

# CLIVAR: CLIMATE & OCEAN variability, predictability and change

WCRP Core Project on the  
Ocean-Atmosphere System

SSG 24,DC

# Welcome to the 24th CLIVSR SSG

Annalisa Bracco, Wenju Cai, and Detlef Stammer  
(CLIVAR co-chairs)

# Goal of SSG 24

- Review developments related to the WCRP review and the new WCRP strategic plan.
- Interact with US CLIVAR community and US Inter Agency Group.
- Review progress, steer activities within panels and within RF.
- Planning of meetings, summer schools
- Discuss implementation of new science plan.
- Identification and budget requirements and distribution of resources
- Membership and other internal SSG business.

We will devote the entire first day of the CLIVAR SSG to a discussion of the plan and possible consequences following from its implementation.

# Day-1 Objectives

With JSC lead and agency representatives:

- Discuss CLIVAR Success and progress
- Review new CLIVAR Science Plan
- Summarize new WCRP Strategic Plan
- Discuss future WCRP directions with respect to CLIVAR science
- Brainstorm on possible implementation directions in light of CLIVAR science needs and US agency suggestions.

# Agenda Day 1

Participants: Invited Program Managers and Representatives from US Institutions and CLIVAR SSG members					
Tuesday 27/11			Session	Presenter / Discussion lead	Time
09:00			Opening of the first day and charge to the 24 <sup>th</sup> CLIVAR SSG Meeting	Annalisa Bracco, Detlef Stammer, CLIVAR SSG with JSC chairs and PM	30
09:30			Summary of CLIVAR results and discussion of the new CLIVAR Science Plan.	D. Stammer and A. Bracco	60
10:30			<b>Break</b>		
11:00			Discussion on WCRP Strategic Plan and its future implementation	Guy Brasseur, Amanda Lynch	90
12:30			<b>Lunch</b>		
13:30			Feedback to WCRP Strategic Plan and its implementation requirements from point of view of audience	SSG Members, Agency Representatives	120
15:30			<i>Summary of the day</i>	D. Stammer and A. Bracco, G. Brasseur, A. Lynch	30
16:00			<b>Adjourn for day</b>		
17:00			<b>Reception hosted by UC CLIVAR</b>		120

# CLIVAR Accomplishments

# CLIVAR – The Context

- The ocean covers 70% of our planet's surface.
- It represents major reservoirs of heat, freshwater, carbon, and thus the memory of the global climate system.
- Ocean heat capacity, circulation and mixing shape the Earth's heat and water budgets and hence play major roles in determining the climate response to anthropogenic forcing.
- CLIVAR (Climate and Ocean: Variability, Predictability and Change) deals with the ocean's role in the coupled climate system.
- CLIVAR is one of the four core projects of the [World Climate Research Programme \(WCRP\)](#).

# World Climate Research Program

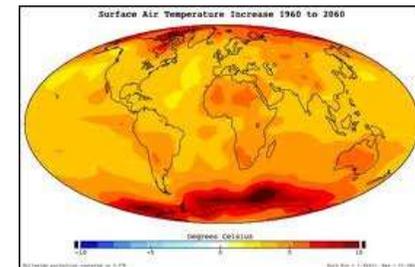
## Mission:

Facilitate **analysis and prediction of Earth system variability and change** for use in an increasing range of practical applications of direct societal relevance.

Overarching objectives of the WCRP:

- **determine the predictability of climate;**
- **determine the effect of human activities on climate**

**Sponsored by the WMO, ICSU, and IOC**



# WCRPs Organizational Structure

## JOINT SCIENTIFIC COMMITTEE (JSC)

WCRP MODELLING ADVISORY COUNCIL (WMAC)

WCRP DATA ADVISORY COUNCIL (WDAC)

**WORKING GROUPS ON:** COUPLED MODELLING (WGCM), SUBSEASONAL TO INTERDECADAL PREDICTION (WGSIP), NUMERICAL EXPERIMENTATION (WGNE), REGIONAL CLIMATE (WGRC)



CRYOSPHERE-  
CLIMATE



OCEAN-  
ATMOSPHERE



LAND-  
ATMOSPHERE



TROPOSPHERE-  
STRATOSPHERE



REGIONAL CLIMATE  
DOWNSCALING

**GRAND CHALLENGES ON:** CLOUDS, CIRCULATION AND CLIMATE SENSITIVITY;  
MELTING ICE AND GLOBAL CONSEQUENCES; UNDERSTANDING AND PREDICTING WEATHER AND CLIMATE EXTREMES;  
REGIONAL SEA-LEVEL CHANGE AND COASTAL IMPACTS; WATER FOR THE FOOD BASKETS OF THE WORLD;  
AND CARBON FEEDBACKS IN THE CLIMATE SYSTEM

JOINT PLANNING STAFF (JPS)

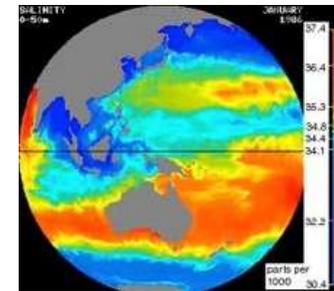
# CLIVAR: CLIMATE & OCEAN

variability, predictability and change

## Mission:

Improving understanding and prediction of the ocean-atmosphere system and its influence on climate variability and change, to the benefit of society and the environment.

Observe, simulate and predict changes in Earth's climate system with a focus on the **ocean-atmosphere system** as part of the climate system.

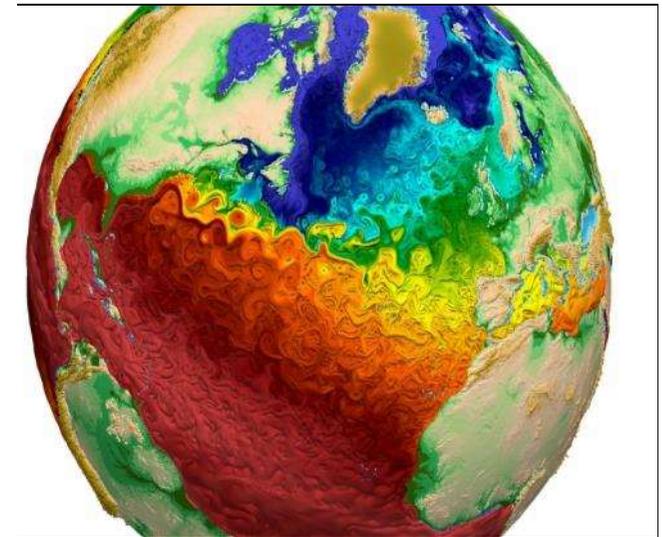


# CLIVAR: CLIMATE & OCEAN

variability, predictability and change

## Objectives:

- Describe and understand the dynamics of the coupled ocean-atmosphere system,
- Identify processes responsible for climate variability, change and predictability,
- Develop - through the collection and analysis of observations - and apply models of the coupled climate system.



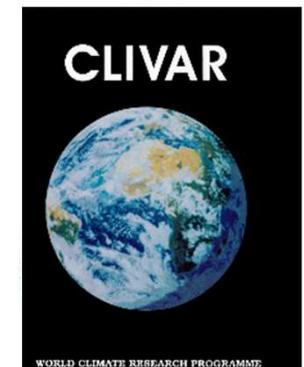
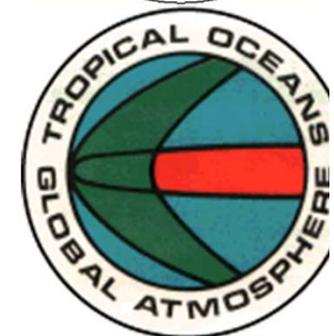
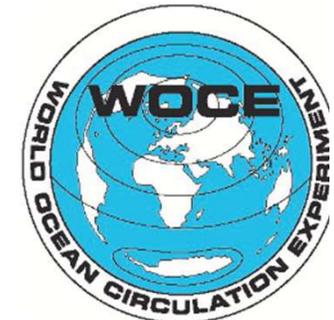
Credit: Los Alamos National Laboratory

# CLIVAR's Advent



L. Bengtson

- **CLIVAR was established 1995** as one of the core-projects of the World Climate Research Programme, building on WOCE and TOGA.
- WCRP Study Group agreed on ***CLIVAR (CLimate VARIability and Predictability)***.
- New research programme for the **understanding and possible prediction of low frequency climate variations.**
- WCRP study group members: Lennard Bengtson (chair), David Anderson, Tim Barnett, Kirk Bryan, Mark Cane, Allyn Clarke, Larry Gates, David Goodrich, Gordon McBean, Jagadish Shukla and ex officio Pierre Morel (Director of WCRP).



In 2016 at the time of the 2nd CLIVAR Open Science Conference



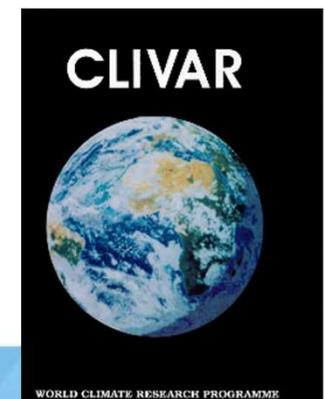
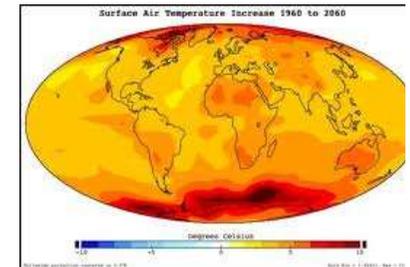
*CLIVAR 20 Years of Progress*

**SPECIAL ISSUE**

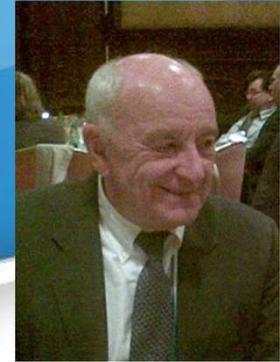
# Early CLIVAR

Concerned with **natural processes** of the climate system acting on time scales from months to decades plus **anthropogenic climate change**.

