Commission 3 – Earth Rotation and Geodynamics

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

http://www.rcep.dpri.kyoto-u.ac.jp/iag-commission3/Commission_3.htm

Terms of Reference

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.

Sub-Commission 3.1 (Earth Tides and Geodynamics) addresses the entire range of tidal phenomena including its effect on Earth rotation. Sub-Commission 3.2 (Crustal Deformation) addresses the entire range of global and regional crustal deformation including intraplate deformation, the earthquake deformation cycle, aseismic phenomena such as episodic tremor and slip, and volcanic deformation. Sub-Commission 3.3 (Earth Rotation and Geophysical Fluids) addresses the space-time variation of atmospheric pressure, seafloor pressure and the surface loads associated with the hydrological cycle, and Earth's (mainly elastic) responses to these mass redistributions. Sub-Commission 3.4 (Cryospheric Deformation) addresses the Earth's instantaneous and delayed responses to ice mass changes, including seasonal (cyclical) mass changes and progressive changes associated with climate change. This group also studies postglacial rebound at all spatial scales and the elastic deformation taking place in the near-field of existing ice sheets and glaciers. Sub-Commission 3.5 (Tectonics and Earthquake Geodesy) addresses the integration of space and terrestrial approaches for studying the kinematics and mechanics of tectonic plate boundary zones, and in particular of the Eurasian/African/Arabian boundary zone.

Commission 3 interacts with GGOS, other Commissions and Services of the IAG as well as with other organizations such as the International Astronomical Union (IAU). For example, the recent space mission GRACE has expanded our common interests with IAG Commission 2 (Gravity Field) since temporal changes in gravity are associated with both the drivers of Earth deformation (e.g. changing ice and loads) and with Earth's response to these and other forcing.

Objectives

- To promote cooperation and collaboration on the theory, modelling and observation of Earth rotation and geodynamics.
- To ensure development of research in Earth rotation and geodynamics by organizing meetings, symposia, and sessions at conferences and general assemblies, by creating working groups on specific topics, and by encouraging the exchange of ideas and data and the

comparison of methods and results with the goal of improving accuracy, content, methods, theories, and understanding of Earth rotation and geodynamics.
- To serve the geophysical community by facilitating interactions with organizations that provide the data needed to study Earth rotation and geodynamics.

Structure

Sub-Commissions

SC 3.1: Earth Tides and Geodynamics
Chair: Janusz Bogusz (Poland)
SC 3.2: Crustal Deformation
Chair: Zheng-Kang Shen (China)
SC 3.3: Earth Rotation and Geophysical Fluids
Chair: Jianli Chen (USA)
SC 3.4: Cryospheric Deformation
Chair: Shfaqat Abbas Khan (Denmark)
SC 3.5: Tectonics and Earthquake Geodesy
Chair: Haluk Ozener (Turkey)

Joint Study Groups

JSG 0.16 Earth's inner structure from combined geodetic and geophysical sources
(joint with Commission 2 and ICCT, description see ICCT)
Chair: R. Tenzer (China)

JSG 0.19 Time series analysis in geodesy
(joint with ICCT and GGOS, description see ICCT)
Chair: W. Kosek (Poland)

JSG 0.21 Geophysical modelling of time variations in deformation and gravity
(joint with Commission 2 and ICCT, description see ICCT)
Chair: Y. Tanaka (Japan)

JSG 3.1: Intercomparison of Gravity and Height Changes
(joint with IGFS, Commissions 1 and 2)
Chair: Severine Rosat (France)

Joint Working Groups

JWG 3.1: Theory of Earth Rotation and Validation
(joint with IAU)
Chair: José Ferrándiz (Spain)

JWG 3.2: Constraining Vertical Land Motion of Tide Gauges
(joint with Commission 1)
Chair: Alvaro Santamaría-Gómez (France)

Program of Activities

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 be focused narrowly on the interests of the sub-commissions and other entities listed above, and others will have a broader commission-wide focus.

