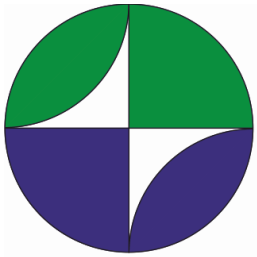

IUGG

International Association of Geodesy

Newsletter

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Contents

The *IAG Newsletter* is under the editorial responsibility of the *Communication and Outreach Branch* (COB) of the IAG.

It is an open forum and contributors are welcome to send material (preferably in electronic form) to the IAG COB (newsletter@iag-aig.org). These contributions should complement information sent by IAG officials or by IAG symposia organizers (reports and announcements). The *IAG Newsletter* is published monthly. It is available in different formats from the IAG new internet site: http://www.iag-aig.org

Each *IAG Newsletter* includes several of the following topics:

I. news from the Bureau Members
II. general information
III. reports of IAG symposia
IV. reports by commissions, special commissions or study groups
V. symposia announcements
VI. book reviews
VII. fast bibliography

General Announcements

IAG Young Authors Award 2015 – Xingxing Li

The IAG Young Authors Award 2015 is presented to Dr. Xingxing Li for his paper "Accuracy and reliability of multi-GNSS real-time precise positioning: GPS, GLONASS, BeiDou, and Galileo". The work was published in the Journal of Geodesy, 2015, Volume 89, Issue 6, pp.607-635. The lead author, Dr. Xingxing Li, has focused on high-precision GNSS and Geosciences' applications for more than ten years. He started his Geodesy studies at Wuhan University in 2004. In 2010, he was hired by the German Research Center for Geosciences (GFZ) as a project scientist for the project "Online-GNSS service with scalable accuracy for precise positioning and navigation". In 2015, he defended his doctoral thesis on "Real-time high rate GNSS techniques for earthquake monitoring and early warning" at Technische Universität Berlin. He has already received several awards. In 2012, he won the ION paper Award and he won the GFZ "Friedrich-Robert-Helmert" Award in 2016. In 2017, he won the EGU Outstanding Young Scientist Award. Dr. Li has an excellent publication record with more than 30 papers in leading ISI journals of his research field during this period and in majority as first author. Currently, he is the Chair of the IAG working group "Biases in Multi-GNSS data processing" and the co-Chair of the EGU session "High-Precision GNSS Algorithms and Applications in Geosciences".

The award-winning paper presents a four-system integrated model with GPS, GLONASS, BeiDou and Galileo for real-time precise orbit determination, clock estimation and positioning. Meanwhile, an efficient multi-GNSS real-time precise positioning service system is designed and demonstrated. A rigorous multi-GNSS analysis is performed to achieve the best possible consistency by processing the observations from different GNSS together in one common parameter estimation procedure. For satellite orbit, the overlap (two adjacent three-day solutions) RMS values of estimated Galileo orbits are 2.1, 3.7 and 7.8 cm, respectively in radial, cross and along components. The corresponding overlap RMS values for BeiDou IGSO satellites are 2.5, 3.3, and 4.4 cm in the three components, respectively. The RMS values of BeiDou MEO satellites are 3.4, 4.3 and 11.3 cm in the radial, cross, and along directions, respectively. The GEO satellites have comparable performance compared with IGSO and MEO satellites in the radial and cross directions, but the accuracy in the along component decreases to about 1 m due to the rather weak geometry. For satellite clock, the RMS values of clock differences between the real-time and batch-processed solutions for GPS satellites are about 0.10 ns, while the RMS values of BeiDou, Galileo and GLONASS satellites are 0.13, 0.13 and 0.14 ns, respectively. Both satellite orbits and clocks can achieve an accuracy of cm level in real time. It is worth noting that the errors of orbits and clocks can be compensated by each other when they are used together at user end. For precise point positioning (PPP), it can be used to validate the capability of real-time precise positioning service based on the predicted orbits and real-time estimated clocks. The multi-GNSS PPP shows faster convergence and higher accuracy in all three components than single-system PPP. After adding BeiDou, Galileo and GLONASS systems to the standard GPS-only processing, the convergence time is decreased by 70 % and the positioning accuracy is improved by 25 %. The real-time positioning capabilities of the combined systems under different elevation cutoffs is different. Its positioning accuracy hardly decreases and an accuracy of several centimeters is still achievable in horizontal components even with a 40° elevation cutoff. At 30° and 40° elevation cutoffs, the availability rates of GPS-only solutions drop dramatically to only around 70 and 40 %, respectively. However, multi-GNSS PPP shows excellent results. In a word, the fusion of multiple GNSS significantly increases the number of observed satellites, optimizes the spatial observation geometry at a site and improves convergence, accuracy, continuity and reliability of positioning solutions. Moreover, the performance of multi-GNSS integration at high elevation cutoffs will significantly increase its applications in constrained environments, such as in urban canyons, open pits and mountainous areas.

