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# Report of the Fourth WCRP Grand Challenge on Regional Sea Level Change and Coastal Impacts

14-15 November 2019, Orléans, France



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## Executive Summary

The 2019 meeting of the WCRP Grand Challenge on Regional Sea Level and Coastal Impacts was held over four days, with the first two days focused on the links between science and coastal climate services. The workshop, which was organized in association with IOC/GLOSS, WMO and CLIVAR focused on stimulating the uptake of coastal climate services, how they support present days and future coastal resilience, and making recommendations as to the best way forward. Outcomes included a plan for a special issue for which at least 6 papers are proposed and a summary paper about the use of sea-level rise scenarios, which builds on earlier Grand Challenge contributions in this area. Detailed outcomes are outlined in a separate report.

This report focuses on the Outcomes and Actions from the Steering Meeting of the Grand Challenge. The presentations (when permission is given) from the workshop are available from <http://www.clivar.org/events/workshop-wcrp-grand-challenge-and-climate-services>.



Participants of the Fourth WCRP Grand Challenge on Regional Sea Level Change and Coastal Impacts, 14-15 November 2019, Orléans, France. See Annex 1 for an annotated version.

## Contents

<b>1. Goals of the meeting</b>	<b>1</b>
<b>2. Reflections on the Climate Services Workshop</b>	<b>1</b>
<b>3. Presentations from the Work Programmes of the Grand Challenge as well as invited experts</b>	<b>1</b>
3.1. WP1 An integrated approach to paleo time scale sea level estimates - Thomas James, Roderik van de Wal	1
3.2. WP2 Quantifying the contribution of land ice to near-future sea level rise – Tony Payne	2
3.3. WP3 Causes for contemporary regional sea level variability and change - Rui Ponte, Benoit Meyssignac, Catia Domingues, Detlef Stammer	2
3.4. WP4 Predictability of regional sea level – Jonathan Gregory	2
3.5. WP5 Sea level science for coastal zone management	3
3.6. WP6 Sea level budget	3
<b>4. Discussions and the Way Forward</b>	<b>4</b>
4.1. Leadership of the Grand Challenge	4
4.2. Next conference	4
4.3. Priorities in WP activity, membership and Leadership	4
4.4. Next annual meeting	4
<b>Annex 1 - Agenda of the Climate Service Workshop</b>	<b>6</b>
<b>Annex 2 – List of Participants for the Climate Service Workshop</b>	<b>9</b>
<b>Annex 3 – Agenda of the SL GC Meeting</b>	<b>10</b>
<b>Annex 4 – List of Participants for the SL GC Meeting</b>	<b>11</b>

## 1. Goals of the meeting

Roderik V d W outlined the aims and structure of the meeting over the coming two days, based upon the agenda outlined in the Appendix. He highlighted that we needed to discuss replacing Detlef S as a third co-chair and the planning of a possible conference in Singapore.

## 2. Reflections on the Climate Services Workshop

Rob N organized a drafting team to take the lead on a paper reflecting the outcomes of the workshop, though it was noted that the potential author list would be much larger.

Goneri Le C highlighted that they would also look into the possibility of producing a special issue highlighting a number of aspects raised during the workshop. In December a decision would be made with regards to which papers to move forward with, which journal submit to etc., with a request around mid Feb for extended abstracts (likely 6-10 papers in total).

**ACTION:** Goneri to look into possible journals etc. for a special issue around the outcomes of the workshop. Participants to respond to Goneri with regards to possible papers to be included (mid December; Goneri and workshop participants)

David B gave a short reflection on the workshop from a user/decision maker perspective. He noted that communication and collaboration has improved noticeably, though there is more to be done. There are still disconnects that are causing confusion. For example, are probabilistic projections providing decision makers with what they need? We should bring more decision makers to the planned conference and to the GC meetings. They need to be actively engaged in workshop planning. The suggestion was made that we consider producing a policy brief from any journal article.

