IVS Newsletter

Issue 46, December 2016

VLBI to Near Field Targets – All about the New Hype

– Lucia Plank and Jamie McCallum, University of Tasmania

Andreas and Jamie at the Mt. Pleasant Observatory in Hobart, trying to 'catch' the APOD satellite signal with the AuScope telescopes.

It has been around for a few years now, this talk about near field targets. Well known from space craft tracking there were rumors VLBI could solve the issues with satellite antenna phase center offsets in GPS. An initial working group on this topic was skeptical though. But the idea was born.

Wouldn't it be handy to directly observe satellites of the GNSS with VLBI? All these problems with local ties between the techniques on ground could be resolved. Observing satellites would allow VLBI a new sensitivity to the Geocenter, and the GNSS orbits could be directly measured in the inertial CRF, inconsistencies with combined EOP time series resolved. What a prospect!

Well, it is not that simple. Geodetic VLBI is used to observe signals as weak as about one thousandth of the system noise, slowly moving across the sky. The radio emission by extragalactic quasars spreads across all frequencies allowing to use bandwidth synthesis to achieve precisions at the picosecond level in the delay measurements. Not so for artificial signals emitted aboard an Earth orbiting satellite. Overwhelmingly strong and narrow band is what we hope to see in our data, if our telescopes can successfully follow the targets' rapid pass through the sky. A series of new challenges for our data acquisition systems and processing chains awaits.

If it is *that* complicated, do we really need to do it? Yes! The concept of a space-tie satellite, carrying components of all space geodetic techniques is thought to resolve one of the major issues for future improvements of the International Terrestrial Reference Frame (ITRF), namely the connection of the various techniques. While aiming for the millimeter, today we find discrepancies between space geodesy results and local tie measurements at the level of five millimeters to a few centimeters for more than fifty percent of co-locations. It is believed that these are the results of technique specific systematic errors.

First mentioned as part of the GGOS (Global Geodetic Observing System) concept, the space tie has now reached the status of mission proposals to NASA and ESA. Often referred to as GRASP, the Geodetic Reference Antenna in SPace is proposed as low earth orbiting mission (orbit between 900 and 1400 km), carrying a GNSS receiver, an SLR retro-reflector, a DORIS receiver, and a VLBI transmitter. While the first three techniques are routinely used, VLBI to a low Earth orbiting satellite is completely novel.

So how novel is it then? Serious testing started a few years back, mainly driven by Rüdiger Haas and Vincenza Tornatore in observing satellites of the GLONASS system using VLBI antennas with appropriate receivers operating in L-band. Also, initial simulation studies in terms of visibilities as a function of the satellite orbit and a telescope ground network followed. Recent developments in the scheduling and operating software now allow such observations to be organized on short notice and undertaken almost automatically.

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Call for 2015+2016 Biennial Report

The IVS Coordinating Center invites each IVS Component and the Coordinators to submit reports on activities during the calendar years 2015+2016. Reports are due January 31, 2017.

http://ivscc.gsfc.nasa.gov/publications/br2015+2016-call.html

Please Vote

All IVS Associate Members have the privilege and opportunity to vote in the elections for representative positions on the IVS Directing Board. Please visit http://ivscc.gsfc.nasa.gov/about/org/board/elections for information.

The voting period will be January 9–20.

Please cast your vote.

Feature

State of the IVS – An Appraisal of Four Years of Chairmanship

Four years ago Axel Nothnagel took over the IVS chairmanship from Harald Schuh. Completing his first full term as IVS chair is a good moment to reflect on the achievements, the current topics, and the future challenges for the IVS. Newsletter editor Hayo Hase caught up with Axel and brought back some interesting tidbits about the IVS past, present, and future.

IVS Chair Axel Nothnagel at the Cape of Good Hope prior to the General Meeting 2016 in Johannesburg.

Axel, when did you enter IVS activities and why?

