



GEWEX

CLIVAR: CLIMATE & OCEAN
variability, predictability and change

Lei Han, Nico Caltabiano, Valery Detemmerman
International CLIVAR Project Office (ICPO)

29th SOLAS SSC Meeting, 6-9 Feb, 2017 Sanya, China

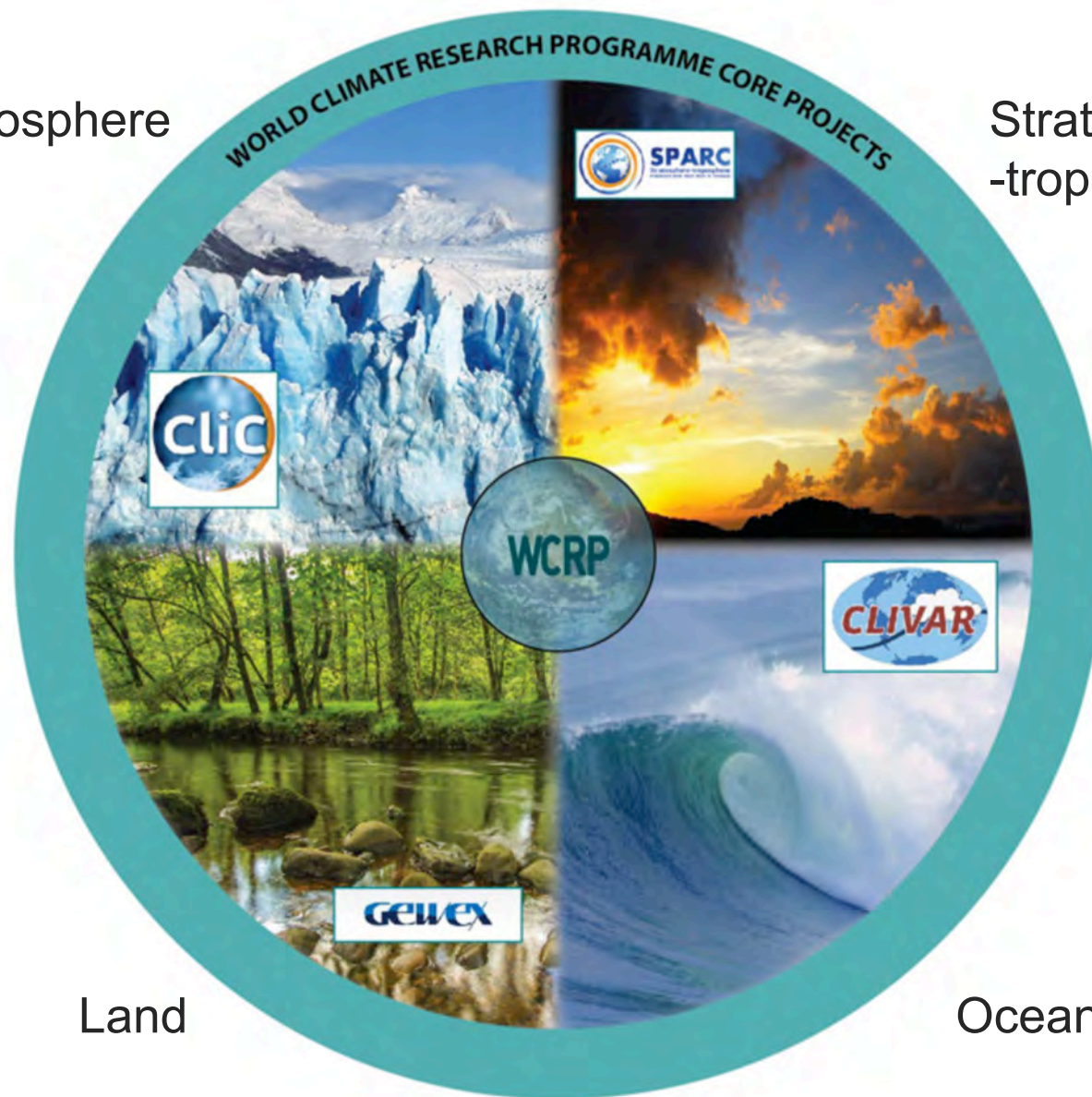


CLIVAR is WCRP's core project on the **Ocean-Atmosphere System**

www.wcrp-climate.org

Cryosphere

Stratosphere
-troposphere



Land

Ocean

CLIVAR: Successor of TOGA and WOCE

TOGA (1985-1994)



WOCE (1990-2002)



New international
climate-ocean program



1995-present

IVAR Organization

Scientific Steering Group



Core Panels

Ocean Model Development Panel

Global Synthesis and Observations Panel

Climate Dynamics Panel

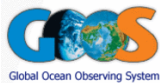
Monsoons Panel

Atlantic Region Panel

Pacific Region Panel

Indian Ocean Region Panel

Southern Ocean Region Panel



Research Foci

Decadal climate variability and predictability

Eastern Boundary Upwelling Systems

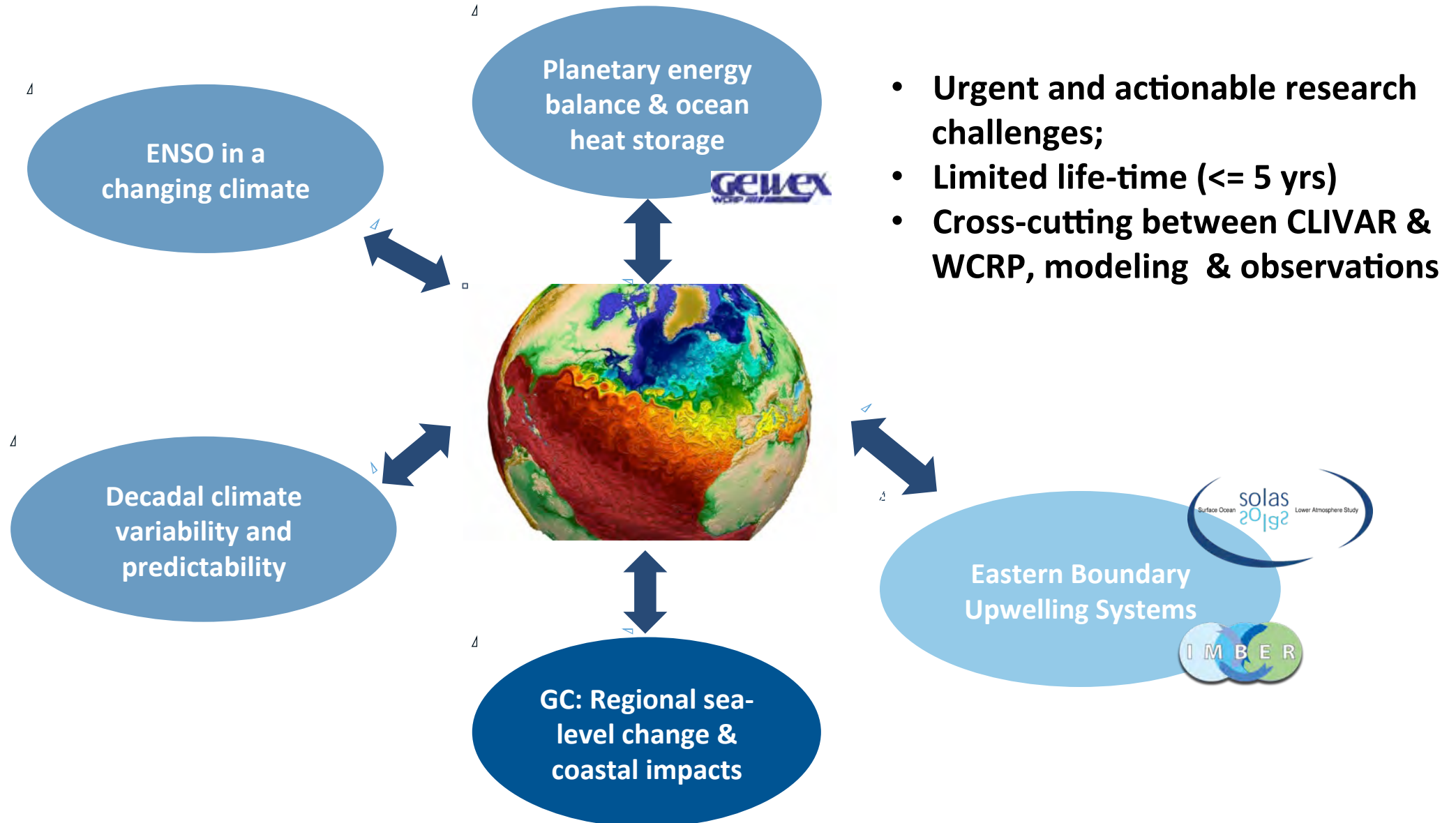
Regional sea-level change & coastal impacts

Planetary energy balance & ocean heat storage

ENSO in a changing climate

...