HARALD SCHUH
IAG President

IAG Young Authors Award 2016 – Olga Didova

The IAG Young Author Award 2016 is given to Olga Didova for her paper "An approach for estimating time-variable rates from geodetic time series", which has been published in the Journal of Geodesy (2016) 90:1207-1221. The paper is co-authored by Brian Gunter, Riccardo Riva, Roland Klees, and Lutz Roese-Koerner representing 3 different scientific institutions.

The original article considers the problem of estimating trends in mass loss over Antarctica from GRACE and GPS time series in the presence of inter-annual and seasonal variability. The traditional approach parameterizes the time series using a bias, trend, and harmonic constituents, which are considered as being deterministic. The main weakness of this approach is that the distinct components of mass loss (as those of many other geophysical processes) are not deterministic, but fluctuate in time around some reference values. The idea to model them stochastically using a state space model and estimating the state parameters using a Kalman filter was introduced to the geodetic community in a paper by Davis et al (2012), though state space analysis is a well-established methodology for treating a wide range of problems in the analysis of econometric time series as documented in the excellent books by Harvey (1989) and Durbin and Koopman (2012). Davis et al (2012) assumed that the parameters, which determine the stochastic movements of the state variables ("hyperparameters"), are known. Moreover, little is known in econometric literature about the robust estimation of hyperparameters, which is a non-convex optimization problem.

In her paper, Olga considers the hyperparameters as unknowns and estimates them using Maximum Likelihood. The optimization problem is solved using a gradient-based local solver, which can deal with non-convex problems. To increase the probability of finding the global minimum, Olga suggests to define a random set of uniformly distributed starting values and selects the starting values that provides a solution which has the smallest log likelihood objective function. To improve the chance of finding the global minimum, Olga suggests several measures to limit the parameter search space. Moreover, she introduces inequality constraints on some of the hyperparameters, and suggests a method, involving among others a likelihood ratio test and an algorithm for determining the degrees of freedom for this test, to verify whether the constraints are supported by the data.

The suggested methodology is applied to the analysis of real GRACE and GPS time series, both representing vertical deformations due to elastic and visco-elastic responses of the solid Earth to surface loading. The data analysis reveals that compared to the classical deterministic model using least-squares, the proposed methodology provides more reliable trend estimates, because it accounts for any long-term evolution in the time series and avoids any contamination from seasonal variability.

The proposed methodology may become a standard tool in time series analysis of geodetic data, in particular when long time series comprising years of data are involved.

Olga Didova studied Geodesy and Geoinformation at the University of Bonn, Germany. She received her Bachelor of Science in 2009 and her Master of Science in 2011 under supervision of Karl Heinz Ilk and Juergen Kusche, respectively. Between 2012 and 2016, she was a PhD candidate at Delft University of Technology in the Department of Geoscience and Remote Sensing working on "Separating GIA and ice mass change signals in Antarctica using satellite data". She will defend her PhD thesis at Delft University of Technology in fall 2017. Since March 2017, she is a Postdoctoral Fellow at the University of Bonn and involved in the assimilation of remote sensing data in a hydrological model.

