

SeaLevel Newsletter

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Welcome to the SPP-1889 SeaLevel Newsletter!

We are excited to present our spring edition with lots of new sea level science and highlights from the most recent activities the SPP SeaLevel community has been involved in, including the Evaluation Colloquium for the 2nd funding phase of our program.

In this issue, find out **what kind of sea level rise (SLR) information** can scientists produce to **support informed coastal decision making**; about an innovative **geodetic research on global (60°N-56°S) elevation and mass change rates of glaciers** including the first complete inventory for some mountain regions, and the contribution to SLR; simulating and reconstructing **long-term storm flood variability in the S.E. North Sea** and implications for future flood risks assessments; **sensitivity of the SL response** in surface flux anomalies experiments with two different **model resolutions** and which regions are the most sensitive; and about **maintenance of the tide gauge network in Indonesia**.

Also in this issue, updates on three sea-level related scientific meetings as well as on the engagement of the

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SPP SeaLevel in inspiring young females on career orientation.

We hope you enjoy reading the SeaLevel Newsletter and thank you for your interest to our program!

The outcome of the SPP SeaLevel Evaluation Colloquium for its 2nd phase

The SPP-1889 SeaLevel program is already undergoing its last year of the 1st phase, which will officially end in June 2019 when the program will enter its 2nd funding phase for another 3-year period.

The Evaluation Colloquium of SPP-1889 SeaLevel for the 2nd funding phase, organized by the German Research Foundation (DFG) and hosted by the SPP-1889 Coordination in Hamburg, took place on 19-20 March in the Institute of Oceanography, University Hamburg.



Fig 1: The poster session of the Phase 2 SPP-1889 SeaLevel Evaluation Colloquium was held in the Institute of Oceanography, University Hamburg on 19th March.

During the Evaluation Colloquium, the applicants presented their project proposals in a poster session during which the 12-member Experts Committee and the DFG Representative Dr. Daniel Weymann, had the opportunity to discuss with the applicants, ask questions and thus get a thorough insight of the proposed projects before their final decision. As result of the review process 15 proposals were

recommended for funding during the second phase.

The 2nd phase of the SPP-1889 SeaLevel will officially start on 1st July 2019. Nevertheless, several projects from the 1st phase will continue in a cost-neutral way several months beyond the official end of the 1st phase to complete their research work from the 1st phase.

SEASCAPE Baltic: Meeting User Requirements For Sea Level Rise Information

Jochen Hinkel and Thomas van der Pol; Global Climate Forum – Berlin

A new framework based on decision analysis can help scientists produce practical data that support informed decisions about climate adaptations.

Although information about future sea level rise is essential for coastal communities to make informed decisions about how to adapt to climate change, few studies have analyzed the types of data users need to accomplish this. Despite recent attempts to equip decision makers with the practical, scientifically based data they need to help communities effectively adapt to climate change, few studies have examined the specific types of [climate services](#) these users require. This deficiency includes information about mean sea level rise, a crucial basis for informed decisions about local coastal adaptations.

To address this gap [Hinkel et al.](#) utilize decision analysis to systematically identify which sea level rise data users most need and then determine whether these requirements can be met given current scientific knowledge. The results indicate that the kinds of information that would be most helpful to decision makers depend upon both the context and the level of uncertainty each user can tolerate.

The team's analysis identified several types of desired sea level rise information that are currently scientifically attainable. These include high- and low-end sea level rise scenarios created for a range of uncertainty tolerance levels as well as probabilistic predictions, which can support short-term decisions (prior to 2050) in locations where the reasons behind climate variability are relatively well understood. The team also determined that learning scenarios,

which estimate what new information about sea level rise will become available in the future, could improve longer-term decisions.

By focusing on the needs of decision makers as well as sea level rise data that are scientifically attainable, this study offers a noteworthy example of how to bridge the divide between the scientists who produce climate information and the decision makers who use it. Because this approach can also be applied to other types of climate change mitigation and adaptation information, it offers a practical roadmap for co-designing the climate services upon which the health and safety of communities around the world will increasingly depend.



Fig 2: What kind of sea level rise information can be produced to help coastal decision making?

