WCRP REPORT
World Climate Research Programme

Project Report

Report of the 7th Session of the CLIVAR Indian Ocean Panel

12-14 July 2010, Perth, Australia

March 2013

ICPO Publication Series No. 186
WCRP Informal Report No: 5/2013

CLIVAR is a component of the World Climate Research Programme (WCRP). WCRP is sponsored by the World Meterorological Organisation, the International Council for Science and the Intergovernmental Oceanographic Commission of UNESCO. The scientific planning and development of CLIVAR is under the guidance of the JSC Scientific Steering Group for CLIVAR assisted by the CLIVAR International Project Office. The Joint Scientific Committee (JSC) is the main body of WMO-ICSU-IOC formulating overall WCRP scientific concepts.

Bibliographic Citation
INTERNATIONAL CLIVAR PROJECT OFFICE, 2013:
Variability of the American Monsoon Panel. International CLIVAR
Publication Series No.186 (not peer reviewed).

IOP-7 MEETING
12-14 July 2010, Perth, Australia

1. Members are encouraged to make use of the IndOOS data portal and provide feedback to it (All).
2. Continue to pursue the concept of multi-hazard data buoys through the data Buoy Cooperation Panel and elsewhere. Consider how best to approach this (G. Meyers).
3. Further explore potential to use wave glider to fill the "eastern pole" data gap (G. Meyers)
4. Raise with JCOMM the issue that information about status of IndOOS on JCOMM website is out of date (Y. Masumoto)
5. Circulate initial proposal for funding of potential mooring at 14S, 115E including formally identifying it as a RAMA mooring, with justification and support letter from CLIVAR, if needed. (G Meyers to J Vialard, H Hendon, Y Masumoto and M McPhaden)
6. Explore possibility of Indian ship time to fill the gap following loss of availability of Australia ship time contributing to CINDY (co-chairs)
7. Pursue suggestion of joint SIBER/IOP Workshop on sensor evaluation, configuration and data processing (co-chairs, R Hood)
8. All suggestions for members of the ITF Task Force to be emailed to the IOP Co-chairs, copy to D/ICPO (All IOP members)
9. Explore SCOR interest in joint sponsorship of the ITF Task Force (Y Masumoto, ICPO)
10. Send email to Lisa Beale (co-chair of SCOR Working Group 136 on the Agulhas Current System) and W de Ruijter enquiring, from the perspective of activities under SAMOC, whether the existing arrays to monitor the Agulhas transports include measurements providing the buoyancy input to the Atlantic and if not, whether there are plans are to address this. (Y Masumoto, T Lee)
11. Provide feed-in of Tpny Lee's work to ITF TF, including implications for needed observations (Co-chairs, T Lee)
12. IOP to encourage research to fundamentally understand the role of the Indian Ocean and the West Pacific in biennial variability (co-chairs)

Participants:
IOP members: Ming Feng, Raleigh Hood, Tony Lee, Gary Meyers, Yukio Masumoto, Debasis Sengupta, Fadli Syamsudin, Jerome Vialard, Weidong Yu,
(Apology for absence: Charles Magori, Jay McCreary, Mike McPhaden, VSN Murty, Gabe Vecchi, Will de Ruijter, Lisan Yu)
Invited experts: Ken Ando, Tony Elliott, Harry Hendon, M. Ravichandran, Sidney Thurston, Kunio Yoneyama
Observer: Eric DeWeaver
ICPO staff: Howard Cattle
IOC Perth Office: Nick D'Adamo

Howard Cattle, Director of the International CLIVAR Project Office, welcomed all participants, who introduced themselves. Weidong Yu and Yukio Masumoto, IOP co-chairs, also welcomed members and gave an overview of the how the meeting would be structured. IOP-7 was held in conjunction with IO-GOOS and SIBER-SSG meetings, which have then been followed by the first IndOOS Resource Forum (IRF). Dr. Shailesh Nayak, Chair of IRF, gave an overview of India's support in the coordination and implementation of international SIBER activities. Howard Cattle reported to all participants on the outcome of the last CLIVAR SSG meeting (SSG-17), which was held in Boulder, CO, USA in May 2011. The SSG has started discussions regarding the new structure of CLIVAR post 2014. The CLIVAR Imperatives will be developed and be made available to the entire CLIVAR community. The meeting report can be found on http://eprints.soton.ac.uk/178081/

