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AlpArray 2016 & 2017: Data quality analysis as part of surface wave investigation

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The AlpArray research project allows us to investigate the structure and evolution of the lithosphere beneath the entire Alpine area. The project includes around 250 temporary seismic stations, which have been deployed in the period from spring 2015 to summer 2017. Together with the included permanent stations from all over Europe, there are around 900 stations available in total.

For the surface wave analysis, we are interested in two-hour time windows for each earthquake. For different reasons we cannot use the data of all stations for the data processing. These are: the record is not available for the given day, components are missing, there are too many gaps or overlaps, the traces are shifted in time, the records are too noisy or have no seismic signal. We selected 32 earthquakes spanning 2016 and 2017 and investigate the quality of the data before the surface wave analysis.

The **following table** contains information about availability and quality of the data for 918 stations and respective time window for each earthquake.

useable records:

- **+** ... 1 trace for each component (no gaps, no overlaps)
- **Gm** ... < 20 traces/comp., max. length of the merged gaps: 3 sec.
- **Om** ... < 20 traces/comp., merged overlaps

dismissed records:

- **#T** ... > 20 traces/comp.
- **lG** ... gaps longer than 3 sec.
- **mC** ... missing component
- **S.R.** ... record shorter than required time window (1,5 – 2,0 hr)
- **n.d.** ... no data available
- ... station not installed

The **table below** is a summary of the table on the left, and shows the absolute numbers of stations for the different data properties. In addition percentages of stations with available and useable data for each earthquake are given.

	20160124	20160125	20160210	20160215	20160417	20160518	20160529	20160535	20161109	20161111	20161115	20161208	20161225	20170127	20170132	20170403	20170405	20170526	20170602	20170612	20170613	20170908	20170930	20171010
number of installed stations	790	790	800	800	811	824	850	857	868	873	876	879	880	887	884	899	899	902	905	904	908	907	907	906
... with available data	656	658	665	692	702	719	720	745	739	748	753	762	773	773	776	760	774	766	786	791	771	791	783	787
... without data	134	132	135	108	109	105	130	112	129	125	123	117	107	114	108	139	125	136	119	113	137	116	124	119
... with good data	546	582	596	574	630	582	634	651	619	655	641	669	647	665	662	653	679	662	649	697	700	651	654	710
... with merged gaps	42	9	20	30	7	36	15	28	30	22	13	8	39	45	41	57	35	24	40	26	29	116	64	18
... with merged overlaps	1	0	1	2	0	3	2	0	2	1	2	1	1	1	2	1	1	0	0	2	47	33	0	0
... with shifted traces	29	39	30	53	35	42	40	50	57	36	70	76	57	37	28	39	41	46	36	36	35	43	43	24
... with too many traces	25	21	25	21	11	47	16	30	16	13	9	10	8	6	5	11	3	6	9	6	2	4	10	8
... with too short traces	0	2	1	4	1	1	3	4	3	1	1	1	1	4	3	5	4	3	5	2	3	1	5	5
... with missing component	11	14	15	5	16	6	7	19	10	17	19	10	15	14	31	11	10	19	18	14	16	6	10	16
stations with available data in % with respect to installed stations	82,5	82,3	83,1	85,4	86,6	87,4	87,4	86,7	87,3	86,0	85,6	88,2	88,2	88,3	88,6	87,3	86,7	85,7	87,3	88,5	85,0	87,6	86,8	87,2
stations with useable (green) data in % with respect to stations with available data	89,8	89,7	88,3	87,8	90,7	86,6	90,4	85,9	88,1	90,6	87,1	88,7	88,9	92,0	90,7	91,3	92,4	89,5	90,7	92,0	92,6	92,6	88,6	95,0

	20170918	20171030	20171115	20171208	20171225	20180102	20180103	20180105	20180106	20180112	20180113	20180208	20180210	20180212	20180213	20180308	20180310	20180315
number of installed stations	905	904	908	908	907	907	906	905	905	904	903	902	901	900	898	897	896	895
... with available data	789	787	804	787	786	794	786	788	790	774	760	786	791	771	791	783	787	804
... without data	116	118	100	122	121	113	120	117	115	130	143	116	110	129	107	114	109	91
... with good Data	665	527	695	679	682	649	697	700	551	654	710	719	665	527	695	679	680	688
... with merged gaps	46	122	23	34	25	28	19	44	18	18	15	46	122	23	34	25	28	19
... with merged overlaps	0	5	88	3	3	1	3	2	47	33	0	0	5	88	3	3	1	3
... with shifted traces	53	35	30	37	31	21	41	46	36	36	45	45	34	27	53	35	30	37
... with too many traces	12	5	10	19	26	8	3	2	4	10	8	9	12	5	10	19	26	8
... with too short traces	3	1	5	5	4	11	2	6	5	3	1	3	3	1	5	5	4	11
... with missing component	54	14	17	11	17	36	14	16	6	10	16	18	14	16	6	10	16	18
stations with available data in % with respect to installed stations	87,2	86,9	87,8	86,6	87,3	86,7	87,3	87,1	87,3	85,8	84,2	87,1	87,8	85,7	87,8	87,3	87,8	89,8
stations with useable (green) data in % with respect to stations with available data	92,5	91,6	90,2	89,8	91,1	89,7	92,4	89,5	90,7	92,0	92,6	88,6	93,0	89,3	89,1	92,5	91,6	90,2

The **right table** shows the data completeness from January 2016 to March 2018 for the 30 temporary stations deployed by the University of Vienna .

- ... offline data available
- ... only telemetry data available now
- ... no data (power down)
- ... telemetry down, data available later

After merging gaps and overlaps we select all useable data and plot the geometrically rotated records and inspect them visually to remove zero traces and records with electronic non-seismic noise. Records with non-visible earthquake record (noisy) and with significant peaks are also removed. Since we plot the records with respect to the epicentral distance, we also roughly check for the record timing. If the record is significantly out of time, we remove it. All the earthquakes were big events, so, if not visible at the record, something is wrong, especially when it is well visible at the neighboring stations. After the visual inspection we remove around 1 – 3 % of the stations in addition.

Below this plot is shown for the M 7.1 earthquake North of Ascension Island (Atlantic); we removed 7 stations after the visual inspection.