

Commission 4 – Positioning & Applications
Web: www.gnat.unsw.edu/iag/iag_comm4.html

Interim Report (March 2006)

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 Organizations. Recognizing 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. Recognizing 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
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
Ruth Neilan – IAG representatives

1) Structure of the IAG Commission 4

President: Chris Rizos
Vice-President: Pascal Willis

Sub-commissions:

SC4.1: Multi-sensor systems
President: Dorota Grejner-Brzezinska

SC4.2: Applications of Geodesy in Engineering
President: Heribert Kahmen

SC4.3: GNSS Measurements of the Atmosphere
President: Susan Skone

SC4.4: Applications of Satellite & Airborne imaging systems
President: Xiaoli Ding

SC4.5: Next generation RTK
President: Yang Gao

Study Groups:

SG4.1: Pseudolite applications in positioning & navigation
President; Jinling Wang

Inter-Commission Study Groups

IC-SG4.2: Statistics & Geometry in mixed integer linear models, with applications to GPS & INSAR
Chair: Athanasios Dermanis

IC-SG1.1: Ionospheric modeling and analysis
Chair: Claudio Brunini

IC-SG1.2: Use of GNSS for reference frames
Chair: Robert Weber

2) Reports from the sub-Commissions

2.1) SC4.1: Multi-sensor systems
President: Dorota Grejner-Brzezinska

Past Meetings/Workshop/International Activities

The MOU between the Institute of Navigation (ION) and IAG was finalized in early 2005 (Commission 4 was the driving force behind it; Dorota represented both IAG and ION in the process)

As a result of this MOU, a joint session, Scientific, timing and space applications, co-sponsored by the IAG Commission 4 was organized at the ION National Technical Meeting (NTM) 2006

Dorota Grejner-Brzezinska was the co-organizer of the US Department of Transportation Workshop on Space Based Technology for Transportation, held at The Ohio State University, November 30-Dec. 1, 2005. The primary focus of this workshop was the 2025 vision on navigation and multi-sensor technology supporting transportation applications.

Dorota Grejner-Brzezinska presented an invited talk, From Mobile Mapping to Telegeoinformatics: Paradigm Shift in Geospatial Data Acquisition, Processing and Management, at Surveying Week, Korean Society of Surveying, Geodesy, Photogrammetry and Cartography, Seoul, Korea, November 3, 2005.

Dorota Grejner-Brzezinska, presented an invited seminar, Multisensor System for Automatic Monitoring of Highway Linear Features: Design, Calibration and Performance Evaluation, at Electronics and Telecommunications Research Institute, Telematics/USN Research Division, Daejeon, Korea, November 4, 2005.

Dorota Grejner-Brzezinska presented an invited seminar, The role of the Center for Mapping at The Ohio State University as a national incubator for commercialization of research in mobile mapping technology, at Cooperative Research Centre for Spatial Information Commercialisation Workshop, University of Melbourne, Melbourne, Australia, September 12-13, 2005.

Dr. Naser El-Sheimy organized a special workshop on “Mobile Mapping Technologies“ at the FIG Working Week 2005 and GSDI-8 meeting in Cairo, Egypt, 16-21 April 2005.

Dr. Naser El-Sheimy offers an invited workshop on Mobile Mapping Systems at the first annual Middle East conference on Geospatial Information, Technology and Applications ‘Map Middle East 2005’, Dubai, UAE

Drs. Naser El-Sheimy and Dorota Grejner-Brzezinska were the General Chair and Program Chair of the US Institute of Navigation (ION) National Technical Meeting (NTM) which took place on January 18-20, 2006 - Monterey, California.

Dorota Grejner-Brzezinska was a Technical Chair at the ION GNSS Meeting in Long Beach, CA, September 13-16, 2005.

Future Meeting

Dorota Grejner-Brzezinska is a General Chair for the ION NTM 2007.

Dorota Grejner-Brzezinska is a keynote speaker at the ISPRS Commission I Symposium, From Sensors to Imagery, Paris- Marne la Vallée, France, 3-6 July 2006

The 5th International Symposium on Mobile Mapping Technology (MMT'07) which will take place in Padua, Italy, 28-31 MAY 2007
<http://www.cirgeo.unipd.it/cirgeo/convegna/mmt2007/index.html>

Other:

Dorota Grejner-Brzezinska and her Satellite Positioning and Inertial Navigation (SPIN) Laboratory are the recipients of the United States Geospatial Information Foundation (USGIF) 2005 Academic Achievement Award for their work on multi-sensor personal navigator.

