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PROPERTIES OF NEARSHORE CURRENTS

During this past year, we have initiated a program to obtain a better understanding of the properties of the currents flowing over the nearshore shelf area of southern California. This region, which extends from the coast to a depth of about 100 m, is the area in which most of the wastewater discharges take place; hence, dilution and distribution of wastewater constituents will be closely related to the characteristics of these currents and the exchange of shelf and offshore water. In spite of the importance of this information, relatively little is known about these flows, particularly at the depths at which the effluent is likely to be trapped. Some clues are provided by previous current meter measurements conducted by Los Angeles County Sanitation Districts personnel for the Whites Point area (analyzed at the Project and discussed in previous reports).

We have expanded this type of information to include other areas, particularly the region between Los Angeles and San Diego and plan to extend the area to Point Conception. In addition to using current meters, which conveniently record the time and direction variability of the currents at a particular location, we are also making measurements with drogues; these become involved in the motion of the water mass and hence approximate the path of a particle released in the water column.

One of the more important types of current information relates to their persistence, i.e., how long the water flows in one direction. The presence of currents with tidal periodicity has long been recognized, but little was known about longer persistence currents until the Whites Point measurements. These data, taken at a depth of 45 m in a water depth of 60 m, indicated the presence of long-duration flows (greater than 1 week), which in turn provide a mechanism for flushing the outfall area more effectively than the random motions associated with eddy diffusion. We wanted to determine if this observation was in fact representative of typical flows on the nearshore shelf or merely a special circumstance.

To examine the persistence of the currents, we have used an analytical method (Fourier Transform) that represents the original current measurements as a collection of component currents, each of which has a different persistence or periodicity. The strength, or amplitude, of each of these components then represents the amount of variability in the original record that has the same period of oscillation as that component. For example, one would expect the component with a period of about 12.4 hours to have a large amplitude because semidiurnal tidal currents are expected to be present. The results of this analysis for data taken off Whites Point, La Jolla, and Point Loma, which confirm this, are illustrated in Figure 1. The meters were located 15 m off the bottom in water depths ranging from 53 to 61 m. A strong signal is evident at a periodicity corresponding to a semidiurnal tide, and a somewhat reduced signal is present at a diurnal tidal period (approximately 1 day, although this signal has been spread some-what in the Whites Point record due to some indeterminate sampling interval variations in the original data). A large contribution to the observed currents with periodicities of greater than 4 days is also evident, with the greatest similarity occurring in the Whites Point and La Jolla cur-rents (which were measured over approximately the same length of time and season, but in different years). This feature indicates that currents with durations of several weeks are probably common in these areas. The existence of these long-duration flows not only has significance for dispersion estimates but also demonstrates that short-term measurements of currents on the nearshore shelf (e.g., measurements for a few days during each season) will not give representative data: Rather, the result will depend on the direction of flow and strength of these more persistent flows during the sampling intervals. In addition, interference effects between different tidal components can make even tidal current measurements uncertain over this short a time period. An example showing different flow characteristics for two 3-day periods a week apart is shown in Figure 2.

The contribution of long-period fluctuations to the onshore/offshore component of the flows is considerably less, as might be expected by the presence of a coastal boundary.

The importance of the length of the sampling period should be kept in mind when comparing the distributions of observed speeds for the locations and seasons, shown in Figure 3. Median speeds fall between 4.0 and 9.7 cm/sec, but this variability is reduced when similar seasons are compared over long sampling periods (e.g.. Whites Point and La Jolla in late summer and fall).

We also measured the currents near the bottom along the axis of Santa Monica Canyon. These flows would be expected to differ from those over the nearshore shelf because of the channeling effect of the canyon walls. As expected, the crosscanyon flows are substantially less than those along the canyon axis. In addition to the strong semidiurnal periodicity, with a peak component amplitude of 7.5 cm/sec, there was a persistent downcanyon flow that averaged 5.5 cm/sec for the 22 days of measurement.

In addition to current meter measurements in the Point Loma/La Jolla area, on three occasions, we also followed parachute drogue movement at a depth of 40 m (comparable with the current meter observations). In every case, the drogue movements closely followed the bottom contours (see Figure 4), suggesting that effluent may move substantial distances up or down coast before significant mixing with offshore water takes place. Observations of the distribution of outfall-related sediments support this conclusion. An alongshore trend is intuitively expected, and is observed in the current meter records, but it is not nearly as pronounced as in the drogue movements.

