SeaLevel Newsletter

edition 9 | April 2021

www.spp-sealevel.de

Welcome to the SPP-1889 SeaLevel Newsletter!

We are pleased to present the latest news and research outcomes of the SPP SeaLevel projects, at this newsletter, read about the progress of the SEATRAC project about its overall goal to investigate how major biases impact the recognition of and adaptation to sea level rise, from a cross-cultural perspective, and the newly developed dynamic opinion model with the aim to capture the influence of cognitive biases on opinion formation;
the new advances implemented at high-performance elevation model computation within the SATELLITE-2 project, and how this benefits toward its ambitious goal at the second spp phase, to gain insights on the global perspective of accelerated glacier mass change and the role of glaciers as increasing driver of sea level rise, read about the regional survey of glacier elevation change conducted at the Russian Arctic archipelagos of Novaya Zemlya, Severnaya Zemlya and Franz Josef Land,
also, learn more about the changes at the storm-climate conditions at the south-eastern North Sea region during the last century and their impact on the adjacent intertidal wetland ecosystems, and the resilience and sensitivity of salt marshes modified to different extent by human interventions, and more.

INSIDE THIS ISSUE

SEATRAC: How do cognitive biases affect our perception of sea level rise?

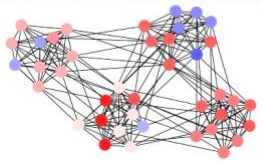
Deyshawn Moser, Peter Steiglechner, Agostino Merico, and Achim Schlüter.
Leibniz Centre for Tropical Marine Research (ZMT), Bremen.

Global environmental changes, such as sea level rise, pose threats and risks that humans must recognise and ultimately adapt to. Yet, humans are prone to cognitive biases, which limit our ability to deal rationally with such problems. This has serious consequences on our ability to recognise the problems and adapt to them.

The current Covid-19 pandemic is a good example of how a global threat can be perceived differently by individuals. Such differences in

Conducting Interviews

Opinion Dynamics Model



perception influence the way we react and adapt to such global threats. Former U.S President Donald Trump believed that the virus would magically "disappear". Was Trump subject to the positive illusion bias? Ultimately, different perceptions may lead to diverging opinions and, in some cases, even to polarisation, which dampens efforts to effectively respond to the threat, such as establishing a comprehensive mask policy.

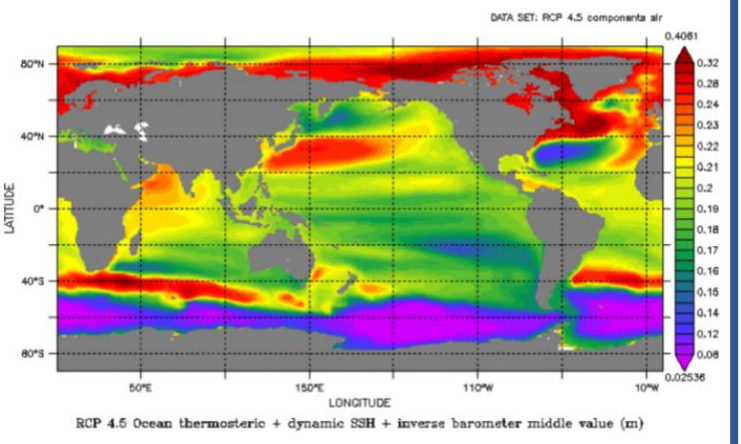
Similar to Covid-19, sea level rise imposes a threat to society, which has been extensively communicated by experts. Although differences exist between the two threats, cognitive biases have an influence on both in the way we perceive and react to them. The overall goal of our project is to investigate how major biases impact the recognition of and adaptation to sea level rise, from a cross-cultural perspective.

To achieve this goal, we plan to gain a better understanding of 1) how people perceive sea level rise in general (and what possible cognitive biases they may have towards this threat), 2) the information sources people generally use, and 3) the place-specific adaptation options available, including the adaptations people have already undertaken (e.g. household adaptations). We conducted non-standardised interviews with different stakeholders (e.g. government, industry/business sector, etc.) and households to assess diverse perspectives ranging from opinion-leaders to the ordinary person. Originally, we planned to conduct the interviews in person. However, due to Covid-related travel restrictions, we adopted telephone and video calls. The insights gained thus far prove useful for the next phase of the project, which is to quantify the relative importance of different cognitive biases in explaining adaptive behaviours.