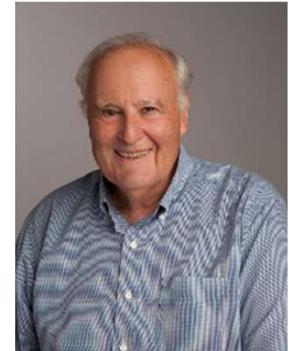
- Determine the extent to which climate can be predicted
- Determine the extent of human influence on climate.



# Original Objectives

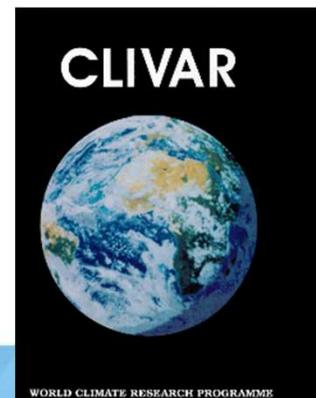


Pierre Morel



Arnold Gordon

- Identify natural modes of variability of the global climate system.
- Simulate observed climate variations, identify their mechanisms, assess extent of their predictability.
- Develop experimental climate predictions by exploiting predictable components of the climate system.
- Investigate response of the global climate system to changes in greenhouse gases concentration and aerosols.



# CLIVAR Achievements

- CLIVAR has contributed to many advances in the field of climate and ocean research and will continue to do so in the future.
- Its legacy includes:
  - the implementation and development of major multinational observing networks in all the ocean basins;
  - the development of ocean-climate models and bridging observations and modeling through the
  - development of ocean reanalyses using data assimilation methods.



# CLIVAR Achievements

- Furthering our understanding of the processes driving ocean circulation and its role in the coupled climate system.
- Develop understanding the characteristics and dynamics of mechanisms of variability in the coupled climate system such as ENSO;
- Development of seasonal prediction systems
- Progress towards initialized decadal prediction and Earth system modeling of past, current and future climate.



# Summary

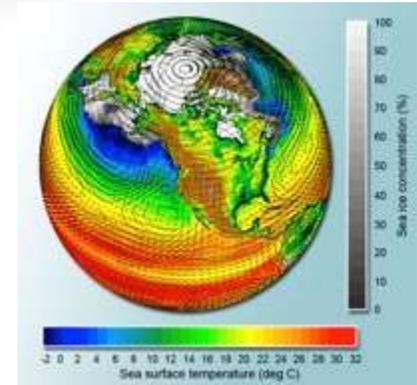
Outstanding progress within all areas of climate research.

- **Major scientific findings.**
- **Coordination, implementation and development of major multinational observing networks** in all ocean basins.
- Development of **ocean and climate re-analyses**, bridging observations and modeling through data assimilation.
- Development of **ocean-climate models, initialized decadal climate predictions building on o&c reanalyses.**
- Through ensemble climate simulations, contributed to **separate natural climate fluctuations from anthropogenic effects.**

# Ongoing CLIVAR Contributions

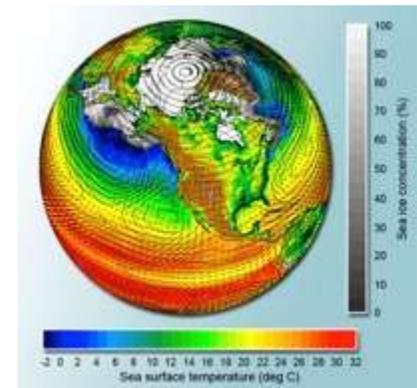
CLIVAR continues to contribute

- to the development of modeling capabilities to understand the response of the climate system to anthropogenic increases in radiatively active gases and changes in aerosols,
- to the development of “seamless” prediction systems for climate prediction on all timescales.



# Ongoing CLIVAR Contributions

- All ongoing and future CLIVAR achievements contribute to the knowledge and understanding of the climate system that must underpin the provision of climate services and that is regularly assessed by the Intergovernmental Panel on Climate Change (IPCC).



# CLIVAR Governance

As part of WCRP – CLIVAR enables:

- International coordination of research in climate and ocean science,
- cooperation amongst national and multinational efforts,
- global scientific capacity beyond regional and institutional capabilities

# CLIVAR Governance

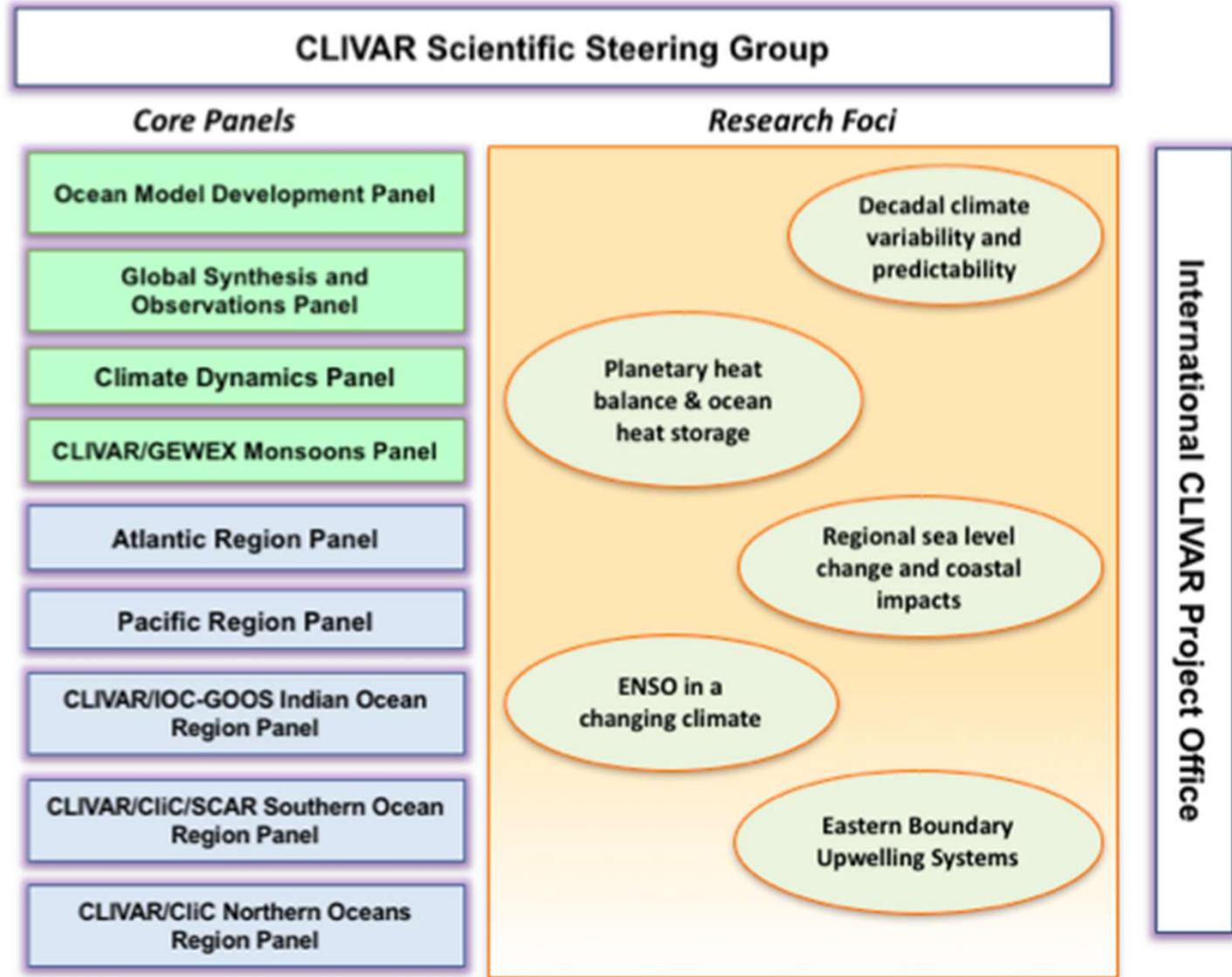
Through Panels, Research Foci, workshops, summer schools and conferences, CLIVAR brings together researchers from all over the world to coordinate international efforts to describe and understand the dynamics of the coupled ocean-atmosphere system and to identify processes responsible for climate variability, change and predictability



CLIVAR Open Science Conference  
Qingdao, September 2016

# Ongoing CLIVAR Structure

## CLIVAR Panels



# CLIVAR Global Panels

## CLIVAR GLOBAL SYNTHESIS AND OBSERVATIONS PANEL

- Demonstrated the value of ocean observing systems (both satellite and in-situ) and ocean state estimation, e.g., for initializing seasonal-to-interannual climate prediction.
- GSOP has fostered the International Quality controlled Ocean Database (IQuOD).

## CLIVAR OCEAN MODEL DEVELOPMENT PANEL

- Fosters the development of ocean models for research in climate.
- Provided ocean model diagnostics guidelines for the evaluation of ocean-ice model components of CMIP6 programs.

## CLIVAR CLIMATE DYNAMICS PANEL

- Coordinates international research efforts to increase understanding of the dynamical processes that control coupled climate variability and change in the atmosphere and ocean on synoptic to centennial time scales.