References:

JL Davis, BP Wernicke, ME Tamisiea (2012), On seasonal signals in geodetic time series. J Geophys Res 117(B01403).

AC Harvey (1989), Forecasting, structural time series models and the Kalman filter. Cambridge University Press, Cambridge.

J Durbin, SJ Koopman (2012), Time series analysis by state space methods. Oxford University Press, Oxford.

HARALD SCHUH
IAG President

Meeting Announcements

Meetings Calendar

IAG Sponsored Meetings

IAG and IASPEI Joint Scientific Assembly

July 30 – August 4, 2017, Kobe, Japan
URL: http://iag.dgfi.tum.de/index.php?id=291

Asia-Pacific Space Geodynamics Symposium (APSG 2017)

August 15-18, 2017, Shanghai, China
URL: http://apsg2017.csp.escience.cn/dct/page/1

Workshop on Glacial Isostatic Adjustment and Elastic Deformation

September 5-7, 2017, Reykjavik, Iceland
URL: http://www.polar.dtu.dk/english/Workshop-on-Glacial-isostatic-adjustment-and-elastic-deformation-2017

COSPAR 2017

September 18-22, 2017, Jeju Island, South Korea
3rd Symposium of the Committee on Space Research (COSPAR): Small Satellites for Space Research
URL: http://cospar.kasi.re.kr/cospar-symposium-2017/

IAG Workshop: Satellite Geodesy for Climate Studies

September 19-21, 2017, Bonn, Germany
URL: http://www.igg.uni-bonn.de/apmg/index.php?id=ws2017

Journees 2017

September 25-27, 2017, University of Alicante, Spain
URL: http://web.ua.es/journees2017/

ILRS Technical Workshop 2017

October 2-5, 2017, Riga, Latvia
URL: https://ilrs.cddis.eosdis.nasa.gov/docs/2017/2017ILRS_TechnicalWorkshop_circular1_20170228.pdf

9th ABLOS Conference

October 10-11, 2017, IHB, Monaco
URL: http://www.ablosconference.com/

SIRGAS Workshop on GNSS Real-Time Positioning

November 22-24, 2017, Mendoza, Argentina
URL: http://ingenieria.uncuyo.edu.ar/sirgas2017/en/

SIRGAS 2017 Symposium

November 27-29, 2017, Mendoza, Argentina
URL: http://ingenieria.uncuyo.edu.ar/sirgas2017/en/

SIRGAS Workshop on SLR in Latin America

November 30 – December 1, 2017, Mendoza, Argentina
URL: http://ingenieria.uncuyo.edu.ar/sirgas2017/en/

10th IVS General Meeting

June 3-8, 2018, Longyearbyen, Spitsbergen, Norway
URL: https://video.kartverket.no/the-10th-ivs-general-meeting

42nd COSPAR Scientific Assembly

July 14-22, 2018, Pasadena, CA, USA
URL: http://cospar2018.org/

21st International Workshop on Laser Ranging

October 27-31, 2018, Canberra, Australia
URL: http://www.iers.org/IERS/EN/NewsMeetings/ForthcomingMeetings/forthcoming.html

27th IUGG General Assembly

July 8 – 17, 2019, Montreal, Canada
URL: http://www.iugg.org/assemblies/

IAG Related Meetings

AOGS 14th Annual Meeting

August 6-11, 2017, Singapore, Singapore
URL: http://www.asiaoceania.org/aogs2017/

Fifth International School on "Least Squares Approach to Modelling the Geoid"

August 21-25, 2017, KTH, Stockholm
URL: https://www.kth.se/en/abe/inst/som/avdelningar/geo/geodesi/handelser-1.78120

EUGEO 2017

September 4-6, 2017, Brussels, Belgium
URL: https://eugeo2017.sciencesconf.org/

ESA/JRC International Summerschool on GNSS 2017

September 4-15, 2017, Longyearbyen, Svalbard-Spitzbergen, Norway
URL: http://www.esa-jrc-summerschool.org

