Article:
Wuestefeld, A, Spica, ZJ, Aderhold, K et al. (2023) The Global DAS Month of February 2023. Seismological Research Letters. ISSN: 0895-0695

https://doi.org/10.1785/0220230180

The Global DAS Month of February 2023

Andreas Wuestefeld[*1], Zack J. Spica[2], Kasey Aderhold[3], Hsin-Hua Huang[4], Kuo-Fong Ma[4], Voon Hui Lai[5], Meghan Miller[5], Lena Urmantseva[6], Daniel Zapf[6], Daniel C. Bowden[7], Pascal Edme[7], Tjeerd Kiers[7], Antonio P. Rinaldi[8], Katinka Tuinstra[8], Camille Jestin[9], Sergio Diaz-Meza[10], Philippe Jousset[10], Christopher Wollin[10], Arantza Ugalde[11], Sandra Ruiz Barajas[12], Beatriz Gaite[12], Gilda Currenti[13], Michele Prestifilippo[13], Eiichiro Araki[14], Takashi Tonegawa[14], Sjoerd de Ridder[15], Andy Nowacki[15], Fabian Lindner[16], Martin Schoenball[17], Christoph Wetter[17], Hong-Hu Zhu[18], Alan F. Baird[1], Robin A. Rørstadbotnen[19], Jonathan Ajo-Franklin[20], Yuanyuan Ma[20], Robert E. Abbott[21], Kathleen M. Hodgkinson[21], Robert W. Porritt[21], A. Christian Stanciu[21], Agatha Podrasky[22], David Hill[23], Biondo Biondi[24], Siyuan Yuan[24], Bin Luo[25], Sergei Nikitin[26], Jan Petter Morten[27], Vlad-Andrei Dumitru[28], Werner Lienhart[28], Erin Cunningham[29], and Herbert Wang[29]

Abstract

During February 2023, a total of 32 individual DAS systems acted jointly as a global seismic monitoring network. The aim of this Global DAS Month campaign was to coordinate a diverse network of organizations, instruments, and file formats in order to gain knowledge and move toward the next generation of earthquake monitoring networks. During this campaign, 156 earthquakes of magnitude 5 or larger were reported by the USGS and contributors shared data for 60 min after each event's origin time. Participating systems represent a variety of manufacturers, a range of recording parameters, and varying cable emplacement settings (e.g., shallow burial, borehole, subaqueous, dark fiber). Monitored cable lengths vary between 152 and 120129 m, with channel spacing between 1 and 49 m. The data has a total size of 6.8 TB, and is available for free download. Organizing and executing the Global DAS Month has produced a unique dataset for further exploration and highlighted areas of further development for the seismological community to address.

Cite this article as Wuestefeld A., Z. J. Spica, K. Aderhold et al. (2023). The Global DAS Month of February 2023, *Seismol. Res. Lett.* **XX**, 1–13, doi: 00.0000/000000000.

Supplemental Material

1. NORSAR, Gunnar Randers vei 15, 2007 Kjeller, Norway; 2. Department of Earth and Environmental Sciences, University of Michigan, Ann Arbor, Michigan, USA; 3. EarthScope, Washington D.C., USA; 4. Academia Sinica, Institute of Earth Sciences, Academia Sinica, 128, Sec. 2, Academia Road, Nangang, Taipei 11529, Taiwan; 5. Australian National University, Research School of Earth Sciences, 142 Mills Rd, Acton, ACT 2601, Australia; 6. AP Sensing GmbH, Herrenberger Str. 130, 71034, Boeblingen, Germany; 7. Institute of Geophysics, ETH Zürich, NO H 39.3, Sonneggstrasse 5, 8092 Zürich, Switzerland; 8. Swiss Seismological Service, ETH Zürich, NO H57, Soneggstrasse 5, 8092 Zürich, Switzerland; 9. FEBUS Optics, 2 Av. du Président Pierre Angot, 64000 Pau, France; 10. Helmholtz Centre Potsdam, German Research Centre for Geosciences, Telegrafenberg, 14473 Potsdam, Germany; 11. Institute of Marine Sciences - CSIC, Passeig Maretim de la Barceloneta 37-49 08003 Barcelona, Spain; 12. Spanish Seismic Network (National Geographic Institute of Spain), Calle del Gral. Ibáñez de Ibero, 3, 28003 Madrid, Spain; 13. Istituto Nazionale di Geofisica e Vulcanologia - Osservatorio Etneo, Piazza Roma 2, 95125 Catania, Italy; 14. JAMSTEC, 2-15, Natsushima-cho, Yokosuka, Kanagawa, 237-0061, Japan; 15. School of Earth and Environment, University of Leeds, Leeds, LS2 9JT, UK; 16. LMU Munich, Department of Earth and Environmental Sciences, Theresienstr. 41, 80333 München, Germany; 17. Nagra, Hardstrasse 73, Postbox, 5430 Wettingen, Switzerland; 18. Nanjing University, 163 Xianlin Ave., Qixia District, Nanjing 210023, China; 19. Norwegian University of Science and Technology, O.S. Bragstads plass 2a, 7034 Trondheim, Norway; 20. Rice University, Dept. of Earth, Environmental, and Planetary Sciences, Rice University, MS-126, 6100 Main Street, Houston, TX 77005, USA; 21. Sandia National Laboratories, Albuquerque, New Mexico, 87185-0404, USA; 22. Silixa LLC, 3102 W Broadway St Ste. A, Missoula, MT 59808, USA; 23. Sintela Ltd, The Distillery, The Old Brewery Office Park, 7-11 Lodway, Pill, Bristol, BS20 0DH, UK; 24. Stanford University, Department of Geophysics, 397 Panama Mall, Mitchell Building, Stanford University, Stanford, CA 94305-2215, USA; 25. Southern University of Science and Technology, 1088 Xueyuan Road, Nanshan District, Shenzhen, Guangdong, China 5180551; 26. T8 Sensor, LLC, Krasnobogatyrskaya 44/1, Moscow, 107076, Russia; 27. ASN Norway AS, Vestre Rosten 77, 7075 Tiller, Norway; 28. Graz University of Technology, Steyrergasse 30, 8010 Graz, Austria; 29. University of Wisconsin-Madison, Dept. of Geoscience, U. of Wisconsin-Madison, 1215 W. Dayton St., Madison, WI 53706, USA.

