

# IVS NEWSLETTER

## ISSUE 62, April 2022



### A Busy First Quarter

The first three-plus months of 2022 have been busy for the IVS. There were new Intensive sessions added to the observing program (e.g., legacy S/X ones to test o UT data points for dUT<sub>1</sub> determination without interpolation, VGOS ones to establish more baselines and involve more correlators). With over 800 Intensive sessions planned for 2022, we have almost doubled the amount compared to a couple of years ago. We held a VLBI Training School and an IVS General Meeting, both with the largest participation in IVS history, as well as numerous Board meetings. ITRF2020 was finished and we observed a volcanic event at Tonga.



### News from the Board

Dirk Behrend

NVI, Inc./NASA GSFC

The IVS Directing Board held a few regular meetings as well as special meetings during the first quarter of the year. The latter were related to responding to the crisis unfolding in Ukraine. As a member service of both the IAG and the IAU, the IVS was involved in the issuance of their respective statements; the releases are also available on the IVS Outreach website at <https://vlbi.org/2022/03/03/iag-releases-statement-on-ukraine/>. Furthermore, the Board released its own response to the war in Ukraine; the statement can be found on page 11 of this issue.

Other noteworthy items from the slew of meetings include the following: (1) The VLBI analysis group at ESA/ESOC was accepted as an IVS Analysis Center (AC); the group will start out as an Associate AC and will be elevated to an Operational AC after a qualifying period. (2) The Board endorsed aligning the UT1 Intensives to the needs of our sister services (mostly the IGS) by shifting the reference epoch to midnight UT (23:30–00:30 UT observing time period), which avoids an extrapolation step in the satellite orbit determination. The implementation may be contingent

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on establishing automated operations at some of the stations .

Finally, I have to report that James Anderson left the VLBI world and resigned from his position as Analysis and Data Centers representative on the Board. He is being replaced by Anastasiia Girduik, who will serve out James' original four-year term. Thank you, Anastasiia, for being available to serve.

## The Wettzell Correlator (WETZ)



Wettzell's correlator crew (from left): Julia Konadl, Michael Seegerer, Robert Wildenauer, Willi Probst, Christian Plötz, and Torben Schüler.

On September 30, 2021, the Geodetic Observatory Wettzell (GOW) became an official IVS correlator. Since then, the Wettzell Correlator (or WETZ in IVS shorthand) has commenced work mostly in processing VGOS data. Newsletter editor Hayo Hase interviewed the WETZ lead Christian Plötz as well as the GOW director Torben Schüler to learn more about the current state of affairs and the plans going forward. Find below an excerpt of the interchange.

Christian, you have recently become the Head of VLBI at the GOW. As such, the new IVS component, the Wettzell Correlator, is part of your responsibility. How did



GOW Head of VLBI (BKG) Christian Plötz

you enter the VLBI world and how did you learn about correlation?

My first job at the GOW was as a student working the night shifts at the 20-m radio telescope. After finishing my studies of electrical engineering and working as a development engineer for analog power amplifiers, I returned to Wettzell at the beginning of 2002. My task, realizing VLBI campaigns at O'Higgins in Antarctica, was exciting. I was frequently travelling there doing VLBI operations until 2015. In 2016, we launched the short baseline VLBI observation project at the GOW. For that purpose, I installed a DiFX correlator on a small server and became engaged with the topic.

Why do you like to work in VLBI?

Since my first steps in VLBI, there was always something new to discover. In 2002 there were still magnetic tape recorders, analog backends, and hardware correlators in use. Since then, new developments brought new challenges. An inspiring period started in 2011 when we were developing and building the TWIN radio telescopes. Altogether, VLBI has many interesting facets. I am fascinated with the development of new technologies and methods. And the international collaboration is very enriching.

*From your experience, what is needed to start a correlator from scratch?*

To start a correlator from scratch you will need some understanding of how VLBI works to prepare all necessary input files for the correlation process (e.g., clock offsets) and to be able to judge if the results are usable. A good knowledge of signal processing, handling of typical procedures for data processing, and an affinity to computer systems are helpful. As a first step at Wettzell, we ran the DiFX software correlator on a single server. Of course, the planning and setup of a professional High-Performance Cluster (HPC) is a higher-level task for which we investigated typical HPC topologies with support of external assessments. Lastly, the good exchange of information with colleagues in Bonn and the whole community facilitated us to build up the correlation capacity.

