WCRP
World Climate Research Programme

Conference report
Regional Sea-level Changes and Coastal Impacts

10-14 July 2017, New York, USA

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Executive Summary

To address existing challenges in describing and predicting regional sea level changes, and to discuss intrinsic uncertainties, the WCRP Grand Challenge on Regional Sea Level Change and Coastal Impacts, jointly with the Intergovernmental Oceanographic Commission of UNESCO (IOC), organized an international conference on sea level research that followed 11 years after the first WCRP sea level conference (Paris, 2006), and three years after the last Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). It provided a comprehensive summary of the state of worldwide climate-related large-scale sea level research. The five-day conference was held at Columbia University in New York. More than 350 Participants from 42 nations attended the event. Participants represented natural scientists, social scientists, coastal engineers, managers and planners.

Conference participants recognized that the present state of sea-level science provides unambiguous evidence that sea level is rising. They also recognized that sea-level rise has accelerated over the past 100 years due to global warming and that the increase will continue to accelerate with unmitigated emissions. Participants discussed evidence indicating that sea-level rise represents a major challenge for coastal societies. This requires that scientists closely collaborate with the stakeholder community to develop plans for responding to sea-level change affecting their coasts and to implement adequate adaptation measures, to enhance understanding of coastal sea-level change, and to project its regional mean and extreme states. This is essential for assessing sea-level rise impacts, as well as for enhancing climate mitigation and adaptation measures over the short-, medium- and long-term. Without urgent and significant mitigating action to combat climate change continued greenhouse gas emissions will almost certainly commit the world to several meters of sea-level rise over the next few centuries.

A conference summary by numbers

- 356 Participants
- 229 Poster presentations
- 111 Early career scientists and students
- 83 Competition posters
- 69 Speakers and panelists
- 46 Countries
- 11 Years since last WCRP sea level conference
- 6 Sessions

A conference statement was finalized at the end of the conference and was signed subsequently by more than 350 scientists from around the world[1].

[1] https://www.wcrp-climate.org/events/sl-statement-2017

Contents

1. Background

Sea level change impacts coastal communities globally and will continue to do so for the foreseeable future. To meet urgent societal needs for useful information on sea level, the World Climate Research Program (WCRP) has established the theme “Regional Sea-Level Change and Coastal Impacts”, as one of its cross-cutting “Grand Challenge” (GC) science questions. The GC Sea Level has designed and developed an integrated interdisciplinary program on sea level research reaching from the global to the regional and coastal scales. In particular, the program aims for close interaction with relevant coastal stakeholders to make sure that the results effectively support impact and adaptation efforts and wider coastal zone development and management.
To address existing challenges in describing and predicting regional sea level changes, and to discuss intrinsic uncertainties, the GC SeaLevel, jointly with the Intergovernmental Oceanographic Commission of UNESCO (IOC), organized an international conference on sea level research that followed 11 years after the first WCRP sea level conference (Paris, 2006), and three years after the last Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). It provided a comprehensive summary of the state of worldwide climate-related large scale sea level research. The five-day conference was held at Columbia University in New York. More than 350 Participants from 42 nations attended the event. Participants represented natural scientists, social scientists, coastal engineers, managers and planners.

2. Outcome

Conference participants recognized that the present state of sea-level science provides unambiguous evidence that sea level is rising. They also recognized that sea-level rise has accelerated over the past 100 years due to global warming and that the increase will continue to accelerate with unmitigated emissions. Participants discussed evidence indicating that sea-level rise represents a major challenge for coastal societies. This requires that scientists closely collaborate with the stakeholder community to develop plans for responding to sea-level change affecting their coasts and to implement adequate adaptation measures, to enhance understanding of coastal sea-level change, and to project its regional mean and extreme states. This is essential for assessing sea-level rise impacts, as well as for enhancing climate mitigation and adaptation measures over the short-, medium- and long-term. Without urgent and significant mitigating action to combat climate change continued greenhouse gas emissions will almost certainly commit the world to several meters of sea-level rise in the next few centuries.
Coasts are vulnerable places due to the combination of extreme events such as storm surges and waves. Many coasts have dense and growing populations and economies, and important ecosystems. Major human and economic losses have occurred due to storm surges: e.g., nearly 2,000 deaths and over $100 billion losses during Hurricane Katrina (US, 2005) and over 100,000 deaths during Cyclone Nargis (Myanmar, 2008).
While global sea levels have varied by over 100 m over geological scales, sea level has been relatively stable through recorded history. Global sea levels started to rise in the mid 19th century and increased by about 14 to 17 cm during the 20th century. The two largest contributions to this rise are the expansion of the oceans as they warm and the addition of mass from melting glaciers. Due to ongoing climate change, sea-level rise is accelerating and currently occurs at a rate of about 30 cm per century.
If greenhouse gas emissions continue without mitigation, global sea levels could rise one meter or more throughout the 21st century, several meters by 2300, and many meters over longer timescales. With substantial and sustained reductions in greenhouse gas emissions, these changes could be greatly reduced, but even then sea level would continue to rise for many

centuries. The largest uncertainty and concern in this respect is the stability of the ice sheets in Greenland and Antarctica. Substantial mass loss from these ice sheets, would have significant consequences for global sea level rise.

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3. Conference Highlights

Paleo sea-level change analyses provide important data and show that (1) the paleo sea-level budgets need further analysis and refinement, (2) dynamic mantle topography is more important than previously thought over timescales of thousands of years or more, requiring further investigation, particularly around past sea level high stands.
Physical understanding of the ice sheets has improved, but ice-ocean interaction remains poorly constrained. While understanding of the role of grounding lines has improved substantially, questions related to buttressing and the processes that control it have moved to the forefront.
There is improved closure of the 20th Century sea-level budget indicating a better understanding of its different components. Despite this progress, we still lack information on sea-level change at regional scales and in coastal zones. In addition, the contributions from the deep ocean and regions covered by sea ice remain open.
Our understanding of extreme sea levels is improving. Trends in extremes largely follow mean sea-level changes. Elevated local sea level can often be related to climate modes (e.g., North Atlantic Oscillation, El Nino). Encouraging pilot forecasts of monthly sea levels across the Pacific can predict extremes linked to coastal flooding. Global scale modelling of storm surges has progressed greatly, although representing the effects of tropical storms remain challenging. Progress is more limited for waves: first ensembles of wave projections exist, but uncertainties remain large and require further development.
The availability of high-resolution regional sea-level projections is important for science and decision makers alike. Probabilistic descriptions of sea-level rise incorporating regional details combined with information about flood recurrence frequencies are useful tools to communicate projected changes to stakeholders. Nonetheless, the future behavior of ice sheets remains an area of uncertainty, and there is considerable disagreement within the community on the shape of the tails of the sea-level rise probability distribution for the second half of this century and beyond.
Impact and adaptation assessments and planning require consideration of a range of different drivers - mean changes (including uplift/subsidence), extremes and waves. Evolving data and model systems have the potential to provide these if ongoing research efforts are sustained. There are encouraging signs that these can be provided. In particular, human-induced land subsidence is a major problem in some coastal areas, especially in coastal cities located in

[2] https://www.wcrp-climate.org/events/sl-statement-2017

deltas. Historic changes in subsidence have in some local regions greatly exceeded climatically-driven mean sea-level rise, and this may continue through the 21st Century. Observations of human response to past subsidence provide a useful analogue for human response to climate-induced sea-level rise, which should be better exploited in the future. Impacts of sea-level rise will disproportionality impact the poor and vulnerable.

