

WHAT SHOULD CLIMAR BE?



Towards a CLIMAR science agenda
and implementation strategy

Based on summary of Panel and Working Group Input



Content

Points to consider when addressing each grand challenge

CLIVAR imperatives & WCRP grand challenges reminder

Intrasessional input (tiger team processes)

Key research topics predominantly from panel/working group input

Other foci pertinent to CLIMAR in addition to science questions

A straw man prospectus for CLIMAR



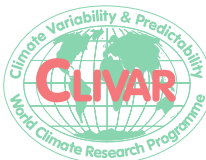
Agenda until coffee break *15:30*

4. FUTURE

4.1. CLIVAR grand challenges – summary of input from panels (Visbeck, Hurrell, Beswick)

4.2. CLIMAR grand challenges discussion --- plenary

4.3. WCRP grand challenges, IGBP, Future Earth, GFCS interactions (change order???)



Points to Consider for Grand Challenges

- Cutting edge science
- Benefitting from global/regional coordination
- Prospects of funding
- Socio-economic benefits
- Key partners within CLIMAR, WCRP, GFCS, IOC, GCP (Future Earth), beyond (UNEP, ...)
- 4-10 year horizon for implementation



Current CLIVAR Research Challenges and Imperatives

- Top priorities of CLIVAR panels and working groups for 5+ years
- Developed and evolving around several criteria;
 - ✓ scientific importance;
 - ✓ opportunity to make considerable progress;
 - ✓ benefit from international coordination
- Imperatives map across:
 - ✓ CLIVAR panels and working groups
 - ✓ WCRP and other international research programs

CLIVAR Research Challenges

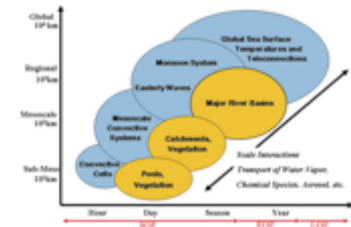
- Anthropogenic Climate Change

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



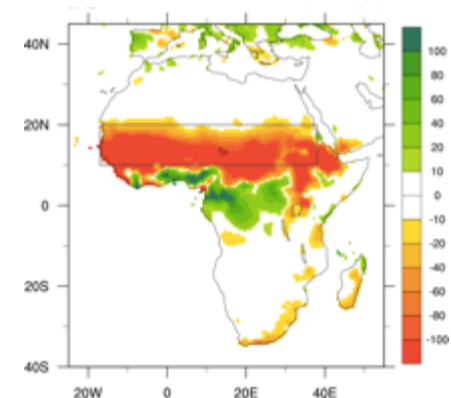
- Intra-to-Seasonal Variability, Predictability and Prediction

- Monsoons (and ENSO, TAV, ...)
- ISV/MJO
- Quantifying prediction uncertainty
- Building pan-WCRP and WWRP links
- CHFP



- Decadal Variability, Predictability and Prediction

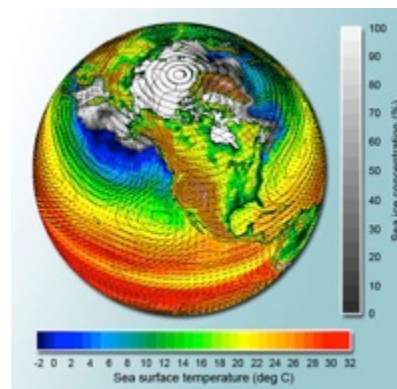
- Determine predictability
- Mechanisms of variability (AMO, PDV, ...)
- Role of oceans
- Adequacy of observing system
- Coupled Initialization
- Quantifying prediction uncertainty
- Building pan-WCRP links



