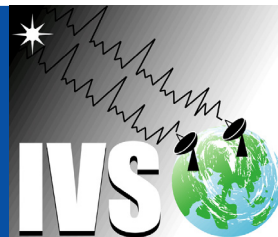


IVS Newsletter

Issue 52, December 2018



Haystack to Host IVS Outreach Office

– Nancy W. Kotary, MIT Haystack Observatory



Nancy Kotary, the newly minted director of the IVS Office for Outreach and Communications.

You might remember the call for proposals issued in July 2018. I am pleased to announce that there is now an IVS Office for Outreach and Communications (OOC) as a result of this call. The IVS OOC is based at MIT Haystack Observatory (Massachusetts, USA). We are very much looking forward to working with fellow IVS members to improve awareness of IVS contributions to science and engineering with multiple audiences—scientists in related and other fields, regional and global organizations, policymakers, the media, and the general public.

Geodesy and its practitioners make unique and crucial contributions to science and society. Despite a newly heightened awareness of global change, the role of geodesy and of the IVS remains largely unknown—we monitor the Earth dependably, but quietly and behind the scenes. The OOC has been created to teach people about VLBI and to promote an increased awareness of the fascinating work that IVS members carry out every day, around the clock.

One of the early tasks for this new office is the creation of a public-facing Web site. Of course, the IVS Coordinating Center has an invaluable site in place, but it is largely focused on internal communication, as is this excellent newsletter. The new Web site will be designed to distribute educational information and downloadable materials about IVS work and products, including explanations of interferometry and VLBI and related contributions to science. We'll announce the Web site's launch and share the URL in a later issue of the IVS Newsletter. You will have a site to share with your friends and family who have some questions about what you do at work!

We will also create social media accounts to publicize IVS events, achievements, and other related information. To some of you, social media might seem like a trivial exercise, but it is actually an important, efficient, and effective outlet for science communication today. Having IVS accounts on various platforms will help make sure that the careful work that you do as members of the IVS is not carried out in silence in the background but is instead understood and valued by decisionmakers and people interested in science worldwide.

I am looking forward to collaborating with you and to hear about existing outreach efforts and materials; please email me if you have documents to share or would like to contribute to upcoming efforts in any way—part of the OOC's responsibility is to coordinate current work and consolidate available materials. I will be reaching out to some of you directly, but welcome contact from all who are interested. If you have never worked in outreach but would like to start, this is a very good time to volunteer! Write to me at nwk@mit.edu with offers of help or materials, or if you have any questions about our plans for improved and increased outreach and communication.

Nancy Wolfe Kotary (nwk@mit.edu) is the director of the IVS Office for Outreach and Communications (OOC) and the communications officer for MIT Haystack Observatory. She has decades of experience in science editing and the communication of complicated scientific subjects to various audiences.

Election Results

The IVS held Directing Board elections in November and December 2018 for four representative positions and three at-large positions on the Board. The representative positions were voted for by the IVS Associate Members over a two-week period in November, whereas the IVS Directing Board elected the at-large positions in the first half of December to balance out the Board in terms of countries, institutions, and interests represented.

The newly elected representatives for the period February 2019 to February 2023 are: Hayo Hase (Networks), Laura La Porta (Correlators), James Anderson (Analysis), and Chet Ruszczyk (Technology Development). The elected at-large members for the period February 2019 to February 2021 are: Jinling Li (SHAO, China), Evgeny Nosov (IAA RAS, Russia), and Aletha de Witt (SARAO, South Africa).

The next IVS Directing Board meeting will be held at the Universidad de Las Palmas de Gran Canaria (Spain) in connection with the EVGA 2019 (<http://www.oan.es/evga2019/index.shtml>) on 21 March 2019.

– Dirk Behrend

German GeoFor'schuh'ngsZentrum Potsdam

The German Research Centre for Geosciences in Potsdam (GeoForschungsZentrum Potsdam) is a large research facility with a long and venerable history. Adding to its track record, it is also hosting an IVS Analysis Center since 2013. Under the leadership of Harald Schuh [HS] and Robert Heinkelmann [RH] a VLBI group was formed that began to make its mark on VLBI analysis work. Newsletter editor Hayo Hase caught up with Harald and Robert and obtained additional insights into the activities and plans of the Potsdam group.