During the March 1975 study, a current meter was installed at a Point Loma location about 6 km south of the initial drogue positions so that we could compare the predicted and observed motion of the drogues. The alongshore movement of the drogues was relatively well predicted by the current meter over an 8-hour period of intensive observation, with average predicted and observed velocities of 9.4 and 9.1 cm/sec respectively, although there were some variations between the observations and predictions during this period. The onshore/offshore movement of the drogues was not predicted well by the current meter, however, indicating that caution should be exercised in using a meter observation to estimate transport in this direction.

Another interesting observation made during this drogue study was that a pair of drogues did not spread apart as rapidly as would be predicted by normal eddy diffusion calculations. However, as only two drogues were used, additional observations would be required before one could conclude that eddy diffusion is suppressed in the sub-thermocline waters on the nearshore shelf.

In summary, persistent flows with durations on the order of a week or longer and magnitudes comparable to the tidal currents are probably a common occurrence on the nearshore shelf. These flows are important in flushing an outfall area; hence short-term current measurements are inadequate for estimating the dispersion and dilution of effluent constituents. Measurements at a depth of 385 m in Santa Monica Canyon indicated that a downcanyon flow of 5.5 cm/sec persisted for the entire 3-week period of record. Typical speeds observed on the nearshore shelf were on the order of 7 to 10 cm/sec but ranged from 0 to 50 cm/sec. Observations of the movement of parachute drogues at a depth of 40 m show that currents closely follow the bottom topography. There was also some indication that eddy diffusion processes are weaker than normal in the subthermocline waters over the shelf. Studies relating to eddy diffusion and the exchange of shelf and offshore water are planned for the coming year.

Figure 1. Fourier component velocities (alongshore direction).