**ACTION:** GC Chairs to consider how to engage more decision-makers in next GC meeting (Chairs; in advance of next meeting)

**ACTION:** GC Members to consider production of policy brief from the main paper highlighting the outcomes of the workshop (GC Chairs and members; once journal article drafted)

## 3. Presentations from the Work Programmes of the Grand Challenge as well as invited experts

### 3.1. WP1 An integrated approach to paleo time scale sea level estimates - Thomas James, Roderik van de Wal

Thomas gave an overview of progress with WP1, including interactions with other organisations such as SCAR. Highlighting how Glacial Isostatic Adjustment plays an important role in understanding sea level, he summarized the key research areas being focused on:

- impact of 3D earth structure
- ice dynamic-GIA feedbacks
- importance of low viscosity regions
- data inversion approaches

Bette Otto-Bliesner also presented on CESM2-CISM2 simulations, focusing on Greenland Ice mass loss. She highlighted out comes in Nature Communications “Asynchronous Antarctic and Greenland ice-volume contributions to the last interglacial sea-level highstand” Rohling et al.

### **3.2. WP2 Quantifying the contribution of land ice to near-future sea level rise – Tony Payne**

Tony presented progress with WP2. This has focused on quantifying the contribution of land ice to future sea level rise. The main deliverables have been achieved via ISMIP6 & CliC.

- ISMIP6 has been successful in linking the CMIP and ice sheet modelling communities
- Spawned additional research on the ocean and atmospheric forcing of the ice sheets
- SLR Projections for IPCC AR6 albeit based on CMIP5 forcing
- Limited number of projections using CMIP6
- The first results for interactively coupled ice sheets within IPCC class ESMs

### **3.3. WP3 Causes for contemporary regional sea level variability and change - Rui Ponte, Benoit Meyssignac, Catia Domingues, Detlef Stammer**

Catia presented an update on WP3, highlighting a number of science journals, contributions to the IPCC process, workshops and meetings. A number of potential future workshops were suggested, including:

- Understanding and reducing uncertainties in mass and steric contributions to contemporary sea level budget (Global (WP6), regional to local spatial scales): improving datasets, budget assessments
- Understanding role of coastal and ocean interior processes on local sea level (e.g. shelf sea dynamics, ocean mixing, freshwater input, etc.): ISSI review
- Understanding role of natural variability (including known climate modes) on sea level: ISSI review
- Attribution of regional sea level change to natural (e.g., solar, volcanic) and anthropogenic (e.g., tropospheric aerosols, greenhouse gases) radiative forcing agents
- Requirements for an optimal and integrated (satellite and ground based) sea level observing system: OCEANOBS'19 review

### **3.4. WP4 Predictability of regional sea level – Jonathan Gregory**

Jonathan summarized progress with WP4 on predictability of Regional Sea Level:

- FAFMIP results indicate that the spread of ocean heat uptake efficiency is due to efficiency of passive tracer uptake, probably due to parametrised eddies.
- Comparison of FAFMIP and 1pctCO2 results indicate that the spread of patterns of ocean dynamic sea level rise is intrinsic to the response of the ocean models, especially to surface heat flux perturbation.

- Projections consistent with AR5 can be estimated for SSPs using the two-box model or the step model. GMSLR by 2100 is 0.05 m less for SSP1.9 than 2.6, and very similar in SSP8.5 and RCP8.5.
- Regional projections using extended AR5 methods have been estimated to 2300 with consistent treatment of regional uncertainty.
- Up to 2100, the dominant uncertainty depends on location. By 2300, Antarctic ice sheet dynamics is the dominant uncertainty practically everywhere.

### 3.5. WP5 Sea level science for coastal zone management

Scott Stephens presented on WP5 from the perspective of New Zealand adaptation. In summary:

- Historic sea-level rise is already causing problems in NZ
- NZ will experience impacts in the near decades from modest SLR
- Banking and insurance sectors are concerned with the short-medium term (present to 2050)
- Uncertainties and constraints for near-term decision-making are socio-economic, not physical
- Simple coastal climate services are in demand – they are understandable and communicate the science to facilitate action

Kathy McInnes presented on the development of a decision support system for end users, with an example of the Port Phillip Bay Coastal Hazards Assessment:

