LOCOMOOR:
A LOw-COst MOORing for the Measurement of Internal Solitary Waves

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In order to supplement the ASIAEX field effort to measure the temporal and spatial structure of the internal solitary wave field in relationship to acoustic propagation and scattering studies, an array of low-cost temperature moorings (LOCOMOOR) has been developed. The basic concept is to provide spatial coverage as opposed to dense vertical resolution in temperature. Three temperature sensors on each mooring will adequately measure the time of passage of the internal solitary waves. A horizontal array of 20 of these moorings deployed for about three weeks will allow the internal solitary wave front geometry (curvature) and velocity to be measured as they propagate through the experiment region. The arrival time of each pulse within the packet of internal waves will be easily resolved, but the wave amplitude less exactly estimated. However, the amplitude will be very well measured by the velocity and density observations on the more heavily instrumented environmental moorings associated with the acoustic experiment.

The LOCOMOOR moorings (Figure 1) are designed with an 800-pound Seaboard Anchor, a 1-m length of 3/8" Proof Coil chain, a length of 3/8" Yalex rope, and the subsurface flotation/recovery package. The flotation package will be located at about 10-meters depth in 90-meters of water for ASIAEX. The Yalex rope is cut to the mooring depth, and marked every 10 meters with tape to aid in attaching the sensors. Along the upper part of this mooring, two or three Sea Bird or Hugrun temperature sensors are placed at about 15 to 25 meters deep - in or just below the thermocline at depths estimated from information gathered by CTD profiles before deployment. The top-most of these temperature sensors on each mooring is a Sea Bird SBE39 temperature and pressure recorder. The pressure observation will measure the amount of mooring dip due to the mean and tidal current fluctuations, and dip due to the passage of internal solitary waves. This will assist in data analysis of estimated time of arrival and amplitude.

The sampling program for the sensors is set to 4 samples per minute. The Sea Bird SBE39 temperature and pressure recorder is limited by battery power and not memory. With a 9 V Lithium battery, the instruments will sample every 15 seconds for just less than 4 weeks. This is well matched to the three week expected experiment length. The 15-second sample interval will easily resolve the 15-minute internal solitary oscillations seen in the April 2000 pilot experiment in the region (Lynch, 2000). With observed temperature variations of a couple of degrees C, the sensor's resolution of 0.002º C is more than adequate. The external pressure protected thermistor has a suitable response time of about 1 second.

The subsurface flotation and recovery package was built around the EdgeTech Pop-Up buoy and line canister and their new, low-cost, model AM200 acoustic release (Figure 2). Without the acoustic transponder capability of larger releases, these units are reasonable in cost, small in size, yet capable of releasing a subsurface float to bring a retrieval line to the surface. They are also controlled with standard EdgeTech deck gear. For ASIAEX the canister holds 40-meters of 3/8" Tenex coated line (to prevent abrasion) and two plastic net floats - an

