratory is participating in "TectoVision: What is controlling plate motions over the minutes to decades timescale?". European Research Council, Call ID: ERC-2021-STG, Topic: PE10 - Earth System Science https://erc.easme-web.eu/?p=101042674

Publications

K. Aspioti, D. Anastasiou, M. Gianniou, V. D. Andritsanos and V. Pagounis (2022) Velocity and strain field estimation from episodic GNSS campaigns (2012-2021) for the region of Attica, Greece. Presented at REFAG 2022 – Reference Frames for Applications in Geosciences, 17th – 20th October 2022, Thessaloniki, Greece.

Mouslopoulou V., V. Saltogianni, G.M. Bocchini, S. Cesca, J. Bedford, A. Dielforder, O. Oncken, M. Gianniou, G. Petersen (2022): "Slow-slip events destabilize upper-plate and trigger large magnitude earthquake at the western-end of the Hellenic Subduction System", EGU22-1692, https://doi.org/10.5194/egusphere-egu22-1692.

Mouslopoulou V., G.M. Bocchini, S. Cesca, V. Saltogianni, J. Bedford, G. Petersen, M. Gianniou, and O. Oncken (2021): "Slow-slip, earthquake-swarms and fault-interactions at the westernend of the Hellenic Subduction System precede the Mw 6.9 Zakynthos Earthquake, Greece", EGU21-8623, https://doi.org/10.5194/egusphere-egu21-8623

Mouslopoulou, V., G. M. Bocchini, S. Cesca, V. Saltogianni, J. Bedford, G. Petersen, M. Gianniou, O. Oncken (2020): "Earthquake swarms, slow slip and fault interactions at the western-end of the Hellenic subduction system precede the moment Mw 6.9 Zakynthos earthquake, Greece". Geochemistry, Geophysics, Geosystems, 21, e2020GC009243. https://doi.org/10.1029/2020GC009243

Saltogianni, V., V. Mouslopoulou, O. Oncken, A. Nicol, M. Gianniou, S. Mertikas (2020): "Elastic Fault Interactions and Earthquake Rupture Along the Southern Hellenic Subduction Plate Interface Zone in Greece", Geophysical Research Letters, 47, e2019GL086604. https://doi.org/10.1029/2019GL086604

Saltogianni, V., V. Mouslopoulou, O. Oncken, A. Nicol, M. Gianniou, S. Mertikas (2020): "Persistent earthquake-rupture segmentation due to variable interseismic slip accumulation within the southern Hellenic subduction plate-interface zone in Greece", Geophysical Research Abstracts, Vol. 20, EGU2020-4857, 2020.

Commission 4: Positioning and Applications

The research areas of the Laboratory of Geodesy and Surveying at the Department of Surveying and Geoinformatics Engineering (University of West Attica, Athens) include accurate positioning and applications. For these purposes the Laboratory is equipped with modern geodetic instruments such as total stations (robotic and image stations), GNSS geodetic receivers, 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 and 1 sec, providing accurate position data for educational and research purposes. A permanent meteorological station is working since 2017, in conjunction with the GPS station (https://labgeo.uniwa.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.

Publications

Gianniou, M., D. Mastoris, P. Argyrakis, M. Christou (2022): "Performance of Galileo for geodetic positioning under challenging signal reception conditions", EUREF 2022 Symposium, June 1–3 2022, Zagreb, Croatia.

6. Department of Surveying and Geoinformatics Engineering of the School of Engineering of the International Hellenic University

Assistant Prof. D. Ampatzidis

Main research activities

- GNSS and SLR Processing
- Combination of different space techniques at the NEQ level
- Special applications of Least Squares Adjustment
- DEM evaluation
- GNSS levelling
- GNSS-derived deformations
- Bathymetric models assessment
- Datum transformations

Peer Reviewed Journals, Proceedings and Chapters

Mouratidis, A., D. Ampatzidis (2019). European Digital Elevation Model (EU-DEM) validation against extensive Global Navigation Satellite Systems data and comparison with SRTM DEM and ASTER GDEM in Central Macedonia (Greece), ISPRS Int. J. Geo-Inf. 2019,8,0;, doi:10.3390/ijgi8030000.

Ampatzidis D. (2019). On the assessment of the temporal evolution of global terrestrial reference frames: the VEDA approach. Acta Geodyn. Geomater., 15, No. 1 (193), 85–97. DOI: 10.13168/AGG.2019.0007.

T-M Perivolioti, A. Mouratidis, D. Terzopoulos , P. Kalaitzis, D. Ampatzidis, M. Tušer, J. Frouzova and D. Bobori (2021). Production, Validation and Morphometric Analysis of a Digital Terrain Model for Lake Trichonis Using Geospatial Technologies and Hydroacoustics. ISPRS Int. J. Geo-Inf., 10, 91. https://doi.org/10.3390/ijgi10020091.

M. Foumelis, Papazachos, C., Papadimitriou, E., Karakostas, V., Ampatzidis, D., Moschopoulos,G., Kostoglou, A., Ilieva,M., Minou, D., Mouratidis, A., KKallas, C., Chatzipetros A. (2021). On Aspects of Rapid Multidisciplinary Response to Samos-Izmir 2020 M7.0 Earthquake. Acta Geophysica. https://doi.org/10.1007/s11600-021-00578-6.

G. Moschopoulos, D. Ampatzidis, A. Mouratidis, N. Demirtzoglou, D-G Perperidou, I. Mintourakis (2021). On the problem of the transformation between the official Hellenic Geodetic Datum and the 'Old Bessel' or Old Greek Datum. A case study in the Serres region (Northern Greece). NZ Surveyor Journal, Vol. 306.

Ampatzidis, D., Wang, L., Mouratidis, A. et al. (2022) Rigorous and fast constraints transformations at the solution level: case studies for regional and global GNSS networks. GPS Solut 26, 44. https://doi.org/10.1007/s10291-022-01225-3.

Ampatzidis, D., Thaller, D., Wang, L. (2022). The Correlations of the Helmert Transformation Parameters as an Additional Auxiliary Diagnostic Tool for Terrestrial Reference Frames Quality Assessment. In: International Association of Geodesy Symposia. Springer, Berlin, Heidelberg. https://doi.org/10.1007/1345_2022_164.

Memberships

2017-now: Dimitrios Ampatzidis is a member of International Laser Ranging Service (ILRS)

2021-now: Dimitrios Ampatzidis is a member of European Space Education Resource Office (ESERO)

2019-now Dimitrios Ampatzidis is a member of Copernicus Academy of the Aristotle University Thessaloniki.

Assistant Prof. E.A. Tzanou

Main research activities

During the last four years the main research activities have been focused on the analytical gravity field and geoid modeling in support of GNSS/Levelling and the practical realization of seamless orthometric height

determination from CORS stations. Moreover, studies on the cyclo-stationarity of sea level anomalies and correlation with climatic indexes have been performed as contribution to climate variability over the Mediterranean area.

References for the reporting period:

Ampatzidis D, Tzanou EA, Demirtzoglou N, Vergos GS (2022) Strategies for the optimal combination between local 3D modern GNSS and 2D classical networks, expressed in different reference frames: Case study in Greece. Presented at the IAG Commission 1 "Reference Frames for Applications in Geosciences" – REFAG2022 Conference, October 17-20, Thessaloniki, Greece.

Natsiopoulos DA, Tzanou EA, Vergos GS (2022) Cyclo-Stationarity in Sea Level Variability from Satellite Altimetry Data and Correlation with Climate Indices in the Mediterranean Sea. In: T. Bašić (ed.), Altimetry - Theory, Applications and Recent Advances, IntechOpen, London. doi: https://doi.org/10.5772/intechopen.109013.

Natsiopoulos DA, Mamagiannou E, Tzanou EA, Triantafyllou A, Vergos GS, Tziavos IN, Ramnalis D, Polychronos V (2022) Gravity and GNSS/Leveling data collection towards developing a regional geoid model in support of the newly established GeoNetGNSS CORS network. Presented at the 3rd joint meeting of the International Gravity Field Service and Commission 2 of the International Association of Geodesy "Gravity Geoid and Height Systems 2022" – GGHS2022, Conference, September 12-14, Austin TX, USA.

Natsiopoulos DA, Mamagiannou E, Tzanou EA, Triantafyllou A, Vergos GS, Tziavos IN, Ramnalis D, Polychronos V (2022) GeoNetGNSS, a newly established CORS network in Northern Greece in support of high-accuracy positioning applications. Presented at the IAG Commission 1 "Reference Frames for Applications in Geosciences" – REFAG2022 Conference, October 17-20, Thessaloniki, Greece.

7. Hellenic Military Geographical Service's (HMGS) report to IAG (2019-2022)

Establishment of a new GNSS network alongside gravity observations

By the year 2014 until 2022 HMGS has organized yearly campaigns of simultaneous GNSS and gravity measurements in Greek territory in order to establish a new Hellenic Military Reference Frame (HMRF), aligned to the International Reference Frame 2008. In the year 2022 the project was completed, having performed GNSS and gravity measurements at almost 700 triangulation and levelling points throughout Greece. Most of the aforementioned points were triangulation pillars which had already been surveyed for the national coordinate system, the HGRS87, using classic methods many decades ago.

The implementation of the ITRF08 was held using 13 permanent GNSS stations of the IGS network whilst the data of the GNSS observations, for the direct reference, were processed with the scientific software GAMIT. Additionally, during the processing, precise IGS final orbits, grids for the ocean tide loading {Finite Element Solutions (FES2004)}, the atmospheric delay corrections (Vienna Mapping Functions 1) and non-tidal atmospheric loading corrections (for each year referenced to the earth center of mass), were used. Afterwards the GLOBK software through a Kalman filter stabilized all the stations to the ITRF08. The use of GLOBK took into consideration standard errors of the reference stations. This means that it moves the whole network in a manner that it best fits, always inside the uncertainty of each of the reference stations. The total accuracy of the network is estimated under ± 3 cm.

Figure 1- HMGS GNSS measurements

Figure 2- HMGS gravity measurements

Figure 3- The HMRF network

Publications:

Katsafados, I., Galanis, J., Zacharis, V., Paraskevas, M., Strempa, M., Forotzidou, C., Papadopoulos, N.,Kalenteridis, K. &Tsakiri, M. Combined analysis of GNSS, gravity and historic surveying data at theAlkyonides fault. 37th General Assembly (GA) of the European Seismological Commission, 19-24 Sep 2021, virtually (oral presentation).

Katsafados, I.,Paraskevas, M. &Papadopoulos, N.,Determination of velocity field for Greece processing data fromGNSS permanent stations. Technical Bulletin of HMGS no. 2021.001, HMGS, Athens (in greek).

Papadopoulos, N., Paraskevas, M., Katsafados, I., Nikolaidis, G. &Anagnostou, E. (2020). Deformation detection through the realization of reference frames. Journal of Applied Geodesy. DOI: 10.1515/jag-2019-0056.

Geoid Model Determination for the Hellenic Territory"HELLAS GEOID 2022"

The geoid "HELLAS GEOID 2022" (HG2022) constitutes the most completed modelthat HMGS produced for the Greek territory.Data comprised of gravity timeseries,orthometric and ellipsoid heights, high resolution digital terrain and depth models. Accuracy and adequacy evaluation took place for all the above datasets. Furthermore, data originated from other studies were used in order to fulfill regions with low coverage (mostly in sea and neighbor countries). Gravity signal from the heterogeneous data extracted adopting the "remove-compute-restore" technique. The Global Geoid Model that fits best in Greece is the EIGEN 6C4 in complete degree and order 2190. Contribution of average residual gravity calculated using Stokes theorem in frequency spectrum with Fourier transformation. The resulting gravimetric geoid surface adapted properly to the national height system with 5cm accuracy. For this adaption the method of collocation was enabled and the use of normally distributed points with known orthometric and ellipsoid heights.

Publications:

Paraskevas, M. &Papadopoulos, N.,Geoid Model Determination for the Hellenic Territory"HELLAS GEOID 2022"Technical Bulletin of HMGS no. 2022.002, HMGS, Athens (in greek).

Paraskevas, M., Forotzidou, C., Katsafados, I., Strempa, M., Kalenteridis, K. &Tsakiri, M. Gravitymeasurements as precursors of Earthquake, 37th General Assembly (GA) of the European SeismologicalCommission, 19-24 Sep 2021, virtually (e-poster).

Papadopoulos, N., Paraskevas, M., Katsafados, I. &Nikolaidis, G. Calculating a geoid model forGreece using gravity and GPS observations. 4th Joint International Symposium on DeformationMonitoring (JISDM), 15-17 May 2019, Athens, Greece (oral presentation).

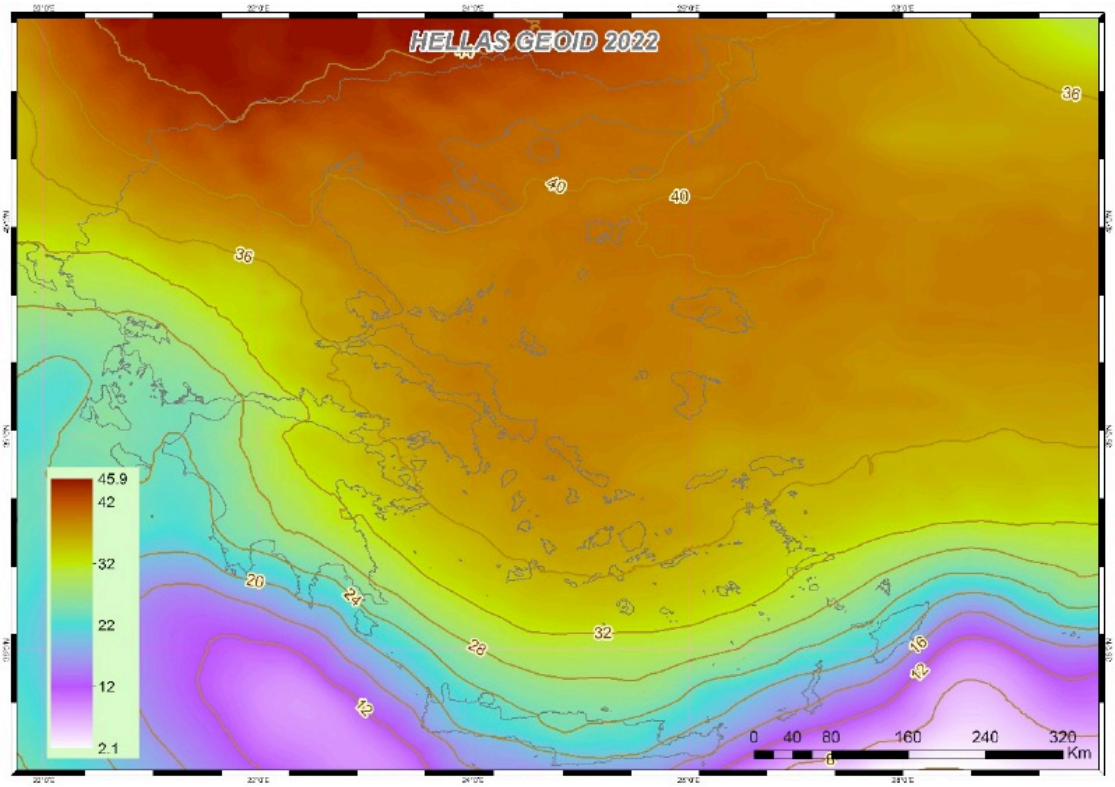


Figure 4- HELLAS GEOID 2022

Geodetic determination of the border pyramids at the borderline between the Hellenic Republic and the Republic of Albania

In the years 2021 and 2022 the HMGS, in cooperation with the corresponding public services of Albania, carried out GNSS observations and updated the coordinates of the border pyramids at the borderline between Greece and Albania. The field work was performed by joint Greek and Albanian working groups in the summers of 2021 and 2022 along the entire borderline, using entirely GNSS receivers and performing observations at static mode. The data extracted by the joint GNSS observations were processed at the level of code and phase, for the final collocation of the network and the integration in the desired reference frame, using the research / scientific software GAMIT / GLOBK version 10.71 and the commercial software Magnet Tools. The final coordinates of the pyramids are reported in the ITRF2014 reference frame at the epoch of their measurement.

