

# **COMITÉ ESPAÑOL DE GÉODÉSIE ET GÉOPHYSIQUE SPANISH COMMITTEE OF GEODESY AND GEOPHYSICS**

## **NATIONAL REPORT ON GEODESY**

**FOR**

**2011 - 2014**

## **IUGG XXV GENERAL ASSEMBLY**

### **PREFACE**

This report outlines some Spanish activities in Geodesy for the period 2011 to 2014. It has been prepared for submission to the International Association of Geodesy (IAG) on the occasion of the XXVI General Assembly of the International Union of Geodesy and Geophysics in Prague, Czech Republic, June 22 to July 2, 2015. It is issued on behalf of the Spanish Committee of Geodesy and Geophysics.

In the report the main activities in Geodesy developed in Spain in the period 2011-2014 by different Institutions are presented. These Institutions in alphabetic order are.

1. Astronomy, Geodesy and Cartography Laboratory. Facultad de Ciencias. Universidad de Cádiz, Puerto Real, CÁDIZ.
2. Department of Astronomy and Geodesy, Facultad de Ciencias Matemáticas Universidad Complutense, MADRID.
3. Department of Cartographic, Geodesic and Photogrammetric Engineering (DICGF) - Cartography Geodesy and GPS. VALENCIA
4. Microgeodesia Jaén Research Group. Universidad de Jaén, JAEN
5. National Geographic Institute (Instituto Geográfico Nacional). MADRID.
6. Royal Institute and Observatory of the Navy. (Real Instituto y Observatorio de la Armada). San Fernando, CÁDIZ.

The information provided by the Institutions has been incorporate in the Report, and due to the quantity and diversity of works done some of these have been resumed, giving for each Institution a list of the activities followed by the list of papers published in the period.

Madrid, May, 2015

**Miguel J. Sevilla**  
**(IAG Spanish National Correspondent)**



# **1. ASTRONOMY, GEODESY AND CARTOGRAPHY LABORATORY**

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## **People at the Laboratory**

		<i>Research Interest</i>
<b>Manuel Berrocso Domínguez</b>	Ph.D. in Mathematics	Astronomy, Geodesy, Cartography
<b>María José González Fuentes</b>	Ph.D. in Mathematics	Mathematical Analysis
<b>Alberto Fernández Ros</b>	Ph.D. in Mathematics	Astronomy, Geodesy, Cartography
<b>Alejandro Pérez Peña</b>	Ph.D. in Mathematics	Spatial Geodesy
<b>Cristina Torrecillas Lozano</b>	Ph. D. in Sciences	Geodesy, Cartography
<b>Gonzalo Nuno Delgado Prates</b>	Ph. D. in Sciences	Geodesy, Cartography
<b>Luis Miguel Peci Sánchez</b>	Ph. D. in Sciences Computer	Spatial Geodesy
<b>Raúl Páez Jiménez</b>	MsC in Mathematics (DEA)	Spatial Geodesy, Cartography
<b>Bismarck Jigena Antelo</b>	Geodesy and Cartography Engineer	Spatial Geodesy
<b>Amós de Gil Martínez</b>	Superior Studies (Ministry of Defence)	Geodesy
<b>Ignacio Barbero Guerrero</b>	MsC (Geodesy and Cartography Engineer)	Geodesy, Cartography
<b>Belén Rosado Moscoso</b>	MsC (Mathematics)	Astronomy, Geodesy

## **Research interests**

- Design and development of GNSS geodetic network and its applications.
  - Establishment of a geodetic reference frame for South Shetland Islands, Bransfield Sea and the Antarctic Peninsula (RGAE geodetic network).
  - Establishment of geodetic networks in Deception Island: REGID geodetic network, RENID levelling network and REGRID gravimetric network.
  - Design and development of the Andalusian GPS Positioning Network (RAP network)
  - Establishment of a geodetic network on Tenerife Island to control its volcano-tectonic (TEGETEIDE-GEO network).

- Establishment of a levelling network to control the deformation of the volcanic complex TEIDE-Pico Viejo (TEGETEIDE-NIVEL network)
- Determination of volcanic and tectonic deformation models.
  - Application of the RGAE geodetic network to determine the tectonic deformation occurring in the South Shetland Islands, Bransfield Sea and the Antarctic Peninsula.
  - Monitoring of the volcano-tectonic activity in Deception Island and its environment and volcanic deformation models determination.
  - Determination of tectonic deformation models for Andalusia and the North of Africa.
  - Volcano-tectonic deformation models for Tenerife Island and Teide-Pico Viejo volcanic complex.
  - Real time monitoring of the volcanic activity on Deception Island and in the Teide-Pico Viejo volcanic complex.
- Determination of experimental geoids
  1. Determination of geophysical and geodetic experimental models in volcanic areas (Deception Island and Teide-Pico Viejo volcanic complex).
  2. Geoid determination in Cádiz Bay for seaside areas delimitation.
- Cartography: Technical and scientific information systems and remote sensing.
  - Design and development of a multidisciplinary system of scientific support (SIMAC). An application of Deception Island.
  - Maps Server development and Web Client.
  - Design and elaboration of an information system for universities management (SIGUCA), by means of free software and web client.
  - Quality control for the toponimy of cartographic series.
  - Satellite images for multispectral sensors. Using of panchromatic images for cartography update.

### **Publications (Papers and Book Chapters)**

Garrido-Borrego, María Teresa; Torrecillas-Lozano, Cristina (2011). *NOMÉNCLATOR GEOGRÁFICO DE ANDALUCÍA*. REVISTA PH. INSTITUTO ANDALUZ DEL PATRIMONIO HISTÓRICO. *VOLUMEN 77, 2011, PÁGS 92, 93*.

J. Vidal, M. Berrocoso, B. Jigena (2011). Hydrodynamic Modeling of Port Foster, Deception island (Antarctica). En: J. A. T. Machado et al. *Nonlinear and Complex Dynamics: Applications in Physical, Biological, and Financial Systems*. Páginas: 193-204. ISBN-13: 978-1-4614-0230.5. DOI: 10.1007/978-1-4614-0231-2 16. Springer.

J. Vidal, M. Berrocoso, A. Fernández-Ros (2012). Study of tides and sea levels at Deception and Livingston islands, Antártica. *Antarctic Science*, 24(2), páginas: 193-201. Cambridge Journal. DOI: 10.1017/S095410201100068X. ISSN: 0954-1020.

M. Berrocoso, C. Torrecillas, B. Jigena and A. Fernández-Ros (2012). Determination of geomorphological and volumetric variations in the 1970 land volcanic craters area (Deception Island,

Antarctica) from 1968 using historical and current maps, remote sensing and GNSS. *Antarctic Science* 24(4), 367–376 (2012). ISSN: 0954-1020.

L. M. Peci, M Berrocoso, R Páez, A Fernández-Ros, A de Gil (2012). IESID: Automatic system for monitoring ground deformation on Deception Island volcano (Antarctica). *Computers & Geosciences* 48 (2012) 126-133.

M. Berrocoso, G. Prates, A. Fernández-Ros and A. García (2012). Normal vector analysis from GNSS–GPS data applied to Deception volcano surface deformation. *Geophys. J. Int.* Vol 190-3, 1562-1570 (2012).

C. Torrecillas, M. Berrocoso, R. Pérez-López, M. D. Torrecillas (2012). Determination of volumetric variations and coastal changes due to historical volcanic eruptions using historical maps and remote sensing at Deception island. (*West-Antarctica*). *Geomorphology*, 136 (2012) 6-14. ISSN: 0169-555X.

C. Torrecillas, M. Berrocoso, A. Felpeto, A. García, M. D. Torrecillas (2013). Reconstructing paleovolcanic geometries using a geodynamic regression model (GRM): applications to Deception island volcano (South Shetland islands, Antarctica). *Geomorphology*, 182, pag. 79-88. DOI: 10.1016/j.geomorph.2012.10.032.

G. Prates, M. Berrocoso, A. Fernández-Ros, A. García (2013). Enhancement of sub-daily positioning solutions for surface deformation monitoring at Deception volcano (South Shetland Islands, Antarctica). *Bulletin of Volcanology*. ISSN: 0258-8900. Volumen 75, Número 2. Páginas 1-10. DOI 10.1007/s00445-013-0688-3.

F. L. Mancilla, D. Stich, M. Berrocoso, R. Martín, J. Morales, A. Fernández-Ros, R. Páez, A. Pérez-Peña (2013). Delamination in the Betic Range: Deep structure, seismicity and GPS motion. *Geology*, 41, 307-310. Geological Society of America GSA. DOI:10.1130/G33733.1.

G. Prates, A. García, A. Fernández-Ros, J. M. Marrero, R. Ortiz, M. Berrocoso (2013). Enhancement of sub-daily positioning solutions for surface deformation surveillance at El Hierro volcano (Canary Islands). *Bulletin of Volcanology*. ISSN: 0258-8900. Volumen 75:724. Páginas 1-9. DOI 10.1007/s00445-013-0724-3.

García, A. Fernández-Ros, M. Berrocoso, J.M. Marrero, G. Prates, S. De la Cruz-Reyna, R. Ortiz (2014) Magma displacements under insular volcanic fields, applications to eruption forecasting: El Hierro, Canary Islands, 2011-2013. *Geophysical Journal International*. DOI: 10.1093/gji/ggt505.

Luis M. Peci , Manuel Berrocoso , Alberto Fernández-Ros , Alicia García, José M. Marrero, and Ramón Ortiz. (2014). Embedded ARM system for volcano monitoring in remote areas: application to active volcano on Deception Island (Antarctica). *Sensors*. ISSN 1424-8220. Vol 14. Páginas 672-690. DOI:10.3390/s140100672.

Alicia García, Manuel Berrocoso, José M. Marrero, Alberto Fernández-Ros, Gonzalo Prates, Servando De la Cruz-Reyna, Ramón Ortiz (2014). Volcanic alert system (VAS) developed during the 2011–2014 El Hierro (Canary Islands) volcanic process. *Bulletin of Volcanology*. ISSN: 0258-8900. Volumen 76:825. Páginas 1-13. DOI 10.1007/s00445-014-0825-7

T. Durgonics, G. Prates, and M. Berrocoso (2014). Detection of ionospheric signatures from GPS-derived total electron content maps. *Journal of Geodetic Science*, vol. 4, páginas 98-108. ISSN: 2081-9943.

M. Berrocoso, M. R. Arias, A. Serrano, A. Fernández-Ros, A. de Gil, C. Torrecillas, J. A. García (2008). Geodetic and thermometric monitoring of the volcanic activity at Deception Island (Antarctica): VOLTEDEC Project (2005-2008). En: M. Leppe, C. Gimpel, L. F. Leiva (eds): *Antártica y Sudamérica. Ciencia en el Año Polar Internacional*. Páginas: 382-384. ISBN-13: 978-956-7046-03-4. Editorial: Instituto Antártico Chilena. Valparaíso (Chile).

M. Martín, B. Rosado, M. Berrocoso (2014). Description of El Hierro volcanic process (2011-2014) from variability analysis of topocentric coordinates obtained by GNSS observations . Proceedings ITISE International work-conference On Time Series. Vol 2. Páginas 1293-1298. I.S.B.N: 978-84-15814-97-4. Editorial Copicentro Granada S.L.

Belén Rosado, Marta Martín, Raúl Páez, Manuel Berrocoso (2014). Establishing models of surface deformation from geodetic time series GNSS in areas of tectonic plate interaction. Application to the Southern region of the Iberian Peninsula and North Africa. Proceedings ITISE International work-conference On Time Series. Vol 2. Páginas 1299-1302. I.S.B.N: 978-84-15814-97-4. Editorial Copicentro Granada S.L.

López, J.F., Viramonte, J. G., Berrocoso, M., Barbero, I., Gil Martínez, A, Eulllades, P. Blanco, M. (2014). Validación de la subsidencia del complejo volcánico Cerro Blanco con el uso del GPS Diferencial Geodésico. En Actas del XIX congreso Geológico Argentino (Eds. R. D. Martino, R. Lira, A. Guerreschi, E. Baldo, J. Franzese, D. Krohling, M. Manassero, G. Ortega, L. Pinotti). ISBN: 978-987-22403-5-6. Asociación Geológica Argentina.

### **Conferences and meetings attended**

Berrocoso, M., G. Prates, L. Peci, A. Fernández-Ros, A. de Gil, R. Paez, A. García. The spatial inclinometer and spatial dilatometer and its application to study the deformation of Deception volcano (Antarctica). International Union of Geodesy and Geophysics XXV General Assembly. Melbourne, Julio, 2011. Poster

Berrocoso, M., A. Fernández-Ros, G. Prates, A. García. Geodynamic deformation models in Deception volcano and its environment (1990-2011). 11th International Symposium on Antarctic Earth Sciences. Edinburgh, Julio, 2011. Poster

Prates, G., A. Fernández-Ros, A. García, M. Berrocoso. Spatial deformation parameters based on GNSS-GPS observations at Deception Island (Shetland Archipelago - Antarctica). 11th International Symposium on Antarctic Earth Sciences. Edinburgh, Julio, 2011. Poster

M. Berrocoso, A. Fernández-Ros, G. Prates, M. Martín, R. Hurtado, J. Pereda, M. J. García, L. García-Cañada, R. Ortiz, A. García. Analysis of surface deformation during the eruptive process of El Hierro Island (Canary Islands, Spain): Detection, Evolution and Forecasting. Geophysical Research Abstracts, Vol. 14, EGU2012-4355, 2012. eISSN 1607-7962. Dirección Internet: <http://www.geophys-res-abstr.net>

G. Prates, M. Berrocoso, A. Fernández-Ros, A. García, R. Ortiz. Processes of Compression-Expansion and Subsidence-Uplift detected by the Spatial Inclinometer (IESHI) in the El Hierro Island eruption (October, 2011). Geophysical Research Abstracts, Vol. 14, EGU2012-4050-1, 2012. eISSN 1607-7962. Dirección Internet: <http://www.geophys-res-abstr.net>

A. García, M. Berrocoso, J. M. Marrero, R. Ortiz (2012). Improvement forecasting of volcanic activity by applying a Kalman filter to the SSEM signal. The case of the El Hierro Island eruption (October 2011). Geophysical Research Abstracts, Vol. 14, EGU2012-1799, 2012. eISSN 1607-7962. Dirección Internet: <http://www.geophys-res-abstr.net>

R. Ortiz, M. Berrocoso, S. de la Cruz-Reyna, J. M. Marrero, A. García (2012). Seismic evidence of a second submarine eruption in the north of El Hierro Island. Geophysical Research Abstracts, Vol. 14, EGU2012-1807, 2012. eISSN 1607-7962. Dirección Internet: <http://www.geophys-res-abstr.net>

G. Prates, M. Berrocoso, A. Fernandez-Ros, J. M. Marrero, R. Ortiz, A. Garcia (2013). Enhanced sub-daily near real-time surface deformation analysis at Deception (South Shetland) and El Hierro (Canaries) Islands. IAVCEI 2013 Kagoshima (Japón), 20-24 Julio, 2013.

