

# IVS NEWSLETTER

## ISSUE 64, December 2022



### Anniversaries, New Faces, and Reports

The final third of the year saw several interesting events taking place in the IVS world. The Geodetic Observatory Wettzell celebrated its 50th anniversary in a festive event. The IVS Associate Members elected four Representative positions on the Directing Board; three of the four positions were claimed by younger candidates, bringing new faces to our governing body. The At-Large elections are still running with results expected shortly before Christmas. For the first time, the ITU published a Report (RA.2507) addressing geodetic VLBI and spectrum management.



### Toe to Toe at TOW

*Dirk Behrend*  
NVI, Inc./NASA GSFC

The planning phase has started for our next Technical Operations Workshop (TOW), which is scheduled to take place from April 30 to May 4, 2023, at MIT Haystack Observatory. It will be the twelfth installment of this workshop with hands-on training and problem resolution in VLBI operations for the technical staff of the stations. While the previous TOW was held virtually (see IVS Newsletter, Issue #60), we plan on an in-person event for TOW2023 only.

We feel it is important that there is a direct interaction between the teachers and the students; of course, we don't anticipate actual quarrels—perhaps some minor arguments—when we go toe to toe. In the online form it is virtually impossible to implement real hands-on training or to read how the material is being received. In addition, with the wide spread of time zones of the IVS stations, a virtual or hybrid event by necessity needs to be curtailed in time, reducing the material that can be covered (TOW2021 covered 60% of the class load of a regular TOW).

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We are aware that in a post-pandemic world (here's hoping) travel allowances may be challenging for the operators (but also teachers) and that thus the attendance level may not be as high as in the past. Still, we do hope that most stations will be able to send one or two technical representatives to the workshop. It is our experience that data quality improves after a TOW; this is a clear incentive to turn TOW2023 into a success. Let's go for it.

## Associate Analysis Center at ESA/ESOC

On January 13, 2022, the European Space Agency (ESA) officially became an IVS Analysis Center via its European Space Operations Center (ESOC). This step was the culmination of a process that started several years ago, when group members commenced to regularly attend IVS meetings (such as the GM and VLBI Training School in South Africa in 2016) to learn about VLBI data processing and to inform about the progress of the development of their own analysis software.



Newsletter editor Hayo Hase interviewed the VLBI Project Manager Erik Schönemann and Software Developer Sara Bruni to get an understanding of where things are and where they are headed. Here an excerpt of the interchange, slightly edited for clarity.

*Erik Schönemann, VLBI Project Manager.*

*Erik, ESA/ESOC is beginning activities in VLBI analysis. Where is your center in terms of hierarchy and where is it located?*

The Navigation Support Office is an integral part of the Ground Systems Engineering Department of ESA's Operations directorate. It is located at the ESOC in Darmstadt, Germany.

*The main objective of your branch is related to space navigation and mission support. What is the motivation to expand this activity to VLBI?*

Navigation in space and mission support heavily depend on the access to reliable estimates and predictions of the Earth Orientation Parameters, as well as on the availability of an accurate and precise Terrestrial Reference Frame. For many years, the Navigation Support Office at ESA/ESOC is contributing to the realization of these two

products in its capacity as an official Analysis Center of the International Association of Geodesy (IAG) Services for Global Navigation Satellite Systems (GNSS), Satellite Laser Ranging (SLR), and Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS). Therefore, it is natural to further expand our activity to the analysis of VLBI data, considering the key role of this technique in the realization of those geodetic products that are vital to ensure the unrestricted access to space for Europe.

*Why did it take so long for ESA to consider VLBI to be essential for its tasks?*

The first activities of our Office focused on satellite techniques. The unique information that VLBI was able to contribute has always been recognized and highly valued. However, while expanding our activities to techniques such as GNSS, SLR, DORIS, and satellite altimetry was quite natural, as all techniques are used for Precise Orbit



*Radio telescope at ESA's Kiruna station in northern Sweden.*

Determination (POD), VLBI required a shift of perspective that costed a little bit more effort. We wanted to integrate the VLBI processing by design in the NAVigation Package for Earth Observation (NAPEOS), the single analysis software that we use for all the geodetic data routinely processed by our Office. Since VLBI is not (yet!) satellite-based, harmonizing its requirements in an existing software already optimized for satellite techniques was not always trivial. On the other hand, we are quite proud of the achieved result that guarantees the highest possible consistency in the analysis of the different techniques, and also supports inter-technique combination at the observation level.

