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DATA BUOY COOPERATION PANEL

**RECOMMENDATIONS OF THE FOURTH CAPACITY
BUILDING WORKSHOP OF THE DBCP FOR THE NORTH
PACIFIC OCEAN AND ITS MARGINAL SEAS (NPOMS-4),
BUSAN, REPUBLIC OF KOREA, 2-4 NOVEMBER 2015**

***Application of Regional Ocean Observations for
Increasing Society's Understanding and Forecasting
of Typhoons***

Report Editors:
Etienne Charpentier - WMO
Sidney Thurston - DBCP

DBCP Technical Document No. 55

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NPOMS-4 Group Photo

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Application of Regional Ocean Observations for Increasing Society's Understanding and Forecasting of Typhoons

Hosted by
Ocean Science and Technology (OST)-School
Korea Maritime and Ocean University ([KMOU](#))

Busan, Republic of Korea

Venue: Ocean Science and Technology Building (D1) 100 Hall
Busan, South Korea

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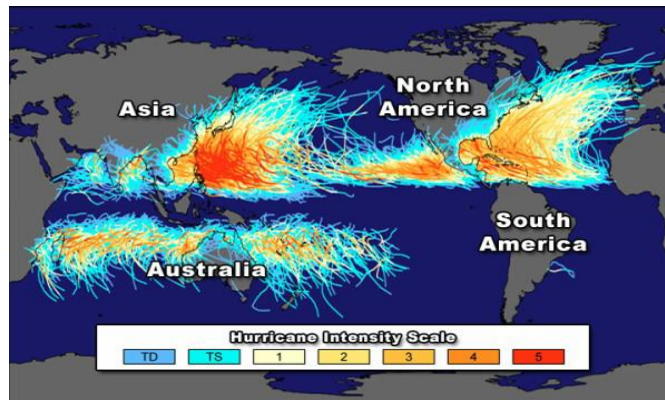
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WORKSHOP REPORT



NPOMS-4 is a Workshop in a Series of IOC/WMO JCOMM [PANGEA](#) Workshops:

- [1st Western Indian Ocean Capacity Building Workshop](#)
- [2nd Western Indian Ocean Capacity Building Workshop](#)
- [3rd Western Indian Ocean Capacity Building Workshop](#)
- [4th Western Indian Ocean Capacity Building Workshop](#)
- [1st In-Region Capacity Building Workshop for Asian Countries](#)
- [2nd Typhoon Workshop for the North Pacific Ocean and Marginal Seas \(NPOMS-2\)](#)
- [5th Western Indian Ocean Capacity Building Workshop](#)
- [3rd Typhoon Capacity Building Workshop for the North Pacific Ocean and Marginal Seas](#)
- [1st Pacific Islands Training Workshop on Ocean Observations and Data Applications](#)

NPOMS-4 was Co-Sponsored by the IOC/WMO Data Buoy Cooperation Panel ([DBCP](#)) and NOAA's Office of Climate Observation ([OCO](#)), and generously hosted by the Ocean Science and Technology (OST)-School, and the Korea Maritime and Ocean University ([KMOU](#)). The Terms of Reference of the workshop are provided in [Annex 4](#). The composition of the Organizing Committee is provided in [Annex 3](#).

Thirty participants from ten Northeast Asian countries participated at the workshop (see list of participants in [Annex 2](#)).

The workshop was chaired by Dr. Sid Thurston, chair of the DBCP Task Team on Capacity Building. After the opening remarks with keynotes from the President of KMOU, Dr Han-il Park, the WESTPAC representative, Dr Youn Ho Lee, and the WMO Secretariat representative, Mr Etienne Charpentier, series of presentations were made, interleaved with key discussions on the workshop's theme, Application of Regional Ocean Observations for Increasing Society's Understanding and Forecasting of Typhoons. The following sessions took place (see complete agenda in [Annex 1](#)):

1. Session 1: Reviews of Relevant Research Programs and Regional Studies, chaired by Dr. Sid Thurston;
2. Session 2: Technology of Ocean Data Buoys, Applying Ocean Observation to Typhoon Research and Forecasts, chaired by Prof. Scott Glenn;
3. Session 3: Understanding the Processes and Mechanisms of Typhoon-Ocean Interaction, Concluding Remarks, chaired by Dr. Joe Cione.

A round table discussion was organized during Session on Designing the Optimal Ocean Observing System for NPOMS Cyclogenesis Forecasting - Continuation from [NPOMS-3](#) (Kyoto) and [NPOMS-2](#) (Hangzhou, [Report](#)).

Following these discussions, the workshop made 17 recommendations, which are listed in [Annex 5](#).

