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EDITORIAL

Editorial to OFES special issue of Ocean Dynamics

Yukio Masumoto · Hideharu Sasaki · Jin-Song von Storch

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Numerical simulation, or ocean modeling, has been a useful method to investigate ocean conditions and to explore mechanisms responsible for their variations. Following pioneering works of Bryan (1969) and Takano (1974), who established a concrete pathway to a new era of ocean sciences, there have been tremendous studies based on numerical modeling method. Together with recent significant advances in computer sciences, we are entering a new stage of high-resolution, eddy-resolving modeling. A high-resolution ocean general circulation model (OGCM) is a powerful tool to investigate phenomena with wide spectra in temporal and spatial scales and their interactions. Recent developments in this research field ensure that such models are capable of representing well relatively small-scale ocean phenomena, such as meso-scale eddies and frontal structures associated with current systems, as well as global/basin-scale circulations. As one of the high-resolution modeling projects running on world top-class super computers, OFES (OGCM for the Earth Simulator) project started just after the establishment of the Earth Simulator in 2002. Following a 50-year climatological spin-up run, hindcast integrations from 1950 to 2008 and additional integrations with CFC tracer and biological processes have been conducted, with a basic concept of sharing outputs within research communities. By April 2010, the outputs from OFES have contributed to more than 50 publications, authored by worldwide scientists, covering various topics: meso-scale eddy behaviors, global energy analyses, intra-seasonal to decadal variability, and marine eco-system of the world oceans.

In order to exchange results from analyses of the model outputs, to share our knowledge on the ocean variations, to stimulate idea of new research directions, and to encourage collaborations among interested scientists, the first OFES International Workshop was held on August 25–26, 2008 in Yokohama Japan. (http://www.jamstec.go.jp/esc/event/ofes-workshop/). Thirty-seven scientists from seven countries participated in the workshop and gave presentations in various topics. A keynote presentation on a brief history of the ocean modeling and the way forward was given by Prof. Kirk Bryan of Princeton Univ. He strongly encouraged to

Responsible Editor: Jörg-Olaf Wolff

Y. Masumoto (✉)
Research Institute for Global Change, JAMSTEC,
Yokohama, Japan
e-mail: masumoto@jamstec.go.jp

H. Sasaki
Earth Simulator Center, JAMSTEC,
Yokohama, Japan

J.-S. von Storch
Max Planck Institute for Meteorology,
Hamburg, Germany

embrace future challenges by exploring the richness in ocean variability using high-resolution OGCMs. Following this successful first workshop, the "2nd OFES International Workshop and ESC–IPRC Joint Workshop on Computationally-Intensive Modeling of the Climate System" was held on December 9–10, 2009 in Honolulu, Hawaii, USA. (http://www.jamstec.go.jp/esc/event/ofes-workshop2/).

This OFES special issue of Ocean Dynamics is a collection of papers based on the talks presented at the two workshops, including nine original articles and one review paper. The review paper, Masumoto (2010), introduces not only model descriptions of a series of OFES simulations but also highlights of various research achievements using OFES results during 2004–2009, providing an overview of the OFES project.

Several articles focus on variability in the Pacific Ocean. Melnicheko et al. (2010) investigate dynamics of a quasi-stationary jet-like structure and suggests importance of linear dynamics for the structure, although the nonlinear processes can obviously be important. Ma et al. (2010) study sea surface height variations along the coast of Japan using both satellite altimetry data and the OFES results. The mechanism that relates these variations to the Kuroshio Extension (KE) via Rossby waves and boundary Kelvin waves is investigated. Taguchi et al. (2010) focuses on low-frequency variability of the KE's recirculation gyres, particularly the gyre to the north of the Kuroshio. Their diagnosis based on the turbulent Sverdrup balance suggests that eddy feedback triggers the change in the northern recirculation intensity. Using output from the OFES biological simulation, Sasai et al. (2010) investigate impacts of meso-scale eddies on marine ecosystem in the KE region. It is suggested that cyclonic eddies make a substantial contribution to the surface chlorophyll concentration south of the KE jet. Sasaki et al. (2010) investigate seasonal variations of the Hawaiian Lee Countercurrent, using the OFES results and satellite sea surface height and wind stress observations. They concluded that the westward-propagating Rossby waves, excited by local wind stress curl near Hawaii, contribute the most to the seasonal variation.

Ogata and Masumoto (2010) investigate interactions between meso-scale variability and Indian Ocean Dipole (IOD) events in the southeastern tropical Indian Ocean. They indicate an important role played by the eddy heat transport during a decaying phase of the IOD events, although the degree of influence changes significantly at each event. Iskandar et al. (2010) also study the effect of cyclonic eddies in enhancing offshore chlorophyll bloom in the southeastern tropical Indian Ocean. The surface chlorophyll bloom is likely induced by the cyclonic eddies through the injection of nutrient-rich water into the upper layer. Aoki et al. (2010) investigate flow structure in the Australian–Antarctic basin. Spatial and temporal characteristics of a cyclonic circulation in the basin are described using the OFES results and validated with iceberg and mid-depth float trajectories. Von Storch (2010) investigates global distribution of vertical velocity field in OFES and its relation to the internal gravity wave generation at the bottom of the Southern Ocean.

The above new findings reported in this special issue provide references for future works and demonstrate one good example of sharing the high-resolution OGCM outputs in the international research community.

Following the success of the OFES project, we have just started new modeling efforts, for example, a higher-resolution Pacific basin model with sea–ice component to partially resolve sub-mesoscale structures and a higher resolution CFES (Coupled GCM for the Earth Simulator) project to explore impacts of meso-scale ocean variations on air–sea coupled phenomena. These new challenges, together with ongoing OFES project, will help the research community to push the frontier of ocean/climate research further ahead.

Finally, we thank all the contributors to this special issue and anonymous reviewers for many constructive comments to the original articles. We also appreciate Prof. Joerg Wolff for providing us with the opportunity to publish this special issue and for his patience in finalizing the issue.

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