GFZ

Helmholtz Centre
POTSDAM

HELMHOLTZ CENTRE POTSDAM
GFZ GERMAN RESEARCH CENTRE
FOR GEOSCIENCES

Angelo Strollo, Peter Evans, Winfried Hanka, Andres Heinloo, Susanne Hemmleb, Karl-Heinz Jäckel, Javier Quinteros, Joachim Saul, Riccardo Zaccarelli, Thomas Zieke and Frederik Tilmann.

GEOFON Annual Report 2018

Scientific Technical Report STR 20/06

Version 2.2 2019-06-05

Recommended citation for the report:

Strollo, A., Evans, P., Hanka, W., Heinloo, A., Hemmleb, S., Jäckel, K.-H., Quinteros, J., Saul, J., Zaccarelli, R., Zieke, T., & Tilmann, F. (2019). GEOFON Annual Report 2018. In Scientific Technical Report STR; 20/06 (Version 2.2). GFZ German Research Centre for Geosciences. https://doi.org/10.2312/GFZ.B103-20066

Imprint

Helmholtz Centre Potsdam
GFZ German Research Centre for Geosciences

Telegrafenberg
D-14473 Potsdam

Published in Potsdam, Germany
June 2019

ISSN 2190-7110

DOI: 10.2312/GFZ.b103-20066
URN: urn:nbn:de:kobv:b103-20066

This work is published in the GFZ series
Scientific Technical Report (STR)
and electronically available at GFZ website
www.gfz-potsdam.de

Angelo Strollo, Peter Evans, Winfried Hanka, Andres Heinloo, Susanne Hemmleb, Karl-Heinz Jäckel, Javier Quinteros, Joachim Saul, Riccardo Zaccarelli, Thomas Zieke and Frederik Tilmann.

GEOFON Annual Report 2018

Scientific Technical Report STR 20/06

Version 2.2 2019-06-05

Contents

1 Executive summary

- Four additional stations were added to the GEOFON Global Seismic Network: BALJ, MARCO, ACRG and SALTA. SALTA was installed by our partners in Argentina with only remote support from the GEOFON team. The other stations were installed with GEOFON staff present on site. 16 stations required corrective maintenance actions. The GEOFON engineering team performed on-site maintenance at 3 sites, whereas 13 stations were repaired by our local partners. In the latter case, in 11 cases spare parts were assembled and tested in Potsdam and delivered to the local partners.
- The GFZ Seismological Data Archive hosted at GEOFON has grown by ~20 TB in 2018. The total size of the archive is ~100 TB including 128 networks and 4304 stations. Tailor-made requests from the archive have been served to more than 2000 unique users, which cumulatively made more than 100 million requests for 200+ million time windows. Real-time data export has increased slightly to ~150 TB/year to more than 300 clients. The EUDAT project ended at the beginning of the year. The new EIDA Authentication Service and the replication of the full archive at KIT based on EUDAT-developed products are the main outcomes of this project for GEOFON.
- GEOFON published 4920 events and 936 moment tensor solutions via the web pages and other dissemination channels. The assessment phase for crowdseeded fast locations using real-time picks exchanged with EMSC via HMB (httpmsgbus - software developed at GEOFON previously) has been completed. A paper co-authored with staff at the EMSC and the Hungarian Academy of Science has been submitted and accepted for publication by *Science Advances*, demonstrating the benefits of the integrated approach. By drawing on crowd-sourced data (web access to EMSC, app launches, submitted reports on level of shaking), the publication delay can be decreased from several minutes to 1.7 min (median value for analysed data set).
- Software development supported by EPOS-IP has resulted in completion of the EIDA Authentication Service and the software package *stream2segment*, a modular tool to download and process customised event based windows. The authentication service is being rolled out across EIDA nodes, while *stream2segment* was developed in response to the needs of the ground motion community to process massive datasets containing large numbers of short analysis windows and is already being used at several data centres dealing with ground motion studies. Additional modules are being developed for an even wider range of applications. *SeisComP3* continues to be highly popular and has been adopted in at 40+ earthquake observatories. One new release (2018.327) and one maintenance (bug fix) release (2017.334) have been published in the last year.

2 Introduction

The GEOFON program consists of a global seismic network (GE Network), a seismological data centre (GEOFON DC) and a global earthquake monitoring system (GEOFON EQinfo). These three pillars are part of the MESI research infrastructure of the Helmholtz Centre Potsdam - GFZ German Research Centre for Geosciences aiming at facilitating scientific research. GEOFON provides real-time seismic data, access to its own and third party data from the archive facilities as well as global and rapid earthquake information. The GEOFON Seismological Software can be considered a fourth cross-cutting module of the GEOFON Program.

Data, services, products and software openly distributed by GEOFON are used by hundreds of scientists and data centres worldwide. Its earthquake information service is accessed directly by tens of thousands of visitors. The *SeisComP3* package is the flagship software provided to the community, which is geared for seismic observatory and data centre needs and used extensively to support our internal operations. As all other MESI (Modular Earth Science Infrastructure) modules GEOFON has the majority of users outside the GFZ as well as an external advisory committee that provides advice to the GFZ Executive Board and to the GEOFON team. This report describes the main activities carried out within the three GEOFON pillars and the software development group.

3 The GEOFON global seismic network

The GEOFON network at the end of 2018 consisted of 88 GEOFON stations (mostly distributed under the GE network code, but also including the four former GE stations today distributed under the WM seismic network code and WM.TIO) (Fig. 1). Four additional stations were added to the GEOFON Global Seismic Network in 2018: BALJ, MARCO, ACRG and SALTA.

Installation of the Balqua (BALJ) station in Jordan in January completes the DESERVE network of multiparametric stations in the Dead Sea Region; all stations within this network are equipped with high quality GNSS and environmental sensors, and are embedded within a wider Helmholtz funded multi-disciplinary initiative in the region.

The Tramutola station (MARCO) has been deployed in Southern Italy during the summer in the context of a new cooperation with the Italian National Research council (IMAA-CNR) on integrated seismo-fluid monitoring on active faults. The activities are carried out in cooperation with section 2.1 (Physics of Earthquakes and Volcanoes) and 1.1 (Space Geodetic Techniques) of the GFZ. This station is located on the largest continental oil reservoir in Europe.

The Accra station (ACRG) follows the concept trialed 2016 in Myanmar, where the station is installed as training exercise during the GFZ International Training Course held in September/October and then left to the local hosts together with a computer running *SeisComp3* and large screens to engage them with open data and real time seismology. This installation is likewise a joint effort with sections 1.1 and 2.1. The station is equipped with both broadband and strong motion sensors as well as GNSS and environmental sensors.

Finally, the Salta (SALTA) station has been deployed by our partners at INPRES in Argentina, with whom an MoU was signed several years ago. After some months of testing the station in the lab at INPRES with remote support from GEOFON the colleagues went to the field and successfully deployed the station in November.

Four of the GEOFON stations have not delivered any data in 2018 (SOCY and DAMY in Yemen, PUL in Russia and KERA in Greece) due to civil war in the country or political issues. Despite the

complex issues we are facing with these stations we hope to have them back online in the future, thus keep their epochs open. The LVC station in Chile operated in cooperation with the IRIS/GSN has been vandalised in November and is not yet back in operation.

The average availability for the network excluding the new and four non-working stations is at 92%.

Representatives of GEOFON participated to a Technical Interchange Meeting (TIM) in Paris at IPGP jointly orgniazed by GSN (US), GEOSCOPE (FR) and GEOFON (DE) between January 31 and Febraury 1 2018. Aim of the meeting was to share technical knowledge between several network operators as well as coordinate future efforts were possible.

3.1 Regular maintenance

Sixteen GEOFON stations required corrective maintenance actions. The GEOFON engineering team performed on-site maintenance at three of these sites (FLT1 in Germany, SALP, Palestine; GHAJ, Jordan), whereas 13 stations were repaired by our local partners. Here, it was necessary in 11 cases to assemble and test spare parts in Potsdam and deliver them to the local partners (Figure 1).

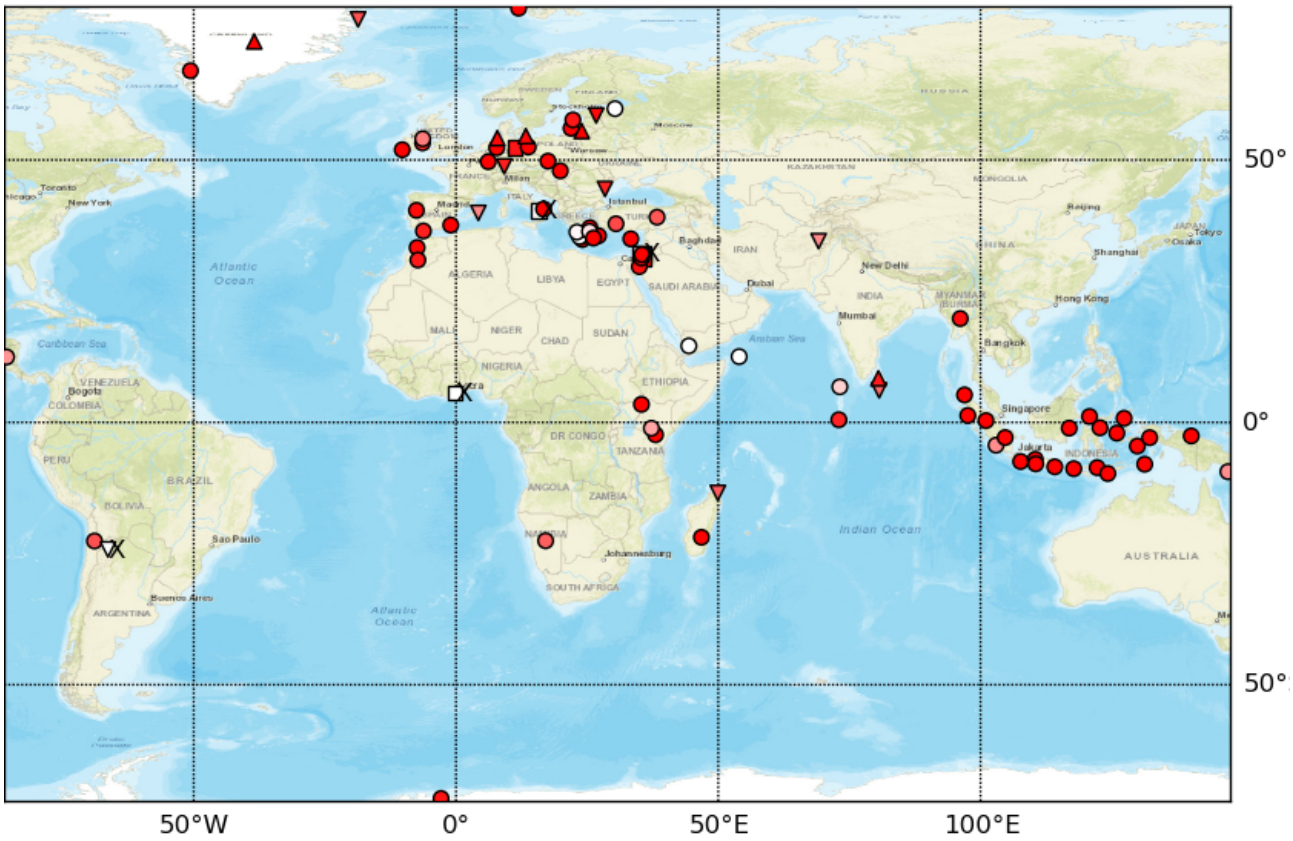

Fig. 1: GEOFON stations in 2018. Colours denote the data availability (white: 0% to red: 100% availability). Symbols represent the level of maintenance needed: circle for “none”, square for “on site”, triangle (up) for “remote”, triangle (down) for “Remote including HW shipment”. An “X” next to the symbol indicates metadata updates.

3.2 Technical developments

R&D efforts were mainly directed at operational testing of mobile routers running an instance of SeisComP3/seedlink to be used as primary or backup seedlink server. Station SBV in Madagascar and HMDM in the Maldives are currently using the seedlink server running on the router since the primary one has problems. Some time has been invested also in designing and building 'ready-to-deploy' boxes integrating data logger, mobile router and power systems for easy deployment of portable stations with real-time communication using mobile networks or WAN, which can then stream directly into the GEOFON archive; this development was prototyped during the GFZ-UNIBRA deployment and is now being used for the ZS_2017 (Swath-D, Alps) and 6C_2019 (MySCOLAR, Myanmar) deployments.

3.3 Technical support to other GFZ groups (e.g. Observatories)

The engineering group also provided support to other projects/groups within the GFZ. Within our own section (2.4) we supported the SWATH-D (an AlpArray Complementary Experiment) field activities and the preparation of the hardware for a new temporary campaign in Myanmar. Moreover, the AlpArray UNIBRA stations of the GFZ were recovered this year; the sites were occupied again by the LMU (University of Munich) team with DSEBRA stations. A substantial effort went into supporting the Integrated Plate Boundary Observatory Chile (IPOC) seismic network with maintenance actions carried out at seven stations (CX seismic network). Last but not least the GEOFON group continuously provided assistance to our long term partner BMKG in Indonesia to run their seismic network and data centre for tsunami early warning.

3.4 Annexes

A comprehensive report on engineering actions and Probability Density Functions (PDFs) for all BB channels are provided as separate documents (Appendices at the end of the report).

4 The GEOFON Data Centre

4.1 Archive Service Delivery

The GFZ Seismological Data Archive hosted at GEOFON has grown by ~20 TB in 2018, with most of the added data having been acquired by temporary networks between 2011 and 2018, but also with some old data dating back to 2002 and 2003 (Fig. 2).

The archive (total size ~100 TB, Fig. 3) is replicated three times at two different locations. The primary and secondary hot copies are stored at GFZ, whereas the holdings are replicated daily to the KIT in Karlsruhe as a cold backup copy. In an effort to clean up the archive we have reviewed holding and curation agreements. When redundant data, i.e. data also available from other data centres, were found without a clear curation policy, or where we are only the secondary data centres, the data are backed up only once, with full replication (three times) reserved for our own networks and those for which we are recognised as formal curator via agreement with a partner. Most of the data were served to the 2000+ users of the archive via fdsnws, in total more than 100 million requests (25 TB), compared to only 10 million via Arclink (10 TB). The long obsolete BREQ_FAST service was finally

switched off on January 4th and an alternative method has been provided to the very few remaining users (https://geofon.gfz-potsdam.de/waveform/breq_fast_transition.php).

