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Editorial

Marine Metrology and Oceanographic Measurements 2020

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The measurement of oceanic parameters, and the consequent monitoring of their evolution in space and time, represent the basis for environmental information services that support a wide range of societal and commercial applications. Ocean observations are of paramount importance for a better understanding of the effects of climate change on the Earth's global system. They are also essential for weather forecasting, helping with predicting and facing extremely hazardous events. A sustainable ocean economy is fundamental to ensuring a major source of food, energy, and jobs.

The Global Ocean Observing System (GOOS) has established a framework for ocean observation centred on 31 essential ocean variables (EOVs), 19 of which are listed among the 54 essential climate variables (ECVs) defined by the GCOS. EOVs are physical, chemical, and biological parameters related to climate, operational services, and ocean ecosystem health. The development of measurement and modelling methods and their validation, the integrated approach for the determination of various parameters by also using diffused sensor networks, the establishment of proper references, and data harmonisation are some of the activities that are carried out by oceanographers which require closer and stronger cooperation among different scientific communities in order to assure the meaningfulness of the records over time and space and their robustness.

This Special Issue, "Marine Metrology and Oceanographic Measurements", includes three contributions published between 2021 and 2023. It aims to present a collection of papers focusing on recent developments in the field of oceanic parameter measurement. The presented scientific works are of great interest to scientists involved in measurement sciences, from physics to marine chemistry, and aim to promote a broader coordinated approach among different scientific communities, such as marine scientists and metrologists.

A brief overview of all the contributions follows, emphasizing the main investigation topics and the outcomes of the analyses.

Among the oceanic variables to be monitored, current data are particularly meaningful, as they can be used for several applications. Some examples include the understanding of the marine ecosystem, the tracking of pollution sources, the assessment of coastal water quality and coastal protection projects, and the validation of hydrodynamic models. Acoustic Doppler Current Profilers (ADCPs) are commonly used to carry out current measurements in seas and oceans for various reasons. They can be deployed on the seafloor, and fixed along mooring lines, but also installed in the keels of boats or on buoys. Due to their operating principles, ADCPs are able to tackle both temporal and depth coverage. However, the operations of current profilers still lack metrological controls. A. Bordone et al. [1] present a procedure to carry out a proper uncertainty analysis for current meters mounted on spar buoys where current profiles need to be post-processed to account for the influence of the buoys. The methodology was tested for a measurement station in the Ligurian Sea, Italy. An ADCP was installed on the surface buoy of the Western 1 Mediterranean Moored Multisensor Array (W1-M3A) oceanographic observatory, facing upwards, at a depth of about 37 m. Current measurements were continuously carried out for 5 months (April–August 2017). The consistency of the method was evaluated by comparison with marine current numerical models and historical data obtained for the

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area. The results demonstrated that the method can be applied to spar buoy-mounted ADCP systems to obtain reliable measurements, which can be used both for oceanographic studies and to validate 3D hydrodynamic models.

A promising oceanographic research field is devoted to the assessment of the conditions of the sea state by using data collected on-board during shipping, and developing proper wave spectrum resembling procedures. The knowledge of the real-time sea state conditions that can be encountered by ships during navigation is useful for different purposes, including the provision of proper information to avoid potentially dangerous phenomena, thus protecting the safety of navigation and the on-board comfort level. It can give proper tools to optimise the ship voyage, also in terms of minimising the consumption. Proper modelling may lead to improved knowledge of sea states, leading to better separation between swell and wind waves. S. Pennino et al. [2], starting from the measurements of heave and pitch motions carried out on-board the research ship "Laura Bassi" during an oceanographic campaign in the Antarctic Ocean in January and February 2020, present the application of a parametric wave spectrum resembling procedure for the detection of the wave peak periods and significant wave height. The wave spectrum procedure presented in their paper was applied in a real environment; a subsequent successful validation was carried out against a set of weather forecast data provided by the third-generation Global Wave Model (GWAM). The main results confirm that the applied procedure of wave spectrum resembling is useful for the assessment of the sea state parameters, in terms of both significant wave height and wave peak period; in addition, such an assessment is more effective if carried out from the analysis of ship motions instead of ship accelerations.

The oceanographic community, dealing with the measurements of many EOVs, is well organized both at regional and international levels. Fundamental requirements for addressing quality assurance and control are in place, and state-of-the-art equipment is currently used. However, in order to cover the EOVs' quality requirements from GOOS and GCOS, and to achieve robust data to support reliable long-term observation of trends, fundamental metrological principles, such the establishment of proper traceability paths and the uncertainty evaluation, are needed. F. Rolle et al. [3] present a review paper recalling some successful examples of collaborative projects, as well as European and international initiatives dealing with the application of metrology in marine research. Their paper focuses on three main EOVs: surface and subsurface temperature, carbon dioxide partial pressure, and stable carbon isotopes. Close scientific cooperation in the framework of joint research projects on ocean observations is particularly useful for supporting the measurement capabilities of marine research worldwide. Technologies and methods developed so far represent the starting point for further improvements in monitoring networks at the international level. All of these techniques and methodologies may be applied by laboratories and centres working in the marine sector. Applications and possible future developments are also presented in this review.

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