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NEWSLETTER OF THE GEOPHYSICAL INSTITUTE

DEAR GPI ALUMNI

The second half of this year was influenced by Ṙriedemann Wenzel's retirement and the beginning of the negotiations with his potential successor who hopefully will join the Institute during next year. With Friedemann Wenzel's retirement GPI is losing an internationally highly respected leading scientist who contributed strongly to our success and reputation over the last 20 years. The GPI expresses its deep gratitude to Friedemann Wenzel and wishes him health, satisfaction and continued enthusiasm while approaching new horizons.

We wish all of you peaceful and happy holidays!

Thomas Bohlen

SEISMOLOGY

By Joachim Ritter

The seismology group is involved in the international ScanArray experiment in Scandinavia. The fieldwork by GPI was finished in autumn 2016 after two years of successful continuous recording with broadband instruments borrowed from GIPP at GFZ Potsdam. Michael Grund and Werner Scherer conducted several trips to Finland and Sweden to install and service the recording stations. The whole experiment included about 128 temporary broadband recording stations and 109 permanent stations. In addition up to 187 recording stations from previous temporary experiments are available for research projects (see station map). At present Michael Grund analyses SKS phases for studying mantle anisotropy and Franz Lutz looks at travel times of teleseismic shear waves for a tomography study. The latter is done in cooperation with GPI alumni Christian Weidle from Kiel University. Our research is financed by DFG within a cooperation project with GFZ Potsdam (LITHOS-CAPP: LITHOspheric Structure of Caledonian, Archaean and Proterozoic Provinces).

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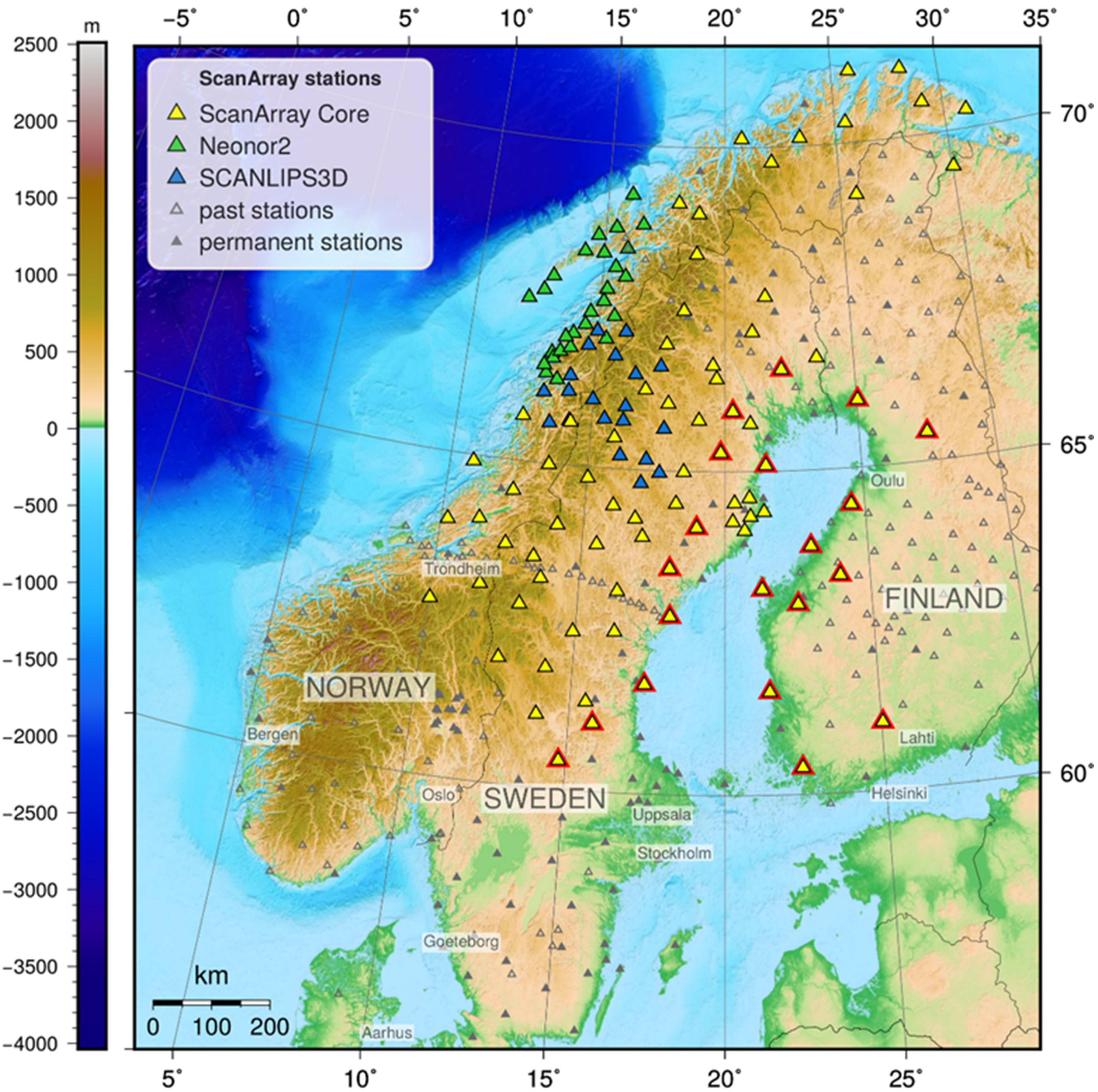