## CLIVAR CLIVAR/GEWEX MONSOONS PANEL

- Has a global remit and joint membership and operation between GEWEX and CLIVAR.
- Work encompasses aspects of tropical dynamics, the ITCZ, multi-scale convective physics and much work in understanding the response of monsoons to common forcing.

# CLIVAR Region Panels

## CLIVAR PACIFIC REGION PANEL

- Focus on process studies, ocean circulation and interannual to decadal climate variability and predictability in the region;
- Understanding the Western Boundary Currents.
- Supports the CLIVAR Indonesian. PRP has much involved in the TPOS-2020 planning.

## CLIVAR ATLANTIC REGION PANEL

Promote, recommend and oversee the implementation of observational systems in the Atlantic Ocean sector and major research initiatives on Atlantic climate variability and predictability. Important achievements have been made in development of the Atlantic observing system, ocean and climate modeling systems.

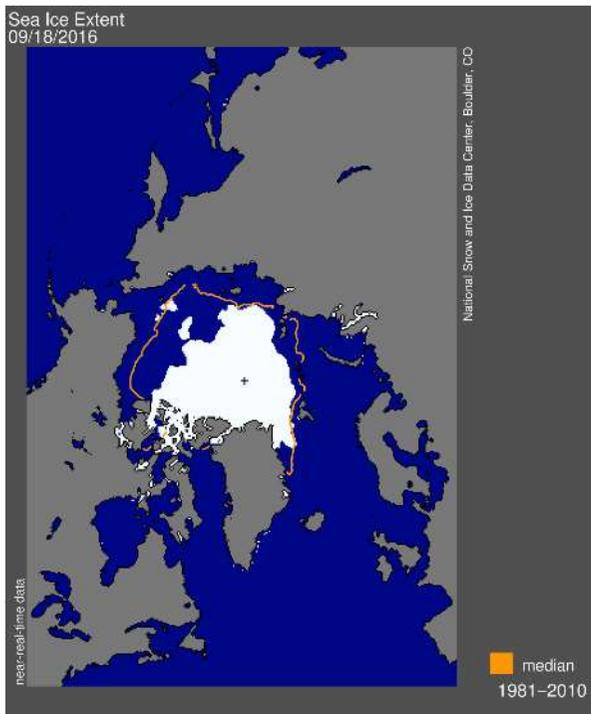
## CLIVAR/CLIC/SCAR SOUTHERN OCEAN REGION PANEL

- Development of tools and methods required to assess climate variability, climate change and climate predictability of the ocean-atmosphere-ice system in the Southern Ocean.
- Works closely together with SOOS, providing scientific and technical input, and collaborating as required with other relevant programs.

## CLIVAR/IOC-GOOS INDIAN OCEAN REGION PANEL

- Designs and implements an integrated observing system for the Indian Ocean, IndOOS with RAMA array.
- The climate variability modes of different time scales from intraseasonal to decadal are always the research priorities
- Involved in the planning of IIOE-2 project as one of the four organizing groups.

# Newer CLIC/CLIVAR Panel: NORP



An International Panel to Coordinate and Facilitate Activities on the Role of the Northern Oceans in the context of the Global Climate System from a Coupled Ocean-Air-Ice Perspective

NORP plays a central role in coordinating, monitoring, and evaluating the progress of such activities during and beyond the Year of Polar Prediction.

Founding Chairs:  
Amy Solomon and John Fyfe

# CLIVAR Research Foci

- CLIVAR has developed *Research Foci* (RF) fostering cross panel, cross community collaboration, and an opportunity to bring young scientists into CLIVAR.
- RF focus on topics with high potential for significant progress within 5 years that would benefit from enhanced international coordination.
- CLIVAR also embraces new activities and projects that may develop outside the CLIVAR framework but that demonstrate clear relevance to CLIVAR goals and objectives.

# First Round of RF

- Decadal variability and predictability of ocean and climate variability
- Regional sea level change and coastal impacts
- Planetary heat balance and ocean heat storage
- Biophysical interactions & dynamics of upwelling systems
- ENSO in a changing climate

# Research Foci

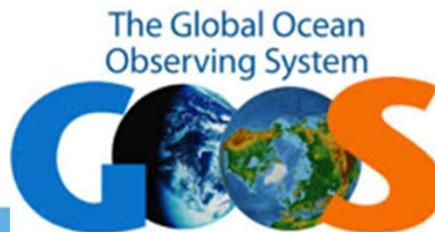
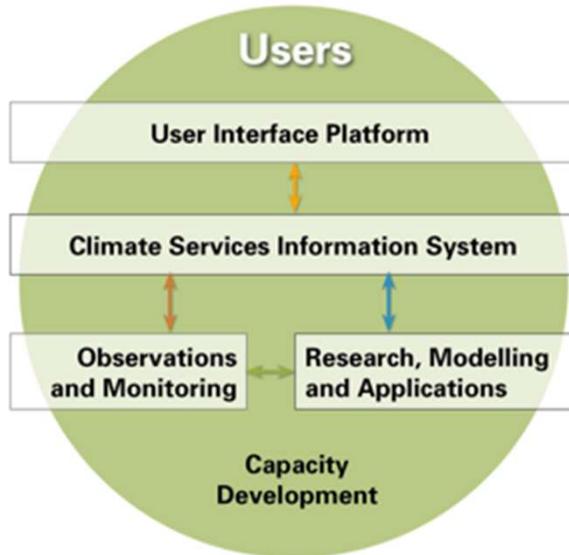
## First RF will come to end:

- Decadal Climate Variability & Predictability:
  - 2019 conference
  - Will become pan-WCRP effort
- Planetary Heat Balance & Ocean Heat Storage:
  - 2018 workshop,
  - will become pan-WCRP
- ENSO in a Changing Climate:
  - Conference in 2018
  - will move into PRP

- **New call anticipated**



# WCRP/CLIVAR partners and users



# Observing System Review

- CLIVAR is reviewing its role in defining observing system requirements for ocean and climate with ongoing reviews in various basins.
- **Short-term:**
  - **TPOS2020**

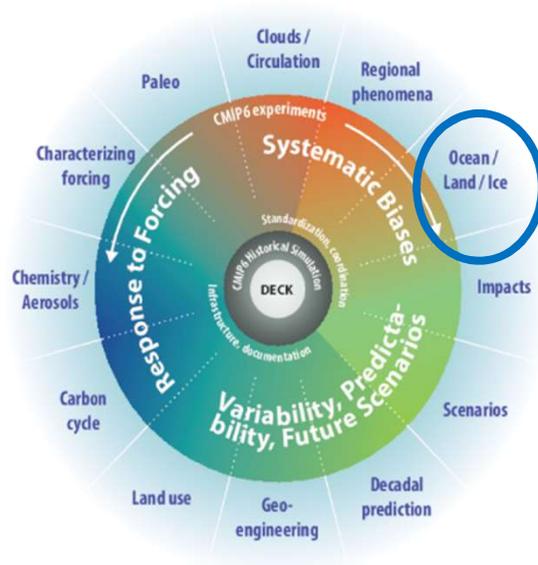
CLIVAR PRP, ENSO RF and SSG co-chairs recommend that TPOS2020 carefully reconsider its design strategy, with emphasis of preserving to the maximum extent possible the core elements of the TAO/TRITON array.
  - **Tropical Atlantic Observing System (TAOS) review**

2nd TAOS Review Workshop being organized back-to-back with PIRATA-23 in Marseille, France October 22-26, 2018
  - **Indian Ocean Observing System (IndOOS) decadal review**

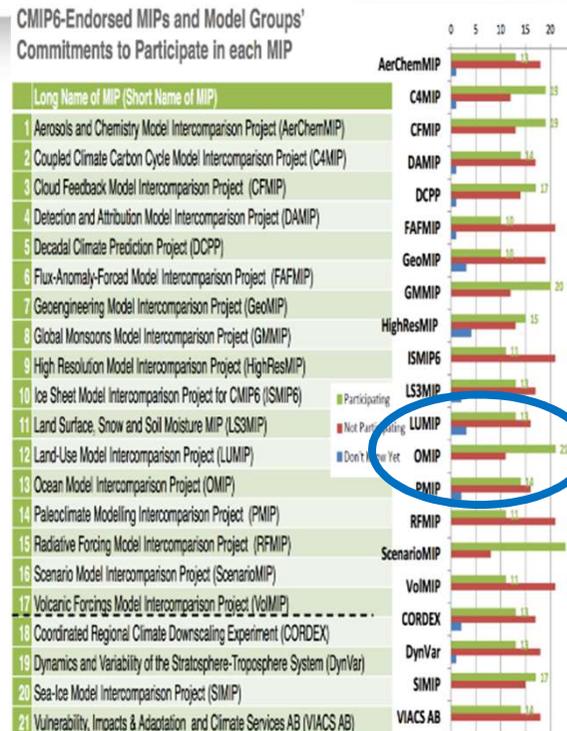
Close to completion. Last meeting in March 2018. Commented by IMBeR, OOPC, IOGOOS, IOC PPO
  - **Contribution to TPOS**

Advocating to keep the off-equatorial mooring sites in the original TAO/TRITON array, which have been producing unique data of great value for 25 years or more.