A. García, J. M. Marrero, M. Berrocoso, A. Llinares, S. de la Cruz-Reyna, R. Ortiz (2013). Magma injection process in monogenetic volcanoes: the El Hierro eruption, Canary Island, Spain: applications to eruption forecasting. IAVCEI 2013 Kagoshima (Japón), 20-24 Julio, 2013.

J. M. Marrero, A. García, A. Llinares, R. Ortiz, M. Berrocoso (2013). Increasing volcanic risk: the case of El Hierro, Canary Island, Spain. IAVCEI 2013 Kagoshima (Japón), 20-24 Julio, 2013.

A. García, A. Fernández-Ros, M. Berrocoso, J. M. Marrero, G. Prates, S. de la Cruz-Reyna, R. Ortiz (2014). Modelling framework developed for managing and forecasting the El Hierro 2011-2014 unrest processes based on the analysis of the seismicity and deformation data rate. Geophysical Research Abstracts, Vol. 16, EGU2014-3530, 2014. eISSN 1607-7962. Dirección Internet: <http://www.geophys-res-abstr.net>

R. Ortiz, M. Berrocoso, J. M. Marrero, A. Fernández-Ros, G. Prates, S. de la Cruz-Reyna, A. García (2014). Volcanic Alert System (VAS) developed during the (2011-2013) El Hierro (Canary Islands) volcanic process. Geophysical Research Abstracts, Vol. 16, EGU2014-3591, 2014. eISSN 1607-7962. Dirección Internet: <http://www.geophys-res-abstr.net>

A. García, L. M. Peci, M. Berrocoso, A. Fernández-Ros, J. M. Marrero, R. Ortiz (2014). Development of multiparameter system for Antarctic researching. Geophysical Research Abstracts, Vol. 16, EGU2014-3666, 2014. ISSN 1607-7962. Dirección Internet: <http://www.geophys-res-abstr.net>

López, J.F., Viramonte, J. G., Berrocoso, M., Barbero, I., Gil Martínez, A, Eullliades, P. Blanco, M. (2014). Validación de la subsidencia del complejo volcánico Cerro Blanco con el uso del GPS Diferencial Geodésico. XIX Congreso Geológico Argentino. Córdoba del 2 al 6 de Junio de 2014.

Almendros, E. Carmona, I. Serrano, M. Berrocoso, A. Fernández-Ros, M. Rodríguez-Arias, D. Stich. Vigilancia volcánica en la isla Decepción. VIII Simposio de Estudios Polares. Palma de Mallorca, Septiembre de 2011. Oral.

M. Berrocoso. El distanciómetro espacial IESID-W y su aplicación a la vigilancia y el seguimiento de la actividad volcánica de la isla Decepción (Antártida). VIII Simposio de Estudios Polares. Palma de Mallorca, Septiembre de 2011. Poster.

Berrocoso, M., L. Peci, A. García, R. Ortíz, G. Prates, A. Fernández-Ros. Modular Volcano Monitoring System (MVMS) for the Deception volcano (Antarctica): seismicity, ground deformation and soil temperature parameters. SCAR Open Science Conference 2014. Auckland, Agosto, 2014. Poster.

Berrocoso, M., A. Fernández-Ros, A., G. Prates, A. García. Volcanotectonic deformation models in Deception volcano and its environment: update and time evolution (1992-2014). SCAR Open Science Conference 2014. Auckland, Agosto, 2014. Poster.

Berrocoso, M., G. Prates, A. García, A. Fernandez-Ros, L. Peci, R. Ortiz. Bransfield basin's strain marker: insights from Deception's GNSS-GPS benchmarks' enhanced sub-daily surface deformation analysis. SCAR Open Science Conference 2014. Auckland, Agosto, 2014. Poster.

## **PH. D. Thesis**

Título: GNSS-GPS Geodetic Time Series Treatment for Volcanic Activity Monitoring and Surveillance: Spatial Dilatometer and Inclinometer. Applied to Deception (Antarctica) and El Hierro (Canaries) Islands.

Doctorando: Gonçalo Nuno Delgado Prates

Universidad: Cádiz

Facultad: Ciencias

Director: Manuel Berrocoso Domínguez

Fecha: 19 de diciembre de 2012

Calificación: Apto cum Laude

*TITULO:* El sistemas de información multidisciplinar de apoyo científico para la isla Decepción (islas Shetland del Sur, Antártida)

*DOCTORANDO:* Torrecillas-Lozano, Cristina;

*DIRECTOR:* Berrocoso-Dominguez, Manuel

*UNIVERSIDAD:* Universidad de Cádiz *FACULTAD/ESCUELA:* Facultad de Ciencias

*AÑO:* 2012 *CALIFICACION:* apto (cum laude)

*TITULO:* DISEÑO Y DESARROLLO DE UN SISTEMA AUTOMÁTICO PARA LA VIGILANCIA VOLCÁNICA. APLICACIÓN AL VOLCÁN DECEPCIÓN (ANTÁRTIDA) Y AL PROCESO VOLCÁNICO DE EL HIERRO (2011-2014).

*DOCTORANDO:* Luis Miguel Peci Sánchez.

*DIRECTOR:* Manuel Berrocoso Domínguez, Alicia García García y Ramón Ortíz Ramis.

*UNIVERSIDAD:* Cádiz *FACULTAD/ESCUELA:* Facultad de Ciencias.

*AÑO:* 2014 *CALIFICACION:* Sobresaliente, Cum Laude.

**(The information of this Institution has been remitted by M. Berrocoso)**



## **2. DEPARTMENT OF ASTRONOMY AND GEODESY. UCM**

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### **WORKING AREAS AND RESEARCH LINES**

Earth Tides. Oceanic loading.  
Gravimetry and inverse problem.  
Gravity networks,  
Optimization methods  
Joint analysis of geophysic data,  
Geodetic study of natural risks  
GPS  
Monitoring Crustal Movements.  
Satellite orbit Control.  
Relativity and Geodesy.  
Cartographic projections.

### **PUBLICATIONS (PAPERS AND BOOK CHAPTERS)**

- Arnosó J., U. Riccardi J. Hinderer, B. Córdoba, F. G. Montesinos: “Analysis of co-located measurements made with a LaCoste&Romberg Graviton-EG gravimeter and two superconducting gravimeters at Strasbourg (France) and Yebes (Spain)”. *Acta. Geod. Geophys.* 2014. DOI: 10.1007/s40328-014-0043-y ED: Springer. ISSN: 2213-5812 (print version) ISSN: 2213-5820 (electronic version).
- Arnosó, J., M. Benavent, FG. Montesinos, MS.Bos. “Análisis de observaciones en nuevas estaciones de marea gravimétrica en España”. “*Actas de la VII Asamblea Hispano Portuguesa de Geodesia y Geofísica*”, 2013, ISBN: (en trámite). Revista Munibe ISSN: 1132-2217.
- Arnosó, J., Benavent M., Boss, M.S., F.G. Montesinos, Vieira, R.: “Verifying the body tide at the Canary Islands using tidal gravimetry observations”. *Journal of Geodynamics*, 51, 358-365, 2011. ISSN: 0264-3707. DOI: 10.1016/j.jog.2010.10.004. Pergamon-Elsevier Science Ltd.
- Barderas, G., Plaza, C., Romero, P.: “Comparison of the methodology used for orbital parameters determination in the International GNSS Service Analysis Centers”. *Física de la Tierra*, 2014, 26, 163-173.
- Barderas, G., Romero, P., Vazquez, L., Vazquez-Poletti, J.L., Llorente, I.M.: “Opportunities to observe solar eclipses by Phobos with the Mars Science Laboratory”. *Monthly Notices of the Royal Astronomical Society*, 2012, 426, 3195–3200.

- Barderas, G., Romero, P.: “Observations of Phobos shadow: Analysis of parameters connecting Earth–Mars reference frames”. *Planetary and Space Science*, 2013, 89, 30–36.
- Barderas, G., Romero, P.: “On the inverse problem of determining Mars lander coordinates using Phobos eclipse observations”. *Planetary and Space Science*, 2013, 79, 39–44.
- Benavent, M., J. Arnosó, E. Vélez, F. G. Montesinos. “Estudio de las Mareas Oceánicas en la Costa Este de Lanzarote (Islas Canarias). Aplicaciones Geodésicas”. *Actas de la VII Asamblea Hispano Portuguesa de Geodesia y Geofísica*, 2013, ISBN: (en trámite), en prensa. Revista Munibe ISSN: 1132-2217
- Gómez-Ortiz, D., F. G. Montesinos ,T. Martín-Crespo, M. Solla, J. Arnosó, E. Vélez: “Combination of geophysical prospecting techniques into areas of high protection value: identification of shallow volcanic structures”. *Journal of Applied Geophysics*, 2014. DOI: 10.1016/j.jappgeo.2014.07.009.
- Gorbatikov, A.V. Montesinos, F.G., Arnosó, J., Stepanova, M. Yu., Benavent, M.: “New features in the subsurface structure model of El Hierro Island (Canaries) from low-frequency microseismic sounding”. *Surveys in Geophysics*, 34, issue 4, 463-489, 2013. SPRINGER. ISSN: 0169-3298 (print version ISSN: 1573-0956 (electronic version). DOI: 10.1007/s10712-013-9240-4.
- Harri, A.M., Schmidt, W., Romero, P., Vázquez, L., Barderas, G., Kempinen, O., Aguirre, C., Vázquez-Poletti, J., Llorente, I. M., Haukka, H., Paton, M.: “Phobos eclipse detection on Mars: Theory and practice”, *Reports 2012:2*, Finnish Meteorological Institute, pp. 1–48. [http://ascelibrary.org/suo/resource/1/jsued2/v137/i2/p53\\_s1?isAuthorized=no](http://ascelibrary.org/suo/resource/1/jsued2/v137/i2/p53_s1?isAuthorized=no). [http://www.caminos.upm.es/matematicas/revistapm/index4\\_numero2.html](http://www.caminos.upm.es/matematicas/revistapm/index4_numero2.html).
- M. J. Sevilla: “Determinación de la constante  $W_0$  del geoide y del sistema mundial de altitudes”. Seminario de Astronomía y Geodesia, 2013, nº 205, pp 1-56. ISBN 0213-6198.
- M. J. Sevilla: “Introducción Histórica a la Geodesia”. *Pensamiento Matemático*, 2012, nº 2, pp.1-63. ISSN2174-0410.
- M. J. Sevilla, Zurutuza, J. and A. M. Martín: “Continuity of the Pasaia Tide Gauge measurements”. *Coordinates* September 2012, pp 44-49.
- Martín A., M. J. Sevilla y J. Zurutuza: “Crustal deformation study in the Canary Archipelago by the analysis of GPS observations”. *Journal of applied Geodesy*, 2014, 8, 2, 129-140. DOI: 10.1515/jag-2014-0002.
- Montesinos, F. G., Arnosó, J., Vieira, R., Luque, T., Benavent, M. T.: “Subsurface geometry and structural evolution of La Gomera Island based on gravity data”. *Journal of Volcanology and Geothermal Research*, 199, 105-117, 2011 .DOI:10.1016/j.jvolgeores.2010.10.007. Elsevier Science Bv. ISSN: 0377-0273.
- Represas, P., João Catalão, F. G. Montesinos, J. Madeira, J. Mata, C. Antunes, M. Moreira: “Constraints on the structure of Maio Island (Cape Verde) by a 3D gravity model: imaging

partially exhumed magma chambers”. *Geophysical Journal International*, 190, Issue 2, 931–940, August 2012. DOI: 0.1111/j.1365-246X.2012.05536.x. ISSN: 1365-246X.

- Romero, P., Antolín, R.: “Temporal patterns of solar eclipses on areostationary relay satellites”. *Acta Astronautica*, 2014, 102, 27-34.
- Romero, P., Barderas, G., Vazquez-Poletti, J. L., Llorente, I. M.: “Spatial chronogram to detect Phobos eclipses on Mars with the MetNet Precursor Lander”. *Planetary and Space Science* 59, 2011, 1542–1550.
- Sainz-Maza, J. Arnos, F. G. Montesinos and J. Martí: “Volcanic signatures in time gravity variations during the volcanic unrest on El Hierro (Canary Islands)”, AÑO. *Journal of Geophysical Research (Solid earth)*, 119, 5033–5051, DOI: 10.1002/2013JB010795.
- Sevilla, M. J. (Ed): “Comunicaciones presentadas en la 7ª Asamblea Hispano-Portuguesa de Geodesia y Geofísica”. Seminario de Astronomía y Geodesia, 2012, nº 204, pp.41 páginas ISBN 0213-6198.
- Sevilla, M. J., J. Zurutuza and A. Martín: “Three Years of Tide Gauge Measurements in the Pasajes Harbour”. FIG Working Week Bridging the Gap between Cultures Marrakech, 2011, pp 1-12.
- Silva, JJ., Romero, P.: “Optimal longitudes determination for the station keeping of areostationary satellites”. *Planetary and Space Science*, 2013, 87, 14-18.
- Vazquez-Poletti, J. L.; Barderas, G.; Llorente, I. M., Romero, P.: “A Model for Efficient Onboard Actualization of an Instrumental Cyclogram for the Mars MetNet Mission on a Public Cloud Infrastructure. Applied Parallel and Scientific Computing, PT I”, *Lecture Notes in Computer Science*. 2012, para 2010: State of the Art in Scientific and Parallel Computing, 7133, pp. 33-42, Springer Verlag.
- Vélez, E., J. Arnos, F. G. Montesinos, M. Benavent, Vieira, R. “Medidas geodésicas de deformación en el Parque Nacional de Timanfaya”. *Actas de la VII Asamblea Hispano Portuguesa de Geodesia y Geofísica*, 2013, ISBN: (en trámite). Revista Munibe ISSN: 1132-2217
- Zurutuza, J. and M. J. Sevilla: “Tropospheric Modeling and Fixed Stations Constraints in Precise GPS Computations: Case Study”. *J. Surveying Eng. ,* 2011, vol. 137-2, pp. 53-59. DOI: 10.1061/(ASCE)SU.1943-5428.0000039.