Dorota Grejner-Brzezinska is a co-recipient of the 2005 ESRI Award for Best Scientific Paper in Geographic Information Systems published in 2004 (Grejner-Brzezinska D. A., Li, R., Haala, N. and Toth, C. K.: From Mobile Mapping to Telegeoinformatics: Paradigm Shift in Geospatial Data Acquisition, Processing and Management. *Photogrammetric Engineering & Remote Sensing*, Vol. 70, No. 2, pp. 197-1009, 2004

Dr. Naser El-Sheimy and Cameron Ellum won the best paper presentation award at the annual US Institute of Navigation's (ION) GNSS Conference, held in Long Beach, California, from September 13-16 for their paper on "Integrating Photogrammetry and GPS at the Measurement-Level".

Dr. Naser El-Sheimy, Chris Goodall and Kai-Wei Chiang won the best paper presentation award at the annual US Institute of Navigation's (ION) GNSS Conference, held in Long Beach, California, from September 13-16 for their paper on "The Development of a GPS/MEMS INS Integrated System Utilizing a Hybrid Processing Architecture": This research work will advance the direct georeferencing of MEMS sensors for Mobile Mapping Systems.

Working Group 4.1.2

The IAG WG 4.1.2 on Indoor and Pedestrian Navigation has currently 25 members from 12 different countries. In 2005 the WG has jointly organized with ICA Commission on Ubiquitous Cartography and ISPRS WG V TC2 the 3rd symposium on Location Based Services and Telecartography which was held in Vienna, Austria in end of November. In three sessions on Positioning and Wayfinding 10 papers were presented also from some of the members of WG4.1.2. The conference proceedings has been published Several WG members will meet again and present their research work at the next PLANS GNSSconference, which will be held in San Diego, CA, USA in April 2006 and at the IGNSS conference in Surfers Paradise, Queensland, Australia in July 2006.

2.2) SC4.2: Applications of Geodesy in Engineering

President: Heribert Kahmen

In October 2005 the SC 4.2. organized together with ISPRS and FIG the 7th conference on Optical 3-D Measurement Techniques. The conference was attended by about 150 participants from 25 countries. Main topics were applications in GIS, mapping, manufacturing, quality control, robotics, navigation, mobile mapping, medical imaging, virtual reality generation and animation. It was an interdisciplinary conference with engineers and scientists from geodesy, photogrammetry, computer science, mathematics, physics and medicine. The working groups WG 4.2.1 and WG 4.2.4 organized an annual meeting during the conference.

In May 2006 SC 4.2. is organizing another international conference, i.e., the 3rd IAG symposium on Geodesy for Geotechnical and Structural Engineering held together with the 12th FIG Deformation Measurement symposium. The main topics are geodesy on large construction sites, geodesy and mining, monitoring of landslides, dams, tunnels, bridges, laser scanning, GPS/pseudolites, InSar and navigation of construction processes.

We expect more than 140 participants. All WG's 4.2.1, 4.2.2., 4.2.3 and 4.2.4 will have their annual meeting there. In addition the steering committee will come together.

2.3) SC4.3: GNSS Measurements of the Atmosphere

President: Susan Skone

SC4.3 members from Canada, the United States and Italy presented a joint paper on scintillation effects associated with storm-enhanced densities at northern high latitudes at the ION NTM 2005, 24-26 January 2005, in San Diego, CA.

Four SC4.3 members participated in the Ionospheric Effects Symposium 3-5 May 2005, in Alexandria, VA.

Four members of SC4.3 attended the Dynamic Planet 2005 meeting in Cairns, Australia (26-28 August 2006). Members co-convended and co-chaired sessions on "Atmospheric studies using space geodetic techniques" and meetings were held to define terms of reference for the new WG4.3.3.

Members have conducted joint fieldwork for scintillation studies in Antarctica during November 2005. A Canadian scintillation receiver was deployed by the USGS in Antarctica to explore the feasibility of establishing a long-term site in the region. Observations were collected near the pole for one month, and this data has been made available to WG4.3.1 for validation of scintillation index derivations.

Members participated in a national press conference on storm-enhanced density effects observed using GPS-based models of the ionosphere, at the 2005 AGU Fall Meeting, 5-9 December 2005, in San Francisco, CA.

