IAG Commission 4 – Positioning & Applications

http://www.gmat.unsw.edu.au/iag/iag_comm4.htm

Terms of Reference

To promote research into the development of a number of geodetic tools that have practical applications to engineering and mapping. The Commission will carry out its work in close cooperation with the IAG Services and other IAG Entities, as well as via linkages with relevant Entities within Scientific and Professional Sister Organisations. Recognising the central role that GNSS plays in many of these applications, the Commission's work will focus on several GPS-based techniques. These include *precise positioning*, but extending beyond the applications of reference frame densification and geodynamics, to address the demands of precise, real-time positioning of moving platforms. Several Sub-Commissions will deal with precise kinematic GPS positioning technology itself (alone or in combination with other positioning sensors) as well as its applications in surveying and engineering. Recognising the role of continuously operating GPS reference station network, research into *non-positioning applications* of such geodetic infrastructure will also be pursued, such as atmospheric sounding.

Steering Committee

Chris Rizos – President
Pascal Willis – Vice President (Liaison with IGGOS, IDS representative)
Dorota Brzezinska – Chair SC4.1
Heribert Kahmen – Chair SC4.2
Susan Skone, Hans van der Marel – Chairs SC4.3
Xiaoli Ding - Chair SC4.4
Yang Gao - Chair SC4.5
Marcelo Santos – Member at Large (Liaison with ICCT)
Ruth Neilan – IAG representatives

Structure

The Commission is organised around five Sub-Commissions, each with several Working Groups:
• SC4.1 "Multi-sensor Systems"
• SC4.2 "Applications of Geodesy in Engineering"
• SC4.3 "GNSS Measurement of the Atmosphere"
• SC4.4 "Applications of Satellite & Airborne Imaging Systems"
• SC4.5 "Next Generation RTK"

There are several Study Groups:
SG1.1 "Ionospheric Modelling & Analysis" (joint with Commission 1)
SG1.2 "Use of GNSS for Reference Frames" (joint with Commission 1)
SG4.1 "Pseudolite Applications in Positioning & Navigation"
SG4.2 "Statistics and Geometry in Mixed Integer Linear Models, with Applications to GPS & InSAR" (joint with ICCT)

There are currently no Commission Projects defined.

Sub-Commission 4.1:
Multi-sensor Systems:

http://www.ceegs.ohio-state.edu/IAG-SC41

Terms of Reference

To coordinate research and other activities that address the broader areas of multi-sensor system theory and applications, with a special emphasis on integrated guidance, navigation, positioning and orientation of airborne and land-based platform. The primary sensors of interest will be Global Navigation Satellite Systems (GNSS) and inertial navigation systems; however the important role of other techniques used for indoor and pedestrian navigation is also recognised. The SC will carry out its work in close cooperation with other IAG Entities, as well as via linkages with relevant scientific and professional organisations such as ISPRS, FIG, IEEE, ION.

Objectives

- To follow the technical advances in navigation sensors and algorithms, including autonomous vehicle navigation, based on:
    - positioning sensors and techniques such as GPS (and pseudoliltes), INS, including MEMS-IMU, wheel sensors, ultrasonic and magnetic sensors, and
    - positioning methods based on cellular networks and their combination with GPS.
- To follow the technical advances in mapping sensors, such as CCD cameras, laser range finders, laser scanners and radar devices.
- To standardise definitions and measurements of sensor-related parameters.
- To study and report on the performance of standalone and integrated navigation systems.
- To stimulate new ideas and innovation in:
    - navigation algorithms, sensor calibration, synchronisation and inter-calibration,
    - real-time sensor information processing and georeferencing
    - sensor and data fusion, and
    - automation techniques for information extraction from multi-sensor systems using expert systems.
- To study and monitor the progress in new applications (not limited to conventional mapping) of multi-sensor systems (transportation, engineering, car navigation, personal navigation, indoor navigation, etc.).
- To study and report on the progress in performance, market availability and pricing of multi-sensor mapping systems and their hardware and software components.
- To promote research and collaboration with countries with no or limited access to modern multi-sensor technology.

Steering Committee

Chair: Dorota Grejner-Brzezinska (OSU, USA; dbrzezinska@osu.edu)
Vice-Chair: Naser El-Sheimy (U. of Calgary, Canada; naser@geomatics.ucalgary.ca)

Secretary: Jinling Wang (UNSW, Australia; jinling.wang@unsw.edu.au)
Member-at-Large: Guenther Retscher (Vienna Univ. of Technology, Austria; gretsch@pop.tuwien.ac.at)
Joao Fernando Silva (UNESP, Brazil; jfcsilva@prudente.unesp.br)

Working Groups

WG4.1.1 Advances in Inertial Navigation and Error Modelling Algorithms
Chair: Sameh Nassar (University of Calgary, Canada: snassar@ucalgary.ca)
Co-Chair: Jay Kwon (Sejgon University, Korea; jkwon@sejong.ac.kr)
Terms of Reference: To study and report the performance of the currently used inertial error modelling algorithms, and to promote the development of new methods and techniques for modelling inertial sensor errors. To implement innovative ideas for processing inertial data and integrating inertial systems with other sensors. To report the advances in the development of new inertial sensor technologies.