As a matter of fact, I was a member of the Steering Committee that set up the IVS in 1998/1999. We wrote the Terms of Reference and organized the first elections. Subsequently, I volunteered to take over the responsibilities of the IVS Analysis Coordinator and I held this position until 2013. The question of why I did this is a bit more difficult to answer. The VLBI Group at Bonn, led by James Campbell, was very active in many fields and had a strong position in Germany and in Europe due to its involvement in the Bonn Correlator. Taking over the IVS Analysis Coordinator responsibilities was a logical consequence.

The vision of sharing globally distributed resources for a global geodetic and astrometric VLBI activity under the umbrella of IAG and IAU played a key role for its creation. What do you consider major milestones in the development of the IVS and its main achievements?

The first milestone was, of course, the founding of the IVS itself with a practical structure for coordinating all activities in a concerted effort. This has to be seen in the light of the past where a number of separate activities existed and participation had to be organized on a case-by-case basis. Closely linked to this is the adoption of the VDIF format through the efforts of Alan Whitney, which brought together the different realizations of VLBI data formats. This was a serious limitation beforehand. With VDIF compatibility was reached and many more telescopes could be scheduled in the same session. Another noteworthy achievement was the establishment of the R1 sessions. Since their first days in 2002, they have provided a valuable augmentation of the IVS EOP time series which consisted only of a single, regular rapid-turnaround, multi-station session per week beforehand (the NEOS-A sessions on Thursdays, now called R4). The completion of the VLBI2010 document gave another push to the enthusiasm of the IVS associates, because that gave them a clear path to follow. The current activities of the first broadband observations and the related developments are a (late) consequence of these ideas.

Why do we need the IVS and is the model of voluntarily shared resources viable in the future?

That's an interesting question. The world needs the IVS because the state-of-the-art results of today can only be achieved in this way. National or multi-lateral activities would only be sub-optimal and produce too much political friction. With respect to the second part of your question, the best-effort voluntary participation is certainly not a reliable structure in the long run, but it's the best we have. The danger of key institutions dropping out of their commitments is always looming. On the other hand, this gives us much freedom to organize ourselves and we cannot be held responsible for failures by any commercial framework. The UN Resolution on the Global Geospatial Information Management (UN-GGIM) and the activities of the panel of experts will hopefully lead to a better acknowledgement of the work we do for reference frame realizations and might, in some distant future, help the IVS components to secure or even increase funding from their national governments.

With your long experience as IVS Analysis Coordinator, what was your most important experience in that position?

Unfortunately, my memories are a bit somber on this. There has never been a time when all the unsolved contemporary analysis issues were addressed by the Analysis Centers in a well distributed way. The Analysis Coordinator can point at deficits and ask around for volunteers but he cannot force anybody to work on a certain topic. This led and still leads to the fact that many problems are still in the pipeline, but nobody seems to be motivated or has the time to work them out. Today, the IVS has 29 institutions, which are registered as IVS Analysis Centers, and there were only a few less ten years ago. One would expect that there always was and still is ample opportunity to find a niche off the main stream with great importance to the IVS. Here, analysts can contribute to the IVS even with limited personnel. However, this has never been the case and we are still far off our optimum.

What is the difference between your guidance as IVS Analysis Coordinator with the one of being the IVS Chair?

The position of the IVS Analysis Coordinator is meant as a concentration point for the IVS Analysis Centers and should focus on the quality of the combined results to be submitted to the colleagues making use of our output. This also requires some interfacing between the analysts and the users of the results. As the Chair, in the first place, I try to keep the components linked together. What worries me is that there are only very few individuals who actually work on the fringe fitting issues. The small number of experts makes this part of the IVS very prone to a loss of valuable expertise when those few colleagues are going to retire. In addition, I have to deal with the more global politics, i.e., our relations with the IAG, GGOS, and IAU among others. The UN-GGIM initiative may have some benefits for us, but this needs to be

followed and explored at all stages of the development.

Looking back over the last four years of your IVS chairmanship, what was your vision in the beginning and what did you achieve? Which themes need still to be developed?