EGSIEM Autumn School for Satellite Gravimetry Applications

September 11-15, 2017, Potstdam, Germany
URL: http://www.egsiem.eu/autumn-school

WMESS 2017

September 11-15, 2017, Prague, Czech Republic
URL: http://www.mess-earth.org

ION GNSS+ 2017

September 25-29, 2017, Portland, Oregon, USA
URL: http://www.ion.org/gnss/index.cfm

Geodätische Wochhe / INTERGEO 2017

September 26-28, 2017, Berlin, Germany
URL: http://www.intergeo.de/

ILRS Technical Workshop 2017

October 4-7, 2017, Riga, Latvia
URL: http://www.ilrstw2017.lu.lv

HAPS4ESA

October 9-10, 2017, ESA/ESTEC, Noordwijk, The Netherlands
HAPS4ESA - Towards an ESA Stratospheric High Altitude Pseudo-Satellites (HAPS) Programme for Earth Observation, Telecommunication and Navigation

URL: http://www.haps4esa.org/

International Workshop on the inter-comparison of space and ground gravity and geometric spatial measurements

October 16-18, 2017, Strasbourg, France
URL: http://geodesy.sciencesconf.org

OSTST 2017

October 23-27, 2017, Miami, FL, USA
URL: https://sealevel.jpl.nasa.gov/science/ostscienceteam/scienceteammeetings/

6th International Colloquium on Scientific and Fundamental Aspects of GNSS / Galileo

October 25-27, 2017, Valencia, Spain,
URL: http://esaconferencebureau.com/2017-events/17a08

LAPIS 2017 School

October 29 – November 4, 2017, La Plata, Argentina
URL: http://www.maggia.unlp.edu.ar/lapis2017

AGU 2017 Fall Meeting

December 11-15, 2017, New Orleans, LA, USA
URL: https://meetings.agu.org/

LBS 2018

January 15-17 , 2018, Zurich, Switzerland
URL: http://lbsconference.org

EGU General Assembly 2018

April 8-13 , 2018, Vienna, Austria
URL: http://www.egu2018.eu/

AOGS 15th Annual Meeting

June 3-8, 2018, Hawaii, USA
URL: http://www.asiaoceania.org/society/public.asp?view=up_coming

IAU XXXth General Assembly

August 20-31, 2018, Vienna, Austria
URL: http://astronomy2018.univie.ac.at/

AGU 2018 Fall Meeting

December 10-14, 2018, Washington, D.C., USA
URL: https://meetings.agu.org/

EGU General Assembly 2019

April 7-12 , 2019, Vienna, Austria
URL: http://www.egu2019.eu/

AOGS 16th Annual Meeting

July 28 – August 2, 2019, Singapore, Singapore
URL: http://www.asiaoceania.org/society/public.asp?view=up_coming

Reports

Unified Analysis Workshop

July 10-12, 2017; Paris, France

Overview

Unified Analysis Workshops are co-organized by the International Association of Geodesy's (IAG's) Global Geodetic Observing System (GGOS) and International Earth Rotation and Reference Systems Service (IERS). This was the 5th in a series of workshops that are held every two to three years for the purpose of discussing issues that are common to all the space-geodetic measurement techniques. Attendance at the Workshops are by invitation only with each IAG Service nominating 5-6 experts to attend and participate in the discussions. At this Workshop, the discussions of the 41 participants from 9 countries focused on:

- Systematic Errors and Biases in GNSS, VLBI, SLR, and DORIS
- Site Survey and Co-location
- Reference Systems and Frames
- Conventional Mean Pole
- Standards, Conventions, and Formats
- Interoperability of Portals and Metadata

Summary of Discussions and Recommendations

The discussions during the sessions about the measurement techniques concerned the source of errors and biases in the techniques and resulted in recommendations to mitigate them. For GNSS, this included recommendations to improve the force and background models including the use of modern static and time variable gravity models, improved diurnal and semi-diurnal EOP models, and improved solar radiation pressure models. Improved calibrations of GNSS antennae are also needed, particularly *in situ* site-dependent calibrations. In order to investigate the origin of draconitic signals in GNSS data and products it was recommended that the use of arcs longer than 24 hours be investigated.