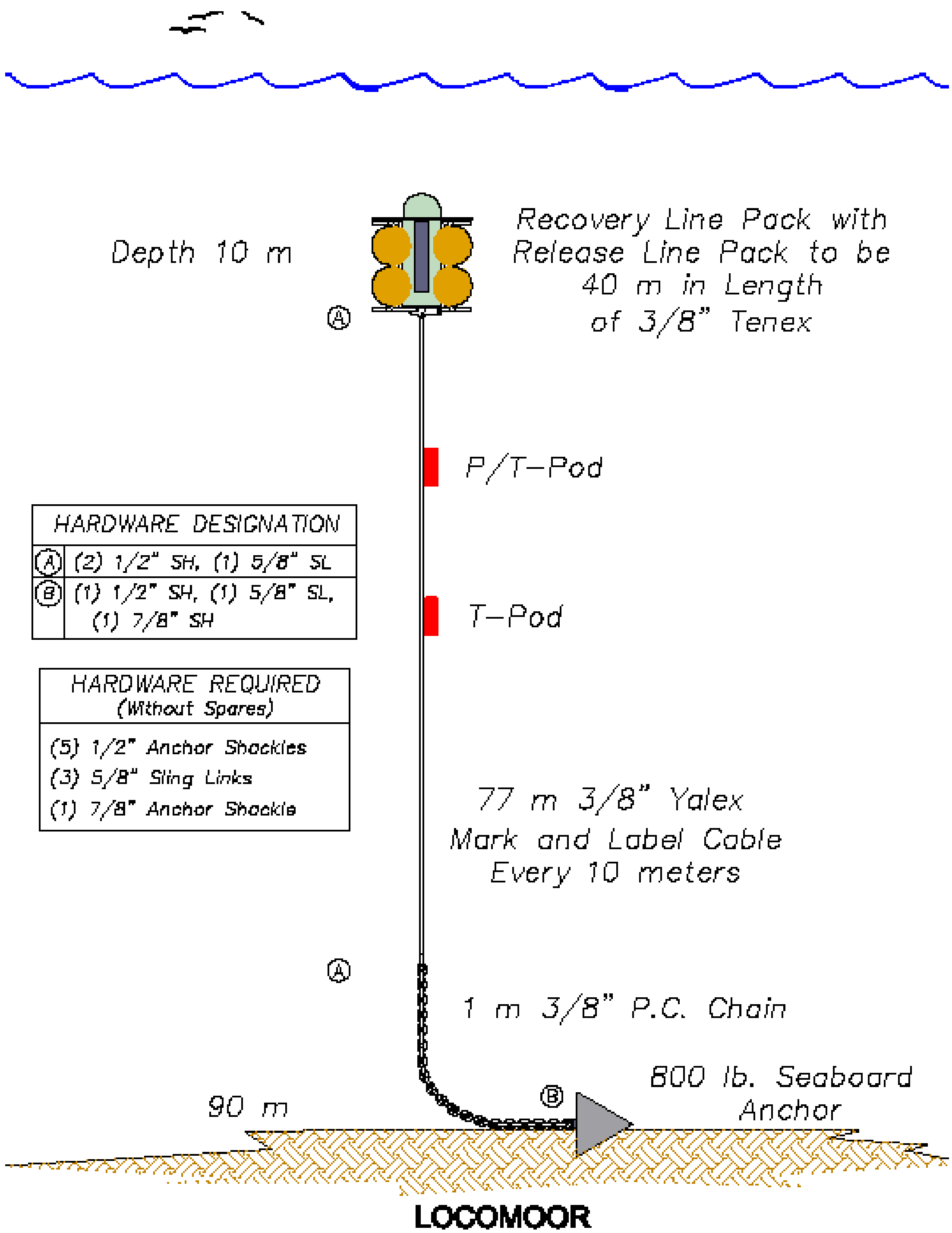

Figure 1. A sketch of the LOCOMOOR configuration with anchor, chain, cable, sensors and recovery float package (see Figure 2).

Figure 2. Testing of the release/recovery package off the WHOI dock. The Edge Tech acoustic release can be seen as the small vertical cylinder on the line canister toward the camera. The eight additional flotation spheres are attached around the PVC line canister by aluminum brackets. This also gives the package a recovery bail to ease pickup. The recovery float is seen in the top center of the package, closing the line canister. The ball is held in place by a hook to the acoustic release that is released upon command.

11" one that seals the top of the line canister, and an 8" one that rests inside the canister with the line. This two-ball configuration gives an easier target for a grapnel when the floats are on the surface. Upon acoustic command, these two spheres bring the Tenex line to the surface. The floats are picked up, and the entire mooring is then pulled up for recovery.

The positive buoyancy for mooring flotation and stiffness was provided by eight additional 11" diameter plastic fishing net floats mounted on an aluminum frame (Figure 2). The total buoyancy at the top of the mooring is about 140 pounds (64 kg). Modeling the proposed LOCOMOOR mooring configuration (Figure 3) with WHOI Cable software (Gobat, et al, 1997) showed minor sideways movement and mooring dip in a 1-knot (typical tidal) current. However, there was significant dip in a 5-knot (survival) current. The top of the mooring dips from 10 meters depth (in 90 meters water depth) to about 65 meters depth with about a 75-meter horizontal excursion. Changing the buoyancy doesn't significantly change these results. Most moorings are fairly stiff and move little in less than 1 knot current, and most moorings feel significant drag and therefore dip significantly in a 5-knot current. The tension in the mooring increases from 142 to 210 lbs (64 to 95 kg). An ADCP record from ASIAEX 2000 in the East China sea show typically 1-knot additional currents due to the passage of an internal solitary waves, so we expect to see minor mooring dip. However, 5 knot currents have been observed in large South China Sea solitary waves.

