Commission 3 – Earth Rotation and Geodynamics


President: Manabu Hashimoto (Japan)
Vice President: Cheng-Li Huang (China)

Structure

Sub-commission 3.1: Earth Tides and Geodynamics
Sub-commission 3.2: Crustal Deformation
Sub-commission 3.3: Earth Rotation and Geophysical Fluids
Sub-commission 3.4: Cryosphere Deformation
Sub-commission 3.5: Tectonics and Earthquake Geodesy
Joint Study Group 3.1: Intercomparison of Gravity and Height Change
Joint Working Group 3.1: Theory of Earth Rotation and Validation
Joint Working Group 3.2: Constraining Vertical Land Motion of Tide Gauges

Overview

Geodynamics is the science that studies how the Earth moves and deforms in response to forces acting on the Earth, whether they derive from outside or inside of our planet. This includes the entire range of phenomena associated with Earth rotation and Earth orientation such as polar motion, Universal Time or length of day, precession and nutation, the observation and understanding of which are critical to the transformation between terrestrial and celestial reference frames. It also includes tidal processes such as solid Earth and ocean loading tides, and crust and mantle deformation associated with tectonic motions and isostatic adjustment etc.

During the last few decades, many geophysicists have come to use geodynamics in a more restricted sense to address processes such as plate tectonics and postglacial rebound that are dominantly endogenic in nature. Because the Earth as a mechanical system responds to both endogenic and exogenic forces, and because these responses are sometimes coupled, Commission 3 studies the entire range of physical processes associated with the motion and the deformation of the solid Earth. The purpose of Commission 3 is to promote, disseminate, and, where appropriate, to help coordinate research in this broad arena.

Commission 3 fosters and encourages research in the areas of its sub-entities by facilitating the exchange of information and organizing Symposia, either independently or at major conferences in geodesy or geophysics. Some events will focus narrowly on the interests of the sub-commissions and other entities listed above, and others will have a broader commission-wide focus.

Summary of the Commission’s activities during the period 2015-2017

Commission 3 members were active to hold several meetings, where they served as chairpersons of LOC or keynote speakers, and convene sessions in international conferences. In total, 6 meetings and 16 sessions or splinter meetings convened by Commission 3 members in international conferences. 3 books were published by Commission 3 members.

Commission 3 will convene a session G04 “Earth Rotation and Geodynamics” in coming IAG-IASPEI 2017 held in Kobe, Japan, July 31 - August 4, 2017. 29 papers ware submitted, which will be presented in 4 oral sessions and 1 poster session. The commission will have a splinter meeting during IAG-IASPEI to discuss future activities.
Commission 3 will be active in the next two years. Some sub-commissions will schedule several meetings and a couple of proceedings of past meetings are now under revision.

Meetings


Publications (by President and Vice-president)


Hashimoto, M., Ground deformation in the Kyoto and Osaka area during recent 19 years detected with InSAR, “International Symposium on Geodesy for Geology and Natural Hazards (GENAH)”, IAG Symposia Series, 145, 155-164, 2016.


Hashimoto, M., Observation of ground deformation in the Osaka and Kanto plains with ALOS-2/PALSAR-2, IGARSS2016, Beijing, China, July 2016.

Hashimoto, M., Observation of deformation in northern Kanto, Osaka and Nagoya detected by PALSAR/PALSAR-2, The 2nd PI Workshop for ALOS-2, S2-1-02, Tokyo, Japan, November 2015.


Presentations (by President and Vice-President)


Hashimoto, M., and T. Ozawa, Ground deformation near active faults in the Kinki, district, southwest Japan, detected by InSAR, 2016 AGU Fall Meeting, G22A-02, San Francisco, USA, December 2016.

Hashimoto, M., Observation of surface deformation with ALOS-2/PALSAR-2 in southern Taiwan before, during and after the Meinong earthquake, 2016 Taiwan-Japan Workshop on Crustal Dynamics, 13-13, Tainan, Taiwan, November 2016.

Fukahata, Y., and M. Hashimoto, InSAR data inversion to simultaneously estimate the dip angles and slip distribution of the two seismogenic faults at the 2016 Kumamoto earthquake, 2016 Taiwan-Japan Workshop on Crustal Dynamics, 17-17, Tainan, Taiwan, November 2016.


Hashimoto, M., Surface deformations associated with the Meinong, Taiwan, earthquake detected by InSAR, AOGS2016, Beijing, China, August 2016.

Hashimoto, M., Observation of ground deformation in the Osaka and Kanto plains with ALOS-2/PALSAR-2, IGARSS2016, Beijing, China, July 2016.


Sub-commission 3.1: Earth Tides and Geodynamics

*Chair:* Janusz Bogusz (Poland)
*Vice-Chair:* Carla Braitenberg (Italy)

SC 3.1 addresses the entire range of Earth tidal phenomena and dynamics of the Earth, both on the theoretical as well as on the observational level. The phenomena responsible for these variations include the full range of periodic and non-periodic occurrences such as solid Earth tides, ocean and atmospheric tidal loading, ocean, atmospheric and hydrologic non-tidal effects as well as plate tectonics and intraplate deformation. The periods range from seismic normal modes over to the Earth tides and the Chandler Wobble and beyond. Thus, the time scales range from seconds to years and for the spatial scales from local to continental dimensions. SC 3.1 national representatives are involved in:

- organization of International Symposium on Geodynamics and Earth Tide (GET Symposium held every four years) as well as other thematic conferences together with other Commission 3 SCs if possible;
- awarding of the outstanding scientists with the Paul Melchior Medal, formerly known as the Earth Tides Commission Medal;
- organization of special sessions at international meetings;
- organization of the comprehensive SC meeting together with the IGETS;
- publishing the outcome of the researches, either as stand-alone publications or as proceedings or special issues of scientific journals;
- cooperating with other Joint Study Groups (JSG), Joint Working Groups (JWG) or Inter-Commission Projects (ICP) and Committees (ICC);
- cooperate with GGOS, as mentioned above.

**Summary of the Sub-commission’s activities during the period 2015-2017**

**Meetings:**

18th International Symposium on Geodynamics and Earth Tides (G-ET Symposium 2016), title of Meeting: “Intelligent Earth system sensing, scientific enquiry and discovery”, venue: University of Trieste, Italy, date: June 5 (Sunday) to June 9 (Thursday) 2016, coordination: Carla Braitenberg. The Symposium attracted 105 attendants from 31 countries who presented 66 oral presentations and 40 posters. The contributions were grouped into the following sessions:

1. tides and non-tidal loading,
2. geodynamics and the earthquake cycle,
3. variations in Earth rotation,
4. tides in space geodetic observations,
5. volcano geodesy,
6. natural and anthropogenic subsurface fluid effects,
7. instrument and software developments.

Nine invited lectures of half an hour each allowed insight into specific themes, as the principal outcomes of 18 years superconducting gravity in Medicina (Italy) (H.Wziontek), the lunisolar stress tensor and the triggering of earthquakes, the correction of observed free oscillation spectra due to local heterogeneities obtainable from tidal observations (W. Zürn), a review on the results of 40 years of long base laser strainmeter observations in California (D. Agnew), the geodetic observation of slow slip events (SSE) or giant silent earthquakes at
subduction zones (K. Heki), the role of earth tides in global plate tectonics (C. Doglioni), an overview of local to global geodetic monitoring of natural hazards and global change (H. Schuh), the separation of surface loading from time dependent tectonic deformation in GNSS observations (J. Freymueller), and a review of new developments of terrestrial and space based gravimetric instrumentation in China (Houze Xu). The program included a talk of the Rector of the University M. Fermeglia on ‘The great energy challenge: how to avoid the ‘perfect storm’ and the President of the OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale) M.C. Pedicchio.

Website: https://g-et2016.units.it/.

**Special sessions at international meetings:**

Joint International Workshop of the Sixth TibXS (Multi-observations and Interpretations of Tibet, Xinjiang and Siberia) during 25-29 July 2015, in Tianjin, China.

Joint International Workshop of the Seventh TibXS (Multi-observations and Interpretations of Tibet, Xinjiang and Siberia) during 26-30 July 2016, in Tianjin, China.

**Paul Melchior Medal:**

It’s been a tradition of Earth Tides Symposia, that with the “Paul Melchior Medal” an outstanding scientists with a huge experience and high impact on to the Tidal Community who contributed significantly to develop the science and technology of tidal research used to be awarded. First Medal was given in 1997 to Paul Melchior and it has been named with the “Earth Commission Medal”. After Paul Melchior passed away the name of the Medal was changed to honour his contribution to the development of tidal research.

The procedure of nomination to the 2016 Paul Melchior Medal was completed in 31st of October, 2015 with 5 successfully submitted nominations:

1. David Crossley;
2. Walter Zuern;
3. Trevor Baker;
4. Gerhard Jentzsch and
5. Shuzo Takemoto.

After that the Committee consisted of the past Awardees, Chair of the IAG’s Sub-Commission 3.1 as well as 4 experienced tidalists who were not nominated, 8 people in total decided that 2016 Paul Melchior Medal will go to Trevor Baker.

