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X9 2015-2016

**Klyuchevskoy volcanic group experiment
(KISS)**

Scientific Technical Report STR - Data 21/01

GIPP Experiment and Data Archive

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If you use the GEOFON dataset described in this report, please use the following citation:

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The raw unprocessed data are archived as assembled dataset and should be cited as:

Shapiro, N. M., Sens-Schönfelder, C., Lühr, B.-G., Weber, M., Abkadyrov, I., Koulakov, I., Jakovlev, A., Kugaenko, Y. A., & Saltykov, V. (2021). Klyuchevskoy volcanic group experiment (KISS): Supplementary data of the passive seismological measurement [Data set]. GFZ Data Services. <https://doi.org/10.5880/GIPP.201505.1>

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Klyuchevskoy volcanic group experiment (KISS)

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Abstract

The KISS network was installed in the frame of the “Klyuchevskoy Investigation - Seismic Structure of an extraordinary volcanic system” project and recorded data between summer 2015 and summer 2016 in one of the world’s largest clusters of subduction volcanoes - the Klyuchevskoy volcanic group (KVG). It is located in eastern Russia at the northern end of the Kuril-Kamchatka subduction zone close to its intersection with the Aleutian arc and the north-western termination of Hawaii-Emperor seamount chain. Additional to the 4700m high Mount Klyuchevskoy the KVG contains 12 other volcanoes that have together erupted about 1 cubic meter rock per second averaged over the past 10,000 years. Among those Klyuchevskoy, Bezymianny and Tolbachik were the most active ones during the last decades with eruptions styles ranging from explosive to Hawaiian-type. The KISS experiment is designed to investigate the volcanic and seismic processes and its structural setting in the KVG. The network covers a circular region of about 80km diameter with some linear extensions. It includes data from 77 temporary seismic stations with broadband and short period sensors that were installed on concrete plates in about 60cm deep holes. Due to the local conditions the stations were battery powered and could not be serviced during the experiment. GPS reception of the digitizers was not continuous at all stations due to thick snow cover and vegetation. Waveform data are available from the GEOFON data centre, under network code X9, and are embargoed until end of 2019.

1 Introduction

To undertake a large- scale seismological investigation of the Klyuchevskoy Volcanic Group (KVG), we formed a consortium of institutions from Russia, France, and Germany and designed the KISS experiment. We operated a temporary network of 83 seismographs between August 2015 and July 2016. An EOS article about the experiment is available from Shapiro et al. (2017, <https://doi.org/10.1029/2017EO071351>).

As part of the KISS project (“Klyuchevskoy Investigation - Seismic Structure of an extraordinary volcanic system”), the deployment of temporary stations was designed to complement the permanent network of the Kamchatka Branch of the Geophysical Survey of Russia. The waveform data from the permanent stations during the concurrent recording period is available from the GEOFON data centre under network code D0. Due to terms of the project, authorisation must be granted to access this restricted dataset (D0).

2 Data Acquisition

2.1 Experimental Design and Schedule

The station distribution is shown in [Fig. 1](#), and [Table 1](#) summarises the most important information about each station.

2.2 Site Descriptions

Both broadband and short period sensors were installed on cement founded concrete plates in about 60cm deep holes. Due to the local conditions the stations were battery powered and could not be serviced during the experiment. GPS reception of the digitizers was not continuous at all stations due to thick snow cover and vegetation.

2.3 Instrumentation

Stations for this network were partly supplied through a GIPP equipment loan: <http://gipp.gfz-potsdam.de/webapp/projects/view/507>

Table 1 summarises the most important information about each station.

2.4 Sensor orientation

Sensors in the KISS experiment were oriented using a compass and the location estimated using a GPS. To assess the accuracy of the sensor orientation a second reference location was measured with GPS at some distance in the north-direction indicated by the deployed sensor. Locations of these reference points are listed in table Table 2. In some cases the reference point could not be taken due north because of topographic circumstances. In these cases the reference point was taken in the directions that the deployed sensor indicated as south which is indicated in the last column of Table 2. In some cases it was not possible to measure the location of a reference point at all.

3 Data Description

3.1 Data Completeness

Fig. 3 shows the uptime of each stations.

3.2 Data Processing

Data of this dataset is not processed. However, format conversion was necessary. In the case of station operated with Omnirecs Cube digitizers the conversion involves a resampling of the data to correct the actual sampling rate of the digitizer that is determined by the internal clock only to a proper constant sampling rate. This conversion and resampling was done using the GIPP tools <https://www.gfz-potsdam.de/en/section/geophysical-deep-sounding/infrastructure/geophysical-instrument-pool-potsdam-gipp/software/gipptools/> with the cube2mseed option `-fringe-samples=NOMINAL`. Raw data recorded by the Omnirecs Cube digitizers can be accessed as a supplementary dataset.

3.3 Data quality and Noise Estimation

Fig. Fig. 2 shows noise probability density functions for all channels.

3.4 Timing Accuracy

The timing accuracy of the dataset was assessed with the methodology described in Sens-Schönfelder (2008). Synchronizing seismic networks with ambient noise, *Geophysical Journal International*, 174, 966–970, <https://doi.org/10.1111/j.1365-246X.2008.03842.x>

No systematic timing errors were found in the dataset indicating that the GPS tags were frequent enough for the linear drift correction to provide timing accuracy below the resolution of the noise method. For the Cube digitizers the daily number of GPS locks are illustrated in Fig. 4. Time periods with low numbers indicate impaired GPS signal due to vegetation or snow.

4 Data Access

4.1 File format and access tools

The data are stored in the GEOFON database, and selected time windows can be requested by EIDA access tools as documented on <http://geofon.gfz-potsdam.de/waveform/> . Normally the data are delivered in miniseed format. The current data access possibilities can always be found by resolving the DOI of the dataset.

4.2 Raw Data and Pictures of the Station Locations

A supplementary dataset including pictures of the station locations and the raw files recorded by the DataCube recorders is archives at the GIPP (<http://doi.org/10.5880/GIPP.201505.1>).

4.3 Availability

Data are embargoed until 12/2019 and are then open.

5 Acknowledgments

The KISS experiment was supported by the Russian Science Foundation (grant 14- 47- 00002), the French project Labex UnivEarth, and the Université Sorbonne Paris Cité project VolcanoDynamics. Sixty seismographs were provided by Geophysical Instrument Pool Potsdam (GIPP) from the Helmholtz Center Potsdam- GFZ German Research Centre for Geosciences, and 23 were provided by the partner institutions from the Russian Academy of Sciences: the Institute of Volcanology and Seismology, the Trofimuk Institute of Petroleum Geology and Geophysics, and the Kamchatka Branch of the Geophysical Survey. KISS data are stored in the GFZ Seismological Data Archive operated by the GEOFON program and will be openly available after a 3-year embargo period. We are grateful to Sergey Abramnikov, Benjamin Heit, Pavel Kuznetsov, Ekaterina Kukarina, Roman Kulakov, Alexey Kotlyarov, Valeriy Gladkov, Petr Voropaev, Dmitry Droznin, Sergey Senyukov, and Vitaly Bliznetsov, who participated in the fieldwork. Special thanks are owed to Sergey Chirkov for providing field photographs and to the truck driver, Igor Uteshev, as well as to the helicopter pilot, Gennady Kroshkin.

Table 1 – continued from previous page

Label	Lat	Lon	Ele	Azi	Rate	Sensor	ID	Logger	Id	Start	End	Channels
SV2	55.75449	160.0419	207.3	90	50	Trillium Compact	C050	CUBE	0855	2015-08-04	2015-09-21	HHZ HHN HHE
SV3	55.55764	160.0851	117.2	90	50	Trillium Compact	C051	CUBE	0856	2015-08-08	2016-05-17	HHZ HHN HHE
SV4	55.88939	159.9505	174.3	90	50	LE-1D/1	1332	CUBE	0601	2015-08-04	2016-07-15	SHZ SHN SHE
SV5	56.01107	160.0373	235.3	90	50	Trillium Compact	C052	CUBE	0603	2015-08-02	2015-09-08	HHZ HHN HHE
SV6	55.79492	160.3444	2105.4	90	50	LE-1D/1	1334	CUBE	0825	2015-08-08	2016-07-05	SHZ SHN SHE
SV7	55.79243	160.5344	1300.6	90	50	Trillium Compact	C054	CUBE	0826	2015-08-08	2016-07-07	HHZ HHN HHE
SV8	55.89952	160.4906	1427.9	90	50	LE-1D/1	334a	CUBE	0827	2015-08-08	2015-11-13	SHZ SHN SHE
SV9	55.99524	160.4304	1835.5	90	50	Trillium Compact	C055	CUBE	0857	2015-08-07	2015-12-18	HHZ HHN HHE

Table 2: Locations of reference points for sensor orientation. Please note the last column which indicates cases where the reference points are not located in the *north-pointing* direction (default) but in the direction that the deployed sensor indicated as *south*.

Label	Ref Lat	Ref Lon	Ref Ele	Location of ref
B01	56.005256	160.331637	1535.017	
B02	56.146097	160.332212	1346.875	
B03	56.206812	160.492630	1287.959	
B04	56.222923	160.687482	1133.844	
B05	56.115524	160.753091	1373.966	
B06	56.055136	160.766400	1542.63	
B07	55.985612	160.679112	1508.101	south
B08	55.933209	160.605780	1438.499	
B09	56.190458	160.678024	1266.205	
IR1	55.718206	160.304863	1163.385	
IR10	55.119897	159.953160	265.381	
IR11				
IR12				
IR13				
IR14				
IR15	55.688044	160.699798	771.288	
IR16	55.651297	160.502734	427.532	south
IR17	56.178473	160.407352	1311.256	
IR18	56.200050	160.593600	1353.08	south
IR19	56.174108	160.752815	1062.377	
IR2	55.785599	160.232393	1062.506	
IR20	56.100329	160.827657	935.049	
IR3	55.857529	160.225437	1111.721	south
IR4	55.957850	160.236245	985.36	
IR5	56.031230	160.244186	973.647	
IR6	56.111965	160.269102	1314.898	
IR7	55.347778	160.583785	1462.549	
IR8	55.231249	160.080119	506.262	
IR9	55.311622	159.864097	1089.672	
OL1	55.877994	159.357963	145.438	
OL2	55.888915	159.543573	62.373	
OL3	55.438798	159.677199	83.452	
OL4	55.549435	159.454161	147.426	
OL5	55.292021	159.565895	112.317	
OL6	55.301392	160.278550	1051.971	
OL7	56.156949	161.508697	891.982	
OL8				
OL9				
OR1	55.965136	159.804443	49.919	south
OR10	56.050928	161.213353	44.678	
OR11	55.952916	161.209056	60.906	
OR12	55.876351	161.129859	109.252	
OR13	55.786396	161.100933	1119.887	
OR14	55.717616	161.027518	755.295	
OR15				
OR16	55.594981	160.819311	996.67	
OR17	55.543740	160.695138	882.982	south
OR18	55.485047	160.583280	935.535	south
OR19	55.456038	160.447563	765.791	south
OR2	56.146316	159.980011	70.176	
OR20	55.449858	160.257716	155.443	
OR21	55.439206	160.039521	101.443	
OR22	55.468822	159.857553	102.602	
OR23	55.566506	159.780687	59.801	
OR24	55.677039	159.787401	61.128	
OR25	55.767544	159.729128	49.038	

Continued on next page

Table 2 – continued from previous page

Label	Ref Lat	Ref Lon	Ref Ele	Location of ref
OR26	55.861250	159.775498	64.444	
OR27	56.262674	160.216187	142.908	
OR28	56.322818	160.363902	88.111	
OR29				
OR3	56.221179	160.080074	75.527	
OR30				
OR31				
OR32				
OR4	55.954217	159.215638	308.103	
OR5	56.030655	159.053095	282.853	
OR6	56.025697	158.843609	396.165	
OR7	55.784446	159.398817	93.715	
OR8	55.673629	159.450295	56.789	
OR9	55.601158	159.620791	61.278	
SV1	55.640260	160.244564	686.86	
SV10	56.022206	160.725875	1777.906	
SV11	55.190398	159.767129	155.78	
SV12				
SV13	56.099382	160.631512	2450.758	
SV2	55.754591	160.041935	208.452	
SV3	55.557840	160.084959	117.4	
SV4	55.889103	159.950441	173.729	
SV5	56.011158	160.037244	234.825	
SV6	55.795164	160.344300	2103.548	
SV7	55.792115	160.534561	1305.958	south
SV8	55.899784	160.490660	1426.31	
SV9	55.995680	160.430187	1834.615	

