MODE HOT LINE NEWS

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CURRENT MEASUREMENTS FROM SURFACE AND SUBSURFACE MOORINGS

by Al Kalvaitis

Much has been written in the MODE Hot Line News concerning interpretation of current measurements from instruments placed on surface moorings. Gould showed deep (>1000 m) current meter records from surface moorings with higher energy levels at all frequencies as compared to records taken on subsurface moorings (Hot Line News Nos. 10, 12, 16, and 21). In contrast, Pollard & Halpern, and Briscoe & Hayes (Hot Line News No. 40) report three different intercomparisons of surface and subsurface buoys, indicating that near surface (10-50 m) current spectra do not appear to have significant energy differences.

A possible explanation of these measurements is offered. Points on a cable in the near-surface region of a surface mooring are likely to be moving in an elliptical pattern with the major axis vertical as the buoy is excited by a surface wave. A specific example is illustrated in Figures 1 and 2, which show inputs and outputs respectively to NOAA's National Data Buoy Office (NDBO) Mooring Dynamics Program. Figure 2 gives the normal (U) and tangential (V) mooring velocity as a function of depth for a 12.5-second wave, 246 m long, and 0.61 and 1.83 m high. Near the surface, the lateral (normal) velocity component (U) of the mooring motion

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CURRENT MEASUREMENTS FROM A SUBSURFACE MOORING AND A RIGID TOWER

by Bill Boicourt

The accuracy of current measurements from taut-wire moorings in shallow water is limited by wave and mooring motion. As part of a larger current meter array in our study of the circulation on the Atlantic Continental Shelf, we placed a rigid tower (Figure 3) and a taut-wire mooring with subsurface flotation (80 kg buoyancy at 2 m) in 15 m of water. On each of the two mountings, which were separated horizontally by 20 m, we placed four Braincon 1381 Savonius rotor meters. A bottom-dragging fisherman cut one of the

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SUBJECTIVE MAPPING AND QUASIGEOSTROPHIC WAVE INTERPRETATION OF MODE-I REAL-TIME DENSITY DATA

(G. Flierl, J. McWilliams, A. Robinson, and D. E. Harrison: Hot Line News No. 42)

A Clarification

The subjective maps of isothermal surfaces were constructed entirely from real-time data and incorporated only corrections suggested during the time of the MODE-I Field Program. We are grateful for subsequent discussions with members of the density program, who, in giving us further estimates of their progress in calibration, helped us assess the degree of error in the maps.

NOTES from the Editor

These *Notes* are intended to supplement the scientific articles that usually exclusively comprise the MODE Hot Line News. I hope to report informally on MODE-related developments of general interest to Hot Line News readers. These *Notes* will appear irregularly, depending on the availability of news.

One motive for beginning these *Notes* at this time is the period of change that MODE is now going through. With MODE-I field work done, further MODE's are now being discussed. Whatever their form, they may involve oceanographers beyond those now active in MODE-I. I hope that these Notes will be one way of bringing a wider circle of scientists into the discussions.

The *Notes* won't officially represent MODE policy: the views expressed will be my own. As with the Hot Line News, I'd like your comments.

Scientific Council Meeting

On November 14, 15, and 16, members of the MODE Scientific Council and others working on MODE-I results met in Miami. About half the meeting time was spent reviewing the MODE-I field work and the status of the data obtained. I hope that some of the exciting results will soon be described in the Hot Line News.

The next stage of MODE was discussed in Miami. The next in the sequence of Soviet *Polygon* experiments may take place in 1976. It was agreed to proceed with preliminary planning for a joint MODE/*Polygon* experiment to be known as POLYMODE. A POLYMODE planning group was nominated to begin looking at what the form of the joint experiment might be and what U.S. contributions might be possible. There will be more about POLYMODE planning in future Hot Line News issues.