Additionally, we are developing a dynamic opinion model with the aim of capturing the influence of cognitive biases on opinion formation. Over the years, the study of opinion formation has acquired a multidisciplinary character. `Sociophysics' is an attempt to use analogies from physics to investigate how societal phenomena like opinion clustering or polarisation emerge in a society. Similarly to the way some metals magnetise (i.e. the magnetic moments of the single atoms line up parallel to each other) along the direction of a magnetic field, the opinions of individuals in the model may align towards a common view following social interactions or media influence. Our model is based on a simple assumption: individuals are fully rational in the way they form an opinion about sea level rise; however, cognitive biases influence the way individuals perceive information about it. Under which conditions do these processes lead to a fragmented or even polarised society? How can we overcome the limits imposed by cognitive biases? These are questions at the base of our investigations.

A simple tool to instantly extract and visualize IPCC AR5 global and coastal sea level projections for everyone!
Alternatively, you can get access and download the datasets directly from the Integrated Climate Data Center (ICDC), University Hamburg.
Try it and learn about regional differences in sea level rise!

www.spp-sealevel.de → "Resources"→ "Extract and Visualize Sea Level Projections"



Satellite 2: Advances in high-performance elevation model computation and contributions of Arctic glaciers to sea level rise

Christian Sommer, Philipp Malz & Matthias Braun, Friedrich-Alexander Universität Erlangen-Nürnberg.

Mountain glaciers and ice caps are retreating in most regions of the world. Within the SPP „Sea level rise and society“, the SATELLITE project initially estimated ice volume change and its contribution to sea level rise of almost all glaciers outside the polar regions during the first decade of the 21st century by means of satellite-borne synthetic aperture radar (SAR). Upcoming new measurements of recent years and the ongoing acceleration of glacier mass loss in many mountain regions require an efficient processing infrastructure. Also, mass changes of the vast glacierized regions of the Northern Hemisphere polar region, which have been balanced or close to Zero during past decades, are becoming increasingly negative. Those regions could have the potential to strongly contribute to global sea level rise due to their sheer size. New computing capacities are necessary to efficiently measure region-wide glacier elevation changes of the mid-latitudes mountain regions and extend the analysis to the large Arctic glaciers and ice caps.

The transfer of data processing to High Performance Computation Center NHR@FAU was an envisaged project goal of SATTELITE 2. Now it is close to completed thanks to the fruitful support of the NHR team: The resources for hundreds of Petabyte of satellite data imagery were obtained and integrated in the data supply chain. Code optimizations towards a multi-node parallel computation of the several thousand DEM scenes were implemented and tested. Taking the last steps towards an operationally programmed surface elevation change and mass balance computation module, we see promising results: Computation time is reduced by up to 80%. This facilitates reaching the ambitious goal of the second project phase: to shed a light on the global perspective of accelerated glacier mass change and the resulting contribution to sea level rise. Once fully available, the second global coverage of glaciers, acquired by the twin satellite TanDEM-X, will be assessed within weeks, instead of several months time. This will add a profound knowledge on the role of glacier as increasing driver of sea level rise. The results of a regional survey carried out in the Russian Arctic in the meantime give a first impression of that.

Within the 21st century, the Polar Regions have been subject to extensive warming due to global climate change. However, there are few broad-scale observations of Arctic glacier dynamics outside the Greenland ice sheet. A first analysis of glacier elevation change was conducted at the Russian Arctic archipelagos of Novaya Zemlya, Severnaya Zemlya and Franz Josef Land (~52,000 km² glacier area). The results showed a high vertical accuracy of the interferometric X-Band SAR and revealed a mass loss of -23±5 Gt a-1, corresponding to a sea level rise contribution of 0.06±0.01 mm a-1 between 2010 and 2017 (Fig.3). Compared to measurements of past decades, glacier mass loss in this region has almost doubled in recent years. The respective publication is currently under review in the journal „The Cryosphere“. In future, the analysis will be extended to the remaining Arctic glaciers and ice caps outside the Greenland ice sheet (Alaska, Arctic Canada, Iceland, Svalbard and North Asia) to better constrain Arctic glacier mass change.

