|  |  |
| --- | --- |
| **World Meteorological Organization &****Intergovernmental Oceanographic Commission (of UNESCO)****JOINT WMO/IOC TECHNICAL COMMISSION FOR OCEANOGRAPHY AND MARINE METEOROLOGY****Data Buoy Cooperation Panel Thirty Sixth Session**, Geneva, Switzerland, 8-11 November 2021 | Image result for ioc logo unesco**DBCP-37/Doc. 6.9** |
| Submitted by:R.E. Jensen22.10.2021**DRAFT 1** |

**AGENDA ITEM 6: RECOMMENDATIONS BY THE TASK TEAMS**

**AGENDA ITEM 6.9: Task Team on Wave Measurements (TT-WM)**

# SUMMARY

### This document provides a report on the activities of the Task Team on Wave Measurements including recommendations to the panel for approval and actions/decisions required.

### A. INTRODUCTION/SUMMARY[[1]](#footnote-1):

6.9.1 Robert Jensen/Val Swail reported on the progress of wave measurement activities undertaken during the last intersessional period. Continuous testing and evaluation of operational and pre-operational measurement systems continues to be an essential component of a global wave observing system, particularly given the recent proliferation of new sensors and platforms. The overriding objective of this evaluation is to ensure consistent wave measurements to a level of accuracy that will serve the requirements of the broadest range of wave information users.

6.9.2 Work continued on the evaluation of both legacy and emerging measurement sensors and platforms, with several ongoing field studies. In addition, the Task Team published papers from two of those evaluations to a Topical Collection in Ocean Dynamics (Jensen et al., 2021; Magnusson et al., 2021).

6.9.3 Deployments of wave drifters continued, through the Global Drifter Program and others including the Coastal Observing Research and Development Center at SIO. CORDC was successful in transmitting some of their mini-drifter wave measurement buoys to the GTS. ECMWF is now reviewing the data structure for forecast evaluations and potentially ingest into their operational forecasting system, facilitated by the Task Team.

6.9.4 The key action from DBCP-36 for the Task Team was the organization of a Wave Measurement Workshop, as a follow-on to the 2008 workshop in New York, which led to the development of the original Pilot Project on Wave measurement Evaluation and Test (PP-WET). The Workshop was originally planned for September 28-30, 2020 at ECMWF, with more than 70 participants representing a broad spectrum of buoy developers, operators, national weather services, satellite agencies, climate services, researchers, and users including the oil and gas industry. Unfortunately, due to Covid-19, the meeting was postponed until at least 2021, and the continuing travel-related issues led to further postponement. It is now planned to hold virtual meetings on individual topics of the proposed workshop agenda in early 2022. This remains the primary action for TT-WM.

### B. ACTIONS/DECISIONS REQUIRED:

(a) A[6.9/1](#_Draft_Decision_X.X.X(X)/1) — *Wave Measurement Workshop 2*

* Organize a follow up workshop (Re: New York 2008 Workshop) between researchers in the field of wave measurements, institutional end users, data providers, manufacturers and the IOGP (TT-WM chair to work with Candice Hall and Val Swail), virtual Q1/Q2 2022).

**C. RECOMMENDATIONS:**

(a) [R6.9/1](#_Title_of_the_1) *— Consolidated Wind-Waves Data Base*

* Continue to investigate a consolidated Waves data base (with TT-MB) to house point-source wave measurements and complementary metadata

(b) R6.9/2 — *Establish QC Flag for Wind-Generated Surface Gravity Wave Frequency Spectra*

* Recommend establishing QC flags on wind-generated surface gravity waves coordinated with TT-WM, MB, DM and OceanOps.

(c) R6.9/3 – Observations of Raw Displacement Time Series

* Encourage buoy operators to collect, where feasible, time series of raw displacement time series of waves in addition to spectral and integral properties.

# C. BACKGROUND INFORMATION

Continuous testing and evaluation of operational and pre-operational measurement systems is an essential component of a global wave observing system, equal in importance to the deployment of new assets. The overriding objective of this evaluation is to ensure consistent wave measurements to a level of accuracy that will serve the requirements of the broadest range of wave information users. Inter-platform tests have been pursued in the past, however with the global variations in hull, sensors and processing systems, evolution of sensors, changes in buoy designs, and new platform systems, a fresh look is required.

Directional wave measurements have been recovered from the Buoy Farm (Field Laboratory for Ocean Sea Surface Investigation and Experimentation) in Monterey Canyon consisting of a 6N (NOMAD) buoy containing three NOAA/NDBC wave sensors, two AXYS sensors (transmission failure Oct 2018 both sensors) , a 3D NOAA/NDBC buoy with two sensors and a Datawell Directional Waverider buoy (DWR). More than 4-years of data have been recovered and analysed to determine the relative differences between all sensor/buoy systems. The relative reference used in the analysis is a DWR. Assessment of the relative reference is based on three years of data from two co-deployed DWR’s offshore Point Conception, CA. A first journal paper has been published (Jensen et al., 2021) on the NOMAD-DWR comparisons; additional submissions are planned.

