International CLIVAR: updates and plans

Nico Caltabiano
International CLIVAR Project Office

With thanks to Martin Visbeck, Jim Hurrell (CLIVAR SSG co-chairs)

?

International CLIVAR Project Office

Catherine Beswick
Interim Director

Bob Molinari
(Retired)

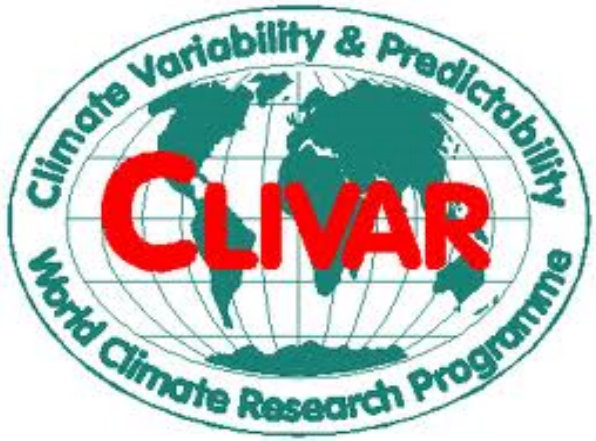
Nico Caltabiano

Valery Detemmerman
WCRP JPS

Carlos Ereño

Anna Pirani

Xiaohui Tang



International CLIVAR Project Office

Natural Environment Research Council (NERC)
Fiscal year: 1 April 2012 to 31 March 2013

- Support extended to March 2014
- Total NERC funding support ~$300,000
- Salary support
- Office expenses (e.g. computing, teleconferencing)
- Office space for UK staff (NOC)

International CLIVAR Project Office

US CLIVAR Interagency Group
Fiscal year: 1 May 2012 to 30 April 2013

- NASA, NOAA, NSF, through US CLIVAR
- Salary support
  - ~$190,000
- Travel support
  - For US-based CLIVAR members to attend panel/ working group meetings

International CLIVAR Project Office

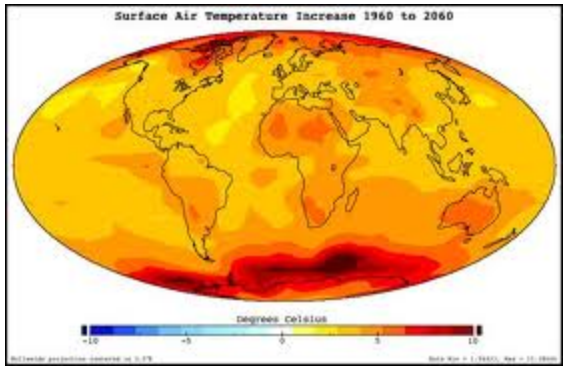
ICPO Director Vacancy

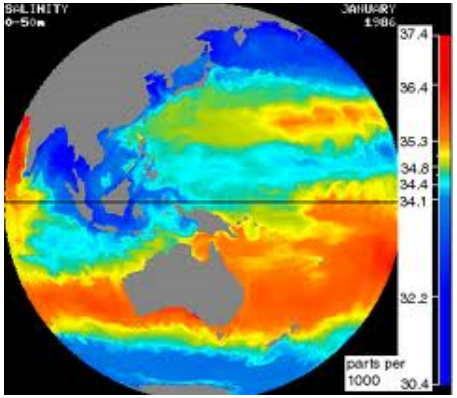
- Advertised widely early May 2012
- Closing date was 14th June 2012
- Selection process ongoing

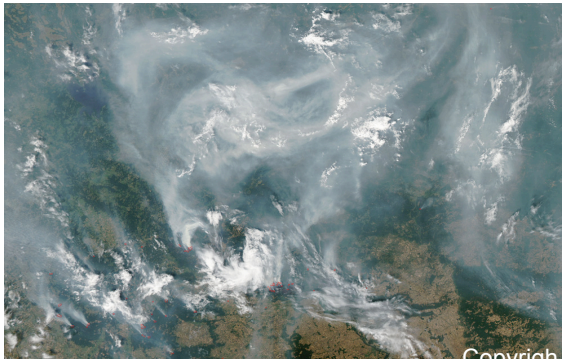
CLIVAR (Climate Variability and Predictability)

Mission

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







CLIVAR Objectives

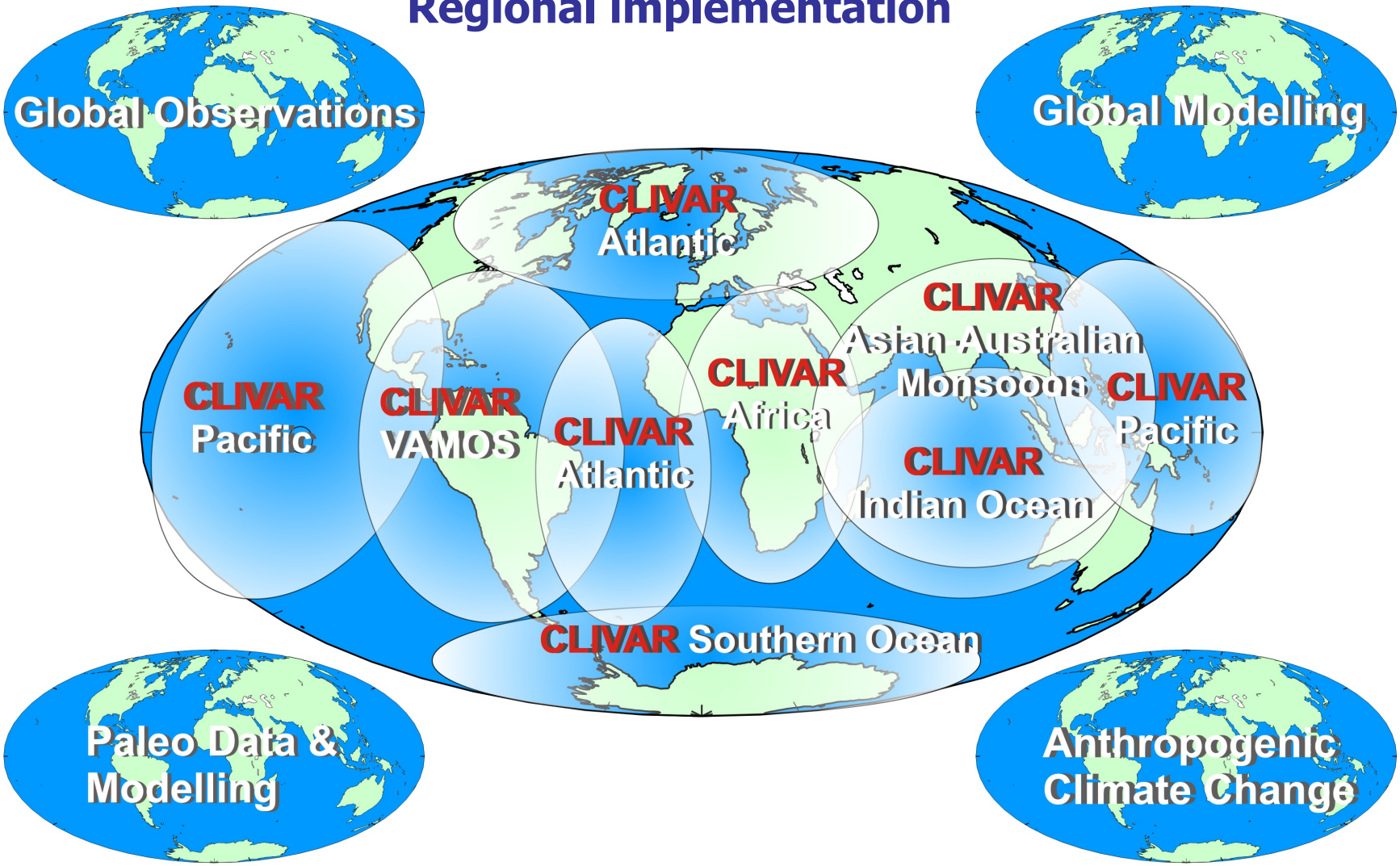
- Understand the causes of climate variability on intra-seasonal to centennial time-scales through observations, analysis, and modeling

- Improve predictions of climate variability and change associated with both internal and external processes on global and regional scales