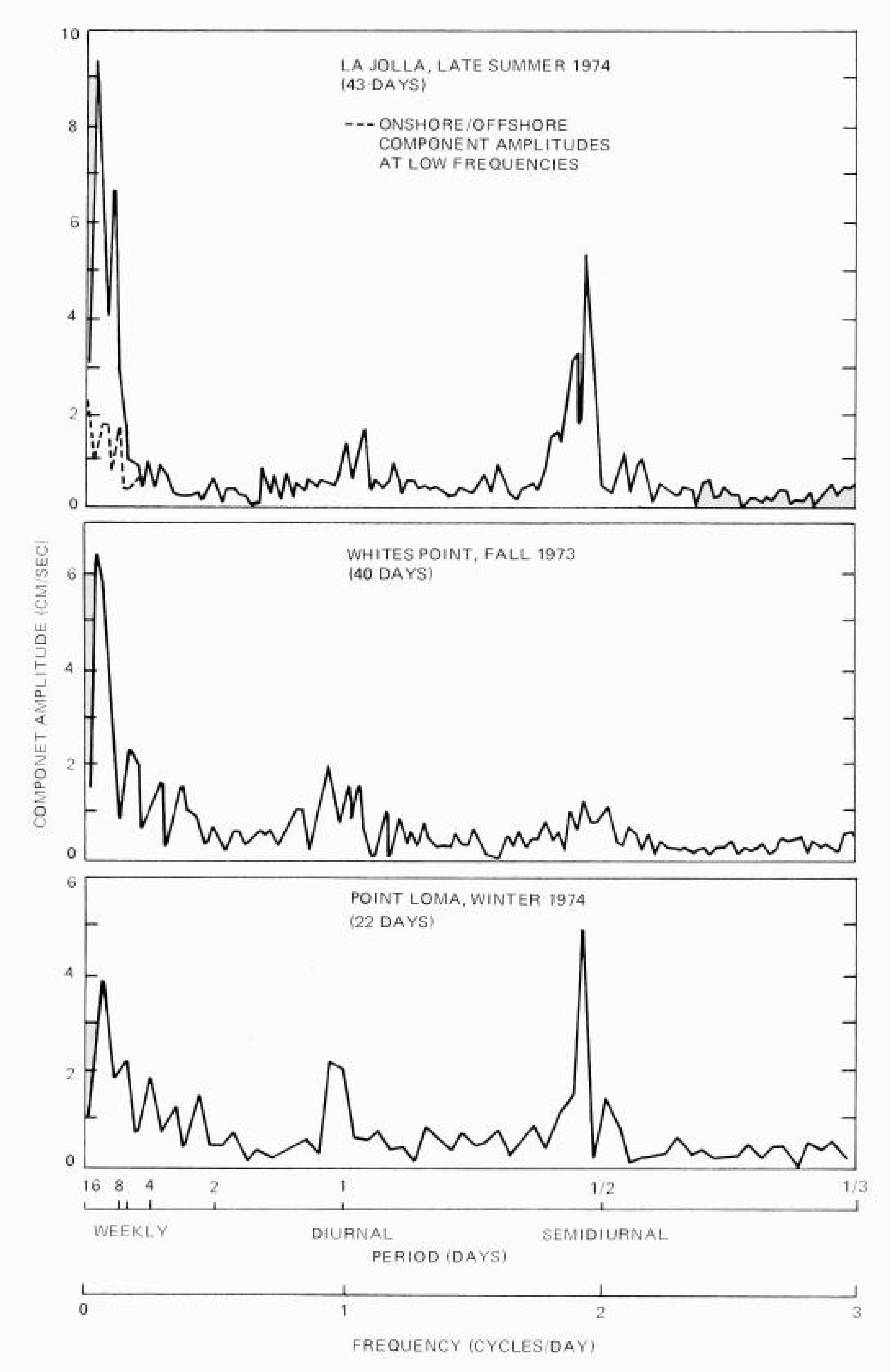

Figure 2. Alongshore current at 40-m depth (55-m water depth) off Point Loma, March 1975, showing considerably different flow conditions only a week apart.

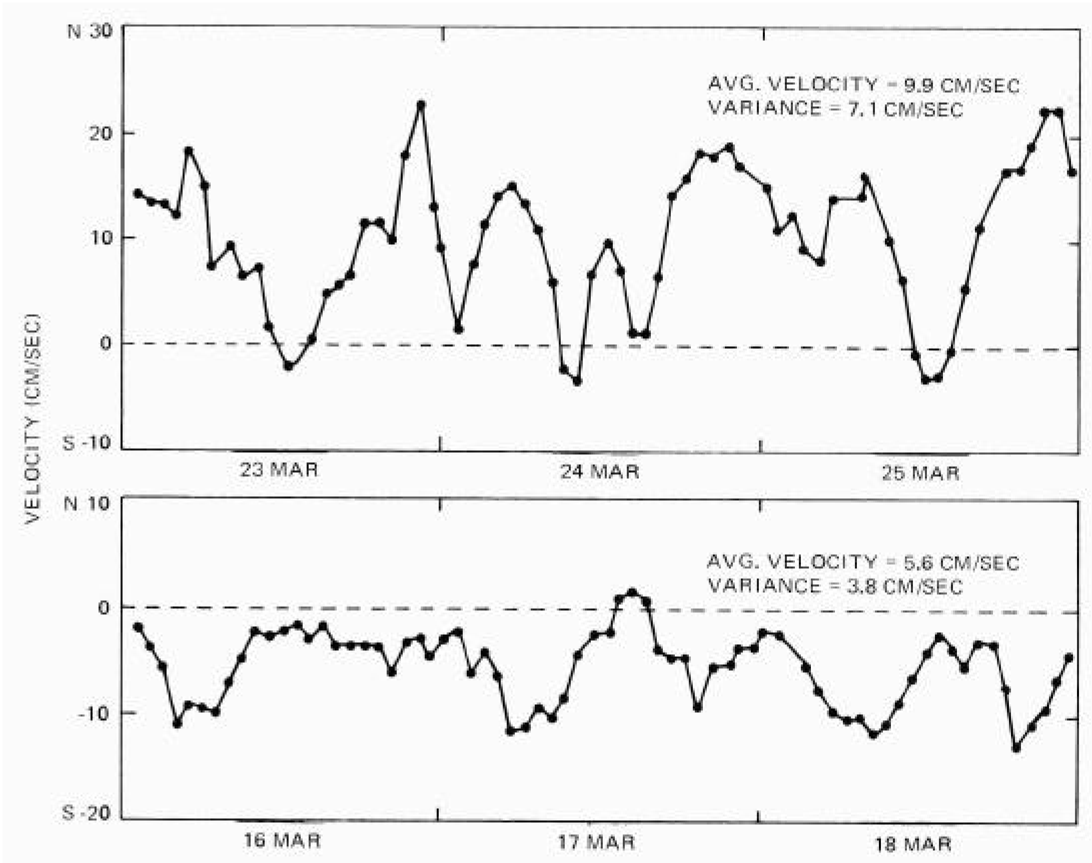

Figure 3. Distribution of observed current speeds.