*Do you have plans to use your radio telescope infrastructure for geodetic VLBI operations?*

The use of ESA/ESOC's telescope infrastructure for geodetic VLBI operations is being discussed, but a final decision is still to be taken.

*What are your short-term and long-term goals with VLBI analysis?*

We are now in the phase of finalizing the implementation of a few missing models for the state-of-the-art analysis of VLBI data. As soon as this implementation will be completed, we will start submitting our solutions to the IVS, hoping to provide a valuable contribution to the whole community. In addition, we are looking forward to integrating the results of the ESA VLBI analysis in the ESA ERP Service that generates, on a daily basis, predictions of Earth Rotation Parameters (ERP) up to 119 days into the future. The Service, that is currently running in pre-operational mode on our infrastructure, will be published on our website once all IAG services have adopted the ITRF2020 in their official products.

On a longer time scale, we aim at further advancing our analysis capacity to support satellite missions hosting a VLBI transmitter. In this context, the Navigation Support Office is also actively investigating and promoting the actual development of future missions, strengthening the tie between VLBI and the other space-geodetic

techniques. As an example, as we speak, the financing of the future GENESIS mission is being discussed at the ESA Council at Ministerial level. If approved, this mission will co-locate a VLBI transmitter and receivers in space, implementing GNSS, SLR, and DORIS techniques.

*What is the benefit for your organization to participate in the IVS?*

Benefits have actually emerged even before committing to an official participation. The dialogue with IVS members and their support to our activities has always been constructive and fruitful. We would really like to take this opportunity to express our sincere gratitude. We believe that participating in the IVS will help us bridge any remaining gap in our analysis capacity and will deepen our understanding of the many components of the VLBI reality. At the same time, we aim to become active members of the community and to provide our contribution to the future of VLBI that looks, admittedly, rather exciting.



*Werner Enderle, Head of the Navigation Support Office.*

*Are there links between your space-oriented work and the Global Geodetic Observing System (GGOS)?*

We, ESA/ESOC's Navigation Support Office, are responsible for providing the Geodetic Reference for ESA and European space missions. In this context we are actively contributing to the



*European Space Operations Center (ESOC) in Darmstadt, Germany.*

generation of the Global Geodetic Reference via active contributions to the services of the IAG, being an Analysis Center (AC) for the International GNSS Service (IGS), the International Laser Ranging Service (ILRS), the International Doris Service (IDS), and now an Associate AC for the IVS.

*How did you become involved with VLBI?*

[SB] I grew up not far from the Medicina antenna. The countryside there is completely flat, and the antenna is a very distinctive landmark, visible and recognizable from quite some distance. The first time I visited the observatory as a kid, I remember being impressed by how quickly such a massive instrument could move. I am now really looking forward to visiting a VGOS site and being fascinated by the new generation of instruments.

*Besides long working hours, is there any special interest your team has?*

For many years, the Navigation Support Office indulges in a rather peculiar German tradition. Once a year, we gather for the Weißwurstfrühstück, a special breakfast based on Bavarian sausages and Pretzels. We also used to celebrate team members' birthdays with homemade cakes; but, since the beginning of the COVID pandemic, many gateaus are sadly long overdue... but we are planning to make good on this.

*Thank you for the interview and giving us insight into the work at ESA/ESOC.*



*Sara Bruni, Developer/Operator.*



*Inside ESA/ESOC's Navigation Facility.*

## Results of the Representative Elections

We are pleased to inform you of the results of the elections for the representative positions on the IVS Directing Board. The IVS Associate Members have voted on four positions in the period November 9–23, 2022.

The elected representatives are:

- Networks representative: Lucia McCallum, University of Tasmania, Australia
- Correlator and Operations Centers representative: Phillip Haftings, U.S. Naval Observatory, USA

- Analysis and Data Centers representative: Anastasiia Girdiuk, BKG, Germany
- Technology Development Centers representative: Chet Rusczyk, MIT Haystack Observatory, USA

Their four-year term runs from February 2023 to February 2027. We thank all of the candidates who were nominated for their willingness to serve on the Board.

