The JCOPE ocean forecast system

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INTRODUCTION

Recent development in the global ocean observation system such as the ARGO enables us to effectively forecast oceanic conditions on a real-time basis. As a part of the Japan Coastal Ocean Predictability Experiment (JCOPE), we have developed a high-resolution ocean forecast system. The routine prediction of oceanic variation ('ocean weather forecast'), combining with in-situ verifications, will significantly contribute to improve atmosphere-ocean models for prediction of longer-term climate change.

MODEL

The present ocean model is based on one of world community models, which is called Princeton Ocean Model (POM). A high-resolution, regional model with spatial grid of 1/12 degree and 35 sigma levels is embedded in a low-resolution basin-wide model with spatial grid of about 1/4 degree and 21 sigma levels (Fig.1). The former model domain covers the northwestern Pacific ocean(117E-180E, 12N-56N) and its lateral boundary condition is specified using the one-way nesting method (Guo et al., 2003) from the latter model. The model is driven by wind stresses, and heat and salt fluxes. The wind stress and heat flux field are calculated from the 6-hourly NCEP/NCAR reanalysis data and the QuikSCAT Near-Realtime (NRT) data product using the bulk formula. The salinity at the surface is restored to the monthly mean climatology with a time scale of 30 days. Synoptic variations in the northwestern Pacific ocean are well simulated using the high-resolution model (Miyazawa et al.,2002).

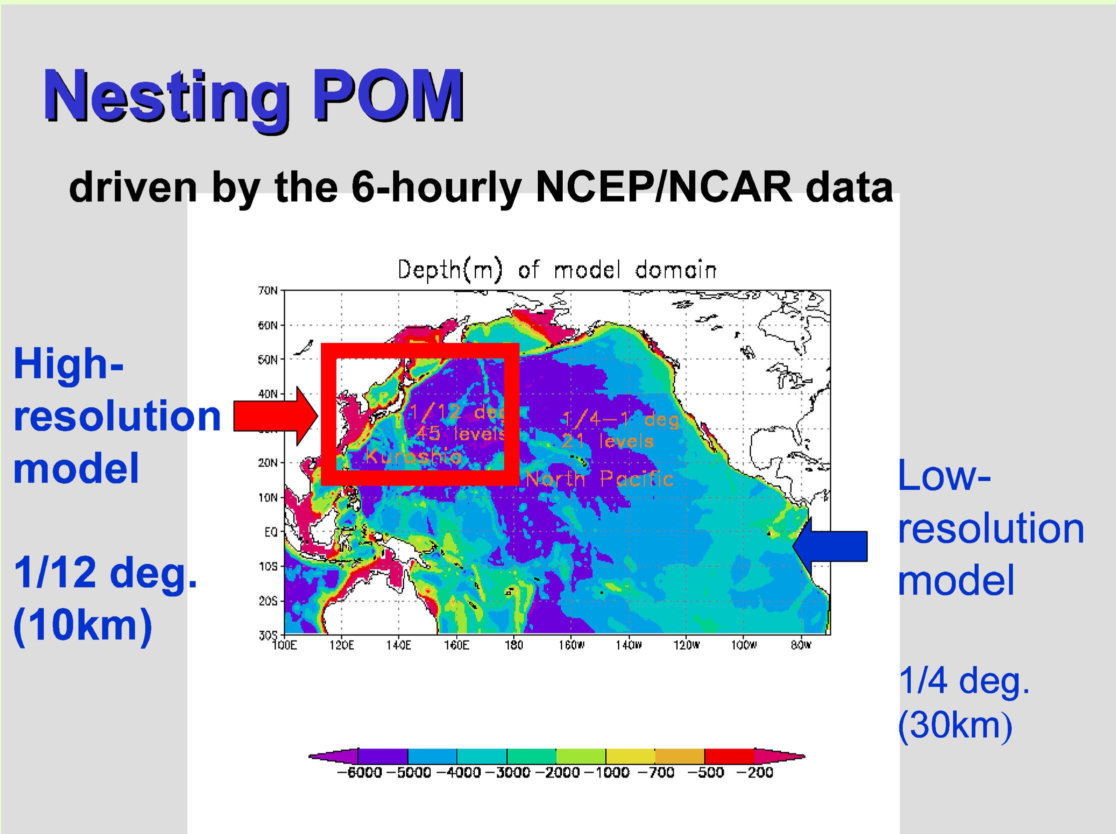

Figure 1. Bottom topography of the JCOPE model

FORECAST SYSTEM

Using an optimum interpolation (OI) method, weekly mean various data are created from sea surface height anomaly (Jason-1 and Geosat Follow On), sea surface temperature (NOAA/AVHRR), and subsurface temperature/salinity profiles including the ARGO data (GTSPP). To consistently assimilate those data into the model, the multivariate optimum interpolation method is adopted to estimate the analysis data of temperature/salinity in vertical column. The analysis data are smoothly introduced into the model using the Incremental Analysis Update(IAU). Two months forecast run driven by the monthly mean climatological surface forcing is weekly updated.