Harald, GFZ is a national research center in Germany that can look back onto a long history. Can you give us some important historic facts that stand out?

[HS] Sure. GFZ is the first research organization worldwide that essentially deals with all solid Earth sciences from geodesy and geophysics to geology, to mineralogy, to geochemistry. With about 1,300 employees in total it is the biggest geoscientific research entity in Germany. As a member of the Helmholtz Association, GFZ is in charge of operating large scientific research infrastructures including the famous GRACE and GRACE-FO satellites monitoring the time-variable gravity field of the Earth. The history of science and research at Telegrafenberg (our campus in Potsdam) dates back to the 19th century, when Friedrich Robert Helmert, Director of the Geodetic Institute, developed the theoretical foundations of geodesy; but he also did a lot of practical surveying work like triangulation measurements, observation of polar motion, and determination of the deflection of the vertical and of absolute gravity values. When you factor in the legacy of scientists like Albert Einstein, Max Planck, Karl Schwarzschild, or Albert Michelson, who all used to work on our campus, you become very humble and modest.

Concerning VLBI at GFZ Potsdam, when and why did VLBI become part of the center's activities?

[HS] When the position of Director of the Geodesy Department was offered to me by GFZ, they knew about my background in VLBI and it was very clear that my recruitment would go along with establishing a new VLBI group. This activity was strongly supported by GFZ and I am very glad that from the very beginning in November 2012 Robert took the lead of the VLBI group, which very soon consisted of 10 to 15 people and was accepted as an IVS component already in 2013.

The GFZ VLBI group actively supports the IVS with an Analysis Center. How is the group organized and who belongs to it?

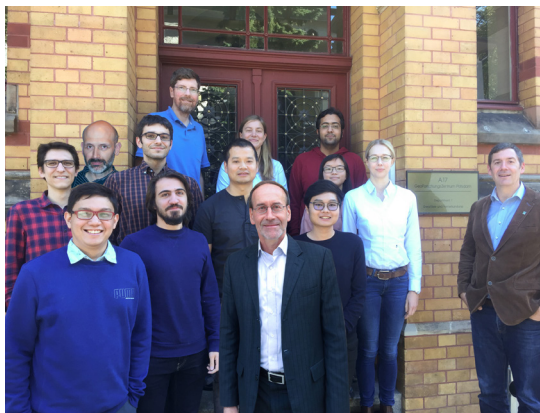
[RH] The group is led by Harald Schuh, who initiates new research ideas and triggers international cooperations, and Robert Heinkelmann, who is responsible for the VLBI group management and funding acquisition. As post-doc scientists, James Anderson organizes the operational IVS tasks, Georg Beyerle manages and develops our geodetic/astrometric VLBI analysis software, Susanne Glaser works on the combination of VLBI with the other space-geodetic techniques, and Minghui Xu supports our source structure investigations.

A significant part of the scientific work is carried out together with our PhD students, who often hail from the TU Berlin where Harald is a full professor. At the moment we have seven PhD students working in various fields: Kyriakos Balidakis (atmospheric modelling and geophysical surface loading), Suxia Gong (dispersive delays and ionospheric parameters), Okky Syahputra Jenie (VLBI fringe-fitting), Chaiyaporn Kitpracha (joint atmospheric parameter estimation of GNSS and VLBI), Susanne Lunz (radio and optical celestial catalogs, global VLBI solutions for CRF and TRF), Nicat Mammadaliyev (extension of the stochastic model in our VLBI analysis software), and Sadeh Modiri (combined deterministic and stochastic algorithms

for Earth Orientation Parameter prediction).

What are your specific contributions to the IVS?

[RH] All VLBI group members, including our PhD students, contribute to the regular GFZ submission for the Earth Orientation Parameter products. The duty plan is organized in weekly periods with group members having one full week of duty at a time. James Anderson is in charge of organizing the IVS duty plan. We analyze the IVS-R1 and IVS-R4 rapid-turnaround sessions with minimum latency, i.e., we upload the SINEX files within 24 hours after arrival of the databases at the IVS servers. The GFZ VLBI group is also in charge of the IVS troposphere product. The algorithm for the tropospheric combination was revised recently making it more robust. In the near future, we would like to become an operational analysis center and we also intend to extend our further commitments to IVS, in particular towards reference frame solutions.