WG4.1.2 Indoor and Pedestrian Navigation
Chair: Guenther Retscher (Vienna Univ. of Technology, Austria; gretsch@pop.tuwien.ac.at)
Co-Chair: Bertrand Merminod (Swiss Federal Institute of Technology, Switzerland; bertrand.merminod@epfl.ch)
Terms of Reference: To promote research and development in the area of indoor and pedestrian navigation using multi-sensor integrated systems, based on medium to low-accuracy small-sized inertial systems, including micro-electro-mechanical systems (MEMS), and other positioning sensors, such as wheel sensors, ultrasonic and magnetic sensors, integrated with imaging sensors. To report progress on positioning methods based on cellular networks and their combination with GPS.

WG4.1.3 Advances in MEMS Technology and Applications
Chair: Mikel Miller (Sensors Directorate, Wright Patterson Air Force Base, USA; mikel.miller@wpafb.af.mil)
Co-Chair: Jan Skaloud (Swiss Federal Institute of Technology, Switzerland; jan.skaloud@epfl.ch)
Terms of Reference: To promote research into the development and integration of MEMS-based IMU that have practical applications to engineering and mapping. To promote research and development into precise, low-cost, low-power, small-sized, and high reliability IMU's for integration with other position, navigation, attitude, and time systems.

Program of Activities

- To study the technology and applications of multi-sensor systems in order to address the objectives for SC4.1 (see above).
- To report on the progress in research, performance, market availability, etc., of multi-sensor mapping systems in various ways, including seminars, position papers and via the SC4.1 web page.
- To organise and to participate in professional workshops, seminars, meetings, etc.

- To establish a web page providing information on SC4.1 activities, technology updates, professional meeting calendar, etc.

Sub-Commission 4.2:
Applications of Geodesy in Engineering

http://info.tuwien.ac.at/ingeo/sc4/sc42.html

Terms of Reference

Rapid developments in engineering, microelectronics and the computer sciences have greatly changed both instrumentation and methodology in *engineering geodesy*. To build higher and longer, on the other hand, have been key challenges for engineers and scientists since ancient times. Now, and for the foreseeable future, engineers confront the limits of size, not merely to set records, but to meet the real needs of society minimising negative environmental impact. Highly developed engineering geodesy techniques are needed to meet these challenges. The SC will therefore endevour to coordinate research and other activities that address the broad areas of the theory and applications of engineering geodesy tools. The tools range from convenional terrestrial measurement and alignment technology (optical, RF, etc.), Global Navigation Satellite Systems (GNSS), geotechnical instrumentation, and software systems such as GIS, decision support systems, etc. The applications range from construction engineering and structural monitoring, to natural phnemona such as landslides and ground subsidence that have a local effect on structures and community infrastructure. The SC will carry out its work in close cooperation with other IAG Entities, as well as via linkages with relevant scientific and professional organisations such as ISPRS, FIG, IEEE, ION.

Objectives

- To monitor research and development into new technologies that are applicable to the general field of "engineering geodesy", including hardware, software and analysis techniques.
- To study advances in dynamic monitoring and data evaluation systems for buldings and other manmade structures.
- To study advances in monitoring and alert systems for local geodynamic processes, such as landslides, ground subsidence, etc.
- To study advances in geodetic methods used on large construction sites.
- To study advancfes in the application of knowledge-based systems in engineering geodesy.
- To document the body of knowledge in this field, and to present this knowledge in a consistent frame work at symposia and workshops.
- Through the SC4.2 Working Groups to promote research into several new technology areas or applications.

Steering Committee

Chair:	Heribert Kahmen (Vienna Univ. of Technology, Austria; Heribert.Kahmen@tuwien.ac.at)
Vice-Chair:	Gethin Roberts (IESSG, Nottingham University, UK; Gethin.Roberts@nottingham.ac.uk)
Secretary:	Guenther Retscher (Vienna Univ. of Technology, Austria;

gretsch@pop.tuwien.ac.at)
Member-at-Large: Wolfgang Niemeier (Tech. Univer. Braunschweig, Germany; W.Niemeier@tu-bs.de)

Working Groups

WG4.2.1 Measurement Systems for the Navigation of Construction Processes
Chair: Wolfgang Niemeier (Technical University Braunschweig, Germany; W.Niemeier@tu-bs.de)
Co-Chair: Guenther Retscher (Vienna University of Technology, Austria; gretsch@pop.tuwien.ac.at)
Terms of Reference: To study and report the performance of the currently used navigation/guidance systems for construction machinery, and to promote the development of new methods and techniques for controlling construction processes.

