Towards a unified sea level record: assessing the performance of global mean sea level reconstructions from satellite altimetry, tide gauges, paleo-proxies and geophysical models

Abstract
Sea-level rise is one of the most certain and costly consequences of a warming world with potentially hazardous impacts on coastal infrastructure, property, and the livelihoods of coastal communities (Nicholls and Cazenave, 2010). Since 1992, radar altimeters on board of satellites have been continuously monitoring sea-level changes with high accuracy and nearly global coverage, providing essential information on the behavior of regional and (near-) global mean sea level (GMSL) (Ablain et al., 2015). However, placing this valuable record into historical context is challenging, since estimates of GMSL before the altimetry era rely on a spatially and temporally sparse set of either tide gauge or proxy-records along the coast. In addition, these in-situ records are affected by regionally varying geoid and solid earth processes such as vertical land motion (VLM) caused by glacial isostatic adjustment (GIA) or other local processes, which may mask the global information in the records. Uncertainties in geoid and solid earth corrections in combination with different processing schemes (manifesting itself in a different weighting of the tide gauges) cause current estimates of 20th century GMSL change based on tide gauges to vary widely between ~1 and 2 mm/yr (Church and White, 2011; Jevrejeva et al., 2014; Hay et al., 2015). Furthermore, pre-industrial reconstructions of GMSL based on sea level proxies are limited to one single study (Kopp et al., 2016). The approaches and datasets used in the different published estimates of past GMSL change differ considerably, and there has been no consistent assessment of the differences between the individual reconstructions.

The objective of this proposal is to bring together a team of sea level experts to (i) objectively assess the performance of pre-altimetric sea level reconstructions using a consistent and reproducible framework of common datasets, (ii) understand and reduce the wide range of past estimates, and (iii) put the high contemporary GMSL rates obtained from satellite altimeters (~3.4 mm/yr) into a better constrained historical context.

List of confirmed members

Team members: Sönke Dangendorf (team co-leader, Germany; responsible for the communication to ISSI), Marta Marcos (team co-leader, Spain), Francisco Calafat (UK), Roland Gehrels (UK), Ben Hamlington (USA), Carling Hay (USA), Robert Kopp (USA), Roelof Rietbroek (Germany), Alvaro Santamaria-Gómez (France), Aimée Slangen (Netherlands), Phillip Thompson (USA), Guy Wöppelmann (France)

Self-supported scientists: Ole Andersen (Denmark), Eduardo Zorita (Germany)

Young scientists (to be invited after approval): Chris Piecuch (USA), Thomas Frederikse (Netherlands)

Each member confirmed his/her commitment to the proposed project.

1. Scientific rationale, goals, and timeliness of the project
Sea level is a climate variable that integrates ocean warming, melting in the cryosphere, and the terrestrial water cycle, which are all sensitive to global warming (Rietbroek et al. 2016). For this reason, sea level plays a crucial role as a climate indicator. At the same time, sea level rise impacts the world’s low lying coastal zones and inhabitants by increasing the risk of coastal
floodling (especially in combination with storm surges) and concomitant effects such as salinization (Nicholls and Cazenave 2010). Hence, sea level has been defined as one of the Essential Climate Variables (ECV) by the Global Climate Observing System (GCOS). Sea level changes have been continuously monitored by high-precision radar altimeters on board of satellites since October 1992, providing a GMSL rise rate of 3.4±0.4 mm/year (1993-2014; Ablain et al, 2015). In contrast, before the altimetry era, direct estimates of GMSL changes rely on the coastal network of tide gauges that provide in situ observations of sea level relative to the land. These long-term sea level observations show that GMSL rose slower during the 20th century. Depending on how tide gauge records are combined, rates range between 1.3 and 2.0 mm/year (Church and White 2011; Jevrejeva et al. 2014; Hay et al. 2015) with uncertainties that have been estimated at about an order of magnitude smaller. The differences in rates at multi-decadal and centennial time scales between the various reconstructions are likely to arise from: (i) the selection of the tide gauge stations (e.g. Hamlington and Thompson 2015; Hay et al. 2017); (ii) the corrections (or lack of) of the VLM of the Earth’s crust and of the geoid deformations induced by mass load changes that affect local tide gauge locations (Wöppelmann et al. 2014; Hay et al. 2015; Hamlington et al. 2016; Dangendorf et al. under review); (iii) the methodologies used to merge a limited number of tide gauge stations or proxy records into a GMSL series (Church and White 2011; Calafat et al. 2014; Jevrejeva et al. 2014; Hay et al. 2015; Dangendorf et al. under review); and (iv) the limited ability of all methods to separate the externally-forced long-term changes from the low-frequency fluctuations associated with internal climate variations. However, a complete understanding of the relative importance of each of those factors is lacking. This severely limits our ability to provide a unique estimate of GMSL change at century to millennial time scales and thus restrict the historical interpretation of the altimetric GMSL record.