Last year I pushed for a strategic plan for the IVS for the next decade. With good cooperation within the Directing Board and some advice from external experts, we produced a document which should serve as a good guideline for decision makers and individual colleagues alike. The uneven global distribution of key observatories is a fact that needs to be worked on. A balanced distribution of the correlation process onto many more shoulders is another important issue for the near future.

The spectrum of your duties is very wide. How important is the VGOS initiative for the IVS?

VGOS with its broadband observing capabilities is the IVS network of the future. Without VGOS there is no progress. The VGOS development itself is on a good path with the colleagues involved, having a good plan of the necessary development and implementation steps.

We understand that VGOS operation will outperform the legacy S/X operation in the near future. What is your vision of the IVS legacy station network in the VGOS age?

Independently of any station distribution issues or phasing-in difficulties of the VGOS operations, the legacy telescopes will continue to be needed also in the future. Since the IVS also has "Astrometry" in its name, the often large telescopes will be used for improving the celestial reference frame in the radio frequency domain for some time to come. Where there is no VGOS telescope in close vicinity of the legacy telescope, the latter one will continue to be the fundamental reference point in this area. And, of course, this needs continued observations.

What do you expect from VGOS in terms of the envisaged precision of 1 mm?

The global scale determined with geodetic VLBI observations appears to be different from that of SLR by about 5 mm at one Earth radius. Unless we can prove that VLBI does not have any systematic effects left stemming, e.g., from atmospheric refraction, we are still far away from the 1 mm goal. The VGOS network will help to reduce the influence of refraction through dense sampling of the hemisphere above each telescope improving our abilities to estimate the refraction effects.

What are shortcomings in the daily IVS business?

Time. A lot more controllable manpower and womanpower would be needed to tackle all the unaddressed issues which I see within geodetic and astrometric VLBI in general and the IVS in particular. I would love to be in a position where I could distribute work to groups and individuals regardless.

What do you admire most about the IVS?

That all individuals work with a lot of enthusiasm for the overall goal and that there is a serious identification with all the efforts at hand.

Thank you very much for your frank words and sharing your views with us.

(left) Axel at the IVS General Meeting in Shanghai in March 2014; (right) Axel at the inauguration event of the Ishioka VGOS Antenna in October 2015; (below) Axel engaged in a discussion at the Directing Board meeting in Ponta Delgada, Azores, Portugal.

News...

The 7th VieVS User Workshop

– Apurva Phogat, BKG Wettzell

The 7th VieVS User Workshop was organized at TU Vienna, Austria from September 14, 2016 to September 15, 2016. The main objective of the workshop was to introduce the VieVS 2.3 software to all the interested new users and to provide information about the newly added features to the frequent users. Dr. Johannes Böhm gave the opening presentation about the basic concept of VLBI followed by the talks from VieVS developers about all the different modules of the software. I gained some insight about the powerful features, such as scheduling satellite observations and simulation modules. It was a good combination of theory and practice, as we were given a brief introduction by the presenter before performing any task or exercise. All the planned future developments to make the software more user friendly and lucrative were also discussed.

All the sessions were well organized and there were refreshment breaks in between the sessions to help keep our energy and also gave us opportunity to interact. Being a newcomer, I got this opportunity to introduce myself to some of the experienced people working in the field of VLBI. There were some informative presentations from the VieVS users from other institutes as well. The weather in Vienna was fortunately warm, which allowed me to explore the stunning architecture of this beautiful city.

Participants at the 7th VieVS User Workshop.

On September 16, 2016, Jamie McCallum from the University of Tasmania, Australia delivered a tutorial on the DiFX correlator for all the interested participants of the VieVS workshop. He answered all questions very patiently and explained the correlation process precisely. Lastly, I would like to give my sincere thanks to Dr. Johannes Böhm and to the speakers and organizers of the workshop who made it worthwhile.

Transition to Multi-tone Phase Calibration on January 1, 2017

– John Gipson, NVI, Inc.

