DBCP NEWSLETTER

Data Buoy Cooperation Panel

June 2025, Volume 1 No 2

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LOOKING TOWARDS THE FUTURE: ARTIFICIAL INTELLIGENT (AI) IN OCEAN OBSERVATION

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The global ocean observation system has advanced significantly over the past few decades, marked by a growing number of instruments and expanded monitoring coverage. Among the most vital components of this system is the buoy. Historically, buoys have been used as far back as the 14th century. According to Atlas Winch Hire & Hoist Service[1], early buoys were utilized

Kinds of Buoys Integrated AI

by German and Dutch sailors, who deployed wooden barrels weighted with stones to serve as maritime markers. In 1514, King Henry VII of England established Trinity House by royal charter, incorporating buoys as navigation aids in English waters. Over time, buoys evolved beyond their original function, becoming essential tools for monitoring physical and environmental conditions in the ocean.

In the past decade, rapid advancements in technology—especially in artificial intelligence (AI)—have transformed our understanding of what buoys can do. Once limited to navigation and passive observation, modern buoys now possess capabilities far beyond their traditional roles. Several institutions have begun developing intelligent buoys equipped with AI, enabling onboard data pre-processing before transmission or direct use by end users. Modern AI-driven buoys can conduct real-time data pre-processing, filtering, and analysing before transmission to central data repositories. This feature reduces the volume of data sent over communication networks, alleviating bandwidth constraints and enhancing data transmission efficiency.

Over the last five years, the development of AI-integrated buoys has gained momentum. At the 2021 International Symposium on Intelligent Signal Processing and Communication Systems, researchers from Taiwan proposed a low-cost, AI-powered buoy system for offshore aquaculture[2]. These buoys are designed to monitor water quality

[1] *https://www.winchhire.co.uk/a-history-of-buoys-and-what-they-may-look-like-in-future/*
[2] *H. Y. Lu et al., "A Low-Cost Buoy System with Artificial Intelligence (AI) for Offshore Aquaculture," 2021 International Symposium on Intelligent Signal Processing and Communication Systems (ISPACS), Hualien City, Taiwan, 2021, pp. 1-2, doi: 10.1109/ISPACS51563.2021.9651136.*

WORLD METEOROLOGICAL ORGANIZATION
United Nations Educational, Scientific and Cultural Organization
Intergovernmental Oceanographic Commission
The Global Ocean Observing System

and proposed a low-cost, AI-powered buoy system for offshore aquaculture. These buoys are designed to monitor water quality and provide users with both real-time data and short-term forecasts of aquatic conditions. The private sector has also entered the field, with several companies now offering AI-enabled buoy products for a various of applications. Typically, AI integration involves enhancing the buoy's software to enable autonomous operation and intelligent output generation based on recorded data. The application of AI in buoy-based ocean observation is significantly enhancing marine monitoring systems. These advancements promise improved data acquisition and analysis, leading to more effective management of ocean resources. One notable development in this area is the creation of multifunctional buoys equipped with advanced communication technologies, such as 5G and acoustic systems. These innovations enable real-time data transmission, which enhances the responsiveness of ocean observation networks to changing environmental conditions[3].

However, the path forward is not without its challenges. Technically, AI systems require high-quality, consistent data to deliver reliable results. Environmentally, buoys must withstand harsh ocean conditions and biofouling, which can reduce their lifespan. Operationally, AI components demand greater power, prompting the need for efficient, sustainable energy sources. In addition, the complex communication infrastructure required for real-time data exchange can increase operational expenses . Incorporating AI into buoy-based ocean observation systems presents a promising frontier in marine science. Yet, the operationalization of these systems is not without significant hurdles. Addressing the technical need for reliable data, overcoming environmental limitations such as biofouling, ensuring sustainable energy provision, and establishing a feasible communication infrastructure are vital steps toward advancing the utility of AI in ocean monitoring. Future research and policy initiatives should prioritize these challenges to enhance the effectiveness and sustainability of buoy systems in fulfilling their monitoring roles in an increasingly complex marine environment.

Despite these challenges, they offer opportunities for innovation. Tackling these obstacles head-on will drive the next wave of advancement in AI-powered ocean observation systems—paving the way for smarter, more resilient marine monitoring technologies.

