Appendix A

Title: Temporary seismic network and empirical amplification functions from earthquake recordings

Mapping site amplification with the dense recording of ambient vibration for the city of Lucerne (Switzerland) – comparison between two approaches

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Appendix A displays detailed information about the local temporary network (Table A1) and the events used for calculating SSR_{amp} (Table A2). Moreover, it visualizes the number of earthquakes contributing for a given frequency in the derived empirical amplification functions using SSR and ESM methods (Fig. A1), the ESM_{amp} for local rock sites (Fig. A2), and the comparison between two approaches (ESM and SSR) for selected sites (Fig. A3).

Table A1. The list of the stations of the local temporary seismic network (short-period seismometers) and SSMNet network (accelerometers, SED 1983) used in this study. The table shows the basic information, location, period of recording, etc. The lithology information is based on the geological map (Swisstopo 2022) and soil class definition – on the national soil class map (Mayoraz et al. 2016, Keller and Lorenz AG 2010). The majority of the stations of the temporary network were recording during three separate winter campaigns which are indicated in the 4th and 5th columns (i.e. start and end date).

Station name	**Coordinates (CH1903)**	**Elevation [m]**	**Start date**	**End date**	**Lithology**	**Soil class (SIA 261)**	**f_0 [Hz]**	**Sensor/Digitizer**	**Short description**
LUZ01	666‘512 209‘702	513	28.11.19 08.12.20 16.11.21	14.05.20 06.04.21 06.04.22	siltstone, sandstone, marlstone	A	-	LE-3D 5-s (Lennartz) / Centaur (Nanometrics)	free field, buried sensor, located on a hillside
LUZ02	667‘238 210‘615	436	26.11.19 10.12.20 09.11.21	14.05.20 19.05.21 04.04.22	artificial deposits	D	1.5	LE-3D 5-s (Lennartz) / Centaur (Nanometrics)	free field, buried sensor
LUZ03	665‘785 211‘192	436	21.11.19 15.12.20	14.05.20 19.05.21	alluvial deposits	D	1.2	LE-3D 5-s (Lennartz) / Centaur (Nanometrics)	the sensor in an underground shelter (parking) about 5m below the free surface
LUZ04	668‘225 211‘580	435	26.11.19 15.12.20	14.05.20 06.04.21	artificial deposits	D	1.2	LE-3D 5-s (Lennartz) / Centaur (Nanometrics)	urban free field, buried sensor, close to the tracks of a small steam train, distance to the building: 5m
LUZ05	665‘737 210‘364	449	08.12.20 10.11.21	09.04.21 04.04.22	alluvial deposits	C	3.4	LE-3D 5-s (Lennartz) / Centaur (Nanometrics)	free field, a buried sensor placed 1m from the small shed
HOR01	666‘532 207‘917	455	21.11.19 08.12.20 09.11.21	25.06.20 06.04.21 06.04.22	till/ siltstone, sandstone, marlstone	A	-	LE-3D 5-s (Lennartz) / Centaur (Nanometrics)	free field, buried sensor
HOR02	666‘340 207‘103	435	26.11.19 10.12.20 16.11.21	25.06.20 06.04.21 06.04.22	alluvial deposits	D	1.1	LE-3D 5-s (Lennartz) / Centaur (Nanometrics)	free field, a buried sensor placed 1m from the small shed
HOR03	665‘731 208‘080	446	26.11.19 08.12.20 10.11.21	25.06.20 06.04.21 04.04.22	alluvial deposits	D	1.0	LE-3D 5-s (Lennartz) / Centaur (Nanometrics)	urban free field, buried sensor, located 2m from the one-storey single-family detached house, distance to the building: 2m
HOR04	665'918 209'270	450	10.11.21	04.04.22	alluvial deposits	D	3.8	LE-3D 5-s (Lennartz) / Centaur (Nanometrics)	Urban free field, buried sensor, one low building, and 2 high buildings (30 floors) in the vicinity