*What is the maximum baseline capacity? Do you have plans to extend it?*

Currently, the most significant limitation we have is the storage capacity. If you calculated roughly for a ten-station VGOS network with about 300 TB (with the current 8 Gbps observation mode), we would be able to store only two sessions before going any further. For a larger VLBI network, the transfer capacity of 5 Gbps would need to be extended to 10 Gbps. These upgrades are in the pipeline and will be applied, if necessary. The baseline capacity itself depends mainly on the main memory of the compute nodes, which has been sufficiently dimensioned and can be easily upgraded in the future.

*Who is working with you in correlation?*

Our correlation group consists of Willi Probst, Michael Seegerer, Robert Wildenauer, and myself. We are all involved in the routine correlation duties. Willi is a physicist and expert in radio frequency interference. His focus is on data quality assurance and quality processes. Michael handles the VLBI IT administration and the reporting of quality met-

rics of the VLBI system. As a computer scientist, Robert takes care of all IT related aspects including programming and configuration duties of the VLBI system. Julia Konadl is responsible for coordination and overall performance monitoring. Torben Schüler is head of the GOW and leads the overall activities of our operations.

*Which sessions are correlated at Wettzell? What are your plans for the future?*

Since December 2021, we have been processing the S2 VGOS Intensive sessions between Wettzell-South (Ws) and McDonald (Mg). Currently, this one-hour session is scheduled once a week.

Related to that is the observation program S2a, which is intended to improve the scheduling of the S2 series. A strong focus in the near future is the automation of the VGOS Intensives correlation. Latency is crucial for dUT1 determination and, therefore, we will exploit all possibilities to reach this goal.

*Christian, to finalize this interview, what are your preferred leisure activities?*

Currently, most of my leisure time I spend with my two little kids. My daughter is three years and my son seven years old. Pleasantly, my family keeps me rather busy. I also like biking and hiking in the mountains of the Bavarian Forest.

*Torben, the 2008 Directive on European Critical Infrastructure of the European Community established procedures for identifying and designating European Critical Infrastructure. Germany identified the GOW as a national critical infrastructure. What does this classification mean for the GOW in general and for the correlator in particular?*

The data measured at Wettzell yield important operational parameters for satellite navigation. All parts of the GOW in support of the European satellite navigation system Galileo as well as GPS are considered a critical asset for the sector of transportation. All components of VLBI are classified as



*GOW Director Torben Schüler*

a critical infrastructure, including the correlator. The WETZ correlator is important to reduce product latency. With three telescopes at the site and their data already residing at the local repository, we need to receive the partner telescopes' data and can start correlation. Hence, we can speed up product delivery considerably. However, we must fulfill strict requirements regarding IT security and reliability. In this context, we are implementing a comprehensive risk management system according to national standards. This also means additional efforts, and more bureaucracy. Being a "critical infrastructure" is not just a label.

*BKG is also supporting the correlator at the Max-Planck-Institute for Radio Astronomy in Bonn. How is the correlation work divided between Bonn and Wettzell?*

We started to fund geodetic VLBI correlation at Bonn in the year 2000. The Bonn correlator is one of few correlators enabling the IVS to provide global geodetic services, so to say a pillar of long-term stability. Compared to the mature state of Bonn, we have just started to become a qualified correlator within the IVS. The prime focus of WETZ is on "mission-critical sessions." In very few words, this means to deliver satnav support in terms of UT1-TAI accuracy at a level of approximately 60  $\mu$ s or better and low product latency. We have not yet started to initiate any coordinating action regarding a correlation share between Bonn and Wettzell. However, given the sheer amount of VLBI data in the VGOS era, both correlators will face a high level of utilization.

*Where do you see the bottlenecks when VGOS will be rolled out to 24h/7d operations?*

VGOS requirements are challenging. From a local perspective, we have a road map to increase the bandwidth from the current speed of 2 x 5 Gbps to 2 x 10 Gbps as soon as a clear need arises. Being a critical infrastructure also imposes the need to implement a secondary network line from an independent provider. However, the main limitation will be man and woman power. Hence a key aspect will be automation of the correlation process. From a more global IVS perspective, I must emphasize that VGOS correlation will have to be



*View of the WETZ correlator computing cluster.*

a collaborative approach rather than the work of just some few correlators. Consequently, we will encourage the community to investigate the prospects of distributed correlation systematically.