**Peer-reviewed publications:**


Defraigne P., Aerts W., Pottiaux E. Monitoring of UTC(k)’s using PPP and IGS real-time products GPS Solutions, January 2015, Volume 19, Issue 1, pp 165-172, 10.1007/s10291-014-0377-5.


Meurers, B., 2017: Scintrex CG5 used for superconducting gravimeter calibration, accepted for publication in Geodesy and Geodynamics.


Varga P., 2015: Long-term variations of the gravitational potential and of the geodynamical properties of a deformable Earth due to axial despinning, Leibniz Online, Jahrgang 2015, , Nr. 19, 1-8, Zeitschrift der Leibniz-Sozietät e. V. ISSN 1863-3285.


Not peer-reviewed publications:


Aerts W., Defraigne P., Cerretto G. State of the Art in Time and Frequency Transfer and user need, Technical Note 1 of the project TIME5, accepted by ESA in December 2014.


Defraigne P. & Sleewaegen J.-M., Correction for Code-Phase Clock Bias in PPP. Proc. Of the EFTF-IFCS 2015, Denver, April 12-17, 2015

Defraigne P., Sleewaegen J.-M., Matsakis D. How Important is it to Synchronize the Internal Process of a GNSS Receiver? Inside GNSS, December 2015, 26-32

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Ozdemir N. and Defraigne P. Service Infrastructure #6 Specification and Design Deliverable 15.1 for the H2020 project DEMETRA (36 pages)


Ruotsalainen H., (2016) 100 years Michelson-Gale’s interferometric water tube tilt meter experiment in USA and 50 years instrument development in Finland. Abstracts of the 18th International Symposium on Geodynamics and Earth Tides, Trieste (Italy), 5 – 9 June, 2016, (http://g-et2016.units.it/node/232).


Books:


Presentations:

Presentations given at the 18th International Symposium on Geodynamics and Earth Tides in Trieste, 2016:

Orals:

First analyses of the new iOSG-type Superconducting Gravimeters at the J9 Gravimetric Observatory of Strasbourg and at the Low Noise Underground Laboratory of Rustrel, France, Severine Rosat (1), Jacques Hinderer (1), Jean-Paul Boy (1), Frédéric Littel (1), Daniel Boyer (2), Jean-Daniel Bernard (3), Yves Rogister (3), Anthony Mémin (4), Stéphane Gaffet (5), (1) IPGS - EOST, Strasbourg, (2) LSBB Underground Research Laboratory, UMS3538 CNRS, (3) EOST, Strasbourg, (4) Université Nice Sophia Antipolis, CNRS, IRD, Observatoire de la Côte d’Azur, (5) LSBB Underground Research Laboratory, UMS3538 AMU/CNRS/UPAV/UNS.

Strain tides observed by two geodetic laser strainmeters at Canfranc (Spain): clues on nonlinear and minor ocean tides in the Bay of Biscay. Antonella Amoruso, Luca Crescentini University of Salerno, Italy.
What uses in today’s research for non-superconducting gravimeter observations in Earth Tides and geodynamics modeling? Jean-Pierre Barriot (1), Bernard Ducarme (2) (1) Geodesy Observatory of Tahiti, (2) Catholic University of Louvain.

Analyses of continuous time-varying gravity and barometric records of a sea-floor gravimeter in the North Sea Severine Rosat, Jean-Paul Boy, Benjamin Escot, Jacques Hinderer IPGS - EOST, Strasbourg.

100 years Michelson-Gale’s interferometric water tube tilt meter experiment in USA and 50 years instrument development in Finland Hannu Ruotsalainen Finnish Geospatial Research Institute, NLS.

Tidal analyses of long-base tiltmeters at Rustrel (France), Sainte-Croix (France) and BFO (Germany) Severine Rosat (1), Sophie Lambotte (1), Umberto Riccardi (2), Jean-Paul Boy (1), Frédéric Boudin (3), Walter Zürn (4) (1) IPGS - EOST, Strasbourg, (2) DiSTAR, Università Federico II di Napoli, (3) UMR 8538, Ecole Normale Supérieure, Paris, (4) BFO, Karlsruhe Institute of Technology and University of Stuttgart.

Report of the first year of the International Geodynamics and Earth Tide Service (IGETS) Jean-Paul Boy (1), Jean-Pierre Barriot (2), David Crossley (3), Christoph Foerste (4), Jacques Hinderer (1), Bruno Meurers (5), Vojtech Palinkas (6), Spiros Pagiatakis (7), He Ping Sun (8), Hartmut Wziontek (9) (1) EOST/IPGS, Strasbourg, France, (2) University of French Polynesia, (3) Saint Louis University, USA, (4) GFZ, Potsdam, Germany, (5) University of Vienna, Austria, (6) Geodetic Observatory of Pecny, Czech Republic, (7) York University, Canada, (8) Chinese Academy of Sciences, Beijing, China, (9) BKG, Leipzig, Germany.

Processing SG data according to the requirements of the IGETS database, with Apache Point as an example David Crossley (1), Tom Murphy (2) (1) Saint Louis University, (2) Dept. Physics, UCSD, California.

Relation of different type Love-Shida numbers determined with the use of time-varying incremental gravitational potential Peter Varga (1), Erik Grafarend (2), Johannes Engels (2) (1) Seismological Observatory, Institute of Geodesy and Geophysics, (2) Department of Geodesy and Geoinformatics,., Stuttgart University.

Time-correlated noise signatures in gravity records Janusz Bogusz (1), Severine Rosat (2), Anna Klos (1), Jean-Paul Boy (2) (1) Military University of Technology, Poland, (2) Université de Strasbourg (EOST), France.

Investigation of the Solid Earth Tide Based on GPS Observation and Superconducting Gravimeter Data Arismana Pahlevi (1), Kosaisih Frijatna (2), Irwan Meilano (2), Ibnu Sofian (1) (1) Geospatial Information Agency for Indonesia, (2) Institute Technology of Bandung, Indonesia.

M2 tidal parameter modulation revealed by superconducting gravimeter Bruno Meurers (1), Michel Van Camp (2), Olivier Francis (3), Vojtech Palinkas (4) (1) University of Vienna, (2) Observatory of Belgium, Brussels, Belgium, (3) Faculté des Sciences, de la Technologie et de la Communication, University, (4) Research Institute of Geodesy, Topography and Cartography, Geodetic Observatory Pécný.

18 years continuous gravity time series at station Medicina: A benchmark for tidal analysis Hartmut Wziontek (1), Reinhard Falk (2), Klaus Schüller (3), Susanna Zerbini (4) (1) Bundesamt für Kartographie und Geodäsie, (2) Bundesamt für Kartographie und Geodäsie, Germany, (3) Research Initiative for Tidal Analysis (RITA), Thailand, (4) Dipartimento di Fisica e Astronomia, Università di Bologna, Italy.

Time stability of SG instrumental scale factor versus time stability of tidal parameters at the J9 Gravitmetric Observatory of Strasbourg (1987 – 2016) Marta Calvo (1), Jacques Hinderer (2), Severine Rosat (2), Jean Paul Boy (2), Hilaire Legros (2), Frédéric Littel (2), Jean Daniel Bernard (2) (1) IGN-Spain, (2) IPGS/EOST Strasbourg France.

New gravimetric tide observations in the vicinity of Lake Nasser Khalid Zahran NRIAG.

The potential of the cross least squares wavelet analysis for estimating the time-frequency transfer function of New gravimetric tide observations in the vicinity of Lake Nasser Khalid Zahran NRIAG.

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New gravimetric tide observations in the vicinity of Lake Nasser Khalid Zahran NRIAG.

The potential of the cross least squares wavelet analysis for estimating the time-frequency transfer function of atmospheric variations effect of superconducting gravity data Mahmoud Abd El-Gelil (1), Ebrahim Ghaderpour (2), Spiros Pagiatakis (2) (1) Sultan Qaboos University, Oman, (2) York University, Canada.

On GPS-based Ocean Tidal Loading Displacements and Their Potential to Constrain Mechanisms of Anelasticity Pierre-Michel Rouleau Memorial University of Newfoundland - Grenfell Campus.

Accuracy assessment of ocean tide models in China using GPS Peng Peng (1), Yan Hao-Ming (1), Yuan Ling-Guo (2), Zhu Yao-Zhong (1), Wu Ding-Cheng (1) (1) State Key Laboratory of Geodesy and Earth's Dynamics, Institute of Geodesy and Geophysics, Chinese Academy of Sciences, Wuhan 430077, China, (2) Faculty of Geosciences and Environmental Engineering, Southwest Jiaotong University, Chengdu 610031, China.