CLIVAR Research Foci



- **Urgent and actionable research challenges;**
- **Limited life-time (≤ 5 yrs)**
- **Cross-cutting between CLIVAR & WCRP, modeling & observations**

ICPO – Who are we?

Distributed offices:

- ❑ Acting ICPO ED: Southampton, UK
- ❑ ICGPO (International CLIVAR Global Project Office): Qingdao, China
- ❑ ICMPO (International CLIVAR Monsoon Project Office): Pune, India



**Dr Lei Han,
Staff Scientist,
Coordinator of ICGPO**



Jing Li, Staff Scientist



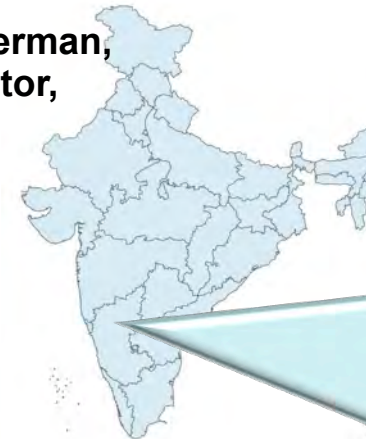
Assistant: Lina Kang



**Acting ICPO Executive Director
Dr. Nico Caltabiano**



**Valery Detemmerman,
Executive Director,
Retired**



**ICMPO Director
Dr. Rokkam R. Rao**



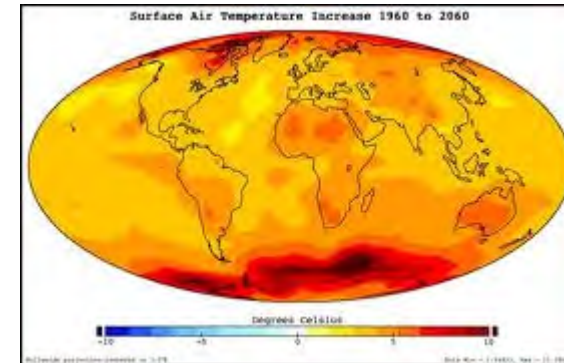
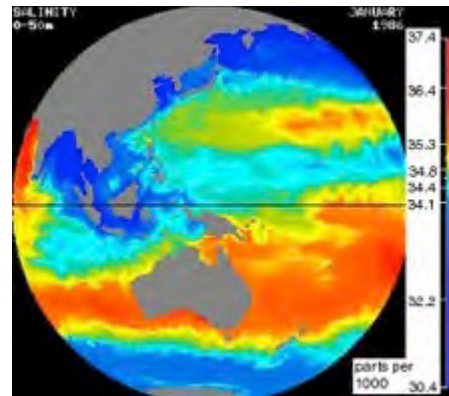
**Dr. Ramesh Kripalani
Senior Scientist**



**Harish Borse
D.T.P. Operator**

CLIVAR Mission

To observe, simulate and predict changes in Earth's climate system with a **focus on ocean-atmosphere system**, enabling better understanding of climate variability, predictability and change, to the benefit of society and the environment in which we live.

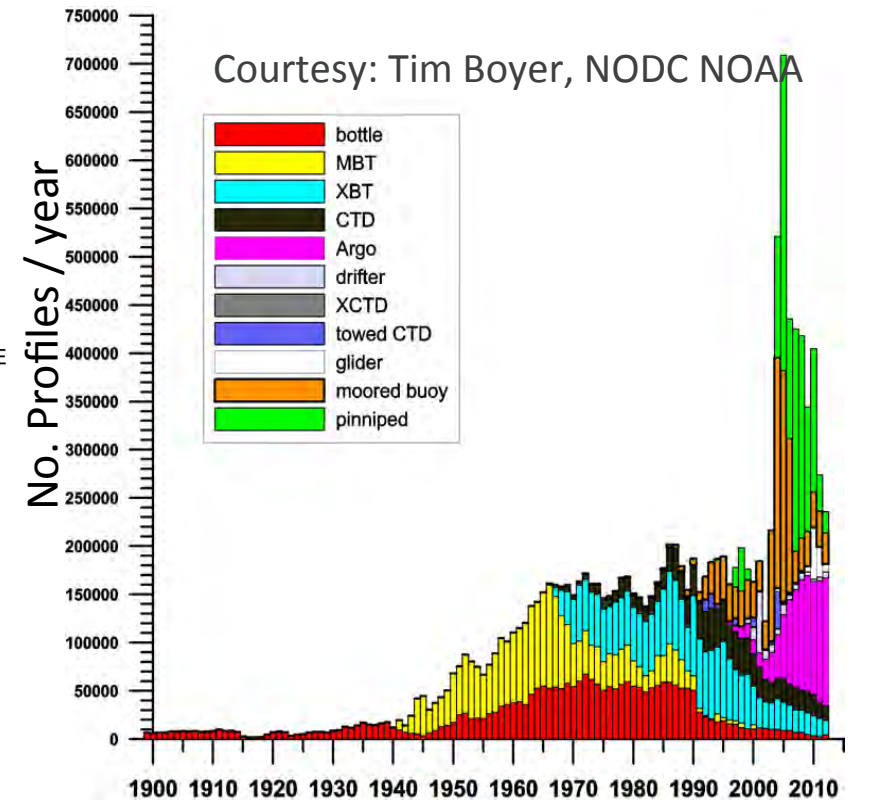
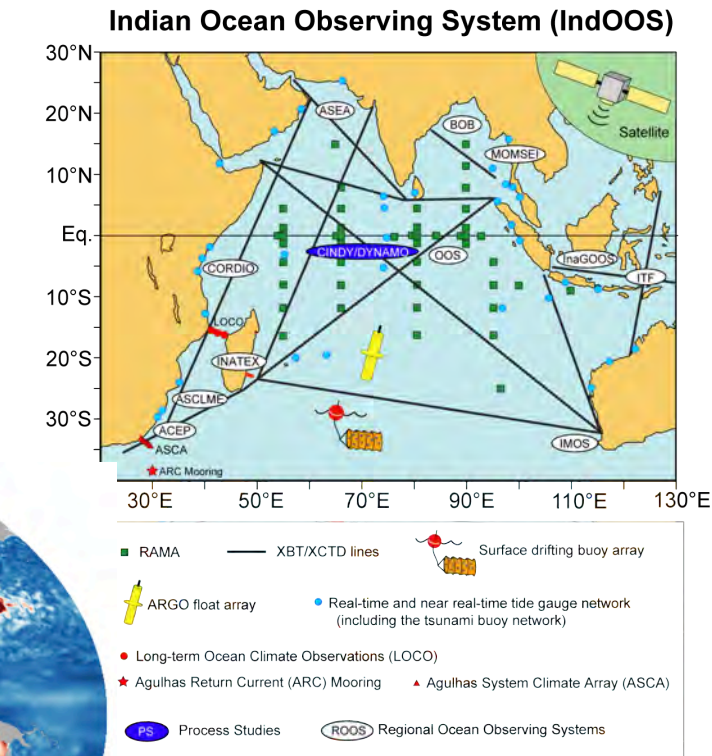
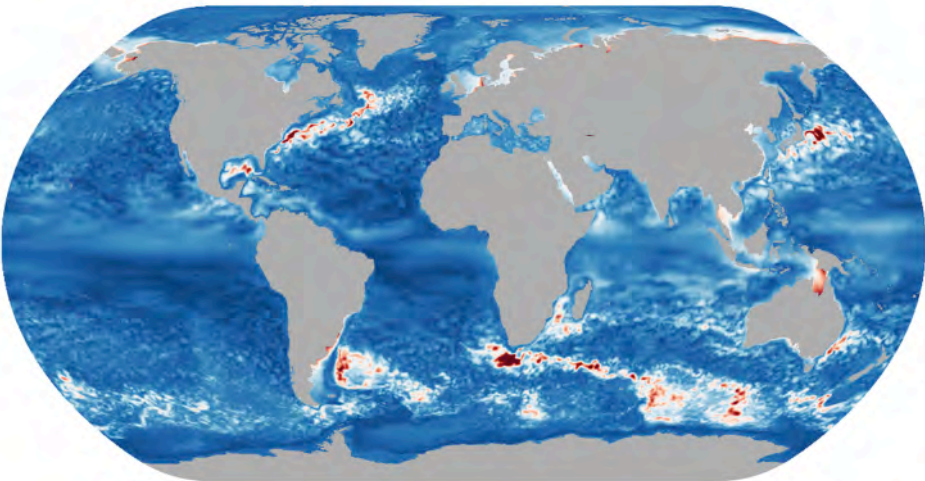


