

4.4 WCRP Grand Challenges

Compiled from CLIVAR Panel/Working Group Reports to SSG-19

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Provision of skillful future climate information on regional scales

Asian-Australian Monsoon Panel (AAMP)

- Evaluation of decadal prediction and predictability of the AAM is seen as a new effort by AAMP. This is being facilitated by a September 2012 workshop “International Workshop on Interdecadal Variability of Global Monsoons” that AAMP is sponsoring in Nanjing, just prior to AAMP-12. AAMP has obtained \$15K from NSF to support the participation of early career scientists at this workshop.
- The evaluation of monsoon intraseasonal variability and predictability in present-day and climate change simulations in CMIP5 and operational forecast models may yield insight into potential changes to the frequency and intensity of active and break cycles that are associated with short-term extremes of regional drought and flood and provide insight into model shortcomings that are acting to limit monsoon intraseasonal predictions.

Atlantic Implementation Panel (AIP)

- Causes of interannual to interdecadal North Atlantic climate variability: relative roles of the external forcings and internal variability
- Improvement of the observing system for the North Atlantic Ocean: AMOC, and the South Atlantic: SAMOC
- Identifying required observing system to address the tropical Atlantic bias: TACE, contribution to the CLIVAR Working Group on the 'Upper-Ocean Heat Budget Synthesis for the Eastern Equatorial Pacific and Atlantic Oceans'
- Improvement of the deep ocean observing system

CLIVAR/PAGES Working Group

- Development of methodologies relating model skills for paleoclimates to projections.

Indian Ocean Panel (IOP)

- IOP is promoting the implementation of the Indian Ocean Observing System (IndOOS), especially its critical component called the Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction (RAMA). This will dramatically change the data-poor condition in Indian Ocean and will definitely improve the understanding of the monsoon climate system. All these will improve the relative poor model simulation and prediction skill in the monsoon region.
- IOP is working closely with AAMP to realize the maximum scientific contribution from observation to prediction.
- IOP is working on the review paper on the decadal variability in Indian Ocean, which will also discuss the further research priorities along this direction.

Pacific Panel

- Research conducted by projects in the Pacific's western boundary currents region will provide the necessary understanding to support climate studies and impacts in the region. As an example, changes in the Northwestern

Pacific (NWP) water properties and ocean circulation can influence the heat and freshwater budget and hence the atmospheric deep convection over the Indo-Pacific warm pool, thereby playing a role in modulating ENSO cycles and the East Asian Monsoon variations, as well as in the development and evolution of the NWP cyclones.

Southern Ocean Panel (SOP)

- Close engagement with WGOMD on SO modeling activities (e.g. joint Hobart panel meeting Feb 2013)
- Evaluation and synthesis of CMIP5 model projections spanning atmosphere, oceans, sea-ice

Working Group on Seasonal and Interannual Prediction (WGSIP)

- The CHFP (climate historical forecast project) will give a state of the art measure of the skill of regional climate predictions out to months ahead

Working Group on Ocean Model Development (WGOMD)

- Provision of skillful future climate information on regional scales (includes decadal and polar predictability)

Variability of the American Monsoon Panel (VAMOS)

- VAMOS Modeling Working Group
- CLARIS-LPB

Variability of the African Climate System (VACS)

- Regional-scale climate prediction in Africa has served as a catalyst for the organization of climate science and its connectivity to users/society. The regional climate outlook forums have been running longer and are more numerous in Africa than on any other continent. This partly reflects the importance of climate prediction given the exposure of the continent to rainfed subsistence agriculture. RCOFS are represented on the VACS panel through panel members from the core RCOF regions. Key activities of the panel are uncovering the limitations to prediction and the connection of users with climate information. VACS panel meetings and conferences are one mechanism by which the impediments are identified.

Regional sea-level rise

Global Synthesis and Observations Panel (GSOP)

- Ocean syntheses should provide information for the assessment and attribution of regional sea level rise. Sea level change comparisons will be part of the synthesis evaluation program initiated by GSOP and GODAE-Oceanview

Indian Ocean Panel (IOP)

- IndOOS includes the tide gauge component and IOP works to coordinate the sea-level observation in the rim of Indian Ocean, which helps to better monitor the regional sea level rise. However, efforts are underway to study

and document the sea level changes in the Indian Ocean using Altimeter, Argo and GRACE.

- In addition to the observational efforts, modeling researches have been conducted at several places. IOP encourages such research activities.

Pacific Panel

- Recent regional sea-level trends in Indo-Pacific are largely wind-driven and there is a robust regional sea-level response pattern to CO₂ doubling which emerges as a response to SST-induced changes in wind-stress curl (Ekman pumping). Wind-induced sea-level changes can delay sea-level rise in some regions in the Southwestern Pacific by up to several decades. Some models do not capture well the magnitude of recent sea level trends although the pattern of those trends is well captured. There is a strong opportunity for the Pacific Panel to further explore links with sea level research community, and support research on the impact of sea level change for countries in the Pacific basin, mainly Small Islands States.

Southern Ocean Panel (SOP)

- Ongoing input on the role of the southern hemisphere cryosphere on sea level
- 2013 workshop being co-organised with WGOMD on sea level rise, amongst other topics

Working Group on Ocean Model Development (WGOMD)

- Regional sea-level rise

Cryospheric response to climate change

CLIVAR/PAGES Working Group

- Improving understanding of MOC variability.

