ACOUSTIC COMMUNICATIONS WORKSHOP

(SUPPLEMENT)

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DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

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(SUPPLEMENT)

AMBIENT NOISE IN SHIPPING CHANNELS

Dr. L. A. King
MAR, Incorporated

While at Penn State, I performed research dealing with one aspect of the communication channel - the fluctuating signal. In particular, I studied fluctuations caused by thermal inhomogenities and microstructures present in the channel. The time scales associated with these experiments were of the order from a few periods of a 60 kHz signal to a few minutes. This paper, however, addresses another major aspect of the communication channel - noise (Figure 1). In particular, we examine the noise in a channel located in a heavily ship-trafficked region. The time scale, in contrast to micro-structure scales, will not be of the order of seconds or minutes, but of hours and tens of hours. The time and frequency scales will be broadened in order to characterize the long-term mean spectrum associated with a channel.

MEASUREMENT SYSTEM AND THE ACOUSTIC CHANNEL

To obtain a set of long-term measurements that is free of the radiated noise of the deploying platform (presumed a ship), a moored acoustic system is often used. The one illustrated (Figure 2) is that of a Moored Acoustic Buoy System or MABS. Some of the results, as presented, have been acquired with the system configured as illustrated.

The MABS, as configured, was deployed in 4000 m of water in a heavily ship-trafficked region southwest of the English Channel (Figure 3). A second MABS, configured for shallower water, was deployed on the continental shelf in about 160 m of water.

Figure 4 shows another prespective of the summer deployments, the sensor locations with respect to the bathymetric features and sound speed profiles. The sensors of the deep water MABS are located in both the shallow and