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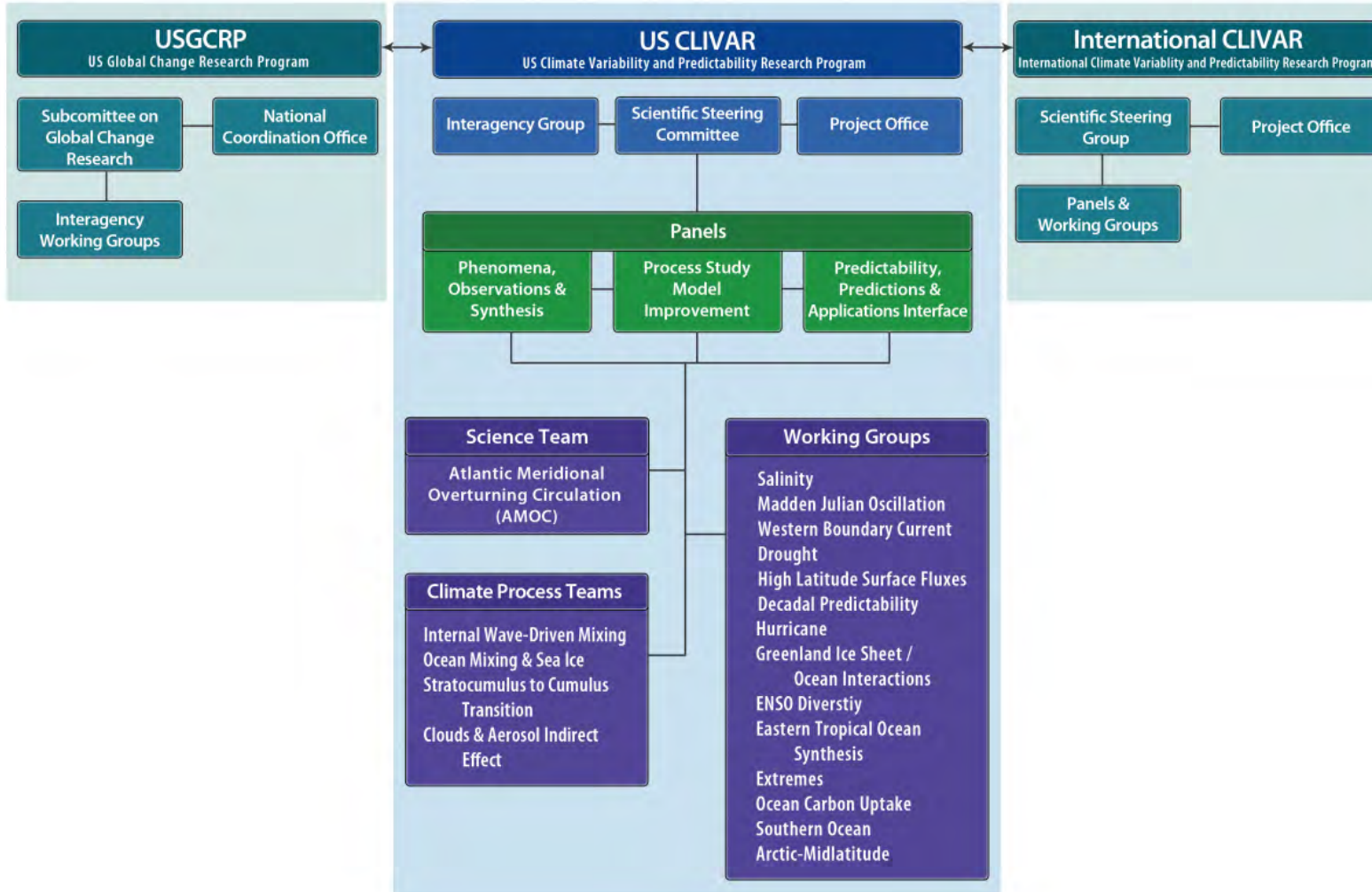
What does CLIVAR do?

Facilitates international coordination and cooperation

- Field projects
- Modelling studies
- Data synthesis
- Capacity development
- Meetings



US CLIVAR – national program



Funding for US CLIVAR provided by



IAG (Inter-Agency Group)



CLIVAR Research Foci



<http://www.clivar.org/research-foci/heat-budget>

Research foci

Consistency between planetary energy balance and ocean heat storage (CONCEPT-HEAT)

Co-chairs:

K. von Schuckmann, K. Trenberth

Scientific steering team members:

C.-A. Clayson; C. Domingues; S. Gulev; K. Haines; N. Loeb; M. Palmer; P.-P. Mathieu; R. Weller; M. Wild; Y. Xue



First meeting June 2014, Bern, Switzerland

Consistency between planetary energy balance and ocean heat storage

An overall goal is to **bring together different climate research communities** all concerned with the energy flows in the Earth's System to advance on the **understanding of the uncertainties through budget constraints:**



- **Atmospheric radiation**
- **Ocean Heat Content**
- **Earth's surface fluxes**
- **Climate variability and change**
- **Data assimilation & operational services (R&D)**
- **Climate projection**
- **Global sea level**

Remote sensing**In situ****Reanalysis systems****Models**

PERSPECTIVE

PUBLISHED ONLINE: 27 JANUARY 2016 | DOI: 10.1038/NCLIMATE2876

nature
climate change

An imperative to monitor Earth's energy imbalance

K. von Schuckmann^{1,2*}, M. D. Palmer³, K. E. Trenberth⁴, A. Cazenave^{5,6}, D. Chambers⁷, N. Champollion⁶, J. Hansen⁸, S. A. Josey⁹, N. Loeb¹⁰, P.-P. Mathieu¹¹, B. Meyssignac⁵ and M. Wild¹²

