Climate and Ocean - Variability, Predictability, and Change

40th Session of the WCRP Joint Scientific Committee

Annalisa Bracco & Wenju Cai

May 2019

Geneva, Switzerland

CLIVAR

WORLD METEOROLOGICAL ORGANIZATION

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

International Science Council

WCRP World Climate Research Programme

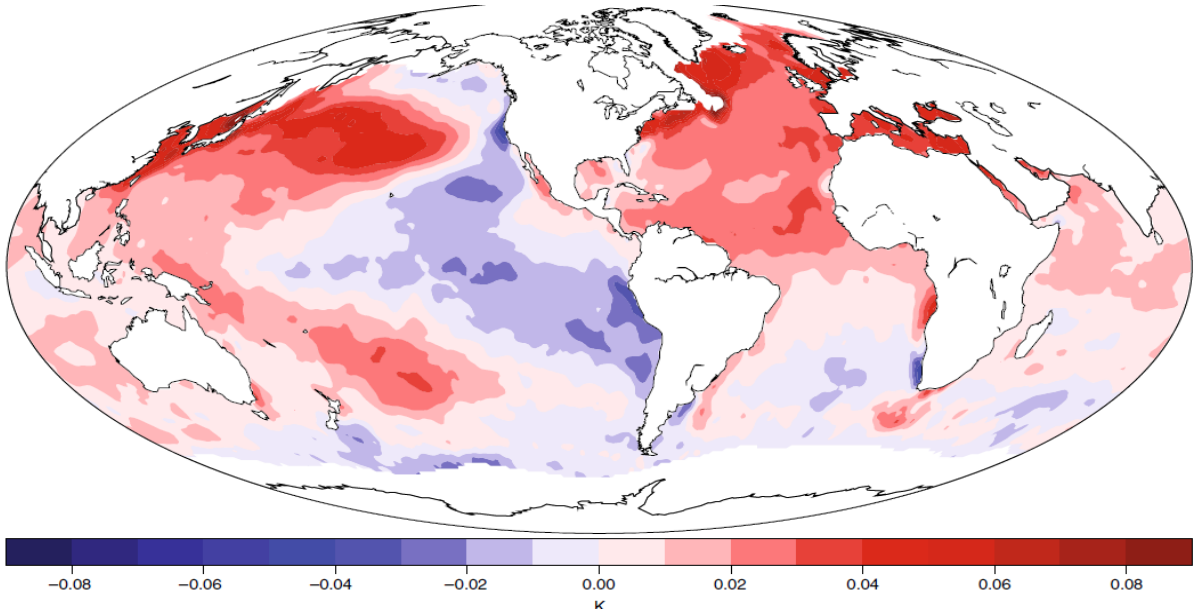
Progress and achievements

Advancement in Science

Published:

1. **Science Directions in a Post COP21 World of Transient Climate Change: Enabling Regional to Local Predictions in Support of Reliable Climate Information** (*Earth's Future,* D. Stammer D., Bracco A. et al.) – by SSG
2. **Challenges and opportunities for improved understanding of regional climate dynamics** (*Nature Climate Change*) – by CDP

Collins et al. NCC, 2018



ENSO RF

ar. Sci.) – by

se warming

d Climate Research Programme

Progress and achievements

Advancement in Science

Published:

1. **Science Directions in a Post COP21 World of Transient Climate Change: Enabling Regional to Local Predictions in Support of Reliable Climate Information** (*Earth's Future,* D. Stammer D., Bracco A. et al.) – by SSG
2. **Challenges and opportunities for improved understanding of regional climate dynamics** (*Nature Climate Change*) – by CDP
3. **Pantropical Climate Interactions** (Science, Cai, W. et al) – by PRP and ENSO RF
3. **Challenges and Prospects in Ocean Circulation Models** (*Front. in Mar. Sci.*) – by OMDP;
4. **Increased variability of eastern Pacific El Nino under greenhouse warming** (*Nature,* Cai W. et al.) by PRP and ENSO RF friends

Ongoing:

