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GLOBEC: Moored Current Observations Along the Eureka LTOP Transect

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The over-arching goal of GLOBEC North Pacific is to understand the effects of climate variability and climate change on the distribution, abundance and production of marine animals in the eastern North Pacific. A combination of shipboard and moored observations has been deemed essential to establish the linkages between physical forcing and biological response. Moorings are essential to quantify the scales of the variability, and to understand the different processes occurring north and south of Cape Blanco. This proposal is to deploy and maintain (for four years) a 300 kHz, bottom-mounted, upward-looking ADCP on the 84 m isobath at mid-shelf along 40.9° N, the Eureka "LTOP" line. This mooring will be very similar to the one presently being maintained along the Newport line by Mike Kosro (Oregon State University). We will collaborate with Dr. Kosro and other investigators conducting the shipboard LTOP transects to compare and contrast the physical oceanography over the shelf north and south of 42° N, and show how the physical dynamics contribute to zooplankton and juvenile salmon survival.

The objectives of the proposed experiment are:

- Monitor the temporal variability of the currents and bottom temperature over the continental shelf off Eureka, from tidal to interannual scales.
- Collect the corresponding wind stress and sea level data from the nearby NOAA offshore buoys and coastal stations to examine the forcing functions.
- Relate the observed current structure over the shelf to the surface wind stress and coastal sea level within a dynamically consistent framework.
- Correlate changes in the physical indices with the population health of key GLOBEC target species of interest (zooplankton, salmonids) as determined by cooperating investigators.
- Compare and contrast the variability south vs. north of Cape Blanco and its impact on coho and chinook salmon growth, retention, and survival.

Hypotheses to be tested:

- The timing of the outward migration of juvenile salmonids with respect to the occurrence of the spring transition off the Oregon coast is a key factor in determining the initial survival rate and year-class strength.
- The separation of the coastal jet at Cape Blanco, and associated rich mesoscale structure inshore of the jet to the south, plays an important role in the health of the salmon stocks to the north and south of 42° N.
- A greater onshore component of the wind stress near Eureka (just north of Cape Mendocino) may trap nutrients closer to shore than elsewhere, providing a more productive food chain which contributes to the improved health of the southern vs. northern salmon stocks.

Proposed Research

We propose to deploy a bottom-mounted upward-looking acoustic Doppler current profiler (ADCP) at mid-shelf along the Eureka LTOP line at 40° 52.5' N, 124° 20.0' W, 14 km offshore, on the 90 m isobath. This site was chosen using scientific, practical, and historical considerations: The site is near a well-known shipwreck and is avoided by fishermen [R. L. Smith, personal communication] and is the location where a single mooring was maintained from February 1982 through March 1983 as part of the SuperCODE

experiment [Denbo et al., 1984; Denbo and Allen, 1987; Strub et al., 1987]. Following several catastrophies along the Coos Bay line, this mooring went unmolested for the duration of its deployment. It is also ideally located for characterizing the mid-shelf variability along the Eureka LTOP line.

The instrument to be used will be an RD Instuments Inc. 300 kHz broadband unit in a trawl-resistant housing, and will sample bottom temperature and the currents in the water column from just off the transducer heads to near the surface in 4-m bins. The instrument's range is sufficient to reach the surface, but the sampling capability is limited by side-lobe reflection off the surface in the last few bins. The instrument will be deployed in April 2000 from the proposed LTOP transect cruise by Oregon State University and will be maintained at six-month intervals, also on the proposed LTOP cruises. No additional ship time is requested for this effort, assuming the Eureka LTOP cruises are executed by some group of investigators. The final recovery will be scheduled for April 2004, which provides a four-year time series and leaves the final 8 months of the grant for dedicated analysis. The mooring in conjunction with the Eureka LTOP line will result in a data set comparable to that being collected along the Newport line by OSU. As described below, there are several objectives and hypotheses which can be addressed by the Eureka mooring alone, and others that will be addressed by comparing the two data sets from north and south of Cape Blanco.

Previous observations at this site consisted of two Aanderaa current meters moored at nominally 36 and 66 m depth [Denbo et al., 1984; Denbo and Allen, 1987]. The mean alongshore currents were small with respect to the rest of the coast with values of (-0.6, 3.1) cm s-1 at (36, 66) m respectively. This would suggest longer retention of organisms in the area than in other regions along the coast. The greater, poleward mean at the deeper instrument is fairly typical of the west coast shelf and is due to the greater presence of the undercurrent along the bottom. The low-passed current vectors were coherent across these depths and fluctuated at approximately monthly periods at about (20 cm s^{-1} amplitude but occasionally larger. This may be due to wind-forced reversals of a generally poleward flow or may also be due to poleward propagating waves in the intra-seasonal band. The general tendency towards barotropic poleward flow over the continental shelf off the U.S. west coast in the absence of strong equatorward wind stress has been noted by several previous investigators [Winant et al., 1987; Lentz, 1987; Kosro, 1985; Ramp and Abbott, 1998]. The monthly waves are prevalent in moored observations to the south [Ramp et al., 1997b] but have been less prevalent off Oregon.

The important across-shore transport is difficult to discern from these limited point measurements. Moored ADCPs on the other hand have been used to successfully observe and model the across-shore flow including the surface and bottom boundary layers for a single mooring 10 km off Point Sur [Ramp and Abbott, 1998]. These authors added the bottom boundary layer to a simple, unstratified model [Csanady, 1982] for the wind-forced setup near the coast to study the vertical structure of the daily-averaged currents. This model showed the importance of the nearby coastline, which caused the current vectors to back counterclockwise with depth, rather than clockwise in the usual, open-ocean sense. They also used the model to extrapolate the observed current vectors up to the surface to examine the integrated across-shore mass balance. This balance took place mainly in the boundary layers, with the across-shore flow at mid-depth fueling the spin-up of the alongshore geostrophic jet. The proposed observations off Eureka can be analyzed in a similar way. The greater distance from shore (14 vs. 10 km) and different coastline orientation with respect to the prevailing alongshore wind stress will no doubt call for some modifications to the theory which will become apparent during the analysis. The new observations will clearly advance our knowledge of the shelf dynamics off Eureka with respect to the limited observations presently published in the literature. Further, the availability of similar observations along the northern California / Oregon shelf will allow the transport and dynamics at the different locations to be compared.

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