Read more in: [Hinkel, J., J.A. Church, J.M. Gregory, E. Lambert, G. Le Cozannet, J. Lowe, K.L. McInnes, R.J. Nicholls, T. van der Pol, and R. van de Wal \(2019\), Meeting User Needs for Sea Level Rise Information: A Decision Analysis Perspective, Earth's Future, 7, 320-337.](#)

SATELLITE: Measuring global change of mountain glaciers and contribution to sea level rise

Christian Sommer, Philipp Malz, Matthias Braun; FAU Erlangen-Nürnberg

Mountain glaciers are vanishing in almost all regions of the world. The SATELLITE project originally intended to estimate glacier mass loss, outside the polar regions, and respective sea level rise contribution by measuring geodetic mass balances of selected glaciers and subsequent upscaling to regionwide results. Our approach is based on elevation change rates of glaciers during the first decade of the 21st century. We use acquisitions from the German TanDEM-X satellite mission from 2010-2014 and data of the Shuttle Radar Topography Mission from February 2000. However, due to improved data processing and computation infrastructure we were able to extend our geodetic measurements to the entire regions. By this means we were able to directly measure almost all glaciated areas between 60°N and 56°S (measured area > 80%) with high-resolution elevation models. For some mountain regions, e.g. Tropical Andes, Patagonia & South Georgia, our geodetic mass balances represent the first complete glacier change inventory.

Currently, we are working on region-specific publications with more detailed analysis of glacier elevation and area changes for South Georgia, High Asia and the European Alps. We are also finalizing our global coverage (Fig. 3) which will provide a novel baseline for the interpretation of mountain glacier change worldwide. Due to the standardized methodology and consistent data source, it will be possible to directly compare mountain ranges or even continents to each other. Our results show significant surface depletion in entire regions such as the Alps, South Georgia or the Caucasus. Yet, actual mass loss and sea level rise contribution of this regions is negligible because of the small proportion of glaciated area compared to North & South America and High Mountain Asia. Balanced conditions to slight surface elevation gain are found in Central Asia and parts of the Tibetan Plateau, contrasting the enormous elevation loss signal in southern Himalaya range. These varying patterns are now subject to more detailed analysis.