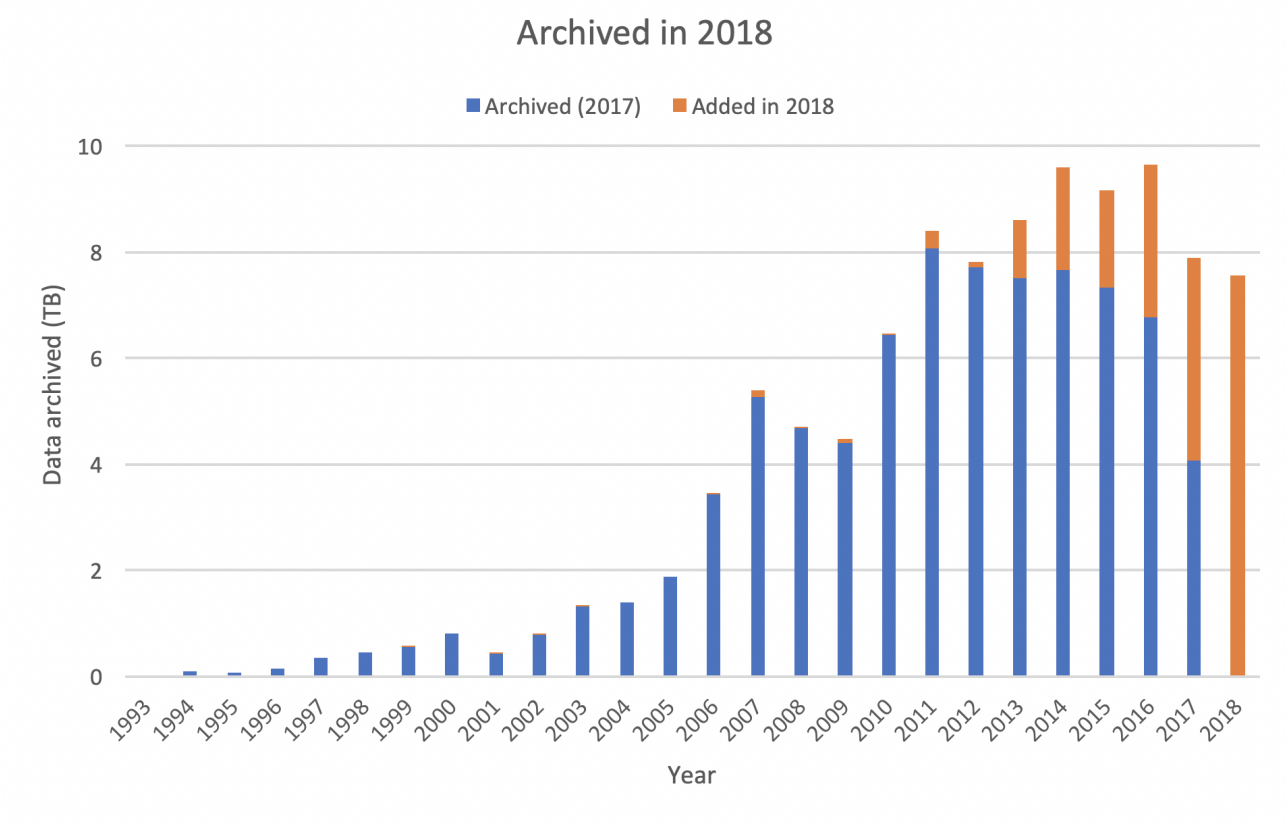

Fig. 2: Data archived by year of acquisition.

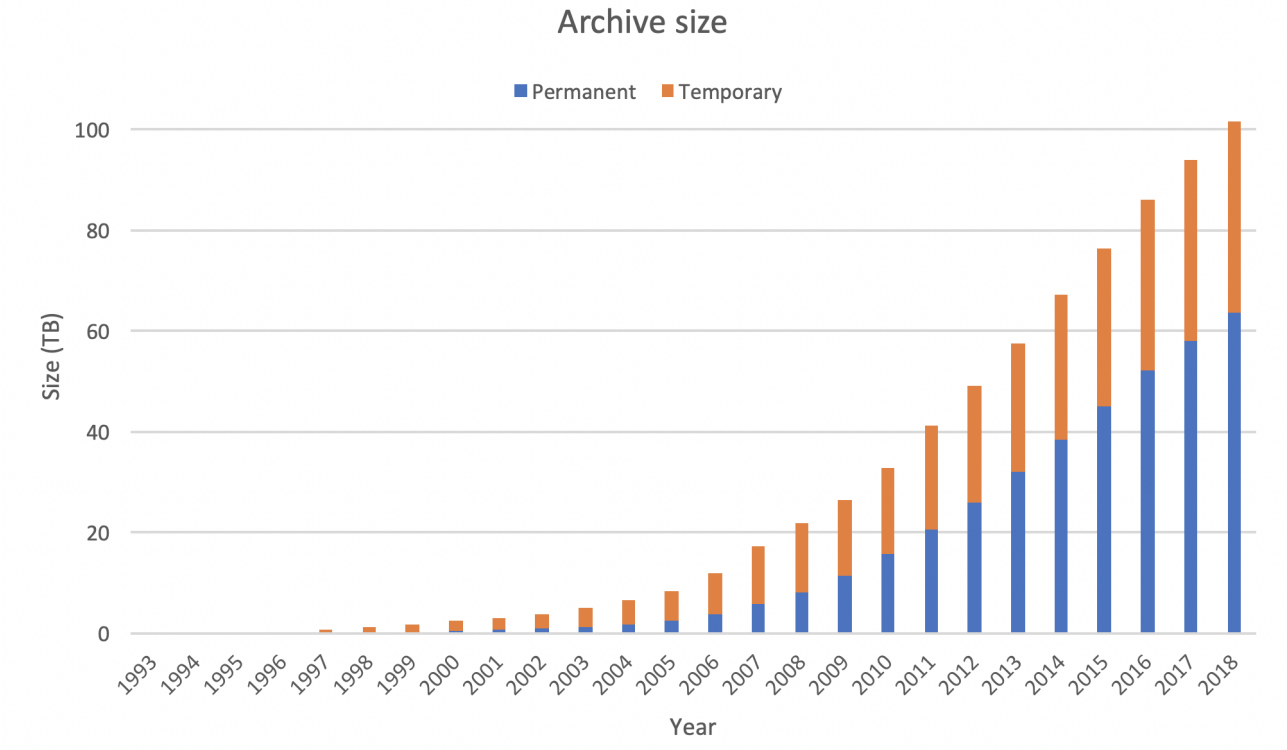

Fig. 3: Cumulative size of the GEOFON archive.

Requests by method and by type.

Table 1: Requests by method and by type

Request method	Requests	Timewindows	Volume	Users
fdsnws (external)	108.021.966	97.327.589	19 TB	2.041
fdsnws (GFZ)	1.254.084	130.732.055	6 TB	177
arclink (external)	7.211.889	10.865.607	10 TB	1.123
arclink (GFZ)	142.511	161.323	0 TB	41
Total	116.630.450	239.086.574	35 TB	

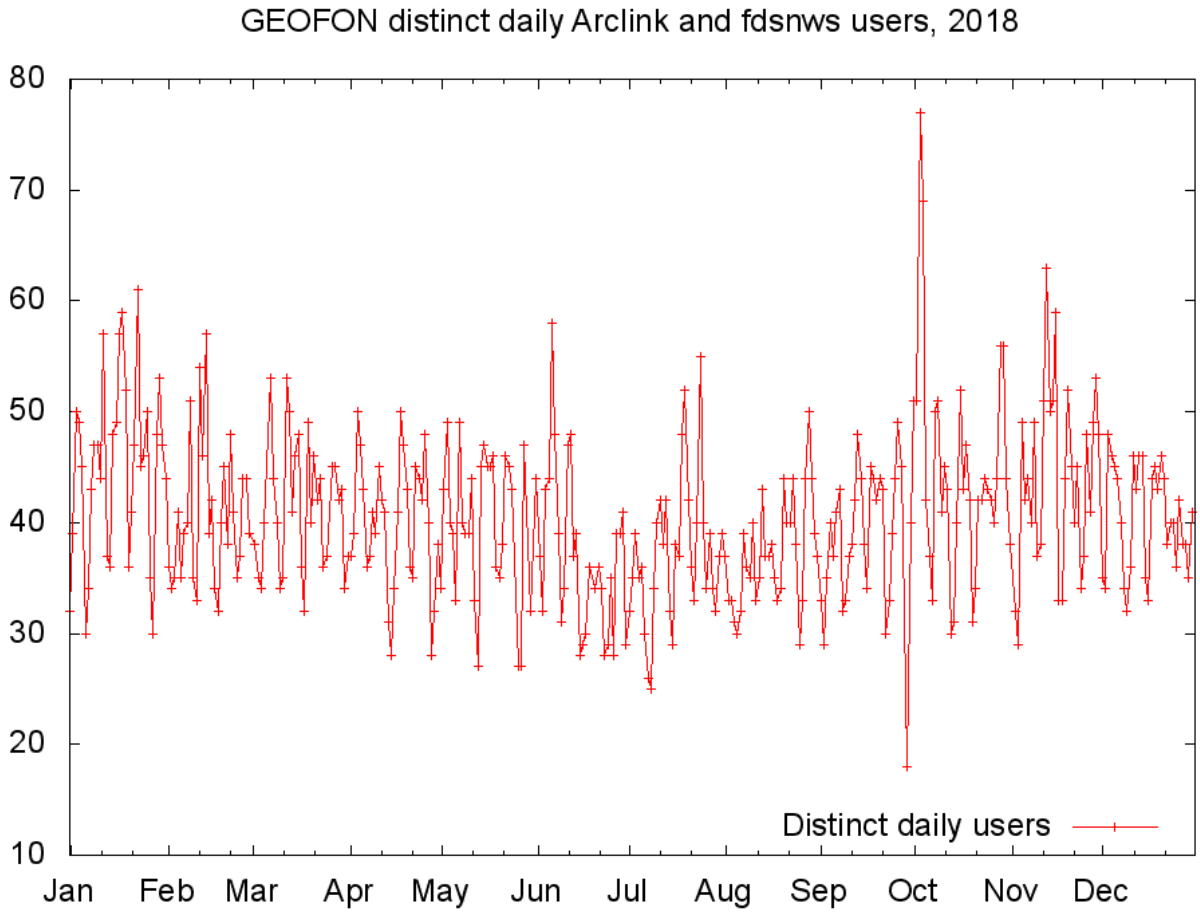

Fig. 4: Number of distinct user IDs provided for fdsnws and/or arclink on each day in 2018.

4.2 New networks (embargo period end reports or any other change)

New networks: 9 temporary

- 1C_2013 Wittewierum (Groningen Gas Fields, Netherlands)
- 1P_2014 DEEP-TEE Phase 1 (Eifel, Germany)
- 1T_2014 TomoEtna (Italy)
- 3J_2013 HIRE II (Southern Spain)

- 4C_2017 TIPTIMON Afghanistan II
- 5H_2013 COOL (Oman)
- 6G_2011 Ketzin (Northern Germany)
- 9H_2013 TRANSCORBE (Southern Spain)
- D0 Kamtchatka seismic network

Released:

- 6A_2010 Walpass (Namibia)
- 2F_2012 LONGMEN (Longmen Shan)
- IQ Iquique (Northern Chile)
- 2B_2007 PUDEL (Argentina)

DOIs minted: 19 new in total

- 4 permanent (KD Bishkek, AD ACROSS, HE Finnish National, IQ Iquique Chile)
- 15 temporary (1A_2016 Sri Lanka, 1C_2016 Wittewierum, 1M MIDAS, 1P_2014 DEEP-TEE Phase 1, 2D_2018 DISTRESS, 4C_2017 TIPTIMON Afghanistan II, 6G_2011 Ketzin, 8A_2010 WILAS, 8H_2015 East Pamir, 9H_2016 Sarez Pamir aftershock, XN_2015 HART Ghorka, X9_2015, KISS,YZ_2017 East Pollino, ZE_1996 ANCORP, ZS_2017 Swath-D)

Out of the total 128 networks and 4304 stations in archive, 71 networks and 565 stations have been updated/added during the year.

4.3 Real-time data export via seedlink:

The real-time data export via seedlink from the public Seedlink server at geofon.gfz-potsdam.de increased to ~150 TB/year with 300-350 continuous connections. The most requested network for real-time distribution is GE with 100+ TB.

4.4 Service uptime

Service	Up	Down/Problem
WebDC	99.825%	0.175%
EIDA Master Table	94.864%	5.136%
fdsnws-dataselect	98.371%	1.629%
fdsnws-station	98.212%	1.789%
routingsvc	99.749%	0.251%
geofon-proc	99.982%	0.018%
geofon (ping)	99.980%	0.020%
geofon (Web pages)	99.813%	0.187%
geofon (eqinfo)	99.163%	0.837%
geofon (Seedlink)	99.411%	0.589%

The EIDA master table outage on webdc.eu relates to the switchover to new hardware in April 2018. During this time the master table was in fact probably accessible and usable. However, it was missing

its node component, triggering a reported "critical" state for Nagios. Other services also had relatively large outages during the transition to new hardware between March and May.

Note that the service uptime is measured by a Nagios instance running on a local machine. This means that times when the computer running Nagios was down, e.g., during a power out, would not be included in the analysis, and also times when the connection to the internet was broken would not necessarily be reported as down time. Even though technically this makes the report service uptime an upper bound estimate, no major episodes of either network or power outage are known to us, such that the numbers can probably be taken at face value.

Details of checks carried out:

- WebDC: check Arclink responds on port 18002 at webdc.eu.
- EIDA Master Table: check http://webdc.eu/arclink/table?group=eida is accessible.
- geofon-proc: MySQL (SeisComP db) available, and contains recent events.
- **FDSN web services:**
  - check fdsnws-station at http://geofon.gfz-potsdam.de/fdsnws/station/1/version
  - check fdsnws-dataselect at http://geofon.gfz-potsdam.de/fdsnws/dataselect/1/version
- **routing service:**
  - check http://geofon.gfz-potsdam.de/eidaws/routing/version
- geofon (ping): ping of geofon.gfz-potsdam.de
- geofon (web pages): visit the front page, http://geofon.gfz-potsdam.de/
- geofon (Seedlink): `telnet geofon.gfz-potsdam.de 18000` succeeds.
- geofon (eqinfo): only to display http://geofon.gfz-potsdam.de/eqinfo/list.php,

5 GEOFON Rapid Earthquake Information

5.1 Published earthquake locations and moment tensor solutions

GEOFON published 4920 events and 936 moment tensor solutions in total via the web pages and other dissemination channels. Fig. 5 shows the geographic distribution of the published events and Fig. 6 the distribution of the moment tensors.

Table 2: Events by magnitude classes in 2018

Mag	Num. events
≥ 7.5	5
≥ 6.5	42
≥ 5.5	419
≥ 4.5	3.818
All	4.920

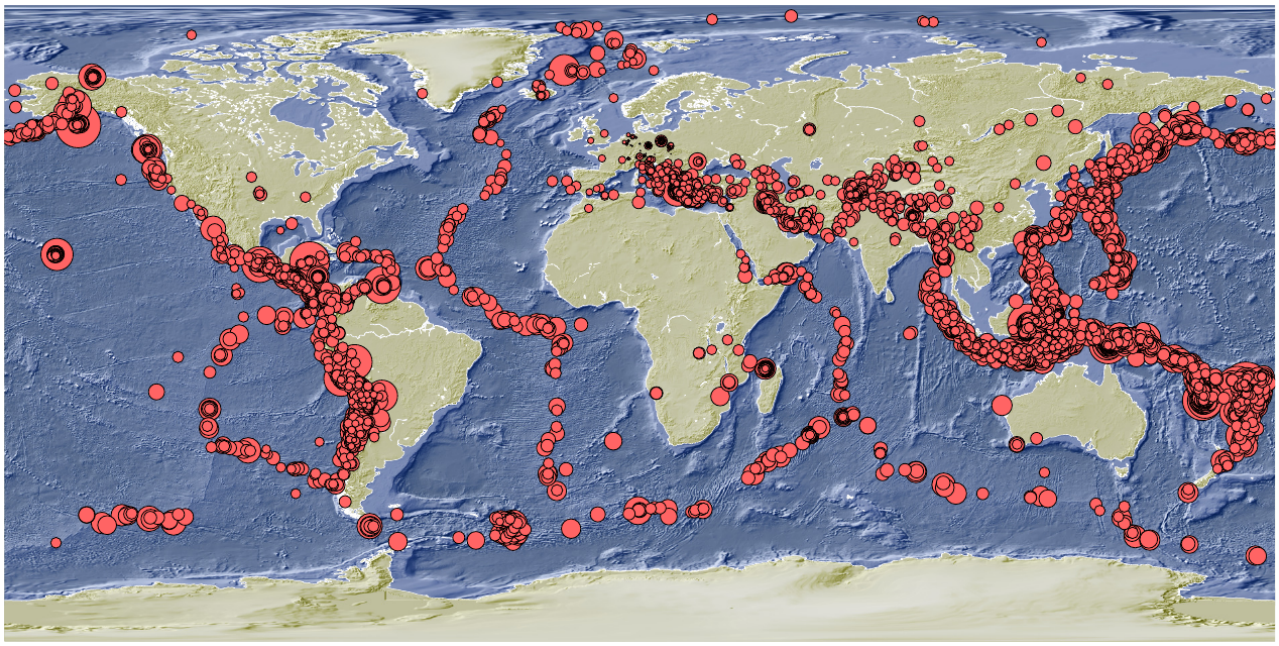

Fig. 5: Geographic distribution of the published events in 2018.