## **RESEARCH PROJECTS**

**Título del Proyecto:** CGL2011-25494 Modelización geodésica y geofísica avanzada en Gran Canaria. Integración en el contexto estructural y dinámico de Canarias

**Entidad Financiadora:** Ministerio de Ciencia. Plan Nacional I+D+i

**Organismos Participantes:** CSIC, UCM, Universidad Rey Juan Carlos, Universidad de Jaén, Universidad de NewCastle (Inglaterra), Universidad do Porto (Portugal), Russian Academy of Sciences (Schmidt Institute of Physics of the Earth)

**Duración desde 2012 hasta:** Diciembre de 2015

**Investigador principal:** José Arnosó Sampedro

**Investigadores participantes:** 11

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**Título del Proyecto:** Ref- 320/2011- Caracterización estructural del Parque Nacional de Timanfaya mediante uso combinado de técnicas y métodos geodésicos y geofísicos

**Entidad Financiadora:** Organismo Autónomo Parques Nacionales. Ministerio de Medio Ambiente. Plan Nacional I+D+I

**Organismos Participantes:** CSIC, UCM, Universidad Rey Juan Carlos, Universidad de Lugo, Universidad de Burgos, Russian Academy of Sciences (Schmidt Institute of Physics of the Earth)

**Duración desde:** 2012 **hasta:** Diciembre de 2015

**Investigador principal:** José Arnosó Sampedro

**Investigadores participantes:** 9

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**Entidad Financiadora:** Convocatoria de Equipamiento Científico-tecnológico e Infraestructura. Campus de Excelencia Internacional: Campus Moncloa. Universidad Complutense de Madrid, Universidad Politécnica de Madrid.

**Organismos Participantes:** Universidad Complutense de Madrid, Universidad Politécnica de Madrid.

**Duración desde:** 2012 **hasta:** Diciembre de 2014

**Investigador principal:** Susana Martín Fernández (Escuela Técnica Superior de Ingenieros de Montes UPM) y Javier Pérez Tris (Facultad De Biología U.C.M)

**Investigadores participantes:** 10 grupos de investigación UCM y UPM

**Cuantía de la subvención:** 80 163 €

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**Convocatoria:** Convocatoria año 2010 del Programa de Grupos de Investigación Santander-UCM (modalidad A- Consolidados) (GR35/10-A)

**Grupo:** 910505 – GEODESIA (Grupo Consolidado)

**Número de solicitud:** 1557

**Entidad Financiadora:** Universidad Complutense de Madrid- Banco Santander Central Hispano

**Organismos Participantes:** Universidad Complutense de Madrid, Consejo Superior de Investigaciones Científicas, Universidad Nacional de Educación a Distancia, Universidad Politécnica de Madrid

**Investigadores participantes:** 12

**Duración desde:** 1 de Enero de 2011 **hasta** 31 de Diciembre de 2011

**Investigador Responsable:** Fuensanta González Montesinos

Convocatoria año 2014 del Programa de Grupos de Investigación Santander-UCM (modalidad A Consolidados) (GR35/10-A) **Grupo:** 910505 **GEODESIA** (Grupo Consolidado, 1619,29)

## **CONTRACTS (PRIVATE OR PUBLIC COMPANIES)**

**Título del contrato:** Redes geodésicas y GPS.

**Empresa/administración financiadora:** GEOLAN-DONOSTI

**Duración:** 2006 **HASTA:** 2014

**Investigador responsable:** M. J. Sevilla

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**Título del contrato:** “Estudio gravimétrico en un área de recursos geotérmicos en la isla de Tereceira (Azores)”

**Empresa/administración financiadora:** GEOTERCEIRA- SOCIEDADE GEOELECTRICA DA TERCEIRA S.A. (Art. 83 LOU)

**Duración:** 1 Agosto de 2013 al 31 de Abril de 2014

**Investigador responsable:** Dra. F.G. Montesinos

**Entidades participantes:** Universidad Complutense de Madrid, Instituto de Geociencias (CSIC-UCM)

**Número de investigadores participantes:** 4

### **CONFERENCES AND MEETINGS ATTENDED**

- Arnosó, J. F.G. Montesinos, M. Benavent y E. J. Vélez: “The 2011 volcanic crisis at El Hierro: monitoring ground deformation through tiltmeter and gravimetric observations”. *European Geosciences Union General Assembly 2012*. Viena (Austria) fecha: 22-27 de Abril 2012. (Póster).
- Arnosó, J., E. J. Vélez, V. Soler, F.G. Montesinos y M. Benavent : “The Lanzarote Geodynamic Laboratory: new capabilities for monitoring of volcanic activity at Canary Islands. *European Geosciences Union General Assembly 2012*. Viena (Austria) fecha: 22-27 de Abril 2012. (Póster).
- Arnosó, J., M. Benavent, F.G. Montesinos, M.S. Bos: “Análisis de observaciones en nuevas estaciones de marea gravimétrica en España” Congreso: *7º Asamblea Hispano Portuguesa de Geodesia y Geofísica. 7ª Asamblea Hispano Portuguesa de Geodesia y Geofísica*. Comisión Española de Geodesia y Geofísica (CEGG). Sección Portuguesa de Uniones Internacionales Astronómica, Geodésica y Geofísica (SPUIAGG), ARANZADI Sociedad de Ciencias. San Sebastián (Guipúzcoa, España), 23-28 Junio 2012.
- Arnosó, J., S. Sanz-Maza, FG. Montesinos, M. Benavent: ”Temporal gravity variations during the 2011-2012 seismo-volcanic process at El Hierro, Canary Islands”. *ETS2013. Understand the Earth*, Varsovia, Polonia, 15-19 Abril, 2013.
- Arnosó, J.; M. S. BOS; M. Benavent; E. J. Velez: “OTL calculations for studying elastic response of the upper crust in Gran Canaria (Canary Archipelago)”. *Earth Tides Symposium 2013: Understand the Earth*. Varsovia, Polonia, 2013.
- Arnosó, U. Riccardi, J. Hinderer, B. Córdoba, F.G. Montesinos: “Analysis of co-located measurements made with a LaCoste&Romberg Graviton-EG gravimeter and two superconducting gravimeters at Strasbourg (France) and Yebes (Spain)”. *ETS2013. Understand the Earth*. Varsovia, Polonia **año:** 15-19 Abril, 2013, (Póster).
- Barderas, G. y P. Romero: “Lander Position Determination on Mars Using Phobos Transits. Space Research Institute (IKI)”. *Academia de Ciencias del Espacio Rusa*, Moscú, Rusia. Conferencia Invitada. Enero, 2012.

- Barderas, G. y P. Romero: “Observación de Eclipses de Fobos para la Determinación de las Coordenadas de Amartizaje de las Sondas Metnet”. *III Encuentro de Ciencias Planetarias y Exploración del Sistema Solar*. Madrid, España. Junio, 2013.
- Barderas, G. y P. Romero: “Positioning with Astrogeodetic Techniques for the Mars Exploration. *8ª Asamblea Hispano Portuguesa de Geodesia y Geofísica*. Evora 29-31 de enero de 2014.
- Barderas, G., P. Romero y L. Vázquez: “Phobos Eclipse Observation Opportunities with the Mars Science Laboratory”. *European Planetary Science Congress*. Madrid, España. Septiembre, 2012. (Póster).
- Barderas, G.: “Characterization of Phobos Eclipses events for Viking, Phoenix, Pathfinder and MERS Lander Missions on Mars”. *MetNet Finnish-Spanish Eclipse Workshop*. Helsinki, Finlandia. Enero, 2011. (Conferencia Invitada).
- Benavent, M. A. Martin, M. J. Sevilla, E. J. VÉLEZ, J. ZURUTUZA: Determination of the tidal harmonic constants and tide prediction for Pasajes harbour (Spain). VIII Hotine-Marussi Symp. Roma 17-21 junio 2013.
- Benavent, M. T., J. Zurutuza, E. J. Vélez and M. J. Sevilla: Análisis armónico de las observaciones mareográficas en el Puerto de Pasaia. *7ª Asamblea Hispano Portuguesa de Geodesia y Geofísica*. San Sebastian 25-28 de junio de 2012.
- Benavent, T., Arnosó, J., Montesinos, F.G.: “ECOM: New software for ocean tide loading computation”. *96th “Journées Luxembourgeoises de Géodynamique” (JLG)*. European Center for Geodynamics and Seismology and the Walferdange Underground Laboratory for Geodynamics. Luxembourg, 24-26 Octubre, 2011.
- Benavent, T., Arnosó, J., Vélez, Montesinos, F.G.: “Estudio de las mareas oceánicas en la costa este de Lanzarote (islas Canarias). Aplicaciones geodésicas”. *7ª Asamblea Hispano Portuguesa de Geodesia y Geofísica*. Comisión Española de Geodesia y Geofísica (CEGG). Sección Portuguesa de Uniones Internacionales Astronómica, Geodésica y Geofísica (SPUIAGG), ARANZADI Sociedad de Ciencias. San Sebastián (Guipúzcoa, España), 23-28 Junio 2012.
- Benavent, M., Arnosó, J., Velez, E. J.: “Tides at the East Coast of Lanzarote”. *Geophysical Research Abstracts*. European Geosciences Union General Assembly, 2012. eISSN: 1607-7962.
- Benavent, M., J. Arnosó. “Study of sea level variability and vertical crustal motions at Gran Canaria (Canary Islands) from altimetry and tide gauge data. International” *Association of Geodesy Scientific Assembly*. Potsdam, Alemania. 2013.
- Gomez-Ortiz, D., Fuensanta G. Montesinos, Tomas Martin-Crespo, Mercedes Solla, Jose Arnosó, and Emilio Velez: “Identification of shallow volcanic structures in Timanfaya National Park (Lanzarote, Canary Islands) through combined geophysical prospecting techniques”. *European Geosciences Union General Assembly 2014*. Viena (Austria) fecha:

Mayo 2014. (Póster). *Geophysical Research Abstracts*, Vol. 16, EGU2014-13461, 2014. (Póster).

- Montesinos, F. G., J. Arnosó, A. Gorbatikov, M. Benavent, E. Vélez: "Estudios gravimétricos en El Hierro en el marco de la crisis volcánica del 2011" *7ª Asamblea Hispano Portuguesa de Geodesia y Geofísica*. *7ª Asamblea Hispano Portuguesa de Geodesia y Geofísica*. Comisión Española de Geodesia y Geofísica (CEGG). Sección Portuguesa de Uniones Internacionales Astronómica, Geodésica y Geofísica (SPUIAGG), ARANZADI Sociedad de Ciencias. San Sebastián (Guipúzcoa, España), 23-28 Junio 2012.
- Montesinos, F. G., J. Arnosó, E. Vélez, M. Benavent: "Characterization of the crustal structure of Timanfaya volcanic area (Lanzarote, Spain) through gravity study". *IAG Scientific Assembly 2013*. Potsdam, Alemania, 1-6 Septiembre, 2013. (Póster).
- P. Romero, G. Barderas, Jose Luis Vazquez-Poletti y Ignacio M. Llorente. Temporal Areographic Patterns of Phobos Eclipses on Mars for the MetNet Precursor Mission. Asamblea General de la EGU. Viena, Austria. Abril, 2011. Póster.
- Parada, I.M., P. Romero, G. Rodríguez-Caderot, C. Amorós y G. Barderas: "Optimización de estrategias de vuelo de vehículos pilotados por control remoto (RPAS)". *FuzzyMAD 2014*. Madrid, España. Diciembre, 2014. (Póster).
- Rodríguez-Caderot, G., P. Romero, B. Moreno y G. Barderas: "Geodetic Aspects in the Application of Unmanned Aerial Vehicles (UAV) to the fire Prevention". *8ª Asamblea Hispano Portuguesa de Geodesia y Geofísica*. Evora 29-31 de enero de 2014 (Póster).
- Rodríguez-Caderot, G., P. Romero, G. Barderas y B. Moreno Monge: "Aplicaciones de Plataformas Aéreas no Tripuladas (UAV) en la Prevención de Incendios". *FuzzyMAD 2013*. Madrid, España. Diciembre, 2014. (Póster).
- Romero, P. y G. Barderas. "Aspectos científicos y tecnológicos de la determinación precisa de coordenadas de las sondas MetNet a partir de la observación de tránsitos de Fobos utilizando el sensor MetSIS". *MEIGA project progress meeting*. Torrejón de Ardoz, España. Junio, 2012.
- Romero, P. y G. Barderas: "An inverse problem with a multievaluated function: Mars lander position determination from Phobos eclipses". *Fuzzy/MAD meeting*. Madrid, España. Diciembre, 2011. (Póster).
- Romero, P. y G. Barderas: "Areographic Temporal Patterns of Phobos Eclipses. Space Research Institute (IKI)". *Academia de Ciencias del Espacio Rusa*, Moscú, Rusia. Conferencia Invitada. Enero, 2012.
- Romero, P. y G. Barderas: "Determining Mars Lander Coordinates Using Phobos Transit Observations. The Mars Planetary System Workshop", *Europlanet Towards Mars!* Tallín, Agosto, 2012.