For VLBI, besides also recommending that improved diurnal and semi-diurnal EOP models be used, it was recommended that the new mean pole model be implemented in VLBI data reduction software, that gravitational deformation of the antennae be taken into account when reducing VLBI observations, that the impact of source structure variability be investigated, that the atmospheric loading signal removed during the data reduction process be included in the SINEX file so that users can restore it when needed, and that differences in the different formulations of relativistic effects on VLBI observations be investigated.

For SLR, it was recommended that time biases be investigated and to facilitate this that time and range biases be given in SINEX files, that the ILRS provide network-fixed products as well as the loosely constrained products that they already provide, that the ILRS should establish a Pilot Project to study the impact of applying non-tidal atmospheric loading when reducing SLR observations, that complete and accurate metadata continue to be developed, and that the quality control process continue to provide feedback to station operators and analysis centers.

For DORIS, it was also recommended that improved diurnal and semi-diurnal EOP models be used as well as modern static and time variable gravity models and improved solar radiation pressure models. In addition, it was recommended that T2L2 data be used to better understand the behavior of the ultra-stable oscillators and that the IDS should continue to investigate the DORIS scale by examining the impact of low-elevation data on the scale.

Following an introduction to site ties, the *Site Survey and Co-location* discussions resulted in recommendations to develop *in situ* site-dependent GNSS antennae calibrations (as also recommended by the GNSS session), to survey sites that have not yet been surveyed, to develop an optimized strategy to employ different surveying techniques at the same site, and to examine the discrepancies between the local site surveys and the results of space-geodetic analyses.

The activities of the three IERS ITRS Combinations Centers (CCs) were presented at the *Reference Systems and Frames* session as well as presentations comparing the three solutions (ITRF2014, JTRF2014, and DTRF2014) to each other and the results of adopting ITRF2014 by the different Services. It was recommended that the three CCs consider the possibility of updating their frames between determinations, that the Services provide the CCs with the information that they need to update their frames, that the IERS identify reference frame users who will benefit from time series reference frames and how these reference frames will satisfy their

needs, and that the IERS provide up-to-date locations of discontinuities in the coordinate time series of the four techniques.

During the *Conventional Mean Pole* session, consensus was reached to develop and use a linear mean pole to replace the mean pole model currently given in the IERS Conventions. In particular, it was recommended that all analysis groups, including the altimetry community, adopt a common linear mean pole model for pole tide computations and that the IERS continue to provide a filtered mean pole table for the purpose of modeling and comparing long-term trends in C21 and S21.

There was much discussion in the *Standards, Conventions, and Formats* session about the proposal stemming from the IGS Workshop the week before to extend station codes from 4 to 9 or more characters. It was recommended that the SINEX Working Group examine this issue. It was also recommended that a unique format for EOP data files be derived, that a formal process be developed for evaluating new models before they are adopted by the IERS Conventions, that updates to the IERS Conventions be citable, and that efforts continue to ensure that all techniques use consistent gravity field models, both static and time variable. The UAW also endorsed the recommendations given in the GGOS Bureau of Products and Standards Inventory that numerical standards should be clearly documented, that the W0 value given in IAG Resolution No. 1 (2015) be used as the new reference value for geodetic work, and that the development of a new Geodetic Reference System GRS20XX based on best estimates of the major parameters is desired.

The objective of the *Interoperability of Portals and Metadata* session was to begin a dialogue between the Services and GGOS to develop interoperable web portals that interface to and are discoverable by the portals of other organizations such as GEO. Following presentations about the status of the portals and metadata management systems being developed by the different Services it was recommended that the IAG Services develop web portals that are interoperable with each other and with the GGOS portal that is being developed.

Additional Information

Additional information about the UAW, including the Program Book and a more complete report about the discussions and recommendations, is available from the meeting web site at http://176.28.21.212/en/meetings/2017/unified-analysis-workshop, or simply http://bit.ly/UAW2017.

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