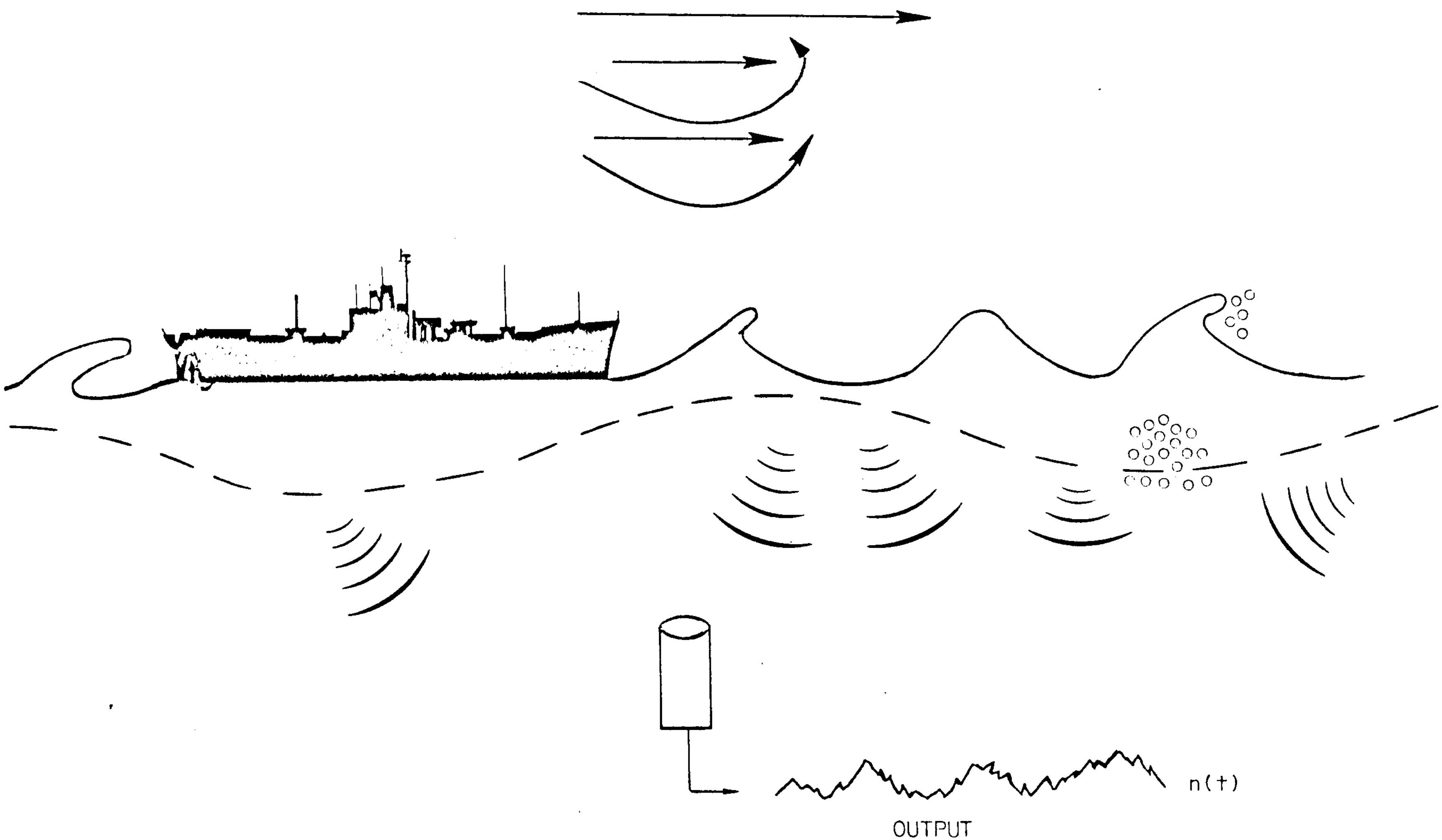

Figure 1. Ship- and Wind-Related Underwater Sound

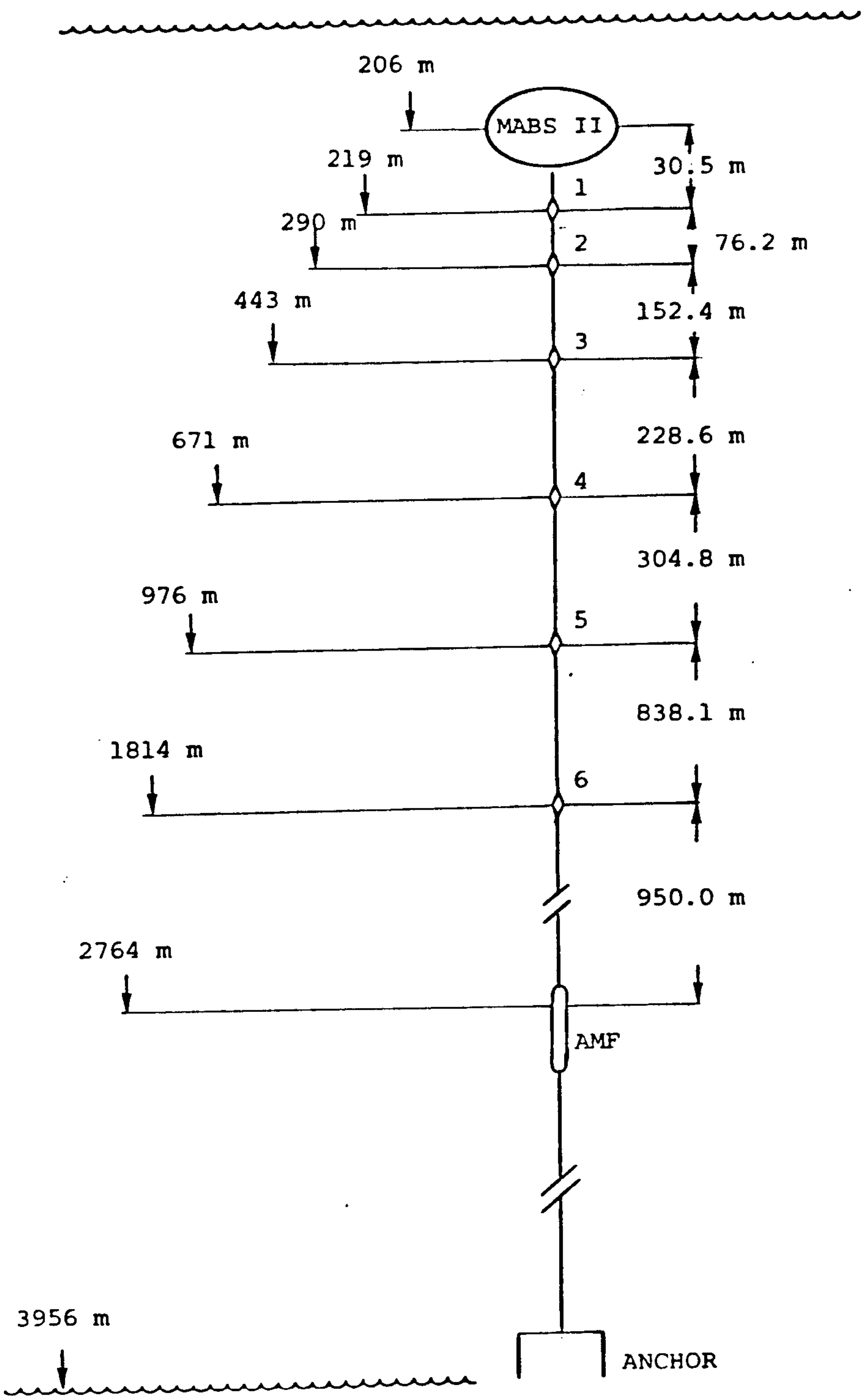

Figure 2. MABS II, July 1980, SK-2

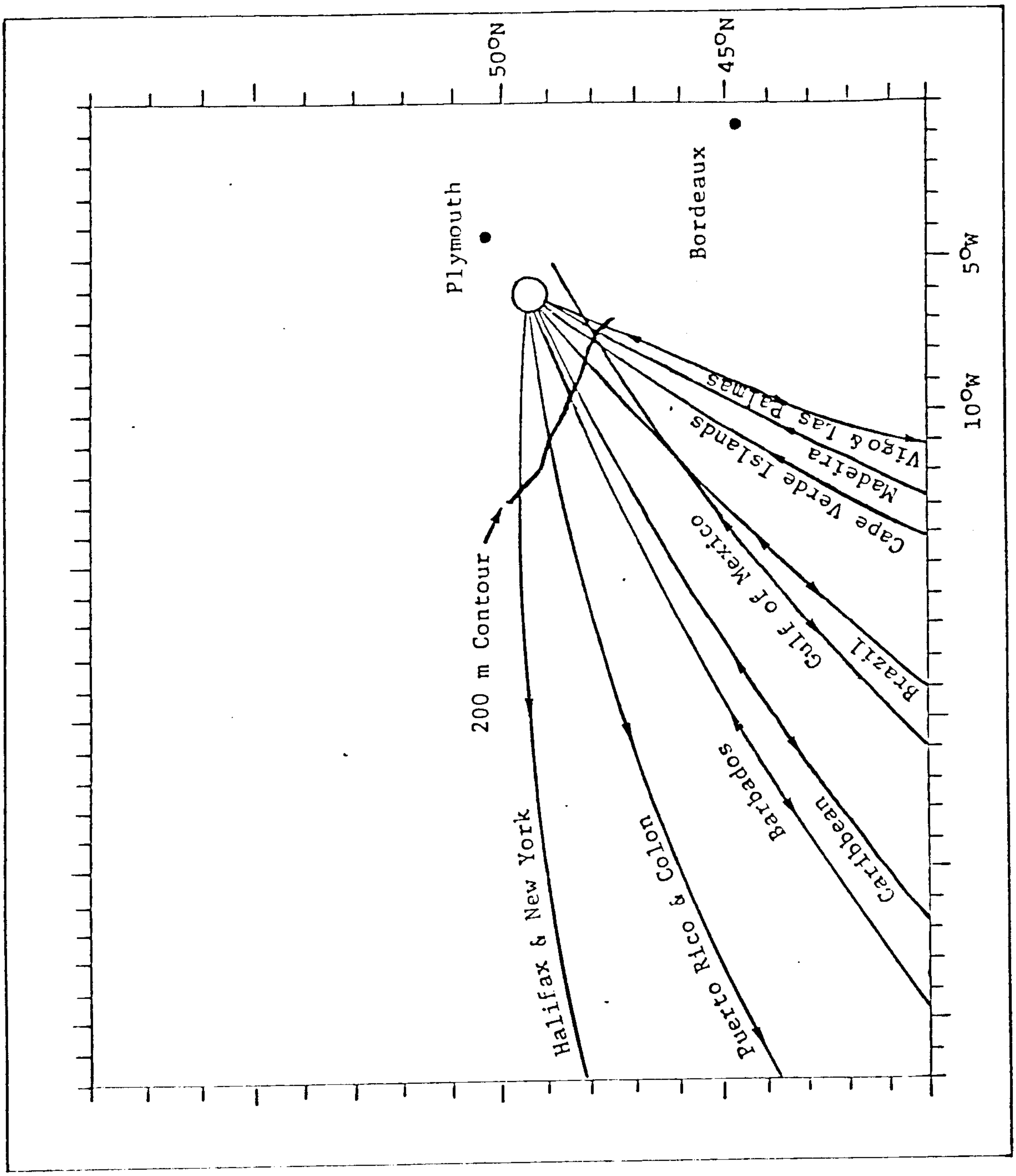

Figure 3. Shipping Lanes Through English Channel Area

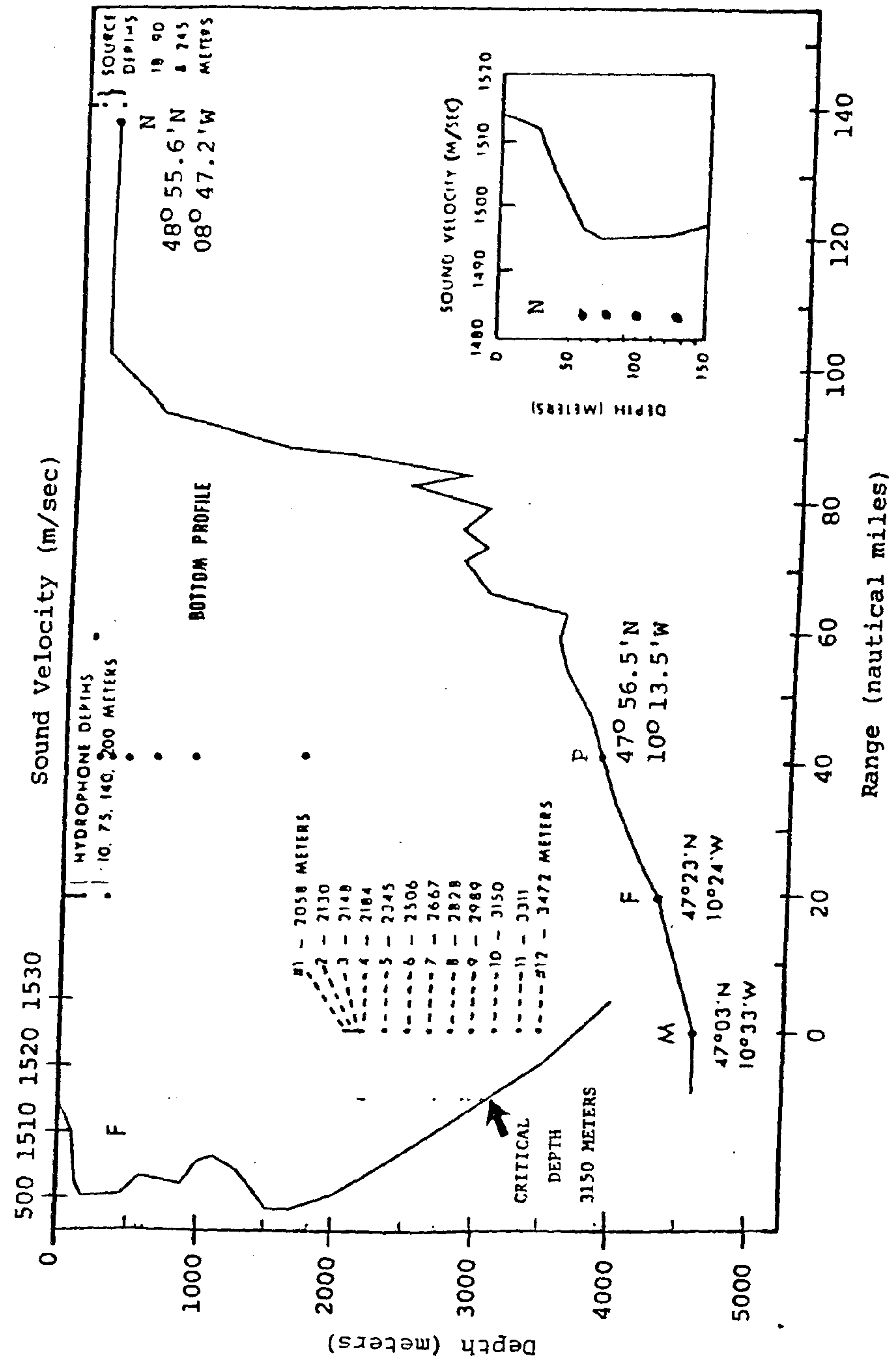

Figure 4. MABS Systems and Phase I Sound Speed Profiles

deep acoustic channels which are characteristic of this region in the summer. A-2
Shipping contributions to the noise spectrum may arrive at the sensor in a variety of modes, direct, bottom-bounce, convergency zone, RSR, and RRR.

The MABS system was programmed to record simultaneously, every hour, a continuous 1-minute background sample from all sensors. Battery capacity for this sampling allowed coverage of up to 30 days, although the actual deployment was for a period of 25 days. Presented are but a few narrowband samples that illustrate the nature of the noise. On some occasions we observed biologics such as porpoise whistles (Figure 5). Quite often there was evidence of shipping lines such as in Figure 6. Figure 7 is an FFT sample to give an idea of the levels observed. Observed are multiple tonals and high levels of ship-ambient noise.

LONG TERM DATA

These samples were integrated over the 1-minute interval and integrated over frequency to produce time histories of 1-minute averages of 1/3 octave spectral levels. Figures 8, 9, and 10 show examples of such time histories for a sensor depth of 465 m and 1/3-octave center frequencies of 100, 400 and 2500 Hz. The 100 Hz is usually associated with shipping noise and the 2500 Hz is usually associated with wind speed dependent (sea surface action) noise. The 100 and 400 Hz histories have approximately the same time scales of variability, although the 100 Hz graph is approximately 15 dB higher in level. The 2500 Hz curve has a large amplitude, long-period feature that is not observed in either the 100 or 400 Hz curves.

The statistics of each time history were obtained for each sensor depth. Figures 11 and 12 show the spectral percentiles and means for two sensor depths. When they are superimposed, no depth dependence becomes obvious. Superimposing the mean spectral curves for all sensor depths (Figure 13) does not reveal any significant change with depth. It seems unusual not to have any indication of depth dependence over the 1600 m extent of the array.

