Report to Pan-CLIVAR meeting

Panel or Working Group: **Variability of the American Monsoon Systems (VAMOS)**

1. Implementation of the science priority topics identified by the panel and how the panel's activities will be integrated within CLIVAR, and WCRP to advance CLIVAR objectives in the next 5-10 years.

a) Organizing the WCRP-LAC Conference: Developing, linking and applying climate knowledge, under the auspices of the World Climate Research Programme (WCRP), with support from the Inter-American Development Bank (IDB), the Inter-American Institute for Global Change Research (IAI), and a number of regional and local organizations, held in Montevideo, Uruguay, from 17 to 21 March 2014.
220 participants from 19 countries of the Americas and 13 countries from Europe, Asia and Africa attended the conference, 80 of them were early-career scientists and PhD students.
The conference was structured in five main themes: health, water & energy, agriculture & ecosystems, urban & coastal environments and climate monitoring & prediction.
These main themes were developed through keynote and invited talks, oral and poster sessions, and round tables. Following are the keynote speakers: Roger Pulwarty, Kristie L. Ebi, German Poveda, Soroosh Sorooshian, Robert Wilby, Walter Baethgen, Holm Tiessen, Laura Gallardo, Gabriel Vecchi, Roberto Mechoso and Caio Coelho.
Below are listed the main challenges discussed during the conference for supporting the development of climate services in LAC:

- Better understanding climate drivers in LAC, with emphasis on those that could increase current levels of predictability at subseasonal to decadal time scales
- Improve understanding and assess predictability of climate extreme events
- Better monitoring climate –including extreme events– and climate drivers
- Define Ocean-Climate Services
- Better synergy between WCRP global initiatives and regional activities
- Develop knowledge networks adequate for co-exploration and co-production

b) Organizing two regional VAMOS/CORDEX workshops for S. America and Caribbean, supported by the World Climate Research Programme (WCRP) in partnership with ICSU-ROLAC, the Inter-American Institute for Global Change Research (IAI) and the Caribbean Community Climate Change Centre (5Cs) under the Project entitled "Regional Climate Downscaling over South America, Central America and the Caribbean: A coordinated effort to pursue Vulnerability, Impacts and Adaptation studies in the region"
A first training workshop focused in South American CORDEX domain

was held at the Instituto Geofísico del Peru, in Lima, on 11-13 September, 2013. 70 participants from 19 countries attended this first workshop, of which around 50% were early-career scientists.The second workshop, focused on Central American and the Caribbean, was host by the Oficina Nacional de Meteorologia, in Santo Domingo, Dominican Republic, April 2014. 38 participants from 16 countries within North America, Latin America and the Caribbean plus invited speakers from South Africa and Russia attended this second workshop. Most of them were early career scientists.

The major aims of these Workshops were:

- To develop a capacity building effort to evaluate regional climate downscaled model projections,
- To provide targeted downscaled information for impact assessment analysis, and
- To plan strategies for adaptation/mitigation options.
- The two Workshops allowed identifying regionally focused Vulnerability, Impact and Adaptation (VIA) on-going studies and user knowledge needs as well as on-going climate modelling activities within the CORDEX framework within the region.

The Training sessions allowed initiating a dialogue between different communities and regions. Participants gained a deeper understanding of approaches for identifying vulnerability and risk and they also developed skills in integrating and communicating climate related risk and the appropriate policy responses.

c) Transition of VAMOS from a regional CLIVAR program to a component of the CLIVAR monsoon panel.

VAMOS scientific priorities under the new MP structure

- Improve understanding of large-scale controls on American monsoon behavior and how those patterns control monsoon variability and climatic extremes
- Explore interactions among between regional monsoon systems (e.g. west Africa, MJO, tropical easterly waves)
- Diagnose potential inter-hemispheric controls on onset/demise
- Improve understanding of the role of local forcing and feedback mechanisms
- Characterize the response of American monsoon systems to long-timescale past forcing variations (solar, volcanic)
- Reduce uncertainty in projections in the distribution and intensity of American monsoon precipitation and water resources change under a warming climate
- Improve understanding of cloud physical responses and larger scale dynamical feedbacks from aerosols (from dust and biomass burning) on monsoon behavior (onset, rainfall character)
- Improve quantification of the role of the monsoons in global carbon cycle (role of monsoons in evolving ecosystems and agriculture)
- Improve understanding of the predictability of the monsoon.
- Extensive work to generate new findings on the relationships between sea surface temperature variability in the Caribbean and tropical/sub-tropical Atlantic and weather and climate processes in North America through the VAMOS Intra-America seas Study of CLimate Processes (IASCLiP) Project.