Figure 5- Border pyramid

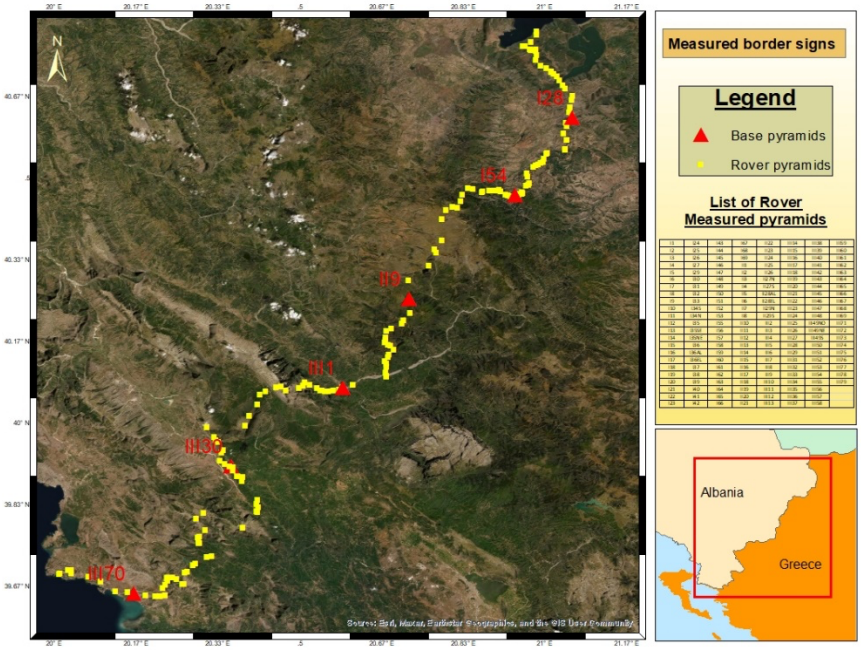


Figure 6- Measured Border Pyramids

Publications:

HMGS internal report.

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

Scientific responsible: Dr. Konstantinos Chousianitis, Associate Researcher, chousianitis@noa.gr
Dr Athanassios Ganas , Research Director, aganas@noa.gr

1. Permanent GNSS stations and telemetry

The Institute of Geodynamics (GEIN) of the National Observatory of Athens (NOA) operates the NOANET, which is a continuously operating GNSS network in Greece, for regional studies in seismology and geodynamics. Its primary scientific role is to support high precision, real-time geodetic measurements using Global Navigation Satellite System (GNSS) observations, in order to measure and quantify coseismic, postseismic, and interseismic deformation across major fault zones, active crustal deformation processes and tectonic deformation in the plate boundary zones of the eastern Mediterranean, as well as to support GPS seismology and other earth science applications. The NOANET network has been operating since 2006, following the EUREF Permanent GNSS Network (EPN) standards. The network, as of December 2022, comprises 24 stations all of which are telemetered in real-time to the main GNSS server of the Institute of Geodynamics in Athens. All stations collect data every 1 sec and transmit them to Athens on the hour (hourly files). At some stations, 5 Hz or 10 Hz are also collected on the ring buffer and remain available for manual download for a period of 72 hours. Data archiving is performed in two modes: a) 1 sec data of each station are archived in hourly intervals and b) daily data for each station are archived in 30 sec sampling rate. 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 sec intervals. This file is converted to RINEX format and delivered to the NOA Web Server where it is available for download. Additionally, the NOANET GLASS node disseminate, on a daily basis, data from a number of continuously operating GNSS stations located throughout the Balkan region. NOANET supports a free and open data policy.

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

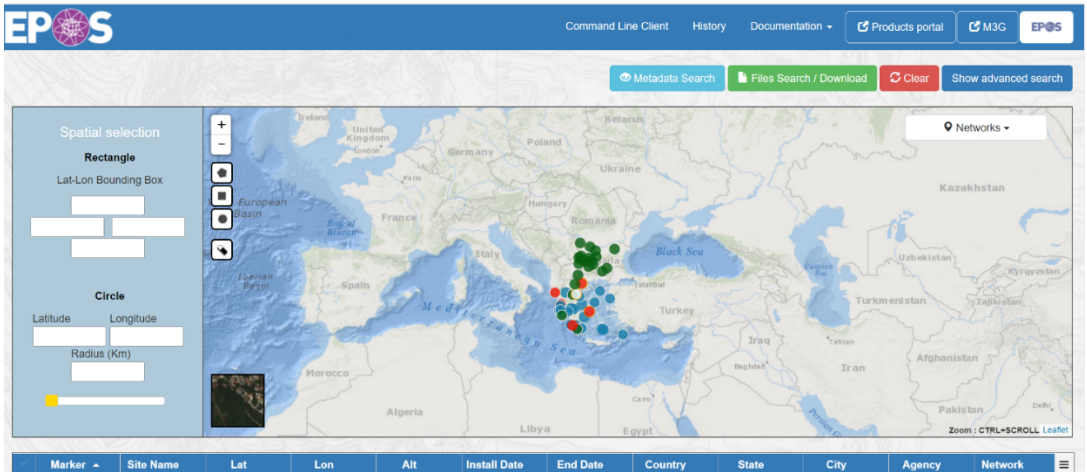


Figure 2. The NOA GLASS node for GNSS data Dissemination.

2. Hardware and software

NOA operates a mixed pool of receivers (Leica, Trimble, Topcon) and antennas for permanent GPS/GNSS observations. For the Leica and Topcon receivers, which compose the majority of the NOANET network, data transmission is performed via real-time streaming; data collected on site are immediately transmitted via telemetry to a dedicated server located at NOA. This server is equipped with two software packages, namely Leica Spider Software Suite and TopNET+, which receive and manage the incoming streams and provide remote interaction with the Leica and Topcon receivers of NOANET, respectively. Apart from data acquisition management, these software packages are able to monitor satellite and site parameters. All this relevant information is archived to supervise the network performance and detect awkward station behavior, especially during the testing and evaluation phase after the establishment of a new station. Assisted by a number of in-house developed Python programs, this software bundle enables also the monitoring of station status, data validity, integrity, and continuity. Data interruptions as well as streaming problems are detected in near-real time, and a warning system has been configured to automatically send alert messages to inform network operators in case of problems. Streamed data are stacked to binary, raw hourly files. For the rest of the NOANET stations (namely the ones equipped with Trimble receivers), data transmission and acquisition are performed in near-real time. Data collected by the receivers are recorded in hourly files and stored locally (at the receiver's internal memory). NOA has designed and implemented an array of programs to connect to these remote instruments (normally via FTP). These allow searching, identifying, and downloading the hourly files to the NOANET dedicated server at NOA. This process takes place on an hourly basis with a time lag of a few minutes. Both schemes described previously result in hourly, binary, raw (also known as receiver-manufacturer dependent) files for each of the NOANET stations. These files are in turn preedited, checked, compressed, and archived in a network attached storage (NAS) server located at NOA dedicated to hosting NOANET's GNSS data. 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.

3. Network Funding

a) EPOS SP - European Plate Observing System Sustainability Phase, financed by the European Union Horizon 2020 Grant agreement ID: 871121, 2020-2023.
b) "Support of Research Infrastructures and Prevention of Seismic Disaster in Lixouri Municipality, Cephalonia" financed by the Municipality of Lixouri, 2021-2023.
c) "Seismotectonic investigation of western Ioannina Area – Geometry and Kinematics of active structural elements investigation based on seismological, geological and geodetic data»" financed by Energean PLC, 2022.
d) "Monitoring of ground displacements in two quarries (Greece and north Macedonia)" financed by TITAN SA, 2022.
e) "Landslide Risk Management of Attica region" M.I.S. (5050327) co-financed by Greece and the European Union (European Social Fund – E.S.F.) through the Operational Program "Human Resources Development, Education and Lifelong Learning 2014-2020", 2020-2021 http://dias-proj.civil.duth.gr/
f) "Seismicity investigation of Katakolo area, Ilia – Geometry and kinematics of active structural elements investigation based on seismological and geodetic data" financed by Energean PLC, 2019-2020.
g) HELPOS "Hellenic System for monitoring of the lithosphere", 2016-2020.

4. Websites – Portals

a) NOANET website: http://geodesy.gein.noa.gr:8000/nginfo/
b) GLASS node at NOA (Geodetic Linking Advanced Software System): http://194.177.194.250:8080/glasswebui/#/site

5. Publications in Peer-reviewed SCI Journals (2019-2022)

Kontoes, Ch., Alatza, S., Chousianitis, K., Svigkas, N., Loupasakis, C., Atzori, S., Apostolakis, A., 2022. Coseismic Surface Deformation, Fault Modeling, and Coulomb Stress Changes of the March 2021 Thessaly, Greece, Earthquake Sequence Based on InSAR and GPS Data. Seismological Research Letters, 93(5), 2584-2598, https://doi.org/10.1785/0220210112

Lazos, I., Sboras, S., Chousianitis, K., Kondopoulou, D., Pikridas, C., Bitharis, S., Pavlides, S., 2022. Temporal evolution of crustal rotation in the Aegean region based on primary geodetically-derived results and palaeomagnetism. Acta Geodaetica et Geophysica. https://doi.org/10.1007/s40328-022-00379-3

Ganas A, Hamiel Y, Serpetsidaki A, Briole P, Valkaniotis S, Fassoulas C, Piatibratova O, Kranis H, Tsironi V, Karamitros I, Elias P, Vassilakis E. 2022. The Arkalochori Mw = 5.9 Earthquake of 27 September 2021 Inside the Heraklion Basin: A Shallow, Blind Rupture Event Highlighting the Orthogonal Extension of Central Crete. Geosciences. 12(6):220. https://doi.org/10.3390/geosciences12060220

Taymaz T., Ganas A., Berberian M., Eken T., T. Serkan Irmak, Kapetanidis V., Yolsal-Çevikbilen S., Erman C., Keleş D., Esmaeili C., Tsironi V., Özkan B., 2022. The 23 February 2020 Qotur-Ravian earthquake doublet at the Iranian-Turkish border: Seismological and InSAR evidence for escape tectonics, Tectonophysics, 838, 229482, https://doi.org/10.1016/j.tecto.2022.229482.

Fernandes R, Bruyninx C, Crocker P, Menut J-L, Socquet A, Vergnolle M, Avallone A, Bos M, Bruni S, Cardoso R, Carvalho L, Cotte N, D'Agostino N, Deprez A, Andras F, Geraldes F, Janex G, Kenyeres A, Legrand J, Ngo K-M, Lidberg M, Liwosz T, Manteigueiro J, Miglio A, Soehne W, Holger S, Toth S, Dousa J, Ganas A, Kapetanidis V, Batti G. 2022. A new European service to share GNSS Data and Products. Ann. Geophys. [Internet]. 2022Jul.12 [cited 2022Jul.21];65(3):DM317 Available from: https://www.annalsofgeophysics.eu/index.php/annals/article/view/8776

Sarhosis, V., Giarlelis, C., Karakostas, C., E. Smyrou, I. E. Bal, S. Valkaniotis & A. Ganas. 2022. Observations from the March 2021 Thessaly Earthquakes: an earthquake engineering perspective for masonry structures. Bull Earthquake Eng. https://doi.org/10.1007/s10518-022-01416-w

Mesimeri, M., Ganas, A., Pankow, K.L., 2022. Multisegment ruptures and Vp/Vs variations during the 2020-2021 seismic crisis in western Corinth Gulf, Greece, Geophysical Journal International, Volume 230, Issue 1, Pages 334–348, ggac081, https://doi.org/10.1093/gji/ggac081

Tsironi, V., Ganas, A., Karamitros, I., Efstathiou, E., Koukouvelas, I., Sokos, E. 2022. Kinematics of Active Landslides in Achaia (Peloponnese, Greece) through InSAR Time Series Analysis and Relation to Rainfall Patterns. Remote Sens., 14(4), 844. https://doi.org/10.3390/rs14040844

Kassaras, I., Kapetanidis, V., Ganas, A., Karakonstantis, A., Papadimitriou, P., Kaviris, G., Kouskouna, V., Voulgaris, N., 2022. Seismotectonic analysis of the 2021 Damasi-Tyrnavos (Thessaly, Central Greece) earthquake sequence and implications on the stress field rotations. Journal of Geodynamics, 150, 101898, https://doi.org/10.1016/j.jog.2022.101898

Papathanassiou, G., Valkaniotis, S., Ganas, A., Stampolidis, A., Rapti, D., Caputo, R., 2022. Floodplain evolution and its influence on liquefaction clustering: The case study of March 2021 Thessaly, Greece, seismic sequence. Engineering Geology, 298, 106542, https://doi.org/10.1016/j.enggeo.2022.106542

Ganas, A., Elias, P., Briole, P., Valkaniotis, S., Escartin, J., Tsironi, V., Karasante, I, Kosma, Chr. 2021. Co-seismic and post-seismic deformation, field observations and fault model of the 30 October 2020 Mw = 7.0 Samos earthquake, Aegean Sea. Acta Geophys., 69, 999-1024 https://doi.org/10.1007/s11600-021-00599-1

Iezzi, F., Roberts, G., Faure Walker, J., Papanikolaou, I., Ganas, A., et al. 2021. Temporal and spatial earthquake clustering revealed through comparison of millennial strain-rates from 36Cl cosmogenic exposure dating and decadal GPS strain-rate. Sci Rep 11, 23320. https://doi.org/10.1038/s41598-021-02131-3

Cordrie, L., Gailler, A., Heinrich, P., Briole, P. & Ganas, A. 2021. The July 20, 2017 Mw = 6.6 Bodrum-Kos Earthquake, Southeast Aegean Sea: Contribution of the Tsunami Modeling to the Assessment of the Fault Parameters. Pure Appl. Geophys., https://doi.org/10.1007/s00024-021-02766-3

Matsakou, A., Papathanassiou, G., Marinos, V., Ganas, A., Valkaniotis, S. 2021. Development of the coseismic landslide susceptibility map of the island of Lefkada, Greece. Environ Earth Sci 80, 457, https://doi.org/10.1007/s12665-021-09741-0

Briole, P., A. Ganas, P. Elias, D. Dimitrov, 2021. The GPS velocity field of the Aegean. New observations, contribution of the earthquakes, crustal blocks model, Geophysical Journal International, ggab089, https://doi.org/10.1093/gji/ggab089

Kouskouna, V., Ganas, A., Kleanthi, M. et al. 2021. Evaluation of macroseismic intensity, strong ground motion pattern and fault model of the 19 July 2019 Mw5.1 earthquake west of Athens. J Seismol. https://doi.org/10.1007/s10950-021-09990-3

Kontoes, C., Loupasakis, C., Papoutsis, I., Alatza, S., Poyiadji, E., Ganas, A., Psychogyiou, C., Kaskara, M., Antoniadi, S., Spanou, N. 2021. Landslide Susceptibility Mapping of Central and Western Greece, Combining NGI and WoE Methods, with Remote Sensing and Ground Truth Data. Land, 10, 402. https://doi.org/10.3390/land10040402