*Corresponding author: andreas.wuestefeld@norsar.no

Goals

Global Seismometer Networks (GSNs) have greatly contributed to our understanding of the Earth. Originally established to help monitor nuclear tests, the World-Wide Standardized Seismograph Network (WWSSN) was set up in the 1970s (Oliver and Murphy, 1971) and supplanted by the GSN and IMS (Global Seismographic Network, and International Monitoring System, respectively). Additional networks were subsequently established, notably GEOSCOPE and GEOFON in the 1980s and 1990s, respectively. Ringler et al. (2022) give an excellent history of global networks. In recent years, technological advancement made Distributed Acoustic Sensing (DAS) with fiber-optic cables available to the seismological research community (e.g., Lindsey and Martin, 2021). DAS systems owned by research organizations are recording for a broad variety of research projects globally. In addition, DAS systems record continuously for commercial purposes, monitoring for example trains, pipelines, and oil fields.

DAS systems have the advantage over seismometers of measuring vibrations not at single point, but rather at a multitude of positions along a fiber. Current technology allows up to 170 km of fiber to be monitored with a single "interrogator" system (Waagaard et al., 2021). Furthermore, existing telecommunication fiber infrastructure can be used, reducing costs for example in urban environments (e.g. Spica et al., 2020) or giving access to the currently sparsely monitored ocean floor (Spica et al., 2020). However, one of the most pressing scientific need towards a global network of DAS systems is a better understanding of the characteristic transfer function for each installation: How does this vary along the cables, by manufacturer, by cable type and deployment style, et cetera. Establishing this would allow for magnitude determination and more. A dataset comprised of various systems recording the same events might facilitate such research.

In this paper, we present the efforts of the DAS community toward the next generation of GSN based on fiber optic sensing: A "Global Fiber Sensing Network", or GFSN. We thus declared February 2023 as the first *"Global DAS Month"*. This campaign aimed to address the following questions:

1. Is there interest in the community to collaborate towards a GFSN?
2. How can large amounts of data be efficiently shared?
3. What are the bottlenecks to an effective GFSN (e.g., data format, data storage, legal access)?

More generally, such dataset may allow the community to develop tools for augmenting global monitoring systems with DAS installations. Notably, research is required to standardize DAS cable transfer functions, which will allow event magnitude determination. Furthermore, the benefits of high channel counts of DAS cables for event localisation needs to be formalised.

Initial feedback from various academic and commercial actors indicated a strong interest from the community in a GFSN. Therefore we laid out the framework for the Global DAS Month of February 2023: During the campaign month, all available DAS systems in different regions of the globe share periods of identical time windows. We focused on windows around events with $M \geq 5$, as reported by the USGS. Based on historical averages, we anticipated 150 events. A 1 h window after the reported source time was considered sufficient to capture the most interesting parts of the wave trains for most system distances. To limit data volume, we suggested a temporal sampling rate of 100 Hz and spatial sampling of 20 m. In case the systems recorded with other parameters, post-recording down-sampling has been applied to obtain the desired parameters by the vast majority of contributors. Other recording parameters were left to be adjusted by the user for their specific needs.

In addition to these triggered event files, continuous data is considered useful for some research topics. We thus declared February 14^{th} 2023, 00:00 - 23:59 UTC as the *"Global DAS Day"*, or the period during which 24h of continuous data shall be shared (at 50 Hz). Many of the systems did contribute to this effort. Note that more data may be available from the contributors upon request. See the respective ReadMe.txt files for more information.

Data Overview

In total, 156 events with $M \geq 5$ were reported by the USGS during February 2023. See Figure 1 for a map of earthquakes and locations of contributing DAS systems. Europe, and especially the Alps, are well covered with DAS systems, while other parts are more sparsely sampled. Notably, South America, Africa, and Antarctica have no contribution. However, this heteregenous distribution of systems can be seen as an opportunity to allow investigation on various coverage scales. Figure 3 gives a close-up view of the cable paths of each contribution. Two destructive earthquakes occurred on Feb. 06, 2023 with magnitudes 7.8 and 7.7, respectively, as part of the Kahramanmaraș sequence in Turkey and Syria (Dal Zilio and Ampuero, 2023). These events are part of the Global DAS Month dataset (Jousset et al., 2023). Figure 2 shows a single trace of selected DAS systems of the event at Feb 06 2023, 01:17:34, sorted by distance to the event. We also show the theoretical arrival times of various phases.

