Climate and Ocean - Variability, Predictability, and Change

Sonya Legg, Annalisa Bracco & Wenju Cai
SSG Co-chairs

CLIVAR

WORLD METEOROLOGICAL ORGANIZATION | United Nations Educational, Scientific and Cultural Organization | Intergovernmental Oceanographic Commission | International Science Council

WCRP World Climate Research Programme

GEWEX, Feb., 2020

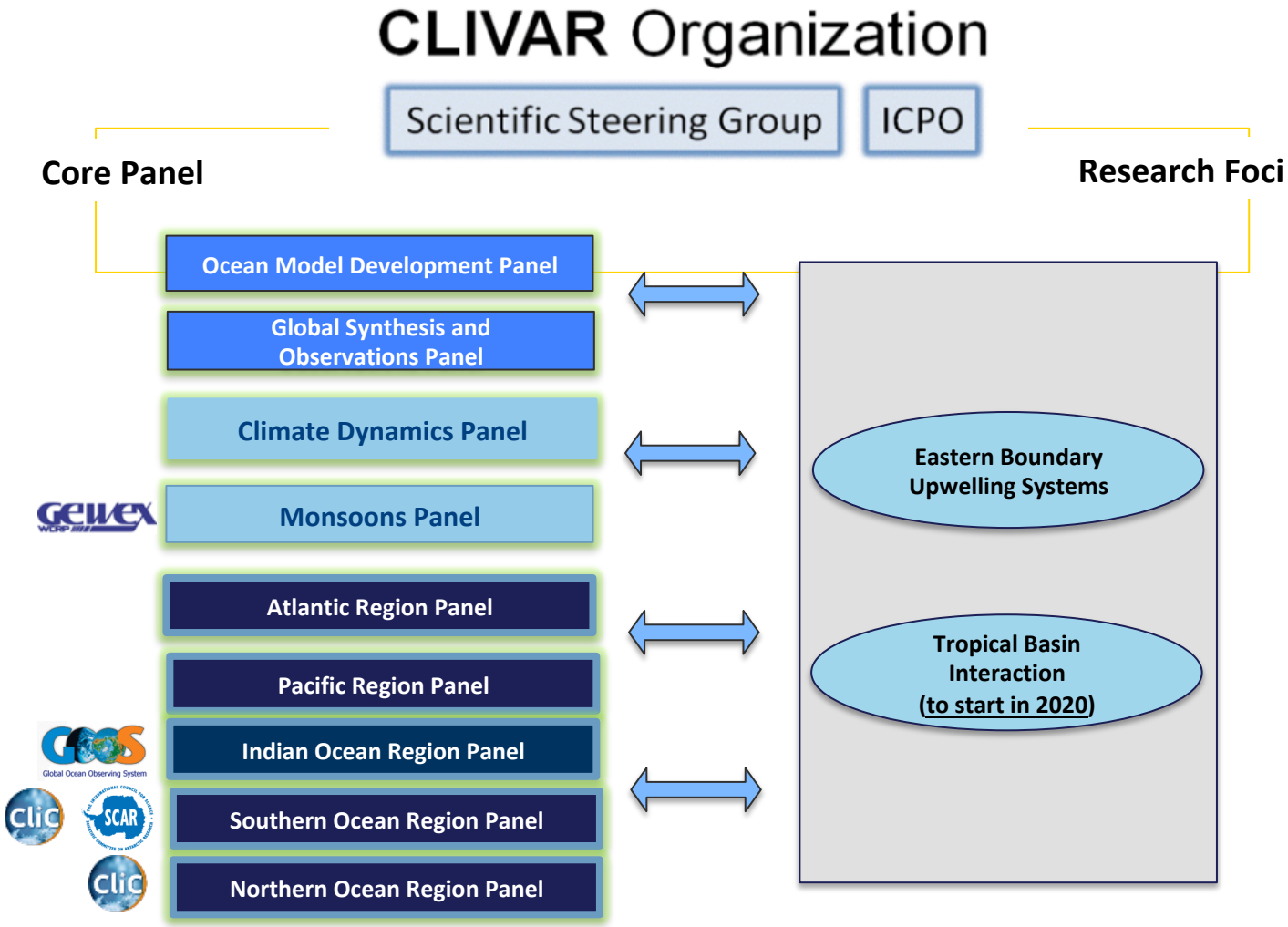
Mission and Scientific Priority of CLIVAR

CLIVAR's **mission** is to understand the dynamics, interaction, and predictability of the climate system with emphasis on ocean-atmosphere interactions.