Influence of external forces on the triggering of quakes Peter Varga Seismological Observatory, Institute of Geodesy and Geophysics.

Mapping of tidal effects in the Pannonian basin – an effort to check location dependencies at microGal level Gábor Papp (1), Judit Benedek (1), Bruno Meurers (2), Márta Kis (3), András Koppán (3), Roman Leonhardt (4) (1) Geodetic and Geophysical Institute, MTA CSFK, (2) University of Vienna, Department of Meteorology and Geophysics, (3) Geological and Geophysical Institute of Hungary, (4) Zentralanstalt für Meteorologie und Geodynamik, Conrad Observatory.

Non-tidal gravity change and Vrancea intermediate-depth seismicity Lucian Besutiu Institute of Geodynamics of the Romanian Academy.
Investigation of the relationship between rock strain and radon concentration in the tidal frequency domain
Gyula Mentes RCAES of HAS, Geodetic and Geophysical Institute.

Long-term gravity changes in Lhasa, Tibet and their implication to hydrology and crust movement Jianqiao Xu, Qianqian He, Xiaodong Chen, Jiangcun Zhou, Heping Sun Institute of Geodesy and Geophysics. Chinese Academy of Sciences.

Local Elastic Effects in Low-Frequency Spectra of Earth's Free Oscillations Walter Zuern Black Forest Observatory, Karlsruhe Institute of Technology.

Observation of Earth Free Oscillation Modes Using Cross Least Squares Wavelet Method Mahmoud Abd El-Gelil, Mohammed Al-Shahri Sultan Qaboos University, Oman.

Long-Base Laser Strainmeters: Four Decades of Results Duncan Agnew, Frank Wyatt IGPP, Scripps Institution of Oceanography, UC San Diego.

Accessing power-law properties of post-seismic deformation in land movements Anna Klos (1), Addisu Hunegnaw (2), Machiel Simon Bos (3), Felix Norman Teferle (2), Rui Fernandes (3), Janusz Bogusz (1) (1) Military University of Technology of Warsaw, Poland, (2) University of Luxembourg, Geophysics Laboratory, FSTC, Luxembourg, (3) University of Beira Interior, Instituto D. Luis, R. Marquês d’Avila e Boloma, Portugal.


Investigation of relationships in time-domain between tectonic and tidal signals observed in the Geodynamic Laboratory of SRC and seismic events which occur in the Middle Odra Faults Zone (The Lower Silesian copper mining region) Marek Kaczorowski (1), Zbigniew Szczerskiowski (2), Damian Kasza (3), Ryszard Zdunek (4), Michal Jozwik (5), Roman Wronowski (4) (1) Space Research Center of PAS, (2) AGH University of Science and Technology, (3) Wrocław University of Technology, (4) Space Research Centre, Polish Academy of Sciences, (5) AGH University of Science and Technology.

Interference of tectonic signals in subsurface hydrologic monitoring through Gravity and GNSS due to mountain building Carla Braitenberg (1), Tommaso Pivetta (2), Wenjin Chen (3), Enrico Serpelloni (4) (1) University of Trieste, (2) Dipartimento di Matematica e Geoscienze, University of Trieste, (3) Dipartimento di Matematica e Geoscienze, University of Trieste and School of Geodesy and Geomatics, Wuhan University, (4) INGV.

Constrain large earthquake source mechanism by using low frequency normal mode data Zhang Lingyun Institute of Geodesy and Geophysics, Chinese Academy of Sciences.

Earth's tides, plate motions, graviquakes and elastquakes Carlo Doglioni (1), Guido Maria Adinolfi (2), Antonio Carcaterra (3), Eugenio Carminati (2), Marco Cuffaro (4), Eleonora Ficini (2), Patrizio Petricca (5), Federica Riguzzi (6), Emanuela Valerio (2) (1) Sapienza University Earth Sciences Department, INGV, (2) Sapienza University Earth Sciences Department, (3) Sapienza University DIMA, (4) IGAG-CNRS, (5) GFZ-Potsdam, (6) INGV-Roma.

The role of tides and LOD in the case of earthquake triggering Pavel Kalenda (1), Lubor Ostřihanský (2), Jana Rušajová (3), Karel Holub (3) (1) IRSM Academy of Science, Czech Republic, (2) Prague, (3) IGN Academy of Science, Czech Republic.

Glacially induced seismicity in Europe Holger Steffen (1), Christian Brandes (2), Rebekka Steffen (3), Patrick Wu (4) (1) Lamnatüter, Sweden, (2) Leibniz Universität Hannover, Germany, (3) Uppsala University, Sweden, (4) University of Hong Kong.

Seismological and geotechnical long-term monitoring of a closed down potash mine Astrid Gessert (1), Hubert Pruehl (2) (1) K-UTEC AG Salt Technologies, (2) LMBV mbH Bereich Kali-Spat-Erz.


Crustal gravitational energy change caused by earthquakes in Tibet Jiangcun Zhou, Heping Sun, Jianqiao Xu Institute of geodesy and geophysics, Chinese academy of sciences.

A comparative study of gravity and crustal deformation performed through Superconducting Gravimeter and GPS in the Garhwal Himalayan Naresh Kumar, Vishal Chauhan, P.K.R. Gautam Wadia Institute of Himalayan Geology.

Determination of the transfer functions for OSG-057 (Lhasa) and OSG-065 (Wuhan) Xiaodong Chen Institute of Geodesy and Geophysics, CAS.

Assessing the seasonal signals between environmental loadings and gps coordinates with singular spectrum analysis Marta Gruszczynska (1), Anna Klos (1), Machiel Simon Bos (2), Jean-Paul Boy (3), Janusz Bogusz (1) Military University of Technology of Poland, (2) University of Beira Interior, Portugal, (3) Institut de Physique du Globe de Strasbourg, France.

Plio Quaternary Structuring Of Hamma Bouziain Basin, Constantine Region (North-East Of Algeria) Laziz Ouided, Boularak Moussa, Benabbes Chaouki Constantine University.

The geodynamics of Ny Alesund from ITRF2014 time series Marco Roggero (1), Vincenza Tortoreto (2) (1) Politecnico di Torino, (2) Politecnico di Milano.

Monitoring high frequency Earth rotation by ring laser: on modeling the local tilts Monika Terćjak (1), Marcin Rajner (1), Aleksander Brzeziński (2) (1) Department of Geodesy and Geodetic Astronomy, Warsaw University of Technology, Warsaw, Poland, (2) Department of Geodesy and Geodetic Astronomy, Warsaw University of Technology, Space Research Centre, Polish Academy of Sciences, Warsaw, Poland.

Ultra rapid oscillations in Earth rotation parameters derived from GNSS data Jolanta Nastula (1), Robert Weber (2), Aleksander Brzeziński (3), Alexander Gruber (2), Maciej Kalarus (1), Elke Unnig (2), Agata Wielgosz (1) Space Research Centre of the PAS , 00-716 Bartycka 18a, Warsaw,Poland, (2) TU-Vienna, Department for Geodesy and Geoinformation,Gußhausstraße 27-29/E120 1040 Vienna Austria, (3) Warsaw University of Technology, Department of Geodesy and Cartography, Warsaw, Poland.

An alternative model for short period ocean tidal variations of Earth rotation (SPOT) Jan Hagedoorn (1), Okky Jenie (2), Tobias Nilsson (2), Maria Karbon (2), Harald Schuh (2), Matthias Madzak (3), Wolfgang Bosch (4) (1) Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, (2) Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, Department 1: Geodesy, (3) TU Vienna, Department of Geodesy and Geoinformation, (4) DGF-TUM Technical University Munich. S1 tidal contributions to changes in length-of-day: mean atmosphere-ocean excitation estimates and a possible modulation through ENSO. Michael Schindelegger (1), David Salstein (2), David Einspigel (3) (1) TU Wien, Austria, (2) Atmospheric and Environmental Research Inc., U.S.A., (3) Dublin Institute for Advanced Studies, Ireland.

Excitation of Free Core Nutation by geophysical fluids Xiaoming Cui, Heping Sun, Jianqiao Xu Institute of Geodesy and Geophysics. Chinese Academy of Sciences.

Evaluating Tide Models for Operational Prediction of EOPs Richard Gross Jet Propulsion Laboratory, California Institute of Technology, Pasadena, USA.

Contributions of Geodesy to Monitoring Natural Hazards and Global Change Harald Schuh Helmholtz-Zentrum Potsdam - Deutsches GeoForschungsZentrum GFZ.

Separating Surface Loading Deformation from Time-dependent Tectonic Deformation Jeff Freymueller (1), Yuning Fu (2), Tim Jensen (3) (1) Geophysical Institute, University of Alaska Fairbanks, (2) Bowling Green State University, Ohio, USA, (3) DTU-Space, Denmark.

Long Period Tide Variation from Satellite Laser Ranging (SLR) Minkang Cheng, Center for Space Research, University of Texas at Austin.