The data set comprises (at the time of writing) of 6.8 TB of data from 32 individual DAS systems from 10 different vendors. Note that additional contributions may become available in the future. The total cable length is 666 km, providing 44883 channels. Systems represented a range of cable emplacement styles, including shallow burial, borehole, subaqueous, and existing dark fiber. The suggested temporal and spatial sampling rates were not strictly enforced. Limitations in recording and processing capabilities of the various systems resulted in a heterogeneous database with sampling rates ranging from 50 to 1000 Hz, and channel spacing varying between 1 and 49m. Table 1 gives an overview of the datasets contributing to the Global DAS Month campaign. Additional supporting material for each dataset includes a ReadMe.txt with information about the installation, as well as a coordinate file with the locations of the individual channels. The data are uploaded to PubDAS in native interrogator format or a post-processed form to give strain or strain-rate data. Example functions for reading the data into computers have been provided with each data set.

Data Access

Data is hosted in PubDAS, an open repository managed by the Advanced Research Computing division of the Information and Technology Services at the University of Michigan (UM) (Spica et al., 2023). In the future, the data might migrate to a different server once the infrastructure for DAS data has been established at a suitable organization. PubDAS can be accessed using the link provided in Data and Resources and via the nonprofit software-as-a-service provider, Globus (Foster, 2011). Globus offers secure and high-performance file transfers between storage systems and is free and easy to use. It simplifies data management, allowing researchers to focus on science rather than technology. Globus coordinates data transfers by handling complex aspects such as parallel transmission control protocol streams and authentication at the source and destination. It also provides automatic fault recovery and notification of completions and problems. Users can deploy the lightweight single-user agent, Globus Connect Personal software, on Windows, Mac, and Linux computers for fast and reliable data transfers. Additionally, users can register their desired storage as a Globus "endpoint", which includes metadata such as ownership, name, and descriptions. After endpoint setup, end-users can download their preferred PubDAS data set. A step-by-step guide on how to log into Globus and use it to transfer files is available in Data and Resources. See Spica et al. (2023) for more information about PubDAS.

Data Acknowledgment

The Global DAS Month of February 2023 comprises a broad assemblage of independent fiber deployments and data collections, each in turn enabled by the effort of a distinct suite of individuals and organizations. In order to acknowledge those within the nested layers of efforts and allow for tracking of data usage, we turned to the strategy employed by seismic network operators and encouraged the generation of a digital object identifier (DOI) for each dataset (see Table 2). This approach has been recommended and enabled by the International Federation of Digital Seismograph Networks (Clark et al., 2014). There are known issues to address with seismic network DOIs, including journal limits on references and inconsistent use (Staats et al., 2023); however their routine use is gaining traction within the seismological community.

Key Areas for Further Development

This campaign can be considered a great success as it brought together the seismological DAS community, as well as raised awareness among commercial actors on the needs for seismological research datasets. These include considerations such as easy access to patch panels, publishable cable locations, as well as cable deployment details. The latter is of particular importance to determine the transfer function. To routinely share DAS data, in the same way seismometer data are shared now, four main topics still need further coordination:

1) Data Format

Data are provided in various formats, sometimes specific to the interrogator manufacturer or the providing organization. Having such a heterogeneous database was a conscious decision: while a homogeneous data format would have been preferable from a data analysis perspective, no common and agreed upon data format was established among the community at the time of this campaign. Rather, a heterogeneous dataset with various readers will provide a unique collection of the available approaches. Note that for each individual dataset, an example code to read in that specific format is provided on the download server. Such a collection can help building the foundation of a common *"GFSN format"*, which picks the best parts of each available solution. Note that most data are shared in an HDF5-format variant (see Table 1), either homegrown, manufacturer developed, or industry specific. HDF5 thus seems to offer very suitable features. The members of the DAS Research Coordination Network working group on Data Management have developed a metadata model while engaging significant community feedback (Lai et al., prep).

2) Channel Coordinates

A concern of some data providers was the public sharing of coordinates of the individual channels. Commercial fiber cables are often considered critical infrastructure and can provide data within difficult to access areas. Similarly, monitored pipelines can offer a unique seismological dataset for their unprecedented lengths. Lastly, long and deep boreholes from oil fields offer a different kind of unique data. Unfortunately, the exact path for such infrastructure is considered sensitive information and there is understandable hesitancy to share. In the Global DAS Month, we addressed these concerns in two ways: geographical coordinates could be shared either with a truncated number of digits or as Cartesian coordinates relative to the start point. Truncated coordinates have their limits in the resolution, considering a channel spacing of ∼20m. On the other hand, relative coordinates have little value for teleseismic event analysis. In the end, all contributions shared the cable locations with sufficient details. However, without sensitivity concerns, many more datasets may have become available.

3) Legal Considerations

The Global DAS Month suggested the use of the license "By-Attribution Non-Commercial Creative Commons 4.0" (BY-NC-CC4.0). Note that some data owners may have different licenses, as specified in the respective ReadMe.txt files. Feedback particularly from commercial data owners indicate that this license might be too open in some cases. Any future GFSN should consider a license that is acceptable for non-academic data owners.

4) Permanent Storage

DAS generates enormous amounts of data, depending on cable length and acquisition parameters in the order of TB per day. Most seismological data centers are not used to or currently equipped to store such volumes permanently. This problem is similar to the limitations encountered by the early seismometer networks. It thus seems appropriate that in the near future, any GFSN will require only "time-windowed" or triggered data. A longer time window (> 60 minutes) may be interesting in future coordinated monitoring endeavours in order to fully capture event signals for global monitoring applications.

The drawback of the time-windowed storage approach is that ambient noise studies typically require much longer windows. This is adressed in the Global DAS month by having the "Global DAS Day" of 24 hours of continous data. Note that more continuous data may be stored with the data provider and shared upon request.

Conclusion

The Global DAS Month of 2023 resulted in a unique dataset of 156 $M \geq 5$ earthquakes recorded on up to 32 DAS systems worldwide. For each event 60 minutes of data is available with a variety of spatial and temporal sampling rates, in various formats, and most importantly, in various deployment conditions. The efforts in collecting the dataset will be valuable in future decisions on sharing and storing DAS data.