- Romero, P. y G. Barderas: “Phobos Eclipses data acquisition cyclogram for the Mars MetNet Precursor Lander”. *EPSC-DPS joint meeting*. Nantes, Francia. Octubre, 2011. (Póster).
- Romero, P. y Juan Jose Silva: “Optimal Longitudes Determination for the Station Keeping for Areostationary Satellites”. *Asamblea General de la EGU*. Viena, Austria. Abril, 2011. (Póster).
- Romero, P. y R. Antolín: “Caracterización de los eclipses de Sol en un satélite de comunicaciones en marte en órbita areoestacionaria”. *III Encuentro de Ciencias Planetarias y Exploración del Sistema Solar*. Madrid, España. Junio, 2013 (Póster).
- Sainz-Maza Aparicio, S., José Arnosó Sampedro, Fuensanta González Montesinos, and Joan Martí Molist : “Volcanic signatures in time gravity variations during the volcanic unrest on El Hierro (Canary Islands)”. *European Geosciences Union General Assembly 2014*. Viena (Austria) fecha: Mayo 2014. (Póster). *Geophysical Research Abstracts*, Vol. 16, EGU2014-13461, 2014. (Póster).
- Sevilla, M. J., A. Martín and J Zurutuza: “Three Years of Tide Gauge Measurements in the Pasajes harbour”. *FIG Working Week 2011 - Bridging the Gap between Cultures Marrakech, Morocco, May 18-22 2011*.
- Sevilla, M. J., J. Zurutuza and A. Martín: “Continuidad de las medidas del mareógrafo de Pasaia (Continuity of the Pasaia Tide Gauge measurements)”. *7ª Asamblea Hispano Portuguesa de Geodesia y Geofísica*. San Sebastian 25-28 de junio de 2012.
- Sevilla, M. J., J. Zurutuza, Z. Agea Y A. Antzizar: “Nuevos datos de la estación GNSS mareográfica de Pasajes”, *8ª Asamblea Hispano Portuguesa de Geodesia y Geofísica*. Evora 29-31 de enero de 2014.
- Vélez, E., J. Arnosó, V. Soler, M. Benavent, F.G. Montesinos: ”Geodetic and geophysical measurements in Lanzarote Island“. *IAG Scientific Assembly 2013*. Potsdam, Alemania, 1-6 Septiembre, 2013.
- Vélez, E.; Arnosó, J.; Montesinos, F. G.; Benavent, M.; Vieira, R.: “Medidas Geodésicas De Deformación en El Parque Nacional De Timanfaya”. *7ª Asamblea Hispano Portuguesa de Geodesia y Geofísica*. San Sebastián (Guipúzcoa, España), 23-28 Junio 2012.
- Zurutuza J., M. J. Sevilla, M. Elorza, F. Gainzarain y A. Antzizar: “Infraestructura Geodésica en Gipuzkoa: trabajos iniciales y estado actual. (Geodetic Infrastructure in Gipuzkoa: previous works and current state)”. *7ª Asamblea Hispano Portuguesa de Geodesia y Geofísica*. San Sebastian 25-28 de junio de 2012.
- Zurutuza J., Z. Agea, M. J. Sevilla, A. Martín and M. C. Ruiz: “Aplicación PPP para la determinación de Posiciones y Velocidades. (PPP Application for Positions and Velocity Estimations.)”. *7ª Asamblea Hispano Portuguesa de Geodesia y Geofísica*. San Sebastian 25-28 de junio de 2012.



## **Meetings attended**

- 7ª Asamblea Hispano Portuguesa de Geodesia y Geofísica. San Sebastian 25-28 de junio de 2012. (M. J. Sevilla)
- 8ª Asamblea Hispano Portuguesa de Geodesia y Geofísica. Evora 29-31 de enero de 2014. Congreso Internacional de Museos Universitarios. Madrid 3, 4 y 5 de diciembre de 2014. (M. J. Sevilla)

## **PH. D. THESIS**

**Alumno:** Gonzalo Barderas Manchado

**Título de la tesis:** Determinación de las coordenadas de amartizaje de las sondas MetNet

**Directora:** Pilar Romero Pérez

**Fecha:** Julio 2013

## **MSC. AND GRADE DISSERTATIONS**

**Alumno:** Chun Quan Huan Lin

**Título de trabajo:** Estaciones de referencia ITRF óptimas para la compensación de redes GPS en Panamá

**Fecha:** Febrero 2011 C.U. 2504.07 (Geodesia Espacial)

**Calificación:** Sobresaliente

**Alumno:** Miguel González Hidalgo

**Título de trabajo:** Caracterización del Pabellón de Gravimetría del Observatorio Astronómico de Yebes mediante Técnicas Gravimétricas

**Tutores:** Sergio Sanz (Instituto Geográfico Nacional); FG Montesinos

**Máster:** Máster en Ingeniería Matemática. Facultad de Matemáticas. Universidad Complutense de Madrid.

**Fecha:** Septiembre 2013

**Calificación:** 8.7 Notable

## **EVENTS ORGANIZATION**

**Título:** *¿Cuánto sabes de Astronomía?*

XI Semana de la Ciencia en Madrid. Facultad de Ciencias Matemáticas. Universidad Complutense de Madrid

Responsable de la actividad: Teresa Benavent Merchán

Tipo de actividad: Talleres   Ámbito: Nacional

Fecha: Madrid, 10 de Noviembre de 2011

**Título:** *¿Cómo medimos la Tierra los Geodestas?*

XI Semana de la Ciencia en Madrid. Facultad de Ciencias Matemáticas. Universidad Complutense de Madrid

Responsable de la actividad: F.G. Montesinos

Tipo de actividad: Talleres   Ámbito: Nacional

Fecha: Madrid, 17 Noviembre de 2011

Título: Geocaching UCM

XI Semana de la Ciencia en Madrid. Facultad de Ciencias Matemáticas. Universidad Complutense de Madrid

Responsable de la actividad: G. Rodriguez Velasco

Tipo de actividad: Talleres   Ámbito: Nacional

Fecha: Madrid, 16 Noviembre de 2011

Título: Geocaching UCM

XII Semana de la Ciencia en Madrid. Facultad de Ciencias Matemáticas. Universidad Complutense de Madrid

Responsable de la actividad: G. Rodriguez Velasco

Tipo de actividad: Talleres   Ámbito: Nacional

Fecha: Madrid, 13 Noviembre de 2012

Título: De Geo a Desia y mido porque me toca

XII Semana de la Ciencia en Madrid. Facultad de Ciencias Matemáticas. Universidad Complutense de Madrid

Responsable de la actividad: T. Benavent

Tipo de actividad: Talleres   Ámbito: Nacional

Fecha: Madrid, 16 Noviembre de 2012

Título: De Geo a Desia y mido porque me toca

XIII Semana de la Ciencia en Madrid. Facultad de Ciencias Matemáticas. Universidad Complutense de Madrid

Responsable de la actividad: Gonzalo Barderas

Participantes: Gonzalo Barderas Manchado, Teresa Benavent Merchán, Fuensanta González Montesinos, Gracia Rodríguez Caderot, Gema Rodríguez Velasco, Pilar Romero Pérez.

Tipo de actividad: Talleres   Ámbito: Nacional

Fecha: Madrid, 7 Noviembre de 2013

**(The information of this Institution has been remitted by F. González Montesinos)**

### **3. DEPARTMENT OF CARTOGRAPHIC, GEODESIC AND PHOTOGRAMMETRIC ENGINEERING (DICGF) - CARTOGRAPHY GEODESY AND GPS**

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Camino de vera s/n  
VALENCIA (SPAIN)  
Tlf: +34-963877550  
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[www.upv.es/cgf](http://www.upv.es/cgf)

#### **SUMMARY OF RESULTS DESCRIPTION (2011-2015)**

##### **Staff**

Dr. José Luís Berné Valero [jlberne@cgf.upv.es](mailto:jlberne@cgf.upv.es)  
Dr. Ana Belén Anquela Julián [anquela@cgf.upv.es](mailto:anquela@cgf.upv.es)  
Dr. Sergio Baselga Moreno [serbamo@cgf.upv.es](mailto:serbamo@cgf.upv.es)  
Dr. Carmen Femenia Ribera [cfemenia@cgf.upv.es](mailto:cfemenia@cgf.upv.es)  
Dr. Natalia Garrido Villen [ngarrido@cgf.upv.es](mailto:ngarrido@cgf.upv.es)  
Pascual Garrigues Talens [pasgarta@cgf.upv.es](mailto:pasgarta@cgf.upv.es)  
Dr. Luis García-Asenjo Villamayor [lugarcia@cgf.upv.es](mailto:lugarcia@cgf.upv.es)  
Dr. Angel Martín Furones [aemartin@upvnet.upv.es](mailto:aemartin@upvnet.upv.es)  
Amparo Martínez Domingo [madoming@cgf.upv.es](mailto:madoming@cgf.upv.es)  
Dr. Israel Quintanilla García [iquinta@cgf.upv.es](mailto:iquinta@cgf.upv.es)

##### **1. Research interests**

###### **GNSS: Navigation.**

Positioning and navigation services based on permanent GNSS networks with RTK applications. Geodetic surveying with GNSS. Geodetic networks and GNSS. Analysis and optimization of Precise Point Positioning technique (PPP).

PPP technique analysis is actually carrying out based on time convergence solution, repeatability, IGS products, different software processing and GPS+GLONASS constellation, both in static and kinematic mode, postprocessing or real time.

A new line research has been integrated, a research project about EGNOS (European Geostationary Navigation Overlay Service) to improve his accuracy using VRS (Virtual Reference Station) differential corrections phase applied to emergency medical helicopters

Some new proposals have been made for optimizing GNSS positioning capabilities under different assumptions: application of global robust estimation has been proven to be useful for mitigating multipath effects, as well as for avoiding the ionospheric delay in the single frequency case. Further, the classical approach of ambiguity functions has proven to be strengthened by the use of global optimization algorithms.

###### **Terrestrial Reference Systems and/or Frames**

DICGF has cooperated with some of the responsible regional institutions (Valencian Cartographic Institute, Asturias Principality) for the computation of ETRS89 coordinates of their active networks. As it can be seen in the publication list section, methodology and results were presented in the Symposium IAG Subcommission for Europe (EUREF).

## **2.- Research Projects**

Next generation in positioning, navigation and sensor positioning. Analysis and optimization of Precise Point Positioning technique (PPP)

The main goal of this project, funded by the Spanish Science Ministry, is to advance in the knowledge and implementation of the Precise Point Positioning technique (PPP) as a potential technique for positioning and navigation with GNSS. No reference station data is necessary making the technique applicable e.g. for airborne high accuracy GPS positioning with InSar, LIDAR or geophysical sensors in remote areas such as Greenland, Northern Canada and the Northern parts of Scandinavia.

Research in static and real-time characteristics of PPP will be done in order to develop potential improvements those guarantee accuracy in the results (centimetric in absolute and decimetric for real-time applications).

Development of an architectural information system for automatic modelling documentation and multimedia diffusion of cultural heritage.

This project, funded by the Spanish Science Ministry, involve the integration of multispectral imagery, laser scanner data and spatial positioning sensors (GPS/INS), looking for optimum return and cost. The project focuses on developing an information system to automate the processes of acquisition, processing, and plotting spatial data and is especially useful for architectural heritage inventories and conservation tasks.

## **3.- Publications**

Garrido-Villén, Natalia;Anton Merino; Berné Valero, José Luis; Anquela Julián, Ana Belén . STUDY OF GROUND MOVEMENTS PRODUCED BY EL HIERRO SUBMARINE ERUPTION OF OCTOBER 2011 THROUGH GNSS TECHNIQUES TO FIND PRECURSORS TO ERUPTION. *Sylwan* (ISSN 0039-7660) 2014

Garrido-Villén, Natalia; Berné Valero, José Luis; Anton Merino;C.Q. Huang . Displacement of GNSS permanent stations depending on the distance to the epicentre due to Japan's earthquake on 11 March 2011. *SURVEY REVIEW* (ISSN 0039-6265) . 2013

Garrido-Villén, Natalia; Berné Valero, José Luis;Anton Merino ;Anquela Julián, Ana Belén; JURISDICTIONAL BOUNDARIES IN SPAIN, SURVEY AND MARKING OF BOUNDARIES IN TERUEL (SPAIN . *SURVEY REVIEW* (ISSN 0039-6265) .2013

Baselga, S., García-Asenjo, L. and Garrigues, P. (2014) SUBMILLIMETRIC GPS DISTANCE MEASUREMENT OVER SHORT BASELINES: NOISE MITIGATION BY GLOBAL ROBUST ESTIMATION. *Meas. Sci. Technol.*, 25(10): 105004 (6 pp).

Baselga, S., García-Asenjo, L. and Garrigues, P. (2014) PRACTICAL FORMULAS FOR THE REFRACTION COEFFICIENT. *J. Surv. Eng.*, 140(2): 6014001 (5 pp).

Baselga, S. (2014) AMBIGUITY-FREE METHOD FOR FAST AND PRECISE GNSS DIFFERENTIAL POSITIONING. *J. Surv. Eng.*, 140(1): 22-27.

Baselga, S., García-Asenjo, L. and Garrigues, P. (2013) Submillimetric GPS DISTANCE MEASUREMENT OVER SHORT BASELINES: CASE STUDY IN INNER CONSISTENCY. *Meas. Sci. Technol.*, 24(7): 075001 (8 pp).

Baselga, S. (2011) EXHAUSTIVE SEARCH PROCEDURE FOR MULTIPLE OUTLIER DETECTION. *Acta Geod. Geophys. Hung.*, 46(4): 401-416.

Baselga, S., Garrigues, P., Berné, J.L., Anquela, A.B. and Martín, A. (2011) DEFORMATION MONITORING IN HISTORIC BUILDINGS: a Case Study. *Surv. Rev.*, 43: 484-492.

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**(The information of this Institution has been remitted by J. L. Berné)**

## 4. MICROGEODESIA JAÉN RESEARCH GROUP

Grupo de Investigación MICROGEODESIA JAÉN  
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### 1. Introduction

The "MICROGEODESIA JAÉN" research group was set up in 1997 in the Department of Cartographic, Geodetic and Photogrammetric Engineering of the University of Jaén. It is mainly focussed on Geometrical and Physical Geodesy applications. The main researches carried out are in the following topics: Geodetic monitoring of crustal deformation, Engineering Geodesy, Geodetic networks and GPS, Positioning and navigation services based on permanent GNSS networks with RTK applications and Application of radar interferometry to monitor ground deformation.