WG4.2.2 Dynamic Monitoring of Buildings
Chair: Matthew Tait (University of Calgary, Canada; tait@geomatics.ucalgary.ca)
Co-Chair: Gethin Roberts (IESSG, Nottingham University, UK; Gethin.Roberts@nottingham.ac.uk)
Terms of Reference: To study and report the performance of currently used building monitoring systems, including techniques based satellite and terrestrial measurements, and to promote new the application of new sensor technology.

WG4.2.3 Application of Knowledge-based Systems in Engineering Geodesy
Chair: Klaus Chmelina (GeoData, Austria; Chmelina@GEODATA.at)
Co-chair: John Bosco Miima (Technical University Braunschweig, Germany; j-b.miima@tu-bs.de)
Terms of Reference: To study and report on topics such as control of measurement- and guidance-systems, deformation analysis, control of alert systems, and the evaluation of their complex data stream through the use of knowledge-based systems. To implement new research outcomes in Artificial Intelligence for deformation analysis and measurement system control.

WG4.2.4 Monitoring of Landslides & System Analysis
Chair: Gyula Mentes (Geodetic & Geophysical Research Institute of HAS, Hungary; mentes@ggki.hu)
Co-chair: Zhenglu Zhang (Wuhan University, China; zz1623@wtusm.edu.cn)
Terms of Reference: Worldwide landslides are one of the major types of natural hazards killing or maiming many people, and causing considerable damage to infrastructure. There has already been done a wide range of research work on landslides. Most of this work had a bias towards one discipline, such as remote sensing or geology. The proposal of the WG is to promote multi-disciplinary integration of different methods. The main goal is to establish an integrated workflow for landslide hazard management.

Program of Activities

- To study the technology and applications of engineering geodesy in order to address the objectives for SC4.2 (see above).

- To organise and to participate in professional workshops, seminars, meetings, etc.
- To establish a web page providing information on SC4.2 activities, professional meeting calendar, etc.

Sub-Commission 4.3:
GNSS Measurement of the Atmosphere

Terms of Reference

Over the past decade, significant advances in GPS technology have enabled the use of GPS as an atmospheric remote sensing tool. With the growing global infrastructure of GPS reference stations, the capability exists to derive high-resolution estimates of total electron content and precipitable water vapour in near real-time. Recent advances in tomographic modelling and the availability of spaceborne Global Positioning System (GPS) observations has also allowed 3-D profiling of electron density and atmospheric refractivity. Future plans for the GALILEO system will allow further opportunities for exploiting Global Navigation Satelliote Systems (GNSS) as an atmospheric remote sensing tool. Many countries have initiated efforts in this area of research and application. The focus of this Sub-Commission is to facilitate collaboration and communication, and support joint research efforts, for GNSS measurement of the atmosphere. Specific objectives will be achieved through the formation of appropriate Working Group. A Steering Committee will work closely with members and other IAG Commissions/Sub-Commissions to achieve mutual goals. Collaboration with the International GPS Service (IGS), the SG1.1, and other IAG entities and agencies will be promoted through, for example, joint sponsorship of workshops and conference sessions.

Objectives

This Sub-Commission will focus on the following principal objectives:

- To promote improvement of existing estimation algorithms and (near) real-time processing for atmospheric parameter monitoring using GNSS techniques, from both ground-based and spaceborne systems.
- To coordinate data collection campaigns, in order to encourage research and development into the measurement of crucial parameters of the atmosphere that impact on GNSS measurements.
- To investigate applications in both the atmospheric and space sciences.

Steering Committee

Chair:	Susan Skone (Univ. of Calgary, Canada; sskone@geomatics.ucalgary.ca)
Co-Chair:	Hans van der Marel (TU Delft, The Netherlands; H.vanderMarel@geo.tudelft.nl)
Vice-Chair:	Jens Wickert (GFZ, Germany; jens.wickert@gfz-potsdam.de)
Members-at-Large:	Anthea Coster (MIT Haystack Observatory, USA)

Program of Activities

- To monitor research activities and operational developments in GNSS-based atmospheric parameter measurement related to the objectives for SC4.3 (see above).

- To report on the progress in research, performance, applications, etc., of atmospheric remote sensing using GNSS technology, including seminars, position papers and via the SC4.3 web page.
- To organise and to participate in professional workshops, seminars, data collection campaigns, meetings, etc.
- To establish a web page providing information on SC4.3 activities, technology updates, professional meeting calendar, etc.