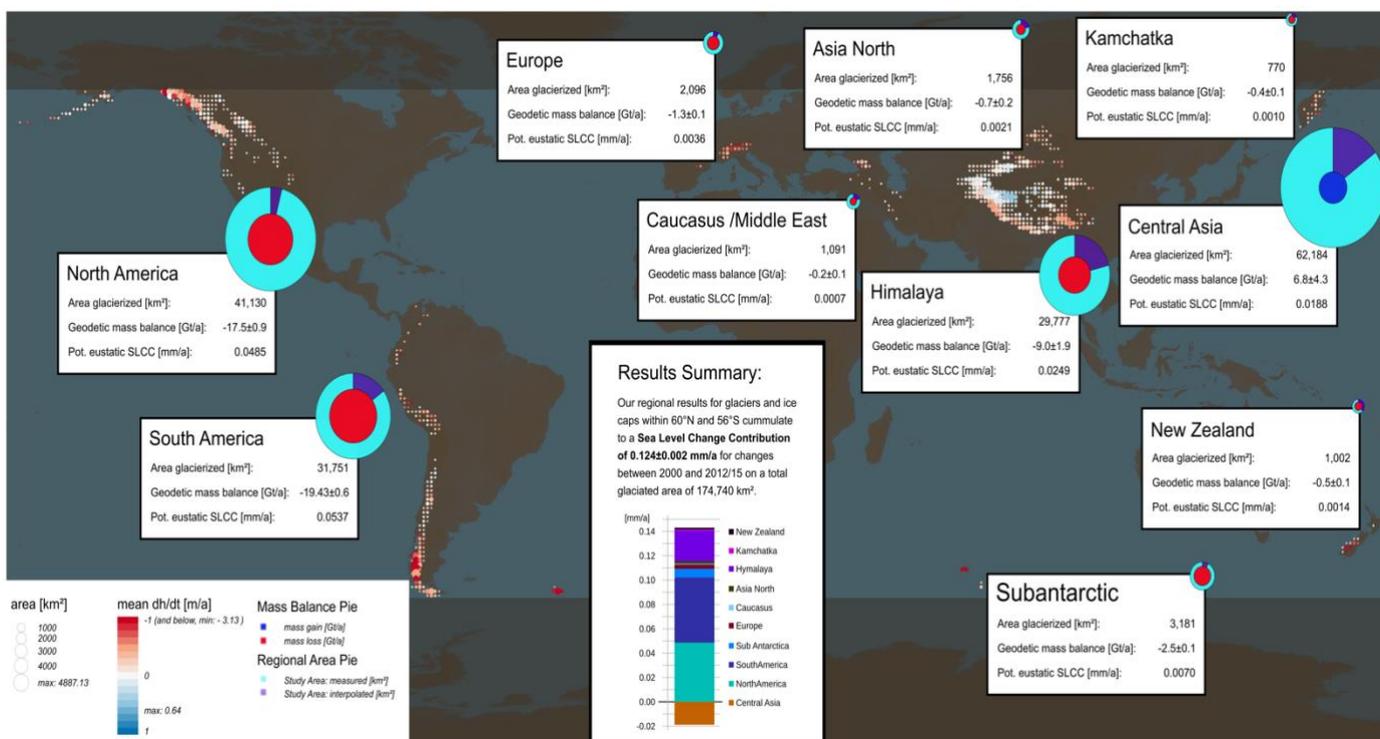


Fig. 3: Glacier elevation and mass change and contribution to sea level rise between 60°N and 56°S.

SEASTORM: Simulating & reconstructing long-term storm flood variability in the southeastern North Sea

A. Lang¹, D. Bunzel², K. Müller-Navarra², G. Schmiedl², U. Mikolajewicz¹, S. Lindhorst², Y. Milker², C. Betzler², J. Jungclaus¹;

¹ MPI Meteorology Hamburg; ² CEN, Institute of Geology, University of Hamburg

The SEASTORM project follows an interdisciplinary approach to investigate the occurrence of storm-floods in the North Sea by combining sedimentology, micropaleontology and climate modeling. In the first phase of the project, we have established an integrated stratigraphic framework for modern salt marshes [Bunzel et al., in review], and performed model simulations of the last 1000 years using a regionally coupled climate system model to downscale global MPI-ESM simulations from the PMIP3 *past1000* project [Lang & Mikolajewicz, in review]¹.

Based on the combination of radionuclides (¹³⁷Cs, ²⁴¹Am, ¹⁴C) together with human-induced pollutants (Hg), and proxy-based sedimentological inter-correlation (ln(Zr/Rb) ratio), we reconstructed salt-marsh accretion rates for the past ca. 100 years. As a result, lowest sediment accretion rates were documented for the more semi-enclosed (Bay of Tümlau) and grazed coastal salt marsh sites (Friedrichskoog). In contrast, highest accretion rates were reconstructed for the dynamic open coastal salt marsh (Kaiser-Wilhelm-Koog) and the Eider estuary. Thus, the investigated salt marshes reflect their specific exposition to submergence intensity and storm-flood frequency.

Additionally, the climate simulations provide a long high-resolution sea-level data record, which allows for extreme value analysis and the identification of associated forcing mechanisms in the climate system. Simulated storm floods show large variations on interannual to centennial timescales (Fig. 4) without preferred periods. As a result of this high internal variability, storm-flood variations are decoupled from those of the background sea level, and mask any potential signals from solar or volcanic forcing. Periods of high storm-flood activity are associated with a pressure dipole between the Gulf of Biscay and north-eastern Scandinavia, a

regime that is robust for periods of higher storm floods in the wider region.

The results gained from the analysis of storm-flood statistics during the last millennium have further implications for the assessment of future flood risks: With the strong, but random fluctuations of extreme storm floods on various timescales, we expect existing estimates of future changes in the occurrence of such events to be dominated by internal variability rather than climate-change signals. Traditional extreme value estimates based on short data subsets or a small set of model simulations fail to account for such long-term variations. Large ensemble simulations will be necessary to detect any significant change in extreme storm-flood statistics in the presence of the high variability found in our simulation. Whether and how extreme storm-flood statistics may change under global warming will thus be subject of the project's second phase.

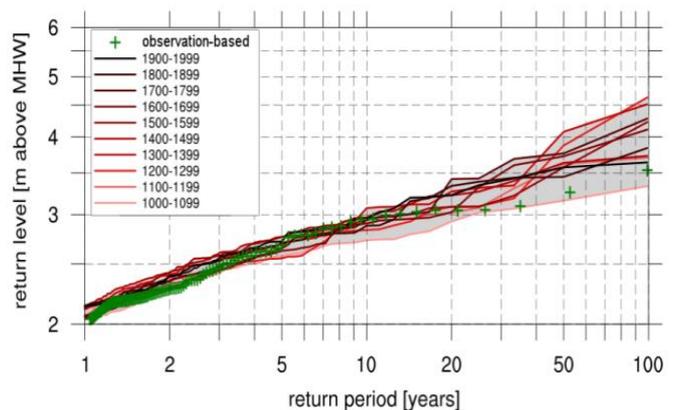


Fig. 4: Return-value-plot of simulated (colored lines, 100-year long subsets of the full simulation) and observed (green crosses) sea level at Cuxhaven.