The participants wished to recognize with sincere gratitude the kind and warm hospitality and support of our Local Hosts the Ocean Science and Technology (OST)-School, and the Korea Maritime and Ocean University ([KMOU](#)). Specifically we offer our sincere gratitude for the tireless efforts of KMOU Professors Cheol Huh and Hyeong-Seog Kim. Kamsahamnida.

ANNEX 1

FINAL NPOMS-4 WORKSHOP AGENDA

(Note: Each Presentation Includes 10 Minutes for Q&A)

TIME	SUBJECT	LEAD
Day 1: Monday 2 November Opening Day Remarks, Reviews of Relevant Research Programs and Regional Studies Chair: Sidney Thurston Rapporteur: Byung-Gul Lee		
09:30-10:00	Opening Ceremony VIP addresses	Han-il Park – President KMOU Youn Ho Lee - WESTPAC
10:00-10:30	Changes in Tropical Cyclone Season in Western North Pacific Associated to the Tropical Sea Surface Temperature	Hyeong-Seog Kim (KMOU)
10:30-11:00	The 1st-ever Successful Flight of an Unmanned Aircraft Deployed from a Manned Aircraft Into a Major Hurricane (Edouard, 2104)	Joe Cione (NOAA Hurricane Research)
11:00-11:30	Tea Break & Group Photography – All Workshop Participants	
11:30-12:00	Shift in Tropical Cyclone Lifetime Maximum Intensity	Doo-Sun R. Park (Seoul National University)
12:00-12:30	WIGOS Prep-Operational Phase (2016-2019) following WMO 17th Congress Decisions	Etienne Charpentier (WMO)
12:30-13:00	Stratified Coastal Ocean Interactions with Tropical Cyclones	Scott Glenn (Rutgers COOL)
13:00-14:00	Lunch	
14:00-14:30	DMH Early Warning System and Case Study of KOMEN Cyclone	Thandar Aye (Myanmar)
14:30-15:00	DBCP Activities and its Benefits to the Region	Chompika Gallage (DBCP)
15:00-15:30	WESTPAC/DBCP <i>TC-Ocean</i> Working Group: A Prospectus	Sidney Thurston (DBCP)
15:30-16:00	Afternoon Tea Break	
16:00-16:30	China National Report	Liangxun Lin
16:30-17:00	Thailand National Report	Anucha Srerurngla
17:00-17:30	Discussion of Today's Hot Topics	Sidney Thurston (DBCP) Tetsuya Takemi (DPRI)
18:00-	Banquet Hosted by KMOU OST-School (at Commodore Hotel Busan)	

TIME	SUBJECT	LEAD
Day 2: Tuesday 3 November Technology of Ocean Data Buoys, Applying Ocean Observation to Typhoon Research and Forecasts Chair: Scott Glenn Rapporteur: Tetsuya Takemi		
9:00	Daily Planning Objectives: Review from Yesterday	Sidney Thurston
9:00-9:30	The Assessment of Typhoon Hazards at Regional-scales in the Pacific Regions with Downscaling Numerical Experiments	Tetsuya Takemi (DPRI)
9:30-10:00	Indonesia National Report	Gerry Giliant Salamena (LIPI)
10:00-10:30	Update: The Barometer Drifter, A Cost Effective Technology For Providing Sea Level Pressure Observations, and Addressing Multiple Requirements	Etienne Charpentier (WMO)
10:30-11:00	WMO/IOC <i>Partnerships for New GEOSS Applications (PANGEA)</i>	Sidney Thurston (NOAA Office of Climate Observation)
11:00-11:30	Tea Break	
11:30-12:00	Coastal Sediment Resuspension and Transport During Hurricane Sandy and Arthur	Travis Miles (Rutgers COOL)
12:00-12:30	Novel Air-sea and Ocean Observations Collected During Hurricane Edouard (2014)	Joe Cione NOAA Hurricane Research
12:30-13:00	A Long Neglected Damper in the El Niño—Typhoon Relationship: a 'Gaia-Like' Process	I.I. Lin (NTU Via VTC) _____
13:00-15:30	Lunch & Tour of KMOU	
15:30-16:00	Targeted in-situ Tropical Cyclone Observations from Air-deployed Drifters	Luca Centurioni (Scripps Institution of Oceanography)
16:00-16:30	Ocean Data Services at Indian National Centre for Ocean Information Services	Murty Pudipeddi (INCOIS)
16:30-17:00	A Vision of NPOMS Training Center in DBCP	SK Park/BG Lee (PNU)
17:00-17:30	Discussion of Today's Hot Topics	Sidney Thurston (DBCP) Joe Cione (NOAA)