Working Groups

WG4.3.1 Ionspheric Scintillation

Chair: B. Fortes (Abdus Salam International Centre for Theoretical Physics)
Co-Chair: TBA

Terms of Reference: To collect experimental data on ionospheric scintillation, by means of GPS monitors/receivers, at high latitudes, and to study the scintillation impact on precise positioning operations, during both quiet and disturbed conditions, as well as during low to high solar activity, at high latitudes

WG4.3.2 Ionsophere Modelling Algorithms & Evaluation

Chair: Z. Liu (University of Calgary, Canada)
Co-Chair: X. Pi (JPL, Pasadena)

Terms of Reference: The ionosphere tomographic modelling method based on GNSS measurements is an interesting research topic and recently has attracted much attention from a wide range of researchers. The performance of the tomographic model will be assessed through comparisons against other available ionospheric models and calibration with different ionospheric data sets, under both ionospherically benign and severe conditions.

Sub-Commission 4.4:
Applications of Satellite & Airborne Imaging Systems

Terms of Reference

Satellite and airborne imaging systems, primarily Synthetic Aperture Radar (SAR) and Light Detection And Ranging (LiDAR) systems, are increasingly being used for geodetic applications such as ground deformation monitoring due to seismic and volcanic activity and man-induced subsidence due to fluid extraction, underground mining, etc. This Sub-commission will endevour to promote and report on hardware/software research into these imaging systems that is relevant to geodetic applications. The SC will also facilitate communications and exchange of data, information and research results, in order to encourage wider application of these technologies, particularly in less developed countries. The SC will carry out its work in close cooperation with other IAG Entities, as well as via linkages with relevant scientific and professional organisations such as ISPRS, FIG, IEEE.

Objectives

- To promote the development of satellite and airborne imaging systems, primarily including Synthetic Aperture Radar (SAR) and Light Detection And Ranging (LiDAR) systems, for geodetic applications.
- To study and report on models and algorithms for the processing and analysis of data from satellite and airborne imaging systems.
- To promote research into the effects of the atmosphere and field conditions on satellite and airborne imaging systems.
- To encourage research and development into the integration of satellite and airborne imaging systems with other geodetic/geospatial technologies such as the Global Positioning System (GPS) and Geographic Information Systems (GIS).
- To promote the development of new applications of satellite and airborne imaging systems.
- To encourage lower SAR image prices for research purposes, and for use in less developed countries.

Steering Committee

Chair:	Xiaoli Ding (The Hong Kong Polytechnic Univ., Hong Kong; lsxlding@polu.edu.hk)
Vice-Chair:	Linlin Ge (UNSW, Australia; l.ge@unsw.edu.au)
Secretary:	Makoto Omura (Kochi Womens University, Japan; omura@cc.kochi-wu.ac.jp)
	Member-at-Large: Ramon F. Hanssen (TU Delft, The Netherlands; hanssen@geo.tudelft.nl)

Working Groups

WG4.4.1 Permanent Scatterer / Corner Reflector / Transponder InSAR
Chair: Fabio Rocca (Politecnico di Milano, Italy; rocca@elet.polimi.it)
Co-Chair: Chao Wang (Institute of Remote Sensing Applications, Chinese Academy of Sciences; cwang@public.bta.net.cn)
Terms of Reference: To study and report on the use of permanent scatters, corner reflectors and active transponders to enhance the quality and the scope of applicability of InSAR.

WG4.4.2 Atmospheric Effects in InSAR / InSAR Meteorology
Chair: Linlin Ge (UNSW, Australia; l.ge@unsw.edu.au)
Co-Chair: TBD
Terms of Reference: To characterise the spatial and temporal variations of atmospheric effects on InSAR and LiDAR measurements, and to study methods for the mitigation of the effects.

WG4.4.3 InSAR for Polar Regions
Chair: Makoto Omura (Kochi Womens Univ., Japan; omura@cc.kochi-wu.ac.jp)
Co-Chair: TBD
Terms of Reference: To study and report on the dynamic processes of the earth's polar regions, including the changes in the extent, thickness, and dynamics of ice shelves, ice streams and glaciers in Antarctica, and in Arctic sea ice and permafrost with satellite radar systems.

WG4.4.4 Imaging Systems for Ground Subsidence Monitoring
Chair: Andrew Manu (Iowa State Univ., USA; akmanu@iastate.edu)
Co-Chair: TBD
Terms of Reference: To study and report on ground surface deformation monitoring using satellite and airborne imaging systems, especially ground subsidence associated with, e.g., city development, mining and ground liquid withdrawal, land reclamation and seismic activities.

Program of Activities

- To monitor research activities and operational developments in satellite and airborne imaging systems such as InSAR and LiDAR as related to the objectives for SC4.4 (see above).
- To report on the progress in research, performance, geodetic applications, etc., of InSAR and LiDAR, including seminars, position papers and via the SC4.4 web page.
- To organise and to participate in professional workshops, seminars, campaigns, meetings, etc.
- To establish a web page providing information on SC4.4 activities, technology updates, professional meeting calendar, etc.