The Potsdam VLBI group: (upper row from left to right) Mateus Litvin-Prestes, Georg Beyerle, Kyriakos Balidakis, James M. Anderson, Minghui Xu, Susanne Lunz, Sadeh Modiri, Suxia Gong, Susanne Glaser, and Robert Heinkelmann; (bottom from left to right) Okky Jenie, Nicat Mammadaliyev, Harald Schuh, and Chaiyaporn Kitpracha.

Which VLBI data analysis software are you using?

[RH] At GFZ we obtain our VLBI solutions using our own version of the original VieVS software. The VieVS@GFZ version has been developed in parallel to the Vienna VieVS version since the end of 2012 when Harald left TU Wien. At this stage, it has only very little in common with the current version run at Vienna University of Technology. A very powerful Kalman filter approach allows us to get excellent results and we are close to finish the first release of the new GFZ VLBI analysis and simulation software called PORT (Potsdam Open-source Radio interferometry Tool). It will be soon provided as a MatLab (MathWorks) program code under an open-source license.

Which research subjects were addressed in the past or are currently being addressed?

[HS] In addition to the research topics mentioned by Robert, we always try to be at the forefront of geodetic research applying innovative technology and novel methods. With respect to VLBI, we are thinking about observing satellites and spacecraft by (differential) VLBI methods. In recent years there has been a rapid and very exciting development in quantum technology and many of these developments can be used in geodesy and might also have strong relevance in VLBI. New precise optical clocks and an extremely stable frequency transfer might become part of the next generation VLBI system.

How important is VGOS (VLBI Global Observing System) for your research goals?

[RH] We are very much looking forward to analyzing VGOS data, as it will affect many aspects of the geodetic data analysis in a very positive way. Performing quasi-continuous observations will provide better results for a multitude of applications. More observations will allow for more advanced parameterization leading to higher resolutions. For the radio source structure and astrometric positions, it will not be trivial to integrate the different frequency setups; but moving towards higher frequencies facing the RFI problem particularly in the lower frequency bands seems to be a reasonable step. VGOS—once fully operational—will enable a completely different and more advanced analysis chain and we are looking forward to apply and test new analysis concepts and ideas.

Do you consider projects involving VLBI infrastructure to be important for GFZ?

[HS] Using artificial VLBI transmitters in space and combination of these VLBI observations with GNSS, SLR, and DORIS would be an important step to stabilize the dynamic reference frames of satellites and spacecraft and to avoid systematic biases or drifts of the frames. Another important task will be the comparison and validation of the ICRF with the celestial frames obtained in the optical domain by the *Gaia* mission of ESA.

What do you consider important for achieving the goals of the Global Geodetic Observing System (GGOS) in general and with VGOS in particular?

[HS] As we also have a strong GNSS group in our section as well as SLR and DORIS analysis centers (of the ILRS and IDS) in the Department, we can consistently combine all four space-geodetic techniques. This is essential for global geodesy in the GGOS sense to obtain the famous goals of 1 mm accuracy and 0.1 mm/yr long-term stability. Another important development happens within the United Nations Global Geospatial Information Management (UN-GGIM) and its GGRF (Global Geodetic Reference Frame) which, for the first time, brought global geodesy on a high political level. As one of the main space-geodetic techniques, VLBI plays an essential role in this framework. One of our goals in this respect is to establish further partnerships with VLBI groups all over the world and to invite and train young scientists.



View of the historical library.



Main building A 17 of GFZ's Department 1 "Geodesy" where the VLBI group is working. The photo was taken on 6 April 2017 at our department's 125-year celebration of the moving of the Royal Prussian Geodetic Institute (founded in 1870) with its director Friedrich Robert Helmert from Berlin to Telegrafenberg hill near Potsdam.

NEWS...

What about your non-VLBI activities? When you enjoy moments of recreation, what are you doing?



The Great Refractor of the Astrophysical Observatory built in 1899.