Scientific priorities of CLIVAR:

1. Mechanisms of climate variability and change that require further investigation with the ultimate goal of better constraining the fluxes of energy and carbon in the climate system;
2. Ocean processes that modulate climate variability and change for which open questions remain;
3. Climate predictability challenges over a broad range of space and time scales.

Organization Chart



The CLIVAR SSG provides overall guidance for CLIVAR activities, in concert with WCRP objectives, and establishes CLIVAR Panels and Working Groups and their term of reference.

Research Foci addresses urgent and actionable research challenges. RF has a limited life-time (3-5 yrs)

Regional sea-level change & coastal impacts

The Sea Level Grand Challenge is cross-cutting between CLIVAR & WCRP, and includes modeling & observations

World Climate Research Programme

CLIVAR Science Plan 2019-2028

Identified scientific priorities

- **Mechanisms** of climate variability and change that require further investigation with the ultimate goal of **better constraining the fluxes of energy and carbon in the climate system**
- Ocean **processes** that modulate climate variability and change for which open questions remain
- Climate **predictability** challenges that exist over a broad range of space and time scales

Where we are going: CLIVAR Future

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

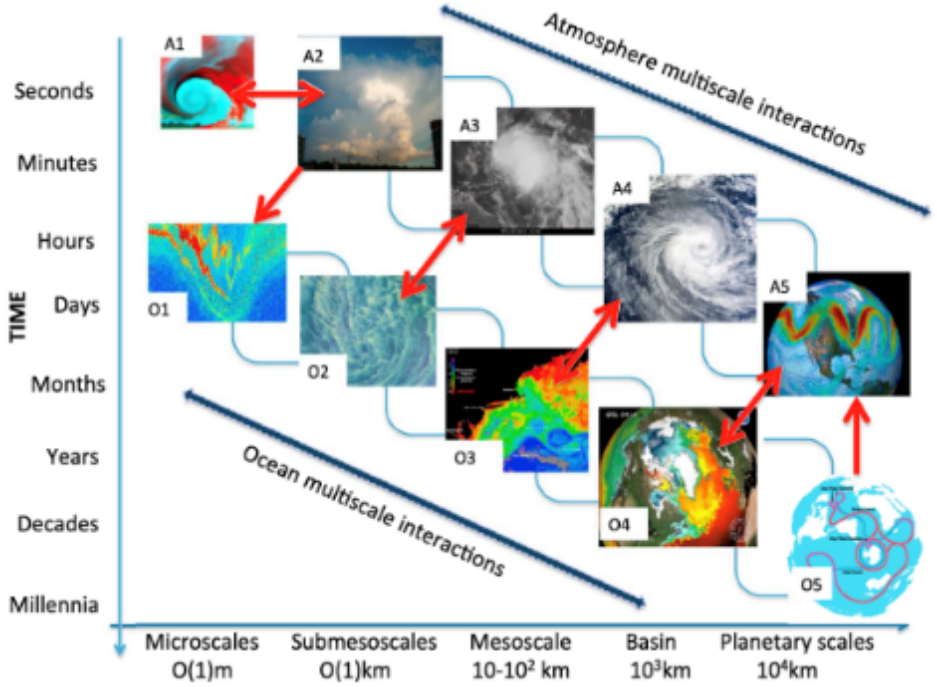
What is needed (I):

- 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**

Where we are going: CLIVAR Future

What is needed (II):

- 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 we **NEED** fundamental climate science after COP21