# Activity-Ocean Model Intercomparison Project (CMIP6/OMIP)



CMIP6-Endorsed MIPs and Model Groups' Commitments to Participate in each MIP



Eyring et al.,  
GMD, 2016

Courtesy V. Eyring



# Early Career Scientists Symposium



- Hosted by FIO: 18, 23-24 Sept
- Unique opportunity for young scientists to interact and exchange ideas with their peers and senior scientists.
- Designed by and for the CLIVAR ECS community, jointly with YESS



# Capacity Development: Summer Schools



## CLIVAR-FIO Joint Summer School Past, Present and Future Sea Level Changes



- July, 2018, Qingdao  
38 trainees from 25 countries



- Planning underway for: ICTP-CLIVAR Summer School on Oceanic Eastern Boundary Upwelling Systems. July, 2019  
<http://indico.ictp.it/event/8702/>

# Endorsed Training Activities in 2018

- **ICTP Summer school: Theory, Mechanisms and Hierarchical Modelling of Climate Dynamics: Multiple Equilibria in the Climate System**

25 June – 5 July 2018  
Trieste, Italy

Bordoni, Kang, Xie (CDP) as the speakers

- **NCAS Climate Modelling Summer school**

<https://www.ncas.ac.uk/en/climate-modelling-summer-school>

Rowan Sutton contributed to this activity

The screenshot shows the ICTP website page for the Summer School. The title is "ICTP Summer School on Theory, Mechanisms and Hierarchical Modelling of Climate Dynamics: Multiple Equilibria in the Climate System | (smr 3214)". The dates are "Starts 25 Jun 2018" and "Ends 5 Jul 2018". The location is "ICTP Glablagli Lecture Hall (AGH) Via Grignano, 9 I - 34151 Trieste (Italy)". The page includes a description of the climate community's challenges and a list of organizers: Fred Kucharski (ICTP), Anna Prati (Université Paris-Saclay), Adrian Tompkins (ICTP), Michela Bianutti (Columbia University), Aljo Wags (KIT), Riccardo Farnesi (ICTP). Co-sponsors include CLIVAR, EGU, and IUGG.

The screenshot shows the NCAS website page for the Climate Modelling Summer School. The title is "Climate Modelling Summer School". The text states: "The NCAS Climate Modelling Summer School will take place at the University of Cambridge from Monday 11 - Friday 22 September 2017. This intensive 12-day course is aimed at advanced PhD students and post-doctoral researchers, working in the natural sciences wishing to become experts in climate modelling." It also mentions that the course is a two-week course during which a mix of lectures and practical assignments are used to deliver world class teaching. The page includes a navigation menu with "HOME", "ABOUT", "PEOPLE", "MEETINGS & EVENTS", "TRAINING & RESOURCES", "OPPORTUNITIES", and "CONTACT". There is also a "CLIVAR" logo on the right side.

# Workshop organized

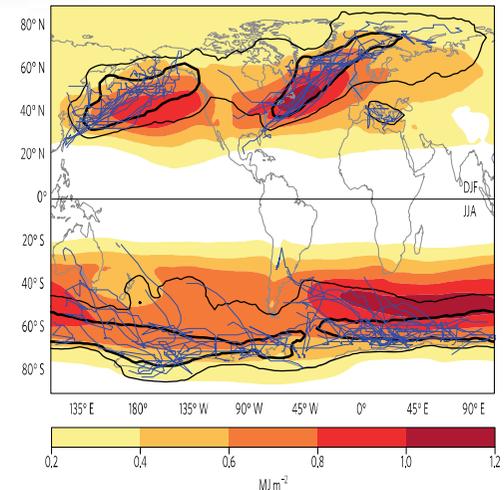
## Stormtracks 2018

### Coming to grips with alternative perspectives on storm tracks in a changing climate

Stockholm 27-31 August 2018  
Utö, Stockholm, Sweden

Organizers: [Yohai Kaspi \(CDP\)](#)  
Rodrigo Caballero

Participants: 60-80

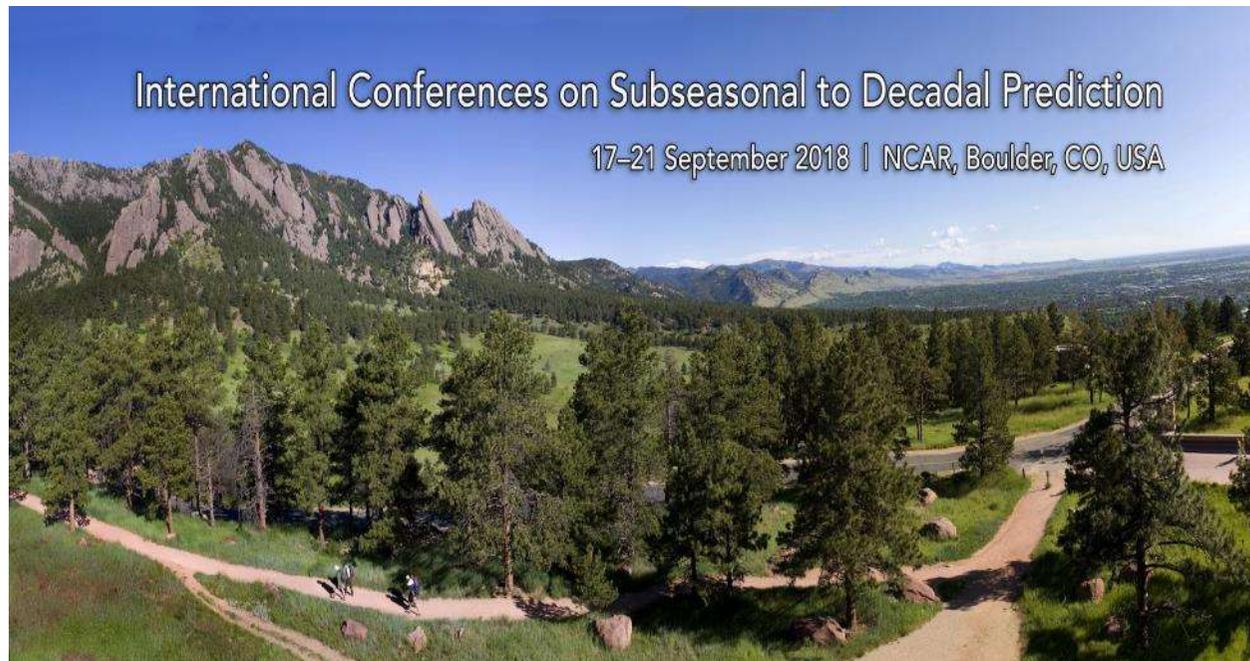


The aim of this focused meeting is to bring together scientists studying different perspectives of storm track dynamics, particularly the more climate/general circulation view of storm tracks and the more weather/synoptic perspective of storms tracks to (i) explore how insights from their different perspectives may be integrated, and (ii) identify opportunities for testing different mechanistic storylines quantitatively.

# **Second International Conference on Subseasonal to Seasonal Prediction (S2S) and Second International Conference on Seasonal to Decadal Prediction (S2D)**

**17-21 September 2018 NCAR, Boulder, CO, USA**

Keenlyside and Rym Msadek (from CDP panel) contributed the speeches about improvement in climate prediction.





- The conference devoted to analyze the current state of ENSO in terms of its diversity (types of El Niño) and its development.



## WCRP workshop on “The Earth’s Energy Imbalance and its implications”

13 - 16 November 2018, Toulouse, France

### Expected outcomes:

- Discussion and reporting on how the CONCEPT-HEAT topic could evolve into a WCRP topic, together with research goals and priorities.
- Strengthening future international scientific collaborations with experts concerned with the flow of energy through the climate system, and its implications for climate variability on multiple time scales.
- Developing plans for future assessments of the Earth Energy Imbalance and its variability with the aim of documenting uncertainties, assessing their implications for prediction, and identifying future observational needs.
- Developing a community paper on the Earth energy imbalance, or equivalent (e.g. special issue etc.).



## Earth's Future



### COMMENTARY

10.1029/2018EF000979

#### Key Points:

- The challenge of improving seamless regional climate forecast requires enhanced scientific understanding of regional to local climate processes
- Establishing actionable climate information calls for the technical development of multiscale approaches to climate predictions
- Reaching these goals relies on international coordination and on a close interaction between the science and stakeholder communities

#### Correspondence to:

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detlef.stammer@uni-hamburg.de

#### Citation:

Stammer, D., Bracco, A., Braconnot, P., Brasseur, G. P., Griffies, S. M., & Hawkins, E. (2018). 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*, 6. <https://doi.org/10.1029/2018EF000979>

Received 2 JUL 2018  
Accepted 19 OCT 2018

## Science Directions in a Post COP21 World of Transient Climate Change: Enabling Regional to Local Predictions in Support of Reliable Climate Information

D. Stammer<sup>1</sup> , A. Bracco<sup>2</sup> , P. Braconnot<sup>3</sup>, G. P. Brasseur<sup>4,5</sup> , S. M. Griffies<sup>6</sup> , and E. Hawkins<sup>7</sup> 

<sup>1</sup>Centrum für Erdsystem Forschung und Nachhaltigkeit, Universität Hamburg, Hamburg, Germany, <sup>2</sup>School of Earth and Atmospheric Sciences, Georgia Institute of Technology, Atlanta, GA, USA, <sup>3</sup>Laboratoire des Sciences du Climat et de l'Environnement, unité mixte CEA-CNRS-UVSQ, Université Paris Saclay, Gif sur Yvette Cedex, France, <sup>4</sup>Max Planck Institute for Meteorology, Hamburg, Germany, <sup>5</sup>National Center for Atmospheric Research, Boulder, CO, USA, <sup>6</sup>NOAA Geophysical Fluid Dynamics Lab and Princeton University Atmospheric and Oceanic Sciences Program, Princeton, NJ, USA, <sup>7</sup>National Centre for Atmospheric Science, Department of Meteorology, University of Reading, Reading, UK

**Abstract** During recent decades, through theoretical considerations and analyses of observations and model simulations, the scientific community has fundamentally advanced our understanding of the coupled climate system, thereby establishing that humans affect the Earth's climate. Resulting from this remarkable accomplishment, the COP21 agreement marks a historic turning point for climate research by calling for actionable regional climate change information on time scales from seasonal to centuries for the benefit of humanity, as well as living and nonliving elements of the Earth environment. Out of the underlying United National Framework Convention on climate Change process, improving seamless regional climate forecast capabilities emerges as a key challenge for the international research community. Addressing it requires a multiscale approach to climate predictions. Here we offer a vision that emphasizes enhanced scientific understanding of regional to local climate processes as the foundation for progress. The scientific challenge is extreme due to the rich complexity of interactions and feedbacks between regional and global processes, each of which affects the global climate trajectory. To gain the necessary scientific insight and to turn it into actionable climate information require technical development, international coordination, and a close interaction between the science and stakeholder communities.