KRI01	665‘450 209‘840	456	26.11.19 10.12.20 10.11.21	24.06.20 19.05.21 04.04.22	alluvial deposits	E	2.3	LE-3D 5-s (Lennartz) / Centaur (Nanometrics)	free field, buried sensor, surrounded by several high trees
KRI02	664‘756 209‘435	468	28.11.19 08.12.20 16.11.21	25.06.20 06.04.21 04.04.22	alluvial deposits	C	2.2	LE-3D 5-s (Lennartz) / Centaur (Nanometrics)	free field, buried sensor
KRI03	664'384 209'002	473	09.11.21	04.04.22	alluvial deposits	C	4.0	LE-3D 5-s (Lennartz) / Centaur (Nanometrics)	Urban free field, buried sensor, close to a two-storey house
SLUB	665’858 212’238	511	01.12.11	-	sandstone, mudstone	A	-	EpiSensor ES-T (Kinemetrics) / Taurus (Nanometrics)	urban free field, located in a large vault
SLUW	666’815 210’926	436	15.12.10	-	artificial deposits	D	1.3	EpiSensor ES-T (Kinemetrics) / Taurus (Nanometrics)	urban free field, located in a large vault
SLUK	666’083 211’129	436	02.12.14	-	alluvial deposits	D	1.4	EpiSensor ES-T (Kinemetrics) / Taurus (Nanometrics)	free field, located in a small pot

Table A2. The list of the earthquakes recorded by the temporary seismic network in the Lucerne area that were used to derive the SSR_{amp}. Only events, which have a good signal-to-noise ratio (>3) in a frequency range longer than half an octave for at least one pair of the stations are listed. The approximated epicentral distance is the mean of all stations.

No.	Starting time (GMT)	Origin place	Latitude	Longitude	Magnitude	Depth [km]	Epicentral distance [km]
1	2019-11-26T02:54:12.620000Z	Albania	41.52	19.52	6.4	20	1079
2	2019-11-26T06:08:22.012000Z	Albania	41.58	19.43	5.4	10	1068
3	2019-11-26T09:19:26.080000Z	Northwestern Balkan Region	43.24	17.96	5.4	10	863
4	2019-11-27T07:23:42.552000Z	Crete, Greece	35.73	23.27	6.0	72	1763
5	2019-11-27T14:45:24.434000Z	Albania	41.54	19.47	5.3	13	1074
6	2019-11-30T02:14:45.704610Z	Verbier (VS), Switzerland	46.10	7.30	3.0	4	129
7	2019-12-09T03:37:05.390000Z	Central Italy	43.99	11.31	4.6	10	409
8	2020-01-24T17:55:13.987000Z	Turkey	38.39	39.09	6.7	10	2669
9	2020-01-25T19:07:43.302808Z	Realp (UR), Switzerland	46.61	8.46	2.4	6	47
10	2020-01-25T19:13:28.756778Z	Graechen (VS), Switzerland	46.24	7.72	3.0	4	99
11	2020-01-27T22:05:41.108176Z	Albstadt, Germany	48.30	8.95	3.5	7	150
12	2020-01-30T11:21:37.234000Z	Dodecanese Islands, Greece	35.23	27.81	5.8	10	2083
13	2020-02-14T03:13:05.634198Z	Binn (VS), Switzerland	46.34	8.13	2.4	6	77
14	2020-03-18T01:54:57.057565Z	Montreux (VD), Switzerland	46.48	7.00	2.7	9	118
15	2020-03-21T00:49:51.451000Z	Greece-Albania Border Region	39.37	20.63	5.7	10	1308
16	2020-03-22T05:24:03.700000Z	Northwestern Balkan Region	45.91	15.97	5.3	10	598
17	2020-03-22T06:01:20.679000Z	Northwestern Balkan Region	45.91	15.98	4.6	10	598
18	2020-03-25T02:49:20.896000Z	East of Kuril Islands	48.97	157.69	7.5	55	8940
19	2020-04-23T21:52:40.988023Z	Steckborn (TG), Switzerland	47.61	8.97	2.6	0	83
20	2020-05-02T12:51:06.662000Z	Crete, Greece	34.21	25.71	6.6	17	2036
21	2020-05-18T23:22:35.293000Z	Crete, Greece	34.22	25.52	5.8	10	2023