We hope that data from the Global DAS Month will initiate DAS research, development, and collaboration with the now available data sets. The open-access aspect of this initiative, despite adding logistical complication, should expedite advancements in seismology and geosciences, streamline the process of training, validating, and comparing performance, and most importantly, simplify the integration of optimal practices when utilizing DAS data. We anticipate this dataset will be useful for research into coupling conditions and sensitivity of the different deployments, as well as detection thresholds as function of distance. Furthermore, directional response of installations and earthquake radiation patterns can be investigated. The ultimate objective of this campaign is to enable a wider community to participate in ongoing seismological DAS research.

Data and Resources

The Global DAS month data set is accessible via Globus to reach the PubDAS endpoint under the DAS-Month-02.2023/ folder. A step-by-step guide for logging in and transferring files is available through this link: docs.globus.org/how-to/get-started/. To access the PubDAS Globus endpoint at Univ. of Michigan, use this link: https://tinyurl.com/PubDAS. Please note that a Globus account is required to access the PubDAS endpoint, and instructions for downloading and running Globus Connect Personal can be found at this link: www.globus.org/globus-connect-personal. The firewall policy for Globus Connect Personal can be accessed through this link: docs.globus.org/how-to/configure-firewall-gcp/. The complete Globus documentation is available here: docs.globus.org/. For any questions about Globus, it is recommended to work directly with the Information and Technology specialists of your organisation.

Most dataset contribution are associated with a Digital Object Indentifiers (DOIs), see Table 2. These DOIs are required to be cited when a dataset is used.

Declaration of Competing Interests

The authors acknowledge there are no conflicts of interest recorded.

Acknowledgements

Significant community engagement took place under the umbrella of the DAS Research Coordination Network (NSF grant number EAR-1948737). Initial discussion was supported by the Air Force Research Laboratory through grant FA9453-21-2-0018. A. W. thanks all contributors for discussing data formats. Z.J.S acknowledges support from the NSF through grant EAR2022716. The Global DAS Month relied on voluntary contributions from various organizations, and we are grateful to them for making this possible. Each institution, as referred to their number in Table 1, acknowledge the following: [1] thank Kuo-Lung Wang, Ching-Chou Fu, and Chin-Shang Ku for field support. Funding support from the Academia Sinica Career Development Award (grant AS-CDA-111-M01). [2] thank the MiDAS team, Chin-Jen Lin, and Chin-Shang Ku from IESAS for technical support and data management. This grant is supported by Academia Sinica Grand Challenge Program (AS-GC-109-11). [3] thank InPAC lab at RMIT and AARTNet for providing access to the ALIRT fiber. AuScope and the Australian Government enabled the project via the National Collaborative Research Infrastructure Strategy (NCRIS). [4] thank Schweizerische Südostbahn AG for providing data access. [5] thank the Bedretto BULGG for providing access to their borehole fibers, and the Bedretto Team and FEBUS optics for their continued support. [6] thank ETH, and specifically the ETH-Domain grants for Open Research Data (ORD) Explore projects for funding. [8] thank Disentis Bergbahnen for the access to their fiber-optic systems and continuous support before, during and after the acquisition, as well as the European Union's Horizon 2020 research and innovation program under the Marie Skłodowska-Curie grant agreement #955515. [10] thank Landsvirkjun for providing access to the geothermal site and the telecom cable; Project funding by Helmholtz Association, and geoPuR project funded by the European Regional Development Fund (ERDF) and the "Investitions und Landesbank Brandenburg" (ILB) under the contract 85037956, and IMPROVE ETN from the Horizon 2020 research and Innovation program under the grant agreement 858092, and and SPIN ITN from the horizon 2020 research and Innovation program under the Marie Skłodowska-Curie grant agreement #955515. This work was also supported by the European Union's Horizon 2020 Research and Innovation Programme (Geo-INQUIRE grant number 101058518) [11] are indebted to CANALINK-Canarias submarine link S.L. for allowing the use of the optical fiber and Aragón Photonics for the acquisition support. [12] thank Aragón Photonics for providing an HDAS interrogator and ADIF for allowing the use of an optical fiber. We also acknowledge Hugo F. Martins, Resurreccion Antón, and Daniel Minguez Prado for their support during the data preparation and processing. [13] are indebted to Istituto Nazionale di Astrofisica for providing their facilities for fiber cable installation at Serra La Nave Observatory. We also acknowledge Rosalba Napoli, Mario Pulvirenti, Daniele Pellegrino and Marcello D'Agostino for their help in the fieldwork and data storage [15] thank David Green for project support, and Stewart Poole and Gareth Phillips for extensive field support at Eskdalemuir. Funding support from AWE/Blacknest, and

NERC grants NE/T012684/1, NE/X005496/1, and NE/S00677X/1. University of Leeds Fibre-Optic Sensing Facility loan UOL-FOF-0002.

