Preface

It has long been recognized that the role of the ocean in the earth's climate system is conclusively important in such issues as the global warming, the long-term variability in the air-sea coupled system like ENSO, associated meteorological extreme phenomena, and so forth. In these situations, modeling of the ocean has become an indispensable method of studying the climate variability and predicting its future state as well as studying the mechanisms of the oceanic variability itself.

The Oceanography and Geochemistry Research Department of the Meteorological Research Institute (MRI) developed its original, general-purpose numerical ocean model, the Meteorological Research Institute Community Ocean Model (MRI.COM), in the early 2000s for both the research work in MRI and operational work in the Japan Meteorological Agency (JMA) by combining two ocean models developed for their research work. The ocean modeling activities are maintained under MRI research programs "Development of a high-resolution (eddy-resolving) ocean general circulation model and study on formation, maintenance, and variation mechanisms of water masses based on the model" (fiscal years 2003 through 2007), "Development of an ocean environmental model and assimilation system and study on variation mechanisms of the ocean environment – feasibility study –" (fiscal year 2008), "Development of ocean environmental forecasting methods" (fiscal years 2009 through 2013), and "Research on advanced ocean models" (starting from fiscal year 2014). The MRI.COM was revised as its fourth version. The present publication is the new MRI.COM manual corresponding to the MRI.COM (version 4). The manual has been thoroughly revised from the previous version published in 2010.

The ocean modeling study in MRI began in the late 1970s for investigating the variability of the Kuroshio south of Japan. First, an ocean model with the primitive-equation system developed by former Prof. K. Takano in UCLA, USA, was introduced. Another ocean model was then introduced slightly later in 1981. It was similar to the former but developed by an ocean research group in the University of Tokyo. Since that time, the two ocean models with different codes have been improved in parallel in MRI for various purposes. The former model from UCLA has been vigorously optimized to exhibit a high computational efficiency in vector machines, and has been used in experiments with long-term integrations. The latter model from the University of Tokyo incorporated many options from the early stage, such as a surface mixed layer model, an isopycnal diffusion scheme, and a simple sea ice process, for various research and operational purposes.

In the early 1990s, the first coupled ocean-atmosphere model experiment was conducted through cooperation between the Oceanographic Research Department (at the time) and the Climate Research Department, MRI, to simulate El Nino phenomenon. Since then, construction of a climate model synthesizing atmosphere, ocean, sea ice, and land surface has been strongly desired both for research and operational work associated with climate warming projection and seasonal forecasts, including the ENSO cycle prediction. To this end, development of a new, general-purpose ocean model, MRI.COM, which could provide the oceanic part of the synthetic climate model, has been initiated based on the two ocean models used so far to achieve efficiency in model improvement and management and to integrate their merits. In designing the new model, the main frame of the former model and the various physical options of the latter model were transferred to the new model, and many newly developed physical processes and schemes were added.

Since 2010 in which the first English version of the MRI.COM manual was published, the model has been continuously updated through further improvements in physical processes and addition of new processes. One of the most pronounced improvements in MRI.COM (version 4) is the introduction of a new vertical coordinate system (z^* coordinate system) which better represents the shallow area in coastal modeling. The introduction of a new two-way nesting scheme which accurately conserves water and heat has the benefit in climate modeling. This makes it possible for an ocean model to seamlessly handle climate change and coastal disaster prevention. Recent achievements have been fruited in this manual.

MRI.COM has been developed along with its own usage as a part of the climate model and the ocean data assimilation system in MRI as well as stand-alone experiments. MRI.COM has already been in operation at JMA for 9 years, contributing to providing reliable information such as seasonal prediction and ocean prediction. Based on our experiences,

we believe MRI.COM is one of the best ocean models in the world. I express special thanks to the present and past participants in the model development for their great deal of efforts and help. We hope MRI.COM and the present manual will contribute to research work in the fields of climatology, oceanography, and environmental sciences in domestic and foreign institutions as well as to the research and operational work in MRI and JMA.

Tsurane Kuragano
Director
Oceanography and Geochemistry Research Department