*Torben, after a long working day, what is your favorite leisure activity?*

Living in the Bavarian Forest is like being on vacation for the entire year (excluding those days when it is raining). Our home is beneath a small hill and I am regularly cycling to the top, an ascent of a bit more than 300 meters. A round-trip tour takes me about 40 minutes to complete. I like to do this after a long working day (or before, or both).

*Thank you both for the interview. All the best for your correlation efforts and the challenges of the critical infrastructure.*

# 4th VLBI Training School: Virtual Edition

Abel García, Diogo Avelar, Mariana Moreira, Valente Cuambe  
RAEGE Santa Maria

The 4th IVS Training School on VLBI for Geodesy and Astrometry was celebrated between March 22–25, 2022, three years after the previous school in Gran Canaria. Due to the Covid-19 pandemic,

for the radio astronomy world! A splendid and interactive presentation illustrated the imaging of astronomic sources with the data available from the correlated sessions, naturally invoking the importance of the baseline choices in this kind of exercise.



The teaching team of the 4th VLBI Training School.

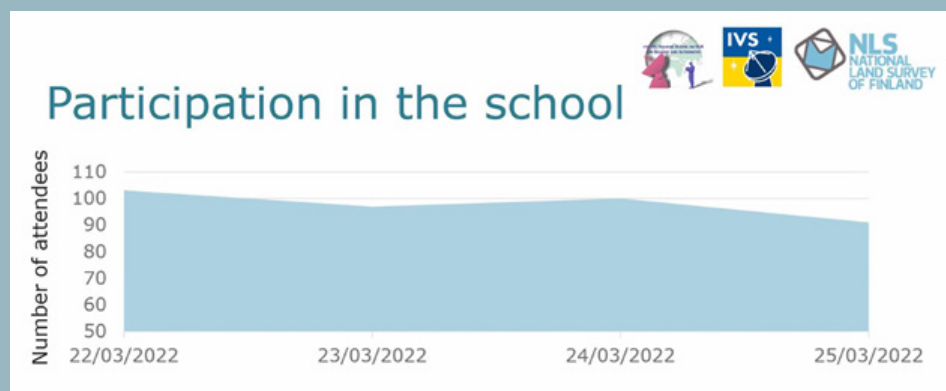
this training school had a very different format from the previous ones, being entirely moved to a virtual setting. Despite the unusual format, for those of us who were new in VLBI, and even for repeating attendees, the expectation was high.

The school sailed off with the motivations that take the scientific community on using the VLBI technique to obtain valuable data for geodesy and geosciences. The participants were also presented with detailed information about the VLBI data chain: starting from the astronomic observable sources with analog signals, the radio telescopes to collect it, the calibration signals along the path, and finally the digitization, recording of data, and delivery to the correlator.

After a global overview of geodetic VLBI, it was time

Once the motivations and technology were all explained, the school moved on with an amazing overview of scheduling and a hands-on demonstration of the VieSched++ software used to create the observations. The webinar moved on to the correlation and fringe-fitting topics. Participants are now able to answer complicated questions such as: “How do we plan observations?”, “How do we determine delays?”, and “How do we determine group delays?”

Following along the data chain, modelling and data analysis were the main topics of the last day of school. The geophysical models used by analysts and the signal propagation, with a focus on the Vienna Mapping Functions, were discussed in the first part of the day. Having discussed the theory of data analysis, the processing chain was then presented. The school ended with a brilliant and comprehensive exercise on nuSolve, allowing



The level of participation varied slightly over the days. Note that some attendees shared the same computer for Zooming.

beginners a great start on the software and experienced analysts to extend their knowledge.

We are pleased to mention the amazing work done by the organizing committee and all the teachers at the school, with special thanks to Nataliya Zubko, Rüdiger Haas, Alet de Witt, Chris Jacobs, Ganesh Rajagopalan, Marjolein Verkouter, Matthias Scharner, Lucia McCallum, Johannes Böhm, John Gipson, Sergei Bolotin, Patrick Charlot, and Frédéric Jaron.

To conclude we would like to acknowledge the high number of participants (90–100) in all sessions, partially due to the videoconference format. In general, the school accomplished the overall objectives such as preparing for the next generation VLBI, both in terms of technical development and in terms of conveying knowledge between generations of researchers. It is important to mention that, although

this virtual format has clearly its advantages, there is a lack of interaction between the speaker and the audience during the lectures. To lessen this issue to some degree, the audience had the chance to interact through chat messages.

