

## Decadal climate variability and predictability\*

To address the challenges and advancement in modern climate research, a workshop on the decadal climate variability and predictability (DCVP) was held recently. The main objective of this workshop was to integrate expert scientific opinion in making use of updated observational records and state-of-the-art coupled climate models to understand the slowdown in the rate of global surface temperature change since the late 1990s, and make timely progress to identify and address these climatic events.

The event included five days of lectures/presentations followed by four days of training activity for students and early career researchers. The training activity comprised of an introductory overview of DCVP experiments followed by intensive hands-on experiments on the analysis of CMIP5 as well as running/tuning of the fast intermediate complexity models such as Speedy and IICM developed by the Earth System Physics (ESP) section of the Abdus Salam International Centre for Theoretical Physics (ICTP), Trieste, Italy. Nearly 150 scientists, climate experts and young researchers gathered to discuss the progress, opportunities and challenges in climate research with a focus on DCVP that plays a key part in the earth's climate system for better understanding of the climate variability, predictability and change. The principal themes of the workshop were general introduction to decadal climate variability, the Cryosphere and DCVP, Atlantic decadal variability, Pacific decadal variability, the recent

Hiatus and the Atlantic/Pacific decadal variability connection, monsoon variability and teleconnections, decadal climate variability and predictability: challenge and opportunity as well as connecting palaeo-modern data to understand the past, present and future climate variability and predictability. A total of 62 oral and 53 poster presentations were made covering the prescribed principal themes of the workshop. The opening session included the welcome note of In-Sik Kang (Seoul National University, Republic of Korea) followed by an introductory note on ICTP and ESP by Filippo Giorgino (ICTP, Italy), workshop objectives and the CLIVAR-DCVP research objectives by Yochanan Kushnir (University of Columbia, USA), and an overview of post-workshop training activity by Fred Kucharski (ICTP).

In his welcome address, Kang mentioned that the workshop will provide an opportunity to discuss the WCRP grand challenge for understanding palaeoclimates and DCVP. Giorgino reviewed the main areas of ESP, which include anthropogenic climate change, climate impacts on society and ecosystem, chemistry–climate interaction and air quality, structure and deformation of lithosphere, earthquake, tsunami and volcano physics, oceanography and ocean–climate interactions, biosphere–atmosphere interactions, seasonal to inter-annual climate predictability, natural climate dynamics and variability, and computational earth system modelling. Kushnir presented the decadal climate variability (DCV) impacts on humans and the environment by explaining the core issues of natural and anthropogenic climate change. He also presented evidences that the North Atlantic, North Pacific and the Southern Ocean are regions of high inter-decadal and longer timescale variability, while it is relatively weak over land. Commenting on the workshop objectives, he explained that CLIVAR DCVP seeks to characterize the multi-year to multi-decadal variability of climate system in response to internal process, and natural and anthropogenic forcing as well as their interactions, and to determine and understand the phenomena, their govern-

ing mechanisms and impacts through diagnostic analysis and modelling, to use them for societal benefits.

The first four days of the workshop consisted of seven lecture and two poster sessions. Session 1 was dedicated to a general introduction to DCV in which Mojib Latif (GEOMAR, Germany) discussed about DCV and its challenges, while Rowan Sutton (University of Reading, UK) threw light on DCV attribution and prediction. Edwin Schneider (George Mason University, USA) spoke on climate shift and its role in decadal to centennial variability. Ed Cook (University of Columbia, USA) explained DCV during the last millennium with the help of high-resolution proxies like tree-ring dendrochronological records as well as the related mathematical models. Other important talks included a discussion on the consistency between planetary energy balance and ocean heat storage by Karina Von Schuckman (MERCATOR, France) as well as the determination of forced aspects of DCVP by Gavin Schmidt (NASA GISS, USA) and the brainstorming presentation on volcanically forced DCV by Davide Zanchettin (University of Venice, Italy). In his talk, Zanchettin emphasized on strong historical explosive volcanic eruptions and their decadal climatic impact by showing evidences from reconstructions and ensemble climate model simulations. Clara Deser (NCAR, USA) presented an overview of DCV in the historical records. Roxy Mathew Koll (Indian Institute of Tropical Management, Pune) highlighted the interplay between the Indian Ocean, ENSO and monsoon, and its climatic impact over the Asian domain in warming the environment.

