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Michel Rixen, Jeffrey W. Book, Mirko Orlic

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Preface

Coastal processes: Challenges for monitoring and prediction

Michel Rixen [a,*], Jeffrey W. Book [b,1], Mirko Orlic [c,2]

[a] NURC–NATO Underseo Reseorch Centre, Viole San Bartolomeo 400, 19126 La Spezia, Italy
[b] Novol Reseorch Laborotory, Stennis Space Center, MS 39529, USA
[c] Andrijo Mohorovicic Geophysicol Institute, Foculty of Science, University of Zogreb, Horvotovac bb, 10000 Zogreb, Crootio

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The knowledge of the coastal environment is critical to a variety of activities and operations at sea, such as fishing, search and rescue, coastal zone management, pollution control and mitigation, disaster recovery, severe storm forecasting, maritime safety, harbor and port security, etc. The success of Rapid Environmental Assessment (REA) efforts relies on precise enough understanding of coastal processes to have significant impacts on critical decisions despite the inherent complexities of the processes and the practical limits in characterizing them. The presence of processes at short spatio-temporal scales due to the chaotic nature of the marine environment and the lack of sustained–high quality–real-time observations limit our monitoring capability and the prediction skills of operational models at meso- and smaller scales. In practice, heavy fishing activity, maritime traffic, mechanical and biological stress on sensors and territory issues (to cite but a few) pose additional monitoring and prediction challenges.

Satellites allow for regular monitoring of the ocean but only for the (near-) sea surface parameters and at limited temporal frequencies. In contrast, in situ data collection is almost always much more sparse and irregular in spatial coverage. Traditional ship-based oceanographic field experiments are expensive, time-consuming and pose a series of logistical (and political) hurdles. Even when focusing on small areas of interest for a targeted period, observing systems cover at best a small portion of the spectrum of ocean processes. New technologies, such as autonomous platforms, can routinely provide observations at higher temporal and spatial scales than before, and while this has greatly increased our monitoring capabilities, it has also revealed new challenges for practical utilization of data and for understanding the dynamics of smaller scales.

On the prediction side, advances in computing power have allowed the routine use of realistic high resolution numerical models that have been able to simulate and forecast dynamically accurate coastal mesoscale variability. However, increasing resolution is not enough as initial and boundary conditions uncertainties as well as physical and numerical approximations impose severe limitations in forecast skills. Realization of these problems have recently led to an emergence of innovative data assimilation and stochastic and statistical modeling techniques that attempt to optimize use of the available data and models to produce more accurate assessments and predictions.

Environmental information can be limited, overwhelming, or contradictory and must therefore be fully exploited, fused, and reconciled. Despite recent improvements on numerous scientific and technological fronts, large uncertainties can still be expected in the operational characterization of the marine meteorological and ocean environment. For the end-user, the confidence level of any products becomes as valuable as the product itself for a robust and timely decision making process.

With the aim of reviewing the present state-of-the-art in REA and operational oceanography in general, of identifying scientific and operational shortfalls and of determining future challenges in real-time environmental monitoring and prediction for coastal environments, a scientific conference was held on 27–29 September 2007 at Villa Marigola in Lerici, Italy. The conference was also an opportunity to identify pathways for operational transition, and common strategies with national bodies and international organizations. The conference followed numerous REA research efforts at NATO Undersea Research Centre (NURC) and elsewhere, and reported on significant progress made since the previous conference in 2004 at NURC and the related *Journal of Marine Systems* special issue on *Maritime Rapid Environmental Assessment (MREA): New Trends in Operational Oceanography*, Vol. 69, Issues 1–2.

The present special issue contains selected papers, many based on presentations given at the 2007 conference, and were subjected to the standard reviewing procedure of the *Journal of Marine Systems*. The goal of this volume is to review recent results regarding research on coastal processes that challenge effective REA, and research on methods for handling the problems thus posed. The range of topics encompasses observational efforts, process studies, and numerical modeling, unified by their application to potential operational requirements. Within the

* Corresponding author. Tel.: +39 0187 527 457; fax: +39 0187 527 354.
E-mail addresses: rixen@nurc.nato.int (M. Rixen), book@nrlssc.navy.mil (J.W. Book), orlic@irb.hr (M. Orlic).
[1] Tel.: +1 228 688 5251; fax: +1 228 688 5997.
[2] Tel.: +385 1 460 5900; fax: +385 1 468 0331.

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context of this theme, specific topics covered in this issue include studies of mesoscale eddies and fronts, internal tides, coastal atmospheric processes, together with technologies such as AUV gliders and remote sensing, wave-current modeling, data assimilation for shallow-water acoustic predictions, ensemble and non-deterministic modeling, seabed and bathymetry characterization, adaptive sampling and systems for mission planning and decision support.

This volume of *Journal of Marine Systems* integrates some of the important scientific contributions in the field of REA resulting from recent multi-institutional and international at-sea collaborations. They cover a number of areas ranging from fundamental to applied sciences to operational and conceptual aspects, thereby illustrating the interdisciplinary nature of the REA system-oriented approach for which the *Journal of Marine Systems* is particularly well suited. The papers present the state-of-the-art in operational oceanography and current solutions to the monitoring and prediction challenge in coastal waters but also offer perspectives for future improvements and future research in numerous areas.

The guest editors are grateful to the NURC, the Office of Naval Research Global and the Fondazione Cassa di Risparmio di La Spezia for the financial support provided for the conference and the special issue.