2011

Editorial-The 2nd International Workshop on Modeling the Ocean (IWMO-2010)

Tal Ezer
Old Dominion University, tezer@odu.edu

Lie-Yauw Oey

Huijie Xue

Xiao Hua Wang

Original Publication Citation

Ezer, T., Oey, L. Y., Xue, H. J., & Wang, X. H. (2011). Editorial-the 2nd International Workshop on Modeling the Ocean (IWMO-2010). *Ocean Dynamics, 61*(9), 1287-1289. doi:10.1007/s10236-011-0470-z

Ocean Dynamics (2011) 61:1287–1289
DOI 10.1007/s10236-011-0470-z

EDITORIAL

Editorial—The 2nd International Workshop on Modeling the Ocean (IWMO-2010)

Tal Ezer · Lie-Yauw Oey · Huijie Xue · Xiao Hua Wang

Received: 18 June 2011 / Accepted: 29 June 2011 / Published online: 2 August 2011

The formation of the International Workshop on Modeling the Ocean (IWMO) in 2009 has been motivated by the rapid growth in ocean modeling research around the world. In particular, the spread of ocean modeling research in Asia during recent years and the establishment of many international collaborative modeling projects led to the first meeting, IWMO-2009, which was held in Taipei, Taiwan, 23–26 February 2009 (see the two special issues resulted from this meeting: Oey et al. 2010a, b). The second meeting (IWMO-2010; http://www.ccpo.odu.edu/~tezer/IWMO_2010/) was hosted by the Center for Coastal Physical Oceanography at Old Dominion University in Norfolk, VA, USA, 24–26 May 2010. The collection of manuscripts resulted from this IWMO-2010 meeting are included in this special issue and have been published in Ocean Dynamics issues from May to this issue. Two important foci are highlighted in IWMO meetings: (1) international collaborations and (2) involvement of young scientists. As evident in the papers in this special issue, the co-authors of papers are often from different countries and include several graduate students and post-docs. To encourage young scientists to participate, IWMO hosts a special session for the Outstanding Young Scientist Award competition. Despite difficulties in international travel during the IWMO-2010 meeting due to the Iceland volcano eruption and increased security that prevented scientists from some countries to travel to the USA, participants from over 15 countries attended the meeting, including attendees from Europe, North and South America, Asia, and Australia. The meeting received considerable attention from the local media due to the BP oil spill in the Gulf of Mexico that happened just before the meeting; a paper on the oil spill was presented in the meeting and is included in the special issue (Chang et al. 2011). The IWMO returned to Asia for the third meeting (IWMO-2011; http://www.fio.org.cn/iwmo2011/iwmo2011.htm) that has been hosted by the First Institute of Oceanography, Qingdao, China, 6–9 June 2011. The next meeting (IWMO-2012) will be hosted by the Japan Agency for Marine-Earth Science and Technology (JAMSTEK), Japan.

The collection of 13 papers in this special issue covers a wide range of geographical domains, seven different types of ocean models, and process studies ranging in scales from a few centimeters to regional and global. The studies demonstrate the recent progress in numerical modeling: on one hand, the ability to simulate smaller and smaller scales and, on the other hand, the advancement in realistic simulations of large-scale ocean processes. Models are applied to various interdisciplinary practical problems, from the dispersion of oil spill in the Gulf of Mexico to the

Responsible Editor: Jörg-Olaf Wolff

T. Ezer (✉)
Old Dominion University,
Norfolk, VA, USA
e-mail: tezer@odu.edu

L.-Y. Oey
Princeton University,
Princeton, NJ, USA
e-mail: lyo@princeton.edu

H. Xue
University of Maine,
Orono, ME, USA
e-mail: hxue@maine.edu

X. H. Wang
University of New South Wales,
Canberra, Australia
e-mail: hua.wang@adfa.edu.au

dispersion of pollutants in macro-tidal basin in the Gulf of Maine or the dispersion of eggs from a spawning aggregation site in the Caribbean Sea. All papers have been through the same rigorous review process as other papers published in Ocean Dynamics; reviewers include both participants of IWMO and many outside experts. The papers can be roughly divided into four categories: (1) high-resolution process studies; (2) regional coastal ocean circulation studies; (3) basin-scale to global modeling and analysis studies; and (4) forecast systems and practical applications.