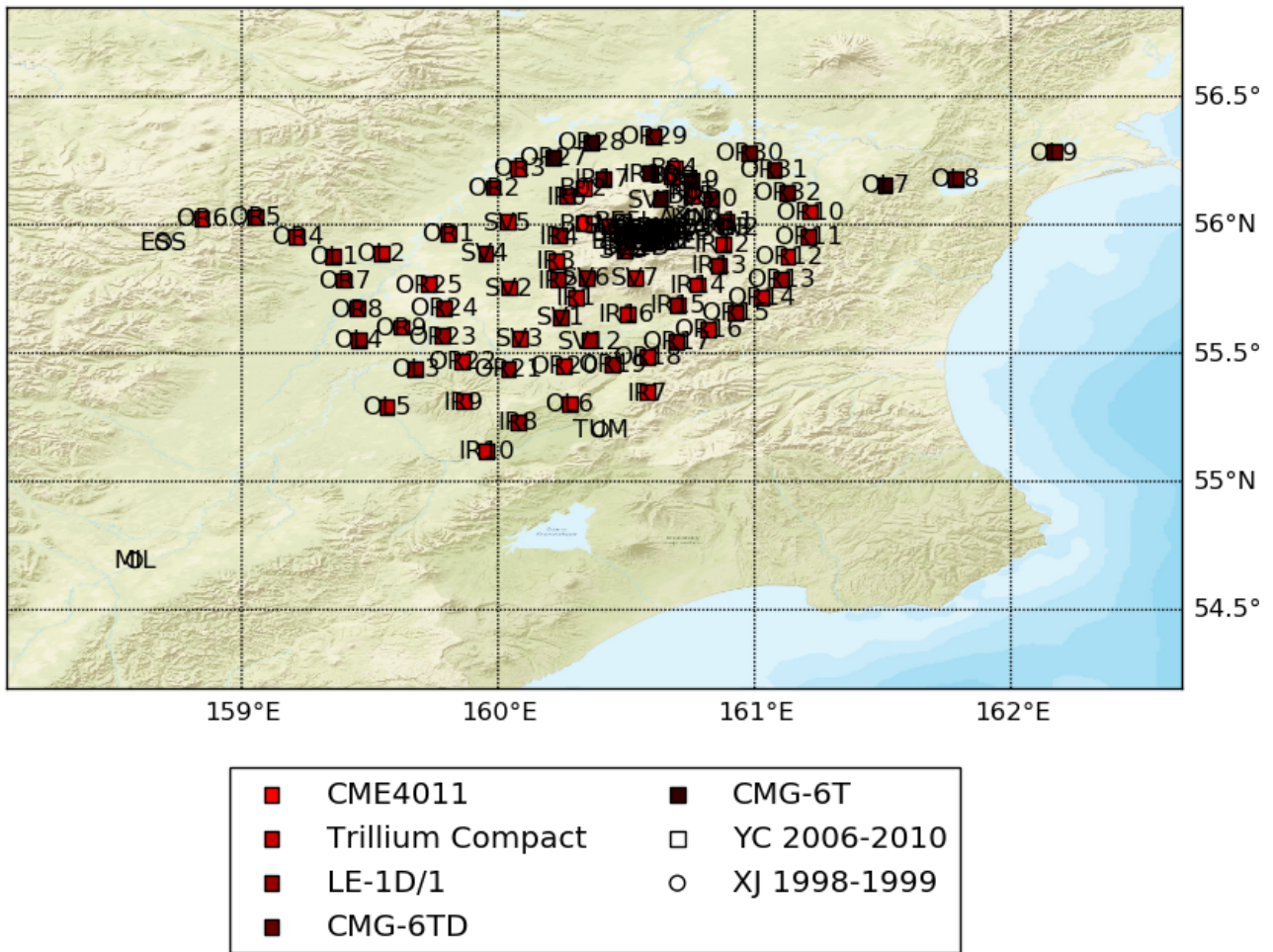


Fig. 1: Station distribution in experiment (red symbols). If present, white-filled symbols show permanent stations and other temporary experiments archived at EIDA or IRIS-DMC, whose activity period overlapped at least partially with the time of the experiment. If present, open symbols show station sites which were no longer active at the time of the experiment, e.g. prior temporary experiments.

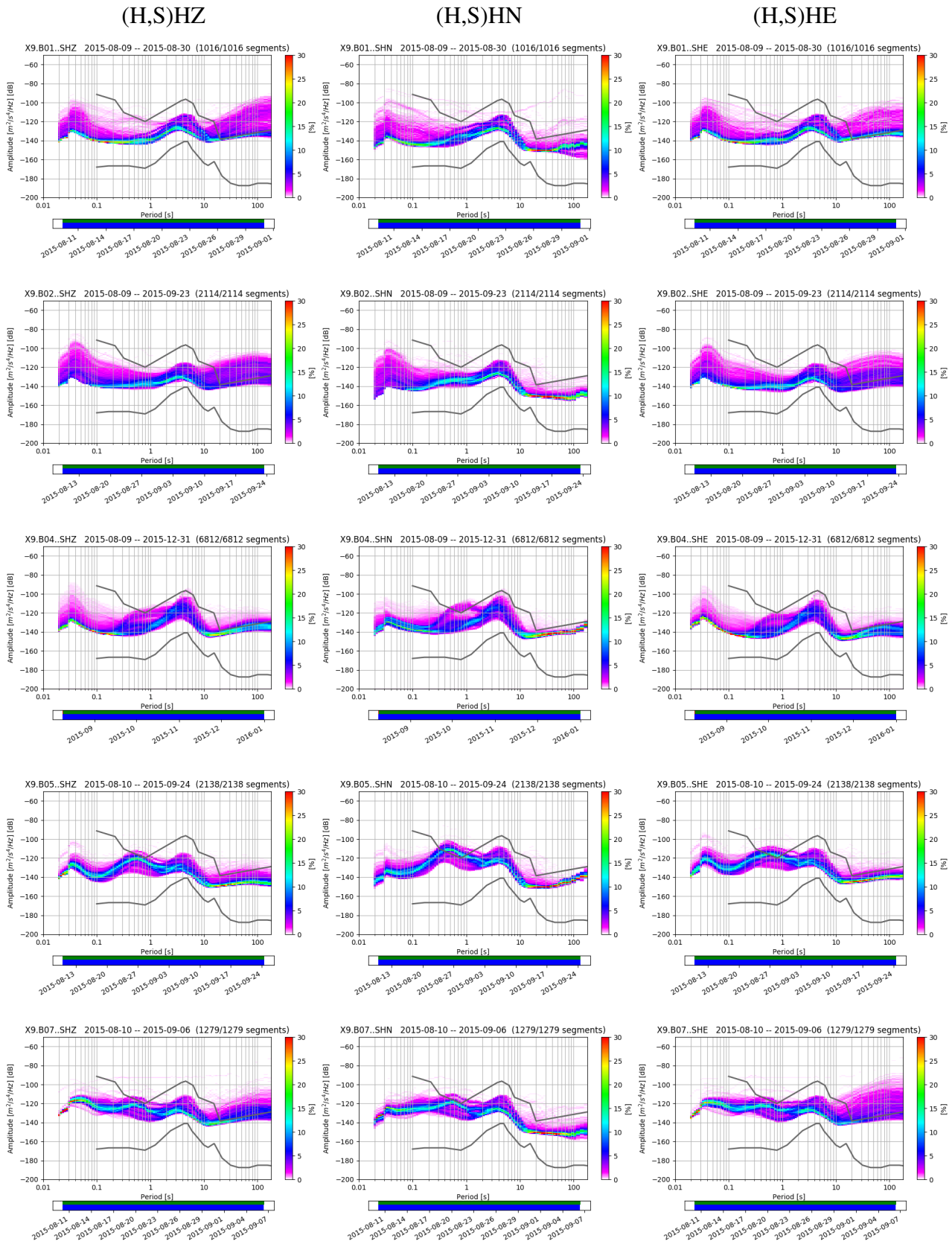


Fig. 2 – continued on next page

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(H,S)HZ

(H,S)HN

(H,S)HE

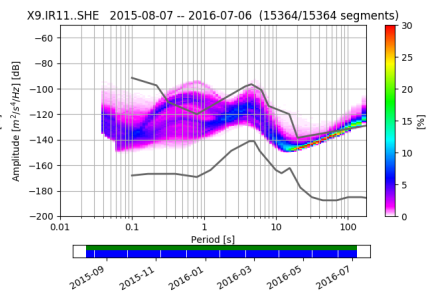
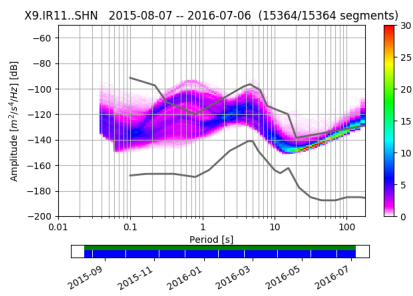
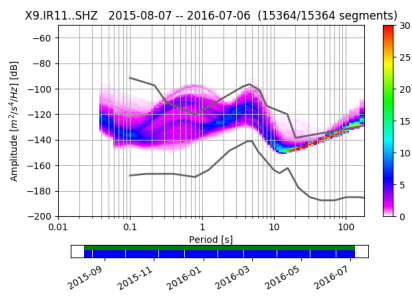
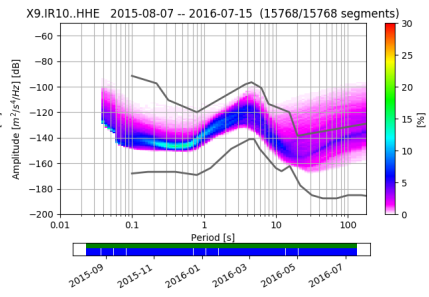
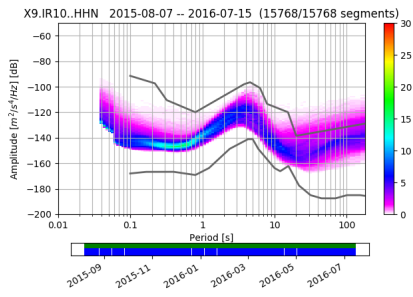
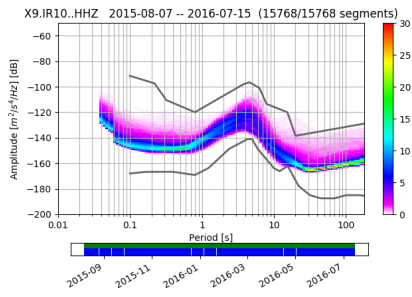
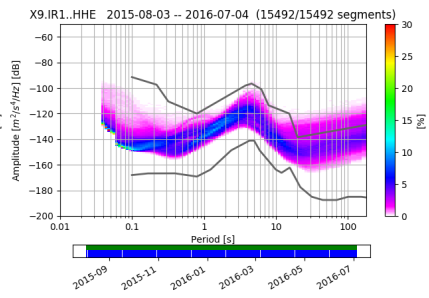
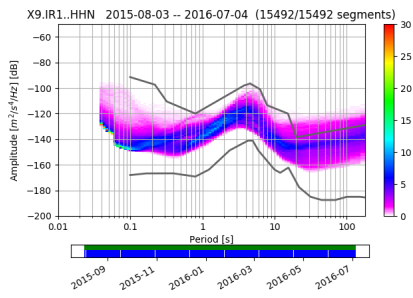
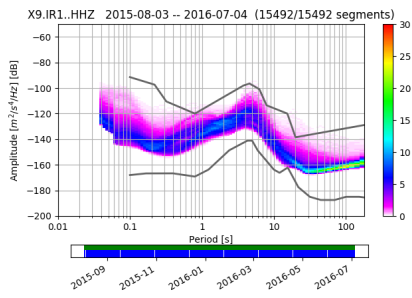
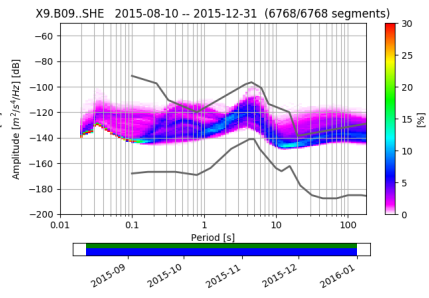
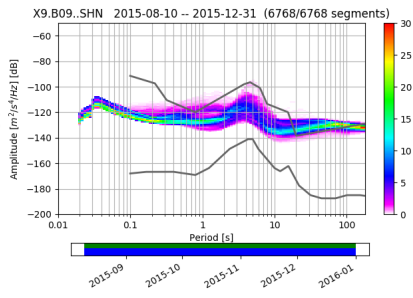
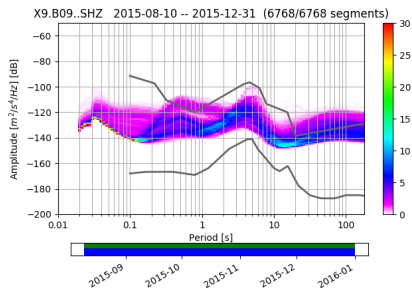
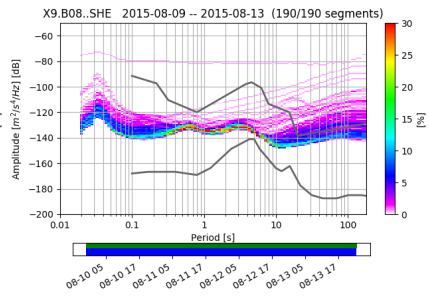
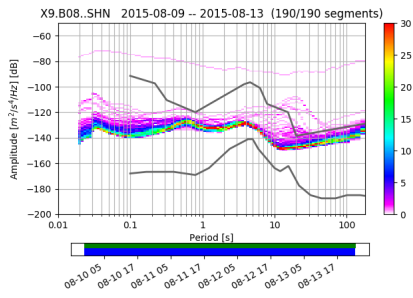
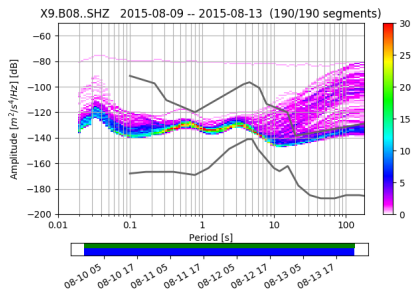


