Dynamics of Atmospheres and Oceans 61–62 (2013) 35–45

Contents lists available at SciVerse ScienceDirect

Dynamics of Atmospheres and Oceans

journal homepage: www.elsevier.com/locate/dynatmoce

Impact of remote forcing, model resolution and bathymetry on predictions of currents on the shelf

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ARTICLE INFO

Article history:
Received 14 November 2012
Received in revised form 28 February 2013
Accepted 1 March 2013
Available online 14 March 2013

Keywords:
Coastal circulation
Ocean modeling and prediction
Coastally-trapped waves
USA/California/Monterey Bay

ABSTRACT

Impacts of remote forcing, model resolution and bathymetry on current predictions at two moorings located on the shelf of the Monterey Bay area are investigated. We consider three Monterey Bay model configurations which differ in resolution and bathymetry representation, and we specify open boundary conditions for these three configurations from two larger scale models, which have different accuracy in the representation of the remote forcing (in the form of poleward propagating along the coast coastally-trapped Kelvin type waves).

Comparisons of correlations between observed and model currents as well as visual comparisons show that the most critical element in reproducing currents on the shelf is accurate representation of the remote forcing. Our results also show that accurate representation of bathymetry is the second most critical factor in reproducing observed currents.

Published by Elsevier B.V.

1. Introduction

The objectives of the August 2006 field experiment, called Adaptive Sampling and Prediction (ASAP), were mostly focused on the study of the properties of the upwelling center at Año Nuevo

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0377-0265/$ – see front matter. Published by Elsevier B.V.
http://dx.doi.org/10.1016/j.dynatmoce.2013.03.001

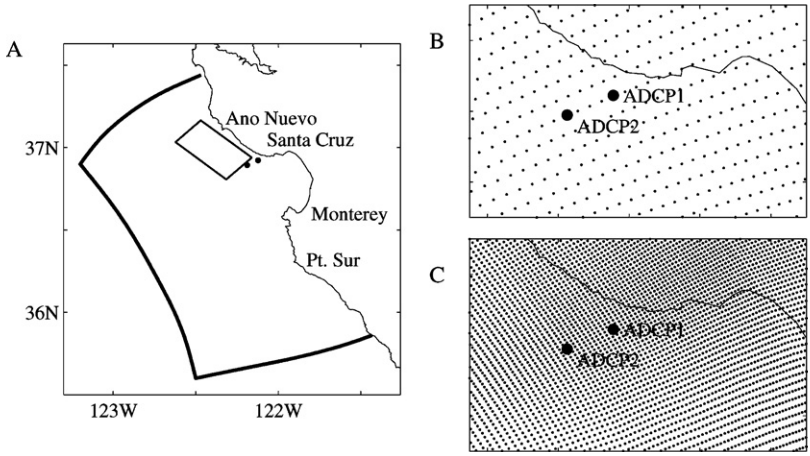

Fig. 1. (A) The Monterey Bay modeling domain with locations of ADCP1, ADCP2 and the ASAP glider sampling domain to the north of the ADCPs. (B) Grid resolution around ADCPs for MBS1 and MBS2 configurations. (C) Grid resolution around ADCPs for MBS3.

to the north of the Monterey Bay (Ramp et al., 2011; Leonard et al., 2010; Shulman et al., 2010). For this reason, the extensive sampling was conducted inside of an approximately 1000 km^2 box (Fig. 1), where a fleet of ten gliders under autonomous control were deployed for a period of 30 days, and research aircraft observed the fluxes through the sea surface. Two bottom-mounted acoustic Doppler current profilers (ADCPs) were deployed about 6.5 km apart to the south of the ASAP box (Fig. 1), to monitor the currents over the continental shelf (Ramp et al., 2011). Despite being only 6.5 km apart, ADCP moorings 1 and 2 responded differently to the sequence of upwelling favorable winds separated by brief relaxations. Predictions from three simulations of the Monterey Bay area based on the Harvard Ocean Prediction System (HOPS), the Regional Ocean Modeling System (ROMS), and the Navy Coastal Ocean Model (NCOM) were quantitatively compared with the observed currents at the two moorings' locations on the shelf (Ramp et al., 2011). All three model simulations, with well-established performance at larger space and time scales, had difficulty reproducing the current variability in this small sample region around mooring locations (with relatively better performance in the alongshore than a cross-shore directions). It was speculated that one of the reasons is that model open boundary conditions could not capture remote forcing in the form of alongshore pressure gradient forces or coastally-trapped waves, which propagate from south to north with the coast on the right in this region. Other considered reasons were that very high horizontal resolution (at least 0.5 km) and more accurate representation of bathymetry are needed to reproduce currents variability on the continental shelf (based on relatively better performance of the finer resolution simulation based on the HOPS system). Because the three considered modeling systems had so many differences in specification of open boundary conditions, data assimilation schemes, bathymetry, horizontal and vertical resolution, parameterization, and ways of applying atmospheric conditions, it was difficult to sort out reasons for model difficulties in reproducing currents in the framework of the Ramp et al. (2011) study.

The objective of this short follow up to Ramp et al. (2011) paper is to use one model (NCOM) and identify the impacts of remote forcing, model resolution and bathymetry representation on the model current predictions on the shelf. For doing these we consider three NCOM configurations which differ in resolution and bathymetry representation and we specify open boundary conditions for these three configurations from two different larger scale models, which have different accuracy in the representation of the remote forcing (the coastally-trapped Kelvin type waves).

The structure of the paper is as follows: Section 2 describes observations, Monterey Bay model configurations and open boundary conditions used in this study. The design of model runs is described in Section 3, Section 4 presents results of experiments and Section 5 is devoted to conclusions and discussions.