### 2. Research Projects

AYA2010-15501(ESP). "Aplicación de la Interferometría Radar de Satélite y los Sistemas Globales de Navegación por Satélites en Estudios sobre Control de Deformaciones de la Cordillera Bética.", Antonio J. Gil (Universidad de Jaén), MICINN, 01/2011-12/2015. 181.500 €

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#### **Committees and international representation**

*A.J. Gil - Expert in the evaluation of PRIN/Futuro in Ricerca projects. MIUR - Ministero dell'Istruzione, dell'Università e della Ricerca (Italy). 2012-.*

*A.J. Gil in "Electronic Journal of Polish Agricultural Universities" Editorial Board (Poland) 2010-.*

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## **5 NATIONAL GEOGRAPHIC INSTITUTE**

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### **1. GNSS Reference Station Network (ERGNSS).**

ERGNSS is the GNSS Permanent Network of the National Geographic Institute of Spain. The installation of the first station was carried out in March 1998. Currently, ERGNSS is constituted by 50 stations. All of them accomplish the requirements to be a station of the EUREF Permanent Network (EPN) respecting monumentation, stability and firmware equipment.

The main objectives of this network are:

- To obtain precise coordinates and velocities of the points.
- 3 of them (YEBE, MELI and LPAL) are IGS stations contributing to the definition of the International Terrestrial Reference Systems ITRS.
- 23 of them are stations of the EPN, contributing to all projects that affect to this Network and to the definition of the European Terrestrial Reference Systems ETRS.
- To collaborate in other scientific projects, like Geodynamical, Meteorological or Geophysical projects.
- To participate in the Real Time Project (EUREF-IP).
- To provide public and free RINEX files one second hourly data through a public ftp server with the address: <ftp://ftp.geodesia.ign.es>.
- To provide a public and free RTK service to users in Spain.

In the last four years (2011-2014) around 20 new stations have been installed and most of the former stations have been upgraded to be able to track GLONASS satellite signals.

For real-time applications a Professional NTRIP Caster (<http://ergnss-ip.ign.es>) on TCP ports 8080 and 2101 has been developed with RTCM2.3 and RTCM3.x data streams for each GNSS station.

During 2014 different tests have been made in order to achieve a new RTK service based on network solution, not only based on a single station solution. This solution will be available at the middle of this year, providing to the public users a service with VRS, MAC and FKP solution in all the Spanish territory.

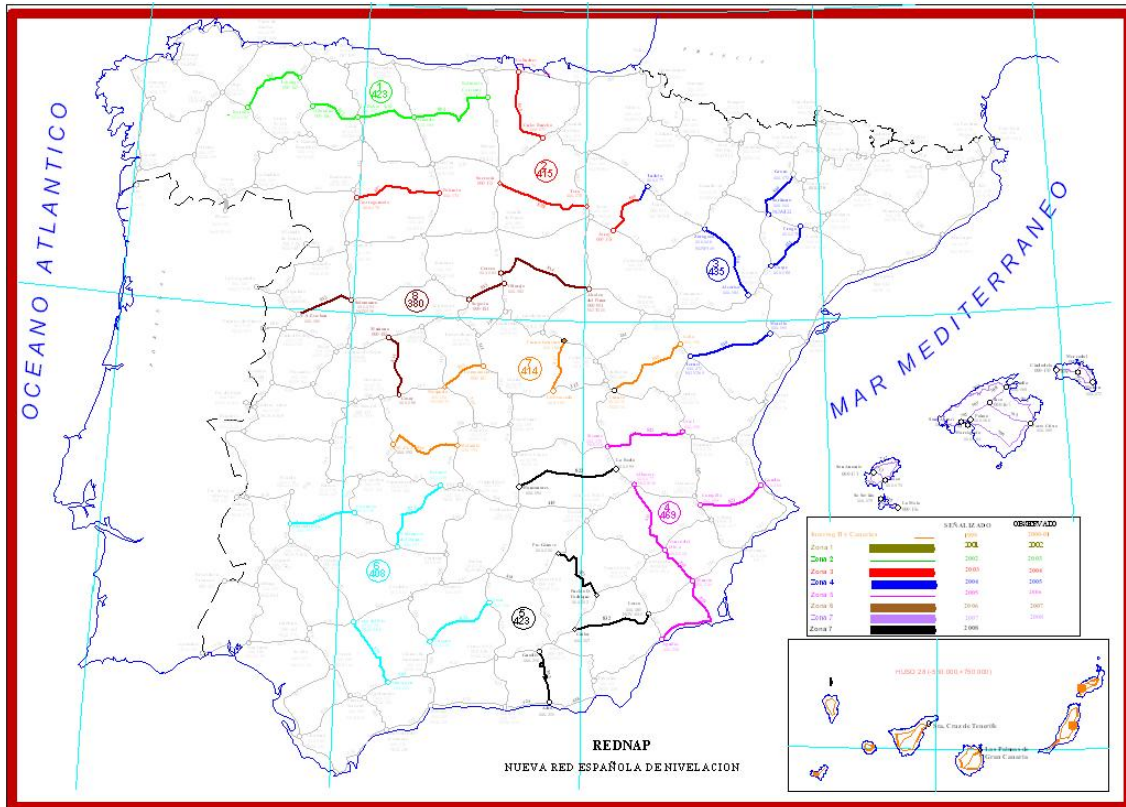


**National GNSS Reference stations network (ERGNSS).**

## **2. National High Precision Levelling Network (REDNAP).**

After finishing the observation work, analysis and adjustment of the New High Precision Levelling Network of Spain (REDNAP Project, 2001-2008), the National Geographic Institute of Spain (IGN) has continued with a densification and maintenance plan for this network. The original network consisted of about 16,500 kilometres of levelling lines and about 21,500 benchmarks. During the 2008-2010 period, the network was densified and new additional lines were observed, adding more than 2,000 km, including the extension to the Balearic Islands and links to the network of GNSS permanent stations and tide gauges.

Throughout the years 2011-2014, the IGN has continued with the densification and maintenance plan of REDNAP, observing new levelling lines and lines for link to GNSS stations and tide gauges facilities, adding 1,500 km to the network. Thus, REDNAP now consists of about 25,000 benchmarks along about 20,000 km. These observations are complemented by GPS and gravity observations.



### *Densification of the High Precision Levelling Network of Spain (REDNAP).*

#### **3. Tide Gauges Network**

At present, the tide gauges network of the IGN has nine operating stations throughout the coast of the Peninsula and the Canary Islands: Alicante1, Alicante2, Cartagena, Almería, La Coruña, Santa Cruz de Tenerife, Puerto de la Cruz, Los Cristianos and Puerto del Rosario.

During the period 2011-2014, routine maintenance and digital publishing (ftp-based) of raw and analyzed data from the nine IGN tide gauges was carried out. Three new radar sensors have been installed to complete, across the network, the system of observation by redundant sensors. The equipment of three stations was also renovated, so they can transmit their data in real time and thus they can be adapted to the demands of the National Network for Tsunami Warning. At present, five of them are working in these conditions. It has therefore been necessary to adapt the communications software.



*Tide gauge facilities of Alicante2, Santa Cruz de Tenerife and Puerto del Rosario.*

There has also been carried out the restoration of historical tide gauge data from Cadiz, comprising between 1880 and 1924, and the same work was performed with data from Santa Cruz de Tenerife from 1927 to today.

The historical data from Ceuta for the years 1907 and 1928 have been recovered, and soon will be studied in collaboration with experts from the University of Illes Balears. In the same line of work, there have been initiated works to rescue the tide gauge data from Santander between 1876 and 1928.

The necessary steps to open the web-based query access and data download are about to be completed.

#### **4. GNSS Processing at IGN.**

- **EUREF Analysis Centre.**

The IGN geodetic department became a EUREF Analysis Centre since the first week of September of 2001 (GPS WEEK 1130) under the acronym of IGE.

Currently, the processing is being carried out with Bernese Processing Engine, BPE of Bernese 5.2 under LINUX platforms in an automatic procedure. Weekly (final orbits) and daily (rapid orbit) solutions are reported in SINEX format (Solution Independent Exchange format), together with a weekly SUMMARY of results and seven troposphere parameter files (one per day of the week) corresponding to a special project of estimation of troposphere parameters (zenith path delays) of EUREF.

The current number of EPN stations that are being processed is around 66. The processing strategy have changed in these years with new and better models, using new values at processing, Absolute Antenna Phase Centre Variations (APCV) and individual calibrations, GPS + GLONASS observations, GMF as a troposphere model, etc.



***Current EUREF subnetwork processed by IGE.***

- **Repro2 activities.**

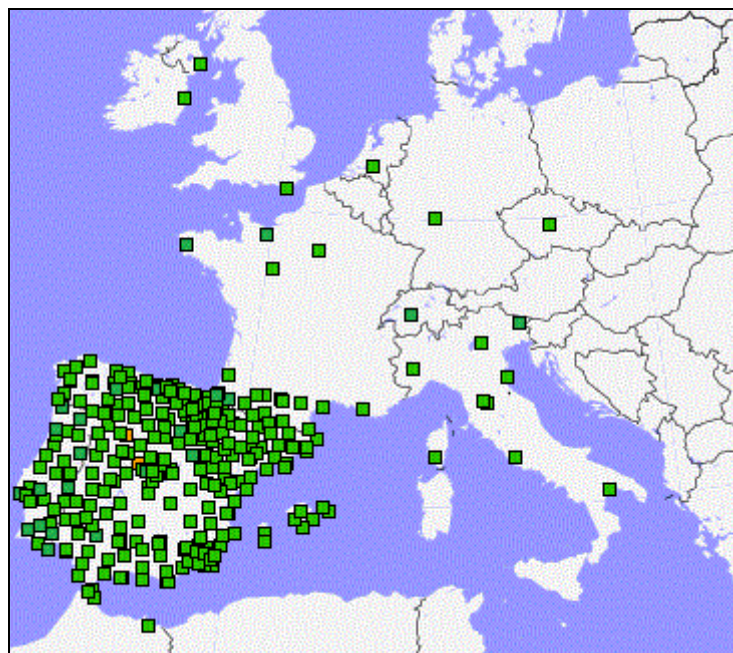
During 2014 a new reprocessing has been made in EUREF network, the so called REPRO2. In this project IGE has participated reprocessing a subnetwork of 125 EPN stations, covering the whole period 1994 – 2014. The stations are focused in the European south-west area, covering all stations located in Portugal, Spain, France, Italy, Ireland and Great Britain. This process has been made using the same options that IGE uses for EUREF routine processing.

- **E-GVAP Analysis Centre.**

IGE Analysis Centre began the collaboration with AEMET, the Spanish Meteorological Institution, in E-GVAP since March 2009. In this project Zenith Troposphere Delay (ZTD) is estimated in “near real time” each hour in a set of stations covering all the Iberian Peninsula and adjacent archipelagos (Azores, Canary and Balearic Islands) in order to be used in Numerical Weather Prediction by meteorological agencies integrated in the EUMETNET organization.

For this purpose hourly data are collected by IGN immediately after every hour from 15 different networks belonging to IGP (Portugal), IGN (France), IGS and regional administrations in Spain. In the minute 20 of each hour the process starts with BSW 5.2 and ZTD data in COST file format are sent to Met-Office (GB) around minute 40, which disseminates the information.

During this time the number of stations have grown up and the strategy have been re-adapted. Currently processing of IGE consists of about 350 stations. The processing consists of two phases, a weekly process with the objective of getting precise coordinates and an hourly process to get zenith total delays. The first process is done with double differences strategy using final IGS products and at the end making a weekly combination. Due to the huge number of stations, the process is made clustering the network. The hourly process is done using the precise coordinates from the first process, with double differences strategy and using ultra rapid CODE products. Finally, the 6 last hours of normal equations are combined to get the hourly ZTD.

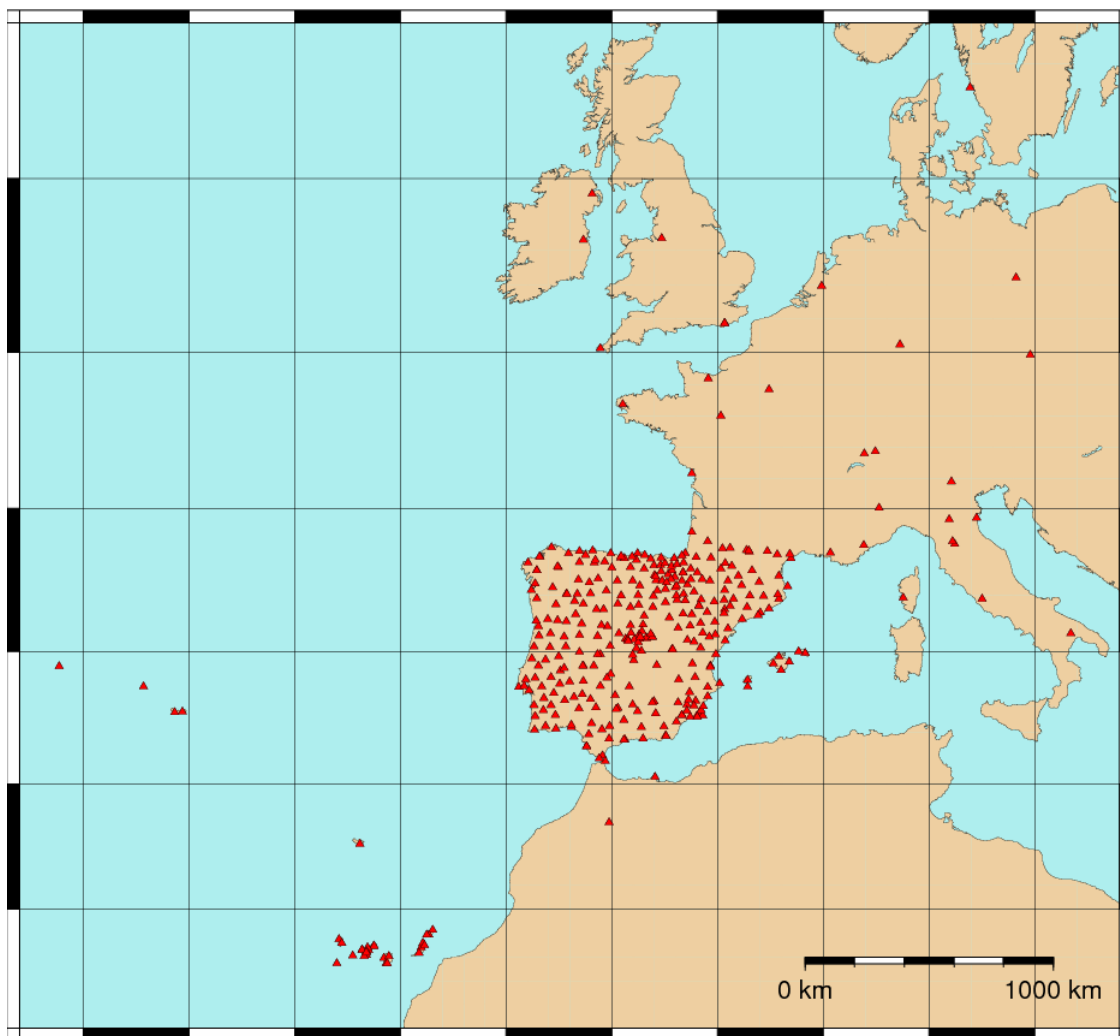


*E-GVAP network processed by IGE.*

- **IBERRED & Regional Dense Velocity Field Project.**

Following almost the same strategy used for EUREF, the IGE Analysis Centre is processing an Iberian Network with geodynamic purposes with stations of the area which provide public data. The name of this network is called IBERRED. These stations belong to dense networks managed by the Regional Governments and the same stations processed for E-GVAP. As a result of this process IGN is making a Time Series analysis of the coordinates for monitoring and geodynamical studies.