Contemporary State of the Elbrus Volcanic Center (the Northern Caucasus). Vadim Milyukov (1), Andrey Gorbatikov (2), Alexey Mironov (3), Andrey Myasnokov (3), Eugeny Rogozhin (2) (1) Lomonosov Moscow University, Sternberg Astronomical Institute, (2) Institute of Physics of the Earth, Russian Academy of Sciences, (3) Lomonosov Moscow University, Sternberg Astronomical Institute. What is behind Campi Flegrei inflations and deflations? Clues from 35 years of geodetic monitoring. Luca Crescentini, Antonella Amoruso University of Salerno.

Using relative gravity measurements between surface and underground stations to assess the hydrology of the soil layers in between Jaakko Mäkinen (1), Ivars Liepiņš (2), Viesturs Sproģis (2), Jānis Sakne (2), Kalvis Salmiņš (3), Jānis Kaminsks (4), Reinhard Falk (5), David Stizza (6) (1) Finnish Geospatial Research Institute FGI, Masala, Finland, (2) Department of Geodesy and Cartography, Latvian Geospatial Information Agency (LGIA), Riga, Latvia, (3) Institute of Astronomy, University of Latvia, Riga, Latvia, (4) Institute of Geodesy and Geoinformation, Riga Technical University, Riga, Latvia, (5) Division of Geodesy, Federal Agency for Cartography and Geodesy (BKGeo), Frankfurt am Main, Germany, (6) National Geospatial-Intelligence Agency (NGA), St. Louis, USA (at the time of the measurements)


Hybrid gravity monitoring of a geothermal reservoir: a case study in northern Alsace, France Jacques Hinderer (1), Marta Calvo (2), Séverine Rosat (1), Yassine Abdelfettah (1), Gilbert Ferhat (1), Umberto Riccardi (3), Basile Hector (4), Jean-Daniel Bernard (5), Frédéric Littel (1) (1) IPGS, Strasbourg, France, (2) IGN, Madrid, Spain, (3) University of Napoli, Italy, (4) LTHE, Grenoble, France, (5) EOST, Strasbourg, France.
Observation of groundwater-related subsidence and thermal effects in tilt and strain measurements Victor Volkov (1), Jan Mrlina (2), Mstislav Dubrov (3), Vaclav Polak (2) (1) Schmidt Institute of Physics of the Earth of the Russian Academy of Sciences, (2) Institute of Geophysics of the Czech Academy of Sciences, (3) Fryazino Branch Kotel’nikov IRE RAS.

Surface displacement due to groundwater exploitation in the Lorca (Murcia, Spain) region. Tamara Abajo (1), Jose Fernandez (2), Joaquin Escayo (2), Francisco Luzon (3), Pablo J. Gonzalez (4) (1) Institute of Geosciences, CSIC, (2) Institute of Geosciences, CSIC-UCM, Madrid, Spain, (3) 2. Universidad de Almeria, Almeria, Spain, (4) School of Earth and Environment - University of Leeds, Leeds, UK.

Plate movement and karstic underground water flow in fifty years of ultra broad band tilt observations in the Karst- implications for GNSS Carla Braitenberg (1), Ildikó Nagy (1), Barbara Grillo (1), David Zuliani (2) (1) University of Trieste, (2) OGS-CRS.

Long-term variations of the cGNSS data at the N-Adria plate edge and relation with deep fluid movements. Giuliana Rossi (1), Paolo Fabris (2), David Zuliani (2) (1) OGS Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, (2) OGS (Istituto Nazionale di Oceanografia e di Geofisica sperimentale)

Cansiglio Plateau: Ten Years Of Geodetic Observations In A Seismic And Karstic Area In North-Eastern Italy Barbara Griffi (1), Carla Braitenberg (1), Ildikó Nagy (1), Roberto Devoti (2), David Zuliani (3), Paolo Fabris (3) (1) University of Trieste, Italy, (2) INGV, Roma, Italy, (3) INOGS, CRS, Udine, Italy.

Modeling river storage from radar altimetry and remote sensing: validation using GRACE and GPS Jean-Paul Boy EOST/IPGS.

Non-tidal tilt and strain signals observed at the Geodynamic Observatory Moxa, Thuringia Thomas Jahr Institute of Geosciences, Friedrich Schiller University Jena.

Recent development of gravimeter research in China Houze Xu Institute of Geodesy and Geophysics, Chinese Academy of Science.

The Automated Burris Gravity Meter for single and continuous observation Gerhard Jentzsch (1), Richard Schulz (2), Adelheid Weise (3) (1) Professor, retired, (2) Anpplied Gravimetry Dr.Schulz, Rosengarten / Kreis Schwäbisch-Hall, (3) Institute of Geosciences, General Geophysics, Friedrich Schiller University Jena.


Superconducting Gravimeter Calibration Using Earthquake Signal Shaocong Luo, Jianqiao Xu State Key Laboratory of Geodesy and Earth’s Dynamics, Institute of Geodesy and Geophysics Chinese Academy of Sciences, Wuhan, China, 430077.

Verification of transfer functions of co-located Superconducting Gravimeters in time and frequency domain Hartmut Wziontek Bundesamt für Kartographie und Geodäsie.

More thoughts on AG-SG calibrations, drift assessment, and the transfer function of the iGrav system David Crossley (1), Marta Calvo (2), Severine Rosat (3), Jacques Hinderer (3) (1) Saint Louis University, (2) IGN, Spain, (3) CNRS UMR7516, IPGS, Strasbourg.

PreAnalyseExtended: An graphical analysis program for the investigation of (geophysical) time series André Gebauer Ludwig-Maximilians-University.

Atmosphere and ocean loading and their interactions with the earthquake cycle Victor Volkov (1), Jan Mrlina (2), Mstislav Dubrov (3), Vladimir Smirnov (3), Sergey Golovachev (3), Vaclav Polak (2) (1) Schmidt Institute of Physics of the Earth of the Russian Academy of Sciences, (2) Institute of Geophysics of the Czech Academy of Sciences, (3) Fryazino Branch Kotel’nikov IRE RAS.


Gravity Analysis Of The Kef Basin And Surrounding Regions, Northwest Tunisia Nesrine Frifita (1), Kevin Mickus (2), Fouad Zargouni (1) (1) University of Sciences of Tunisia, (2) Missouri State University USA.

GeoGuard: an innovative service for continuous geodetic monitoring by means of single-frequency GNSS receivers Daniele Sampietro, Stefano Caldera, Eugenio Realiini Geomatics Research & Development s.r.l., Italy.

Technical details of the modern Michelson-Gale type interferometric fluid level tilt meter of the Finnish Geospatial Research Institute, NLS, Finland Hannu Ruotsalainen Finnish Geospatial Research Institute, NLS.

Posters:

Observation of the Earth liquid core resonance by extensometers Dóra Bán (1), Gyula Mentes (2), Márta Kis (3), András Koppán (3) (1) Geodetic and Geophysical Institute, RCAES, HAS, (2) Geodetic and Geophysical Institute, RCAES, HAS, Hungary, (3) Geological and Geophysical Institute of Hungary, Hungary.

Tidal effects in the Earth’s crust Dmitry Loktev, Alexander Spivak INSTITUTE OF GEOSPHERE DYNAMICS RAS, Russia.

Storm surges in the German Bight: Are loading effects detectable by the SG recording at the Geodynamic Observatory Moxa in Thuringia? Thomas Jahr (1), Adelheid Weise (1), Sylvin Müller-Navarra (2) (1) Institute of Geosciences, Friedrich Schiller University Jena, (2) Bundesamt für Seeschifffahrt und Hydrographie (BSH), Hamburg.

Investigation of the non-stationary ocean loading with ARTOFS and STORMTIDE ocean models Eva Schroth (1), Thomas Forbriger (2), Malte Westerhaus (3), Malte Müller (4), Avichal Mehra (5), Liyan Liu (5) (1) Geophysical Institute, Karlsruhe Institute of Technology, Germany, (2) Geodetic Institute, Karlsruhe Institute of Technology, Germany, (3) Geodetic Institute, Norwegian Meteorological Institute, Oslo, Norway, (5) NCEP/EMC/Marine Modeling and Analysis Branch, NOAA Center for Weather and Climate Prediction, College Park, USA.

Use of Earth tide analysis for study of unstable aquifer regime. Evgeny Vinogradov, Ella Gorbunova, Alina Besedina Institute of Geospheres Dynamics.

IGETS Analysis Centre Tahiti (ICET): Status of GGP data processing Jean-Pierre Barriot (1), Bernard Ducarme (2), Youri Verschelle (1) (1) Geodesy Observatory of Tahiti, (2) Catholic University of Louvain.

Installation and initial results from the iGrav-027 superconducting gravimeter at Borowa Gora Geodetic-Geophysical Observatory Przemyslaw Dykowski, Jan Krynski, Marcin Sekowski Institute of Geodesy and Cartography.