[HS] Unfortunately, my spare time is very limited because of the many commitments in national and international science activities and due to my duties at GFZ and TU Berlin. But I still try to maintain my physical fitness by jogging along the beautiful rivers and lakes in Potsdam and, if time allows, I enjoy one of the many cultural events in Potsdam and Berlin such as classical concerts and performances in the various opera houses and theaters. Meeting the multitude of personal friends and collaborators from all over the world (many of them from the VLBI community) is also a source of fun and happiness.

[RH] In my spare time, I try to spend joyful time with my family, in particular with my wife and two kids. As a family we enjoy sports, e.g., badminton, bicycle trips along the shores of the river (Havel), mountain hiking (when at home in the Bavarian Alps), bouldering (when in Berlin), skating, swimming, table tennis, and we listen to music. In the summer we enjoy evenings in the garden sometimes accompanied by mangal (Turkish-style barbecue).



The Einstein Tower from 1924 houses a solar observatory.



Sanssouci Palace, on top of a terraced hill, was the summer residence of the Prussian kings.



The Chinese Teahouse, a garden pavilion in Sanssouci Park.



The Nauener Tor (Nauen Gate) is one of the three preserved gates of Potsdam. Today a tram line leads directly through the gate.

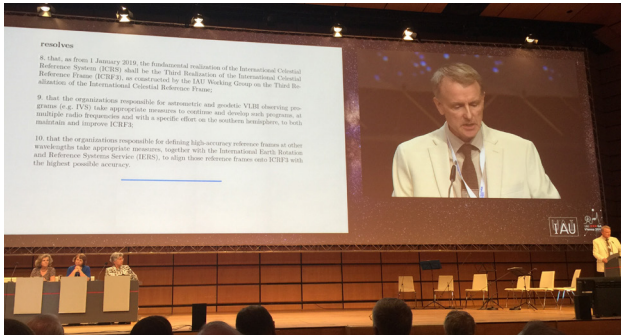
Upcoming Meetings...

VLBI Training School	EGU General Assembly
Las Palmas de Gran Canaria, Spain	Vienna, Austria
March 14-16, 2019	April 7-12, 2019
24th EVGA Meeting	Tenth IVS TOW
Las Palmas de Gran Canaria, Spain	Westford, MA, USA
March 17-19, 2019	May 5-9, 2019
18th IVS Analysis Workshop	AGU Fall Meeting
Las Palmas de Gran Canaria, Spain	San Francisco, CA USA
March 20, 2019	December 9-13, 2019

<https://ivscc.gsfc.nasa.gov/meetings>

ICRF3 Is Here!

– Patrick Charlot, *Laboratoire d'Astrophysique de Bordeaux*



The Chair of the IAU Resolution Committee presenting Resolution B2 on ICRF3, minutes before the voting by the General Assembly.

On August 30, ICRF3 was adopted as the new fundamental celestial reference frame following a unanimous vote of the delegates who had gathered in Vienna for the XXXth General Assembly of the IAU. This vote marked the end of a formal process that was initiated six months before with the submission to the IAU General Secretary of the designated resolution on ICRF3 (later known as Resolution B2). Other formal steps (prior to the voting) included endorsement of ICRF3 by the IVS and IERS Directing Boards, the release of ICRF3 and its presentation to the IAU delegates— followed by a question-and-answer session on ICRF3—at the General Assembly. This adoption also marked the culmination of the efforts accomplished by the ICRF3 Working Group (mostly made up of IVS Associate Members) over the past six years. The entire group shared a sense of collective pride in this accomplishment and duly celebrated the event through a very memorable ICRF3 dinner that evening, on invitation by the locals (i.e., TU Vienna).

The months and weeks prior to the IAU General Assembly were very busy—no less than eight teleconferences and one face-to-face meeting were organized in the preceding six months—and the adoption of ICRF3 was thus a bit of relief. Issues tackled in that period included understanding and properly correcting for the effect of Galactic aberration, comparisons with the *Gaia* DR2 optical frame (released on 25 April 2018), the selection of defining sources, and the internal alignment of the S/X, K, and X/Ka band catalogs forming ICRF3. The cutoff date of the data used for ICRF3 was pushed ahead as far as spring 2018 in order to include as many bi-monthly VLBA sessions as possible (at S/X band and K band) conducted since 2017 as part of the special agreement between USNO and the Long Baseline Observatory. Certainly, a step ahead towards the realization of ICRF3 was the repeat of ICRF2 after incorporating Galactic aberration in the modeling, which revealed that the bulk of the long-standing declination bias between ICRF2 and ICRF3 was in fact due to not considering Galactic aberration when ICRF2 was constructed.