Figure: ScanArray station network. 20 LITHOS-CAPP stations (yellow triangles with red edges) are part of the subnetwork ScanArray Core that consists also of stations from the Universities of Copenhagen, Aarhus, Oslo and Uppsala. The Neonor2 network is operated by the University of Bergen, and SCANLIPS3D by University of Leicester. There are also 109 permanent stations and 187 stations of past temporary experiments (e.g. MAGNUS, SCANLIPS 1&2, TOR, SVECALAPKO etc.).

The seismology group studies seismic emissions from wind mills (see last alumni newsletter). We now received a grant for a second project called WINSENT. Within this interdisciplinary research project, several groups will study the long-term behaviour of wind mills. An experimental setting for research studies will be installed near Stötten on the Swabian Alb. Our contribution will be the continuous observation of seismic waves in three shallow boreholes. The instrument installation is expected for 2017 or 2018 depending on the project progress by the different partners. WINSENT will be strongly linked to WINDFORS (www.windfors.de) and coordinated by KIT IMK-IFU and University of Stuttgart.

MODELING VOLCANIC PROCESSES

By Ellen Gottschämmer

A challenge for the characterization and assessment of volcanic risk is the variety of hazards posed by volcanic eruptions. Thus, assessing volcanic risk requires the analysis of a multi-hazard process. Volcanic hazards include flow processes as lava flows, mud flows, ash flows and pyroclastic flows which are usually confined to valleys in the surrounding of the volcano. In contrast, deposits from fall processes like volcanic bombs, lapilli, and fine ash transported through the air can be lifted over the crater rim and accumulate in all directions from the crater. Those deposits can even be found in distal areas and pose risk to regions at large distance from the volcano. Similarly, hazard due to volcanic degassing is relevant at proximal distances as well as on a global scale. Further hazards are posed by mass movements like landslides due to flank instabilities. Those can, as well as submarine volcanic eruptions, generate volcanic tsunamis.
Physical models can help to better understand the physics of the eruption process and the process of transport and deposition, and thus to quantify both, the individual hazard posed by a volcano, and the risk connected to it. Research recently carried out in the group Natural Hazards and Risk at GPI deals with computational modelling volcanic hazards and their impacts on critical infrastructure and population.