Papathanassiou, G., Valkaniotis, S. & Ganas, A. 2021. Spatial patterns, controlling factors, and characteristics of landslides triggered by strike-slip faulting earthquakes: case study of Lefkada island, Greece. Bull Eng Geol Environ. https://doi.org/10.1007/s10064-021-02181-x

Chousianitis, K., Papanikolaou, X., Drakatos, G., Tselentis G.-A., 2021. NOANET: A Continuously Operating GNSS Network for Solid-Earth Sciences in Greece. Seismological Research Letters, 92 (3), 2050-2064. https://doi.org/10.1785/0220200340

Chousianitis, K., & Konca, A.O., 2021. Rupture Process of the 2020 Mw7.0 Samos Earthquake and its Effect on Surrounding Active Faults. Geophysical Research Letters, 48, e2021GL094162, https://doi.org/10.1029/2021GL094162

Karpouza, M., Chousianitis, K., Bathrellos, G.D., Skilodimou, H.D., Kaviris, G., Antonarakou, A., 2021. Hazard zonation mapping of earthquake-induced secondary effects using spatial multi-criteria analysis. Natural Hazards, 109, 637-669, https://doi.org/10.1007/s11069-021-04852-0

Lazos, I., Sboras, S., Chousianitis, K., Bitharis, S., Mouzakiotis, E., Karastathis, V., Pikridas, C., Fotiou, A., Galanakis, D., 2021. Crustal deformation analysis of Thessaly (central Greece) before the March 2021 earthquake sequence near Elassona-Tyrnavos (northern Thessaly). Acta Geodynamica et Geomaterialia, 18(3), 379-385, doi:10.13168/AGG.2021.0026

Taymaz, T., A. Ganas, S. Yolsal-Çevikbilen, F. Vera, T. Eken, C. Erman, D. Keleş, V. Kapetanidis, S. Valkaniotis, I. Karasante, V. Tsironi, P. Gaebler, D. Melgar, T. Öcalan, 2021. Source Mechanism and Rupture Process of the 24 January 2020 Mw 6.7 Doğanyol–Sivrice Earthquake obtained from Seismological Waveform

Analysis and Space Geodetic Observations on the East Anatolian Fault Zone (Turkey). Tectonophysics, Volume 804, 228745. https://doi.org/10.1016/j.tecto.2021.228745

Tavoularis, N., Papathanassiou, G., Ganas, A., Argyrakis, P. 2021. Development of the Landslide Susceptibility Map of Attica Region, Greece, Based on the Method of Rock Engineering System. Land, 10, 148. https://doi.org/10.3390/land10020148

Valkaniotis, S., Briole, P., Ganas, A., Elias, P., Kapetanidis, V., Tsironi, V., Fokaefs, A., Partheniou, H., Paschos, P. 2020. The Mw = 5.6 Kanallaki Earthquake of 21 March 2020 in West Epirus, Greece: Reverse Fault Model from InSAR Data and Seismotectonic Implications for Apulia-Eurasia Collision. Geosciences, 10, 454. https://www.mdpi.com/2076-3263/10/11/454/htm

Kassaras, I., Kapetanidis, V., Ganas, A., Tzanis, A., Kosma, C., Karakonstantis, A., Valkaniotis, S., Chailas, S., Kouskouna, V., Papadimitriou, P. 2020. The New Seismotectonic Atlas of Greece (v1.0) and Its Implementation. Geosciences, 10, 447. https://www.mdpi.com/2076-3263/10/11/447

Melgar, D. Ganas, A., Taymaz, T., Valkaniotis, S., Crowell, BW, Kapetanidis, V., Tsironi, V., Yolsal-Çevikbilen, S., Öcalan, T. 2020. Rupture kinematics of January 24, 2020 Mw 6.7 Doğanyol-Sivrice, Turkey earthquake on the East Anatolian Fault zone imaged by space geodesy, Geophysical Journal International, 223, 2, 862–874. https://doi.org/10.1093/gji/ggaa345

Ganas, A., Elias, P., Briole, P., Cannavo, F., Valkaniotis, S., Tsironi, V., Partheniou, E.I. 2020. Ground Deformation and Seismic Fault Model of the M6.4 Durres (Albania) Nov. 26, 2019 Earthquake, Based on GNSS/INSAR Observations. Geosciences, 10 (6), 210. https://www.mdpi.com/2076-3263/10/6/210/htm

Ganas A, Briole P, Bozionelos G, Barberopoulou A, Elias P, Tsironi V, Valkaniotis S, Moshou A, Mintourakis I, 2020. The 25 October 2018 Mw= 6.7 Zakynthos earthquake (Ionian Sea, Greece): a low-angle fault model based on GNSS data, relocated seismicity, small tsunami and implications for the seismic hazard in the west Hellenic Arc, Journal of Geodynamics. doi: https://doi.org/10.1016/j.jog.2020.101731

Karamitros, I., Ganas, A., Chatzipetros, A., Valkaniotis, S., 2020. Non-planarity, scale-dependent roughness and kinematic properties of the Pidima active normal fault scarp (Messinia, Greece) using high-resolution terrestrial LiDAR data, Journal of Structural Geology, 136, 104065. doi: https://doi.org/10.1016/j.jsg.2020.104065

Argyrakis, P., Ganas, A., Valkaniotis, S. et al. 2020. Anthropogenically induced subsidence in Thessaly, central Greece: new evidence from GNSS data. Nat Hazards, 102, 179-200. https://doi.org/10.1007/s11069-020-03917-w

D'Agostino, N., M. Métois, R. Koci, L. Duni, N. Kuka, A. Ganas, I. Georgiev, F. Jouanne, N. Kaludjerovic, R. Kandić, 2020. Active crustal deformation and rotations in the southwestern Balkans from continuous GPS measurements. Earth and Planetary Science Letters, 539, 116246. https://doi.org/10.1016/j.epsl.2020.116246

Haddad, A., A. Ganas, I. Kassaras, M. Lupi, 2020. Seismicity and geodynamics of western Peloponnese and central Ionian Islands: insights from a local seismic deployment, Tectonophysics, 778, 228353. https://doi.org/10.1016/j.tecto.2020.228353

Cirella, A., F. Romano, A. Avallone, A. Piatanesi, P. Briole, A. Ganas, N. Theodoulidis, K. Chousianitis, M. Volpe, G. Bozionellos, G. Selvaggi, S. Lorito, 2020. The 2018 Mw 6.8 Zakynthos (Ionian Sea, Greece) Earthquake: Seismic source and local tsunami characterization, Geophysical Journal International, 221 (2) 1043-1054. https://doi.org/10.1093/gji/ggaa053

Ganas, A., Elias, P., Kapetanidis, V, Valkaniotis, S., Briole, P., Kassaras, I., Argyrakis, P., Barberopoulou, A., Moshou, A., 2019. The July 20, 2017 M6.6 Kos Earthquake: Seismic and Geodetic Evidence for an Active North-Dipping Normal Fault at the Western End of the Gulf of Gökova (SE Aegean Sea), Pure and Applied Geophysics, 176 (10), 4177-4211. https://doi.org/10.1007/s00024-019-02154-y

Robertson, J., Meschis, M., Roberts, G.P, Ganas A., Gheorgiou, D., 2019. Temporally constant Quaternary uplift rates and their relationship with extensional upper-plate faults in south Crete (Greece), constrained with 36Cl exposure dating. Tectonics. 38 (4), 1189-1222. https://doi.org/10.1029/2018TC005410

Ferrier, Graham, Richard Pope, Athanassios Ganas, 2019. Prospectivity mapping for high sulfidation epithermal porphyry deposits using an integrated compositional and topographic remote sensing dataset. Ore Geology Reviews, 107, 353-363. https://doi.org/10.1016/j.oregeorev.2019.02.029

Ferrier, G.; Ganas, A.; Pope, R.; Jo Miles, A. 2019. Prospectivity Mapping for Epithermal Deposits of Western Milos Using a Fuzzy Multi Criteria Evaluation Approach Parameterized by Airborne Hyperspectral Remote Sensing Data. Geosciences, 9 (3), 116. https://doi.org/10.3390/geosciences9030116

Giannaraki, G. Kassaras, I., Roumelioti, Z., Kazantzidou-Firtinidou, D., and Ganas, A. 2019. Deterministic seismic risk assessment in the city of Aigion (W. Corinth Gulf, Greece) and juxtaposition with real damage due to the 1995 Mw6.4 earthquake, Bulletin of Earthquake Engineering, 17 (2), 603-634. https://doi.org/10.1007/s10518-018-0464-z

Ruhl, Christine J., Diego Melgar, Jianghui Geng, Dara E Goldberg, Brendan W Crowell, Richard M Allen, Yehuda Bock, Sergio Barrientos, Sebastian Riquelme, Juan Carlos Baez, Enrique Cabral-Cano, Xyoli Pérez-Campos, Emma M Hill, Marino Protti, Athanassios Ganas, Mario Ruiz, Patricia Mothes, Paul Jarrín, Jean-Mathieu Nocquet, Jean-Phillipe Avouac, Elisabetta D'Anastasio, 2019. A Global Database of Strong-Motion Displacement GNSS Recordings and an Example Application to PGD Scaling, Seismological Research Letters, 90 (1), 271-279. https://doi.org/10.1785/0220180177

Chousianitis, K., & Konca, A.O., 2019. Intraslab Deformation and Rupture of the Entire Subducting Crust During the 25 October 2018 Mw 6.8 Zakynthos Earthquake. Geophysical Research Letters, 46, 14358-14367. https://doi.org/10.1029/2019GL085845

9. Report of Hellenic Cadastre to IAG 2019-2022

Commission 1: Reference Frames

The Hellenic Cadastre is in charge for 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 2019-2021 have been:

- Monitoring of the coordinates of HEPOS stations
- Estimation of tectonic velocities of the HEPOS stations
- Estimation of crustal deformations induced by strong earthquakes (the 2020 Samos, east Aegean Sea earthquake, the 2021 Elassona, Thessaly Central Greece earthquake)
- Contribution to the EUREF Working Group "Unified European Reference": Supply of information about the vertical reference in Greece (HEPOS geoid etc.)
- Participation in the Working Group of the Geodetic and Geophysical Committee of the (Hellenic) State in order to assess the prospect of developing a new contemporary Geodetic Reference System in Greece.

Publications

Gianniou, M., D. Mastoris, E. Mitropoulou (2021): "National Report of Greece to EUREF 2021", EUREF 2021 Symposium, May 30 - June 1 2021, Ljubljana, Slovenia.

Mouslopoulou V., G.M. Bocchini, S. Cesca, V. Saltogianni, J. Bedford, G. Petersen, M. Gianniou, and O. Oncken (2021): "Slow-slip, earthquake-swarms and fault-interactions at the westernend of the Hellenic Subduction System precede the Mw 6.9 Zakynthos Earthquake, Greece", EGU21-8623, https://doi.org/10.5194/egusphere-egu21-8623.

Saltogianni, V., V. Mouslopoulou, O. Oncken, A. Nicol, M. Gianniou, S. Mertikas (2020): "Persistent earthquake-rupture segmentation due to variable interseismic slip accumulation within the southern Hellenic subduction plate-interface zone in Greece", *Geophysical Research Abstracts,* Vol. 20, EGU2020-4857, 2020

Saltogianni, V., V. Mouslopoulou, O. Oncken, A. Nicol, M. Gianniou, S. Mertikas (2020): "Elastic Fault Interactions and Earthquake Rupture Along the Southern Hellenic Subduction Plate Interface Zone in Greece", *Geophysical Research Letters,* 47, e2019GL086604. https://doi.org/10.1029/ 2019GL086604.

Commission 4: Positioning and Applications

The Hellenic Cadastre is in charge for the operation of the national RTK network HEPOS (Hellenic Positioning System). In this context, the main activities of the Hellenic Cadastre in the period 2019-2021 have been:

- Upgrading of the HEPOS network to a full GNSS system, which supports GPS, GLONASS, Galileo, BeiDou and SBAS.
- Conduction of field measurements for assessing the performance of the full GNSS services of HEPOS.
- Monitoring of the ionospheric activity over Greece and assessment of its impact on the RTK measurements.

Publications

Gianniou, M., D. Mastoris, E. Mitropoulou (2022): "National Report of Greece to EUREF 2022", EUREF 2022 Symposium, June 1-3 2022, Zagreb, Croatia.

Mastoris, D., M. Gianniou, E. Mitropoulou (2021): "Full GNSS Services of the upgraded Hellenic Positioning System HEPOS: First experiences & perspectives", in Greek, 6th Panhellenic Conference of Rural and Surveying Engineers, Athens, June 3-4, 2021.

Gianniou, M., E. Mitropooulou, D. Mastoris (2019): "On the role of the length of GPS time-series in the accuracy of tectonic velocities' estimation: Examples from the HEPOS network", 4th Joint International Symposium on Deformation Monitoring (JISDM), 15-17 May 2019, Athens, Greece.

IAGA REPORT

GEOMAGNETISM AND AERONOMY
RESEARCH ACTIVITIES IN GREECE
FOR THE PERIOD 2019-2023

Edited by

Ioannis A. Daglis
IAGA National Correspondent

Contributions by:

- *Democritus University of Thrace (DUTH), Department of Electrical and Computer Engineering*
- *National & Kapodistrian University of Athens (NKUA), Department of Physics*
- *National Observatory of Athens, IAASARS*
- *University of Ioannina, Department of Physics*
- *University of Thessaly, Department of Physics*

FOREWORD

This report was prepared as part of the national report of the Committee of Geodesy and Geophysics of Greece, for the 28th General Assembly of the International Union of Geodesy and Geophysics (IUGG) that will be held in Berlin, Germany, in July 2023.

The report presents the research activities in geomagnetism and aeronomy and the progress achieved by Greek Universities and Research Institutions during the reporting period 2019-2023.

The report is structured in sections that correspond to the IAGA Divisions.

I would like to express my sincere thanks to all colleagues for their contributions to this report.

Athens, June 2023

Prof. Dr. Ioannis A. Daglis
National & Kapodistrian University of Athens / Hellenic Space Center

Division 2: Aeronomic Phenomena

Democritus University of Thrace (DUTH), Department of Electrical and Computer Engineering

Space Physics Group: Associate Prof. Theodoros Sarris (TS), Stelios Tourgaidis (ST), Panagiotis Pirnaris (PP), Dimitrios Baloukidis (DB)

The Space Physics Group of the Democritus University of Thrace conducts research in solar-terrestrial physics, magnetospheric physics, ionosphere-thermosphere physics, and space weather with a special emphasis on the Earth's radiation belts.

Related to Division 2: Aeronomic Phenomena, DUTH studies the electrodynamics of the upper atmosphere and ionosphere-atmosphere interactions in the polar regions (WG II.G).