The poster sessions covered a wide variety of climate-related topics dealing with palaeoclimatic reconstructions and their possible relation with present-day DCVP. Prakasam Muthusami (Wadia Institute of Himalayan Geology, Dehradun) discussed multi-centennial climatic variability from Tso-Moriri Lake, NW Himalaya, India. Sivachandran Alagudurai (Bhartidasan University, Tiruchirappalli) discussed the high-resolution planktonic foraminifera records of Indian

\*A report on the 'CLIVAR-ICTP Workshop on Decadal Climate Variability and Predictability (DCVP) 2015' held at the Abdus Salam International Centre for Theoretical Physics (ICTP) Trieste, Italy during 16–24 November 2015 and organized by ICTP in association with Climate Variability and Predictability (CLIVAR), NOAA (National Oceanic and Atmospheric Administration, US Department of Commerce) and PAGES (Past Global Changes) and both parts of this scientific event (lectures and lab sessions) were co-sponsored by World Climate Research Programme (WCRP), The Chinese University of Hong-Kong, Institute of Environment Energy and Sustainability (IEES).

summer monsoon (ISM) variability from the southeastern Arabian Sea. Feba Francis (University of Hyderabad) highlighted returning to the weakening teleconnections of Tropical Pacific and ISM/Rainfall. Syed Azharuddin (Birbal Sahni Institute of Palaeobotany, Lucknow) presented the high-resolution palaeoceanographic record off Saurashtra, NE Arabian Sea.

The workshop concluded with the overview of CMIP6 Pace Maker experiments by Christophe Cassou (CERFACS, France).

The workshop was followed by four days of training activity to run certain simulation experiments on the CMIP5 model. The results obtained using ICTP-SPEEDY model showed that ENSO impacts are relatively stronger over the Inter Tropical Convergence Zone region compared to extra-tropics and high-latitude regions. Positive phase of ENSO causes weakening of rainfall over Africa and East Asia, whereas La Nina phase produces more rain over these regions, particularly in the winter season. Model results further reveal that ENSO has

stronger impact over South Asia, particularly over the Indian region because of its strong impact over the Indian Ocean and Bay of Bengal through Walker circulation. Results of geopotential height changes and wind vector at 850, 500 and 250 hPa further reveal that ENSO significantly impacts Hadley circulation. Positive phase of ENSO (El Nino) weakens the Hadley cell, whereas negative phase of ENSO (La Nina) causes strengthening of the Hadley cell. This ENSO-induced strengthening and weakening of the Hadley cell causes significant impact over Indian monsoon in summer.

The workshop provided an opportunity to the scientists, especially young researchers and students to interact with a galaxy of experts in climate change science from all over the world. Exchange of opinions/suggestions helped the participants, especially the students and young researchers to have a broad idea of the recent developments in present-day science of climate change as well as their correlation with the global climatic events, which could be of help in decoding and verifying the climatic models for

prediction of future climate change, relevant to the society.

ACKNOWLEDGEMENTS. S.A. thanks Prof. Sunil Bajpai (Director, Birbal Sahni Institute of Palaeobotany (BSIP), Lucknow) for permission (BSIP/RDCC/Publication no. 71/2015-16) to publish this report; Dr Pawan Govil and Dr Md. Firoze Quamar (BSIP, Lucknow) for their encouragement. S.A. also thanks to ICTP, Trieste, Italy for fund support. Whereas M.M.D. thanks KAUST, Saudi Arabia for providing financial assistance to attend the workshop.

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## MEETING REPORT

### Asian urban environment and climate change\*

A conference was held to review recent research on the changing environment and atmospheric conditions in growing Asian cities, especially in relation to global climate change, and how these cities may in turn affect regional and global climate, and how changing technologies, transportation systems and planning may mitigate these effects. The following summarizes the presentations made at this conference, with over 40 participants, to highlight the important issues that need to be addressed.

Using over 140 years of observations, Matsumoto (Tokyo Metropolitan Univer-

sity, Japan) found a rise in annual mean temperature of 3°C since 1900 in the Tokyo metropolitan area, compared with ~1.3°C in the rural areas. Extremes of hourly rainfall have also risen. Chen *et al.* (Sun Yat Sen University, China) suggested the use of high-resolution satellite observations to detect extreme local temperatures that could occur at locations with significant features of land use and anthropogenic emissions but that are often missed from standard weather-station data. In another study, Chen *et al.* (Sun Yat Sen University, Chinese Academy of Sciences and NOAA Climate Division, USA) also showed the emissivity of the surface material in urban areas using data from Landsat.

Lagmay (University of the Philippines) described a science-based disaster warning system that provides hazard maps for floods, landslides and storm surges from tropical cyclones. This sys-

tem works through the participation of local people who transmit on-line data about flood levels to a centre where computer models predict the evolving hazard and impact in the affected areas; the warning is then sent back to the local communities.

Hunt *et al.* (University College London, UK) pointed out that with very high temperatures, weak winds driven by deep turbulent convection can vary markedly across the urban area due to surface conditions and density of high buildings, with the maximum towards the downwind part of the city. Li and Fan (University of Hong Kong, Hong Kong, China) found that in Hong Kong, temperatures within the central business district increase rapidly than those outside. The annual average wind speed also decreased until 1995, but has remained relatively steady since then. Using a laboratory model, they found buoyant

\*A report on the conference 4th ANCSST Workshop on Climate Change and Urban Environment organized by the Asian Network on Climate Science and Technology in collaboration with Tsinghua University, China in July 2015 at Tsinghua University, Beijing, China.