[16] thank Silixa for providing an iDAS interrogator and acknowledge support through the German Research Foundation (grant LI3721/2-1), ERC-Advanced Project ROMY, UFS Schneefernerhaus GmbH and A1 Telekom Austria AG. [18] thank Yong Chen, You-Yi Ruan, Tao Wang, and Wei Liu for their support during field instrumentation and data processing. Funding support from the National Natural Science Foundation of China (grant 42225702). [19] thank the Norwegian research council for partially funding the NORFOX array under grant # 296486. [20] thank CGF (grant # 309960) and the Research Council of Norway for funding the acquisition. We also thank ASN for the support during the acquisition and Sikt for accessing the fiber optic cables. [21] acknowledge Fervo Energy and particularly Aleksei Titov, Sireesh Dadi, and Jack Norbeck for generous access to the DAS fiber in Blue Mountain well 73-22. [22] full acknowledgements are provided in the SandiaNL-Coupling data set's README.txt [24] thank 3 Rivers Communications for their kind hospitality.[25] thank OptaSense Inc. for loaning the interrogator unit and the Stanford ITS fiber team for crucial help with the Stanford DAS-2 experiment. [28] thank N. Lord, D. Fratta, A. Chavarria, B. Pietzyk, M. Hephner, T. Artz, and W. Roggenthen for DAS deployment. [29] thank all colleagues from Sternberg Astronomical Institute, Moscow State University, for accommodating the equipment at their facility in Caucaus and providing technical assistance. [30] thank Tampnet and ASN for permission to publish the results. [31] thank the Central IT Services of Graz University of Technology for providing access to the telecommunication cable. [32] thank N. Lord, D. Fratta, A. Chavarria, R. Sutyla B. Pietzyk, L. Scott, J. Tollefson, M. Hephner, T. Artz, and W. Roggenthen for DAS deployment and AFRL and UW-Madison for funding.

References

Clark, A., P. L. Evans, and A. Strollo (2014). FDSN recommendations for seismic network DOIs and related FDSN services. *International Federation of Digital Seismograph Networks - WG3 recommendations*, 12 pp.

Dal Zilio, L. and J.-P. Ampuero (2023). Earthquake doublet in Turkey and Syria. *Communications Earth Environment* **4**(71).

Foster, I. (2011). Globus Online: Accelerating and Democratizing Science through Cloud-Based Services. *IEEE Internet Computing* **15**(3), 70–73.

Jousset, P., A. Wuestefeld, C. Krawczyk, A. Baird, G. Currenti, M. Landrø, A. Nowacki, Z. Spica, S. R. Barajas, F. Lindner, A. Konca, P. Edme, V. H. Lai, V. Treshchikov, L. Urmantseva, J. P. Morten, W. Lienhart, B. P. Lipovsky, M. Schoenball, K.-F. Ma, and the "DAS-month" team (2023). Global Distributed Fibre Optic Sensing recordings of the February 2023 Turkey earthquake sequence. pp. EGU23–17618. EGU: EGU General Assembly, Vienna, Austria, 24–28 Apr 2023.

Lai, V. H., K. M. Hodgkinson, R. W. Porritt, R. Mellors, and the DAS Research Coordination Network Data Management Working Group (in prep.). A Distributed Acoustic Sensing (DAS) Metadata Model. *Seismological Research Letters*.

Lindsey, N. J. and E. R. Martin (2021). Fiber-optic seismology. *Annual Review of Earth and Planetary Sciences* **49**(1), 309–336.

Oliver, J. and L. Murphy (1971). WWNSS: Seismology's global network of observing stations. *Science* **174**(4006), 254–261.

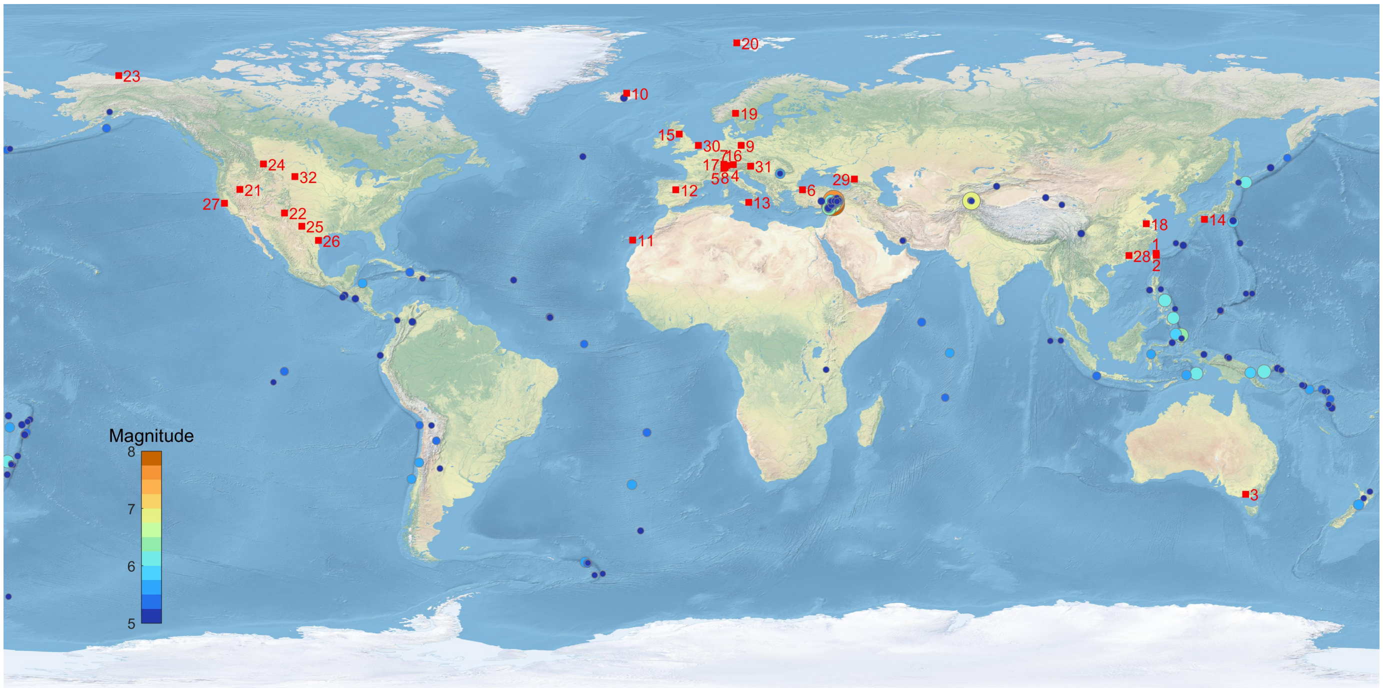

Figure 1. Map of systems contributing to the Global DAS Month of February 2023. Red squares indicate the location of the various DAS systems with numbers according to the ID in Table 1. Also shown are the locations of the 156 earthquakes with $M \geq 5$ that occurred during February 2023, with size and color proportional to event magnitude.