For a re-eruption of Laacher See volcano with comparable eruption intensity as the 10900 BC eruption, Leder (2015) simulated different fallout scenarios using a present-day wind-field derived from 44 years of radiosonde observations. The fallout fans of fine ash particles spread mainly westwards with some variation to the North and to the South, and affect the cities of Cologne, Bonn, Koblenz, and Frankfurt. Schuh (2016) computed that – depending on the wind speed – an area between 770 km² and 850 km² would be covered with at least 1 m of ash, and an area between 4800 km² and 5800 km² would be covered with at least 0,1 m of ash. Subject to the prevailing wind direction and thus to the season, Schuh (2016) showed that this corresponds to a coverage of the German autobahn at a total length of 280 km – 340 km. Dietzmann (2016) worked on the influence of volcanic ash of on respiratory disorders and quantified the additional number of doctors, hospitals and medical equipment needed in a re-eruption of Laacher See volcano. Results of this work have been discussed at the 2nd Workshop on Risk, Disasters and Safety at KIT in December 2016.

Modeling volcanic processes is also the topic of the research group's seminar during this winter semester. Students from Geophysics and Meteorology study and apply different tools to model volcanic processes in order to understand the influence on eruption parameters on the hazard and risk posed by volcanoes. That way, we integrate current research results into our degree course, in accordance with the Mission Statement of KIT.

Dietzmann, A.: Health Hazard going on with a Reeruption of Laacher See Volcano, Bachelor Thesis, KIT, 2016.

Leder, J.: Hazard and loss assessment of a Laacher See Volcano re-eruption, Master Thesis, KIT, 2015.

Schuh, J.: Quantitative Estimation of the Impact of a Laacher-See-Volcano Eruption on Transport Routes in Germany, Bachelor Thesis, KIT, 2016.

RECENT EARTHQUAKE NEAR PICTON, NEW ZEALAND

By James Daniell

Upon taking my paternity leave trip to NZ, I never thought that it would become a work trip as well! Leaving from Christchurch on the south island, we spent a lovely day heading through Kaikoura and eating a crayfish along the national highway SH1, up through the town of Ward stopping off for afternoon tea and then on to Picton. A couple of days later shortly after midnight we thought someone might be breaking into our hotel room (P wave). Then suddenly a massive movement to the right of the beds followed by around 90 seconds of shaking, and then aftershocks galore, tsunami warnings and lots of people travelling around. A Mw7.9 earthquake had occurred. My family and I had felt our first major earthquake. In Picton, we were about 80-100 km away north-west from the main fault traces, and about 40km away from the nearest major aftershock, so there was luckily only mainly non-structural damage and landslides, with around intensity VI felt.

The earthquake raised some interesting issues:

1) at Ward, a recording of close to 4g at Sa(0.2s) was seen with around 1.27g PGA recorded.

2) there was uplift of the coast of around 2m, causing crayfish to be relocated above ground.

3) over 100,000 landslides have been recorded, many of which we had to drive around!

4) the earthquake actually occurred on 6-8 faults, jumping over faults during the event raising interesting issues for future seismic hazard and risk mapping.

5) the infrastructure along the coast (railway and road) will likely be closed for years and was harder hit than the buildings.

6) In Wellington, just across the strait they had major damage in the CBD, and many more buildings should be cordoned off than have been, raising many concerns about safety procedures vs. tourism!

7) Every location where we ate on our trip through the epicentral region, unfortunately has been destroyed.

We enjoyed the rest of our trip with only a few felt aftershocks, escaping down the west coast of the south island along the overdue Alpine fault, circling around Mt. Cook and back to Christchurch, with the usual NZ earthquake humor of the locals shining through.

