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EDITORIAL

The 10th International Workshop on Modeling the Ocean (IWMO 2018) in Santos, Brazil, June 25–28, 2018

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The 10th International Workshop on Modeling the Ocean (IWMO 2018) was hosted by the University of Sao Paulo and held on June 25–28, 2018, at the beautiful coastal city of Santos, Brazil. This old city was founded by the Portuguese in the 1500s and is known for its world's longest beach garden, the Coffee Museum and the Pele Museum (featuring the famous football player and a local hero). Since the inaugural IWMO meeting in Taiwan in 2009, meetings were held in Asia, Europe, North America, and Australia, but this was the first meeting to be held in South America. With the 10th anniversary of IWMO, we would like to acknowledge the foremost contribution and dedication of Prof. L.-Y. Oey who was one of the founding fathers of IWMO in 2009 (Oey et al. 2010a, b) and who led the organization for 10 successful years, before passing the leadership baton to a new generation of scientists. During this meeting, a special session was held to honor Professor Emeritus George L. Mellor for his pioneering contribution to ocean modeling, which started some 6 decades ago and continues today with his own contribution to this special issue (Mellor 2019). We would like thus to dedicate this special issue to Professor Mellor and his legacy.

About 80 scientists from more than dozen different countries attended the IWMO 2018 meeting, which included keynote invited speakers, as well as oral and poster presentations on various topics involved ocean modeling, analysis, and dynamics. Continuing with the IWMO tradition, students and postdocs participated in the Outstanding Young Scientist Award (OYSA) competition; forming interactions between senior and young scientists and between scientists from different countries is a hallmark goal of the IWMO idea. The meeting covered a wide range of topics with sessions focusing on air-sea-ice coupled processes, large-scale circulation and climate dynamics, ecosystems/biogeochemical modeling, multi-scale interactions, waves, currents and turbulence, coastal and marginal seas, and the development of ocean forecast systems and data assimilation methods. This topical collection of papers in Ocean Dynamics includes 15 peer reviewed papers from participants of IWMO-2018. The papers went through rigorous reviews as regular papers in Ocean Dynamics, with the help of reviewers from both, IWMO members and external experts. The papers in this topical collection were divided into 4 general groups:

1 Four papers address theoretical and modeling aspects of air-sea interaction, turbulence, and surface mixing processes

Mellor (2019) addressed the issue of surface forcing in numerical ocean models and the distinction between wind-driven drag due to turbulent skin friction and form drag that drives surface waves; the two formulations asymptotically apply to low and high wind speeds, respectively. Equations for air flow over surface gravity waves were formulated for the two processes to describe transfer of momentum, heat, and water vapor across the air-sea interface. Bulk coefficients for various wind speeds were presented and compared with observations—these formulations can help applying surface forcing in numerical ocean models.

Ezer (2019) applied a regional ocean model based on the Princeton Ocean Model (POM) to the US East Coast to simulate air-sea interactions under hurricane conditions and study

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the impact of storms on the Gulf Stream structure and flow. Realistic simulations of Hurricane Matthew (October 2016) were compared with idealized hurricane simulations with different tracks. The simulations show that hurricanes that pass within hundreds of kilometers from the GS can result in a significant disruption to ocean circulation and a long-term weakening in the GS flow that can cause coastal flooding in the days after the storm disappeared.

Kumar et al. (2020) used a coupled ocean-atmosphere-wave-sediment transport (COAWST) model to study sea surface roughness parameterizations and the impact of sea spray on surface gravity waves. Hurricane Isaac (August 2012) in the Gulf of Mexico was used as a test case. The results show that a new sea-spray parameterization performed better than three other existing formulations, demonstrating the important role of sea spray in simulations of winds and waves.

Thomas et al. (2019) investigated the impact of turbulent mixing induced by non-braking surface waves on simulations of sea ice in a global ocean model (MOM5). The wave-induced mixing is parameterized by modification of the k-ε turbulence scheme. The results show improvement in the simulations of the seasonal ice extent compared with observations and an increase in sea ice thickness during the Antarctic summer.

2 Two papers address biogeochemical interactions and modeling

Langa and Calil (2020) used the Regional Ocean Modeling System (ROMS) coupled with a biogeochemical model (PISCES) to study the seasonal cycle of surface chlorophyll in the Northern Mozambique Channel of the Indian Ocean. Sensitivity experiments show how the seasonal cycle of surface chlorophyll is influenced by heat flux and the seasonal monsoon wind field. Analysis of phytoplankton biomass reveals that in this region grazing plays a role in addition to mixed layer and upwelling dynamics.