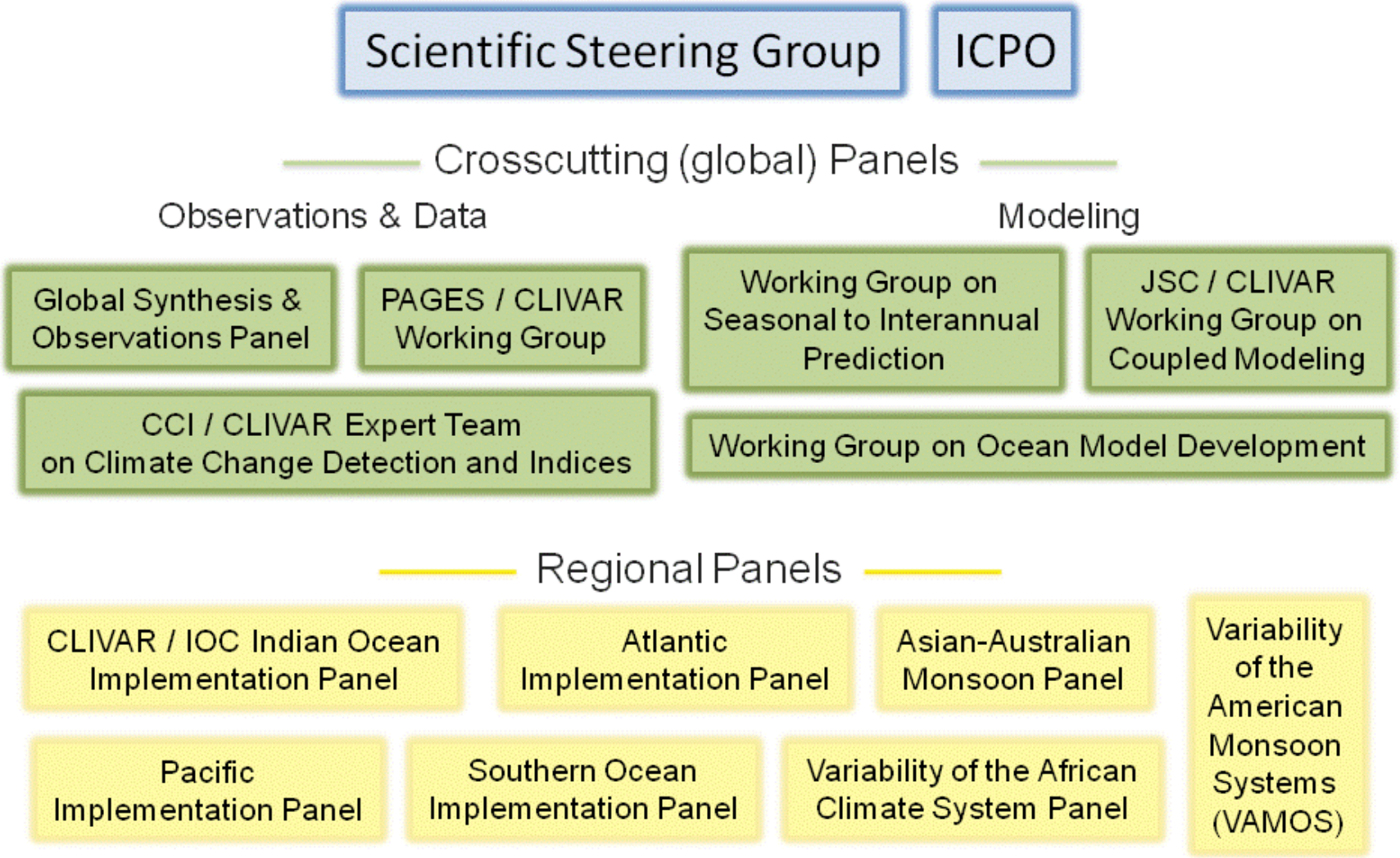
- Extend observational climate record through assembly of quality-controlled paleoclimatic and instrumental data sets

CLIVAR – A Global View

Regional implementation



CLIVAR Organization
(Historical)

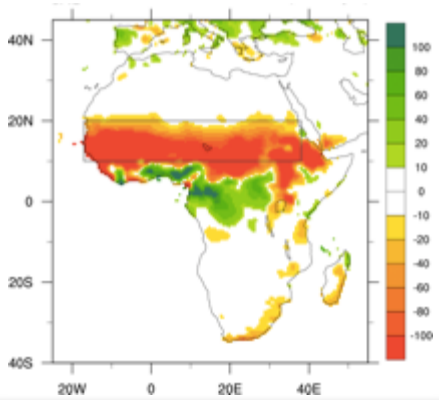


CLIVAR Research Challenges

- Anthropogenic Climate Change
  - Natural variability versus forced change
  - Climate sensitivity and feedbacks
  - Regional phenomena (e.g., ENSO, AMOC, …)
  - Extremes
  - CMIP#
  - Climate Engineering (Geo-engineering)

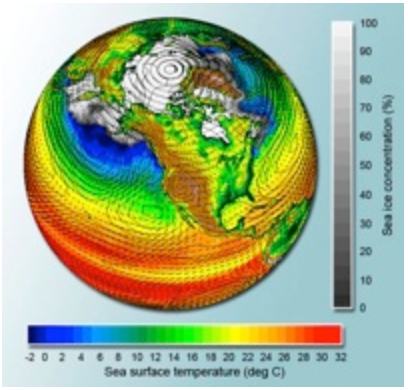
- Intra-to-Seasonal Variability, Predictability and Prediction
  - Monsoons (and ENSO, TAV, …)
  - ISV/MJO
  - Quantifying prediction uncertainty
  - Building pan-WCRP and WWRP links
  - CHFP

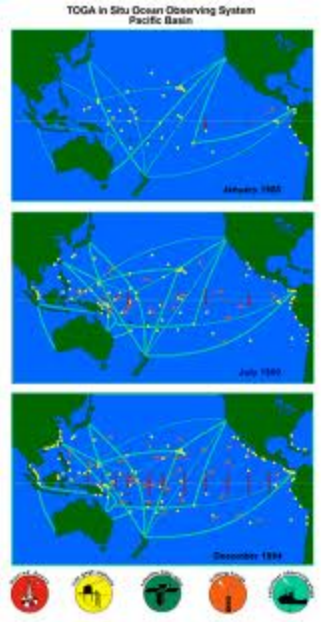
- Decadal Variability, Predictability and Prediction
  - Determine predictability
  - Mechanisms of variability (AMO, PDV, …)
  - Role of oceans
  - Adequacy of observing system
  - Coupled Initialization
  - Quantifying prediction uncertainty
  - Building pan-WCRP links



CLIVAR Imperatives

- Improved Atmosphere and Ocean Components of ESMs
  - Analysis and Evaluation
  - "Climate Process Teams" (process studies)
  - Building links pan-WCRP and IGBP
  - Model-Data comparisons





- Data Synthesis and Analysis
  - Ocean
  - Coupled Data Assimilation Systems
  - Links – carbon, biogeochemistry, marine-ecosystems

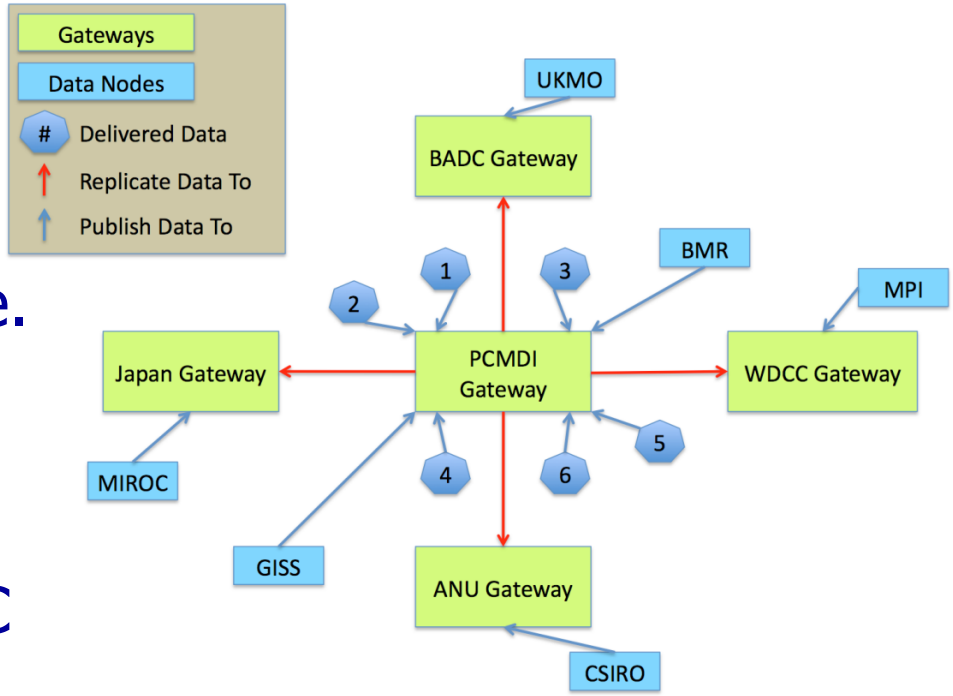
- Ocean Observing System
  - Development, implementation and system design
  - Advocacy for sustained observations
  - IGBP links for Carbon, Biogeochemistry, Ecosystems

- Capacity Building
  - Summer schools and topical workshops
  - Expert training
  - Call for panel membership

Anthropogenic Climate Change

CMIP5 – Unprecedented International Coordination

- More than 20 participating modeling groups → 40+ models
- 2.3Pbytes of model output expected → ~100 times greater than CMIP3
- Data being served by federated centers around the world and will appear to be a single PCMDI archive.
- Archive available to analysts now …
- CMIP5 session at WCRP OSC
- Analysis workshop March 2012 (Hawaii)

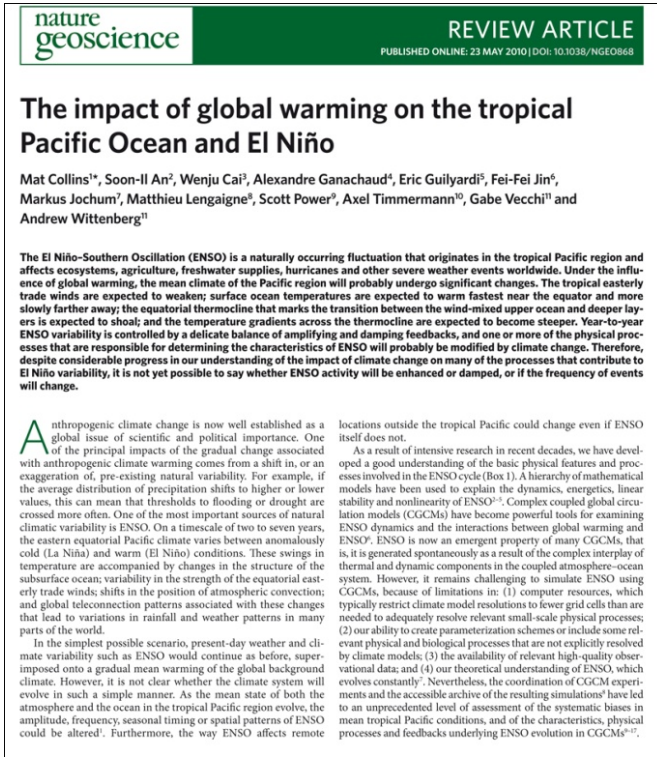


Anthropogenic Climate Change

- Promote analysis of CMIP5 (e.g., small grants program)
- Explore regional change through regional CLIVAR panels

