# JCOMM MARINE INSTRUMENTATION WORKSHOP FOR THE

# ASIA PACIFIC REGION

Tianjin, China

11-13 July 2011

FINAL REPORT

JCOMM Meeting Report No. 87

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WORLD METEOROLOGICAL ORGANIZATION

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (OF UNESCO)

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**C O N T E N T S**

## EXECUTIVE SUMMARY

The JCOMM Marine Instrumentation Workshop for the Asia Pacific Region was held in Tianjin, China, from 11 to 13 July 2011 at the kind invitation of the State Oceanic Administration (SOA) and the National Centre of Ocean Standards and Metrology (NCOSM) of China.

The workshop recalled the importance of ocean observations to achieve socio-economical benefits at the global, regional, national, and local (e.g. Tianjin city) levels by addressing the requirements of WMO and IOC Applications, including the Global Framework for Climate Services (GFCS), and working in the multi-disciplinary frameworks of the IOC-WMO-UNEP-ICSU Global Ocean Observing System (GOOS) and the WMO Integrated Global Observing System (WIGOS).

The workshop participants received background information regarding the establishment of IOC-WMO Regional Marine Instrument Centres (RMICs) per Recommendation 1 (JCOMM-III), and in particular the recent formal establishment of the RMIC for the Asia Pacific Region at the NCOSM, Tianjin, China through WMO Resolution 3.1.4/3 (Cg-XVI) and IOC Resolution XXVI-9. A visit of the NCOSM facilities was organized.

The participants acknowledged the need for high quality marine meteorology and oceanographic measurements of the world oceans, and received comprehensive information on instrument standards, instrument calibration and inter-comparisons (for waves observations), real-time and delayed-mode data exchange, Quality Management Systems, and Quality Control best practices for realizing the integration of ocean observations in GOOS and WIGOS frameworks, and achieving the WMO and IOC Applications requirements.

The workshop issued series of recommendations detailed in *Annex V*.

The workshop thanked China, SOA, and the NCOSM for providing such excellent facilities to the countries of the Asia Pacific Region and to their strong commitment to operate the RMIC from now on.

# WORKSHOP REPORT

## *1. International framework*

1.1 The workshop recalled the importance of ocean observations to achieve socio-economical benefits at the global, regional, national, and local (e.g. Tianjin city) levels. In particular, as addressed at the opening session of the workshop by Dr Wenjian Zhang (Director, Observing and Information Systems Department, WMO Secretariat), met-ocean applications provide the means to prevent, mitigate, and adapt to the impacts of ocean phenomena, weather, and climate on the environment and human activities in coastal regions and beyond. These applications include for example weather forecasting and operational meteorology, the monitoring, understanding and prediction of seasonal-to-interannual climate variability and climate change, arising climate services, operational marine services such as the description and forecast of the state of the ocean, including its living resources, and marine meteorology forecasting in support of marine transportation and operations in the open and coastal ocean areas, the safeguard of life and property at sea, the mitigation of damage from natural hazards, and response to marine pollution, the protection and sustainable development of the ocean and marine environment, and the efficient management of marine resources.

1.2 While useful to realize socio-economical benefits, Met-ocean applications rely heavily on *in situ* and satellite meteorological and oceanographic observations. This is achieved by the Members of the World Meteorological Organization (WMO) and Member States of the Intergovernmental Oceanographic Commission (IOC) of UNESCO (IOC) by addressing the requirements of WMO and IOC Applications, and working in a multi-disciplinary framework through the IOC-WMO-UNEP-ICSU Global Ocean Observing System (GOOS) and the WMO Integrated Global Observing System (WIGOS).

1.3 With the implementation of the GOOS and WIGOS during the period 2012 to 2015, the IOC and WMO are making efforts to establish an integrated, comprehensive and coordinated observing system that satisfies in a cost-effective and sustained manner the evolving observing requirements of IOC and WMO Members towards harmonization of instrument practices and related standards, and interoperability between data systems.

1.4 Climate applications, as well as the Global Framework for Climate Services (GFCS) that is now developing is increasing the demand for high quality, documented, and traceable observations of known uncertainty, not only for current observations of newly deployed instruments but also for historical data. The Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) provides an international coordination mechanism for implementing GOOS and the ocean component of GCOS [1], and addressing the required standardization, harmonization, and optimization of ocean observations in their implementation and operations serving the needs of WMO and IOC Members/Member States applications.

1.5 The WMO Sixteenth Congress adopted Resolution 11.3/1 (Cg-XVI), and decided to implement the WMO Integrated Global Observing System (WIGOS) during the next financial period as one of the major efforts of the Organization with the goal that WIGOS should become operational from 2016 onwards. The WMO Sixteenth Congress through Resolution 4.4/1 emphasized the importance of the Marine Meteorology and Oceanography Programme (MMOP), implemented through the work of JCOMM. It noted the long-term objectives of MMOP, including its traditional activities for Maritime Safety Services, as well as the new priorities in the implementation of an integrated marine meteorological and oceanographic observing and data management system. Congress agreed that the MMOP should be strengthened and expanded to address new emerging challenges and issues, especially on Disaster Risk Reduction, Coastal Management and the GFCS. This can only be realized if the required ocean observations are made available to the

1: GCOS : WMO-IOC-UNEP-ICSU Global Climate Observing System

end users with the required data quality and traceability to SI units. The RMIC in Tianjin will be contributing to these developments at the regional level.

## *2. International requirements for ocean observations relevant to the activities of the RMIC for the Asia Pacific Region*

### *Sea level*

2.1 Dr.Kexiu Liu, Professor of the Oceanic Information Center reported on water level observations in China and associated requirements for port and navigation activities, marine forecasting, coastal engineering and MSL research purposes. A brief history of such measurements in the last 100 years, and tide gauge network development since the 1950s was provided, including rapid development since the 1980s. Dr Liu explained the technical standards regulating water level observations in China. Content and types of water sea level observations were detailed. Advice was given on how to select sites, setting the tide gauge well. Different types of tide gauges (float water level gauge, pressure water level gauge, laser water level gauge, tide pole) and observation instrument (pressure tide gauge, acoustic water level gauge, radar water level gauge) were described, as well as the Benchmark system setting. In recent years, more attention has been paid to leveling for tide gauge benchmark in China. Historical information has also been collected. Global Positioning System (GPS) receivers have been installed at some tide gauge stations. GPS data processing research is ongoing. China is leveling benchmark regularly, and special attention is given to the Quality Control of water level data, to find any possible datum changes due to misoperation. The tide gauge network in China contributes to the Global Sea Level Observing System (GLOSS) of JCOMM.

### *Waves*

2.2 Dr Chung-Chu Teng (USA) reported on JCOMM requirements with regard to the calibration of wave measuring buoys. He recalled that Non-directional waves (also called point, one-dimensional, or unidirectional waves) are vertical fluctuations of the water surface at a fixed location or point. Directional waves include information on both the non-directional waves and directionality of the waves. In situ wave measurements are made using different types of measurements, including wave staffs, particle velocity sensors, subsurface pressure sensors, acoustic sensors, wave buoys, etc. For in situ measurements, sensors and instruments need to be installed on platforms to support them when they are making measurements. These platforms can be either floating or fixed. Fixed ocean platforms and the sea floor can be considered as fixed platforms for in situ sensors. Floating platforms include ships, buoys, and surface and subsurface moorings. Dr Teng explained the steps required to obtain wave data from ocean waves using buoys, and explained directional wave analysis. He briefly described the buoy motion sensors, and mechanical wave simulators used at the US National Data Buoy Center (NDBC[2]), and listed the NDBC Wave Measurement Requirements. He reported on general principles for wave data Quality Assurance (QA) and Quality Control (QC) i.e. reasonability, continuity, consistency.