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(H,S)HZ

(H,S)HN

(H,S)HE

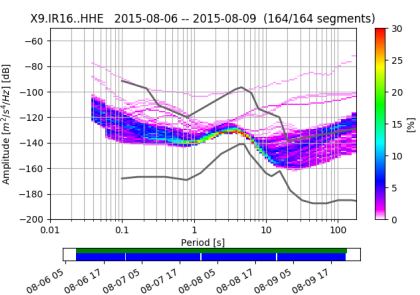
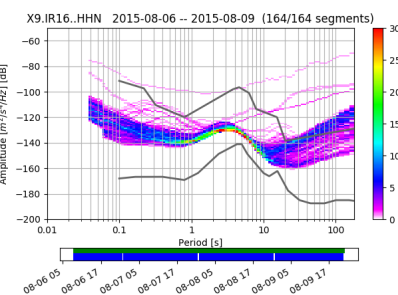
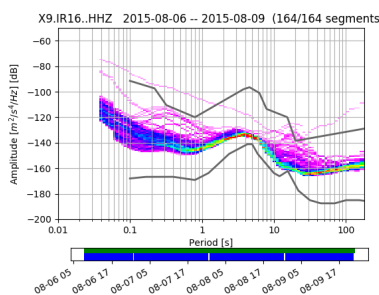
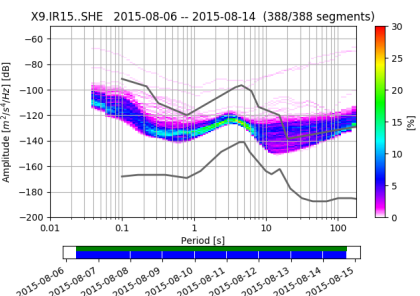
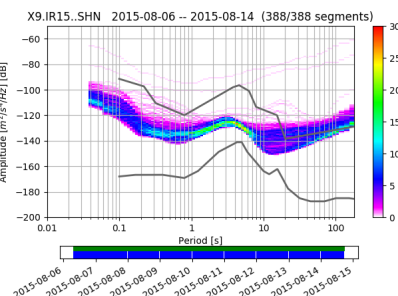
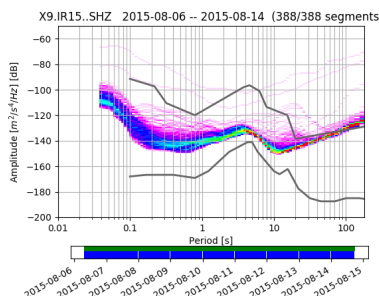
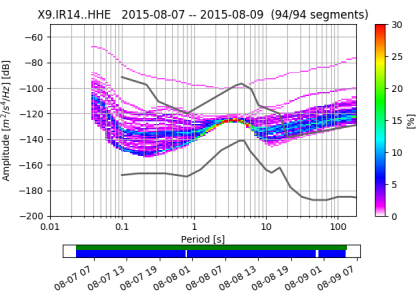
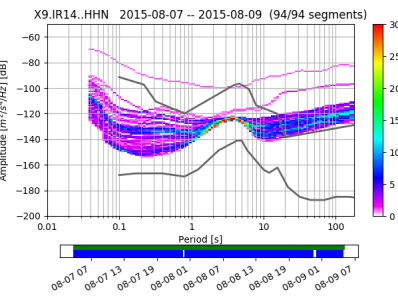
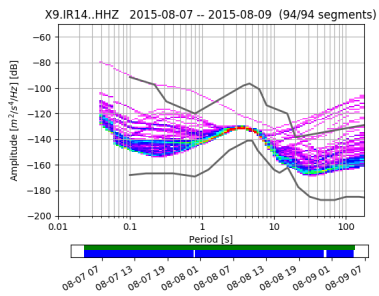
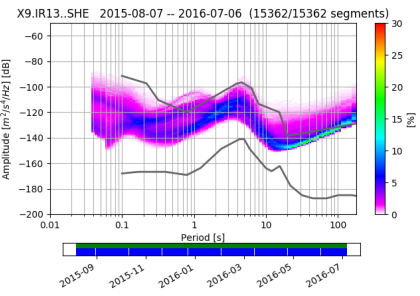
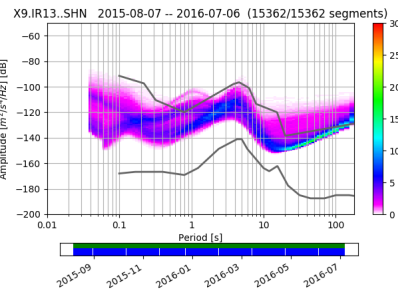
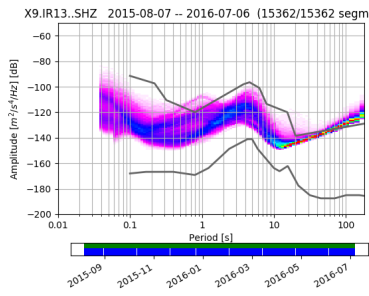
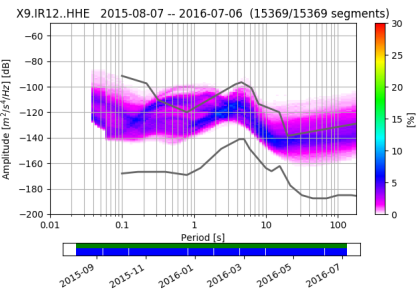
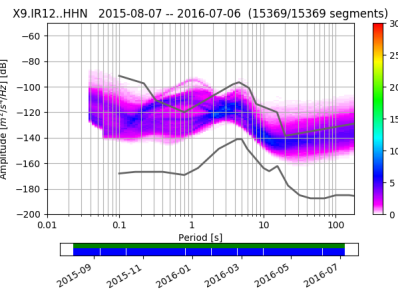
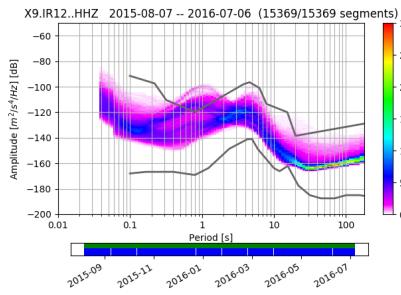


