DATA ASSIMILATION MODEL STUDY OF THE SANTA BARBARA CHANNEL SURFACE CIRCULATION

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INTRODUCTION

The circulation pattern in the Santa Barbara Channel (SBC) is very complex. The region is affected by strong wind, meandering California Current, and large-scale pressure forcing (Harms and Winant 1998). To understand the regional surface circulation pattern, the Minerals Management Service (MMS) has sponsored a comprehensive field program, the SBC-SMB Circulation Study, to monitor the circulation and water mass properties in the Santa Barbara Channel and Santa Maria Basin (SMB). The first field deployment from October 1992 to January 1996, includes ten current meter moorings and six National Data Buoy Center (NDBC) weather buoys. At each mooring, temperatures are measured at six depths between surface and bottom (100 m) and currents are measured at 5 m and 45 m below the surface. The field program is aided by a coastal ocean model component to help with the data interpretation as well as to provide a consistent flow analysis. A validated circulation model can be used to analyze and forecast surface particle trajectories, among other applications.

WIND STRESS, CIRCULATION AND TEMPERATURE STRUCTURES

The wind stress field is derived from the six NDBC buoys through an objective mapping (Chen 1998). In winter, coastal winds are variable, marked by passing storms. During the spring and summer seasons, winds become persistent and are predominantly from the northwest. They are strong along the southern central California coast, but are 'blocked' by headlands near Point Conception. The wind jet veers offshore, creating steep horizontal wind shears in the western entrance of the SBC (Winant and Dorman 1997). The wind stress exceeds 0.2 Pa near San Miguel Island (dark red). It is less than 0.05 Pa (blue) in the western SBC. (Figure 1). (The map is rotated 52 degrees.) Mean circulation in the SBC is strong and persistent during the spring and summer upwelling seasons (March - August). It consists of a poleward current on the northern shelf and an equatorward current on the southern shelf. Off Point Conception the mean current is equatorward. The three-dimensional coastal ocean circulation model is driven by the daily wind stress. The hindcast period is from January to August 1994 during which the spatial data coverage is more complete. The model hindcast is in a data-assimilation mode based on a local

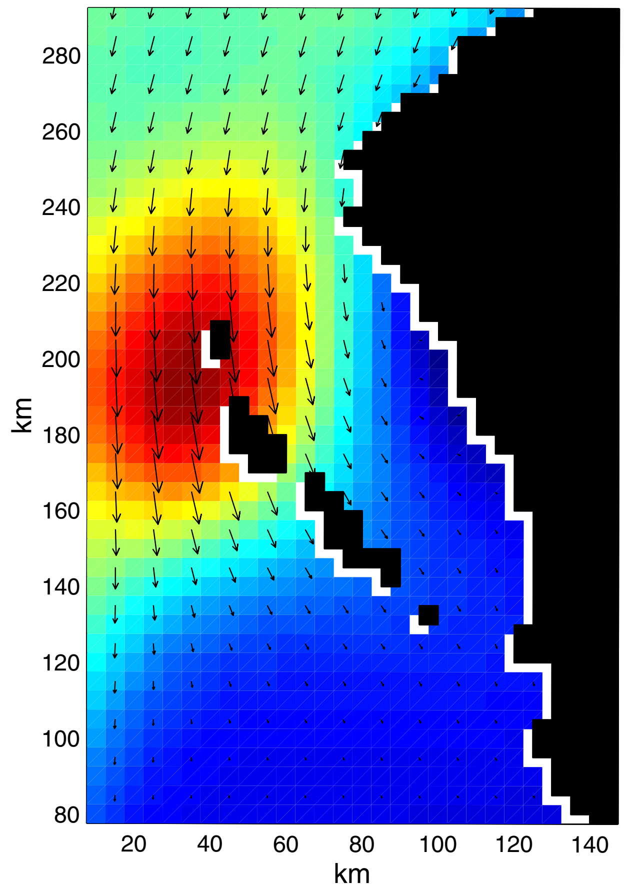

Figure 1. The seasonal mean wind stress distribution interpolated from the buoy data.

correction scheme (Chen and Wang 1999). The mooring temperature data is assimilated daily. The effect of salinity on the buoyancy is included.

Model results indicate an offshore flow in the SMB, a cyclonic eddy in the western basin of the SBC and a poleward flow in the eastern basin (Figure 2). These results agree quantitatively with the current meter mooring measurements. Comparison of the seasonal mean currents between model and observation shows an offset of only few cms^{-1}. The major flow features are reflected in the model temperature distribution. The SMB is cold (~ 12^{o}C) and the SCB is warm (~ 16^{o}C). The cyclonic eddy brings the cold water into the SBC, whereas the poleward current brings the warm water northward.