Sub-Commission 4.5:
Next Generation RTK

http://www.ucalgary.ca/~ygao/iag.htm

Terms of Reference

Current carrier phase-based Real-Time Kinematic (RTK) positioning at the centimetre accuracy level requires the combination of observations from two GPS receivers, with one serving as the base station with known coordinates and another as the mobile/user station. One significant drawback for this approach, however, is the practical constraints imposed by the requirement that simultaneous observations be made at the user and reference stations, and that the user station be within the vicinity of the reference station typically up to 20 kilometres. Development of methods and algorithms to eliminate such constraints for increased flexibility and accessibility using RTK therefore presents a current trend. This Sub-Commission will identify, encourage investigation into the important research issues and problems for the development of next generation RTK technologies, report on such developments, and will promote international collaborations among researchers and organisations from academia, government and private sectors. The latter will be done through linkages with sister scientific and professional organisations, and especially with the IAG's International GPS Service (IGS).

Objectives

The objective of the Sub-Commission are to promote collective research efforts on the development of new methods and technologies for next generation RTK and to stimulate strong research collaborations among international organisations, including the industry. The main objectives of SC4.5 will be:

- To identify and investigate important technical issues in next generation RTK system development.
- To investigate and develop data standards and operational procedures for next generation RTK, including the communication protocols and message formats.
- To establish collaborative relationship with other organisations, and especially with the IGS.
- To develop strong links with the industry sector.
- To participate and organise international conferences, workshops and meetings.

Steering Committee

Chair: Yang Gao (Univ. of Calgary, Canada; gao@geomatics.ucalgary.ca)
Vice-Chair: Lambert Wanninger (Ingenieurbüro Wanninger, Germany; wanninger@wasoft.de)
Secretary: Wu Chen (The Hong Kong Polytechnic Univ., Hong Kong; lswuchen@polyu.edu.hk)
Member-at-Large: Mark Caissy (Natural Resources Canada, Canada)
Member-at-Large: John Raquet (Air Force Institute of Technology, USA; John.Raquet@afit.edu)
Member-ar-Large: Sunil Bisnath (Univ. of Southern Mississippi, USA; Sunil.Bisnath@usm.edu)

Working Groups

WG4.5.1 Network RTK

Chair: Lambert Wanninger (Ingenieurbüro Wanninger, Germany; wanninger@wasoft.de)
Co-Chair: Ola Ovstedal (Agricultural University of Norway, Norway; ola.ovstedal@imt.nlh.no)
Terms of Reference: To study the various technical aspects of network RTK positioning and to stimulate further research work in this field. To report progress on the development of GNSS reference station networks for RTK positioning.

WG4.5.2 Carrier Phase based Precise Point Positioning

Chair: Sunil Bisnath (Univ. of Southern Mississippi, USA; Sunil.Bisnath@usm.edu)
Co-Chair: Maxim Kechine (Delft University of Technology, The Netherlands; M.O.Kechine@lr.tudelft.nl)
Terms of Reference: To address and investigate issues and problems related to the development of a new RTK positioning technology based on the processing of un-differenced carrier phase (and pseudo-range) observations without the need of a reference station.

WG4.5.3 High Precision Positioning on Buoys and Moving Platforms

Chair: Wu Chen (The Hong Kong Polytechnic Univ., Hong Kong; lswuchen@polyu.edu.hk)
Co-Chair: Mark Dumville (IESSG, Nottingham Univ., UK; Mark.Dumville@nottingham.ac.uk), Oscar Colombo (NASA, USA; ocolombo@helmert.gsfc.nasa.gov)
Terms of Reference: To study precise positioning in marine environment including precise positioning algorithms on moving platforms, multipath effects off water surfaces, and data fusion of GNSS and other ocean environment sensors. To promote the collaboration of researchers from different research areas, including geodesy, navigation, oceanography, and meteorology.

Program of Activities

- To monitor research activities and operational developments in real-time GNSS positioning, both for "precise point positioning" and network-based modes as related to the objectives for SC4.5 (see above).
- To report on the progress in research, performance, etc., of next generation RTK, including seminars, position papers and via the SC4.5 web page.
- To focus on the development of standardised terminology for the various RTK systems, and to promolgate relevant standards such as those produced by RTCM, IGS, etc.
- To organise and to participate in professional workshops, seminars, meetings, etc.
- To establish a web page providing information on SC4.5 activities, technology updates, professional meeting calendar, etc.

