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PREPARATORY COMMISSION

Operating temporary seismic array during modernization of IMS station

Gernot Hartmann, Lukas Menke
(Federal Institute for Geosciences and Natural Resources, Germany)

O4.4-135

ORAL PRESENTATION

BGR Bundesanstalt für Geowissenschaften und Rohstoffe

Operating temporary seismic array during modernization of IMS station

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Outline

- Thirty years history of PS19 (GERES)
- Objective for the PS19 (GERES) modernization
- Technical implementation of temporary seismic array elements
- Ambient seismic noise conditions
- Evaluation of the array response for the reduced array configuration
- Comparison of azimuthal residuals for the different array configurations
- Statistics of GERES signal analysis
- Conclusions

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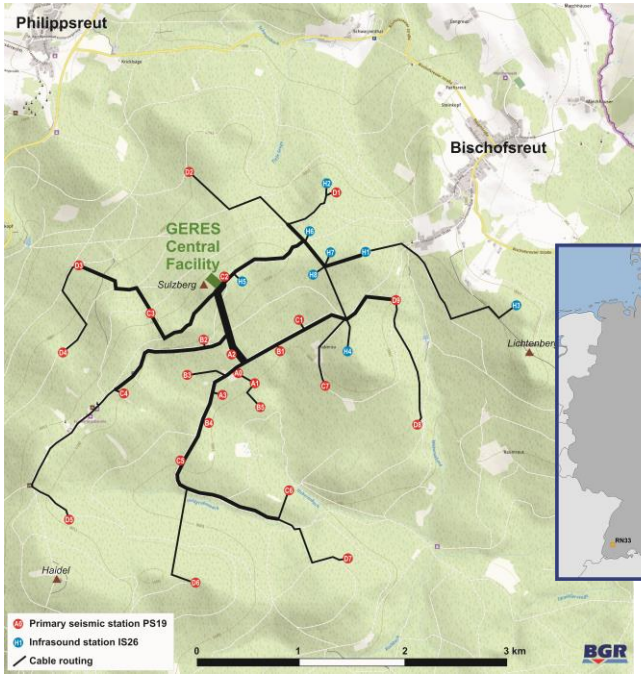
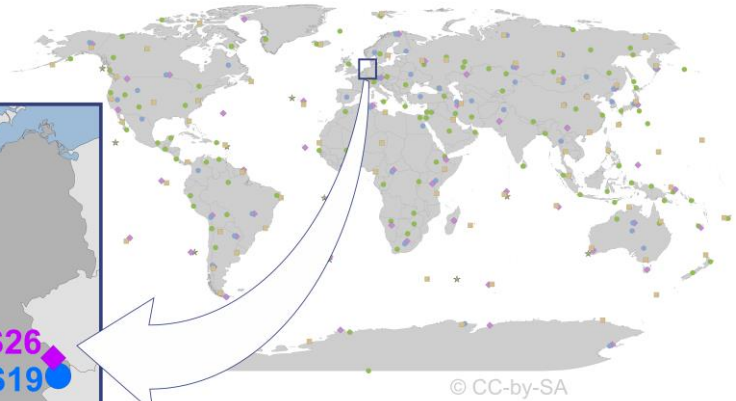
Thirty years history of PS19 (GERES)



1989-1991
GERES
Installation

2001-2002
Upgrade to
IMS Station PS19

2017-2018
PS19
Modernization



- The only primary seismic station of the IMS in Central Europe
- Seismic array with 25 elements with excellent background noise conditions
- Remotely operated by the German NDC

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Objective for the PS19 (GERES) modernization

Interference-prone power supply of array elements after 25 years of operation

- Replacement of the cabling connecting the array elements with the central facility
- Improvement of the overvoltage protection and refurbishment of the infrastructure of the central facility
- Shut down of the data acquisition of the complete seismic array for 18 months

200 km cables for power supply, data transmission and backup communication lead to each seismometer vault in a star-shaped layout. All cables are merged in the main cable duct to the central facility.