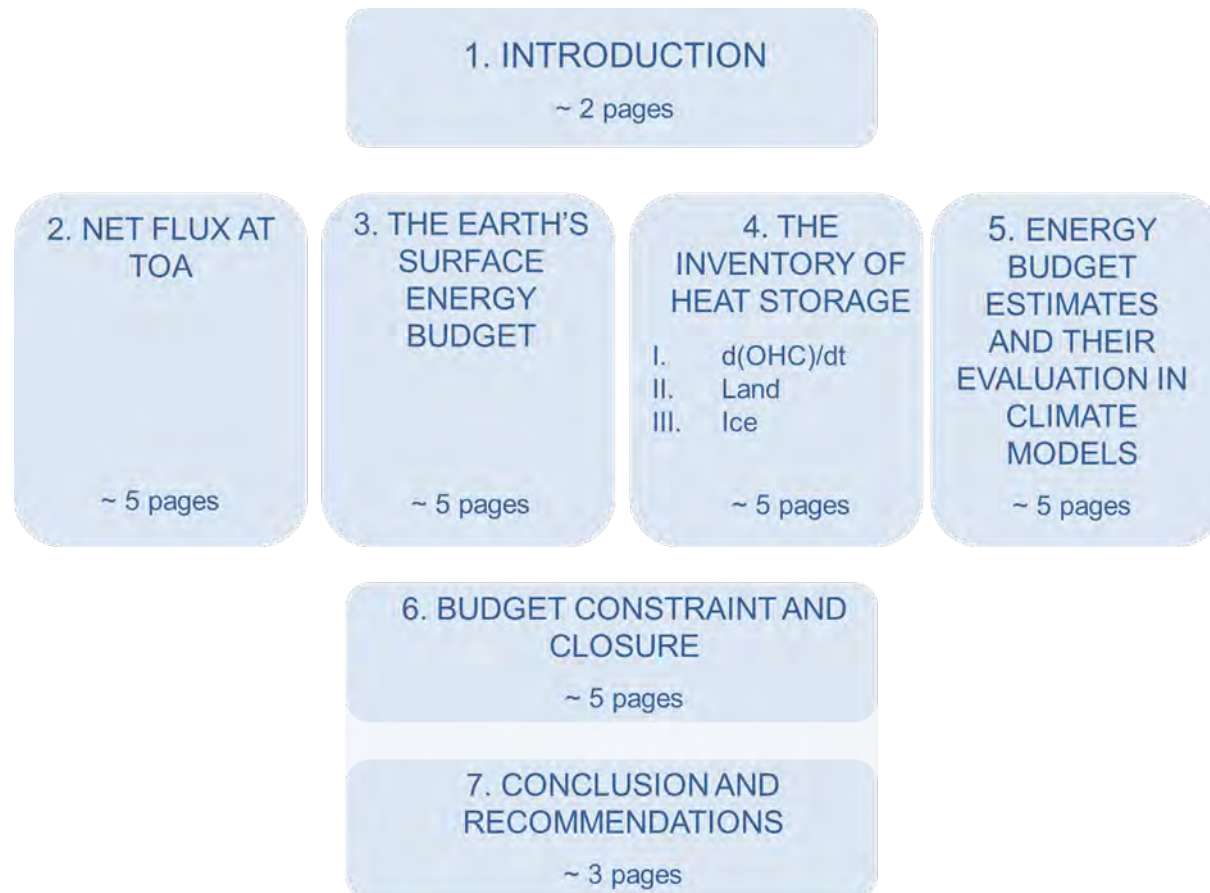
Workshop on **energy flow through the climate system**
29 September - 01 October 2015
MetOffice - Exeter - UK





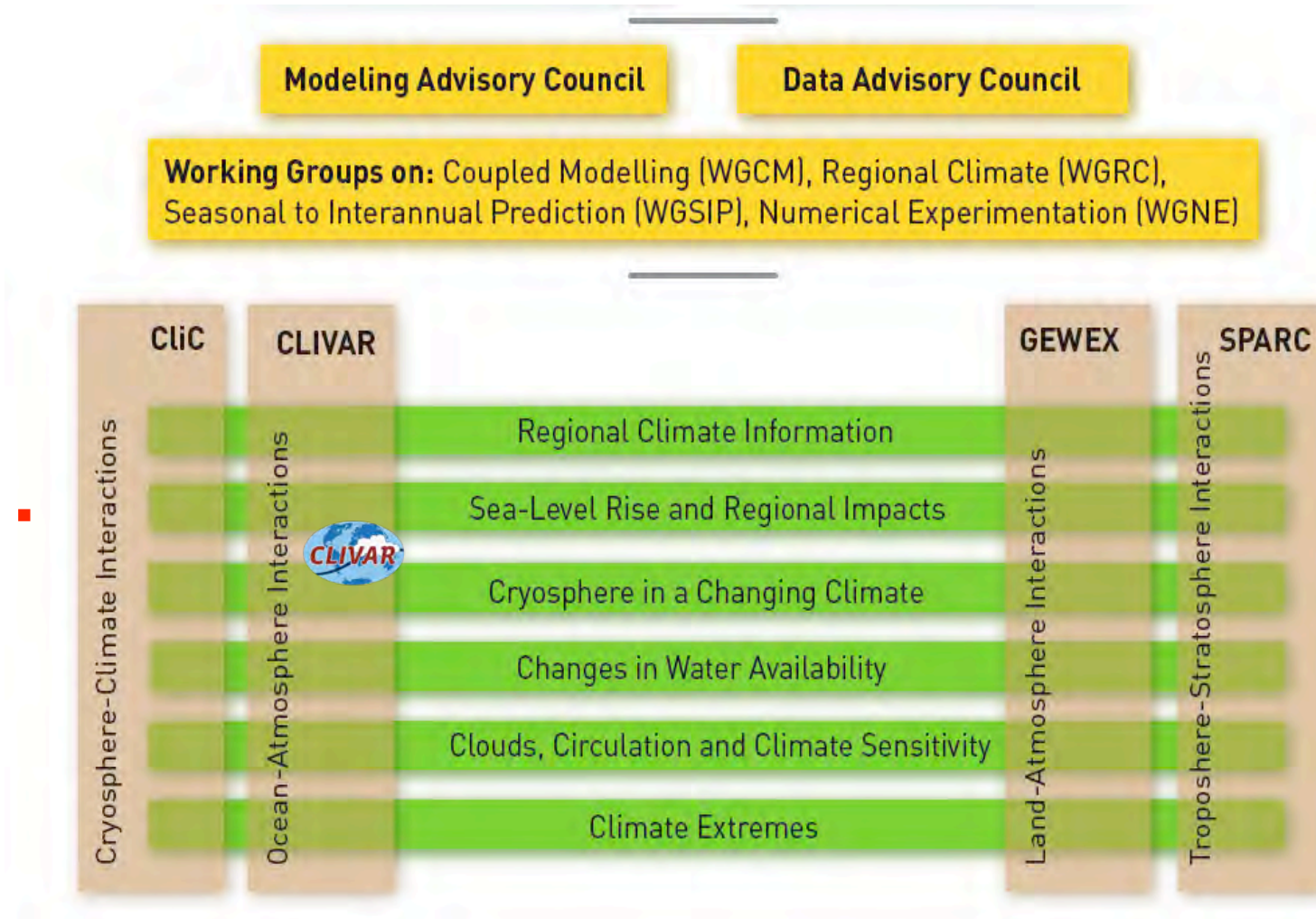
TOWARDS AN INTEGRATED VIEW OF THE GLOBAL EARTH ENERGY BUDGET

The main goal of this initiative is to develop a community-based synthesis of the Earth's energy budget as a key measure to understand and monitor the Earth's evolving climate.




A dedicated workshop is planned in July in the US for the core team of this initiative.

Regional Sea Level Change and Coastal Impacts



Structure

- GC steering team + 5 working groups (WG)
- GC steering team : 3 co-chairs + WG leadership 
- Membership within WGs involves members from CLIVAR/CLIC/GEWEX/SPARC, modeling groups, but also from other relevant programs (e.g, PAGES, IAG).



1st Sea Level Steering Team Meeting, March 18-19, 2015, Utrecht, NL

Expertise	Name	Country	Partner Organization
Geodesy/ Geophysics	Natalya Gomez	McGill University, USA	
	Mark Tamisiea	NOC, UK	
Glaciology/ Ice sheets	Roderik van de Wal	U. Utrecht, The Netherlands	Co-chair
	Tony Payne	U. Bristol, UK	CliC
Regional processes, Reconstructions Climate modes Climate modeling	David Holland	Courant, USA	CliC
	Rui Ponte	AER, USA	
	Detlef Stammer	CEN, Germany	Co-chair
	Catia Domingues	U. Tasmania, Australia	CLIVAR
	Benoit Meyssignac	LEGOS, France	
	Jianjun Yin	U. Arizona, USA	
Subsidence, Extremes, storm surges, waves and coastal impacts and adaptation.	Jonathan Gregory	U. Reading, UK	
	A.S. Unnikrishnan	NIO, India	
	Gonéri Le Cozannet	BRGM, France	
	Kathy McInnes	CSIRO, AU	
	Kevin Horsburgh	NOC	IOC/WMO JCOMM
	R. Nicholls	U. Southampton, UK	Co-chair
	Pietro Teatini	U. Padova, Italy	

WCRP GC Regional Sea Level Change and Coastal Impacts



Five parallel, but interconnected, working groups:

1. An integrated approach to **paleo** time scale sea level estimates
2. Quantifying the contribution of **land ice** to near-future sea level rise
3. Causes for **contemporary** regional sea level variability and change
4. **Predictability** of regional sea level
5. Sea level science for **coastal zone management**