CLIVAR Pacific Panel

Projected 21st century changes in amplitude of ENSO variability (CMIP3)



nature geoscience

REVIEW ARTICLE

PUBLISHED ONLINE: 23 MAY 2010 | DOI: 10.1038/NGEO868

The impact of global warming on the tropical Pacific Ocean and El Niño

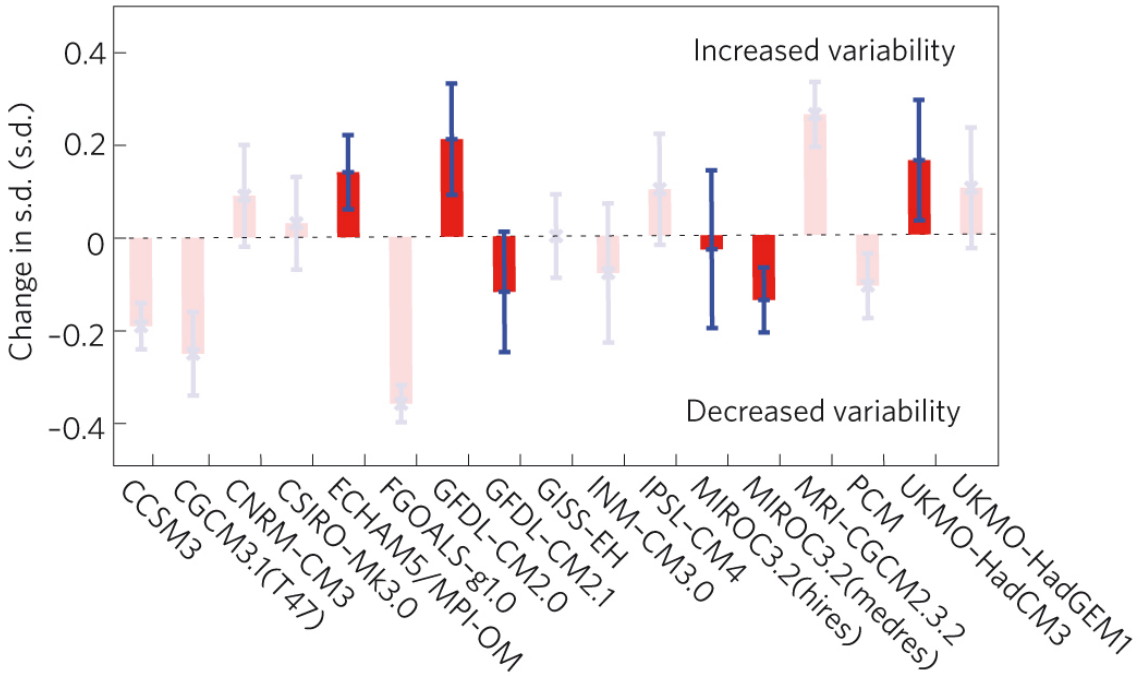
Mat Collins[1]*, Soon-Il An[2], Wenju Cai[3], Alexandre Ganachaud[4], Eric Guilyardi[5], Fei-Fei Jin[6], Markus Jochum[7], Matthieu Lengaigne[8], Scott Power[9], Axel Timmermann[10], Gabe Vecchi[11] and Andrew Wittenberg[11]

The El Niño–Southern Oscillation (ENSO) is a naturally occurring fluctuation that originates in the tropical Pacific region and affects ecosystems, agriculture, freshwater supplies, hurricanes and other severe weather events worldwide. Under the influence of global warming, the mean climate of the Pacific region will probably undergo significant changes. The tropical easterly trade winds are expected to weaken; surface ocean temperatures are expected to warm fastest near the equator and more slowly farther away; the equatorial thermocline that marks the transition between the wind-mixed upper ocean and deeper layers is expected to shoal; and the temperature gradients across the thermocline are expected to become steeper. Year-to-year ENSO variability is controlled by a delicate balance of amplifying and damping feedbacks, and one or more of the physical processes that are responsible for determining the characteristics of ENSO will probably be modified by climate change. Therefore, despite considerable progress in our understanding of the impact of climate change on many of the processes that contribute to El Niño variability, it is not yet possible to say whether ENSO activity will be enhanced or damped, or if the frequency of events will change.

Anthropogenic climate change is now well established as a global issue of scientific and political importance. One of the principal impacts of the gradual change associated with anthropogenic climate warming comes from a shift in, or an exaggeration of, pre-existing natural variability. For example, if the average distribution of precipitation shifts to higher or lower values, this can mean that thresholds to flooding or drought are crossed more often. One of the most important sources of natural climatic variability is ENSO. On a timescale of two to seven years, the eastern equatorial Pacific climate varies between anomalously cold (La Niña) and warm (El Niño) conditions. These swings in temperature are accompanied by changes in the structure of the subsurface ocean; variability in the strength of the equatorial easterly trade winds; shifts in the position of atmospheric convection; and global teleconnection patterns associated with these changes that lead to variations in rainfall and weather patterns in many parts of the world.

In the simplest possible scenario, present-day weather and climate variability such as ENSO would continue as before, superimposed onto a gradual mean warming of the global background climate. However, it is not clear whether the climate system will evolve in such a simple manner. As the mean state of both the atmosphere and the ocean in the tropical Pacific region evolve, the amplitude, frequency, seasonal timing or spatial patterns of ENSO could be altered[1]. Furthermore, the way ENSO affects remote locations outside the tropical Pacific could change even if ENSO itself does not.

As a result of intensive research in recent decades, we have developed a good understanding of the basic physical features and processes involved in the ENSO cycle (Box 1). A hierarchy of mathematical models have been used to explain the dynamics, energetics, linear stability and nonlinearity of ENSO[2,3]. Complex coupled global circulation models (CGCMs) have become powerful tools for examining ENSO dynamics and the interactions between global warming and ENSO[4]. ENSO is now an emergent property of many CGCMs, that is, it is generated spontaneously as a result of the complex interplay of thermal and dynamic components in the coupled atmosphere–ocean system. However, it remains challenging to simulate ENSO using CGCMs, because of limitations in: (1) computer resources, which typically restrict climate model resolutions to fewer grid cells than are needed to adequately resolve relevant small-scale physical processes; (2) our ability to create parameterization schemes or include some relevant physical and biological processes that are not explicitly resolved by climate models; (3) the availability of relevant high-quality observational data; and (4) our theoretical understanding of ENSO, which evolves constantly[5]. Nevertheless, the coordination of CGCM experiments and the accessible archive of the resulting simulations[6] have led to an unprecedented level of assessment of the systematic biases in mean tropical Pacific conditions, and of the characteristics, physical processes and feedbacks underlying ENSO evolution in CGCMs[6–17].



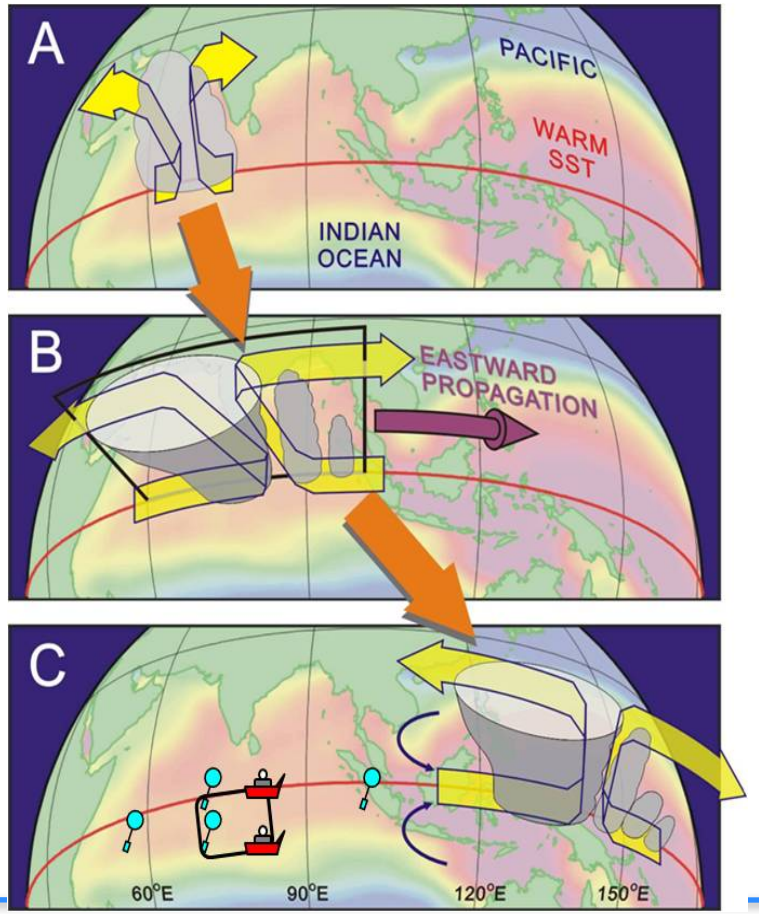
Collins et al., 2010: *Nature Goesciences*

"…despite considerable progress in our understanding of the impact of climate change on many of the processes that contribute to El Niño variability, it is not yet possible to say whether ENSO activity will be enhanced or damped, or if the frequency of events will change"

Intra-to-Seasonal Variability, Predictability and Prediction

CINDY2011 (Cooperative Indian Ocean exp. on ISV in 2011) and **DYNAMO*** (Dynamics of the MJO)

Endorsed and **Supported** by IOP and AAMP through the provision of high resolution forecasts and analyses from available forecast centers. AAMP and YOTC are also promoting coordinated numerical experimentation for CINDY-DYNAMO, making use of the full range of modeling abilities.