- The PPB coastal hazard assessment is focusing on inundation, erosion and groundwater hazards in the context of various sea level rise scenarios
- Time frames of sea level rise and uncertainties in projections are of secondary importance
- A coastal climate service is being co-developed with end-users to ensure maximum relevance for decision making
- The main characteristics required of the service are the housing of multiple spatial datasets relating to landform, land-use, land-use change, infrastructure, hazard (erosion, inundation and groundwater), exposure and sensitivity to future SLR

### 3.6. WP6 Sea level budget

Roderik gave a short presentation on WP6 on behalf of Anny Cazenave. WP6 is currently contributing to the WMO Statement on the State of the Global Climate 2019. WP6 will start in early 2020 a new assessment of the global mean sea level budget (update of the WCRP, ESSD, 2018 paper) with updated values for the components over an extended time period. Ocean reanalyses will be also considered for the steric component.

Garry Mitchum also presented on GLOSS, the Global Sea Level Observing System, highlighting progress with the GLOSS webpages, data access etc.

Bob Kopp gave an additional requested presentation on AR6 developments of relevance to the GC, including work in progress, key dates etc. In particular he highlighted:

- Sea level budget
- Literature context of sea-level projections Long-term sea-level commitments
- New sea-level rise projections framework

## 4. Discussions and the Way Forward

### 4.1. Leadership of the Grand Challenge

Detlef is now leading the JSC and stepped down as a chair of the GC. After some discussion the proposal is to add David Behar to the team of co-chairs to strengthen the user engagement of the challenge and further improve our understanding of the links from sea-level science to application.

**ACTION:** GC Members to give their views on including David Behar as a third co-chair to strengthen user engagement (All; before end November)

### 4.2. Next conference

The GC members continued the discussion around the second big sea level conference which should finalise the grand challenge, at least in its present form. The proposal is to organise it in July 2022 in Singapore (after the release of AR6-WG2, in Asia because of the large vulnerability). Local organizers will be Erland Kallen, Svetlana Jevrejeva Climate Centre Singapore and Ben Horton University Singapore.

**ACTION:** GC Co-Chairs to contact the local organisers by 1<sup>st</sup> December and to update the rest of the GC Members (GC co-chairs: 1<sup>st</sup> December)

### 4.3. Priorities in WP activity, membership and Leadership

As WRCR moves ahead with the development of its Implementation Plan (<https://www.wcrp-climate.org/wcrp-ip-overview>) its important that the GC provides input and formulates how its sees its priorities in the future. To help this, we would like to get from each WP 1 slide on priorities for the coming years and 1 slide with plans/activities to achieve these goals and also consider possible interactions with other WPs, as well as other grand challenges and WRCR activities.

**ACTION:** WP leads to provide 1 slide on priorities for the coming years and 1 slide with plans/activities to achieve these goals and also consider possible interactions with other WPs, as well as other grand challenges and WRCR activities (WP leads; by end of the year)

The suggestion was also made that we review the membership and look for new members, including early career researchers. Please provide names linked to specific WPs. Also review leadership of the WP as appropriate.

**ACTION:** Each WP to suggest new membership (in particular Early Career Researchers) and to review the leadership of the WP as appropriate (All; by Feb 2020)

### 4.4. Next annual meeting

Thomas James has kindly offered to host the next meeting in autumn 2020 in Victoria, Canada. The meeting will be combined with a workshop for which the theme needs to be defined, possibly around the Arctic and/or end user needs for sea-level science.

**ACTION:** GC Members to discuss the theme of the next workshop, possibly around engaging Arctic communities and/or end user needs to sea level science (All; by end of the year)

## Annex 1 - Agenda of the Climate Service Workshop

### Workshop on WCRP Grand Challenge and Climate Services

BRGM, Orléans, France, 12 -13<sup>th</sup> November 2019

The **WCRP** Grand Challenge on Regional Sea Level Change and Coastal Impacts<sup>1</sup> has inspired efforts to link sea-level science and climate services<sup>2</sup>. This recognises that coastal zones are strongly in need of coastal climate services (CCS) to support adaptation planning, as they are increasingly threatened by sea level rise and its impacts, such as submergence, flooding, shoreline erosion, salinization and wetland change. To this end, we have reviewed the development of CCS, and identified the research and development efforts needed to overcome barriers to progress and facilitate progress. These include: (1) research in the field of sea level, coastal and adaptation science and (2) cross-cutting research in the area of user interactions, decision making, propagation of uncertainties and overall service architecture design. As a number of projects are currently developing CCSs in a number of countries and regions (e.g. USA, Australia, Europe - Copernicus, ERA4CS...), there is **a need to assess how this research meets the challenges identified above and how it is being transferred to operations.**