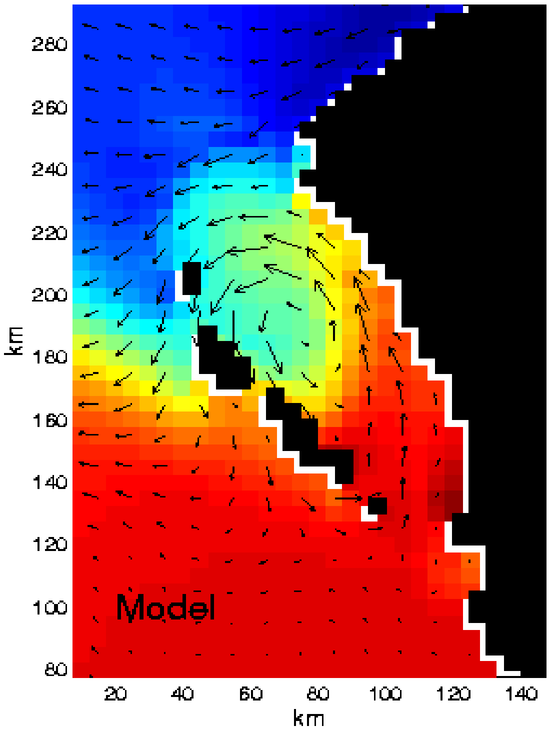

Figure 2. The seasonal mean surface velocity and temperature distributions derived from the model simulation.

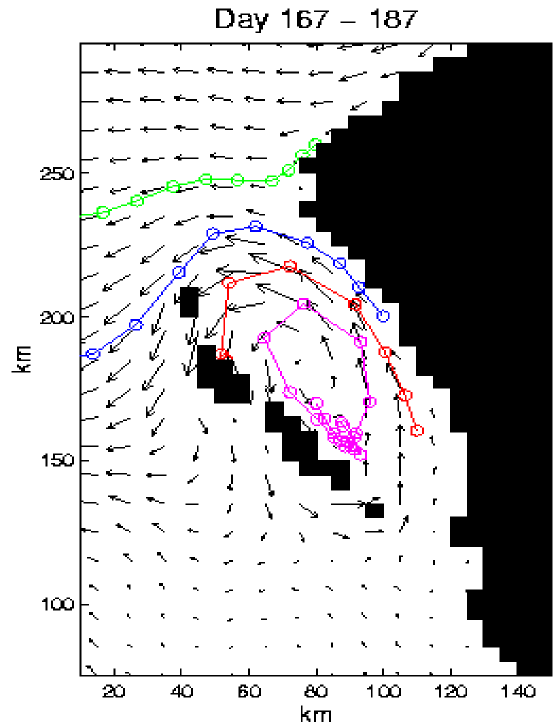

Figure 3. Selected particle trajectories released at different locations.

Selected particle trajectories are computed from the model flow field. The example shown is for a 20 day period (Figure 3). Four drifters are released at day 167, and are tracked. (Circle marks a daily interval.) The 20-day averaged flow vectors are overlapped. Drifters starting near Point Arguello move offshore. Drifters released on the northern shelf initially move up the coast. One leaves the channel but the other beaches on Santa Rosa Island. Drifter released near Santa Cruz Island makes a complete loop in the channel, and becomes stagnant near Chinese Harbor.

CONCLUSIONS AND MANAGEMENT IMPLICATIONS

The numerical model is capable of simulating the seasonal (monthly) mean circulation and temperature structures in the SBC. The model hindcast provides a robust analysis, representing possibly the best synthesis (map) of the point observations. The model, at present, tends to underestimate the shorter-term velocity fluctuations.

Our understanding of the circulation pattern in the SBC-SMB is far from complete. Significant progress has been made through comprehensive observation and modeling studies. This improved knowledge base can be used for informed management of coastal resources. For example, dispersion of materials may be evaluated from analysis of the simulated particle trajectories.

ACKNOWLEDGMENTS

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LITERATURE CITED

Chen, C.-S. 1998. Coastal model simulation of the Santa Barbara Channel circulation. Ph.D. dissertation, Marine Sciences Research Center, State University of New York, 85 pp.

Chen, C.-S., and D.-P. Wang. 1999. Data assimilation model study of the Santa Barbara Channel circulation. Journal of Geophysical Research 104:15727-15742.

Harms, S., and C. D. Winant. 19998. Characteristic pattern of the circulation in the Santa Barbara Channel. Journal of Geophysical Research 103:3041-3065.

Winant, C. D., and C. E. Dorman. 1997. Seasonal patterns of surface wind stress and heat flux over the Southern California Bight. Journal of Geophysical Research 102:5641-5653.