Period:
October 2011 – January 2012

Main Location:
In and around central equatorial Indian Ocean

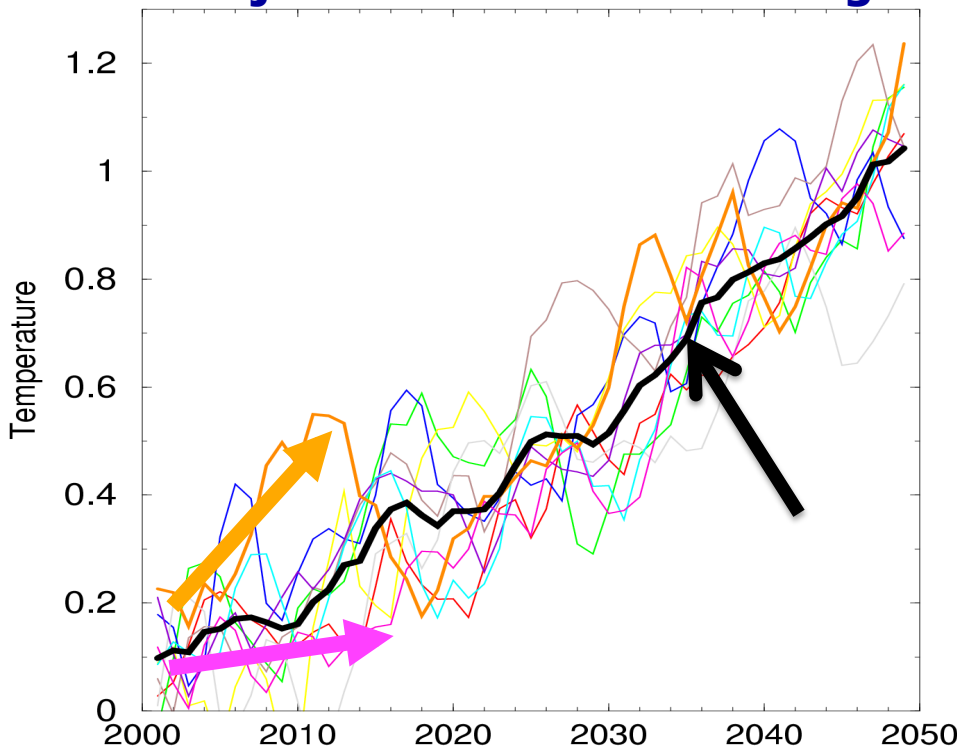
Strong International Participation
Japan, USA, India, France, UK, Seychelles, China, Australia, and others

*DYNAMO is a US program and its field campaign is US component of CINDY2011.

Decadal Prediction: pan-CLIVAR effort

- Clear evidence of decadal variability in ocean and atmosphere, but to what extent is it predictable?
- What are the sources of predictability and the processes that give rise to decadal variability?

Projected Atlantic SST Change



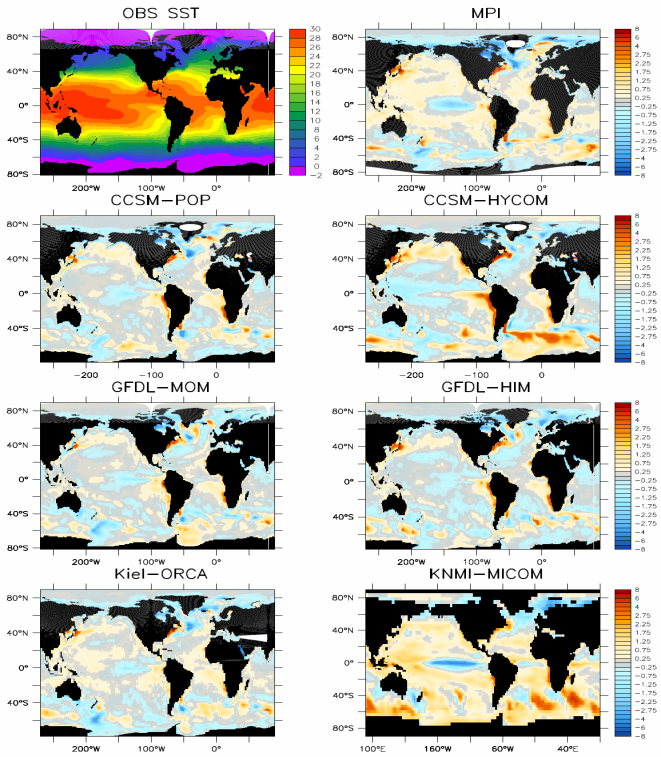
Decadal Variations:

- ✓ **Forced by External Processes**
- ✓ **Generated by Internal Processes**
- ✓ **Interactions of Forced and Natural Variability**

Evaluation of Ocean Models

WGOMD: Coordinated Ocean-ice Reference Experiments (CORE)

http://www.clivar.org/organization/wgomd/core/core.php



CORE: Benchmark simulations for global ocean-ice models with detailed protocols, facilitating solution comparisons from different models

CORE-I Results: 500-yr repeating annual cycle
(Griffies et al. 2009, *Ocean Modeling*)

CORE-II: Interannually-varying forcing (1948-2007)

- ✓ evaluation, understanding, and improvement of the ocean component in CMIP5 models
- ✓ investigation of mechanisms for interannual to decadal variability, e.g., AMOC;
- ✓ evaluation of robustness of mechanisms across models;
- ✓ providing initial conditions for decadal predictability studies;
- ✓ CORE-II synthesis papers in time for evaluation and inclusion in AR5.

CORE: Web-based repository to facilitate access and analysis

http://www.clivar.org/organization/wgomd/reos/reos.php

Improved Atmosphere and Ocean Models

AIP/VAMOS Joint targeted workshop

Workshop on Coupled Ocean-Atmosphere-Land Processes in the Tropical Atlantic

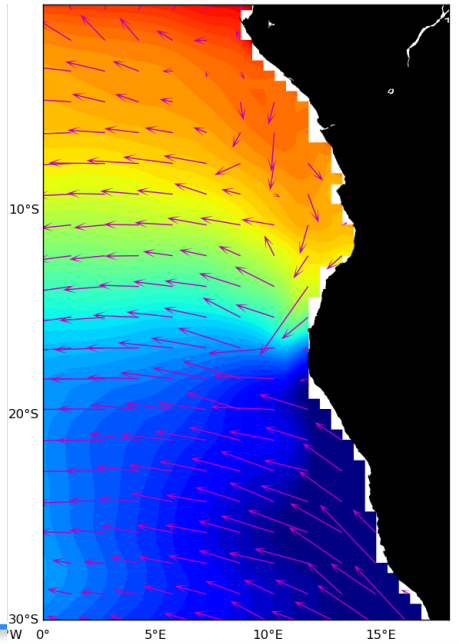
23-25 March 2011, Miami, FL, USA

- Large tropical Atlantic biases are present in the current generation of seasonal and longer-term prediction systems
- These biases lead to large model uncertainties as to the future evolution of the tropical Atlantic climate and limit prediction skill

Meeting Objectives

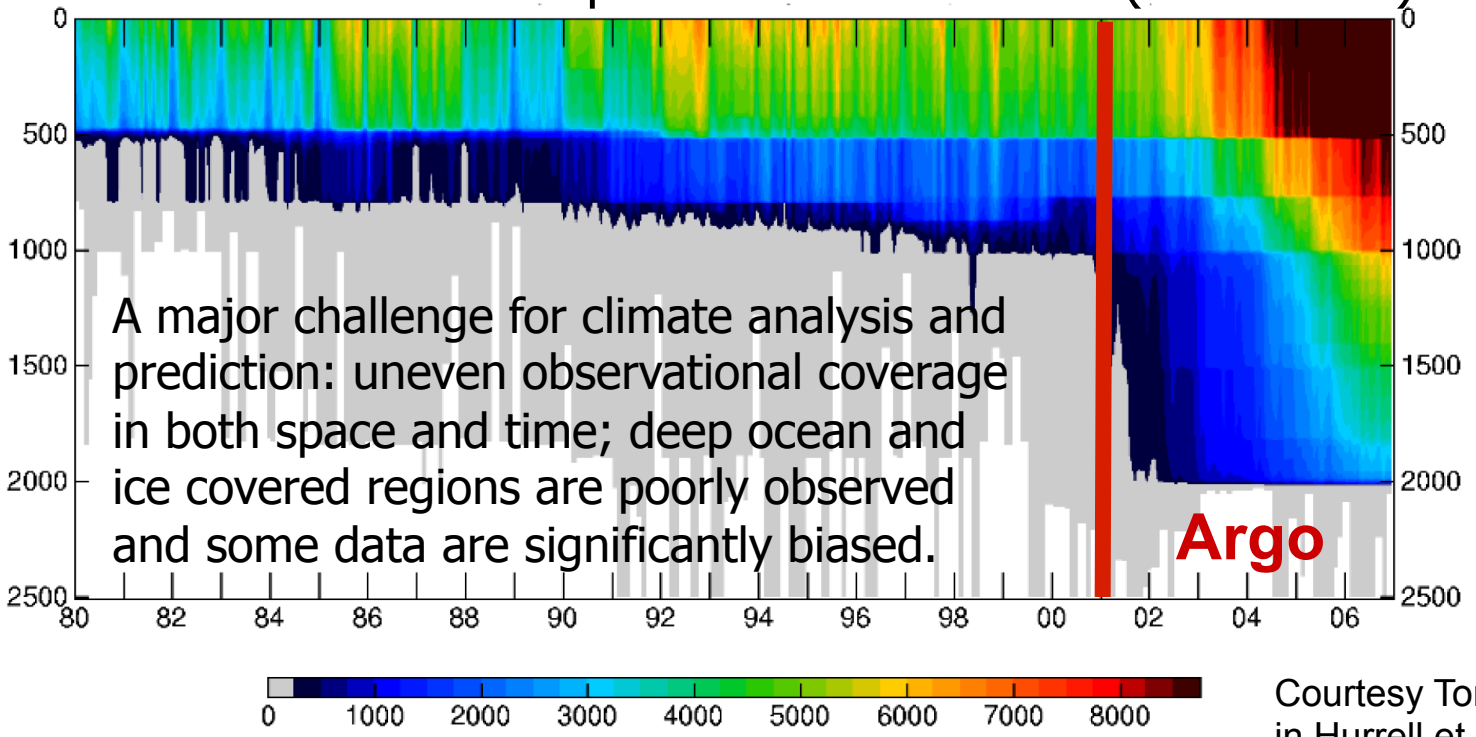
- Develop a coherent synthesis of knowledge on Atlantic biases and their causes;
- Articulate an effective way forward;
- Identify an international network of interested, active researchers, groups, funding agencies; and
- Determine geographical focus