International WCRP/IOC Conference

Regional Sea Level Changes and Coastal Impacts

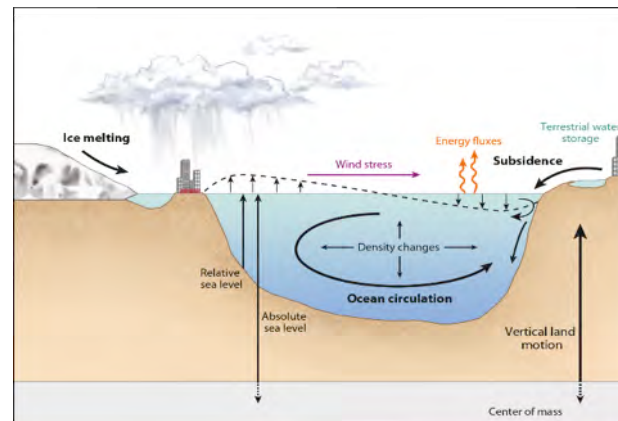
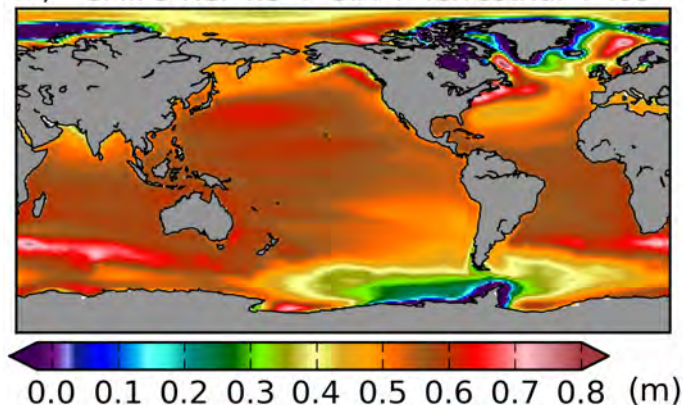
July 10-14, 2017

THE EARTH INSTITUTE
COLUMBIA UNIVERSITY

New York, NY, USA

www.sealevel2017.org

a.) CMIP5 RCP4.5 + GIA + Terrestrial + Ice



Decadal Climate Variability and Predictability

DCVP RF

- Two focus areas:
 - **Atlantic Decadal Climate Variability and Predictability:** variations of ocean circulation systems (AMOC, gyres), related SST (AMV/AMO extratropical and tropical) and atmospheric (NAO/AO, blocking) variability; their interactions with land areas and other ocean basins.
 - **Pacific Decadal Climate Variability and Predictability:** decadal tropical SST variability (IPO); links to North Pacific ocean circulation and SST
- CLIVAR and WCRP are already engaged in observational, analysis and modeling research on these subjects.
- DCVP RF will draw on these activities but focusing on **process understanding**

“Drivers of Teleconnectivity” – Motivation

Regions where DCV is prominent (top figs) are globally teleconnected (bottom)

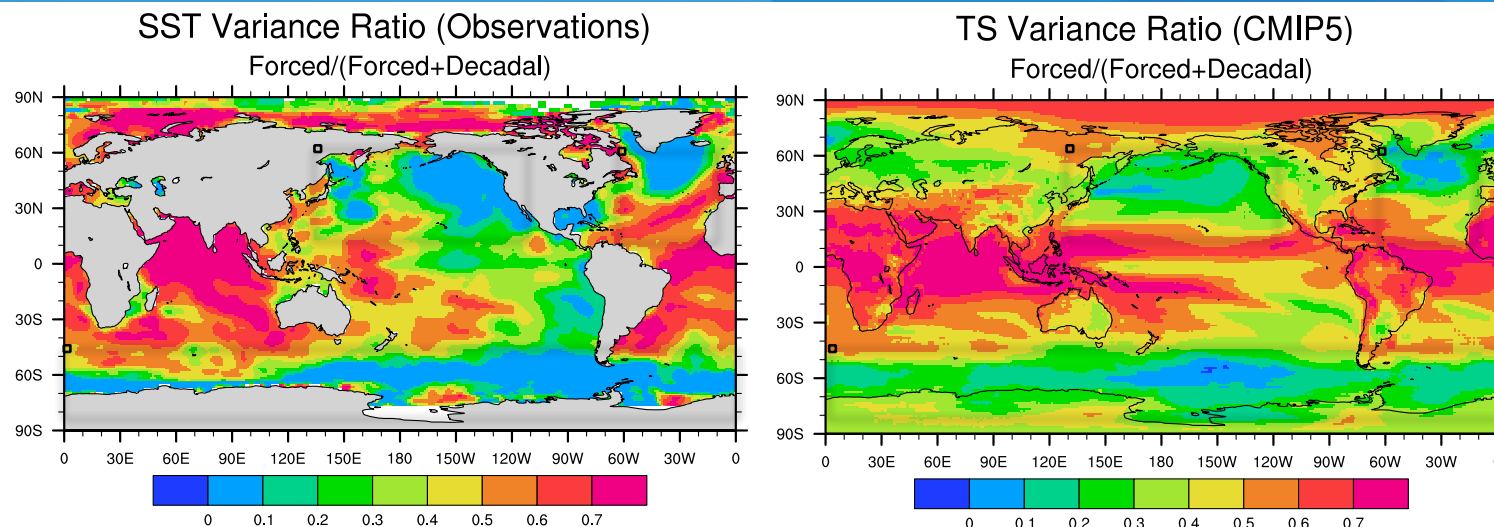


Figure after Ting et al. (2009)

Pacific

Atlantic

Southern Ocean

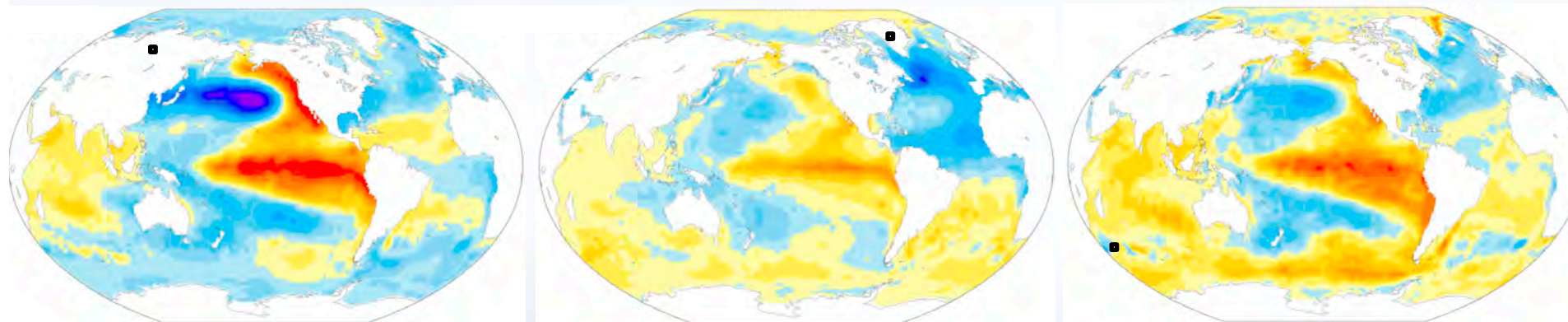
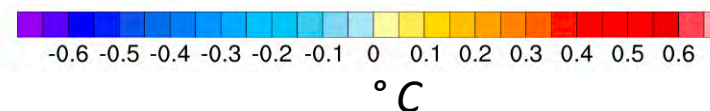


Figure courtesy C. Deser (presented at the CLIVAR-ICTP International Workshop on Decadal Climate Variability and Predictability: Challenge and Opportunity Trieste, Italy 16-20 November 2015)





Global Synthesis and Observations Panel (GSOP)

Ocean Model Development Panel (OMDP)

CLIVAR GSOP/GODAE Ocean View Ocean Reanalysis Inter-comparison (ORA-IP)

Magdalena Alonso Balmaseda (ECMWF)
Takahiro Toyoda (MRI-JMA)
Maria Valdivieso (UoReading)
Andrea Storto (CMCC)
Gregory Smith (Environment Canada)
Matthew Palmer (UK MetOffice)
Fabrice Hernandez (Mercator Ocean)
Li Shi (BMRC)
Keith Haines (UoReading)
Tony Lee (JPL)
Yosuke Fujii (MRI-JMA)
Kirsten Wilmer-Becker (MetOffice)