Publication: *Sommer, C., Seehaus, T., Glazovsky, A., and Braun, M. H.: Brief communication: Accelerated glacier mass loss in the Russian Arctic (2010–2017), The Cryosphere Discuss. [preprint], https://doi.org/10.5194/tc-2020-358, in review, 2020.*

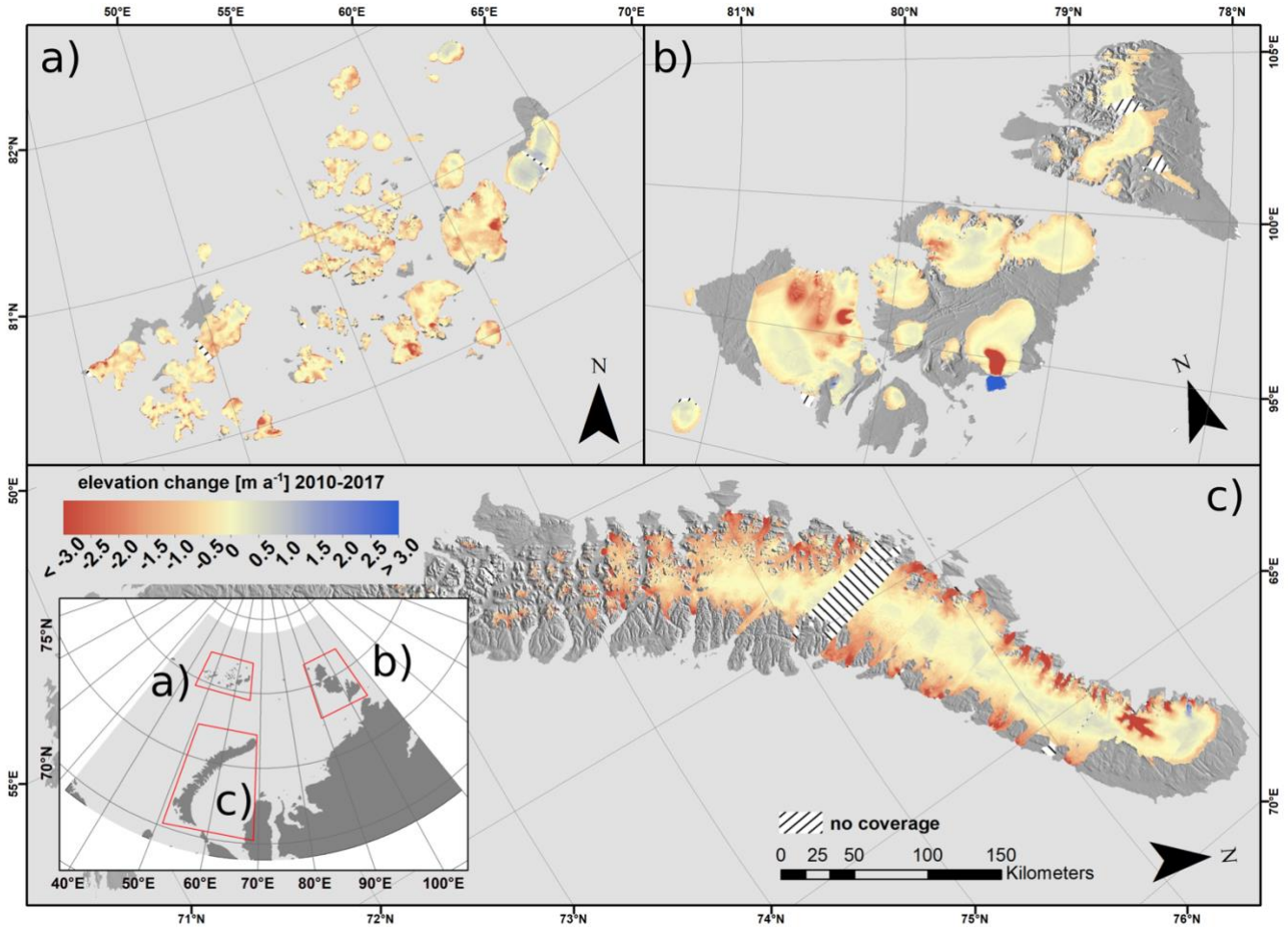


Fig. 3: Surface elevation change of glaciers in the Russian Arctic archipelagos between 2010 and 2017 from TanDEM-X elevation models: a) Franz Josef Land, b) Severnaya Zemlya and c) Novaya Zemlya. Background: TanDEM-X Global DEM hillshade (German Aerospace Center (DLR) (2018): TanDEM-X - Digital Elevation Model (DEM) - Global, 90m. https://doi.org/10.15489/ju28hc7pui09).