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(H,S)HZ

(H,S)HN

(H,S)HE

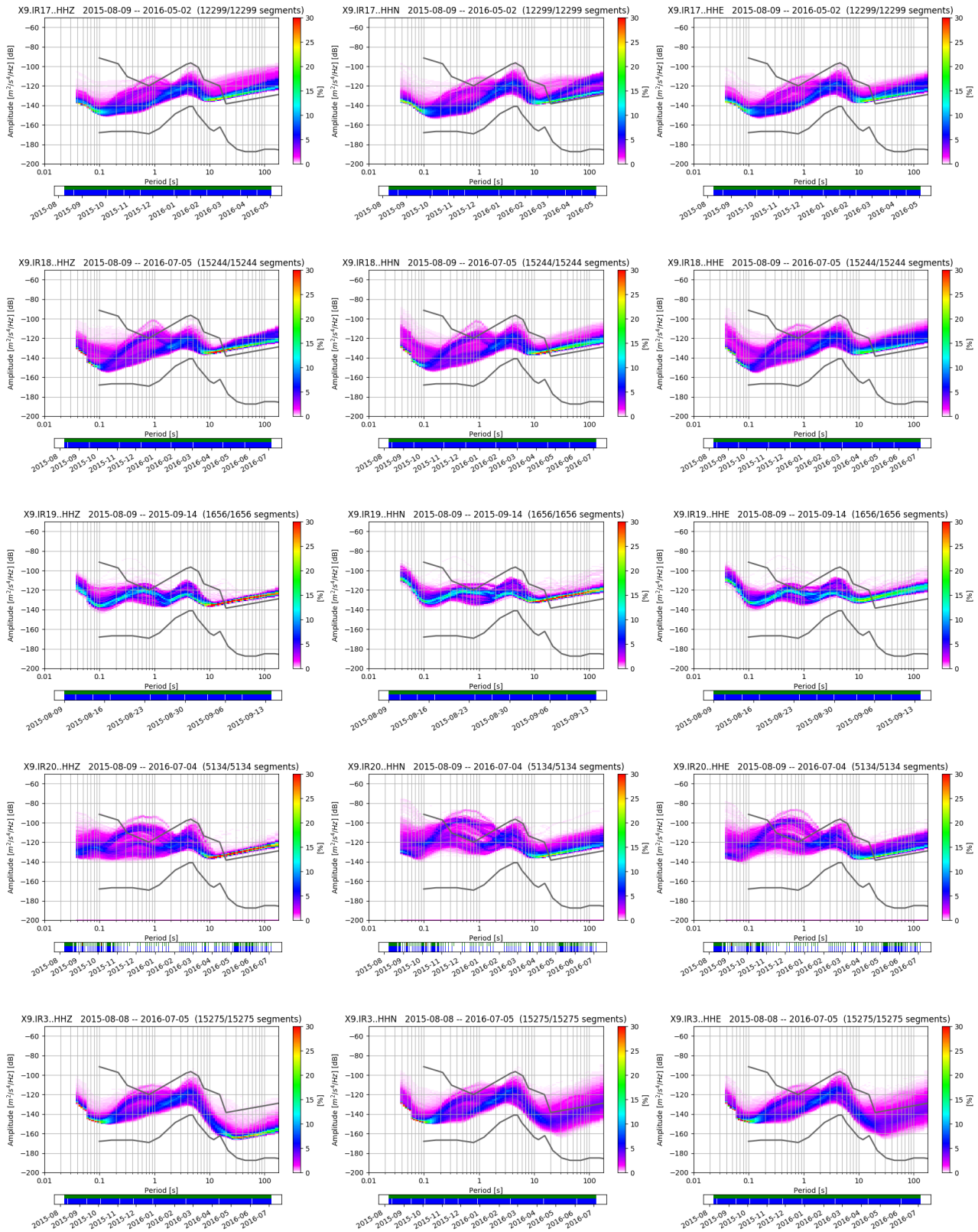


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(H,S)HZ

(H,S)HN

(H,S)HE

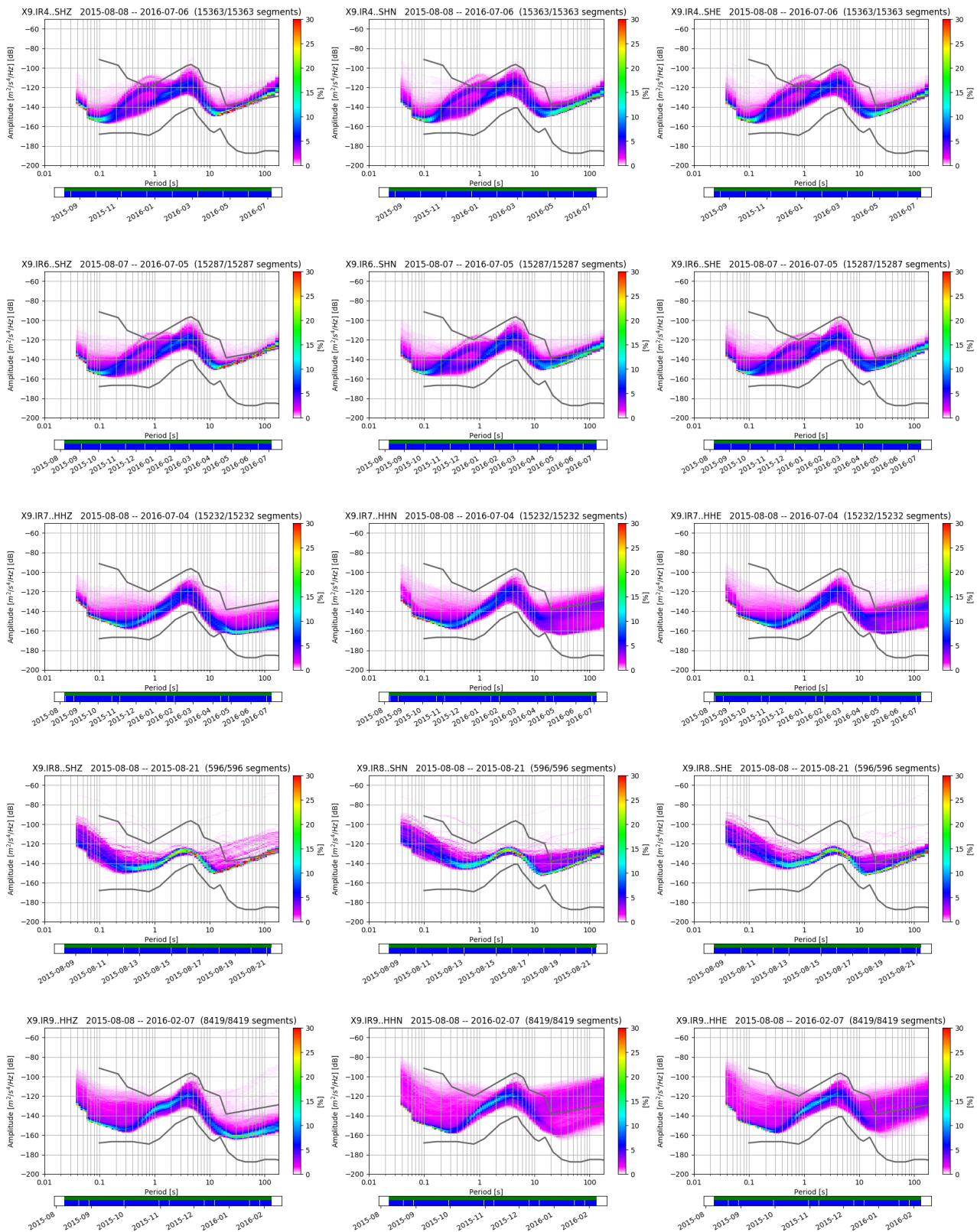


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(H,S)HZ

(H,S)HN

(H,S)HE

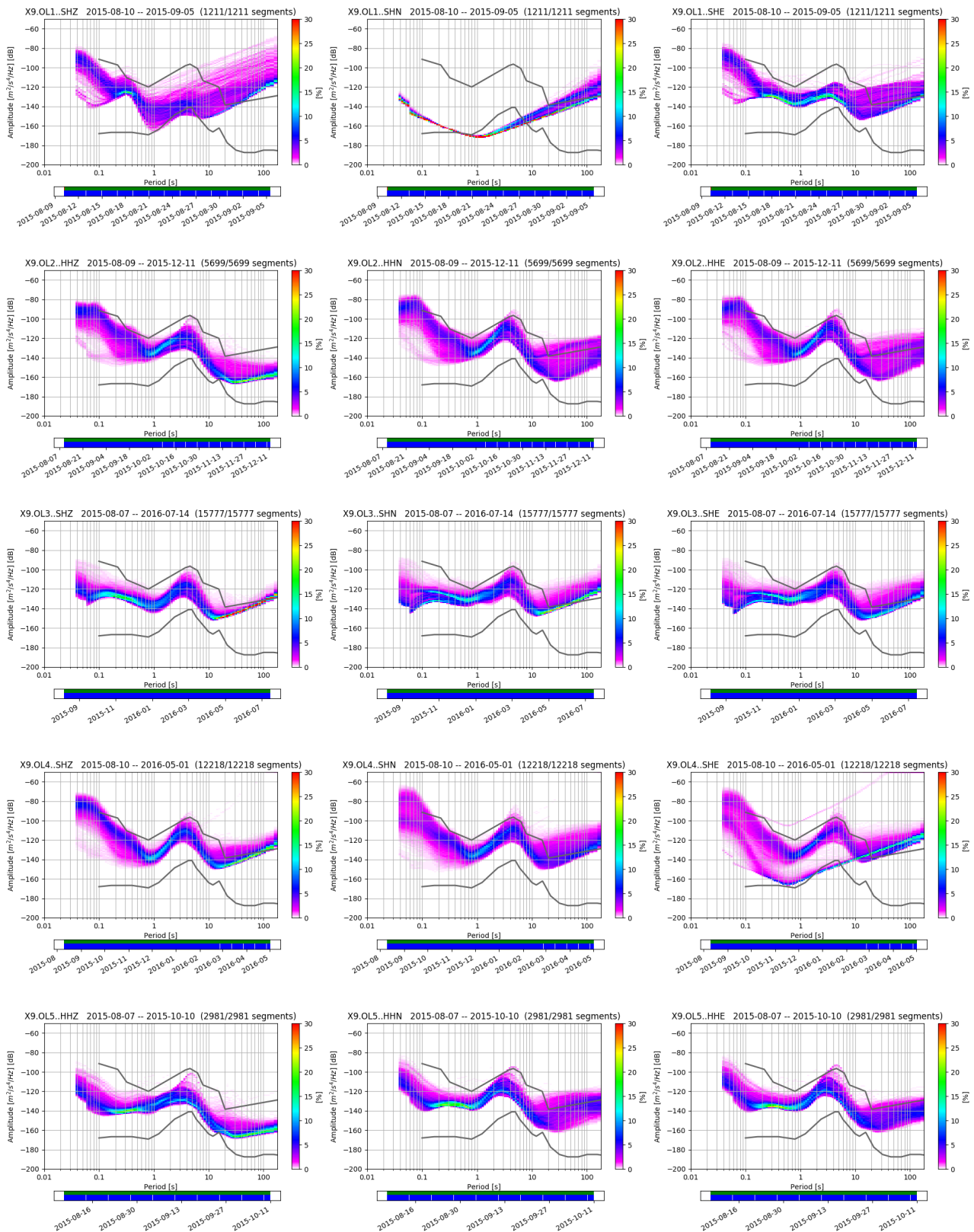


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(H,S)HZ

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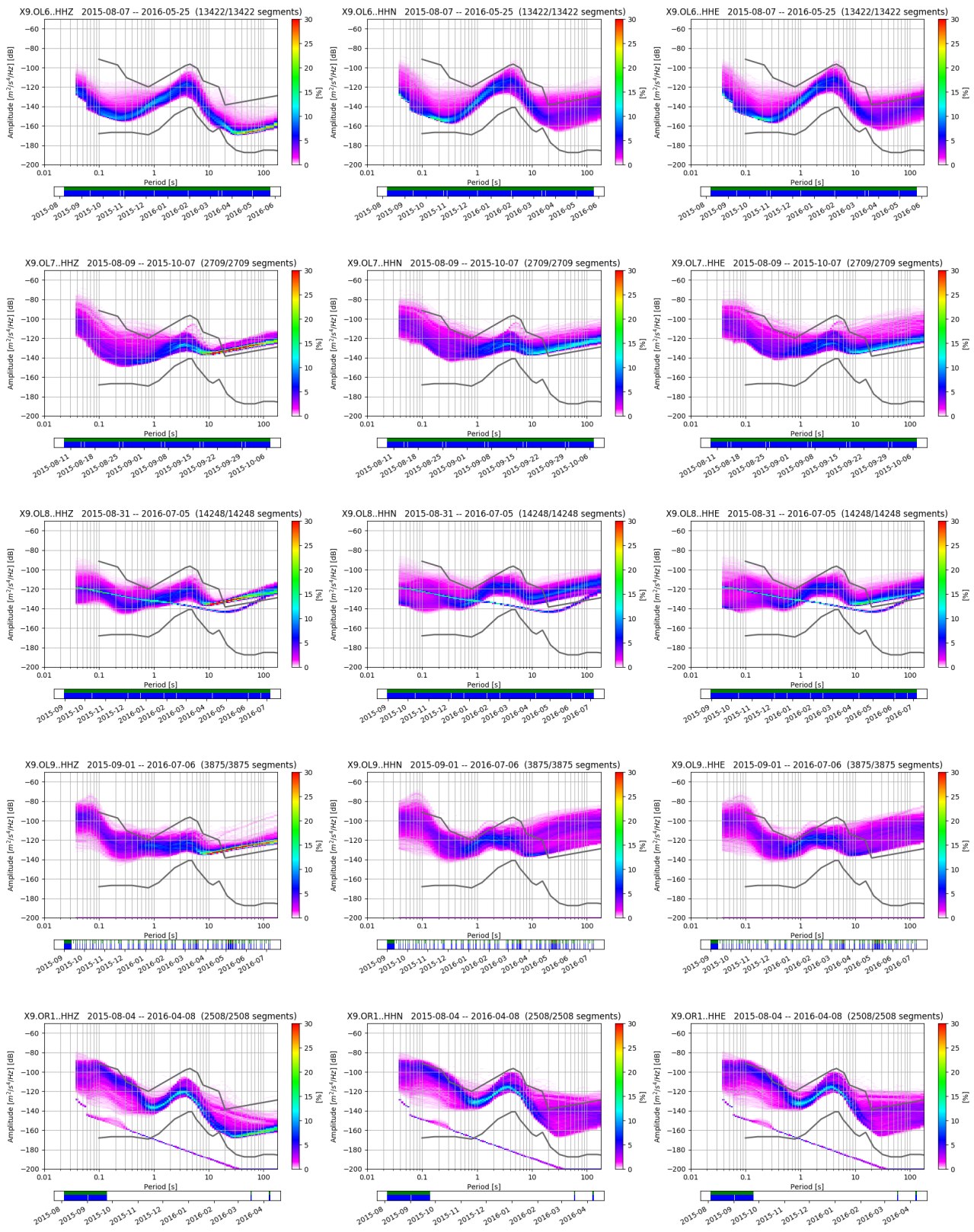


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(H,S)HZ

(H,S)HN

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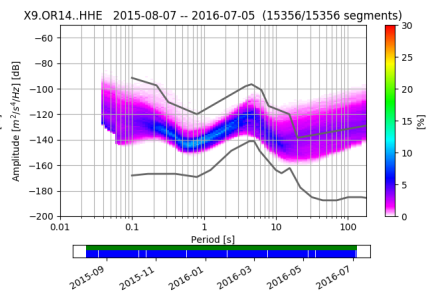
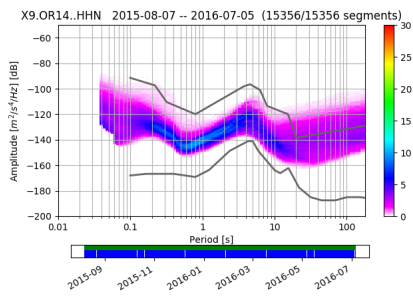
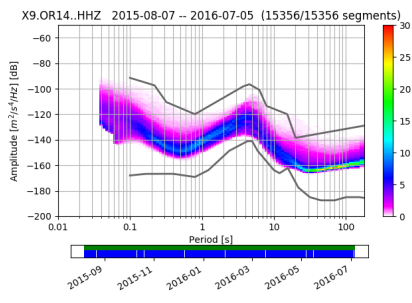
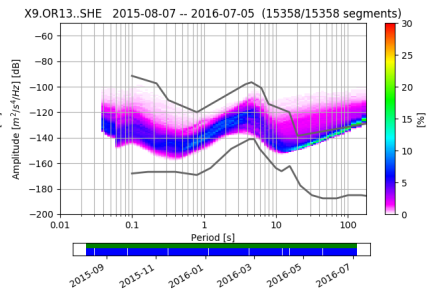
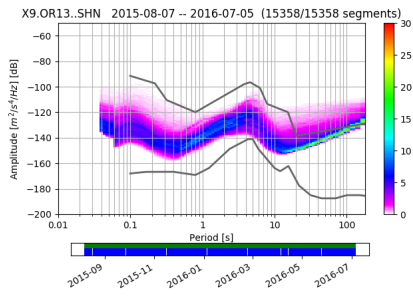
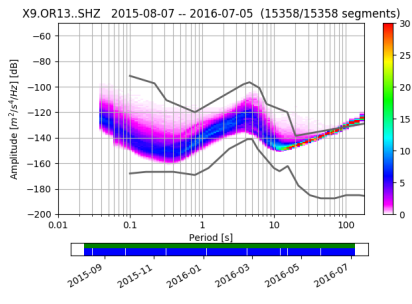
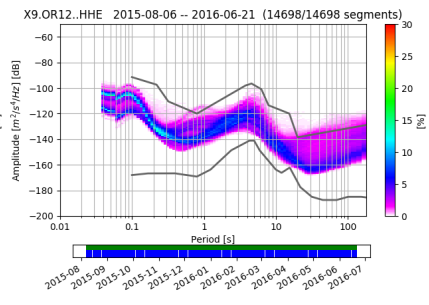
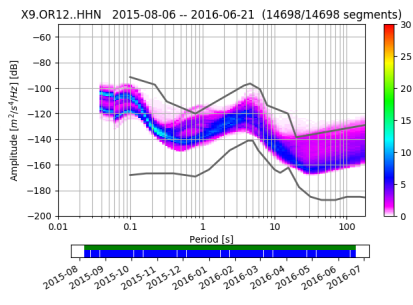
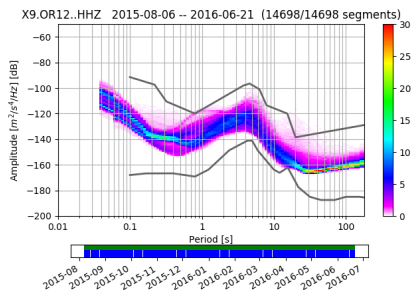
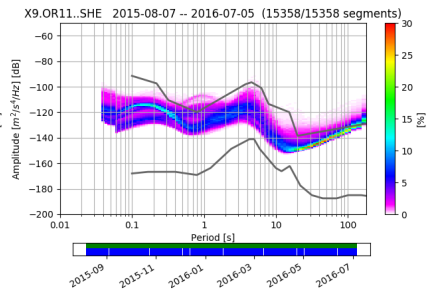
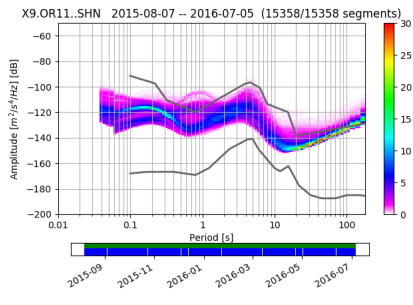
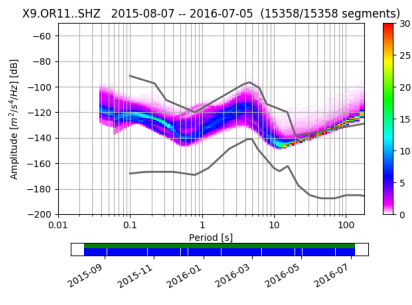
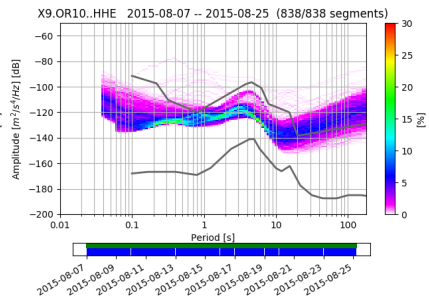
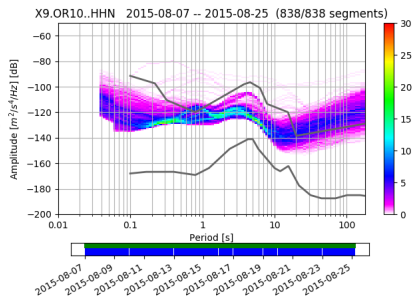
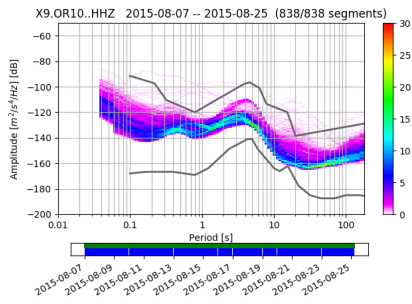