Dr. M. Ravichandran has presented "Long term measurements of currents in the equatorial Indian Ocean through deep-sea current meter moorings – a contribution to RAMA" on behalf of Dr. V S N Murty, NIO, India. He has shown the present status of 3 existing deep-sea moorings at 77 E, 83 E and 93 E along the equator. He also mentioned that 4 additional moorings were established at 77 E and 93 E north and south of equator and hence India's OOS deep-sea moorings increased to the total of 7. All the 7 moorings will be recovered in Setp/Oct 2010 using onboard ORV Sagar Kanya. He reported that Observed zonal currents from RAMA moorings at 77E, 80E, 83E, 90E and 93E show consistency and coherence during 2004-06. Distinct variability is noticed from the central Basin (77E, 80E and 83E) to the eastern basin (90E, 93E). Zonal currents at deeper depths are out of phase with those at surface. Similarly, the deeper depth zonal currents are out of phase with the measured temperature. Semi-annual wave amplitude is weak in the eastern basin. Upward phase propagation of semi-annual wave is noticed. In 2008, eastward flowing spring jet is strong at 93E and the eastward flow persists for a longer period till Nov. 2008.

Dr. K. Ando introduced the recent effort by JAMSTEC to develop the RAMA array. JAMSTEC could deploy one new site at 8S95E as the third site in JAMSTEC surface buoy sites in RAMA. This surface buoy consists a part of the 8S mooring line from 55E to 105E for monitoring and understanding oceanic Rossby wave, SST variations, and air-sea interaction. Dr. Ando also reported several failures and evidences of vandalism on our buoy system experienced during the cruise in November 2009.

Dr. M. Ravichandran presented the current status of Argo floats in the Indian Ocean. He mentioned that there are 680 floats are active in the total Indian Ocean and about 416 floats in the north of 40 S. About more than 80 floats to be deployed in the Indian Ocean was delayed due to Pressure sensor problem. Pressure offset correction in real-time data has been corrected for more than 90% of the floats and more than 60 % of the floats were done with delayed mode QC and remaining will be completed before Dec 2010. About 15 floats were deployed with Iridium communication to acquire higher vertical resolution of temperature and salinity and more than 20 floats with oxygen sensors in the Indian Ocean. He mentioned that though the required number of active floats meets the Argo design criteria of one float in 3x3 deg box in the Indian Ocean, there are some gaps where there is no floats exists. He also mentioned that Argo float information is available in Google earth and data download site for the Indian Ocean from INCOIS website and for the global ocean from Coriolis data center or US GOADE website. He also shows the new Live Access Server, where in users can access Indian Ocean Argo Gridded data sets.

He also presented the status of IndOOS portal. This portal is built on distributed network of data archives and provides both direct binary accesses to data via OpeNDAP and ftp protocols. It has web based browsing, live access server (LAS) and data discovery. Data archives are maintained by the individual groups in IndOOS at their institutes. However, satellite data (wind, SSHA, SST and chlorophyll) are available in LAS for the Indian Ocean region. The primary data consists of all in-situ systems and secondary data set consists of products and satellite data are available in the IndOOS data portal. He also mentioned the present status of the centralized data system, being developed at INCOIS, where users can access data at one place with single or multiple format by parameter wise or platform wise. He requested members to access this portal and send their feedback to improve the same.

Dr. Ming Feng has reviewed some recent observations in both tropical Pacific and southeast Indian Ocean and pointed out a strengthening of the Pacific subtropical cells (STCs) since the early-1990's has reversed a multi-decadal weakening tendency. Stronger STCs correspond to a stronger Leeuwin Current in the southeast Indian Ocean (SEIO) and a stronger Indonesian Throughflow, due to dynamic connections of the Pacific and SEIO through equatorial and coastal waveguides. Multi-decadal trends of the STCs and their influence on the SEIO have confounded the detection of human induced global change signals in the short instrumental records of the two circulation systems. Multi-decadal trends in the interior Indian Ocean was also discussed.