– Election Committee

# Geodetic Observatory Wettzell Turns 50

Dirk Behrend  
NVI, Inc./NASA GSFC

On October 6, 2022, the Geodetic Observatory Wettzell (GOW) celebrated half a century of operations. About 100 attendees from Germany and around the world came together in Wettzell to honor the 50-year anniversary in a festive event, which was jointly organized by the two host institutions of BKG and TU Munich. A series of welcome notes by the hosts, national and local government representatives, and the IAG services was followed by two festive talks covering the history of GOW as well as its key role in the international reference systems.

The history was laid out by no other than Wolfgang Schlüter, who was the first IVS Chair and served for eight years in that function. Wolfgang was the director of GOW from 1983 to 2008. From its humble beginnings in 1972, the observatory has grown to become one of the best

equipped geodetic observatories in the world. Who would have thought 50 years ago that Wettzell would become a well-known name in the geodetic community? The first instrument on site was a laser ranging system. The 20-m radio telescope, which is still being used for VLBI today, was put into operation in 1983. And for about a decade now the site also sports VGOS twin telescopes.

In the history of the IVS, the GOW has played a major role in the service's development on several occasions. Beyond providing leadership in the forming years and quality VLBI data over the many years, the first IVS General Meeting was held in nearby Kötzing (it wasn't "Bad" at the time). A number of Directing Board meetings (including the inaugural one) took place

here and two dedicated technology meetings (the Workshop on Future Frequencies and Feeds in 2009; the VLBI2010 Workshop on Technical Specifications in 2012), which were instrumental for the development of VGOS, were organized. In that tradition, an IVS Retreat is planned to be held at GOW in June 2023.

Congratulations on 50 years of excellence!



Wolfgang Schlüter during his history lecture.



Wolfgang Schlüter and James Campbell in front of a depiction of the "Kötztlinger Pfingstritt," one of the largest mounted religious processions in the world being held on Whit Monday.



Attendees during a recess.

# New ITU-R Report RA.2507 on Geodetic VLBI

Hayo Hase  
BKG

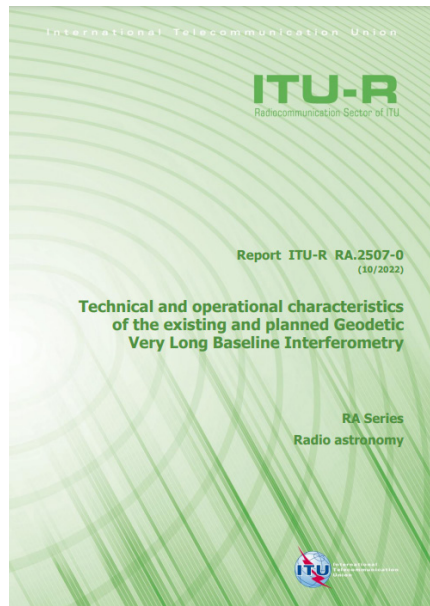
In October 2022, Study Group 7 (Scientific Services) of the ITU Radiocommunication Section published the approved Report RA.2507 ([https://www.itu.int/dms\\_pub/itu-r/opb/rep/R-REP-RA.2507-2022-PDF-E.pdf](https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-RA.2507-2022-PDF-E.pdf))

“Technical and operational characteristics of the existing and planned Geodetic Very Long Baseline Interferometry.” This is the first ITU-R document on geodetic VLBI and lists the levels of harmful signal strengths of unwanted electro-magnetic radiation to VLBI in its annex. This report should be known or made known at each VLBI station and at each national spectrum authority.

Geodetic VLBI observes cosmic radiation and belongs to the ITU-R service classification of the Radio Astronomy Service (RAS). As VLBI only receives but does not transmit, it is considered a passive service. Passive services are tolerated if they are not interfering communication services that own allocated frequency bands on a primary or secondary base. The term “radio frequency interference” is used in the language of spectrum management exclusively for owners of allocated bands and interfered by a third party. Geodetic VLBI has no allocated frequency bands. Hence VLBI operators cannot complain about radio frequency interference (RFI), although they may perceive any artificial signal in their spectra as RFI. But in a legal sense these are “only” unwanted electro-magnetic emissions. However, a few smaller bands in the VGOS range are allocated to RAS, and VGOS may observe with one observation channel in such an RAS band. But the VGOS bandwidth of at least 480 MHz is more than twice of what is allocated in total to RAS.