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(H,S)HZ

(H,S)HN

(H,S)HE

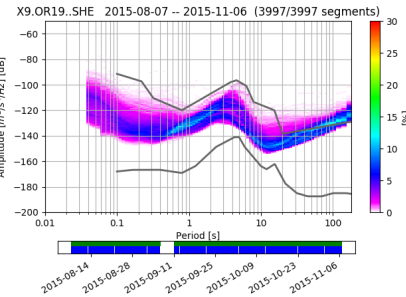
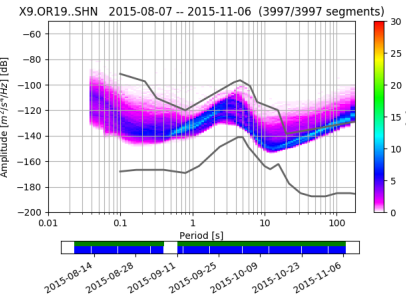
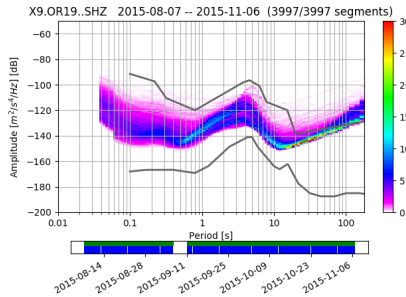
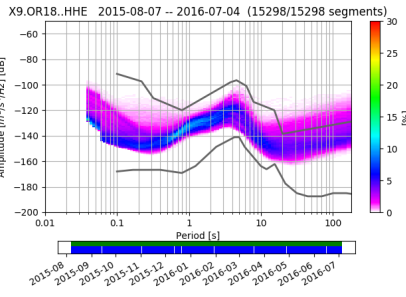
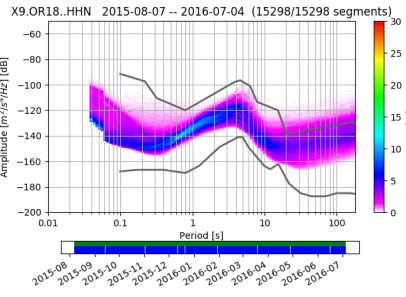
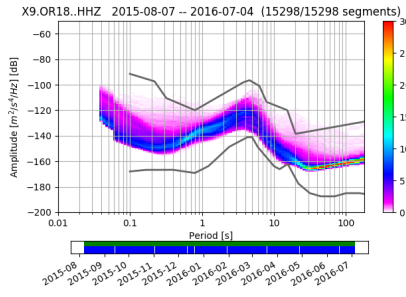
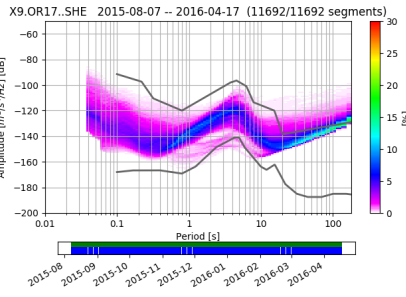
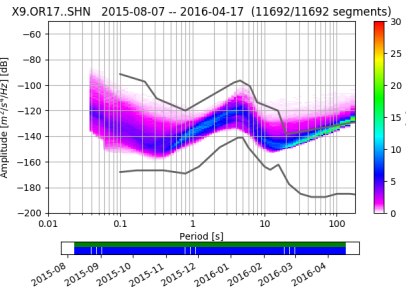
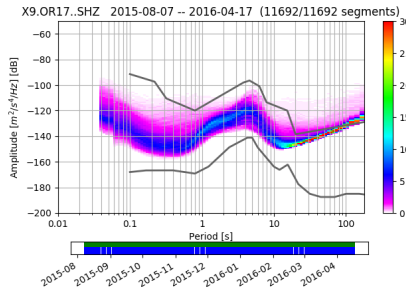
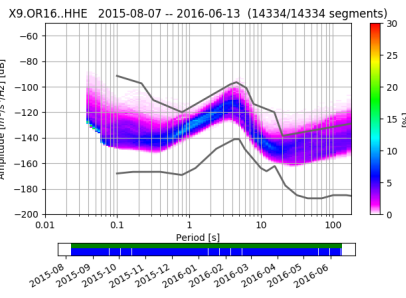
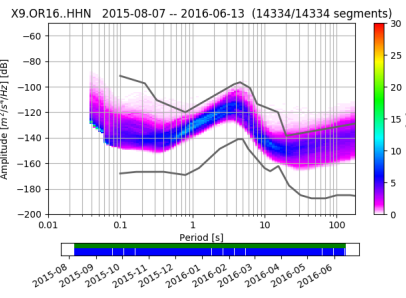
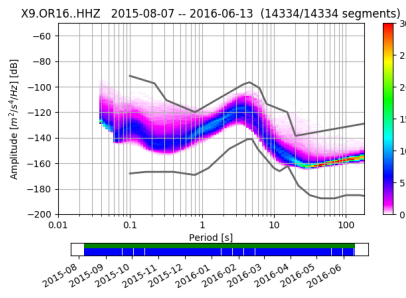
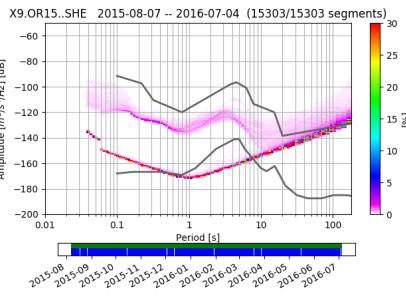
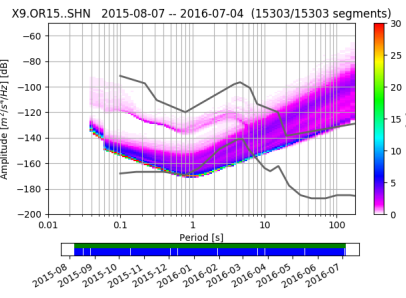
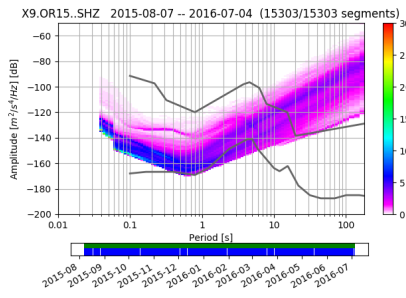