Currently IGE is processing about 350 stations in this project, collaborating at the same time with the “Regional Dense Velocity Field” Project managed by the same called IAG Working Group.



***IBERRED network.***

## **5. ABSOLUTE and RELATIVE GRAVITY**

Absolute gravity stations are divided into two sub-networks: the Zero Order Network and the First Order Network.

### Zero Order Network

The Zero Order Network consists of 30 sites observed from 2001 until 2010 in the Iberian Peninsula with the FG5 gravity meter. Some sites have already been re-occupied, allowing thus the beginning of the time series. All results must be considered in the frame of the international absolute intercomparisons and carefully observed in the future to detect outliers. All observation and processing protocols are similar to those performed in the above mentioned intercomparisons and the World Gravity Standards (Boedecker, 1988).

Most stations, placed in geophysical or astronomical observatories, have a strong well founded pier without any metallic reinforcement bar. Piers are usually connected to bedrock to reduce instrumental vibrations. Seismically quiet sites far from cultural and industrial noise bring up low scattered observations. In those cases where no such facilities were found, a special selection of old well founded buildings (abbeys, old churches, universities, etc) were chosen. Thus, examples such as Geophysical Observatory of Santiago de Compostela,

Geophysical Observatory of Logroño, Geophysical Observatory of Málaga, Geophysical Observatory of Almería, Geophysical Observatory of San Pablo de los Montes (Toledo), El Miracle Cluster (Lleida), Astronomical Observatory of Fabra (Barcelona), Ebro Observatory (Tarragona), El Puig Monastery (Valencia), and Valle de los Caídos (IAGBN station) already observed, point up a quietness and very long permanence qualities.



*Absolute gravity sites*

The station Astronomical Observatory of Madrid is located in the library of the main facility building of "Observatorio Astronómico Nacional", inside the "Parque del Retiro" in Madrid. The measurement was made in the pillar where Mr. Joaquin Barraquer placed the Strasser clock for his 1882 absolute gravity determination, which is about 1 meter to the west of the pier where he made the measurements with the Repsold Pendulum. The station is placed on a granite outcrop around 1.8 m deep in the ground. There is a IGSN71 point next to these piers (MADRID-A).

Since 1933 the Gravity Laboratory of IGN in Madrid is a fundamental point, where an IGSN71 core station Madrid-C and absolute piers coexist in the same room.

The geological stability and low noise (far from big roads) of the San Pablo de los Montes and Sonseca sites in "Montes de Toledo", in the Sistema Central Mountain Range, allows to join geodetic, magnetic, seismological and gravity instruments in the same site. Two piers are set up to measure gravity.

An easily accessible eccentric at every station will be set up to facilitate direct value of gravity. Some eccentrics were already measured.

Before absolute measurements, true gravity gradient observations were made to introduce the best possible gradient in the absolute gravity formula and to translate the absolute value



from effective height to the floor, see for instance Niebauer et al. (1989, 1995) and also Francis and Van Dam (2003). A LaCoste & Romberg, Model G, gravimeter with analogue feedback system was used to develop this task. At least 24 hours of measurements were made in every station to obtain the final absolute value, 24 set of a hundred drops per set, namely about 2400 drops. The starting fringe was 30 in all cases, and the number of fringes were 600, namely a million and a half time-distance pairs. To obtain the final results, the g software processing tool from Microsolutions Inc. (Niebauer et al., 2002) has been employed.

### First Order Network

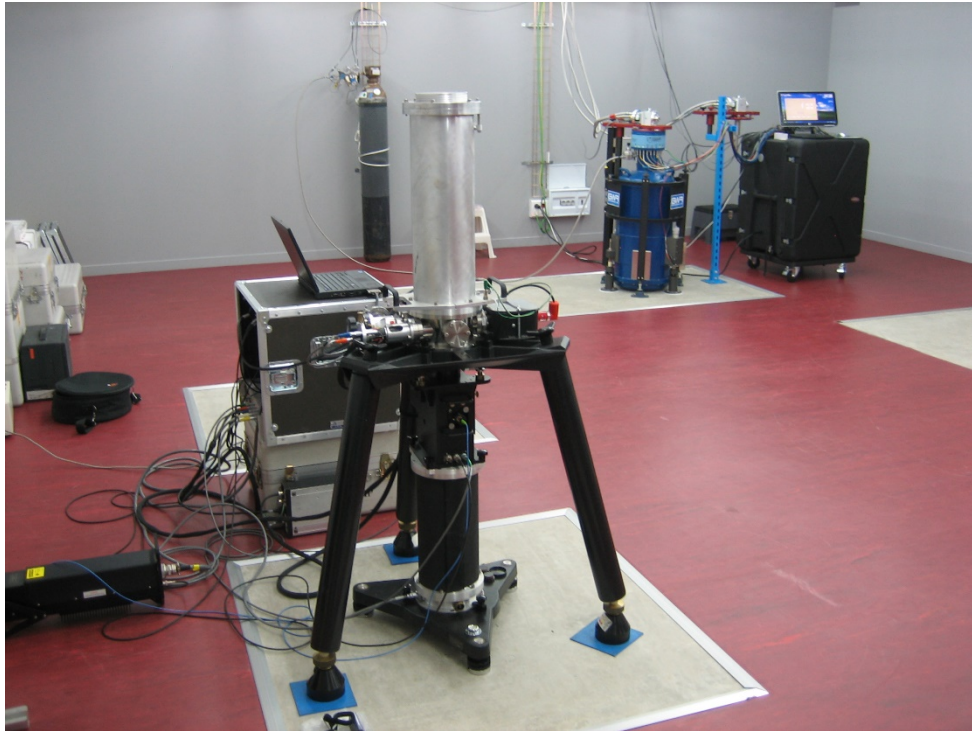
The First Order Network consists of 44 sites observed from 2003 until 2010 in the Iberian Peninsula and the Balearic Island (Majorca, Minorca and Ibiza) with the A10 gravity meter (figure 1). Most of these sites have also a concrete pier to obtain a good stability, sharing accelerometer sites. Also the main entrance of churches and cathedrals are stable buildings and considered as sites. Measurements of gradient were carried out to translate the 0.7 m nominal height value to the floor datum. All stations were processed identically as the zero order stations.

From 2010 to 2015, 49 new emplacements have been observed both in the Canary Islands and in the Iberian Peninsula.

### Gravity Pavilion at Yebes

In 2008 the IGN started a new project at the Yebes Astronomical Observatory endowing it with new facilities for combining top quality techniques (VLBI, Laser ranging, GPS and continuous gravity measurement) at the same site. To this end, in 2008, is designed and built a pavilion of gravimetry in the outbuildings Yebes Observatory. The pavilion, designed to reach a high-quality, has a dual-chamber with seven pillars of measurement, which allows simultaneous measurement and inter comparison of gravimetric instrumentation. It has been also installed instrumentation for environmental conditions measurement (weather station, measuring the water table, measurement of soil moisture ...). In this pavilion, in May 2010, has been installed the newly acquired Gravimeter Superconductor (SG) launched in the world of superconducting gravimetry. The new SG has been made by G.W.R Company and it is now installed in one of the gravity meter pier. The new SG is being calibrated with one of the IGN's absolute FG5 instrument.

The SG opens a wide range of new possibilities for study, allowing research in seismology, geodesy, geomagnetism, volcanology, VLBI or GPS, and to measure the acceleration of gravity in real time, continuously and with high resolution, which was unattainable until now. At present, data from the Superconducting Gravimeter of Yebes, is integrated in many projects, as GGP (Global Geodynamics Project) and the IRIS (Incorporated Research Institution for Seismology).



Indoors Gravity Pavilion. To the left is the absolute gravimeter FG5 of the IGN, the simultaneous measurement of the SG is required for the control of superconducting gravimeter drift during the first months of registration.

### Continuous relative gravimeters

In 2009, the IGN acquire a relative continuous gravimeter for continuous earth tides registration. The instrument, a gPhone, from Micro-g-Lacoste Company, has been installed in Tenerife for volcano monitoring proposes.

## **6. Geodetic Network in the Canaries, Volcanic Monitoring System Project**

El Hierro, La Palma and Tenerife islands are the island with active volcanoes. For this reason the Spanish Government decided to develop a Volcanic Monitoring System project in 2004 after several seismic movements affected that islands.

The Spanish National Geographic Institute is developing a network to monitor the Canaries, using different techniques: geodetic, seismic, geochemical and geomagnetic techniques. Due to volcanic process, land movements can occur at different spatial and temporal scales. The measurement of these possible deformations can be useful precursors to active volcanoes. So, it is necessary to have a geodetic network covering the whole island, which uses land and space techniques. Apart from REGCAN network (REGENTE Canary Island) and the National High Precision Levelling Network (REDNAP), permanent GPS stations and tide gauges, GPS periodic campaigns and InSAR techniques has been used in the last years.

A permanent GPS network of about 30 sites is being installed in order to control ground deformation on the whole island. Nowadays there are 5-10 GPS stations working in each one of the active islands. Some stations are located at the coast next to a tide gauge. Next figure

shows the Continuous GPS stations installed in Tenerife (CGPS in red and CGPS with Tide Gauge blue).

Data are sampled every second and downloaded hourly in two analysis centres at Centro Geofísico de Canarias (CGC) in Tenerife and in Madrid. In these centres quality is checked using TEQC software and data are processed together with IGS and EUREF stations around the area using the Bernese Processing Engine (BPE) of Bernese 5.0 software.

The strategy depends on the type of movement expected in the deformation monitoring. In the case of volcano monitoring the deformation is expected to be slow or not present during quiescence periods. Nevertheless ground movements of increasing magnitude can occur in the hours to days prior to a magma intrusion. This is why two strategies are being used to process GPS data:

- Rapid processing mode occurs with minimum delay (the day after) in static sessions of a day in length using ultra-rapid orbits.
- Post-processing mode with static sessions of a day in length to measure slow deformation, such as a constant rate, using precise orbits and Earth rotation parameters to improve the quality of the solution.

The network solution is connected to the ITRF2005 through some IGS core stations. In this way, daily solutions are reported in SINEX files and coordinate time series from our stations in ITRF2005 are obtained to control ground deformation associated with volcanic activity in Tenerife.

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**(The information of this Institution has been remitted by M. Valdés)**

## **6. ROYAL INSTITUTE AND OBSERVATORY OF THE NAVY. (SAN FERNANDO)**

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The “Real Instituto y Observatorio de la Armada en San Fernando” (ROA), is a Naval institution working on geodesy from its foundation on the mid XVIII century. Now, activities on this area are focused in Satellites Laser Ranging (SLR) and Global Positioning System (GPS) measurements and applications.

### **1. Satellites Laser Ranging (SLR).**

Installed on the top of the main building, under a dome, ROA has a SLR station successively improved since 1968. During the period 2011-2015, the station has been upgraded, partially funded by the Spanish Government through the following research projects:

- “Satellite Laser Ranging automating and accuracy improving” (AYA2009-11896), from the National Program for Space Research, ‘Ministerio de Ciencia e Innovación’, from the beginning of 2010 to the end of 2013. The most important goal of this project has been the development of a new movement control system to reach a significant improvement in the tracking accuracy.

A brief tracking statistics for the 2011-2014 period is shown in the following tables.