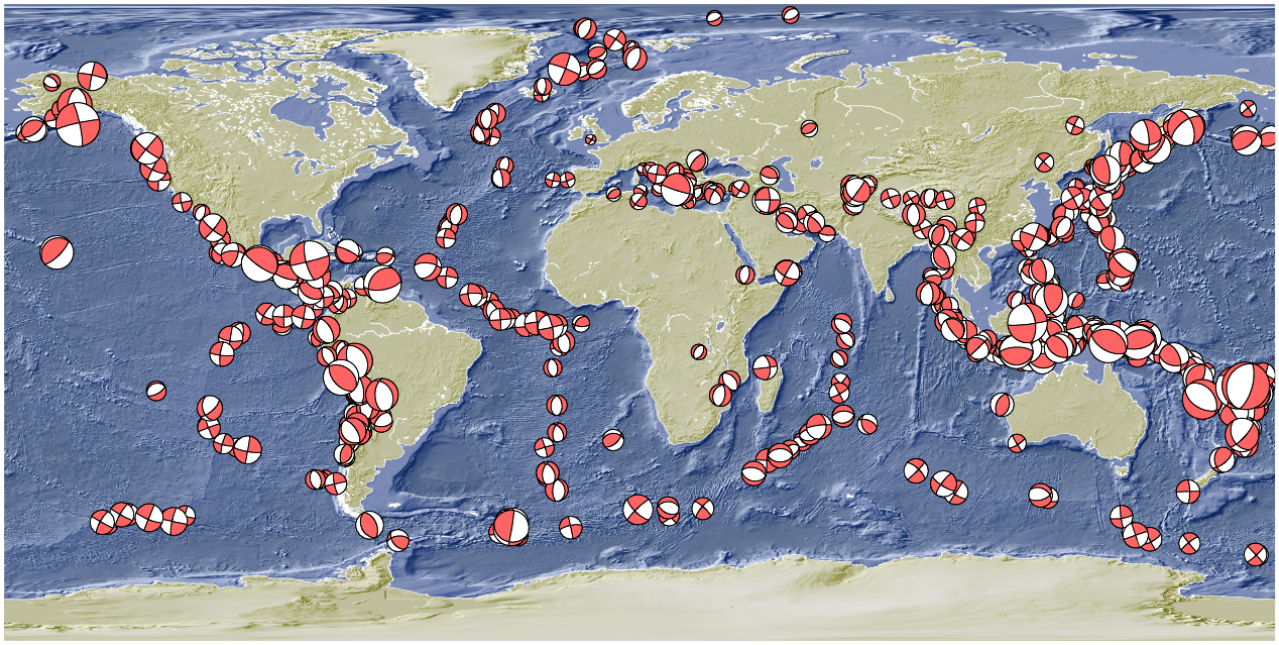

Fig. 6: Geographic distribution of the published moment tensors solutions in 2018.

Removed “Fake” events are usually characterized by unfavorable azimuthal station coverage or even strongly clustered stations (IPOC, parts of Central Europe, Taiwan).

Table 3: Event dissemination

Events	No MT	Has MT	Total
Published	3.984	936	4.290
Status A	999	—	999
Status C	2.117	801	2.918
Status M	868	135	1.003
Removed	7	0	7

Event notification delays are shown in Fig. 7 and Fig. 8 .

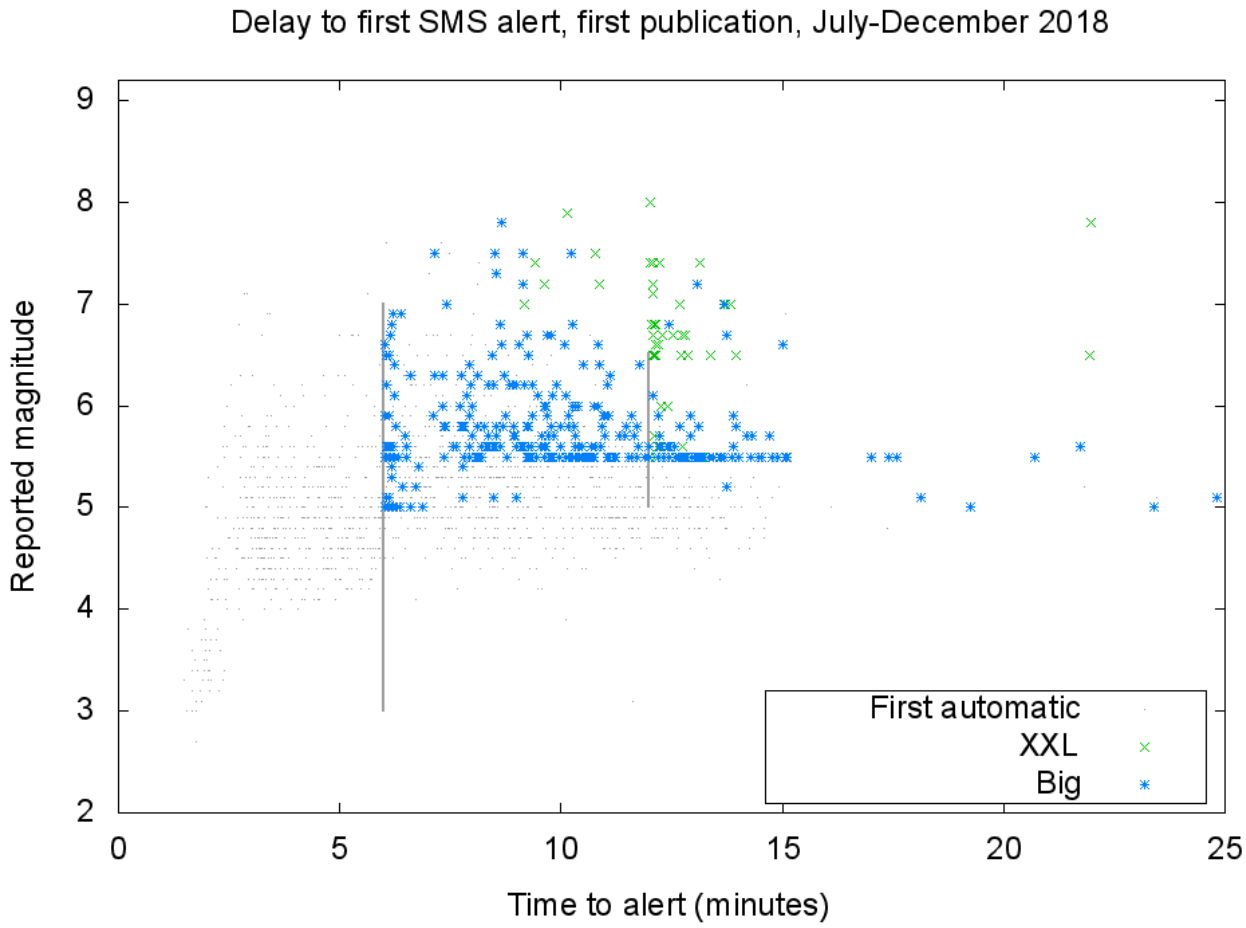

Fig. 7: Event publication (grey dots) and alert delay (big green and xxl red) vs. magnitude in 2018. Alert delay for GEOFON events in 2018 resulting in SMS alerts. Magnitude is the magnitude reported at the time of the alert. Events with only an automatic detection (status 'A') are also shown. Please note that numbers are incomplete due to hardware upgrade/migration during the year.

Table 4: Alerts issued by type

2018	xxl	big	Other	All classes
Total	38	354	4.528	4.920

The definitions of these alert types are:

- 'xxl' events are those with magnitude larger than 6.5 worldwide, or larger than 5.5 in or near

Europe, or 5.0 in central Europe.

- ‘big’ events have magnitude above 5.5 in most of the world, or above 5.0 in the wider Europe/Mediterranean area and M>=4.5 in central Europe.
- the ‘Other’ category includes internal alerts and some regional notifications.

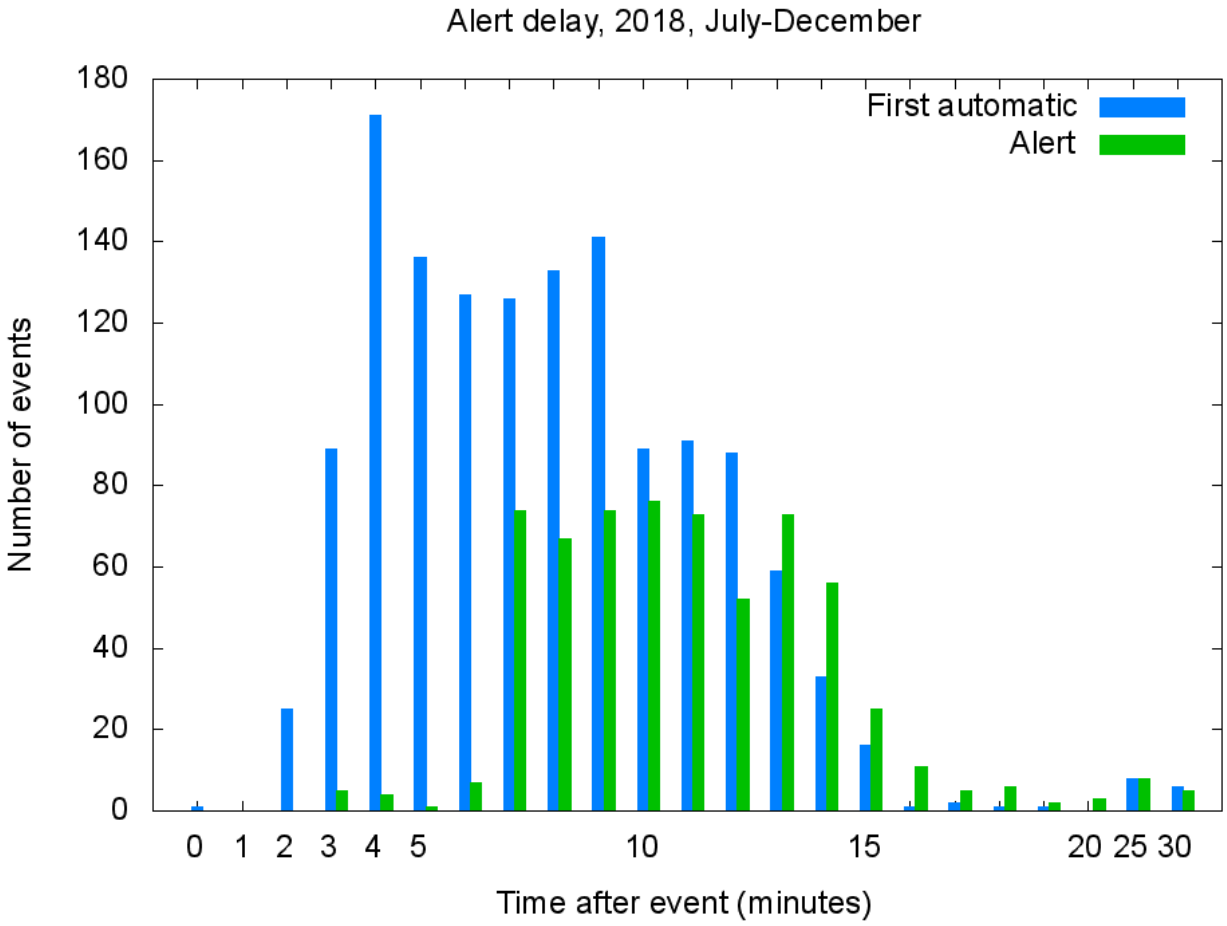

Fig. 8: GEOFON alert delay vs. first automatic publication. Please note that numbers are incomplete due to hardware upgrade/migration during the year.

5.2 GEOFON web server traffic

The number of distinct users connecting to geofon.gfz-potsdam.de is of typically ~30.000/day (Fig. 9). Significant traffic is driven to our web server immediately after large events, particularly those in Europe, exceeding 60.000 distinct users on peak days (“Distinct” users are those with distinct IP address and User-Agent, on mobile devices IP may change and thus increase the numbers of counts).

5.3 Ongoing cooperation with EMSC

The assessment phase for crowdseeded fast locations using real-time picks exchanged with EMSC via HMB (*httpmsgbus* - software developed at GEOFON previously) has been completed. A paper co-authored with staff at the EMSC and the Hungarian Academy of Science has been submitted and

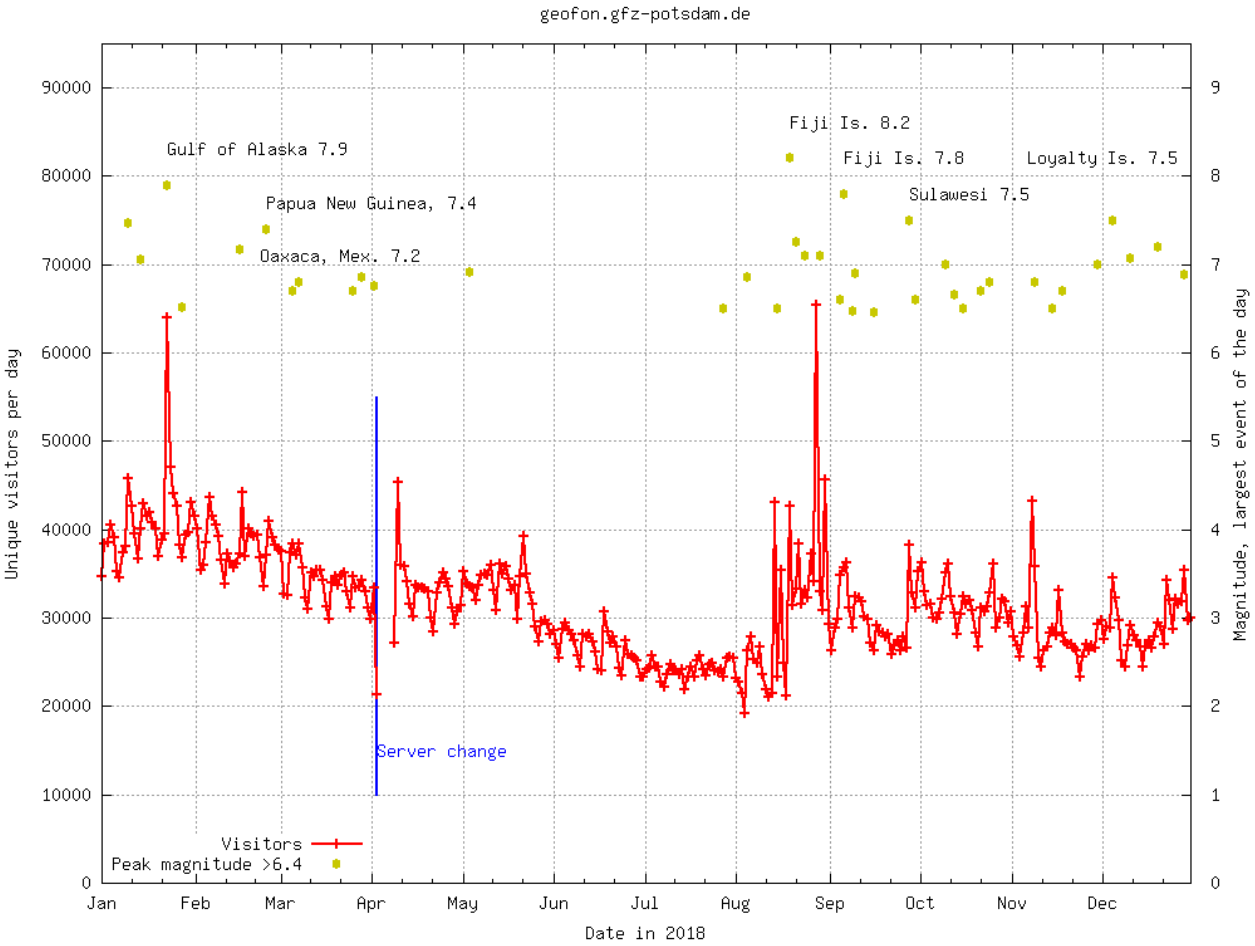

Fig. 9: Daily distinct visitors to geofon.gfz-potsdam.de during 2016 (unique IP + user application which is dominated by automatic applications including mobile devices apps). Also shown is the magnitude of the *largest* event recorded on each day, when this exceeds 6.4. (The threshold for 'xxl' alerts is 6.5 in most of the world).

accepted for publication by *Science Advances*, demonstrating the benefits of the integrated approach. By drawing on crowd-sourced data (web access to EMSC, app launches, submitted reports on level of shaking), the publication delay can be decreased from several minutes to 1.7 min (median value for analysed data set).