# New CLIVAR Science Plan

[http://www.clivar.org/sites/default/files/documents/CLIVAR%20Science%20Plan\\_Final.pdf](http://www.clivar.org/sites/default/files/documents/CLIVAR%20Science%20Plan_Final.pdf)



Climate and Ocean – Variability,  
Predictability and Change

Science Plan and Implementation Strategy



# Brief history of the new CLIVAR Science Plan

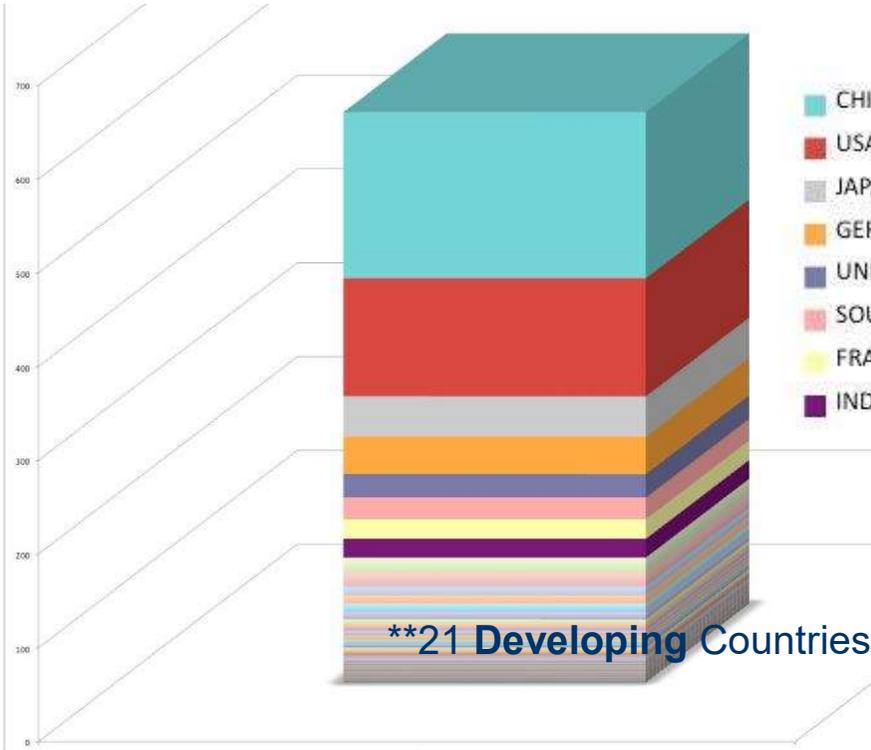


# CONFERENCE OBJECTIVES

More than a decade after the first CLIVAR Open Science Conference (Baltimore; USA), the OSC in Qingdao aimed to:

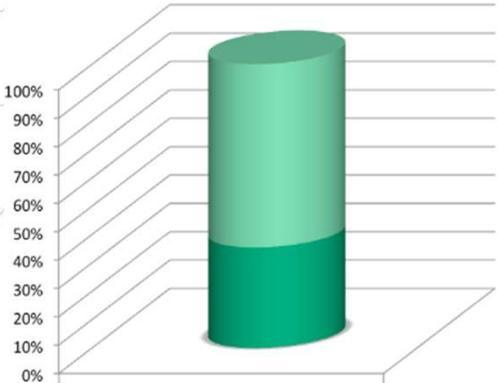
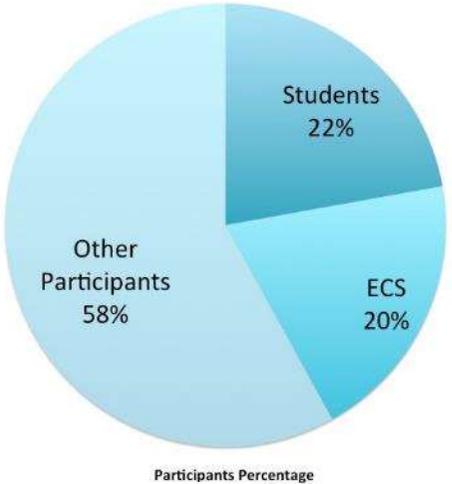
- **Review progress** toward understanding dynamics, interactions, and predictability of the coupled ocean-atmosphere system
- **Shape ideas** to meet emerging ocean and climate science challenges
- **Engage with the future generation** of climate scientists
- **Identify key climate research** and stakeholder **issues**
- **Develop and strengthen collaborations** across nations, disciplines and age groups
- **Promote integrative studies**

# OSC statistics



**608 Participants from 47 Countries**

- CHINA 177 PARTICIPANTS
- USA 126 PARTICIPANTS
- JAPAN 43 PARTICIPANTS
- GERMANY 40 PARTICIPANTS
- UNITED KINGDOM 25 PARTICIPANTS
- SOUTH KOREA 23 PARTICIPANTS
- FRANCE 21 PARTICIPANTS
- INDIA 20 PARTICIPANTS



Participants

- Male 64.5%
- Female 35.5%

# New CLIVAR Science

## 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):

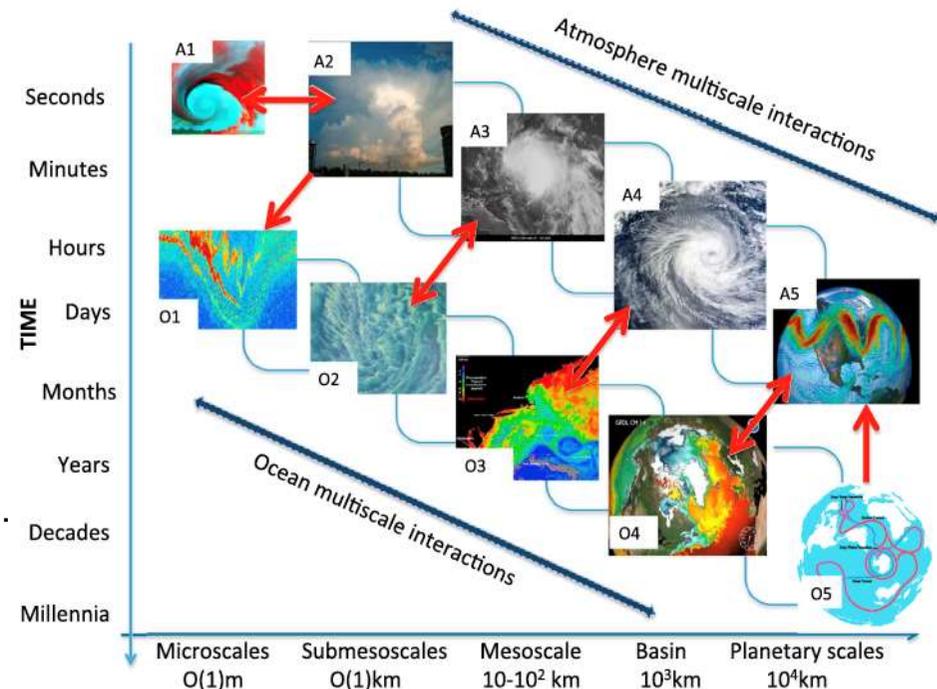
- Expanding on a climate risk concept (**uncertainty**)
- Providing **regional climate information and seamless predictions across timescales**
- Understanding mechanisms and consequences of climate variability and change, globally and **regionally**

# 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 still **NEED** fundamental climate science after COP21)

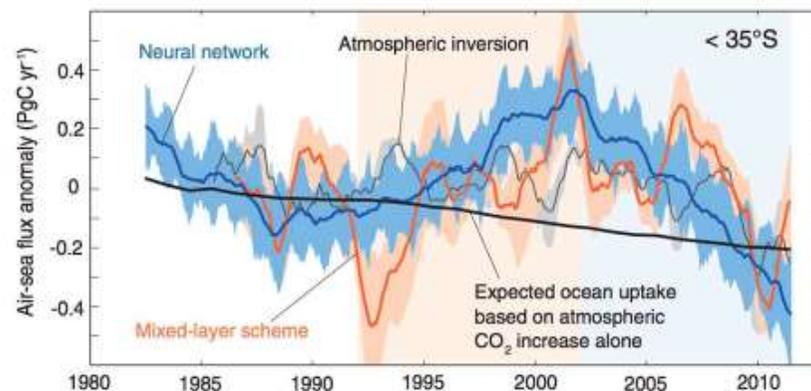
Stammer, Bracco, Braconnot, Brasseur, Griffies, & Hawkins, E. (2018). Earth's Future, 6. <https://doi.org/10.1029/2018EF000979>



