Woods Hole Oceanographic Institution
Upper Ocean Processes Group

Technical Note

Evaluation and Modification of SeaBird's Seaguage Pressure Recorder

Accurate measurement of oceanic pressure gradients is extremely challenging because the associated pressure differences are for many applications very small. For example, pressure gradients associated with the wind-driven circulation over continental shelves on time scales of days to weeks, correspond to pressure differences of a few millibars (1 mb is equivalent to about 1 cm of water) over separations of about 100 km. Since pressure sensor accuracy is generally a function of full range, a sensor that can be deployed in 100 m of water (typical shelf depth) must have an absolute accuracy of about 0.01% of full range. To estimate pressure gradients over the North Carolina inner shelf as part of the CoOP inner-shelf field program (Butman, 1994) we purchased eight Seagauges. Seagauges are relatively new, self-contained instruments for measuring absolute pressure and are manufactured by Sea-Bird Electronics, Inc. of Bellevue, Washington. This note describes evaluation and modification of the Seagauge pressure ports done at Woods Hole Oceanographic Institution (WHOI) prior to deploying the instruments in the CoOP field program. The Seagauge uses a high precision Paroscientific Digiquartz "T" series pressure transducer to measure absolute pressure (see Wearn and Larson, 1982, for a detailed description of the Digiquartz pressure sensor). The instrument has a quoted accuracy of 0.01% of full scale for a given pressure transducer, e.g. about 0.3 mb for the 45 psia pressure transducers used in the CoOP inner-shelf study. The pressure measurement is made by continuously integrating the pressure signal over the record cycle, resulting in an accurate measure of the average pressure over the record cycle. The pressure sensor, electronics and batteries are housed in an acetal polymer, cylindrical pressure housing that is 9.9 cm in diameter and 70 cm long (Figure 1). The external pressure is transferred to the pressure transducer via a small oil filled bladder connected to the transducer by a small piece of tubing. The bladder is in a covered cavity in the bail attached to the end of the instrument (Figure 2). The cavity cover is a rectangular plate with four small holes through the corners of the cover. The location of the bladder in the bail and the geometry of the bail raised concerns that the pressure might vary with flow speed and the orientation of the instrument relative to the flow. To evaluate the Seagauge pressure measurements in the presence of a current, tests were conducted from late September 1993 through early January 1994 using a flume located in the Coastal Research Center at WHOI. The flume used is 17 m long and 0.65 m wide and the water depth was maintained at 0.2 m. A Seagauge was mounted vertically with the pressure sensor at the bottom end of the instrument in the flume with the factory pressure port about mid depth in the water column. The flow in the flume was maintained at a speed of about 14 cm/s and the instrument was rotated at 45 degree increments through 360 degrees. The flow speed was then increased to 48 cm/s and the instrument was incremented through the same orientations. Over the 360 degree rotation the measured pressure varied by 0.6 mb for the 14 cm/s flow speed and by 1.5 mb for the 48 cm/s flow speed. For both speeds the maximum pressure was measured when the instru-

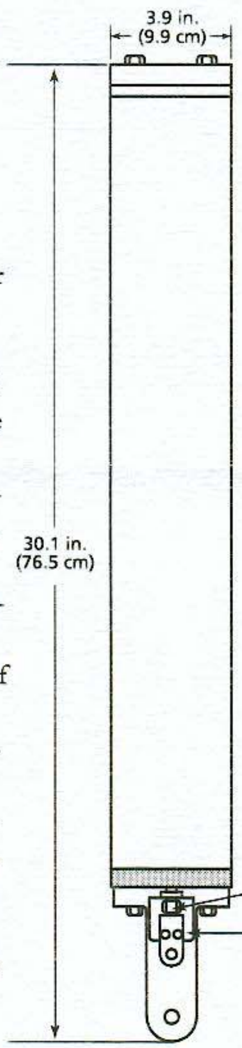

Figure 1: Seaguage–full view

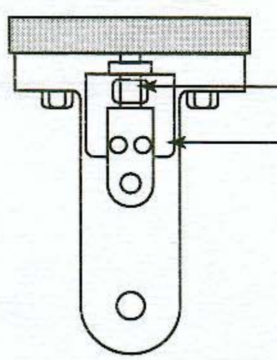

Figure 2: Pressure bladder location on Seaguage

ment was oriented so that the flow was directly at the bladder cover and the minimum pressure when the instrument was turned 180 degrees so the bladder cover was facing downstream. The results from these initial flume tests indicated that a new pressure port design was needed to minimize flow effects on the pressure measurement. We chose a parallel plate design for the new pressure port based on tests done for barometric pressure sensors by Gill (1976) and discussions with J. Candela (WHOI) who had used a parallel plate port previously with pressure sensors similar to the Seagauges. Based primarily on extensive wind tunnel testing done by Gill (1976) we chose the following characteristics (Figure 3). The parallel plates were separated by 0.5" with 3 spacers. A spiral of 36 grooves per inch was put on the plates and the outer edge of the plates were chamfered 15 degrees toward the inside of the plates to smooth out the flow and reduce the pressure dependence on flow speed. Material choice was also a consideration when designing the pressure port. A copper nickel alloy was chosen for its antifouling and corrosion resistance properties, as well as machinability. There was no significant biofouling of the instruments during the four-month (August to December, 1994) CoOP inner-shelf field study indicating this was a good choice of materials. A new mounting block to accommodate the pressure bladder was designed and fabricated out of delrin. The parallel plate assembly was attached to the mounting block via a piece of threaded fiberglass tubing with a 1/8" diameter hole through the mounting post to allow the pressure to get to the pressure bladder. The flume tests were repeated with the new pressure port for flow speeds of 6, 18 and 38 cm/s. The variation in pressure was about 0.2 mb with higher pressures at the lower flow speeds. The only dependence on instrument orientation was whether one of the three spacer posts (holding the parallel plates apart) was oriented into the flow. Pressures were typically 0.1 to 0.15 mb higher with a post oriented into the flow than when the gap between posts was oriented into the flow. The dependence on both flow speed and the orientation of the posts are tenuous because the experimental uncertainty is about 0.1 mb. However, these results indicate that the parallel plate port reduced flow effects on the pressure measurements by about a factor of 10.

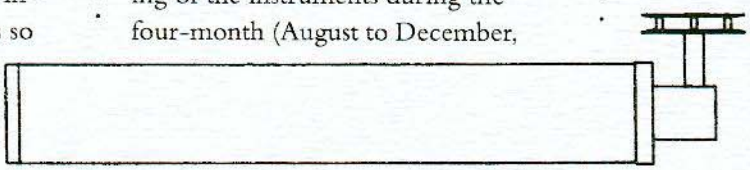

Figure 3: Parallel plate pressure port as mounted on Seaguage.

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Note: Previous issues of the UOP Technical Note can be found on our homepage at http://uop.whoi.edu

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