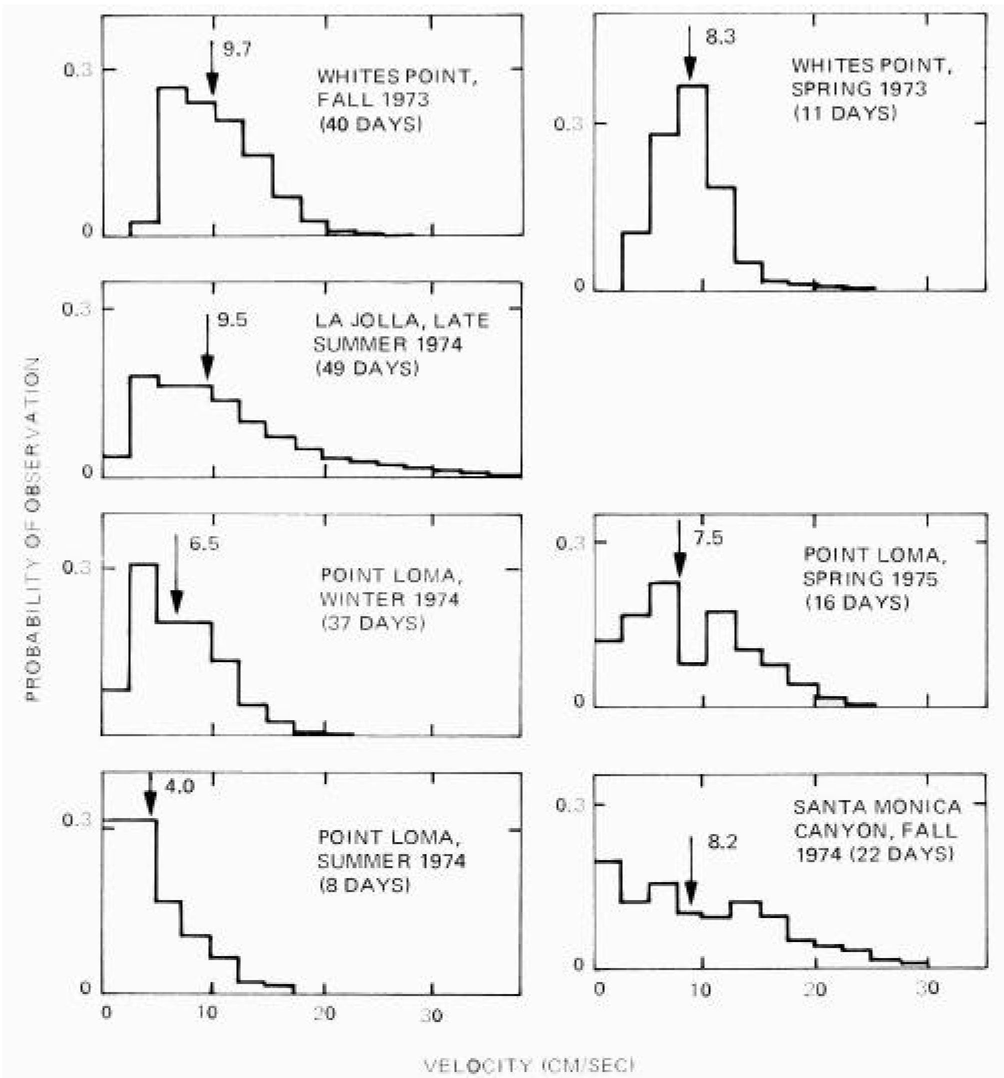

Figure 4. Trajectories of 40-m deep drogues in the Point Loma/La Jolla area. Space between dots corresponds to a 1-hr interval.