Several additional evaluation studies are presently in progress, as noted below:

1. Field Experiments: Collaboration with NDBC, CHL and CDIP. DWR’s funded by USACE.
	1. OWL payload sensor system: 2.1D Foam buoy. Dual wave sensor system, the new motion sensor and a 3DMG (NDBC standard). Datawell Directional Waverider co-located.
		1. Lake Superior (45001). Waverider is a Mark III 0.7m buoy. Deployed late July (45001) and mid-August (DWR).

* 1. OWL payload sensor system: 3D Aluminum buoy. Dual wave sensor system as noted in a.)
		1. Planned deployment in Monterey Canyon (46042), where FLOSSIE is located. With DWR.
		2. Gulf of Mexico West Central (42002). No DWR.
	2. FLOSSIE: Planned recovery of FLOSSIE in October 2021.
	3. Mini-Buoy Experiment: Tripp Collins (USACE/Coastal and Hydraulics Laboratory, Field Research Facility). Deployed five buoys (SoFar Spotter; Datawell 4-G; Zunibal Anteia; Scripps (E. Terrill) mini wave buoy; University of Washington Swift buoy) in the fall of 2020 and spring 2021, near the USACE’s Field Research Facility’s (Duck, NC) 8-m array. Analysis of data in progress.
	4. Sensor from E. Terrill mini-wave buoy mounted in 0.7m Datawell hull. Deployed in Lake Superior (near 45001 and DWR) Aug 2021 to remain in water through the winter season to evaluate wave-ice interactions.
1. Additional Publications in progress:
	* 1. Foam Buoy Evaluation in review in *Ocean Dynamics*.
		2. Tilt Correction Evaluation submitted to JTech (Collins and Jensen)
		3. 2.1 SCOOP Evaluation plan to submit to JTech Q1 2022.
2. While the primary focus of an operational wave measurement program is on integral properties of the wave field (height, period, direction) and on the First-5 components of the wave spectra, for some purposes including measurement evaluation, research such as wave breaking, rogue waves, etc. it is necessary to have the raw surface elevation time series. Where feasible, on a limited number of platforms, it would be very useful to record this data onboard and make available afterwards. See Recommendation R6.9/3.
3. Integral wave parameters are routinely quality controlled, based on one standard or another. No such process is applied to wave spectra. Methods of quality control for wave spectra should be developed and applied to all transmitted spectra with suitable flags. See Recommendation R6.9/2.
4. Wave data, and particularly metadata, are fragmented and incomplete, existing in many different data centres globally. There has been an increasing call among the various users communities (climate, satellite, NWP centres, engineering design) for a consolidated, quality-controlled data base of wave measurements, with complete machine-readable metadata. Inquiries have so far failed to identify a financially-supported sustainable host. Efforts will continue, possibly tied to a Global Data Assembly Centre (GDAC) for moored buoys led by TT-MB. See Recommendation R6.9/1.

### References (if any):

Jensen, R.E., **Swail, V.R.** & Bouchard, R.H., 2021. Quantifying wave measurement differences in historical and present wave buoy systems. *Ocean Dynamics* **71**(6-7), 731-755. <https://doi.org/10.1007/s10236-021-01461-0>

Magnusson, A.K., Jensen, R.E & **Swail, V.R.**, 2021. Spectral shapes and parameters from three different wave sensors. *Ocean Dynamics* **71**(9), 893-909. <https://doi.org/10.1007/s10236-021-01468-7>

**Draft Actions/Decisions**

(a) A[6.9/1](#_Draft_Decision_X.X.X(X)/1) — *Wave Measurement Workshop 2*

* Organize a follow up workshop (Re: New York 2008 Workshop) between researchers in the field of wave measurements, institutional end users, data providers, manufacturers and the IOGP (TT-WM chair to work with Candice Hall and Val Swail), virtual Q1/Q2 2022).

**Draft Recommendations**

(a) [R6.9/1](#_Title_of_the_1) *— Consolidated Wind-Waves Data Base*

* Continue to investigate a consolidated Waves data base (with TT-MB) to house point-source wave measurements and complementary metadata

(b) R6.9/2 — *Establish QC Flag for Wind-Generated Surface Gravity Wave Frequency Spectra*

* Recommend establishing QC flags on wind-generated surface gravity waves coordinated with TT-MB, DM and OceanOps.

(c) R6.9/3 – *Observations of Raw Displacement Time Series*

* Encourage buoy operators to collect, where feasible, time series of raw displacement time series of waves in addition to spectral and integral properties.
1. Half a page or less of Summary [↑](#footnote-ref-1)