6 Software development

6.1 stream2segment

Stream2segment is a software package to download a large number of short seismic waveform segments and storing them in a database for highly efficient application of pre- and post- processing utilities (https://github.com/rizac/stream2segment). This code was initially developed to answer the needs of the ground motion community, with pre-set processing modules geared towards this use case, but extensions can be easily added for other applications (Zaccarelli et al., submitted to SRL)

6.2 SeisComP3 releases and usage (in cooperation with GEMPA)

The following *SeisComP3* releases were published in 2018: 2018.327.01, 2018.327.02 and 2018.327.03 officially released on January 15th 2019 , 2017.334.03 on January 18th, 2017.334.04 on February 22th, and 2017.334.05 on April 18th (2017.334.nn are maintenance releases). 42 new non-commercial licenses were released in 2018 (total 522 at the end of 2018).

7 Impact, Outreach and Capacity Building

GEOFON data, services and products have been cited in ~600 papers published in ISI journals up to 2018 (~40 added in 2018). The full list of publications which explicitly acknowledged use of GEOFON products is available at http://geofon.gfz-potsdam.de/references.php and updated to 01.2019.

In 2018 GEOFON staff have presented at several conferences and contributed to several training events. In particular lectures and presentations about the usage of GEOFON products were given at the following events/venues:

- Technical Interchnage Meeting (TIM) jointly organized by GSN (US), GEOSCOPE (FR) and GEOFON (DE),
- GFZ INternational Training Course, Accra, Ghana,
- BMKG Jakarta, Indonesia,
- EGU Vienna, Austria,
- 11th Plenary of the Research Data Alliance (RDA), Berlin, Germany,
- AG Seismologie, Berggießhübel / Pirna, Germany,
- ESC, Valletta, Malta,
- University of Kiel, Germany,
- Tailor made SC3 training for Afghan University lecturers, Potsdam, Germany.

Additionally, we participated in the Powell Center workshop “Future opportunities in regional and global earthquake monitoring and science” organised by the NEIC.

8 GEOFON running projects

8.1 EUDAT2020 (ended in February)

- Title: Collaborative Data Infraestracture
- Description and tasks: The main tasks taken on by GFZ in this project are the safe replication of the archive, the federated identity management and the constant tracking of changes in the (meta)data. Safe replication: the off-site replication of the GEOFON archive (~70 TB) has been realised with the support of our partner institution within the Helmholtz Association (Karlsruhe Institute of Technology - KIT). Persistent Identifiers heve been also attributed to the data and metadata. Identity Management: the implementation of a federated identity management to be used within EIDA will allow users to still interact with EIDA as a unified virtual data centre,

even if they want to access restricted data through FDSN web services. Users are authenticated by the institution to which the user belongs, so that EIDA does not need to have a centralized users database and manage passwords.

- Duration: 2015-2018
- Funded by: European Commission
- Local PI at GFZ: Angelo Strollo
- PI: Kimo Koski (CSC)
- 27 PMs

8.2 Geo-Data-Node

- Description and tasks: GDN aims to improve data management practices at GFZ by fostering the implementation and practice of research data guidelines recently approved by GFZ. These guidelines are inspired by the FAIR data principles. Specifically the GEOFON team developed procedures to improve internal data policies. Relations between existing Persistent Identifiers have been reviewed for a better discovery of all resources related to a data set. In synergy with GIPP we plan to adopt Persistent Identifiers (PID) for Instruments and jointly work towards an API aiming at facilitating seismic metadata creation. This work will be coordinated internationally with the Research Data Alliance (RDA). Finally, templates for the GFZ's existing Scientific Technical Report (STR) series will created facilitate creation of STR to complement the data sets in archive.
- Duration: 2017-2019
- Funded by: BMBF
- PI: Roland Bertelmann (GFZ)
- 12 PMs

8.3 EPOS-IP

- Title: European Plate Observing System - Implementation Phase
- Description and tasks: EPOS-IP aims at creating a pan-European infrastructure for solid Earth science to support a safe and sustainable society. GEOFON and Section 2.6 at the GFZ are contributing to the Seismology Thematic Core Service (TCS). GEOFON is responsible for the coordination of the EIDA Next Generation development and contributes to strategic activities and governance. In particular for EIDA-NG the GEOFON team is developing the Routing Service, the Authorization system and updating the Web Interface to access data (WebDC3). Coordination of the developments is ensured through the active participation of GEOFON managers and developers in to the Management Board and Technical boards of EIDA.
- Duration: 2015-2019
- Funded by: European Commission
- Local PI at GFZ: Jörn Lauterjung
- PI: M. Cocco (INGV)

- 22 PMs

8.4 EOSC-Hub (started in February)

- Title: Integrating and managing services for the European Open Science Cloud
- Description and tasks: The EOSC-Hub project creates the integration and management system of the future European Open Science Cloud that delivers a catalogue of services, software and data from the EGI Federation, EUDAT CDI, INDIGO-DataCloud and major research e-infrastructures. The Hub acts as a single contact point for researchers from scientific communities to discover, access, use and reuse a broad spectrum of resources for advanced data-driven research. GEOFON will be responsible for the tasks related to the Authentication and Authorization (AAI) system, as well as the Federated Data Life Cycle. In the case of AAI, this extends from the initial collection of requirements, to definition of attributes, roles and rules, the design and prototype of development, and finally to validation and assessment. In the case of the Federated Data Life Cycle, we will work on the design of automatic workflows for seismological data centres, including replication, persistent identifiers (PID) creation, and improvements in the data distribution. In a final stage, when services are already in production, we will focus on the training activities (e.g.: seminars, workshops) to foster the adoption of the services beyond seismology.
- Duration: 2018-2020
- Funded by: European Commission
- Local PI at GFZ: Javier Quinteros
- PI: Y. Legre (EGI - Netherlands)
- 15 PMs

8.5 SERA

- Title: Seismology and Earthquake Engineering Research Infrastructure Alliance
- Description and tasks: The Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe (SERA) aims to reduce the risk posed by natural and anthropogenic earthquakes based on innovative research and development projects. SERA will significantly improve the access to data, services and research infrastructures for scientists and other professionals. The GEOFON team, together with four EIDA node operators, will work towards consolidating the European Integrated Data Archive infrastructure with particular focus on facilitating the integration of new data and nodes as well as improving the user experience. We are specifically contributing to: (i) extend EIDA to integrate data types from OBS, induced seismicity observation networks, structural monitoring arrays, etc.; (ii) facilitate integration and long-term sustainability by providing extensive documentation, best practice guidelines for data acquisition and distribution as well as technical support; (iii) connect key scientists to the main operators of seismological networks to design the future generation of monitoring tools for Europe.
- Duration: 2017-2020
- Funded by: European Commission

- Local PI at GFZ: Fabrice Cotton
- PI: D. Giardini (ETHZ - Switzerland)
- 5 PMs

9 Publications by GEOFON staff

Bunakov, V., Atamas, A., de Casanove, A., Dugénie, P., van Horik, R., Lambert, S., **Quinteros, J.**, Reijnhoudt, L. (2018): Data Curation Policies and Data Provenance in EUDAT Collaborative Data Infrastructure. - In: Kalinichenko, L., Manolopoulos, Y., Malkov, O., Skvortsov, N., Stupnikov, S., Sukhomlin, V.(Eds.), Data Analytics and Management in Data Intensive Domains: Communications in Computer and Information Science, (Communications in Computer and Information Science ; 822), Springer International Publishing, pp. 249-263. DOI: http://doi.org/10.1007/978-3-319-96553-6_18

Schuh, H., Anderson, J., Beyerle, G., Dick, G., Flechtner, F., Förste, C., Ge, M., Glaser, S., Heinkelmann, R., König, R., Männel, B., Michaelis, I., **Quinteros, J.**, Ramatschi, M., Rauberg, J., Rother, M., Schmidt, T., Stolle, C., Wickert, J. (2018): Big Data in Geodäsie, Seismologie und Geomagnetismus. - System Erde, 8, 1 DOI: http://doi.org/10.2312/GFZ.syserde.08.01.5

10 GEOFON Team (Human Resources)

Name	GE Net.	GE DC	EQ info	GE op.	Soft. Dev.	Out-reach	Funding
Angelo Strollo	x	x	x	x		x	GFZ
Thomas Zieke	x						GFZ
Karl-Heinz Jäckel[*]	x						GFZ
Javier Quinteros		x			x	x	EOSC-Hub/GDN
Susanne Hemmmleb		x					GFZ
Riccardo Zaccarelli[*]		x			x		EPOS-IP/GFZ
Joachim Saul[*]		x	x		x	x	GFZ
Winfried Hanka[*]			x				GFZ
Andres Heinloo	x	x	x	x	x		GFZ
Peter Evans	x	x	x	x	x	x	GFZ

[*] Not working full time for GEOFON.

11 GEOFON Advisory Committee Members

- Dr. Florian Haslinger, Chair, ETH Zurich, Zurich,CH
- Dr. Christian Bönnemann, BGR Hannover, D
- Prof. Dr. Wolfgang Friederich, RU Bochum, Bochum, D

- Prof. Dr. Thomas Meier, CAU Kiel, D
- Prof. Dr. Max Wyss International Centre for Earth Simulation, Geneva, CH
- Dr. Jan Zednik, GFU Prague, CZ

12 Acknowledgements

We acknowledge partners co-operating GEOFON stations and data providers enabling us to create the so called GEOFON Extended Virtual Network (GEVN) used for the rapid earthquake information. We are also thankful to users and in particular to our advisory committee for their valuable feedback.

13 References

McNamara, Daniel & Buland, Raymond. (2004). Ambient Noise Levels in the Continental United States. Bulletin of the Seismological Society of America. 94. 1517-1527. 10.1785/012003001.

14 Appendices

14.1 Probability Density Functions (PDF) for operational GEOFON stations 01.2018 - 12.2018

The PDF displayed in this appendix have been calculated with PQLX v. 2011.365.P4 (McNamara & Buland 2004) only for the primary channels, that is generally a Broad-Band sensor at 20 Hz. Only operational stations during the year have been included, stations that were off-line for most of time are not included in this appendix.