Ringler, A. T., R. E. Anthony, R. C. Aster, C. J. Ammon, S. Arrowsmith, H. Benz, C. Ebeling, A. Frassetto, W.-Y. Kim, P. Koelemeijer, H. C. P. Lau, V. Lekić, J. P. Montagner, P. G. Richards, D. P. Schaff, M. Vallée, and W. Yeck (2022). Achievements and prospects of global broadband seismographic networks after 30 years of continuous geophysical observations. *Reviews of Geophysics* **60**(3), e2021RG000749. e2021RG000749 2021RG000749.

Spica, Z. J., J. Ajo-Franklin, G. C. Beroza, B. Biondi, F. Cheng, B. Gaite, B. Luo, E. Martin, J. Shen, C. Thurber, L. Viens, H. Wang, A. Wuestefeld, H. Xiao, and T. Zhu (2023, 01). PubDAS: A PUBlic Distributed Acoustic Sensing Datasets Repository for Geosciences. *Seismological Research Letters*.

Spica, Z. J., K. Nishida, T. Akuhara, F. Pétrélis, M. Shinohara, and T. Yamada (2020). Marine sediment characterized by ocean-bottom fiber-optic seismology. *Geophysical Research Letters* **47**(16), e2020GL088360. e2020GL088360 10.1029/2020GL088360.

Spica, Z. J., M. Perton, E. R. Martin, G. C. Beroza, and B. Biondi (2020). Urban seismic site characterization by fiber-optic seismology. *Journal of Geophysical Research: Solid Earth* **125**(3), e2019JB018656. e2019JB018656 10.1029/2019JB018656.

Staats, M., K. Aderhold, K. Hafner, C. Dalton, M. Flanagan, H. Lau, F. J. Simons, M. Vallée, S. S. Wei, W. Yeck, A. Frassetto, and R. Busby (2023). Inconsistent Citations of the Global Seismographic Network in Scientific Publications. *Seismological Research Letters*, accepted.

Waagaard, O. H., E. Rønnekleiv, A. Haukanes, F. Stabo-Eeg, D. Thingbø, S. Forbord, S. E. Aasen, and J. K. Brenne (2021, Feb). Real-time low noise distributed acoustic sensing in 171km low loss fiber. *OSA Continuum* **4**(2), 688–701.

Manuscript Received 00 Month 0000

TABLE 1.

List of contributions. Columns indicate, respectively, an ID number; the data providing organization (with project name in brackets if multiple datasets are provided by that organisation); interrogator manufacturer and model; file format (note that some formats are used only internally in the respective organisation); channel spacing [m]; the total cable length [m]; number of channels; gauge length [m]; temporal sampling rate [Hz]; and data volume [GB]. Further information about each installation and cable can be found in the accompanying README files on the download server.

ID	Provider (Site)	Instrument	Format	dx [m]	length [m]	nChnl	GL [m]	fSamp [Hz]	Size [GB]
1	Acad. Sinica (LAMDA)	Silixa iDAS	mSEED	2	810	405	10	1000	177
2	Acad. Sinica (MiDAS)	Silixa iDAS	mSEED	4	1196	299	10	1000	214
3	ANU	Silixa iDAS2	custom H5	20.0	25000	6252	10	100	62
4	AP Sensing	AP Sensing	APS (H5)	19.6	44500	2270	10	100	115
5	ETH (Bedretto)	FEBUS A1-R	FEBUS (H5)	2	4500	2250	20	100	124
6	ETH (Istanbul)	Silixa iDAS	ProdML	16	8000	500	10	100	96
7	ETH (Limmat)	Silixa iDAS	ProdML	20	800	40	10	100	3.3
8	ETH (Sedrun)	Silixa iDAS	ProdML	20	3100	155	10	125	29
9	GFZ (Potsdam)	Silixa iDAS2	custom H5	20.0	18600	930	10	100	469
10	GFZ (Iceland)	Silixa iDAS2	custom H5	4.0	17000	4250	10	100	121
11	ICM CSIC/Canalink	Aragón Photonics	custom H5	20.0	65000	3248	10	50	110
12	IGN/ADIF	Aragón Photonics	Aragón (H5)	10.0	36000	3616	10	100	1800
13	INGV / GFZ	Silixa Carina	custom H5	1.0	320	271	2	100	29
14	JAMSTEC	AP Sensing	custom H5	49.0	120129	2450	40	100	467
15	Leeds / AWE	FEBUS A1-R	custom H5	19.2	7507	391	50	100	90
16	LMU Munich	Silixa iDAS2	ProdML	20.4	1062	52	10	100	13
17	Nagra	FEBUS A1-R	mSEED	19.6	1225	400	10.2	100	11
18	Nanjing Univ	Wuhan Optical	DAT	5.0	3800	757	5	100	105
19	NORSAR	ASN OptoDAS	ASN (H5)	10.0	12250	1225	20	100	185
20	NTNU CGF	ASN OptoDAS	ASN (H5)	24.5	50000	2040	8.2	100	866
21	Rice Univ.	Silixa iDAS2	custom H5	20.4	2430	120	10	100	41
22	Sandia Ntl. Lab (FACT)	Silixa iDAS	TDMS	1	152	152	10	100	105
23	Sandia Ntl. Lab (Alaska)	Silixa iDAS	TDMS	24.6	37096	1509	10	100	182
24	Silixa	Silixa iDAS-MG	ProdML	20.4	28400	1393	30	100	156
25	Sintela (MIS1)	Onyx	ProdML	19.2	33254	1732	11.2	100	287
26	Sintela (MIS2)	Onyx	ProdML	19.2	51187	2666	11.2	100	439
27	Stanford Univ.	Optasense ODH-3	custom H5	8.2	2856	350	16	100	125
28	SUS Tech	Silixa iDAS-MG	NPY	20.4	3000	147	10	100	15
29	T8 Sensor	T8 DAS Dunay	T8 (H5)	19.2	700	36	20	100	4.6
30	Tampnet/ASN	ASN OptoDAS	ASN (H5)	20.0	80000	4000	20	125	889
31	TU Graz	FEBUS A1-R	FEBUS (H5)	9.6	2600	271	20	100	62
32	Univ. Wisc.-Madison	OptaSense ODH-4	custom H5	4.0	3432	858	16	100	382