# CLIVAR short-term priorities

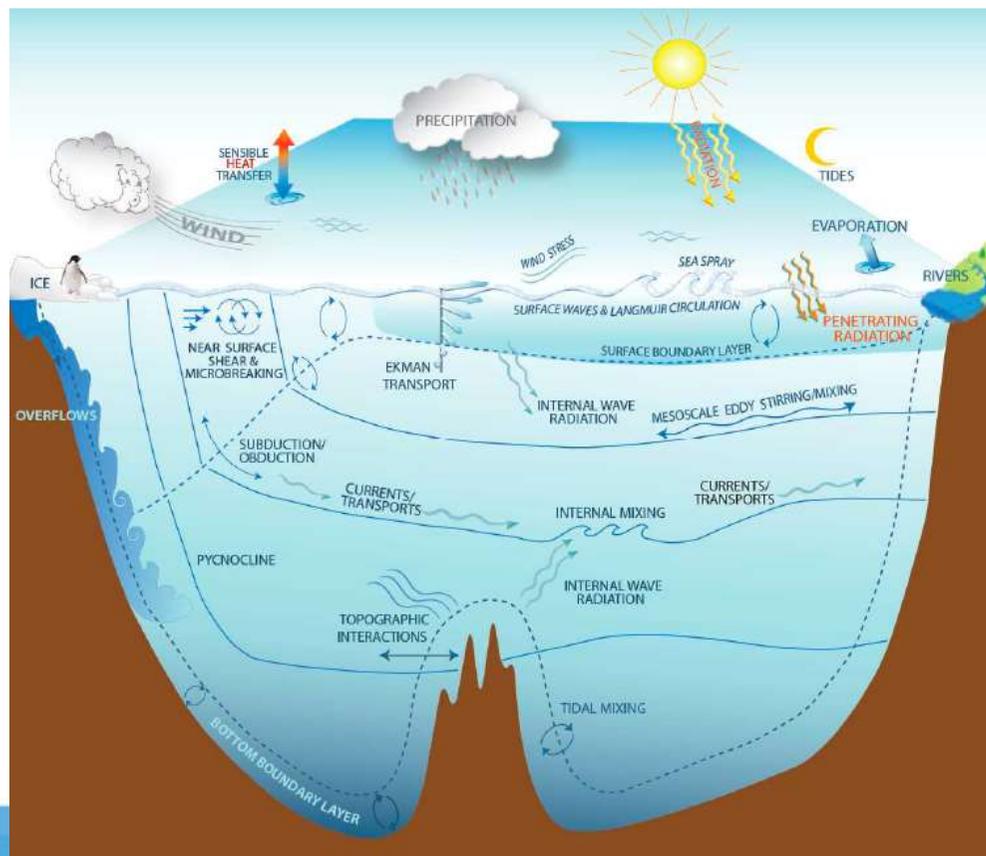
- The ocean's role in transient climate sensitivity and changes to sea level under increasing anthropogenically induced radiative changes
- Ocean contributions to energy, heat, water and carbon budgets, their perturbations and changes

Decadal variability of air – sea CO<sub>2</sub> fluxes in the Southern Ocean comparing the decadal modes from empirical models and the steady state trend (Landschutzer et al. 2015).



# CLIVAR short-term priorities

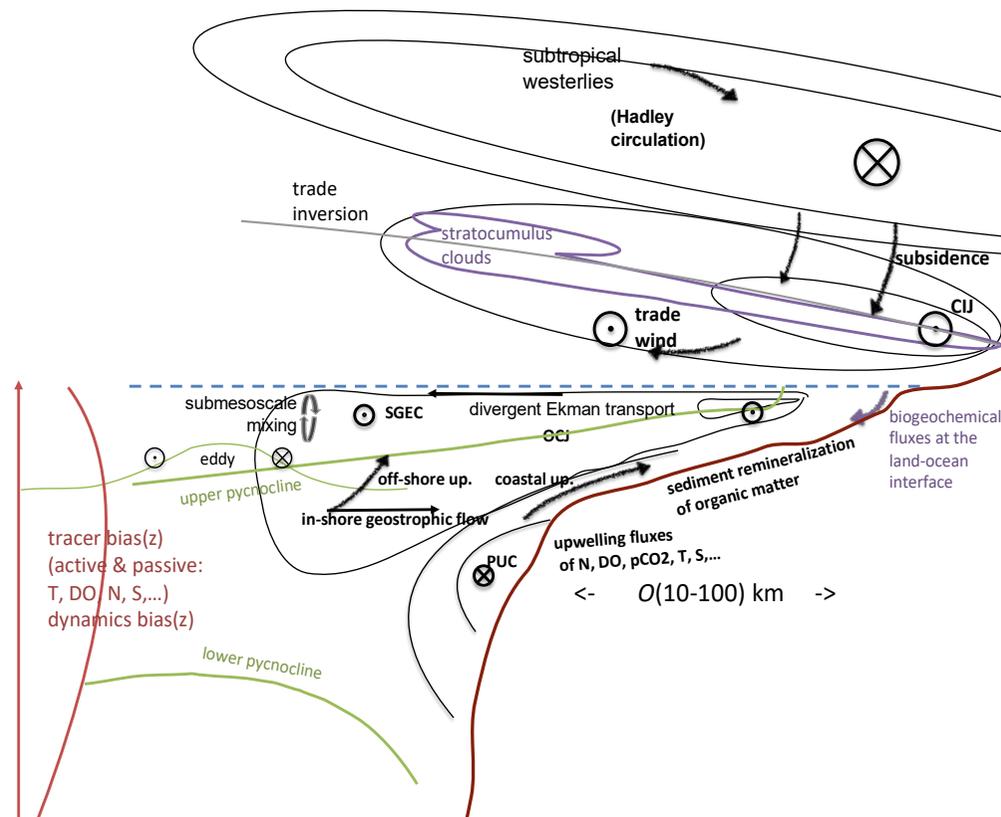
- Regional climate variability and change; high resolution model simulations; extremes; fine scales processes



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

# CLIVAR short-term priorities

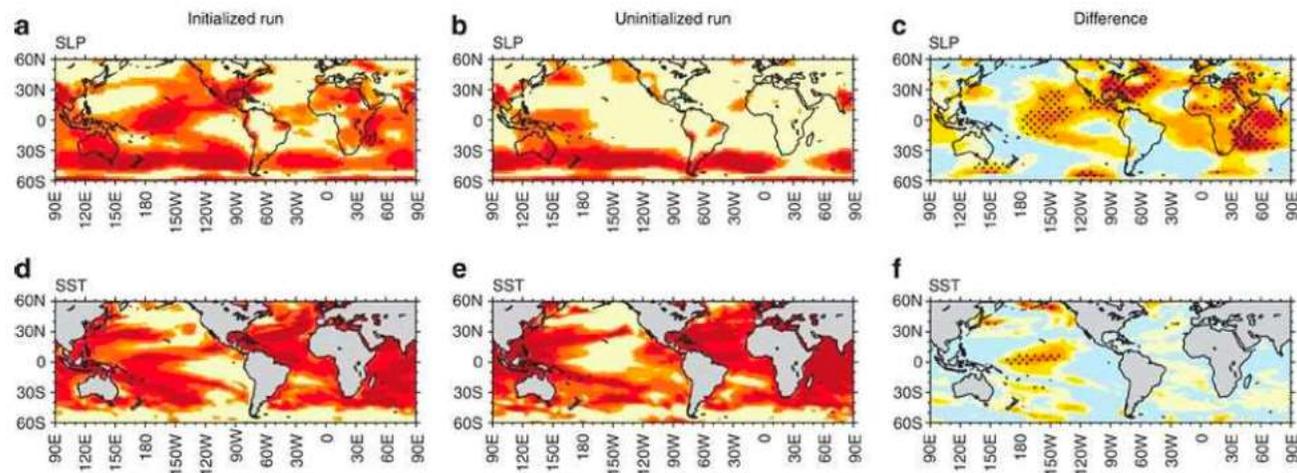
- Physical and biogeochemical interactions in the coastal ocean and changes to this vital and vulnerable region of the planet.



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

# CLIVAR short-term priorities

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



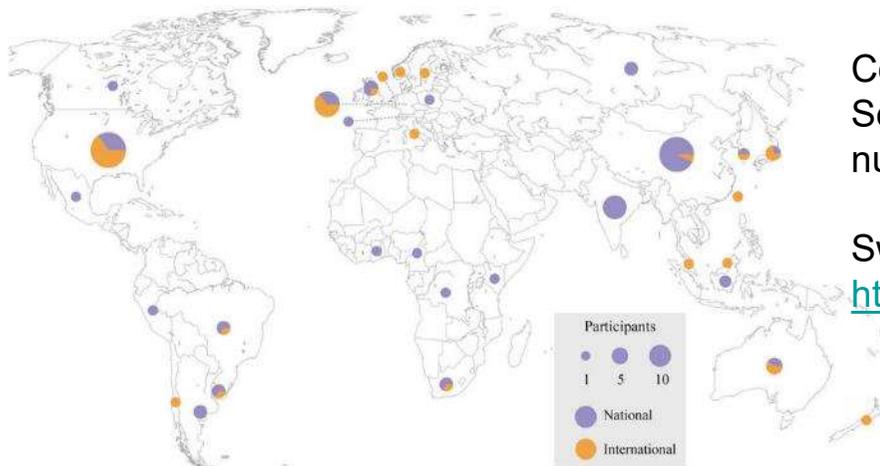
Potential predictive skills of (a–c) SLP and (d–f) SST anomalies for averaged 2–5 years lead time in the initialized run (left), the uninitialized run (center) and their difference (right).