Number of successful tracking in 2011:

	ENE	FEB	MAR	ABR	MAY	JUN	JUL	AGO	SEP	OCT	NOV	DIC
Lageos 1	2					3	27	11	35	33	15	6
Lageos 2	1					9	18	3	3	11	16	1
Ajisai	3					34	40	52	76	38	60	39
Starlette	7					38	20	31	46	30	34	14
Stella	2					16	15	16	26	19	14	10
ERS2	1					20	8					
HY2A										10	17	19
Jason-1	3					1	34	18	30	8	8	15
Jason-2	3					0	34	22	44	17	11	11
BEC	7					13	42	44	35	75	18	45
Grace A	2					7	17	8	1	4	6	6
Grace B	0					4	14	7	3	3	3	1
Envisat	3					27	27	15	17	15	4	6
Larets	0					6	14	8	19	13	9	3
Goce	0					0	0	0	4	7	1	0
Cryosat 2	0					17	15	2	14	9	6	6
TerrasarX	1					0	2	0	3	10	9	12
TandemX	0					0	6	1	8	15	13	15
Glonass102	1					0	0	0	0	1	1	0
Glonass109	0					0	0	0	2	0	2	0
Glonass110	1					0	0	0	0	0	0	0
Glonass115	0					1	2	0	0	5	1	0
Glonass118	1					0	0	0	0	1	0	0
<b>TOTAL</b>	<b>38</b>					<b>196</b>	<b>335</b>	<b>238</b>	<b>366</b>	<b>327</b>	<b>248</b>	<b>209</b>

Number of successful echoes in 2011:

	ENE	FEB	MAR	ABR	MAY	JUN	JUL	AGO	SEP	OCT	NOV	DIC
Lageos 1	140	MAINTENANCE				530	7611	1344	10170	10841	2106	352
Lageos 2	99					1561	7691	416	518	2555	3652	155
Ajsai	4290					36079	48687	79177	98481	21804	56079	29398
Starlette	2616					21453	5392	16023	24897	13904	9083	2479
Stella	1359					5890	10200	4656	12521	5010	3019	1592
Ers2	514					7587	6900					
HY2A										4860	8302	6813
Jason-1	1465					34	22885	10435	11188	2082	1079	2580
Jason-2	1196					0	24514	11643	23741	8515	2476	2394
Beacon-C	6821					4027	40846	28705	21436	52051	6698	17147
Grace A	551					861	4306	1598	558	530	435	460
Grace B	0					209	3131	2397	401	402	283	17
Envisat	1051					17645	21171	7325	4099	3736	611	755
Larets	0					357	4438	640	3206	1911	851	392
Goce	0					0	0	0	853	1121	27	0
Cryosat 2	0					9105	4897	129	4330	2445	1218	471
TerrasarX	243					0	191	0	196	3184	2814	2398
TandemX	0					0	569	42	781	3796	2969	2814
Glonass102	107					0	0	0	0	27	7	0
Glonass109	0					0	0	0	48	0	31	0
Glonass110	49					0	0	0	0	0	0	0
Glonass115	0					32	56	0	0	422	9	
Glonass118	20					0	0	0	0	129	0	0
<b>TOTAL</b>	<b>20521</b>					<b>105370</b>	<b>213485</b>	<b>164530</b>	<b>217424</b>	<b>139325</b>	<b>101749</b>	<b>70217</b>

Number of successful tracking in 2012:

	ENE	FEB	MAR	ABR	MAY	JUN	JUL	AGO	SEP	OCT	NOV	DIC
Lageos 1	9	24	5	8	5	8	5	1	1	4	0	3
Lageos 2	8	17	2	0	0	5	13	17	11	14	1	0
Ajsai	43	109	47	28	90	38	44	80	21	48	39	30
Starlette	42	20	29	14	17	54	11	48	18	32	15	18
Stella	9	19	10	7	22	17	15	20	14	16	4	12
Lares			4	5	15	10	4	26	9	19	3	10
Larets	5	12	5	7	6	8	3	3	1	9	3	14
Jason1	12	6	3	4	25	13	33	35	22	15	12	16
Jason2	21	18	17	22	29	11	40	34	25	14	18	18
BEC	24	59	29	27	43	23	38	22	47	33	27	33
GRACE A	8	12	0	1	8	16	2	2	4	9	5	12
GRACE B	5	8	0	0	7	17	1	1	6	1	3	10
Envisat	12	13	8	17	18	17						
Cryosat	11	24	19	0	9	20	17	13	8	14	13	25
Blits	1	2	0	0	0	0	0	0	1	1	0	2
Goce	2	8	7	1	0	0	0	0	1	3	0	2
HY2A	17	20	7	1	0	2	1	2	3	18	8	25
TerrasarX	11	8	0	1	1	0	2	1	0	10	7	17
TandemX	11	15	3	1	2	2	2	2	2	16	8	17
Zy3							5					
Glonass102	2	0	0	0	0	0	0	0	0	0	0	0
Glonass110	0	0	0	0	0	0	1	0	0	0	0	0
Glonass115	0	0	0	0	1	1	0	0	0	0	0	0
Glonass130	0	0	0	0	0	0	2	0	0	0	0	0
<b>TOTAL</b>	<b>253</b>	<b>394</b>	<b>195</b>	<b>144</b>	<b>298</b>	<b>262</b>	<b>239</b>	<b>307</b>	<b>194</b>	<b>276</b>	<b>167</b>	<b>264</b>



Number of successful echoes in 2012:

	ENE	FEB	MAR	ABR	MAY	JUN	JUL	AGO	SEP	OCT	NOV	DIC
Lageos 1	889	3895	499	1306	669	1738	996	47	97	716	0	260
Lageos 2	853	2458	186	0	0	394	3400	4420	1928	2925	27	0
Ajisai	30104	78269	31066	34210	109405	37090	53162	82656	13545	45339	42942	41554
Starlette	8750	3968	3387	3887	4938	20070	3882	16588	6371	10642	4803	4781
Stella	2127	2813	776	1808	9116	7908	9339	6648	3420	3012	1110	3706
Lares			116	2212	2253	1899	818	4610	646	3294	370	1122
Larets	807	651	169	1029	678	454	209	357	32	2464	819	6718
Jason1	1347	1747	502	1311	7699	4581	14179	8143	9188	2853	3050	4349
Jason2	5224	4299	1980	6987	11459	2698	19943	10120	7848	4267	8838	6750
BEC	6019	15916	9031	19192	32761	15649	46020	8100	29856	22732	24759	36556
GRACE A	737	1206	0	11	703	3799	414	258	649	2040	1083	5312
GRACE B	268	630	0	0	392	3724	43	131	339	124	670	3250
Envisat	2305	1892	830	3033	8133	6361						
Cryosat	2212	3453	2789	0	4214	5850	4964	2128	1744	2689	7203	11550
Blits	7	51	0	0	0	0	0	0	52	12	0	73
Goce	100	844	754	183	0	0	0	0	282	90	0	137
HY2A	5349	4650	697	135	0	44	147	238	567	8420	3013	17564
TerrasarX	2490	830	0	76	106	0	277	133	0	3438	1868	7245
TandemX	2655	1565	302	90	105	41	487	29	307	4724	1589	7974
Zy3							760					
Glonass102	34	0	0	0	0	0	0	0	0	0	0	0
Glonass110	0	0	0	0	0	0	27	0	0	0	0	0
Glonass115	0	0	0	0	20	33	0	0	0	0	0	0
Glonass130	0	0	0	0	0	0	162	0	0	0	0	0
<b>TOTAL</b>	<b>72277</b>	<b>129137</b>	<b>53084</b>	<b>75470</b>	<b>192651</b>	<b>112333</b>	<b>159229</b>	<b>144606</b>	<b>76871</b>	<b>118781</b>	<b>102165</b>	<b>158901</b>

Number of successful tracking in 2013:

	ENE	FEB	MAR	ABR	MAY	JUN	JUL	AGO	SEP	OCT	NOV	DIC
Lageos 1	4	8	1	0	0	0	0	0	0	0	0	
Lageos 2	2	9	0	0	0	0	0	0	0	0	0	
Ajisai	47	75	10	24	64	13	58	56	5	44	24	
Starlette	45	24	2	0	5	23	7	24	5	9	9	
Stella	12	24	1	0	1	8	12	9	0	4	5	
Lares	13	14	1	0	1	3	2	0	1	1	3	
Larets	8	11	1	0	0	0	0	0	0	0	2	
Jason1	20	12	5	9	8	32	3					
Jason2	23	10	5	10	8	29	27	28	2	7	10	
Beacon-C	39	60	2	9	7	60	10	38	6	15	18	
Grace A	5	6	0	1	6	0	6	5	0	1	4	
Grace B	5	4	1	0	8	0	6	0	1	0	0	
Saral			3	1								
Cryosat	7	9	0	2	23	22	2	0	4	1	3	
Goce	2	1	4	0	1	0	0	2	5	2		
HY2A	14	23	2	0	0	0	0	0	1	14	10	
TerrasarX	11	10	2	0	0	1	0	0	0	10	7	
TandemX	17	13	4	0	0	3	3	0	0	10	8	
<b>TOTAL</b>	<b>274</b>	<b>313</b>	<b>44</b>	<b>56</b>	<b>133</b>	<b>194</b>	<b>136</b>	<b>162</b>	<b>30</b>	<b>118</b>	<b>103</b>	

Number of successful echoes in 2013:

	ENE	FEB	MAR	ABR	MAY	JUN	JUL	AGO	SEP	OCT	NOV	DIC
Lageos 1	444	411	277	0	9	0	0	0	0	0	0	
Lageos 2	55	703	0	0	0	0	0	0	0	0	0	
Ajisai	53501	105589	9797	23067	59603	4357	61498	42967	1295	21870	9873	
Starlette	17355	12405	712	0	331	3666	1481	3336	999	1060	1037	
Stella	4664	9036	572	0	162	1998	1550	805	0	516	486	
Lares	3438	3415	135	0	69	123	132	0	45	172	111	
Larets	2849	5492	241	0	0	0	0	0	0	0	35	
Jason2	11823	4188	2762	2833	2065	6423	8187	3379	120	1535	996	
Beacon C	36990	61889	366	5550	2717	51303	3432	14583	4758	3974	6787	
Grace A	1396	1300	0	90	1545	0	1225	406	0	199	427	
Grace B	773	559	60	0	1011	0	1194	0	46	0	0	
Saral			801	45								
Cryosat	1648	1857	0	257	2426	8724	136	0	287	9	188	

Goce	51	384	505	0	14	0	0	85	977	48		
HY2A	9958	13661	370	0	0	0	0	0	66	1910	996	
TerrasarX	5472	4554	365	0	0	403	0	0	0	1088	840	
TandemX	3849	4345	615	0	0	160	130	0	0	1610	1183	
<b>TOTAL</b>	<b>162280</b>	<b>233811</b>	<b>19907</b>	<b>33496</b>	<b>71112</b>	<b>83192</b>	<b>79310</b>	<b>65561</b>	<b>8593</b>	<b>33991</b>	<b>22959</b>	

Number of successful tracking in 2014:

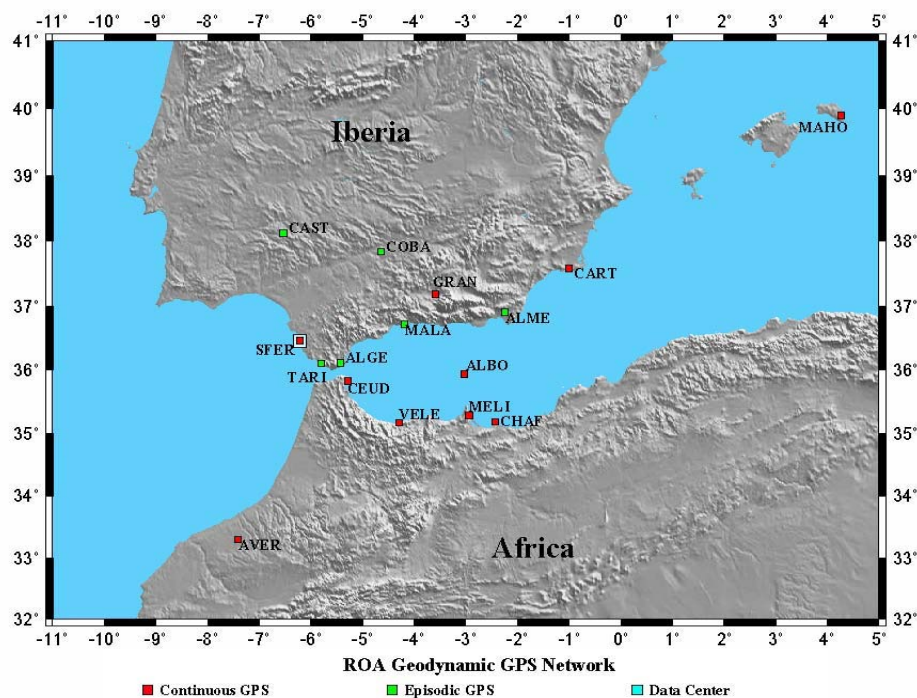
	ENE	FEB	MAR	ABR	MAY	JUN	JUL	AGO	SEP	OCT	NOV	DIC
Lageos 1	0	0	0	0	0	5	13	38	31	40	20	23
Lageos 2	0	0	0	0	1	5	18	11	8	10	10	14
Ajisai	3	14	13	8	13	25	106	46	34	102	37	36
Starlette	0	0	4	2	21	50	8	85	23	63	33	15
Stella	0	1	1	0	10	24	24	35	22	22	10	15
Lares	0	0	0	2	3	10	16	39	9	24	16	12
Larets	0	0	1	0	3	3	8	17	13	18	6	3
Envisat										5	2	1
Jason2	0	1	23	3	11	48	49	39	17	38	31	22
Beacon-C	5	3	27	5	41	24	61	52	30	73	18	58
Grace A	0	1	0	1	7	15	23	16	18	16	5	6
Grace B	0	0	0	0	5	12	9	13	17	10	2	3
Saral	3	3	17	1	2	0	2	11	21	33	30	37
Cryosat	0	4	12	0	10	26	26	25	18	19	23	28
Glonass102							0	0	1	1	0	0
Glonass109							0	0	0	1	1	0
Glonass118							0	0	0	0	1	0
Glonass129							0	0	0	0	3	0
HY2A	2	3	4	0	1	0	0	1	13	26	22	26
SwarmA	0	0	6	0	3	17	3	14	7	12	10	3
SwarmB	0	5	4	0	9	27	4	20	11	8	9	16
SwarmC	0	2	4	0	3	18	2	9	5	3	9	2
TerrasarX	0	0	0	0	0	0	0	0	1	16	18	22
TandemX	1	1	1	0	1	0	2	1	6	21	21	21
<b>TOTAL</b>	<b>14</b>	<b>38</b>	<b>117</b>	<b>22</b>	<b>144</b>	<b>309</b>	<b>374</b>	<b>472</b>	<b>305</b>	<b>561</b>	<b>337</b>	<b>363</b>

Number of successful echoes in 2014:

Lageos 1	0	0	0	0	0	692	3148	15692	21797	13111	5556	4748
Lageos 2	0	0	0	0	18	259	6819	7495	4249	3006	1887	2519
Ajisai	6681	9292	4306	3004	17082	38895	261355	82001	49134	101730	33288	35693
Starlette	0	0	183	47	5871	10556	4757	40216	20433	24230	8925	4284
Stella	0	341	17	0	4115	5737	8127	13674	10784	5333	1621	2376
Lares	0	0	0	89	251	925	3244	10162	2239	5268	2950	1496
Larets	0	0	23	0	215	122	763	3096	2692	1573	542	117
Envisat										685	345	104
Jason2	0	106	2461	65	3883	19508	26734	31372	14886	4933	7088	5409
Beacon C	1601	1503	4764	1409	46431	18811	59401	52738	30759	44260	10490	22738
Grace A	0	11	0	155	2136	2741	4031	5406	8542	4372	479	980
Grace B	0	0	0	0	1897	1501	986	1107	8902	4450	274	160
Saral	178	711	1433	20	121	0	285	3976	10667	31741	9993	13945
Cryosat	0	989	1566	0	3775	10599	8684	5253	6012	5142	9325	12841
Glonass102							0	0	54	59	0	0
Glonass109							0	0	0	35	36	0
Glonass118							0	0	0	0	21	0
Glonass129							0	0	0	0	163	0
HY2A	751	537	220	0	86	0	0	135	8404	23108	8413	15017
SwarmA	0	0	433	0	395	4049	1505	3096	1026	2137	2511	177
SwarmB	0	1181	397	0	1252	13612	2477	7440	2870	1260	2450	5429
SwarmC	0	474	710	0	195	4228	1300	1660	1153	399	1484	221
TerrasarX	0	0	0	0	0	0	0	0	81	6019	4987	4997
TandemX	14	119	28	0	12	0	53	86	1010	5501	6046	5470
<b>TOTAL</b>	<b>9225</b>	<b>15264</b>	<b>16541</b>	<b>4789</b>	<b>87735</b>	<b>132235</b>	<b>393309</b>	<b>284658</b>	<b>205694</b>	<b>295352</b>	<b>118874</b>	<b>138721</b>