ICRF3 incorporates nearly 40 years of VLBI observations acquired at S/X band (75% of which are IVS data) along with additional measurements collected at K band (24 GHz), and X/Ka band (8.4/32 GHz) over the past 15 years. The K band data comes mostly from the VLBA, while the data acquired at X/Ka band originate from the DSN. ICRF3 comprises positions for 4,536 sources at S/X band, 303 of which, selected in a way to obtain a uniform sky distribution, are identified as defining sources. The S/X positions are supplemented with positions at K band for 824 sources and at X/Ka band for 678 sources. In all, 600 sources have three-frequency positions available. The positions were estimated independently at each of the three radio frequencies in order to preserve the underlying astrophysical content behind such estimates. The frame is aligned onto the International Celestial Reference System to within the accuracy of ICRF2. Positions are reported for epoch 2015.0 and must be propagated for observations at epochs away from that epoch, accounting for a Galactocentric acceleration of 5.8 $\mu\text{s}/\text{yr}$, for the most accurate needs. Compared to ICRF2, the median position uncertainty in ICRF3 is reduced by a factor of 3.5, while the noise floor in the individual source coordinates is now at the level of 30 μs .

ICRF3 is available from the ICRS Centre Web site at <http://iers.obspm.fr/icrs-pc/newwww/icrf/>. As per Resolution B2, it will replace ICRF2 as the fundamental IAU celestial reference frame on 1 January 2019. We hope it will serve the community well.



IAU General Assembly unanimously voting in favor of ICRF3.



ICRF3 Working Group celebrating the adoption of ICRF3 by the IAU at the restaurant "Wiener Wirtschaft" in Vienna on 30 August 2018.

Geoscience Australia Hosts 3rd AOV Meeting in Canberra

– Takahiro Wakasugi, GSI; Oleg Titov, Geoscience Australia



The AOV meeting group at the entrance to GA.

The Asia-Oceania VLBI Group for Geodesy and Astrometry (AOV) is a regional subgroup of IVS to foster and encourage closer collaboration in the science, technology, and education aspects of VLBI in the region (see the special report on the AOV in the IVS 2014 Annual Report; <https://ivscc.gsfc.nasa.gov/publications/ar2014/spcl-aov.pdf>). We had two face-to-face meetings since its establishment in 2014 (Hobart, Australia in 2015 and Kobe, Japan in 2017). This time, we got back to the southern hemisphere to discuss regular observing sessions, technical developments, research programs, and future activities.

The 3rd AOV meeting took place in Canberra from November 9–10, 2018 and was hosted by Geoscience Australia (GA) in conjunction with the 21st International Laser Ranging Workshop. A total of 20 people joined the meeting from Australia, China, Japan, New Zealand, Thailand, Russia, and USA. Thanks to a great conference room and nice foods and drinks sponsored by GA, the meeting was delightful with a congenial atmosphere.

On the first day, several topics concerning AOV activities were discussed among “pure” AOV components. We had intensive group discussions about the following topics:

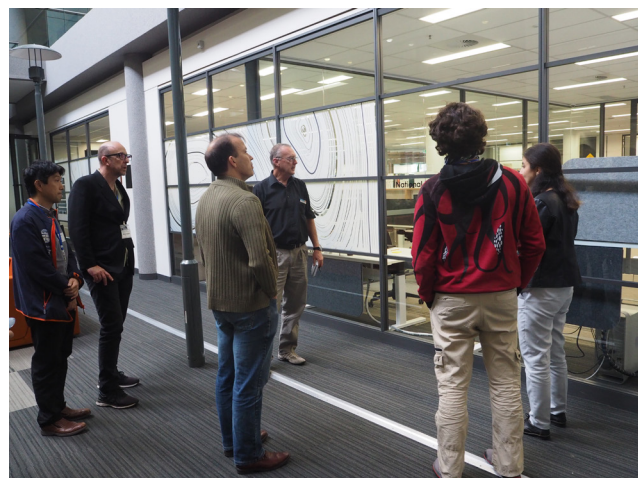
- the AOV observing program in 2019;
- the intensification of the feedback loop from the correlators to stations and schedulers for the improvement of data quality;
- promotion of studies utilizing AOV facilities and its advertisement;
- VGOS developments in the Asia-Oceania region; and
- future plans and the next meeting.