Outcome: high enthusiasm, working group formed



Data Synthesis and Analysis

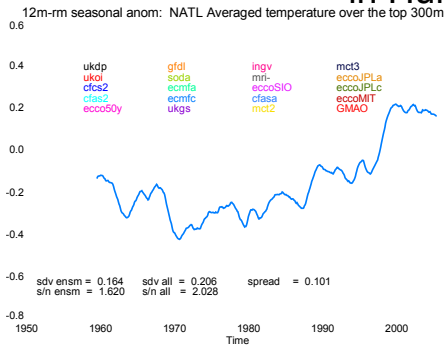
Global Number of Temperature Observations (1980-2006)



Courtesy Tony Rosati in Hurrell et al. (2010)

GSOP: Ocean Synthesis Evaluation Workshops

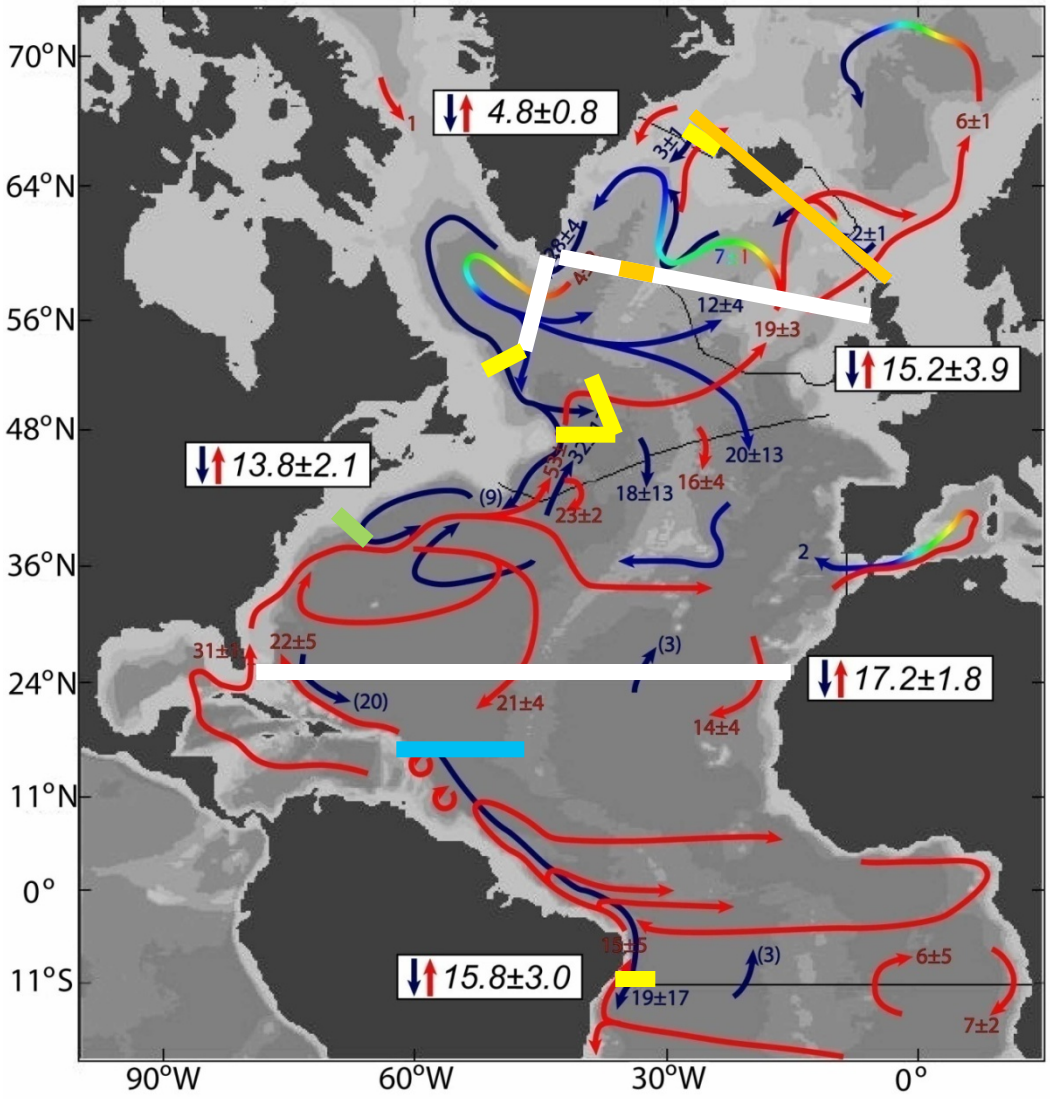
- Inter-comparison of products from multiple groups
- Evaluation of product quality and skill
- Identification of system strengths and weaknesses
- Definition of standards for assessment



N. Atlantic T (0-300 m)

AMOC Observing System

International Coordination of Integrated Observing Networks



AMOC observing system including trans-basin, overflow & western boundary current observations.

RAPID/MOCHA (-2015, NERC Climate Theme Action 2-page proposal for the continuation of the array from 2015-2022)

EU-NACLIM (2013-2016)

German RACE (2013-2015, possible 2nd phase -2018)

WHOI Line W at 40°N

US MOVE at 16°N

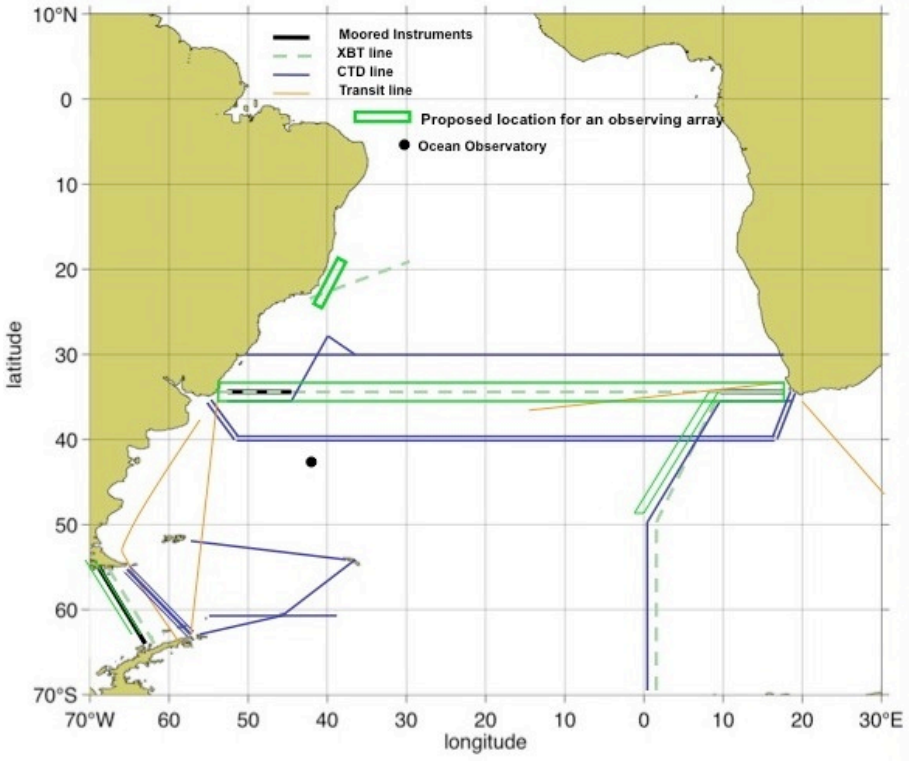
OSNAP (US, UK, Canada, Germany, Netherlands)

SAMOC: South Atlantic Meridional Overturning Circulation

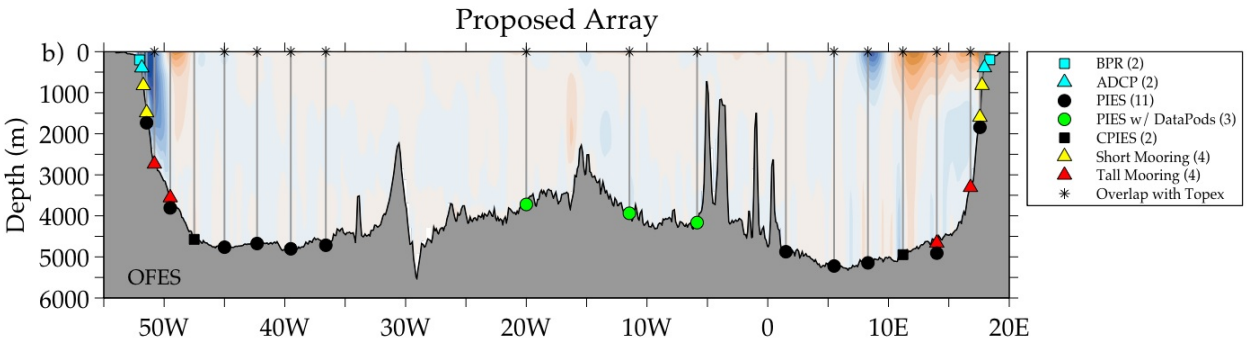
The main objectives of SAMOC are to measure the strength and variability of the MOC as well as the meridional heat and fresh- water transport in the South Atlantic, all of which are crucial to improving our understanding of climate system variability.