DATA ASSIMILATION

The data assimilation creates the initial state with root mean square (RMS) error of about 1 deg.C for temperature and 0.2 psu for salinity (Fig.2). Magnitude of the RMS error, which depends on the simulation skill, the assimilation method and the quality of the data, is consistent with that of the OI error (not shown).

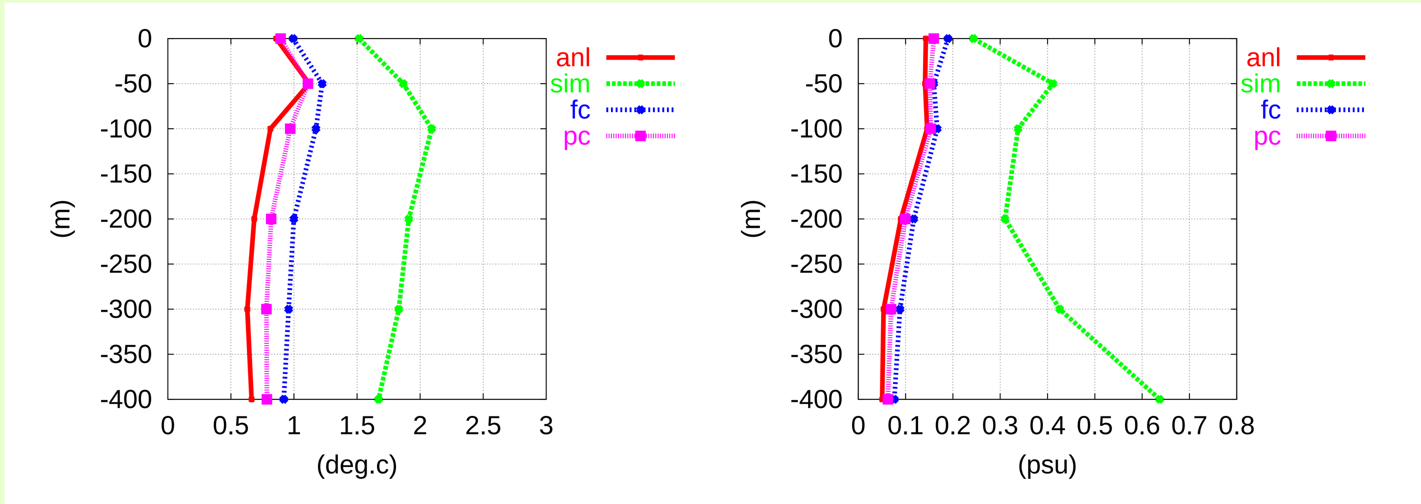

Figure 2. Vertical profiles of RMS error for temperature (left) and salinity (right) during the period from 6 Sep. 2002 to 26 Feb. 2003. 'anl': analysis(assimilation). 'sim': simulation. 'fc': 3.5 days forecast. 'pc': persistence for 3.5 days forecast.

Assimilating subsurface temperature/salinity profiles improves the surface high-salinity water distribution in the subtropical front as well as meso-scale features associated with variations of the Kuroshio and the Kuroshio Extension (Fig.3).