Stammer, Bracco, Braconnot, Brasseur, Griffies, & Hawkins, E. (2018). Earth's Future, 6. https://doi.org/10.1029/2018EF000979

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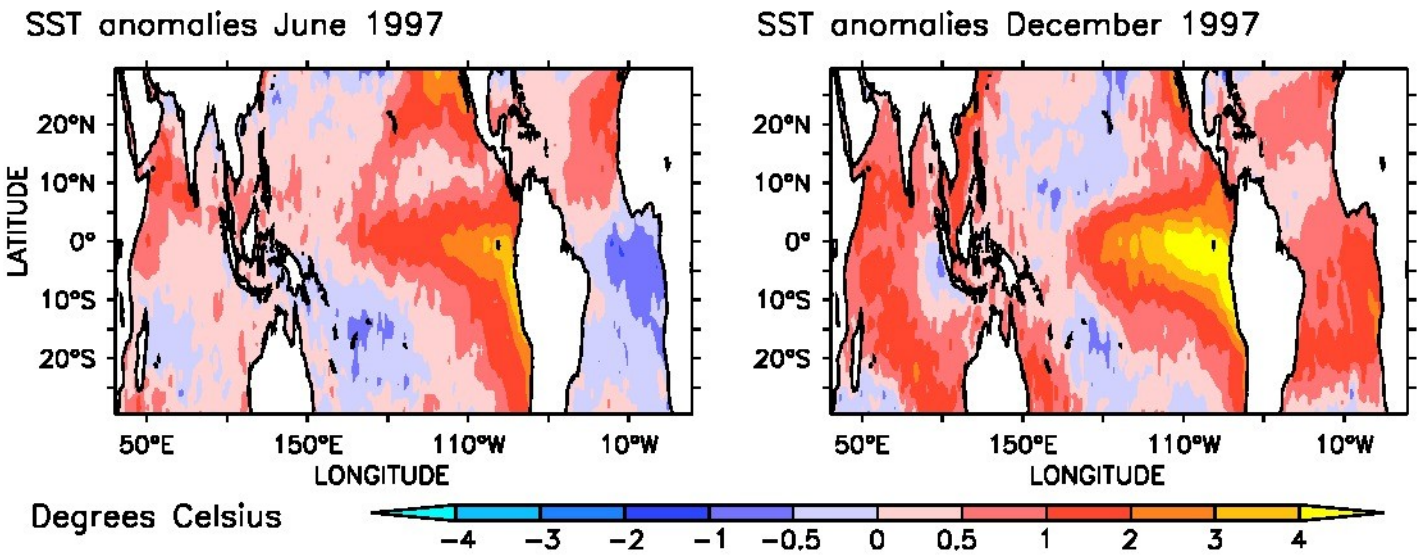
Major meetings in 2019

- Workshop on Sources and Sinks of Ocean Mesoscale Eddy Energy, and 5th Session of CLIVAR OMDP, 11-15 March 2019, Tallahassee, USA
- US CLIVAR/CLIVAR Joint Workshop on Atmospheric Convection and Air-Sea Interactions over the Tropical Oceans, 7-9 May 2019, Boulder, USA
- ICTP-CLIVAR Summer School on Oceanic Eastern Boundary Upwelling Systems, 15-19 July 2019, Trieste, Italy
- CLIVAR PRP/PICES WG-40 Joint Meeting on Climate and Ecosystem Predictability, 19 October 2019, Victoria, Canada
- Workshop on WCRP Grand Challenge on Regional Sea Level Change and Coastal Impacts and Climate Service, 12-13 November, 2019, Orléans, France
- Three SORP/NORP joint sessions on ‘Sea ice, ocean and climate connections in the Northern oceans and the Southern Ocean’ in the international glaciological society - sea ice symposium, Winnipeg, Canada, 19-23 August, 2019