In VLBI measurements the measured delays are corrupted by unknown and unstable phase shifts in the signal as it travels down the signal path from the front end to the sampler. Many of these effects can be removed through the use of phase calibration. The most common approach is to inject a calibration signal near the front of the of signal chain. The calibration signal consisting of a set of tones ('phase-cal tones') equally spaced in frequency and derived from the station frequency standard. These signals are extracted during the correlation process and used to adjust the phases prior to fringe-fitting. Since the spurious phase shifts are frequency dependent, each frequency channel is calibrated independently.

Historically, only a single phase-cal tone was used in each frequency channel. Due to advances in correlator software, for the past several years the correlators have been able to use multiple phase-cal tones in each channel. This latter approach is called multi-tone phase-cal. Naively, the use of multiple phase-cal tones should reduce the noise. Prior to implementing multi-tone phase-cal routinely, I thought it would be a good idea to verify that doing so produced better results when applied to real data. With this in mind, I asked the Bonn correlator to process the CONT14 data set twice, once with single-tone phase-cal and once with multi-tone phase cal.

In analyzing the CONT14 data correlated in these two ways, I found that multi-tone was generally slightly better than single-tone based. On average, the multi-tone sessions had ~1% more observations. The session fit was slightly better, again on the ~1% level, indicating that the data within a session was less noisy and more consistent. Lastly, the RMS baseline scatter across all of the CONT14 sessions was generally lower. All of these are arguments for using multi-tone phase-cal. However, it also turned out that for Zelenchukskaya, there was a difference of 8 mm, or 3-sigma, in the vertical position depending on whether you used multi-tone or single-tone phase-cal. There are differences for other stations, but none of these are greater than 1-sigma.

These issues were discussed publicly at the IVS Analysis Workshop at Ponta Delgada in May of 2015. More recently there was a special meeting devoted to this subject held at MIT Haystack Observatory in October, 2016, after the technology workshop and before the IVS Directing Board meeting. This was an opportune time to bring together many of the experts in correlation, the VLBI signal chain, and data analysis. One conclusion of this meeting was that the IVS will switch over to multi-toned phase-cal for all sessions observed on or after January 1, 2017. We expect that this will yield an improvement in the quality of the data. It may also introduce a discontinuity in some station positions.

From the VGOS World...

Onsala Twin Telescopes

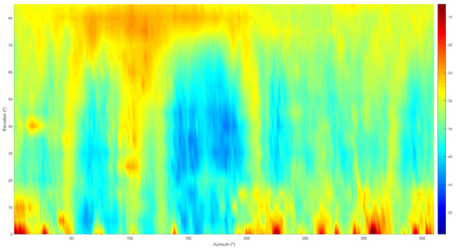
– Rüdiger Haas

The Onsala Space Observatory, with the Twin Telescopes in the center.

The reflectors for the Onsala Twin Telescopes (OTT) were mounted on 18 August 2016. This was a major milestone for the installation of two new VGOS-type radio telescopes. During the autumn, the installation work was completed and the site acceptance tests are planned for the end of November. Two broadband receiver systems are currently under development at the Electronics Lab at Onsala. One will be equipped with an Eleven feed and the other one with a QRFH feed. First tests with the receiver with the QRFH feed show receiver temperatures at about 10 K for more than half of the frequency band. First light is expected before the end of the year and first VGOS test observations for early 2017. The official inauguration of the OTT will be in connection with the 23rd Working Meeting of the European VLBI Group for Geodesy and Astrometry (EVGA) in May 2017 in Gothenburg. The attached photo depicts the Onsala radio telescope cluster, with the new twin telescopes in the center.

Thorough RFI Survey at Yebes

– José Antonio López Pérez, Pablo García Carreño and Pablo de Vicente



RFI signal power for 0.5–6 GHz (total power in dBm) at Yebes as a function of azimuth and elevation.

The RFI environment at Yebes Observatory is being intensely monitored, as interfering signals pose a problem for the broadband receiver currently installed in the 13.2-meter VGOS radio telescope. The RFI signals are limiting the sensitivity of the telescope, because they drive the fiber optic links needed for signal transportation into saturation. As a result, the power and spectrum of the interferences are being measured to evaluate the best approach for splitting the VGOS 2–14 GHz frequency band. The figure shows the total power (in dBm) detected at the output of the receiver cryostat (V-pol channel) in the telescope as a function of azimuth and elevation for the frequency range 0.5–6 GHz, where the most important RFI signals are concentrated. It can be seen that the RFI levels are very strong below 10º elevation and that the ring-focus spillover collects some interferences at high elevations. These data and their evaluation will help in the optimization of the VGOS network receivers to reach their maximum sensitivity. A memo with the complete RFI analysis will be prepared in the next few weeks.