22	2020-05-20T23:43:18.178000Z	Central Mediterranean Sea	35.16	20.29	5.7	20	1652
23	2020-06-23T06:25:41.127671Z	Chamonix, France	46.04	6.92	3.8	5	153
24	2020-07-22T06:12:44.593000Z	Alaska Peninsula	55.03	-158.522	7.8	28000	8603
25	2020-12-28T05:28:07.913000Z	Northwestern Balkan Region	45.44	16.19	4.8	10	629
26	2020-12-29T11:19:54.771000Z	Northwestern Balkan Region	45.43	16.26	6.4	10	635
27	2020-12-30T05:15:04.495000Z	Northwestern Balkan Region	45.47	16.18	4.8	5	627
28	2020-12-30T05:26:42.200000Z	Northwestern Balkan Region	45.53	16.17	4.7	10	624
29	2021-01-06T17:01:43.684000Z	Northwestern Balkan Region	45.43	16.24	4.7	10	633
30	2021-02-03T22:35:36.860227Z	Bern (BE), Switzerland	46.98	7.44	2.8	4	68
31	2021-02-05T14:14:11.661805Z	Singen, Germany	47.75	8.83	3.2	11	90
32	2021-02-07T09:37:20.715010Z	Neuchatel (NE), Switzerland	47.04	7.01	2.9	-1	101
33	2021-02-10T13:19:55.905000Z	Southeast of Loyalty Islands	-23.05	171.60	7.7	10	16961
34	2021-02-14T23:11:04.474313Z	Unterschaechen (UR), Switzerland	46.89	8.83	2.1	8	41
35	2021-02-17T03:36:07.081000Z	Greece	38.41	22.02	5.5	5	1468
36	2021-03-01T19:43:36.475270Z	Steckborn (TG), Switzerland	47.69	9.06	3.1	22	93
37	2021-03-03T10:16:10.197000Z	Greece	39.76	22.18	6.3	10	1376
38	2021-03-04T18:38:19.350000Z	Greece	39.78	22.12	5.8	10	1371
39	2021-03-04T19:28:33.176000Z	New Zealand	-29.723	-177.279	8.1	28940	18032
40	2021-03-12T12:57:51.728000Z	Greece	39.855	22.03	5.6	10000	1360
41	2021-03-15T13:27:35.630776Z	Bern (BE), Switzerland	46.89	7.42	3.2	5	71
42	2021-03-18T00:04:06.798000Z	Northern Algeria	36.92	5.20	6.0	8	1152
43	2021-03-27T13:47:55.771000Z	Adriatic Sea	42.44	16.07	5.5	10	794
44	2021-04-06T08:54:21.510000Z	Northwestern Balkan Region	45.22	16.29	4.7	10	645
45	2021-11-28T10:52:13.239000Z	Northern Peru	-4.49	-76.846	7.5	112480	10009
46	2021-11-16T17:27:32.472684Z	Thun (BE), Switzerland	46.738	7.541	2.34	7410	69

47	2021-12-10T23:08:13.459475Z	Liestal (BL), Switzerland	47.426	7.742	3.22	25170	66
48	2021-12-18T10:34:47.618170Z	Bergamo, Italy	45.62	9.606	4.41	26180	181
49	2021-12-20T01:17:52.576220Z	Unterschaechen (UR) , Switzerland	46.836	8.859	2.61	2593	44
50	2021-12-21T08:56:46.307560Z	Le Locle (NE), Switzerland	47.075	6.614	2.91	5137	131
51	2021-12-24T23:59:56.706839Z	Porrentruy (JU), Switzerland	47.373	6.919	4.1	4424	115
52	2021-12-25T14:49:40.125942Z	Porrentruy (JU), Switzerland	47.372	6.917	3.54	3364	115
53	2022-01-09T21:43:46.720000Z	Greece	40.842	21.376	5.5	10000	1246
54	2022-01-11T01:07:47.981000Z	Cyprus Region	35.146	31.91	6.6	19600	2360
55	2022-01-16T11:48:05.595000Z	Aegean Sea	40.035	24.369	5.5	9290	1503
56	2022-01-04T00:38:42.283158Z	Porrentruy (JU), Switzerland	47.373	6.921	3.16	4312	115
57	2021-12-20T01:17:52.576220Z	Unterschaechen (UR), Switzerland	46.836	8.859	2.61	2593	44
58	2022-03-19T09:59:30.941000Z	Northern Algeria	36.856	5.207	5.2	10000	1156
59	2022-03-12T17:03:23.324094Z	Annecy, France	45.664	6.363	4.17	6995	212
60	2022-03-12T17:21:14.723776Z	Annecy, France	45.668	6.339	3.4	8506	213
61	2022-03-12T19:19:18.674054Z	Annecy, France	45.669	6.337	3.55	9780	213