Planned activities for next 12 months

- GOOS/GCOS workshop on heat and freshwater transport and storage in models and observations, Exeter, UK，28th April to 1st May, 2020.
- Workshop on Changing Patterns of Climate: Understanding Uncertainties, Fjordhotel Rosendal, Norway, Tentatively 22-26 June 2020
- CLIVAR-FIO Summer School on Ocean Macroturbulence and Its Role in Earth's Climate, 6-11 July 2020, Qingdao, China (Organised by CLIVAR ARP)
- NORP Bootcamp Summer School tentatively to be held in Helgoland, Germany in Summer 2021
- A one day joint SORP/SOOS side meeting alongside the SCAR OSC, Hobart, Tasmania, Australia, during 31 July to 11 August 2020
- Third Summer School on Theory, Mechanisms and Hierarchical Modeling of Climate Dynamics: Tropical Oceans, ENSO and their Teleconnections 3-14 August 2020, Trieste, Italy (Organised by CLIVAR PRP)
- WCRP/CLIVAR workshop/conference on “Indian Ocean-ENSO-Monsoon interactions in a changing climate” , Fall 2020, Pune, India (Jointly organised by IORP and MP)
- Workshop on challenges and future directions in high-resolution ocean modeling, Kiel, Germany, October 7-9, 2020.

CLIVAR New Research Foci
Tropical Basin Interaction (TBI)



The main goal of TBI is to elucidate the complex two-way interaction between the tropical basins and to quantify the benefit to climate prediction. TBI will initiate and facilitate research activities with a focus on seasonal to multi-annual variability and predictability, thus complementing the CLIVAR DCVP RF.

Workshop planned for Spring 2021: Towards a sustainable Global Ocean Observing System

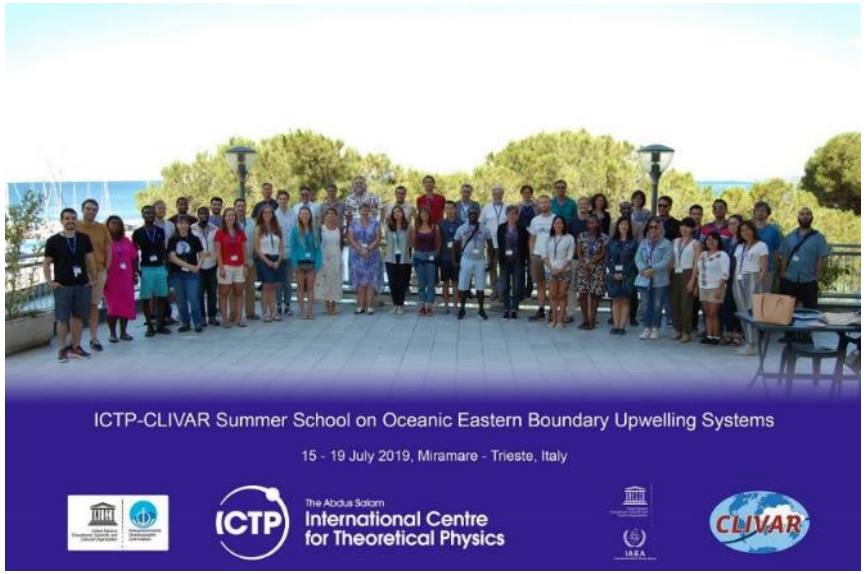
(1) Discuss the current most important ***societal and scientific drivers*** *of regional observing systems.*

(2) Discuss challenges/outcomes of reviewing/designing regional observing systems for the next decade, including (i) transition to more ***multidisciplinary observing systems****, (ii) need for regional-scale forecasting and expansion into the* ***coastal zone****, (iii) lobbying for* ***resources, capacity-building****, and developing partnerships, (iv)* ***data*** *archiving, and* ***sharing****.*

(3) Discuss how these ***efforts combine*** *and how the panels can prepare for the UN's upcoming International Decade of Ocean Science for Sustainable Development, 2021-2030*

Capacity Building and Knowledge Management

CLIVAR-FIO Summer School



ICTP-CLIVAR Summer School

CLIVAR Exchanges (Two Upcoming issues):

#77: Ocean Mesoscale Eddy
#78: Indian Ocean Observing System (IndOOS)

