Development of a regional ocean reanalysis system in the China Seas

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Abstract

A regional ocean reanalysis system in the China seas and the adjacent sea area has been developed recently. The regional ocean model in use is a parallel version of Princeton Ocean Model with generalized coordinate system (POMgcs). A global version of the MIT general circulation model (MITgcm) is employed to provide open boundary conditions for the regional ocean model. A sequential three-dimensional variational (3DVAR) analysis scheme has been designed and implemented in both the regional and global model, using a multi-grid framework. Such sequential 3DVAR analysis scheme can be performed in three dimensional spaces which is totally different from the traditional 3DVAR that is practically performed on each model level with the vertical correlations ignored. This sequential 3DVAR analysis scheme can retrieve resolvable information from longer to shorter wavelengths for a given observation network and yield multi-scale, analysis. The ocean model is forced by National Centers for Environmental Prediction (NCEP) reanalysis surface wind stress (combining QuikSCAT observing wind fields), heat and water fluxes. By assimilating the oceanic observation data into the model, including satellite remote sensing sea surface temperature (SST), altimetry sea surface height (SSH), temperature and salinity profiles taken from Argo and WOD05 maintained by NODC, and ocean database maintained by NMDIS (China), the reanalysis fields of sea surface height, temperature, salinity and current in the China seas and the adjacent sea area are produced which spans 20 years from 1986 to 2005.

1. Overview

A regional ocean reanalysis experiment in the China Seas has already been started three years ago. The project is supported by the Ministry of Science and Technology of China for the purpose of sharing and service of ocean scientific dataset. The present ocean reanalysis system has been achieved using almost all available data obtained from satellites, Argo floats and ships to produce regional ocean reanalysis.

2. Ocean model

The present regional ocean model is based on one of world community models, general coordinate system of Princeton Ocean Model (POMgcs). A Parallel version of POMgcs has been developed by ourselves. The model domain covers the China Seas, extending from 10˚S to 52˚N and 99˚E to 150˚E. The model grid spacing is varied from 1/8˚ to 1/2˚ which produces a moderate number of grid points in the model domain reducing the computational time. The vertical 35-level is a combination of sigma and z-level. The mixed temperature surface layer and tidal front in the China Seas can be well simulated by considering the effect of wave-breaking and tides in POMgcs (Fig. 1) .

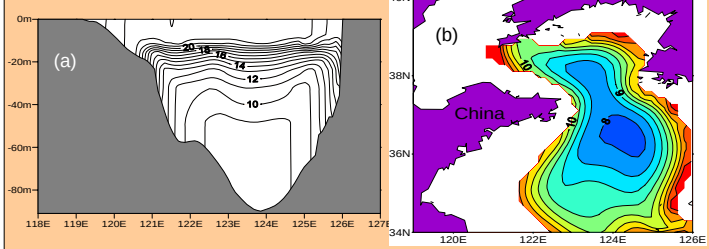

Fig. 1 Model simulated temperature of 35° N (a) and 50m (b) in July .

3. Surface forcing

The model is driven by wind stress, and heat and water fluxes. The wind stress and heat flux field are calculated from the 6-hourly NCEP/NCAR reanalysis data combined with the QuikSCAT data product using the bulk formula.

4. Data

The model assimilates three types of data: sea surface temperature (SST) from Reynolds grid analysis data, temperature/salinity profiles (0m-1000m) which includes both the Argo and ship data, and sea surface height anomaly (SSHA) from T/P、Jason-1、ERS-2 and Envisat (http://www.jason.oceanobs.com).

5. Data assimilation scheme

A sequential three-dimensional variational (3DVAR) analysis scheme has been designed to assimilate temperature and salinity using a multi-grid framework (Li, et al 2008). The sequential 3DVAR analysis scheme can be performed in three dimensional spaces which is totally different from the traditional 3DVAR that is practically performed on each model level with the vertical correlations ignored. It can retrieve resolvable information from longer to shorter wavelengths for a given observation network and yield multi-scale analysis. A similar variational scheme proposed by Yan et al (2006) is used to convert SSHA into temperature and salinity increments, that combined with the model background fields, are used as background for the assimilation of in situ temperature and salinity.

6. Reanalysis experiment and on-going evaluation

A 20-year (1986-2005) reanalysis experiment is performed and the reanalysis fields of temperature, salinity, current and sea surface height are produced.

We are now validating the reanalysis results using various indices. Some preliminary quality checks are given here (Fig. 2, 3 and 4). Further validation of the reanalysis results is in progress for the preparation of the public release of the dataset.

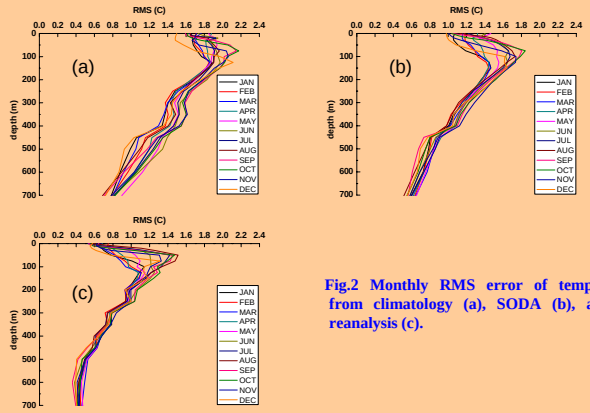

Fig.2 Monthly RMS error of temperature from climatology (a), SODA (b), and the reanalysis (c).

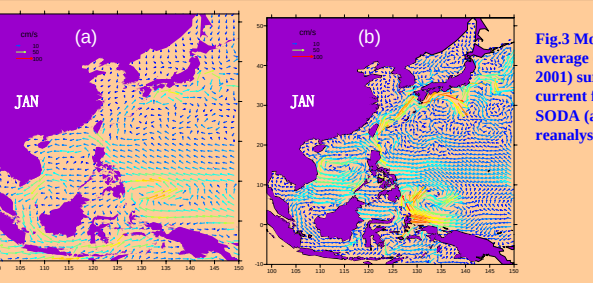

Fig.3 Monthly average (Jan. 2001) surface current from SODA (a), and the reanalysis (b).

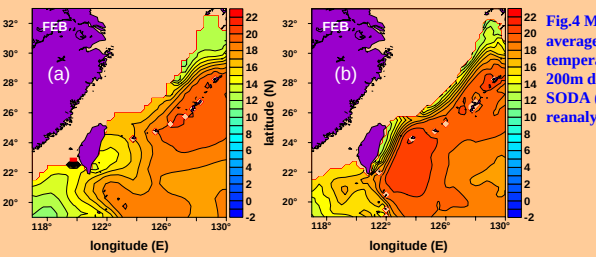

Fig.4 Monthly average (Feb. 2000) temperature on 200m depth from SODA (a), and the reanalysis (b).

References

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