Steering Committee

President Commission 3:	Manabu Hashimoto (Japan)
Vice President Comm. 3:	Cheng-Li Huang (China)
Chair Sub-Comm. 3.1:	Janusz Bogusz (Poland)
Chair Sub-Comm. 3.2:	Zheng-Kang Shen (China)
Chair Sub-Comm. 3.3:	Jianli Chen (USA)
Chair Sub-Comm. 3.4:	Sh. Abbas Khan (Denmark)
Chair Sub-Comm. 3.5:	Haluk Ozener (Turkey)
Representative of IERS:	Brian Luzum (USA)
Representative of IGFS:	Riccardo Barzaghi (Italy)
Representative of GGOS:	Richard Gross (USA)
Member-at-Large:	José Ferrándiz (Spain)
Member-at-Large:	Alvaro Santamaría-Gómez (France)

Sub-Commissions

SC 3.1: Earth Tides and Geodynamics

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

Terms of Reference

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. Earth tide observations have a very long tradition. These observations led to the discovery of the Earth's elasticity which allows deformation and variations in Earth orientation and rotation parameters. 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 hydrospheric 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.

As tidal friction is affecting Earth rotation, all the physical properties of the Earth contribute to the explanation of this phenomenon. Therefore, the research on tidal deformation due to changes of the tidal potential as well as ocean and atmospheric loading are a prerequisite to answer such questions. Further, direct and indirect tidal phenomena affect the position of fiducial sites and have to be corrected to provide accurate spatial referencing. Such referencing is needed for the observation and monitoring of changes of the Earth's surface at global, regional and local scales. Therefore, there is a considerable contribution of tidal research to global geodynamics and climate change by providing important constraints to geophysical models.

Modern gravimetry is improving our knowledge on the Earth's: global gravity field and its temporal variations, structure and dynamics. Notably, superconducting gravimeters allow continuous monitoring of the gravity signal at selected sites with a precision of better than 10^{-10}. These geophysical observations together with other geodetic observations and geological information provide the means to better understand the structure, dynamics and evolution of the Earth system. Nowadays, the range of the applications of superconducting gravimeters (SG) becomes very wide and applicable not only to Earth tides investigations, but also to support studies on Earth's seismicity or hydrological influences.

The Chair of SC 3.1 is also responsible for close cooperation with the International Geodynamics and Earth Tide Service (IGETS) to provide effective service-with-science coupling.

Objectives

Objectives of SC 3.1 include:

- To study and implement new observational techniques and improve existing ones, including clinometric and extensometric techniques;
- To advance tidal data analyses and prediction methods;
- To enhance the models on the interaction among solid Earth, ocean, and atmospheric tides;
- To research the effects of the atmosphere on gravity and other geodetic observations;
- To study the response of the Earth at tidal and non-tidal forcing frequencies;
- To study the interplay between tides and Earth rotation;
- to study tides on the planets;
- To study the effects of ocean loading and global water distribution;
- To create and coordinate working groups on specific topics of interest and relevancy to the understanding of our planet;
- To develop, coordinate and promote international conferences, programs and workshops on data acquisition, analysis and interpretation related to the research fields mentioned above;
- To contribute to the definition and realization of the International Terrestrial Reference Frame via advanced geodynamic models at global, regional and local scales;
- To promote the systematic calibration and intercomparison of absolute and superconducting gravimeters;
- To promote interdisciplinary research in Earth and planetary tides;
- To support the IAG Global Geodetic Observing System (GGOS) in the field of
  - the integral effect on Earth rotation of all angular momentum exchange inside the Earth, between land, ice, hydrosphere and atmosphere, and between the Earth, Sun, Moon, and planets,
  - the geometric shape of the Earth's surface (solid Earth, ice and oceans), globally or regionally, and its temporal variations, whether they are horizontal or vertical, secular, periodical or sudden,
  - the Earth's gravity field-stationary and time variable-mass balance, fluxes and circulation.

Program of Activities

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.

