M.S. 85–JOSEPH, M.G.–Studies on mixed layer depth in the Arabian Sea–1987–Dr. D. Sreenivasan

Mixed layer depth distribution in the Arabian Sea is mainly influenced by southwest and northeast monsoons and respective reversals of currents and gyre systems. The mixed layer depth characteristics in the Arabian Sea (between 10–25 ° N and 60–75°E) with sepcial references to its annual and short term predictability is the aspect of study in this thesis. Climatological data from the atlases of Wooster et al. (1967), Hastenrath and Lamb (1979) and Robinson et al. (1979) and BT/hydrometorological data collected during OCEANAVEX (1973-74), MONSOON (1977) and the local cruise of MV PRASIKSHANI have been analysed to present the variability of the mixed layer depth in relation to the causative factor like wind forcing, net heat tránsfer at sea surface, machanical/convective mixing, advection, convergence/divergence and internal oscillations. The study area was divided into 8 subareas of 5 degree quadrangles and the mean characteristics were studied. The thesis comprises of 6 chapters.

Distribution of surface wind field analysed indicated the dominance of southwest monsoonal wind forcing (May to September) by duration and severity in contrast to the northeast monsoon wind forcing (November to January). The monsoon controlled Arabian Sea exhibits unique characeristics of bimodality in the annual signals of net heat transfer. SST and MLD brought about by the distinctive modifying features of strong summer heating, periodic upwelling and mid-summer surface layer cooling. Spring/summer heating is maxium (about 120 Wm^{-2}) and minimum off southwest coast of India (about 80 Wm^{-2}). While winter cooling is maximum in northern subareas (more than $-40 Wm^{-2}$), annual maxium cooling (more than -50 to -70 Wm^{-2}) is observed in central and southern Arabian Sea. Biomodal annual SST variation with range 2–4°C reflected response delay of 1–2 months behind net heating cycle. Annual range in MLD variability revealed is about 5–195m on close grid analysis and 20–100m on coarser 5 degree mean analysis for the study area. Bimodal pattern in MLD variability is by shoaling during spring/summer heating and deepening during winter and mid-summer cooling. In the northern and east coastal subareas of study the secondary deepening in midsummer is supressed due to coastal divergence and upwelling processes. Mechanical and convective mixing values computed indicate that convective mixing closely describes the annual march of MLD in all subareas while wind mixing seems significant only during July-September (22-52m).

Advection influence area controlled by surface circulations of the changing monsoonal systems. Maxium current speeds (16-40 cm sec^{-1}). in the area occur during May-September, while currents are weaker during winter monsoon. In most of the subareas, deepening of MLD due to cooling in January and July-September is found to be augmented by covergence, inducing sinking. Similarly shoaling of MLD during heating in March-May for a significant portion of the study area is found supplemented by divergence causing upwelling. For long term predictive characteristics, difference in MLD given by wind (mechanical) and convective mixing could be reasonably reduced by incorporating convergence/divergence effects quantitatively evaluated in the study. Spectral analysis of internal oscillations revealed the possibility of amplitude perturbations of 1.5–3 m in the short period and 4–10 m in long period domains over predicted MLD during southwest monsoon period in the central Arabian Sea.

Spatial variability of MLD along 4 meridional sections suggested the influence of cyclonic circulation (anticlockwise) during December-February with dome shape in MLD topography and anticyclonic (clockwise) circulation during March-October. During winter, a warm cell (around 26°C) off Bombay and cold cell (around 23°C) off Pakistan/Iran were found to coincide with MLD trough (around 100m) and dome (around 110m) representing anticyclonic and cyclonic eddies respectively. During premonsoon regime, a warm cell of SST (around 30°C) off Bombay coinciding with MLD trough of anticyclonic eddy, cold cell (around

23°C) in the centre of northern Arabian Sea coinciding with MLD dome of cyclonic eddy and MLD troughs of anticyclonic eddies at the mouth of Gulf of Oman and off Kutch were also located. These imply importance of eddy interaction in prediction of MLD variability in the study area.

Lastly a one dimensional MLD prediction scheme (Laevastu, 1965; James, 1966) with assumptions of negligible advection and salinity gradient was used to predict short term variability of MLD both at shallow and deep sites in the study area. This proved reasonably good for predictions upto 6 hrs with only 5-10 m differences between predicted and observed MLD in 83% of 3 hourly predictions and 71% of 6 hourly predictions.