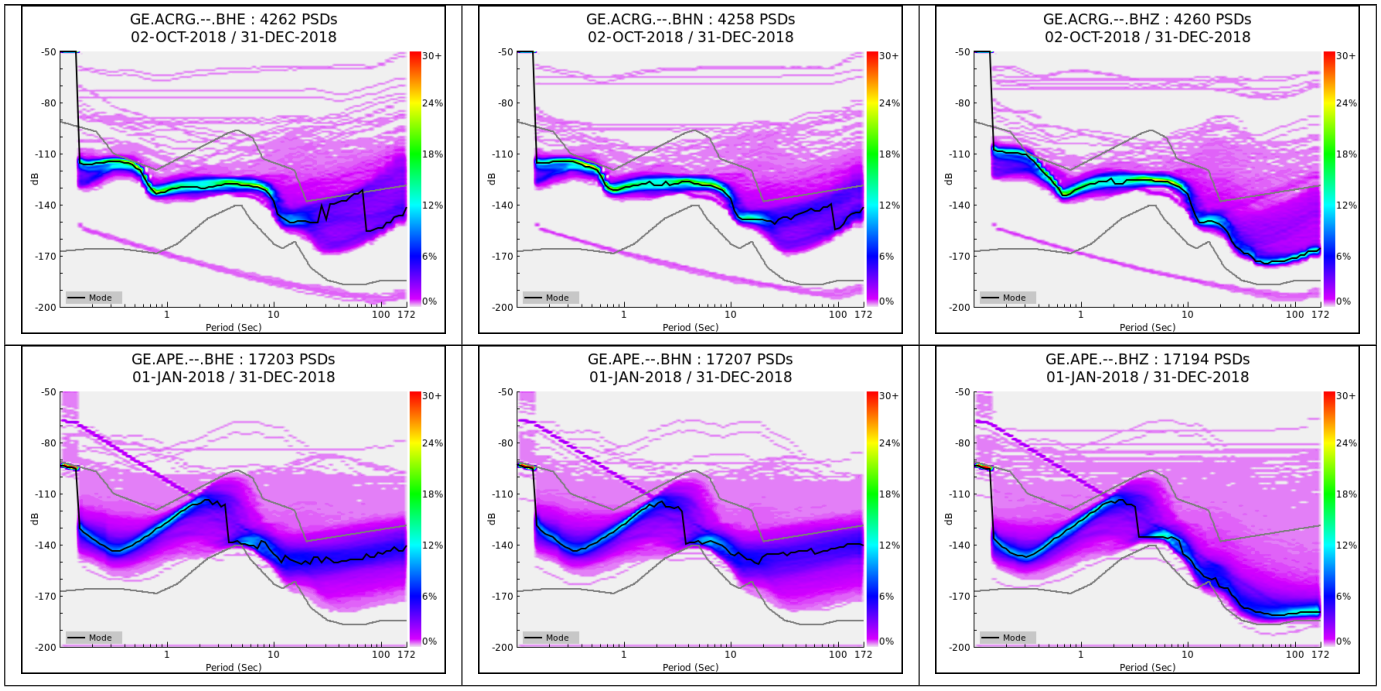

Fig. 10 – continued on next page

Continued from previous page

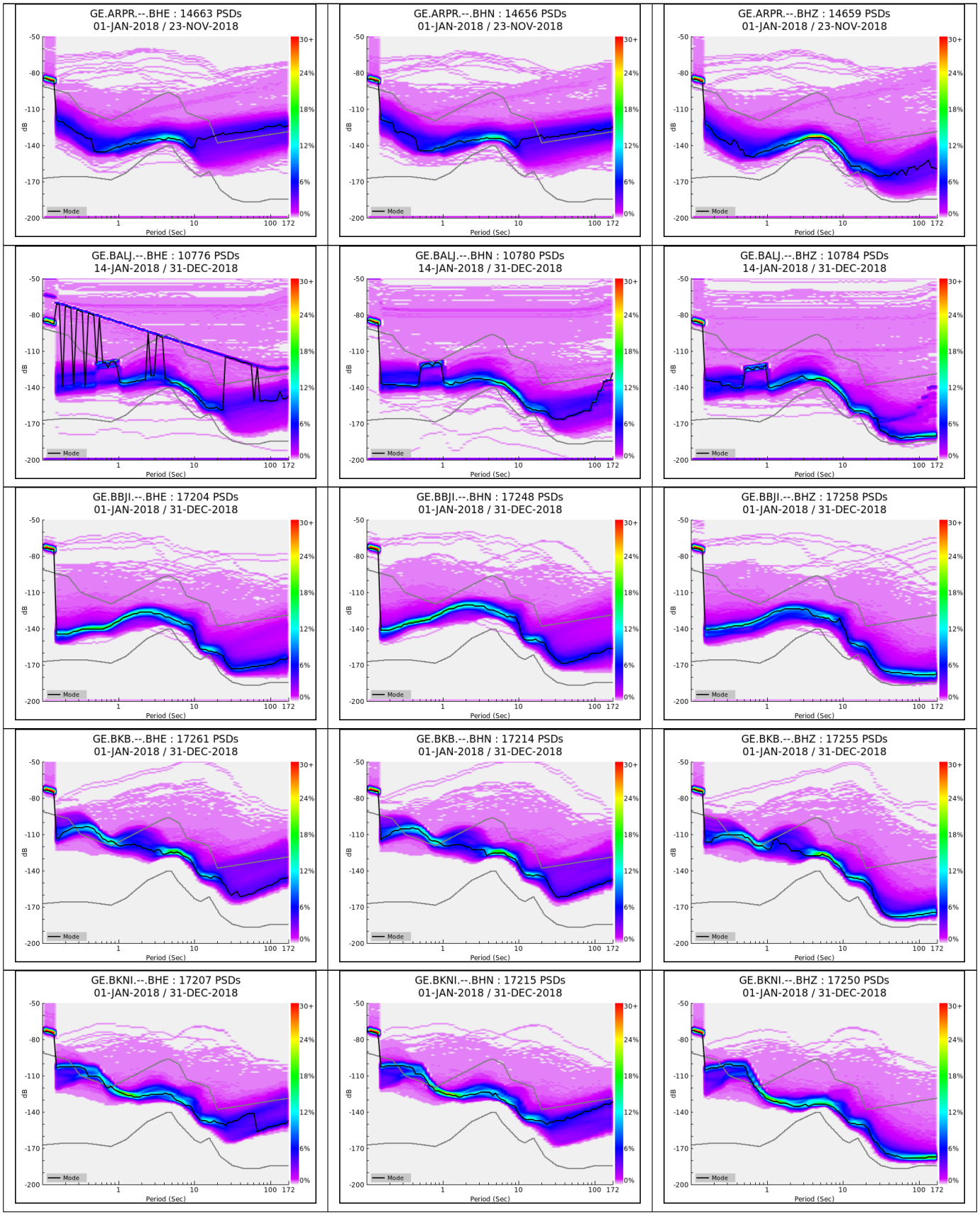

Fig. 10 – continued on next page

Continued from previous page

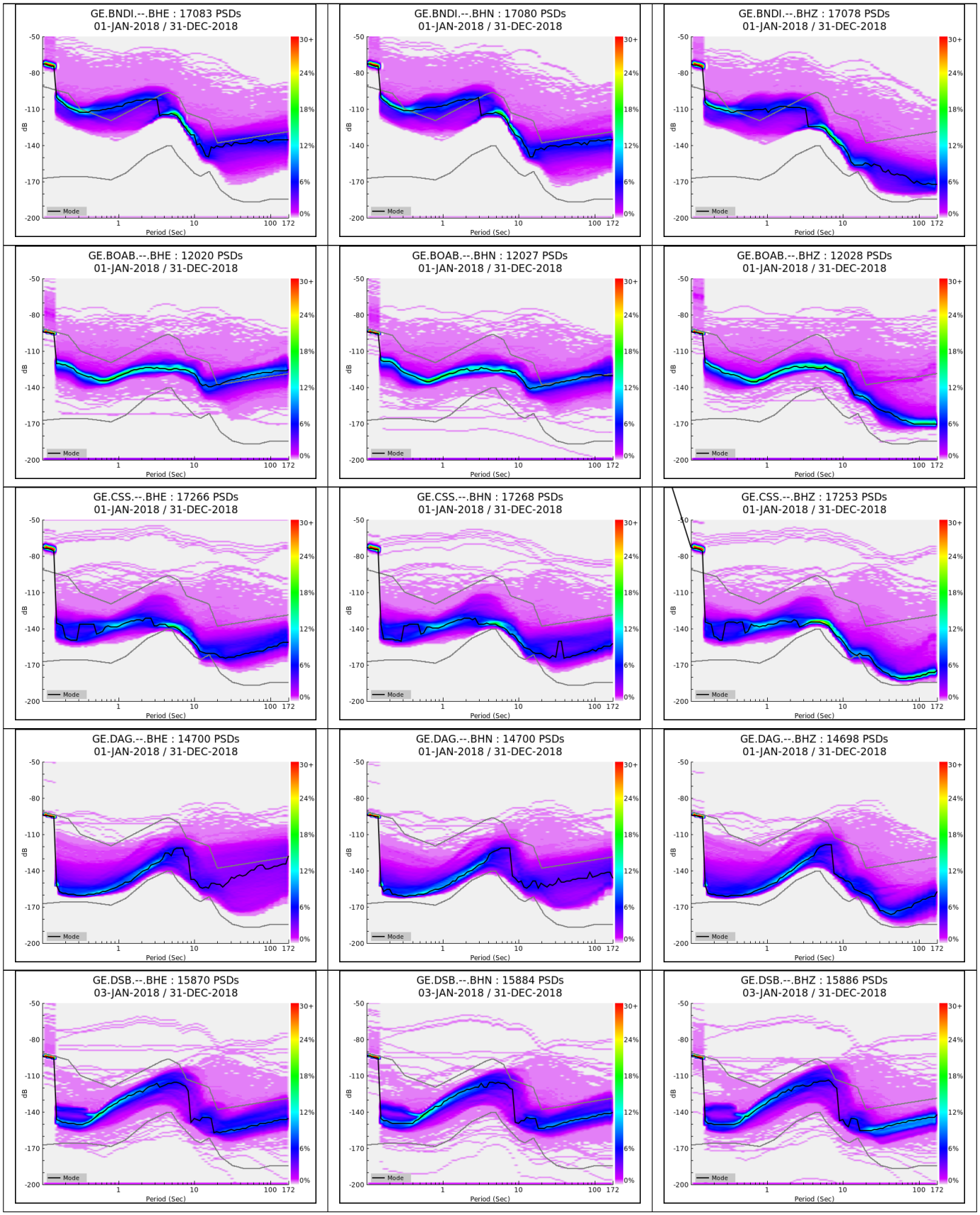

Fig. 10 – continued on next page

Continued from previous page

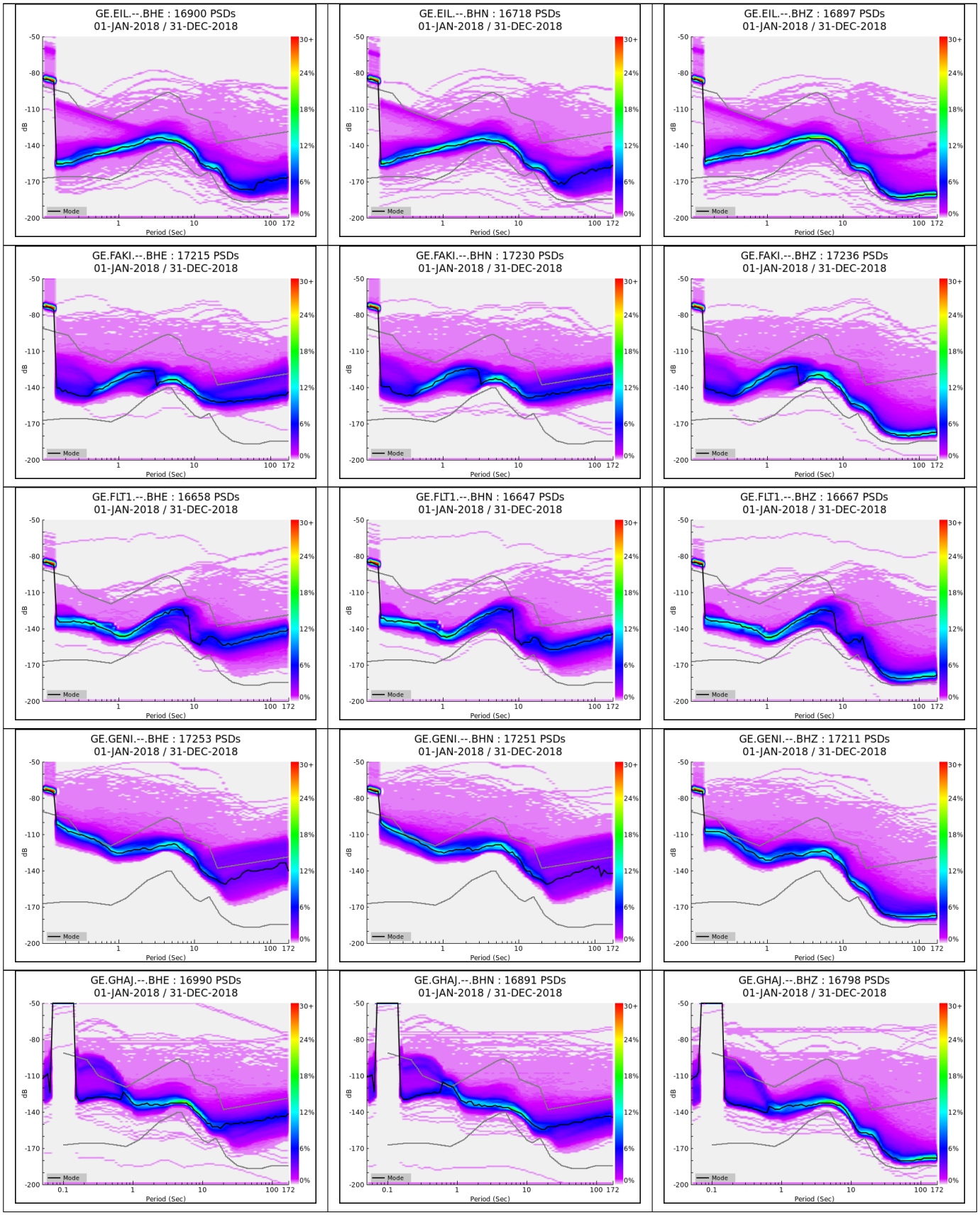

Fig. 10 – continued on next page

Continued from previous page

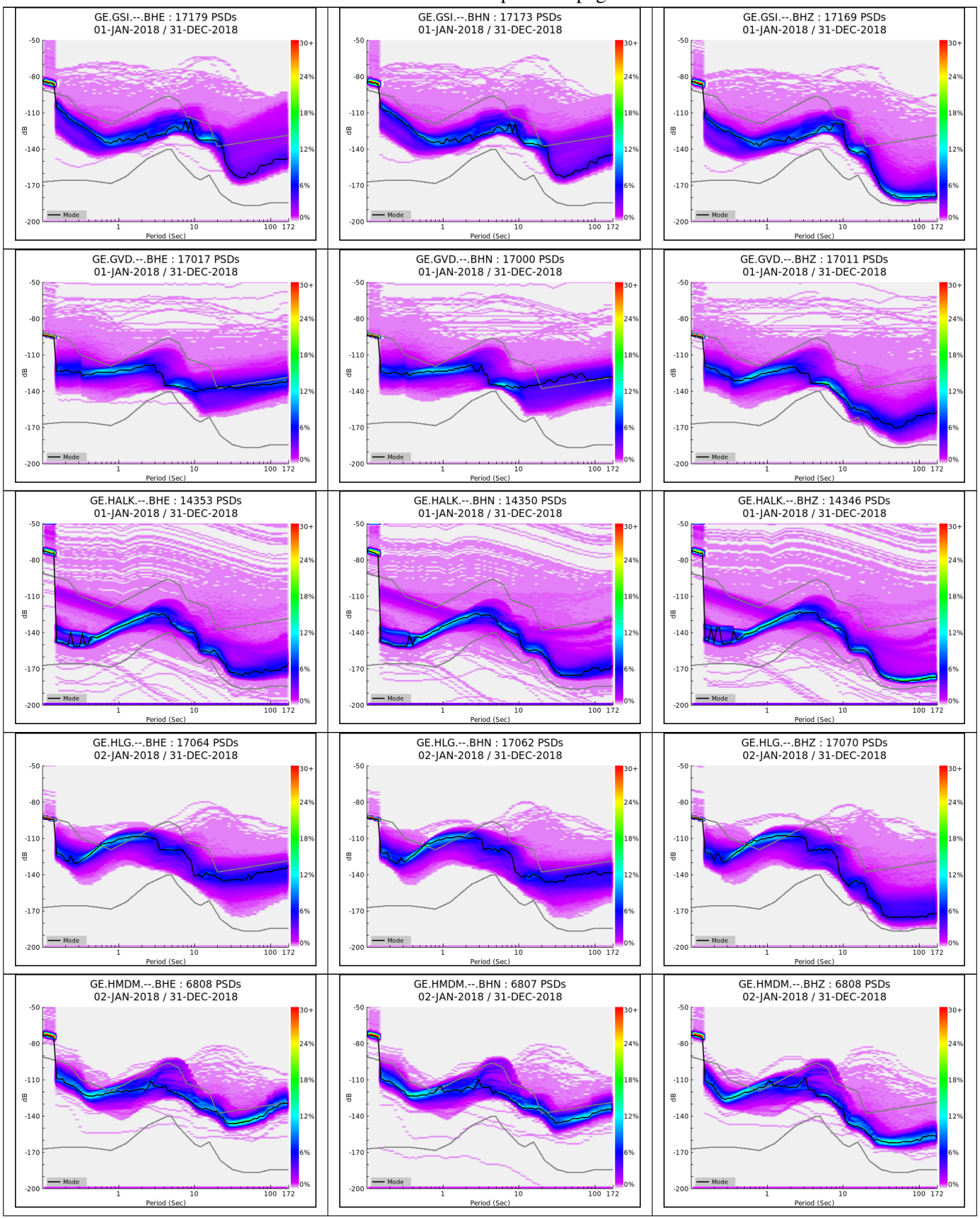

Fig. 10 – continued on next page

Continued from previous page