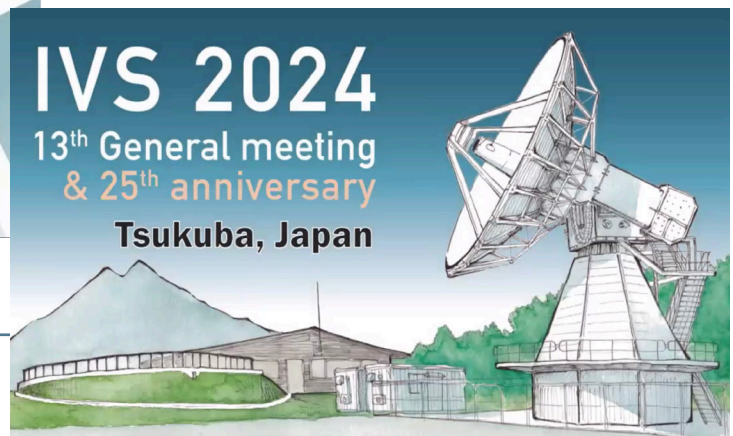
The overall impression of the school is very positive thanks to the organizing committee and the teachers mentioned above who all did a very good job from start to finish!



Nataliya Zubko, lead of the organizing committee.

## Open Tutorial on VLBI

Axel Nothnagel prepared an open tutorial on geodetic and astrometric VLBI (Elements of Geodetic and Astrometric Very Long Baseline Interferometry), currently a 50+ page document. The tutorial is intended for educational purposes, in particular for newcomers to geodetic and astrometric VLBI, but also for the specialists wanting to expand their knowledge on certain topics. It is a living document and contributions (additions, corrections, and clarifications) are welcome. You can find the most recent version of the tutorial as well as contact information on Axel's homepage at: [https://www.vlbi.at/index.php/rushmore\\_teams/axel-nothnagel/](https://www.vlbi.at/index.php/rushmore_teams/axel-nothnagel/).



## Meetings

AOGS 19th Annual Meeting  
Honolulu, HI, USA  
June 5–10, 2022

IAU XXXI General Assembly  
Busan, Republic of Korea  
August 2–11, 2022

REFAG 2022  
Thessaloniki, Greece  
October 17–20, 2022

Unified Analysis Workshop 2022  
Thessaloniki, Greece  
October 21–23, 2022

GGOS Days 2022  
Munich, Germany  
November 7–25, 2022

AGU Fall Meeting  
Chicago, IL, USA  
December 12–16, 2022

The 13th IVS General Meeting will be held in March 2024 in Tsukuba, Japan. As part of the GM, there will be festivities for the 25th Anniversary of the IVS. The local organizers published a teaser video on the GGOS YouTube channel at <https://www.youtube.com/watch?v=mQkA8VHKWD4>.

# 12th IVS General Meeting Held in Cyberspace

Yu Takagi  
GSI Japan



Markku Poutanen, IAG Secretary General, giving a welcome address.

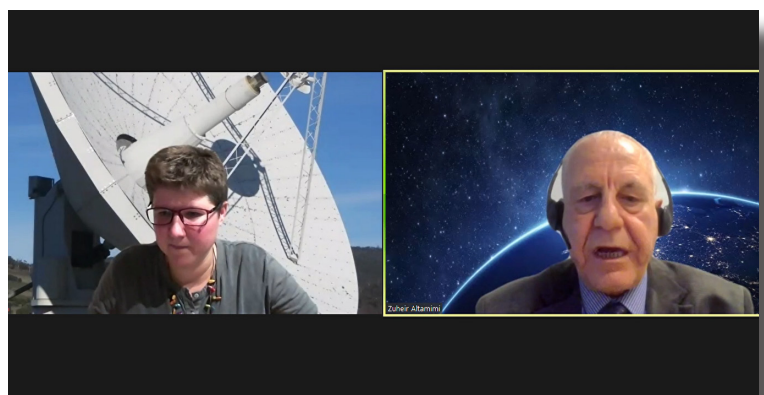
In the last week of March 2022, the IVS held its 12th General Meeting (GM) in cyberspace. This GM was organized after a four-year break, because, unfortunately, the previous GM in 2020, which was scheduled to take place in Annapolis, was canceled due to the COVID-19 pandemic. The 12th IVS General Meeting was initially planned as a hybrid event in Helsinki, Finland; but due to the worsening situation caused by the worldwide spread of the Omicron variant the format was changed to online only. Recently, many academic conferences and meetings have been organized online and a lot of experience has been gained; however, this was the first time that an IVS General Meeting took place online. Therefore, it can be assumed that the planning by the LOC and SOC was very hard.