Dr. Y. Masumoto presented status and recent progresses on observational activities around the region of Agulhas Current system on behalf of Dr. W. de Ruijter. LOCO mooring array has been measuring transports and their variability in the Mozambique Channel since 2003. Time mean transport during a period from 2003 to 2009 is 16 Sv southward with 14.3 Sv standard deviation. The mean transport is larger before middle of 2006 (13.7 Sv) with smaller standard variation (17.5 Sv) compared with those after mid-2006 (18.2 Sv and 11.2 Sv, respectively). Relations of these transport variations with the climate modes in the Indian Ocean as well as those in the other basins should be investigated in detail. In addition, Agulhas Current Time-series (ACT) array was deployed in April 2010 off the coast of southeastern South Africa, and LOCO-East Madagascar Current mooring array will be deployed in September 2010, using the ASCLME cruise. This is another good collaboration with ASCLME, besides ASCLME collaboration with NOAA/PMEL.

The first meeting of SCOR working group 136 on the climate importance of the great Agulhas system, co-chaired by Drs. Lisa Beal and Arne Biastoch, was held in February 2010 just before the AGU Ocean Sciences Conference in Portland, Oregon. Current and future observational and modeling activities related to the working group were discussed. A new observation using an additional mooring along the ACT line was emerged from the working group discussion. The working group also discussed about writing a review paper on the topic. A meeting summary report was published in EOS (Vol.91, no 18, 4 May 2010).

Ming Feng introduced some of the active WA IMOS programs in the Leeuwin Current system off Perth and west coast of Australia, including a shelf mooring array, 3 reference stations, a repeated glider survey, and Radar systems. These systems have been operating for the last two years. He also introduced the new initiatives in the northern Australia to monitor the volume and heat transports of the Indonesian Throughflow and related shelf current. A proposal to deploy the 25S RAMA mooring, led by Prof. Bindoff from University of Tasmania, is being reviewed by the Southern Surveyor committee, and there has been discussion within Australia community on the best options for Australia to contribute to the RAMA array.

Despite its importance of Indonesian throughflow (ITF) in local, regional, and global climate systems and their variability, our understanding of ITF is rather limited due to difficulties in observations and accurate modeling. Dr. Y. Masumoto introduced an idea of the ITF Task Team, whose proposal is being written with Pacific Panel and will be submitted to CLIVAR SSG by the end of 2010. Aims of

the Task Team would be 1) to review the current understanding and uncertainty in ITF and Indonesian Sea variability and their influence on climate variations, 2) to facilitate collaborations between existing and planned observational and modeling studies to minimize the gaps in the research and maximize the scientific outcome, and 3) to develop strategy to monitor ITF for long term. IOP is strongly supportive of the idea and agreed to provide names of possible member of the Task Team.

Dr. D. Sengupta reported their recent work on construction of a daily surface flux dataset covering 2003-2007 over the tropical Indo-Pacific ocean based on satellite data. The radiative fluxes are incoming shortwave and longwave radiation from ISCCP FD. Outgoing longwave radiation and latent and sensible heat fluxes use TRMM-AMSRE SST, AIRS surface air temperature and humidity, and QuikSCAT scatterometer winds. The surface fluxes have low bias compared to RAMA buoy data, and good representation of intraseasonal variability. They are now studying intraseasonal heat balance using the flux dataset.

Dr. J. Vialard presented his recent work on evaluation of surface fluxes in the tropics and introduction of a new product. The aim in their work (Praveen Kumar et al. 2010) is to evaluate several timely, daily air-sea flux products (NCEP, NCEP2, ERA-I, OAFlux) against observations from the global tropical moored array, and to present the new Tropflux product. Validation of basic meteorological variables used as an input for bulk turbulent flux estimates (sea surface temperature, air temperature and humidity at 2m height and wind at 10m height) showed the recently released ERA-Interim data generally captures best the temporal variability despite some systematic bias and underestimation of variance. The shortwave variations from the various re-analyses are generally inferior to those from the ISCCP project. The longwave radiations from all sources have low correlations to mooring observations (0.3 to 0.6) with ISCCP and ERA-I performing best.