SEASTORM: Why more frequent storm surges stress salt marshes

D. Bunzel, Y. Milker, G. Schmiedl; Institute for Geology, University of Hamburg

Twentieth-century acceleration of global sea level and accompanying changes of storm-surge dynamics pose an increasing risk to cultivated and densely populated low-lying coastal areas. In this context, the SEASTORM project aims to investigate changes in the storm-climate conditions in the south-eastern North Sea region during the last century and their impact on the adjacent intertidal wetland ecosystems. These salt marshes are important because they can basically keep up with changing sea level through lateral and vertical growth and thus are important lateral and vertical growth and thus are important for natural coastal protection. However, salt marshes along the North Sea coast have been heavily altered by human activity over the past century through artificial drainage ditches, grazing and dike construction. It remains questionable if these human-altered salt marshes can adapt to storm surges under the influence of future sea-level rise.

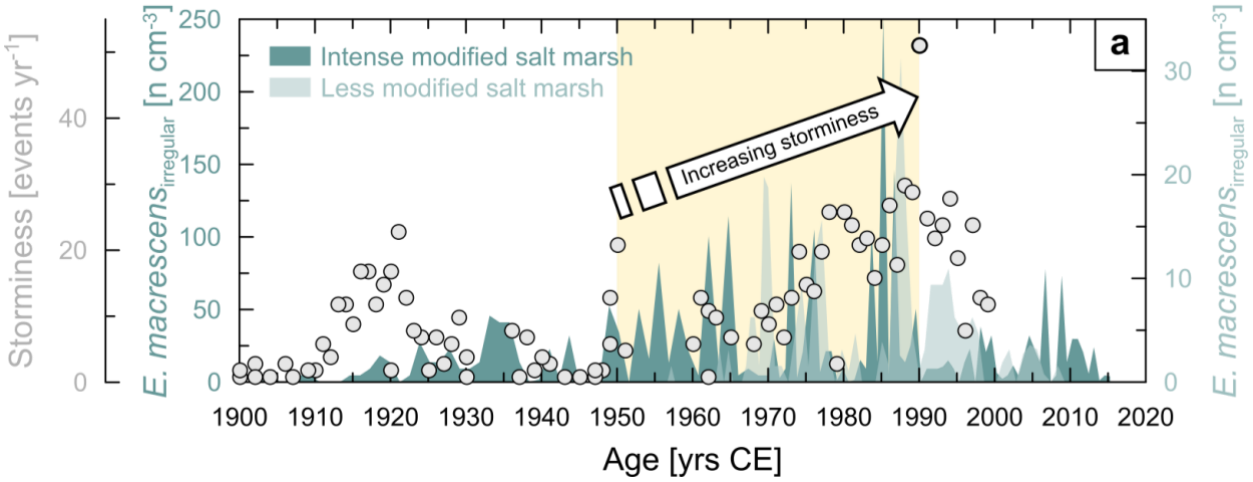
for natural coastal protection. However, salt marshes along the North Sea coast have been heavily altered by human activity over the past century through artificial drainage ditches, grazing and dike construction. It remains questionable if these human-altered salt marshes can adapt to storm surges under the influence of future sea-level rise.

To assess the resilience and sensitivity of salt marshes modified to different degrees by human interventions, two well-stratified sedimentary salt-marsh sequences were studied, including an un-grazed and more naturally developed salt marsh from the Bay of Tümlau and a grazed and frequently drained salt marsh from Friedrichskoog[1,2]. For assessing the stress on both salt-marsh ecosystems caused by a more frequent flooding, the occurrence of a benthic foraminiferal salt-marsh indicator species (*Entzia macrescens*) was evaluated, particularly considering the number of deformed specimens (i.e., *E. macrescens*$_{irregular}$).