4. Consequences and Future Requirements

Major immediate climate-related impacts of sea-level rise occur due to the increased likelihood of extreme sea-level events arising from the combination of high tides, storm surges and waves on top of higher sea levels. This increased frequency of extreme sea-level events, and increased impact of storm surges and waves, is already being observed, including routine flooding on spring tides at some locations. Hence it is important to understand present and future occurrence of extreme conditions, in addition to mean sea-level rise.
Coastal impacts will not only depend on sea-level rise but will also be heavily influenced by the strong socio-economic trends in coastal areas (expanding populations, urbanization, etc.), which will almost certainly continue in the coming decades. If the world does not respond to the challenges of sea-level rise, impacts are likely to be severe. Both climate mitigation to reduce emissions and adaptation to deal with rising sea levels that cannot be avoided will be needed. Adaptation offers many possible measures, which, when planned appropriately, are highly effective in managing coastal risks and impacts.
The conference participants recognized the need for an enhanced and internationally coordinated new sea-level change program, including the provision of appropriate sea-level change climate services as part of a wider sea-level rise impact and adaptation effort. This program should be designed in consultation with users to serve the needs of local to national stakeholders, as well as the global community to cope with present and future sea-level change risks.

Conference participants called for:

- A commitment to sustained and systematic global and regional sea-level observations, including the different components of sea-level change (cryosphere, ocean heat content and other relevant ocean parameters, land hydrology).
- The implementation of new observations where necessary, making use of both remotely-sensed and *in-situ* observations. Special emphasis should be given to the monitoring of coastal regions worldwide where a variety of climate- and non-climate-related processes interact. These observations can provide early warnings of sea-level rise acceleration.
- Additional paleo data, particularly local evidence in the polar regions, in conjunction with improved earth, ice sheet and sea-level models, are needed both to better characterize the natural variability and non-anthropogenic contributors to ongoing sea-level rise, and to develop a better understanding of sea-level high stands, rates of change, and ice-sheet behavior in past states of the world warmer than at present.
- A broad-scale assessment of uplift/subsidence, especially human-induced subsidence, to guide analysis of regional sea-level change.
- The development of improved sea-level forecasts and projections for planning, early warning, adaptation and mitigation. The time frame should extend beyond 2100 to highlight the evolution of sea level and address the sea-level commitment.
- Improvements of our understanding of the physics of ice sheets for better projections of their contributions to future sea-level change.
- An open climate model development effort based on a range of models with advanced process parametrizations and enhanced calibration by observations to produce improved

regional coastal sea level information including storm surges, waves, subsidence and land water storage at high resolution in support of the needs of coastal stakeholders.

- Development of a stakeholder forum that enables timely and effective exchange of vital information for mitigation of and adaptation to sea-level change including present states of and projected changes in mean and extreme sea levels, wave conditions, and potential impacts such as changes in coastal flooding events, coastal erosion, and saltwater intrusion.
- Development of policies and regulatory frameworks for impact and adaptation assessments for all vulnerable coastal areas, such as major cities, deltas and islands.

5. Summary Day by Day

5.1. Day 1: Paleo sea-level data and GIA modelling

The conference schedule started by focusing on sea level change, starting with the past and working towards the future.
The significance of rising waters in New York City was evident during Hurricane Sandy and on 10 July 2017 when hundreds of scientists gathered at Columbia University to kick-off a week long Regional Sea Level Changes and Coastal Impacts Conference. The international conference — organized by the World Climate Research Programme (WCRP), CLIVAR, and the UNESCO Intergovernmental Oceanographic Commission —had a stated vision to be:
A collective voice and expertise of the international sea level community to address existing challenges in describing and projecting regional and coastal sea level changes, and in quantifying intrinsic uncertainties.

Day one of the conference began with high-profile remarks on the societal importance of addressing sea level changes. “We have a special responsibility to help society respond to the climate issue. We need to develop smart, end-to-end, climate information systems of basic research to climate services,” said Guy Brasseur, Chair of the WCRP. Science-based information can help decision makers and stakeholders better prepare for the impacts of sea level rise through adaptation and coastal management. Brasseur suggested that the community develop a robust sea level budget.
When talking about sea level, we should be thinking about an integrated system. “Sea level is an integrated quantity of many of climate indices,” said Detlef Stammer, University of Hamburg and co-chair of the Conference Scientific Organizing Committee.
The US East Coast has some of the highest projected sea level increases. Pointing out that Manhattan is an island and lies within a few feet of sea level, Michael Purdy, Executive Vice President for Research at Columbia University, emphasized that the rate at which we are increasing our understanding and the rate of our actions are insufficient.
Globally, sea level is just as much a threat. Many low-lying nations see their sovereignty at risk. “As global temperatures inexorably rise, desertification spreads, the Arctic melts, and islands submerge, we are confronted by powerful forces who deny that any of this is actually happening, or that if it is happening it is not for the anthropogenic reasons identified by scientific consensus,” said H. E. Peter Thomson, President of the 71st Session of the United Nations General Assembly.
Sea level rise will not stop at the end of the 21st century but will continue for many centuries. “Humankind is pushing ever harder against our planetary boundaries. These impacts are becoming more stronger every day,” stated Peter Schlosser, Associate Director of the Earth Institute. Which is why the next Intergovernmental Panel on Climate Change (IPCC) assessment (AR6) is pressing. The IPCC AR6 will give governments the scientific, technical, and socio-economic information relevant to understanding the scientific basis of risk of human-

induced climate change, its potential impacts, and options for adaptation and mitigation. Specific to sea level rise, Valerie Masson-Delmotte, co-chair of the IPCC Working Group 1, shared how in the last decade over 4000 peer review papers were published with “sea level” in the title. She also presented the IPCC AR6 schedule, which includes a special report on 1.5°C of global warming (scheduled for release in Fall 2018) and an oceans and cryosphere special report (schedule for release in Fall 2019), both of which will discuss the latest science of sea level rise.