IWEX

The Internal Wave Experiment (IWEX) tri-mooring (HLN #34, 36) was successfully implanted in the MODE-I region in early November. Recovery is planned for mid-December. The mooring was precisely positioned using an acoustic navigation system. We'll have a discussion of that soon in the Hot Line News.

—F.W.

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CURRENT MEASUREMENTS FROM SURFACE AND SUBSURFACE MOORINGS (continued)

can exceed the steady horizontal current. If (U) does exceed the horizontal current, the current meter vane will respond to these oscillations. If the wave periods are long enough for the vane and vane follower to respond to the motions correctly (>4 seconds), then the velocity of the oscillations can be averaged to nearly zero by the current meter, and the true current velocity can be measured.

In deep water, the mooring motion is different in that (U) diminishes with increasing depth while (V) remains nearly constant. Thus, at the deeper levels, mooring motion is comprised largely of longitudinal (tangential) oscillations. Under certain conditions this type of motion has been empirically shown (Hot Line News No. 29, Kalvaitis) to induce a positive velocity error on a Savonius rotor and vane as well as an electromagnetic sensor mounted between end plates. The vane aligns itself to the horizontal current while the rotor is energized by both the horizontal current and by the longitudinal motions. The resulting velocity measurement is larger than the true steady flow. In the low current velocity region (at deep levels, typically), the induced positive velocity error will magnify the energy spectrum since the error may be several hundred percent of the actual current.

CURRENT MEASUREMENTS FROM A SUBSURFACE MOORING AND A RIGID TOWER (continued)

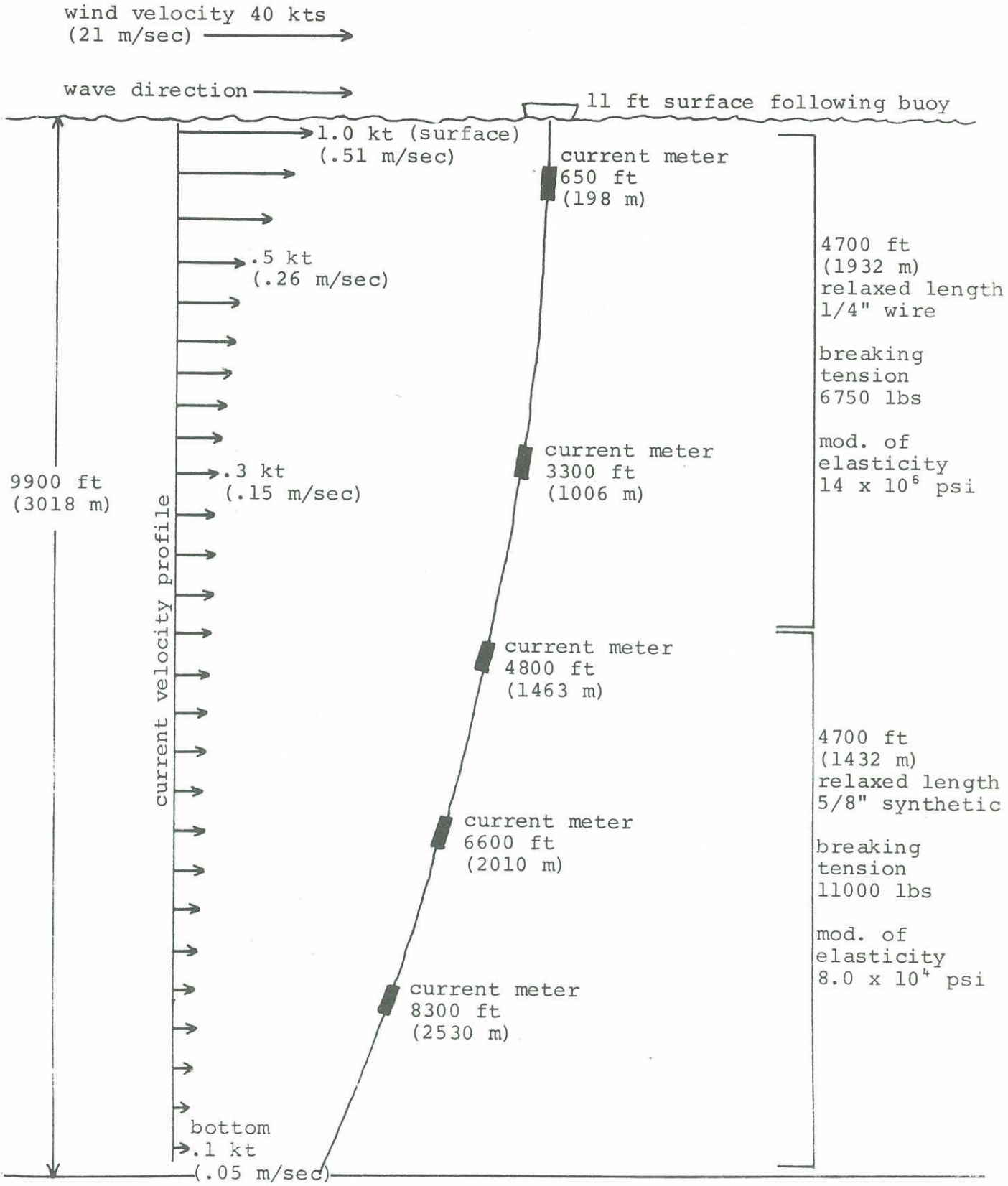
guy wires, and the tower fell. The 36-hour overlap of the records from the two vertical arrays is too short to allow useful spectral comparison, but a look at the rotor speeds (Figure 4) suggests that sizeable errors originate from the motion of the taut-wire mooring. The effect of this motion on a particular instrument will depend on the time constant of the direction sensor and on the processing and recording schemes. We are skeptical, however, that any Savonius rotor meter, including the VACM, will be able to resolve a mean flow in the midst of the noise.