Planning commenced in January 2006 to jointly sponsor a GNSS Ionosphere Working Group (GIWG) in Fort Worth, Texas in September 2006. This will be a one-day international workshop of invited participants with a focus on defining policy and identifying issues of importance for GNSS monitoring of the ionosphere. Several members of SC4.3 will participate.

Several members of WG4.3.1 and WG4.3.2 are co-investigators in the Upper Atmosphere Monitoring Initiative for Polar Year 2007-2008. This proposal has been accepted as part of the international ICESTAR initiative for solar-terrestrial research during International Polar Year (IPY) 2007-2008.

WG4.3.1: Ionospheric Scintillation (chair: B. Forte)

In accordance with outcomes of a WG meeting held at the Beacon Satellite Symposium 2004, members have established standards and validated methods for deriving reliable phase scintillation indices. Inconsistencies between methods implemented by various groups in the past have limited the effectiveness of data sharing to conduct global studies. Standard methods have now been established and implemented in post-processing

techniques, and have been compared with internal receiver firmware models. Several members of this WG are involved in the ICESTAR IPY proposal.

WG4.3.2: Performance Evaluation of Ionosphere Tomographic Model (co-chairs: Z. Liu and A. Komjathy)

Performance evaluations of various 3-D modeling techniques have been conducted for case study events. Members of the WG presented relevant papers and met at IES 2005 to discuss further joint collaboration. A current focus is the global assimilative ionosphere model (GAIM) approach, in which GPS ground and spaceborne observations, ionosonde measurements, and others are assimilated in a 4DVAR method. Requirements for reliable performance and applications in positioning have been published and presented at ION NTM 2005, ION AM 2005, IES 2005, and AGU 2005.

WG4.3.3: Numerical Weather Predictions for Positioning (co-chairs: M. Santos and A. Jensen)

This WG was approved jointly with SC4.5 in September 2005, with a focus to study various technical aspects of using Numerical Weather Prediction (NWP) model data to map the effect of troposphere on space geodetic signals. Major objectives include standardizing the terminology used by both meteorological and geodetic communities, testing and validating procedures related to ray-tracing through NWP layers, and suggesting quality control criteria to be used for assessing the quality of tropospheric data and results obtained from them. Initial actions have included 1) compiling a list of 13 members (from both geodetic and meteorology communities), 2) building a detailed working plan, 3) compiling a list of relevant references, and 4) establishing a web site and building a discussion list. In 2006-2007, members will investigate technical issues in support of the major objectives and a final report will be delivered Fall 2007.

2.4) SC4.4: Applications of Satellite & Airborne imaging systems

President: Xiaoli Ding

Activities in 2005:

SC4.4 co-organised the 2005 InSAR Technology Workshop, Foresight of InSAR towards the ALOS/PALSAR at EORC/JAXA, Tokyo, 18 November 2005.

Several members of SC4.4 participated in the International Geoscience and Remote Sensing Symposium (IGARSS) in Seoul, 25-29 July 2005 and presented research results on InSAR. A working meeting was held during the Symposium to discuss and plan the activities of SC4.4.

SC4.4 contributed to the organization of the Dynamic Planet 2005 symposium in Cairns, 26-28 August 2005. Several members participated in the symposium and the members held a working meeting with Prof. Chris Rizos, President of Commission 4, in Sydney after the symposium discussing the activities of SC4.4.

SC4.4 co-sponsored the Asia Pacific Space Geodynamics (APSG) Workshop, Geodynamics and Natural Hazards, held in Hong Kong, 15-17 June 2005.

Discussions have been made between SC4.4 and Commission 3 on the possibility of forming a joint WG on InSAR Application to Crustal Deformation Measurements. It has been agreed by both Commission 4 and Commission 3 to go ahead with the proposal.

A test campaign at selected sites for evaluating the performance of InSAR in monitoring ground deformations is being prepared.

Activity Planned for 2006:

SC4.4 is organizing a Special Session, InSAR Geodesy and Geodynamics, at the Western Pacific Geophysics Meeting (WPGM) organized by the American Geophysical Union (AGU) in Beijing, 24-27 July 2006.

A session on InSAR technology for deformation measurements has been organized by SC4.4 for the 3rd IAG Symposium on Geodesy for Geotechnical and Structural Engineering and the 12th FIG Symposium on Deformation Measurements in Baden, 22-24 May 2006.

Preparation on a special issue on InSAR technology for geodesy in a journal (e.g., Journal of Geodesy, or Journal of Spatial Science) will be carried out.

