

Short Communications

Power Spectra of Currents Off Bombay

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Current measurements were carried out using a recording current meter across the continental shelf off Bombay at 4 stations from an anchored ship. Power spectra were computed for selected lengths of records. Spectral energy was predominantly contributed by tidal frequencies. Effect of direct wind drift was observed in the spectrum in the frequency range 0.01-0.03 cy/min. During windy periods the records showed high frequency oscillations whose frequency was 0.1 cy/min. These oscillations were induced by the movements of the anchored ship resulting from wind and surface currents.

Power spectra from current records are very well suited to delineate the characteristic frequencies^{1,2}. During the course of an oceanographic survey across the continental shelf on the Bombay High region in March 1976 (3rd cruise of *RV Gaveshani*) continuous current recording was undertaken at 4 stations (Fig. 1). Speed and direction of current were recorded using T-S selfrecording current meter (Type-2, Tsurumi Precision Instruments Co., Japan). The current records gave average current values at 4.5 min intervals. Eventhough the current meter was used for at least one tidal cycle at each site, failure of instrument due to mechanical problems or unreliable recording sometimes limited the length of records suitable for analysis. This limitation resulted sometimes in less resolution to the spectra (Table 1). The length of the records is limited and the data recorded were analysed mainly for qualitative results. Taking into account the tidal dominance of the currents³ this limitation does not lead to any serious drawback especially when viewed in conjunction with the estimates at other stations where the spectra were well resolved.

Preliminary analysis of the same data was carried out and reported³. Some of the earlier³ findings immediately relevant to the present study are as follows: The current observations at st 1 (Fig. 1) were very much influenced by high winds. The currents were

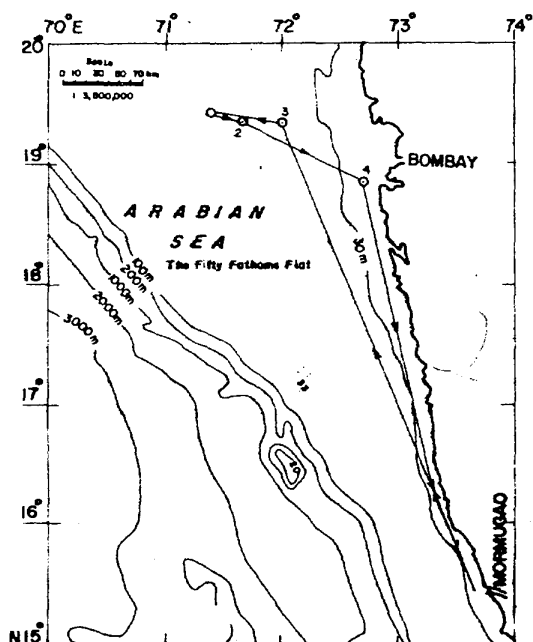


Fig. 1—Station location map

Table 1—Details of Spectral Computations
(Sampling interval 4.5 min)

St	Depth (m)	No. of points (N)	No. of lags (m)	Degrees of freedom (DF)
1	20	161	24	13
	40	321	64	10
	40	321	48	13
2	20	96	14	13
	40	311	48	13
3	20	301	45	13
	20	301	60	10
4	8	287	48	12

tidal in character disturbed by high frequency oscillations. As the stations are near to the coast and the depth decreases the currents grow stronger with more peaked distributions for direction and skewed distributions for speed towards high values.

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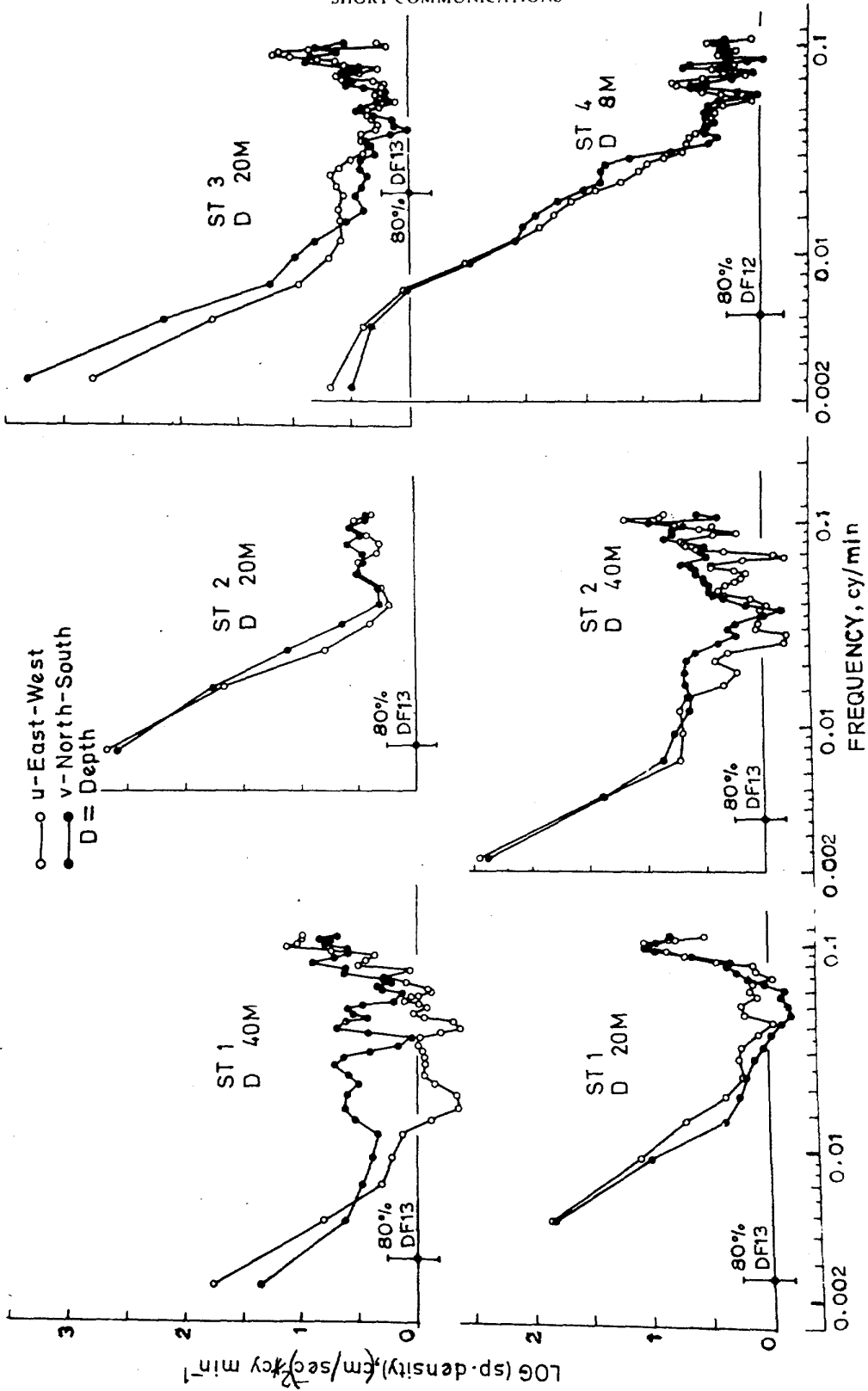