CLIVAR Monthly Bulletin

http://www.clivar.org/clivar-bulletin

Website: www.clivar.org

Twitter:

https://twitter.com/WCRP_CLIVAR

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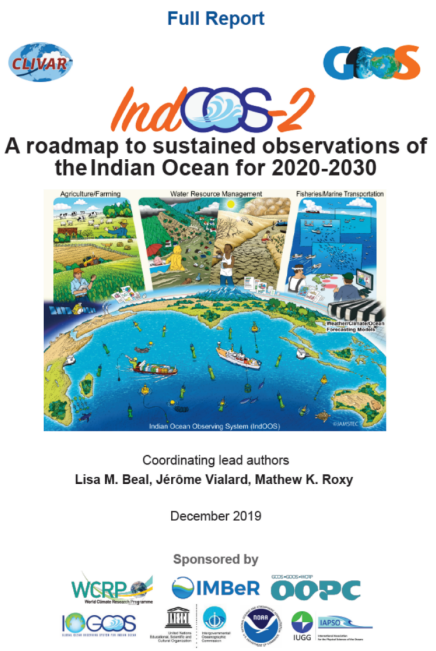
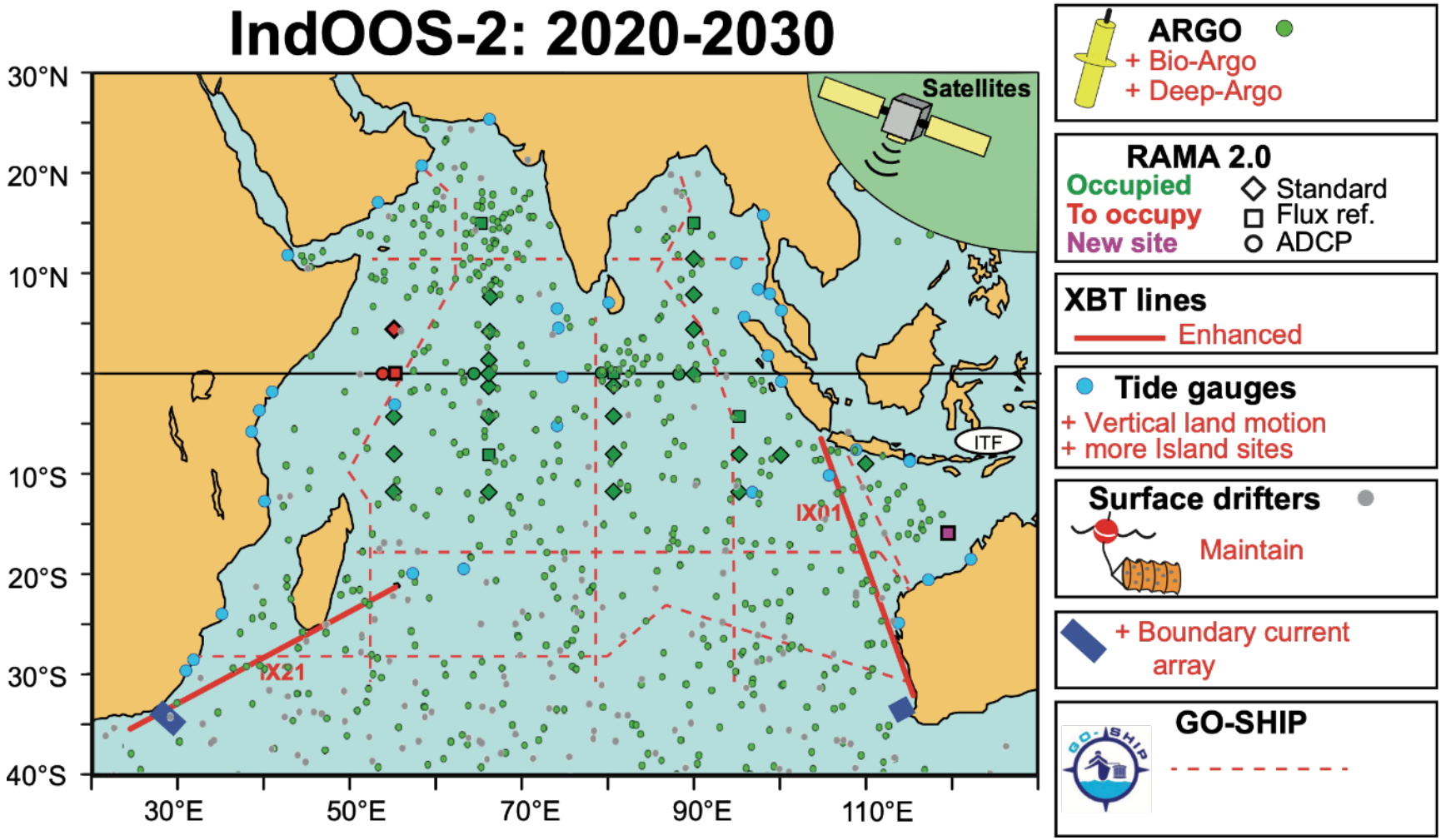
Launching of IndOOS-2