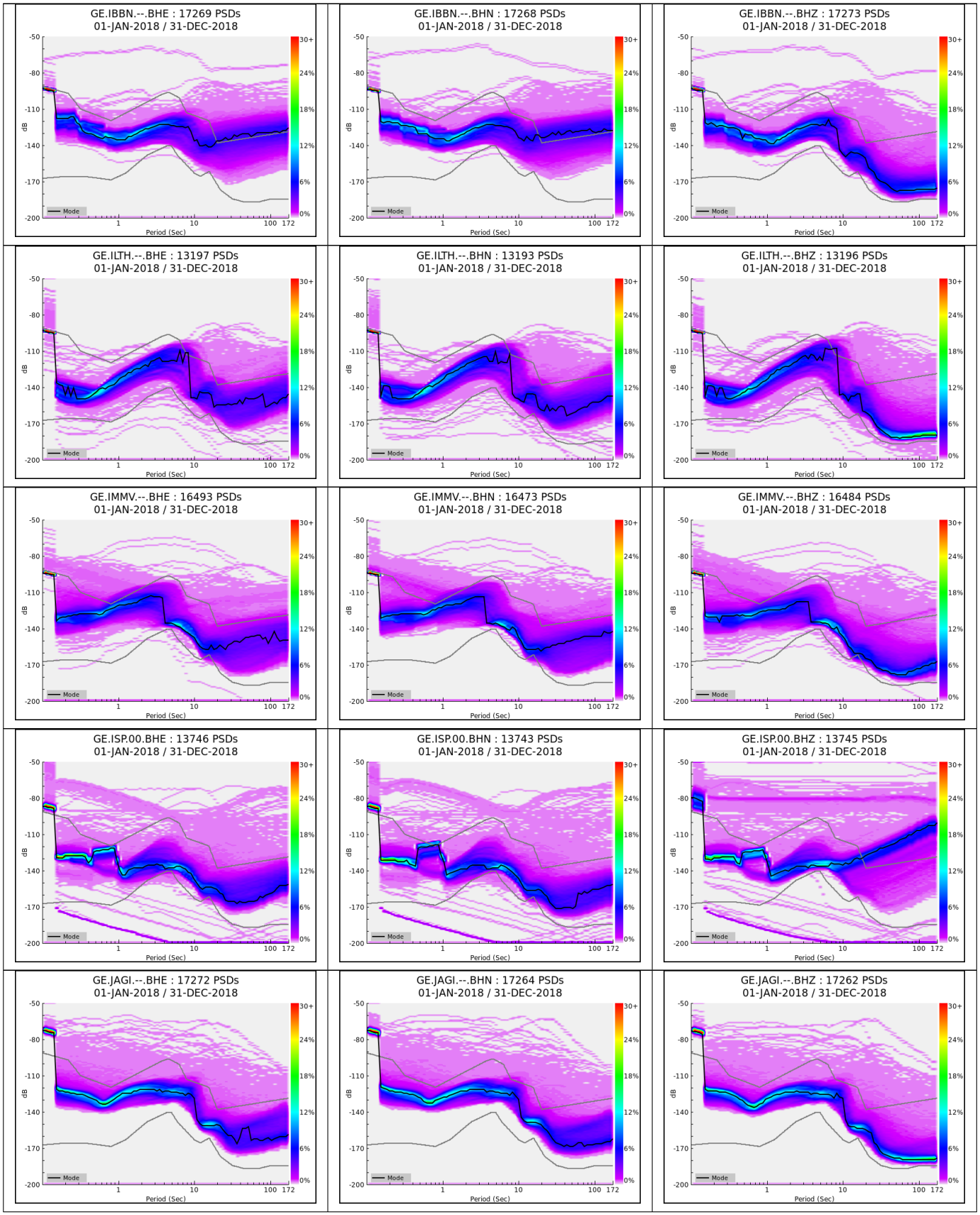

Fig. 10 – continued on next page

Continued from previous page

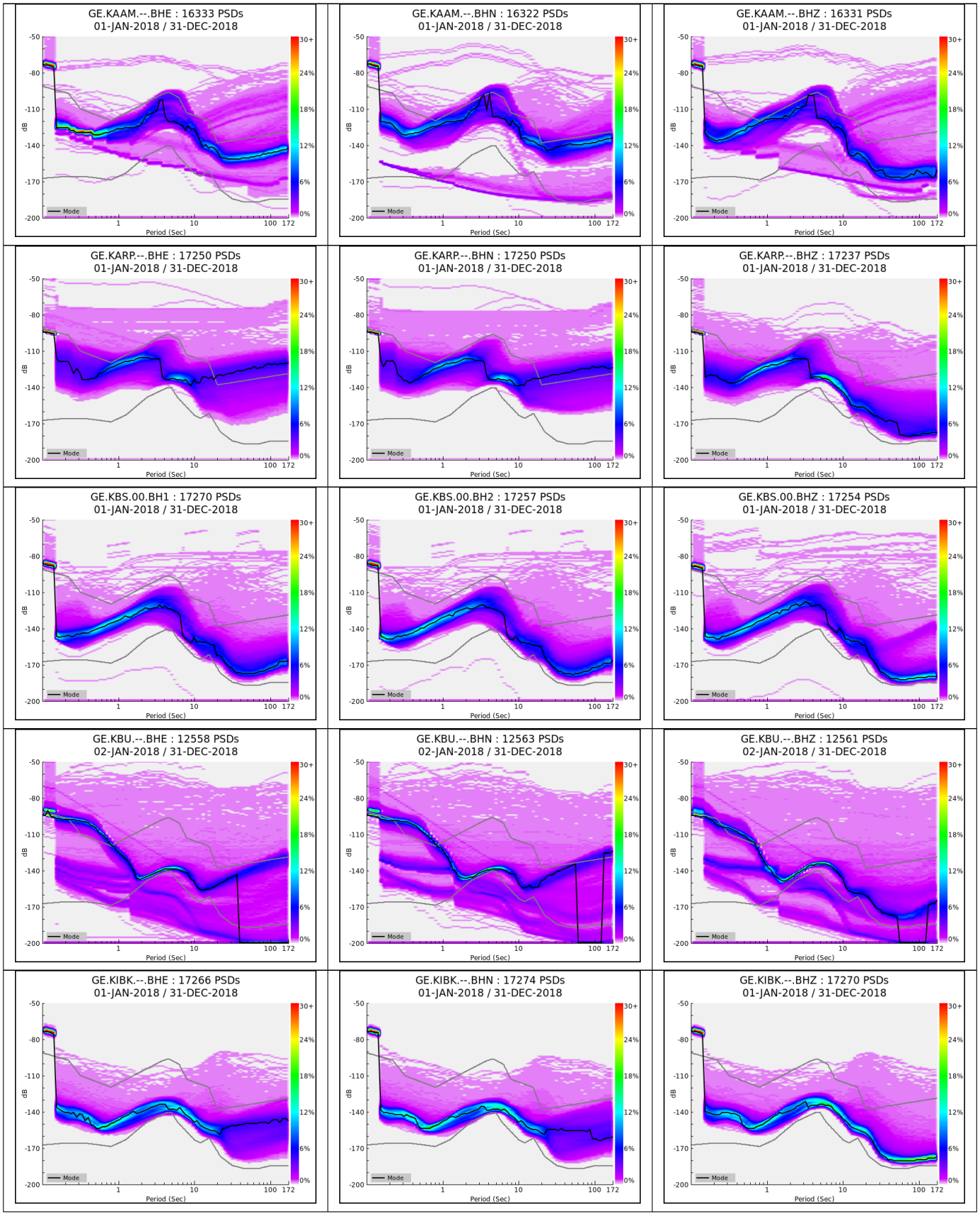

Fig. 10 – continued on next page

Continued from previous page

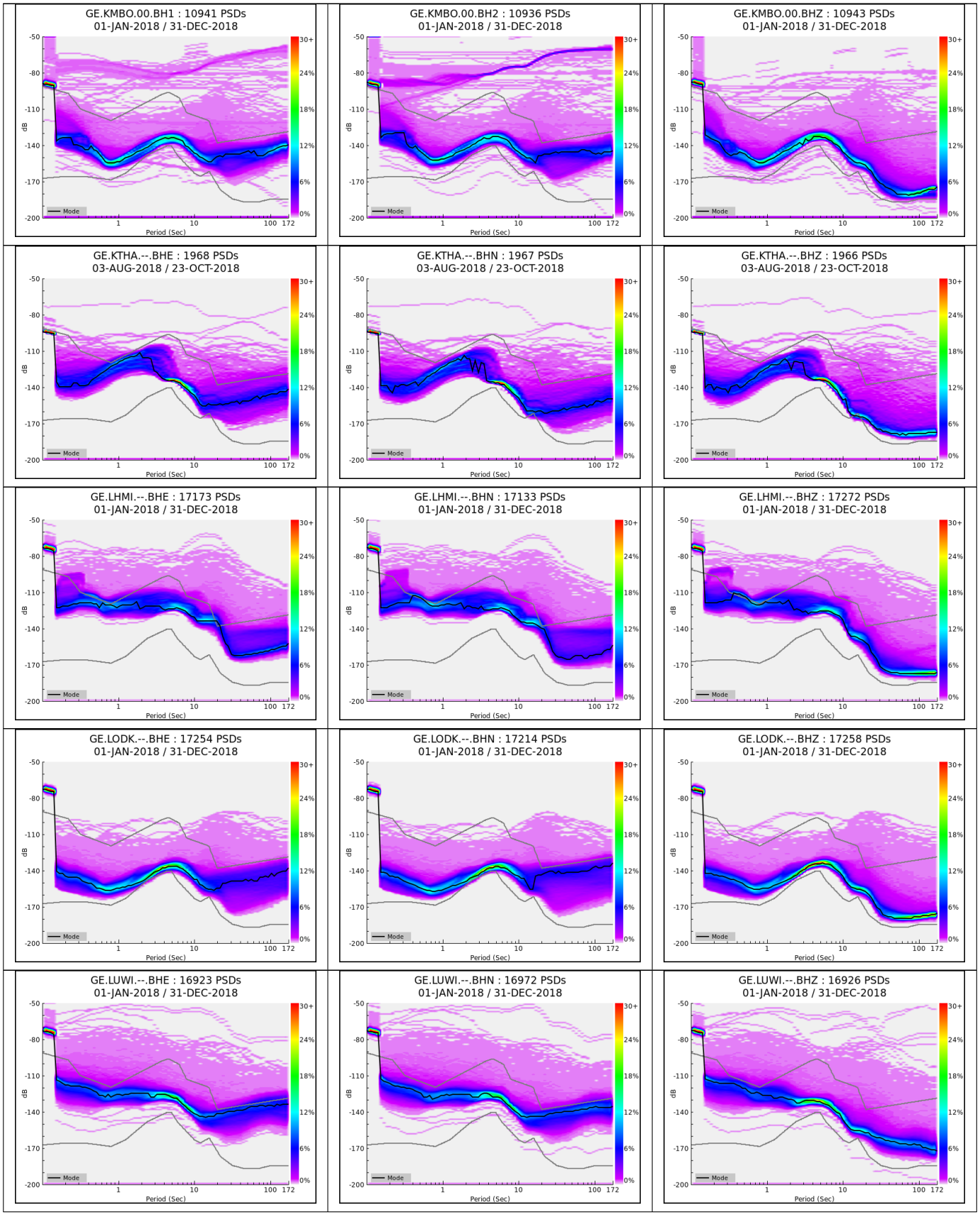

Fig. 10 – continued on next page

Continued from previous page

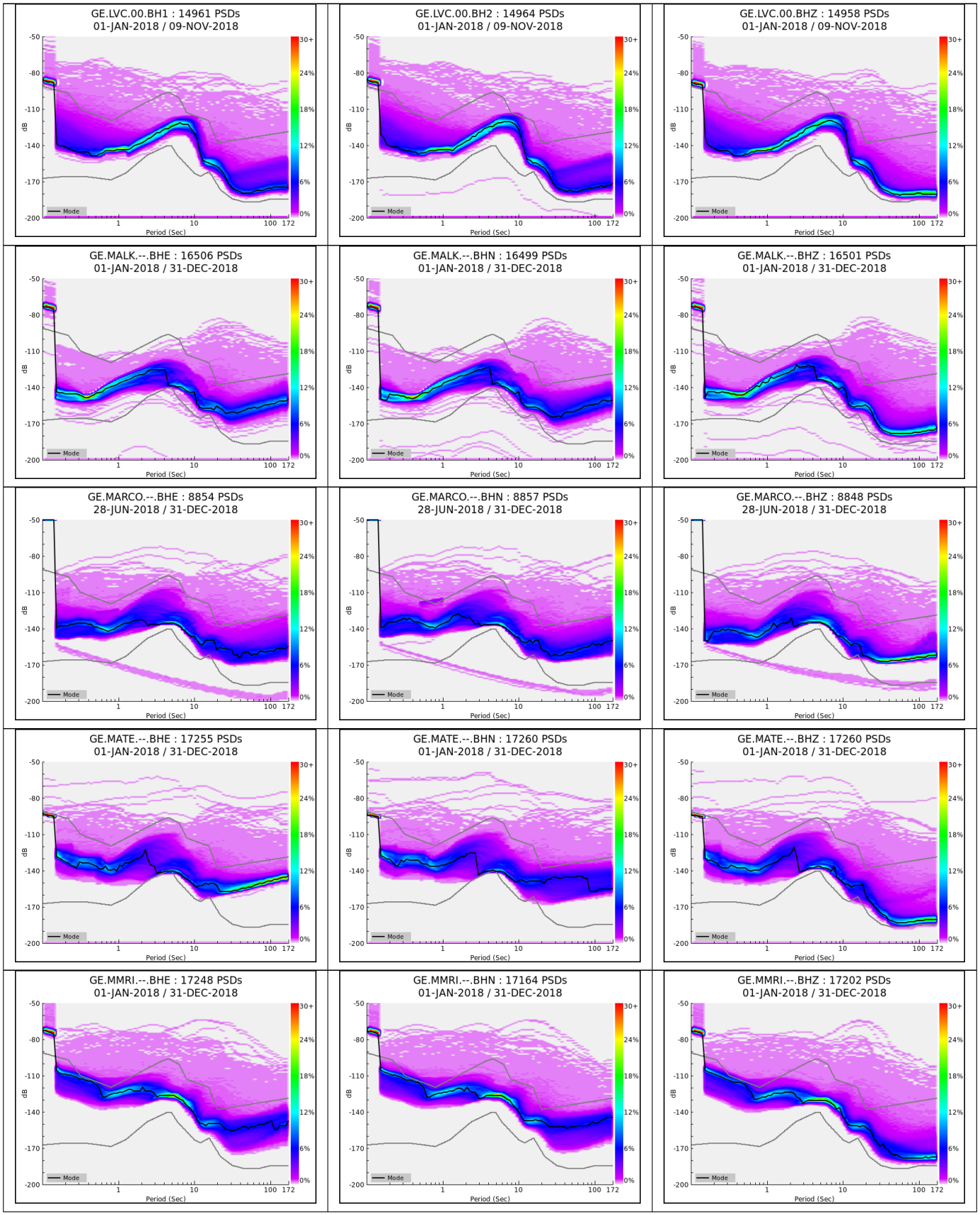

Fig. 10 – continued on next page

Continued from previous page

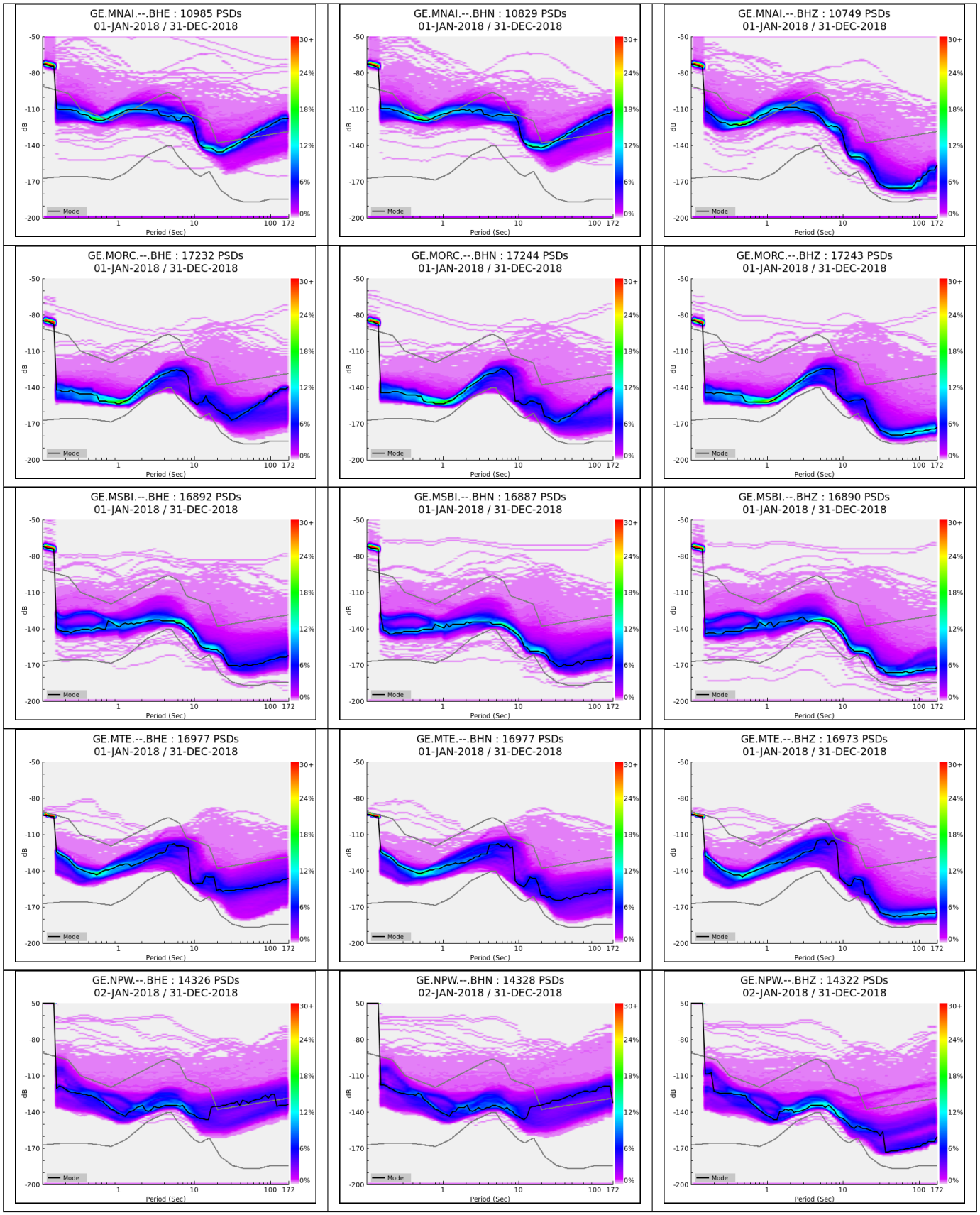

Fig. 10 – continued on next page

Continued from previous page

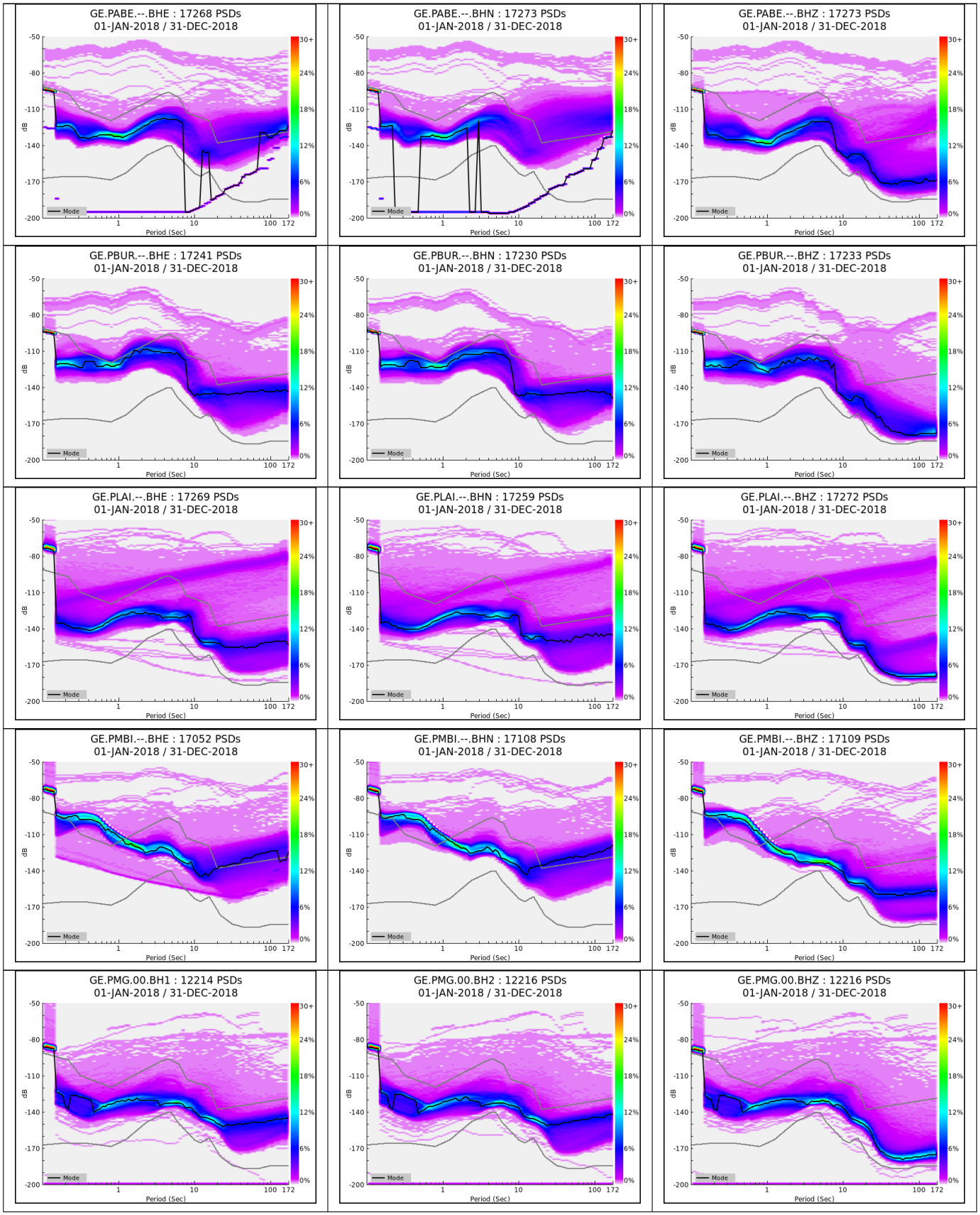