The opening session also included overview talks that set the stage for the six conference sessions. Highlights include:

- Scientists are improving the closure of the sea level budget, but there is still significant uncertainty on all components. While modeled sea level changes are increasingly representing regional variability, some big challenges remain, such as accurately estimating ocean heat uptake in the deep ocean and under the ice. (John Church, University of New South Wales)
- There is room for huge advancements in the rate and locations of understanding historical paleo records. For example, deformation of Orangeburg scarp (located in South Carolina) is not simply glacial isostatic adjustment. Dynamic topography causes non-horizontal shorelines – a few meters over 100,000 years. (Maureen Raymo, Lamont-Doherty Earth Observatory)
- Ice sheets are responding to the ocean, and if we want to understand ice sheets, then we need to understand regional climate change. High-end projections of sea level change are harder than the ‘most likely’ outcomes because many processes that control mass loss are highly localized. Recent increases in ice flow are due to ocean circulation changes and may involve natural variability. (Tony Payne, University of Bristol)
- Governments should take a metropolitan regional approach to city adaptation with a response structure across sectors and communities. New York was used as an example, which has its own panel for climate change that addresses resilience with a “portfolio approach” that combines policy, engineering, social action, and ecosystem based solutions. As with physical processes, there are tipping points in community response, such as lost homes. (Cynthia Rosenzweig, NASA GISS)

Following the opening session were three sessions on paleo sea level data and modeling, millennial-scale ice sheet and sea level interactions, and contemporary contributions from ice sheets and glaciers. Below are some highlights:

- Scientists need to take crustal dynamic topography into account when looking at geological evidence of paleo sea level, which could significantly affect regional sea level on shorter timescales. With this correction, there is globally consistent evidence for an ephemeral fall followed by rise of a few meters about 121,000-125,000 years ago (during the last interglacial period). (Andrea Dutton, University of Florida)
- Scientists can reconcile observations of paleo glacial isostatic adjustment following the Last Glacial Maximum in North America using 3D visco-elastic solid Earth modeling. Seismic data confirms low upper mantle viscosity along the US West Coast, with substantial spatial variation. This new result gives confidence in improved glacial isostatic adjustment corrections that are applied to tide gauge data. (Jerry Mitrovica, Harvard University)
- Using POLENET, GPS and seismometer data show the Amundsen Embayment of the West Antarctic Ice Sheet has a very low upper mantle viscosity with large spatial variability and some very localized crustal deformation. These results suggest that the ‘corrected’ GRACE data may be significantly underestimating contemporary mass loss from this very dynamic region. (Terry Wilson, Ohio State University)
- New marine sediment cores from the Mid-Pliocene (3-3.2 million years ago) produce a time series of relative sea level, suggesting the Antarctic Ice Sheet had rapid melt and

re-growth of 20 m sea level equivalent in approximately 20,000 year cycles. (Georgia Grant, Victoria University of Wellington)

- A 3D Earth structure is important to accurately model sea level and ice sheet feedbacks, and the recent (last millennia) ice history is vital for making accurate predictions of ice sheet evolution. (Natalya Gomez, McGill University)
- Increased understanding of grounding line dynamics and high-resolution models reduce uncertainties in the marine ice sheet instability contribution to sea level rise. (Frank Pattyn, Université libre de Bruxelles)
- Glaciers will be a significant contribution to sea level rise in the next century and beyond. While there are a relatively small amount of glacier modeling efforts (only 7 in last 15 years), results show that at least 50% of all glacier volume will still be present by 2100. (Regine Hock, University of Alaska, Fairbanks)
- Observations with sufficient spatial and temporal sampling are available to allow for data assimilation in ice sheet dynamical modeling (Patrick Heimbach, University of Texas at Austin)
- The wind direction drives ocean heat transport, which influences sub-ice shelf melting, sea ice volume, and resulting sea level contribution. (Gustavo Marquez, Princeton University/NOAA GFDL)
- Comparing last interglacial modeling results with pre-industrial modeling results — both of which have similar greenhouse gas emissions — the whole periphery of the Greenland Ice Sheet shows much more melt than the current day, particularly in the west of Greenland. (Bette Otto-Bliesner, National Center Atmospheric Research)

5.2. Day 2: Understanding today's sea level: trends, amplitude, and new approaches

The second day of the conference was dedicated to presentations on contemporary sea level change, ranging from the role of ocean heat content to satellite missions to drivers in variability of extreme sea levels. The two plenary sessions were accompanied by a morning and afternoon poster session and a town hall on the operational monitoring of sea level using satellites.

Below are highlights from the day's presentations.

- Trends in local sea level are responsible for most of the trends in extreme sea level event amplitudes over 1960-2015. (Marta Marcos, University of the Balearic Islands)
- Extreme events amplitude show temporal variability at interannual and multidecadal timescales driven mostly by regional sea level related to large-scale climate modes such as the North Atlantic Oscillation.
- Phases of ENSO have very distinct differences in the magnitude of wave fields generated by extra-tropical events, and these differences influence water levels at the coast. Storm tracks change and can modify the wave directionality, creating teleconnections in the basins through swell. (Justin Stopa, Laboratoire d'Océanographie Physique et Spatiale)
- A multi-model approach has been found to be more appropriate than dynamic or statistical modeling for prediction sea level variability. Research has also found sea level predictions from multiple models are skillful out to at least six months in the tropical Pacific. (Matthew Widlansky,University of Hawaii Sea Level Center)
- Integrated ocean measures like sea level and heat content--made possible by modern observing systems (e.g., altimetry, Argo)--are ideal metrics for tracking Earth's energy imbalance. However, improvements to the observing system are needed, such as extending Argo's reach into high latitudes, the deep ocean, and marginal seas. (Karina von Schuckmann, Mercator Ocean)

- Good agreement has been achieved between recent observation- and model-based estimates of global and regional sea level rise over the 20th century. (Benoit Meyssignac, LEGOS)
- The ocean's dynamic response to forcing by winds and natural variability is a key driver of interannual-to-multidecadal variability in sea level over the western North Pacific and coastal Japan. (Yoshi Sasaki, Hokkaido University)
- The use of high-resolution coupled climate models is essential for accurately simulating coherent sea level variations along the US East Coast. (Diane Palko, University of Miami)
- Western boundary sea level is influenced by the open ocean, but this influence is critically mediated by topography and friction. Boundary trapped waves are capable of transmitting information rapidly and efficiently around ocean basins. (Chris W. Hughes, University of Liverpool/National Oceanography Centre)

A town hall, Operational monitoring of global and regional sea level by satellite altimetry, featured speakers from US and international agencies that manage and operate satellites, including the National Oceanic and Atmospheric Administration (NOAA), National Aeronautic and Space Administration Jet Propulsion Laboratory (NASA/JPL), European Space Agency (ESA), European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), and the Centre Nationale d'Études Spatiales (CNES). Participants heard updates on current and next generation missions, data products and processing, partnerships, and calibration/validation challenges.

5.3. Day 3: Risk, adaptation strategies, and stakeholder needs for coastal zone management

Halfway through the conference, day three brought a series of presentations on the coastal zone. Presenters in the two plenary sessions discussed impacts of rising seas from small island countries to large metropolitan cities like Shanghai, planning and adaptation strategies, and information needs for stakeholders and decision makers. Almost 70 posters were also presented on this theme. A panel closed out the day with discussions about New York's adaptation strategies and response to Hurricane Sandy.

"Adaptation has many steps. It's a pathway," said Robert Nicholls, University of Southampton, when discussing planning horizons for decision makers. Klaus Jacob, University of Columbia, reminded the audience that adaptation is not just a financial problem but comes with political and ethical challenges. Josh DeFlorio of the New York and New Jersey Port Authority discussed their resiliency efforts on sea level rise, noting planning horizons for design reach out to the about 2100. Sandy served as a catalyst for the Port Authority to develop more nuanced and flexible guidelines.