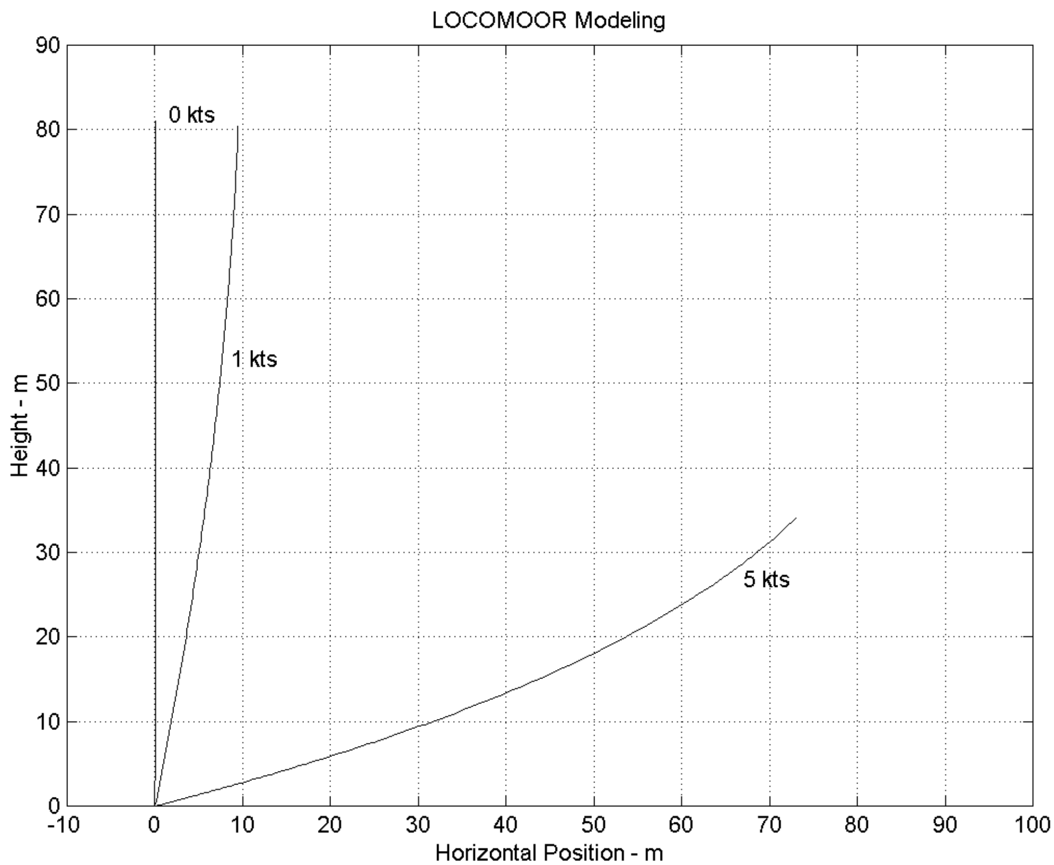

Figure 3. WHOI Cable modeling of the LOCOMOOR in different currents. The 1-knot current has minimal mooring dip and small horizontal displacement. The 5-knot current has significant mooring dip and horizontal displacement.

A more critical issue is whether the recovery line can reach the surface in high currents for recovery. In a 1.5-knot current, the recovery float should surface for pickup. At higher currents the drag on the line will keep the recovery float underwater. If the mooring is kept out of the Kuroshio (in the South China Sea, with currents of a few knots), there should be no difficulties recovering the package. If the Kuroshio does move up onto the shelf to the depth of these moorings, then the floats will not surface (as well as the moorings dip significantly) and the moorings will not be recovered. Adding more line does not significantly improve the situation as the drag on the line increases also.

Two of these systems were constructed and deployed for a three-week pilot experiment in April 2000 in the East China Sea as part of ASIAEX 2000. Unfortunately, when the R/V *ROGER REVELLE* returned to recover these moorings, the population of fishing boats in the area was and extremely high, and the two LOCOMOORs and two other environmental moorings were not recovered. We believe that fishing activity rather than design or mooring failure problems were the cause of the loss. This means that area and mooring protection of some kind will have to be used for the full array deployment in the spring 2001. In the meantime, local tests of remaining prototype moorings will be done to assure that the systems are working properly and behaving as modeled so that the required observations can be made.

The initial goal of making a solitary wave measuring mooring for $5k each was not met. The basic idea of putting in 20 moorings of $5k each to get spatial coverage, rather than one mooring of $100k is still valid. The basic parts cost for this package is about $6k, with machining and assembly costs for adding the additional flotation on the line canister being extra. This lower cost approach can be used in many regions and applications to get a wider horizontal sampling plan than typically has been accomplished with moorings. Hopefully, this approach will allow new and different observations of spatial variability to be made, and improve our understanding of oceanic processes.

References:

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