ESTIMATE OF THE CAPACITY OF NEARSHORE WATERS TO DISPERSE DISCHARGED EFFLUENTS

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Full-scale prediction of the spatial-temporal distribution ofeffluent concentration around a discharge in nearshore watersrequires extensive plume-modelling applied to a variety ofreceiving-water conditions representing the long-term statistics ofcurrents and density stratification. As a preliminary step, it is useful to have a rough estimate of the spatial distribution of vertically-averaged long-term mean concentration of effluent, to predict the ranges along and across the shelf over which the effluent may have appreciable effects on the environment. This kind of rough estimate may be obtained by treating the matter as a diffusion problem, with time-varying diffusivity estimated from the autocovariance functions of long local current records.

In principle, an accurate estimate of long-term diffusivity can only be made from the Lagrangian autocovariance of the velocities of a large set of drifters or dye-marks released from the same point at random intervals over a long period of time (taking the time as zero at the release of each drifter), and not from the Eulerian autocovariance derived from a current-record at a fixed point. In the limit of small times, however, both kinds of autocovariance give the same-time varying diffusivities $K^i = w_i^2 t$, in which w_i^2 is the long-term variance of velocity in the i^{th} direction. The differences at longer times will not generally spoil a rough estimate.

To deal with a nearshore discharge over a sloping bottom, the diffusion problem may solved for a space in the shape of a long wedge, bounded by sea-bottom and the surface, with the apex at the shoreline. Taking the discharge as uniform from top to bottom allows the generally unknown vertical diffusivity to drop out of the solution, and gives vertically-averaged concentrations due to the total discharge. The solutions show concentrations directly proportional to discharge rate and inversely proportional to bottom slope, the long-term standard deviation of current velocity, and the square of the distance from shore to the discharge.

An estimate for a continuous cooling water discharge of 1000 m^3/sec (ELWANY *et al.*, 1990) into southern California waters, 2.5 km from shore with an average bottom slope of .006, gave long term mean concentrations of discharged water near the shore as about 9 parts per thousand 5 km alongshore from the discharge and about 5 parts per thousand at 10 km alongshore (Fig. 1). The effect of a long-term mean longshore current of 2.9 cm/sec was to displace the whole pattern of concentration about 2 km downcurrent (Fig. 2).

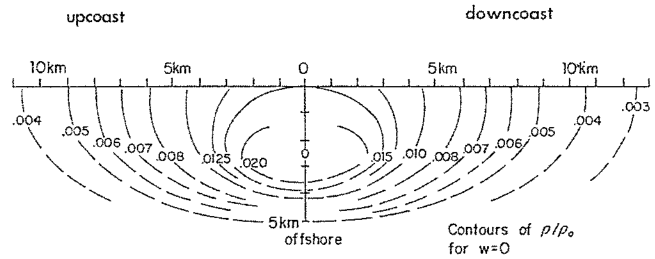

Figure 1. Contours of relative concentration ρ/ρ_0 with no mean current (W = 0)

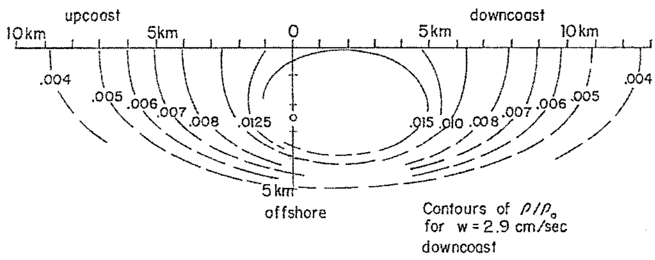

Figure 2. Contours of relative concentrations ρ/ρ_0 with for mean current W = 2.9 cm/sec downcoast.

REFERENCES

ELWANY, M. H. S., J. REITZEL and M. R. ERDMAN, 1990. Modification of coastal currents by power plant intake and thermal discharge systems. Coastal Engineering, v. 14 p. 359 - 383.