1. A 'perspective style' paper by **EBUS RF**;
2. Review on the **Decadal Variability in the Tropical Pacific**

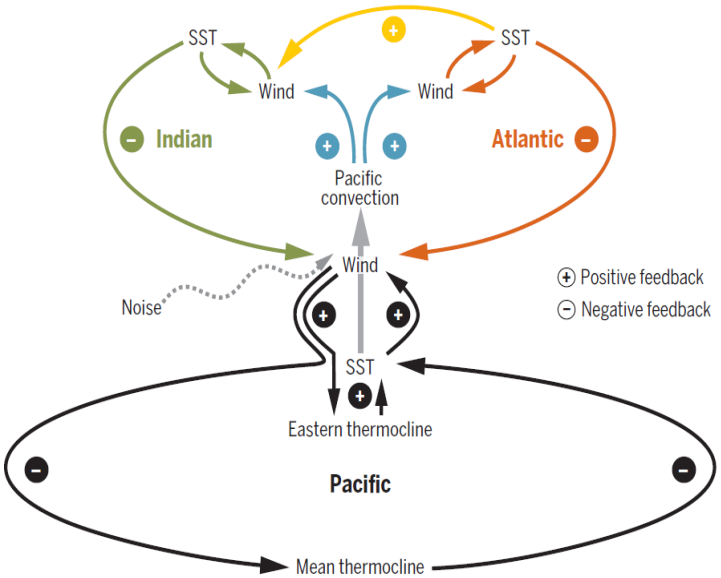
Progress and achievements

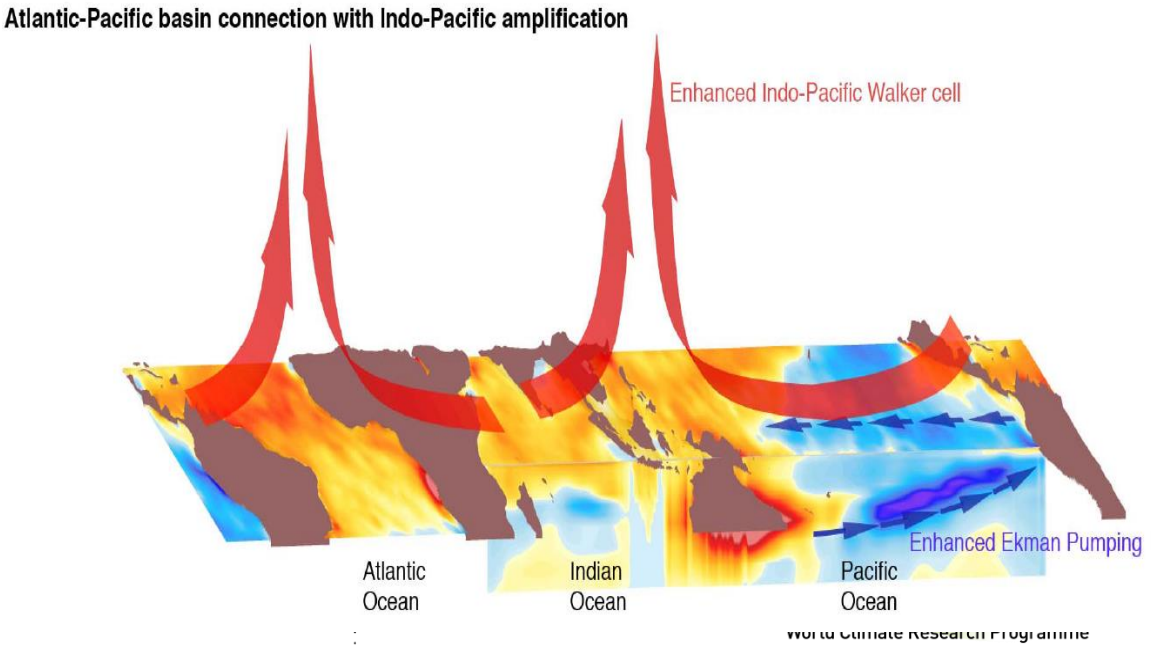
Advancement in Science

Published:

1. **Science Directions in a Post COP21 World of Transient Climate Change: Enabling Regional to Local Predictions in Support of Reliable Climate Information** (*Earth's Future,* D. Stammer D., Bracco A. et al.) – by SSG
2. **Challenges and opportunities for improved understanding of regional climate dynamics** (*Nature Climate Change*) – by CDP
3. **Pantropical Climate Interactions** (Science, Cai, W. et al) – by PRP and ENSO RF

Cai et al. Science 2019





Progress and achievements

Advancement in Science

Published:

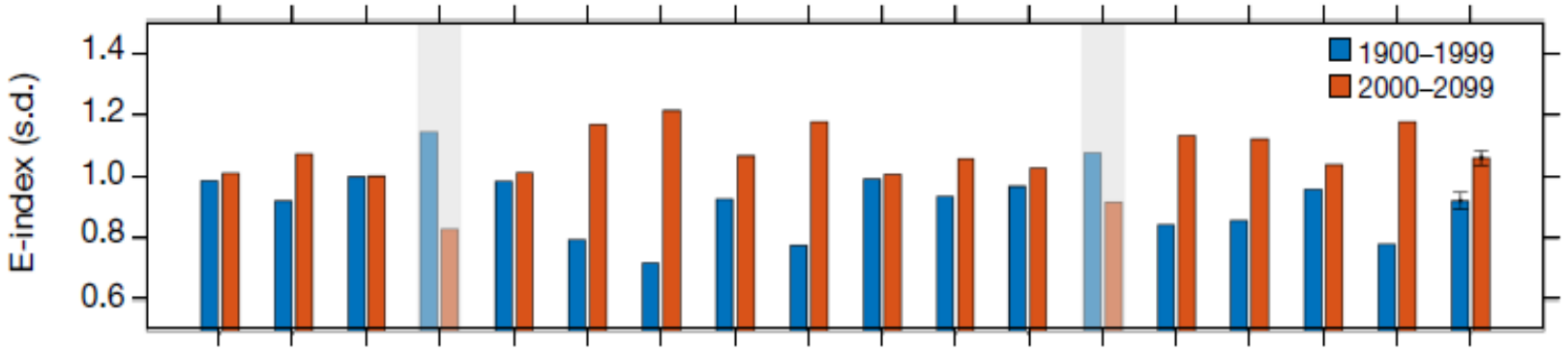
1. **Science Directions in a Post COP21 World of Transient Climate Change: Enabling Regional to Local Predictions in Support of Reliable Climate Information** (*Earth's Future,* D. Stammer D., Bracco A. et al.) – by SSG
2. **Challenges and opportunities for improved understanding of regional climate dynamics** (*Nature Climate Change*) – by CDP
3. **Pantropical Climate Interactions** (Science, Cai, W. et al) – by PRP and ENSO RF
3. **Challenges and Prospects in Ocean Circulation Models** (*Front. in Mar. Sci.*) – by OMDP;
4. **Increased variability of eastern Pacific El Nino under greenhouse warming** (*Nature,* Cai W. et al.) by PRP and ENSO RF friends

Ongoing:

1. A 'perspective style' paper by **EBUS RF**;
2. Review on the **Decadal Variability in the Tropical Pacific**

Cai et al. Nature 2018

Increased Eastern Pacific El Nino Variability



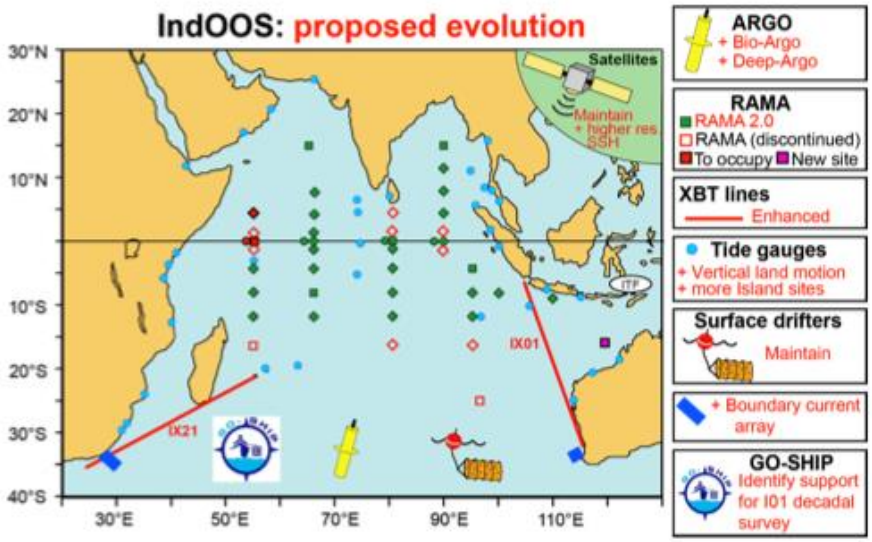
4. **Increased variability of eastern Pacific El Nino under greenhouse warming** (*Nature,* Cai W. et al.) by PRP and ENSO RF friends

Ongoing:

1. A 'perspective style' paper by **EBUS RF**;
2. Review on the **Decadal Variability in the Tropical Pacific**

Progress and achievements

Observations



Indian Ocean Observing System (IndOOS) Decadal Review

134 actionable recommendations prioritised into 3 tiers | Final report in Aug. 2019 |

- **Tropical Atlantic Observing System (TAOS) Review:** 2nd Workshop held in Marseille France, Oct. 2018 | 2nd draft of TAOS Review Report is being finalized.
- **OceanObs'19:** Several Community White Papers by CLIVAR panels. A Session: "Ocean observations for climate reconstructions" proposed by GSOP.
- PRP and GSOP provided feedback to the **2nd TPOS2020 report.**

Progress and achievements

Capacity Building and Knowledge Management

- IV International Conference on El Niño Southern Oscillation: **ENSO in a Warmer Climate** (Oct., 2018, Guayaquil, Ecuador) - *by PRP&ENSO RF*.
- 1st CLIVAR-FIO summer school **on "Past, Present and Future Sea Level Changes"** (Jun. 2018, Qingdao)
- Workshop on '**The Earth's Energy Imbalance and its implications**' (13-16 Nov. 2018, Toulouse, France) – *by CONCEPT-HEAT RF*
- Workshop on **'The Sources and Sinks of Ocean Mesoscale Eddy Energy'** (12-14 Mar. 2019, US) - *by OMDP*
- **SORP National reports** were obtained from 20 Countries for 2017-18 (http://www.clivar.org/clivar-panels/southern/national-representatives), to develop meaningful strategies for future coordinated cooperation in the Southern Ocean.