- Continued challenges in CMIP5 generation models to properly simulate the magnitude and extent of the Atlantic Warm Pool (AWP).
- Relationship between AWP and severe weather and climate extremes such as tornados, tropical storms and drought in North America.
- Ongoing development of the GPS-precipitable wáter observation networks in the Caribbean ('COCNET') and over Mexico ('Tlaloc-NET'). The COCNET continues to expand its spatial extent and number of stations and the data is currently being collected by UNAVCO and passed on to the global telecommunications system for operational data assimilation by NOAA.
- Evolving the final plan for Tlaloc-NET, an experimental GPS network has been deployed during the summer of 2013 in northwest Mexico.
- Research evaluating the impact of those temporary observations on model analyses during the North American monsoon is ongoing by groups in Mexico and at the U. of Arizona.

d) VAMOS Ocean-Cloud-Atmosphere-Land Study (VOCALS) continues to generate new scientific results on the topics of cloud-climate interactions, small-scale upper ocean dynamics and aerosol indirect effects

- The project is in the final stages of data analysis and synthesis, model-evaluation and experimentation.
- Field activities completed in 2008/2009 with the Regional Experiment (VOCALS-REx), but the WHOI/IMET mooring continues to operate and provide new insights into lower atmosphere and upper ocean properties.

e) VOCALS Scientific Legacy

- In total, over 100 publications trace their roots to VOCALS, including 50 in a special issue of the EGU journal Atmospheric Chemistry and Physics that was set up as a focal point for post-field publications.
- Several papers have been written synthesizing various observational datasets with specific focus on producing integrated datasets for model evaluation. These including documentation of the aerosol, cloud and boundary layer transitions from the coast to the remote ocean, surface and the upper ocean energy budget at 20S, 85W.
- Through the decade-long intensive study under VOCALS, the Southeast Pacific stratocumulus cloud sheet has now arguably become the most well-understood of all of the subtropical stratocumulus sheets.
- The region is now understood to be a key modulator of tropical precipitation across the Pacific through the effect of clouds and the upper ocean on sea-surface temperature.
- VOCALS is also revealing extremely strong two-way interactions between aerosols and low clouds that have global importance.

f) US CLIVAR Eastern Tropical Oceans Synthesis (ETOS) Working Group

- Initiated in January, 2012, with the goal of maintaining scientific inquiry into southeast Pacific Ocean cooling processes building in part on VOCALS and extending the inquiry to Atlantic tropical SST bias issues. Their scientific objectives include:

    - Promote collaboration between observationalists and modelers, and atmospheric scientists and oceanographers, active in the southeast oceanic basins.
    - Coordinate a model assessment of surface flux errors for the equatorial Atlantic, mining all available observations.
    - Identify recent model improvements and common and persistent model errors both, CMIP5 and higher-resolution coupled models.
    - Provide recommendations of cases for community simulation and evaluation using eddy-permitting ocean models, sharing specified model conditions and output datasets.