SC 3.2: Crustal Deformation

Chair: Zheng-Kang Shen (China)
Vice-Chair: Paramesh Banerjee (Singapore)

Terms of Reference

There are many geodetic signals that can be observed and are representative of the deformation mechanisms of the Earth's crust at different spatial and temporal scales. This includes the entire range of tectonic phenomena including plate tectonics, intraplate deformation, the earthquake deformation cycle, aseismic phenomena such as episodic tremor and slip, and volcanic deformation. The time scales range from seconds to years and the spatial scales from millimeters to continental dimension.

A variety of geodetic technologies such as GNSS, InSAR, LiDAR, terrestrial LiDAR, tiltmeter, and strainmeter now provides the means to observe deformation and movements of the Earth's crust at global, regional, and local scales. This is a considerable contribution to global geodynamics by supplying primary constraints for modeling the planet as a whole, but also for understanding geophysical phenomena occurring at local scales. Some phenomena are potentially hazardous, like earthquake and volcanic activity related phenomena. On the other hand, there are many slow deformations which are not hazardous, but in long time scales may have considerable effects. These include steady tectonic deformations and postglacial rebound. Other non-tectonic deformations which may have significant societal impacts include landslide, ground subsidence, sinkhole, and the ones related to surficial and underground fluid circulations.

One of the key issues nowadays is the definition and stability of global and regional reference frames. Crustal deformations in all time and spatial scales as well as mass transfer will affect reference frames. Gravimetry, absolute, relative, and nowadays also spaceborne, is a powerful tool providing information to the global terrestrial gravity field and its temporal variations, and helping define global and regional reference frames. Integration of variety of geodetic observations and data from other geophysical and geological sources provides the means to understand the structure, dynamics and evolution of the Earth system.

Organizational Aspects

There is a natural relationship with IAG Commission 1, as the reference frame definition must be consistent with the actual crustal deformation. The work of the Sub-Commission will be organized as working-group like. A core group of people will be invited to meet regularly and try to evaluate different models or approaches for computing or evaluating these effects. Due to global distribution of participants, electronic meetings and e-mails will be an essential part of communication for the organization. The Sub-Commission aims to organize 1-2 topical symposia during the 4-year period.

Objectives

General objectives of the Sub-Commission 3.2 will include:

- To study crustal deformation in all scales, from plate tectonics to local deformation;
- To contribute reference frame related work in order to better understand deformations, and to improve global, regional and local reference frames and their dynamical modeling;
- To study sea-level fluctuations and changes in relation to vertical tectonics along many parts of the coastlines and in relation to environmental fluctuations/changes affecting the geodetic observations;
- To study deformation during the seismic cycle including earthquakes, episodic slow slip events, and postseismic transients, in relation to physical processes of fault zones, crust and mantle rheology, and seismic hazards;
- To characterize strain partitioning in fault systems with reference to block or continuum mechanics;
- To monitor and study volcanic, fluid circulation related, and anthropologic deformations;
- To monitor and study natural hazard related deformations such as landslide, ground subsidence, and sinkhole, etc.;
- To promote, develop, and coordinate international programs related to observations, analysis and data interpretation for the fields of investigation mentioned above;
- To promote free data sharing/exchange and collaborations within the community;
- To organize and co-organize meetings and symposia related to the topic.

SC 3.3: Earth Rotation and Geophysical Fluids

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

Terms of Reference

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.

Objectives

The objective of the SC 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.

The SC complements and promotes the objectives of GGOS with its central theme "Global deformation and mass exchange processes in the Earth system" and the following areas of activities:

- quantification of angular momentum exchange and mass transfer;
- deformation due to mass transfer between solid Earth, atmosphere, and hydrosphere including ice.

Program of Activities

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 will be 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. SC 3.3 will have close contacts to the GGOS activities, in particular to the activities of the newly established GGOS Working Group 'Contributions to Earth System Modelling'.