Related international programmes include:

- ESA-NASA Thermosphere-Ionosphere Science Working Group (ENLoTIS) https://science.nasa.gov/science-news/NASA_and_ESA_Exploring_New_Joint_Satellite_Mission_Concepts

Related publications include:

- Sarris, T., Palmroth, M., Aikio, A., Buchert, S. C., Clemmons, J., Clilverd, M., Dandouras, I., Doornbos, E., Goodwin, L. V., Grandin, M., Heelis, R., Ivchenko, N., Moretto-Jørgensen, T., Kervalishvili, G., Knudsen, D., Liu, H.-L., Lu, G., Malaspina, D. M., Marghitu, O., Maute, A., Miloch, W. J., Olsen, N., Pfaff, R., Stolle, C., Talaat, E., Thayer, J., Tourgaidis, S., Verronen, P. T., and Yamauchi, M.: Plasma-neutral interactions in the lower thermosphere-ionosphere: The need for in situ measurements to address focused questions, Frontiers in Astronomy and Space Sciences, 9, https://doi.org/10.3389/fspas.2022.1063190 , 2023.480
- Sarris, T. E.: Understanding the ionosphere thermosphere response to solar and magnetospheric drivers: status, challenges and open issues, Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 377, 20180 101, https://doi.org/10.1098/rsta.2018.0101 , 2019.
- Sarris, T. E., Talaat, E. R., Palmroth, M., Dandouras, I., Armandillo, E., Kervalishvili, G., Buchert, S., Tourgaidis, S., Malaspina, D. M., Jaynes, A. N., Paschalidis, N., Sample, J., Halekas, J., Doornbos, E., Lappas, V., Moretto Jørgensen, T., Stolle, C., Clilverd, M., Wu, Q.,485 Sandberg, I., Pirnaris, P., and Aikio, A.: Daedalus: a low-flying spacecraft for in situ exploration of the lower thermosphere–ionosphere, Geoscientific Instrumentation, Methods and Data Systems, 9, 153–191, https://doi.org/10.5194/gi-9-153-2020 , 2020.
- Palmroth, M., Grandin, M., Sarris, T., Doornbos, E., Tourgaidis, S., Aikio, A., Buchert, S., Clilverd, M. A., Dandouras, I., Heelis, R., Hoffmann, A., Ivchenko, N., Kervalishvili, G., Knudsen, D. J., Kotova, A., Liu, H.-L., Malaspina, D. M., March, G., Marchaudon, A., Marghitu, O., Matsuo, T., Miloch, W. J., Moretto-Jørgensen, T., Mpaloukidis, D., Olsen, N., Papadakis, K., Pfaff, R., Pirnaris, P., Siemes, C., Stolle, C., Suni, J., van den IJssel, J., Verronen, P. T., Visser, P., and Yamauchi, M.: Lower-thermosphere–ionosphere (LTI) quantities: current status of measuring techniques and models, Annales Geophysicae, 39, 189–237, https://doi.org/10.5194/angeo-39-189-2021 , 2021.
- Wu, Q., Sheng, C., Wang, W., Noto, J.,Kerr, R., McCarthy, M., et al. (2019).The midlatitude thermosphericdynamics from an interhemisphericperspective.Journal of GeophysicalResearch: Space Physics,124. https://doi.org/10.1029/2019JA026967

- Rae, J., Forsyth, C., Dunlop, M. *et al.* What are the fundamental modes of energy transfer and partitioning in the coupled Magnetosphere-Ionosphere system?. *Exp Astron* **54**, 391–426 (2022). https://doi.org/10.1007/s10686-022-09861-w

Division 3: Magnetospheric Phenomena

National & Kapodistrian University of Athens (NKUA), Department of Physics

Space Physics Group: Prof. Ioannis A. Daglis (IAD), Dr. Christos Katsavrias (CK), Dr. Marina Georgiou (MG), Dr. Sigiava Aminalragia-Giamini (SAG), Ms. Adamantia Zoe Boutsi, MSc (AB), Ms. Afroditi Nasi, MSc (AN), Ms. Georgia Moutsiana, MSc (GM), Ms. Konstantina Moutsouroufi, MSc (KM), Mr. Constantinos Papadimitriou (CP), Mr. Vassilis Pitsis, MSc (VP)

The Space Physics Group of the National and Kapodistrian University of Athens conducts research in solar-terrestrial physics, magnetospheric physics and space weather with a special emphasis on the Earth's radiation belts.

International Research Programs:

- **G4G** (Geant4-based Particle Simulation Facility in Greece for Future Science Mission Support) project, funded by the European Space Agency (2018 - 2022)
- SafeSpace**: Radiation Belt Environmental Indicators for the Safety of Space Assets** funded by the European Union in the Horizon 2020 framework (2020 - 2022)
- SWUNMed**: Space Weather User Needs for the Mediterranean Region** project, funded by the European Space Agency (2019 - 2021)

Products and Infrastructure:

- **The SafeSpace radial diffusion coefficients database**: An open-access database of ULF wave power spectral density and radial diffusion coefficients for the outer radiation belt (https://synergasia.uoa.gr/modules/document/?course=PHYS120)
- **The Sentinel model**: A Machine Learning model for the nowcasting/forecasting of the daily electron fluxes (0.03 – 4 MeV) in the outer radiation belt and the slot region (https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2021SW002936).
- **The GEO model**: A non-linear multiple regression model for the nowcasting/ forecasting of the 3-hour sub-relativistic electron fluxes (30 – 600 keV) at geostationary orbit (https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2020JA028939)
- **The EMERALD model**: A Machine Learning model for the nowcasting/forecasting of the 1-hour radial diffusion coefficients in the outer radiation belt (https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2022SW003283).

Contribution to International Associations:

- IAD: Editor-in-Chief of Annales Geophysicae journal, European Geosciences Union (https://www.annales-geophysicae.net/)
- IAD: Editor of Scientific Reports journal (https://www.nature.com/srep/about/editors - astronomy)
- IAD: Scientific Discipline Representative to SCOSTEP (Scientific Committee on Solar-Terrestrial Physics)
- IAD: Chair of the Next Scientific Program (NSP) Committee of SCOSTEP (2017-2019)
- IAD: Steering Board Member of the Space Weather Working Team, European Space Agency.
- IAD: Chair of the South-Eastern Europe Europlanet Society Hub (2019-2022)

- IAD: Full Member of the International Academy of Astronautics
- IAD: IAGA National Correspondent of Greece
- CK: Editor of Annales Geophysicae journal, European Geosciences Union (https://www.annales-geophysicae.net/)
- GM: Early Career Scientists representative of the Planetary and Solar System Sciences Division, at the Council of the European Geosciences Union

Community Service:

- IAD: Member of the International Living With a Star Working Group (https://www.cosmos.esa.int/web/esa-heliophysics/organization)
- IAD: Member of the COSPAR Task Group on Establishing an International Geospace Systems Program (TGIGSP, https://cosparhq.cnes.fr/scientific-structure/task-groups/task-group-on-establishing-an-international-geospace-systems-program-tgigsp/)
- IAD: Main Scientific Organizer of session "PRBEM.3 Extending the Prediction Horizon of Earth's Radiation Belts: from Science to End-Users Space Weather Services" of the COSPAR 2022 Assembly (Athens, 16-24 July 2022).
- KM: Scientific Organizer of the EWASS2019 Special Session SS37 "Making the case for European astronomy and space science: public and political engagement".
- KM: Co-organizer of session "D3.7 Dialogues Between Space Science and Art" of the COSPAR 2022 Assembly (Athens, 16-24 July 2022).
- KM: Organizer of the 15-week course "SpaceGates Academy: Teaching science communication and outreach of Astronomy, Planetary Science and Space to Physics Students" that took place from Autumn 2019 to Spring 2020, under the auspices of the Section of Astrophysics, Astronomy, and Mechanics, Department of Physics, University of Athens.
- KM: Member of the Greek evaluation committee for the IAU Name ExoWorlds 2022 Competition.

Invited talks at International Conferences:

- I.A. Daglis: Predictability of the variable Solar-Terrestrial Coupling (PRESTO), *Space Climate 7 Symposium*, Canton Orford, Canada, 8-11 July 2019.
- I.A. Daglis: SafeSpace - Designing Radiation Belt Environmental Indicators for the Safety of Space Assets, PWING-ERG Conference on the Inner Magnetosphere (Online Conference), Nagoya University, Japan, 8-12 March 2021.
- I.A. Daglis: Plasma wave properties and storm-substorm relationship as reflections of the coupled solar wind-magnetosphere-ionosphere dynamic system, 16th European Space Weather Week, Liege, Belgium, 18-22 November 2019.
- C. Katsavrias: Acceleration and loss of relativistic electrons in the outer radiation belt: recent scientific insights and prediction efforts, IAGA-IASPEI Joint Scientific Assembly 2021 (Hybrid Conference), Hyderabad, India, 21-27 August 2021.
- I.A. Daglis: Designing Radiation Belt Environmental Indicators for the safety of space assets, IAGA-IASPEI Joint Scientific Assembly 2021 (Hybrid Conference), Hyderabad, India, 21-27 August 2021.

Publications:

- Aminalragia-Giamini, S., Katsavrias, C., Papadimitriou, C., Daglis, I.A., Nasi, A., Brunet, A., Bourdarie, S. and Dahmen, N.: The EMERALD model for the estimation of the radial diffusion coefficients in the outer Van Allen belt, Space Weather, 20, e2022SW003283, DOI: 10.1029/2022SW003283, 2022.

- Balasis, G., Papadimitriou, C., Boutsi, A.Z., Daglis, I.A., Giannakis, O., Anastasiadis, A., De Michelis, P., and Consolini, G.: Dynamical complexity in Swarm electron density time series using Block entropy, *EPL (Europhysics Letters)*, *131*, doi: 10.1209/0295-5075/131/69001, 2020.
- Daglis I.A., C. Katsavrias, and M. Georgiou: From solar sneezing to killer electrons: outer radiation belt response to solar eruptions, *Phil. Trans. R. Soc. A 377*: 20180097, http://dx.doi.org/10.1098/rsta.2018.0097, 2019.
- Dahmen, N., Sicard, A., Brunet, A., Santolik, O., Pierrard, V., Botek, E., Darrouzet, F. and Katsavrias, C.: FARWEST: Efficient computation of wave-particle interactions for a dynamic description of the electron radiation belt diffusion, Journal of Geophysical Research: Space Physics, 127, e2022JA030518, DOI: 10.1029/2022JA030518, 2022.
- Katsavrias, C., C. Papadimitriou, S. Aminalragia-Giamini, I.A. Daglis, I. Sandberg, and P. Jiggens: On the Semi-Annual Variation of Relativisitc Electrons in the Outer Radiation Belt, Ann. Geophys., 39, 413–425, DOI 10.5194/angeo-39-413-2021, 2021.
- Katsavrias, C., I. Sandberg, W. Li, O. Podladchikova, I.A. Daglis, C. Papadimitriou, C. Tsironis and S. Aminalragia-Giamini: Highly relativistic electron flux enhancement during the weak geomagnetic storm of April–May 2017, Journal of Geophysical Research: Space Physics, 124, DOI 10.1029/2019JA026743, 2019.
- Katsavrias, C., I.A. Daglis and W. Li: On the Statistics of Acceleration and Loss of Relativistic Electrons in the Outer Radiation Belt: a Superposed Epoch Analysis, Journal of Geophysical Research: Space Physics, 124, DOI 10.1029/2019JA026569, 2019.
- Katsavrias, C., Nasi, A., Daglis, I.A., Aminalragia-Giamini, S., Dahmen, N., Papadimitriou, C., Georgiou, M., Brunet, A., and Bourdarie, S.: The SafeSpace database of ULF power spectral density and radial diffusion coefficients: dependencies and application to simulations, Ann. Geophys., 40, 379–393, DOI: 10.5194/angeo-40-379-2022, 2022.
- Katsavrias, C., Papadimitriou, C., Hillaris, A., and Balasis, G.: Application of Wavelet Methods in the Investigation of Geospace Disturbances: A Review and an Evaluation of the Approach for Quantifying Wavelet Power, Atmosphere, 13, 499, DOI: 10.3390/atmos13030499, 2022.
- Katsavrias, C., S. Aminalragia-Giamini, C. Papadimitriou, I. Sandberg, P. Jiggens, and I.A. Daglis: On the Interplanetary Parameter Schemes which Drive the Variability of the Source/Seed Electron Population at GEO, Journal of Geophysical Research: Space Physics, 126, e2020JA028939, DOI 10.1029/2020JA028939, 2021.
- Katsavrias, C., S. Aminalragia-Giamini, C. Papadimitriou, I.A. Daglis, I. Sandberg, and P. Jiggens: Radiation belt model including semi-annual variation and Solar driving (Sentinel), Space Weather, 19, e2021SW002936, DOI 10.1029/2021SW002936, 2021.
- Katsavrias, C., S. Raptis, I.A. Daglis, T. Karlsson, M. Georgiou, and G. Balasis: On the Generation of Pi2 Pulsations due to Plasma Flow Patterns Around Magnetosheath Jets, Geophysical Research Letters, 48, e2021GL093611, DOI 10.1029/2021GL093611, 2021.
- Nasi A., I.A. Daglis, Katsavrias, C. and W. Li: Interplay of source/seed electrons and wave-particle interactions in producing relativistic electron PSD enhancements in the outer Van Allen belt, Journal of Atmospheric and Solar Terrestrial Physics, 210 (105405), DOI 10.1016/j.jastp.2020.105405, 2020.
- Nasi, A., Katsavrias, C., Daglis, I.A., Sandberg, I., Aminalragia-Giamini, S., Wen Li, Miyoshi, Y., Evans, H., Mitani, T., Matsuoka, A., Shinohara, I., Takashima, T., Hori, T., and Balasis, G.: An event of extreme relativistic and ultra-relativistic electron enhancements following the arrival of consecutive corotating interaction regions: Coordinated observations by Van Allen Probes, Arase, THEMIS and Galileo satellites, Front. Astron. Space Sci. 9:949788, DOI: 10.3389/fspas.2022.949788, 2022.
- Pitsis, V., G. Balasis, I. A. Daglis, D. Vassiliadis, and A.Z. Boutsi: Power-law dependence of the wavelet spectrum of ground magnetic variations during magnetic storms, Advances in Space Research, https://doi.org/10.1016/j.asr.2022.10.064, 2022.
- Sandberg, I., P. Jiggens, H. Evans, C. Papadimitriou, S. Aminalragia‐Giamini, C. Katsavrias, A.J. Boyd, T.P. O’ Brien, N. Higashio, T. Mitani, I. Shinohara, Y. Miyoshi, D.N. Baker, I.A. Daglis: Harmonization of RBSP and ARASE energetic electron measurements utilizing ESA radiation monitor data, Space Weather, DOI 10.1029/2020SW002692, 2021.

National Observatory of Athens, IAASARS

Dr Georgios Balasis (serves as the co-chair of IAGA Division 3)

Contribution to International Associations:

- Co-Chair (2019–2022) of the International Association of Geomagnetism and Aeronomy (IAGA) Division III - Magnetospheric Phenomena
- Member (2019–2022) of the International Union of Geodesy and Geophysics (IUGG) Commission on Geophysical Risk and Sustainability (GeoRisk)
- Secretary (2019–2022) of the Earth Magnetism and Rock Physics Division, European Geosciences Union (EGU)
- Leader of International Space Science Institute (ISSI) International Team "Complex Systems Perspectives Pertaining to the Research of the Near-Earth Electromagnetic Environment" (2019-2022)
- Member of Scientific Committee, ESA Living Planet Symposium 2022, Bonn, Germany, 23–27 May 2022
- Chair of Local Organizing Committee, ESA 11th Swarm Data Quality Workshop, Athens, Greece, 11–15 October 2021
- Member of Scientific Committee, ESA Living Planet Symposium 2019, Milan, Italy, 13–17 May 2019
- Convener/Co-convener of Conference Session (last ones): European Geosciences Union (EGU) General Assembly [2019-2022], COSPAR 2022 - 44th Scientific Assembly, Joint Scientific Assembly IAGA-IASPEI 2021
- Topical Editor of EGU journal Annales Geophysicae in Magnetosphere and Space Plasma Physics section
- Associate Editor, Frontiers in Physics; Frontiers in Astronomy and Space Sciences
- Editor of MDPI journal Atmosphere (in the field of Upper Atmosphere)
- Editor of MDPI journal Geosciences (in the field of Geophysics)
- Special issue Editor, "Satellite observations for space weather and geo-hazard", Annales Geophysicae, 2019–2020
- Special issue Editor, "Detecting Geospace Perturbations Caused by Earth", Geosciences, 2019–2021

Community Service:

- Convener of session "EMRP2.2 Observing Earth with Swarm: Results from Six Years in Orbit and Future Perspectives" of the EGU 2020 General Assembly (online, 4–8 May 2020).
- Chair of Local Organizing Committee of ESA 11th Swarm Data Quality Workshop (Athens, 11–15 October 2021).
- Main Scientific Organizer of session "C1.7 Information Theory and Machine Learning for Geospace Research" of the COSPAR 2022 Assembly (Athens, 16-24 July 2022).