On Monday, March 28, the meeting started with the welcome addresses from Arvo Kokkonen, Director General at National Land Survey of Finland; Markku Poutanen, IAG Secretary General; and Rüdiger Haas, Chair of IVS Directing Board. This was followed by five science sessions over four days. Two or three chairs led each session.

The session dealing with technical developments at the stations was led by Nataliya Zubko, Stuart Weston, and José A. López-Pérez. In this session, Rolf Dach talked about the effect of  $UT_1$  on satellite techniques and Federico DiVruno represented the effect of large satellite constellations on

VGOS operations as invited presentations. Fengchun Shu, Chet Rusczyk, and Phillip Haftings managed the session about observations, operations, and correlation, in which the status of some projects, stations, and correlators was shared. The session about data structures, scheduling and analysis strategies was chaired by Anastasiia Girduik, John Gipson, and Matthias Schartner. In this session, some results and analysis strategies of VGOS observations were presented. Lucia McCallum and Chris Dieck presided over the talks about the interpretation of VLBI results in geophysics, geodesy, and astrometry. In this session, Zuheir Altamimi gave a summary of ITRF2020 and talked about the contribution from IVS as an invited presentation. Finally, Alet de Witt, Megan Johnson, and Benedikt Soja headed the session dealing with extending the use of VLBI to frame ties, deep space exploration, and other areas.

Poster/video sessions took place for three days from March 28 to 30 after the oral session block of each day, using a system called Wonder.me. This was a fascinating system, and it felt as if we were actually in a poster hall. When we entered the 'poster hall,' there was a space for each poster. Once inside, we could discuss with the presenter and other participants as if we were in front of the poster. We could also see who was in the 'poster hall' at a glance and could freely create spaces for conversation and free discussion outside each poster space. We hope that the participants had a meaningful time using these functions.



Zuheir Altamimi (right) gave an invited talk about ITRF2020 in a session chaired by Lucia McCallum (left).

There were 98 contributions throughout the four days. Of these, 59 (about 60%) were given as oral presentations. The remaining 39 were given as poster/video presentations. The number of presentations was almost the same as the previous meeting. On the other hand, the proportion of oral presentations was slightly lower than in the last meeting. This may have been due to the time constraints imposed by the online participation from different time zones. However, all sessions were lively and opinions were exchanged. I look forward to further developments in the future.

What was notable about this meeting was the number of participants. In fact, 177 people registered. Although on-site communication was not possible (many participants may have been looking forward to an excursion and dinner in addition to the scientific program), it was significant that many people interested in the application of VLBI were able to share their research and situation.

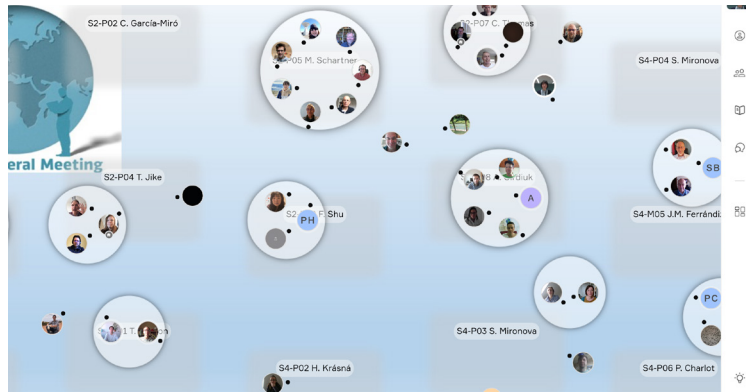
Several splinter meetings were held before and after the GM. The 4th IVS Training School on VLBI for Ge-

odesy and Astrometry took place from March 22 to 25, and an Analysis Workshop and a Correlator Workshop were held on April 1. All of them had many participants. Finally, the Directing Board had a meeting on April 5.