SC 3.4: Cryospheric Deformation

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

Terms of Reference

Past and present changes in the mass balance of the Earth's glaciers and ice complexes induce present-day deformation of the solid Earth on a range of spatial scales, from the very local to global. Of principal interest are geodetic observations that validate, or may be assimilated into, models of glacial isostatic adjustment (GIA) and/or constrain models of changes in present-day ice masses through measurements of elastic rebound. Using geometric measurements alone, elastic and GIA deformations cannot be separated without additional models or observations. Reference frames of GIA models do not allow direct comparison to measurements in an International Terrestrial Reference Frame and ambiguity currently exists over the exact transformation between the two. Furthermore, there is no publicly available and easy-to-use tool for model computations of elastic effects based on observed elevation/mass changes over the spatial scales of interest (small valley glaciers to large ice streams) and including gravitational/rotational feedbacks. This SC will focus on resolving these technical issues and work on dissemination of these measurements within the glaciological community (notably IACS).

Program of Activities

- Organize a workshop to discuss separation of elastic and GIA signals in key regions of interest, including Greenland, Antarctica, Patagonia and Alaska. Include WG 2.6.3 “Glacial isostatic adjustment (GIA) Model and Effects” and SC 1.2 “Global Reference Frames” on global reference frames for validation of GIA models.
- Establish and publish a list of PSMSL tide gauges that are subject to large, time-variable elastic deformation associated with present-day glacier mass change.
- Compile a database of predictions for relative sea level changes at tide gauges, gravity field, and 3D deformation rates at geodetic sites and on global or regional grids for a set of reasonable GIA models, both for the deglaciation after LGM and more recent ice changes. While this database may not lead to consensus about the “best” model, it will clarify the range of predictions made by models that have some support within the broader community.
- Interact where possible with those working on alternative measurements of the same signals (gravimetric or Earth rotation).
- Organize a workshop on “Present-day changes in the mass balance of Earth's glaciers and ice sheets”.

SC 3.5: Tectonics and Earthquake Geodesy

Chair: Haluk Ozener (Turkey)

Terms of Reference

Space and terrestrial geodesy provide key observations to investigate a broad range of the Earth's systems. These data are collected, analyzed, and interpreted by geodesists and other scientists. Studies of crustal deformation rely on the continuous and/or repeated acquisition of geodetic measurements and their analysis in the frame of active tectonics, and on their combination with results obtained from other geological and geophysical investigations (seismology, neotectonics, gravity, rock physics, electromagnetic, ...).

The evolution of geodetic techniques in the past decade, with unprecedented achievements in the precise detection and monitoring of 3D movements at the millimeter level has opened new prospects for the study of Earth kinematics and geodynamics. However, these achievements also raise new issues that have to be properly taken into account in the processing and analysis of the data, demanding a careful inter-disciplinary approach.

Areas that involve the broad collision zone between Europe, Africa and Arabia, provide natural laboratories to study crucial and poorly understood geodynamic processes. The recent occurrence of giant earthquakes (with Mw > 9), unexpected and in subduction areas with weak geodetic monitoring provides further challenges to the scientific community. Although these active zones were systematically monitored in the last decade by different institutions and research groups using a variety of space geodesy and other methods, in general the data analysis and interpretation have been done from the perspective of one discipline and have rarely followed an integrated approach. Never completely explored, the existence of these data (geodata) justifies a new, integrated approach including different observational techniques and input from other disciplines in the Earth sciences (geology, seismology, tectonics ...). This should lead to the development of interdisciplinary work in the integration of space and terrestrial approaches for the study of, for instance, the Eurasian/African/Arabian plate boundary deformation zone (and adjacent areas), and contribute to the establishment of a European Velocity Field. With this objective, it is important to promote stronger international cooperation between Earth scientists interested in plate boundary zones.