[3] *Zhang, H., Zhang, D., & Zhang, A. (2020). An innovative multifunctional buoy design for monitoring continuous environmental dynamics at tianjin port. IEEE Access, 8, 171820-171833. https://doi.org/10.1109/access.2020.3024020*

STANDARDS AND PRACTICES IN CONDUCTIVITY AND SEAWATER TEMPERATURE CALIBRATION

Conductivity and Temperature calibration setup at NIOT,India

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Asia's second facility for calibrating conductivity and seawater temperature sensors was established at the National Institute of Ocean Technology under the Ministry of Earth Sciences, Government of India, in February 2025. This facility complements the existing CTD calibration facility at the National Center of Ocean Standards and Meteorology (NCOSM) in Tianjin, China.

The calibration of temperature and conductivity sensors is conducted using computer-controlled temperature baths equipped with high-accuracy reference sensors. For temperature calibration, a Standard Platinum Resistance Thermometer (SPRT) serves as the reference sensor, which itself is calibrated using internationally recognized physical standards such as triple-point-of-water cells and gallium melt cells. Conductivity calibration relies on the International Association for the Physical Sciences of the Oceans (IAPSO) standard seawater, employed as the primary standard. The practical salinity of IAPSO seawater is derived from a series of conductance measurements performed at Ocean Scientific International Ltd (OSIL) relative to Potassium Chloride (KCL) standard solutions, prepared using meticulously weighed KCL crystals.

The reference conductivity is calculated based on the salini-

ty of the seawater and its reference temperature. Following deployment, sensors undergo a post-deployment calibration without prior cleaning of the conductivity cell to assess field conditions. Subsequently, pre-deployment calibration is performed after cleaning the interior of the cell to ensure optimal performance. Temperature sensors are generally stable; however, conductivity sensors tend to drift more rapidly due to changes in cell geometry caused by biofouling or scouring within the conductivity cell. The accuracy of temperature and conductivity sensor used in moored buoy are 0.002 0C & 0.003 mS/cm respectively with a very high stability. This facility will reduce the time and costs towards re-export to foreign OEMs calibration and also motivate other laboratories to intercalibrate with their procedures. Efforts are underway to obtain ISO:17025 accreditations for this facility.

OCG CAPACITY DEVELOPMENT WEBINAR: PREPARING FOR WIS 2.0 IN THE OCEAN COMMUNITY

The Ocean Observing community took an important step forward in data modernization through the recent OCG Capacity Development Webinar, which introduced the WMO Information System 2.0 (WIS 2.0). Organized by the Capacity Development Team of the Observation Coordination Group (OCG) under GOOS, the session provided critical insights into the future of global data exchange.

OCG Capacity Development: WMO Information System 2 0

WIS 2.0 is designed to replace the long-standing Global Telecommunication System (GTS) and WIS 1.0 with a more agile, open, and interoperable platform. As Mr. Hassan Haddouch, WIS 2.0 Manager at WMO, explained, “WIS 2.0 is the framework for WMO data sharing in the 21st century, making international, regional, and national data sharing simple, effective, and inexpensive.” With its adoption of open standards, web technologies, and a publish-subscribe model similar to modern messaging platforms, WIS 2.0 represents a major shift in how data will be shared and accessed.

The webinar covered the motivations behind this transition—namely the increasing volume, variety, and velocity of data—and the urgent need to support all Earth system domains, not just meteorology. WIS 2.0 also supports the implementation of the WMO Unified Data Policy and Global Basic Observing Network (GBON), ensuring equitable access to critical data.

For the ocean community, this transition means rethinking how data is integrated and shared globally. Many questions during the Q&A focused on practical implications: how ocean data providers can participate, what technical requirements are needed, and how WIS 2.0 will interact with existing systems like IOC’s Ocean Data and Information System (ODIS). Mr. Haddouch emphasized the flexibility of WIS 2.0, including support for both core and recommended datasets, multiple data formats (e.g., NetCDF, BUFR, CSV, XML), and open access through global services.

Of particular interest is the “WIS 2.0 in a Box” initiative—an open-source, plug-and-play software package designed to lower the entry barrier for national services and programs to publish and consume data. Ocean data centers are encouraged to participate in the ongoing pilot phase, which includes opportunities to set up WIS 2.0 nodes and test data publication workflows.

The webinar concluded with a clear invitation: ocean programs and data centers interested in becoming part of the WIS 2.0 pilot phase are welcome to reach out. As Ms. Champika Gallage from the WMO Secretariat noted, “We are waiting to see many centers joining us in the pilot phase to move this initiative forward.”

As WIS 2.0 implementation progresses toward full operational status by 2030, the ocean observing community has a key opportunity to shape the future of open, efficient, and inclusive data exchange.