TIME	SUBJECT	LEAD
Day 3: Wednesday 4 November Understanding the Processes and Mechanisms of Typhoon-Ocean Interaction, Concluding Remarks Chair: Joe Cione Rapporteur: Etienne Charpentier		
9:30	Daily Planning Objectives: Review from Yesterday	Sidney Thurston (DBCP)
10:00-10:30	WMO Integrated Global Observing System (WIGOS) Implementation	Etienne Charpentier (WMO)
10:30-11:00	Ocean and Climate	Patricia Ricard (IOPR)/ Francoise Gail
11:00-11:30	Morning Tea Break	
11:30-12:00	Operational Wave and Storm Surge Forecasting System in KMA	Dr. Sung Hyup You (KMA)
12:00-13:00	Round Table Discussion: Designing the Optimal Ocean Observing System for NPOMS Cyclogenesis Forecasting - Continuation from NPOMS-3	Lead: Joe Cione, Scott Glenn – All Workshop Participants Please Prepare
13:00-14:00	Lunch	
14:00-15:00	Round Table Discussion: Designing the Optimal Ocean Observing System for NPOMS Cyclogenesis Forecasting - Continuation from NPOMS-3 (continued)	Lead: Joe Cione, Scott Glenn – All Workshop Participants Please Prepare
15:00-15:30	Workshop Recommendations, Future DBCP NPOMS Capacity Building Workshops, PNU Summer School	Sidney Thurston (DBCP)
15:30-15:45	Closing Remarks	Etienne Charpentier (WMO)
15:45	Conclude the Fourth DBCP NPOMS-4	

ANNEX 2

LIST OF NPOMS-4 PARTICIPANTS

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ANNEX 3

NPOMS-4 ORGANIZING COMMITTEE

1. Cheol Huh (Co-chair) – Korea Maritime and Ocean University
 2. Hyeong-Seog Kim (Co-chair) - Korea Maritime and Ocean University
 3. Sangkil Park, Director "NPOMS Regional Training Center", Pusan National University, Korea
 4. Byung Gul Lee - Chair NPOMS-1, Director Jeju Sea Grant, Korea
 5. Dake Chen, Chair NPOMS-2, Second Institute for Oceanography, China
 6. Tetsuya Takemi, Co-Chair NPOMS-3, Disaster Prevention Research Institute, Kyoto University, Japan
 7. Joe Cione, Senior Research Scientist, NOAA's Hurricane Research Division, Earth System Research Laboratory, USA
 8. I. I. Lin - National Taiwan University, Taiwan, Province of China
 9. Hyo Choi – Wonju National University, Korea
 10. Etienne Charpentier - WMO Secretariat, Geneva
 11. Tom Gross - IOC Secretariat, Paris
 12. Sidney Thurston - DBCP Task Team for Capacity Building, USA
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ANNEX 4

TERMS OF REFERENCE OF THE NPOMS-4 WORKSHOP

The Following Goals and Associated Actions reflect the needs of this NPOMS-4 Workshop and of the long-term Ocean-Climate Monitoring Capacity for Cyclogenesis and Forecasting:

1. Continue to build regional collaboration to improve the implementation of ocean observations for improving typhoon track and intensity forecasts, and estimating the impacts of TCs on ocean environment,
 2. Review recent, on-going and planned regional programs on typhoon and its interaction with the ocean,
 3. Discuss new advances in our understanding of the processes and mechanisms of typhoon-ocean interaction,
 4. Build Regional 1) human, 2) institutional and 3) infrastructure capacity needed to acquire, process and deliver rapid deployment, potentially from aircraft, of operational data buoys, floats, gliders, etc. for the collection of buoy data, and related data management, for improving typhoon forecast accuracy,
 5. Demonstrate the crucial role of ocean observations in the Western Pacific, such as for understanding and predicting regional cyclogenesis,
 6. Continue to Learn Practical Implementation Skills for the Deployment of Operational Data Buoys at Sea, the Collection of Buoy Data, and Related Data Management,
 7. Continue to Align with Objectives of the *Global Framework for Climate Services* (GFCS) and Global Framework for Ocean Observations to Deliver Ocean Data to the End-User,
 8. Enhance Coordination and Cooperation between the DBCP Task Team for Capacity Building (TT-CB), WMO Regional Associations (RA-II/V) and the IOC Sub-Commission for the Western Pacific (WESTPAC).
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ANNEX 5