In the evening, Columbia University hosted a public lecture on Sea Level Rise: Causes, Impacts, and Options for Solutions, featuring public officials, scientists, coastal managers, architects, and other stakeholders. Around 400 people attended the event in person as well as online participants.

Below are highlights from the day's presentations.

- For estimating flood risk, every factor contributing to local extreme water levels needs to be included: local sea level rise, tides, land subsidence, storm surge (from storms or tropical hurricanes), and wave run-up and set-up.

- Rates of land subsidence can exceed climate-induced sea level rise rates by a factor of 10 or more. Some cities, such as Tokyo and more recently Shanghai, have successfully limited subsidence through regulation. (Shujun Ye, Nanjing University)
- Including tropical cyclones in projections of extreme water levels are important to estimate present-day and future extreme sea levels (Devendra Rao Ambarukhana, Indian Institute of Technology, and Sanne Muis, Vrije Universiteit Amsterdam)
- With a flexible model mesh, it is possible to make global projections on extreme water levels (surges and tides). These global projections are very accurate, with exception of areas where tropical cyclones are present, because these are not well resolved within the reanalysis datasets. (Sanne Muis, University Amsterdam)
- There seems to be a need for improved two-way communication and more effective engagement between scientists and the diverse stakeholder community. A lack of a clear source of the best available information is a barrier to stakeholder action.
- Different decision-making contexts require different decision-making methods and scientific information. The confidence that physical scientists place on results is an essential piece of information. (Jochen Hinkel, Global Climate Forum)
- Due to a lack of consistent global storm surge/storm tide datasets and analyses, models and projections hinder coastal adaptation efforts in many places. A global scientific community effort would continue the improvements in modeling efforts, where many challenges remain. (Kathleen McInnes, CSIRO)
- The poor, who often inhabit areas are most risk, have disproportionate impacts from sea level rise. Society will continue living along the sea (in densely populated areas at least), even though it is expensive. And people may not migrate or retreat from their homes or communities just because of flooding. (Miguel Esteban, University of Tokyo)
- Scientists must engage with stakeholders as a community and on a personal level. Trust can be worth more than thousands of faceless scientists (Robert Bindschadler, NASA Emeritus/SEARCH)
- Actionable science must be co-produced between the scientific community and decision makers. When dealing with sea level rise, managers often say the issue with information is that it's fragmented, confusing, dispersed, and complex. (Faud Sweiss, Office of Mayor Edwin Lee, and David Behar, San Francisco Public Utilities Commission)

5.4. Day 4: The dynamics of sea level rise today and into the future

The conference rolled into the fourth day wrapping up the contemporary sea level presentations and beginning to address future projections. The two plenary sessions had corresponding posters for each topic. Participants also heard about the evolving requirements of integrated sea level observations for regional and local decision making during the town hall.

Katy Hill, scientific officer for the Global Climate Observing System and Global Ocean Observing System, framed the town hall by wanting to know how we get the global ocean system humming to meet our decision making needs, particularly the requirements for moving into the coastal regions. The resolution depends on the application for the temporal and spatial sea level data needs of decision makers, said Melisa Menendez, University of Cantabria. We require observations from global and regional scales, but need to reach down to the scale of a city, according to Gary Mitchum, University of South Florida, who works with local officials to provide scientific guidance on coastal projects that will be influenced by rising waters. We also need to resolve flooding events that last for less than a day. NOAA is developing products that try to show people that sea level rise is happening now, as compared to a far-off threat. A few opportune areas for improvement include enhancing ocean observations in the coastal region, engaging better with hydrologists and other disciplines, co-locating observations (e.g., at tide gauge stations), and improving understanding of the continental slope region.

Highlights from Thursday:

- Current observing systems (e.g., GRACE, Argo) allow the global sea level budget to be closed for the top 2000 m of the ocean. But there are residuals regionally, and systematic errors may mask global trends. (Felix Landerer, NASA JPL)
- Small-scale regional wind-driven oceanic processes are involved in causing sub-ice shelf warming around Antarctica, with global consequences for sea level. (Steve Griffies, NOAA Geophysical Fluid Dynamics Laboratory)
- Ocean initial-condition uncertainty can generate more uncertainty in sea level projections than atmospheric initial-condition uncertainty. (Aixue Hu, National Center for Atmospheric Research)
- Regional sea level projections differ significantly from global mean sea level projections. Regional sea level change is highly spatially variable, more temporally variable than the global mean, and different processes dominantly contribute to the sea level change in different regions. Regional consideration of sea level projections is important. (Aimee Slangen, Royal Netherlands Institute for Sea Research, Robert Kopp, Rutgers University, and Matt Palmer, Met Office Hadley Centre)
- There is a demand for probabilistic estimates of sea level rise – these provide a lot more information than just a likely range. Moreover, a probabilistic framework includes information on tail-end projections that are outside the likely range but still possible and important for policy makers. (Robert Kopp, Rutgers University, and Aimee Slangen, Royal Netherlands Institute for Sea Research)
- Improvements have been made for projections of the contribution of ice sheets to sea level change through ice sheet model development and model intercomparison efforts. The Ice Sheet Model Intercomparison Project for CMIP6 (ISMIP6) will involve improved climate forcing and climate-ice sheet coupling. (Sophie Nowicki, NASA Goddard Space Flight Center)
- Increasing the resolution of the dynamic component of global ocean models provides improved sea level projections, especially in coastal regions. (Xuebin Zhang, CSIRO)
- We are now making CMIP5-based sea level projections beyond 2100. Full climate model simulations are often too computationally expensive to general multi-century climate projections. But much can be done using large ensemble runs with simplified climate models to look at a wide range of scenarios and project each of the contributions to regional sea level changes independently. The modular nature means that individual elements can be refined over time. (Matt Palmer, Met Office Hadley Centre)

5.5. Day 5: Investing in the future of sea level rise: lessons, progress, and new ideas

On the fifth day, conference participants — filled with four days of fascinating, relevant, and timely discussions — were able to hear about the latest modeling efforts and different scenarios for the future. A panel of stakeholders also held a lively discussion on what they learned during the week and what their recommendations are for collaborative opportunities and research to support coastal management.

Getting communities together is a shared problem," said David Behar, San Francisco Utilities Commission. It's not just unique to the scientific community. One clear agreement among the panelists was that good communication is vital. Information that is better understand and more appropriate is then better used. Managers and scientists should be involved in the co-design and co-production of information for coastal policies; a one-way process doesn't work. Furthermore, we should be using actionable data to enable tools, according to Kevin

Horsburgh, National Oceanography Centre. The participants and panelists also discussed the role of the Paris Accord and how setting a target for temperature doesn't take into account the ocean warming and resulting impact of sea level rise.