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(H,S)HZ

(H,S)HN

(H,S)HE

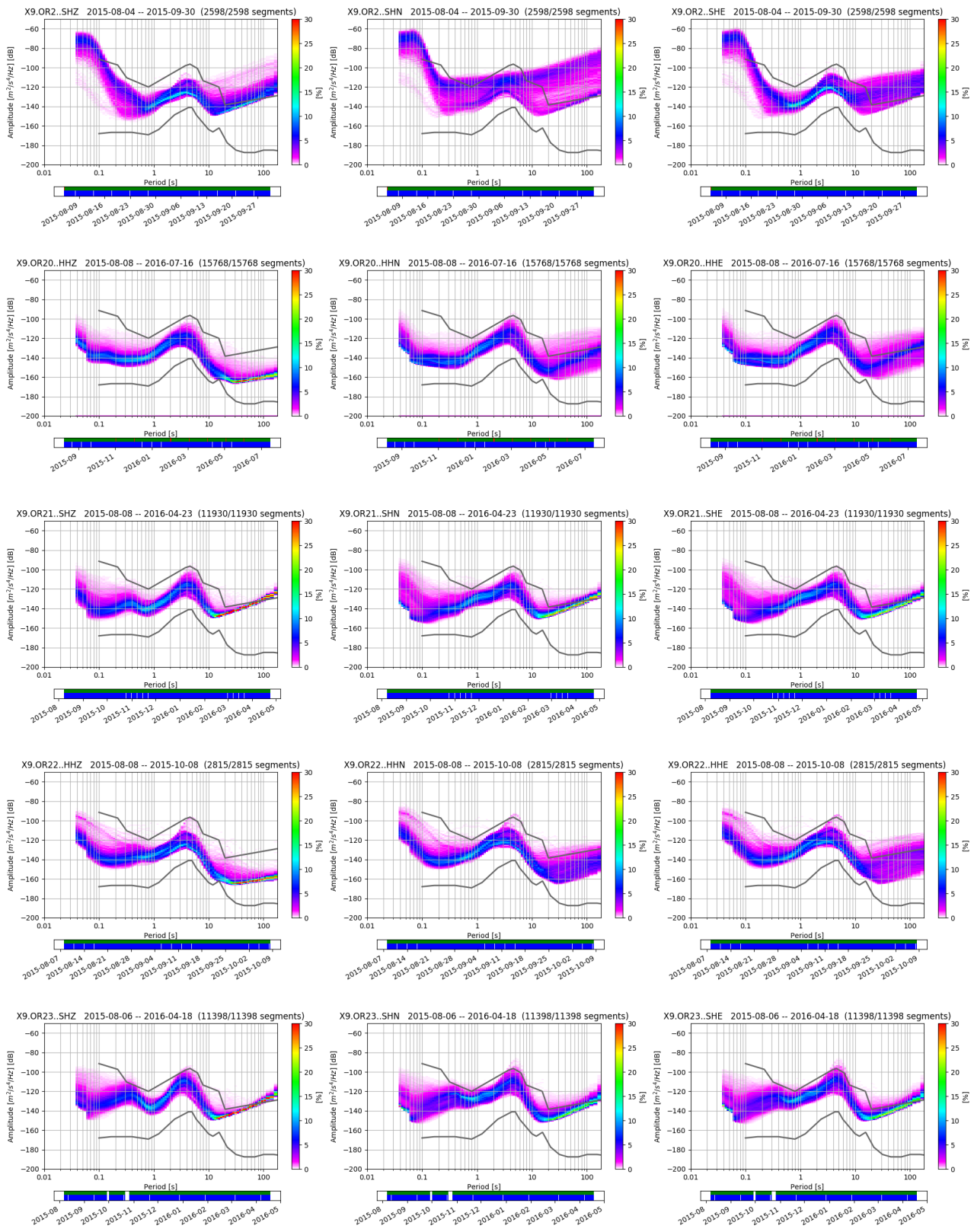


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(H,S)HZ

(H,S)HN

(H,S)HE

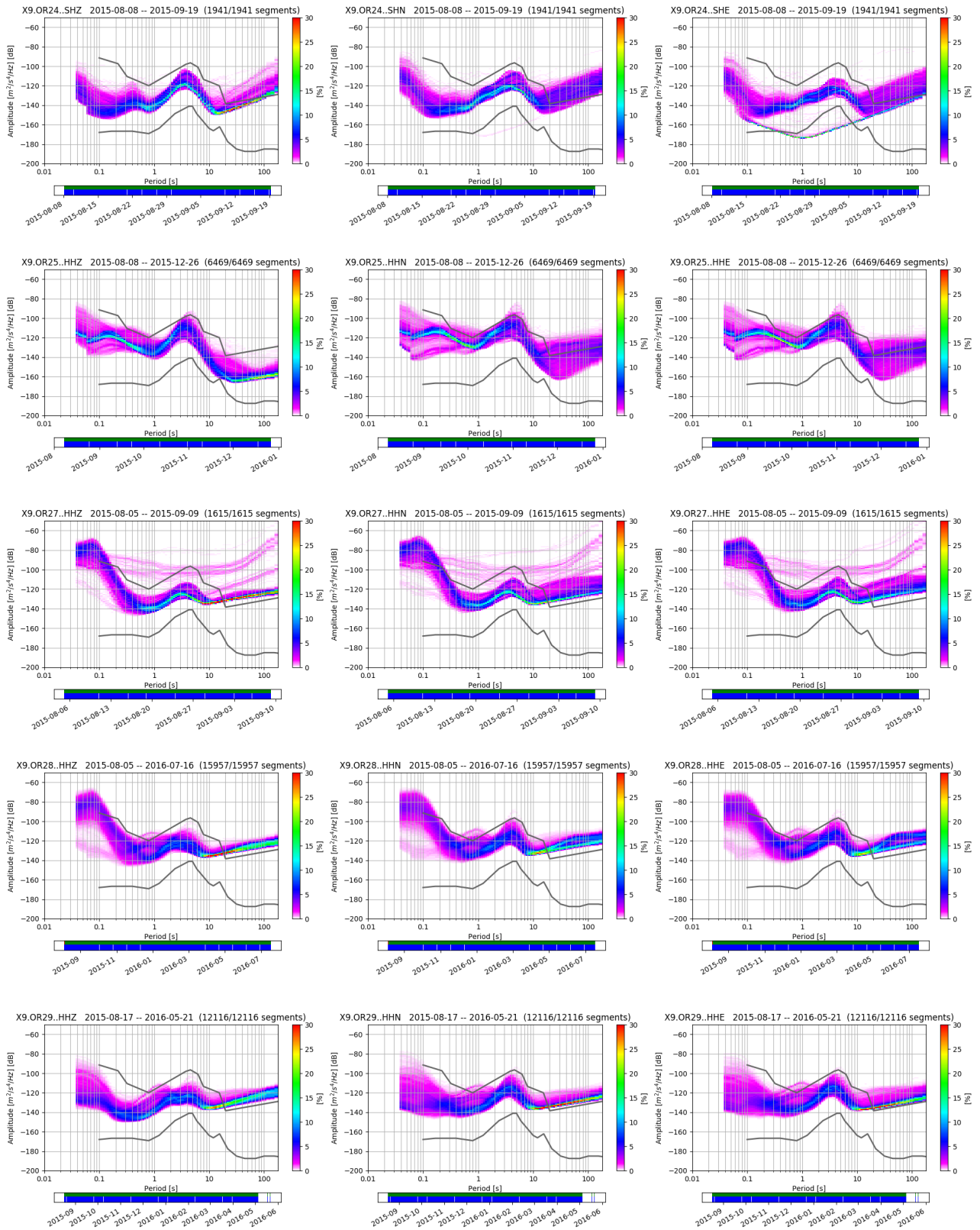


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(H,S)HZ

(H,S)HN

(H,S)HE

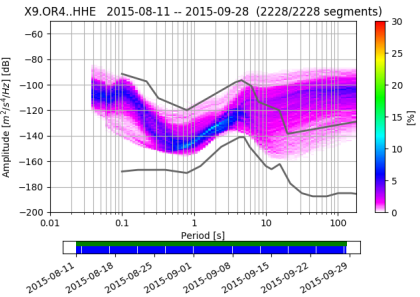
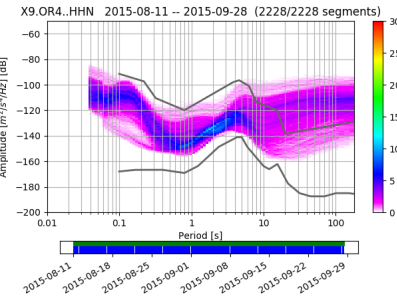
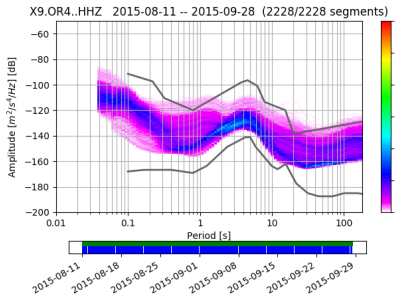
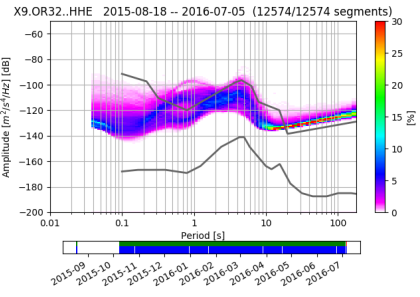
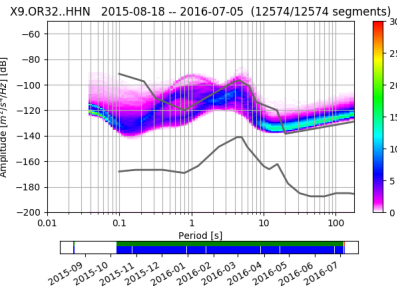
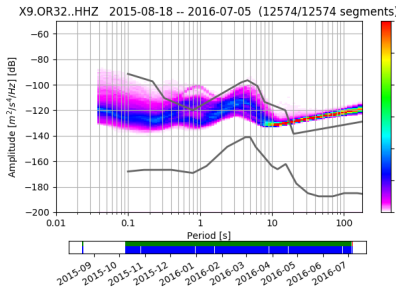
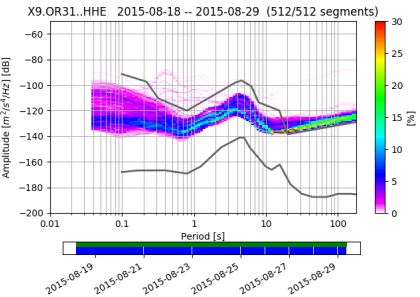
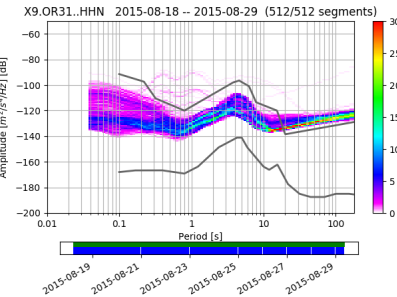
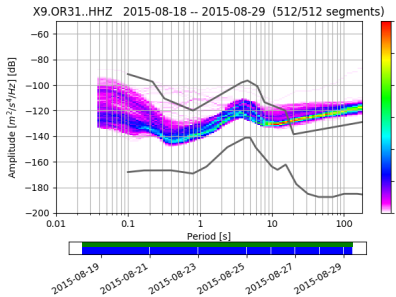
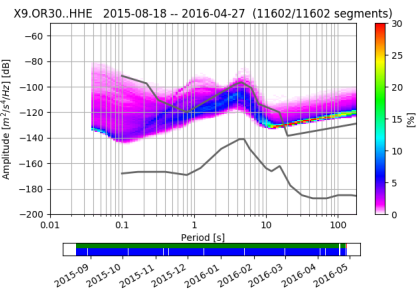
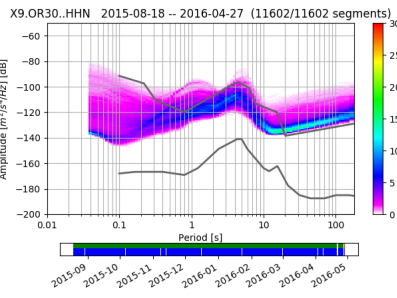
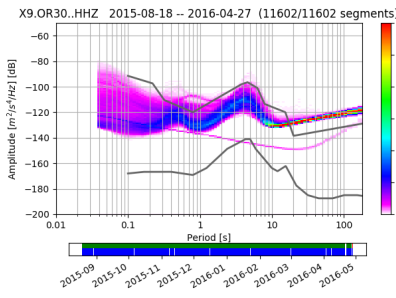
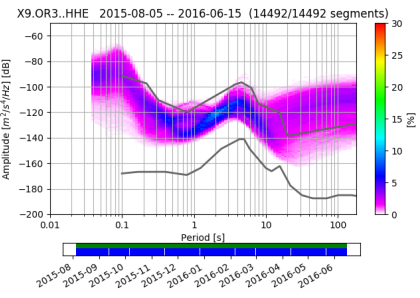
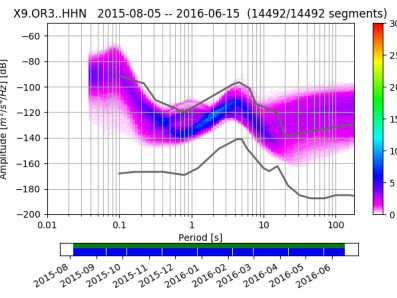
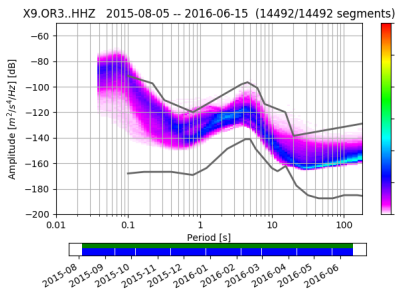