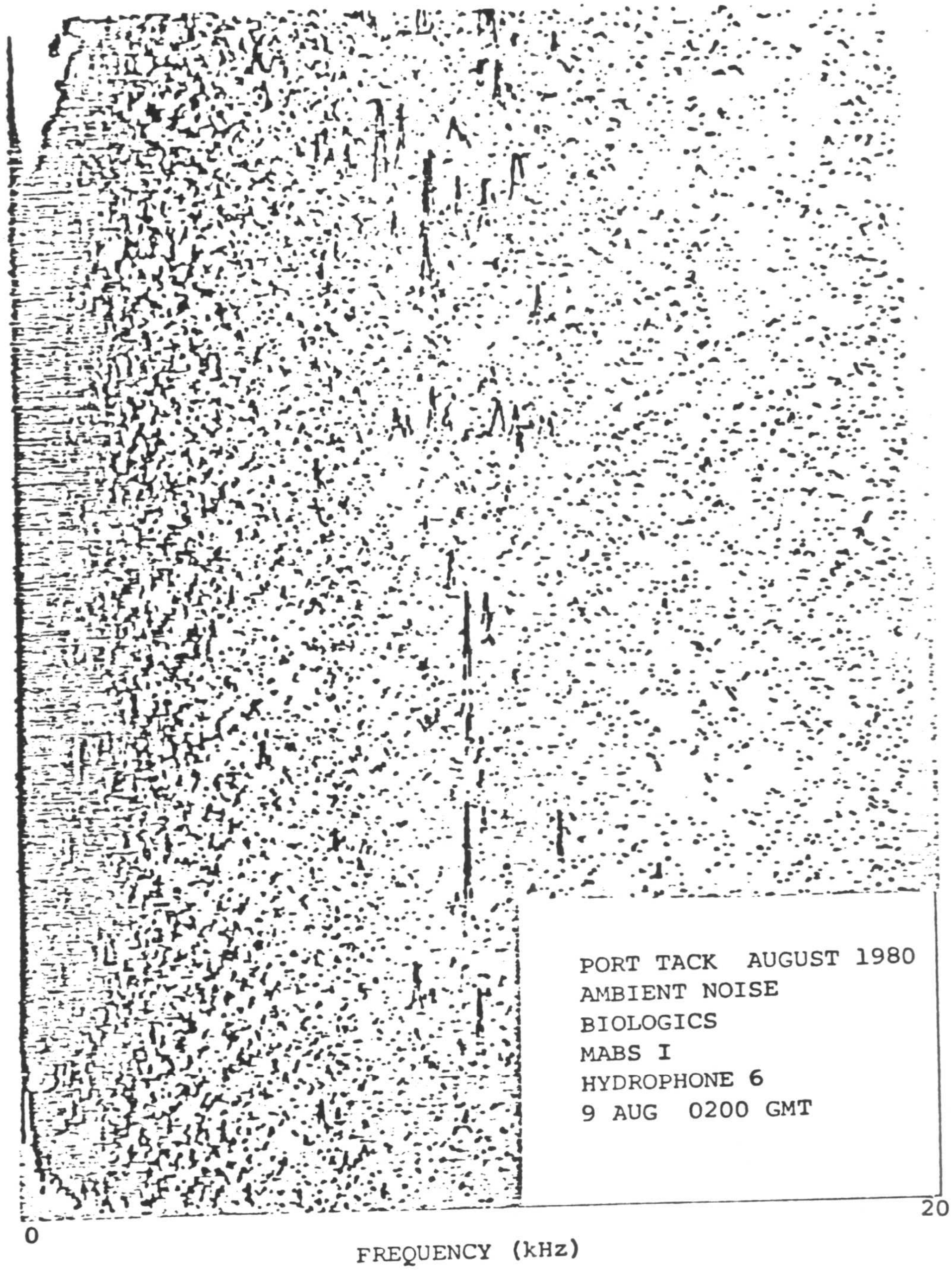

Figure 5. Frequency-Time Gram, Biologics

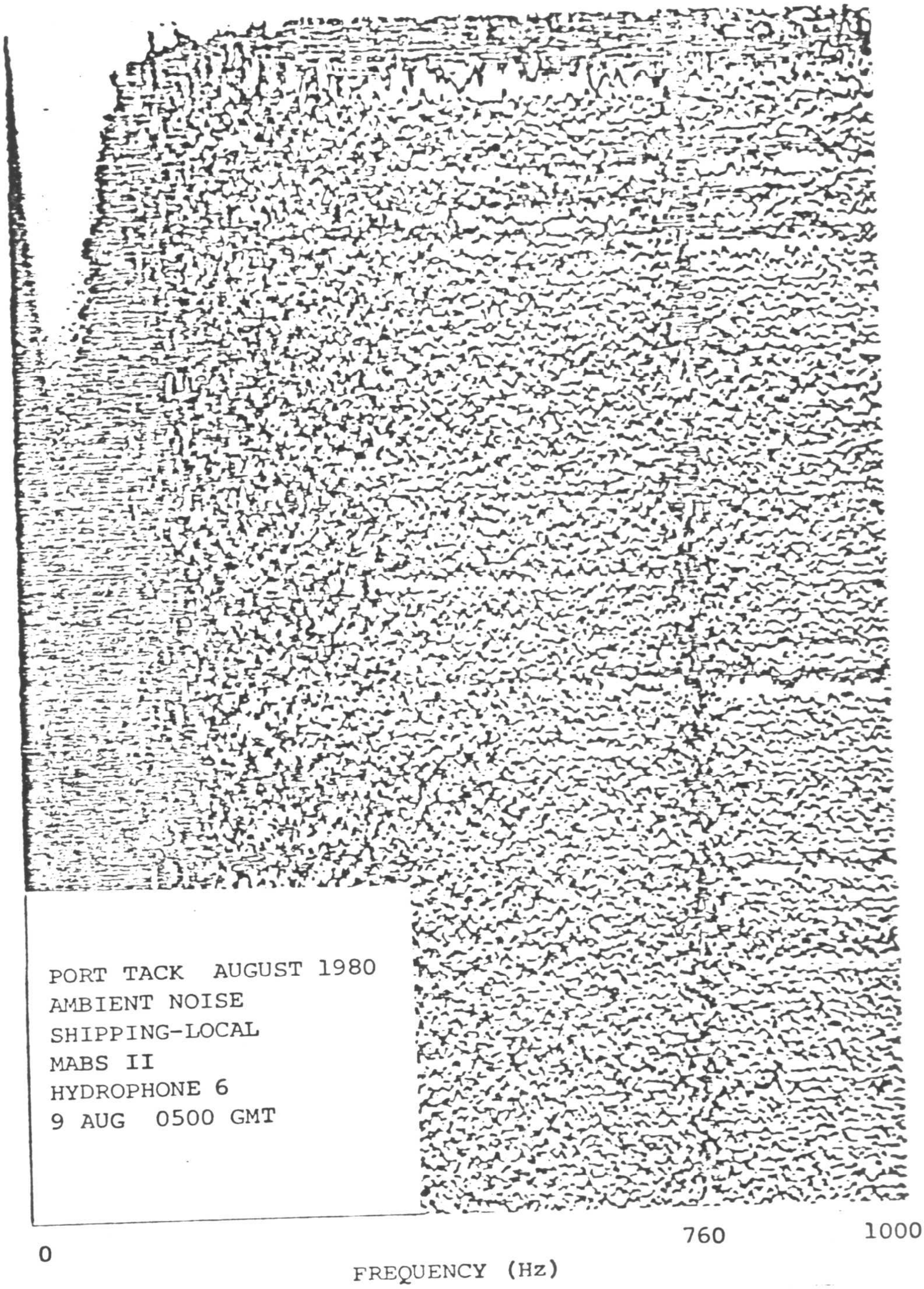

Figure 6. LOFARgram, Shipping, MABS II, Phase I