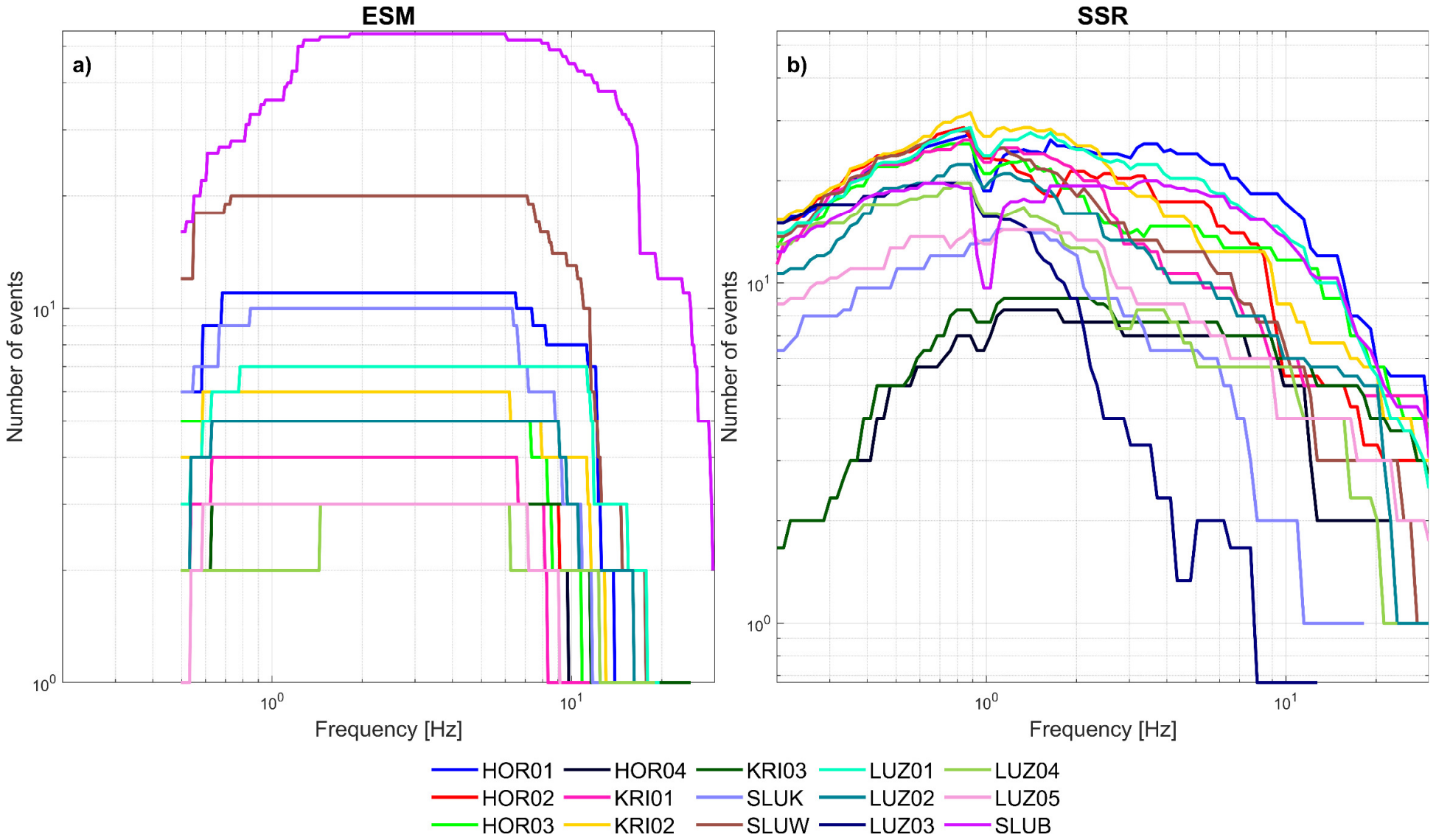

Fig. A1. Number of events contributing for each frequency band to derive amplification using a) ESM and b) SSR methods.