... And all the reanalyses producers and data providers

Variable	Responsible	Institution
Steric Height	Andrea Storto	CMCC
Sea Level	Fabrice Hernandez	Mercator Ocean
Ocean Heat Content	Matthew Palmer	UK MetOffice
Depth of 20 degree Isotherm	Fabrice Hernandez	Mercator Ocean
Mixed Layer Depth	Takahiro Toyoda	MRI-JMA
Salinity	Li Shi	BMRC
Heat and Freshwater surface fluxes and transports	Maria Valdivieso	University of Reading
Atlantic Meridional Overturning at 26N	Vladimir Stepanov/Keith Haines	University of Reading
Sea Ice	Gregory Smith	Environment Canada

ORAIP Variables and processing agents

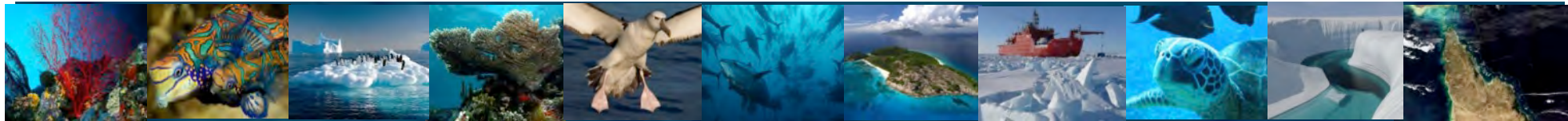
Reanalyses Products entering ORAIP

Product	Institution	Product	Institution
CFSR	NCEP	ECCO-v4	NASA/JPL
GODAS	NCEP	GECCO2	Hamburg University
Glosea5	UK MetOffice	MOVE-C	MRI/JMA
ORAS4	ECMWF	MOVE-G2	MRI/JMA
PEODAS	BMRC	MOVE-CORE	MRI/JMA
GLORYS	Mercator	K7-ODA	JAMSTEC
C-GLORS	CMCC	K7-CDA	JAMSTEC
UR025.4	Reading University		
GEOS5	NASA/GMAO	ARMOR3D	CLS (T/S/SLA)
ECDA	GFDL	NODC	NOAA (T only)
SODA	University Meryland	EN3	MetOffice (T only)
ECCO-NRT	NASA/JPL	LEGOS	LEGOS (SLA only)

The IQuOD initiative

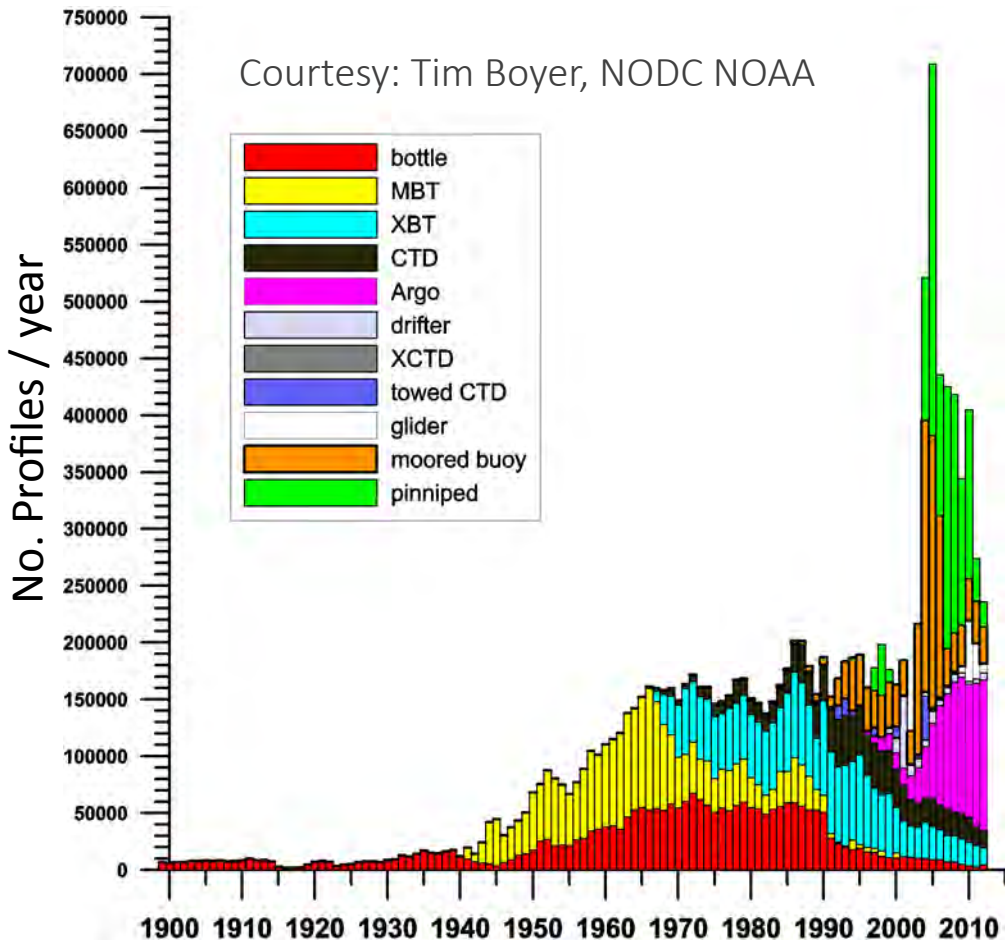
International Quality-Controlled Ocean Database

Fischer et al. Oceanobs'09: *“The critical importance of comprehensive, integrated long-term observations was identified repeatedly.”*



Current international partners: Argentina, Australia, Brazil, Canada, China, France, Germany, India, Japan, Mexico, Norway, Russia, Spain, South Africa, UK, USA.

Today's big challenge: 'Climate quality' global database



- Significant contributions from various **independent efforts** in terms of assembling, rescuing and QCing historical ocean temperature profiles.
- But still... global database contains a relatively **large fraction of biased, duplicated and substandard quality** (e.g., lack of original and full-resolution) **data and metadata** that can confound climate-related research & applications.

**Need for timely/effective action:
a globally-coordinated approach.**

Global database: Millions of temperature profiles (**\$\$ Tens of billions dollars**)

- Historical obs. system not purposely designed for climate change monitoring
- Mix of instruments/evolving technology (various accuracies & biases)



Global Synthesis and Observations Panel (GSOP)

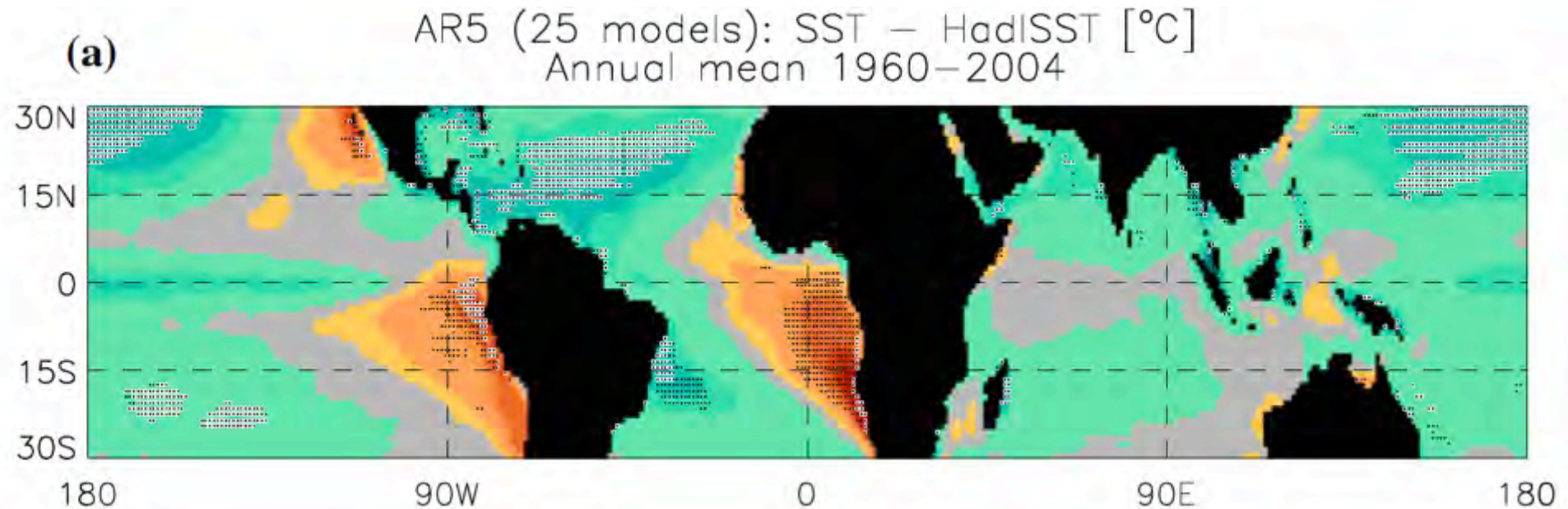
Ocean Model Development Panel (OMDP)

Key roles for OMDP in CLIVAR and WCRP

To collaborate with and to advise other CLIVAR panels and Research Foci Teams on issues related to ocean modelling.