Towards this goal the SC aims:

- To actively encourage the cooperation between all geo-scientists studying the Eurasian/African/Arabian plate boundary deformation zone, by promoting the exploitation of synergies;
- To reinforce the study of subduction zones in Mediterranean regions and elsewhere by increasing and developing infrastructures and geodetic stations;
- To be a reference group for the integration of the most advanced geodetic and geophysical techniques by developing consistent methodologies for data reduction, analysis, integration, and interpretation;
- To act as a forum for discussion and scientific support for international geoscientists investigating the kinematics and mechanics of the Eurasian/African/ Arabian plate boundary deformation zone;
- To promote the use of standard procedures for geodetic data acquisition, quality evaluation, and processing, particularly GNSS data;
- To promote earthquake geodesy and the study of seismically active regions with large earthquake potential;
- To promote the role of Geodesy in tectonic studies for understanding the seismic cycle, transient and instantaneous deformation, and creeping versus seismic slip on faults.

Objectives

The primary goals of the SC are:

- To continue as a framework for geodetic cooperation in the study of the Eurasian/African/Arabian plate boundary zone;
- To identify and characterize a potential "Wegener Supersite";
- To develop scientific programmes in earthquake geodesy for subduction zones (e.g., Hellenic Arc) and possible occurrence of giant earthquakes and associated tsunamis;
- To foster the use of space-borne, airborne and hybrid techniques as high-resolution GNSS, InSAR, GOCE, GRACE, ENVISAT, SENTINELLE, LIDAR, etc. for earth observation;
- To define effective integrated observational strategies for these techniques to reliably identify and monitor crustal movements and gravity variations over all time-scales;
- To facilitate and stimulate the integrated exploitation of data from different techniques in the analysis and interpretation of geo-processes;
- To organize periodic workshops and meetings with special emphasis on interdisciplinary research and interpretation and modeling issues;

- To reinforce cooperation with African and Arab countries and colleagues with scientific projects, that can contribute to understanding the kinematics and dynamics of the Eurasian/African/Arabian plate boundary zone and promote the growth of such research and geodetic expertise in these countries.

Program of Activities

- Build a web-portal and an associated geo-database that enables access to metadata, processed results, and when possible historical data from continuous GNSS stations and episodic geodetic campaigns, as well as other derived products such as strain rates, velocity fields, etc.;
- Promote the application of standards for GNSS network establishment, data acquisition, and guidelines for data processing and reliability checks;
- Define strategies for a full exploitation of different geo-data (GNSS, gravimetry, InSAR, etc.);
- In coordination with the IGS and other relevant organizations, establish a GNSS analysis centre specially dedicated to process permanent and episodic campaign data, not analyzed by other GNSS centres, which will contribute to the development of a joint velocity field (EUROVEL) that can support kinematic and geodynamic modeling;
- Organize bi-annual conferences to serve as high-level international forums in which scientists from all over the world can look at a multi-disciplinary interpretation of geodynamics, and strengthen the collaboration between countries in the greater Mediterranean region.

Links to Services

The SC will establish links to relevant services and other IAG (sub-) components, such as:

- International Earth Rotation and Reference Systems Service (IERS);
- International GNSS Service (IGS);
- International Laser Ranging Service (ILRS);
- International VLBI Service for Geodesy and Astrometry (IVS);
- International DORIS Service (IDS);
- Global Geodetic Observing System (GGOS);
- African Reference Frame (AFREF);
- Asia-Pacific Reference Frame (APREF);
- European Reference Frame (EUREF):
- North American Reference Frame (NAREF);
- South-Central American Reference Frame (SIRGAS).

Joint Study Groups of Commission 3

JSG 3.1: Intercomparison of Gravity and Height Changes
(joint with IGFS, Commissions 1 and 2)

Chair: Séverine Rosat (France)

Terms of Reference

Surface deformations are continuously recorded from space and from the ground with increasing accuracy. Vertical displacements and time-varying gravity are representative of various deformation mechanisms of the Earth occurring at different spatial and temporal scales. We can quote for instance post-glacial rebound, tidal deformation, surficial loading, co- and post- seismic deformation and volcanic deformation. The involved temporal scales range from seconds to years and the spatial scales range from millimeters to continental dimension. Large-scale deformation are well monitored by space geodetic measurements from monthly spatially-averaged GRACE measurements while local deformation are precisely monitored by daily GNSS solutions and sub-daily gravimetric data at a site. The intercomparison of the space- and ground-gravity measurements with vertical surface displacements enables us to better understand the structure, dynamics and evolution of the Earth system.