Our goal in the proposed project is therefore to better understand the differences between existing estimates of GMSL change and to narrow, as effectively as possible, the range of estimates of GMSL rise in the past. This goal will be tackled by addressing the following specific objectives:

1. To test objectively the performance of each reconstruction approach in controlled conditions, using synthetic sea level fields, provided by state of the art climate models, where the model truth is a priori known.
2. To constrain pre-altimetry rates of GMSL in order to place the contemporary GMSL rise observed by satellite altimetry in the adequate historical context of in-situ (20th century) and proxy data (Late Holocene).

This is essential to address important questions such as whether GMSL rise is accelerating in response to global warming and whether the anthropogenic fingerprint in rising sea levels is already detectable. We expect that the results of the proposed research will lead to papers in major journals, and are consequently relevant to a broad range of climate sciences. Furthermore, due to the continued extension of the radar altimetry record, altimetry is becoming an ever more valuable tool for policymakers, and our research aims to facilitate this. The methods investigated here can also be extended far beyond the sea level application to the many other disciplines where the problem of reconstructing spatio-temporal fields using sparse observations is encountered.

To address these challenges we propose to build a multi-disciplinary international team of leading experts in sea level science with demonstrated expertise in tide gauge and satellite altimetry data analyses, numerical ocean modelling, VLM and mass load deformation, statistical methods and paleo-sea level reconstructions. To achieve our objectives we propose
to focus the project on two time periods (corresponding to two work packages plus an integration work package), as detailed in the following.

**Work Package 1: 20th century GMSL reconstructions**

In order to quantify and understand the differences in the resulting GMSL curves from different methodologies, we will objectively assess the performance of individual state-of-the-art GMSL reconstruction approaches (e.g. Church and White 2011; Jevrejeva et al. 2014; Ray and Douglas 2011; Hay et al. 2015; Hamlington et al. 2016; Dangendorf et al. under review) using a variety of synthetic sea level fields. We will compile a set of test fields consisting of a combination of ocean dynamics, ice-melt, GIA and hydrological fingerprints. The ocean dynamic contribution will be obtained from modelled sea surface height (SSH) fields generated by (i) historical runs from Atmosphere Ocean General Circulation Models (AOGCMs) available at the Coupled Model Intercomparison Project Phase 5 (CMIP5) data base (we plan to base our selection on earlier assessments such as those achieved by the ISSI International Team on contemporary, regional and global sea level rise, [http://www.issibern.ch/teams/climatemodels/](http://www.issibern.ch/teams/climatemodels/)) and (ii) ocean reanalysis such as SODA (Carton and Giese, 2008) or the eddy-resolving (1/12°) global model NEMO (Marzocchi et al., 2015), which should be able to resolve many of the coastal processes that are important to sea level. Fingerprints from glaciers and ice-sheet melting, hydrological changes, and GIA will be linearly added to the SSH fields. We will then create a series of surrogate datasets to simulate the near-global altimetry observations and the temporally long but spatially sparse tide gauge records. The latter will be additionally “contaminated” by synthetic time series of VLM derived using the statistics of observed GPS measurements minus GIA (i.e. a trend plus a noise term).

The surrogate datasets will be distributed among all participants who will then apply their individual reconstruction techniques. All results will be inter-compared and tested against the a priori known modelled GMSL curves. It is expected that the information provided insight on how to choose the optimal tide gauge dataset, the pros and cons of individual reconstruction approaches, and guidance on how to best integrate a priori knowledge of solid Earth and geoid corrections.