UPCOMING EVENTS

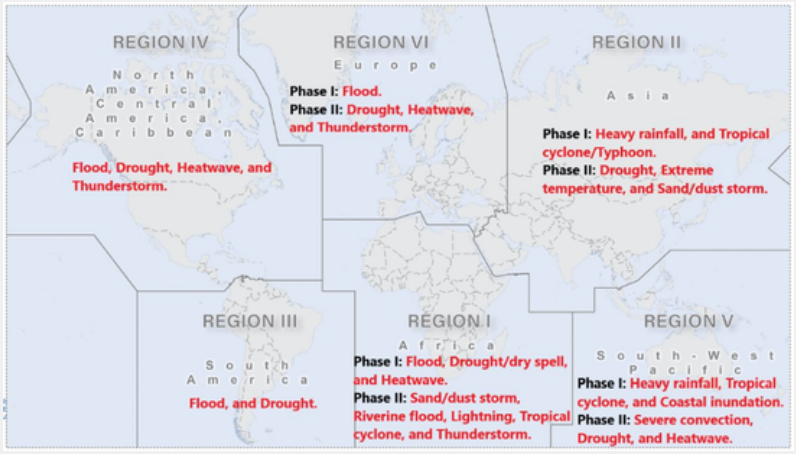
5 - 7 Aug 2025	DBCP Training Workshop on Ocean Observations for Operational Services in the Indian Ocean
3 July 2025	DBCP Task Team on Wave Measurements Quarterly Meeting (contact mkhotimah@wmo.int for more information)

OCEAN OBSERVATIONS: A REGIONAL PRIORITY ON THE BASIC OBSERVATION NETWORK OF THE WMO

Ocean observations are a cornerstone of the World Meteorological Organization's (WMO) Regional Basic Observing Network (RBON) in Regions II (Asia) and V (South-West Pacific). Unlike the Global Basic Observing Network (GBON), which sets global standards, RBON focuses on regional priorities, tackling challenges like tropical cyclones and coastal flooding.

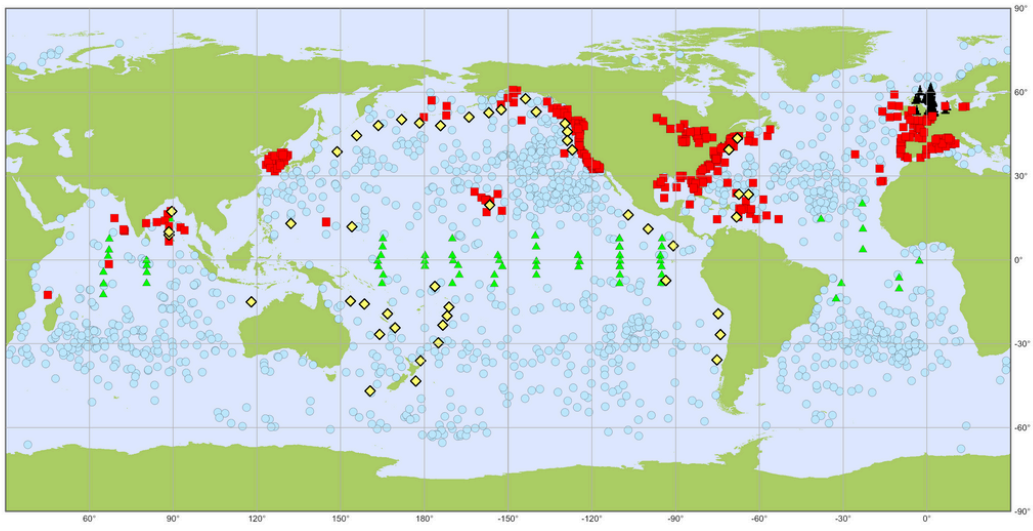
Recent WMO workshops—RA II RBON Implementation (17-20 February 2025) and RA V WIGOS (19-23 May 2025)—highlighted ocean observations as critical RBON variables. In Region V, the Weather Ready Pacific program deploys wave buoys and tide gauges to bolster multi-hazard early warning systems (MHEWS), such as those in Samoa, improving forecast for extreme weather. Similarly, Region II emphasizes data on sea surface tempera-ture, salinity, and wave height to enhance disaster preparedness.

Buoys play a key role, delivering real-time data on ocean conditions to strengthen early warning systems. RBON encourages countries to optimize their observation networks, with support for developing nations to build infrastructure. By prioritizing region-specific ocean data, RBON enhances global efforts to monitor and respond to climate challenges, better protecting vulnerable communities from environmental hazards.



RBON Key challenges per region: phenomena to be addressed in order to bring substantial socioeconomic benefits.

LATEST NETWORK STATUS



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