This **workshop** will be designed to link these efforts across the Grand Challenge and more widely with our Stakeholder and to develop a manifesto to take this issue forward. This manifesto will re-assess how to stimulate the uptake of CCSs, how they support present days and future coastal resilience, and make recommendations as to the best way forward. The manifesto would be published as a journal paper. The workshop is organized in association with **IOC/GLOSS, WMO** and **CLIVAR**.

To achieve this aim, the workshop will address the following topics:

- Assessments of the current status of coastal climate services
- Identification and mapping of users
- Identification and analysis of needs for different types of users (e.g., insurance, critical infrastructures or settlements, observation needs...)
- Review of existing practices and how they can be improved
- Translating sea-level science to operations and communicating uncertainties
- Potential Framework for coastal climate services

The **target audience** are members of the WCRP Sea Level and Coastal Impacts Grand Challenge (in particular WP5), as well as a number of invited participants with experience in several projects on coastal climate services involving stakeholders such as coastal planners and engineers and e.g. the Global Framework for Climate Services at WMO. To maximize efficiency, the target number of participants is 25 approximately.

The workshop addresses an important and timely issue because the economic model of climate services, including at the coast, is being defined now. It anticipates future milestones relevant to the WCRP Grand Challenge, such as conferences providing scientifically sound sea-level information to coastal adaptation practitioners. Finally, we believe that **publicizing the results of the workshop as a manifesto in a high impact scientific journal** is effective to inform future research supporting the development of CCS.

Organizing committee: Robert Nicholls (Univ. Southampton), Gonéri Le Cozannet (BRGM), Detlef Stammer (Univ. Hamburg), Roderik Van De Wal (Univ. Utrecht), Michael Sparrow (WCRP), Kate Hill (GOOS/GCOS), Julie Billy (BRGM), Jing Li (Clivar)