International Research Projects:

- **TFA toolbox**: Time-Frequency Analysis toolbox, Coordinator: Swarm DISC (Data, Innovation, and Science Cluster) @ DTU Space, Funding: European Space Agency, 2022

- **INTENS**: Characterisation of IoNospheric TurbulENce level by Swarm constellation, Coordinator: INGV, Italy, Funding: European Space Agency, 2018–2021

Invited talks at International Conferences:

- Swarm investigations of ULF pulsation signatures associated with extreme space weather and geophysical events, COSPAR 2022 - 44th Scientific Assembly, 16–24 July 2022, Athens, Greece
- Complex Systems Methods Characterizing Nonlinear Processes in the Near-Earth Electromagnetic Environment, Solar Wind Magnetosphere Interaction Workshop (online), JHUAPL, USA, August 30–September 2 and September 13–16, 2021
- Information Theory Perspectives for Geospace Research, 15th Hellenic Astronomical Conference, 5–8 July 2021
- Entropic measures and magnetospheric dynamics (Lecturer), Course on "Dynamical Systems and Machine Learning Approaches to Sun-Earth Relations", International School of Space Science, 1–5 February 2021, L'Aquila, Italy
- Information theory and complex systems perspectives pertinent to the research of Geospace, Virtual Workshop on "machine Learning, data Mining and data Assimilation in Geospace (LMAG)", JHUAPL, USA, 21–24 September 2020

Publications:

- Aminalragia-Giamini, S., Katsavrias, C., Papadimitriou, C., Daglis, I. A., Nasi, A., Brunet, A., et al. (2022). The EMERALD model for the estimation of the radial diffusion coefficients in the outer Van Allen belt. Space Weather, 20, e2022SW003283. https://doi.org/10.1029/2022SW003283
- Antonopoulou, A.; Balasis, G.; Papadimitriou, C.; Boutsi, A.Z.; Rontogiannis, A.; Koutroumbas, K.; Daglis, I.A.; Giannakis, O. Convolutional Neural Networks for Automated ULF Wave Classification in Swarm Time Series. Atmosphere 2022, 13, 1488. https://doi.org/10.3390/atmos13091488.
- Balasis G., C. Papadimitriou, A. Z. Boutsi (2019), Ionospheric response to solar and interplanetary disturbances: a Swarm perspective, Phil. Trans. R. Soc. A, 377: 20180098.
- Balasis, G., C. Papadimitriou, A. Z. Boutsi, I. A. Daglis, O. Giannakis, A. Anastasiadis, P. De Michelis, & G. Consolini (2020), Dynamical complexity in Swarm electron density time series using Block entropy, Europhysics Letters, 131, 69001 doi:10.1209/0295-5075/131/69001.
- Balasis, G., S. A. Giamini, C. Papadimitriou, I. A. Daglis, A. Anastasiadis, and R. Haagmans (2019), A machine learning approach for automated ULF wave recognition, J. Space Weather Space Clim., 9, A13.
- Balasis, G.; De Santis, A. Editorial of Special Issue "Detecting Geospace Perturbations Caused by Earth". Geosciences 2021, 11, 496. https://doi.org/10.3390/geosciences11120496.
- Consolini, G. et al. (2021), High-latitude polar pattern of ionospheric electron density: scaling features and IMF dependence, Journal of Atmospheric and Solar-Terrestrial Physics, 217, 105531, https://doi.org/10.1016/j.jastp.2020.105531.
- Contoyiannis, Y.; Hanias, M.P.; Papadopoulos, P.; Stavrinides, S.G.; Kampitakis, M.; Potirakis, S.M.; Balasis, G. Tachyons and Solitons in Spontaneous Symmetry Breaking in the Frame of Field Theory. Symmetry 2021, 13, 1358. https://doi.org/10.3390/sym13081358.
- De Michelis, P. et al. (2021), Looking for a proxy of the ionospheric turbulence with Swarm data, Scientific Reports, 11, 6183, https://doi.org/10.1038/s41598-021-84985-1.
- De Michelis, P., Pignalberi, A., Consolini, G., Coco, I., Tozzi, R., & Pezzopane, M., Giannattasio, F., & Balasis, G. (2020). On the 2015 St. Patrick's storm turbulent state of the ionosphere: Hints from the Swarm mission. Journal of Geophysical Research: Space Physics, 125, e2020JA027934. https://doi.org/10.1029/2020JA027934.
- Dimitrakoudis, S., Mann, I. R., Balasis, G., Papadimitriou, C., Anastasiadis, A., & Daglis, I. A. (2022). On the interplay between solar wind parameters and ULF wave power as a function of geomagnetic

activity at high- and mid-latitudes. Journal of Geophysical Research: Space Physics, 127, e2021JA029693. https://doi.org/10.1029/2021JA029693.
- Donner, R. V., Balasis, G., Stolbova, V., Georgiou, M., Wiedermann, M., & Kurths, J. (2019). Recurrence-based quantification of dynamical complexity in the Earth's magnetosphere at geospace storm timescales. Journal of Geophysical Research: Space Physics, 124, 90–108.
- Katsavrias, C., Raptis, S., Daglis, I.A., Karlsson, T., Georgiou, M., & Balasis, G. (2021). On the generation of Pi2 pulsations due to plasma flow patterns around magnetosheath jets. Geophysical Research Letters, 48, e2021GL093611. https://doi.org/10.1029/2021GL093611.
- Katsavrias, C.; Papadimitriou, C.; Hillaris, A.; Balasis, G. Application of Wavelet Methods in the Investigation of Geospace Disturbances: A Review and an Evaluation of the Approach for Quantifying Wavelet Power. Atmosphere 2022, 13, 499. https://doi.org/10.3390/atmos13030499.
- Manshour, P.; Balasis, G.; Consolini, G.; Papadimitriou, C.; Paluš, M. Causality and Information Transfer Between the Solar Wind and the Magnetosphere–Ionosphere System. Entropy 2021, 23, 390. https://doi.org/10.3390/e23040390.
- Nasi A, Katsavrias C, Daglis IA, Sandberg I, Aminalragia-Giamini S, Li W, Miyoshi Y, Evans H, Mitani T, Matsuoka A, Shinohara I, Takashima T, Hori T and Balasis G (2022), An event of extreme relativistic and ultra-relativistic electron enhancements following the arrival of consecutive corotating interaction regions: Coordinated observations by Van Allen Probes, Arase, THEMIS and Galileo satellites. Front. Astron. Space Sci. 9:949788. doi: 10.3389/fspas.2022.949788.
- Paouris, E. et al. (2021), Propagating Conditions and the Time of ICME Arrival: A Comparison of the Effective Acceleration Model with ENLIL and DBEM Models, Solar Physics, 296:12, https://doi.org/10.1007/s11207-020-01747-4.
- Papadimitriou, C., Balasis, G., Boutsi, A. Z., Antonopoulou, A., Moutsiana, G., Daglis, I. A., et al. (2021). Swarm-derived indices of geomagnetic activity. Journal of Geophysical Research: Space Physics, 126, e2021JA029394. https://doi.org/10.1029/2021JA029394.
- Papadimitriou, C., G. Balasis, A. Z. Boutsi, I. A. Daglis, O. Giannakis, A. Anastasiadis, P. De Michelis, & G. Consolini (2020), Dynamical Complexity of the 2015 St. Patrick's Day Magnetic Storm at Swarm Altitudes Using Entropy Measures, Entropy, 22, 574, doi:10.3390/e22050574.
- Pitsis, V., G. Balasis, I. A. Daglis et al., Power-law dependence of the wavelet spectrum of ground magnetic variations during magnetic storms, Advances in Space Research, https://doi.org/10.1016/j.asr.2022.10.064.
- Potirakis, S. M., Schekotov, A., Contoyiannis, Y., Balasis, G., Koulouras, G. E., Melis, N. S., Boutsi, A. Z., Hayakawa, M., Eftaxias, K., Nomicos, C. (2019), On Possible Electromagnetic Precursors to a Significant Earthquake (Mw = 6.3) Occurred in Lesvos (Greece) on 12 June 2017, Entropy, 21, 241. doi:10.3390/e21030241.
- Sasmal, S.; Chowdhury, S.; Kundu, S.; Politis, D.Z.; Potirakis, S.M.; Balasis, G.; Hayakawa, M.; Chakrabarti, S.K. Pre-Seismic Irregularities during the 2020 Samos (Greece) Earthquake (M = 6.9) as Investigated from Multi-Parameter Approach by Ground and Space-Based Techniques. Atmosphere 2021, 12, 1059. https://doi.org/10.3390/atmos12081059.
- Zitis, P.I.; Potirakis, S.M.; Balasis, G.; Eftaxias, K. An Exploratory Study of Geospace Perturbations Using Financial Analysis Tools in the Context of Complex Systems. Geosciences 2021, 11, 239. https://doi.org/10.3390/geosciences11060239.

National Observatory of Athens

Dr Anna Belehaki and the Ionospheric Group of IAASARS

Infrastructures:

The Ionospheric Group of the National Observatory of Athens (IAASARS/NOA) implements research and development projects aiming at the release of ionospheric models for the specification of large-scale storm effects, ionospheric irregularities and instabilities. The group coordinates the European Project PITHIA-NRF (www.pithia-nrf.eu) that develops the Research Infrastructure for the Integration of Data, Models and Research Facilities for Ionosphere, Thermosphere and Plasmasphere Research, in a unified research environment. The PITHIA-NRF project already provides the e-science center for the standardized registration of relevant assets, and the Trans-National Research programme for access to users from all over the world, who have successfully applied for the implementation of a research programme in one of the nodes of the PITHIA-NRF network. PITHIA-NRF offers a test bed for the development and validation of models and for their transition to operations. The Ionospheric Group of NOA succeeded in producing several data-products for the nowcasting and forecasting of ionospheric storms and for the identification of Travelling Ionospheric Disturbances. These products are registered in the European Space Agency Space Weather Network and are made available in real-time to all interested users who belong to the Trans-Ionospheric Domain and to Satellite Operations Domain.

Very recently the Ionospheric group of NOA coordinates a new research activity, T-FORS (www.t-fors.eu), that aims at the forecasting of Travelling Ionospheric Disturbances (TIDs), in collaboration with 10 research centers in Europe, with funding from the European Commission Horizon Europe. T-FORS aims at providing new models able to interpret a broad range of observations of the solar corona, the interplanetary medium, the magnetosphere, the ionosphere and the atmosphere, and to issue forecasts and warnings for TIDs several hours ahead. Machine Learning techniques are used to forecast the occurrence of Large Scale TIDs, while the occurrence probability for Medium Scale TIDs is obtained through empirical and statistical models.

In the international landscape, the Ionospheric Group of NOA is very active in moderating research teams that contribute to the Ionospheric Variability Group (G2b) of the International Space Weather Teams (ISWAT), a network supported by NASA under the COSPAR auspices (https://www.iswat-cospar.org/). The objective of the Ionospheric Variability Group is to work for the improvement of monitoring, modeling and detection capability of ionospheric space weather effects in order to meet users' requirements for nowcasting and forecasting the ionospheric storm effects, the ionospheric bubbles, scintillations and the traveling ionospheric disturbances. In 2023 all ISWAT Groups have prepared review articles that summarize advances in space weather understanding and capabilities to alert and shield society, highlighting the completed goals in respect to the COSPAR/ILWS Space Weather roadmap for 2015 – 2025, and issuing new recommendations based on the scientific, technological developments and on the users' requirements.

International Research Programs:

- "T-FORS: Travelling Ionospheric Disturbances Forecasting System" (2023-2024), Funded by the European Commission, Horizon Europe Programme.
- "PITHIA-NRF: Plasmasphere Ionosphere Thermosphere Integrated Research Environment and Access Services: a Network of Research Facilities" (2021 – 2024), Funded by the European Commission, Horizon 2020 Research Infrastructures Programme
- "SWESNET: Space Weather Service Network Development and Pre-Operation Part 1" (2021 – 2023), Funded by the European Space Agency
- "TechTIDE: Warning and Mitigation of Travelling Ionospheric Disturbances Effects", (2017 - 2020), Funded by the European Commission Horizon 2020 Programme.

Invited talks at International Conferences:

- Belehaki A., "Progress achieved in the TechTIDE-Horizon2020 project for the identification of traveling ionospheric disturbances in real-time", Session: Remote Sensing Ionosphere, 7th International Colloquium on Scientific and Fundamental Aspects of GNSS, Zurich, Switzerland, 4-6 September 2019
- Belehaki A., "Real-Time identification of Travelling Ionospheric Disturbances resulted from the TechTIDE project", Session SA22A-07, AGU Fall Meeting San Francisco, 8-11 December 2019
- Belehaki A., "Ionospheric Variability ISWAT Cluster Activities", Session SM31C-3545 Ionospheric Variability ISWAT Cluster Activities, AGU Fall Meeting San Francisco, 8-11 December 2019 (ISWAT presentation)
- Belehaki A., "Characteristics of the Effective Scale Height in the Topside Ionosphere Extracted from Swarm A and Digisonde Observations", Session C4.1: Real-time and Retrospective Ionosphere Modelling with In-situ and GNSS Satellite Data, COSPAR 2022, Athens Greece.
- Tsagouri I., "Ionospheric forecasts driven by solar wind parameters: evaluation of the SWIF model performance", URSI GASS 2021, Rome, Italy, 28 August - 4 September 2021.
- Tsagouri I., "Forecasting the ionospheric response to solar wind forcing: Suggestive results obtained through the evaluation of the performance of the Solar Wind driven autoregressive model for Ionospheric short-term Forecast (SWIF)", Chapman Conference on Scientific Challenges Pertaining to Space Weather Forecasting Including Extremes, Pasadena, USA, 11-15 February 2019.