Some additional highlights from the day include:

- For the first time scientists will be able to understand global and regional spread in sea level projections from CMIP models used in IPCC assessments, through the Flux-Anomaly Forced Model Intercomparison Project (FAFMIP). (Jonathan Gregory, University of Reading)
- Society has committed to sea level on centennial timescales due to ice sheet response. Burning the remaining fossil fuel reserves has the potential to make Antarctica almost ice-free over multi-centennial timescales, and policy decision making today has implications on timescales from centuries to millennia. (Ricarda Winkelmann, Potsdam Institute for Climate Impact Research)
- Collaboration — across disciplines, communities, and even with data sharing — helps to not only advance the science but also the policies to manage and deal with sea level rise.
- Sea level change is going to disproportionately harm poor people and countries. We need to focus on leaving no one behind.
- Managers are interested in the whole story of the sea level continuum, from the low to high projections. There also needs to be a fundamental shift in thinking. If we only look at the problem starting with just the climate signal, then it leads down a different path than if we look at components of sea level rise that are important to decision-makers. (Kathleen White, US Army Corps of Engineers, and Jochen Hinkel, Global Climate Forum)

The conference organizers presented best poster awards to early career scientists and students. Congratulations to:

- Sönke Dangendorf, University of Siegen, Germany
- Andra Garner, Rutgers University, US
- Céline Grall, Columbia University, US
- Luke Jackson, Oxford University, UK
- Jessica Kenigson, University of Colorado, US
- Bradley Paul Lipovsky, Harvard University, US
- Alexander Nauels, University of Melbourne, Australia
- Meenu Rani, G.B. Pant Institute of Himalayan Environment & Development, India
- Geoffrey Richards, University of York, UK

Annex 1 Conference Program

DAY 1: Monday, July 10

08:00 Registration

09:00 Opening Ceremony

Chairs: D. Stammer, R. Nicholls, R. van de Wal

- Conference chairs (15 min)
- Earth Institute, Director (5 min)
- Columbia University (President, Provost) (5 min)
- Guy Brasseur, WCRP (10 min)
- Vladimir Ryabinin, IOC (10 min)
- President of the UN General Assembly (10 min)
- Prince Albert 2nd (Video message, 5 min)
- V. Masson-Delmotte: Sea level change in the 6th IPCC Assessment: a WGI perspective (20 min)

10:30 Coffee break

11:00 Opening Session

- J. Church: Achievements and challenges in understanding contemporary sea-level change (20 min)
- M. Raymo: Sea Level During Past Warm Periods – Past is Prologue (20 min)
- T. Payne: Why is it so difficult to make projections of the contribution of the ice sheets to future sea level rise? (20 min)
- C. Rosenzweig: Coastal cities: Preparing for sea level rise and storms (20 min)
- Discussion (10 min)

12:30 Lunch and press conference

14:00 Oral Session

Session 1: Paleo sea level data and GIA modeling & Session 2: Millennial-scale ice sheet and sea level interactions

Chairs: N. Gomez, T. Payne, M. Tamisiea, R. van de Wal

Invited talks:

- A. Dutton: New perspectives on “old” data: What the earth’s past tells us about future sea-level rise (20 min)
- J. Mitrovica: Probing ancient ice Sheet stability using a sea level lens: A geodynamic perspective (20 min)

Contributed talks:

- M. King: Geodetic evidence for predominance of a low viscosity upper mantle in West Antarctica (15 min)
- B. Otto-Bliesner: Coupled Long-Term Evolution of Climate and the Greenland Ice Sheet During Past Warm Periods: A Comparison for the Last Interglacial and the Late Pliocene (15 min)
- G. Grant: Mid-Pliocene warm period (3.3-3 ma) sea-level reconstructions from the Wanganui Basin, New Zealand (15 min)

15:30 Coffee break

16:00 Oral Session

Session 2: Millennial-scale ice sheet and sea level interactions & Session 3: Contemporary contributions from ice sheets and glaciers

Chairs: N. Gomez, T. Payne, M. Tamisiea, R. van de Wal

Invited talks:

- N. Gomez: Insights from coupled modeling on ice, sea level and solid Earth changes in Antarctica (20 min)
- F. Pattyn: Grounding line stability in Antarctic ice sheet models (20 min)
- R. Hock: Sea-level contributions from glaciers (20 min)

Contributed talks:
- P. Heimbach: A Prediction Approach for Estimating Sea Level Contributions of West Antarctic Ice Streams via Transient Model Calibration (15 min)
- G. Marques: Sensitivity of Sub-ice-shelf Melting to Changes in Wind, Topographic Features and Surface Heat Fluxes (15 min)

18:00 Icebreaker Reception (The Rotunda, Low Memorial Library)

Join us for a welcome reception in the Rotunda of Low Memorial Library. Built in 1895 by University President Seth Low, the Library is in the United States National Register of Historic Places and is both a National and New York City historic landmark.

DAY 2: Tuesday, July 11

09:00 Oral Session
Session 4(a): Contemporary sea level change
Chairs: B. Meyssignac, R. Ponte, J. Church, C. Domingues
Invited talk:
M. Marcos: Drivers of the spatial and temporal variability in sea level extremes (20 min)
Contributed talks:
- J.-F. Legeais: Accurate Estimation Of Regional Sea Level Changes With The ESA CCI Sea Level Essential Climate Variable (15 min)
- M. Menéndez: Examining Extreme Sea Level Variations From In-Situ Tide-Gauge Records And Satellite Observations (15 min)
- J. E. Stopa: Wave driven El Nino impacts to water level anomalies in the Pacific (15 min)
- M. J. Widlansky: Multi-model Seasonal Sea Level Forecasts for Vulnerable Coasts (15 min)

10:30 Coffee break
11:00 Poster Session
Session 1: Paleo sea level data and GIA modeling
Session 2: Millennial-scale ice sheet and sea level interactions
Session 3: Contemporary contributions from ice sheets and glaciers
12:30 Lunch plus Town hall 1
14:00 Oral Session
Session 4(b): Contemporary sea level change
Chairs: B. Meyssignac, R. Ponte, J. Church, C. Domingues
Invited talk:
- K. von Schuckmann: The Role of ocean heat content on contemporary sea level change (20min)

Contributed talks:
- B. Meyssignac: 20th Century Observed Regional Sea-Level Changes Compared To Climate Model Simulations (15min)
- Y. Sasaki: Sea level variability in the western North Pacific during the 20th century (15min)
- D. Palko: Natural Variability of Regional Sea Level in a High Resolution Global Coupled Climate Model (15min)
- C.W. Hughes: How are open-ocean dynamic sea level signals communicated to the coast? (15min)

15:30 Coffee break
16:00- 17:30 Poster Session
Session 4(a): Contemporary sea level change
18:00 End of day

DAY 3: Wednesday, July 12

09:00 Oral Session
Session 5(a): Coastal Zone
Chairs: R. Nicholls, J. Hinkel, K. McInnes, G. Le Cozannet
Invited talks:

- S. Ye: Impact of land subsidence and sea-level rise on coastal cities in China (20 min)
- H. Yokoki: Global distribution of projected sea level changes using multiple climate models and economic assessment of sea level rise (20 min)

Contributed talks:

- Devendra Rao: Computation of extreme sea levels along the Indian coasts due to tropical cyclones in probabilistic climate risk scenario (15 min)
- S. Muis: Mapping Of Coastal Flood Hazard At The Continental To Global-Scale (15 min)
- I. J. Losada: On the Combined Use of Sea Level Rise, Waves and Storm Surges in Impact Assessment and Decision Making (15 min)