Checking the gPhone-054 spring gravimeter after several years under intense seismo-volcanic activity conditions Sergio Sainz-Maza Aparicio, Marta Calvo Garcia-Maroto, Beatriz Córdoba Hita, Jorge Pereda De Pablo Instituto Geográfico Nacional (Spain).

Extensometric observation of Earth tides and local tectonic processes at the Vyhne station, Slovakia Ladislav Brimich (1), Martin Bedarik (2), Peter Vajda (2), Dora Bán (3), Ildikó Eper-Pápa (3), Gyula Mentes (3) (1) Earth Science Institute of the Slovak Academy of Sciences, (2) Earth Science Institute of the Slovak Academy of Sciences, (3) Geodetic and Geophysical Institute, Research Centre for Astronomy and Earth Sciences, Hungarian Academy of Sciences.

A search for a correlation between Earth-tides and seismicity in Colombia-first results Gloria A. Moncayo (1), Jorge I. Zuluaga (1), Gaspar Monsalve (2) (1) Solar, Earth and Planetary Physics Group, Computational Physics and Astrophysics Group, Instituto de Física-FCEN, Universidad de Antioquia, (2) Departamento de Geociencias y Medioambiente, Facultad de Minas, Universidad Nacional de Colombia.

Physical explanation of tsunami, a shallow water wave its generation and disastrous effect Daya SHANKER Indian Institute of Technology Roorkee, Department of Earthquake Engineering

Understanding Baltic Sea loading Maaria Nordman, Heikki Virtanen, Mirjam Bilker-Koivula, Sonja Lahtinen Finnish Geospatial Research Institute, NLS, Finland.

Comparative analysis of new hourly ERP series derived from GNSS data and the high resolution VLBI series based on complex demodulation Aleksander Brzezinski (1), Jolanta Nastula (2), Robert Weber (3), Sigrid Boehm (3) (1) Warsaw University of Technology, Department of Geodesy and Cartography, Poland, (2) Space Research Centre of the Polish Academy of Sciences, Warsaw, Poland, (3) TU-Vienna, Department for Geodesy and Geoinformation, Austria.


An image segmentation based algorithm for imaging of slow slip earthquakes Mohammad Hazrati Kashi (1), Noorbakhsh Mirzaei (1), Behzad Moshiri (2) (1) Institute of Geophysics, University of Tehran, Tehran, Iran., (2) School of Electrical and Computer Engineering, Control and Intelligent Processing Centre of Excellence, University of Tehran, Tehran, Iran.

Analysis of effects related to earthquakes and seismic oscillations appearing in rock deformation and gravimeter recordings Marta Kis (1), András Koppán (1), Gyula Mentes (2), Dora Bán (2), Mátra Kiszely (2), Katalin Gribovszky (2), László Merényi (1) (1) Geological and Geophysical Institute of Hungary, (2) Geodetic and Geophysical Institute, Research Centre for Astronomy and Earth Sciences, Hungarian Academy of Sciences, (3) Geodetic monitoring in Nepal: preliminary results from Gorkha earthquake (25 April 2015) Federico Morsut, Tommaso Pivetta, Giorgio Poretti, Carla Braitenberg Department of Mathematical and Geosciences, University of Trieste.

Research of the Earth Tides and GGP in China Heping SUN Institute of Geodesy and Geophysics, Chinese Academy of Science.

What drives the normal faults at the northern piedmont of the West Kunlun range? Xiaodian Jiang Ocean University of China.
Late Cenozoic Geodynamic Evolution Of Simav Fault And Surroundings, Nw Turkey Erdem Gündoğdu, Süha Özden Çanakkale Onsekiz Mart University, Turkey.

A study on the investigation of crustal deformation along the Iznik-Gemlik segment of the estern Part of North Anatolian Fault System Onur Yilmaz (1), Cengiz Zabei (2), Kerem Halicioglu (1), Bulent Turgut (1), Semih Ergintav (1) (1) Bogazici University Earthquake Research Institute, (2) Istanbul Technical University Geological Engineering Department.

Analysis of the Inter-Diking Deformation Pattern at the Ongoing DabbahuManda Hararo (Afar), Ethiopia Rift Segment Using GPS and InSAR Technique Esuablew Adem Yibrie Arba Minch University.

Evolution Of Jurassic Carbonate Platform (Ne Algerian) El Hadj YOUCEF BRAHIM Batna 2 University.

Neotectonics and seismicity of Algers region Sahra Aouarri CGS.

Detection of free Earth oscillations using the GNSS VADASE algorithm: results for the 2011 Tohoku-Oki earthquake Giorgio Savastano, Mattia Crespi, Augustoazzoni Geodesy and Geomatics Division-DICEA-University of Rome La Sapienza.

Reconstruction Of Changing Kinematic Parameters Of Tectonic Blocks Based On The Results Of Tide Gauge Measurements (The Territory Of Northern Europe Is Taken As An Example) Solomiya Dosyn.


A comparison of slow slip events at Etna and Kilauea volcanoes mariottia (1), Emily Montgomery-Brown (2), Valentina Bruno (1), Danila Scandura (1) (1) INGV Catania, (2) USGS.

On potential contribution of harmonic inversion method to studying volcanic unrest or reactivation Peter Vajda (1), Vladimir Pohánka (2), Jaroslava Pánisová (2) (1) Earth Science Institute, Slovak Academy of Sciences, (2) Earth Science Institute, Slovak Academy of Sciences, Slovakia.

A portable superconducting gravimeter in a field enclosure: comparison to traditional observatory gravimeters Michal Mikolaj (1), Andreas Günttner (1), Marvin Reich (1), Stephan Schröder (1), Hartmut Wziontek (2) (1) Helmholtz-Zentrum Potsdam – Deutsches GeoForschungsZentrum GFZ, (2) Federal Agency for Cartography and Geodesy (BKG), Branch Office Leipzig, Germany.

Local hydrology and the hydrological gravity signal observed by three superconducting gravimeter sensors at Metsähovi Geodetic Fundamental Station, Finland Arttu Raja-Halli (1), Heikki Virtanen (1), Jaakko Mäkinen (1), Tero Hokkanen (2), Risto Mäkinen (3) (1) Finnish Geospatial Research Institute, (2) Aalto University, Finland, (3) Finnish Environmental Institute.


The improved hydrological gravity model for Moxa observatory, Germany Adelheid Weise, Thomas Jahn Institute of Geosciences, Friedrich Schiller University Jena.

An update of the main parameters of the SG064 (Yebes Station) Beatriz Cordoba (1), Marta Calvo (2), Javier López-Ramasco (3), Sergio Sainz-Maza (2) (1) Universidad Carlos III de Madrid, (2) Observatorio Geofisica Central (IGN), (3) Observatorio de Yebes (IGN).

An update of the main parameters of the SG064 (Yebes Station) Beatriz Cordoba (1), Marta Calvo (2), Javier López-Ramasco (3), Sergio Sainz-Maza (2) (1) Universidad Carlos III de Madrid, (2) Observatorio Geofisica Central (IGN), (3) Observatorio de Yebes (IGN).

Gravity Monitoring at the Conrad Observatory (CO) Bruno Meurers (1), Dietherd Ruess (2), Christian Ullrich (2), Anton Nielsen (2) (1) University of Vienna, (2) Federal Office of Metrology and Surveying, Vienna, Austria.
Evaluation of water budget changes in a territory of Poland Jolanta Nastula (1), Monika Birylo (2), Rzepecka Zofia (2) (1) Space Research Center Polish Academy of Science in Warsaw, (2) University of Warmia and Mazury in Olsztyn.

Other presentations:


Gruszczynski M., Bogusz J., Klos A.: „Orthogonal transformation in extracting of common mode errors from continuous GPS networks”. 16th Czech-Polish Workshop ON RECENT GEODYNAMICS OF THE SUDETY MTS. AND ADJACENT AREAS, Srebrna Góra, Poland, November 5 - 7, 2015, oral presentation in English.

Gruszczynska M., Bogusz J., Klos A.: „Application of singular spectrum analysis for determination of the GPS time series seasonal components”. 16th Czech-Polish Workshop ON RECENT GEODYNAMICS OF THE SUDETY MTS. AND ADJACENT AREAS, Srebrna Góra, Poland, November 5 - 7, 2015, oral presentation in English.


Gruszczynska M., Bogusz J.: „Implementation of Singular Spectrum Analysis to study the variability of the GPS time series”. 5th International Conference for Young Researchers — Multidirectional Research in Agriculture, Forestry and Technology, 16-17 April 2016, Krakow, oral presentation in English.