**Work Package 2: Paleo GMSL (late Holocene)**

Following the same approach as in WP1, a series of surrogate synthetic proxy records will also be created. Since the focus is on Late Holocene time scale, the synthetic sea level fields will be created using a millennial simulation with the Earth System model MPI-ESM-P AOGCM. The point-wise information will correspond to the locations and temporal resolution of all available proxy records from paleo sea level studies (Kopp et al. 2016) and random noise will be added to each mimicking the limitations of actual proxy records (e.g. Gomez-Navarro et al. 2016). Gaussian process regression (i.e. Kopp 2013) will be used to convert the non-equidistant proxy records and their climate model surrogates into the required temporal resolution. Paleo-sea level reconstruction techniques from Kopp et al. (2016) and Dangendorf et al. (under review) will be then applied to the surrogate time series and compared to the a priori known modelled GMSL curves.

**Work Package 3: Application to observations and comparison to the altimeter record**

Based on the results of WP1 and WP2 we will apply each reconstruction approach with all available and applicable a priori information to real observations. This will provide a variety of reconstructions over the late Holocene from proxies and over the 20th century from tide gauges (combined with altimetry or not). By doing this we aim to provide constrained rates of
GMSL changes over the past that will be compared to the unique near-global altimeter record since 1992. This component of the work is essential to understanding whether the elevated rate of global rise during recent decades represents an acceleration in the secular rate of change or a temporary increase due to decadal climate variability.

2. Expected outputs

The proposed research will lead to the publication of two scientific peer-review papers:

- Paper on 20th century GMSL rise using different reconstruction methods that will: (i) test the sensitivity of each method to the selection of tide gauges and the corrections applied; (ii) determine the most suitable approach(es), if any, to recover the a priori known GMSL from synthetic fields; (iii) constrain the 20th century GMSL rise rate and its uncertainties as observed by tide gauges and altimetry from the findings in (i), (ii) and (iii); and (iv) quantify the increase and the possible acceleration of GMSL rise during the altimetry period.

- Paper on sea level reconstructions during the Late Holocene that will: (i) test two approaches to reconstruct paleo sea levels and compare them to the a priori known modelled GMSL; (ii) refine the value and the uncertainties in GMSL changes during late Holocene; and (iii) quantify the probability of acceleration of GMSL rise during the last decades.

In addition to the two papers a final report will be produced, which will be used to summarize our findings and serve as a means to report back to ISSI.

3. Added value to ISSI

The expected outcome of the proposed research is highly relevant for the interpretation of the satellite altimetry GMSL observations, which represent one of the major and most crucial applications of the space missions for climate studies. By placing the current rates of GMSL rise in the appropriate historical context we will: (i) assess how the rate of present-day GMSL rise compares to earlier decades and centuries; (ii) contribute to detection and attribution studies by improving the knowledge of GMSL sensitivity to anthropogenic climate change; (iii) improve our confidence in estimates of the acceleration of GMSL rise; and (iv) potentially contribute to an improved design of future Earth observation systems. The ISSI support to build the proposed International Team will therefore aid current efforts to understand past GMSL changes as reported by satellite and by ground-based observations and will contribute to advance the state-of-the-art interpretation of long-term sea level observations.

Our proposal fits into the research field of Earth Sciences using space data fostered by ISSI. Our team is formed by scientists based in Europe and North America, thus ISSI Bern provides a location that is convenient for the majority of team members.

4. Schedule

Two four-day meetings are foreseen within this proposal, tentatively scheduled in:

- **Meeting 1 in November/December 2017.** Prior to the meeting the team leaders will encourage the members to contribute to the compilation and preparation of the individual datasets that will be used to build synthetic fields and surrogate records. During the meeting the complete test fields and synthetic datasets will be presented, extended if needed and provided to all team members, who will agree on the sensitivity tests to be carried out using different approaches and the timing to deliver the reconstructed GMSL curves. The common framework for the inter-comparison of reconstructions will be discussed.

- **Meeting 2 in July 2018.** Individual GMSL reconstructions for the 20th century and the late Holocene will be presented and inter-compared. Different skills and methods will be discussed
among all participants. The elements, structure and contributors to the two scientific papers with the main results will be agreed.

Submission of the two papers is expected before the end of 2018. The final report to ISSI will be delivered no later than spring 2019.

5. Facilities required
The facilities requested are a meeting room for 16 people with projector and internet connection. A black board/white board would also be helpful. Also, IT support for the project website is requested.

6. Financial support requested
Accommodation and per diem is requested for 12 team members (plus 2 young scientists) for the two four-day meetings. Also travel support for one of the two team co-leaders for each meeting.

References
Dangendorf, S., et al. (under review) Reassessment of 20th century global mean sea-level rise, PNAS.