10:30 Coffee break
11:00 Poster session
Session 5: Coastal Zone
12:30 Lunch plus Town hall 2
14:00 Oral Session
Session 5(b): Coastal zone
Chairs: R. Nicholls, J. Hinkel, K. McInnes, G. Le Cozannet
Invited talks:

- J. Hinkel: Sea level information for coastal adaptation decision making (20 min)
- K. McInnes: Global to local predictions of sea level, surges and waves (20 min)

Contributed talks:

- M. Esteban: Adapting to sea level rise: Real lessons from examples of land subsidence in Japan, Indonesia and the Philippines (15min)
- R. Bindschadler: What SLR Stakeholders Really Want: We asked! (15min)
- D. Behar: San Francisco's Approach to Sea Level Rise Planning and Science (15min)

15:30 Coffee break
16:00-17:00 Panel discussion on "Sea level rise adaptation in Greater New York: The Response to Sandy and Beyond"
Members: Klaus Jacob (Columbia), Claire Weisz (W X Y architecture + urban design), Joshua DeFlorio (Port Authority of New York and New Jersey);
Facilitator: Robert Nicholls

18:00-21:00 *Public Outreach Event: Sea Level Rise: Causes, Impacts and Options for Solutions*
Perspectives from science and the stakeholder community. This discussion focusses on the causes, impacts and options for solutions on sea level rise features scientists from The Earth Institute and the Lamont-Doherty Earth Observatory as well as members from government, NGOs and the private sector.

- Welcome: Peter Schlosser, Associate Director, The Earth Institute, Columbia University
- Moderator: Gavin Schmidt, The Earth Institute, Columbia University
- Presentations/Discussion

- Science: The foundation - featuring scientists from the Earth Institute and its Lamont-Doherty Earth Observatory
- Stakeholder Panel – including members from government, NGOs and the private sector
- Closing Remarks

DAY 4: Thursday, July 13

09:00 Oral Session
Session 4(c): Contemporary sea level change
Chairs: B. Meyssignac, R. Ponte, J. Church, C. Domingues
Invited talk:

- F. Landerer: Weighing in: Ocean mass changes and their role in understanding sea level (20min)

Contributed talks:

- A. Proshutinsky: Causes and Consequences of Decadal Sea Level Changes in the Arctic Ocean in 1954-2016(15min)
- S. Griffies: Localized Rapid Warming of West Antarctic Subsurface Waters by Remote Winds (15min)
- E. Charles: Observational Constraint On Greenhouse Gas And Aerosol Contributions To Global Ocean Heat Content Changes (15min)
- A. Hu: Role Of Perturbing Ocean Initial Condition On Simulated Regional Sea Level Change (15min)

10:30 Coffee break
11:00 Poster Session:
Session 4(b): Contemporary sea level change
12:30 Lunch
14:00 Oral Session:
Session 6(a): Projections
Chairs: J. Gregory, A. Slangen, D. Stammer, R. von de Wal
Invited talks:

- B. Kopp: Probabilistic Projections of sea level change (20 min)
- A. Slangen: Regional sea-level change projections: Current state and applications (20 min)

Contributed talks:

- X. Zhang: High Resolution Sea Level Projections In The 21st Century (15 min)
- M. Palmer: Towards CMIP5-based Multi-Century Regional Sea Level Projections (15 min)
- H. Goelzer: Results Of The Greenland Ice Sheet Model Initialisation Experiments ISMIP6 – initMIP-Greenland (15 min)

15:30 Coffee break
16:00-17:30 Poster Session
Session 6: Projections
18:00 Conference Dinner: Optional Dinner Cruise:

Join us for a dinner cruise aboard the Hornblower Infinity, leaving from 353 West Street, Pier 40, NYC. With views of the Manhattan skyline, the Statue of Liberty, Ellis Island, and the Brooklyn Bridge, the tour includes a three-course meal, wine, beer, and live DJ for after-dinner dancing.

DAY 5: Friday, July 14

08:30 Oral session:

Session 6(b): Projections
Chairs: J. Gregory, A. Slangen, D. Stammer, R. von de Wal
Invited talks:

- J. Gregory: The characteristics and uncertainties of sea level change due to ocean climate change (20 min)
- R. Winkelmann: Projecting the long-term sea-level contribution from Antarctica (20 min)

Contributed talks:

- J. Krasting: Enhanced Atlantic sea-level rise under high carbon emission rates (15 min)
- S. Price: Antarctic Ocean-Ice Shelf Interactions In High-Resolution, Global Simulations Using The Accelerated Climate Model For Energy (ACME) (15 min)
- Sophie Nowicki: Overview of the Ice Sheet Model Intercomparison Project for CMIP6 (ISMIP6) (15 min)
- Carmen Boening: On the application of science systems engineering and uncertainty quantification for ice sheet science and sea level projections (15 min)
- M. Terada: Western Boundary Sea-Level: A Theory, Rule of Thumb, and Application to Climate Models (15 min)

10:30 Coffee break
11:00 Closing Session
Chairs: D. Stammer, R. Nicholls, R. van de Wal

- Panel Discussion: Sea-Level Information Requirements to Support Coastal Management
- M. Rahman, M. Snoussi, A. Shareef, K. Horsburgh, P. Teatini, D. de Gusmao-Sorensen, K. White. A. Cazenave
-
- Conference Statement (Chairs)
- Discussion
- Poster Awards (Mike Patterson)
- Summary of conference (Conference Chairs)

13:00 Closing the Meeting

Annex 2 Steering Committee

Co-Chairs Robert Nicholls, Roderik van de Wal, and Detlef Stammer

Members Thorkild Aarup, Anny Caszenave, John Church, Gonéri Le Cozannet, Catia Domingues, Natalya Gomez, Jonathan Gregory, David Holland, Kevin Horsburgh, Kathy McInnes, Benoit Meyssignac, Ayako Abe-Ouchi, Tony Payne, Rui Ponte, Mark Tamisiea, Pietro Teatini, A.S. Unnikrishnan, Jianjun Yin

Local Organizing Committee

Chair *Peter Schlosser*

Members Robin Bell, Jérôme Benveniste, Nico Caltabiano, Gregory Fienhold, Jennifer Genrich, Lei Han, Catherine Michaut, Mike Patterson, Anne-Lisa Pichler, Maureen Raymo, Jill Reisdorf, Cynthia Rosenzweig, Mike Sparrow, Detlef Stammer, Marco Tedesco, Kristan Uhlenbrock, Pamela Vreeland, Haili Wang