Ma et al. (2019b) used a one-dimensional physical-biogeochemical coupled model based on ROMS to simulate the variability of the lower-trophic planktonic ecosystem in the South China Sea and the influence of the seasonal East Asian monsoon system. The modeled particulate organic carbon (POC) export flux compared quite well with 7-year long observations from a moored sediment trap. The roles of heat flux and wind-driven mixing in regulating the seasonal cycle of nutrient supply and the growth of phytoplankton in this region were investigated.

3 Three papers address deep ocean and coastal dynamic processes

Berntsen et al. (2019) used the sigma coordinates Bergen Ocean Model (BOM) to simulate dense water overflow in an idealized configuration, following the Dynamics of Overflow Mixing and Entrainment (DOME) setup that was used in many previous modeling studies. The role of model grid resolution and the impacts of bottom drag formulation and eddies were investigated. While the rates of plume's descent along the slope was not very sensitive to horizontal resolution, vertical resolution and drag coefficient influenced the Ekman drainage and how deep the plume reached. Eddy-permitting resolution also increased mixing and along-slope plume transports.

Chen et al. (2019) analyzed 14 years of daily high-resolution satellite SST data to describe the pattern of oceanic fronts on the southeastern continental shelf of Brazil. Empirical orthogonal function (EOF) analysis was used to describe the seasonal variability of the coastal fronts, showing the role of along shore wind stress and wind curl in the frontal activities. Additional factors that influenced the fronts include the shape of the coastline, seafloor topography and the Brazil Current.

Kodaira and Waseda (2019) used a regional ocean model (MITgcm) nested within the operational Japan Coastal Ocean Prediction Experiment (JCOPE) based on POM, to study how the Kuroshio generates cold wakes behind islands in the Northwestern Pacific Ocean. They study events observed by satellites during 2015–2017 and the role that tidal currents, upwelling, and vertical mixing play. The cold-water formation was found to be different for different islands, depending on their topography and the nearby ocean currents.

4 Six papers describe the development and testing of ocean forecast systems and data assimilation methods

Campos et al. (2020) evaluated the National Centers for Environmental Prediction (NCEP) Ensemble Forecast System and its ability to forecast winds and significant wave height. The errors in the forecast system were systematically evaluated using four satellite altimeter missions in 2017. The results show a large reduction in errors in the ensemble mean compared to a control run, but the skill of forecasting extreme significant wave height and winds beyond 5 days is significantly reduced, so post-prediction corrections may be needed.

Costa et al. (2020) described and evaluated the Santos Operational Forecasting System (SOFS), which is based on a version of the ocean circulation model POM nested into a coarse-resolution South Brazil Bight (SBB) model. The system provides short-term prediction of sea surface elevations, currents, temperature, and salinity. Results show that the system simulated well seven storm tides with average skill of 0.95 and average error of 17.0 cm.

Ma et al. (2019a) used the Community Earth System Model (CESM) to study the warm bias of sea surface temperature in eastern boundary upwelling systems, a common feature found in many coupled climate models. The impact of horizontal resolution in the atmospheric models was tested. The results suggest that surface heat flux and Ekman upwelling are major factors in the temperature bias, but underestimation of stratocumulus clouds in the atmospheric model was not an important factor. Increasing horizontal resolution in the atmospheric model resulted in better representation of low-level coastal jets and wind stress that increased upwelling processes.

Miyazawa et al. (2019) evaluated the assimilation of water temperature data obtained from instruments mounted on sea turtles into an operational ocean forecast system (JCOPE2M), which is based on the generalized coordinates version of POM. The turtle data improved the representation of eddies and fronts near the Kuroshio-Oyashio Confluence region and corrected some temperature biases in the model. In some cases, the turtle data were able to capture warm core rings better than standard data previously used.

Santana et al. (2020) tested the data assimilation skill of a triple-nested HYCOM system with special focus on the Cape São Tomé Eddy (CSTE). The model includes the Brazil Current and tides (in the innermost nested grid). Sensitivity experiments evaluated the assimilation of sea level, surface temperature and salinity profiles, and the impact of tides. Model simulated eddies were compared with observed eddies using an eddy tracking algorithm. Assimilation of sea level was found to be the most important factor for representing the CSTE, though assimilation of temperature and salinity were also important for the thermohaline field and eddy motions.

Tanajura et al. (2020) presented and evaluated an operational data assimilation and forecast system for Brazil using HYCOM. The data assimilation is based on a multivariate ensemble optimal interpolation scheme, using temperature and salinity profiles from Argo, as well as satellite SST data and along-track sea level altimeter data. Sensitivity experiments evaluated the usefulness of each data input in simulations of the Atlantic Ocean for 2010–2012. The results show that different observations complement each other, so that each observation type provides improved forecast for different aspects of the forecast system.

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