The legacy S/X-band VLBI network uses frequency bands allocated to space communication. When only a few satellites were being operated by a few space agencies around the world, an issue with unwanted electro-magnetic emissions to VLBI was rare. However, the world has changed. With the implementation of the VGOS broadband receivers operating in 2–14 GHz to gain more bandwidth and precision, the VGOS system faces more active services leaving their traces in the electro-magnetic environment and in the VGOS observation bands. With the introduction of smartphones and the commercialization of space, the active services request more and more bandwidth—making it harder to either find radio quiet zones for new radio telescope sites or to protect the existing sites against emissions from expanding communication networks and radars.

To protect a global VLBI network against unwanted electro-magnetic emissions is proving more difficult, as there is no equivalent global protector. Each country has its own spectrum authority which may serve as a regulator in the case of conflict of interest. Facing this



Hayo Hase as CRAF representative (and in his function as IVS representative at CRAF and Work Item VGOS chair) during the ITU-R meeting in Geneva, Switzerland, on September 30, 2022.

administrative-legal situation, the European Committee on Radio Frequencies (CRAF) took the initiative to bring geodetic VLBI to the attention of ITU-R through the Working Party 7D (Radio Astronomy) to have the participating countries agree on this first document on geodetic VLBI and its requirements. As the protection criteria are similar to those of radio astronomy, a certain recognition for coordination zones near radio telescope sites shall be expected in most countries. However, cosmic radiation comes from far and

is faint; radio telescopes are supersensitive, but unwanted emissions are strong and from nearby.

*I would like to thank Marta Bautista, Raimund Becker, Susana García, Juha Kallunki, Michael Lindqvist, Harvey Liszt, José Antonio López Pérez, Waleed Madkour, Jürgen Nitschke, Ganesh Rajagopalan, Tasso Tzioumis, Vincenza Tornatore, Bevin Ashley Vanderley, and Benjamin Winkel for contributing to this achievement.*

## Santa Maria Installs VGOS Receiver

*João Salmim Ferreira and Mariana Moreira  
RAEGE Santa Maria*

RAEGE Santa Maria station (RAEGSMAR) is located in the middle of the Atlantic Ocean on Santa Maria Island in the Archipelago of the Azores, Portugal. RAEGE is a joint project between the Instituto Geográfico Nacional of Spain and the Regional Government of the Azores. The radio telescope of this station (13.2-m dish) was equipped with a tri-band (S/X/Ka) receiver until October and was observing in the IVS R1/R4 sessions since May 2021.

During October, Santa Maria was the stage of very exciting work: a new VGOS receiver—designed and developed at Yebes Observatory—was installed. A team of five engineers from Yebes alongside with a local team of ten people successfully installed the new receiver together with a DBBC3, two Mark 6, baseband down-converters, and a new cable delay measurement system (CDMS).

The VGOS receiver has new 30-dB cryogenic directional couplers for Phase-Cal and Noise-Cal signal injection in front of the LNAs. It is equipped with a new 10-MHz-spaced tone generator and a new CDMS, both with improved thermal stability. Finally, the baseband down-converters have one mixing stage only, with less phase noise and spurious signals than up/down converters.

The station is still in the process of optimizing the VGOS signal chain. Single Dish Experiments (SDEs) and VLBI tests with the stations of GGAO and Yebes are being performed. These tests are crucial for the fine tuning of the whole receiver and backend chains. Once done, we will join the VGOS network and contribute to fulfill the VGOS goals.



*Installing the VGOS receiver on the radio telescope.*



*Joint installation team from the Santa Maria and Yebes groups.*

# Check the Checklist

Alex Burns and Mike Poirier  
MIT Haystack Observatory

The operator checklist that you use during your session startup and shutdown should be a living, breathing document. During each TOW we talk about using the station's checklist to ensure that every precheck procedure has been completed successfully. The list is a comprehensive one, specific to each station, which includes the systems, computers, network requirements, and many user accounts and passwords that are used by the operators. This list has a lot of information, and what I wanted to share today is that the station must go back often to update this list!