Fig. 10 – continued on next page

Continued from previous page

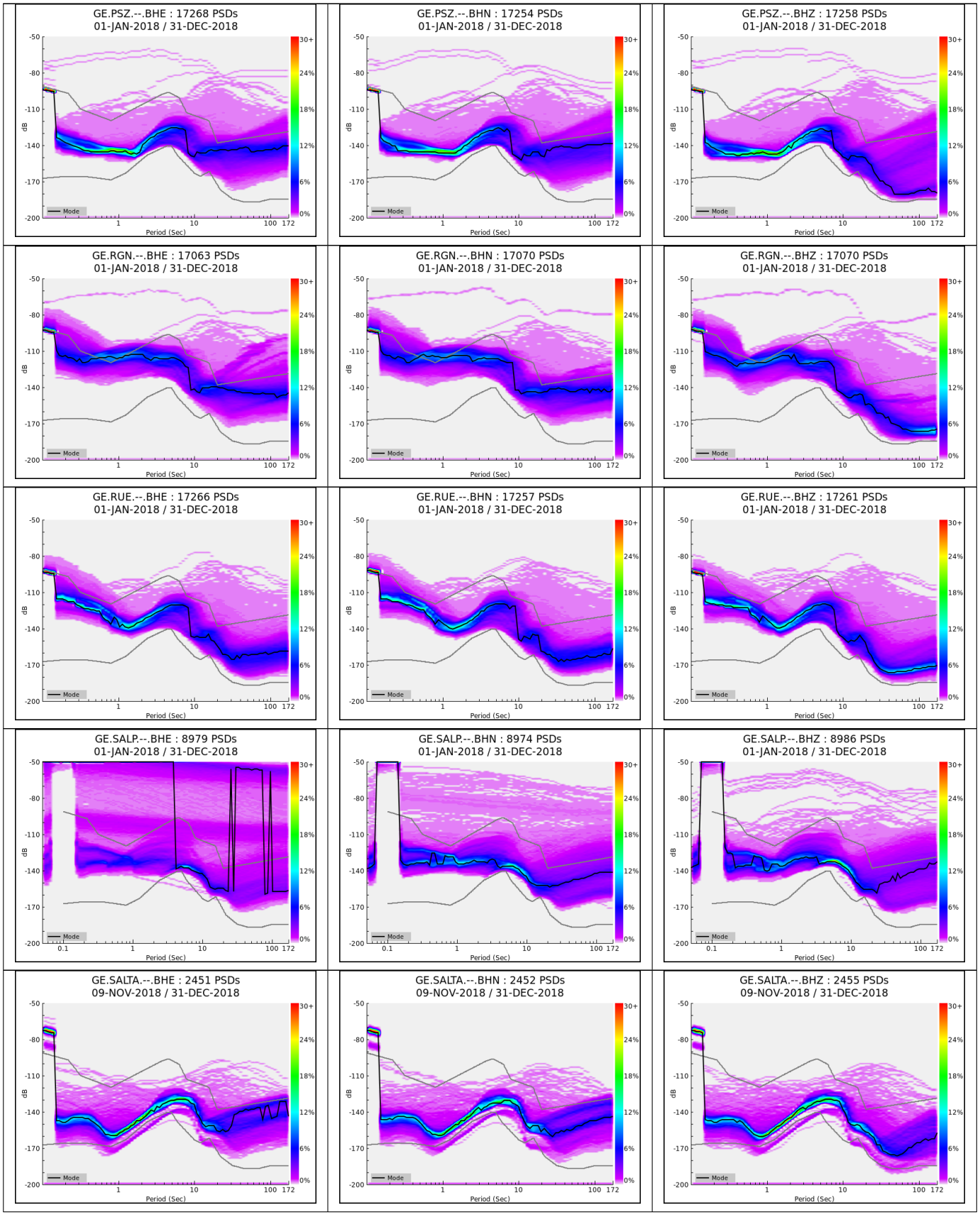

Fig. 10 – continued on next page

Continued from previous page

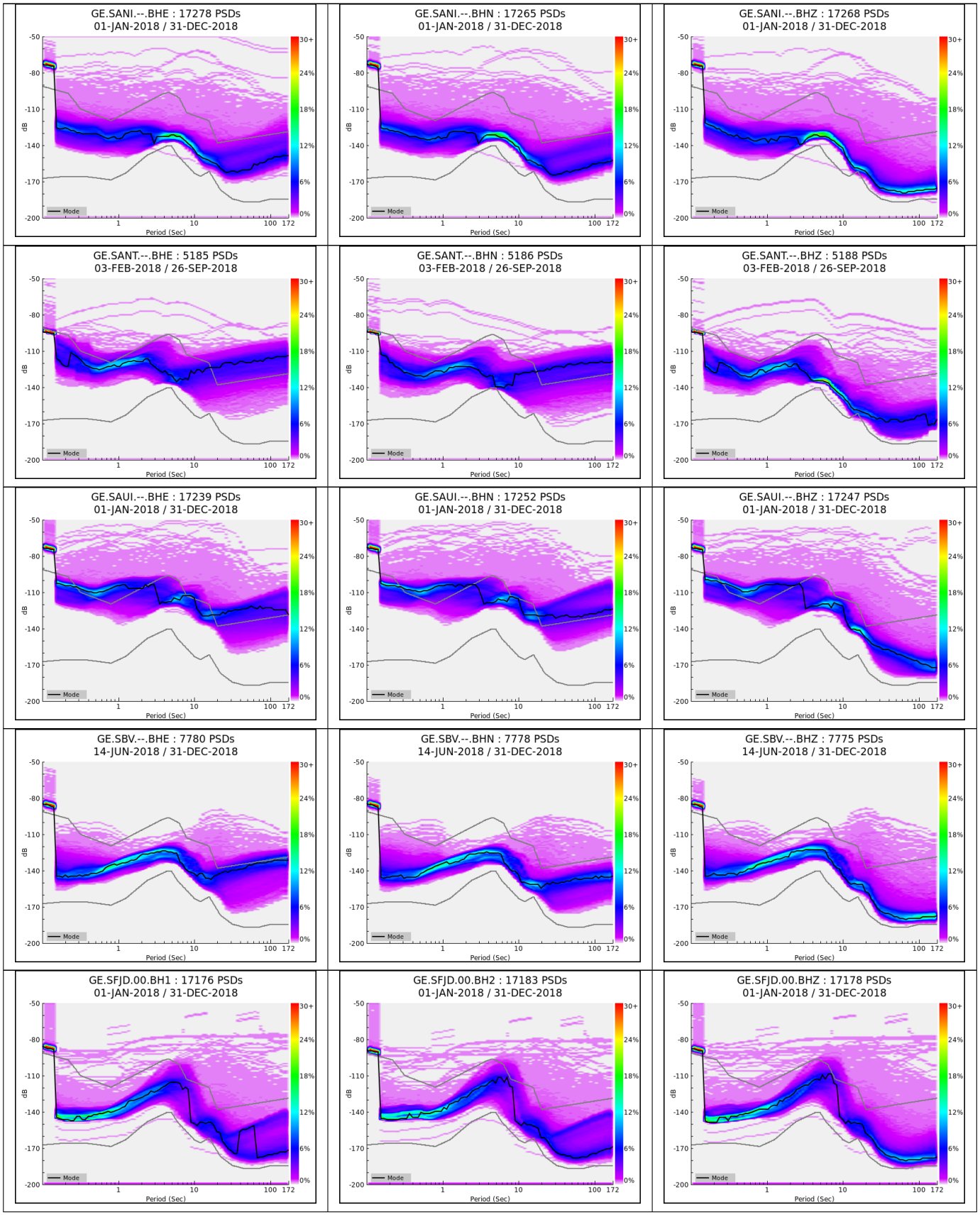

Fig. 10 – continued on next page

Continued from previous page

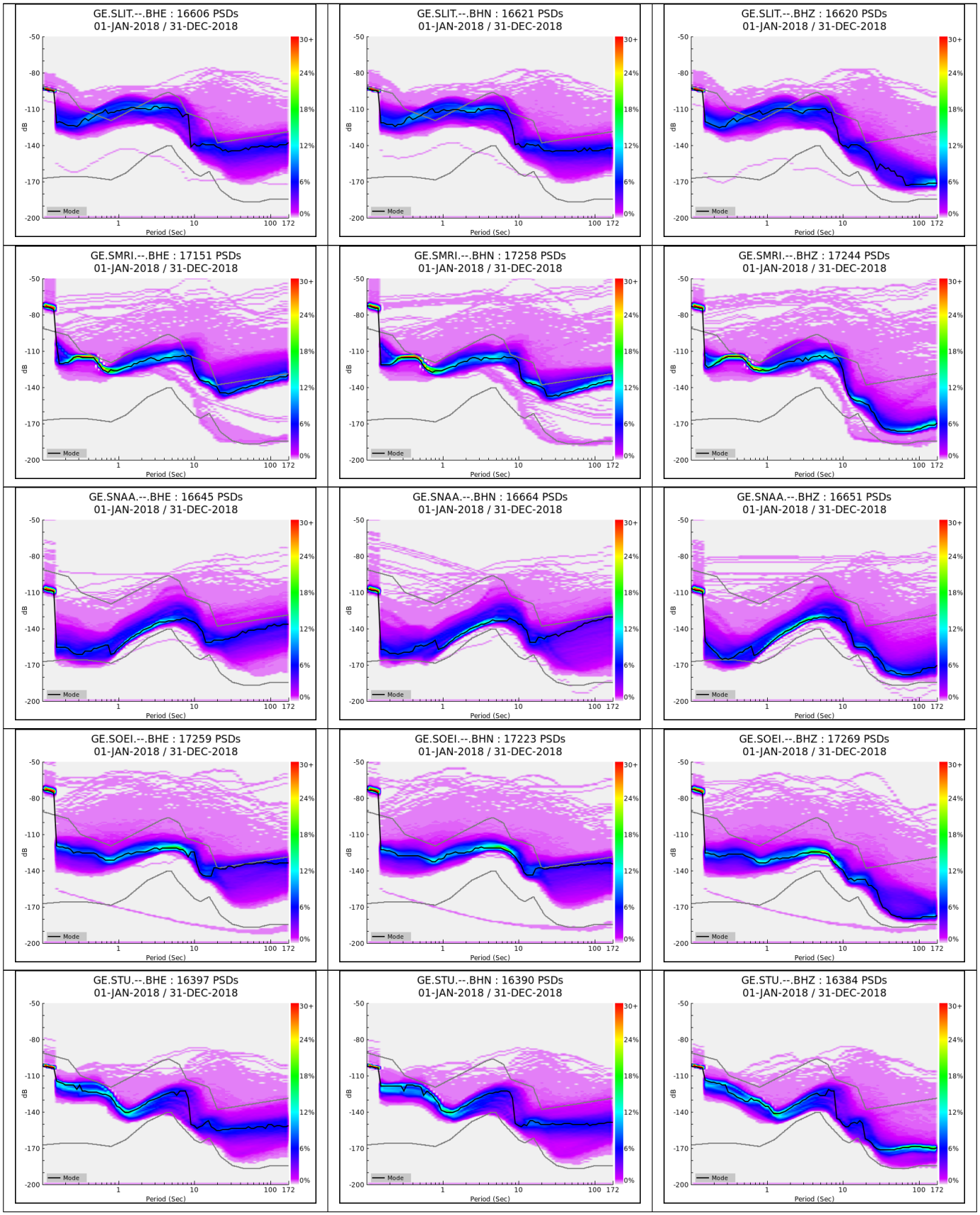

Fig. 10 – continued on next page

Continued from previous page

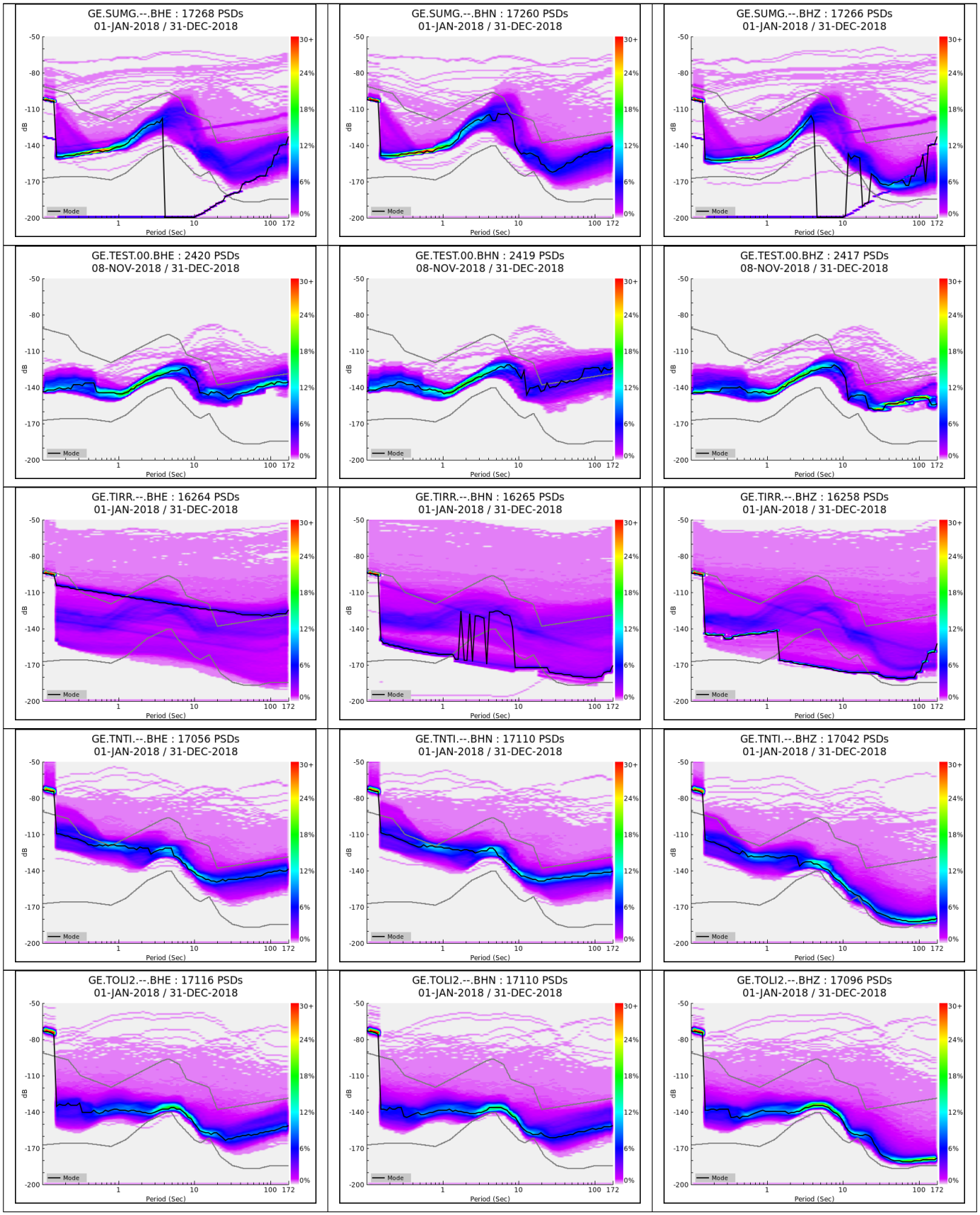

Fig. 10 – continued on next page

Continued from previous page

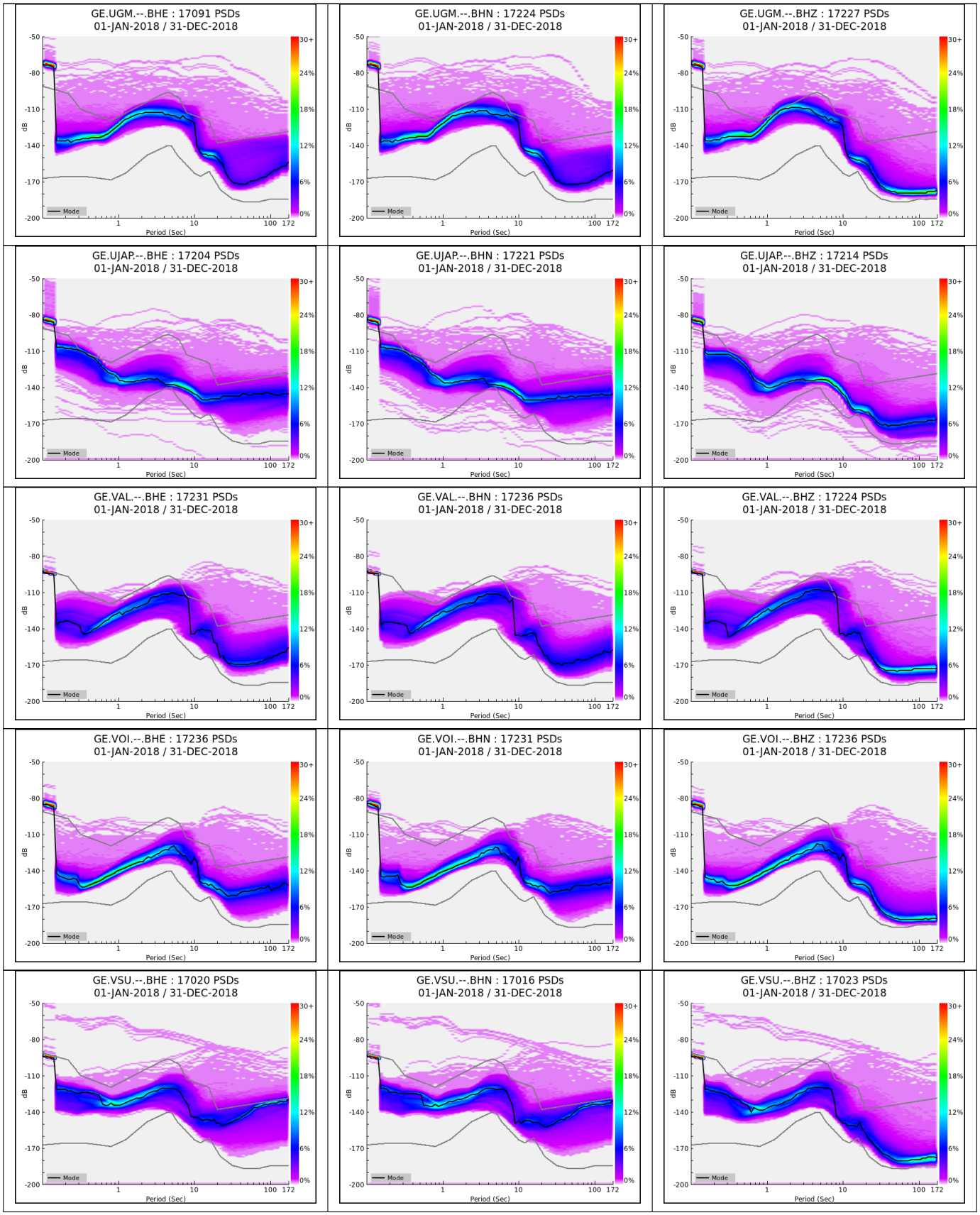

