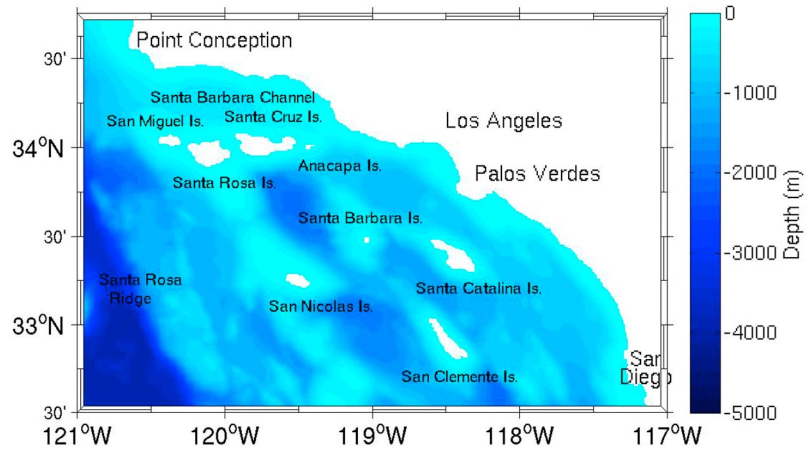

Figure 1. The numerical model domain. The color denotes the water depth.

surface current data and obtained an eddy data set. Based on in situ and remotely sensed measurements and numerical modeling, *Caldeira et al.* [2005] suggests that island wakes represent a mechanism for generation of the submesoscale eddies. To further understand the eddy generation and evolution processes in island wakes, *Dong and McWilliams* [2007] applied a high-resolution (1 km in its horizontal resolution) numerical model to study island wakes in the SCB. The model shows that eddies in lee sides of islands are generated by either an oceanic current passing islands or oceanic response to the wind wake due to the wind passing over the islands. Using the same model as *Dong and McWilliams* [2007], *Dong et al.* [2009a] integrates the model for eight-year (1996–2003) and makes extensive verifications against observational data available including satellite remote sensing, HF radar, and in situ data. The eight-year numerical solution suggests that the circulation in the SCB has multiple-scale variations. Its surface eddy variation is in an inter-annual variation and is in phase with the variation in the sea surface wind curl.

[4] Most of the former eddy studies in the SCB are focused on the sea surface and little is known about the vertical structures of eddies in the region. In this paper, we apply a high-resolution numerical product used by *Dong et al.* [2009a] to study three-dimensional eddy structures and variations (the product has been extended to 2007 and so the numerical product covers 12 years from 1996 to 2007). First of all, an eddy data set is set up by identifying mesoscale and submesoscale (i.e., smaller than the first baroclinic deformation radius) eddies from the numerical product and then statistical analysis is applied.

[5] The rest of the paper is composed of five sections: Section 2 describes the 12-year high-resolution numerical product. Section 3 briefly introduces an eddy detection and tracking scheme used and an approach to construct three-dimensional eddy structures. In section 4 a series of statistical analysis is applied to an eddy data set identified from the numerical product using the eddy detection scheme. Section 5 emphasizes the eddy analysis in the Santa Barbara Channel (SBC) region during September when the Radiance in a Dynamic Ocean (RaDyO) experiment conducted (T. Dickey et al., Introduction to special section, manuscript in preparation, 2012). Section 6 concludes the paper with discussions and summary.

2. The Numerical Product

2.1. Description

[6] The numerical product used in this study is generated using the Regional Oceanic Modeling System (ROMS). The ROMS solves the rotating primitive equations [*Shchepetkin and McWilliams*, 2005] with a generalized sigma-coordinate system in the vertical direction and curvilinear grid in the horizontal plane. A third-order, upstream-biased advection operator allows the generation of steep gradients in the solution, enhancing the effective resolution of the solution for a given grid size when the explicit viscosity is small. The numerical diffusion implicit in the third-order upstream-biased operator allows the explicit horizontal viscosity to be set to zero without excessive computational noise or instability. The vertical eddy viscosity is parameterized using a K-profile parameterization (KPP [*Large et al.*, 1994]).

[7] The model is configured in three levels of nested grids with the parent grid covering the whole U.S. West Coast. The first so-called child grid covers a large southern domain, and the third grid zooms in on the SCB region. The three horizontal grid resolutions are 20 km, 6.7 km, and 1 km, respectively. The external forcings are momentum, heat, and freshwater flux at the surface and adaptive nudging to gyre-scale SODA reanalysis fields [*Carton et al.*, 2000a, 2000b] at the boundaries. The momentum flux is derived from a three-hourly reanalysis mesoscale MM5 [*Grell et al.*, 1995] wind product with a 6 km resolution for the finest grid in the SCB. The oceanic model starts in an equilibrium state from a multiple-year cyclical climatology run, and then it is integrated from years 1996 through 2007. The first eight-year simulation at the 1 km resolution has analyzed and compared with extensive observational data collected: High-Frequency (HF) radar, current meters, Acoustic Doppler Current Profilers (ADCP), hydrographic measurements, tide gauges, drifters, altimeters, and radiometers [see *Dong et al.*, 2009a]. Comparisons with observational data reveal that ROMS reproduces a realistic mean state of the SCB oceanic