Progress and achievements

Upcoming Events

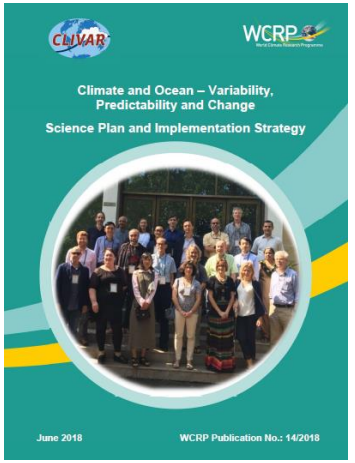
- *ICTP-CLIVAR Summer School on Oceanic Eastern Boundary Upwelling Systems" (Jul 2019, Trieste Italy)*

- *Advanced School and Workshop on American Monsoons: progress and Future plans, (Sao Paulo, Brazil, Aug. 2019)*
- *Workshop on "Sea Level Science for Services" (Nov.19, Orléans France)*
- *CLIVAR endorsed workshop of PICES-40 'Towards an integrated approach to understanding ecosystem'. June/2019. Qingdao*

WORLD METEOROLOGICAL ORGANIZATION
United Nations Educational, Scientific and Cultural Organization
Intergovernmental Oceanographic Commission
International Science Council
WCRP World Climate Research Programme

Future plans

CLIVAR Science Plan and Implementation Strategy



Overarching goal: *Building a society resilient to environmental changes*

What is needed:

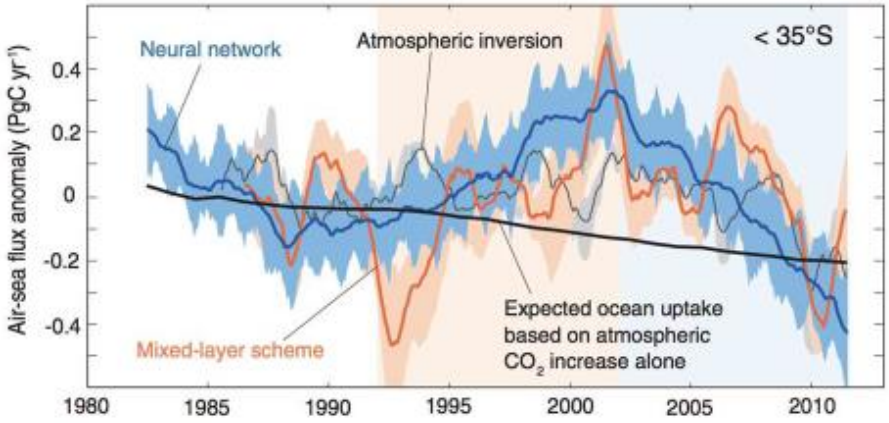
- Expanding on a climate risk concept (**uncertainty**)
- Providing **regional climate information and seamless predictions across timescales**
- Understanding mechanisms and consequences of climate variability and change, **globally** and **regionally**
- Establishing a **multi-scale approach** in space and time to climate science, and to mitigation/adaptation
- Increasing awareness: what is settled, what is not yet understood, and why climate science is still fundamental after COP21

Future plans

CLIVAR short-term priorities（1）

- The **ocean's role in transient climate sensitivity and changes to sea level u**nder increasing anthropogenically induced radiative changes

