# Impact of the spatial-temporal filtered increments for the high-resolution model

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Japan Meteorological Agency (JMA) provides some information such as sea surface temperature, ocean currents, and sea levels using operational ocean systems. The next operational system for monitoring and forecasting ocean state around Japan is under development at the Meteorological Research Institute (MRI) of the JMA. This system mainly consists of the Ocean General Circulation Model for the seas around Japan (forecast model) with about 2 km horizontal resolution and an assimilation system for the North Pacific Ocean model (analysis model) with about 10 km eddy-resolving horizontal resolution. The explicit tidal forcing and depression/suction by sea level pressure are incorporated into the forecast model to represent realistic sea level variations. Control variables of temperature and salinity above 2000 m for the analysis model are optimized by a four-dimensional variational method using observations such as in-situ temperature and salinity profiles, satellite-based sea surface temperature and sea surface height anomaly derived from satellite altimeters.
Initialization for the forecast model is conducted by incremental analysis updates (IAU) scheme. Temperature and salinity increments for the forecast model are calculated against the results of the analysis model. This method can incorporate mesoscale signals reproduced by the analysis model into the forecast model and the representation of the small-scale variations relies on the forecast model. However, there are two major different features between the forecast and analysis models. First, the horizontal resolution for the forecast model is about 2-km which can represent smaller scale variations than the analysis model with 10-km resolution. Second, only the forecast model includes the tidal forcing which would cause large vertical motions by the internal gravity waves around the sharp terrain such as the Izu ridge. These differences may lead to weaken the high spatial-temporal variations in the forecast model. To solve these problems, spatial-temporal filtering is needed when calculating the increments.
For the forecast model, we conducted some experiments applying the horizontal Gaussian filtering with 5, 10, and 20 km e-folding scale when calculating the increments. The differences between the experiments with and without the spatial filtering can be largely seen the Kuroshio Extension and Kuroshio around the south of Japan and seem to be typically 100-km horizontal scale and 4 to 5 days temporal period. It implies that the representation of the small-scale perturbations is different between the models with and without the spatial filtering. Especially, in the southern region of Japan, the perturbations along the Kuroshio would attach the Cape Ashizuri (southwest edge of Shikoku Island) and/or the Cape Muroto (southeast edge of Shikoku Island) and affect the sea level variations uniformly in the western and/or eastern Seto Inland Sea. Furthermore, it seems that larger the smoothing scale is applied, more the short-term variations are intensified. To represent the sea levels around the Japanese coasts well, the appropriate spatial filtering when calculating the increments will be required. For the temporal filtering, a low-pass cosine filter with the Lanczos window will be applied for the forecast model to reduce the diurnal and semi-diurnal tidal effects when calculating the increment. The impacts of the temporal filtering will be given in the presentation.

Keywords: operational system, coastal model, ocean data assimilation, spatial-temporal filtering

 