- The largest SST biases occur in the southeast Atlantic. Two current European-funded field campaigns are focused on understanding the southeast Atlantic oceanography, understanding the physical causes to the SEA SST bias, and their connection to the tropical Atlantic SST biases. These studies are the Southwest African Coastal Upwelling Study or SACUS, and Enhancing Prediction of Tropical Atlantic Climate and its Impact or PREFACE.
- Proposals for three atmospheric field campaigns were being developed, with submission dates in January, 2014. These are CLARIFY in the UK with Jim Haywood as PI; ORACLES is a NASA proposal being led by Jens Redemann, and ONFIRE is an NSF proposal coordinated by Paquita Zuidema.
- ETOS interests intersect with those of the sunsetting VAMOS panel, the Atlantic panel, and the incipient CLIVAR/GEWEX Monsoons panel.
- The equatorial SST distribution feedbacks with the equatorial winds and the Amazonian/Congo monsoonal precipitation.
- ETOS interests also overlap with those of the IASCLIP project through a common interest in Amazonian convection and the Atlantic Warm Pool, with efforts to better understand the causes underlying CGCM tropical SST biases also contributing to IASCLIP goals.
- ETOS is a US CLIVAR WG and as such is programmatically separated from International CLIVAR. However, the new process studies processed for the tropical/southeast Atlantic are highly relevant to both the Atlantic panel and the new MP panel.

2. Implementation of the CLIVAR Research Foci/WCRP Grand Challenges

a) VAMOS members D. Gochis, H. Berbery, R.Arritt and VAMOS ICPO contact C. Ereno have taken part of the CLIVAR Research Foci development team on Predictability of monsoon systems and involved in developing a document on the key priority science questions and associated background.

b) VAMOS member B. Kirtman is taking part of the CLIVAR Research Foci development team on Decadal variability in the climate system and its predictability

c) VAMOS panel has provided feedback to the proposal for a CLIVAR/GEWEX Monsoons Panel, including recommendations on its structure and Terms of Reference for their proposed activities

d) VAMOS co-chair H. Berbery attended the Joint Meeting of the World Climate Research Programme (WCRP) Global Energy and Water Exchanges (GEWEX) Project Hydroclimatology (GHP) and Data and Assessments (GDAP) Panels held in Rio de Janeiro, September 2013.

e) VAMOS co-chair D. Gochis attended the GEWEX Scientific Steering Group meeting (SSG-26) held in Boulder, Colorado, October 2013.

3. Knowledge Sharing

a) Joint Edition of the Newsletter of the Climate and Oceans: Variability, Predictability and Change Project (CLIVAR) Exchanges and the CLIVAR Variability of the American Monsoon Systems Panel (VAMOS) devoted to VAMOS Transitions. *Exchanges No. 63 (Vol18 No.3)-VAMOS! No. 9, December 2013*

b) A summary of the VOCALS field activities and hypotheses was published and an overview of the science findings has been published in BAMS, *Volume 95, Issue 3 (March 2014)*

c) As reported in section 1, VAMOS panel member P. Zuidema is contributing to the US CLIVAR Eastern Tropical Oceans Synthesis (ETOS) Working Group.

4. Capacity Growth and Transfer

a) A coordinated effort to pursue Vulnerability, Impacts and Adaptation studies in the region has being developed in partnership with the WCRP, to hold the two VAMOS/CORDEX workshops. A first training workshop was held at the Instituto Geofísico del Peru, in early September, 2013. The second workshop, focused on Central American and the Caribbean, was hosted by the Oficina Nacional de Meteorologia, Dominican Republic, in April 2014.
The training activity was developed along training sessions with the main aim of training the participants to gain a deeper understanding of approaches for developing useful climate-relevant messages for policy development. The goal of the training activity was to develop key, actionable statements based on case studies identified by sub-groups, based on the participants' expertise.

b) Early career and young scientist were encouraged to attend the WCRP Conference for Latin America and the Caribbean, held in Montevideo, March 2014. The posters presented by students and early career scientists (ECS) were evaluated by a group of senior experts, and 10 of them were selected to receive the WCRP best poster award.

c) During the Montevideo Conference the students and ECS met at lunch to discuss how to contribute to the main objectives of the conference while continuing developing their own careers. Their views articulated

in front of the entire audience contained interesting points to be taken into consideration as outcomes of the conference.

d) Two main capacity building activities has been encouraged by the panel, the support for students and young scientists' participation in workshop and meetings, and expert visits to Central American and Caribbean countries as part of the IASCLiP project.

e) VAMOS has also addressed some outreach activities through the VAMOS list, and published a Joint Edition of the CLIVAR Exchanges and the VAMOS! Newsletter, No. 9, December 2013.