The damage in Main Street, Picton.
By: James Daniell

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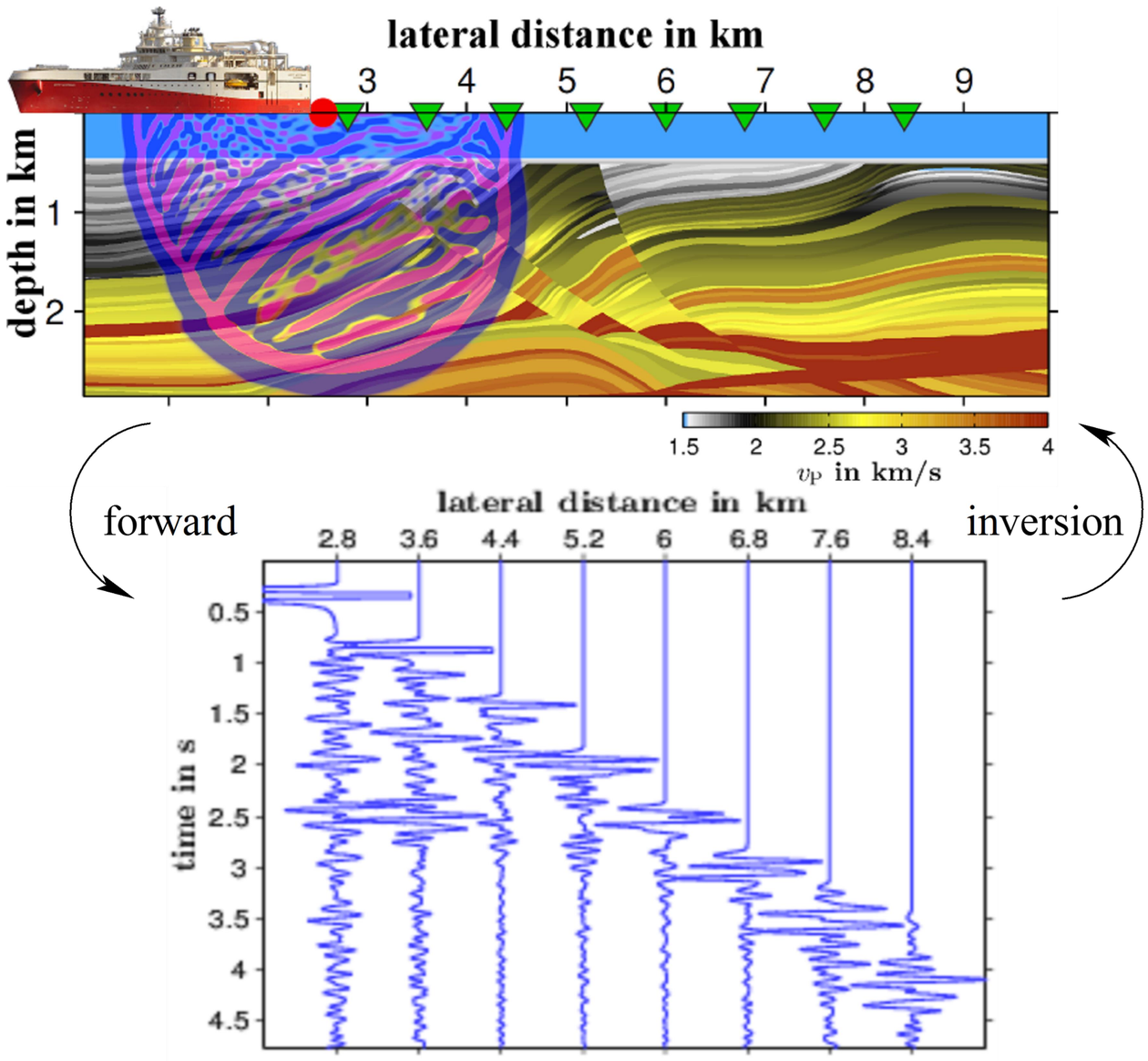
NEW PROJEKT WAVE "PORTABLE HPC-TOOLBOX FOR THE SIMULATION AND INVERSION OFSEISMIC WAVE FIELDS"