Study Group 4.1:
Pseudolite Applications in Positioning and Navigation

http://www.gmat.unsw.edu.au/pseudolite/

Terms of Reference

In satellite-based precise positioning, the dominant factors are the number *and* geometric distribution of the satellites tracked by the receivers. In the case of Global Navigation Satellite Systems such as GPS, GLONASS, and the planned GALILEO system, four visible satellites are the minimum requirement for precise three-dimensional positioning. In general, the more satellites that are tracked, the more reliable the positioning solutions. However, in some situations, such as in downtown urban canyons, engineering construction sites, and in deep open-cut pits and mines, the number of visible satellites may not be sufficient. In the worst situations, such as in underground tunnels and inside buildings, the satellite signals may be completely absent. Such problems with existing GNSS systems can be addressed by the inclusion of additional ranging signals transmitted from ground-based "pseudo-satellites" (pseudolites). Pseudolites are an exciting technology that can be used for a wide range of positioning and navigation applications, either as a substantial augmentation tool of spaceborne systems, or as an independent system for indoor positioning applications.

Objectives

The goal of this study group is to investigate new concepts of pseudolite-related positioning and navigation applications. The objectives of the research activities are to study:

(a) Pseudolite augmentation of GPS.
(b) Pseudolite-only positioning scenarios.
(c) Integration of pseudolites with other sensors, such as INS.

These objectives will be achieved by:

- Promoting dialogue between SG members.
- Encouraging symposia and sessions at conferences with the theme of pseudolite technology and applications.
- Setting up a SG website providing a focus for pseudolite research and applications with the relevant links.
- Developing a comprehensive bibliography for pseudolite research and applications.

Membership

Chair: Dr. Jinling Wang (UNSW, Australia) (jinling.wang@unsw.edu.au)
Vice-Chair: Dr. Gethin Roberts (Univ. of Nottingham, UK) (gethin.roberts@nottingham.ac.uk)
Vice-Chair: Dr. Dorota Grejner-Brzezinska (OSU, USA) (dbrzezinska@osu.edu)

Dr. Joel Barnes (UNSW, Australia)
Prof. Elizabeth Cannon (Univ. of Calgary, Canada)
Prof. Paul Cross (University College London, UK)
Assoc. Prof. Peter Dare (Univ. of New Brunswick, Canada)

Dr. Liwen Dai (Thales Inc., USA)
Dr. Fabio Dovis (Italy)
Prof. Xiufeng He (China)
Prof. Gunter W. Hein (Univ. of the Federal Armed Forces, Germany)
Assoc. Prof. Jonathan P. How (USA)
Dr. Hiroshi Isshiki (Japan)
Assoc. Prof. Changdon Kee (South Korea)
Prof. Alfred Leick (Univ. of Maine, USA)
Dr. Edward LeMaster (USA)
Prof. Jingnan Liu (China)
Mr. Paolo Mulassano (Italy)
Dr. Xiaolin Meng (Univ. of Nottingham, UK)
Dr. Ivan Petrovski (GNSS Technologies Inc., Japan)
Mr. Ilir F. Progri (USA)
Prof. Chris Rizos (UNSW, Australia)
Dr. Fredrick von Schoultz (Finland)
Dr. Toshiaki Tsujii (National Aerospace Laboratory, Japan)
Ms. Sandra Verhagen (TU Delft, The Netherlands)
Dr. Guangjun Wen (Singapore)
Assoc. Prof. Ming Xie (Singapore)
Dr. Aigong Xu (Singapore)

Program of Activities

- To monitor research activities in the field of pseudolite development and application, across a wide range of positioning applications, including indoor and outdoor positioning.
- To report on the progress in research, performance, applications, availability, etc., of pseudolite systems, including seminars, position papers and via the SG4.1 web page.
- To organise and to participate in professional workshops, seminars, campaigns, meetings, etc.
- To establish a web page providing information on SG4.1 activities, technology updates, professional meeting calendar, etc.

Study Group 4.2:
Statistics and Geometry in Mixed Integer Linear Models, with Applications to GPS and InSAR

(joint with Inter-Commission Committee on Theory)

http://der.topo.auth.gr/icct/WGS/7-Dermanis.htm

Terms of Reference

The presence of an unknown number of cycles in GPS observations of phase differences has generated a new challenging theoretical problem, which in its utmost generality may be described as the solution of over-determined equations with both real-valued and integer unknowns. Within this problem these particular issues emerge: (a) the selection and design of an optimality criterion that leads to a unique solution, (b) the development of computationally efficient algorithms for obtaining the optimal solution, especially with respect to the integer unknowns which require search within a discrete set, (c) the new types of distributions of the estimated real-valued and integer parameters, (d) particular geometry in connection with the estimated integer parameters, (e) the assessment of the accuracy of the solution in the presence of both random and systematic errors affecting the observations, and (f) new statistical hypothesis testing techniques.

Objectives

- To attract the attention of researchers beyond geodesy (statisticians, mathematicians) to this fascinating topic, with a view towards finding other possible applications beyond those encountered in geodesy.
- To establish a channel of cooperation on the ground of methodology and support a closer collaboration between “theoreticians“ and “practitioners”.
- To encourage frontier research in the subject concerning e.g. the evaluation–comparison of various different solution principles (e.g. least squares, Bayesian statistics, best linear estimation) as well as of the different algorithms for the realisation of the solutions.