### *Argo Profiling Floats (Temperature, Salinity)*

2.3 Dr Shigeki Hosoda (Japan) reported on Argo international requirements with regard to the calibration of Argo profiling floats. He recalled that the Argo programme receives contributions from over 30 countries/unions. The purpose of the programme is to globally monitoring the interior oceanic change in temperature and salinity associated with climate change. He recalled the Argo data quality requirements (i.e. Pressure: $\pm$ 2.5 dbar, Temperature: $\pm$ 0.005 ºC, Salinity: $\pm$ 0.01 psu). To achieve the purpose of the programme it is necessary to produce higher and uniform quality of data which are kept in the required accuracies in the global ocean. Data quality control including calibration for the Argo floats is very important to recognize biases on the sensors in

2: NDBC is also operating the RMIC for Regional Association IV (North America, Central America, and the Caribbean)

observing automatically at sea. However, the sensor calibration is very difficult, in particular for post-calibration because there are few chances of float recovery during float's lifetime. Therefore pre-calibration at laboratory is necessary to know the status of sensors before deployment and to avoid deployment of floats with biased sensors. He explained the calibration of CTD[3] on Argo floats to achieve the Argo Steering Team's (AST) requirement at the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), including calibration systems used for the temperature and conductivity sensors, judgment of bad conductivity and temperature sensors from the calibration result, pressure sensor checking, and statistical analysis of calibration results. Finally Dr Hosoda reported on exercises to recover floats to estimate salinity sensor bias. Some conductivity sensor problem was also estimated from the calibration process. He briefly mentioned the future trial of Dissolved Oxygen (DO) sensor calibration.

## *3. Regional activities*

3.1 The workshop was briefed by Wenxi Zhu, Head, IOC Regional Office for the Asia Pacific Region, on the development of IOC's Regional Ocean Observing Systems in the Asia-Pacific Region, namely the NorthEast Asian-Global Ocean Observing System (NEAR-GOOS), SouthEast Asian-Global Ocean Observing System(SEAGOOS), and Indian Ocean Global Ocean Observing System (IOGOOS), as well as the complementary role of IOC Regional Network of Training and Research Centers on Oceanography to RMICs. He explained the adaptive approach adopted in the development of different regional ocean observing systems in view of the disparity in ocean observing capacity in different regions. NEAR-GOOS has been developed smoothly among four participating countries (China, Korea, Japan and Russia) with real-time and delayed-mode database systems operating and timely updated and relevant data products developed and put into applications. In term of SEAGOOS, pilot projects titled "Monsoon Onset Monitoring and its Social & Ecosystem Impacts" (MOMSEI) and "Ocean Forecasting Demonstration" were developed recently with objective to demonstrate the value of marine observations for social and economic benefits, ecosystem conservation. MOMSEI aims to improve, from the point of view of ocean-atmosphere interaction, the understanding and forecasting of the Asian monsoon and its multi-scale variability at a regional scale through the development and organization of air-sea observations over the Andaman Sea (AS), Bay of Bengal (BoB) and adjacent waters, and through analyzing the preconditioning role of the ocean in monsoon onset. Ocean Forecasting Demonstration was designed to develop a ocean forecasting system in the South East Asian region, providing crucial information of ocean circulation, sea surface temperature, ocean surface wave, sediment and marine organisms transport (larvae or planktonic form), and also for activities related to oil and gas exploration, fisheries, navigation, marine parks management and coastal recreational activities. Substantial progress has been made on IOGOOS with for example over half of the 'RAMA" deep ocean monitoring array installed in just the past few years, through the joint efforts of all participating countries.

3.2 Mr. Zhu also introduced the IOC's new regional capacity building initiative titled "IOC Regional Network of Training and Research Centers on Oceanography", developed to strengthen the regional capacity in a more sustained and systematic manner through the establishment of a series of training and research centers within these bona fide national marine scientific institutes or universities and the provision of regular training on their areas of specialization to other young scientists from developing countries on a free of charge basis. He highlighted the fundamental role of IOC Regional Subsidiary Bodies, such as IOC Sub-Commission for the Western Pacific (WESTPAC), in the promotion, coordination and implementation of regional programs on marine scientific research, ocean observations and capacity building based on the common interests of member states in the region. He further concluded that there exists possible opportunities for cooperation with the JCOMM RMIC in the light of the substantial ongoing efforts of IOC on ocean observations and related capacity building in the Asia-Pacific Region, and finally encouraged the

3: CTD: Conductivity, Temperature, and Depth probes

JCOMM RMIC for the Asia-Pacific region, once it becomes operational, to contribute to the Regional Network through the provision of technical assistance to member states in the region in inproving their capacity for instrument calibrations and inter-comparisons.

3.3 The Director of NCOSM, Aina WU explained that Ocean observation is a high-risk, high input and high technical activity with participation of many actors in all countries with ocean interest. Because observation method standards promoted in different countries can be inconsistent, and sometimes lack conformity, it can be difficult to share and use observation data between countries. For these reasons, the WMO and IOC, through JCOMM, are actively promoting the standardization aspects of the Global Ocean Observing System. Mrs Wu reported that the establishment of RMIC should strongly contribute to the construction of a global ocean observation quality assurance system. Through the establishment of ocean observation standards, the organization of marine instrument testing and international inter-comparisons, the quality of ocean observation data is expected to improve to provide an effective service and support for addressing response to climate changes, marine disaster prevention, marine research, coastal exploitations and navigation, etc. This is a basic technical work which benefits WMO and IOC Members/Member States, with far-reaching significance. At last she expressed her thanks to the WMO and IOC Secretariats for their efforts in guiding the establishment of RMICs; as well as to the delegations from the Members / Member States of the region for their strong support. She informed the workshop that the NCOSM will hold an RMIC opening ceremony next year, and that she wished the leader of WMO/IOC/JCOMM could attend.

3.4 The Vice Director of the Chinese National Centre of Ocean Standards and Metrology (NCOSM), Jun Sui, introduced the functions of the NCOSM, including a general introduction, its organization, main responsibilities, primary services, and calibration capability. NCOSM, established in 1989, is affiliated to State Ocean Administration (SOA), taking charge of national marine standardization, metrology and quality supervision. It is a legal metrology institution authorized by the Chinese General Administration of Quality Supervision, Inspection, and Quarantine (AQSIQ) and is assessed and accredited every 5 years. NCOSM has been given the accreditation by AQSIQ every time since its establishment. NCOSM takes charge of national marine standardization and management of metrology and quality. The responsibility of the NCOSM is to (i) implement the national technical supervision laws and technical regulations, undertake marine instruments inspection work; (ii) research, establish and maintain the oceanographic special value measurement standard, as well as research and establish the marine instruments verification regulations, national standards and industry standards; (iii) take charge of metrological management and value transfer of oceanographic special value, commit to arbitration test in marine instruments quality dispute and quality inspection entrusted; and (iv) carry out the research on marine instruments testing techniques and methods, guide the quality inspection training. Main services include marine standardization, marine metrology, and marine quality supervision. In terms of capability, NCOSM has more than 100 advanced instruments and facilities produced by China and other countries, mainly used in the following four aspects (i) Marine instruments verification; (ii) Marine instruments calibration; (iii) Environment test of marine instruments; and (iv) Verification of marine reference material production and water treatment facilities. In particular, NCOSM has the capability to perform:

- Temperature calibration
- Salinity calibration
- Pressure test and calibration
- Standard seawater production
- Wave buoy calibration
- Tide gauge calibration
- Test and Calibration of Marine and Meteorological Instruments (temperature, humidity, pressure, wind speed and direction and rainfall)

3.5 Dr Junwu Tang from the National Ocean Technology Center (NOTC) reported on the development of Chinese Ocean Observing instruments and equipment. He reported on the overall Situations of Ocean Monitoring in China, the instruments used onboard different platform types, and provided details on the Regional Integrated Monitoring Systems. It was noted that the China ocean observation and monitoring technology has been greatly progressed over the past 15 years, since it was adopted into the Hi-tech Research and Development Program ("863" Program) in 1996. Over 100 marine observation stations are now maintained in coast and islands, and over 30 radars are distributed in the coastal areas of China. China operates marine research and survey ships (30 SOA units), and 100 Voluntary Observing Ships (VOS). About 50 marine data buoys are maintained in the China Seas. Wave buoys, surface drifters and Argo Floats are also deployed, as well as subsurface buoys and seabed observation platforms. The observing system also includes marine observation satellite (HY-1, HY-2), surveillance planes, and mobile monitoring vehicles. Essential parameters of observations in marine stations include meteorological elements (air temperature, pressure, humidity, precipitation, wind, visibility …), hydrological and oceanographic parameters (sea water temperature, salinity, surface current, tide, wave, turbidity, pH value, dissolved oxygen, chlorophyll-*a* …). He provided some more specific details on the temperature and conductivity sensors used, microstructure shear flow sensors, and ecological sensors.

3.6 Min Li, Professor of the Marine Apparatus Institute of ShanDong Academy of Sciences reported on the status of Oceanic and Atmospheric Observation System in China. Prof Li recalled the importance of ocean and atmosphere observation, and explained in particular that extreme weather and natural disasters resulted in serious damage for human life and property. An integrated observing system forms the vital basis of China's weather forecasting service. The system includes satellite observations, upper-air observations (next generation weather radar - NEXRAD -, L-band air sounding system, wind profile radar, airborne remote sensing), and surface observations. China has established an integrated surface observing system, including 2418 national automatic weather stations and 33111 regional automatic weather stations, which is fit for medium and small scale observation and disasters monitoring.

3.7 Over the oceans China Observation System relies - in addition to satellites - on ships (VOS, Research Vessels), large moored, drifting buoys and stationary platforms (e.g. coastal observation stations), and High Frequency (HF) Surface Wave Radar (HFSWR). Satellites enable to provide consistent, long-term, large-scale observations, for weather forecasting, ocean exploration, natural resource investigation, and disaster monitoring. With continuous efforts, China has developed meteorological satellites including FY-1,FY-2,FY-3,FY-4 contributing to the WMO Space Programme. Ocean SeaWiFS satellite Series provide Monitoring Ocean environment and disasters. Oceanographic satellites have also been launched (HY-1A, HY-1B). Prof Li provided an overview of China's prospects with regard to its Oceanic and Atmospheric Observation System, including deep-ocean Tsunamis buoys, submarine observation vehicles, the active development of regional observation system. In particular, the Fujian zone integrated real-time observation system is composed of moored buoy, coastal observation station, HFSWR, and satellite remote sensing etc. Measurement data prepares for monitoring and warning storm surges, red tides, typhoon, tsunami and other ocean disasters in Taiwan Strait and Fujian offshore zone.

3.8 Dr. Yong Yao, Vice director of NCOSM, reported on the framework of China marine standardization and observation standard. He provided an overview of Standard history in China, and indicated that Standardization in China has developed rapidly with the launch of its economic construction. A complete standard system which consists of national standards, industrial standards, provincial standards and company standards has been established; an organizational system of standardization has been set up, including administration, scientific research, technology and academic institutions. The Standardization Law of People's Republic of China provides that mandatory standards are compulsory to be implemented while the recommendatory standards are optional for enterprises to adopt. The Administrative Organization for Standardization in China was detailed, as well as the structure of the Standardization Administration of China (SAC), with

Provincial Standardization Administration, Industrial Standardization Administration, National Standardization Technical Committee (TC), and sub-committee.

3.9 Dr Yao explained that China gives top priority to the implementation of international standards, and sets it as one of the technological and economical policies to carry out. Regulations for Adoption of International Standards for Product Labels (trail implementation) was issued and implemented in 1993. After China's entry into the World Trade Organization (WTO) in 2001, combining relevant regulations of WTO and the International Organization for Standardization (ISO) with the actual situation of China, administrative regulations for adopting international standards was formulated to promote the adoption of international standards. In 2005, Standardization Administration of China approved SOA to establish SAC/TC283, mainly responsible for the coastal and oceanic standardization. The Secretariat is attached to NCOSM.

3.10 The Chinese marine standard system is made up of the following 11 sub-systems: marine basic general standards, marine instruments manufacture, ocean energy utilization, seawater utilization, marine research and experiment, marine service, marine environment monitoring, marine natural reserve protection, marine special zone protection, marine economy management and marine law supervision and enforcement. Standard Systems were established for management of sea area use, marine observation forecast and disaster reduction, marine instruments manufacture and calibration, and technology and methods of marine survey. General standards of marine instruments manufacture and test and calibration, include marine instruments manufacture, and experimental analysis and calibration of marine instruments. So far, China has issued and implemented 61 marine national standards and 183 marine industrial standards. Dr Yao explained that marine observation standards provide the technical criteria and important technical basis, they permit to coordinate different departments and industries, ensure the comparability of observation data obtained by different departments, and ensure resources sharing. Marine standards also improve the quality of marine environment information products, turn technology into productivity, and improve the quality of marine instruments. Dr Yao suggested developing technical exchanges and cooperation for gaining comparable and exchangeable data. Asian-Pacific region uniform standards and methods should also be developed. He suggested that JCOMM formulate and issue marine regional standards.

## *4. RMIC establishment*

4.1 Through WMO Resolution 3.1.4/3, and IOC Resolution XXVI-9, the WMO Sixteenth Congress and IOC Twenty-sixth Assembly recognized the excellent facilities and long experience of the Chinese National Centre of Ocean Standards and Metrology (NCOSM) regarding ocean instrument calibration, evaluation, and testing, and further recognized that the RMICs facilitate the fulfilment of the Members' need for high quality marine meteorological and oceanographic measurements from the world oceans to address the requirements of WMO and IOC programmes and co-sponsored programmes, and in particular those of the GFCS. WMO and IOC recognized that the RMICs help improving adherence and traceability of ocean observations and associated metadata to high level standards for instruments and methods of observation on a regional basis.

4.2 Through these Resolutions, the WMO Congress and IOC Assembly therefore decided to establish IOC-WMO RMIC for the Asia-Pacific region at the NCOSM in Tianjin.

## *5. Basic objectives of the RMICs*

5.1 The workshop recalled that the RMICs are expected to facilitate adherence of observational data, metadata, and processed observational products to higher level standards for instruments and methods of observation, by providing (i) facilities for the calibration and maintenance of marine instruments and the monitoring of instrument performance; and (ii)

assistance for instrument inter-comparisons, as well as appropriate training facilities complementing what the manufacturers are also providing.

5.2 The role of the RMICs with capabilities and corresponding functions is well described in their Terms of Reference and reproduced in *Annex III*.

5.3 The workshop recalled that the basic objectives of the RMICs are:

1. to assist member countries to establish national marine instrument calibration and intercomparison capability, including by organizing training workshops and instrument intercomparisons
2. to support bilateral cooperation on calibration, intercalibration, intercomparisons, permit staff visits, and provide training materials, etc.