The second day was dedicated to a presentation-style workshop. We invited two SLR experts (Mike Pearlman and Toshimichi Otsubo) to give talks about the current status of the ILRS and the GGOS activities in Japan helping to foster collaboration among the space-geodetic techniques. In addition, two guests (Gary Johnston and Ryan Ruddick from GA) introduced the National Positioning Infrastructure (NPI) project and local-tie survey in Australia. Of course, “regular” activity reports from each AOV component and scientific reports, such as source structure effects on broadband data and the AOV contribution to astrometry and the ICRF realization, were provided. As part of the workshop, we also had a remotely given report on the telescope construction project in Thailand.

The minutes of the group discussions and all presentation slides are openly available on the meeting Web site at <http://auscope.phys.utas.edu.au/aov/meetings/aov2018/3rdaovgm.html>. We will continue our close collaboration through regular observations, e-mail exchange, and future face-to-face meetings. You are more than welcome to join us!



Gary Johnston explaining ways on how to secure a budget.



Meeting participants touring the Tsunami Warning Center at GA.

Using the Field System 'msg' Program

— Alex Burns, MIT Haystack Observatory

It is important for stations to send ready/start/stop messages to the correlator for every session. There is a lot of data the correlator needs that is not included in the session log file, such as operator comments regarding errors at the site, sky conditions, cable measurement, and any timing information at the site that may not be monitored automatically. One tool an operator can use to provide this type of information is the 'msg' program of the Field System. To use the 'msg' program in the Field System please execute

```
>>msg
```

Time for TOW

— Chris Coughlin, Peraton

It's that time of year again! TOW season is right around the corner with the tenth IVS Technical Operations Workshop (TOW), to be hosted at the MIT Haystack Observatory in Westford, MA, USA. The workshop will be held from May 5–9, 2019. The focus of this workshop is the VLBI station operators, giving them the opportunity to meet with the experts face-to-face and take that experience and knowledge back to their stations with them. The TOW has been extremely successful over the years and ensures that the stations are provided with the latest and greatest training and expertise the IVS community can offer.

For the 2017 TOW, 71 participants from 18 different countries came together with the common goal to better their VLBI skill sets for operations and maintenance at their respective stations. The 2017 TOW was heavily focused on the new VGOS broadband network providing insight for stations on the future of VLBI systems and techniques. We can expect the 2019 TOW to also be focused on the new VGOS broadband network, systems, and techniques. The TOW will allow hands-on training with systems as well as lectures and seminars led by VLBI's most experienced technical staff. The details for this TOW—including teachers, registration fee, and classes—will be made available on the IVS Web site.

from a shell window. This opens the window shown in the figure. In addition to the information mentioned above, it also tells the correlator exactly when the station began and ended recording, and if there were any problem scans. This saves the correlator operator a lot of time, for instance, by avoiding trying to find a scan using the wrong offset or trying to find fringes when the antenna was not pointing. At the very least, this program has fields for all of the pointing data you acquire during a session precheck; hence, you cannot forget to check out the system before the observation begins!

The IVS Newsletter is published three times annually, in April, August, and December. Contributed articles, pictures, cartoons, and feedback are welcome at any time.

Please send contributions to the General Editors (see below).

The editors reserve the right to edit contributions. The deadline for contributions is one month before the publication date.

General Editors: Dirk Behrend (Dirk.Behrend@nasa.gov),
Kyla Armstrong (Kyla.L.Armstrong@nasa.gov)
Feature Editor: Hayo Hase (hayo.hase@bkg.bund.de)
Layout Editor: Heidi Johnson (heidij@mit.edu)

The newsletter is published in color with live links on the IVS web site at

<https://ivscc.gsfc.nasa.gov/>.