¹ Read more in: Lang, A. and U. Mikolajewicz (2019), *The long-term variability of extreme sea levels in the German Bight*, *Ocean Sci. Discuss*, in review, [doi:10.5194/os-2019-19](https://doi.org/10.5194/os-2019-19).

DECVAR: Sensitivity of sea level response in FAFMIP experiments to model resolution

Sayantani, O.¹, Köhl, A.¹, Haak, H.², Jungclaus, J.², Stammer, D.¹

¹Universität Hamburg, ²MPI Meteorology

Regional sea level rise is an inescapable consequence of climate change which directly impacts the coastal society and has far-reaching effects on coastal population and economy. Dynamic regional sea level changes (DSL) are primarily caused by change in wind circulation, heat and freshwater fluxes which can result in sea level variability on different time scales.

The Flux-Anomaly-Forced Model Intercomparison Project (FAFMIP), which is a WCRP-endorsed CMIP6 activity, aims to identify forcing mechanism of regional sea level response and changes in the ocean density and circulation pattern under well-defined conditions. In this study, we present an inter-comparison of the response of the MPI-ESM coupled Atmosphere-Ocean General Circulation Model (AOGCM) in global as well as regional sea level (SL) to surface flux anomalies applied to configurations with two different model resolutions.

In the experiments performed under the FAFMIP

protocol, the model has been perturbed with momentum, heat and freshwater flux anomalies resulting from CMIP5-AOGCM projections for doubled CO₂ concentration. FAFMIP has three tier-1 experiments, i.e. faf-stress, faf-heat and faf-water, imposing perturbations in momentum, heat and freshwater fluxes respectively. Two configurations of the same model have been used in this study and run for a timespan of 70 years: MPI-ESM1.2-LR features a resolution of ca. 200 km in the atmosphere (ECHAM6.3 T63L47) and 150 km in the ocean (MPIOM1.6 GR1.5/L40) and MPI-ESM1.2-HR features a resolution of ca. 100 km in the atmosphere (ECHAM6.3 T127L95) and 40 km in the ocean (MPIOM1.6 TP04/L40).

Due to feedback processes all experiments generate additional perturbations in the forcing of the ocean. Particularly, faf-heat