5.4 More information on RMICs, including benefits to Members/Member States of the RMIC activities, as well as statements of compliance of all RMICs is available in JCOMM Technical Report No. 53[4]. The Statement of Compliance of the RMIC for the Asia Pacific Region is reproduced in *Annex IV*.

## *6. Training delivered to participants*

6.1 The participants acknowledged the importance of standards and quality management on marine meteorology and oceanographic measurements, and received comprehensive information on instrument standards, instrument calibration and inter-comparisons (for waves observations), real-time and delayed-mode data exchange, Quality Management Systems, and Quality Control best practices for realizing the integration of ocean observations in the GOOS and WIGOS frameworks, and achieving the WMO and IOC Applications requirements. Information on the measurement and calibration, including theory and practice, of the following types of instrument was delivered:

- Sea Water Temperature Instrument
- Sea Water Conductivity Instrument
- Laboratory Salinometer
- Sea Water Pressure Instrument
- Wave Buoy
- Tide Meter

6.2 The participants recognized the challenge of measuring waves: Calibration of wave sensors is not sufficient, and quality assessment, inter-comparisons of wave observing platforms are also needed. The workshop encouraged its participants to participate in the DBCP[5]-ETWS[6] Pilot Project on Wave measurement Evaluation and Test from moored buoys (PP-WET). The workshop noted that a manual on wave inter-comparison produced by the PP-WET is now available from the JCOMM website[7]. The workshop also noted that the RMIC can play a role in the Pilot Project by (i) calibrating instruments, (ii) providing technical advise, (iii) do data analysis on behalf of the Pilot Project participants. The workshop supported the long term need for instrument evaluations.

6.3 The workshop recognized the importance of instrument pre-calibration and data quality control (both real-time and delayed mode, automatic and manual) and of the use of quality monitoring tools and statistics available from the data monitoring centres (e.g. weather forecasting

4 : http://www.jcomm.info/index.php?option=com_oe&task=viewDocumentRecord&docID=7166
5: DBCP: Data Buoy Cooperation Panel
6: ETWS: JCOMM Expert Team on Wind Waves and Storm Surges
7 : http://www.jcomm.info/WET

centres routinely provide monitoring statistics of surface marine data based on the comparisons of the observations with the Numerical Weather Prediction – NWP – first guess fields). Feedback mechanism (from data users back to platform operators) such as those provided by the JCOMM *in situ* Observations Programme Support Centre (JCOMMOPS[8]) are also vital to ensure that corrective action is applied by the platform operators when systematic errors are detected. The workshop noted that JCOMMOPS can also assist platform operators on other matters such as providing information on instrument best practices, data collection by satellite, quality control, and data exchange.

6.4 The workshop agreed that it was critical to permit the exchange of ocean data and metadata on a free and unrestricted basis as far as possible, in line with the WMO Resolution 40 (Cg-XII), and the Resolution IOC-XXII-6, IOC Oceanographic Data Exchange Policy. Real-time data distribution should be realized by distributing the data onto the Global Telecommunication System (GTS) of the WMO, and data sets should be made discoverable via the IOC Ocean Data Portal (ODP), and the WMO Information System (WIS). The workshop stressed the importance of collecting and sharing instrument/platform metadata so that they can be used[9] as appropriate by the end users.

6.5 The workshop was briefed on current JCOMM plans to modernize the Marine Climatological Summaries Scheme (MCSS), and concurred with the presented vision for a new Marine Climate Data System (MCDS).

6.6 Training materials and presentations of the workshop are available on the JCOMM website[10].

## *7. Workshop recommendations*

7.1 The workshop reviewed and agreed on series of recommendations which are detailed in *Annex V*.

7.2 The workshop, while satisfied with the level of training provided at the workshop, agreed that for future workshops more information should be delivered on marine instrumentation and calibration.

7.3 The workshop recognized that some countries in the Asia Pacific Region do not have adequate ocean observing systems, and the there was strong expectations from these countries to receive training from the Tianjin RMIC regarding instrument calibration, testing, and inter-comparisions so that they can enhance their ocean observation operations and be in a position to start sharing and exchanging ocean data. Bilateral collaborations should also be encouraged by JCOMM.

7.4 The workshop thanked China, SOA, and the NCOSM for acting as RMIC for the Asia Pacific Region, for providing such excellent facilities, and for China's strong commitment to operate the RMIC from now on, and thereby to assist countries in the region in developing their capacities.

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8 : http://www.jcommops.org

9: Instrument/platform metadata are used for example for (i) understanding the data, including traceability to SI units, (ii) estimating uncertainties, weighting observations (e.g. models), (iii) doing bias correction, (iv) black listing stations reporting systematic errors (data assimilation), (v) validating products (models, satellite), (vi) performing reanalysis of historical data, (vii) quality monitoring, platform/instrument evaluation, diagnostic, Quality Control, (viii) providing feedback of quality information to platform operators, (ix) estimating consistency of instrumentation for the climate record, (x) identifying latest, best copy of data, (xi) tracking changes to the data, and linking to the original source.

10: http://www.jcomm.info/rmic2

## ANNEX I

## PROGRAMME OF THE JCOMM MARINE INSTRUMENTATION WORKSHOP FOR THE ASIA-PACIFIC REGION
***(Tianjin, China, 11-13 July 2011)***

**11th July ,2011 (09:00 h – 17:00 h):**

*Morning (09:00 h – 11:25 h)*

| ***Time*** | ***Lead/speaker*** | ***Title*** | ***Emcee*** |
|---|---|---|---|
| 09:00 (5 min) | Dongmei Tang Staff of International Cooperation Department of SOA | Opening of the workshop | Dongmei Tang |
| 09:05 (15 min) | Aina Wu, Director of NCOSM | NCOSM Address Salutatory and Statement | |
| 09:20 (15 min) | Leader of SOA | State Oceanic Administration(SOA) Statement | |
| 09:35 (15 min) | Leader of Government of Tianjin | Government of Tianjin Statement | |
| 09:50 (15 min) | Wenjian Zhang, Director, Observing and Information Systems Department, WMO Secretariat | WMO Statement | |
| 10:05 (15 min) | Wenxi Zhu, Director, of Regional Office for the Asia Pacific, IOC | IOC Statement | |
| ***10:20 - Morning break (15min)*** | | | |
| 11:00 (25 min) | Etienne Charpentier, WMO Secretariat | The Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology and its Pilot Project for WMO Integrated Global Observing System (WIGOS), the concept, role, and Terms of Reference of the IOC-WMO Regional Marine Instrumentation Centers (RMICs), and future plans | Wenjian Zhang |
| 11:25 (25 min) | Wenxi Zhu, Director of Regional Office for the Asia Pacific, IOC | Regional Ocean Observing Systems (SEAGOOS, NEARGOOS and IOGOOS), and the complementary role of IOC Regional Network of Training and Research Centers on Oceanography to RMICs | |
| 11:50 (15 min) | Jun Sui Vice Director of NCOSM | Introduction of the NCOSM | |

*Afternoon (13:30 h – 17:00 h)*

| ***Time*** | ***Lead/speaker*** | ***Title*** | ***Emcee*** |
|---|---|---|---|
| 13:30 (180 min) | Mingxiang Zhang CNAS | How to apply the ISO/IEC17025 to establish the Quality Management System | Wenjian Zhang |
| ***15:30 - Afternoon break (15 min)*** | | | |
| 16:45 (15 min) | Etienne Charpentier, WMO Secretariat | General discussions concerning presentations of the first day | |