Category 1 includes five papers on small-scale process studies and high-resolution modeling. As part of recent ongoing efforts to better understand wave–current interactions and to develop ways to couple surface wave models with ocean models, Mellor (2011) describes a theoretical framework for finding vertically dependent wave radiation stresses. The study also shows how Stokes drift can be derived from irrotational flow under surface waves and not directly from progressive wave considerations. Another approach for studying turbulent shear flows and stress under surface waves and wind action is by Large Eddy Simulation (LES) models (Martinat et al. 2011). The study of Martinat et al. compares the characteristics of turbulence for pressure gradient-driven flow, wind stress-driven flow, and wind plus waves-driven flows over shallow shelves. Such fine-scale (centimeters to meters) simulations with LES models may have implications for improving parameterizations in ocean circulation models that do not resolve those scales. Moving to scales larger than LES but finer than most eddy-resolving regional ocean circulation models, two high-resolution (horizontal grids of ~50 m) model studies investigate mixing and particle dispersion processes, one using the finite element QUODDY model (Xu and Xue 2011) and the other using a generalized coordinate version of the Princeton Ocean Model (POM; Ezer et al. 2011). Xu and Xue simulated the circulation in Cobscook Bay, a macro-tidal basin with complicated topography, various channels, and sub-bays which is connected to the lower Bay of Fundy and the Gulf of Maine. Particle dispersion under tidal forcing was studied with particle tracking statistics. Different dispersion regimes were found in different parts of the bay, depending on the residual currents and the tidal excursion. The study shows the importance of dispersion by chaotic tide-driven advection, even without parameterization of subgrid-scale turbulence. Ezer et al. (2011) used POM with an idealized topography of a typical Caribbean coral reef to simulate small-scale, high-frequency flow–topography interactions and turbulence induced by internal waves. The study shows how the peculiar shape of the reef amplifies flow variations to create intense mixing at the location where many species of Caribbean fishes aggregate to spawn, suggesting a mechanism for egg dispersion that may increase the survival rate. Another study with an idealized topography used a two-dimensional (x–z) POM model with fine grid sizes of 250 m in the horizontal and 1 m in the vertical to resolve frontal circulation that is forced by an up-front wind directed against the frontal geostrophic shear (Chang and Oey 2011). The authors show numerically and analytically that wind acting on the strong, well-resolved frontal vorticity produces near-surface detachment of boluses that are governed by a nonlinear advection–dispersion equation with unchanging waveform solution. The model may be used to explain off-shelf movements of boluses often observed over the Slope Sea region of the Mid-Atlantic north of the Gulf Stream, and also in the Yangtze River plume in the summer when the wind is predominantly southwesterly.

Category 2 includes two papers on regional coastal ocean circulation studies. Nan et al. (2011) studied the Kuroshio intrusion into the South China Sea (SCS) by analyzing altimeter data and simulations of the Hybrid Coordinate Ocean Model (HYCOM). The study characterized the frequency of occurrence and the impact on the SCS of three types of Kuroshio paths, demonstrating the important connection between open ocean circulation and climate and variations in semi-enclosed seas. Another study of semi-enclosed seas in Southeast Asia is the modeling of the Malay Peninsula Eastern Continental Shelf by Tangang et al. (2011) using a coupled wave–tide circulation model based on POM. The model successfully simulated the monsoon wind-driven seasonal changes in circulation and shows how a summer eddy is developed from the combined effect of wind stress curl and bathymetry steering.

Category 3 includes three papers on basin-scale to global modeling and analysis studies. Jensen (2011) studied the Pacific North Equatorial Current and seasonal variations of the bifurcation of the current using a wind-driven 4.5-layer model. Comparisons with a five-layer model demonstrated the role of topography in the dynamics through the process known as the joint effect of baroclinicity and relief (JEBAR). The role of JEBAR as well as Ekman dynamics in the energetics of the global ocean is also the focus of the paper of Aiki et al. (2011). The authors used a high-resolution (0.1° grid) model based on the Modular Ocean Model (MOM3) to estimate the barotropic and baroclinic energy balances. The study also indicated that biharmonic friction used by high-resolution ocean models may need more attention as it may significantly alter the energy balance in particular regions of the ocean such as in the Antarctic Circumpolar Current. Another global modeling study by Yin et al. (2011) used MOM4 to test an Ensemble Adjusted Kalman Filter (EAKF) assimilation methodology of Argo profile data. Errors in temperature and salinity fields were reduced by the assimilation, relative to a control run without assimilation; sensitivity experiments also help optimize various parameters in the EAKF assimilation.

Category 4 includes three papers on forecast–hindcast systems and their applications. Jensen et al. (2011) used the Navy's coupled ocean–atmosphere prediction system in the North Pacific to study the impact of cold air outbreaks on air–sea fluxes over the Kuroshio. The system includes multiple one-way nested high-resolution grids (smallest grid size ~2 km) with the Navy Coastal Ocean Model (NCOM). The simulations found turbulent heat fluxes as large as 2,300 $\mathrm{W\,m^{-2}}$ near large meanders of the Kuroshio, and the study thus suggests that cold air outbreak events can lead to significant mode water formation. Another ocean forecast system is the NOAA/NOS Great Lakes operational forecast system based on POM (Chu et al. 2011). This was one of the first operational ocean forecast systems in the USA which has been in development since the early 1990s. The study reviewed the developmental stages of the system, the data requirements, and the skill assessment methodology of the system and highlighted the challenges that remain. In particular, strong storms that create lake seiches result in sometimes hazardous water level variations that are difficult to accurately predict. The last paper in this category by Chang et al. (2011) is a timely one; it deals with the BP oil spill in the Gulf of Mexico which started in April 2010, a few weeks before the IWMO-2010 meeting, and lasted until mid July. The study used the POM-based Princeton Regional Ocean Forecast System (PROFS) to calculate long-term (weeks to months) projections of oil trajectories by ensemble calculations based on multiyear ocean current analyses. The same dataset was also used during the spill to help NOAA monitor the crisis in the Gulf. The projected spill trajectories agree quite well with observations and explain how the wind pattern at that time and a cyclonic eddy nearby resulted in a more confined surface oil spread than otherwise would have occurred.

Acknowledgments The IWMO-2010 meeting was jointly supported by Old Dominion University's Center for Coastal Physical Oceanography (CCPO), the Department of Ocean, Earth and Atmospheric Sciences (OEAS), and the Virginia Modeling, Analysis and Simulation Center (VMASC). We thank all the students and volunteers who helped during the meeting and the ODU Business Gateway personnel who helped with the registration and logistics. We thank the many reviewers for their time and efforts, which made this special issue possible.

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