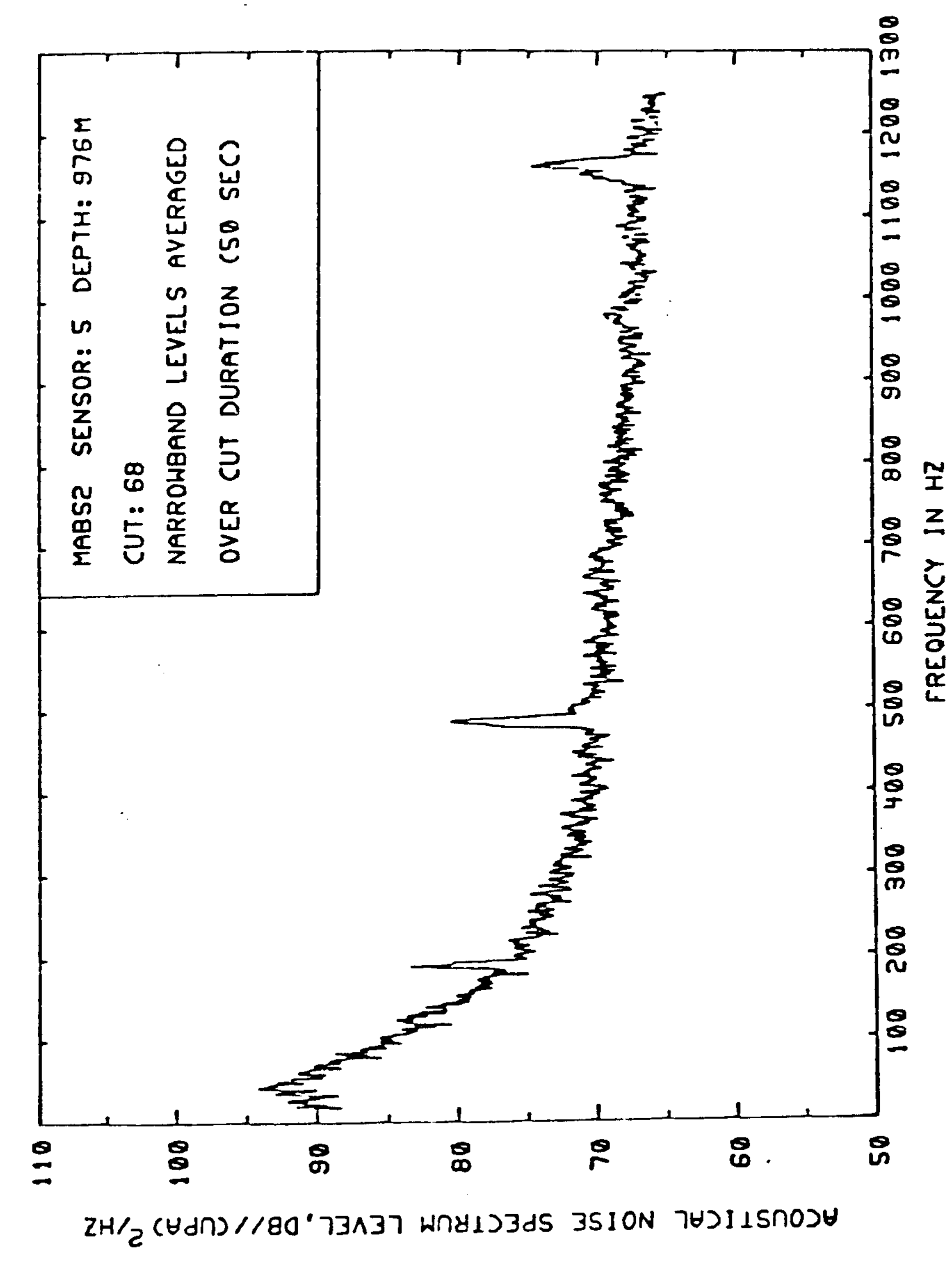

Figure 7. FFT, Shipping, MABS II, Phase I

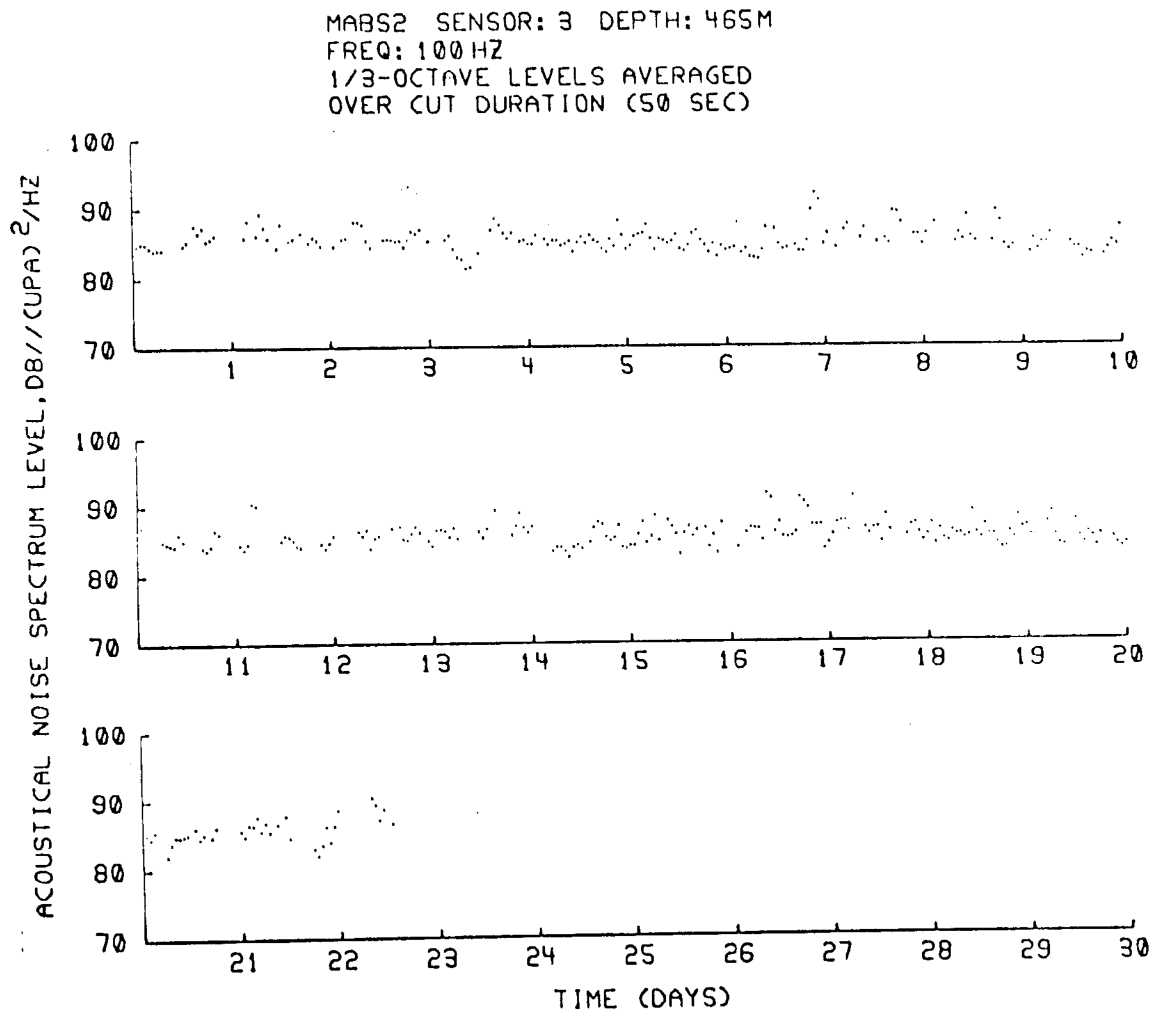

Figure 8. Spectral Time History, MABS II, Phase I, 100 Hz