Annexe: Short CVs of the team members and list with contact information
NAME, First Name: DANGENDORF, Sönke

Affiliation: University of Siegen, Germany

Role in the project: Co-leader (responsible for the communication to ISSI), expertise in sea level observations from tide gauges/altimetry/proxy records and their processing, sea level processes and GMSL reconstructions

Current position: Researcher (Group Leader), Department of Civil Engineering

Former Position(s): PostDoc University of Siegen (2014-2016), PhD University of Siegen (2010-2014)

Education: PhD in Civil/Coastal Engineering (University of Siegen), Diploma in Civil Engineering (University of Siegen)

Services in National and/or International Committees (last ones): Guest Editor for “Scientific Data” (Nature Publishing Group, since 2017), Associate Editor for “Frontiers in Marine Science” (since 2016), Member of the Working Group on “Understanding sea level dynamics in the Baltic Sea region” of Baltic Earth (since 2016), Organizing Committee of the “Workshop on Global and Regional Sea Level Variability and Change” at Mallorca (2015)


Selected Publications:


NAME, First Name: MARCOS, Marta

Affiliation: University of the Balearic Islands, Spain

Role in the project: Co-leader, expertise in sea level observations from tide gauges and altimetry, sea level data analyses and reconstructions

Current position: Lecturer, Department of Physics

Former Position(s): Postdoctoral researcher at IMEDEA (Spanish Research Council & University of the Balearic Islands)

Education: PhD in Physics (2004) at the University of the Balearic Islands

Services in National and/or International Committees (last ones): MedCLIVAR Steering Committee (since 2012), EuroGOOS Tide Gauges Task Team (since 2015), Chief Editor in Frontiers in Marine Science, Specialty on Coastal Ocean Processes (since 2016).

Honors: “Ramón y Cajal” Fellowship (2009); MedCLIVAR Young Scientist Award (2011)

Selected Publications:


NAME, First Name: ANDERSEN, Ole Baltazar

Affiliation: Danish National Space Center/DTU Space, Denmark

Role in the project: expertise in sea level observations from tide gauges and altimetry, Arctic altimetry and sea level reconstructions

Current position: Senior reserach scientist (Responsible for section “Marine remote sensing”)


Education: Masters in Geophysics, University of Arhus (1992); PhD in Geophysics, University of Copenhagen (1996)

Services in National and/or International Committees (last ones): Member of the science working team for Jason-1, Jason-2, and GRACE; Member of Science Advisory Group for ESA, GPS, and GNSS mission GEROS (Launch, 2019); Chair of GMES Sentinel-3 Calibration and Validation Team, and Quality Working Team; Appointed lecturer for the Int. Assoc. Of Geodesy: Buenos Aires (2009) and St. Petersburg (2011)

Honors: Inge Lehmanns Grant to work with the University of Tasmania (1997); Danish Reserach Agency Grant to work as guest scientist at NASA, GSFC (2004)

Selected Publications:


NAME, First Name: MIR CALAFAT, Francisco

Affiliation: National Oceanography Centre, Liverpool, Unites Kingdom

Role in the project: Dr. Calafat will produce one of the various sea level reconstructions using a reduced space optimal interpolation, and will assess its performance.

Current position: Senior Scientist

Former Position(s):
2014-2016 Ocean Altimetry Research Scientist, National Oceanography Centre, UK.
2013-2014 Marie Curie Postdoctoral Research Fellow, National Oceanography Centre, UK.
2011-2013 Marie Curie Postdoctoral Research Fellow, University of South Florida, USA.
2010-2011 Postdoctoral Researcher, University of the Balearic Islands, Spain.

Education: PhD in Physics (2006-2010), University of the Balearic Islands, Spain.
BSc in Physics (1997-2001), University of the Balearic Islands, Spain.

Honors: Marie Curie Postdoctoral International Outgoing Fellowship (IOF) for Career Development (3 years). University of South Florida, USA / National Oceanography Centre, UK. Award: €247,586. Funded by the European Union.

Selected Publications:


NAME, First Name: GEHRELS, Roland

Affiliation: University of York, United Kingdom

Role in the project: Palaeo sea-level reconstructions

Current position: Professor in Physical Geography (since 2013)


Education: PhD, Geology, University of Maine (USA), 1994; MSc, Quaternary Geology, Vrije Universiteit, The Netherlands, 1989.