Southern Ocean Panel (SOP)

- Activities towards the development of SOOS
- 2013 workshop will also focus on ocean/ice-shelf interaction, and ice sheets
- SOP7 addressed Southern Ocean physics (and ice)

Working Group on Seasonal and Interannual Prediction (WGSIP)

- Several seasonal forecast centres (e.g. UKMO, CCCMA) now make real time seasonal to decadal forecasts with initialized sea ice. In addition the WGSIP Ice Historical Forecast Project is investigating the role this plays in the wider climate system (see WGSIP report)

Working Group on Ocean Model Development (WGOMD)

- Cryosphere response to climate change (including ice sheets, water resources, permafrost and carbon)

Improved understanding of air-sea interactions; their connections to clouds, aerosols, precipitation, and radiation; and their contributions to climate sensitivity

Atlantic Implementation Panel (AIP)

- Investigation of the causes of the coupled model biases in the tropical Atlantic.
- Investigation of the causes of the spread in West African Monsoon CMIP5 projections

CLIVAR/PAGES Working Group

- Analysis of insights on climate sensibility based on past climate, based on model/data comparisons.

Indian Ocean Panel (IOP)

- IOP observing system include observations for process studies. During 2006/07, IOP coordinated MISMO and CIRENE and later CINDY2011/DYNAMO focusing on MJO initiation in the Indian Ocean.

Southern Ocean Panel (SOP)

- Atmospheric processes over the Southern Ocean was one of the key topics of SOP7.

Variability of the African Climate System (VACS)

- Africa is the largest source of mineral aerosols on the planet. Mineral aerosols are a key cause of model error on NWP to climate timescales. VACS serves on two key field programmes in Africa aimed at addressing the links between mineral aerosols and climate (namely Fennec and DO4Models).

Variability of the American Monsoon Panel (VAMOS)

- VOCALS

Past and future changes in water availability (with connections to water security and hydrological cycle)

CLIVAR/PAGES Working Group

- Improving understanding of past changes in water cycles including droughts and floods.

Global Synthesis and Observations Pane (GSOP)

- Ocean syntheses can also be used to assess and understand changes in ocean salinity and therefore to provide a perspective on changes in water availability through changes in the regional hydrological cycle and freshwater transports in the oceans over recent decades.

Southern Ocean Panel (SOP)

- Focus on atmospheric processes over the Southern Ocean during SOP7 highlighted e.g. SAM influencing precipitation/drought events in Southern Hemisphere regions

- Support extending the observing under ice, for better cryosphere predictions, glacial ice melt processes

Variability of the African Climate System (VACS)

- Water is the prime focus of climate science in Africa – for example seasonal prediction is overwhelmingly concerned with rainfall prediction. VACS promotes the investigation of issues such as seasonal rainfall onset and cessation that are known to be scientifically challenging but which otherwise be neglected by the scientific community. VACS, for example, is represented on flagship and well-resourced research programmes, such as the Africa CSRP of the UK Met Office, which are able to take up these challenges through improvements in numerical models making up the GPCs.

Variability of the American Monsoon Panel (VAMOS)

- VAMOS Extremes cross-cut
- CLARIS-LPB

Working Group on Seasonal and Interannual Prediction (WGSIP)

- Seasonal and decadal predictions naturally output the full range of climatic variables from models and so there is real time information on precipitation available from these systems, albeit with large seasonal and geographical variations in skill. Nonetheless, these forecasts form the basis for future climate services in water availability out to years ahead.

Science underpinning the prediction and attribution of extreme events

CLIVAR/PAGES Working Group

- Information from paleoclimate data and long (millennial) simulations on the recurrence of extreme events and relationships with external forcings.

Expert Team on Climate Change Detection and Indices (ETCCDI)

- ETCCDI's activities are central to the Grand Challenge on the science underpinning the prediction and attribution of extreme events.

Indian Ocean Panel (IOP)

- RAMA array provides in situ real-time data for the cyclones in Bay of Bengal, especially they measured the air-sea condition during the super cyclone Nargis (2008). These data will help the prediction of the super cyclones. Also the data already led to some research papers. The influences of ENSO on tropical cyclone activity in the Bay of Bengal are documented. It is reported that during La Nina conditions, the number of cyclones and the intensity of cyclones (super cyclone) are enhanced in the Bay of Bengal.
- Further, IOP is enhancing its research focus on the monsoon anomalies, especially the extreme drought and severe flood.

Pacific Panel

- Rising mean sea level projects onto changes in extreme events. In addition to an increase in sea level extremes, other factors include, more extreme

condition as a response of the South Pacific Convergence Zone to greenhouse warming, including droughts, and extreme tropical cyclones in regions in regions not accustomed to such events. Further, accelerated warming along western boundary currents may lead to change in cyclone tracks and frequency.

Southern Ocean Panel (SOP)

- Focus on atmospheric processes over the Southern Ocean during SOP7 highlighted e.g. SAM influencing precipitation/drought events in Southern Hemisphere regions
- Support extending the observing under ice, for better cryosphere predictions, glacial ice melt processes

Variability of the African Climate System (VACS)

- VACS agreed in the last few months to promote this item through highly visible publications written by the panel to journals such as BAMS.

Variability of the American Monsoon Panel (VAMOS)

- VAMOS Modeling Working Group
- VAMOS Extremes cross-cut
- CLARIS-LPB

Working Group on Seasonal and Interannual Prediction (WGSIP)

- Prediction of extreme events is at the core of the seasonal to decadal prediction effort. Predicting the risk of a very cold winter or a very hot summer, an intense or failed rainy season, or the frequency of daily extremes at long lead times are all active topics. Encouragingly, the skill for extremes is often higher than the skill for average conditions. These forecasts form the basis for future warning of the risk of extreme events out to years ahead.

Working Group on Ocean Model Development (WGOMD)

- Science underpinning the prediction and attribution of extreme events.