The checklist contains commands and procedures working with every piece of equipment in the VLBI system. Those pieces of equipment can have upgraded hardware installed, new software or firmware versions, and security patches. All of these can cause the system to fail and or the checklist to be modified. It can be as simple as removing or changing the command or procedure. It could be a syntax change caused by a new software version. Whatever the case is, it takes a lot of additional effort to go back each and every time to keep the list up-to-date to keep your station running smoothly.

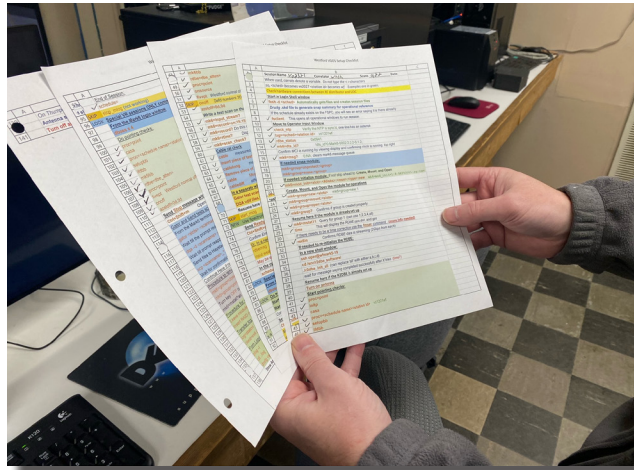
At all sites, there is at least one guru operator who has an entire VLBI Wikipedia inside their head, a mental code base with equipment software version numbers, error codes, and workarounds already mapped out. In cases like this, the checklist can sit in a dusty corner of the console, abandoned, until a new employee comes along and tries to set up

the rack. If you think your checklist is complete and concise, basically a shining example against which all future checklists should be measured, do me a favor: give it to the newest team member and have them read it and try to set up the system by themselves. I guarantee the site guru will discover all the little automatic things they do that aren't on the list. For example, maybe you list out very descriptive steps to run a particular check,

but you forget to mention this check is run in a different shell window than the previous step! Little things like this are autocorrected in your head but can cause a total derailing of the setup by another or new operator.

Of course, even for the guru, there can be gotchas. If an update is pushed to a recorder or backend, the order of the steps might change, or a new command may be needed. Maybe your site has security requirements, and all your passwords must change every 90 days, be 256 characters long, include one state capital, a special character, three separate languages, and a song verse to meet the requirements. That's a lot of passwords to remember. Even for a guru.

So, take the time now to look at your documentation. Make sure all your special use cases are well written. Make sure all the login information is being disseminated to all the operators as needed. Please make sure someone can read it and follow the directions without needing ten years of previous experience to understand. Your new operators will thank you for the clarity, and maybe even the guru will appreciate not having to put out fires after other operators attempt to set up sessions.



Westford VGOS setup checklist.



# Updating the Correlator Report Format

Phillip Haftings  
U.S. Naval Observatory

Communication between stations, correlators, and analysts is extremely important. The correlator report is one of the primary ways that correlators communicate issues to stations and considerations to analysts. They are published to the IVS mailing lists, the IVS data centers (.corr files), and in each vgosDB archive file (.hist file inside the History directory). Reports contain important feedback to stations, including, but not limited to, unexpected clock behavior, phase calibration efficacy, experiment setup issues, non-detections, and signal-to-noise performance. The reports also serve to communicate this info and salient details from the stations' start/stop messages directly to analysts.

The format of these reports was last updated in 2017 in a pair of IVS memos. Several extensions and modifications to the format have been proposed since then, including a discussion at the 2019 Technical Operations Workshop (TOW) and an IVS Correlator Telecon in February 2022. After a great deal of thoughtful commentary and iteration, an updated version 2 of the IVS Correlator Report format is now available.

The new format seeks to retain most of the features of the old format, while also improving it with some new features:

- Unambiguous “magic number” and format version
- Cleaner, more consistent presentation
- Dramatically improved machine readability
- Support for VGOS and alternative band setups
- Compatibility with new vgosDB naming convention
- Additional correlation and fringing configuration details
- Explicit support for future extensions

The new format also comes with a software package to generate and read the reports. This allows correlators to automate most of the report generation process, and anyone receiving the reports to automate reading them as well, e.g., for interoperability with remote VLBI and network automation. The new software is available at <https://github.com/USNO-VLBI/main>, with a memorandum at <https://github.com/USNO-VLBI/main/blob/main/doc/report-memo.md>.

