



Woods Hole Oceanographic Institution  
Upper Ocean Processes Group

## Technical Note

Preliminary techniques for measuring  
waves on UOP buoys



February 2008

Surface waves are one of the most readily apparent physical processes in the upper ocean, but surface wave measurements have not been part of the standard UOP measurement suite.

The scientists and engineers at the National Data Buoy Center (NDBC) have performed much of the cutting-edge research and development of surface wave measurements from buoys; the NDBC group has worked for more than 30 years to address power and data-storage constraints and have implemented wave measurements in buoys very similar to ours. Given previous collaboration with them, it seemed natural to work with NDBC in implementing wave measurements. NDBC graciously loaned two (identical) instruments for measuring the motion of a surface buoy to the UOP group.

**Technical aspects:** WAMDAS: Wave and Meteorological Data Acquisition System

The WAMDAS wave system, used for the “Access to the Sea” buoy and for the STRATUS 8 buoy, is designed and made by NDBC and its support contractor. It includes wave measurements, GPS positions, and GPS times. It utilizes a 3-axis motion pack made by MicroStrain Inc. The WAMDAS is capable of transmitting and storing data. The transmitted data is sent via Iridium communications on an hourly basis. This message is ultimately transmitted to NDBC where the data are subjected to automated quality-control checks and then posted on the NDBC web site. The data is stored in raw and processed format on a 1 GB compact flash card in the instrument.

**Motion sensor:** 3DM-GX1 Gyro Enhanced Orientation Sensor version 3.1.01

The motion sensor is capable of communicating with a host system or alone via RS232 serial communications. The 3-axis sensor is used in the polled mode where the host system requests axis information, processes it, and stores the data.

**Processor & logger:** The onboard computer is a Persistor Instruments Inc., Persistor CF2, 68332 Based computer system. It also utilizes the Texas Instruments ADS8344 16-bit, 8-channel A/D converter and a Maxim RS232 driver.

**Physical mounting:** The mounting of the sensor, electronics box, and antennas are in different locations on the buoy (Fig. 1). The sensor is mounted inside the buoy well approximately at the waterline and in the center of the buoy. The sensor is also 6” below any batteries or electronics in the well for minimizing magnetic interference. The electronics housing is mounted inside the buoy well above the batteries and MET loggers (STRATUS 8 only), (Fig. 2). A longer sensor cable is required to reach between the sensor and the electronics box. The GPS and Iridium antennas are mounted on the top of the wind vane above the radar reflector.

### Instrument preparation

**Magnetometer spin:** A hard-iron calibration is required for the 3DM-GX1 sensor. This calibration is an attempt to correct for the magnetic field caused by the buoy assembly and electronics. This was performed with all electronics and battery packs in place in the well and powered up. This was done to simulate the actual configuration during deployment. On the “Access to the Sea” buoy, mounted and powered up were a tension cell, a DCFS sonic flux system, and a radar enhancer. On the “STRATUS 8” buoy, mounted and powered up, are two each complete ASIMET systems with ARGOS transmitters and antennas, a PCO2 system, and a stand alone RM Young wind instrument. The buoys were hung in Clark South high bay with an overhead crane (Fig. 3). The spin comprises of two complete revolutions at 1 rev. per minute. Data are then acquired, processed, and then applied to X, Y, and Z Iron Calibration Offsets. Once the procedure is completed the offset values are recorded and a copy of the EEPROM map is saved for future reference.

### Set magnetic variation

The WAMDAS has the capability of utilizing the magnetic variation, for a particular location. The magnetic variation needs to be specified before testing and deploying.

**Testing:** Some basic testing has been performed on the tilt and compass aspects of the WAMDAS. The X and Y axis tilts were checked by first placing the buoy on a flat surface. Next,