The TropFlux dataset is a daily dataset on a 1° grid for the 30°N-30°S band. Tropflux turbulent fluxes are computed from the COARE v3 algorithm and bias and amplitude-corrected ERA-I input variables (on the basis of mooring data). Wind speed was corrected to take mesoscale wind gustiness into account, based on the line fit between climatological SST and gustiness values estimated from mooring data. We use bias and amplitude corrected ERA-I surface net longwave radiation. Surface net shortwave radiation are based on ISCCP, with an amplitude-corrected mean seasonal cycle. The evaluation of the resulting fluxes show that TropFlux is superior in quality in comparison with NCEP, NCEP2, ERA-interim and is of the same quality as that of OAFlux. The timeliness of the Tropflux product being limited by the availability of ISCCP products, we complete the timeseries by using a "near realtime" estimated from outgoing longwave radiation non-seasonal anomalies. The near realtime mode shortwave data performs well over convective regions but underestimates variability significantly over the cold tongue.

Dr. J. Vialard summarized the results of two studies (Jayakumar et al. 2010ab) which address the processes of the SST signature of the madden Julian-Oscillation a) during winter over the thermocline ridge region and b) during summer in the Northern Indian Ocean. Observations show that Ekman pumping does not contribute on average too intraseasonal SST variations due to the MJO over the thermocline ridge. Model experiments which compare favourably to observations further show that heat flux contributes to 70% of SST intraseasonal variability in the thermocline ridge region (with shortwave variations explaining ¾ of this heat flux contribution), while wind stress (entrainment, mixing and Ekman pumping) contributes only to 19%. There are large year-to-year variations of these two contributions, though, with wind stress sometimes becoming equivalent or slightly larger than heat fluxes, for example in 2001 and 2002. We further demonstrate that interannual modulation of the thermocline depth contributes to only 30% of the variations of the intraseasonl SST amplitude, mainly by changing the temperature of water entrained into the mixed layer. The main factor explaining year-to-year changes in the amplitude of the SST response is the characteristics (amplitude and timescale) of the MJO air-sea flux perturbations.

In summer, we show that, in addition to the already well-studied intraseasonal SST variations in the Bay of Bengal, there are SST variations of equivalent amplitude in the Arabian Sea. Along with the northward propagation of the atmospheric intraseaosnal perturbation, SST anomalies ~0.4°C develop

first near the tip of India, then in the Somalia upwelling, then in the northern Bay of Bengal and finally in the Oman upwelling. The air-sea flux perturbations amplitude are significantly smaller in the Arabian Sea (~10 Wm-2) than in the Bay of Bengal (~30 Wm-2) pointing to a larger role of atmospheric dynamics in this basin. This is confirmed by modelling experiments, which suggest a much larger contribution of oceanic processes in the Arabian than in the Bay of Bengal, and a significant contribution from internal oceanic variability in the Somalia upwelling region.

Yukio Masumoto led the discussion on the possibility to organize a workshop on the Indian Ocean climate variations are discussed. An original idea of such a workshop came from CLIVAR SSG, considering recent progresses of IndOOS, numerical modeling, and climate variability researches that use IndOOS data and/or model outputs. One possibility would be to have a workshop on Indian Ocean modeling, covering wide spectra of phenomena appearing in the Indian Ocean, since it has been a long time since the last Indian Ocean modeling workshop held in Honolulu, Hawaii in 2004. Another one would be a workshop focusing on the Indian Ocean Dipole (IOD) events and their observations, mechanisms, predictions, predictabilities, and application of predicted outputs. IOP members agree that the workshop is timely and important step forward for better understanding of climate variations in the Indian Ocean. At the same time, they also suggested that the workshop should be well focused in terms of the topics to stimulate good discussions. With these discussions, IOP recommended to organize an IOD workshop during the last half of 2011 or early 2012 and to make a small organizing group. Details of the workshop will be discussed in the organizing group.

Recently, there are several research activities on decadal and multi-decadal climate variations and their relation to the global climate change in the Indian Ocean sector. Based on a comment from Dr. Gabe Vechhi, IOP explored opportunities to write a review paper on this topic and submit it to a peer reviewed journal. The topic is strongly relevant to IndOOS activities, and such a review paper would be useful to summarize our present understanding of the topic and future direction for increase our knowledge on the longer time-scale variations in the Indian Ocean. Lead author(s) and contributors will be determined in the next several months using e-mail correspondences.