Fig. 2—Power spectra for different stations

The current vectors were partitioned into north-south (v) and east-west (u) components. The two resulting time series were high-pass filtered by 'differencing' and then centered to zero mean. These pre-processed data were then used for spectral computations through auto-correlation^{4,5}. A rectangular data window was used. The normalized spectral estimates were corrected for the 'differencing' filter. The spectra were plotted on a log-log scale.

Fig. 2 shows the spectral density curves at the different depths. The peak density occurs for the first ($m = 1$) spectral band. The first spectral band in the resolved spectrum (Fig. 3) corresponds to the tidal period of nine hours. The first analysis was carried out taking 'm' equal to 10% of 'N' which is suggested as a general guideline by Bendat and Piersol for preliminary results. Later analysis was done with a different 'm' value. In reality the first spectral band contains all the tidal frequencies and hence corresponds to the basic tidal period of 12 hr 25 min. It is noted as 9 hr, since the plotting position was 0.002 cy/min. The data were not analysed for large 'm' values, since it would not add to the results—by resolving further the tidal frequencies—with reliable number of degrees of freedom. The similar patterns of spectra at all the stations suggest that the currents are tidal in character. The spectra sharply decrease to a minimum between frequencies 0.03 and 0.06 cy/min. At the high frequency side, close to 0.11 cy/min, the spectra show fluctuations. These are considered not significant even at 80% confidence level. At sts 1 (20 m) and 2 (20 m) these fluctuations are not observed. This is due to the much reduced resolutions used for the spectral estimations (Table 1). A secondary peak (0.1 cy/min) is observed near to the cut-off frequency. This peak is not observed at sts 2 (20 m) and 4 (8 m) where during recording the winds were low and the currents high respectively. This secondary peak is formed as a result of the oscillations in the current velocities due to the anchored ship's movements.

At st 1 (40 m) alone the spectra for u and v components show a very significant difference in the frequency range 0.01-0.03 cy/min. This is due to the effect of strong wind (NW-NE) induced drifts. The exact nature of the wind drift cannot be ascertained clearly due to the lack of efficient models⁶ to predict the vertical structure of the direct wind drifts in shallow waters due to the complex situations of bottom friction, variable eddy viscosity and unsteady surface stress. Yet the following observations from the previous work³ support the conclusions. Plots of the current speeds (Fig. 2a, ref. 3) and wind speeds (Fig. 3, ref. 3) at this station were presented earlier. These diagrams show high wind speeds and much distorted current-speed profiles. Also, this station shows a

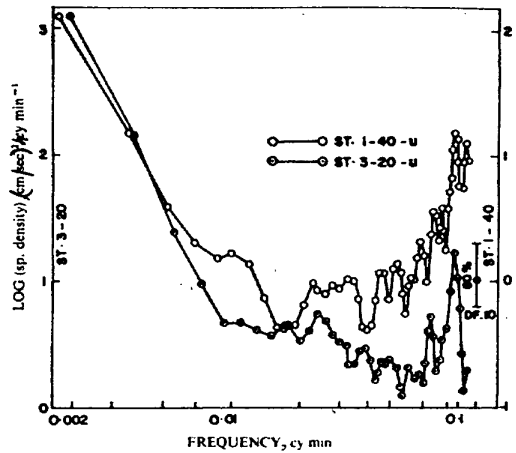


Fig. 3—Power spectra for selected locations

marked change in the frequency distribution of current directions (Fig. 4a, ref. 3). The distribution is highly peaked at 80° giving the u component high magnitudes at 40 m whereas for sts 2 and 3 the peaking was around 50° and for st 4 around 130° giving more or less same contribution to u and v components. These findings reveal that the different patterns observed for the spectra for u and v components at st 1 (40 m) is due to the direct effect of wind induced drifts. Similar deviation observed for st 2 (40 m) between 0.01 and 0.03 cy/min is considered insignificant.

Fig. 3 shows the spectra (u component) at sts 1 (40 m) and 3 (20 m). These spectra were computed with increased resolutions (Table 1) in order to delineate the tidal frequencies. The second computation did not show any marked change in the spectra at the tidal frequencies. Another computation with still increased lag number would have resulted only in shifting the primary peak towards the basic tidal frequency of 0.0014 cy/min (semi-diurnal).

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