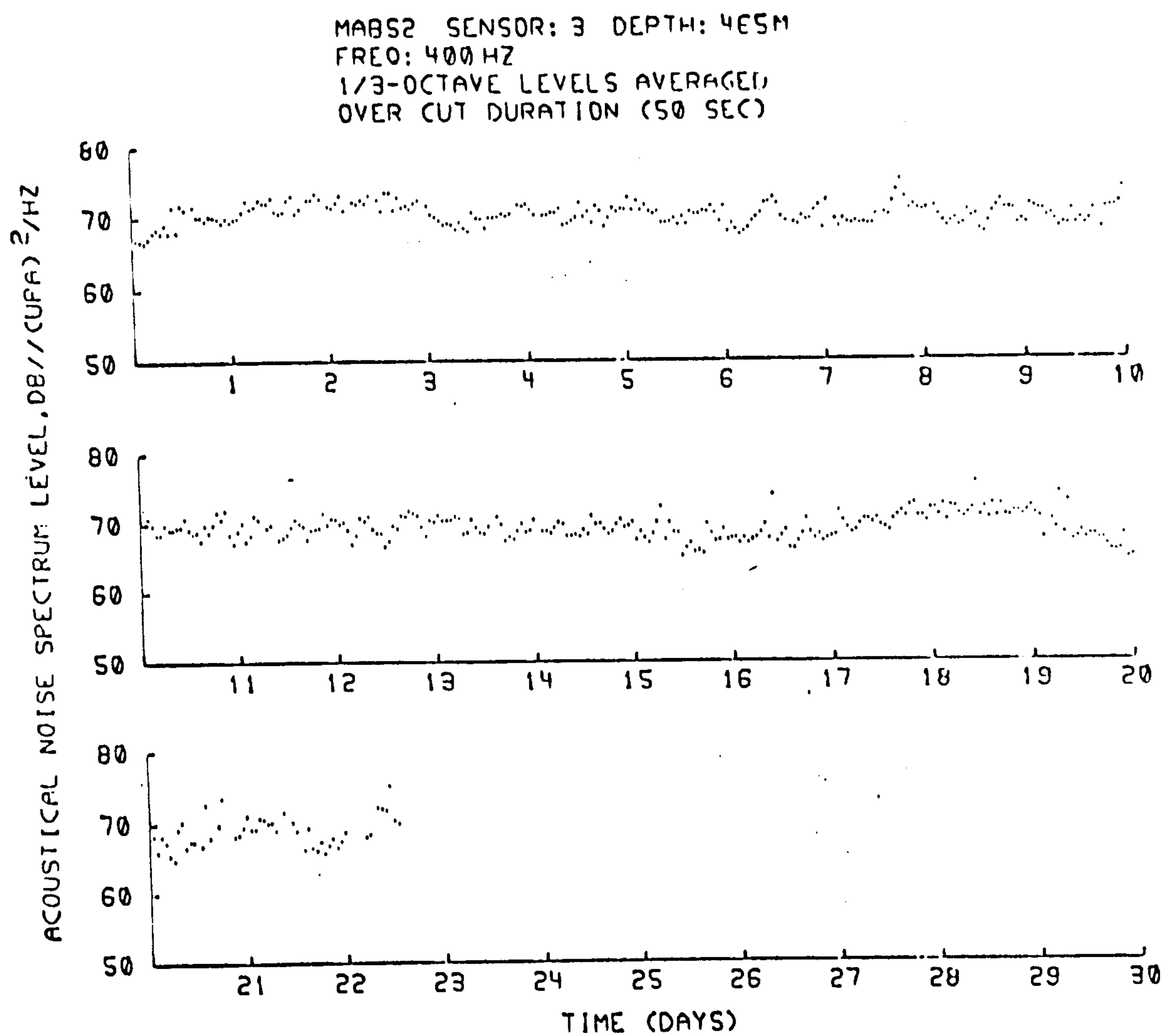

Figure 9. Spectral Time History, MABS II, Phase I, 400 Hz

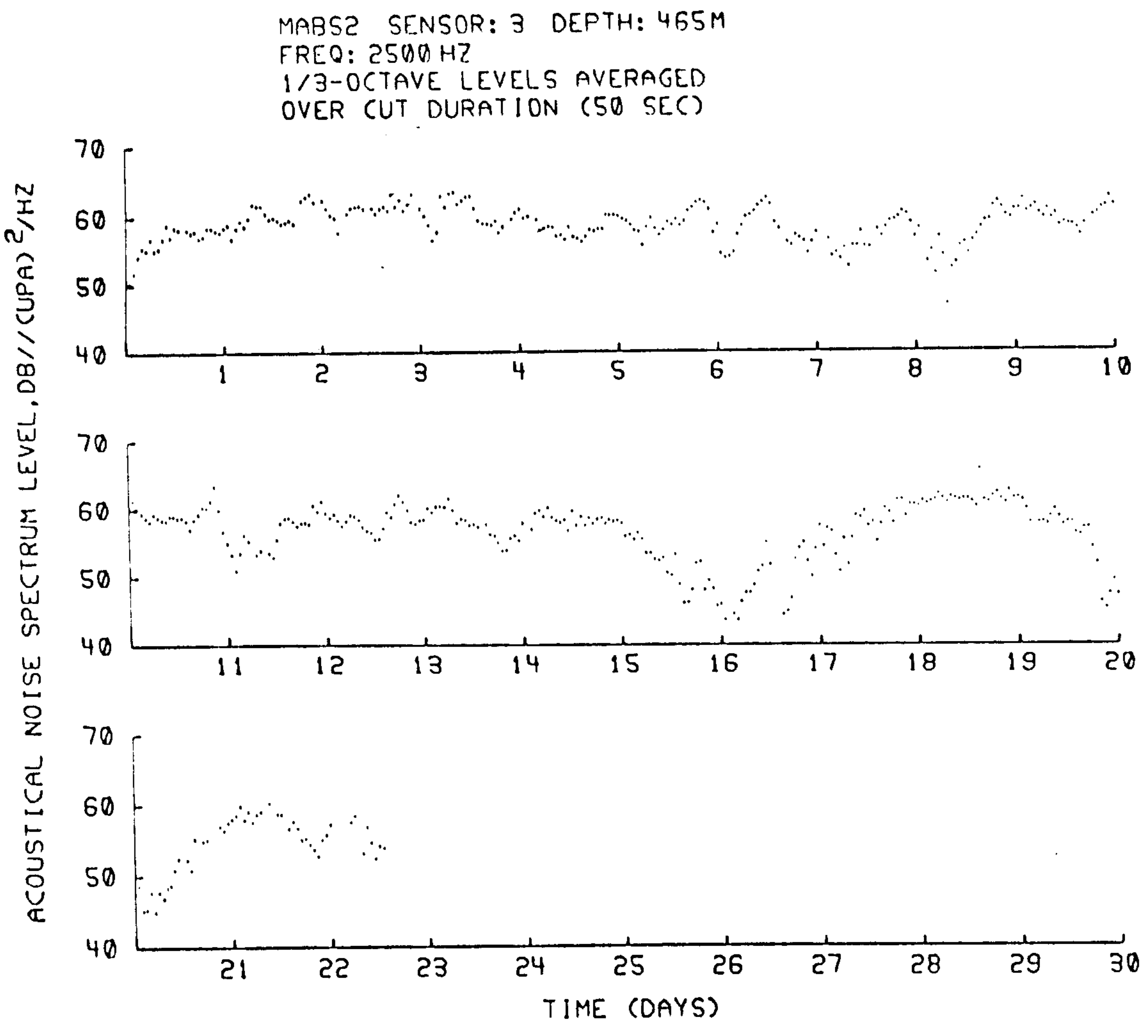