Publications:

- Zawdie K, Belehaki A, Burleigh M, Chou M-Y, Dhadly MS, Greer K, Halford AJ, Hickey D, Inchin P, Kaeppler SR, Klenzing J, Narayanan VL, Sassi F, Sivakandan M, Smith JM, Zabotin N, Zettergren MD and Zhang S-R (2022), Impacts of acoustic and gravity waves on the ionosphere. Front. Astron. Space Sci. 9:1064152. doi: 10.3389/fspas.2022.1064152
- Verhulst T. , D. Altadill, V. Barta, A. Belehaki, D. Burešová, C. Cesaroni, I. Galkin, M. Guerra, A. Ippolito, T. Herekakis, D. Kouba, J. Mielich, A. Segarra, L. Spogli and I. Tsagouri, Multi-instrument detection in Europe of ionospheric disturbances caused by the 15 January 2022 eruption of the Hunga volcano, J. Space Weather Space Clim., 12 (2022) 35, DOI: https://doi.org/10.1051/swsc/2022032
- Tsagouri I. and A. Belehaki, Assessment of solar wind driven ionospheric storm forecasts: The case of the Solar Wind driven autoregression model for Ionospheric Forecast (SWIF), Advances in Space Research, https://doi.org/10.1016/j.asr.2022.06.047
- Tsagouri I., Space weather effects on the Earth's upper atmosphere: short report on ionospheric storm effects at middle latitudes, Atmosphere 13 (2), 346, 2022.
- Pierantoni G, T., Kiss, A. Bolotov, D. Kagialis, J. DesLauries, A. Ullah, H. Chen, D. Chan You Fee, H. Van Dang, J. Kovacs, A. Belehaki, T. Herekakis, I. Tsagouri, (2022), Toward a reference architecture based science gateway framework with embedded e-learning support, Concurrency Comput at Pract Exper, e6872. doi: 10.1002/cpe.6872
- Belehaki, A., I. Tsagouri, E. Paouris (2021) Characteristics of the Effective Scale Height in the Topside Ionosphere Extracted from Swarm A and Digisonde Observations: preliminary results, Journal of Geophysical Research: Space Physics, 127, e2021JA030075. https://doi.org/10.1029/2021JA030075
- Jarmołowski, W., A. Belehaki, M. Hernández Pajares, et al. (2021) Combining Swarm Langmuir probe observations, LEO-POD-based and ground-based GNSS receivers and ionosondes for prompt detection of ionospheric earthquake and tsunami signatures: case study of 2015 Chile-Illapel event, J. Space Weather Space Clim., https://doi.org/10.1051/swsc/2021042
- Belehaki, A., I. Tsagouri, D. Altadill, et al. (2020) An overview of methodologies for real-time detection, characterisation and tracking of traveling ionospheric disturbances developed in the TechTIDE project, J. Space Weather Space Clim., 10, 42, DOI: https://doi.org/10.1051/swsc/2020043
- David Altadill, Antoni Segarra, Estefania Blanch, José Miguel Juan, Vadym V. Paznukhov, Dalia Buresova, Ivan Galkin, Bodo W. Reinisch and Anna Belehaki (2020), A method for real-time

identification and tracking of traveling ionospheric disturbances using ionosonde data: first results, J. Space Weather Space Clim., 10, 2, DOI: https://doi.org/10.1051/swsc/2019042
- Jean Lilensten, Mateja Dumbović, Luca Spogli, Anna Belehaki, Ronald Van der Linden, Stefaan Poedts, Teresa Barata, Mario M. Bisi, Gaël Cessateur, Erwin De Donder, Antonio Guerrero, Emilia Kilpua, Marianna B. Korsos, Rui F. Pinto, Manuela Temmer, Ioanna Tsagouri, Jaroslav Urbář and Francesca Zuccarello 2021, Quo vadis, European Space Weather community?, J. Space Weather Space Clim., 11 (2021) 26, DOI: https://doi.org/10.1051/swsc/2021009
- Jean Lilensten, Anna Belehaki, Jürgen Watermann, Jan Janssens and Agnès Henri (2019), JSWSC: recent developments and further advances, J. Space Weather Space Clim., 9, E2, DOI: https://doi.org/10.1051/swsc/2019011
- Opgenoorth, H., R. F. Wimmer-Schweingruber, A. Belehaki, et al. (2019), Assessment and recommendations for a consolidated European approach to space weather – as part of a global space weather effort, J. Space Weather Space Clim., 9 A37 DOI: https://doi.org/10.1051/swsc/2019033
- Borries, C., Wilken, V., Jacobsen, K.S., García-Rigo, A., Dziak-Jankowska, B., Kervalishvili, G., Jakowski, N., Tsagouri, I., Hernández-Pajares, M., Ferreira, A.A. and Hoque, M.M.. Assessment of the capabilities and applicability of ionospheric perturbation indices provided in Europe. Advances in Space Research, 66(3), pp.546-562, 2020.
- Scherliess, L., Tsagouri, I., Yizengaw, E., Bruinsma, S., Shim, J. S., Coster, A., & Retterer, J. M. (2019). The International Community Coordinated Modeling Center space weather modeling capabilities assessment: Overview of ionosphere/thermosphere activities. Space Weather, 17, 527– 538. https://doi.org/10.1029/2018SW002036

Democritus University of Thrace (DUTH), Department of Electrical and Computer Engineering

Space Physics Group: Associate Prof. Theodoros Sarris (TS), Stelios Tourgaidis (ST), Panagiotis Pirnaris (PP), Dimitrios Baloukidis (DB)

- The Space Physics Group of the Democritus University of Thrace conducts research in solar-terrestrial physics, magnetospheric physics, ionosphere-thermosphere physics, and space weather with a special emphasis on the Earth's radiation belts.
- Related to Division 3: Magnetospheric Phenomena, DUTH studies particle acceleration mechanisms in the magnetosphere, including wave-particle interactions; DUTH also studies the phenomenology of ULF waves in the magnetosphere (WG III – ULF waves). Finally, DUTH is involved in studies of planetary magnetospheres.

International Research Programs:

- Participation in the JUICE/PEP Instrument team

Publications related to Division 3 topics in 2019-2023:

- Dianjun Zhang, Wenlong Liu, Junfeng Du, Yiqun Yu, Xinlin Li, Theodore E Sarris, and Jinbin Cao, Response of Electric Field in Terrestrial Magnetosphere to Interplanetary Shock, The Astrophysical Journal, Volume 938, Number 1 Citation Dianjun Zhang et al 2022 ApJ 938 70 https://doi.org/10.3847/1538-4357/ac90cc , 2022
- Sarris, T. E., Li, X., Zhao, H., Papadakis, K., Liu, W., Tu, W., et al. (2022). Distribution of ULF wave power in magnetic latitude and local time using THEMIS and Arase measurements. Journal of Geophysical Research: Space Physics, 127, e2022JA030469. https://doi.org/10.1029/2022JA030469

- Tourgaidis, S. and T. Sarris, Wave-particle interactions toolset: A python-based toolset to model wave-particle interactions in the magnetosphere, Front. Astron. Space Sci., 25 October 2022, Sec. Space Physics, Volume 9 – 2022, https://doi.org/10.3389/fspas.2022.1005598
- Xaplanteris, L., Gerontidou, M., Mavromichalaki, H. *et al.* First Application of a Theoretically Derived Coupling Function in Cosmic-Ray Intensity for the Case of the 10 September 2017 Ground-Level Enhancement (GLE 72). *Sol Phys* **297**, 73 (2022). https://doi.org/10.1007/s11207-022-02009-1
- Barani, M., Tu, W., Hudson, M. K., & Sarris, T. (2022). High-fidelity analysis of ULF wave mode structure following interplanetary shock compression of the dayside magnetopause using MMS multi-point observations. Journal of Geophysical Research: Space Physics, 127, e2021JA030116. https://doi.org/10.1029/2021JA030116
- Roussos, E., Allanson, O., André, N. *et al.* The in-situ exploration of Jupiter's radiation belts. *Exp Astron* **54**, 745–789 (2022). https://doi.org/10.1007/s10686-021-09801-0
- Zhao, H., Sarris, T. E., Li, X., Weiner, M., Huckabee, I. G., Baker, D. N., et al. (2021). Van Allen Probes observations of multi-MeV electron drift-periodic flux oscillations in Earth's outer radiation belt during the March 2017 event. Journal of Geophysical Research: Space Physics, 126, e2021JA029284. https://doi.org/10.1029/2021JA029284
- Xaplanteris, L., Livada, M., Mavromichalaki, H. *et al.* Improved Approach in the Coupling Function Between Primary and Ground Level Cosmic Ray Particles Based on Neutron Monitor Data. *Sol Phys* **296**, 91 (2021). https://doi.org/10.1007/s11207-021-01836-y
- Sarris, T. E., Li, X., Zhao, H., Khoo, L. Y., Liu, W., & Temerin, M. A. (2021). On the association between electron flux oscillations and local phase space density gradients. Journal of Geophysical Research: Space Physics, 126, e2020JA028891. https://doi.org/10.1029/2020JA028891
- Zhang, D., Liu, W., Li, X., Sarris, T. E.,Wang, Y., Xiao, C., et al. (2020).Relation between shock-relatedimpulse and subsequent ULF wave inthe Earth's magnetosphere.GeophysicalResearch Letters,47, e2020GL090027. https://doi.org/10.1029/2020GL090027
- Sarris, T. E., Li, X., Temerin, M., Zhao,H., Khoo, L. Y., Turner, D. L., et al.(2020). Simulations of electronfluxoscillations as observed by MagEIS inresponse to broadband ULF waves.Journal of Geophysical Research: SpacePhysics,125, e2020JA027798. https://doi.org/10.1029/2020JA027798
- Barani, M., Tu, W., Sarris, T., Pham, K.,& Redmon, R. J. (2019). Estimating theazimuthal mode structure of ULFwaves based on multiple GOES satelliteobservations.Journal of GeophysicalResearch: Space Physics, 124, 5009–5026. https://doi.org/10.1029/2019JA026927
- Rae, J., Forsyth, C., Dunlop, M. *et al.* What are the fundamental modes of energy transfer and partitioning in the coupled Magnetosphere-Ionosphere system?. *Exp Astron* **54**, 391–426 (2022). https://doi.org/10.1007/s10686-022-09861-w

Division 4: Solar Wind and Interplanetary Field

National & Kapodistrian University of Athens (NKUA), Department of Physics

Emeritus Professor Kanaris Tsinganos

Contribution to International Associations:

- K. Tsinganos: Main Scientific Organizer during the 44th COSPAR Scientific Assembly, Athens, Greece (16-24 July 2022) for the event: Exploring the cradle of the solar wind with PSP/SolO/Proba-3: what do we really know about the inner solar corona?

Publications:

- "Recurrent CME-like Eruptions in Emerging Flux Regions. II. Scaling of Energy and Collision of Successive Eruptions", Syntelis, P.; Archontis, V.; Tsinganos, K., The Astrophysical Journal, Volume 876, Issue 1, article id. 61, 8 pp. (2019).
- "Investigation of the possibility of GIC development in Greece during the strongest magnetic storms of solar cycle 24", Boutsi, Adamantia Zoe; Balasis, Georgios; Daglis, Ioannis A.; Tsinganos, Kanaris; Giannakis, Omiros, vEGU21, the 23rd EGU General Assembly, held online 19-30 April, 2021, id.EGU21-8410, Pub Date: April 2021
- "First light observations of the solar wind in the outer corona with the Metis coronagraph", Romoli, M.; Antonucci, E.;, … Tsinganos, K.; … Zimbardo, G., Astronomy & Astrophysics, Volume 656, id.A32, 9 pp., DOI: 10.1051/0004-6361/202140980, 10.48550/arXiv.2106.13344 Pub Date: December 2021
- "The first coronal mass ejection observed in both visible-light and UV H I Ly-α channels of the Metis coronagraph on board Solar Orbiter", Andretta, V. … Tsinganos, K.; … Zimbardo, G., Astronomy & Astrophysics, Volume 656, id.L14, 10 pp., Pub Date: December 2021 DOI: 10.1051/0004-6361/202142407
- "HiRISE - High-Resolution Imaging and Spectroscopy Explorer – Ultrahigh resolution, interferometric and external occulting coronagraphic science", Erdélyi, Robertus, Tsinganos, K.; … Wimmer-Schweingruber, R., Experimental Astronomy, Online First Pub Date: March 2022 DOI: 10.1007/s10686-022-09831-2
- "Obituary: Eugene Newman Parker † (1927-2022)", Tsinganos, Kanaris, Bulletin of the American Astronomical Society, 2022, Vol. 54, id. 039, Pub Date: April 2022 DOI: 10.3847/25c2cfeb.19b7a688
- "Investigating the levels of Geomagnetically Induced Currents in the Mediterranean region during the most intense geomagnetic storms of solar cycle 24", Boutsi, Adamantia Zoe; Balasis, Georgios; Daglis, Ioannis A.; Tsinganos, Kanaris; Giannakis, Omiros, EGU22, the 24th EGU General Assembly, held 23-27 May, 2022 in Vienna, Austria and Online at https://egu22.eu/, id.EGU22-6442, Pub Date: May 2022 DOI: 10.5194/egusphere-egu22-6442
- "A tribute to Eugene Parker † (1927-2022), the founder of Heliophysics and Plasma Astrophysics, via a selection from his research contributions which bear his name", Tsinganos, Kanaris, 44th COSPAR Scientific Assembly. Held 16-24 July, 2022. Online at https://www.cosparathens2022.org/. Abstract D2.1-0001-22, Pub Date: July 2022
- "Science with the ASPIICS coronagraph onboard PROBA-3", Gunár, Stanislav; Zhukov, Andrei; Fineschi, Silvano; Inhester, Bernd; Lamy, Philippe; Mierla, Marilena; Rudawy, Pawel; Tsinganos, Kanaris, 44th COSPAR Scientific Assembly. Held 16-24 July, 2022. Online at https://www.cosparathens2022.org/. Abstract D2.1-0011-22. Pub Date: July 2022
- "The lower solar atmosphere inside and outside coronal holes and the base of the Solar Wind", Gontikakis, Costis; Koletti, Myrto; Patsourakos, Spiros; Tsinganos, Kanaris, 44th COSPAR Scientific Assembly, Held 16-24 July, 2022. Online at https://www.cosparathens2022.org/. Abstract D2.1-0021-22, Pub Date: July 2022

- "Study of the transition region inside a coronal hole using IRIS and SDO observations", Koletti, Myrto; Tsinganos, Kanaris; Gontikakis, Costis, 44th COSPAR Scientific Assembly. Held 16-24 July, 2022. Online at https://www.cosparathens2022.org/. Abstract D2.1-0028-22, Pub Date: July 2022
- "Linking Small-scale Solar Wind Properties with Large-scale Coronal Source Regions through Joint Parker Solar Probe-Metis/Solar Orbiter Observations", Telloni, Daniele, … Tsinganos, K.; …Zimbardo, G., The Astrophysical Journal, Volume 935, Issue 2, id.112, 13 pp., Pub Date: August 2022 DOI: 10.3847/1538-4357/ac8103

National Observatory of Athens, IAASARS

Dr. Anastasios Anastasiadis and Dr. Athanasios Papaioannou

Infrastructures:

- **FORSPEF Tool**: Web-based open access tool (24/7) that provides forecasting of solar eruptive events, such as solar flares with a projection to coronal mass ejections (CMEs) (occurrence and velocity) and the likelihood of occurrence of a solar energetic proton (SEP) event. The tool also provides nowcasting of SEP events based on actual solar flare and CME near real-time alerts, as well as SEP characteristics (peak flux, fluence, rise time, duration) per parent solar event [ESA Contract No. 4000109641/13/NL/AK] (http://tromos.space.noa.gr/forspef/)
- **SAWS-ASPECS System**: Web based open access tool (24/7) (http://phobos-srv.space.noa.gr/), that collates and combines outputs from different modules providing forecasts of solar phenomena, solar proton event occurrence and solar proton flux and duration characteristics. The system incorporates two basic operational modes: the forecasting (pre-event) and the nowcasting (post-event) mode. Concerning the pre-event forecasting mode, the starting point is the flare prediction. The outputs of the flare prediction are utilized in the provision of a conditional likelihood of SPE occurrence and an estimation of the expected characteristics (e.g. peak flux and duration) of a forthcoming SPE, with errors for different energies and as a function of different forecasting horizons. Concerning the post-event mode, the predictions for the probability of SPE occurrence and expected peak flux continuously evolve through updates based on near-real time inputs (e.g. solar flare and coronal mass ejections data/characteristics) received by the system. In addition, for the first time the complete time profile of the SPE at respective energies is provided in near real-time, utilizing both simulations and observations. [ESA Contract No. 4000120480/17/NL/LF/hh]

Contribution to International Associations:

- Member of the Editorial Board of the International Review of Physics journal (A. Anastasiadis)
- Member of the Editorial Board of the Entropy journal (A. Anastasiadis)
- Member of the Editorial Board of the Solar System Section of the Universe journal (A. Papaioannou)
- Review Editor, Frontiers in Physics; Frontiers in Astronomy and Space Sciences (A. Papaioannou)
- Guest Editor of a Topical Issue on "Space Weather research in the Digital Age and across the full data lifecycle", (eds: R. M. McGranaghan, E. Camporeale, A. Anastasiadis and M. Georgoulis), J. Space Weather & Space Climate, 2019
- Leader of the International Space Science Institute (ISSI) International Team "High EneRgy sOlar partICle events analysis (HEROIC)" (2018-2020) (A. Papaioannou)

- Member of the International Space Science Institute (ISSI) International Team “The Role Of Solar And Stellar Energetic Particles On (Exo)Planetary Habitability (ETERNAL)” (2019-2021) (A. Papaioannou)
- Member of the Scientific Committee, NMDB@2022 (online), 26-30 September 2022 (A. Papaioannou)
- Vice-Chair of the sub-Commission D1: The Heliosphere, Commission D: Space Plasmas in the Solar System, Including Planetary Magnetospheres (2021-2024) (A. Papaioannou)
- Member of the Modelling and Data Analysis Working Group (MADAWG) for the ESA/Solar Orbiter mission (A. Anastasiadis, A. Papaioannou)
- Member of the COSPAR International Space Weather Action Teams (ISWAT) (A. Anastasiadis, A. Papaioannou)

Community Service:

Session Organization in International Conferences:

- AGU2022: P44B: Cool Stars and Their Influence on (Exo)Planetary Habitability I & P45D: Cool Stars and Their Influence on (Exo)Planetary Habitability II (Co-convener: A. Papaioannou)
- COSPAR 2022 General Assembly, Session D1.3: "Understanding and Predicting Solar Energetic Particle Events across the Heliosphere", Athens, Greece, 16-24 July, 2022 (Conveners: A. Papaioannou, A. Anastasiadis)
- EGU2022: ST1.6 The Neutron Monitor Network: challenges and future perspective (Convener: A. Papaioannou)
- AGU2021: U43B - Cool Stars and Their Influence on (Exo)Planetary Habitability (Co-convener: A. Papaioannou)
- ESWW17, 25-29/10/2021, Glasgow, UK Topical Discussion Meeting: Current status, issues and space weather applications of the global neutron monitor network (Co-conveners: A. Papaiaonnou)
- European Space Weather Week (ESWW) 16, 18-22/11/2019, Liege, Belgium Topical Discussion Meetings: ESA SSA Space Weather Services for users in the Mediterranean region & The SAWS-ASPECS Tool: A web-based tool for Forecasting Solar Particle Events and Flares (Co-conveners: A. Anastasiadis & A. Papaiaonnou)
- EGU2018: ST1.5/PS4.6 Solar Eruptions and their Heliospheric imprint (Co-convener: A. Papaioannou)

Invited talks in International Conferences:

- ‘Unraveling current challenges in predicting solar energetic particle (SEP) events’, SWATnet 3rd Workshop: Solar Activity and Space Weather, 29/09/2022 (A. Anastasiadis)
- ‘Space Weather and Earth affecting transients: CMEs and SEPs’, SWATnet 2nd School: Sun-Earth interactions, 26/09/2022 (A. Papaioannou)
- ‘What do we learn from Ground Level Enhancements?’, NMDB@2022, 22/09/2022 (A. Papaioannou)
- ‘A Trojan horse for exploration and quantification: The case of Empirical Solar Energetic Particle Scaling Relations’, COSPAR 2022 - 44th Scientific Assembly, 16–24 July 2022, Athens, Greece (A. Papaioannou)
- ‘Characteristics of the First Ground Level Enhancement (GLE) of Solar Cycle 25 on 28 October 2021’, COSPAR 2022 - 44th Scientific Assembly, 16–24 July 2022, Athens, Greece (A. Papaioannou)
- 'The SAWS-ASPECS system: the physics behind a tool', NASA SRAG | CCMC Joint Virtual Meeting, 13/05/2020 (A. Papaioannou & A. Anastasiadis)

- 'Energetic particles in the heliosphere current understanding and challenges for space weather services', ESWW16 – Session 11 / Spacecraft Operations, Liége, Belgium, 21/11/2019 (A. Papaioannou & Rami Vainio)

Publications:

- Papaioannou, A. Belov, M. Abunina, J. Guo, A. Anastasiadis, R. Wimmer-Schweingruber, E. Eroshenko, A. Melkumyan, A. Abunin, B. Heber, K. Herbst, and C.T. Steigies, 2019. A catalogue of Forbush decreases recorded on the surface of Mars from 2012 until 2016: comparison with terrestrial FDs. Solar Physics, 294:66, doi:10.1007/s11207-019-1454-2.
- K. Herbst, A. Papaioannou, S. Banjac, and B. Heber: From Solar to Stellar Flare Characteristics, a new Peak Size Distribution for K- and M-Dwarf Star Flares, Astron. Astophys., 621, A67, DOI: 10.1051/0004-6361/201832789, 2019
- G. Balasis, S. Aminalragia-Giamini, C. Papadimitriou, I. A. Daglis, A. Anastasiadis and R. Haagmans, 2019. A machine learning approach for automated ULF wave recognition. Journal of Space Weather and Space Climate, 9, A13, doi:10.1051/swsc/2019010.
- L. Vlahos, A. Anastasiadis, A. Papaioannou, A. Kouloumvakos, and H. Isliker, 2019. Sources of Solar Energetic Particles. Philosophical Transactions A., A377:20180095, doi:10.1098/rsta.2018.0095.
- Anastasiadis, D. Lario, A. Papaioannou, A. Kouloumvakos and A. Vourlidas, 2019. Solar Energetic Particles in the inner Heliosphere: Status & Open Questions. Philosophical Transactions A., A377:20180100, doi:10.1098/rsta.2018.0100.
- A.P. Rouillard, R.F. Pinto, A. Vourlidas, et.al, 2020. Models and Data Analysis Tools for the Solar Orbiter mission. Anstronomy & Astrophysics, 642, A2, doi:10.1051/0004-6361/201935305.
- S. Aminalragia-Giamini, P. Jiggens, A. Anastasiadis, I. Sandberg, A. Aran, R. Vainio, C. Papadimitriou, A. Papaioannou, A. Tsigkanos, E. Paouris and M. Paassilta, 2020. Prediction of Solar Proton Event Fluence spectra from their Peak flux spectra. Journal of Space Weather and Space Climate, 10, 1, doi:10.1051/swsc/2019043.
- Papaioannou, A. Belov, M. Abunina, E. Eroshenko, A. Abunin, A. Anastasiadis, S. Patsourakos and H. Mavromichalaki, 2020. Interplanetary Coronal Mass Ejections as a driver of non-recurrent Forbush decreases. Astrophysical Journal, 890:101(14pp), doi:10.3847/1538-4357/ab6bd1.
- C.Papadimitriou, G. Balasis, A.Z. Boutsi, I. A. Daglis, O. Giannakis, A. Anastasiadis, P. De Michelis and G. Consolini, 2020. Dynamical Complexity of the 2015 St. Patrick's Day Magnetic Storm at Swarm Altitudes Using Entropy Measures. Entropy, 22(5), 574, doi:10.3390/e22050574.
- G. Balasis, C.Papadimitriou, A.Z. Boutsi, I. A. Daglis, O. Giannakis, A. Anastasiadis, P. De Michelis and G. Consolini, 2020. Dynamical Complexity in Swarm Electron Density Time Series using Block Entropy. Europhys. Letters, 131 (2020) 69001, doi: 10.1209/0295-5075/131/69001.
- J. L. Freiherr von Forstner, J. Guo, R. F. Wimmer-Schweingruber, M. Dumbovic, M. Janvier, P. Demoulin, A. Veronig, M. Temmer, A. Papaioannou, S. Dasso, D. M. Hassler, C. J. Zeitlin, Comparing the Properties of ICME-Induced Forbush decreases at Earth and Mars, J. Geophys. Res., DOI:10.1029/2019JA027662, 2020
- A. Kouloumvakos, A.P. Rouillard, G. H. Share, I. Plotnikov, R. Murphy, A. Papaioannou, Y. Wu, Evidence for a Coronal Shock Wave Origin for Relativistic Protons Producing Solar Gamma-Rays and Observed by Neutron Monitors at Earth, Astrophys. J., 893, 76, DOI:10.3847/1538-4357/ab8227, 2020
- Zouganelis,et. al., 2020. The Solar Orbiter Science Activity Plan: translating solar and heliospheric physics questions into action. Anstronomy & Astrophysics, 642, A3, doi:10.1051/0004-6361/202038445.

- E. Paouris, A. Vourlidas, A. Papaioannou and A. Anastasiadis, 2021. Assessing the Time-of-Arrival prediction performance of empirical methods to correct projection effects on Coronal Mass Ejection Speeds. Space Weather, 19, 2, doi:10.1029/2020SW002617.
- E. Paouris, J. Calogovic, M. Dumbovic, M. L. Mays, A. Vourlidas, A. Papaioannou, A. Anastasiadis and G. Balasis, 2021. Propagating conditions and the time of ICMEs arrival: A Comparison of the Effective Acceleration Model with ENLIL and DBEM models. Solar Physics, 296:12, doi:10.1007/s11207-020-01747-4.
- Belov, A. Papaioannou, M. Abunina, M. Dumbovic, I. G. Richardson, B. Heber, P. Kuhl, K. Herbst, A. Anastasiadis, A. Vourlidas, E. Eroshenko, and A. Abunin, 2021. On the Rigidity Spectrum of Cosmic Ray Variations within Propagating Interplanetary Disturbances: Neutron Monitor and SOHO/EPHIN observations at ~ 1-10 GV. Astrophysical Journal, 908:5 (14pp), doi:10.3847/1538-4357/abd724.
- E. Lavasa, G. Giannopoulos, A. Papaioannou, A. Anastasiadis, I.A.Daglis, A. Aran, D. Pacheco and B. Sanahuja, 2021. Assesing the predictability of Solar Energetic Particles with the use of Machine Learning techniques. Solar Physics, 296, 107, doi:10.1007/s11207-021-01837-x.
- K. Herbst, A. Papaioannou, V. S. Airapetian, and D. Atri: From Starspots to Stellar Coronal Mass Ejections - Revisiting Empirical Stellar Relations, Astrophys. J., 907, 89, DOI:10.3847/1538-4357/abcc04, 2021
- J. L. Freiherr von Forstner, M. Dumbovic, C. Möstl, J. Guo, A. Papaioannou, et al., Radial Evolution of the April 2020 Stealth Coronal Mass Ejection between 0.8 and 1 AU: A Comparison of Forbush Decreases at Solar Orbiter and Earth, Astron. Astrophys., DOI:10.1051/0004-6361/202039848, 2021
- S. Aminalragia-Giamini, S. Raptis, A. Anastasiadis, A. Tsigkanos, I. Sandberg, A. Papaioannou, C. Papadimitriou, P. Jiggens, A. Aran and I. A. Daglis, 2021. Solar Energetic Particle Event occurrence prediction using Solar Flare Soft X-ray measurements and Machine Learning. Journal of Space Weather and Space Climate, doi:10.1051/swsc/2021043.
- S. A. Mallios, G. Papangelis, G. Hloupis, A. Papaioannou, V. Daskalopoulou and V. Amiridis: Modeling of Spherical Dust Particle Charging due to Ion Attachment, Frontiers in Earth Science, DOI: 10.3389/feart.2021.709890, 2021
- R. M. McGranaghan, E. Camporeale, M. Georgoulis and A. Anastasiadis, 2021. Space Weather research in the Digital Age and across the full data lifecycle: Introduction to the Topical Issue. Journal of Space Weather and Space Climate, 11, 50, doi:10.1051/swsc/2021037.
- S. Dimitrakoudis, I. R. Mann, G. Balasis, C. Papadimitriou, A. Anastasiadis, and I. A. Daglis, 2022. On the interplay between solar wind parameters and ULF wave power as a function of geomagnetic activity at high- and mid-latitudes. Journal of Geophysical Research, 127, e2021JA029693, doi:10.1029/2021JA029693.
- Papaioannou, A. Kouloumvakos, A. Mishev, R. Vainio, I. Usoskin, K. Herbst, A. P. Rouillard, A. Anastasiadis, J. Gieseler, R. Wimmer-Schweingruber and P. Kühl, 2022. The First Ground Level Enhancement of Solar Cycle 25 on 28 October 2021. Astronomy & Astrophysics (Letters), 660, L5, doi:10.1051/0004-6361/202142855.
- Papaioannou, R. Vainio, O. Raukunen, P. Jiggens, A. Aran, M. Dierckxsens, S. A. Mallios, M. Paassilta and A. Anastasiadis, 2022. The Probabilistic Solar Particle Event foRecasting (PROSPER) Model. Journal of Space Weather and Space Climate, 12, 24, doi:10.1051/swsc/2022019.
- K. Whitman, R. Egeland, et.al., 2022. Review of Solar Energetic Particle Models. Advances in Space Research, doi:10.1016/j.asr.2022.08.006.
- M. Paassilta, R. Vainio, A. Papaioannou, O. Raukunena, S. Barcewicz and A. Anastasiadis, 2022. Magnetic connectivity and solar energetic proton event intensity profiles at deka-MeV energy. Advances in Space Research, doi:10.1016/j.asr.2022.11.051.

- A. Belov, N. Shlyk, M. Abunina, E. Belova, A. Abunin, A. Papaioannou: Solar energetic particle events and Forbush decreases driven by the same solar sources, Universe, DOI:10.3390/universe8080403, 2022
- S.A. Mallios, A. Papaioannou, K. Herbst, G. Papangelis, G. Hloupis: Study of the Ground Level Enhancements Effect on Atmospheric Electric Properties and Mineral Dust Particle Charging, J. Atmos. Solar-Ter. Phys., DOI:10.1016/j.jastp.2022.105871, 2022
- A. Belov, N. Shlyk, M. Abunina, A. Abunin, A. Papaioannou: Estimating the transit speed and time of arrival of Interplanetary Coronal Mass Ejections using CME and solar flare data, Universe, DOI:10.3390/universe8010000, 2022
- A. Papaioannou, K. Herbst, T. Ramm, E.W. Cliver, D. Lario, A. Veronig: Revisiting Empirical Solar Energetic Particle Scaling Relations I. Solar flares, Astron. Astrophys., DOI:10.1051/0004-6361/202243407,2022

National & Kapodistrian University of Athens, Department of Physics / University of Ioannina / University of Thessaly, HERON Lab

The ARTEMIS-IV/JLS Team

Members of the Team are the following:

- National and Kapodistrian University of Athens
  - Prof. Emeritus Costas Caroubalos (Deceased, December 4, 2021)
  - Prof. Xenophon Moussas (retired)
  - Ass. Prof. Panagiota Preka-Papadema (retired)
  - Dr Alexander Hillaris
  - Dr Costas Bouratzis
  - Dr Spyros Armatas
- University of Ioannina
  - Pros. Emeritus Costas Alissandrakis
  - Prof. Alexander Nindos
  - Ass. Prof. Spyros Patsourakos
- University of Thessaly, HERON Lab
  - Ass. Prof. Giorgos Veldes
  - Prof. Panagiotis Tsitsipis (retired)
  - Prof. Athanasion Kontogeorgos (retired)
  - Phd candidate Theofanis Smanis

Infrastructure:

The **Solar Radiospectrograph ARTEMIS-IV/Jean-Louis Steinberg** of the NKUA operates at the Thermopylae Satellite Communication Station since 1996in collaboration with the University of Ioannina and University of Thessaly-HERON Lab.