The seismometer remained at the original position in the vault (in the foreground) and was connected to the data acquisition system in the mobile container (in the background).

Compensation to sustain the detection capability of the IMS seismic network

- Set up a temporary seismic array with ten elements
- Distributed systems with power supply by fuel cells and data transmission via mobile communications
- Installation in mobile containers, which are robust enough to withstand harsh weather conditions

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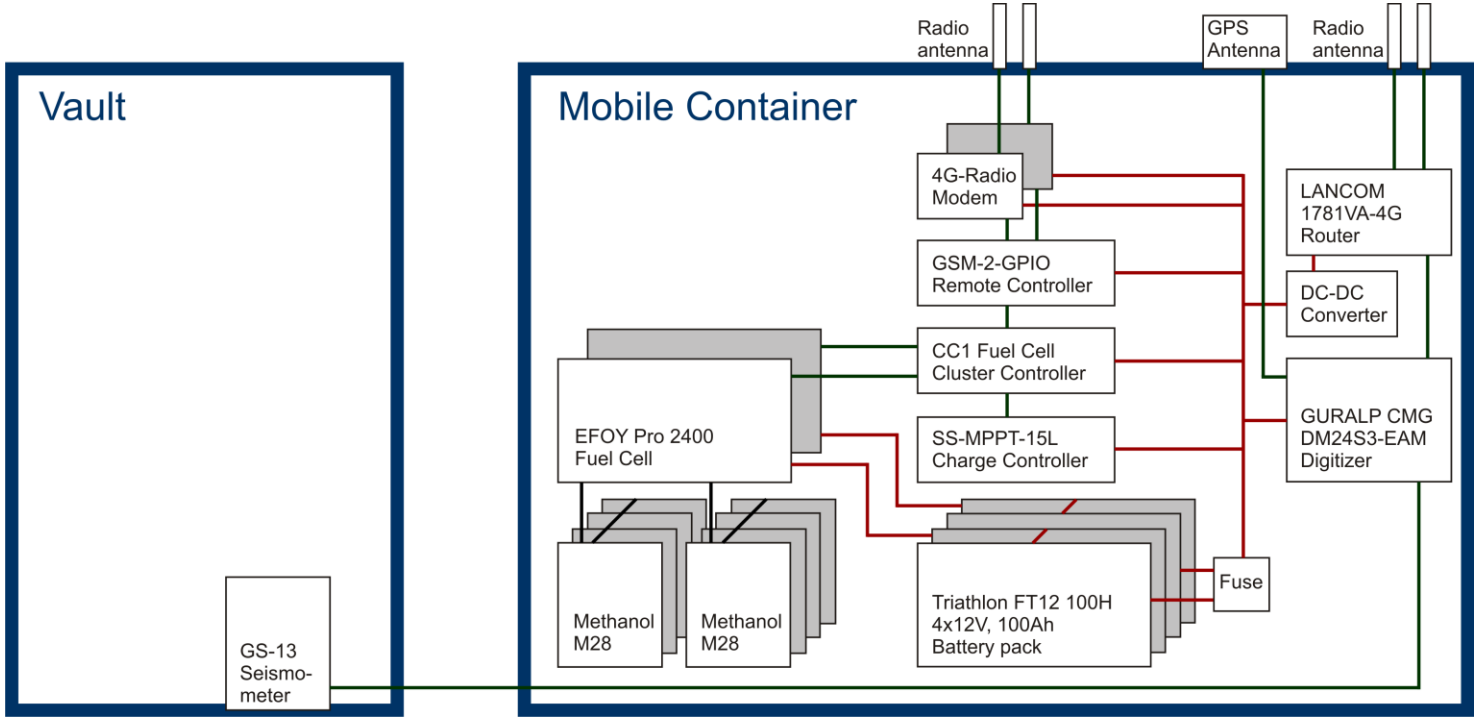
Technical implementation of temporary seismic array elements