A roadmap to sustained observations of the Indian Ocean (2020-2030)

IndOOS-2 can provide a fit-for-purpose observing system that leads to improved weather forecasts, climate predictions, and marine ecosystem understanding for the benefit of all.





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CLIVAR Input for WCRP core projects integrated activities

Third Pole Environment (TPE): Pacific Region Panel, Indian Ocean Region Panel, Climate Dynamics Panel

ANDEX: Pacific Region Panel, Climate Dynamics Panel

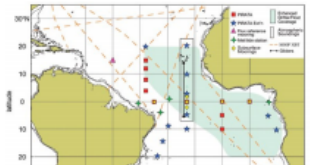
GREENLAND: Atlantic Region Panel, Northern Ocean Region Panel, Climate Dynamics Panel, Ocean Model Development Panel

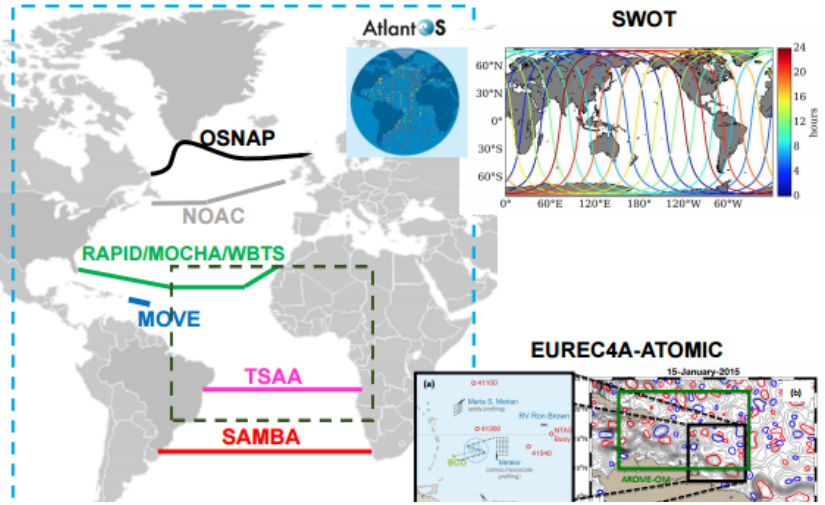
Within the WCRP family, CLIVAR/OMDP would also encourage closer connection with WGSIP, to work on initialized predictions, both seasonal (up-to 1 or 2 years) as well as decadal. Another emerging area is **liaison with S2S activities**, which are also planning **to start looking at the validation of subseasonal prediction of ocean variables.**

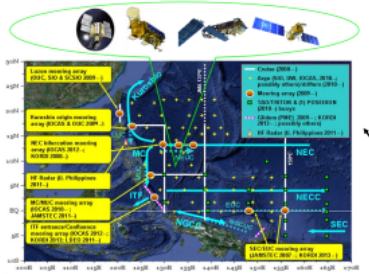
The Contribution of CLIVAR to Sustainable Ocean Observation and Information in Support of Ocean and Climate Research