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(H,S)HZ

(H,S)HN

(H,S)HE

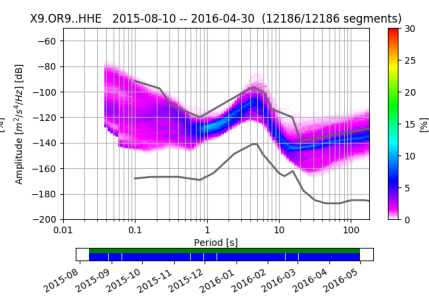
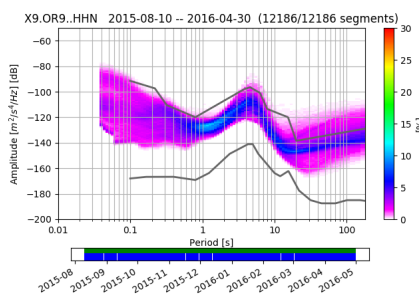
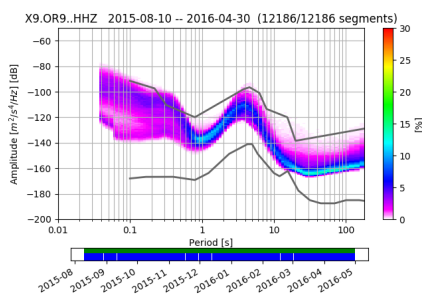
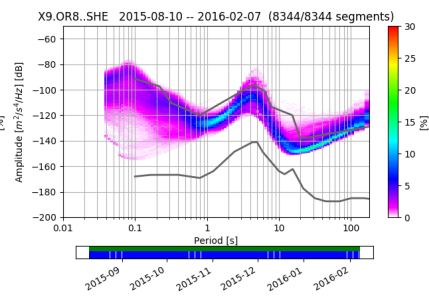
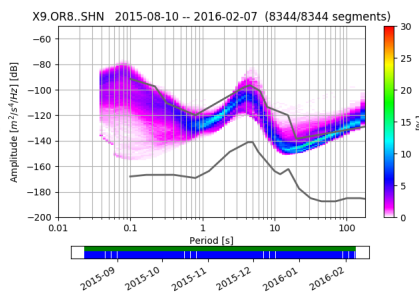
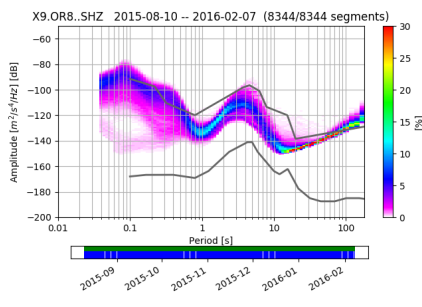
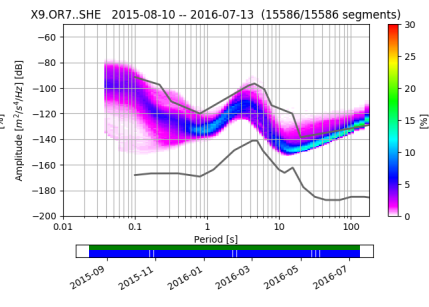
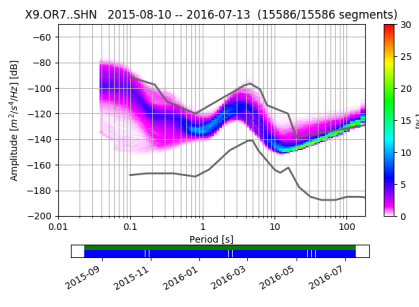
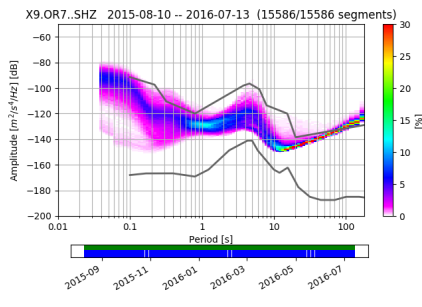
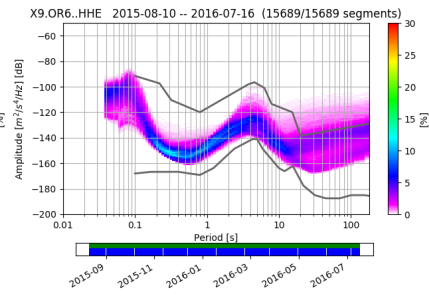
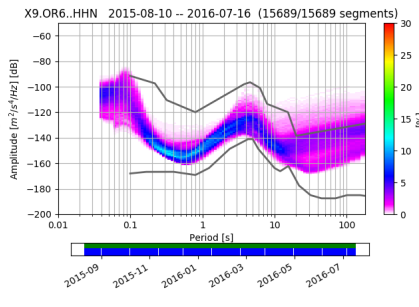
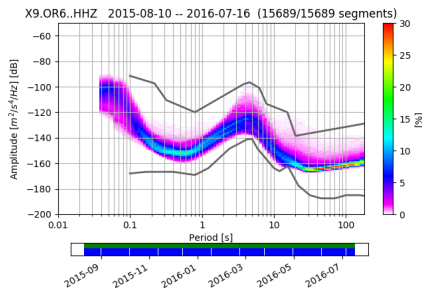
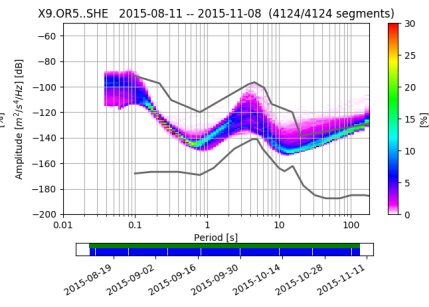
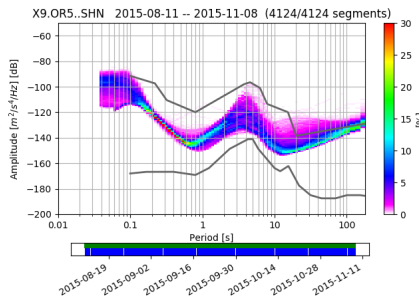
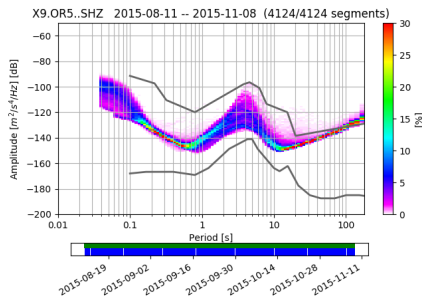


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(H,S)HZ

(H,S)HN

(H,S)HE

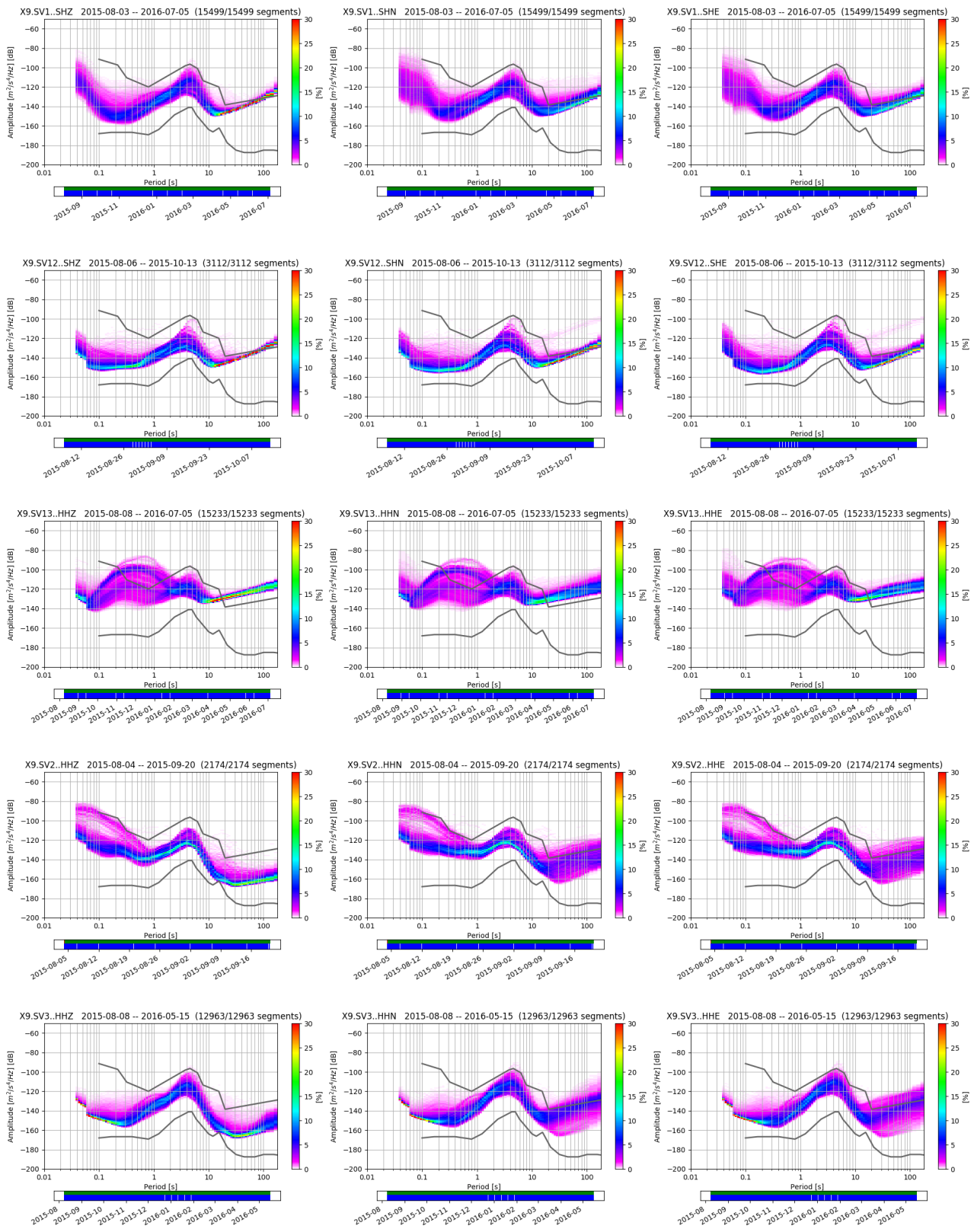


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(H,S)HZ

(H,S)HN

(H,S)HE

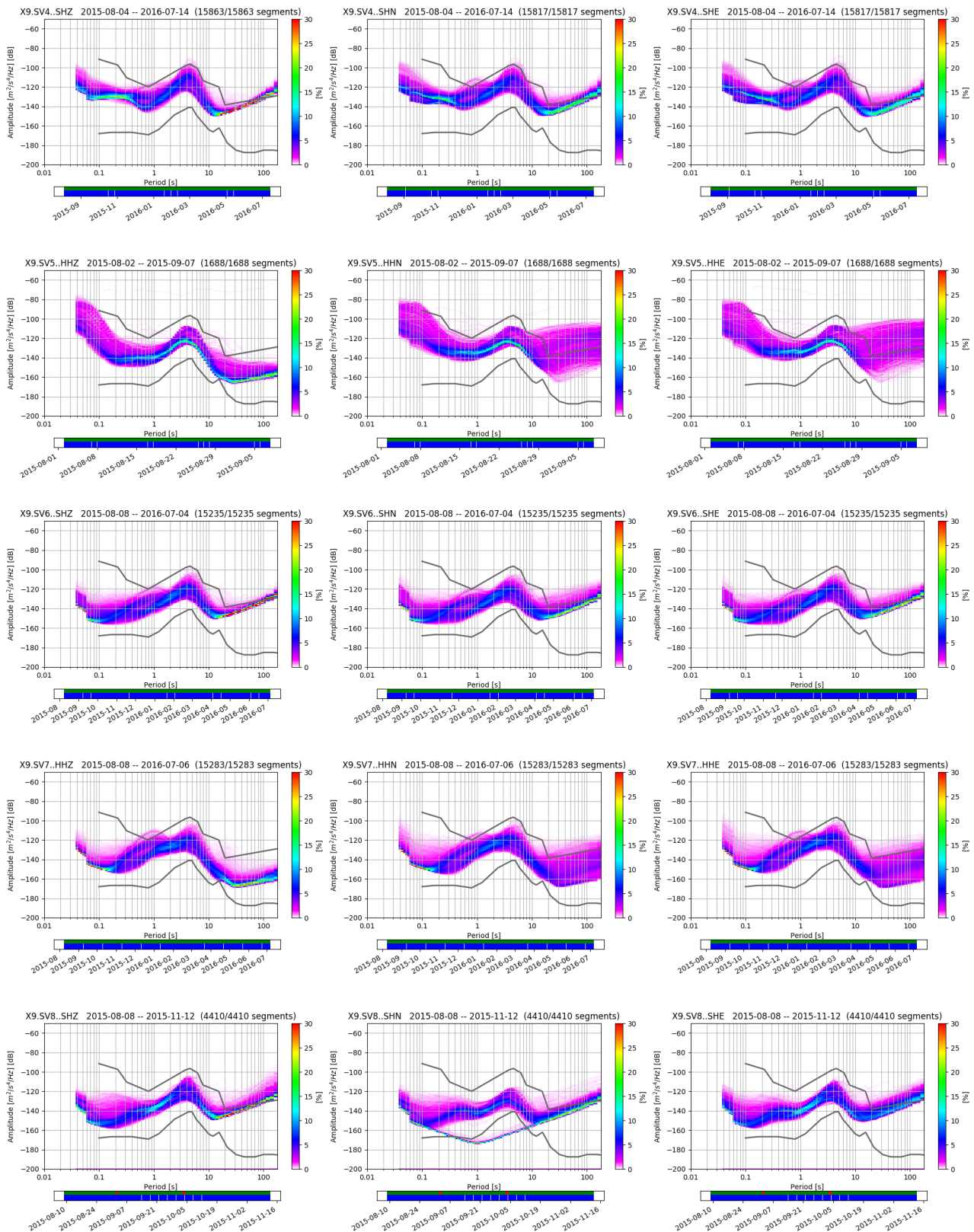


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(H,S)HN

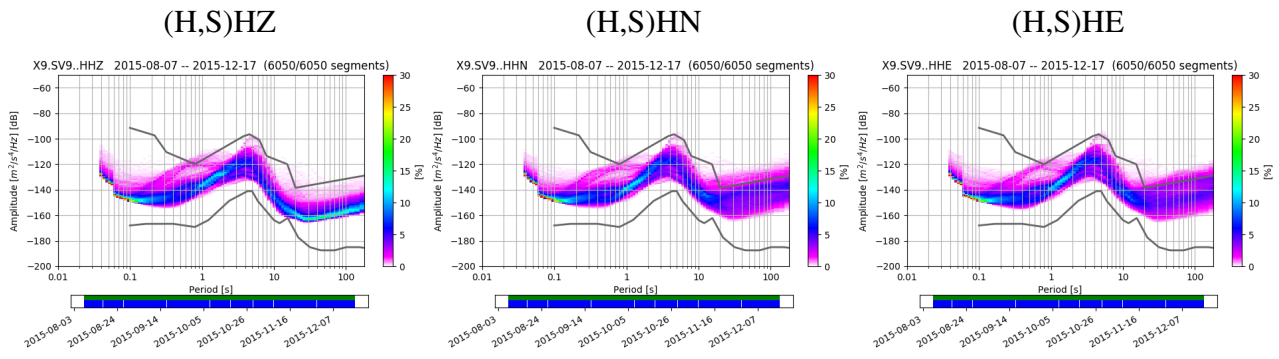


Fig. 2: Noise probability density functions for all stations for database holdings.