Figure 10. Spectral Time History, MABS II, Phase I, 2500 Hz

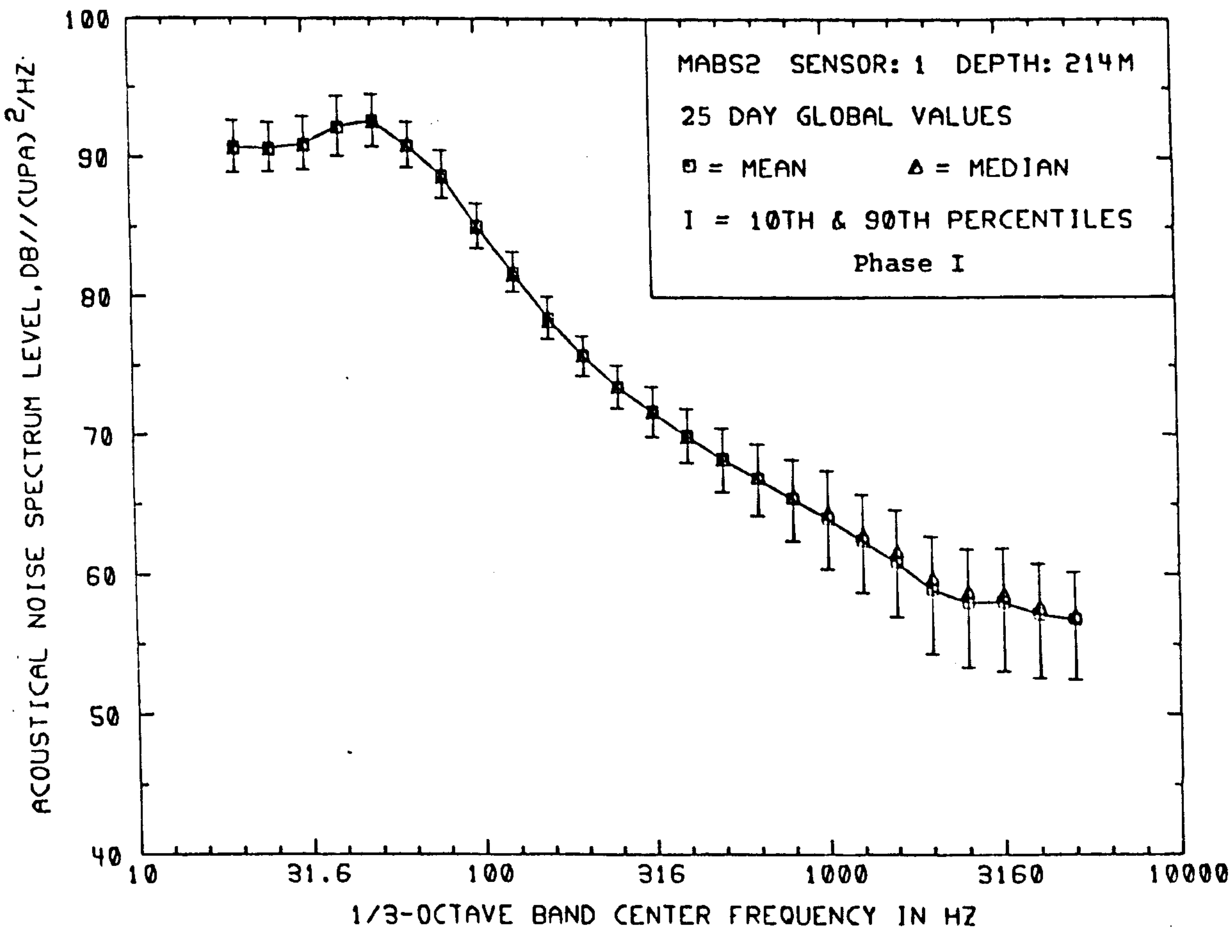

Figure 11. Spectral Statistics, MABS II, Phase I, 214 m

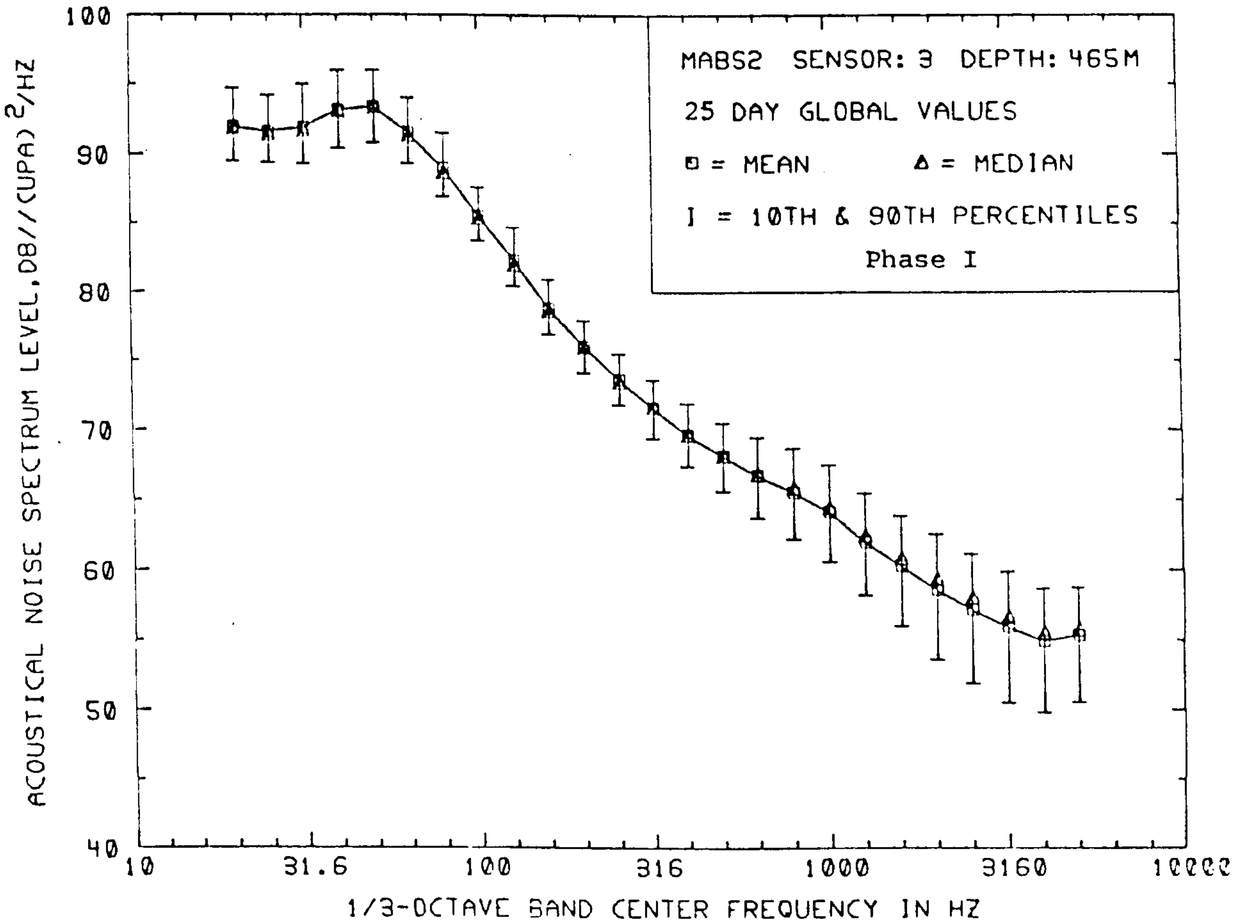