TABLE 2.
List of installations with their associated DOIs, for referencing. The location of interrogators is also given (see Figure 1). Note that details about the installation and cable path is available in in the download package of each contribution.

ID	Provider	Site	Latitude	Longitude	DOI
1	Acad. Sinica	LAMDA	24.535	121.520	10.7914/rbr9-8z88
2	Acad. Sinica	MiDAS	24.023	121.630	10.7914/k56t-4215
3	ANU	Melbourne	-37.807	144.970	10.25914/kf96-nb26
4	AP Sensing	St Gallen	47.227	9.197	10.7914/g0ed-5e68
5	ETH	Bedretto	46.511	8.476	10.7914/8t1v-6j63
6	ETH	Istanbul	40.970	29.058	10.7914/kfkm-x182
7	ETH	Limmat	47.399	8.496	10.7914/42kw-r383
8	ETH	Sedrun	46.697	8.788	10.7914/bvm7-mh78
9	GFZ	Potsdam	52.385	13.020	10.5880/GFZ.2.2.2023.001
10	GFZ	Iceland	65.898	-16.966	10.5880/GFZ.2.2.2023.002
11	ICM CSIC	Canalink	27.949	-15.381	10.7914/73k1-1369
12	IGN/ADIF	Guadarrama Mt	40.909	-4.092	10.7914/66dw-7d40
13	INGV / GFZ	Etna	37.693	14.975	10.7914/j0yz-kj67
14	JAMSTEC	Muroto	33.297	134.190	10.7914/42rp-t560
15	Leeds / AWE	Eskdalemuir	55.336	-3.198	10.7914/3320-5s03
16	LMU Munich	Zugspitze	47.417	10.980	10.7914/SN/X6_2021
17	Nagra	Stadel	47.550	8.485	10.7914/1s1g-c426
18	Nanjing Univ	Xianlin Campus	32.114	118.960	10.7914/2hnj-ex83
19	NORSAR	NORFOX	60.735	11.540	10.21348/d.no.0004
20	NTNU CGF	Svalbard	78.943	11.868	10.7914/1b8m-rj75
21	Rice Univ.	Blue Mt.	40.984	-118.150	10.7914/0w0x-gj96
22	Sandia Ntl. Lab.	FACT	34.951	-106.460	10.7914/m8py-h687
23	Sandia Ntl. Lab.	Alaska	70.511	-149.871	
24	Silixa	Fairfield	47.613	-111.980	10.7914/1hnc-1250
25	Sintela	MIS1	31.524	-101.980	
26	Sintela	MIS2	27.830	-97.614	
27	Stanford Univ.	Sand Hill	37.436	-122.180	10.1190/tle39090646.1
28	SUS Tech	Xinfengjiang	23.919	114.460	10.7914/bqgg-xx98
29	T8 Sensor	Caucasus	43.741	42.662	10.7914/t8my-dk69
30	Tampnet/ASN	Lowestoft Cable	52.439	1.845	10.7914/c236-ds38
31	TU Graz	Graz	47.068	15.450	10.7914/8a5m-zk74
32	Univ. Wisc.-Madison	SURF	44.346	-103.760	10.7914/h4eb-bh32