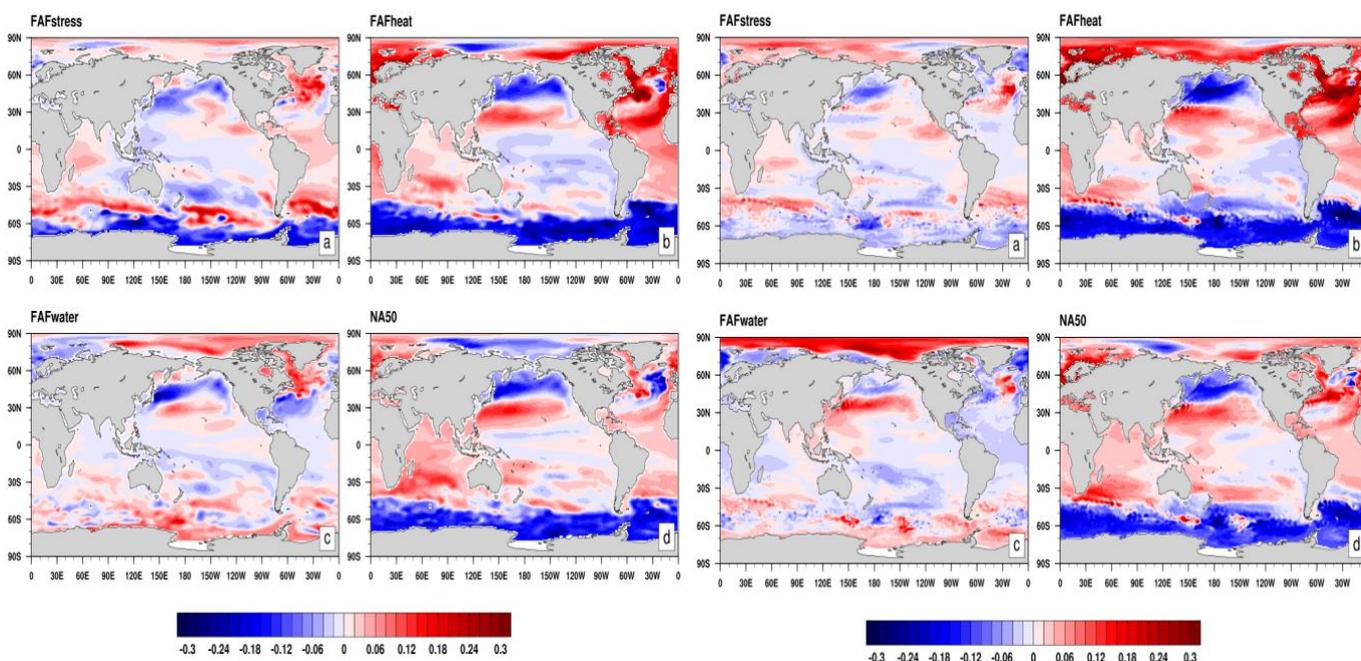


Fig. 5: Change in dynamic sea level (m) in the time mean of the final decade of the FAFMIP experiments relative to the control for MPI-ESM-LR (left) and MPI-ESM-HR (right).

produces a substantially larger surface heat flux in the North Atlantic, which eventually produces a total of nearly double the heat input to this region. To mitigate the problem, an experiment similar to *faf-heat* with 50% reduced heat flux over the North Atlantic Ocean (NA-50) was designed.

The sensitivity of global as well as regional SL change to model resolution is analyzed by comparing LR and HR results. The geographical patterns of the global dynamic SL change relative to the pi-control are similar for the *faf-stress* and *faf-heat* experiments in both resolutions although they differ in magnitude over some regions (Fig.1). Yet, *faf-water* shows noticeable differences between the two resolutions mostly over the North Pacific and North Atlantic Oceans.

In the *faf-heat* experiment, the dipole pattern of DSL is less discernible in the MPI-ESM-HR model than in the MPI-ESM-LR in the North Atlantic Ocean. In contrast, by applying the 50%-heat flux reduction in the North Atlantic, the

overall increase in the North Atlantic reduces and leads to a more evident dipole pattern comparable to the MPIESM-LR. For most of the regions, the ocean heat content change displays a similar pattern in HR and LR but with a difference in magnitude. In contrast, the Antarctic Circumpolar Current (ACC) region shows a noticeable difference in the pattern in the *faf-stress* experiment. Similar to the LR model, the DSL changes are predominantly thermosteric in HR.

From the above the results it can clearly be seen that the momentum or freshwater flux can produce a difference in sea level response in different model resolutions. The Southern Ocean and North Atlantic Ocean are the two most sensitive regions for the SL response. More detailed studies of the processes related to the SL change and its sensitivity to model resolution are in progress.

CoRSEA: Visits to Indonesia for tide gauge maintenance and meetings with present and future cooperation partners and to the Republic of Korea for TWCWG4 & GLOSS-GEXVI-meetings

Julia Illigner¹, Tilo Schöne¹, ¹Helmholtz Centre Potsdam, German Research Centre for Geosciences (GFZ)

The GFZ operates three tide gauges on the northern coast of Java (Surabaya, Semarang and Jakarta) for sea-level and subsidence monitoring. Between 28.03.2019 and 08.04.2019 we visited our tide gauges to perform the usual maintenance routine of cleaning (and replacing, where necessary) of sensors and the crucial levelling to ensure a stable connection between sea-level- and GNSS-measurements.

In Surabaya, we have been invited by the Department of Geomatics Engineering of the University in Surabaya (ITS). While Jakarta and Semarang are known for large subsidence rates, Surabaya has been almost stable during the past years. Recently, certain (industrial) areas also start subsiding presumably triggered by (likely) illegal ground water withdrawal. ITS and GFZ will start a cooperation in the fields of



Fig. 6: Meeting at ITS with members from ITS, BIG and GFZ (@2019juliailigner).

InSAR, GNSS, Altimetry, and water level measurement to monitor this development.



Fig. 7: Pluit, Jakarta. The sea-level is almost on the same level as the first floor of the nearby houses (@2019tiloschöne).