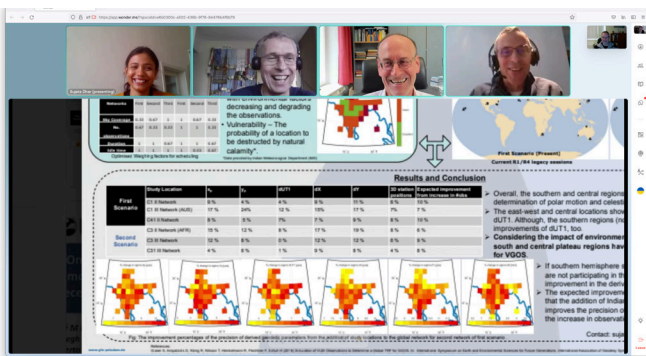
We would like to thank Nataliya and all of the local hosts for their preparation and management of this meeting. It's expected that planning an all-virtual meeting would be challenging at short notice. It would also be challenging to create a program that works for all participants coming from so many time zones. Nevertheless, I think it was

a successful meeting. Arvo Kokkonen hoped that we visit Metsähovi Radio Observatory someday in the opening address. I would be happy to have the opportunity to visit Metsähovi when the situation with the COVID-19 pandemic improves.

The 13th IVS General Meeting—the next GM—will be held in Tsukuba, Japan, in 2024. That year will mark the 25th anniversary of the establishment of IVS. We are looking forward to seeing you in Tsukuba in person.



'Poster hall' provided by Wonder.me. It provided a convenient platform that made the participants feel as if they were in an actual poster hall.



At each poster space, the participants were able to discuss directly with each other.



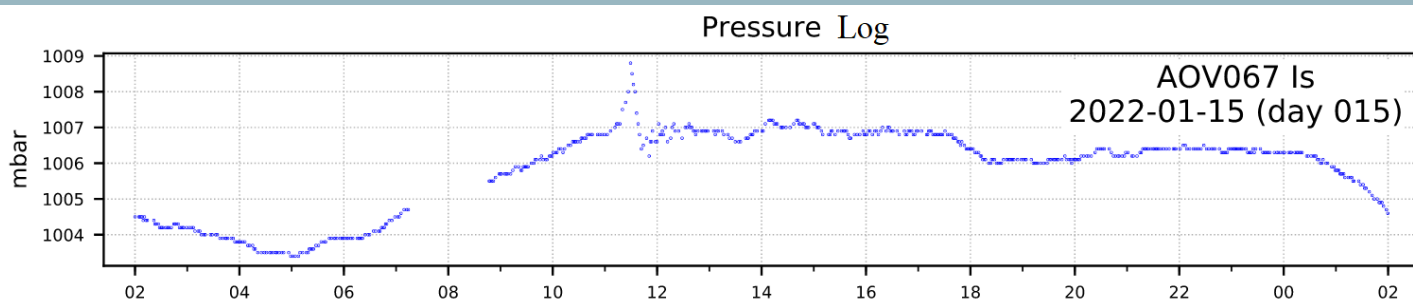
IVS Chair Rüdiger Haas giving his closing remarks.



# Hunga-Tonga Hunga-Ha'apai Event

Alexander Neidhardt

TU Munich (with support from IVS stations)



Pressure plot for Ishioka based on the log file of AOV067. Pressure wave from Tonga event visible between 11–12 UT.

It was an almost normal day in the island region of Tonga on January 14/15, 2022. However, one of the largest phreatomagmatic events, ever measured, shook the region of 100 kilometers around the underwater volcano Hunga-Tonga Hunga-Ha'apai (HTHH) on January 15 at 04:14 UT. The eruption sequence lasted 11 hours and changed the whole region. Satellite films show a dramatic first eruption. Volcanic dust of several centimeters was found all over the island nation. A tsunami crashed into the west coast of Tongatapu Island resulting in a state of emergency for several days.