By Thomas Bohlen

During the second half of last year we made significant progress in our new project WAVE in which we develop a new HPC toolbox for visco-elastic waveform simulation and full waveform inversion. The HPC toolbox will allow to run the same codes on various HPC architectures from small GPU cluster, intermediate distributes/shared memory systems up to exascale massive parallel supercomputers. As a major step we reformulated or established Finite-Difference simulation code SOFI3D in C++ by using sparse matrix vector (SpMV) operations which are efficiently solved by the library LAMA (Library for Accelerated Math Applications) on various HPC architectures. The project WAVE is financially supported by BMBF during the years 2016-2019. The project partners are the Institute of Theoretical Informatics (KIT), the Fraunhofer Institute for Algorithms and Scientific Computing (SCAI), and the company TEEC. The HPC toolbox will consist of simulation of full waveform inversion codes on spatially variable grids, generic data structures and algorithms for wavefields, and load balancing algorithms. For further information we refer to our web-page http://wave-toolbox.org/.



In order to perform seismic full waveform simulation and inversion we require software that performs well on future HPC architectures which becomes more and more hierarchical and heterogeneous.

TEMPORAL VARIATION OF TIDAL PARAMETERS

By Thomas Forbriger, Eva Schroth, Malte Westerhaus

Temporal variations of tidal parameters have been reported recently for observations with superconducting gravimeters. Since the admittance of Earth's body to tidal forces is not expected to vary rapidly (within a few months), the causes of this phenomenon must be searched in temporal variations in the oceans and possibly the atmosphere, deficiencies in the method of analysis, or neglected influence of non-tidal gravity signals. We aim to study the ocean's role in this phenomenon and to improve the method of tidal analysis such that different causes can be distinguished. Recent advances in the development of operational ocean models promise ocean tide models of unprecedented complexity and accuracy including the non-stationary response to tidal forcing.

Such modelling results are provided by four international partners (GFZ Helmholtz Centre Potsdam, Norwegian Meteorological Institute, University of Michigan USA, NOAA Centre for Weather and Climate Prediction USA). On the one hand we will compare the non-stationary tidal loading predicted by these models with results from gravity observations. On the other hand a new approach to tidal analysis will be implemented based on geophysical inverse theory as an alternative to the common geodetic approach. This way we hope to provide useful observational constraints regarding the oceanic mass displacement and an improved accuracy when determining the admittance of Earth's body from gravity recordings.

The monitoring of ocean loading and attraction might become a means to study the oceans response to global climate change, ocean warming, and sea-level rise. The project is carried out in a cooperation of the Geophysical Institute and the Geodetic Institute of KIT at the Black Forest Observatory (BFO). DFG provides funding for two PhD candidates within this project.

