International Journal of Distributed Systems and Technologies
Volume 8 • Issue 2 • April-June 2017

Application of HY-2 Satellite SST Data in 4D Variational Assimilation Ocean Forecast Model

Zhenchang Zhang, Fujian Agriculture and Forestry University, Department of Computer Science, Fuzhou, China
Libin Gao, Fujian Agriculture and Forestry University, Department of Computer Science, Fuzhou, China
Minquan Guo, Fujian Marine Forecasts, Fuzhou, China
Riqing Chen, Fujian Agriculture and Forestry University, Department of Computer Science, Fuzhou, China

ABSTRACT

The 4D variational (4DVAR) assimilation numerical ocean model research is proposed. This model for Taiwan Straits (TWS) is based on Regional Ocean Model System (ROMS). The background of the 4DVAR method is introduced and the development process of assimilation system is presented. In the present research, the model assimilated with Sea Surface Temperature (SST) data of HY-2 satellite (Qi, 2012; Xu, 2013) which is the first marine environmental monitoring satellite of China. In this paper, the model processes from Feb. 1 to Feb. 7, 2014 with one-day assimilation time window and root mean square error (RMSE) reduces averagely by 14.7%.

KEYWORDS

4D Variational, HY-2 Satellite, ROMS, Taiwan Straits

INTRODUCTION

The observation data is precious and is the first-hand information in ocean research. Many countries pay a large amount of human and material resources to collecting the ocean observation data. Nowadays, it is a hot research topic that combining the observation with numerical model and improving the forecast performance of the model. 4D-var assimilation method is one way to solve this problem. This method integrates different space-time observations into a numerical model through physical and temporal constraints.

In generally, the numerical model makes some simplification on the parameters of discrete equation, so its dynamic model is not perfect. Data assimilation method compensate for this disadvantage by observations. Data assimilation method is applied in the weather forecast system firstly. During forecast process, the error of model will increase exponentially. So in long-term forecast, continual assimilation method should be adopted to constraint the error growth.

The operational ocean forecast system based on ROMS and indicated that the 4D variational assimilation method can be applied in the complex ocean dynamical environment.

DOI: 10.4018/IJDST.2017040102

ROMS (Regional Ocean Model System)

ROMS is a free-surface, terrain-following, primitive equations (Shchepetkin & McWilliams, 2005) ocean model, developed by Rutgers University and University of California, Los Angeles. It can be used for a diverse range of applications, such as circulation in global scale, mesoscale water level and flow field caused by meteorological or astronomical tide. In the horizontal, the primitive equations are evaluated using boundary-fitted, orthogonal curvilinear coordinates on a staggered Arakawa C-grid. The vertical mixing parameterization in ROMS is based on the level 2.5 turbulent kinetic energy equations by Mellor and Yamada (1982). To improve the computational efficiency, the problem of 3D flow with free surface is separated into the problem of exterior wave propagation (exterior modal) and internal wave propagation (internal modal). The model has been widely applied on numerical simulation in the regions to circulation simulation at different scales (Budgell, 2005; Dinniman, 2003; Haidvogel, 2000; Lorenzo, 2003; Marchesiello, 2003; Peliz, 2003; Wilkin, 2005; Warner, 2005a).

Research Region

The model research region is from 111.4E to 125.2E and 14.48N to 28.43N (Figure 1) with the resolution grid of 1/32º. The model has 25 vertical sigma (or terrain-following) layers and is integrated with a four-dimensional variational data assimilation algorithm (4DVAR). The surface layer is dense so that it can reflect the complex vertical structure of the mixed sea surface layer, the thermocline and the halocline. The structure is identical on the bottom of the sea, so the bottom of the sea layer is thin. The maximum water depth is 5500 meters in the model region. In order to ensure that model is not affected by tide, the least of water depth is 10 meters.

The factors of temperature, salt, flow and water level are considered in open boundary control parameters, the sea surface heat flux and dialysate from rivers are also considered in model.

ASSIMILATION METHODS

Data assimilation attempts to combine observed and predicted values of the state variables of a system in an optimal way to achieve the best possible estimate of the true state (Powell, Arango, Moore, Lorenzo, Milliff, & Foley, 2008). There are many methods for data assimilation, such as Kalman

Figure 1. Model region (Taiwan Straits and adjacent region)