<sup>1</sup> <https://www.wcrp-climate.org/gc-sea-level>

<sup>2</sup> See e.g. <https://doi.org/10.3390/jmse5040049>



## PROGRAM OF THE WCRP CLIMATE SERVICES WORKSHOP BRGM, ORLÉANS, FRANCE, 12-13<sup>TH</sup> NOVEMBER 2019

TUESDAY 12<sup>TH</sup> NOVEMBER

SESSION			
8H00		<i>SHUTTLE TO THE BRGM</i>	
8H30	<u>WELCOME</u>	<i>MEETING POINT IN THE CITY CENTER AT THE CATHEDRAL</i>	
9H00		BRGM REGISTRATION AND COFFEE	
	<u>INTRODUCTION</u>	<b>WELCOME: PHILIPPE FREYSSINET (BRGM)</b>	
		<b>WCRP CONTEXT: ROBERT NICHOLLS AND RODERIK VAN DE WAL</b>	
		<b>WORKSHOP OBJECTIVES: GONÉRI LE COZANNET AND JULIE BILLY</b>	
10H00		<b>ANGELIQUE MELET - EU COPERNICUS MARINE SERVICE</b>	15'
	<u>SESSION 1:</u>	PRODUCTS AND SERVICES IN RELATION TO SEA LEVEL CHANGES.	
	<u>CURRENT STATUS OF CCS AND PROSPECTS</u>	<b>ROBERT MUIR-WOOD - APPLICATION OF RISK MODELLING</b>	15'
		FOR MEASURING THE COSTS AND IMPACTS OF SEA-LEVEL RISE	
	<u>CHAIR / RAPPORTEUR</u>	<b>MARTA MARCOS - GLOBAL TO LOCAL COASTAL MODELING AS A CLIMATE SERVICE FOR COASTAL ADAPTATION : STATUS AND PERSPECTIVES</b>	15'
10H45		<i>COFFEE BREAK</i>	30'
11H15		<b>DISCUSSION – WHAT IS REQUIRED BEYOND CURRENT COASTAL CLIMATE SERVICES?</b>	1H30
12H45		<b>LUNCH</b>	1H30
14H15		<b>JONATHAN SIMM – EXPERIENCE FEEDBACK WITH COASTAL CLIMATE SERVICES AT USACE AND UK ENVIRONMENT AGENCY</b>	15'
		<b>MATT CAMPO – USERS AND USES OF SEA LEVEL RISE INFORMATION: A TYPOLOGY</b>	15'
14H45	<u>SESSION 2:</u>	<b>DISCUSSION - IDENTIFICATION AND MAPPING OF USERS</b>	1H00
15H45	<u>USERS AND THEIR NEEDS</u>	<i>COFFEE BREAK</i>	30'
16H15		<b>JOCHEN HINKEL – METHODS FOR IDENTIFYING WHAT KIND OF SEA LEVEL RISE INFORMATION USERS NEED: EXPERIENCES FROM THE INSEAPTION PROJECT</b>	15'
	<u>CHAIR / RAPPORTEUR</u>	<b>PAUL BOWYER – ANALYSIS OF SECTORAL USER NEEDS AND AN EXAMPLE CLIMATE SERVICE</b>	15'
		<b>KATHLEEN MCINNES –THE PORT PHILLIP BAY COASTAL HAZARD ASSESSMENT: TOWARDS THE DEVELOPMENT OF A DECISION SUPPORT SYSTEM FOR END-USERS</b>	15'
17H00		<b>DISCUSSION - IDENTIFICATION AND ANALYSIS OF USERS' NEEDS</b>	45'
17H45	END		
18H00		<i>SHUTTLE TO THE CITY CENTER AT THE CATHEDRAL</i>	
19H30		<b>DINER IN A RESTAURANT IN THE CITY CENTER – LE VER DI VIN - 2 RUE DES 3 MARIES, 45000 ORLEANS</b>	

## WEDNESDAY 13<sup>TH</sup> NOVEMBER

SESSION			
8H00		<i>SHUTTLE TO THE BRGM MEETING POINT IN THE CITY CENTER AT THE CATHEDRAL</i>	
8H30	<u>WELCOME</u>	BRGM REGISTRATION AND COFFEE	
9H00	<u>SESSION 3:</u> TRANSLATING SEA-LEVEL SCIENCE TO OPERATIONS AND COMMUNICATING UNCERTAINTIES  CHAIR / RAPPORTEUR	<b>JUDY LAWRENCE</b> – MAKING COASTAL CLIMATE SERVICES RELEVANT 15'	
		<b>JEREMY ROHMER</b> – IMPROVING COMMUNICATION BY CLARIFYING THE IMPACT OF EPISTEMIC UNCERTAINTIES ON FUTURE MARINE FLOODING AS SEA LEVEL RISES 15'	
		<b>DAVID BEHAR</b> – SCIENCE TO ACTION: A DECISION MAKER'S PERSPECTIVE ON A WORK IN PROGRESS 15'	
		<b>THOMAS JAMES</b> - COMMUNICATING SEA-LEVEL RISK AND UPDATING NATIONAL GUIDANCE IN THE CONTEXT OF AN UNCERTAIN HIGH-END 10'	
		<b>DISCUSSION - TRANSLATING SEA-LEVEL SCIENCE TO OPERATIONS AND COMMUNICATING UNCERTAINTIES</b> 50	
10H45		COFFEE BREAK	30'
11H15	<u>SESSION 4:</u> INTERACTING WITH USERS  CHAIR / RAPPORTEUR	<b>MARJOLIJN HAASNOOT</b> – ADAPTATION TIPPING POINTS ANALYSIS & EARLY DETECTION OF SIGNAL OF CHANGE: HOW DO THEY FIT WITHIN ADAPTATION PATHWAYS? 15'	
		<b>WILLIAM SWEET</b> - DEVELOPING ANNUAL-TO-DECADAL SL RISE PROJECTIONS FRAMED BY SOCIETAL IMPACT (WEATHER) THRESHOLDS OF NOAA'S NATIONAL WEATHER SERVICE 15'	
11H45		<b>DISCUSSION - INTERACTING WITH USERS: REVIEW OF EXISTING PRACTICES AND METHODS AND HOW THEY CAN BE IMPROVED</b> 1H	
12H45	<b>LUNCH</b>		1H30
14H30	<u>SESSION 5:</u> CCS FRAMEWORK  CHAIR / RAPPORTEUR	<b>ERICA ALLIS</b> - GLOBAL FRAMEWORK FOR CLIMATE SERVICES 20'	
		<b>ROBERT KOPP</b> – COASTAL ADAPTATION DECISIONS, FROM THEORY TO PRACTICE 20'	
		<b>ROBERT NICHOLLS</b> - TOWARD A COMMON FRAMEWORK FOR COASTAL CLIMATE SERVICES? 20'	
		<b>DISCUSSION - FRAMEWORK FOR COASTAL CLIMATE SERVICES – MODERATORS: RODERIK VAN DE WAL, DÉBORAH IDIER</b> 1H00	
16H30	<u>CONCLUSION</u>	WORKSHOP END	
17H30		SHUTTLE TO THE CITY CENTER AT THE CATHEDRAL	