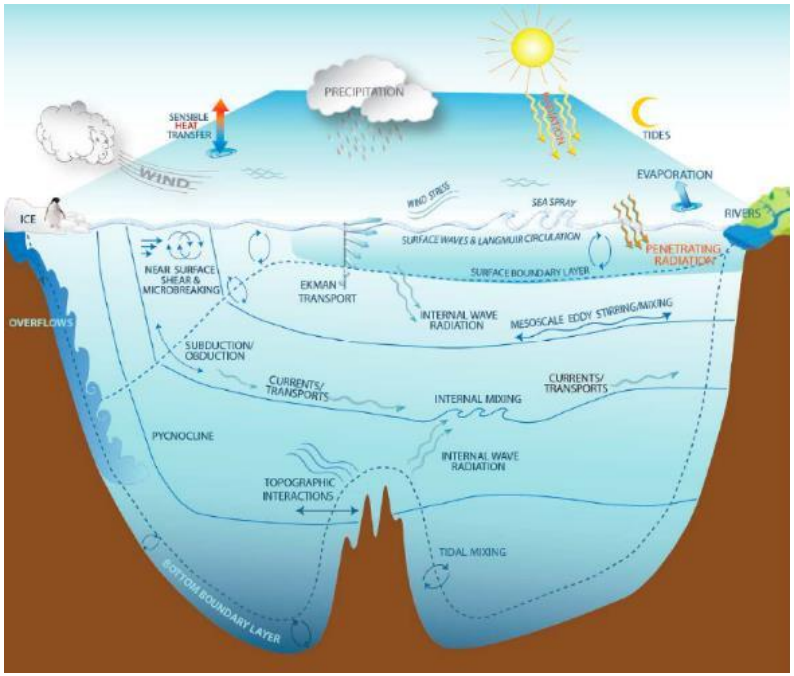
- Ocean's contributions to **energy**, **heat**, **water** and **carbon** budgets, their perturbations and changes



Decadal variability of air – sea CO2 fluxes in the Southern Ocean comparing the decadal modes from empirical models and the steady state trend (Landschutzer et al. 2015).

Future plans

CLIVAR short-term priorities (2)



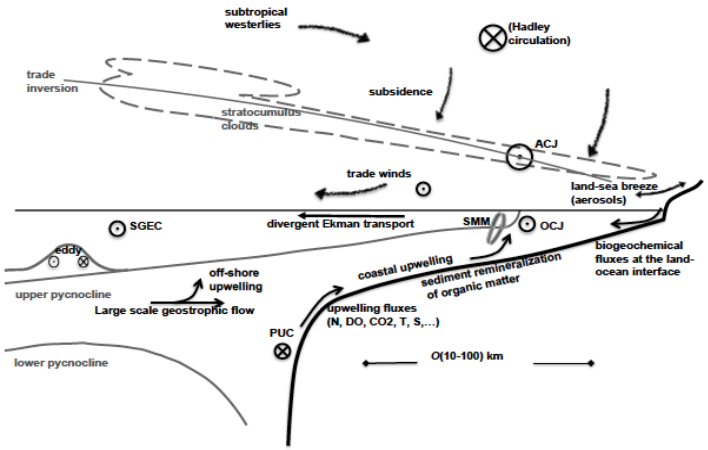
Regional climate variability and change; high resolution model simulations; extremes; fine scales processes

Schematic of ocean physical processes that participate in the cascade of mechanical energy from the forcing scales to the dissipation scales. From Griffies and Treguier (2013).

Future plans

CLIVAR short-term priorities (3)

Physical and biogeochemical interactions in the coastal ocean and changes to this vital and vulnerable region of the planet.



Schematic of processes at play in Eastern Boundary Upwelling Systems (direction of flow corresponds to the northern hemisphere)

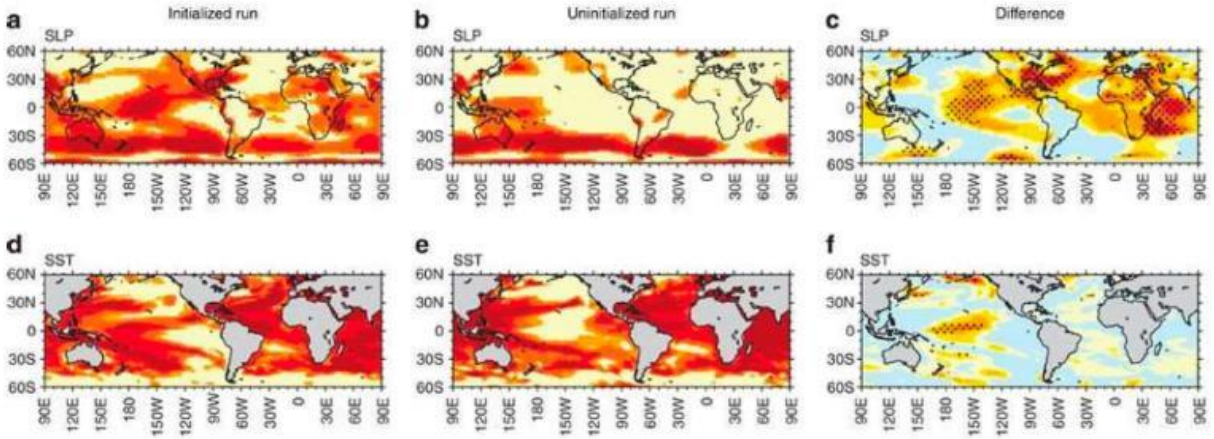
CLIVAR has strengthened its link with **biology and biogeochemistry communities**.