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

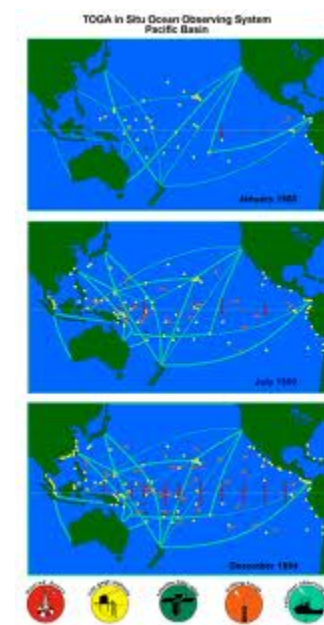


- Data Synthesis and Analysis

- 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

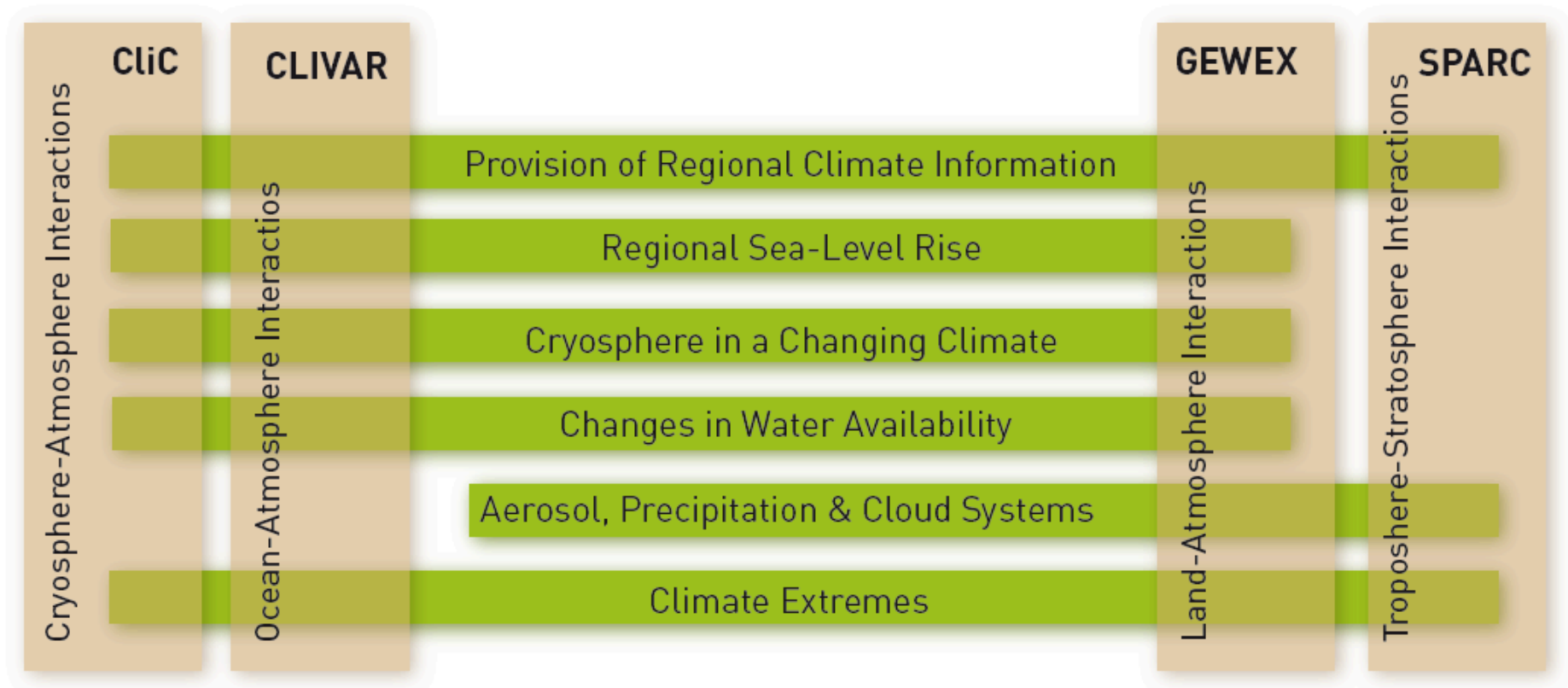


- Capacity Building

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



WCRP proposed Grand Challenges



WCRP proposed Grand Challenges (from the JSC perspective CLIMAR relevant)

- **Provision of skillful future climate information on regional scales (includes decadal and polar predictability)** Filippo Giorgi, Carolina Vera, Fred Semazzi, **CLIVAR**, SPARC, WMAC
- **Regional Sea-Level Rise** Konrad Steffen, WCRP/IOC Task Force on Sea Level Variability and Change, **CLIVAR**, CliC
- **Cryosphere response to climate change (including ice sheets, water resources, permafrost and carbon)** Vladimir Kattsov, CliC, GEWEX, Greg Flato, Sarah Gille, WGCM, WGOMD
- **Improved understanding of the interactions of clouds, aerosols, precipitation, and radiation and their contributions to climate sensitivity** Terry Nakajima, Hong Liao, Graciela Binimelis de Raga, GEWEX, SPARC, WGCM, WGNE
- **Past and future changes in water availability (with connections to water security and hydrological cycle)** Kevin Trenberth, Pius Yanda, Hervé le Treut, GEWEX, **CLIVAR**, WGCM
- **Science underpinning the prediction and attribution of extreme events** David Karoly, **CLIVAR**, GEWEX, Modeling Council, ETCCDI, Fred Semazzi

Information about Future Earth

Will provide the knowledge required for societies in the world to face risks posed by global environmental change and to seize opportunities in a transition to global sustainability

FUTURE EARTH RESEARCH STRATEGY

- From fundamental to actionable Earth system research for global sustainability
- Answer complex questions that require international collaboration
- Co-design and co-production of knowledge
- Integrates natural, economic, engineering, arts, humanities and social sciences
- Regional to global scale