Several components of SAMOC have been funded through national agencies

SAMOC has been endorsed by the CLIVAR SSG in May 2012



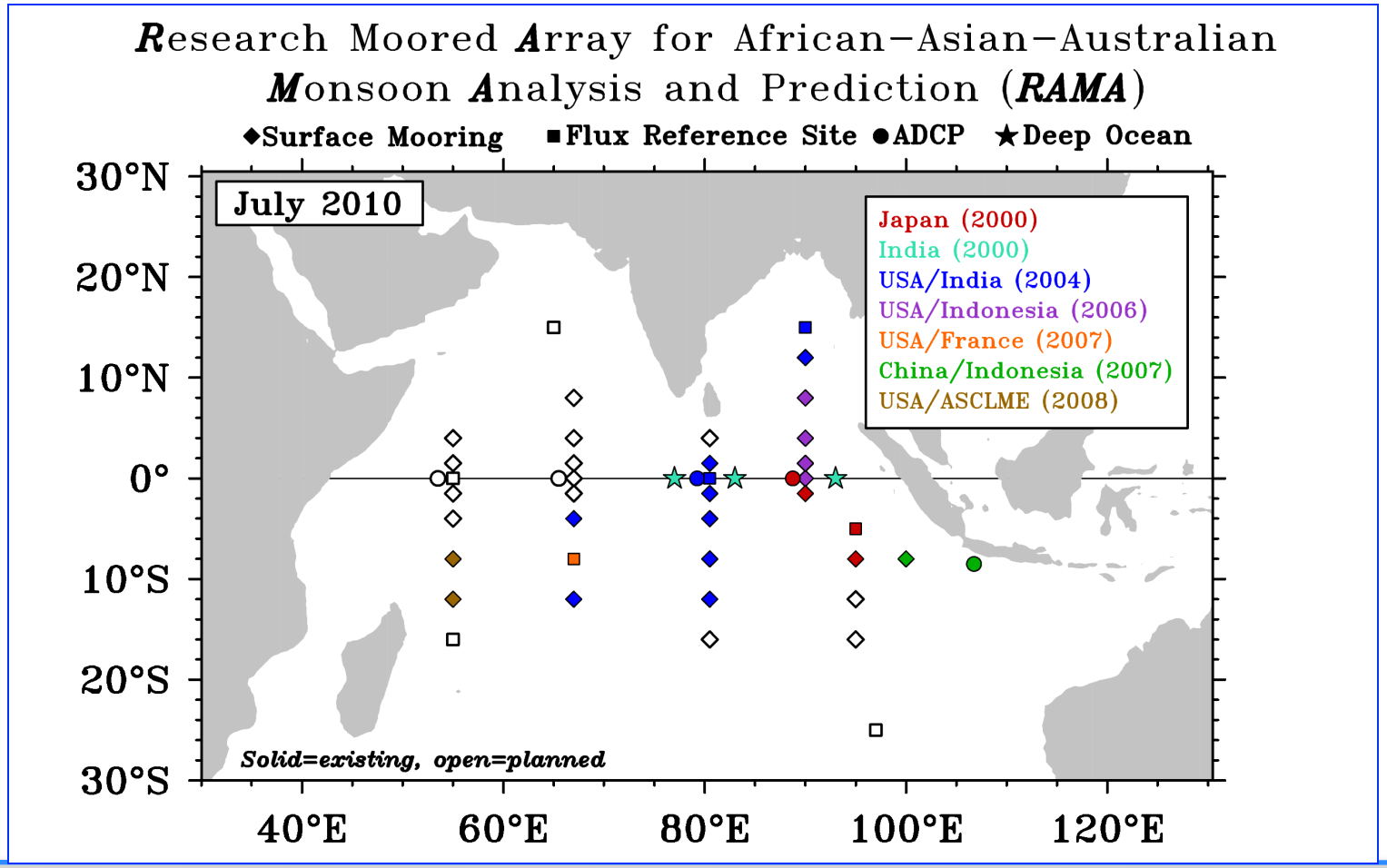
The proposed array along 35°S consists of bottom pressure gauges (cyan squares), upward-looking ADCPs, mid-depth and deep moorings with full water-column T, S, p and discrete current measurements**, PIES (black circles), PIES-with datapods (green circles), and CPIES (black squares). Color contours are of 27-year mean OFES meridional velocity along 34.5°S.**



Ocean Observing System

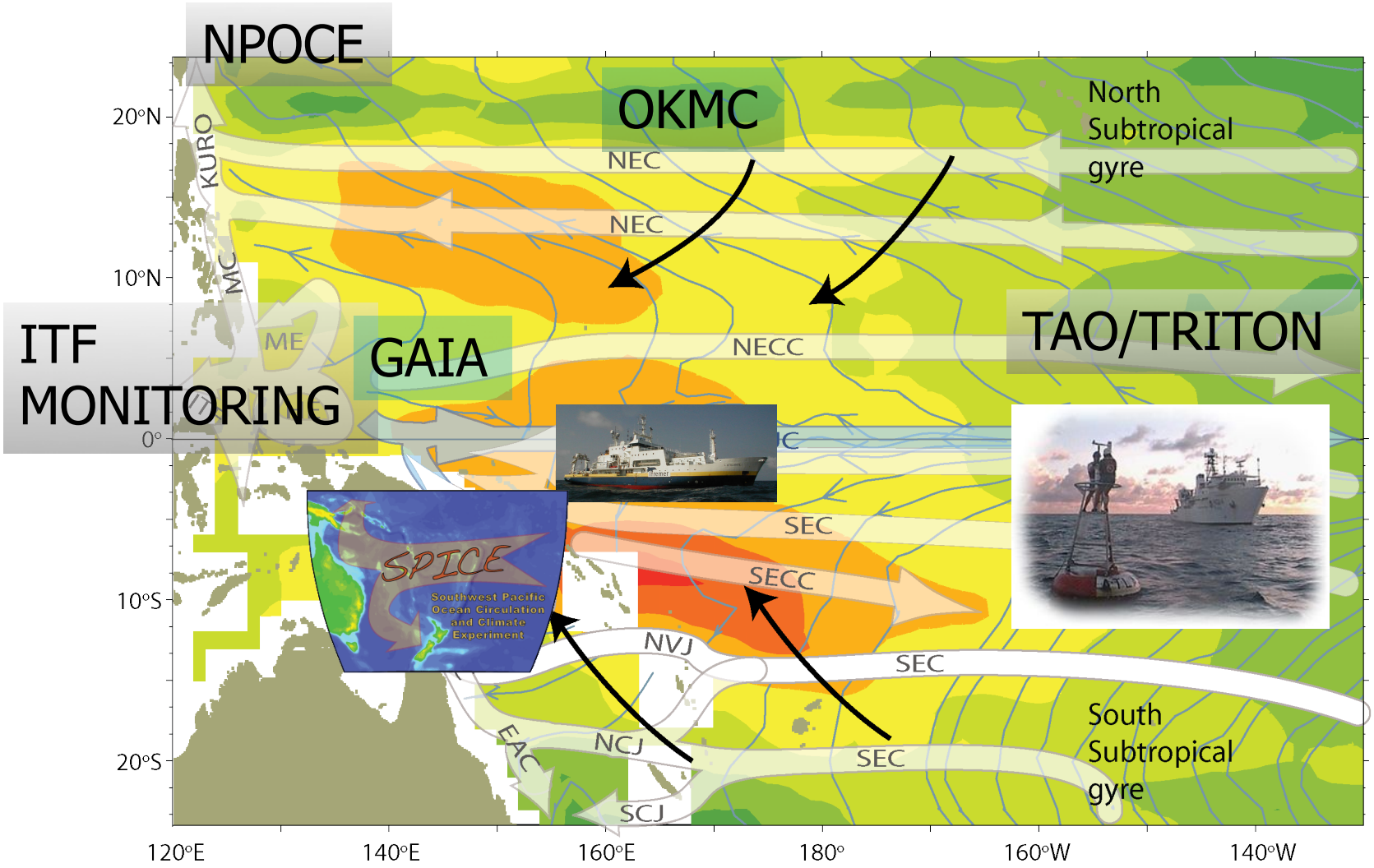
International Coordination of Integrated Observing Networks

RAMA observational network (IOP/GOOS/IOC)



Ocean Observing System

International Coordination of Integrated Observing Networks



Education and Capacity Development

Working together

GHAfrica Workshop (WMO/World Bank) 02/2011

Central Africa (USA) 04/2007

Mexico (UK) 03/2009

West Indian Ocean (France) 09/2009

Southeast Asia (USA)12/2007

Indonesia, Malaysia, Thailand, Philippines (NL) 12/2009

Recent workshops:

Jan 2011, CIIFEN, Equator, S. America

Feb 2011, ICPAC, Keyna, GH Africa

Dec 2011, Gambia, W. Africa

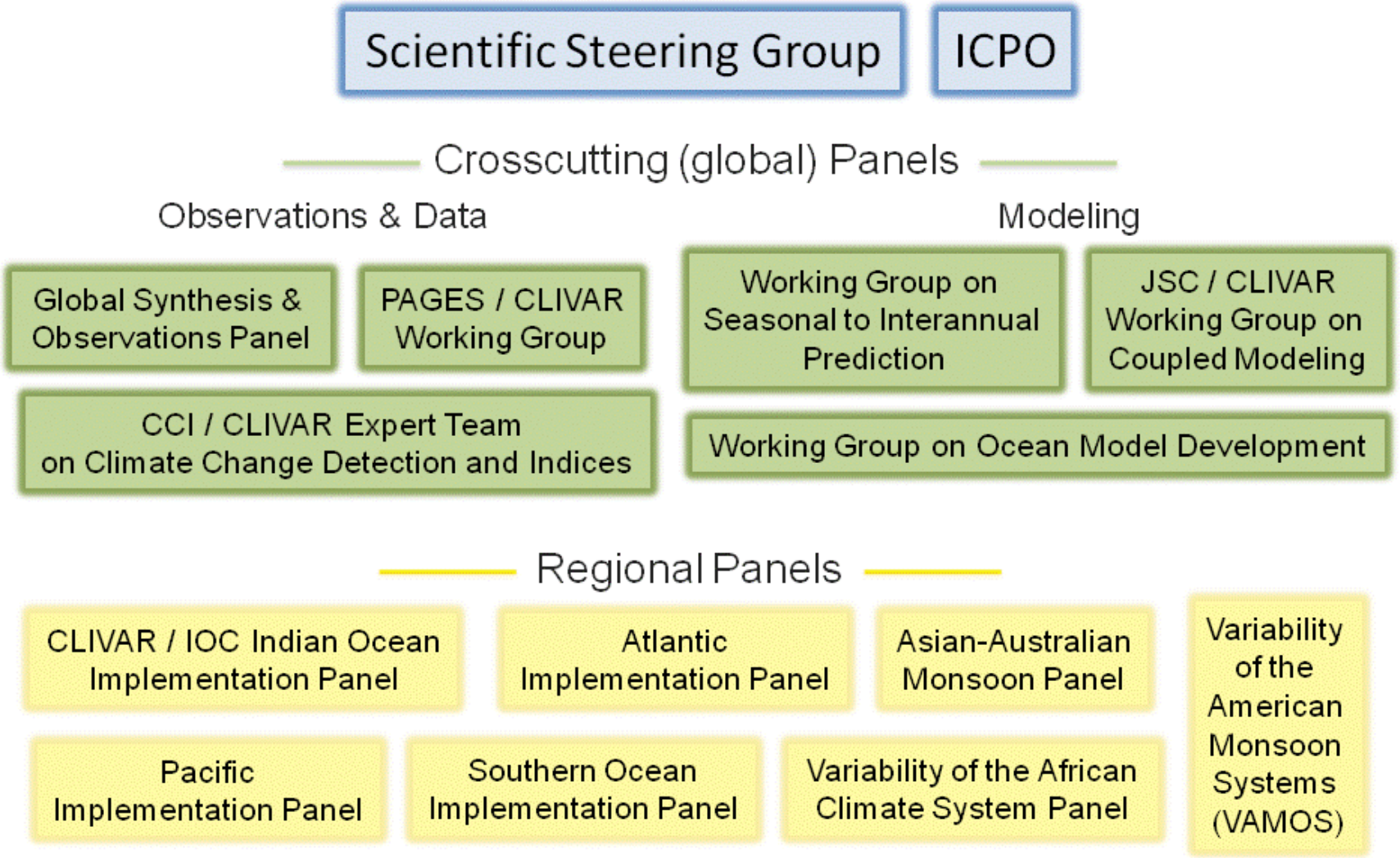
May 2012, New Caledonia, Pacific Island countries and East Timor