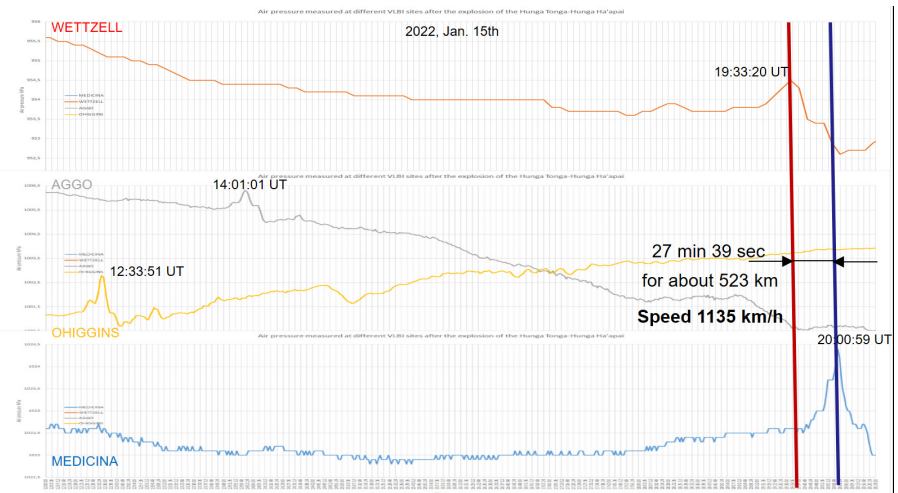
The event also sent out a series of waves around the globe. Besides the usual shock waves in the ground, there was also a huge pressure wave propagating in the atmosphere. The IVS operated an AOV session at the time of the eruption on the network Hobart (Hb), Ishioka (Is), Koganei (Kg), Kunming (Km), Syowa (Sy), Warkworth (Ww), and Yarragadee (Yg), which started at 02:00 UT on January 15. Because of the Tonga event, the processing of AOV067 was given higher priority and Tsukuba did a correlation of the session (without the Syowa data). Sergei Bolotin from NASA did a standard processing run. The hope was to see effects in the zenith delay or gradients. But using the standard analysis there were no detectable effects or changes visible in the analyzed data.

Nevertheless, the pressure wave is visible in the meteorological data from the session log files of, e.g., Warkworth, Yarragadee, Ishioka, and Koganei. But the resolution could be better. Here an advantage of the IVS Seamless Auxiliary Data Archive (SADA) comes into play. Data from different sites are available even if the antennas do not participate in an observation session. The temporal resolution of the data usually is one minute or better. This resolution can even be adapted almost in real-time, if events are expected. Finally, the data can be extracted exactly for any given time interval around an event, like just for the HTHH explosion.

Using data from the archive—here: barometric data from AGGO, Medicina, O'Higgins, and Wetzell—it was possible to detect the pressure wave all over the globe. It is even possible to exactly derive the running time of the wave between dif-

The data archive is available at <https://vlbisyson.evlbi.wetzell.de/zabbix/>. A Python script can be used to extract data seamlessly from the archive. Sites can participate by sending their data via encrypted SSH calls and without installation of additional software. Contact: A. Neidhardt, [alexander.neidhardt@tum.de](mailto:alexander.neidhardt@tum.de).

ferent sites. For example, it required 27 minutes and 39 seconds for the distance of 523 kilometers between Medicina and Wettzell. This leads to a speed of 1135 km/h (see figure). A similar number of 315 m/s (= 1134 km/h) was published by the Royal Meteorological Society in London. It shows that the sensors at VLBI sites can achieve a similar quality in auxiliary data sets as official meteorological sites and thus may support other scientific disciplines because of the widely distributed network. Furthermore, the IVS SADA and/or full logs are able to improve the quality of the final IVS products.



Pressure curves for four IVS stations based on data from IVS SADA.

## Do You See What I See?

Alex Burns and Mike Poirier  
MIT Haystack Observatory

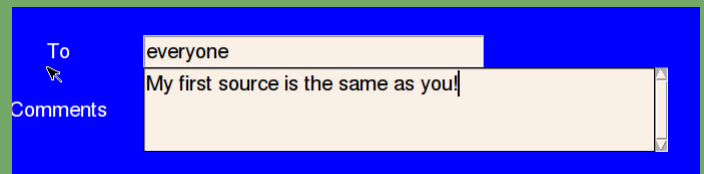
We've all been there, wrapping up an observing session. You're feeling great, sending the logs and even beginning a possible e-transfer, only to realize later that the entire disk pack is filled with useless data, because you had executed a different schedule file than everyone else. Argh!

Sometimes, the schedule must change, usually because of a station problem or if there is a mistake in creating the original schedule. When this happens, the operation center will always change the first source of the replacement schedule to keep track of the changes. This way, when you send your ready message to ivs-ops, you and others will be able to see that you have the same starting source (and start time!) as all of the other stations in your session. The operation center will also be able to see these start messages. And if something is questionable, they can notify the station quickly—to reduce the possible data loss.

However, the ultimate responsibility lies with the station operator. Pay attention to the emails with your session name in the subject line. Late

schedule changes can sometimes even be sent to the [ivs-urgent@lists.nasa.gov](mailto:ivs-urgent@lists.nasa.gov) mail list, so make sure it doesn't go to your junk folder!