Recent Progress at the RAEGE VGOS Radio Telescope Santa Maria

– Susana García Espada and Ruben Bolaño

At Santa Maria (Azores, Portugal) station activities are progressing for having first light by the beginning of 2017 and for doing the first VLBI observations probably during spring time. A major milestone was accomplished on 7 November 2016 with the installation of the tri-band receiver, which was developed at Yebes Observatory (Spain), in the radio telescope (see photo). The tri-band receiver will be used for antenna commissioning up to 32 GHz and the very first VLBI tests using the legacy S/X system. As a side note, this is the third tri-band receiver developed at Yebes (following the ones made for the Ishioka and Yebes telescopes). At a later date (likely close to the end of 2017) it is planned to replace the tri-band receiver at Santa Maria with a VGOS broadband receiver—as was done at Yebes. In the immediate future, i.e., in the weeks before and after Christmas, other tasks will be performed including control system implementation, wiring between instrumentation, and backend set-up.

Installation of the tri-band receiver at Santa Maria.

continued from page 1.

In 2014, the IVS established a new working group (WG7) dealing with the observations to near field targets. In October 2016, the first international workshop on near field targets was held in Bonn.

I was lucky enough to attach this two-day meeting to a month-long research stay in Vienna, making the long travel from Tasmania even more worthwhile. In a number of talks recent progress on VLBI observations of GNSS satellites were discussed—according to Andreas Hellerschmied's statistic, almost 40 sessions were scheduled in the last three years. We heard the latest updates on the implementation of a near field delay model into Calc, DiFX, and VEX—our standard files and routines for observation and correlation. Rüdiger, demonstrably active in almost all discussed projects, gave an update on the challenges involved with the R&D experiments observing the Chinese Lunar lander Chang'E 3. The little star of the workshop was APOD, the Chinese CubSat mission carrying a dedicated VLBI transmitter. Though this mission has been in orbit since late 2015, due to its low orbital height (<500 km) and the lack of experience within the IVS, observations to APOD with IVS telescopes turned out to be really challenging. More talks were given on various updates on new routines, simulation studies and technical achievements. Overall, the workshop was a full success, simply proven by the high number of about 50 participants.

Personally I was surprised to learn how many groups are now working on different problems of these observations and hope that old and new collaborations amongst these groups will really bring this exciting technique forward. Like in 'standard' geodetic VLBI, we can only be successful if we manage to bring the full expertise together, including the scheduling, the technical challenges of telescope operation and observing, correlation and post-processing, delay modelling, and the final analysis.

At the University of Tasmania we have also started to foster research on this topic. During the last year a series of test experiments was performed, in observing GNSS satellites with L-band receivers on the Ceduna–Hobart baseline. A preliminary result is a six-hour session with total delays to a set of five different GPS satellites. Currently in Hobart we have the visiting expertise of Andreas Hellerschmied from the Technische Universität Wien, who is helping us with observations of APOD using the 12-m telescopes in Hobart, Katherine, and Yarragadee. Hopefully a next big step towards making VLBI to near field targets happening on a routine basis in order to be ready for the first GRASP-like mission.