At both sites, highest numbers of *E. macrescens*$_{irregular}$ occurred at times when storminess and storm-surge frequency was likewise highest (Fig. 4a). It can therefore be assumed that a more frequent flooding of the salt marsh leads to increased environmental stress, to which *E. macrescens* reacts with test deformation (Fig. 4b). Stressful conditions are associated with increased salinity gradients on the salt-marsh surface and physical disturbances caused by frequent sediment re-deposition and increased turbulence during times of salt-marsh flooding. The number of deformed foraminiferal tests is comparatively lower in the Bay of Tümlau, while numbers are eight-times higher in the sedimentary sequence at Friedrichskoog. The contrasting numbers suggest that intensely human-altered salt-marsh ecosystems are more susceptible to frequent flooding and associated stress[2].

Read more in:

1. Bunzel, D. et al. North Sea salt-marsh archives trace past storminess and climate variability. *Glob. Planet. Change* **198**, 103403 (2021).
2. Bunzel, D. et al. The response of human-modified



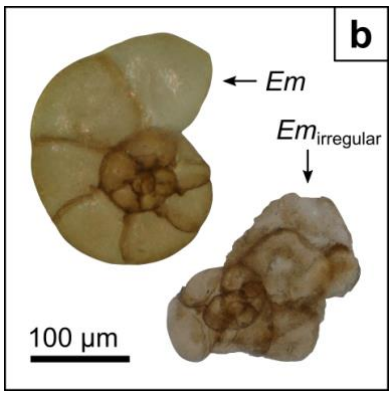
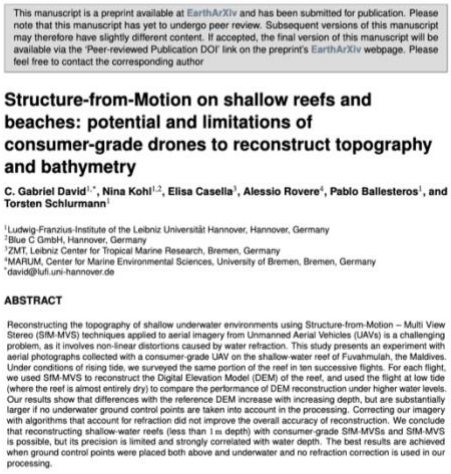


Fig. 4: a) Number of deformed Entzia macrescens that were found to occur in different quantities in the Bay of Tümlau (less modified salt marsh; light green) and at Friedrichskoog (intense modified salt marsh; dark green). Grey circles indicate the number of storm days observed at Husum, Büsum and Cuxhaven, when westerly winds are ≥ 7 Beaufort. The yellow bar marks the period of generally increasing numbers of E. macrescens$_{irregular}$ (~1950–1990 CE), responding to amplified storm-climate conditions and concomitant increased salt-marsh submergences. b) Normally grown and deformed individuals of E. macrescens (Em).

Other recent SPP SeaLevel Publications:



This manuscript is a preprint available at EarthArXiv and has been submitted for publication. Please note that this manuscript has yet to undergo peer review. Subsequent versions of this manuscript may therefore have slightly different content. If accepted, the final version of this manuscript will be available via the 'Peer-reviewed Publication DOI' link on the preprint's EarthArXiv webpage. Please feel free to contact the corresponding author

Structure-from-Motion on shallow reefs and beaches: potential and limitations of consumer-grade drones to reconstruct topography and bathymetry

C. Gabriel David[1,*], Nina Kohl[1,2], Elisa Casella[1], Alessio Rovere[4], Pablo Ballesteros[1], and Torsten Schlurmann[1]

[1]Ludwig-Franzius-Institute of the Leibniz Universität Hannover, Hannover, Germany
[2]Blue C GmbH, Hannover, Germany
[3]ZMT, Leibniz Center for Tropical Marine Research, Bremen, Germany
[4]MARUM, Center for Marine Environmental Sciences, University of Bremen, Bremen, Germany
*david@lufi.uni-hannover.de

ABSTRACT

Reconstructing the topography of shallow underwater environments using Structure-from-Motion – Multi View Stereo (SfM-MVS) techniques applied to aerial imagery from Unmanned Aerial Vehicles (UAVs) is a challenging problem, as it involves non-linear distortions caused by water refraction. This study presents an experiment with aerial photographs collected with a consumer-grade UAV on the shallow-water reef of Fuvahmulah, the Maldives. Under conditions of rising tide, we surveyed the same portion of the reef in ten successive flights. For each flight, we used SfM-MVS to reconstruct the Digital Elevation Model (DEM) of the reef, and used the flight at low tide (where the reef is almost entirely dry) to compare the performance of DEM reconstruction under higher water levels. Our results show that differences with the reference DEM increase with increasing depth, but are substantially larger if no underwater ground control points are taken into account in the processing. Correcting our imagery with algorithms that account for refraction did not improve the overall accuracy of reconstruction. We conclude that reconstructing shallow-water reefs (less than 1 m depth) with consumer-grade SfM-MVSs and SfM-MVS is possible, but its precision is limited and strongly correlated with water depth. The best results are achieved when ground control points were placed both above and underwater and no refraction correction is used in our processing.