**12th July ,2011 (09:00 h – 17:00 h):**

*Morning (09:00 h – 11:30 h)*

| ***Time*** | ***Lead/speaker*** | ***Title*** | ***Emcee*** |
|---|---|---|---|
| 09:00<br>(30 min) | Xueye Luo<br>Director of National Ocean Technology Center | The development of Chinese Ocean Observing instruments and equipment. | Wenxi Zhu |
| 09:30<br>(30 min) | Dr.Kexiu Liu<br>Professor of<br>Oceanic Information Center | GLOSS Requirements | |
| ***10:00 - Morning break (15 min)*** | | | |
| 10:15<br>(30 min) | Min LI<br>Professor of Shandong Academy of Sciences of Institute of Marine Instrumentation | The Status of Oceanic and Atmospheric Observation System in China | |
| 10:45<br>(30 min) | Dr. Yong Yao<br>Vice director of NCOSM | The framework of China marine standardization and observation standard | |
| 11:15<br>(15 min) | Wenxi Zhu, Director of Regional Office for the Asia Pacific, IOC | General discussions | |

*Afternoon (13:30 h – 17:00 h)*

| ***Time*** | ***Lead/speaker*** | ***Title*** | ***Emcee*** |
|---|---|---|---|
| 13:30<br>(60 min) | Jianwen Si,<br>Chief Engineer<br>NCOSM | Sea Water Temperature Instrument measurements & calibration (theory and practice) | Wenxi Zhu |
| | | Sea Water Conductivity Instrument measurements & calibration (theory and practice) | |
| | | Laboratory Salinometer measurements & calibration (theory and practice) | |
| | | Sea Water Pressure Instrument measurements & calibration (theory and practice) | |
| | | Wave Buoy measurements & calibration (theory and practice) | |
| | | Tide Meter measurements & calibration (theory and practice) | |
| 14:30<br>(45 min) | Travel To NCOSM | | |
| 15:15<br>(60 min) | Visit the laboratory of NCOSM | | |
| 16:15<br>(45 min) | Back To Hotel | | |

**13th July ,2011 (09:00 h – 17:00 h):**

*Morning (09:00 h – 1140 h)*

| ***Time*** | ***Lead/speaker*** | ***Title*** | ***Emcee*** |
|---|---|---|---|
| 09:00 (20 min) | Chung-Chu Teng, RA-IV RMIC | JCOMM requirements with regard to the calibration of wave measuring buoys | Etienne Charpentier |
| 09:20 (25min) | Val Swail, Chair, JCOMM ETWS | Protocol for ongoing test and evaluation of wave measurements from different systems, and the role of JCOMM and RMICs | |
| 09:45 (20 min) | David Meldrum, Vice-Chair, JCOMM/OCG | Quality Management and Data Exchange (QM&DE) - Quality control of observations – real-time/automated | |
| 10:05 (20 min) | Etienne Charpentier, WMO Secretariat | QM&DE - Dissemination of time critical observations to the Global Telecommunications System | |
| ***10:25 - Morning break (15 min)*** | | | |
| 10:40 (30 min) | Etienne Charpentier, WMO Secretariat | QM&DE - Historical data records, and instrument/platform metadata | |
| 11:10 (30 min) | Wenxi Zhu, Regional Office for the Asia Pacific, IOC | QM&DE - Exchange of ocean observations and required metadata through the IOC Ocean Data Portal (ODP) | |

*Afternoon (13:30 h – 17:00 h)*

| ***Time*** | ***Lead/speaker*** | ***Title*** | ***Emcee*** |
|---|---|---|---|
| 13:30 (20min) | DrShigeki Hosoda | Argo international requirements with regard to the calibration of Argo profiling floats | David Meldrum |
| 13:50 (70 min) | Free Speech By Trainee | Symposium (e.g.Experience/Idea/Plan/Summary) | |
| ***15:00 - Afternoon break (15 min)*** | | | |
| 15:15 (55 min) | Free Speech By Trainee | Symposium (e.g.Experience/Idea/Plan/Summary) | |
| 16:10 (20 min) | David Meldrum, Vice-Chair, OCG | Final discussion and recommendations on the needs of the participating countries and arrangements for operational activities of RMICs, as well as their role in WIGOS and GOOS | |
| 16:30 (30 min) | Prof Aina Wu, Director of NCOSM | Cocktail Lounge | |

## ANNEX II

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## ANNEX III

## TERMS OF REFERENCE FOR A WMO-IOC REGIONAL MARINE INSTRUMENT CENTRE
***(Annex to Recommendation 1 (JCOMM-III))***[11]

WMO-IOC Regional Marine Instrument Centres (RMIC) should have the following capabilities to carry out their corresponding functions:

**Capabilities:**

(a) A RMIC must have, or have access to, the necessary facilities and laboratory equipment to perform the functions necessary for the calibration of meteorological and related oceanographic instruments deployed to address the common requirements of WMO and UNESCO/IOC marine-related programmes and co-sponsored programmes12;

(b) A RMIC must maintain a set of meteorological and oceanographic standard instruments or references and establish the traceability of its own measurement standards and measuring instruments to the International System of Units (SI);

(c) A RMIC must have qualified managerial and technical staff with the necessary experience to fulfil its functions;

(d) A RMIC must develop its individual technical procedures for the calibration of meteorological and related oceanographic instruments using calibration equipment employed by the RMIC;

(e) A RMIC must develop its individual quality assurance procedures;

(f) A RMIC must participate in, or organize, inter-laboratory comparisons of standard calibration instruments and methods;

(g) A RMIC must utilize the resources and capabilities of its region of interest according to the region's best interests, when appropriate;

(h) A RMIC must apply international standards applicable for calibration laboratories, such as ISO/IEC 17025, to the extent possible;

(i) A recognized authority13 must assess a RMIC, at least every five years, to verify its capabilities and performance.

**Corresponding functions:**

(a) A RMIC must assist Members/Member States of its region in calibrating their national meteorological standards and related oceanographic monitoring instruments according to the RMIC capabilities;

(b) A RMIC must participate in, or organize, JCOMM and/or regional instrument intercomparisons, following relevant JCOMM recommendations;

(c) A RMIC must make a positive contribution to Members/Member States regarding the quality of measurements;

11: IOC Resolution XXVI-9 uses the term IOC-WMO Regional Marine Instrument Centre
12: Basically in situ geo-physical instruments deployed in the surface marine environment or sub-surface
13: JCOMM will be the body that formally proposes new RMICs and proposes any authority to do evaluations

(d) A RMIC must advise Members/Member States on enquiries regarding instrument performance, maintenance and the availability of relevant guidance materials;

(e) A RMIC must actively participate, or assist, in the organization of regional workshops on meteorological and related oceanographic instruments and measurements;

(f) The RMIC must cooperate with other RMICs in the standardization of meteorological and related oceanographic measurements and sensors;

(g) A RMIC must regularly inform Members/Member States and report, on an annual basis, to the JCOMM Management Committee on the services offered to Members/Member States and the activities carried out. JCOMM in turn should keep the Executive Councils of the WMO and the UNESCO/IOC informed on the status and activities of the RMICs, and propose changes, as required.

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## ANNEX IV

## STATEMENT OF COMPLIANCE FOR THE WMO-IOC REGIONAL MARINE INSTRUMENT CENTRE IN TIANJIN[14]

The National Centre of Ocean Standards and Metrology (NCOSM) is committed to provide for the following capabilities and undertake the following functions in order to act as a WMO-IOC Regional Marine Instrument Centre (RMIC) for the Asia-Pacific region and WMO Regional Association II.

### 1. List of capabilities

**Laboratory equipment (item a[15])**

The facilities and laboratory equipment available at NCOSM permit the calibration of the instruments measuring the variables listed in section 3 below.