## Annex 2 – List of Participants for the Climate Service Workshop

### LIST OF PARTICIPANTS

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## Annex 3 – Agenda of the SL GC Meeting

### WCRP GRAND CHALLENGE MEETING BRGM, ORLÉANS, FRANCE, 14-15<sup>TH</sup> NOVEMBER 2019

#### THURSDAY 14<sup>TH</sup> NOVEMBER

SESSION			
8H00		<i>SHUTTLE TO THE BRGM MEETING POINT IN THE CITY CENTER AT THE CATHEDRAL</i>	
8H30	<u>WELCOME</u>	BRGM REGISTRATION AND COFFEE	30'
9H00		<b>Goal of the Meeting (RW/RN)</b>	15'
		Reflection on the climate service workshop 12-13 <sup>th</sup> Nov.	1H15
10H30		<i>COFFEE BREAK</i>	30'
	REPORT OF THE DIFFERENT WORKING GROUPS – PART 1	<b>WP1 Paleo sea level - Thomas James,</b> <i>Roderik van de Wal</i>	30'
		<b>WP2 Ice/ISMIP - Tony Payne</b>	30'
		<b>WP3 causes for regional variability and change –</b> <i>Catia Domingues</i>	45'
12H45		LUNCH	1H30
14H30		<b>WP4 Predictability of RSL – Jonathan Gregory</b>	45'
	REPORT OF THE DIFFERENT WORKING GROUPS - PART 2	<b>WP5 Sea Level science for coastal zone management - Scott Stephens NZ adaption</b>	
		<b>WP5 wave in ESL - Kathy McInnes</b>	15'
15H30		<i>COFFEE BREAK</i>	30'
		<b>WP6 Sea Level budget - Roderik on behalf of Anny Cazenave, Garry Mitchum on Gloss</b>	30'
16H00		Presentations of guests to the meeting - <i>Bette Otto- Bliesner</i>	30'
17H30		AR6 developments Bob Kopp <i>SHUTTLE TO THE CITY CENTER AT THE CATHEDRAL</i>	

#### FRIDAY 15<sup>TH</sup> NOVEMBER

SESSION			
8H00		<i>SHUTTLE TO THE BRGM MEETING POINT IN THE CITY CENTER AT THE CATHEDRAL</i>	
8H30	<u>WELCOME</u>	BRGM REGISTRATION AND COFFEE	30'
9H00		Summary of Achievement so far and knowledge gaps Future meetings, Grand Challenge Papers, acknowledgements	1H
10H00		Sea Level Conference in 2022 (RW)	30'
10H30		<i>COFFEE BREAK</i>	30'
11H00		WCRP developments (RN/Michael Sparrow)?	20'
		Organizational aspects of WCRP grand challenge Stepping back of Detlef (RW)	20'
		<b>Next Meeting</b>	1H
12H45	LUNCH	1H30	
14H30		<b>END OF THE MEETING</b> <i>SHUTTLE TO THE CITY CENTER AT THE CATHEDRAL</i>	

## Annex 4 – List of Participants for the SL GC Meeting

### LIST OF PARTICIPANTS

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**The  
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