Sometimes schedules are loaded, setup, and tested on the stations PCFS well before the scheduled time, so that the station can be sure they are ready for the actual day of the session. If there are any questions or problems detected, you can then notify the scheduler. It is recommended that, on the day of the session, you check to make sure you have downloaded and drudged the latest version of the schedule you are about to run. Always put the first source of your schedule in your ready message, so you can be sure it's correct! Then, you know all of your hard work will be for good data!



## IVS Response to War in Ukraine

Dear colleagues,

The IVS is a member of the IAG and the IAU, both of which have condemned the unprovoked invasion of Ukraine by Russia. The IVS has posted links to these statements on its outreach website, <https://vlbi.org>.

The IVS charter states that the purpose of the IVS is, among other things, to foster the VLBI technique as an international collaboration, to produce VLBI data and products, and to make those data/products publicly available without any restrictions. This underpinning of free exchange of scientific ideas and data is independent of any political ideologies. With the Russian war of aggression raging in Ukraine, it is difficult to uphold these principles.

The IVS is a voluntary collaboration of independent member institutions and cannot dictate specific actions to its members in reaction to the Russian invasion. IVS member institutions need to follow the guidance of their respective governments or governing boards. Some IVS member institutions have already indicated that they will not participate in IVS sessions involving Russian VLBI stations. The IVS Coordinating Center will implement these decisions and at the same time try to maintain a reasonable level of operations.

Everyone on the IVS Board is deeply concerned about the war in Ukraine and hopes that the current abhorrent situation will come to a peaceful resolution soon.

*IVS Directing Board*

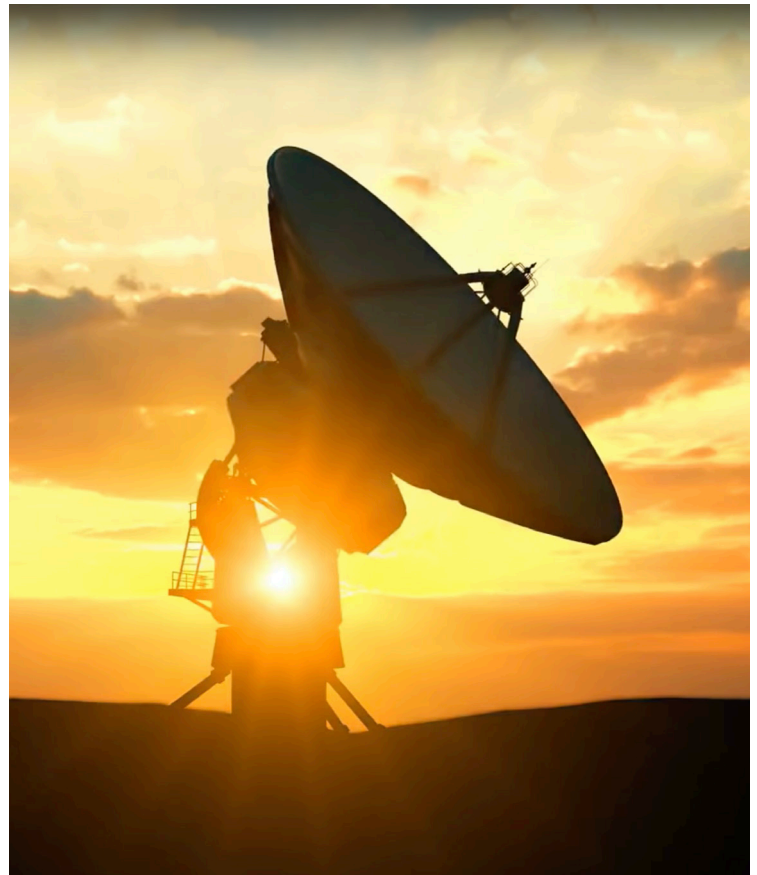
## Discover GGOS

*A short film on geodetic observations and related topics*

Our GGOS colleagues have shared an informational film on geodesy, “Discover GGOS.” It is available on the GGOS YouTube channel in English, Spanish, German, and Japanese, with other translations possibly to follow. The versions can be accessed at [https://www.youtube.com/playlist?list=PLIIfsJS7iAuxXGqoYLAUO\\_m\\_o6za9vqr](https://www.youtube.com/playlist?list=PLIIfsJS7iAuxXGqoYLAUO_m_o6za9vqr)

A link is also available on the IVS Outreach website at <https://vlbi.org/2022/02/16/discover-ggos-short-film-on-geodetic-observations-and-related-topics/>

Feel free to share this video with anyone who might like to learn about geodesy!



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

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