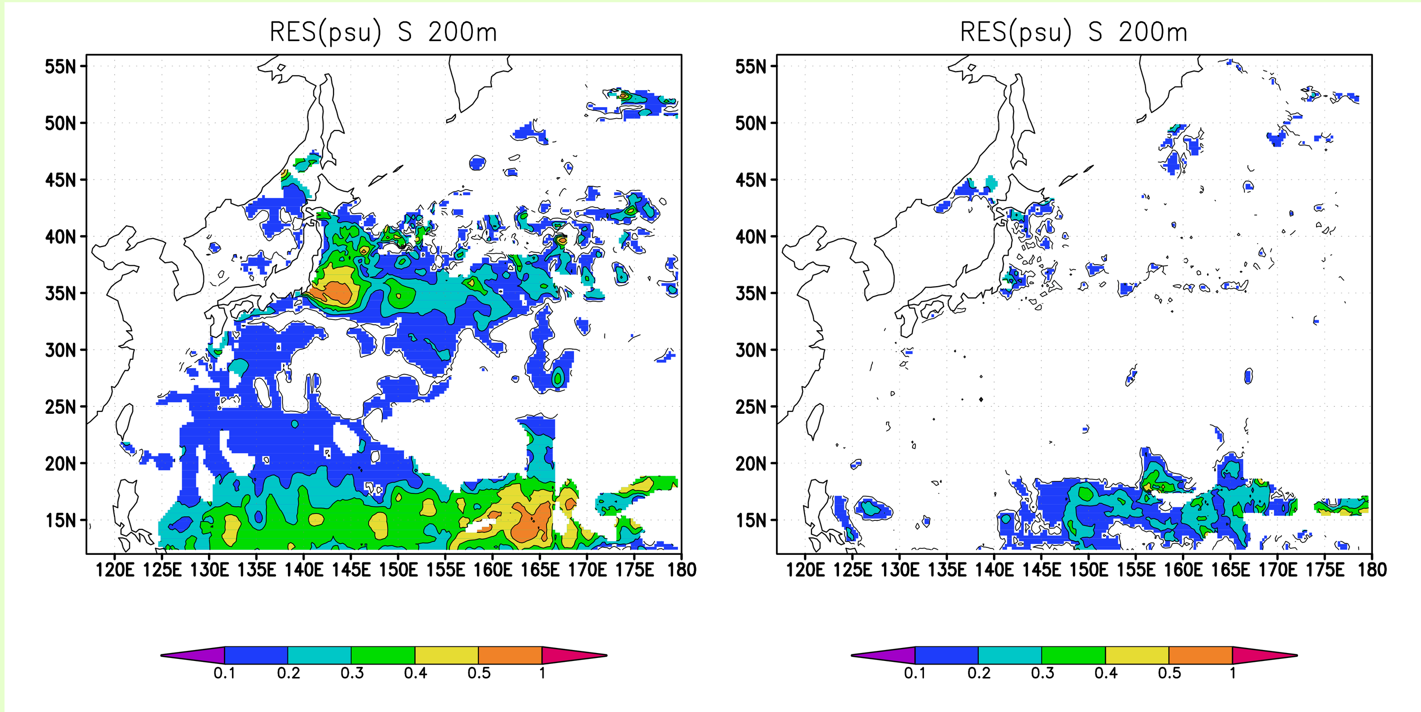

Figure 3. RMS error for salinity at 200m during the period from 6 Sep. 2002 to 26 Feb. 2003. Left: simulation. Right: assimilation.

FORECAST

The system has shown a forecasting skill of about one month during the real-time experiment in 2003 (Fig.4:left). In particular, the system has successfully predicted a small meander propagating eastward along the Kuroshio south of Japan during March-May 2003 (Fig.4:right and Fig.5). However, the right panel of Fig.4 shows that the system failed to predict a rise of the sea level difference between Kushimoto and Uragami in June 2003 due to decay of the meander. Increasing vertical levels of the model, we are trying to improve the forecasting skill for this event.