May 2012, Jamaica, Caribbean

CLIVAR supported workshops (Jan-Sep 2012)

Meeting Title	Group	Venue	Dates
10th Meeting of the CLIVAR Working Group on Ocean Model Development (WGOMD)	WGOMD	Venice, Italy	11-13 January 2012
Workshop on Using Paleo-Climate Model/Data Comparisons to Constrain Future Projections	CLIVAR/PAGES Working Group	Honolulu, Hawaii, US	1-3 March 2012
Indonesian Throughflow Workshop	Indian Ocean Panel / Pacific Panel	Jakarta, Indonesia	12-14 March 2012
WCRP Workshop on developing a Global Drought Information System	Drought Interest Group	Frascati, Italy	11-13 April 2012
7th Pacific Panel Meeting	Pacific Panel	Noumea, New Caledonia, France	28-29 April 2012
Capacity building workshop on Data Rescue & Climate Change Indices: a contribution to the implementation of the GFCS in the Caribbean	ETCCDI	University of West Indies, Mona, Jamaica	7-10 May 2012
VAMOS Workshop on Modeling and Predicting Climate in the Americas	VAMOS	Petropolis, Brazil	4-6 June 2012
15th Session of the CLIVAR VAMOS Panel	VAMOS	Petropolis, Brazil	6-7 June 2012
SSG-19	SSG	La Paz, Mexico	11-14 June 2012
CLIVAR/WCRP Workshop on Decadal and Multi-decadal Variability in Pacific and Indian Ocean	PP - IOP	Qingdao	4 - 7 September, 2012
12th Session of the CLIVAR Atlantic Implementation Panel	AIP	Kiel, Germany	10-11 September 2012
IMBER ClimECO3 Summer School	IMBER	Ankara, Turkey	23-28 July 2012

CLIVAR Organization
(Historical)



current CLIVAR Organization

Scientific Steering Group | ICPO

Crosscutting (global) Panels

Observations & Data

- Global Synthesis & Observations Panel
- PAGES / CLIVAR Working Group
- CCI / CLIVAR Expert Team on Climate Change Detection and Indices
  - joint with GEWEX

Modeling

- Working Group on Seasonal to Interannual Prediction
- Working Group on Coupled Modeling
- Working Group on Ocean Model Development

Regional Panels

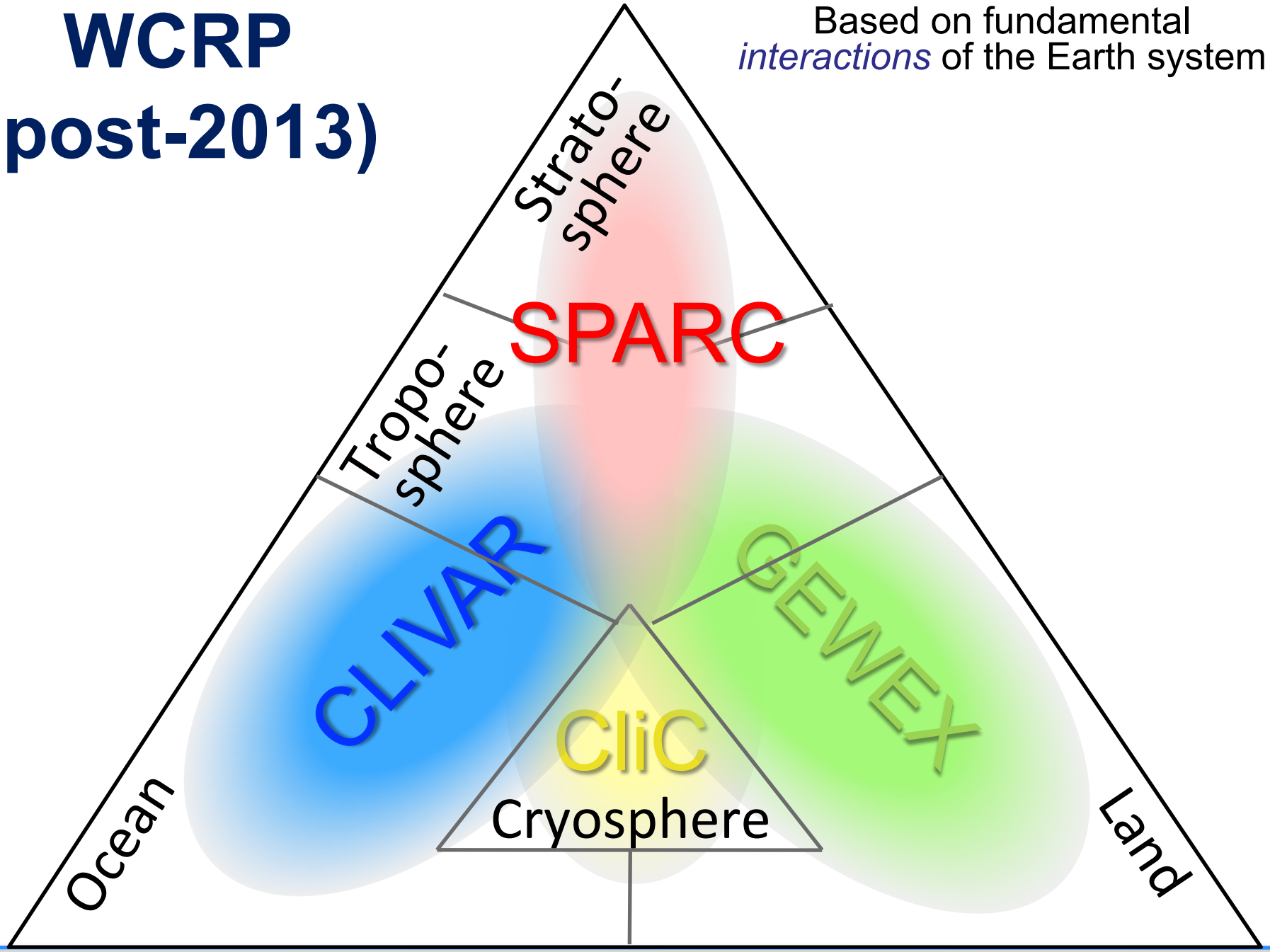
- CLIVAR / IOC Indian Ocean Implementation Panel
- Atlantic Implementation Panel
- Asian-Australian Monsoon Panel
- Pacific Implementation Panel
- Southern Ocean Implementation Panel
- Variability of the African Climate System Panel
  - joint with GEWEX
- Variability of the American Monsoon Systems (VAMOS)