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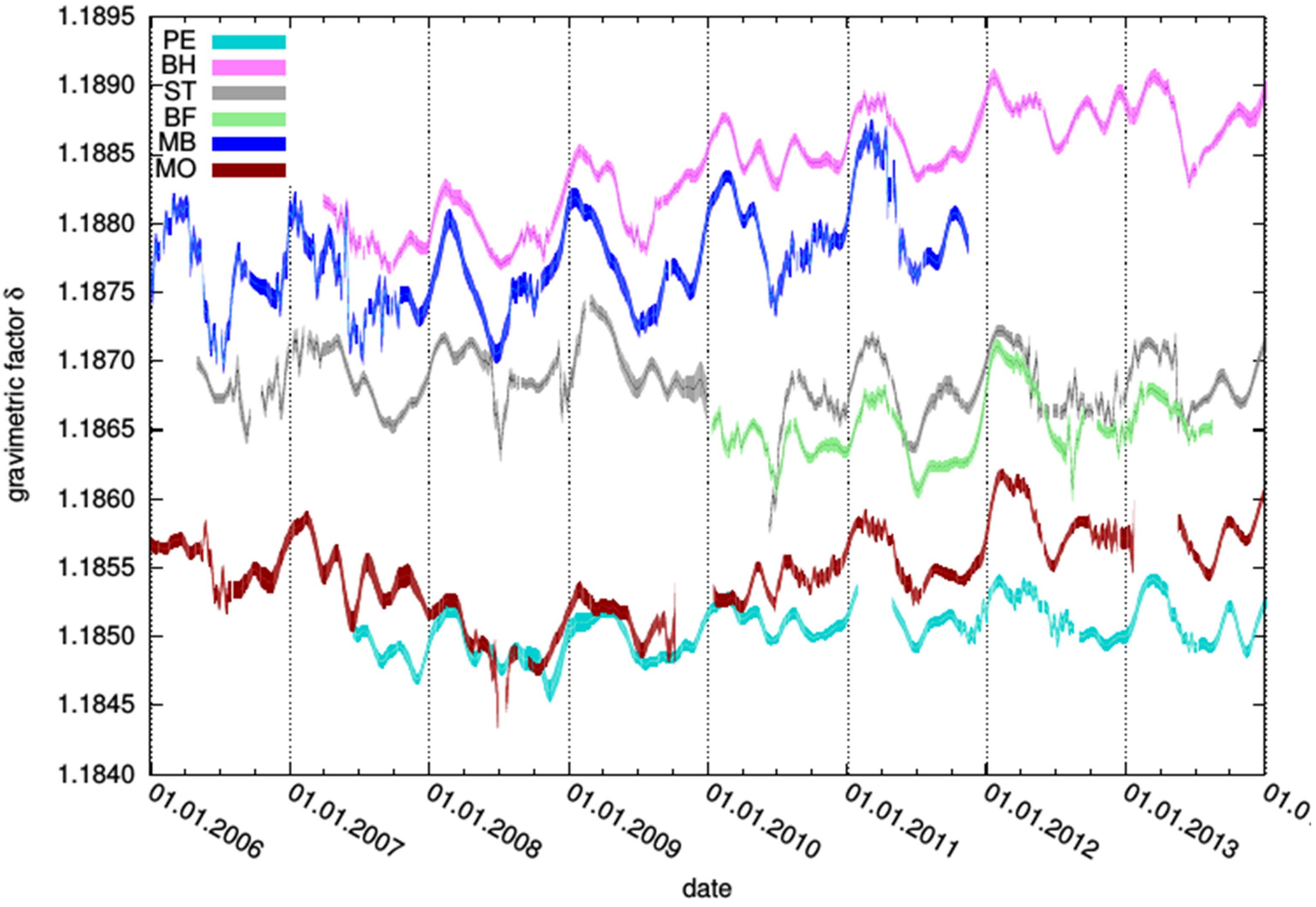

Results of moving window tidal analysis for the gravimetric factor of tidal group M2 at superconducting gravimeter stations in Europe. Data segments of 90 days length, successively shifted by 2 days are analysed with Eterna 3.40. A band-pass from 1 cycle-per-day to 5 cycles-per-day was applied to data and model. The analysis uses a Hanning taper and applies local air-pressure as additional regressor. The thickness of the curves displays the ±1 sigma range equivalent to the standard deviation as output by Eterna 3.40. Stations are BH: Bad Homburg, Germany, BF: Black Forest Observatory (Schiltach), Germany, MB: Membach, Belgium, MO: Moxa, Germany, PE: Pecny, Czech Republic, ST: Strasbourg, France.

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TEACHING

By Ellen Gottschaemmer

Currently, 50 students are enrolled in the Bachelor's degree program at KIT, and 32 students learn at an advanced level in the Master's (and Diplom) degree program. The number of students has slightly decreased over the last semesters after a strong increase in the years before, often explained by the accumulation of high-school graduates due to the reduction from 9 to 8 years of high-school education, which seems to be resolved by now.

In all our degree programs we consider a stable and fundamental education in Physics, Mathematics and Geophysics as most important, but we also involve our students into our current research from the very early beginning of their studies:

The students in the first year for example got in contact with research-oriented teaching during an in-situ lecture which led them to Strasbourg in December this year. They had the chance to visit the seismology museum at Strasbourg University, and discuss about the necessity of historically recorded seismograms in order to perform a better hazard assessment of the Rhine Graben and other regions worldwide.