Thanks to ever-improving measurements techniques and computation methods, reaching a millimeter or even a sub-millimeter level precision has become the new challenge of the geodetic community. A method has been proposed to use time-varying ground gravity recorded by superconducting gravimeter (SG) at co-located sites with geometrical space technique (like VLBI, LLR, SLR or GNSS) to determine more precisely the local deformation.

Several issues arise when comparing geometric and gravimetric measurements of surface deformations. Among these issues we can quote differences in spatial and temporal scales, differences in sensitivity and noise characteristics as well as some variability in the terrestrial reference frame realization. As a consequence, this Study Group is joined between Commission 1 on Reference Frames, Commission 2 on Gravity Field and Commission 3 on Earth Rotation and Geodynamics.

Objectives

The motivation of this Joint Study Group (JSG) is to study surface deformation by comparing site displacement observations with both ground- and space-based gravity measurements. In particular, we will focus on the transfer function of the Earth at various time-scales related to the elastic and visco-elastic properties of the Earth. This JSG will hence theoretically study the gravity-to-height changes ratio in order to discriminate vertical motion from mass transfer. The influence of topography, rheology and lateral heterogeneities of the Earth makes the comparison of gravity and height changes more difficult to interpret in terms of Earth's structure and properties. So this JSG will provide solutions helping to understand such effects.

Another objective will be to propose some examples of comparison of gravity and height changes using GNSS and Superconducting Gravimeter observatory data, for instance to estimate the geocenter motion and mass changes. Such activity will rely on the IGETS (International Geodynamics and Earth Tides Service) products (service of the IAG and of IGFS) for ground gravity data.

Program of Activities

- Study of the noise characteristics of GNSS height change and Superconducting Gravimeter gravity change measurements.
- Love numbers determination using co-located gravity and displacement measurements.
- Review of the gravity-to-height ratio at various time and length scales.
- Theoretical and numerical computation of the influence of rheology and lateral structure of the Earth on the gravity-to-height ratio.
- Estimate of the geocenter motion by combining GNSS and gravity measurements.
- Organization of an international workshop in 2017 in Strasbourg (France).
- Contribution to international meetings and conferences.
- Common publications by JSG members.

Members

Séverine Rosat (France), Chair
José Arnoso (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)

Corresponding member

Giorgio Spada (Italy)

Joint Working Groups of Commission 3

JWG 3.1 Theory of Earth Rotation and Validation
(joint with IAU)

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

Purpose

To promote the development of theories of Earth rotation that are fully consistent and that agree with observations and provide predictions of the Earth orientation parameters (EOPs) with the accuracy required to meet the needs of the near future as recommended by, e.g., GGOS, the Global Geodetic Observing System of the IAG.

Justification

Recent efforts have not led to improvements in the accuracy of theoretical models of the Earth's rotation that approach the required millimeter level, so there is a strong need to develop such theories to meet the current and future accuracy of the observations and trying to improve predictions.

Terms of Reference

A main objective of the Working Group (WG) is to assess and ensure the level of consistency of EOP predictions derived from theories with the corresponding EOPs determined from analyses of the observational data provided by the various geodetic techniques. Consistency must be understood in its broader meaning, referring to models, processing standards, conventions etc. This JWG will closely collaborate with GGOS.

Clearer definitions of polar motion and nutation are needed for both their separation in observational data analysis and for use in theoretical modeling.

Theoretical approaches must be consistent with IAU and IAG Resolutions concerning reference systems, frames and time scales.

Searching for potential sources of systematic differences between theory and observations is encouraged, including potential effects of differences in reference frame realization.

The derivation of comprehensive theories accounting for all relevant astronomical and geophysical effects and able to predict all EOPs is sought. In case more than one theory is needed to accomplish this, their consistency should be ensured.

There are no a priori preferred approaches or methods of solution, although solutions must be suitable for operational use and the simplicity of their adaptation to future improvements or changes in background models should be considered.