Services in National and/or International Committees (last ones): NERC Peer Review College (2012 – present); Marine Geology Editorial Board (2002 – present); PALSEA (PAGES/INQUA) Steering Committee (2010-present); NERC Radiocarbon Steering Committee (2010-2016); President INQUA Commission on Coastal and Marine Processes (2011-2015); UK National Correspondent UNESCO IGCP Projects 495 (2004-2009) and 588 (2010-2011); Chair North and West Europe Working Group, INQUA Commission on Coastal and Marine Processes (2007-2011); Contributing author IPCC AR5 WG1, Chapter 13, Sea-Level Change.

Honors: >60 invited and keynote lectures

Selected Publications:


NAME, First Name: HAMLINGTON, Benjamin

Affiliation: Old Dominion University

Role in the project: Sea level reconstructions using cyclostationary empirical orthogonal functions

Current position: Assistant Professor, Ocean, Earth, and Atmospheric Sciences Department, Old Dominion University, 2014-Present

Former Position(s): Research Scientist II, Cooperative Institute for Research in Environmental Sciences, Boulder, CO, 2013-2014

Education:
2007-2011: Doctor of Philosophy in Aerospace Engineering Sciences, University of Colorado at Boulder
2006-2007: Master of Science in Mechanical Engineering, Washington University in St. Louis
2002-2007: Bachelor of Science in Aerospace Engineering, Washington University in St. Louis

Services in National and/or International Committees (last ones): Member of NASA Sea Level Rise Science Team (2014-present); Member of NASA Ocean Surface Topography Science Team (2011-present)

Honors: Early Career Distinguished Research Award, 2016, Old Dominion University

Selected Publications:


**NAME, First Name:** HAY, Carling

**Affiliation:** Department of Earth and Planety Sciences, Havard University, USA

**Role in the project:** Benchmark the multi-model Kalman smoother methodology of Hay et al. (2015) with synthetic sea-level observations to better understand the spread in historical global mean sea level estimates.

**Current position:** Postdoctoral Fellow Department of Earth and Planety Sciences at Havard University (since 2012)

**Former Position(s):** Postdoctoral Fellow Department of Earth and Planety Sciences at Rutgers University (2014-2017)

**Education:**

University of Toronto, Toronto, Canada: Ph.D., Physics, 2012, Thesis Title: *The Interaction of Ice Sheets with the Ocean and Atmosphere*, Advisors: Prof. G.W.K. Moore and Prof. Jerry X. Mitrovica

McGill University, Montréal, Canada: Bachelor of Science, with Great Distinction, 2006, Physics Major

**Selected Publications:**


NAME; First Name: KOPP, Robert

Affiliation: Rutgers University, New Jersey, USA

Role in the project: sea level reconstructions using Gaussian Process Regression, paleo sea level reconstructions

Current position: Rutgers University, Professor, Dept. of Earth and Planetary Sciences (2017-present) and Associate Director, Rutgers Energy Institute (2011-present)


Education: University of Chicago, S.B., Geophysical Sciences, 2002; California Institute of Technology, M.S., Geobiology, 2005; California Institute of Technology, Ph.D., Geobiology, 2007


Selected Publications:


NAME, first name: RIETBROEK, Roelof

Affiliation: University of Bonn, Institute of Geodesy and Geoinformation

Role in the project: Computation of sea level fingerprints of surface mass loading, and provision of altimetry data.

Current position: Postdoc, University of Bonn

Former Position(s):

2009 - 2014 Researcher at Bonn University (Astronomical, Physical and Mathematical Geodesy)

2007 - 2009 Researcher at Section 1.3 Gravity Field and Gravimetry at Helmholtz Centre Deutsches GeoForschungsZentrum (GFZ)

Education:

2014 Phd in Geodesy (Dr.-Ing) Bonn University
2000 - 2007 Msc Aerospace Engineering, Delft University of Technology, Netherlands

Services in National and/or International Committees (last ones):

2017-2018 Union early career representative of the European Geosciences Union
2014- Early career representative of the geodesy division of the European Geosciences Union

Honors: 2014, EGU Division Outstanding Young Scientists Award

Selected Publications


NAME, first name: SANTAMARIA-GÓMEZ, Alavro

Affiliation: University of Toulouse, UPS, France

Role in the project: Vertical land movements from space techniques, data analysis

Current position: Physicien Adjoint (Associate Professor)