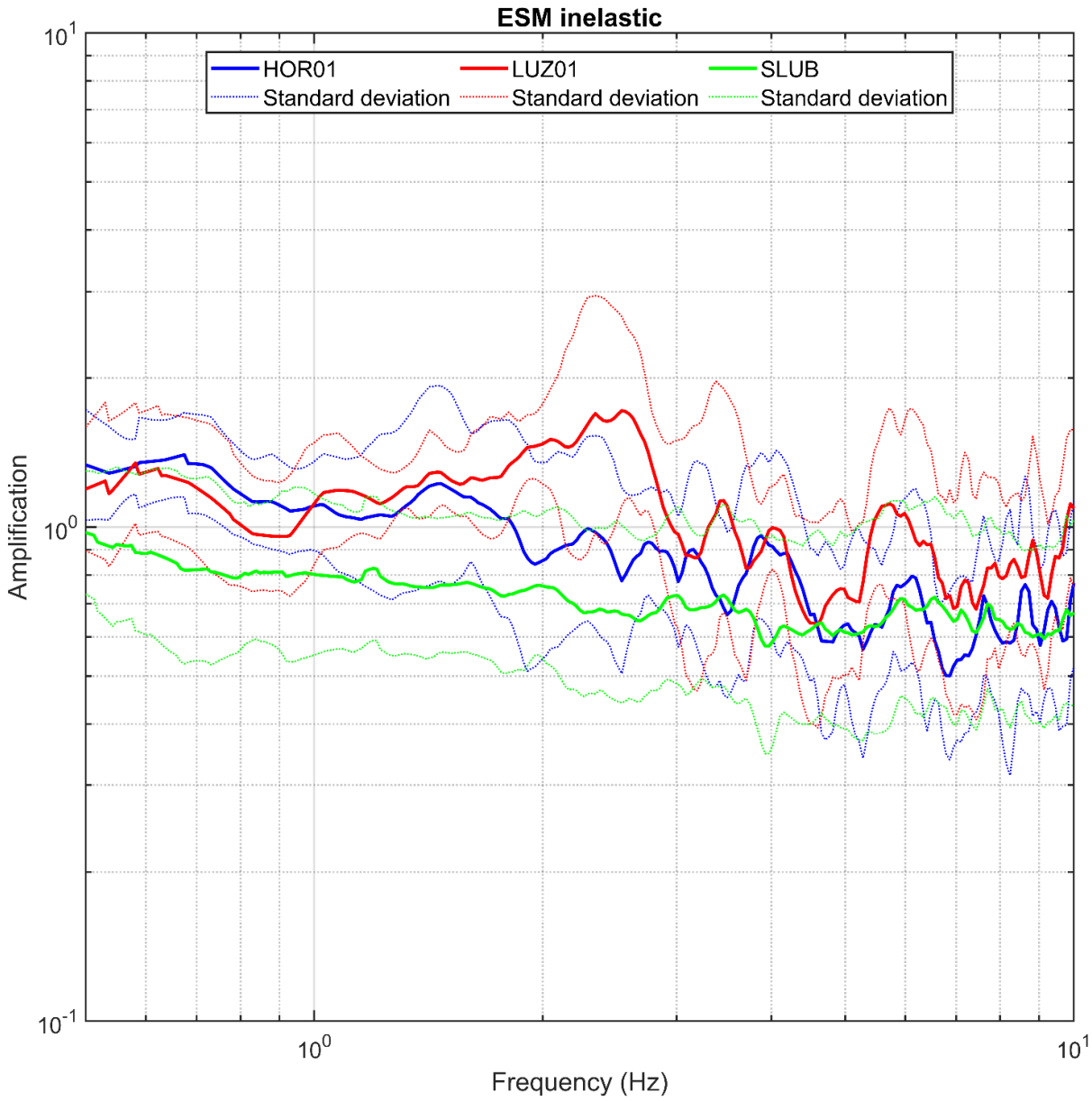

Fig. A2. Inelastic ESM_{amp} for 3 local rock sites used for correction of SSR_{amp} for Swiss rock conditions (Poggi et al. 2011).