Membership

Chair: Athanasios Dermanis (Greece)

Mohamed Abdel-salam (Canada)
Clara de Lacy (Italy)
Donghyun (Don) Kim (Canada)
Georgia Fotopoulos (Canada)
Brigitte Gundlich (Netherlands)
Hung-Kyu Lee (Australia)
Kentaro Kondo (Japan)
Christopher Kotsakis (Greece)
Andre Lannes (France)
Linyuan Xia (China)
Marcelo Santos (Canada)
Burkhardt Schaffrin (USA)
Sandra Verhagen (Netherlands)

Activities

- Prepare a critical presentation of all relative literature.
- Prepare a “tutorial” monograph introducing the subject to the younger generation of researchers, which will include fundamental background material, but will also lead to the outskirts of advanced current research.
- Perform an extensive test of current methodologies and algorithms based upon real as well as properly designed simulated data.
- Establish a web page which will serve as an open forum among all those interested in the subject.
- Organise a joint workshop on the subject with statistician and mathematicians and publish its minutes, if possible.

Study Group 1.1:
Ionospheric Modelling and Analysis

(Jointly Commission 1 and 4 in cooperation with IGS and COSPAR)

Terms of Reference

As a result of many years of research the climatology of the ionosphere is today quite well known. However, variations of the solar activity and emissions of plasma from the solar corona change the conditions of the Sun-Earth environment and can dramatically disturb the ionospheric mean conditions. The development of sophisticated high technological systems for navigation, telecommunication, space missions, etc., created the need of predicting the meteorological conditions of the space around the Earth, giving rise to a branch of knowledge that today is called space weather. Disruptions of the ionosphere caused by massive solar flares can interfere with or even destroy communication systems, Earth satellites and power grids on Earth. A stringent application of ionospheric models would be to provide real-time corrections and integrity information for aircraft navigation and precision approach.

Ionospheric models are important for many space geodesy observing techniques to correct the delay caused by the ionosphere on the propagation of electromagnetic wave, typical applications being single-frequency GPS and GLONASS positioning or real time ambiguity resolution. The Earth's ionosphere has been studied for more than one hundred years using different observational techniques. A large contribution to the knowledge of the bottom-side ionosphere was done by a global network of 100-200 vertical incidence ionosondes, that started operation during the International Geophysical Year 1957-1958. Incoherent backscatter radars were used after 1958 to extend the exploration of the ionosphere to its topside. In 1957 the space age began enabling topside ionosondes onboard satellites, observations of Faraday rotation on transionospheric signals emitted by geostationary satellites, Doppler method with rockets and satellites and in situ techniques aboard spacecrafts.

Using large data bases of classical observations covering different geographical regions and different solar and geomagnetic conditions, several empirical ionospheric models were established. Among them, the International Reference Ionosphere (IRI) is probably the most widely used. IRI is continuously revised and updated through international cooperative effort of different type sponsored by the Working Group created by the Committee on Space Research (COSPAR) and the Union of Radio Sciences (URSI). Today ground-based and space-based GPS observations, and in a less extent observations of other space geodetic dual-frequency observing techniques, e.g., satellite altimetry, bring an unprecedented opportunity for ionospheric studies and may well revolutionize science and technology of the ionospheric meteorology. They provide high quality ionospheric information, with global coverage, simultaneity and time continuity and are easy and free available for ionospheric scientists.

Objectives

A first valuable step toward exploiting the GPS potentiality for ionospheric studies was already done by the IGS in 1998 by the creation of the Ionosphere Working Group. In the framework of this group, five centers are computing and making accessible on a regular basis several GPS-

derived ionospheric products, mainly two-dimensional worldwide grids of vertical total electron content. We believe that the efforts to maintain a regular service for processing GPS data to form VTEC maps should be continued, but we are convinced that the effort should be pursued to fully exploit such amount of high quality data and to maximize the benefits for the scientific community. Therefore, we propose the creation of a study group on Ionospheric Modeling and Analyses, in co-operation with IGS and possibly with COSPAR, to support the already existing Ionospheric Working Groups.

The principal objectives of the Study Group may be summarized as follows:

- To establish a scientific link between geodetic and aeronomy experts in order to maximize the benefit of the ionospheric information provided by geodesy.
- To analyze the ionospheric products derived from GPS and other space techniques and to explore the better use for scientific and practical purposes.
- To study possible improvements of the existing products.
- To propose new products that could be obtained from ionospheric information of GPS and other space techniques.