The TOW will cover three-and-a-half days of classes, lectures, seminars, and workshops as well as an icebreaker event on the Sunday evening (May 5). The icebreaker allows the attendees to meet the teaching staff, fellow station colleagues, and the local staff that helps to organize and host the meeting.

The TOW has been proven over the years to improve station performance for the stations that send technical staff to participate in the workshop. The information and documentation that the stations will gain from the TOW is very important. But the chance to meet the experts face-to-face and sponge off of their knowledge and experiences is invaluable. The TOW will have representatives for all aspects of VLBI including developers, scientists, correlators, and (of course) station technicians and operators. We hope to see you there!

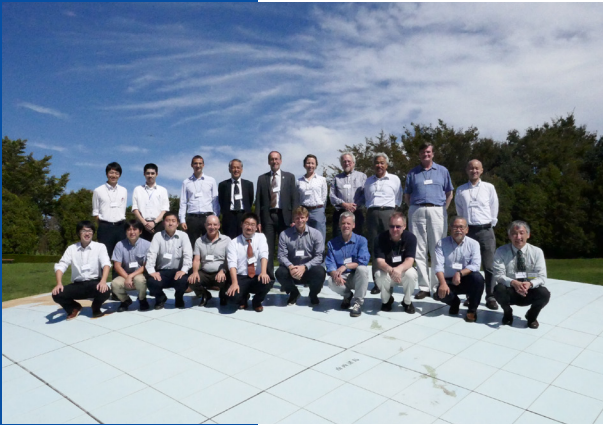


Science is a cemetery of dead ideas.

— Miguel de Unamuno

GGOS Big-in-Japan

– Dirk Bebrend, NVI, Inc.



Participants of the GGOS Days on the outside grounds of the Science Museum of Map and Survey at GSI headquarters.

In the first week of October, the Geospatial Information Authority of Japan (GSI) hosted the 2018 version of the GGOS Days at its headquarters in Tsukuba, Japan, attracting slightly over twenty participants from around the globe. In addition to the folks directly on location, several others partici-

ated remotely for at least part of the meeting. The GGOS Days provide a forum for the various parts of GGOS (Global Geodetic Observing System) to discuss their progress and future plans. Thus, the meeting was organized as a succession of a number of open meetings, including the GGOS Consortium, the Bureau of Networks and Observations (BNO), the Bureau of Products and Standards (BPS), and the four Focus Areas (Unified Height System, Geohazards, Sea Level Change, Geodetic Space Weather Research). Each part had one or several presentations followed by a group discussion.

As it is impossible to recapitulate the whole proceedings of the “days,” let me outline a few of the highlights, some of which may impact the IVS in some form or another. Data citation was considered very important. It was suggested to establish a GGOS Working Group (WG), probably within the BPS or

joint with the BNO, on DOI for data sets. This WG should have representatives from the various services and data centers. Its main goal would be to establish procedures for assigning DOIs to geodetic data sets (e.g., registration agency, standardized DOI naming convention) over its life span of possibly four years.

In order to go away from the ad-hoc nature in dealing with external organizations, the position of Manager of External Relations was created. This should help in better coordinate these efforts and expand the involvement in external organizations. The first manager is Allison Craddock from JPL. There was an inquiry to GGOS if individual membership was possible. The participants could not see any real benefit (for either side) in doing this and recommended to continue with the current status of not having individual membership.

It is planned to prepare an update to the GGOS 2020 book. This shall not be a second edition of the book, but rather an update chapter on the order of 50 pages or so. An Editorial Board will need to be established for this effort. As a more hands-on activity, the participants visited GSI's Ishioka station on the final day of the meeting. The site sports a 13.2-m VGOS antenna, two CORS GNSS antennas, and a gravity measurement facility for up to six gravimeters. This visit perfectly rounded out the well organized GGOS Days in Japan. A big thank-you goes to the staff of GSI who made this event a smooth and very successful affair.

The next GGOS Days will be held in South America in the fall of 2019. The exact time and venue were still to be determined.

<https://ivscc.gsfc.nasa.gov>
ivscc@lists.nasa.gov
phone: 301-614-5939
fax: 301-286-0239

IVS Coordinating Center
NASA GSFC
Code 61A.1
Greenbelt, MD 20771