Commence the test campaign for evaluating the performance of InSAR in monitoring ground deformations. The campaign will involve several research groups on InSAR.

Discuss the feasibility and interest of organizing a conference on InSAR and Geodesy.

Continue to make contributions to the International Polar Year 2007-2008 and other Antarctic SAR (mainly ALOS/PALSAR) observation projects in close corporation with the National Institute of Polar Research (Tokyo, Japan) and other international organizations.

2.5) SC4.5: Next generation RTK

President: Yang Gao

Steering Committee

Y. Gao, L. Wanninger, W. Chen, M. Caissy, J. Raquet, S. Bisnath.

Working Groups

WG4.5.1 - Network RTK (L. Wanninger and O. Ovstedal)

WG4.5.2 - Carrier Phase based Precise Point Positioning (S. Bisnath and M. Kechine)

WG4.5.3 - High Precision Positioning on Buoys and Moving Platforms (W. Chen, M Dumville and O. Colombo)

WG4.5.4 - Multiple Carrier Ambiguity Resolution Methods & Applications (Y. Feng and H. Isshiki)

Activities in 2005:

- 1) 2 new contributions have been published on SC5.4.1 web site (www.network-rtk.info) which were discussed among the WG members and which were published in February and November 2005, respectively.
- 2) Various members of WG4.5.1, co-organized and participated at ION GNSS 2005 Technical Session on "Networked-Based RTK", Long Beach, CA, September 13-16, 2005.
- 3) Various members of WG4.5.1, co-organized and participated at NTRIP Symposium Technical Session on "Networked DGPS/RTK", Frankfurt (Germany), February 6-7, 2006.
- 4) Yang Gao, the chair of WG4.5, organized a technical session at Geoinformatics'2006 held in Toronto, August 13-15, 2006.
- 5) Sunil Bisnath, the chair of WG4.5.2, co-chaired ION GNSS 2005 Technical Session on "Precise Point Positioning", Long Beach, CA, September 13-16, 2005. The session, first started at GNSS04, has been the third year and will again have a session at ION GNSS06.
- 6) Wu Chen, the chair of WG4.5.3, is the chair of the local organizing committee for International Symposium on GPS/GNSS, Hong Kong, December 8-10, 2005 and organized a Technical Session on "Positioning on moving platform" at the conference attracted with more than 10 papers. Those papers will be included in the symposium proceedings and some selected papers will be published in journals in 2006.
- 7) Mark Caissy, member-at-large of SC 4.5 and chair of IGS WG "Real Time Aspects", gave an update and status report on RTWG for the 27th IGS Governing Board Meeting held in San Francisco, December 4, 2005.
- 8) A new Working Group 4.5.4 "Multiple Carrier Ambiguity Resolution (MCAR) Methods & Applications" has been formed within SC4.5. The WG is formed to address an emerging research subject concerning about carrier phase ambiguity resolution with multiple frequency observations and the research work will play a critical role for the development of future RTK technologies. The WG is chaired by Dr. Yanming Feng from Queensland University of Technology. In 2006, he will chair a session at TCAR (three carrier and multiple satellites for next generation of GNSS services). In late 2006, a workshop will be organized in Brisbane or Wuhan for the next generation of GNSS services.

Activity Plan in 2006:

- 1) SC4.5 will discuss the plan to organize an international symposium/workshop on Next Generation RTK Technologies and Applications in 2007/2008.

- 2) SC4.5.1 is preparing 2 more contributions to be published on SC5.4.1 web site.
- 3) A white paper “Carrier Phase based Precise Point Positioning” is under preparation by SC4.5.2 and is expected to complete in April 2006.
- 4) SC4.5.2 will organize a Technical Session on “Precise Point Positioning” at ION GNSS’2006, September 26-29, 2006 - Fort Worth, Texas.
- 5) SC4.5.3 plans to organize a technical session in one international GNSS conference.
- 6) SC4.5.3 will investigate the possibility of publishing a special issue on “High Precision Positioning on Buoys and Moving Platforms” in a journal.
- 7) SC4.5.4 plans to organize a Technical Session on TCAR methodology and related application at IGSS conference to be held in Gold coast in July.
- 8) SC4.5.4 plans to organize a workshop in Brisbane or Wuhan on Next Generation of GNSS Services.
- 9) Mark Caissy, member-at-large of SC 4.5 and chair of IGS WG “Real Time Aspects”, will co-chair the Technical Session on "Real-time Network and Products" at the IGS Workshop to be held in May 8 – 11, 2006, Darmstadt, Germany.
- 10) SC4.5 will participate in IGS “Real-Time Pilot Project” which is a new project in IGS.

