Development of an operational system for monitoring and forecasting coastal and open ocean states around Japan.

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MOVE/MRI.COM-JPN is the next operational system for monitoring and forecasting ocean state around Japan, and is currently under development at the Meteorological Research Institute (MRI) of the Japan Meteorological Agency (JMA). This system is scheduled to be operated in the JMA in a few years later to provide information not only for monitoring and forecasting ocean state but also for preventing coastal disasters such as abnormal sea level and storm surges. The whole system consists of three versions of the Ocean General Circulation Models (OGCM) for the global ocean (GLB), the North Pacific (NP) and the seas around Japan (JPN) and a four-dimensional variational (4DVAR) assimilation system used for the North Pacific Ocean model and its adjoint model (NP-4DVAR).
All the OGCMs used in the system are built based on the Meteorological Research Institute Community Ocean Model (MRI.COM). The domain of the JPN model extends from 117°E to 160°E zonally and from 20°N to 52°N meridionally. The horizontal resolution is about 2 km: 1/33° in the zonal direction and 1/50° in the meridional direction. The model has 60 levels in the vertical direction, with the layer thickness increasing from 2 m at surface to 700m at 6500-m depth. The z* vertical coordinate in the latest version of MRI.COM (ver.4.0) allows the models to set the minimum of the bottom depth to 8 m. A two-way on-line double-nesting method is used for downscaling from GLB to NP and from NP to JPN. The surface forcing of the wind stress and heat fluxes is subtracted from JRA55-do, calibrated dataset for driving ocean circulation based on the Japanese 55-year Reanalysis (JRA-55). The explicit tidal forcing and depression/suction by sea level pressure are incorporated into MRI.COM-JPN.
NP-4DVAR uses MOVE-4DVAR, which is extended from a multivariate three-dimensional variational (3DVAR) analysis scheme using vertical coupled temperature and salinity EOF modes for the background covariance matrix, MOVE. In-situ temperature and salinity profiles above 2000m-depth, satellite-based sea surface temperature (SST) and sea surface height (SSH) data are assimilated in NP-4DVAR. Incremental analysis updates (IAU) are applied for initializing temperature and salinity fields in NP-4DVAR for the first 3 days during the 10-days assimilation window. Both JPN and NP models are initialized by IAU based on the temperature and salinity analysis fields derived from NP-4DVAR.
The experiment in 2009 is carried out by using MOVE/MRI.COM-JPN. To evaluate the reproduction of sea level variability in MOVE/MRI.COM-JPN, we use the independent tide gauge data around the coastal area in Japan. We compare the daily-mean time series of sea level among MOVE/MRI.COM-JPN, free run simulation using the MRI.COM-JPN (JPN-free) and tide gauge data processed by a tide killer filter. These data include the variability caused by sea level pressure. The sea level variability in MOVE/MRI.COM-JPN well captured the variability of the tide gauge data from weekly to monthly time scales. This is attributed to the improvement of the synoptic scale variability through the inclusion of explicit sea level pressure representation and the mesoscale variability (such as eddies) by the initialization of NP-4DVAR. The correlation (root-mean-square difference) of sea level time series between MOVE/MRI.COM-JPN and tide gauge data are higher (smaller) than those between JPN-free and tide gauge data, indicating that MOVE/MRI.COM-JPN has the high potential of forecasting phenomena in the coastal seas.

キーワード：現業システム、沿岸モデル、データ同化
Keywords: operational system, coastal model, data assimilation