Fig. 10 – continued on next page

Continued from previous page

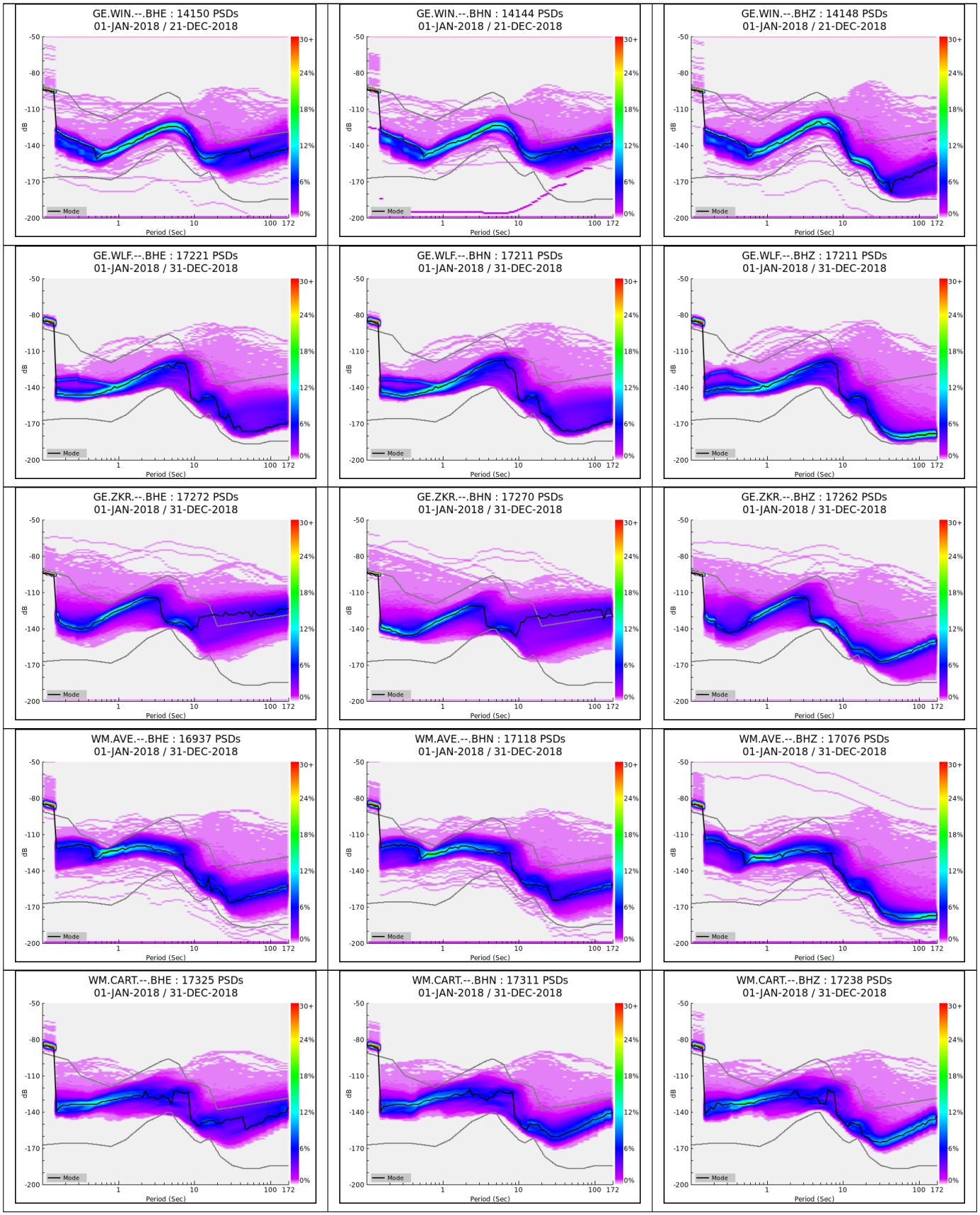

Fig. 10 – continued on next page

Continued from previous page

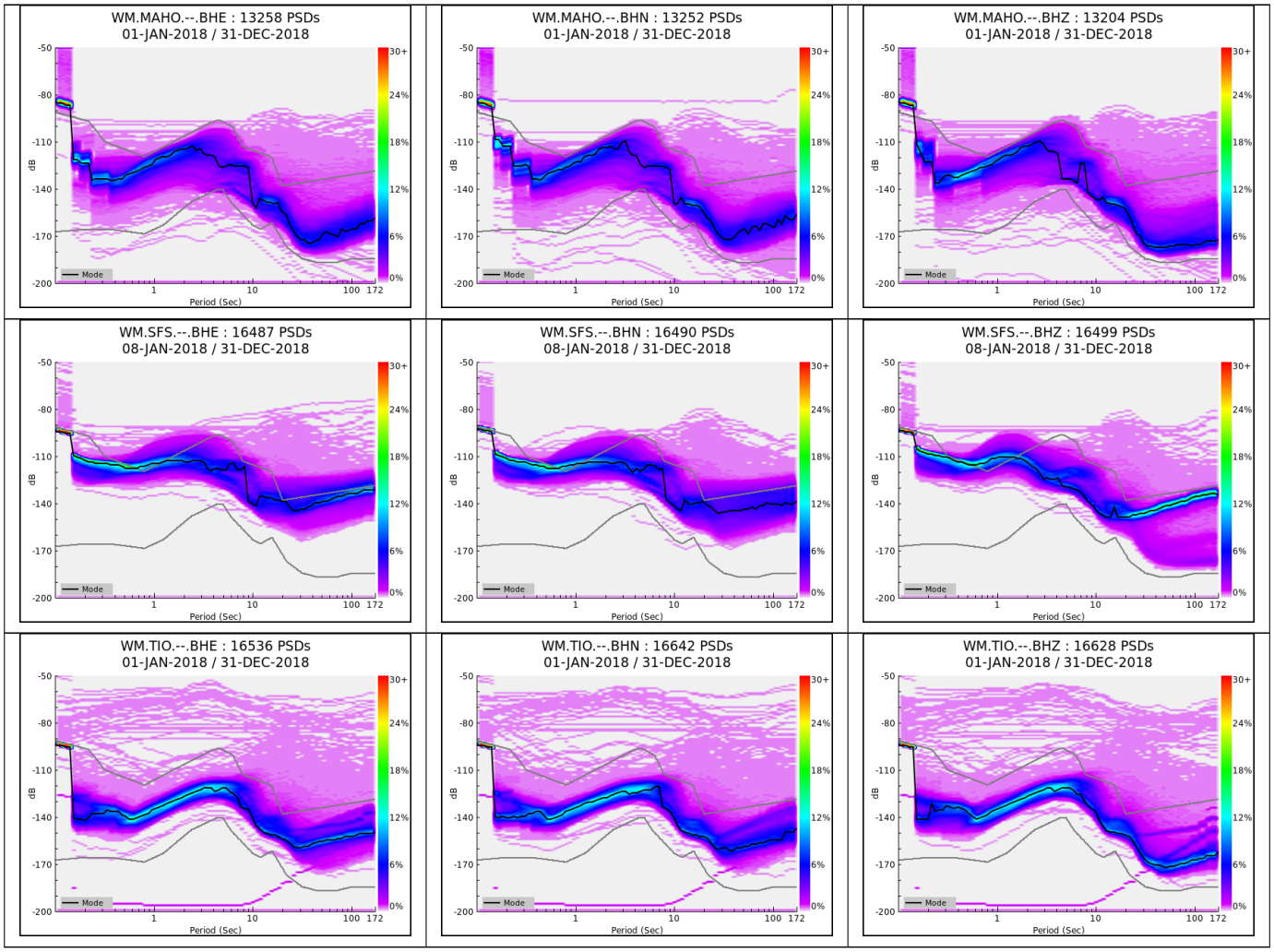

Fig. 10: GE Network PSDs (2018)

15 Annexes

15.1 Summary of GE maintenance team activities

An overview of the activity is provided in Annex 1. For each action at the station a short description is included. The summary includes also support activities for other groups within GFZ.

Annex 1: GE Network maintenance summary (2018)

ISSN 2190-7110