Structure

Chair: Claudio Brunini (Argentina)
Vice-chair: Susan Skone (Univ. of Calgary, Canada; sskone@geomatics.ucalgary.ca)

Members

Edward Afraimovich (Russia)
Dieter Belitza (USA)
Norbert Jakowski (Germany)
Reinhard Leitinger (Austria)
Sandro Radicella (Italy)
Antonio Rius (Spain)
Chris Rizos (Australia)
Stefan Schaer (Switzerland)
Michael Schmidt (Germany)
Edvaldo Simões da Fonseca Jr. (Brazil)
Susan Skone (Canada)

Activities

An effective two-way link between geodesists and aeronomy physicists will play a key role for both, improving the rather simple physical ionospheric models – either deterministic or stochastic – that are currently used by geodesists. As well as interpreting the physical phenomena that take place in the complex environment configured by the ionosphere and the earth's magnetic field, under the action of the solar electromagnetic radiation and the solar wind, imbedded in the interplanetary magnetic field.

The planned activities of the Study Group are, in the first instance, the collection and validation of existing physical ionospheric models. They shall then be represented by different methods, e.g., spherical harmonics and wavelets. The models shall be compared with geodetic

observations, and the effects on geodetic observables and parameters (reference frames and positions) shall be studied.

Links to Services

The Study Group shall be linked to the corresponding working groups in the IGS and COSPAR.

Study Group 1.2:
Use of GNSS for Reference Frames

(Jointly Commission 1 and 4 in cooperation with IGS & IERS)

http://www.hg.tuwien.ac.at/forschung/satellitenverfahren/IAG_IC_SG_1_2.htm

Terms of Reference

Up to now the operating satellite navigation systems GPS and GLONASS allow a huge user community easy access to reference frames very close to the most recent realization of the ITRS. The IAG Services IERS (International Earth Rotation and Reference Systems Service) and IGS (International GPS Service) provide the necessary products to tie these frames to the ITRF, which is based upon a set of estimated coordinates and velocities of stable stations observed by all space techniques. The design of the upcoming GALILEO system - its envisaged accuracy and the long-term stability implies - that also GALILEO will become a highly valuable technique for the definition and maintenance of the ITRF. The modernization of GPS and the completion of the GLONASS system will further improve the situation. The goal of Study Group 1.2 is to evaluate and support the use of Global Navigation Satellite Systems for the definition and densification of the International Terrestrial Reference Frame (ITRF).

Objectives

The principal objectives of the SG will be:

- Document the potential contributions of Global Navigation Satellite Systems to reference frame establishment and maintenance.
- Investigate the ties and their time evolution between GNSS Broadcast Frames like WGS84, PZ-90, and the upcoming GALILEO Reference Frame, and the ITRF.
- Examine deficiencies in the stability of the global GNSS station network, especially focussing on stations contributing to the ITRF2000 catalogue.
- Prepare a consolidated feedback concerning GPS, GLONASS and GALILEO frame establishment and improvement based on relevant experience in areas such as receiver site selection, installation and maintenance.
- Investigate the individual strengths and shortcomings of GPS, GLONASS and GALILEO for Reference System Realisation and work out synergies.
- Study the ties of regional and local frames realized by a permanently increasing number of active real-time GNSS networks.

Structure

Chair: Robert Weber (Tech. Univ. of Vienna, Austria; rweber@luna.tuwien.ac.at)

Members

Y. Bar Sever (USA)
N. Beck (Canada)
C. Boucher (France)
C. Bruyninx (Belgium)
W. Gurtner (Switzerland)
R. Galas (Germany)

R. Langley (Canada)
J. Manning (Australia)
H. van der Marel (The Netherlands)
H.P. Plag (Norway)

Activities

Planned activities in the upcoming two years are to compile a clear picture of the individual strengths and shortcomings of GPS and GLONASS for Reference System Realisation. This also includes inspection of stability of global GNSS ITRF core stations, the question of site-selection and maintenance and a documentation of the ties between the GPS and GLONASS broadcast frames WGS84, PZ-90 and the ITRF. Furthermore the contribution of the permanently increasing number of regional and local real-time GNSS networks for frame densification will be investigated.

Later on the Study Group will focus on the upcoming GALILEO system. Based on the agreed reference network design we will investigate the quality of the tie and anticipated time evolution of the GALILEO Reference Frame with the ITRF. In addition the group will concentrate on expected synergies using a real GNSS observation network covering three satellite navigation systems for reference frame maintenance.

A Web-site will be established for a exchange of information, communication, presentation and outreach purposes. The Study Group will hold working meetings at international symposia. Achievements will be summarized in a mid-term review in 2005 and a final document in 2007 and will be presented at the upcoming IAG Scientific Assembly and at the next IUGG General Assembly.

Links to Services

This Study Group should coordinate closely with the IAG Services IERS and IGS, in particular with the existing GNSS Working Group of the IGS. On condition of approval of the IGS Governing Board both groups may establish a Joint Working Group with united member and objectives lists.