After the maintenance work in Semarang and Jakarta, we visited some spots in the old city of Jakarta (Pluit), where local subsidence rates of more than 20 cm/year lead to areas way below sea level, which are protected by a sea wall. To stay ahead of the fast subsiding progress, the wall has to be elevated frequently. On the day of our visit, the water level was not far below the wall's crown, with the top of the wall almost at the same level as the first floor of the nearby houses. To prevent a permanent flooding, huge pumps are continuously working to pump the water up and out to the sea. A power outage a few years ago caused a flooding of the entire area.

On our last day in Jakarta we visited our partner Institute (BIG) in Cibinong to meet Prof. Dr. Abidin, Head of BIG, to extend and expand the longstanding cooperation agreement between GFZ and BIG.

Starting from the 9th to the 12th of April we attended the 4th meeting of the TWCWG-meeting (Tides, Water Level and Currents Working Group) of the IHO (International Hydrographic Organization). The principal aim of the IHO is to ensure that all the world's seas, oceans and navigable waters are surveyed and charted. Members of Governmental institutions attended the meeting to discuss the improvement of tide gauge data analysis with a focus on standardization to obtain comparable

results as well as the setup of tide gauge stations and the determination of chart datum and mean sea level for ECDIS (Electronic Chart Display and Information System).

Immediately after the TWCWG meeting, with a joined session in between, we attended the 16th GLOSS-GE (Global Sea Level Observing System – Group of Experts) meeting. GLOSS operates under the auspices of the Intergovernmental Oceanographic Commission (IOC) of UNESCO. The GLOSS meeting takes place every two years with national reports of the tide gauge network. Other issues of this year's meeting were the progress in connecting the tide gauge zero to nearby GNSS-stations, the quality control of tide gauge data and the unification of available tide gauge data.



Fig. 8: Tilo Schöne and Julia Illigner (CoRSEA project) at the TWCWG (Tides, Water Level and Currents Working Group) and 16th GLOSS-GE (Global Sea Level Observing System – Group of Experts) meetings, which took place in Busan, Republic of Korea in April 2019 (@2019tiloschöne).

DFG Roundtable Workshop “Scientific Utilization of the Surface Water and Ocean Topography (SWOT) Mission in Germany”, Feb. 7/8 2019, University of Bonn, Germany.

Jürgen Kusche, University of Bonn, Institute for Geodesy and Geoinformation

About forty scientists from oceanography, hydrology, cryosphere research, geodesy and remote sensing met at the University of Bonn’s Institute of Geodesy and Geoinformation on February 7 and 8, 2019, to discuss potential applications of the SWOT (Surface Water and Ocean Topography) satellite mission, which will be launched by NASA and CNES in late 2021. The workshop was organized by Luciana Fenoglio and Jürgen Kusche from the Astronomical, Physical and Mathematical (APMG) group at IGG and was funded by DFG.

The SWOT mission, scheduled for launch in September 2021, will observe the whole continental waters-estuaries-ocean continuum and thus link the ocean and hydrology scientific communities. SWOT will provide global, high-resolution observations in coastal regions with its new capability of mapping sea surface height down to 15 km scales, which will improve the knowledge of coastal ocean dynamics, coastal and internal tides, currents and storm surges. On inland waters, SWOT will measure water elevation, water mask and water slope, which are key measurements for the derivation of the streamflow and discharge. SWOT will map two

parallel 50-km-wide swaths, with a data gap at nadir of 20 km every 21 days during the scientific phase of the mission. Within this repeat period, 2-3 revisits can be expected at our latitudes, 1-2 revisits at lower and more at higher latitudes. During the calibration/validation phase of three months it will map a 1000 km long stripe over Germany every day.

The workshop began with invited presentations from the SWOT ocean and hydrology science leads Lee-Lueng Fu (NASA/JPL) and Jean-Francois Cretaux (CNES), addressing programmatic issues, mission science objectives, instrument performance and research questions and anticipated improvements in ocean science and terrestrial hydrology. These were then followed by contributions from the participants on the first day on oceanographic and on the second day on hydrological and ice applications. Main themes of the workshop were: (1) planned cal/val activities, in particular with respect to the 1-day calibration orbit over Germany, (2) ideas for ocean application, benefits of the high-resolution mapping of sea surface e.g. for eddy research, (3) ideas for land hydrology applications, e.g. for lake and wetlands research, for water resource assessments, and for river discharge mapping, (4) suggestions for other applications such as ice topography, discussion on data products, and (5) exploring funding opportunities at a national level.

All participants acknowledged the productive framework of the workshop, expressed their high interest in continuing the discussion and better coordinating efforts in Germany. It was agreed to form a core group that would develop a strategic agenda, aligned with the official SWOT project, coordinate potential german research contributions.