The incorporation into current models of corrections stemming from newly studied effects or improvements of existing models may be recommended by the JWG when they lead to significant accuracy enhancements, validated by comparisons with determined EOP.

Desired Outcomes

- Contribute to improving the accuracy of precession-nutation and Earth rotation parameters (ERP) theoretical models by proposing both new models and additional corrections to existing ones;
- Clarify the issue of consistency among conventional EOPs, their definitions in various theoretical approaches, and their practical determination;
- Establish guidelines or requirements for future theoretical developments with improved accuracy.

We are aware that subject is too broad for a single Working Group, and also that the existence of independent Sub-WGs for different sub-fields implies a risk that their results will not be consistent with each other. Thus, we establish the following three Sub-WGs.

The subjects of SWG 1 and 2 are self-explanatory. SWG 3 will be dedicated to numerical theories and solutions, relativity and new concepts and validation by comparisons among theories and observational series.

1. Precession/Nutation

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

Members

Yuri Barkin (Russia), Véronique Dehant (Belgium), Cheng-Li Huang (China), Jan Vondrak (Czech Republic)

Correspondents

Nicole Capitaine (France), Steven Dickman (USA), Marta Folgueira (Spain), Alexander Gusev (Russia), Tom Herring (USA), George Kaplan (USA), Jürgen Mueller (Germany), Harald Schuh (Germany), Jean Souchay (France), Sean Urban (USA), Vladimir Zharov (Russia).

2. Polar Motion and UT1

Chair: Aleksander Brzezinski (Poland)

Members

Christian Bizouard (France), Benjamin F. Chao (Taipei), Jolanta Nastula (Poland), David Salstein (USA), Florian Seitz (Germany).

Correspondents

Wei Chen (China), Cheng-Li Huang (China), Wiesław Kosek (Poland), Jim Ray (USA), Cyril Ron (Czech Republic), Harald Schuh (Germany), WenBin Shen (China), Daniela Thaller (Germany), QiJie Wang (China), YongHong Zhou (China).

3. Numerical Solutions and Validation

Chair: Robert Heinkelmann (Germany)

Members

Wei Chen (China), Daniel Gambis (France), Brian Luzum (USA), Zinovy Malkin (Russia), M Schindelegger (Austria).

Correspondents

BF Chao (Taipei), Véronique Dehant (Belgium), Enrico Gerlach (Germany), Cheng-Li Huang (China), Juan F. Navarro (Spain), Maria Eugenia Sansaturio (Spain), Harald Schuh (Germany), Florian Seitz (Germany), Maik Thomas (Germany), QiJie Wang (China).

JWG 3.2 Constraining vertical land motion of tide gauges
(joint with IAG Comm. 1)

Chair: Alvaro Santamaría-Gómez (France)

Terms of reference

Inter-annual to secular vertical motion of the Earth's crust at the tide gauge locations has a substantial impact on the assessment of climatic sea-level variations and for the validation of satellite altimetry missions.

When a postglacial rebound model is used to correct the secular vertical motion of the tide gauges, errors in the model and the omission of other sources of land motion makes the corrections uncertain. The alternative is using land motion estimates from geodetic observations. However, not all the tide gauges are monitored and estimates of vertical land motion from geodetic observations are severely limited in time, especially when considering multi-decadal tide gauge records. Consideration of non-linear deformation and reference frame stability is therefore crucial for extrapolating the vertical motion estimates beyond the observed period.

This Working Group will focus on providing contrasted vertical land motion at tide gauges from a multi-technique perspective. Tide gauges commonly used for long-term sea-level change (e.g., sea-level reconstructions) and for calibration/validation of satellite altimeters are the main target.

Program of activities

- Collect and compare different vertical land motion estimates and constraints at the tide gauges from a multi-approach perspective (geodetic observations and geophysical models).
- Identify tide gauges with large uncertainty on its vertical motion.
- Assess the propagation of vertical land motion uncertainty onto sea-level change.
- Identify InSAR imagery data suitable to determine relative vertical motion around selected tide gauges.

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