- PRP has planned its next meeting in conjunction with 2019 PICES annual meeting in Vancouver, Oct 2019.
- PICES WG-40 Workshop entitled 'Towards an integrated approach to understanding ecosystem predictability in the North Pacific', (20-21 July 2019 in Qingdao, China), endorsed by CLIVAR.

Future plans

CLIVAR short-term priorities (4）

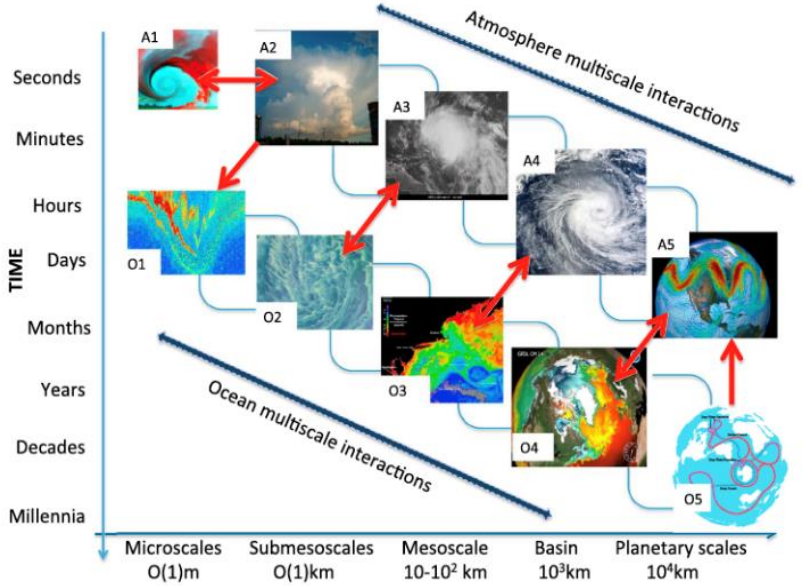
- How variations in the climate mean state interact with teleconnections and feedback on climate modes variability
- Why scale (time and space) interactions are important in predictability



Potential predictive skills of (a–c) SLP and (d–f) SST anomalies for averaged 2–5 years lead time in the initialized run (left), the uninitialized run (center) and their difference (right) (Chikamoto et al. (2015).

Links to the WCRP Strategic and Implementation Plans

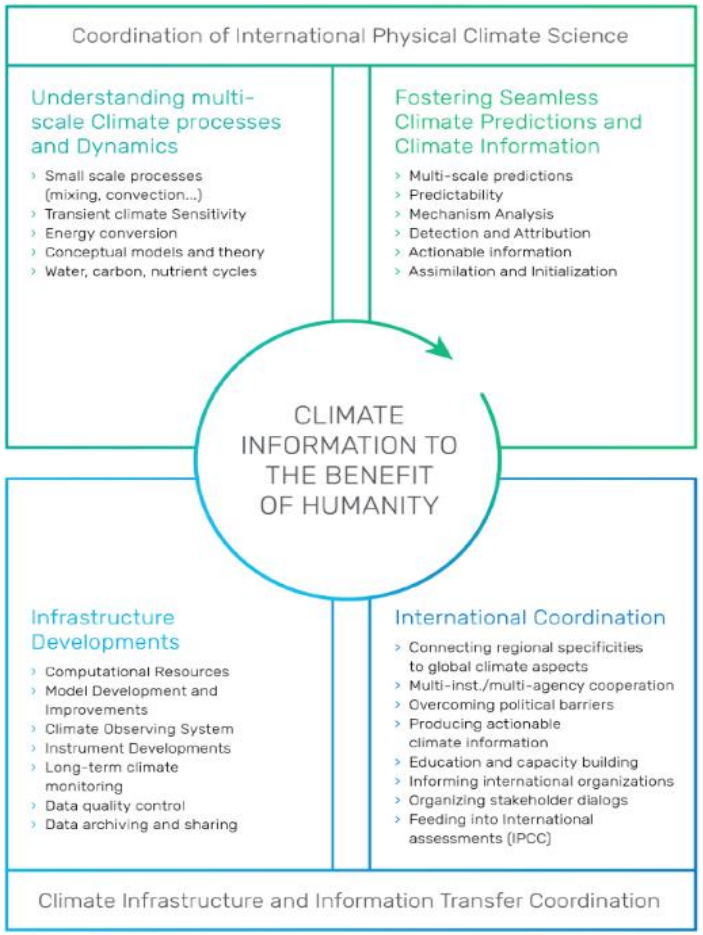
1) Identify ocean and coupled **climate processes** that are critical for global and regional climate variability and change
2) Identify temporal and spatial scales of **climate predictability**
3) Quantify constraints on **climate sensitivity**, air-sea exchange and Earth's energy budget / ocean heat content
4) Quantify **regional impacts** of climate change in **sea level, cryosphere and water cycle**