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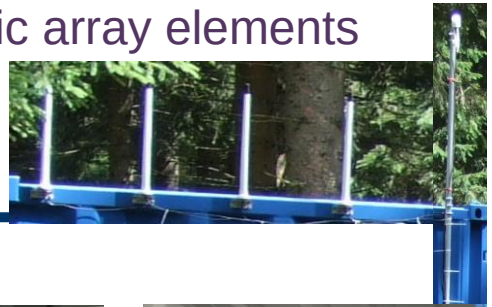
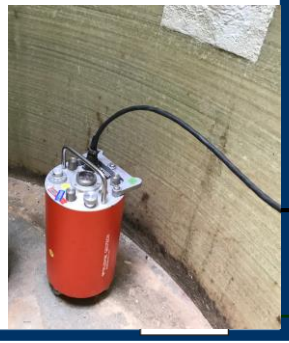


Radio Antennas

GPS Antenna

Vault



Seismometer

Mobile Container

Electronic cabinet

Battery pack

Fuel Cell

Methanol tank

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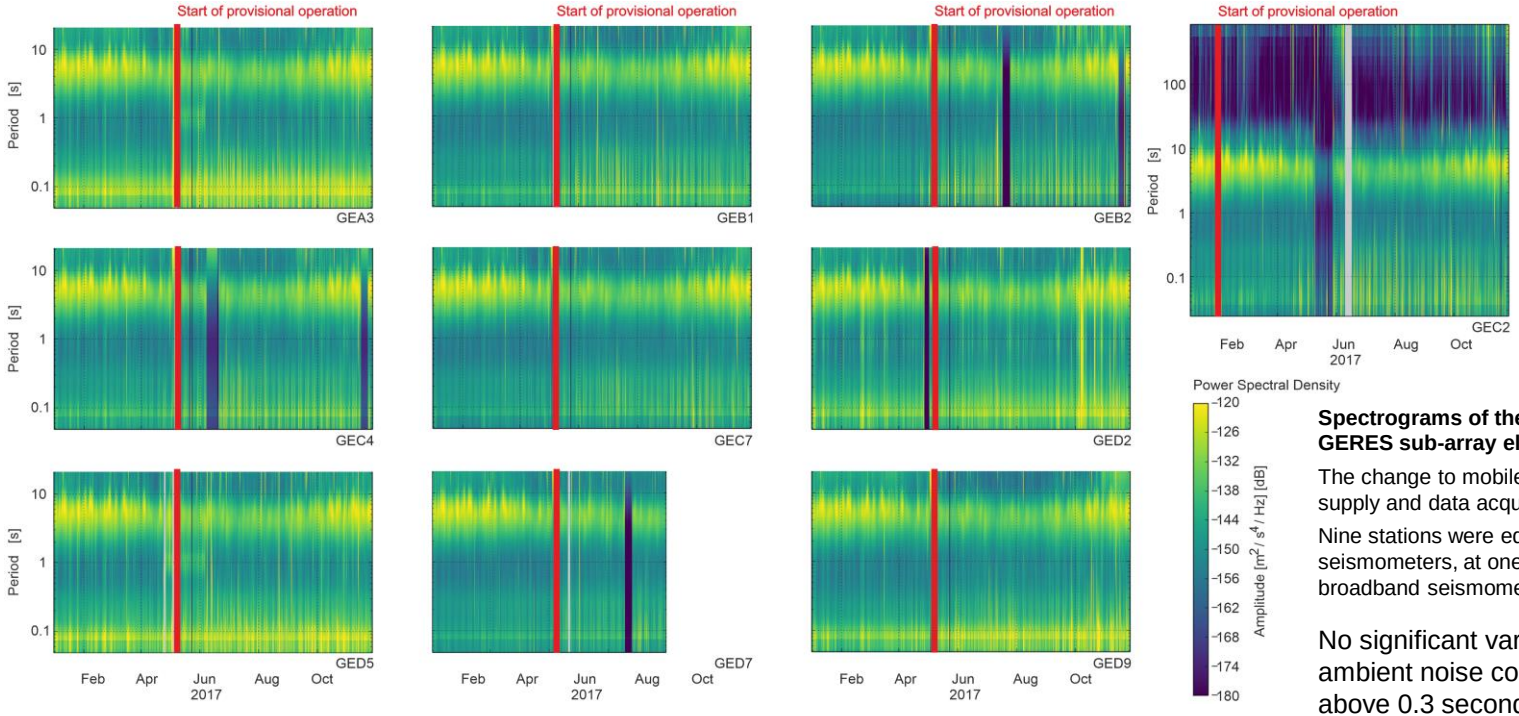
Ambient seismic noise conditions