**Set of standard instruments or references (item b[15])**

NCOSM is maintaining a set of meteorological and oceanographic standard instruments or references for measuring the variables listed in section 3 below, and for which traceability to the International System of Units (SI) is ensured.

**Staff resources (item c[15])**

NCOSM always adheres to the policy of *strengthening the calibration with science and technology* and *strengthening calibration with talents*. All the technical staff carrying out the calibration has passed the qualification accreditation organized by AQSIQ. A group of engineers and technicians with doctor degrees and post-graduate degrees become the backbone of the marine calibration, test and verification in NCOSM. A technical team with solid theory, abundant experience and reasonable talents distribution has come into shape.

**Calibration procedures (item d[15])**

Relevant individual technical procedures for the calibration of meteorological and related oceanographic instruments developed by NCOSM using its own calibration equipment, and intended to be used as part of the RMIC function are listed in section 3 below.

**Quality assurance procedures (item e[15])**

NCOSM has implemented TQM (Total Quality Management) since 1985, and established quality system management referring to the relevant international and national laboratory management standards. After 20 years of continuous improvement, NCOSM has already had a sound management model. The existing management system in strict accordance with the requirements of ISO / IEC 17025 *General Requirements for the Competence of Testing and Calibration Laboratories* , JJF1069 *Rules for the Examination of the Service of Legal Metrological Verification* and other accreditation regulations. This system has been improved and perfected continuously through regular internal audit and management review.

**Inter-laboratory comparisons (item f[15])**

NCOSM actively participated in the inter-comparison of laboratory instruments and methods and carried out the comparison between China Primary Standard Seawater and IAPSO Standard Seawater at regular intervals. The results showed that China Primary Standard Seawater achieved the same level as that of IAPSO Standard Seawater. NCOSM has organized the verification for 63

14: The Statement of compliance of the RMIC for the Asia Pacific Region (including the WMO Regional Association II) was submitted by the Director of NCOSM, Dr Aina WU to the JCOMM Co-Presidents on 15 November 2010.
15: Relevant item of the capabilities part of the annex to the RMIC Terms of Reference

metrology accreditation agencies which have obtained the certificates in marine industry. All these activities are aimed to strengthen the quality awareness of marine industry, to ensure the testing proficiency of marine monitoring /testing laboratories and to basically meet the needs of RMIC capability. NCOSM will actively participate in the inter-laboratory comparison of calibration standards and methods organized by other RMICs, and organize relevant inter-laboratory comparisons at regular intervals.

**Capabilities of the region (item g[15])**

NCOSM will strengthen the cooperation and communication with other countries in the Asia-Pacific region on the calibration of marine instruments and marine meteorological instruments.
NCSOM will make suggestions to JCOMM including:

- Organize inter-laboratory comparisons;
- Formulate International/ regional standards of marine instruments and observation methods;
- Establish the regional Quality Control System of marine observation data;
- Establish access system for international use of marine instruments;
- Provide Services for members on calibration of marine instruments.

**International standards for calibration laboratories (item h[15])**

NCOSM apply ISO/IEC 17025, and passed the assessment of metrology accreditation, laboratory accreditation, CNCA and China National Accreditation Service for Conformity Assessment (CNAS) in Dec. 2007, and obtained *Metrology Accreditation Certificate*, *China Authorization Certificate* and *Laboratory Accreditation Certificate* , which organized every three years. NCOSM passed the assessment which is organized every 1.5 years in Aug. 2009.NCOSM is being evaluated again for accreditation in December 2010; and then every 3 years.

**Verification of capabilities and performances (item i[15])**

NCOSM will allow an authority designated by JCOMM to assess the RMIC and verify its capabilities and performance at least every five years.

**2. Corresponding functions**

**Cooperation with other Asia-pacific countries for the calibration of instruments (item a16)**
The NCOSM is planning to provide assistance to other countries in the Asia-Pacific region in the following way:

- Upon request, calibrating, testing the ocean instruments that fall within the scope of the RMIC stated capabilities and suite of instrument expertise offered;
- Organizing, coordinating, or hosting instrument inter- laboratory comparisons (see paragraph 4.2 below);
- Organizing training events about test/calibrate at the RMIC for IOC Member States of the Asia-Pacific region or Members of WMO Regional Association II.

**Organization of marine instrument inter-comparisons (item b[16])**

Information on why and how inter- laboratory comparisons should be organized is stated in the CIMO Guide (WMO-No. 8, Chapter III.4). However, the scope of marine instrument inter-laboratory comparisons has not been documented yet. NCOSM is willing to contribute to defining such a scope through organizing and participating at instrument inter-laboratory comparisons promoted by JCOMM. This will be done in close relationship with the instrument manufacturers through the HMEI, which will assist in obtaining the necessary equipment to evaluate. Thanks to

16 : Relevant item of the corresponding functions part of the annex to the RMIC Terms of Reference

these activities, NCOSM will be able to assist JCOMM in defining or adjusting guidelines for marine instrument inter-laboratory comparisons for inclusion in the CIMO Guide. Specific inter-laboratory comparison for a given ocean variable might be organized initially to prove concept and help define guidelines (e.g. setting up a small committee with participation from NCOSM, HMEI, JCOMM). Once those guidelines are fully developed and formally approved, NCOSM will be in a position to fully assist in this regard by participating in, or organizing, JCOMM and/or regional instrument inter-laboratory comparisons.

**Improved data quality in the region (item c[16])**

Through the activities of the RMIC, and assuming that some countries in the Asia-Pacific region will take advantage of the RMIC facilities, through participation in RMIC training events, and instrument inter-comparisons, its is expected that the capacities of those countries in terms of ocean measurements will be enhanced, the measurements performed by those countries will become more coherent and better traceable to SI units, and the quality of their measurements will improve and become better known. The overall improvement of ocean observations in terms of quality, consistency, and traceability from the region, and made available to end users, should facilitate improving final products and services delivered by all within the region and achieve socio-economical benefits.

**Advice to other countries (item d[16])**

The NCOSM is committed to devote some limited resources for rendering the following services to other countries in the Asia-Pacific region, including reviewing the requests from those countries, and replying favorably on a case by case basis:

Evaluation of the performance of instruments shipped by other countries to the NCOSM, and returned to them with an evaluation sheet;
Calibration of instruments shipped by developing countries to the NCOSM, and returned to them with a calibration sheet with all required traceability information;

Note: The cost of shipping the instruments to the NCOSM can be negotiated directly with the relevant countries on a case by case basis.
In addition, the organization of training events and instrument inter-laboratory comparisons at the RMIC/Tianjin, and the collaboration with other established RMICs, will be opportunities to develop appropriate guidance materials. The RMIC/Tianjin will play a pro-active role in producing, reviewing, and updating relevant documentation through JCOMM.

**Organization of training workshops (item e[16])**

NCOSM is committed to organize training workshops at least every four years in Tianjin, and contribute to funding the participation of some ocean instrument experts from developing countries at those events. The level of funding will depend on funding available from other sources, and will be negotiated with the WMO and IOC Secretariats. The selection of participants from developing countries to receive financial assistance will be discussed through an organizing committee set up by JCOMM where the NCOSM will be represented.