5) Quantify past/present/future **ocean role in CO_2 and heat uptake** and links between **climate and ocean ecosystems**
6) Provide **regional climate information and seamless predictions across timescales**, from intraseasonal to multidecadal

Links to the WCRP Strategic and Implementation Plans

- CLIVAR's science speaks to all objectives in WCRP SP. Indeed CLIVAR speaks to all capability themes provided in in the WCRP review
- Integrated view of the climate system (heat, water, carbon) required and implemented in the CLIVAR SP



Stammer et al. 2018

Emerging issues

1. Desire/request for a Pan-regional CLIVAR (IORP, ARP, PRP, NORP, SORP & GSOP) meeting to share experience in shaping the **global/regional ocean observing systems** (Planning for 2020, Date and Place TBD, possibly Goa, India)
2. Transition from Scientific Guidance to advocate for resources to implement global/regional observing systems
3. Strengthen the communication with partner programmes for **joint panels/activities** (e.g.: MP with GEWEX & IORP with IOC GOOS) and a more effective collaboration;
4. Further CLIVAR involvement in the **UN Decade of Ocean Science for Sustainable Development** by strengthening the cooperation with IOC-UNESCO and other key regional and national partners in support of adaptation strategies and science-informed policy responses to global ocean changes.
5. Open (on-going) call for a new **Research Focus** activity
6. Funding level

GC: Regional Sea-level Change and Coastal Impacts

40th Session of the WCRP Joint Scientific Committee

Annalisa Bracco and Wenju Cai

May 2019

Geneva, Switzerland

WORLD METEOROLOGICAL ORGANIZATION

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

International Science Council

WCRP World Climate Research Programme

Progress and achievements

Working Groups

WG1: An integrated approach to paleo time scale sea level estimates

WG2: Quantifying the contribution of land ice to near-future sea level rise

WG3: Causes for contemporary regional sea level variability and change

WG4: Predictability of regional sea level

WG5: Sea level science for coastal zone management

WG6: Sea level science for global sea level budget assessment

Progress

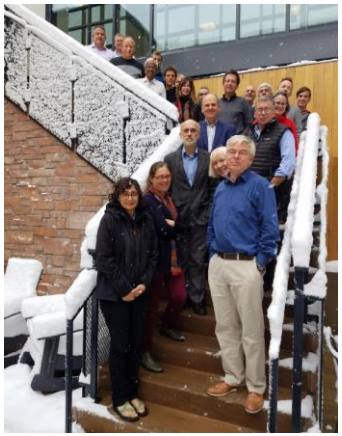
- Partner with SCAR (SERCE & ASIDSL) (WG1)
- Activities planned for new GRA model (WG1)
- Delay in AGCM/AOGCM DECK simulation that will impact the evaluation of polar climate and the start of ISM / ISM-AOGCM runs (WG2)
- ISSI Workshop outcome: a special issue of Survey of Geophysics and a hard cover book by Springer (WG3)
- Proposed workshop on 'Sea Level Sciene for Services (WG3 &5)
- FAFMIP, ISMIP6 & GlacierMIP are underway (WG4)
- **Co-production approach** and strong links to the range of end-users (WG5)
- Dissemination via **policy briefs** (WG5)

Progress and achievements

WCRP Grand Challenge: Regional Sea Level Change and Coastal Impacts **Science and Implementation Plan** (Version 1.0) published!

Meeting & Workshops:

1) **3rd WCRP Grand Challenge** on Regional Sea Level Change and Coastal Impacts (14-15 Oct. 2018, Boulder, USA)



2) CLIVAR-FIO **Summer School** on Sea Level Rise: Past, Present and Future (25-30 June 2018, Qingdao, China)

Papers:

1) Sea Level Terminology Paper (submitted)
2) Coastal Sea Level Science Paper (in progress)
3) High-end Sea Level Paper (in progress)
4) Led/Contributed to OceanObs'19 White Papers

Other scientific documents:

1) 'Recipe book' for dealing with ISMIP6 result (in progress)
2) Report on Sea Level Observing requirement (in progress)
   Deep Argo | Under ice measurement | Coastal zone measurement
3) Report on model improvement requirement for Sea Level (in progress)

WORLD METEOROLOGICAL ORGANIZATION | United Nations Educational, Scientific and Cultural Organization | Intergovernmental Oceanographic Commission | International Science Council | WCRP World Climate Research Programme