Spectrograms of the PPSD for the ten GERES sub-array elements

The change to mobile systems for power supply and data acquisition is marked in red.

Nine stations were equipped with short period seismometers, at one station (GEC2) a broadband seismometer was installed.

No significant variations in the ambient noise conditions for periods above 0.3 seconds were observed.

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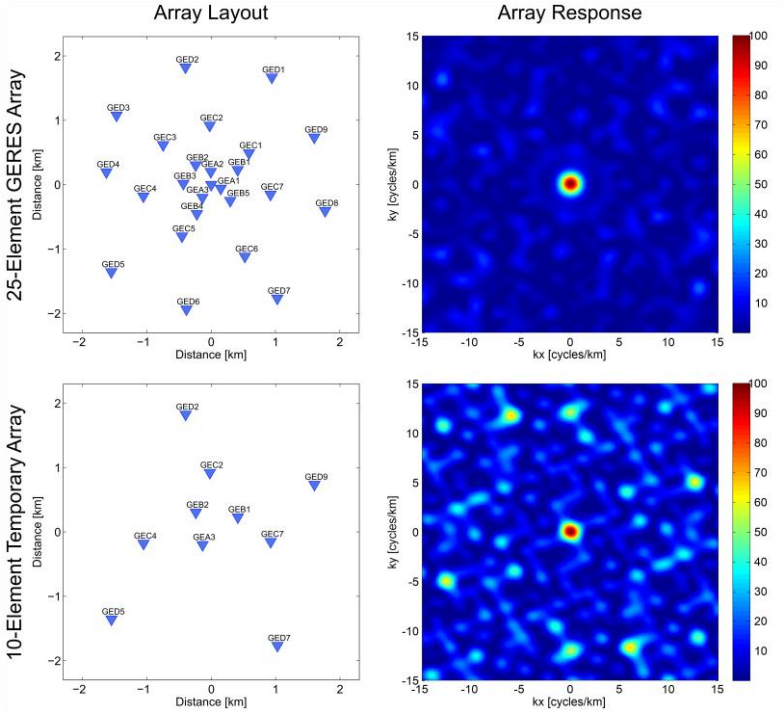
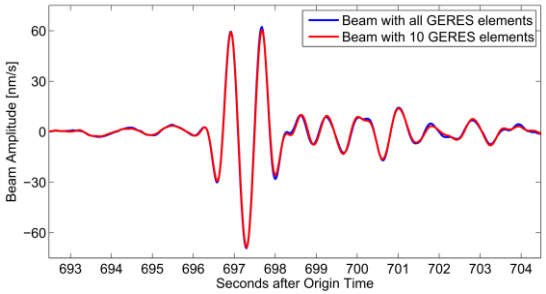
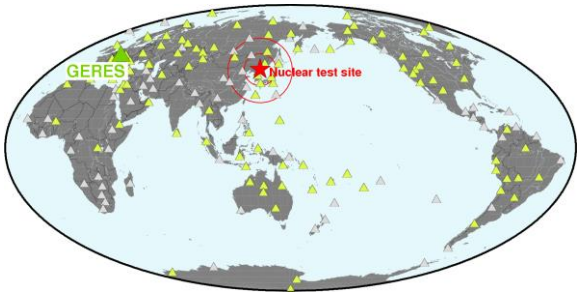
Evaluation of the array response for the reduced array configuration





North Korean nuclear explosion on January 6th, 2016 recorded at GERES array in a distance of 8187 km