To coordinate activities aimed at addressing

- modelling needs (e.g., experimental protocols and analysis methods)
- model biases (e.g., eastern boundary upwelling)
- ocean process representation and parameterization
 - Focus on issues impeding progress of CLIVAR core activities, Research Foci, and WCRP Grand Challenges.

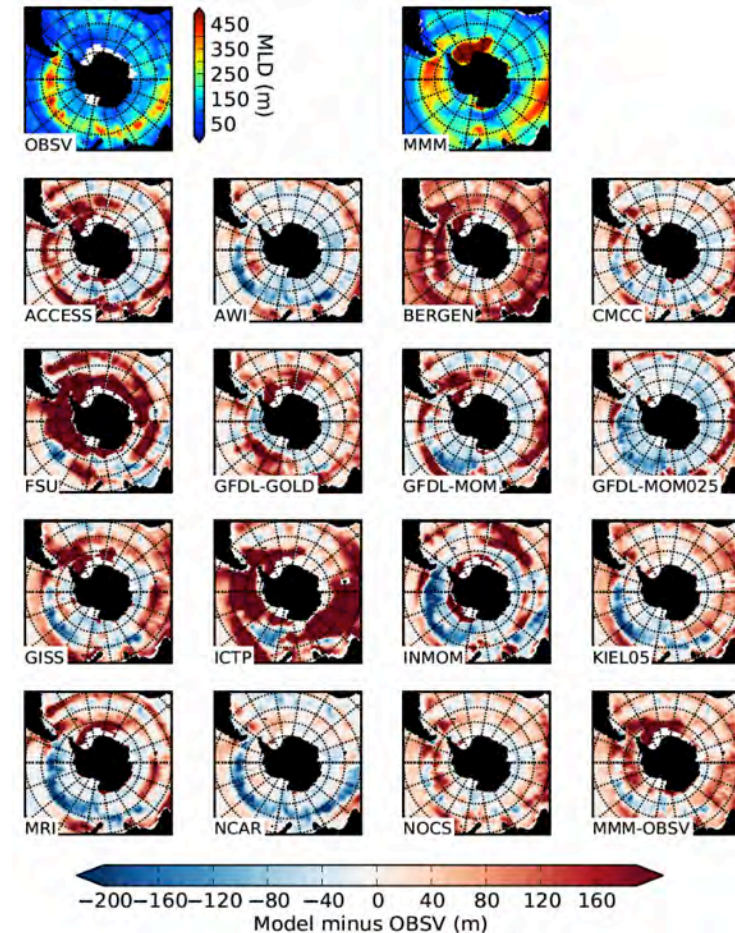


CORE (Coordinated Ocean-Ice Reference Experiment)

The CORE-II framework is now widely recognized as the community standard for global ocean – sea-ice simulations

Participating groups (20+ models):

- Australia: CSIRO (ACCESS)
- France: CERFACS, CNRM
- Germany: AWI, IfM-GEOMAR (KIEL)
- Italy: CMCC, ICTP
- Japan: MRI (free, DA)
- Norway: U. Bergen
- Russia: RAS (INMOM)
- UK: NOCS
- USA: FSU (2), GFDL-GOLD, GFDL-MOM (2), MIT, NASA GISS (2), NCAR



Mixed layer depth: September-mean for 1988-2007
(based on 0.03 kg m^{-3} density change from surface)

Provide guidance for CMIP6's physical ocean diagnostics

4

SAMPLING THE PHYSICAL OCEAN IN CMIP6 SIMULATIONS

CLIVAR OCEAN MODEL DEVELOPMENT PANEL (OMDP)
COMMITTEE ON CMIP6 OCEAN MODEL OUTPUT

STEPHEN M. GRIFFIES (NOAA GEOPHYSICAL FLUID DYNAMICS LABORATORY, USA)
ALISTAIR J. ADCROFT (NOAA/GFDL AND PRINCETON UNIVERSITY, USA)
V. BALAJI (NOAA/GFDL AND PRINCETON UNIVERSITY, USA)
GOKHAN DANABASOGLU (NATIONAL CENTER FOR ATMOSPHERIC RESEARCH, USA)
PAUL J. DURACK (LLNL/PROGRAM FOR CLIMATE MODEL DIAGNOSIS AND INTERCOMPARISON, USA)
PETER J. GLECKLER (LLNL/PROGRAM FOR CLIMATE MODEL DIAGNOSIS AND INTERCOMPARISON, USA)
JONATHAN M. GREGORY (HADLEY CENTRE AND UNIVERSITY OF READING, UK)
JOHN P. KRASTING (NOAA GEOPHYSICAL FLUID DYNAMICS LABORATORY, USA)
RONALD J. STOUFFER (NOAA GEOPHYSICAL FLUID DYNAMICS LABORATORY, USA)
KARL E. TAYLOR (LLNL/PROGRAM FOR CLIMATE MODEL DIAGNOSIS AND INTERCOMPARISON, USA)

DRAFT November 3, 2014



ABSTRACT

We present recommendations for sampling physical ocean fields for the World Climate Research Program (WCRP) Coupled Model Intercomparison Project #6 (CMIP6) and its suite of satellite MIPs, including the CLIVAR Coordinated Ocean-ice Reference Experiments (CORE). Our aim is to precisely define a suite of ocean model diagnostics related to physical properties and processes within the simulated ocean and associated ocean boundary fluxes. The audience for this document includes the WCRP Working Group for Coupled Modeling (WGCM), CLIVAR Scientific Steering Group (SSG), CLIVAR Ocean Model Development Panel (OMDP), scientists contributing model results to CMIP, and scientists analyzing ocean climate simulations.