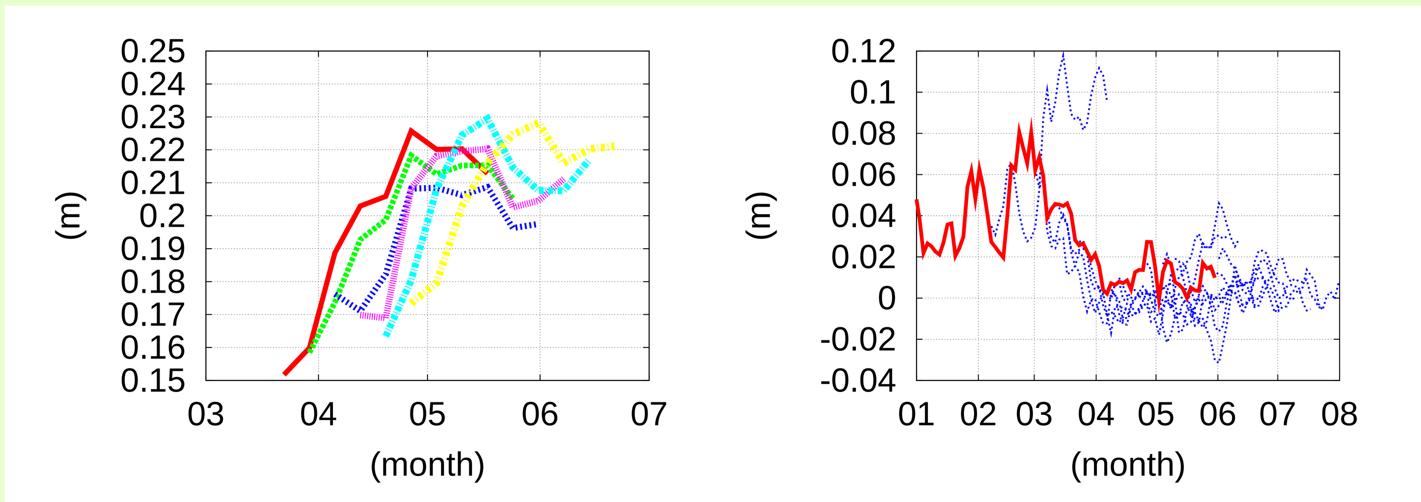

Figure 4. Results from the forecast in 2003. Left: evolutions of RMS error for sea surface height anomaly. Right: evolutions of sea level difference between Kushimoto and Uragami. Dotted lines (blue): forecasts. Thick line (red): assimilation.

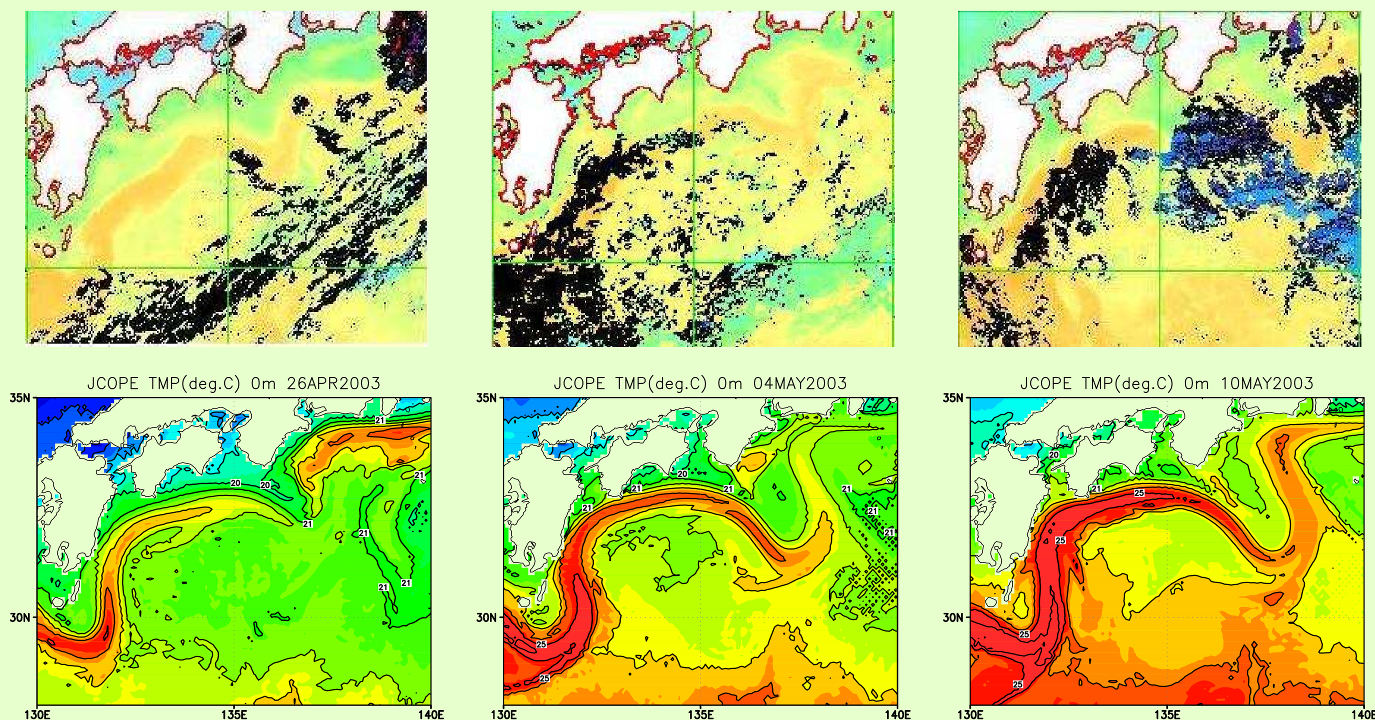

Figure 5. Snapshots of sea surface temperature from 26 April to 9 May 2003. Upper: observation from the NOAA satellites provided by the Japan Coastal Guard. Lower: forecast of the JCOPE system from 16 APR. 2003.