American Geophysical Union Fall Meeting 2016, San Francisco, USA, 12-16 December 2016, Session G021: Separating and explaining multiple signals in geodetic data, oral presentation in English.
Sub-commission 3.2: Crustal Deformation

Chair: Zheng-Kang Shen (China)
Vice-Chair: Banrjee (Singapore)

Summary of the Sub-commission’s activities during the period 2015-2017

Meetings and Special Sessions:

AOGS 2016, 31 July - 5 August, 2016, Beijing, China:
SC3.2 hosted a special session, “Geodetic Observations, Modeling Of Earthquake Cycle Deformation, And Tectonics” (SE13), in the Asia Oceania Geoscience Meeting on August 1. 29 papers were presented, among which 18 were oral and 11 were poster papers. The number of participants of our session exceeded 100.

Peer-reviewed publications:

Sub-commission 3.3: Earth Rotation and Geophysical Fluids

Chair: Jianli Chen (USA)
Vice-Chair: Michael Schindelegger (Austria)

Overview

Mass transport in the atmosphere-hydrosphere-mantle-core system, or the ‘global geophysical fluids', causes observable geodynamic effects on broad time scales. Although relatively small, these global geodynamic effects have been measured by space geodetic techniques to increasing, unprecedented accuracy, opening up important new avenues of research that will lead to a better understanding of global mass transport processes and of the Earth’s dynamic response. Angular momenta and the related torques, gravitational field coefficients, and geocenter shifts for all geophysical fluids are the relevant quantities. They are observed using global-scale measurements and are studied theoretically as well as by applying state-of-the-art models; some of these models are already con-strained by such geodetic measurements. 

The objective of the SC3.3 is to serve the scientific community by supporting research and data analysis in areas related to variations in Earth rotation, gravitational field and geocenter, caused by mass re-distribution within and mass exchange among the Earth’s fluid sub-systems, i.e., the atmosphere, ocean, continental hydrosphere, cryosphere, mantle, and core along with geophysical processes associated with ocean tides and the hydrological cycle. SC 3.3 follows the program of activities defined by Commission 3. In order to promote the exchange of ideas and results as well as of analysis and modeling strategies, sessions at international conferences and topical workshops have been organized. In addition, SC 3.3 interacts with the sister organizations and services, particularly with the IERS Global Geophysical Fluids Centre and its operational component with four Special Bureaus (atmosphere, hydrology, ocean, combination) and its non-operational component for core, mantle, and tides.

Summary of the Sub-commission’s activities during the period 2015-2017

Meetings and Special Sessions:

On behalf of SC3.3, a session on “Earth Rotation and Reference Frame” has been organized at the 2016 Asia Oceania Geosciences Society (AOGS) annual conference held in Beijing China in August 2016, with Dr. Jianli Chen (USA, Chair of SC3.3) as the main convener, Dr. Richard Gross (USA) and Dr. Michael Schindelegger (Austria, Vice-Chair of SC3.3) as co-conveners. This appeared to be the first ever AOGS session focusing on Earth rotation during the short 13-years history of AOGS (the first AOGS was held in 2014). The main consideration for proposing the session is to help promote related research in the Asia and Oceania regions, and broaden the solid Earth component at the AOGS.

For the same consideration, we have proposed another similar session (SE09: Earth Rotation and Reference Frame) at the upcoming 2017 AOGS annual conference to be held in Singapore. While the session sizes are relatively small, with ~ one dozen abstracts submitted in both 2016 and 2017, this is a good start in the AOGS community.

Peer-reviewed publications:


Sub-commission 3.4: Cryospheric Deformation

Chair: Shfaqat Abbas Khan (Denmark)
Vice Chair: Matt King (Australia)

Summary of the Sub-commission’s activities during the period 2015-2017

During 2015-2017 we have organized three sessions at the AGU fall meetings.

- **AGU Fall Meeting 2015:**
  - Session G33A: Geodetic Measurements of the Earth's Elastic Response to Surface Mass Variability

- **AGU Fall Meeting 2016:**
  - Session G33B: Geodetic Measurements of the Earth's Elastic Response to Surface Mass Variability
  - Session G11B: Separating and Explaining Multiple Signals in Geodetic Data

- **We expect 1-2 sessions at AGU Fall Meeting 2017.**

- **Workshop in 2015 on Glacial Isostatic Adjustment and Elastic Deformation at Geophysical Institute, University of Alaska Fairbanks, USA.**
  - Session 1. Relative Sea Level & Ice History.
  - Session 2. GIA since the Little Ice Age.
  - Session 3. Solid Earth response to “rapid” stress change.
  - Session 4. Recent Changes in Greenland’s Ice Sheet.
  - Session 3. Geodetic measurement of viscoelastic deformation.

In 2017 the following workshop on Glacial Isostatic Adjustment and Elastic Deformation is planned and will be held in Reykjavik, Iceland during September 5-7, 2017.

- **Title:** “Workshop on Glacial Isostatic Adjustment and Elastic Deformation”, Website: http://www.polar.dtu.dk/english/workshop-on-glacial-isostatic-adjustment-and-elastic-deformation-2017
  - Session 1. Observations of present-day changes in glaciers, ice caps and ice sheets and the associated Earth deformation.
  - Session 3. Glacial isostatic adjustment on a heterogeneous Earth.
  - Session 4. Reconciling models and observations of GIA.

- **We expect 100-150 participants.**
Sub-commission 3.5: Tectonics and Earthquake Geodesy

Chair: Haluk Ozener (Turkey)

Overview

SC 3.5, (WEGENER group), aims to encourage cooperation between all geoscientists studying the Eurasian/African/Arabian plate boundary deformation zone with a focus on mitigating earthquake, tsunami, and volcanic hazards. Towards these ends, it organizes periodic workshops and meetings with special emphasis on integrating the broadest range of Earth observations, sharing analysis and modelling approaches, and promoting the use of standard procedures for geodetic data acquisition, quality evaluation, and processing. WEGENER organizes dedicated meetings, arranges special sessions in other international meetings, organizes special issues in peer-reviewed journals, and takes initiative to promote and facilitate open access to geodetic databases.

Summary of the Sub-commission’s activities during the period 2015-2017

Meetings:

18th General Assembly of WEGENER

WEGENER organizes bi-annual conferences to serve as high-level international forums in which scientists from all over the world share results, and strengthen collaborations between countries in the greater Mediterranean region and beyond. In this respect, the 18th General Assembly of WEGENER was held in Ponta Delgada, Azores, Portugal between 12 and 15 September 2016. Around 100 scientists from all around the world attended the meeting. A total of 46 oral and 9 poster presentations were made under the theme “Understanding Earth deformation at plate boundaries”. The meeting was conducted on five different sessions as follows:

1. “Current Plate Motions, Inter and Intraplate Deformation with a Focus on Europe, the Mediterranean, Africa and Middle East”
2. “Continental Faulting and Earthquake Cycle”
3. “Elastic surface displacements, surface and satellite gravity observations, global and regional sea-level change”
4. “Data and infrastructures, Instrumentation & Co-location for continuous monitoring of the changing Earth” and
5. “Transient signals in Geodetic Time Series: detection and modeling”

Information and experience in the use of geodetic methods for geodynamic studies such as GPS, InSAR, and terrestrial methods were shared in a wide range of applications from large scale studies such as the studies of continental boundaries to small scale studies such as local observations focusing on single faults. Invited talks enabled the attendees to keep up with the latest research of world leading scientists and the latest technological developments in instrumentation, analysis, modeling, and interpretation. The meeting was carried out in a workshop form, including extensive and inclusive discussions of the results and the methods presented within each session.

Detailed information about the 18th General Assembly of WEGENER can be found at: http://wegener.segal.ubi.pt/
WEGENER Session in 2015 EGU (12-17 April 2015-Vienna)

A session titled “Monitoring and modelling of geodynamics and crustal deformation: progress during 34 years of the WEGENER initiative” was organized and convened by Haluk Ozener, Susanna Zerbini and Mustapha Meghraoui in the EGU General Assembly 2015. Presentations emphasized multidisciplinary studies of Earth deformation using geodetic techniques (GPS, InSAR, LiDAR, space/air/terrestrial gravity, ground-based geodetic observations), complementary tectonic and geophysical observations, and modeling approaches focusing on the European-Mediterranean and Northern African regions. In total, 21 studies were presented in two successive sessions. More detailed information can be found at: http://meetingorganizer.copernicus.org/EGU2015/session/18028

WEGENER Session in 2016 EGU (17-22 April 2016-Vienna)

During the European Geosciences Union (EGU) General Assembly 2016, a session titled “Monitoring and modelling of geodynamics and crustal deformation: progress during 35 years of the WEGENER initiative” was convened by Dr. Haluk Ozener, Dr. Susanna Zerbini and Dr. Mustapha Meghraoui. Six oral talk and twenty five posters were presented in two successive sessions. More detailed information can be found at: http://meetingorganizer.copernicus.org/EGU2016/session/20161

WEGENER Session in 2017 EGU (23-28 April 2017-Vienna)

On behalf of SC3.5, a session on “Monitoring and modelling of geodynamics and crustal deformation: progress during 36 years of the WEGENER initiative” has been organized at the EGU General Assembly 2017, with Dr. Haluk Ozener (Chair of SC3.5) as the main convener, Dr. Susanna Zerbini, Dr. Matthias Becker and Dr. Sara Bruni as co-conveners. Six oral talk and seventeen posters were presented in two successive sessions. More detailed information can be found at: http://meetingorganizer.copernicus.org/EGU2017/session/22877

Peer-reviewed publications:

Aerts, W; Bruyninx, C; Defraigne, P; Vandenbosch, GAE; Zeimetz, P; “On the influence of RF absorbing material on the GNSS position”, GPS Solutions, V:20,1,PP:1-7 (January 2016).