Jose Santos, Jing Li, Liping Yin
International CLIVAR Project Office (ICPO), Qingdao, China

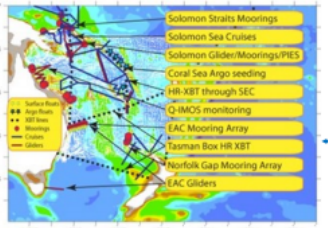
AMOC Observations



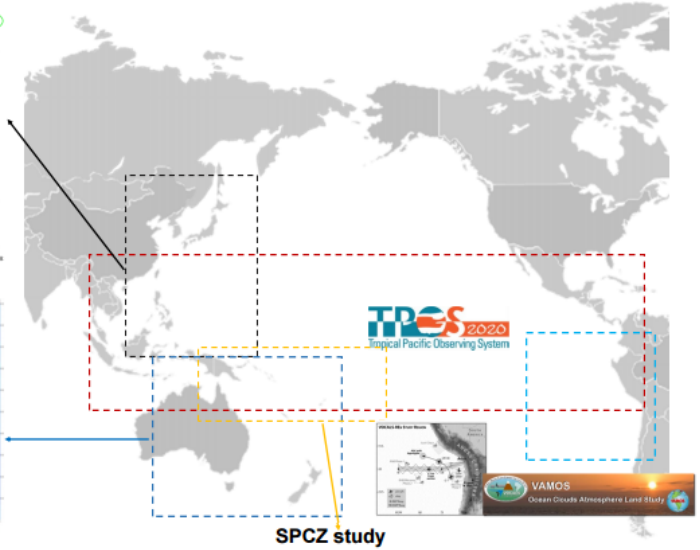




NPOCE Observation Design

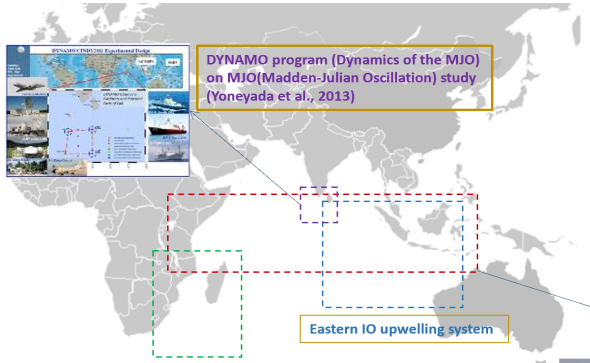


SPICE Observation Design



SPCZ study

CLIVAR/IOC-GOOS Indian Ocean Panel (IORP)



Agulhas System Climate Array (ASCA)
South Africa, USA, Netherlands

IOD study:
MISMO (Yoneyama et al. 2008) and VASCO/CIRENE (Vialard et al. 2009a)
Review paper on decadal variability in IO (Han et al., 2014);
Response to warming climate (Cai et al., 2013)
Extreme IOD events (Cai et al., 2014)
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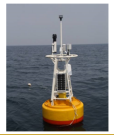
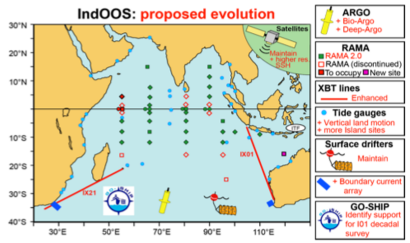
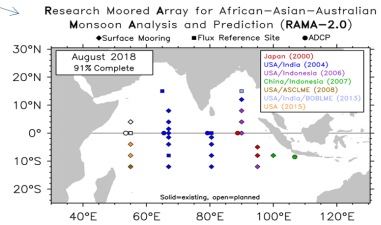


Bailong Buoy



* Indian Ocean Observing System Decadal Review (2017-2019)



CLIVAR/CliC Northern Oceans Region Panel (NORP)

1. Ddeveloping new tools and methods to observe the Arctic Ocean and neighbouring seas and their climate impacts: further design of buoy and radiosonde in the Arctic (MOSAiC).