Annex 3 List of Participants

Last name	First name	Organisation	Country
Aarup	Thorkild	Intergovernmental Oceanographic Commission	France
Aboagye	Charles	MINISTRY OF FOOD AND AGRICULTURE	Ghana
Aboko	Abu Baba	MINISTRY OF FOOD AND AGRICULTURE	Ghana
Adam	Zainab	MINISTRY OF FOOD AND AGRICULTURE	Ghana
Adekuajo	Gbenga Samuel	WORLD METEOROLOGICAL ORGANIZATION, SUB - REGIONAL OFFICE FOR NORTH, CENTRAL AFRICA & WESTERN AFRICA, ABUJA, NIGERIA	Nigeria
Adhikari	Surendra	California Institute of Technology	United States
Akhighu	Andrew Ehiabhi	PI MOFF RESOURCES NIGERIA LIMITED	Nigeria
Akinyemi	Marvel	Covenant University, Ota, Nigeria	Nigeria
Al Ansari	A Rahman	CIVIL AVIATION AUTHORITY	Qatar
Alakkat	Unnikrishnan	CSIR-National Institute of Oceanography	India
Albert	Mary	Dartmouth	United States
Albert	Simon	The University of Queensland	Australia
Albrecht	Frauke	Millennium Institute of Oceanography	Chile
Alexander	Patrick	NASA Goddard Institute for Space Studies	United States
Amaral De Figueiredo	Salette	FURG	Brazil
Ambarukhana	Devendra Rao	Indian institute of Technology Delhi	India
Andersen	Kaija Jumppanen	Danish Coastal Authority	Denmark
Anderson	Tiffany	University of Hawaii at Manoa	United States
André	Gaël	Shom	France
Anselme	Brice	University Paris 1 Panthéon - Sorbonne	France
Appeaning Addo	Kwasi	University of Ghana	Ghana
Archambault	Heather	NOAA Climate Program Office	United States
Ashe	Erica	Rutgers University	United States
Awitty	Chantal	WORLD METEOROLOGICAL ORGANIZATION, SUB - REGIONAL OFFICE FOR NORTH, CENTRAL	Nigeria

		AFRICA & WESTERN AFRICA, ABUJA, NIGERIA	
Azeez	Olayiwola Ademola	Obafemi Awolowo University	Nigeria
Baidya	Haragobinda	Minority Self Empowerment foundation	Bangladesh
Bamber	Jonathan	University of Bristol	United Kingdom
Baringer	Molly	NOAA	United States
Bartholet	Alan	University of Ottawa	Canada
Behar	David	San Francisco Public Utilities Commission	United States
Bell	Robin	Lamont-Doherty Earth Observatory	United States
Bender	Maren	University Bremen	Germany
Benveniste	Jérôme	European Space Agency (ESA)	Italy
Berends	Tijn	Utrecht University	Netherlands
Bindschadler	Robert	SEARCH	United States
Boeira Dias	Fabio	University of Tasmania	Australia
Boening	Carmen	JPL/Caltech	United States
Bohoslavets	Mykola	International Center for diplomatic cooperation	Ukraine
Bott	Lisa-Michéle	University of Cologne	Germany
Brasseur	Guy	Max Planck Institute for Meteorology	Germany
Braun	Boris	University of Cologne	Germany
Buchanan	Maya	Princeton University	United States
Bunting-Howarth	Katherine	NY Sea Grant	United States
Callery	Nancy	STV Inc.	United States
Caltabiano	Nico	International CLIVAR Project Office	United Kingdom
Cane	Mark	LDEO	United States
Carraro	Filippo	Università degli Studi di Padova	Italy
Carson	Mark	University of Hamburg	Germany
Cashman	Miranda	Columbia University	United States
Cazenave	Anny	CNES	France
Chambers	Don	University of South Florida	United States
Charles	Elodie	CLS	France
Chaudhari	Kalpana	Institute For Sustainable Development and Research ,ISDR,India	India
Chen	Nan	University of Daleware	United States
Cheng	Helen	New York Sea Grant - Science and Resilience Institute at Jamaica Bay	United States
Cheng	Xuhua	Hohai University	China
Church	John	University of New South Wales	Australia
Crout	Richard	Naval Research Laboratory	United States

Cullather	Richard	University of Maryland at College Park	United States
Cutler	Emma	Dartmouth College	United States
Dabhi	Madhavi	KSKV Kachchh University	India
Dangendorf	Sönke	University of Siegen	Germany
Das	Indrani	Lamont Doherty Earth Observatory	United States
Davis	James	Lamont-Doherty Earth Observatory of Columbia University	United States
de Boer	Bas	Utrecht University	Netherlands
de Gusmão-Sørensen	Diogo	European Commission	Belgium
De Winter	Renske	Utrecht University	Netherlands
Dean	Cornelia	The New York Times	United States
DeFlorio	Josh	Port Authority of NY & NJ	United States
Dentzien Dias	Paula	Universidade Federal do Rio Grande	Brazil
DiFilippo	Robert	Loughborough University	United States
Domingues	Catia	University of Tasmania	Australia
Domingues	Ricardo	NOAA Atlantic Oceanographic and Meteorological Laboratory	United States
Donato	Vincent	Shom	France
Du	Ling	Ocean University of China	China
Durack	Paul	Lawrence Livermore National Laboratory	United States
Durand	Gael	IGE/CNRS	France
Durand	Paul	University Paris 1 Pantheon-Sorbonne	France
Dutton	Andrea	University of Florida	United States
Edwing	Richard	NOAA	United States
Englander	John	International Sea Level Institute	United States
Esteban	Miguel	The University of Tokyo	Japan
Esu	Paul Malachi	LAGOS STATE RESIDENTS REGISTRATION AGENCY	Nigeria
Ewuah	Richard	MINISTRY OF FOOD AND AGRICULTURE	Ghana
Falcon	Peter	NASA/JPL	United States
Fang	Jiayi	Beijing Normal University; University of Southampton	United Kingdom
Fenoglio	Luciana	University of Bonn	Germany
Ferrero	Bruno	University of Sao Paulo	Brazil
Fields	Robert	STV Inc	United States
Focazio	Paul	New York Sea Grant	United States
Fongo	Mohammed-Sadat	MINISTRY OF FOOD AND AGRICULTURE	Ghana
Forget	Gaël	Massachusetts Institute of Technology	United States
Frederikse	Thomas	Delft University of	Netherlands

		Technology	
Fu	Lee-Lueng	Jet Propulsion Lab	United States
Fu	Shuqing	Guangzhou Institute of Geography	China
Fukumori	Ichiro	Jet Propulsion Laboratory, California Institute of Technology	United States
García-Artola	Ane	Rutgers University	United States
Garner	Andra	Rutgers University	United States
Gehrels	Roland	University of York	United Kingdom
Geller	Laurie	National Academy of Sciences	United States
Genrich	Jennifer	Columbia University	United States
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Gulledge	Olivia	Wesley College	United States
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Haigh	Ivan	University of Southampton	United Kingdom
Hall	Dorothy	Michigan State University	United States
Hamlington	Benjamin	Old Dominion University	United States
Hammarklint	Thomas	Swedish Maritime Administration	Sweden
Han	Guoqi	Fisheries and Oceans Canada	Canada
Han	Lei	International CLIVAR Project Office	China
Han	Weiqing	The University of Colorado	United States
Hausman	Jessica	JPL	United States
Hay	Carling	Harvard University	United States
Heimbach	Patrick	University of Texas at Austin	United States
Hendry	Alistair	University of Southampton	United Kingdom
Hijma	Marc	Deltares	Netherlands
Hill	Katherine (Katy)	World Meteorological Organisation	Switzerland
Hinkel	Jochen	Global Climate Forum	Germany