The two arrays were situated in the path of the low-salinity outflow from Chesapeake Bay, approximately 13 km south of the Bay entrance and 8 km offshore. Sea state was recorded at the Chesapeake Light Tower, 17 km seaward of the arrays. During the morning and afternoon of 17 November, swell was running from the northeast at 1 m height. From 2200 17 November until 0700 18 November, the sea was calm, and then swell began to run from the east at 1 m height for the remainder of the record. Winds were either calm or light and variable, except for the interval 1600 to 2200 18 November during which the Light Tower recorded 10 knots from the southwest.

At the outset, our naive feeling was that the two arrays would experience approximately the same amount of wave contamination and that any discrepancy between the tower and the taut-wire records would be a measure of the mooring-motion contamination. It is not clear, however, that the observed discrepancy in speeds would necessarily be independent of the amount (or the period) of wave motion present. Resolution of this uncertainty will have to await improved understanding of the motions of a taut-wire moving.

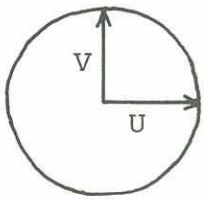
We expect that an increase in the mean flow past a Savonius rotor fixed in space will reduce the pumping effect of the wave motions. On the other hand, an increased mean flow past a taut-wire mooring is likely to raise the frequency of the natural oscillation modes and to increase the energy of the motion induced by vortex shedding. The combined effect of these processes is difficult to predict. The speed records shown in Figure 4 are not long enough to make any strong statements, even though there might be a hint of a reduction in the observed discrepancies with increased flow.

We do not usually place taut-wire flotation as close to the free surface as in this experiment. If the flotation is sufficiently deep to avoid wave coupling for most conditions on the shallow Atlantic Continental Shelf, current information would be lacking from most of the water column. We are now modifying current meters and developing a recording system for tower-mounted propeller sensors to alleviate the problems of both wave and mooring motion.