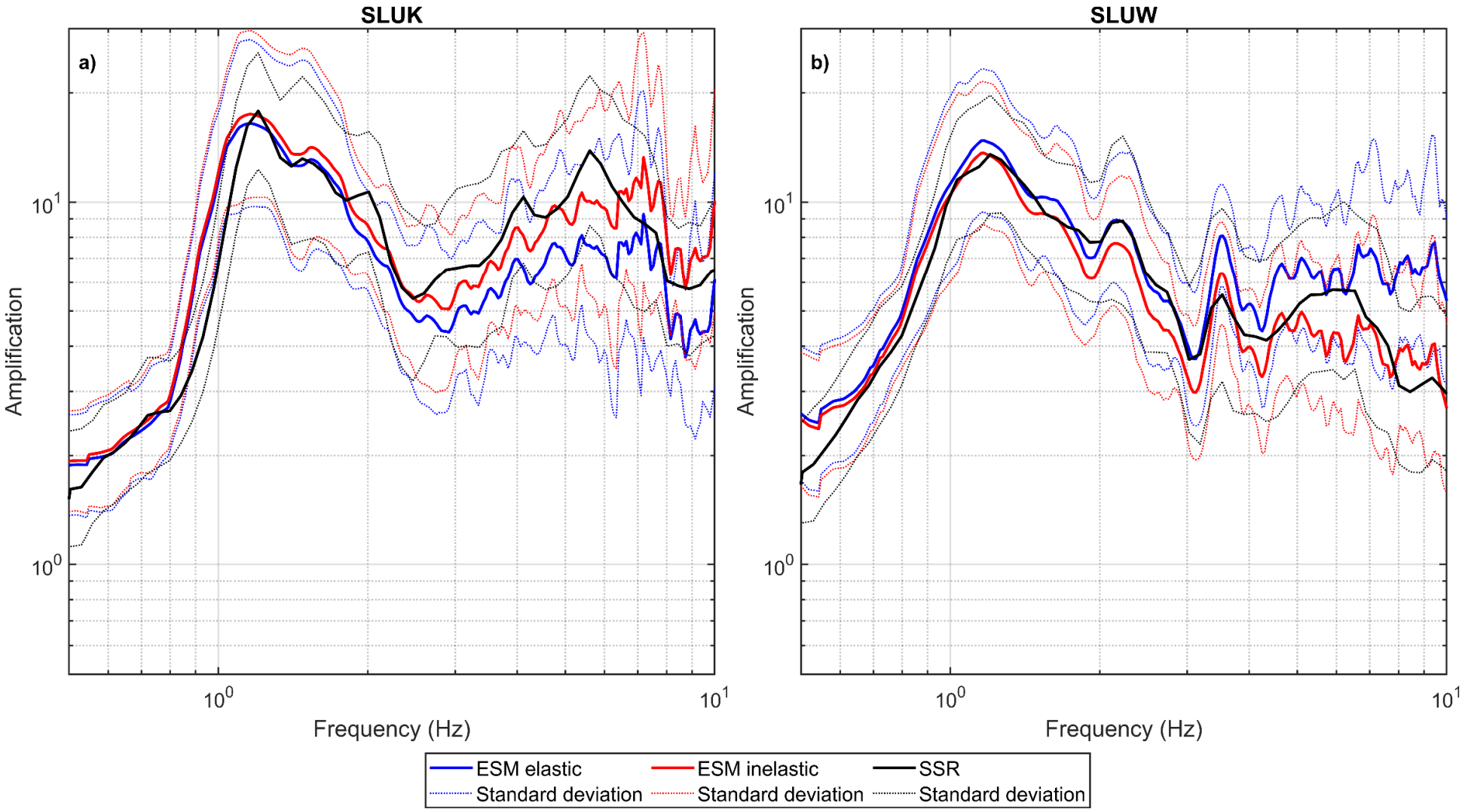

Fig.A1. Comparison between ESM_{amp} and SSR_{amp} corrected for Swiss rock condition (Poggi et al. 2011) for a) SLUK and b) SLUW seismic station.