A better understanding of hazard assessment of Mediterranean volcanoes was the goal of an in-situ-lecture conducted to the Phlegrean Fields, Mount Vesuvius, and to the volcanoes of the Aegean Islands in September this year. 25 students had the opportunity to investigate the hazards posed by volcanic activity on site. They carried out both, temperature and gas measurements at fumaroles, and visited operational volcano observatories. There they had the chance to discuss with local researchers about the data recently recorded by the observatories and got to see different geophysical monitoring equipment. A highlight certainly was the ascent to the craters of Mount Vesuvius, Vulcano and Stromboli.

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GPI students at the active crater of Stromboli volcano, Italy
Photo: L. Mansfeld

GPI students measuring temperature profiles and gas concentrations at Vulcano, Italy
Photo: E. Gottschämmer

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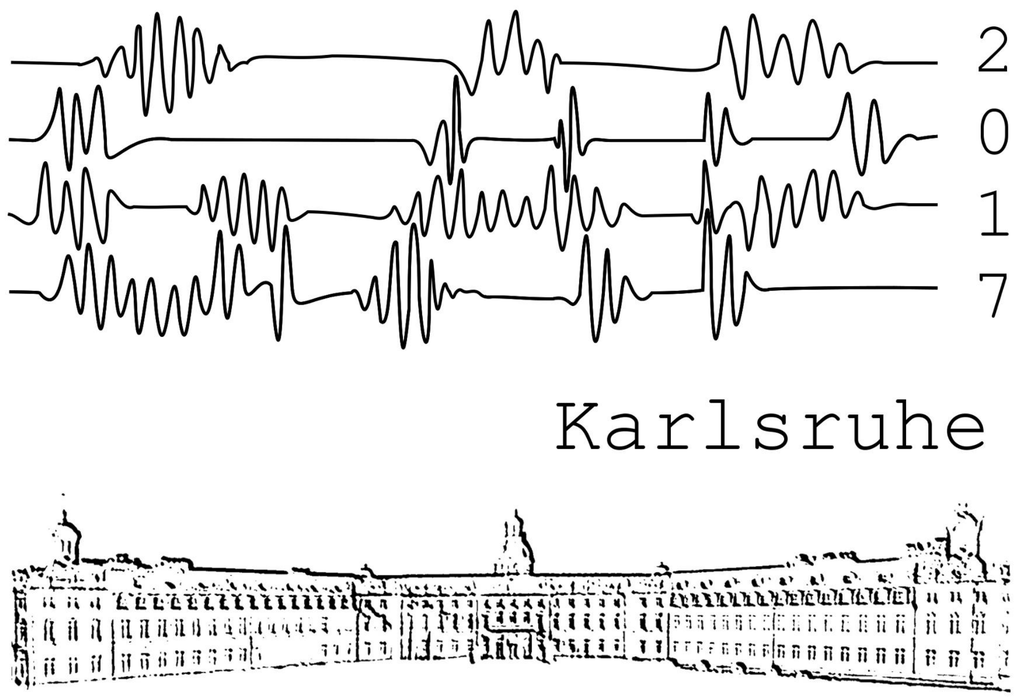
Issue 10, December 2016 *Page 12*

GAP 2017 IN KARLSRUHE

By Sebastian Staudt und Lisa Dalheimer

Next year from the 25th – 28th May the geophysics students of the Geophysical Department of Karlsruhe Institute of Technology (KIT) will organise the 33rd Geophysical Activity Programme (GAP).

GAP is an annual meeting of geophysics and geoscience students from Germany and neighbouring European countries. In 1985 GAP was started by a group of students from the University of Karlsruhe. Since then annual GAP meetings have taken place in several different university venues entirely organised by geophysics students in the host university. The general programme comprises presentations, workshops and excursions.