Fig. 9: Guest presentation by Dr. Lee-Lueng Fu (NASA/JPL).

The World needs Science and Science needs Women: SPP SeaLevel inspires young females at Girl's Day in Hamburg

E. Tzortzi¹ and D. Bunzel¹, ¹University Hamburg / Center for Earth System Research and Sustainability

This year, the [Girls' Day](#) in Hamburg took place on 28th March and the SPP-1889 SeaLevel seized the opportunity to engage with and inspire the young females with career options through examples of the vast range of disciplines involved in the SeaLevel program!

Ms Dorothea Bunzel (Institute for Geology, University Hamburg), currently doing her PhD within the [SPP SEASTORM project](#), and Dr. Eleni Tzortzi (University Hamburg/ Center for Earth System Research and Sustainability) from the [SPP-1889 Coordination Office](#), introduced the girls to the SPP SeaLevel program and its main research objectives, presenting them examples of the various scientific disciplines involved in the program and in sea level research.

[Through photos and videos from the SPP-1889 SeaLevel fieldwork and other activities](#), the girls had the opportunity to find out about the fields of geology, geophysics, oceanography, meteorology, climate modelling, biochemistry, coastal engineering as well as social science disciplines, including geography, anthropology and sociology, the main study objects of each field, as well as the “nature” of the work involved on an everyday basis for each discipline.

In addition to exploring the diverse possibilities of working on sea level research, the young females, aging between 10 and 15 years old, gained also a good insight of how all these scientists work together to approach and



Fig. 10: The SPP SeaLevel presentation during the Girl's Day event on 28th March at the University Hamburg.

address bigger scientific questions and complex phenomena, such as the sea level change and its impacts on and from society.

The 20 girls who participated in the Girls' Day event at CEN/UHH positively showed their enthusiasm and attention to the SPP-1889 SeaLevel presentation, confirming and reinforcing the efforts of the SPP to continue such activities and keep engaging with the children and teenagers, helping them to discover different career options in earth and social sciences and thus, make more conscious choices regarding their future and career orientation.

The next [Girls' Day](#) is scheduled for 26th March 2020 and the SPP SeaLevel will be there again! The world needs Science and Science needs Women!

With currently over 400 papers and reports, the [Sea Level Documentation Database](#) is constantly expanded with the most recent as well as older sea level-related references from both the natural and social sciences, serving as a valuable source of information on sea level both for the wide scientific community, but also students and the general public. You can also help develop further the [Sea Level Documentation Database](#) by forwarding us your publications!

www.spp-sealevel.de → “Resources” → “Sea Level Documentation Database”

Recent SPP SeaLevel Publications:

SEASCape Baltic project: [Hinkel, J., J.A. Church, J.M. Gregory, E. Lambert, G. Le Cozannet, J. Lowe, K.L. McInnes, R.J. Nicholls, T. van der Pol, and R. van de Wal \(2019\), Meeting User Needs for Sea Level Rise Information: A Decision Analysis Perspective, *Earth's Future*, 7, 320-337, doi:10.1029/2018EF001071.](#)

SEASTORM project: [Müller-Navarra, K., Y. Milker, D. Bunzel, S. Lindhorst, J. Friedrich, H. Arz, and G. Schmiedl \(2019\), Evolution of a salt marsh in the southeastern North Sea region - Anthropogenic and natural forcing, *Estuarine, Coastal and Shelf Science*, 218, 268-277, doi:10.1016/j.ecss.2018.12.022.](#)

CoRSEA project: [Rudenko, S., S. Esselborn, T. Schöne, and D. Dettmering \(2019\), Impact of terrestrial reference frame realizations on altimetry satellite orbit quality and global and regional sea level trends: a switch from ITRF2008 to ITRF2014, *Solid Earth*, 10, 293-305, doi:10.5194/se-10-293-2019.](#)

OMCG project: [Uebbing, B., J. Kusche, R. Rietbroek, and F.W. Landerer \(2019\), Processing choices affect ocean mass estimates from GRACE, *Journal of Geophysical Research: Oceans*, 124, doi:10.1029/2018JC014341.](#)

Visit www.spp-sealevel.de → “Resources” → “Publications” to view the full list of the SPP SeaLevel publications

Coming Events related to sea-level research:

Japan Geoscience Union (JpGU) Meeting 2019, 26-30 May, Chiba, Japan

At What Point Managed Retreat? Resilience Building in the Coastal Zone, 19-21 June, New York, USA