The observations extend from the base of the Solar Corona (650 MHz) to about 2 Solar Radii (20 MHz) with time resolution 1/10-1/100s using two receivers operating in parallel the ASG (Analyseur de Spectre Global) and the SAO (Spectrograph Acousto-Optic). The recordings in the form of dynamic spectra, measure radio flux as a function of height in the corona; our observations are combined with spatial data from the Nançay Radioheliograph (NRH) whenever the need for 3D positional information arises. These recordings are used in the study of Solar Radio Radiation, Energetic Events and Interplanetary Space Extensions including Space Weather Drivers. The areas of interest include, in particular, transient activity and flares, energy dissipation, electron acceleration and transport during flares, radio signatures of CMEs and coronal radio radiation amongst others. The ARTEMIS-IV\JLS data are often combined with observations of HXR, energetic electrons, EUV, SXR; these can put coherent radio emissions into context and may open exciting new possibilities for radio diagnostics as a tool for understanding radiative plasma processes and energy release in the solar corona.

The ARTEMIS-IV\JLS is out of service since September 2013 due to a malfunction of the Antenna Steering System and the receivers. Repairs are in progress financially supported by the Onassis Foundation (Grant 15153) and the University of Athens Research Committee (Grant 15018) and the ARTEMIS-IV\JLS is now partially operational with the addition of a third, low cost receiver. At present, research work continues based on archived data. These are available on-line as FITS files by the ARTEMIS-IV\JLS web page. They include the daily spectra of the ASG at a reduced time resolution of 5 seconds (QuickLooks: http://artemis-iv.phys.uoa.gr/Artemis4_list.html) and the Type II burst Gallery from 1998 to 2011 (these are available at: http://artemis-iv.phys.uoa.gr/DataBaseForWeb/data_set_intro.htm) since they are of interest in the space weather study. Data of higher resolution, from both the ARTEMIS-IV\JLS\ASG and SAO receivers, formerly available on-demand, have now been archived in a new server provided by the Grants 15153 and 15018 mentioned above and are accessible from the internet (http://artemisjls.phys.uoa.gr/). On the server, a gallery of Selected Dynamic Spectra has also been included.

Publications:

- C. Bouratzis, A. Hillaris, C. E. Alissandrakis, P. Preka-Papadema, X. Moussas, C. Caroubalos, P. Tsitsipis, and A. Kontogeorgos. «High-resolution observations with Artemis-JLS. II. Type IV associated intermediate drift bursts» Astronomy & Astrophysics., 625: A58, May 2019
- C. E. Alissandrakis, C. Bouratzis, A. Hillaris. «High-Resolution observations with ARTEMIS-JLS and the NRH. III. Spectroscopy and imaging of fiber bursts» Astronomy & Astrophysics., 627: A133, July 2019
- S. Armatas, C. Bouratzis, A. Hillaris, C. E. Alissandrakis, P. Preka-Papadema, X. Moussas, E. Mitsakou, P. Tsitsipis, and A. Kontogeorgos. «Detection of spike-like structures near the front of type-II bursts» Astronomy & Astrophysics., 624: A76, April 2019
- C. E. Alissandrakis, A. Nindos, S. Patsourakos and A. Hillaris. «Multi-wavelength Observations of a Metric Type-II Event» Astronomy & Astrophysics, 654, id.A112, October 2021.
- Armatas, S.; Bouratzis, C.; Hillaris, A.; Alissandrakis, C. E.; Preka-Papadema, P.; Kontogeorgos, A.; Tsitsipis, P.; Moussas, X. «High-resolution observations with ARTEMIS/JLS and the NRH. IV. Imaging spectroscopy of spike-like structures near the front of type-II bursts» Astronomy & Astrophysics, 659, id.A198, March 2022. This work is dedicated to the memory of Costas Caroubalos (1928-2021), founder of the ARTEMIS Radiospectrograph.
- Alissandrakis, C. E.; Patsourakos, S.; Nindos, A.; Bouratzis, C.; Hillaris, A. «First detection of metric emission from a solar surge» Astronomy & Astrophysics, 662, id.A14, June 2022

Division 5: Geomagnetic Observatories, Surveys and Analyses

National Observatory of Athens / National & Kapodistrian University of Athens

Dr. Georgios Balasis and Prof. Ioannis A. Daglis

Infrastructures:

- **ENIGMA**: The National Observatory of Athens (NOA) currently operates ENIGMA (HellENIc GeoMagnetic Array), an array of 4 ground-based magnetometer stations in the areas of Trikala (Klokotos), Attiki (Dionysos), Lakonia (Velies) and Lasithi (Finokalia) that provides measurements for the study of geomagnetic pulsations, resulting from the solar wind - magnetosphere coupling (http://enigma.space.noa.gr/). ENIGMA is the first magnetometer station array to operate in Greece, and within a few years of operation has achieved the status of a SuperMAG contributor. ENIGMA monitors the variations of the geomagnetic field associated with the occurrence of geospace magnetic storms and magnetospheric ultra low frequency (ULF) electromagnetic waves. One of the ENIGMA main research objectives is the study of space weather effects on the ground, i.e., Geomagnetically Induced Currents (GIC).

Division 6: Electromagnetic Induction in the Earth and Planetary Bodies

Democritus University of Thrace

Prof Konstantinos Kourtidis

Facilities and Infrastructures:

- Creation and maintenance of European and middle-East facilities dataspace:

The dataspace was created as part of the ElectroNet EU COST project (2016-2021) and among others, it lists the sites, facilities, instrumentation, period of measurementsand contact person for the following variables, of relevance to IAGA: Airglow, cosmic rays, ELF, ULF, VLF, Schuman resonances, Potential Gradient, Jz, Terrestrial Gamma-Ray Flashes (TGF), Transient Luminous Events (TLE).

DUTH continues the maintenance of the site after the termination of ElectroNet project in April 2021. https://dataspace.atmospheric-electricity-net.eu/

- Maintenance of the Demokritus University of Thrace (DUTH) XANTHI Site of Atmospheric electricity measurements:

Name of site	**DUTH Xanthi**
Site location (including lat/lon)	Demokritus University of Thrace, Campus, 67100 Kimeria-Xanthi, Greece 41.15° N, 24.92° E, 75 m ASL
Host institute for the site	Demokritus University of Thrace
Site point of contact	Prof. Konstantinos Kourtidis
Site point of contact email	kourtidi@env.duth.gr
Short summary of the site characteristics	*Type:* rural *Location:* At the edge of a smooth, S-facing slope with a valley reaching the seashore about 20 km to the S and the E-W oriented Rodopi Mountain Range located to the N. 1.7 km from Xanthi (population 65,000) *Ground surface:* Soil and grass Light-traffic road oriented east– west [traffic density of 10 (nighttime) to 150 (rush hours) cars/hr 120 m to the S No obstacles closer than 30 m, protruding <18° above the horizon

Variable	**Device**	**Data logging**	**Sampling rate**	**Transmission**	**Retrieval and Recording**
Atmospheric electric field (PG)	CS110 Campbell Sci.	Onboard CR1000 Campbell Sci.	1 Hz	Every 2min	Via intranet using Loggernet
Meteo (WV, Wdir, T, RH, P, Global horizontal irradiance, Rain)	Wind Sentry Young (MODEL 03002L), Rotronic Hygroclip (S3),	No data logging. Signal digitization using ADAM modules and on line transmission to PC	1 Hz	constantly	Via intranet using Dasylab

	Barometer Vaisala (PTB110), Rain gauge Young (MODEL 52202)				
Particulate matter (PM2.5)	PurpleAir sensor	No data logging, A/D conversion and cable connection to PC	1 Hz	constantly	Online recording

1-min data (for PG also 1 sec data) are stored at a PC which is periodically synchronized with the NIST time server.

- Regular contributor of data to GLOCAEM (https://glocaem.wordpress.com/)

1-min PG measurements from the DUTH XANTHI site are yearly contributed to the GLOCAEM database (see at https://catalogue.ceda.ac.uk/uuid/bffd0262439a4ecb8fadf0134c4a4a41). Up to now, PG data from 2011 to 2021 are downloaded to GLOCAEM and are publicly available to all (for non-commercial purposes), as described at https://glocaem.wordpress.com/data-access/.

Community Service:

- Member of EGU Committee on Education.

International Research Programs:

- «Global Coordination of Atmospheric Electricity Measurements (GLOCAEM)» (P.I.), National Environment Research Council (NERC), U.K., 3.2016-2.2017.
- «Atmospheric Electricity Network: coupling with the Earth System, climate and biological systems (ELECTRONET)» (Coordinator), E.U., COST, 11.2016-4.2021.

Publications:

- Kastelis N. and K. Kourtidis, Characteristics of the atmospheric electric field and correlation with CO2 at a rural site in southern Balkans. Earth, Planets Sp., 68, 3, 2016 doi:10.1186/s40623-016-0379-3.
- Riancho J., J. Sanchez de la Torre, L. Paz-Fajardo, C. Limia, A. Santurtun, M. Cifra, K. Kourtidis and P. Fdez-Arroyabe, The role of magnetic fields in neurodegenerative diseases, Int. J. Biometeorol., https://doi.org/10.1007/s00484-020-01896-y, 2020.63.
- Nicoll K.A., Harrison R G., V. Barta, J. Bor, R. Brugge, A. Chillingarian, J. Chum, A. K. Georgoulias, A. Guha, K. Kourtidis, M. Kubicki, E. Mareev, J. Matthews, H. Mkrtchyan, A. Odzimek, J.-P. Raulin, D. Robert, H. Silva, J. Tacza, Y. Yair, R. Yaniv, A global atmospheric electricity monitoring network for climate and geophysical research, Journal of Atmospheric and Solar-Terrestrial Physics, 184, 18-29, doi.org/10.1016/j.jastp.2019.01.003, 2019.
- Kourtidis K., K. Szabóné André, A. Karagioras, I.-A. Nita, G. Sátori, J. Bór, N. Kastelis, The influence of circulation weather types on the exposure of the biosphere to atmospheric electric fields, International Journal of Biometeorology, https://doi.org/10.1007/s00484-020-01923-y, 2020.
- Fdez-Arroyabe P., K. Kourtidis, C. Haldoupis, S. Savoska, J. Matthews, L. M. Mir, P. Kassomenos, M. Cifra, S. Barbosa, X. Chen, S. Dragovic, C. Consoulas, E. R. Hunting, D. Robert, O. A. van der Velde, F. Apollonio, A. Odzimek, A. Chilingarian, D. Royé, H. Mkrtchyan, C. Price, J. Bór, C. Oikonomou, M.-V. Birsan, B. Crespo-Facorro, M. Djordjevic, C. Salcines, A. López-Jiménez, R. V. Donner, M. Vana, J. O. Pepke Pedersen, M. Vorenhout, M. Rycroft, Glossary on atmospheric electricity and its effects on biology, International Journal of Biometeorology, https://doi.org/10.1007/s00484-020-02013-9, 2020.

- Ellard R. Hunting, James Matthews, Pablo Fernández de Arróyabe Hernáez, Sam J. England, Konstantinos Kourtidis, Kuang Koh, Keri Nicoll, R. Giles Harrison, Konstantine Manser, Colin Price, Snezana Dragovic, Michal Cifra, Anna Odzimek, Daniel Robert, Challenges in coupling atmospheric electricity with biological systems, International Journal of Biometeorology https://doi.org/10.1007/s00484-020-01960-7, 2021.68.
- Savoska, S., P. Fdez-Arroyabe, M. Cifra, K. Kourtidis, E. Rozanov, K. Nicoll, S. Dragovic, L.M. Mir, Toward the creation of an ontology for the coupling of atmospheric electricity with biological systems. Int. J. Biometeorol. 65, 31–44 (2021) https://doi.org/10.1007/s00484-020-02051-3
- Oikonomou, C.; Haralambous, H.; Pulinets, S.; Khadka, A.; Paudel, S.R.; Barta, V.; Muslim, B.; Kourtidis, K.; Karagioras, A., Inyurt, S., Investigation of Pre-Earthquake Ionospheric and Atmospheric Disturbances for Three Large Earthquakes in Mexico. Geosciences 2021, 11, 16. https://doi.org/10.3390/geosciences11010016, 2021.
- Karagioras A. and K. Kourtidis, A Study of the Effects of Rain, Snow and Hail on the Atmospheric Electric Field near Ground, Atmosphere 12, 996, 2021. https://doi.org/10.3390/atmos12080996
- Stergios Misios, Matthew Kasoar, Elliott Kasoar, Lesley Gray, Joanna Haigh, Stavros Stathopoulos, Konstantinos Kourtidis, Gunnar Myhre, Dirk Olivié, Drew Shindell and Tao Tang, Similar patterns of tropical precipitation and circulation changes under solar and greenhouse gas forcing, Environmental Research Letters, Volume 16, Number 10, 104045, doi:10.1088/1748-9326/ac28b1, 2021.

Interdivisional Commission on Education and Outreach

National & Kapodistrian University of Athens, Department of Physics

Prof. Ioannis A. Daglis (IAD), Dr. Georgios Balasis (GB), Dr. Christos Katsavrias (CK), Konstantina Moutsouroufi, MSc (KM), Afroditi Nasi, MSc (AN)

In the scope of the EU H2020 SafeSpace Research Programme, several public engagement, educational and outreaching activities were organized, including online and physical participation. They were comprised by public and targeted talks, online lectures and videos produced by the SafeSpace team, seminars, hands-on exhibitions at scientific festivals, as well as a musical concert and a documentary. More information can be found at the official website of the Programme: https://www.safespace-h2020.eu/.

Public Talks:

- At the gardens of the Visitor Center of National Observatory of Athens, located on the Hill of the Nymphs, in Athens, Greece:
    - Prof. Ioannis A. Daglis, “Space Sonatas”.
    - Prof. Ondrej Santolik, “Music of Space Plasmas”.
    - Dr. Sébastien Bourdarie, “Space Weather Impacts on Spacecraft”.
    - Dr. Hishashi Hayakawa, “Historical Auroral Displays and Millenial Space Weather History”.
- “Space Sonatas” by Ioannis A. Daglis, during the Iraia-Pythagoria Festival, at the Town Hall Square of Samos island, Greece.
- “The Sounds of Space” by Ioannis A. Daglis and Fiori Metallinou, in the courtyard of the Ecclesiastical Museum of Milos, in the center of Adamas, in Milos Island, Greece

Science Festivals:

- Participation in Researcher’s Night Greece 2022, with an exhibition titled “Geomagnetic storms and satellite hazards”, including the presentation of a scientific magnetometer, the sounds of space, and a mock up of the terrestrial magnetosphere.
- Participation in Athens Science Festival 2022, with the activity, “Space Weather & Earth’s Magnetic Field”. A scientific magnetometer was exhibited. Additionally, the relation between science and art was highlighted, through the “sounds of space” that are unveiled by a magnetometer.

Documentary:

- “Higher than the sky” is a documentary about the Space Physics Group and the SafeSpace Programme, both led by Prof. Ioannis A. Daglis, that was directed by Stavros Kostopoulos and broadcasted on Greek National TV.

Musical Concert:

- "Detecting and feeling the sounds of space" by Lina Tonia, was held on Friday, February 18, 2022, with an opening talk by Ioannis A. Daglis. The event was hosted at the Theoharakis Foundation, under the auspices of the Hellenic Space Center, and it premiered the works called "Electron Emissions" and "Radiation Belts", of award-winning composer Lina Tonia, played by violins and cello. Prof. Ioannis Daglis and composer Lina Tonia opened the event giving talks about the sounds of space and the musical compositions that were presented.