FUTURE EARTH Integrated Research Themes

Some are relevant

Low Carbon Societies: Climate Change Risks and Implications for Energy and Economies

Living with the Sea: Oceans, coasts and blue societies

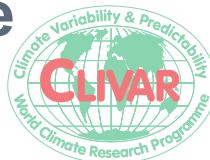
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GEWEX Science Questions

1. How can we better understand and predict variations and changes in **precipitation**?
2. How do changes in **land surface and hydrology** influence past and future changes in water availability and security?
3. How does a warming world affect **climate extremes**, especially droughts, floods, and heat waves, and how do land area processes, in particular, contribute?
4. How can understanding of the effects and **uncertainties of water and energy exchanges** in the current and changing climate be improved and conveyed?

Intraseasonal CLIVAR Input

- *ACTION ITEM 5:* **Clarify the WCRP monsoon structure**
(with one paragraph input from GEWEX, WGSIP, VAMOS, AAMP)
- *ACTION ITEM 6:* **How WCRP/CLIVAR can best improve components of earth systems models**
(perhaps modelling on US CLIVAR CPTs)
- *ACTION ITEM 7:* **How to communicate WCRP/CLIVAR research findings to IMBER and coastal research communities, and mechanisms for collaboration**
- *ACTION ITEM 8:* **How best to communicate CLIVAR research findings**
- *ACTION ITEM 9:* **Design of ocean climate indices on time scales from days to centuries**



Intraseasonal CLIVAR Input

- *ACTION ITEM 10:* **Map out CLIVAR decadal variability and predictability activities across all panels, linking with US CLIVAR Decadal WG and WGCM/WGSIP DCPD**
- *ACTION ITEM 13:* **On-going studies of regional sea level changes**
- *ACTION ITEM 14:* **On-going work and future aspirations on upwelling systems**
- *ACTION ITEM 20:* **Develop a strategy on how to best reduce tropical biases with a focus on the Atlantic**
- *ACTION ITEM 35:* **Identify capacity building activities for CLIVAR**



IntraseSSIONal CLIVAR Input

- WRITTEN INPUT FROM
PANELS AND WORKING GROUPS

File: Panel Input_Key Science Questions.pdf

- **Summary and sorting ... not complete ...
to be discussed ... and decided?**



Key Research Area

Intraseasonal mechanisms of monsoon systems

- Ocean-atmosphere dynamics of monsoon systems
- Role of the Indian Ocean
- Role of the Atlantic Ocean
- Role of aerosols
- Role of the oceans for driving monsoon decadal variability especially related to ENSO



Key Research Area

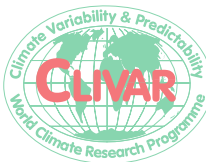
Decadal mechanisms of ocean and climate variability

- Predictability of meridional overturning circulations
- Decadal dynamics of PVD, AVD (AMO) and SAM
- Role of the oceans for driving monsoon decadal variability especially related to ENSO
- Ocean and climate impacts of changing AMOC
- Sea ice dynamics and decadal variability
- Ocean dynamics and biogeochemical feedbacks (aerosols, carbon, phytoplankton ...)

Key Research Area

Trends and Extreme Events

- Detection and attribution of anthropogenic influence on weather and climate extremes at regional scale
- Event attribution
- Can ocean-atmosphere or sea ice-atmosphere coupling drive predictable year to year changes in extratropical atmospheric circulation and hence extreme events?
- Extreme weather in maritime influenced regions (Africa, Asia, Americas) e.g. tropical cyclones, storm surges, hypoxia
- How might ENSO change in a warmer world?
- Trends in the AMOC



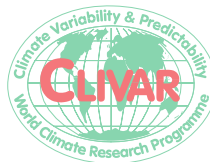
Key Research Area

Upwelling Systems

- Can ocean upwelling dynamics be predicted to inform changes in biogeochemistry and marine ecology?
- What are the key mechanism and how well are they represented in models?

Existing Activities

- Java-Sumatra upwelling system and upwelling in northwestern coastal Indian Ocean of interest to IOP
- Eastern Pacific upwelling system of interest to PP
- Benguela upwelling region studied by several projects e.g. BMBF program, which is of interest to AIP



Key Research Area

Regional Sea Level Change

- How do wind fluctuations influence regional sea level and are they predictable?
- How important are ice sheet ocean interaction in the Arctic and Antarctic?
- What is the role of regional differences in air-sea heat flux?

Existing Activities

- BMBF Nordatlantik in Atlantic (and Arctic) Ocean
- IndOOS in Indian Ocean
- OGCM and CMIP3 results for Indo-Pacific regions
- Difficult to separate anthropogenic and natural variability signals in Pacific region
- Paucity of observations in Southern Ocean – need to extend Argo and revisit full-depth hydrographic surveys



Key Research Areas?