From Chikamoto et al. (2015).

# CLIVAR Enabling Capabilities

***International cooperation is critical to grow the infrastructure that underpins all CLIVAR science:***

- Climate and Ocean Process and Sustained Observations
- Global, Regionally Enhanced and Process Models
- Ocean Data, Synthesis and Assessment
- Capacity Development and Knowledge Exchange



Country affiliation of participants from the Early Career Scientists Symposium. Circle location and size indicate the number of participants currently affiliated with each country.

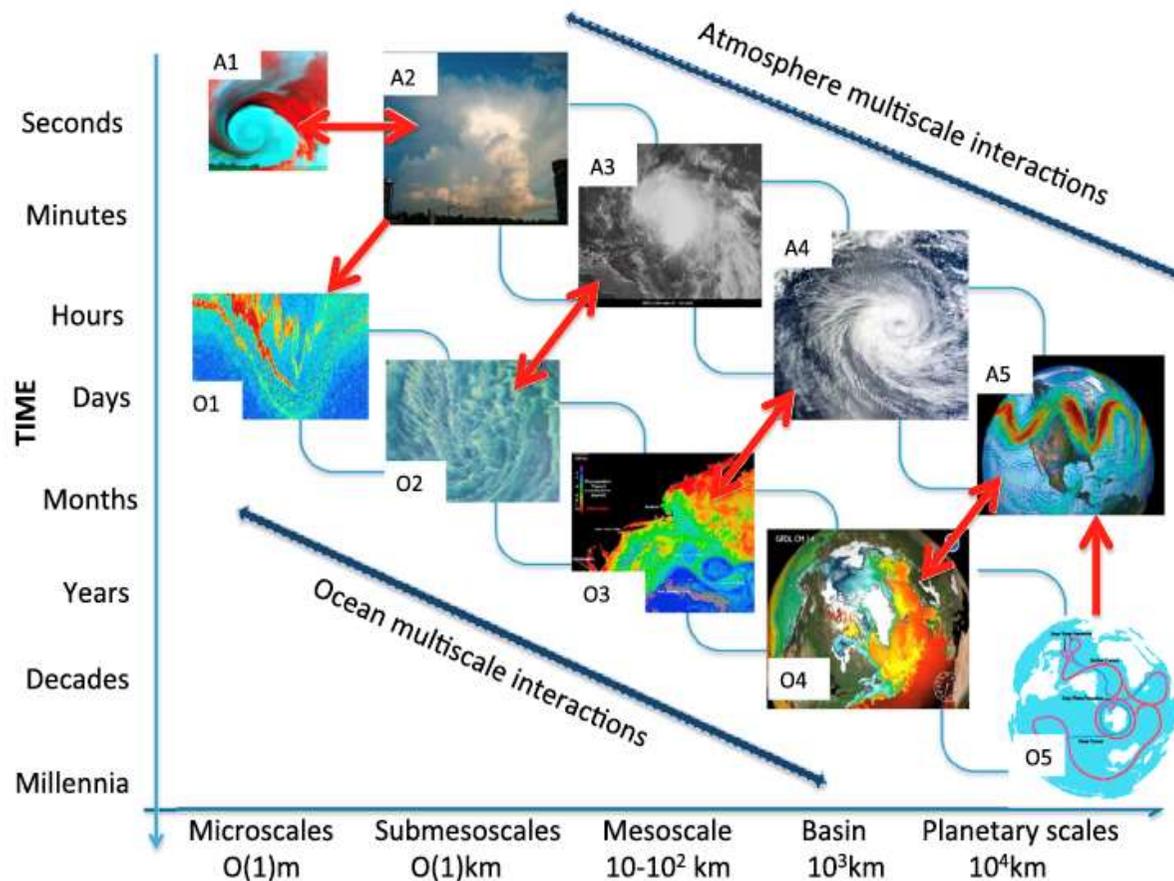
Swart et al., 2018

<https://www.nature.com/articles/s41612-018-0015-y>



# Long term objectives (input to WCRP SP)

- Identify ocean and coupled **climate processes** that are critical for global and regional climate variability and change



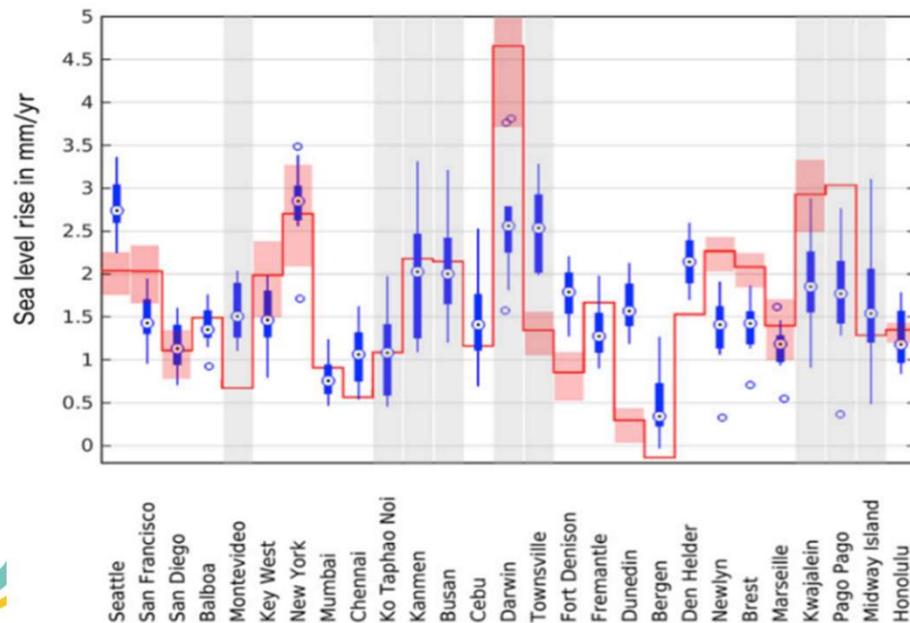
+ similar cross-scale interactions with land and cryosphere

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



# Long term objectives (input to WCRP SP)

- Identify temporal and spatial scales of **climate predictability**
- Quantify constraints on **climate sensitivity**, air-sea exchange and Earth's energy budget / ocean heat content
- Quantify **regional impacts** of climate change in **sea level, cryosphere and water cycle**

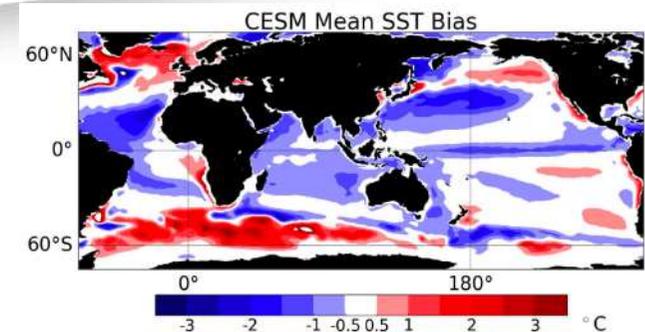


Box plot of the observed (red) and modeled (blue) sea level trends at each tide gauge station (over the tide gauge record period) in  $\text{mm yr}^{-1}$

Meyssignac et al., CLIVAR Exchange, Sea Level Rise issue, Feb 2018

# Long term objectives (input to WCRP SP)

- Quantify past/present/future **ocean role in CO<sub>2</sub> and heat uptake** and links between **climate and ocean ecosystems**