## 2. GPS geodetic activity.

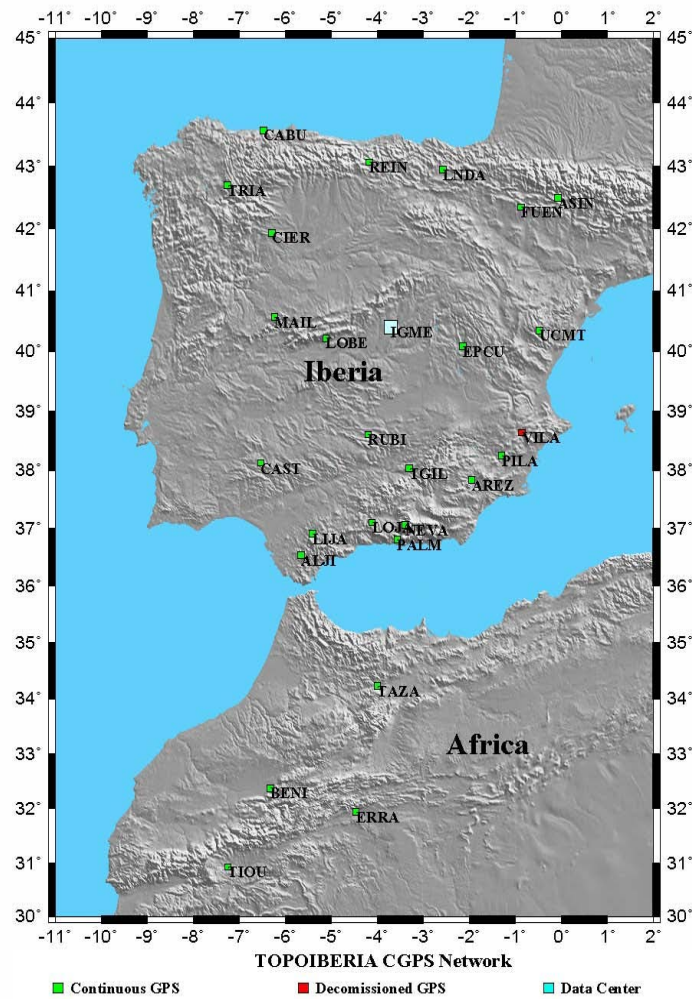
The main contribution to Geodesy by using GPS is the ROA CGPS Geodetic Network which started in 1995 with the permanent installation of the SFER station.



On the other hand, ROA has contributed to the Research Project:” *Geociencias en Iberia: Estudios integrados de topografía y evolución 4D. “TOPO-IBERIA”. CONSOLIDER-Ingenio*” Ref. CSD2006-00041 since 2007 to the end of 2013. ROA is leading the GPS working group. A new 26 CGPS network has been installed in the Region. Up to 22 was placed in the Iberian Peninsula, but 4 additional equipments were mounted in Morocco in order to study Northern Morocco and Southern Spain region as a tectonic unit. The implementation of the network started in March 2008, after a preparative period including the instrumentation election and purchasing, and the network design, which took into account the relevant topography events, and the already existing CGPS high quality networks.

CGPS stations responsibilities were distribute among the different groups contributing to the project: University of Barcelona, CSIC- Jaume Almera Earth Science Institute, University of Jaen, Complutense University at Madrid, Geological and Mining Institute of Spain, University of Oviedo, and University of Salamanca as well as ROA. We have to acknowledge the above mentioned ISRABAT collaboration in the CGPS stations located in Morocco. Data collection is still going on. Data files are archived at the Mining Institute of Spain, working as Project Data Center.

There are three different analysis groups integrated in the Working Group: University of Barcelona, University of Jaen and ROA. Each group analyzes data files by using different software: GAMIT, BERNESSE and GIPSY, respectively. ROA acknowledge Jet Propulsion Laboratory for the software license. Different approaches are also used: network solution as well as Precise Point Positioning.



A significant event on the routinely data acquisition was the stolen of one of the receivers, marked in red in the sketch. But it was more important the anomalous behavior shown by some of the antennae, which had to be replaced, while they were delivered to the manufacturer to be fixed. Time series for the damaged places had to be delayed, and the whole network processing was affected.

Although officially the TOPO-IBERIA project has finished in September of 2013, all the stations are still deployed.

### 3. Publications:

- Título: *New GPS constraints on active deformation along the Africa–Iberia plate boundary*. Revista: [Earth and Planetary Science Letters](#), 2011, vol. 308, 1-2, 211-217.  
Autores: Koulali, A., D. Ouazar, A. Tahayt, R.W. King, P. Vernant, R. Reilinger, S. McClusky, T. Mourabit, D. J. Martin Davila, N. Amraoui.
- Autores: Koulali Idrissi, A.; Ouazar, D.; Tahayt, A.; King, R. W.; Vernant, P.; Reilinger, R. E; McClusky, S.; Mourabit, T.; Davila, J. M.; Amraoui, N  
Título: *New GPS constraints on deformation along the Africa-Iberia plate boundary*.  
Tipo de participación: Póster  
Congreso: EGU 2011  
Lugar: Viena, Austria      Fecha: 3/8 de Abril de 2011

- Autores: Gárate, J.; Martín Davila, J.; González Fernandez, M.A. and the TOPOIBERIA GPS Team  
 Título: CGPS Analysis in the Iberian Peninsula Region by using PPP approach, including TOPOIBERIA, EUREF and ROA networks.  
 Tipo de participación: Póster  
 Congreso: EGU 2011  
 Lugar: Viena, Austria Fecha: 3/8 de Abril de 2011
- Autores: Echevarría, a.; Khazaradze, G.; Gárate, J.; Asensio, E.; Masana, E. and Suriñach, E.  
 Título: Present-day GPS crustal deformation rates in the Eastern Betics (SE Spain).  
 Tipo de participación: Póster  
 Congreso: EGU 2011  
 Lugar: Viena, Austria Fecha: 3/8 de Abril de 2011
- Autores: E. Asensio, G. Khazaradze, P. Santanach, A. Echeverria, J. Gárate, J. Martín Davila, A.J. Gil, A.M. Ruíz, M.C. Lacy, J. Gallastegui, J.M. González-Cortina, I. Jimenez-Munt, C. Ayala, J. Martín, J. Tellez, G. Rodríguez Caderot, F. Álvarez Lobato, P. Ayarza, J. Galindo-Zaldívar, C. Sanz de Galdeano.  
 Título: Crustal deformation studies in Iberia: Topo-Iberia continuous GPS network.  
 Tipo de participación: Póster  
 Congreso: EGU 2011  
 Lugar: Viena, Austria Fecha: 3/8 de Abril de 2011
- Autores: Valdés, M.; Dalda, A.; Gárate, J.; Quirós, R. and Martín Davila, J.  
 Título: The 2009 Local ties survey at San Fernando Naval Observatory.  
 Tipo de participación: Oral  
 Congreso: International Laser Ranging System (ILRS) stations workshop  
 Lugar: Bad-Koetzing, Alemania Fecha: 18 de Mayo de 2011
- Autores: J. Garate, J. Martín Davila y A. Pazos.  
 Título: San Fernando Naval Observatory GPS Network Time Series Analysis.  
 Tipo de participación: Póster  
 Congreso: XXV IUGG General Assembly (IUGG 2011).  
 Lugar: Melbourne (Australia) Fecha: Julio de 2011
- Título: *The Lorca Earthquake observed by GPS: a Test Case for GPS Seismology.*  
 Revista: Física de la Tierra. Universidad Complutense de Madrid. Volume 24, páginas 129-150.  
 Autores: Mendoza, L.; Kehm, A.; Koppert, A.; Martín Davila, J.; Gárate, J.; Becker, M.
- Autores: Mendoza, L. Martín Davila; J. Gárate, J., Becker, M.  
 Título: The Mw 5.1 Lorca (Spain) Earthquake successfully Recorded by GPS.  
 Tipo de participación: Oral  
 Congreso: WEGENER Project: XVI General Assembly.  
 Lugar: Estrasburgo, Francia Fecha: 17/20 de septiembre de 2012
- Autores: J. Gárate, Quijano, M., Cortina, L.M.; Maestre B.  
 Título: Nuevo sistema de movimiento del telescopio láser del ROA.  
 Tipo de participación: Oral  
 Congreso: 7ª Asamblea Hispano Portuguesa de Geodesia y Geofísica  
 Lugar: San Sebastián Fecha: 25/29 de junio de 2012

- Título: *Redes GPS para geodinámica: Red del ROA en el Mar de Alborán y el proyecto TOPOIBERIA*  
Ciclo de conferencias: Viernes Científicos. Organizada por Universidad de Almería.  
Fecha: 8 de Junio de 2012.  
Conferenciante: CF J. Gárate.
- Título: *El Observatorio de San Fernando: desde 1753 hacia el futuro*  
Ciclo de conferencias: IX Semana de la Astronomía y de la Astrofísica en Almería.  
Organizada por Universidad de Almería. Fecha: 8 de Junio de 2012.  
Conferenciante: CF J. Gárate.
- Título: *Posicionamiento por satélite: El futuro de los GNSS*  
Ciclo de conferencias: Tecnologías de posicionamiento espacial: del GPS a Galileo  
Organizada por Universidad Internacional Menéndez y Pelayo, sede de Sevilla. Fecha: 23 de Octubre de 2012. Conferenciante: CF J. Gárate.
- Título: *Crustal deformation in eastern Betics from CuaTeNeo GPS network.*  
Revista: Tectonophysics, 608, 600-612.  
Autores: Echeverría, A.; Khazaradze; G. Asensio, E.; Gárate, J.; Martín Dávila, J.; Suriñach, E.  
Estado: Publicado 2013.
- Título: *Aplicación del sistema GPS a la sismología: el terremoto de Lorca*  
Revista: Boletín ROA 02/2013. NIPO: 083-13-128-1. 48pp.  
Autores: L. Mendoza.  
Estado: Editado 2013.
- Autores: Khazaradze G., Echeverría A., Asensio E., Gárate J. Suriñach E.  
Título: GPS Crustal deformation in the Eastern Betics and the Lorca earthquake of 2011.  
09-04-2013.  
Congreso: EGU General Assembly 2013  
Lugar: Viena (Austria) Fecha: 7/12 Abril 2013
- Autores: Gárate J., Martín Dávila J., Khazaradze G., Gil A., Rimi A.  
Título: TopoIberia and other GNSS networks contributing to EPOS in Spain and Morocco.  
Congreso: EGU General Assembly 2013  
Lugar: Viena (Austria) Fecha: 7/12 Abril 2013
- Autores: R. Reilinger, M. Floyd, T. Mourabout, A. Assaadi, D. Ouzar, A. Tahayt, J. Martín Dávila, J. Gárate, F. Gómez, P. Vernant, M. Meghraoui.  
Título: Geodetic constraints on earthquake and tsunami potential in and around the Alboran Sea.  
Congreso: Earthquake and Tsunami Hazard in the Mediterranean area.  
Lugar: Argel (Argelia). Fecha: 7-9 Junio 2013
- Título: *El Real Observatorio y las Ciencias de la Tierra*  
Ciclo de conferencias: Facultad de Matemáticas de la Univ. Sevilla.  
Fecha: 11 de Abril de 2013.  
Conferenciante: CF M. Catalán.
- Autores: L. Mendoza, M. Becker, J. M. Dávila and J. Gárate  
Título: Analysis of the GPS data recorded during the 2011 Mw 5.1 Lorca earthquake.

Congreso: Workshop on Earthquake Early Warning System: Applications to the Ibero-Maghrebian Region

Lugar: Madrid, 4-5 Febrero 2014

- Autores: Víctor López-Cuesta, Andrés Carbó-Gorosabel, Alfonso Muñoz-Martín, José Luis Granja Bruña, Jorge Gárate Pasquín, and Álvaro Rodríguez-Zurrunero  
Título: Stress analysis for the 2010 Haiti seismic crisis: an example of strain partitioning on a transpressive setting  
Congreso: European Geosciences Union (EGU) General Assembly  
Lugar: Vienna (Austria), 27 Abril-02 Mayo 2014.
- Autores: Frédéric Frappart, Nicolas Roussel, Juan José Benjamin, Richard Biancale, José Martin Davila, Jorge Garate, Begoña Perez, Carlos Gracia, Rogelio Lopez, Ana Tapia, Ii Valles, and Josep Gili  
Título: The 2013 Ibiza calibration campaign of Jason-2 and Saral altimeters: preliminary results.  
Congreso: European Geosciences Union (EGU) General Assembly  
Lugar: Vienna (Austria), 27 Abril-02 Mayo 2014.
- Autores: F. Frappart, N. Roussel, J.J. Martinez-Benjamin, R. Biancale, J. Garate, J.M. Davila, B. Perez, C. Gracia, I. Valles, R. López, A. Tapia, J. Gili, J.C. Gonzalez, M. Salazar-Lino, M. Hernández-Pajares and M.Sanz.  
Título: The Balears 2013 Calibration Campaign of Jason-2 and Saral Altimeters  
Congreso: IGS WORKSHOP 2014.  
Lugar: Pasadena, California (USA), 23-27 Junio 2014.
- Título: El Real Observatorio de la Armada y las Ciencias de la Tierra.  
Conferencia invitada por la Universidad de Cantabria  
Lugar y Fecha: Santander 25 Noviembre 2014.  
Conferenciante: CF Manuel Catalán Morollón.

**(The information of this Institution has been remitted by A. Pazos and A. Cibeira)**