	25 elements	10 elements
Back azimuth [deg]	44.9	45.8
Slowness [s/deg]	5.78	6.07
Signal to noise ratio	9.4	9.6



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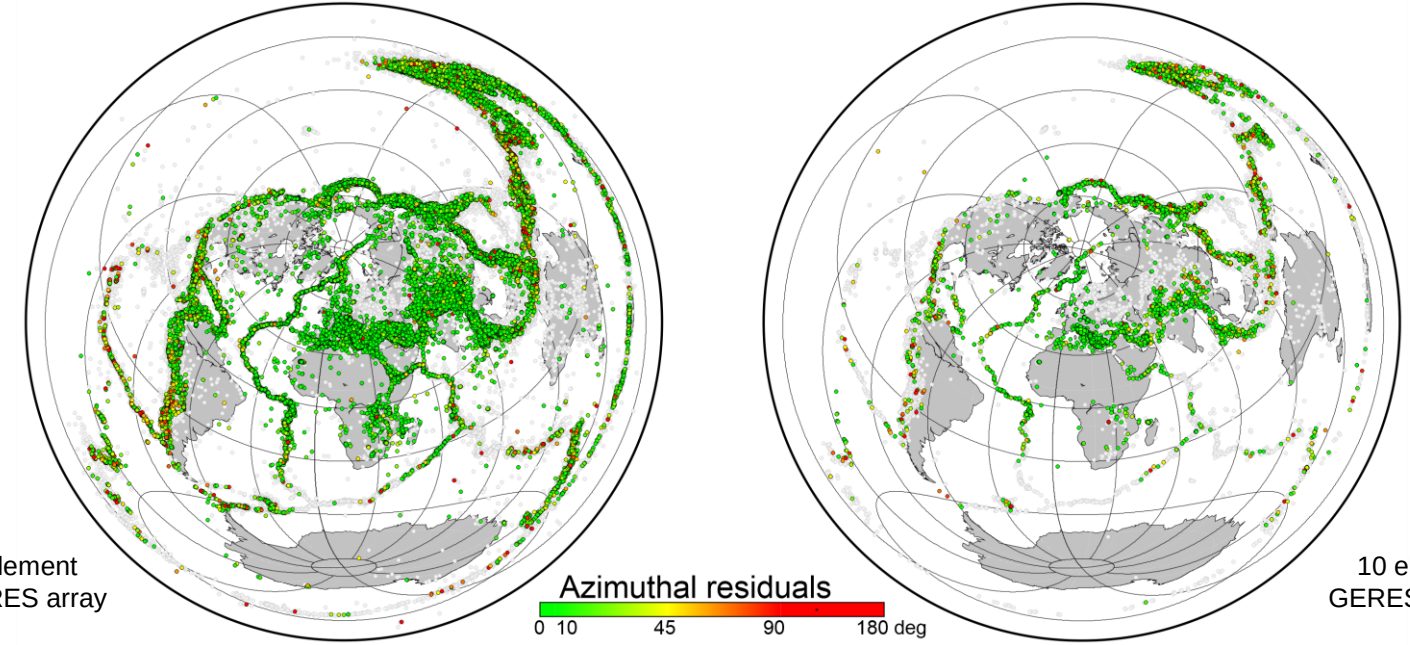
Comparison of azimuthal residuals for different array configurations