		(GCF)	
Hock	Regine	University of Alaska Fairbanks	United States
Holinde	Lars	German Federal Institute of Hydrology (BfG)	Germany
Holochuck	Nordica	New York Sea Grant	United States
Hom	Victor	NOAA	United States
Hong	Bo	South China University of Technology	China
Horsburgh	Kevin	National Oceanography Centre	United Kingdom
Horton	Benjamin	Nanyang Technological University	United States
Horwath	Martin	Technische Universität Dresden	Germany
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Huang	Guangqing	Guangzhou Institute of Geography	China
Huang	Jin	NOAA	United States
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Ishii	Masayoshi	MRI/JMA	Japan
Jackson	Luke	Oxford University	United Kingdom
Jacob	Klaus	Columbia University	United States
Jeong	Kwang-Young	Korea Hydrographic and Oceanographic Agency	South Korea
Jevrejeva	Svetlana	National Oceanography Centre	United Kingdom
Jungclaus	Johann-Hinrich	Max Planck Institute for Meteorology	Germany
Kabiling	Michael	Taylor Engineering, Inc.	United States
Kang	Taesoon	GeoSystem Research Corporation	South Korea
Kanikicharla	Krishna Kumar	Qatar Meteorology Department	Qatar
Kankam	Akwasi	MINISTRY OF FOOD AND AGRICULTURE	Ghana
Kenigson	Jessica	University of Colorado Boulder	United States
Khan	Nicole	US Geological Survey	United States
Kim	Youngmi	NIMS/KMA	South Korea
King	Matt	University of Tasmania	Australia
Kirby	Jason	Liverpool John Moores University	United Kingdom
Kleinherenbrink	Marcel	Delft University of Technology	Netherlands
Knudsen	Per	DTU space	Denmark
Koch	Dorothy	U.S. Department of Energy	United States
Koehl	Armin	University Hamburg	Germany
Komis	Ioannis	Utrecht University	Netherlands

Kondrashov	Dmitri	UCLA	United States
Kopp	Robert	Rutgers University	United States
Krasting	John	NOAA-GFDL	United States
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Kumar	Pavan	Kumaun University	India
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Laignel	Benoit	University of Rouen	France
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Le Bars	Dewi	Royal Netherlands Meteorological Institute (KNMI)	Netherlands
Le Cozannet	Goneri	BRGM	France
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Legler	David	NOAA	United States
Lentz	Erika	U.S. Geological Survey	United States
Limonadi	Daniel	JPL	United States
Lincke	Daniel	Global Climate Forum Adaptation and Social Learning	Germany
Lipovsky	Brad	Harvard University	United States
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Liu	Kexiu	National Marine Data & Information Service, China	China
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Losada	Iñigo	Fundacion Instituto de Hidraulica Ambiental de Cantabria	Spain
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Mamnun	Nabir	Institute of Marine Sciences and Fisheries	Bangladesh
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Marcy	Douglas	National Oceanic and Atmospheric Administration	United States
Marques	Gustavo	Princeton University	United States
Marra	John	NOAA	United States
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Naish	Tim	Victoria University of Wellington	New Zealand
Narayan	Siddharth	UC Santa Cruz	United States
Nauels	Alexander	University of Melbourne	Australia
Nerem	Robert Steven	University of Colorado	United States
Newton	Alicia	Nature Geoscience	United Kingdom
Nicholls	Robert	University of Southampton	United Kingdom
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Obeysekera	Jayantha	South Florida Water Management District	United States
Ojha	Sayantani	University of Hamburg	Germany
Ojo	Afolabi Micheal	AKINADE NIGERIA LIMITED	Nigeria
Olabode	Victor Ade	WORLD METEOROLOGICAL ORGANIZATION, SUB - REGIONAL OFFICE FOR NORTH, CENTRAL AFRICA & WESTERN AFRICA, ABUJA, NIGERIA	Nigeria

Oladokun	Olanrwaju	University Malaysia Terengganu	Malaysia
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Ozturk	Leyla	İndividually	Turkey
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Palko	Diane	University of Miami	United States
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Passaro	Marcello	Deutsches Geodätisches Forschungsinstitut der Technischen Universität München	Germany
Patterson	Mike	US CLIVAR	United States
Pattyn	Frank	Université libre de Bruxelles	Belgium
Patwardhan	Mamta	The Kamla Raheja Vidyanidhi Institute for Architecture and Environmental Studies (KRVIA),	India
Pemha Thina	Lebeau	AIPEA - AIPIA	France
Peng	Dongju	Earth Observatory of Singapore, Nanyang Technological University	Singapore
Persad	Rameez	Institute of Marine Affairs	Trinidad and Tobago
Peteet	Dorothy	NASA/Goddard Institute for Space Studies	United States
Petersen	Mark	Los Alamos National Laboratory	United States
Pichler	Anne Lisa	Nikal FM S.r.l.	Italy
Piecuch	Christopher	Atmospheric and Environmental Research, Inc.	United States
Poitevin	Cyril	University of La Rochelle	France
Ponte	Rui	Atmospheric and	United States

		Environmental Research, Inc.	
Preston	Kurt	SERDP / ESTCP	United States
Price	Stephen	Los Alamos National Laboratory	United States
Proshutinsky	Andrey	Woods Hole Oceanographic Institution	United States
Radtke	Hagen	NOCS	United Kingdom
Rahman	Md. Munsur	Bangladesh University of Engineering and Technology	Bangladesh
Rani	Meenu	G.B. Pant National Institute of Himalayan Environment & Sustainable Development	India
Ransibrahmanakul	Varis	NOAA	United States
Ray	Richard	NASA	United States
Raymo	Maureen E.	Columbia University	United States
Reisdorf	Jill	UCAR	United States
Rezaie	Ali Mohammad	George Mason University	United States
Rhein	Monika	University Bremen	Germany
Richards	Geoffrey	University of York	United Kingdom
Richter	Kristin	University of Innsbruck	Austria
Ringler	Todd	Los Alamos National Laboratory	United States
Rohmer	Jeremy	BRGM	France
Rovere	Alessio	University of Bremen	Germany
Royston	Samantha	University of Tasmania	Australia
Saenko	Oleg	Canadian Centre for Climate Modelling and Analysis	Canada
Said	Mohamed	National Institute of Oceanography and Fisheries (NIOF)	Egypt
Salifu	Mohammed Awal	MINISTRY OF FOOD AND AGRICULTURE	Ghana
Salvadori Olsen	Walkiria	Federal University of Rio Grande	Brazil
Sandstrom	Michael	Columbia University	United States
Santamaría-Gómez	Alvaro	Observatoire Midi-Pyrenees, Universite de Toulouse	France
Sasaki	Yoshi	Hokkaido University	Japan
Sasgen	Ingo	Alfred Wegener Institute	Germany
Schaefer	Joerg	Columbia University	United States
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