the  $X$  axis was tilted clockwise approximately  $5^\circ$ , then the  $X$ ,  $Y$ , and  $Z$  values were recorded. Second, the  $X$  axis was tilted counter-clockwise approximately  $5^\circ$ , then the  $X$ ,  $Y$ , and  $Z$  values were recorded. Next, the  $Y$  axis was tilted clockwise approximately  $5^\circ$ , then the  $X$ ,  $Y$ , and  $Z$  values were recorded. Finally, the  $Y$  axis was tilted counter-clockwise approximately  $5^\circ$  degrees, then the  $X$ ,  $Y$ , and  $Z$  values were recorded. The tilts were checked with a digital level which has an accuracy of  $\pm .1^\circ$ . The equivalent of a buoy spin was performed to check the  $Z$  axis, also known as “Yaw”. The buoy was checked at eight different magnetic headings: (1) the buoy ( $X$  axis) was oriented to point N; (2) the WAMDAS was put into a 3DM-GX1 test mode, and the Yaw value was recorded; (3) the buoy was moved clockwise by  $45^\circ$ ; (4) and the process was repeated.

**Burn in:** Before the buoy can be deployed, as part of its testing, the electronics were powered up and run for a lengthy period of time in a process referred to as a “burn in”. During this period, data were collected and transmitted while the buoy was placed outside. Periodically, the data were extracted by removing the compact FLASH card and removing the files. The data were examined and any issues would be addressed. The transmitted data goes through NDBC Data Assembly Center (DAC) and then is posted online.

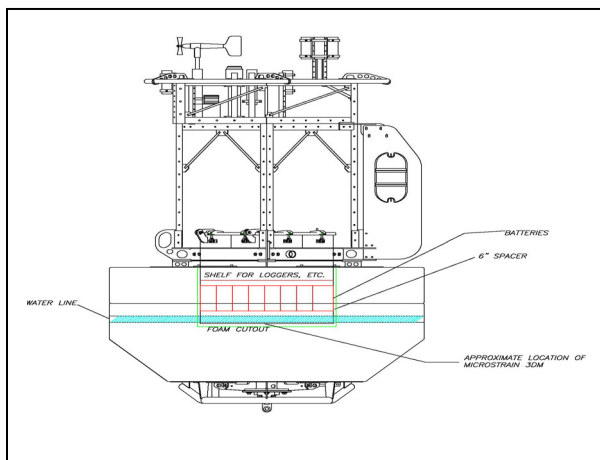


Fig. 1: The standard UOP surface buoy showing WAMDAS sensor location.

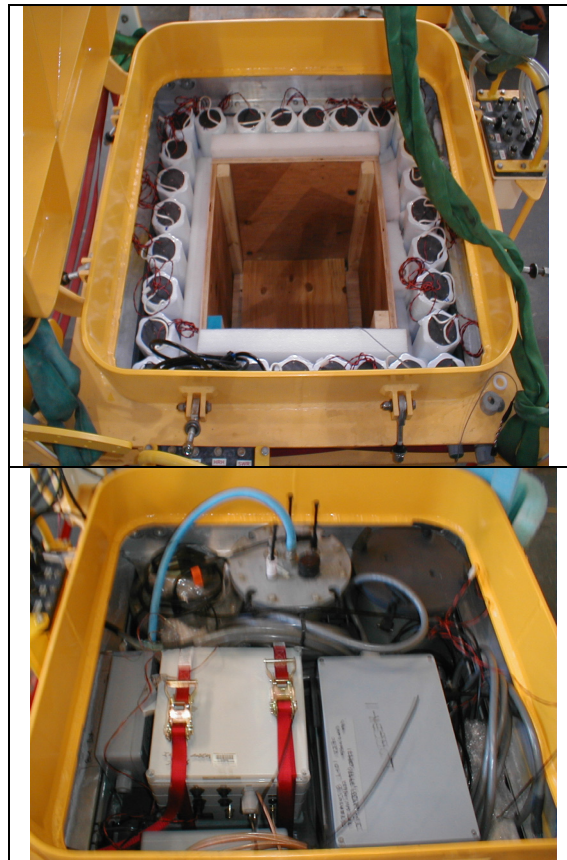


Fig. 2: Upper panel: Buoy well configuration for the ‘Access to the Sea’ buoy test deployment. Lower panel: Buoy well configuration for STRATUS 8 deployment.



Fig. 3: Rigging of the assembled buoy for buoy spin (or ‘hard-iron calibration’).

Contributed by: Paul Bouchard and Tom Farrar (WHOI). The authors thank Chung-Chu Teng, Richard Bouchard, and Rodney Riley of NDBC for their advice and assistance.