Future plans

WG1: To facilitate an integrated sea-level approach through the development of coupled models and data assimilation techniques to capture relevant feedbacks and the integration of geodetic data and information about Earth structure into modeling efforts. (GIA Models)

WG2: To produce probabilistic projections of the land ice contribution to future sea level change that account for all of the relevant sources of uncertainty. (ISMIP6, GlacierMIP, MISOMIP)

WG3: 1) Uncertainties in mass and steric contributions to contemporary sea level budgets across spatial scales. 2) Role of climate modes and internal variability in general on sea level. 3) Role of coastal and ocean interior processes on local sea level. 4) Attribution of regional sea level change to natural and anthropogenic radiative forcing agents. 5) Requirements for sea level observing system.

Future plans

WG4: To establish methods for the peer-reviewed publication of global and regional sea level projections, for particular emissions scenarios, including all contribution and uncertainties, in order to provide a basis for future IPCC assessments. (FAFMIP | ISMIP6 | AOGCMs)

WG5: To provide Sea Level Information that are useful and appropriate for coastal management; downscaling sea level variability and uncertainty from regional to local; Sea Level Rise & Changes in extremes; Mega city, delta & island states (linking closely with decision makers)

WG6: To assess the products for sea level and its components provided by different groups; to publish the global sea level budget assessment annually.

Future plans

Upcoming events

1. Series of Sea Level workshops (in 2019 ~2020):

- Workshop on WCRP Grand Challenge and **Climate Services** (WG3 & 5) +

4th GC SL (Nov. 2019, Orléans, France)

- Workshop on Global Review and Assessment Methods of **Land Subsidence** in 2019
- Workshop on Better **Guidance for Climate Services** in Coastal Areas in 2020

*** Link with other Sea Level related meeting/workshops:**

- **US CLIVAR Workshop** on Sea Level Hotspots from Florida to Maine: Drivers, Impacts and Adaptation (Apr 2019 at Norfolk, USA)
- **TU Delft Summer School** on "Sea Level Change: observations, processes and modelling (July 2019, Delft, the Netherland)

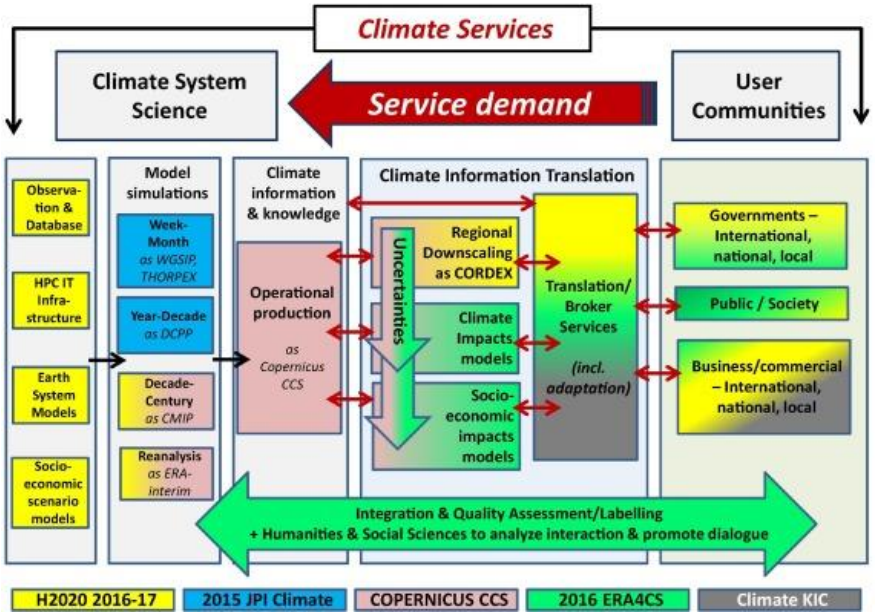
2. Next Sea Level Conference (in 2022 or 2023)

- A region affected by sea level rise (e.g. Bangkok, Jakarta, Shanghai, etc)
- A robust engagement of decision makers;
- Illustration of the decision support methodologies

Links to the WCRP Strategic and Implementation Plans

Bridge for science to society:

1. The SL GC aims for close interaction with relevant coastal stakeholders to make sure that results of the proposed scientific researches are most useful for **coastal zone management and impacts and adaptation efforts**.
2. To SL GC will provide salient and credible **information on current and future states of the Sea Level Rise across different time- & Spatial- scales.**
3. The SL GC focuses both the '**downstream' and 'upstream**' sides of climate services (fig. on the right)



Monfray and Bley, 2016

** To integrate all sea level activities within WCRP, with the GC Sea Level acting as a focal point.*

Thank you!