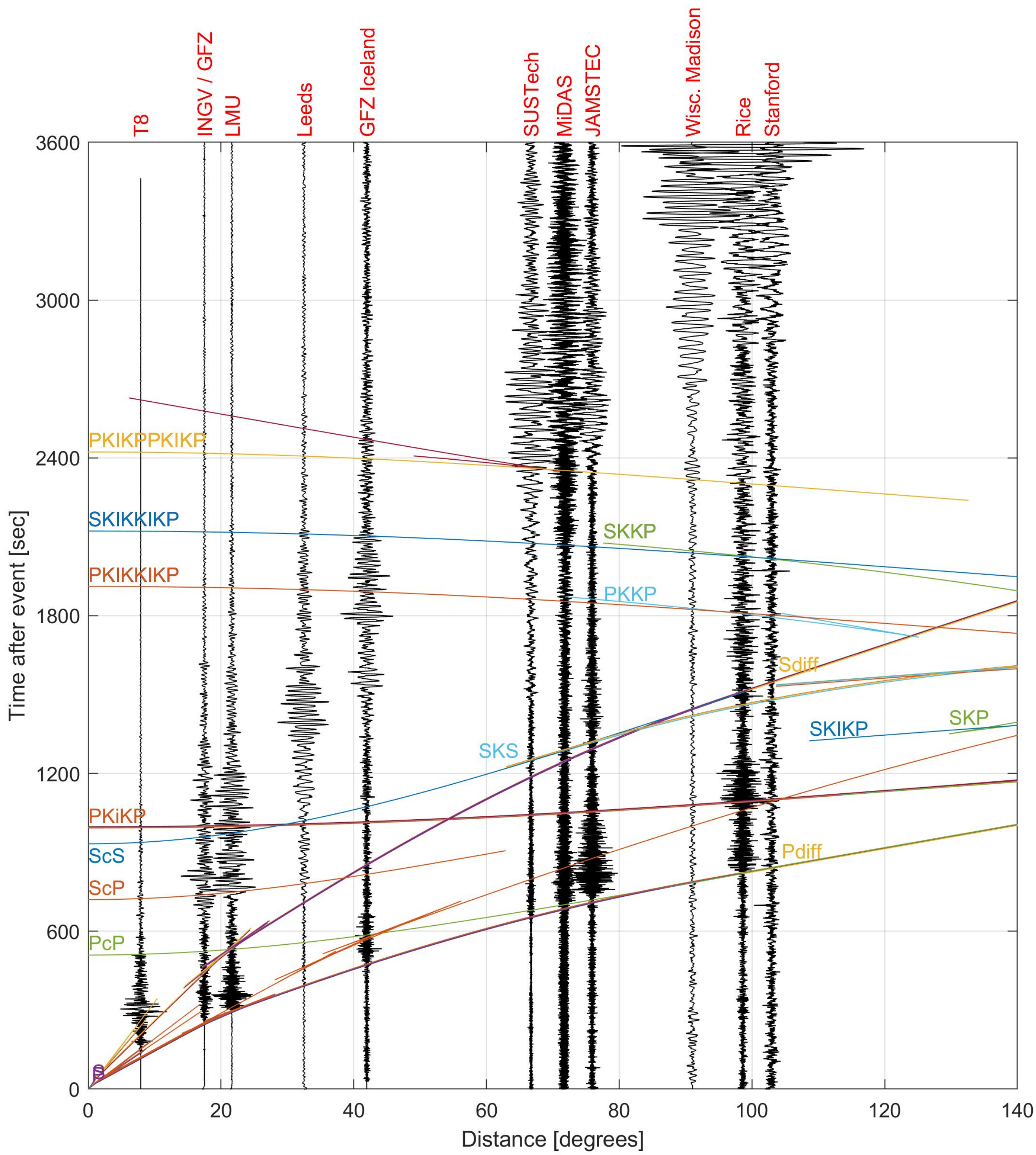

Figure 2. Individual strain-rate traces of selected systems of the Feb. 06, 2023 01:17:34 Turkey event, plotted against hypocentral distance. Also shown are theoretical phase arrivals. Traces are filtered between 0.1 and 3 Hz and normalized to the maximum absolute value of the first 2400 seconds after origin time.

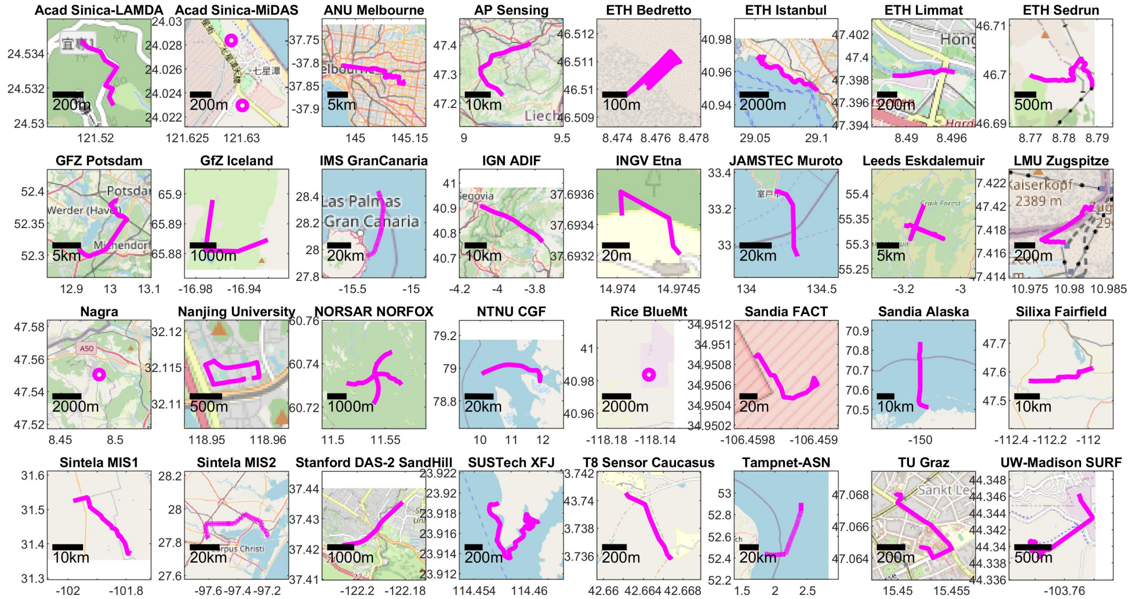

Figure 3. Individual layouts of the contributions. Boreholes are indicated as circles.