Alothman, AO; Fernandes, RM; Bos, MS; Schillak, S; Elsaka, B; “Angular velocity of Arabian plate from multi-year analysis of GNSS data”, Arabian Journal of Geosciences, V:9 I:8. (June 2016).

Adams, DK ; Fernandes, RMS; Holub, KL; Gutman, SI; Barbosa, HMJ; Machado, LAT; Calilheiros, AJP ; Bennett, RA; Kursinski, ER; Sapucci, LF; “THE AMAZON DENSE GNSS METEOROLOGICAL NETWORK A New Approach for Examining Water Vapor and Deep Convection Interactions in the Tropics” BULLETIN OF THE AMERICAN METEOROLOGICAL SOCIETY, Volume: 96 Issue: 12 Pages: 2151-2165, DOI: 10.1175/BAMS-D-13-00171.1, (December 2015)

Alvarado, A ; Audin, L; Nocquet, JM; Jaillard, E; Mothes, P; Jarrin,P; Segovia, M; Rolandone, F; Csireros, D; “Partitioning of oblique convergence in the Northern Andes subduction zone: Migration history and the present-day boundary of the North Andean Sliver in Ecuador” TECTONICS, Volume: 35 Issue: 5 Pages: 1048-1065, DOI: 10.1002/2016TC004117 (May 2016).

Ayers-Sampaio, D ; Deurloo, R; Bos, M ; Magalhes, A; Bastos, L,” A Comparison Between Three IMUs for Strapdown Airborne Gravimetry” Surveys in Geophysics, V:36 I:4 P:571-586 (July 2015).

Baire, Q; Bruyninx, C ; Legrand, J; Pottiaux, E; Aerts, W; Defraigne, P; Bergeot, N ; Chevalier, JM; “Influence of different GPS receiver antenna calibration models on geodetic positioning (vol 18, pg 529, 2014), GPS Solutions, V: 20 I: 1 P: 135-135, DOI: 10.1007/s10291-015-0455-3. (January 2016).

Barlow, J; Barisin, I; Rosser, N; Petley, D; Densmore, A; Wright, T; “Seismically-induced mass movements and volumetric fluxes resulting from the 2010 M-w=7.2 earthquake in the Sierra Cucapah, Mexico”, GEOMORPHOLOGY, Volume: 230 Pages: 138-145.(February 2015).
Hamling, IJ; Hreinsdottir, S; Clark, K; Elliott, J; Liang, CR; Fielding, E; Litchfield, N; Villamor, P; Wallace, L; Wright, TJ; “Complex multifault rupture during the 2016 M-w 7.8 Kaikoura earthquake, New Zealand” SCIENCE, Volume: 356 Issue: 6334, DOI: 10.1126/science.aam7194 (April 2017).

Hussain, E; Wright, TJ; Walters, RJ; Bekaa, D; Hooper, A; Houseman, GA; “Geodetic observations of postseismic creep in the decade after the 1999 Izmit earthquake, Turkey: Implications for a shallow slip deficit” JOURNAL OF GEOPHYSICAL RESEARCH-SOLID EARTH, Volume: 121 Issue: 4 Pages: 2980-3001, DOI: 10.1002/2015JB012737 (April 2016).

Hussain, E; Hooper, A; Wright, TJ; Walters, RJ; Bekaa, DPS; “Interseismic strain accumulation across the central North Anatolian Fault from iteratively unwrapped InSAR measurements” JOURNAL OF GEOPHYSICAL RESEARCH-SOLID EARTH, Volume: 121 Issue: 12 Pages: 9000-9019, DOI: 10.1002/2016JB013108 (December 2016).


Knudsen, S; Bamber, I; Bevis, M; van Dam, T; Bamber, J; Wahr, J; Willis, M; Kjaer, K; Wouters, B; Helm, V; Csatho, B; Fleming, K; Bjork, A; Aschwendung, A; Knudsen, P; "Geodetic measurements reveal similarities between post–Last Glacial Maximum and present-day mass loss from the Greenland ice sheet", Science Advances, V: 2(9), (September 2016).


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Commission 3 Joint Study Group 3.1: Intercomparison of Gravity and Height Changes

Chair: Séverine Rosat (France)

Members
- José Arnos (Spain)
- Valentina Barletta (Denmark)
- Janusz Bogusz (Poland)
- Andrea Bordoni (Denmark)
- Yoichi Fukuda (Japan)
- Anthony Mémin (France)
- Laurent Métivier (France)
- Yves Rogister (France)
- Holger Steffen (Sweden)

Webpage
A website was set up to coordinate and document the group activities: http://iag-jsg.u-strasbg.fr/
It includes the terms of references, objectives, and contact information of the study group members, reports of the study group activities and a complete list of publications originating from the years 2015-2017.

Activities during the period 2015-2017

- Study of the noise characteristics of GNSS height change and Superconducting Gravimeter gravity change measurements: a paper (Bogusz et al.) is in revision.
- Influence of rheology on the gravity-to-height ratio: a first study has been performed for a homogeneous compressible Earth model with a Maxwell or a Burgers rheology and published in Ziegler et al. (2016). For the harmonic degree-2, the ratio between the gravity variation and the vertical surface displacement due to surface loading is almost constant and equal to -0.26 µGal/mm in the elastic domain, up to the relaxation time of the rheological model. In the viscoelastic domain, above 10,000 years, the gravity-to-height ratio tends to -0.08 µGal/mm. In between, the transition is smooth.
- Estimate of the geocenter motion by combining GNSS and gravity measurements: a first work has been published by Rogister et al. (2016) to show that time-varying surface gravity are independent of the terrestrial reference frame. In this study, a preliminary combination of GRACE solutions with surface gravity records has been used to correct hydrological effects that mask the degree-one geocenter motion. Indeed the separation of degree-one signal from other spectral content is impossible with a discrete network at the Earth’s surface since spherical harmonics are not orthogonal any more. A synthetic simulation using atmospheric and hydrological surface loading predictions together with GRACE solution is in progress within a CNES-funded project.
- Organization of the “International workshop on the inter-comparison of space and ground gravity and geometric spatial measurements”, to be held on 16-18 Oct 2017 in Strasbourg (France). The workshop website is at https://geodesy.sciencesconf.org/. It is funded by the University of Strasbourg, Institut de Physique du Globe de Strasbourg and the CNFGG (Comité National Français de Géodésie et de Géophysique – French contributor to the IUGG).
Relevant peer-reviewed publications by Joint Study Group members 2015-2017


Commission 3 Joint Working Group 3.1: Theory of Earth Rotation and Validation (joint with IAU)

Chair: José Ferrándiz (Spain)
Vice Chair: Richard Gross (USA)

Members
According to the Commission 3 bylaws for the current term, the JWG is structured in three sub-WGs that operate in coordination:

1. Precession/Nutation

Chair: Juan Getino (Spain)
Co-Chair: Alberto Escapa (Spain)

Members: N Capitaine (France), V Dehant (Belgium), CL Huang (China), J Vondrak (Czech Republic)
Correspondents: S Dickman (USA), M Folgueira (Spain), A Gusev (Russia), T Herring (USA), G Kaplan (USA), J Mueller (Germany), H Schuh (Germany), J Souchay (France), S Urban (USA), V Zharov (Russia)

2. Polar Motion and UT1

Chair: Aleksander Brzezinski (Poland)

Members: C Bizouard, BF Chao (Taipei), J Nastula (Poland), D Salstein (USA), F Seitz (Germany)
Correspondents: W Chen (China), CL Huang (China), W Kosek (Poland), J Ray (USA), C Ron (Czech Republic), H Schuh (Germany), W Shen (China), D Thaller (Germany), QJ Wang (China), YH Zhou (China)

3. Numerical Solutions and Validation

Chair: Robert Heinkelmann (Germany)

Members: W Chen (China), D Gambis (France), B Luzum (USA), Z Malkin (Russia), M Schindelegger (Austria)
Correspondents: BF Chao (Taipei), V Dehant (Belgium), E Gerlach (Germany), CL Huang (China), JF Navarro (Spain), ME Sansaturio (Spain), H Schuh (Germany), F Seitz (Germany), M Thomas (Germany), QJ Wang (China)

Activities and publications during the period 2015-2017

Web site:

A website was set up to facilitate and document the group activities: http://web.ua.es/en/wgterv>. Reports of many of the meetings and copies of the presentations can be found on-line on. Reports of the JWG meetings, including progress reports of the three SWGs and the whole JWG, minutes of sessions and discussions when relevant, and material provided by members, can be found on-line on it. The web site contains also a link to the documents elaborated by the previous Commission 3 WG on Theory of Earth rotation, joint with IAU.
Meetings:

The JWG has organized splinter meetings and special sessions at conferences of particular relevance for its activity, open to the interested conference attendants. The following took place so far:

- Session 8 at GAGER 2016, entitled: Open meeting on “Current situation, progress, and challenges of the theory of Earth rotation from the JWG TERV perspective”. Reports of progress of all the SWGs were presented in this session, and afterwards there was a long and fruitful discussion whose minutes are available at: https://web.ua.es/es/wgterv/jwg-terv-meetings/open-meeting-at-gager2016.html

Currently, the entire JWG chairing people are strongly involved in the organization of a forthcoming meeting:

“Journées 2017, des Systèmes de Référence et de la Rotation Terrestre”
25 to 27 September 2017, Alicante, Spain. (https://web.ua.es/journees2017/index.html). It is devoted to the study of the space-time celestial and terrestrial reference systems and their evolution with time, with the emphasis on the rotation of the Earth. This meeting intends to be a forum of advanced discussion that continue the successful series of Journées “Systèmes de Référence spatio-temporels”, also supported by IAU and IAG, whose concluding edition was held in 2014. Its sub-title is “Furthering our knowledge of Earth Rotation” and addresses the challenges brought to Earth rotation by the accuracy requirements of GGOS, with a scope ranging from concepts and theoretical solutions to observational techniques and data analysis. Most of the Journées 2017 SOC is affiliated to the JWG as member or correspondent.

Research progresses:

Next we outline briefly some of the main the facts and ideas underneath the research activity of the members and correspondents and present a short selection of their contributions as well. More details are available on the reports of the JWG and its three SWGs available on-line on the JWG web site.

The space geodetic techniques have improved to the point that the theoretical results are judged less accurate than the observational results and therefore the current theory of the Earth’s rotation is no longer adequate. This theory suffers from inconsistencies and at least several components of it require better modelling.

In precession-nutation theory, the consistency between the official theories IAU2000 and IAU2006 has been revised and new corrections derived to improve their mutual consistency and complement the corrections already recommended in the IERS Conventions (2010). The precession model has been re-assessed as well as a set of the minor contributions to the longitude rate. The current results suggest that the value of the Earth’s dynamical ellipticity, an important geodetic parameter in Earth rotation, is affected at a level that produces non-negligible “indirect” effects on nutations. Other contributions to nutations are under study, either of new physical origin or better approximations to previous solutions. Although these corrections are small, several terms are above the GGOS accuracy threshold particularized to the Earth rotation parameters (EOP).
The free core nutation (FCN), which is of particular relevance for improving the prediction of the celestial intermediate pole offsets (CPO), has been addressed from different perspectives, ranging from new theoretical approaches to the development of new empirical models. Besides, new determinations of a set of nutation amplitudes from existing or newly developed VLBI solutions have been carried out recently. Those amplitude are classically used to fit theories, but for the consistency and accuracy sake’s it has to be considered that the reference frames used in data analysis are not identical to the reference systems or frames used for theory; this topic is being investigated.

The polar motion theory has been extended to a triaxial Earth with a fluid core; while these effects are small they are systematic, not random, and should therefore be included in an updated theory according to the discussions inside the JWG. Other improvements of the Earth’s interior modelling have been made or are in progress. As a first result of them, the theoretical estimates of the free periods, particularly Chandler’s, have been brought closer to their observed values.

The knowledge of the geophysical excitation of the polar motion and UT1 at the different bands has also advanced inside the JWG, although more insight is needed, e.g. at high frequencies or regarding the excitation balance of the annual wobble. The quality and consistency of the implied geophysical models seems to be an unavoidable limiting factor.

Among the validation issues we note the research performed on the consistency and actual accuracy of the EOP estimates and their relationship to the celestial and terrestrial frames and processing strategies used for their determination.

Selection of peer-reviewed publications co-authored by JWG members:

The following is an incomplete list of publications on the topic of the working group resulting from the activity of its members and correspondents.


Gattano C., Lambert S., Bizouard C. Observation of the Earth's nutation by the VLBI: how accurate is the geophysical signal, J. Geod. (2016) (10.1007/s00190-016-0940-7)


Meetings organized in full or in part as activities of the IAU/IAG JWG TERV in 2015-2017

2017

1. Conference:
   Title: Journées des Systèmes de Référence et de la Rotation Terrestre
   Subtitle: “Furthering our knowledge of Earth Rotation”
   25 to 27 September 2017, Alicante, Spain
   Supported by IAU & IAG.
   Members of C-3 in the SOC: Cheng-li Huang, Richard Gross, José M. Ferrándiz (Chair)
   https://web.ua.es/journees2017/index.html

2. Open splinter meeting at EGU 2017 (SMP85). April 24, 2017

2016

Splinter meetings and special sessions at conferences

2. Session 8 at GAGER 2016: Open meeting on “Current situation, progress, and challenges of the theory of Earth rotation from the JWG TERV perspective” and discussion
Commission 3 Joint Working Group 3.2: Constraining Vertical Land Motion of Tide Gauges

Chair: Alvaro Santamaria-Gomez (France)

Members
- Matt King (Australia)
- Tonie van Dam (Luxembourg)
- Tilo Schöne (Germany)
- Guy Wöppelmann (France).

Progress of the activities

The JWG has collected vertical velocity estimates from 20 different global GPS solutions, including double-differenced and zero-differenced solutions, including PPP solutions (see table below). The number of available velocity estimates per solution varies between 75 and 12933, but we only considered sites for which at least three estimates were available. We removed sites for which a velocity discontinuity was known. We also paid attention to stations having the same ID but being located at different sites (beyond a radius of 100 km). With these constraints and the solutions being considered at this moment, the number of sites considered is 1132. Some of the solutions are presently outdated, for instance the old ITRF realizations of the first reprocessing solutions at the University of La Rochelle. These solutions were included only to assess velocity changes with the longer time series and the improvement of the GPS processing.

Velocity solutions collected by the JWG

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<tr>
<th>Solution name</th>
<th>Number of stations</th>
<th>Provider</th>
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<tr>
<td>ITRF2008</td>
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<td>itrf.ensg.ign.fr</td>
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<td>CO2</td>
<td>305</td>
<td>Paul Rebischung</td>
</tr>
<tr>
<td>EM2</td>
<td>171</td>
<td>Paul Rebischung</td>
</tr>
<tr>
<td>ES2</td>
<td>283</td>
<td>Paul Rebischung</td>
</tr>
<tr>
<td>JP2</td>
<td>238</td>
<td>Paul Rebischung</td>
</tr>
<tr>
<td>MI2</td>
<td>695</td>
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<tr>
<td>GF2</td>
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<tr>
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<td>260</td>
<td>Matt King</td>
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<td>sideshow.jpl.nasa.gov</td>
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<td>NGL PPP</td>
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<td>geodesy.unr.edu</td>
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<tr>
<td>GFZ PPP</td>
<td>75</td>
<td>Zhiguo Deng</td>
</tr>
</tbody>
</table>
A preliminary combination of all these solutions has been carried out. The target reference frame is the ITRF2014 and the repeatability of the vertical velocities has been obtained for each site. The velocity error bars are not consistent amongst the submitted solutions so different weighting approaches have been considered. For each solution and site, a preliminary WRMS has been obtained. The solution WRMS indicates its agreement with respect to the average (combination) of the available solutions, after the weighting of each solution. The site WRMS provides the velocity repeatability amongst the solutions considered and represents an alternative assessment of the velocity uncertainty for each site.

**Further steps**

A continuous effort to include new global velocity solutions is maintained. Large velocity differences were detected for the PPP solutions and further development of the combination is expected, particularly concerning the lack of velocity covariance for the PPP solutions.

In addition to these 20 solutions, the vertical velocities from the IGS TIGA reprocessed solutions have been recently submitted to the JWG (see table below) and will be integrated in the comparison.

For the last reprocessing at the University of La Rochelle (ULR6), three different velocity solutions exist (ULR6, UL2 and ULR TIGA). This makes a unique dataset to assess velocity differences produced during the stacking, alignment and cleaning of the series by different analysts.

An additional DORIS solution has been submitted and will be integrated in the comparison.

**Recent velocity solutions available:**

<table>
<thead>
<tr>
<th>Solution name</th>
<th>Number of stations</th>
<th>Provider</th>
</tr>
</thead>
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<td>BLT TIGA</td>
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<td>Addisu Hunegnaw</td>
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<tr>
<td>ULR TIGA</td>
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<td>Addisu Hunegnaw</td>
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