27th International Union of Geodesy and Geophysics (IUGG) General Assembly, 8-18 July, Montréal, Québec, Canada

Summer School on “Sea-level change: observations, processes and modelling”, 1-5 July, Delft, The Netherlands

27th International Union of Geodesy and Geophysics (IUGG) General Assembly, 8-18 July, Montréal, Québec, Canada

13th International Conference on Paleoceanography, 2-6 September, Sydney, Australia

Saline Futures and Food Security Conference, 10-13 September, Leeuwarden, the Netherlands

3rd International Conference on Coastal Cities and their Sustainable Future, 11-13 September, Rome, Italy

Coastal Changes and Evolution (CoCHE) Training School for early-career coastal researchers, 15-18 September, Sardinia, Italy

“Globalizing coastal adaptation? Policy mobilities and imaginaries of coastal futures in times of sea level change” panel session at the Deutsche Kongress für Geographie, 25-30 September, Kiel, Germany

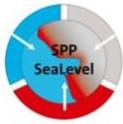
“Extreme Events – Building Climate Resilient Societies” Conference, 9-11 October, Hanover, Germany

International Conference on Regional Climate (ICRC- CORDEX 2019), 15-18 October, Beijing, China

“Institute of Advanced Studies in Climate Extremes and Risk Management” School, 21 October-1 November, Nanjing, China

Instagram

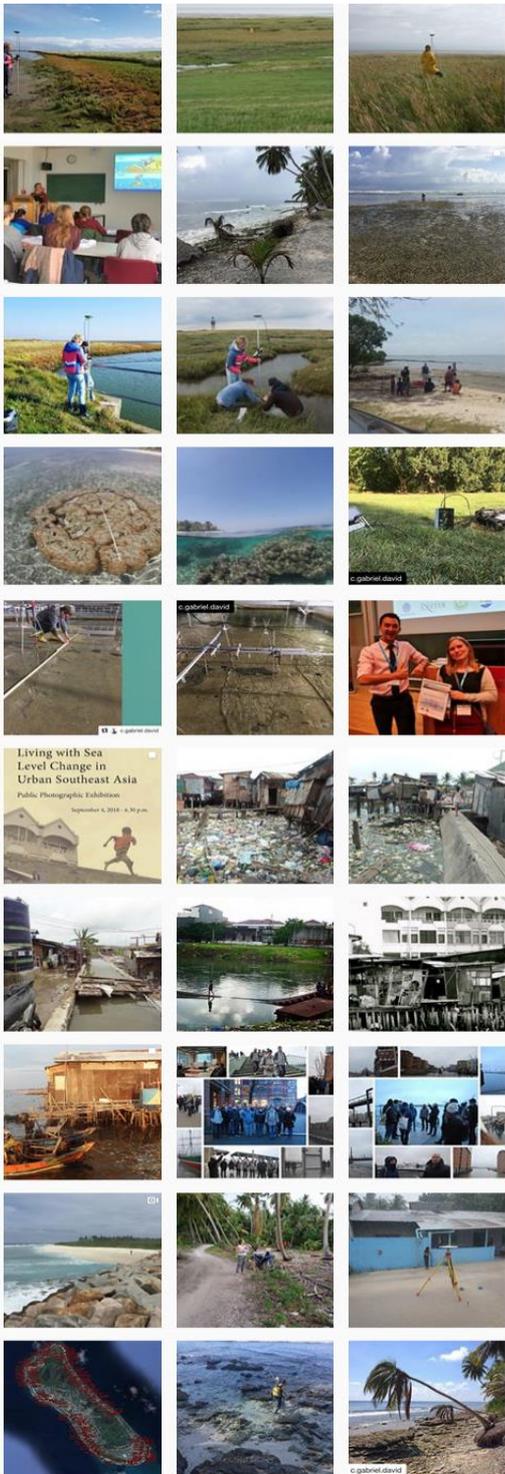
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Main content edited by
Dr. Eleni Tzortzi

Other authors are credited respectively

Coordination Office

Prof. D. Stammer & Dr. Eleni Tzortzi

Center for Earth System Research & Sustainability (CEN)/
Institute of Oceanography,
University of Hamburg
Bundesstraße 53, 20146,
Hamburg, Germany

Email:

eleni.tzortzi@uni-hamburg.de

Phone:

+49 (0) 40 42838 2987

www.spp-sealevel.de