3) Reports from the Study Groups

SG4.1: Pseudolite applications in positioning & navigation

President: Jinling Wang

Activities:

- 1) Study Group Discussion on the paper "Pseudolite and the Augmentation of GPS" (authored by Prof Chris Rizos).
- 2) Development of the study group website: <http://www.gmat.unsw.edu.au/pseudolite/>
- 3) Jinling Wang was a Session Chair at the Int. Symp. on GPS/GNSS, Hong Kong, 8-10 December. The session included one paper on Pseudolite/GPS/INS integration.
- 4) Jinling Wang chaired a Session Chair at the US Institute of Navigation's National Technical Meeting 2006, Monterey, California, 18-20 January 2006. The session was on high precision positioning techniques including the integration of pseudolites with other sensors.
- 5) The study group plans to edit a special publication on pseudolite applications in positioning and navigation in 2006/2007.

4) Reports from the Inter-Commission Study Groups

4.1) IC-SG4.2: Statistics & Geometry in mixed integer linear models, with applications to GPS & INSAR

Chair: Athanasios Dermanis

Despite strong efforts from Peiliang Xu, the planned joint workshop with mathematicians and statisticians has not been realized.

For the future we plan no specific meeting since there is a whole session within the VI Hotine-Marussi Symposium of Theoretical and Computational Geodesy, in Wuhan (Session 5: GNSS: Mathematical theory, algorithms and engineering applications), convened by Peter Teunissen and myself, which fully covers the interests of our group.

4.2) IC-SG1.1: Ionospheric modeling and analysis

Chair: Claudio Brunini

(cancelled)

4.3) IC-SG1.2: Use of GNSS for reference frames

Chair: Robert Weber

Co-Chair: Carine Bruyninx

Activities

- Meeting of European WG members with Galileo Project Team at ESOC (Darmstadt) (17.3.2005)
- Meeting , June,24th , IKK GALILEO Austria (Topics: Galileo Concession, Supervisory Authority, GalileoSat Programme)
- WG Meeting , Dec, 5th ,2005, during AGU-Fall-Meeting (Topics: Status GNSS / IGLOS-PP / Satellite Antenna Phase-Pattern / DCBs)

Web –Pages

- IGS GNSS-Working Group

http://mars.hg.tuwien.ac.at/Research/SatelliteTechniques/GNSS_WG_IGS/gnss_wg_igs.html

- Reference Frame Web-Link (C. Bruyninx)

<http://www.gps.oma.be/IAG-study-group/workprogram.php>

Presentation, Papers

R.Weber on behalf of the IGS GNSS WG ,Activities of the IGS GNSS Working Group, Presentation at the EGU 2005, April 2005, Vienna

R. Weber, S. English, ‘Potential Contribution of Galileo to the TRF and the Determination of ERPs, Presentation at the Journees 2005, September 2005, Warsawa

R.Weber, J. A. Slater, E. Fragner, V. Glotov, H. Habrich, I. Romero and St. Schaer, Precise GLONASS orbit determination within the IGS/IGLOS – Pilot Project Advances in space Research, Volume 36 , Issue 3, 2005, Satellite Dynamics in the Era of Interdisciplinary Space Geodesy, (edited by Phillip Moore), Pages 369-375

Meetings 2006 with WG Involvement (Session Chair + Contributions)

EGU – 2006, Vienna (April, 2nd –7th) :
Session on ‘GPS, Galileo and GLONASS: Future Geoscience Challenges’

IGS Workshop 2006, Darmstadt (May, 8th –11st) :
Session on ‘GNSS Modernization and GNSS/LEO Synergies’

ION GNSS 2006, Fort Worth, Texas (Sept,26th –29th) :
Session on ‘Timing and Scientific Applications’

General WG activities

Monitoring Status of GNSS Modernization

1) Extract information

-concerning Potential improvements of IGS-Products and
-concerning Links of between system specific Reference System Realizations and the ITRF

2) Investigate inter- and intra-system biases, multitude of signals delivered by various GNSS

•Satellite biases

–Interfrequency biases (C1, P1, P2, L2C/ E1,E5a,E5b,E6/G1,G2,G5)

–Antenna phase center offsets and variations

•Station biases

–Interfrequency biases

–Antenna phase center offset and variations

–Interchannel biases