Strategy and Evolution of CLIVAR

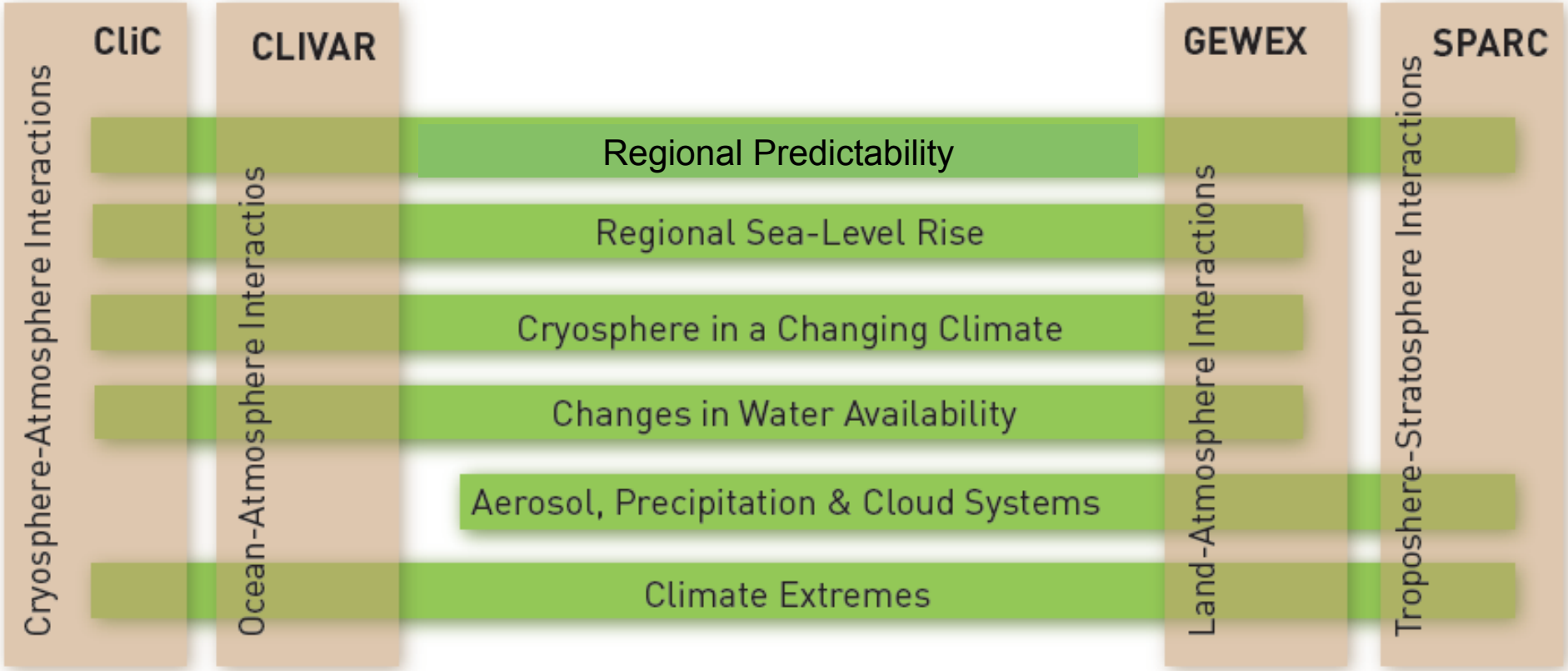
Towards a Science Agenda and Implementation Strategy

WCRP (post-2013)

Based on fundamental *interactions* of the Earth system



WCRP Grand Challenges



What's in a name?

Should CLIVAR become

CLI**M**AR?

Towards a CLIMAR science agenda and implementation strategy

What's in a name?

CLI**J**IM?

Towards a CLIJIM science agenda and implementation strategy

But…

What's in a name?

CLIVAR will become

CLIVAR?

Climate variability and change in the atmosphere - ocean system

CLIVAR Planning Process

Timeline

- SSG-19 (11-14 June 2012)
  - Update on WCRP evolution and charge to CLIVAR
  - Develop first draft science agenda and implementation strategy
  - Discuss and debate
- JSC-33 (17-20 July 2012)
  - Consultation with other core projects and JSC

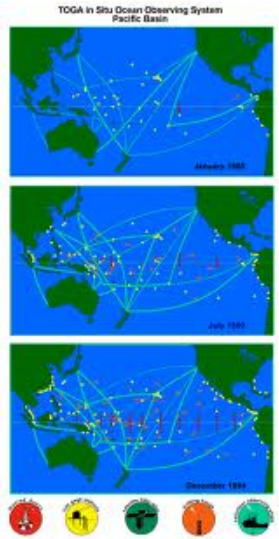
New CLIVAR Research Challenges

- What should they be?
  - How do they relate to existing CLIVAR Research Challenges/Imperatives
  - Preliminary discussion at SSG-18; panel input and good discussions at CLIVAR SSG-19
  - Further community input at Ocean Sciences (Feb 2012, Salt Lake City)
  - US CLIVAR and other National Themes

- WCRP Grand Challenges and the role for CLIVAR

Current CLIVAR Research and Imperatives

- Anthropogenic Climate Change
- Intra-to-Seasonal Variability, Predictability and Prediction
- Decadal Variability, Predictability and Prediction
- Improved Atmosphere and Ocean Components of ESMs
- Data Synthesis and Analysis
- Ocean Observing System
- Capacity Building



All will remain WCRP Priorities

New CLIVAR Research Challenges & Capabilities

Research Challenges

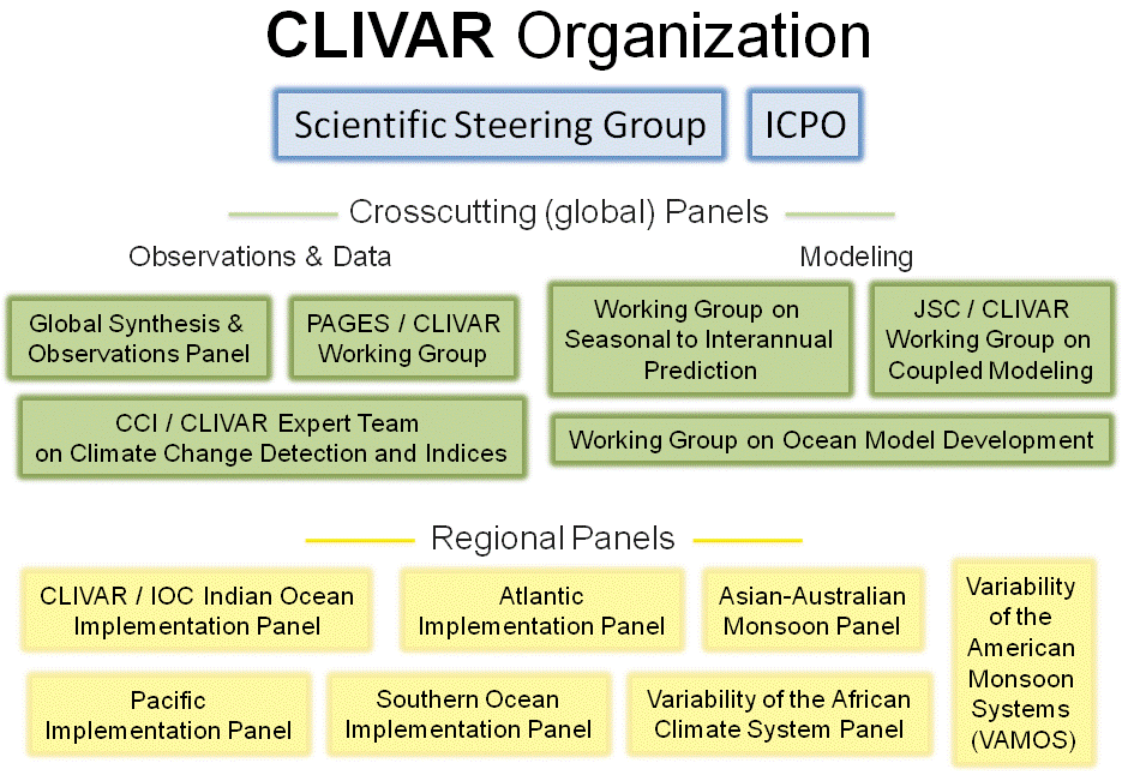
- I-S-I variability and predictability of monsoon systems
- Decadal variability and predictability of ocean and climate variability
- Trends, nonlinearities and extreme events
- Marine biophysical interactions and dynamics of upwelling systems
- Dynamics of regional sea level variability
- …

Capabilities (Imperatives on global and regional scales)

- Improving Ocean system models
- Implementing ocean observations
- Access to ocean data, synthesis and information
- Knowledge transfer and stakeholder feedback
- Education, capacity building and outreach

WCRP Evolution

What does it mean for CLIVAR?



Under Discussion

CLIVAR Planning Process

Timeline

- SSG-19 (11-14 June 2012)
  - Update on WCRP evolution and charge to CLIVAR
  - Develop first draft science agenda and implementation strategy
  - Discuss and debate
- JSC-33 (17-20 July 2012)
  - Consultation with other core projects and JSC
- Debrief from JSC-33 (late July/early August)
  - Teleconference(s) with Panel/WG Co-Chairs & SSG
- Leading to SSG-20 (June 2013, Kiel Germany)
  - Develop Research Challenge position papers
  - Panel and WG discussions of implementation framework
  - Refine and put plans in place for 2014 transition

NEW CLIVAR Organization

Scientific Steering Group | ICPO

Core capabilities

- Working Group on Ocean Model Development
- CLIVAR Synthesis and Observations Panel
- Atlantic Implementation Panel
- Pacific Implementation Panel
- Indian O. Implementation Panel
- Southern O. Implementation Panel
- Knowledge Exchange and Capacity Building

Research challenges

- I-S-I variability and predictability of monsoon systems
- Decadal climate variability and predictability
- Marine biophysical interactions and dynamics of upwelling systems
- Dynamics of regional sea level variability
- Trends, nonlinearities and extreme events

GEWEX WCRP

Evolution of CLIVAR Panel Structure

Matrix advise to the SSG on implementation issues.

- regional/ technical implementation

- science issue implementation

CLIMAR+ research challenge panels (odd year)

CLIMAR implementation panel (even year)

	I-S-I Monsoons	Decadal Variability	Seal Level Regional	Upwelling Ecology	Extremes Trends	...
Atlantic	X	X	X	X	X	
Pacific	X	X	X	X	X	
Indian	X	X	X	X	X	
Southern		X	X	X	X	
Model	X	X	X	X	X	
Data	X	X	X	X	X	
Transfer	X	X	X	X	X	
GEWEX	X	X			X	
SPARC	X	X			X	
CLIC		X	X		X	
WGSIP	X	X		X	X	
WGCM	X	X	X	X	X	
IMBER		X		X		

Will be discussed during 2013 with CLIVAR leader ship in consultation with JSC and affected bodies

I-S-I Monsoon Panel

A single panel focused on Monsoon Research Challenge:

What are the physical mechanisms responsible for modulating predictability of monsoon systems on subseasonal to interdecadal time scales?

- What is the relative role of the oceans and land in contributing to predictability as a function of time scale?
- What is the role of the oceans for interannual to interdecadal variability, especially related to ENSO and its teleconnections?
- What is the role of aerosols for monsoon variability, predictability, and change?

Initial implementation:

- Members from AAMP, VAMOS and VACS
- Also GEWEX, SPARC, WGSIP, WGCM, and other CLIVAR regional panels
- Would thus oversee current AAMP activities, MAHASRI, IASCLIP, AMMA …
- Would foster workshops and other targeted (limited lifetime) projects