Correlators are expecting to start implementing the new format in early 2023. Work to ensure compatibility with downstream software is already underway. Thanks to all the hard-working folks who provided input and guidance to this effort!

## Meetings

EGU General Assembly 2023  
Vienna, Austria  
April 23-28, 2023

Twelfth IVS Technical Operations Workshop  
Haystack Observatory  
Westford, MA, USA  
April 30 - May 4, 2023

26th EVGA Working Meeting  
Bad Kötzting, Germany  
June 12-16, 2023

28th IUGG General Assembly  
Berlin, Germany  
July 11-20, 2023

# Unified Analysis Workshop Held in Greece

Benedikt Soja  
ETH Zurich



Participants of the Unified Analysis Workshop 2022.

The purpose of the Unified Analysis Workshop (UAW) is to bring together members from the different space-geodetic techniques, including VLBI, and discuss common issues and solutions. In October 2022, the seventh edition of the UAW was held in Thessaloniki, Greece, organized by Christopher Kotsakis from Aristotle University of Thessaloniki. The UAW was preceded by the IAG International Symposium on Reference Frames for Applications in Geosciences (REFAG 2022), which meant that several participants were already on site. Although both meetings were organized in a hybrid way, it was good to see most participants making the trip to Greece to meet in person. After more than two years of mostly virtual conferences, it was a very refreshing way of re-convening with many friends and colleagues, which certainly benefited the lively discussions and interactions.

The evening before the official start of the UAW, John Gipson, who was leading the IVS delegation, invited us to an informal get-together with snacks and drinks. Several participants with ties to VLBI joined and spent the evening together in good

spirits, which already set the positive atmosphere for the remaining workshop.

On Friday, October 21, the UAW officially commenced with opening words from Christopher Kotsakis (LOC), Basara Miyahara (GGOS), Robert Heinkelmann (IERS), and Zuheir Altamimi (IAG). The first day was focused on the individual space-geodetic techniques (DORIS, GNSS, VLBI, and SLR). Common themes included the handling of the atmosphere and the application of ITRF2020 in the data analysis. Certain technique-specific issues were also discussed, such as phase center modeling in GPS or range biases in SLR. As for VLBI, Rüdiger Haas addressed antenna deformations (both thermal and gravitational), Minghui Xu discussed the importance of source structure effects (especially for VGOS), Benedikt Soja gave an update on tropospheric modeling and corrections, and Hendrik Hellmers covered the transition to VGOS from an analysis point of view. The VLBI part was concluded with a presentation by John Gipson on the VLBI scale in relation to ITRF2020. VLBI only contributes to the ITRF2020 scale until 2013.75 and the reasons for the scale discrepancy between VLBI and SLR after that are under investigation.

The discussion on the scale of the ITRF was also an important topic of the second day. Potential scale issues of VLBI are not visible in DTRF2020, whereas SLR seemed more problematic. DTRF2020 is thus based on the scales from VLBI and, for the first time, GNSS. JTRF2020 was not completed by the start of the UAW. Other important topics of

Day 2 included the update to the IERS Conventions (with a presentation by John Gipson on the new high-frequency Earth rotation model) and the geodetic infrastructure. For the IVS, Rüdiger Haas highlighted plans concerning the determination of dUT1 twice per day, several 24-hour VGOS sessions with 12+ stations, S/X sessions for the celestial reference frame, and additional R&D sessions.

The final day allowed for additional discussions and eventually concluded with summaries of the individual topics. A written summary with recommendations will be provided following the UAW. After three long days (with the scientific program running from 8:30 to 19:00), the UAW was thus concluded.

All in all, the UAW was very successful, with fruitful discussions and exchange of ideas. The venue at

Electra Palace was well chosen, allowing participants to meander through the city center during breaks and for dinner. Everyone agreed that the cuisine was excellent and very affordable, making the stay in Thessaloniki not only a scientific but also a culinary pleasure.



*Rüdiger Haas during a VLBI presentation.*



*White Tower of Thessaloniki at night.*



*A view of Thessaloniki.*

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

Please send contributions to the General Editors; the deadline is one month before the publication date. The editors reserve the right to edit contributions.

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