Useful links:

- Website of the workshop in Bonn including links to the talks: *http://www3.mpifr-bonn.mpg.de/div/meetings/vonft/*
- WG7 Wiki, collecting information about current activities and documenting ongoing experiments: *http://auscope.phys.utas.edu.au/opswiki/doku.php?id=wg7:home*

Potential Kangaroo Impact on Earth Orientation Parameters

– Jim Lovell, University of Tasmania

When setting up the Yarragadee antenna for R4763 on October 27, our operator Bryn experienced what must be a uniquely Australian problem. Try as he might, Bryn could not get the antenna drives to power up. This was strange because there were no problems with the previous session, the antenna had not been used in the intervening time, and no one had been near it. After some further investigation and a phone call to the station, it was realized that the emergency stop button next to the pedestal door had been pressed, and the only possible culprit could have been one of the local kangaroos that had been congregating around the antenna recently. The e-stop button is about head-height to these marsupials. Fortunately the problem was fixed before the first scan and no data were lost. But we now have another item on our pre-experiment checklist for Yarragadee!

Serious design flaw. The pedestal emergency stop button is at head-height for a kangaroo.

Is this a photo of the culprit? (Taken near the antenna by Randall Carman.)

Part of the new eRemoteCtrl pre-experiment checklist for Yarragadee.

Upcoming Meetings...

AGU Fall Meeting
San Francisco, CA, USA
December 12-16, 2016

9th IVS TOW
Westford, MA, USA
April 30-May 4, 2017

23rd EVGA Working Meeting
Gothenburg, Sweden
May 15-19, 2017

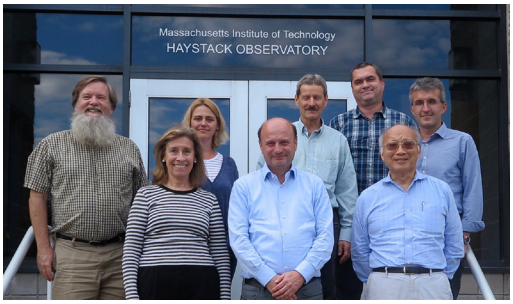
AGU Fall Meeting
New Orleans, LA, USA
December 11-15, 2017

http://ivscc.gsfc.nasa.gov/meetings

Progress Towards ICRF3

– David Gordon, NVI, Inc.

The third realization of the International Celestial Reference Frame (ICRF3) will be generated by a working group of the International Astronomical Union (IAU). The ICRF3 WG was established in 2012 and has 20 members, most of whom are also IVS members. Chris Jacobs served as chairman from 2012–2015 and Patrick Charlot is the current chairman. The charter of the WG is 'to oversee the generation, validation and utility of the third generation ICRF in the radio domain by 2018 with special care to provide for a frame tie and accuracy comparisons with the anticipated Gaia optical catalog.' Since its beginning, WG members have made efforts to significantly improve the future ICRF3 over ICRF2. These efforts have included re-observations of the VLBA calibrator sources (VCS) in RDV sessions and in a second epoch VCS campaign (Ap.J. 151:154, 2016.), and observing campaigns at higher frequencies to create and expand celestial reference frames at K band (24 GHz) and X/Ka bands (8/32 GHz). The WG is striving to make ICRF3 more accurate, more stable, and larger than ICRF2. Already, the average formal errors on 2/3 of the ICRF2 sources have been reduced by a factor of nearly 5 and the number of X/S sources has been increased by over 20%.



Meeting participants of the ICRF3.

The ICRF3 WG recently met for a two-day meeting at Haystack Observatory on October 17–18. Eight members were in attendance and an approximately equal number participated via WebEx. Prototype solutions at X/S band were submitted by working group members from seven analysis centers (AUS, GFZ, GSFC, IAA, OPA, USNO, and VIE) and these were discussed at the meeting along with comparisons between them by several WG members. These comparisons were generally favorable and have pointed out some current issues that still need addressing, such as usage of a common set of sessions, parameters to be solved for, and other criteria. Also discussed were source solutions in Sinex form, which ultimately the WG hopes to use to create a combined X/S catalog. Work on developing the software for such a combined solution is currently underway by WG members and associates at Bonn University. Also discussed were the X/Ka and K band catalogs, selection of defining sources, and the handling of galactic aberration. The first data release from the Gaia astrometry satellite was made shortly before the Haystack meeting and some comparisons with ICRF2 have been made, showing generally good agreement. Comparisons between Gaia and the prototype ICRF3 solutions are currently being made by several WG members. Several WG members will attend an upcoming IAU Gaia meeting in Nice, France in April 2017 to report on these various comparisons.