Other Possible Areas / Activities

- Marine fresh water cycle
- Proxy reconstructions
- Inter-basin exchanges
- Ocean deoxygenation
- Air-sea carbon flux
- Ocean acidification
- Marine ecosystems and their biodiversity
- Marine tipping points
- Marine Services



Key Science Area / Capability

Biases in Coupled Model Simulations

- Reasons for Atlantic biases e.g. SST
- Improve simulation in global coupled models
- Can reanalysis or synthesis methodologies be used to quantify, reduce or bias correct for model errors?
- How do ocean model errors affect the skill of predictions months to years ahead?

Existing Activities

- Atlantic bias workshop (report being drafted)



Key Capability

Ocean System modeling

- Data assimilation
- High resolution modeling
- Oceanic 'downscaling'
- Representation of mesoscale mixing
- Reducing biases
- Overflows and ice shelves
- Regional assessment and verification of climate models/predictions

Key Capability

Ocean Observations

- What are the essential CLIMAR ocean variables (EOV4CLIMAR)?
- Adequacy of existing sustained ocean observations?
- New observing technology and observing systems.
- Future satellite missions
- Data sharing and delivery to data systems



Key Capability

Ocean Data and Information

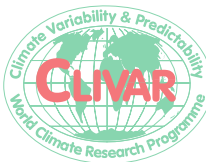
- How to access ocean data for assimilation and research?
- CLIMAR data policy
- Development of ocean climate indices
- Regional assessment and verification of climate models/predictions
- Ocean information products
- Current and future needs from operational ocean activities



Key Capability

Knowledge Transfer

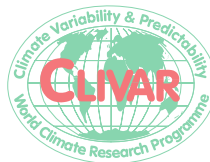
- Who are our stakeholders (science +)
- How can we make sure that CLIMAR science is aware of user needs?
- Target audience predominantly scientific community, through:
 - Workshops, reports, newsletters, webpages, mailing lists etc.
- Support needed to establish longer-term knowledge transfer activities and skills base to develop tools/appropriate language to communicate information
- Need to establish better links with the user community



Key Capability

Communicating CLIVAR research findings

- 'Marketing' CLIVAR
- Promote interactions between programmes
- Promote climate science communication



Key Capability

Capacity Building

- How can we entrain the best ocean climate scientist to CLIMAR?
- How can we build up the needed capacity globally
- CLIVAR young scientist summer school (annual)

What is done currently:

- Predominantly travel support for early career researchers and groups from developing countries
- Some dedicated workshops, but more funding needed to increase these activities

SEE DOCUMENT: [Panel Input_Clivar GCs.PDF](#)



A straw man summary of CLIMAR

- Please disagree and take it apart ...
- Lets construct a common CLIMAR project !
- How to transition from CLIVAR to CLIMAR ?

CLIMAR

CLIMATE PROCESSES, VARIABILITY, PREDICTABILITY AND TRENDS IN THE MARINE REALM

Mission: To observe, simulate and predict changes in the climate system with a focus on ocean interactions with the atmosphere, cryosphere, marine biogeochemistry and ecology, enabling better understanding of ocean-climate processes, variability, predictability and change in the marine realm, to the benefit of society and the environment in which we live.

CLIMAR

Research Area (Grand Challenges)

- Intraseasonal mechanisms of monsoon systems
- Decadal mechanisms of ocean and climate variability
- Trends, nonlinearities and extreme events
- Biophysical interactions in upwelling systems
- Dynamics of regional sea level
- ...

Capabilities (Imperatives on global and regional scales)

- Improving ocean system models
- Improving ocean observing systems
- Ocean data, synthesis and information systems
- Knowledge transfer and stake holder feedback
- Education, capacity building and outreach

CLIMAR

Governance to implement a global effort

Research Foci Working Groups

- Intraseasonal monsoon
- Decadal process
- Regional sealevel
- Dynamics of upwelling systems
- Ocean trends and extreme events

Capability Panels

- Basin implementation panels
- Ocean model development
- Ocean data, synthesis and information
- Knowledge transfer, capacity building, outreach

CLIMAR panels/working groups

- Cross panel membership encouraged 5 year term (3 year extension)
- Meet in leapfrog schedule (odd and even years)
- Nations are invited to send additional representatives at their expense

CLIMAR implementation panel (even year)

CLIMAR research working group (odd year meeting)

	Monsoon	Decadal	Sealevel	Upwelling	Extremes	...
Atlantic						
Pacific						
Indian						
Southern						
Model						
Data						
Transfer						
...						

CLIMAR initiatives / studies

- Define criteria (mainly under research or capability)
- Endorsement process similar to CLIVAR
- More than one nation / funding mechanism involved

	Monsoon	Decadal	Sealevel	Upwelling	Extremes	...
Atlantic						
Pacific						
Indian						
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...						