A collaboration between **DICES** and **SEASchange** projects from the 1st phase.
David G., Kohl, N., Casella, E., Rovere, A., Ballesteros, P., Schlurmann, T., 2021. Structure-from-Motion on shallow reefs and beaches: potential and limitations of consumer-grade drones to reconstruct topography and bathymetry. Coral Reefs, Springer (accepted)

DICES: *David, G., Hennig, A., Ratter, B.M.W., Roeber, V., Schlurmann, T., 2021. Climate change induced effects or maldevelopment: small islands and conflicting attribution of root causes. Nature Communications, Springer Nature Limited (in review). Pre-print available: https://doi.org/10.31223/X5888P*

Find the full list of the SPP SeaLevel published papers at *www.spp-sealevel.de → "Resources" → "Publications"*

Future Events related to sea-level research:

Global Adaptation Month/"Sea Level Rise and When to Retreat?, adaptation pop-up discussion series, 07.04.2021, online.

Climate Science from Space, synergies for a greener innovation economy, 21-22.04.2021, online.

Tropical Pacific Observing Needs Workshop, 24-26.05.2021, Boulder, Colorado, and online.

OCEAN VISIONS 2021 SUMMIT Towards a Global Ecosystem for Ocean Solutions, 18-21.05.2021, San Diego, California, and online.

Climate Change and Water 2021: Extreme Events, 25-27.05.2021, Tours, France, online,

4th European Conference on Flood Risk Management, science and practice of an uncertain future, 21-25.06.2021, online.

ECCA 2021 – 5th European Climate Change Adaptation conference, 22.06.2021, online.

Conference on polar climate and environmental change in the last millennium, 30.08.2021-01.09.2021, Toruń, Poland.

Ecocity World Summit 2021, 27-29.09.2021, Rotterdam, the Netherlands, and online.

UN Climate Change Conference (COP26), 01-12.11.2021, Glasgow, Scotland, UK.

WCRP Workshop on Extremes in Climate Prediction Ensembles (ExCPEns), 25-28.10.2021, Busan, Korea and online.

2021 Global conference on health and climate change: climate justice, 06-7.11.2021, Glasgow, Scotland, UK.

Nature-based Solutions in a changing climate, 05-07.2022, Oxford, UK.

MISCELLANEOUS ANNOUNCEMENTS:

Are you an early career scientist at the SPP community & would like to have a career mentor?

Or are you a senior researcher or professor and would like to volunteer as a mentor within the SPP SeaLevel community?

Check the ***SPP SeaLevel Mentoring Network for ECS***!

Info @ the SPP SeaLevel Redmine/Wiki area!

Find out about the data exchange possibilities within the SPP SeaLevel community!

Info & Data Exchange within the SPP SeaLevel Program

At the **SPP SeaLevel Redmine & Wiki platforms**

all members/projects can:

- upload & share datasets, plots, images, …
- set inquiries & requests for data exchange
- share fieldwork info & other material
- find links for other external resources & databases & much more!

SeaLevel Coordination Office news/announcements

We cordially invite all SPP SeaLevel projects from both phases to send us information about their research locations, the exact coordination + a small summary of their research goals there to be included at the interactive map at the SPP SeaLevel website to demonstrate geographically the diverse research of the program.

All authors are credited respectively.
Content compiled & edited by
Dr. Eleni Tzortzi.

SPP SeaLevel Coordination Office:
Prof. D. Stammer & Dr. Eleni Tzortzi
University of Hamburg/CEN
Institute of Oceanography,
Hamburg, Germany

Contact Us at: eleni.tzortzi@uni-hamburg.de,
or by phone: +49 (0) 40 42838 2987

www.spp-sealevel.de