Much work remains to be done before ICRF3 is finalized and presented to the IAU for approval in August 2018. This includes additional observations of many of the lesser observed sources in VLBA and other sessions, generation of additional prototype solutions, and development of the software to create a combination catalog.

Sad News

On November 18, Jim Ryan lost his battle with pancreatic cancer passing away peacefully in a hospice in Maryland. We lost a great benefactor.

Strategic Plan 2016–2025

The Strategic Plan 2016–2025 is available on the IVS Web in the area for strategic papers. This area was recently established and can be reached from the homepage going to >About IVS>IVS Strategic Papers. You can also go directly to http://ivscc.gsfc.nasa.gov/about/strategic/ to reach the listing of retreat reports and strategic plans. The Strategic Plan 2016–2025 will also be published as a special report in the Proceedings volume of the IVS 2016 General Meeting.

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
ivs-news@ivscc.gsfc.nasa.gov.
The editors reserve the right to edit contributions. The deadline for contributions is one month before the publication date.

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

http://ivscc.gsfc.nasa.gov/.

GGOS Days, IHRF, and Other Things GGOS

– Dirk Behrend, NVI, Inc.

Participants of the GGOS Days 2016 in front of Phillips Auditorium of CfA.

About thirty-five people made the trip to Cambridge, MA, USA in mid-October to participate in the second installment of the GGOS Days. Over 3–4 days (depending on whether you were a member of the GGOS Coordinating Board or not) a series of meetings was held in rapid succession: a GGOS Consortium meeting, a GGOS Bureau of Networks and Observations (BNO) meeting, a GGOS Bureau of Standards and Products (BSP) meeting, a GGOS Focus Areas meeting, and two GGOS Coordinating Board meetings. All meetings were open meetings except for the Coordinating Board. There was a strong representation from the gravity services, which was an important change to previous GGOS meetings. As GGOS is aiming at creating combined products from its wide range of contributing components, an exchange between the geometric and gravimetric fields is an essential part of making this happen. A good example of how to tap into both fields can be seen in the establishment of a unified height system.

Based on the work of the DGFI-TUM group (led by Laura Sanchez) in Munich as well as others, the IAG adopted a resolution in July 2015 to define and realize an International Height Reference System (IHRS). The IHRS realization, i.e., the International Height Reference Frame (IHRF), is planned to be a set of surface points (core sites) determined by their geocentric positions and changes with time (X and X') as well as their geopotential values and changes with time (W, W). While VLBI can contribute to provide the position information, the geopotential value has to be derived from gravity information. So, to state this explicitly, the IHRF is not a subset of the ITRF. In the IHRF the height (or geopotential value) refers to an entity that is meaningful in the gravity field of the Earth (a physical height); in simple terms, water should flow downhill from a higher to a lower elevation. For a geometric height, such as the ellipsoidal height, this is not always true because it neglects the mass distribution underlying the area of interest.

In order to determine the geopotential value of the surface point, it will among other things be necessary to provide local gravity information. For that, GGOS may request the provision of terrestrial gravity data in a radius of 250 km around a core station. Hence, there may be a request coming our way some time in the future. More information can, for instance, be found at https://mediatum.ub.tum.de/doc/1328401/1328401.pdf.

Other interesting tidbits coming out of the GGOS Days include the following. The GGOS Inter-Agency Committee (GIAC) will likely be discontinued in its current form and morph into a Sub-Committee of the UN-GGIM. A Focus Area 4 on Atmospheric Parameters is in the planning phase. The IAG Executive Committee proposed to publish an update of the GGOS 2020 book, i.e., to prepare a GGOS 2030 booklet of lesser scope. Lastly, the GGOS Coordinating Office is now hosted by the Austrian BEV (Bundesamt für Eich- und Vermessungswesen) under the leadership of Günter Stangl.

The GGOS Days were well organized by Mike Pearlman and his team from the Harvard-Smithsonian Center for Astrophysics (CfA). Thanks a lot Mike.

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