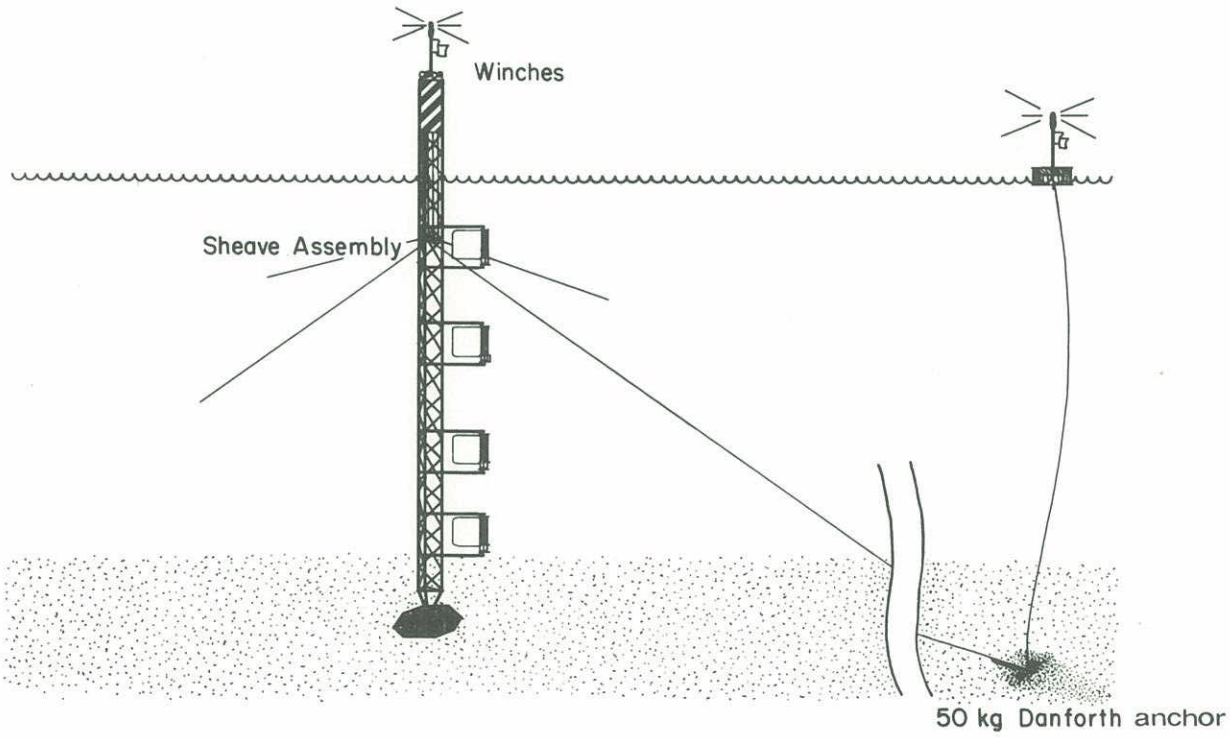
The model used in the NOAA NDBO Mooring Dynamics Program

Figure 1 (Kalvaitis)