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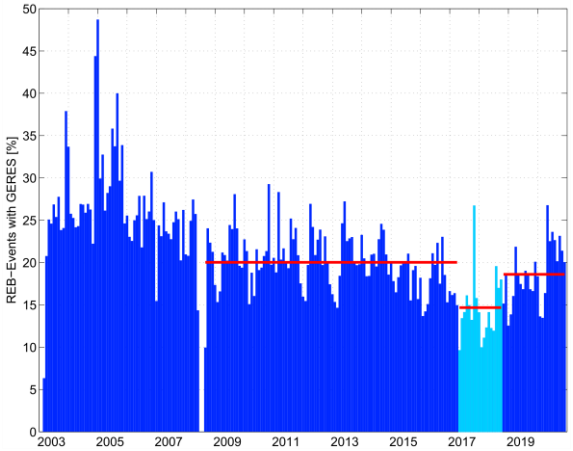
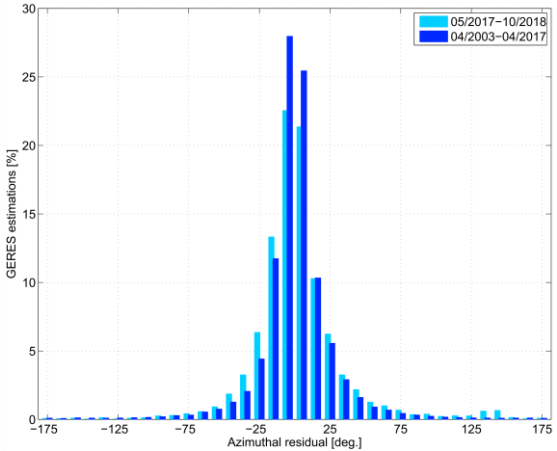
Statistics of GERES signal analysis



Percentage of REB events with GERES phases on a monthly base between 2003 and 2020. The standard configuration with 25 array elements (dark blue) was temporarily interrupted by the period with a 10 element array in operation (light blue). The mean percentage for the corresponding time intervals are marked in red.
It reveals that every fifth event in REB includes GERES phases estimated with 25 array elements, in contrast to only every seventh event with 10 array elements.

	April 2003 – April 2017 (25 array elements)	May 2017 – October 2018 (10 array elements)
Magnitude < 5.0	21 %	14 %
Magnitude ≥ 5.0	86 %	82 %

Percentage of seismic events in the IDC‘s Reviewed Event Bulletin (REB), to which GERES phases are associated.
Above a magnitude of 5.0 the decrease of events with GERES phases using only 10 array elements is negligible.
However, over 75 times more events with magnitudes below 5.0 are reported in the REB than in the magnitude range above 5.0.



The precision of backazimuth determination was slightly affected by the redution of array elements from 25 (dark blue) to 10 (light blue).
The beam forming with 10 array element shows azimuth variations of less than 29 degree for 80 % of determinations. In comparison, 80% of event determinations with the complete 25 element array have azimuth variations of less than 23 degree.

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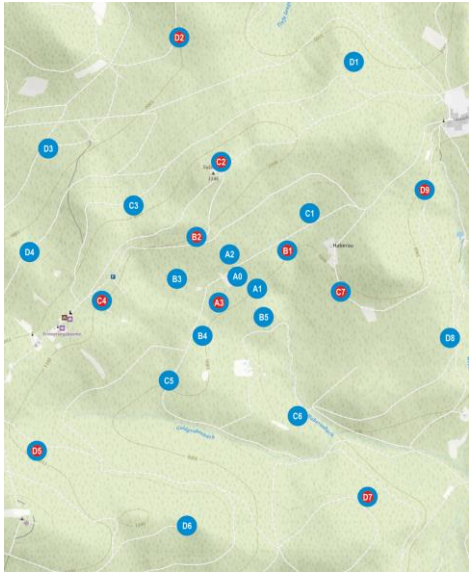
Conclusions

- The scope of work during the modernization of the primary seismic station PS19 made a complete shutdown necessary.
- A downsized array configuration was temporarily installed instead, in order to ensure the sustainment of detection capability of the IMS.
- Distributed systems with power supply by fuel cells and data transmission via mobile communications were successfully operated for 18 months.
- Automatic supervision of operating status ensured the high data availability according to IMS standards.
- The configuration of the sub-array with 10 selected sites out of 25 array elements preserved an acceptable array response.
- Only a little less event detections and marginally greater azimuth variation has to taken into account for estimations with the temporary array.



The continuous provision of seismic data from the only primary seismic IMS station in Central Europe was worth the effort to set up and operate a temporary array during the time of modernization.