CLIVAR Open Science Conference 2016



Summary

September, 2016



	CLIVAR2016 Early Career Scientists Symposium	CLIVAR 2016 Main Open Science Conference					CLIVAR2016 Early Career Scientists Symposium	
		DAY 1	DAY 2	DAY 3	DAY 4	DAY 5		
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
	18-Sep	19-Sep	20-Sep	21-Sep	22-Sep	23-Sep	24-Sep	25-Sep
AM	FIO Registration	7:30 Registration & 9:00 Transport to QNLM	Hotel	Hotel	Hotel	Hotel	FIO	FIO
	Opening session	10:00 Opening Session	9:00 Plenary Session 2	9:00 Plenary Session 3	9:00 Plenary Session 4	9:00 Plenary Session 5	Plenary session: International Climate Projects	Workshop: Effective science communication
	Introduction to the OSC		Climate Variability and Predictability	Understanding Ocean and Climate Processes	The Ocean in a Warmer World	Climate Information and Sustainable Development		
	Coffee/tea	10:30 Coffee/Tea	10:30 Coffee/Tea	10:30 Coffee/Tea	10:30 Coffee/Tea	10:30 Coffee/Tea	Coffee/tea	Coffee/tea
	Meet-and-greet session, Poster discussions	11:30 Keynote 1 Group photo	11:00 Posters of Sessions 1.3, 2	11:00 Posters of Sessions 1.1, 3	11:00 Posters of Sessions 1.2, 4.5, 6	11:00 Plenary 6 Future of Climate and Ocean Science	Plenary session: "Current Hot Research Topics in Climate Science"	Workshop: Editorial tips and training
	Lunch	12:00 Lunch	12:00 Lunch	12:00 Lunch	12:00 Lunch	Closing Ceremony	Lunch	Closure
	PM	Panel discussion: "Bridging the Gap: Cultural Differences in Critical Science Themes"	14:00 Plenary 1 Ocean's Role in Climate	14:00 Parallel 2.1 Intra-seasonal to Interannual	14:00 Parallel 3.1 Mixing & Stirring	14:00 Parallel 4.1 Modes	SSG Meeting (Fri pm and Sat)	Interactive workshop: The future of climate science Workshop presentations and panel discussion
14:00 Parallel 2.2 Decadal				14:00 Parallel 3.2 Ocean & Climate Dynamics	14:00 Parallel 4.2 Sea Level			
14:00 Parallel 2.3 Centennial to Millennial				14:00 Parallel 3.3 Upwelling	14:00 Parallel 4.3 Boundary Current Systems			
Coffee/tea		15:30 Coffee/tea	15:30 Coffee/tea	15:30 Coffee/tea	15:30 Coffee/tea	Coffee/tea		
Informal panel discussions: interactive discussion with senior scientists		16:00 Parallel 1.1 Energy	16:00 Posters of Sessions 1.3, 2	16:00 Posters of Sessions 1.1, 3	16:00 Posters of Sessions 1.2, 4.5, 6	16:00-17:00 Town halls 11, 12		Workshop presentations and panel discussion
	16:00 Parallel 1.2 Carbon							
16:00 Parallel 1.3 Water								
	17:30 Transport to hotel	17:00-17:40 Keynote	17:00-17:40 Keynote	17:00-17:40 Keynote				
Evening	ECS banquet	19:00-22:00 Icebreaker Reception	18:00-19:00 Town halls 1, 2, 3	18:00-19:00 Town halls 7, 8	19:00-22:00 Banquet			
			19:00-19:30 Town hall light dinner break	19:00-19:30 Town hall light dinner break				
			19:30-20:30 Town halls 4, 5, 6	19:30-20:30 Town halls 9, 10				

608 participants from 50 countries



17 sponsors



青岛海洋科学与技术国家实验室
Qingdao National Laboratory for Marine Science and Technology

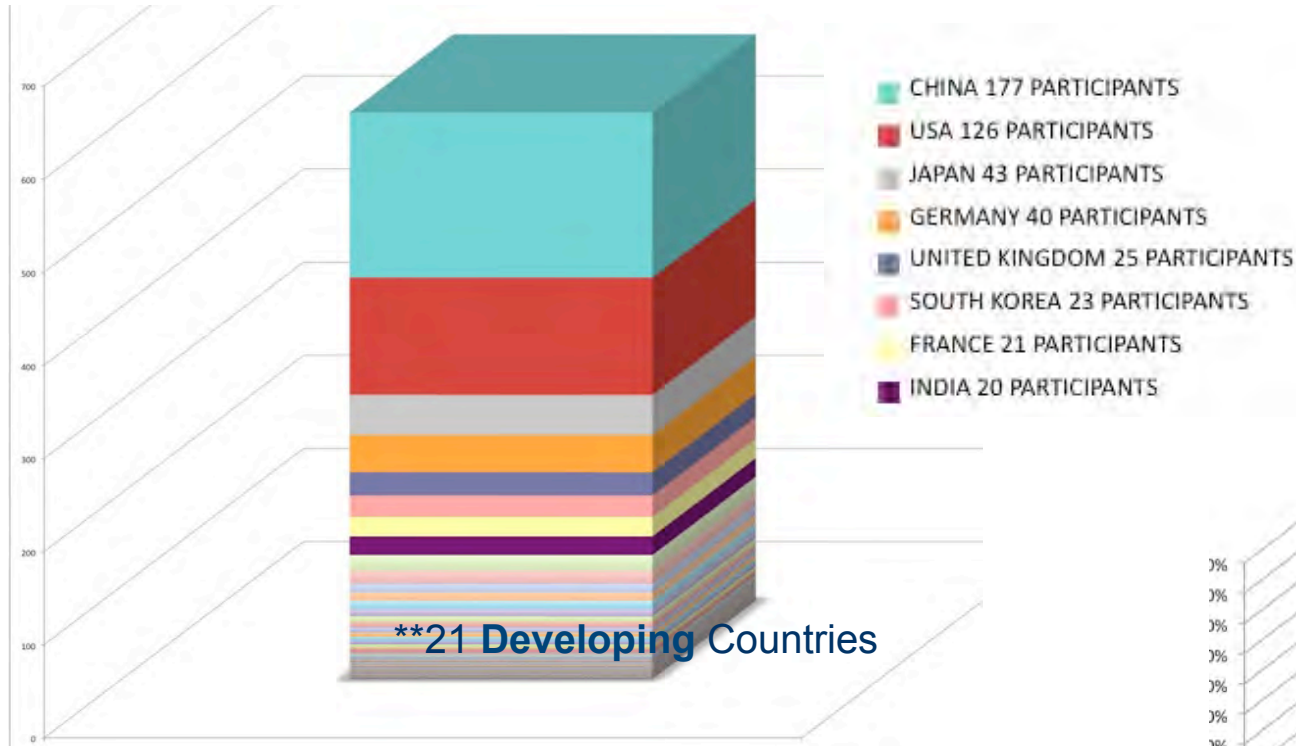


Mayor of Qingdao

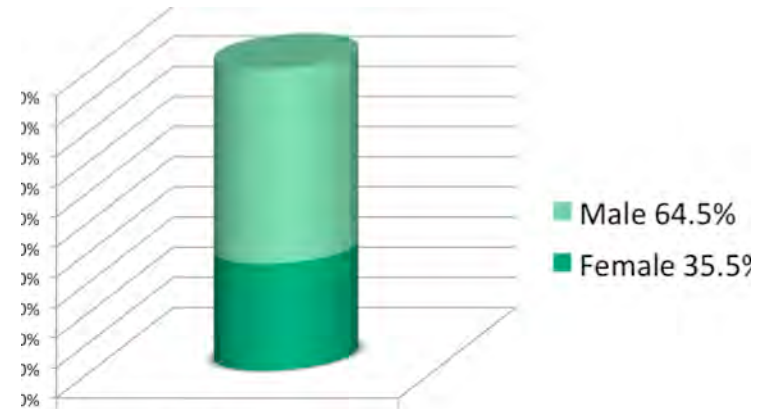
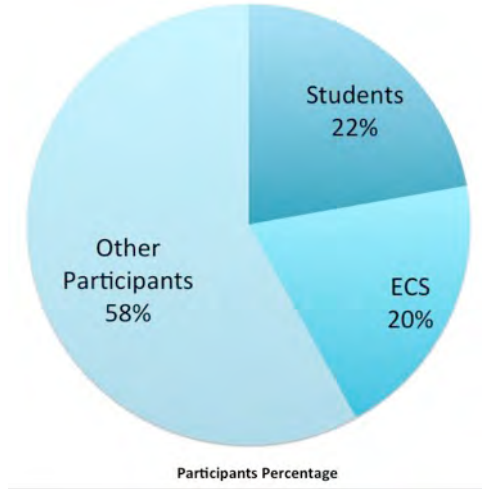


CLIVAR

Open Science Conference
Qingdao, 2016



608 Participants from 47 Countries



Participants

Comment from participant:

“The CLIVAR OSC had the best diversity - national origin, gender, career stage - of any conference I have been to - a great example for others.”

— — Twitter by Sonya Legg, the USCLIVAR SSC Co-chair, OSC participant.

Science Plan

draft available on clivar website

Structure

- 1.1 The WCRP mission
- 1.2 CLIVAR's role within WCRP
2. SCIENCE GOALS
3. Chapter 3. Organizational Structure and Implementation
4. Chapter 4. International Coordination as Enabling Capabilities
5. Chapter 5. Coordination and Cooperation

New CLIVAR Science

Long term objectives:

- Identify ocean and coupled **climate processes** that are critical for global and regional climate variability and change
- 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**
- Quantify past/present/future **ocean role in CO₂ uptake** and links between **climate and ocean ecosystems**

New CLIVAR Science Plan will be released in 2017