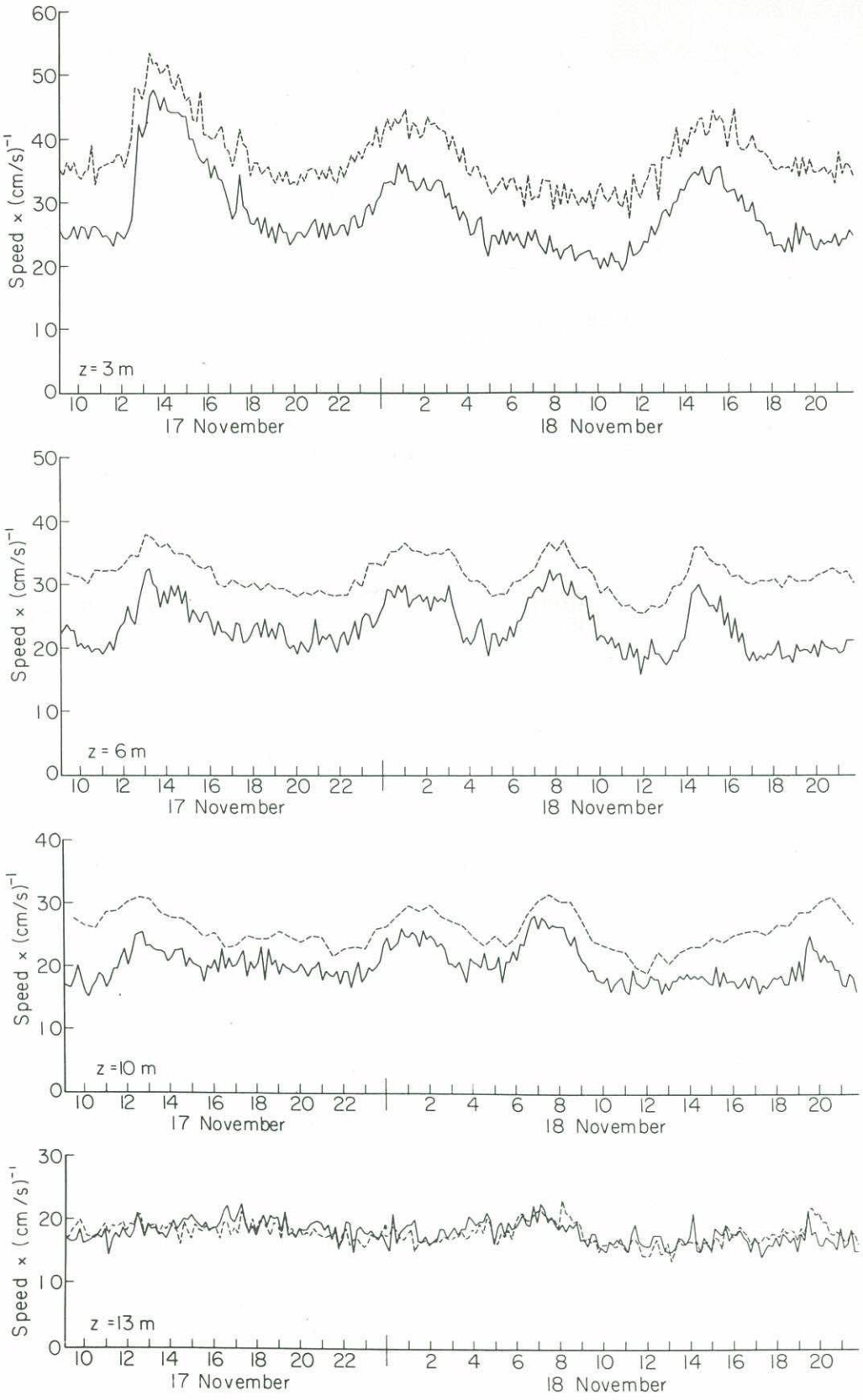
maximum mooring velocity (m/sec)				depth or distance from surface (m)	
longitudinal component (V)		normal component (U)			
.61 m surface wave	1.83 m surface wave	.61 m wave	1.83 m wave		
.155	.465	.153	.459	0	
.155	.465	.09	.27	61	
.155	.465	.055	.165	122	
.155	.465	.036	.108	183	
.154	.462	.024	.071	244	
.154	.462	.015	.045	328	
.153	.46	.002	.006	656	

Orbital ellipses obtained from the Mooring Dynamics Model

Figure 2 (Kalvaitis)



Tower current meter mounting
Figure 3 (Boicourt)



Speeds recorded by Savonius rotors on a rigid tower (solid line) and on a taut-wire mooring (dashed line) in water 15 m deep. All values are 10-minute averages except the rotors at 6 m (20 minutes) and 10 m (30 minutes) on the taut-wire mooring.

Figure 4 (Boicourt)