**Cooperation with other RMICs (item f[16])**

The NCOSM is committed to cooperate with other established RMICs in this regard as necessary. This cooperation will for example address the following:

- Sharing of information on standards being used (primary, secondary) for types of instruments managed by both RMICs;
- Sharing of information on calibration methods;
- Sharing and review/updating of training materials in the view to harmonize them;
- Cooperation with regard to instrument inter-comparisons;

**Report to JCOMM Management Committee (item g[16])**

The NCOSM is committed to submit such a written report to the JCOMM Management Committee on an annual basis through the WMO and IOC Secretariats, including details on:

- A short summary of the RMIC capabilities, including the list of instruments for which assistance is offered.
- List of countries that received assistance.
- Statistics on number of instruments evaluated and/or calibrated
- Workshops organized at the RMIC during the past calendar year with details about the participating countries, the programmes of the workshops, and their outcomes.
- Instrument inter-laboratory comparisons organized by the RMIC during the past calendar year with details about the types of instrumentation evaluated, and the results.
- Type of cooperation established with other RMICs.
- The list of training materials available at the RMIC.
- Some recommendations to JCOMM on how to improve the RMIC network as appropriate.

## 3. Suite of instrument expertise offered

### VARIABLES, AND CORRESPONDING INSTRUMENTS COVERED AS PART OF THE RMIC/TIANJIN CAPABILITY AND CORRESPONDING FUNCTION

As part of the RMIC capability and corresponding functions, the facilities and laboratory equipment available at NCOSM permit the calibration of the instruments measuring the variables listed in the table below. The meteorological and oceanographic standard instruments or references NCOSM is maintaining to support the RMIC function, and for which traceability to the International System of Units (SI) is ensured is also indicated in this table, as well as the relevant individual technical procedures for the calibration of meteorological and related oceanographic instruments developed by NCOSM using its own calibration equipment.

| Variables | Primary Standard | NCOSM Highest Standard | Traceability | Technical Procedures for Calibration |
|---|---|---|---|---|
| Water Conductivity /Practical Salinity /Standard Seawater | Tianjin Institute of Metrological Supervision Testing (TIMST),<br><br>$E_1$ Standard Weight：U=0.003mg | NCOSM CEMS Certificate 57110007 April 2010 | Standard instruments of measurement such as weight and balance are sent to TIMST to be calibrated at required intervals; salinometer is calibrated using weight dilution by NCOSM. | Calibration procedures: set value for the salinometer using the standard seawater with the salinity of 35, and then use the salinometer to measure the salinity of other standard seawater with different salinity. Compare the measured value with the standard value.<br>Capability：MEP:0.001;<br>Environmental condition：temperature:（20±5）℃, relative humidity≤70% |
| Water Temperature | National Institute of Metrology P.R.China,<br><br>Secondary Standard Device of D.C Resistance:U=$2\times10^{-8}$;<br><br>Standard Device of Platinum Resistance | NCOSM Calibrating Apparatus of Marine Temperature Instruments | Standard instruments of measurement such as electric bridge and platinum resistance thermometer are sent to National Institute of Metrology P.R.China to be calibrated at required intervals. | Calibration procedures: Put the platinum resistance and the calibrated instrument into the thermostatic water bath, set a calibrating point every 5℃ from 0℃ to 35℃.After the water temperature falls to the calibrating points, let both the platinum resistance and the instrument record the data at the same time, and take the D-value as the error of the instrument.<br>Capability: MPE：±0.003℃ |

| | | | | |
|---|---|---|---|---|
| | Thermometer：<br>U=（0.1~2.8）mK | | | Environmental conditions:<br>Temperature:（20±2）℃; relative humidity≤70% |
| Water Pressure | National Institute of Metrology P.R.China<br><br>Pressure Standard Device:<br>(0.1~10）MPa<br>U=0.002% | Calibrating apparatus of marine depth instruments held by NCOSM | Standard piston gauge is sent to National Institute of Metrology P.R.China to be calibrated at required intervals. | Calibration procedures: Put the calibrated instrument on the operating platform of standard piston gauge, link the standard piston gauge and the calibrated instrument with the specially made connecting tube, then slowly pressing; Record at least 10 groups of pressure data with 3 minutes after the pressure stabilizes.<br>Capability：U=0.005%<br>Environmental conditions：temperature:<br>（20±1）℃,<br>relative humidity≤70% |
| Sea<br><br>Level and Tide | National Institute of Metrology P.R.China,<br><br>26m Standard Device of Dynamic Calibrator<br>$U=0.5\mu m+5\times10^{-7}L$ | NCOSM Calibrating Apparatus of Tide Gauge | Invar tape is sent to National Institute of Metrology P.R.China to be calibrated at required intervals. | Calibration procedures: Put the tide gauge into the water tower, set calibrating points every 1m from 0m to 8m, carry out calibrations respectively when the water level ascend and descend. When the water level stabilizes to a certain point, let the CCD camera and the instrument record the data at the same time, the D-value is the error of the instrument.<br>Capability: MPE:±2cm<br>Environmental conditions:<br>temperature:（5~35）℃;<br>relative humidity≤85% |
| Waves<br><br>(Height, Period) | TIMST<br><br>Time Calibrator：<br>$MPE:\pm2\times10^{-7}$ | NCOSM Wave Buoy | Steel tape and stopwatch are | Calibration procedures: Set 1m, 3m and 6m as the calibrating points of wave height. within the period range of the calibrated device, according to the principle of equidistribution frequency points, select 7 wave period values at every calibrating points of wave height；fix the calibrated instrument on the |

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| | Standard Steel Tape:<br>MPE:±(0.03+0.03)Lmm | Calibration Device | sent to TIMST to be calibrated at required intervals. | simulating device of wave buoy and then adjust balance and start the simulating device. Start measuring when the uniform motion stabilizes.<br>Capability: wave height MPE±0.2%FS.wave period MPE±0.2s<br>Environmental conditions:<br>temperature:（5~35）℃;<br>relative humidity≤85% |

## ANNEX V

## RECOMMENDATIONS FROM THE WORKSHOP

The workshop agreed on the following recommendations:

1. The Tianjin RMIC and the Joint Secretariat should develop a workplan for the RMIC for the next 5 years;
2. The Tianjin RMIC and the Joint Secretariat should work closely with the IOC Regional Subsidiary Bodies (WESTPAC, IOCINDIO) and the JCOMM Observations Coordination Group (OCG) in the development and implementation of the workplan. The workplan should then be reviewed by JCOMM;
3. The Tianjin RMIC should contribute to calibration and inter-comparisons by (i) calibrating instruments on request, (ii) providing technical advice, (iii) do data analysis on behalf of participants of instrument evaluation exercises. IT should also support the long term need to perform instrument evaluation;
4. JCOMMOPS should provide day to day technical assistance to complement the RMIC functions (e.g. quality monitoring, feedback to platform operators, assistance for data collection, data exchange, information on standards);
5. Participants are encouraged to exchange time critical ocean data in real-time via the Global Telecommunication System (GTS);
6. Participants are encouraged to share delayed mode ocean data via the IOC Ocean Data Portal (ODP) and/or the WMO Information System (WIS);
7. Platform operators are invited to collect, record, and provide Platform/Instrument metadata for international exchange;
8. The workshop supports the Vision for a new Marine Climate Data System (MCDS) as proposed by the JCOMM Expert Team on Marine Climatology (ETMC);
9. China, which is now making XBTs, is encouraged to participate in the international XBT science Team;
10. The scope of RMICs must be visible through a dedicated web page on the JCOMM website, and contact points provided;
11. The Tianjin RMIC should explore collaborations with other countries in the region to provide RMIC function for the variables which are not currently listed in its Statement of Compliance (i.e. to develop a more complete “virtual RMIC” for the Asia Pacific);
12. Instrumentation best practices need to be developed and shared amongst countries in the region with the goal to have them to be reviewed by JCOMM;
13. The Tianjin RMIC is invited to explore how it can assist countries in the region using the RMIC facilities with regard to logistic support (e.g. customs clearance of instruments submitted for calibration or inter-comparisons);
14. The RMICs are strongly encouraged to participate in relevant JCOMM Expert Teams;
15. The RMICs are invited to share and exchange their experiences.