MOSAiC
International Arctic Drift Expedition

2. Standardizing and archiving observations of the Arctic Ocean and the coupling with other components of the climate system.

CLIVAR/CliC/SCAR Southern Ocean Region Panel (SORP)

SOOS
SOUTHERN OCEAN OBSERVING SYSTEM

- ✓ Coordination with SOOS (national planning, ship planning, and data management)
- ✓ SORP national reports.

Download the National reports on Activities in the Southern Ocean:
2015: China
2016: Belgium, Brazil, Canada, China, Finland, Italy, Japan, New Zealand, Russia, South Africa.
2017: Argentina, Belgium, Canada, China, Finland, Italy, Japan, New Zealand, Norway, Russia, South Africa

CLIVAR Endorsed Project

CLIVAR's Contribution to CWP of OceanObs'19

OCEAN OBS'19

1. Ocean Climate observing requirements in support of Climate Research and Climate Information (SSG)
2. A sustained ocean observing system in the Indian Ocean for climate related scientific knowledge and societal needs (IORP)
3. Observational challenges and needs in the polar oceans (NORP & SORP).
4. Delivering an Integrated Southern Ocean Observing System for Global Impact (SORP)
5. Ocean Reanalyses: Advances and Unsolved Challenges (GSOP)
6. Adequacy of the ocean observing system for quantifying regional heat and freshwater storage and change (CH)
7. Planetary Heat Balance and Global Ocean Heat Content (CH & SL)
8. Challenges and Prospects in Ocean Circulation Models (OMDP, published)

CLIVAR Contributions to Ocean Obs'19

1.Ocean Climate Observing Requirements in Support of WCRP Research and Climate Information (Review Article, led by D. Stammer, A. Bracco, CLIVAR SSG members and panel and RF co-chairs) https://www.frontiersin.org/articles/10.3389/fmars.2019.00444/full

2.A Sustained Ocean Observing System in the Indian Ocean for Climate Related Scientific Knowledge and Societal Needs (Review Article, led by IndOOS Review lead authors and IORP members) https://www.frontiersin.org/articles/10.3389/fmars.2019.00355/full

3.Ocean Reanalysis: Recent Advances and Unsolved Challenges (Mini Review Article, led and participated by GSOP members)
https://www.frontiersin.org/articles/10.3389/fmars.2019.00418/full

4.Constraining Southern Ocean Air-Sea-Ice Fluxes Through Enhanced Observations (Mini Review Article, participated by SORP members)
https://www.frontiersin.org/articles/10.3389/fmars.2019.00421/full

5.Adequacy of the Ocean Observing System for Quantifying Regional Heat and Freshwater Storage and Change (Review Article, led and participated by CONCEPT-HEAT RF members) https://www.frontiersin.org/articles/10.3389/fmars.2019.00416/full

CLIVAR Contributions to Ocean Obs'19

6.Measuring Global Ocean Heat Content to Estimate the Earth Energy Imbalance (Review Article, participated by CONCEPT-HEAT and Sea Level RF members)
https://www.frontiersin.org/articles/10.3389/fmars.2019.00432/full

7.Delivering Sustained, Coordinated, and Integrated Observations of the Southern Ocean for Global Impact (Review Article, jointly contributed by SOOS and CLIVAR SORP)
https://www.frontiersin.org/articles/10.3389/fmars.2019.00433/full

8.Challenges and Prospects in Ocean Circulation Models (Review Article, led by OMDP)
https://www.frontiersin.org/articles/10.3389/fmars.2019.00065/full

9.Towards Comprehensive Observing and Modeling Systems for Monitoring and Predicting Regional to Coastal Sea Level (Review Article, contributed by Sea Level RF)
https://www.frontiersin.org/articles/10.3389/fmars.2019.00437/full

10.Waves and Swells in High Wind and Extreme Fetches, Measurements in the Southern Ocean (contributed by OMDP member) https://doi.org/10.3389/fmars.2019.00361

Thank You