NPOMS-4 WORKSHOP RECOMMENDATIONS

1. Workshop participants and Members/Member States of the NPOMS region are invited to participate in the DBCP activities, establish partnerships, and build on potential synergies (sharing observing platforms and instruments, deployment opportunities, training opportunities). The Technical Coordinator Champika (cgallage@jcommops.org) is acting as a focal point between all actors involved in buoy activities, and can provide technical assistance and support upon request.
2. Members making relevant ocean observations are urged to comply with existing WMO and IOC data policies ([WMO resolution 40, Cq 12](#)) and share the data in realtime on GTS. In particular, efforts should be made in the NPOMS region to augment the “973 Typhoon Array” met/ocean observing array (of China) with contributions from other countries, and to share the data in real-time (including “973 Array” data). Particularly important variables to measure are Sea Level Pressure (SLP) and upper ocean heat content. Additional variables to measure include air relative humidity, sub-surface currents, and waves.
3. Members in the NPOMS region are encouraged to make use of (i) the **DBCP barometer upgrade scheme** (details below) and (ii) the [DBCP-VOS drifter donation programme](#) (drifter with SLP reporting from the deck of a ship) (the Technical Coordinator of the DBCP can provide technical assistance on how to benefit or participate).
4. NPOMS supports the DBCP efforts to make **wave observations from drifters**. The guidance of drifter communications should be provided. (Note: CMA offered to add additional comments for this recommendation). This can be expanded to all platforms.
5. NPOMS recognizes the importance of training on met/ocean observations requirements and met/ocean observing systems implementation, and **supports the establishment of the NPOMS Training Centre at the Busan National University**, Republic of Korea.
6. **NPOMS support the development of TPOS-2020** project, and is inviting it to take into account the observational user requirements for typhoon prediction.
7. Consider inviting representatives of the data buoy business sector to NPOMS-5.
8. Include a scientific framework in future NPOMS Workshops for risk impacts (risk assessment and economic impacts).
9. KMA has experience with operational ocean models, and marine observations. Korea can assist other countries for setting up infrastructure (e.g. storm surge model), and for training on marine observations. Interested countries in the NPOMS region are invited to use this opportunity. **KMA is invited to cooperate with and contribute to the NPOMS training centre.**
10. NPOMS is inviting National Meteorological Services in the NPOMS Region, and KMA in particular, to make use of the DBCP **SVPB drifter barometer upgrade [scheme](#)**.
11. The [Ocean and Climate Platform](#), working with the IOC to start addressing Capacity building for empowering vulnerable states to engage in ocean observing activities. **It is also recommended that the platform should advocate the making of more ocean observations**, and their use to address mitigation of high impact weather events.

12. **NPOMS-4 recommends merging NPOMS activities with the North Pacific Data Buoy Advisory Panel (NPDBAP) DBCP Action Group**, in order to better build on potential synergies between buoy deployment activities of NPDBAP, and capacity building and network design activities of NPOMS, and assure better continuity and **national representation** of NPOMS countries in all these activities.
13. An important scientific question emerged from NPOMS-4, how important is stratification in the NPOMS region to TC development? To answer this question, more strategic observations are required, to include upper ocean heat content. Observations can also help assessing the impact of warm and cold eddies on intensification of typhoons. **A centralized data centre** should be established to collect data of interest for impact studies. Impact of data should be assessed e.g. through OSEs, hindcast sensitivity studies can also be made, and efforts made to assimilate more of existing impactful data.
14. An in-depth **inventory** of available observing systems should be made (pre-requisite before designing the required observing system). For example, the research community has data, e.g. in the biological community. **NPOMS National Focal points** (Korea, Japan, China, Taiwan-Province of China, Indonesia, Thailand, Philippines and others) are needed for investigating feasibility of such an inventory and coordinating the gathering of initial information. Information should also be collected on possible barriers for sharing the data; and strategies identified for removing such barriers.
15. Members are encouraged to engage and use the [WMO Rolling Review of Requirements \(RRR\)](#) model. Reach out to WMO Commission for Basic System, [WMO Tropical Cyclone Programme](#), and JCOMM Expert Team on Operational Ocean Forecasting Systems ([ETOofs](#)) to address some important and identified science questions for typhoon prediction. Feedback to then be provided to NPOMS.
16. **More communications and cooperation between countries in the region is needed** (e.g. Korea, Japan, China) for better typhoon forecasting and observing systems addressing the corresponding requirements. Members in the NPOMS region are encouraged to **organize a “Fanape typhoon” workshop** looking at the different models used, existing data, impact of data, stratification issue, etc. in the view to make recommendations on how to improve the observing system and data assimilation. **The new NPOMS Training Centre at Pusan National University could play a role in promoting such activities**, and assist developing countries to develop their own typhoon prediction capacity in a way consistent with the requirements of the region. Identify Target Storms to focus the training for modellers.
17. **More Students are encouraged to participate at NPOMS training events and to present results at NPOMS-5.**