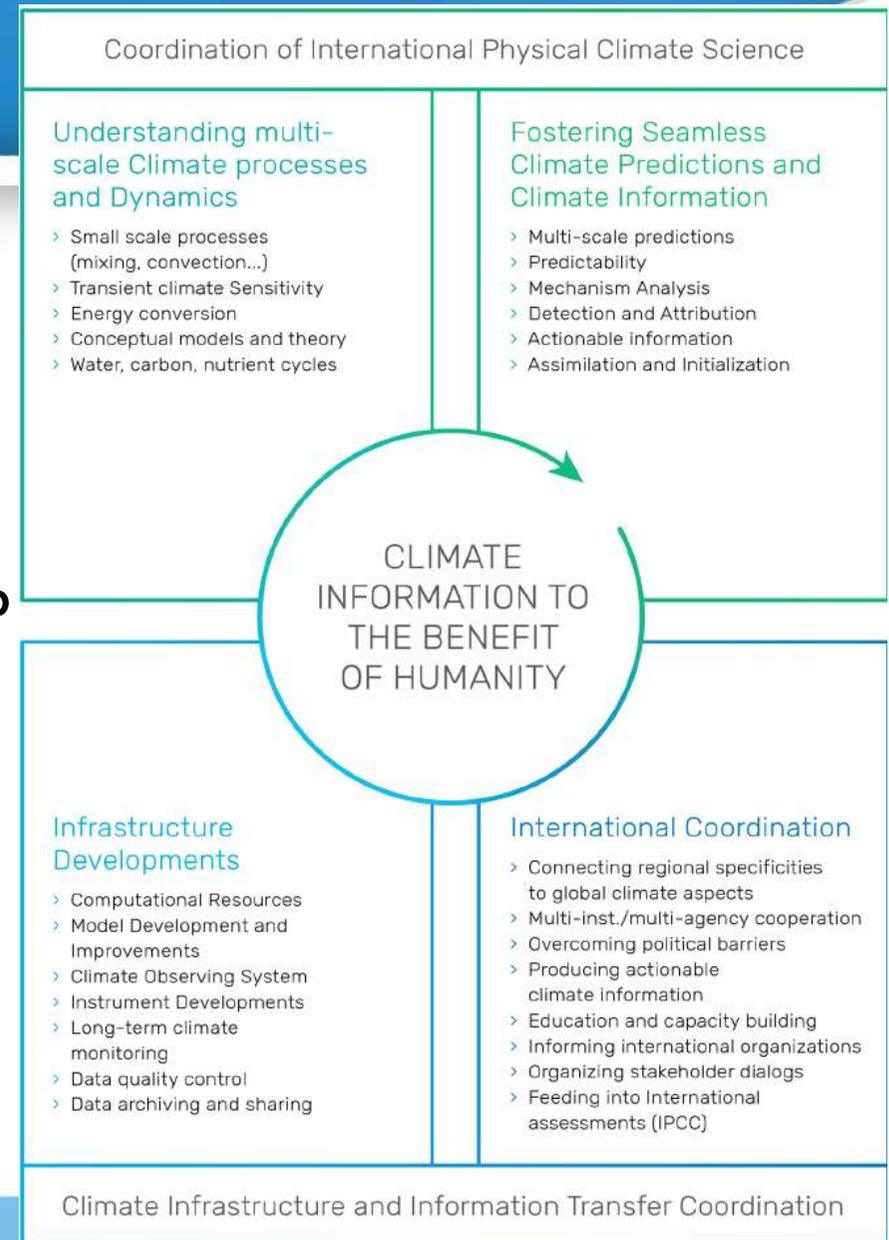


Mean SST bias in CESM Ensemble:  
too warm upwelling systems

- Provide **regional climate information and seamless predictions across timescales**, from intraseasonal to multidecadal
- Quantify predictability of the climate system, including the predictive skills of extreme events in a transient climate
- Facilitate the provision of actionable forecast information, including to developing/in transition economies

# CLIVAR and WCRP SP

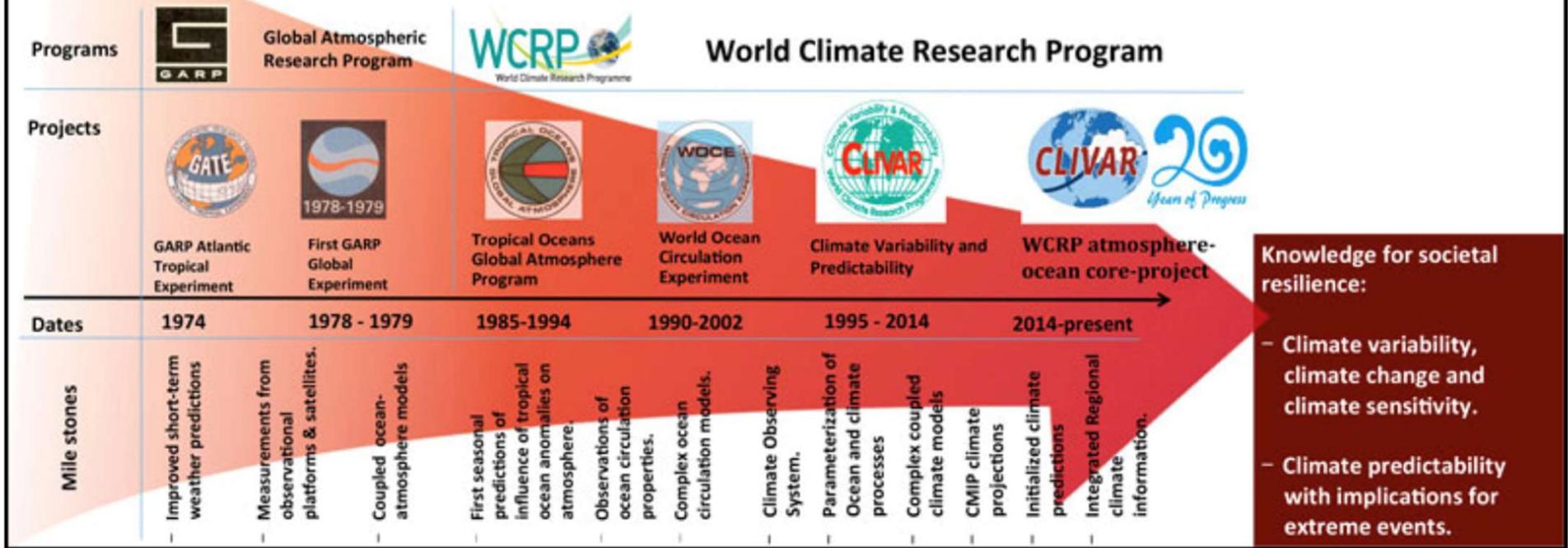
- CLIVARs science speaks to all objectives in WCRP SP. Indeed CLIVAR speaks to all Capability themes provided in in the WCRP review
- Integrated view of the climate system (heat, water, carbon) required and implemented in the CLIVAR SP



# Challenges Ahead

- WCRP Implementation
- Sustaining national funding under a new WCRP structure.
- Streamlining what is in CLIVAR with respect to other WCRP efforts.
- How to effectively integrate activities, organizationally, in the new WCRP, such as those focusing on heat, water, carbon?
- Interaction of potential new WCRP structure with national CLIVAR activities (e.g., US CLIVAR; ICPO).
- Finances!!

# Path Toward Climate Information for Society



# Thank you

**Thank you**

# Day 2 and 3 Objectives

- Discuss and vote on all SSG-related CLIVAR issues
- Report on developments over the last year
- Review progress within panels and RFs
- Review lifetime of RFs
- Review membership proposals of panels and SSG
- CLIVAR finances and outreach
- Work on and finalize the CLIVAR SP
- Hear about WCRP developments
- AOB

**Participants: CLIVAR SS members, CLIVAR Panel/RF representatives, Observers**

<b>Wed. 28/11</b>			<b>Session</b>	<b>Presenter / Discussion lead</b>	<b>Time</b>
	<b>1</b>		<b>Opening</b>		
09:00		1.1	Welcome	Mike Patterson	10
09:10		1.2	Welcome and meeting objectives	D. Stammer/A. Bracco	30
09:40		1.3	WCRP	G. Brasseur	30
<b>10:10</b>			<b>Break</b>		<b>20</b>
	<b>2</b>		<b>Panel Reports</b>		
10:30		2.1	CLIVAR/CliC Northern Ocean Region P.	Amy Solomon	25
10:55		2.2	CLIVAR/CliC/SCAR Southern Ocean R. P.	Riccardo Farneti	25
11:20		2.3	Pacific Region Panel	Xiaopei Lin	25
11:45		2.4	Atlantic Region Panel	Sabrina Speich	25
12:10		2.5	CLIVAR/IOC-GOOS Indian Ocean Region P.	Lisa Beal	25
<b>12:35</b>			<b>Lunch</b>		<b>60</b>
13:35		2.6	Monsoons Panel	Andy Turner (telecon)	25

14:00		2.7	Global Synthesis & Observations P.	Steven Jayne	25
14:25		2.8	Ocean Model Development Panel	Alistair Adcroft	25
14:50		2.9	Climate Dynamics Panel	Mat Collins	25
<b>15:15</b>			<b>Break</b>		<b>25</b>
	<b>3</b>		<b>Research Foci Reports</b>		
15:40		3.1	Consistency between planetary energy balance & ocean heat storage	Karina von Schuckman (telecon)	25
16:05		3.2	Decadal Climate Variability and Predictability	Yochanan Kushnir (telecon)	25
16:30		3.3	ENSO in a changing climate	Wenju Cai	25
16:55		3.4	Eastern Boundary Upwelling Systems	Ryan Rykaczewski	25
17:20		3.5	Regional Sea Level Change and Coastal Impacts Grand Challenge	Detlef Stammer	25
17:45		3.6	Discussion on budget/meetings	D. Stammer/ A. Bracco	15
<b>18:00</b>			<b>Adjourn for day</b>		

Thurs. 29/11			Session	Presenter / Discussion lead	Time
	<b>4</b>		<b>ICPO/WCRP report</b>		
09:00		4.1	ICPO report	J. Santos	20
		4.2	WCRP report	M. Sparrow	10
	<b>5</b>		<b>CLIVAR activities</b>		
09:30		5.1	CLIVAR Summer Schools	D. Stammer/A. Bracco	40
<b>10:10</b>			<b>Break</b>		<b>20</b>
	<b>6</b>		<b>Interactions with Other Projects</b>		
10:30		6.1	US CLIVAR	Dan Vimont	20
10:50		6.2	IOC	Salvatore Arico (telecon)	20
11:10		6.3	CORDEX	Christopher Lennard	20
11:30		6.4	SPARC	Donald Wuebbles	20
11:50		6.5	GEWEX	Peter Van Oevelen	20
12:10		6.6	Discussion, review of action items. Closing of public part of SSG	D. Stammer/ A. Bracco	20
<b>12:30</b>			<b>Lunch</b>		<b>60</b>
			<b>In camera – SSG and ICPO only</b>		
13:30	<b>7</b>		<b>Review of 2019 Meeting proposals and budget</b>	ICPO staff/SSG	45
14:15	<b>8</b>		<b>Membership issues</b>	SSG	45
		8.1	Life cycle of RF	D. Stammer/A. Bracco	
		8.2	Discussion on every panel	D. Stammer/A. Bracco	
<b>15:00</b>			<b>Break</b>		
15:30	<b>9</b>		<b>Preparations for next JSC</b>	D. Stammer/A. Bracco	60
16:30	<b>10</b>		<b>Any Other Business/Next SSG</b>	D. Stammer/A. Bracco	30
<b>17:00</b>			<b>End of meeting</b>		