## ANNEX VI

## ACRONYM LIST

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| AIC | Argo Information Center |
| AP | Air Pressure |
| AQSIQ | General Administration of Quality Supervision, Inspection, and Quarantine (China) |
| Argo | Argo International Profiling Float Programme |
| AS | Andaman Sea |
| AST | Argo Steering Team |
| ATLAS | Autonomous Temperature Line Acquisition SystemBoB Bay of Bengal |
| BUFR | FM 94 BUFR GTS format: Binary Universal Form for Representation of meteorological data |
| BUOY | FM 18 BUOY GTS format: Report of a buoy observation |
| CB | Capacity-Building |
| CBS | Commission for Basic Systems (WMO) |
| Cg | Congress (WMO) |
| CIMO | Commission on Instruments and Methods of Observation (WMO) |
| CONOPS | WIGOS Concept of Operations |
| CTD | Conductivity, Temperature, and Depth measurement |
| DAR | Data Discovery, Access and Retrieval service (WMO WIS) |
| DB | Data Buoy |
| DBCP | Data Buoy Co-operation Panel (WMO-IOC) |
| DCPC | Data Collection and Production Centres (WMO WIS) |
| DMCG | Data Management Coordination Group (JCOMM) |
| DMPA | Data Management Programme Area (JCOMM) |
| DO | Dissolved Oxygen |
| EC | Executive Council |
| ET/DRC | CBS Expert Team on Data Representation and Codes (WMO) |
| ETDMP | Expert Team on Data Management Practices (JCOMM) |
| ETMC | Expert Team on Marine Climatology (JCOMM) |
| ETWS | Expert Team on Wind Waves and Storm Surge (JCOMM) |
| FG | First Guess Field |
| GCC | Global Collecting Centre (of MCSS) |
| GCOS | Global Climate Observing System (WMO, IOC, UNEP, ICSU) |
| GDAC | Global Data Assembly / Acquisition Centre |
| GDP | Global Drifter Programme |
| GEO | Group on Earth Observations |
| GEOSS | Global Earth Observation System of Systems |
| GFCS | Global Framework for Climate Services |
| GHRSST | Group for High-Resolution SST |
| GISC | Global Information System Centres (WMO WIS) |
| GLOSS | Global Sea-level Observing System (JCOMM) |
| GOOS | Global Ocean Observing System (IOC, WMO, UNEP, ICSU) |
| GOS | Global Observing System (WMO) |
| GPS | Global Positioning System |
| GTS | Global Telecommunication System (WWW) |
| HF | High Frequency |
| HFSWR | HF Surface Wave Radar |
| HMEI | Association of Hydro-Meteorological Equipment Industry |
| ICOADS | International Comprehensive Ocean-Atmosphere Data Set (USA) |
| ICSU | International Council for Science |
| I-GOOS | Intergovernmental IOC-WMO-UNEP Committee for GOOS |
| InaGOOS | Indonesian Global Ocean Observing System |
| IndOOS | Indian Ocean Observing System |
| IOC | Intergovernmental Oceanographic Commission (of UNESCO) |

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| IOCCP | International Ocean Carbon Coordination Project |
| IOCINDIO | IOC Regional Committee for the Central Indian Ocean |
| IODE | International Oceanographic Data and Information Exchange (IOC) |
| IOGOOS | Indian Ocean GOOS |
| ISDM | Integrated Science Data Management (formerly MEDS, Canada) |
| ISO | International Organization for Standardization |
| JAMSTEC | Japan Agency for Marine-Earth Science and Technology |
| JCOMM | Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology |
| JCOMMOPS | JCOMM *in situ* Observations Programme Support Centre |
| MAN | JCOMM Management Committee |
| MCSS | Marine Climatological Summaries Scheme |
| MDCS | Marine Climate Data System |
| MOMSEI | Monsoon Onset Monitoring and its Social & Ecosystem Impacts |
| NC | National Centres (WMO WIS) |
| NCOSM | National Centre of Ocean Standards and Metrology (China) |
| NDBC | NOAA National Data Buoy Center (USA) |
| NEAR-GOOS | North East Asian Regional GOOS |
| NMDIS | National Marine Data and Information Service (China) |
| NOAA | National Oceanic and Atmospheric Administration (USA) |
| NOTC | Ocean Technology Center (China) |
| NWP | Numerical Weather Prediction |
| OceanSITES | OCEAN Sustained Interdisciplinary Timeseries Environment observation System |
| OCG | Observations Coordination Group (JCOMM) |
| ODAS | Ocean Data Acquisition Systems |
| ODASMS | ODAS Metadata Service (operated by China on behalf of JCOMM) |
| ODP | Ocean Data Portal (IODE) |
| OOPC | Ocean Observations Panel for Climate (GCOS-GOOS-WCRP) |
| OPA | Observations Programme Area (JCOMM) |
| PA | Programme Area (JCOMM) |
| PANGEA | Partnerships for New GEOSS Applications |
| PMO | Port Meteorological Officer |
| PP-WET | DBCP-ETWS Pilot Project on Wave measurement Evaluation and Test from moored buoys |
| QA | Quality Assurance |
| QC | Quality Control |
| QMF | WMO Quality Management Framework |
| QMS | Quality Management Systems |
| RAMA | Indian Ocean Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction |
| RMIC | IOC-WMO Regional Marine Instrument Centre |
| RNODC | Responsible Oceanographic Data Centre (IODE) |
| RNODC/DB | RNODC for Drifting Buoys |
| RTMC | VOSClim Real-Time Monitoring Centre |
| SAC | Standardization Administration (China) |
| SAMS | Scottish Association for Marine Science |
| SCG | Services Coordination Group (JCOMM) |
| SeaDataNET | Pan-European infrastructure for Ocean & Marine Data Management |
| SEA-GOOS | South East Asian Regional GOOS |
| SFSPA | JCOMM Services and Forecasting Systems Programme Area |
| SLP | Sea Level Pressure |
| SOA | State Oceanic Administration (China) |
| SOC | Specialized Oceanographic Centre (JCOMM) |
| SOOP | Ship-Of-Opportunity Programme |
| SOOPIP | SOOP Implementation Panel (JCOMM) |
| SOT | Ship Observations Team (JCOMM) |

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|---|---|
| SPA | JCOMM Services Programme Area (now SFSPA) |
| SST | Sea-Surface Temperature |
| TAO | Tropical Atmosphere Ocean Array |
| TC | Technical Committee |
| TD | Technical Document |
| TIP | Tropical Moored Buoys Implementation Panel |
| TT | Task Team |
| UN | United Nations |
| UNEP | United Nations Environment Programme |
| UNESCO | UN Educational, Scientific and Cultural Organization |
| UNFCCC | United Nations Framework Convention on Climate Change |
| USA | United States fo America |
| VOS | Voluntary Observing Ship scheme (JCOMM) |
| VOSClim | VOS Climate class ship of the VOS fleet |
| WCRP | World Climate Research Programme |
| WCC-3 | World Climate Conference 3 |
| WDIP | WIGOS Test of Concept Development and Implementation Plan |
| WDIS | WIGOS Development and Implementation Strategy |
| WESTPAC | IOC Sub-Commission for the Western Pacific |
| WIGOS | WMO Integrated Global Observing System |
| WIS | WMO Information System |
| WMO | World Meteorological Organization (UN) |
| WTO | World Trade Organization |
| WWW | World Weather Watch (WMO) |
| XBT | Expendable BathyThermograph |