Fig. 3 – continued on next page

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Fig. 3: Overview of uptimes of all stations generated with 'obspsy-scan'.

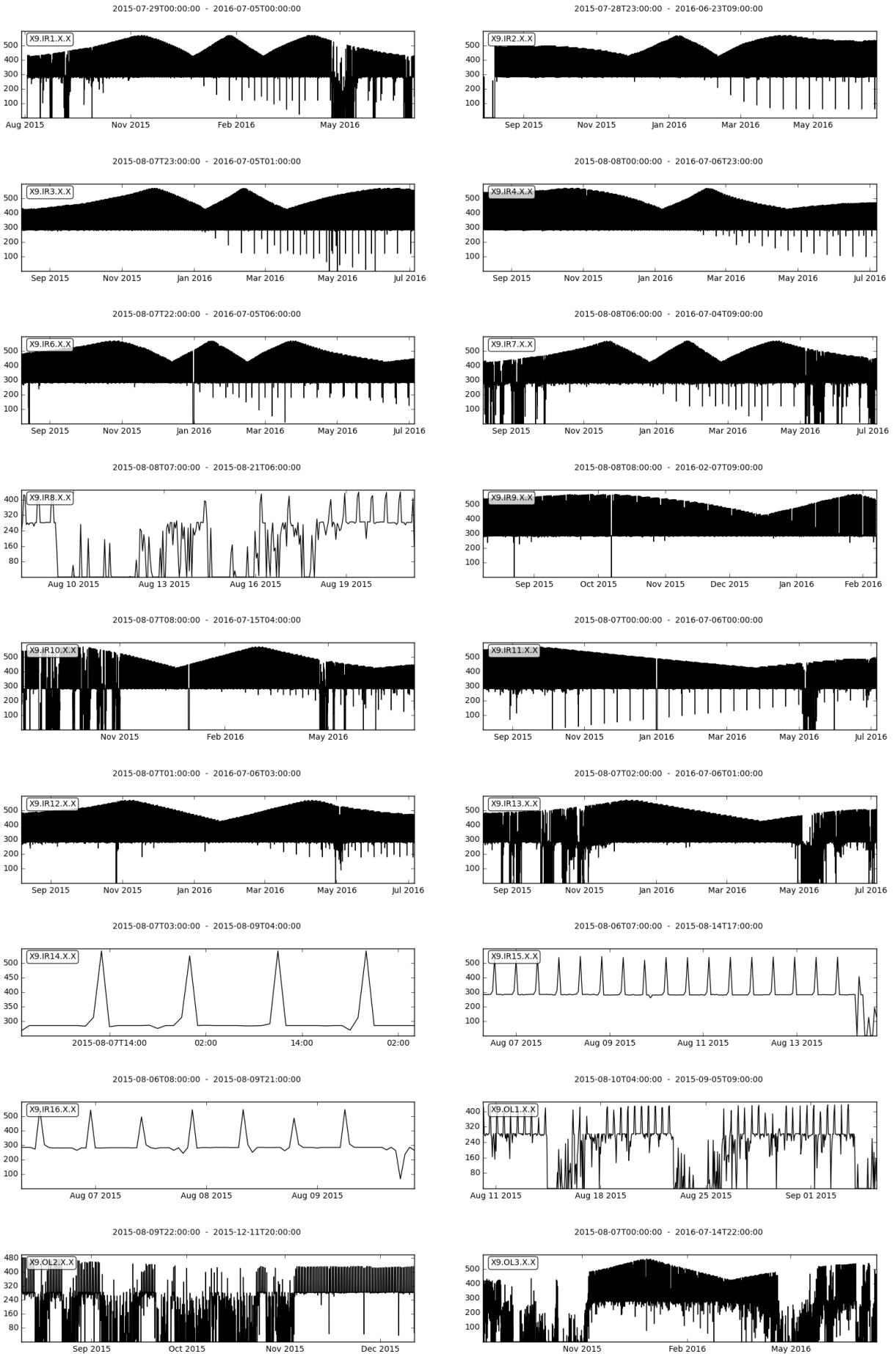


Fig. 4 – continued on next page

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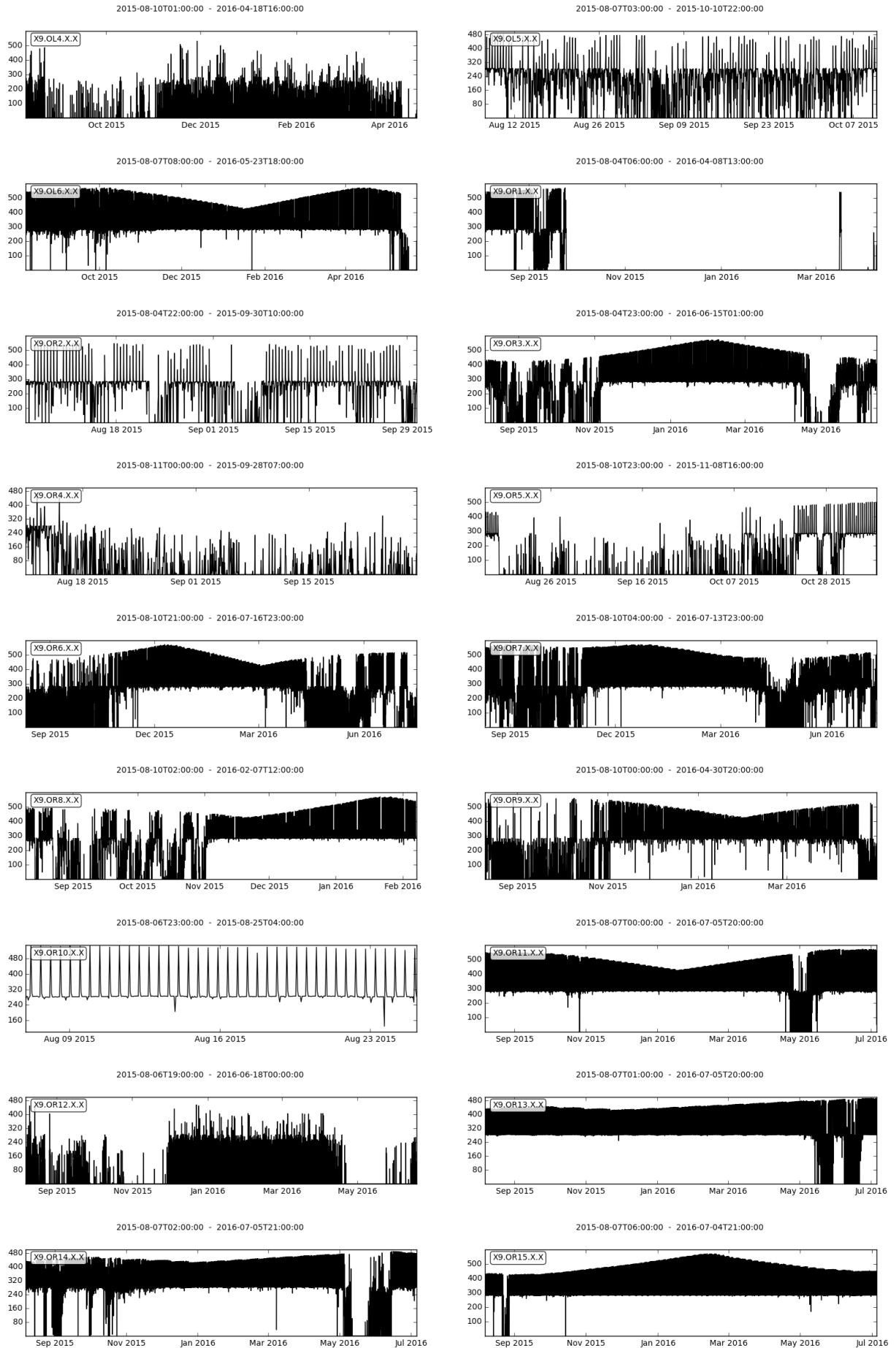


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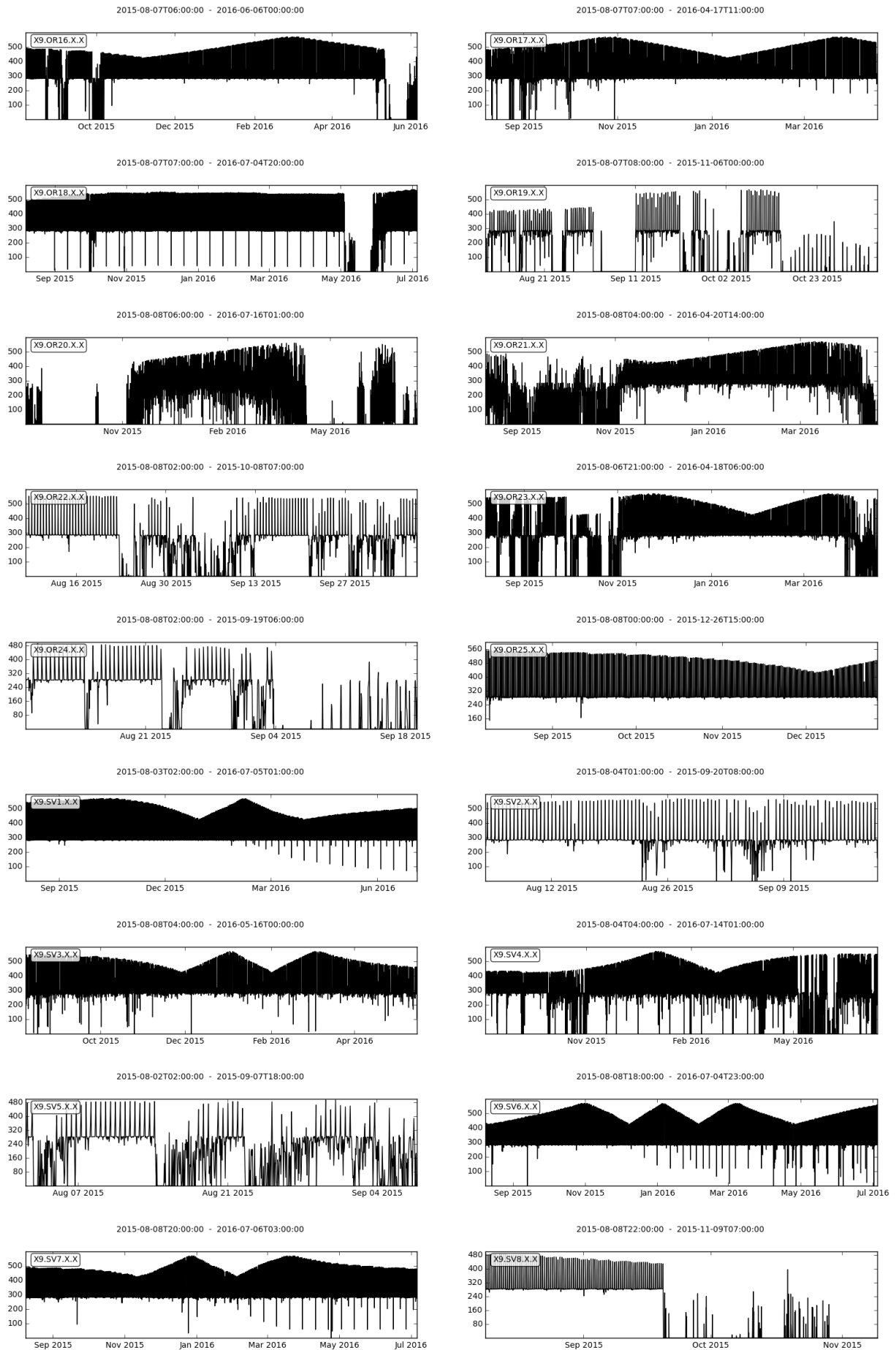


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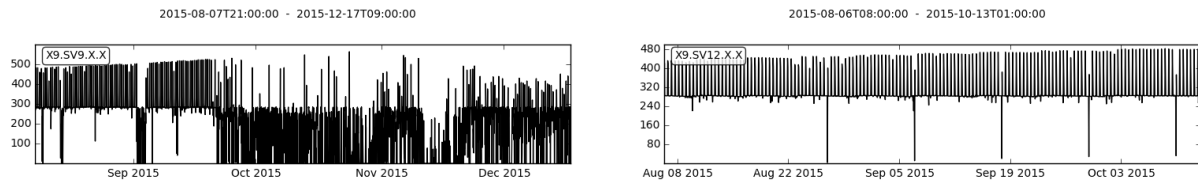


Fig. 4: Number of daily GPS logs for all Cube digitizers.



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