Figure 12. Spectral Statistics, MABS II, Phase I, 465 m

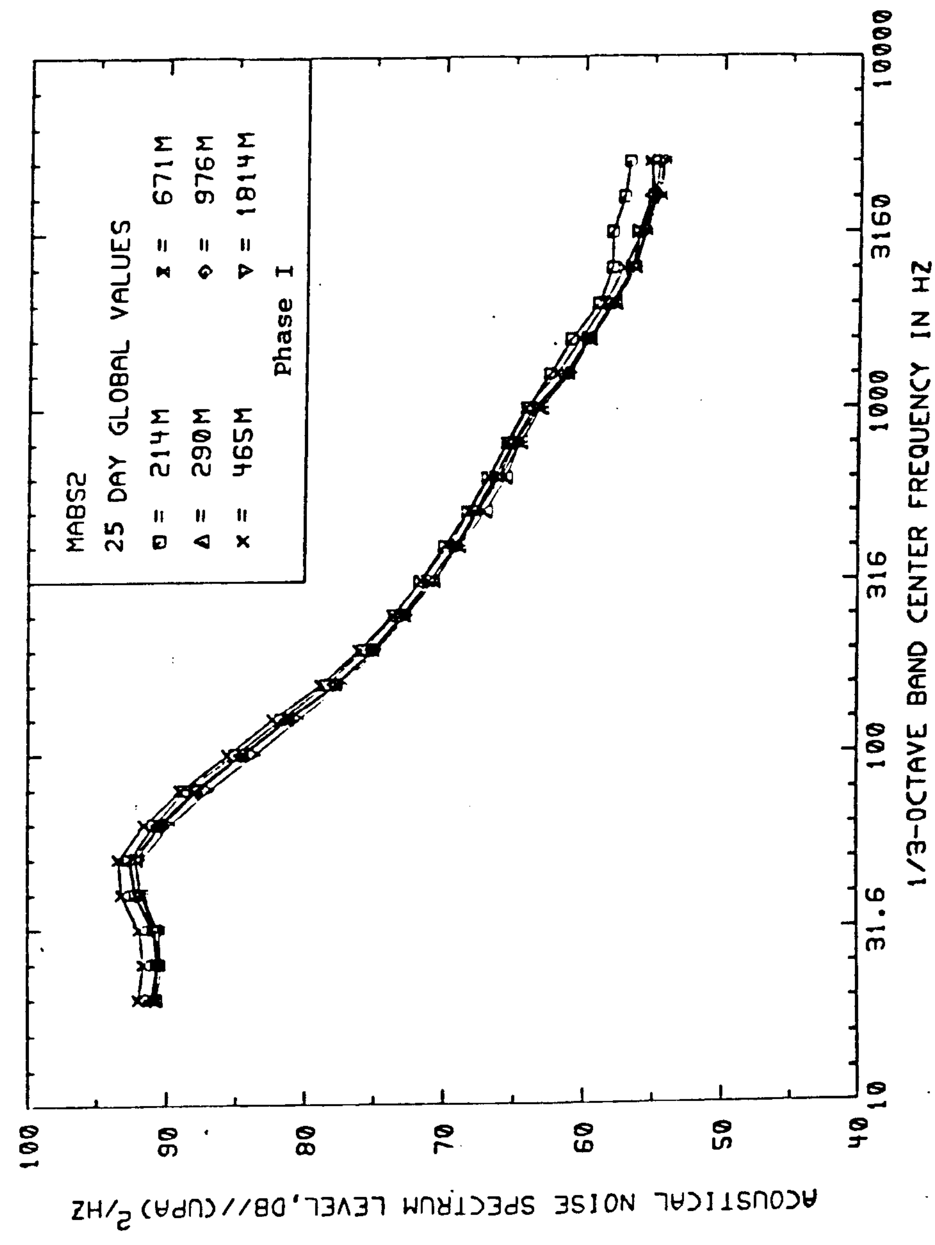

Figure 13. Spectral Mean Values, Depth Parameter, MABS II, Phase I