The aim of GAP meetings is to bring together geophysics and geoscience students and to provide a platform for students to establish contact with relevant companies and research institutions with a view to learning about internships and career opportunities offered. The GAP meetings are attended by about 150 students from Germany and other European countries and thus they offer interested companies a valuable opportunity of direct contact with students from academic disciplines that might be relevant to their recruitment programme.

GAP is organised as an independent, incorporated society**.** It is based entirely on the initiative of students. Therefore the GAP needs companies as partners for the realisation of the meeting. If you are interested in supporting the next GAP you can contact us via e-mail sponsoring@gap2017.de and we will gladly provide you with further information.

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RECENT PUBLICATIONS

In this section we would like to inform those of you who are still active in Geophysics about recently published peer-reviewed journal papers authored by current members of GPI:

Ali S.M., Barth A., Toni M., Wenzel F.: Analysis of the similar epicenter earthquakes on 22 January 2013 and 01 June 2013, Central Gulf of Suez, Egypt, Journal of African Earth Sciences 121, 274-285, 2016.

Bohlen T., Wittkamp F.: Three-dimensional visoelastic time-domain finite-difference seismic modelling using the staggered Adams-Bashforth time integrator, Geophysical Journal International, 204 (3), 1781-1788. doi:10.1093/gji/ggv546, 2016.

Staudt S., Ritter J.R.R., Brüstle A.: 1-D seismische Geschwindigkeitsmodelle, Stationskorrekturen und Hpyozentrenbestimmung in der Südpfalz, Mainzer Geowissenschaftliche Mitteilungen, 44, S. 185-204, 2016.

Garofalo F., Foti S., Hollender F., Bard P.-Y., Cornou C., Cox B. R., Ohrnberger M., Sicilia D., Asten M., Di Giulio G., Forbriger T., Guillier B., Hayashi K., Martin A., Matsushima S., Mercerat D., Poggi V., Yamanaka H.: InterPACIFIC project: Comparison of invasive and non-invasive methods for seismic site characterization, Part I: Intra-comparison of surface wave methods. Soil Dynamics and Earthquake Engineering, 82, 222-240, doi: 10.1016/j.soildyn.2015.12.010, 2016.

Grund M., Groos J.C., Ritter, J.R.R.: Fault reactivation analysis using microearthquake clusters based on signal-to-noise weighted waveform similarity, Pure Appl. Geophys., 173, 2325-2355, doi 10.1007/s00024-016-1281-4, 2016.

Ritter J.R.R.: Die tiefe Quelle des Vulkanismus in der Eifel - Der Eifel-Plume. In: von Loga, S. & Koziol, M., 12 Wanderungen auf den Spuren des Vulkanismus in der Westeifel, Eifel-Verlag, Jünkerath, 10-11, 2016.

Sanz Alonso Y., Barth A., Lehmann K., Wenzel F.: Neubewertung des historischen Schadensbebens von 1735 im Westerwald - Re-evaluation of the historical 1735 earthquake in the Westerwald/Germany, Mainzer Geowissenschaftliche Mitteilungen 44, S. 47-62, 2016.

Van Camp M., Meurers B., de Viron O., Forbriger T.: Optimized strategy for the calibration of superconducting gravimeters at the one per mille level. J. Geodesy, 90(1), 91-99.
doi: 10.1007/s00190-015-0856-7, 2016.

Zieger T., Sens-Schönfelder C., Ritter J.R.R., Luehr B.-G. and Dahm T.: P-wave scattering and the distribution of heterogeneity around Etna Volcano, Annals of Geophysics, 59, 4, S0432; doi:10.4401/ag-7085 (13 pages), 2016.

The popular science journal PM reported a cover story of our research on the volcanism in the Eifel region. GPI staff contributed material and interviews, see also: GPI in the press under: http://www.gpi.kit.edu/1071.php

Feedback

If you have any comments, questions or remarks, please do not hesitate to contact us. We appreciate your feedback.

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Happy Holidays

All the best for a prosperous and happy 2017