Former Position(s): Marie-Curie Research Fellow (2014-2016), University of La Rochelle, France and University of Tasmania, Australia; Research Engineer, National Geographic Institute, Spain (2010-2013); Geodetic Engineer, National Geographic Institute, Spain (2006); Land surveyor, Spain (2002, 2005);

Education: PhD in Geodesy (Doctoral School of Astronomy and Astrophysics, Ile-de-France, France Laboratory of Research in Geodesy (LAREG), IGN, France, Dissertation: Estimation of crustal vertical movements with GPS in a geocentric frame, within the framework of the TIGA project); Geodesy and Cartography Engineer (Masters), Technical University of Madrid, Spain (2002-2004); Land Surveying Technical Engineer (Bachelors), University of Salamanca, Spain (1997-2001)

Services in National and/or International Committees (last ones): Chairman of IAG Joint Working Group 3.2 on Constraining vertical land motion of tide gauges (since 2015); Second IGS reprocessing campaign (2013-2015); Scientific Responsible of the University of La Rochelle GPS Analysis Centre


Selected Publications:


NAME, First Name: SLANGEN, Aimée

Affiliation: Royal Netherlands Institute for Sea Research (NIOZ), Department of Estuarine & Delta Systems (EDS), PO Box 140, 4400 AC Yerseke, The Netherlands

Role in the project: Sea-level modelling, climate model analysis

Current position: Tenure Track Scientist at NIOZ

Former Position(s): Postdoc at IMAU (Utrecht, Netherlands, 2016-2017), Postdoc at CSIRO (Hobart, Australia, 2013-2016)

Education: PhD at IMAU (Utrecht, Netherlands, awarded Dec. 2012), BSc & MSc Meteorology (Wageningen University, Netherlands)

Services in National and/or International Committees (last ones): ISSI team on Contemporary regional and global sea level rise (Benoit Meyssignac); WCRP-CiC targeted activity on Glacier Modelling Intercomparison GlacierMIP (Ben Marzeion & Regine Hock).

Honors: SIEF John Stocker Postdoctoral Fellowship (276k AUD, 4% success rate)

Selected Publications:


NAME, First Name: THOMPSON, Philip R.

Affiliation: University of Hawaii

Role in the project: Sea level reconstructions using area-weighting approaches, sea level processes, tide gauges

Current position: Associate Director of the University of Hawai‘i Sea Level Center (since 2014)

Former Position(s): Assistant Researcher of the University of Hawai‘i Sea Level Center (2012-2014)

Education: PhD in Physica Oceanography, University of South Florida, Tampa, FL, USA (2012); B.S. Physics, North Carolina State University, Raleigh, NC, USA (2004)

Services in National and/or International Committees (last ones): Supervises the maintenance, expansion, and dissemination of the tide gauge sea level datasets and products provided to the research community by the UHSLC; Tide gauge global mean sea level index for the Climate.gov Climate Dashboard (https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level); Lead author of the sea level section in the 2016 BAMS State of the Climate Report. Co-author for 2012-2015; Session Chair for sea-level-related sessions at 2013-2015 AGU meetings

Selected Publications:


NAME, First Name: WÖPPELMANN, Guy

Affiliation: University of La Rochelle, France

Role in the project: Vertical land movements from space techniques, long records from tide gauges, data analysis

Current position: Full Professor (permanent position)

Former Position(s): Associate Professor (2007-2012)

Education: PhD in space geodesy from the “Observatoire de Paris”, France.

Services in National and/or International Committees (last ones): Chair of the science steering group of the Global sea level observing program (GLOSS) under the Intergovernmental Oceanographic Commission of UNESCO (since 2012).

Selected Publications:


Further details in http://lienss.univ-larochelle.fr/Guy-Woppelmann-1337
NAME, First Name: ZORITA, Eduardo

Affiliation: Institute of Coastal Research, Helmholtz-Zentrum Geesthacht (HZG)

Role in the project: Provide simulated sea-level data from millennial paleo-climate simulations.; design

Present position: Senior Scientist at HZG


Education: Degree in Physics( University Zaragoza, Spain, 1984), doctorate in Solid State Physics (U. Zaragoza, 1988)

Services in National and/or International Committees (last ones): Past Global Changes 2K Euro-Mediterranean Working group

Honors: Bert-Bolin Fellow University of Stockholm

Selected Publications:


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