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SUBJECT: Use of Teledyne RD Instruments “Pulse to Pulse Coherent Mode” to Study Shear in the Wave Orbital Bottom Boundary.

Teledyne RD Instruments “Pulse to Pulse Coherent” has been used since 1992 by engineers and scientists to increase their field measurement productivity by significantly increase the temporal and spatial resolution of ADCP data collection. Mode 11, the most recent advance in the pulse to pulse coherent mode is optimized to allow the collection of high precision data with a resolution as small as 1 cm, making the ADCP suitable for turbulence + sediment transport data collection.

The following web sites provide an overview of mode 11’s capabilities and limitations:

http://www.rdinstruments.com/tips/tips_archive/mode11_0203.html

The following is an example of Mode 11 data that were collected by the US Army Corps of Engineers at the Field Research Facility (FRF) in Duck, North Carolina.

The US Army corps of engineers deployed an ADCP on their Sensor Insertion System (SIS). Goal was to collect velocity and acoustic backscatter data within the bottom boundary layer to understand sediment transport phenomena. Figure 1 is a picture of the research pier and the SIS. More information on the USACE FRF and the SIS is available at the following web site: <http://www.frf.usace.army.mil/vehicles2.stm>



FIGURE 1: Sensor Insertion System

The ADCP was deployed on the SIS in ~3.5 meters total water depth. The ADCP oriented in a downward looking position 1.5 meters above the bottom. The ADCP was setup in the “pulse to pulse” coherent water profiling mode 11 with 5 cm bin sizes resulting in a single ping standard deviation of 1 cm/sec. The ADCP was setup to also transmit one bottom tracking ping to record range to bottom and “speed” of the bed load sediments as they passed the ADCP. The ADCP was able to achieve one “ensemble” of water + bottom pings every 0.35 seconds (2.85 hz).

During the deployment the significant wave height was 0.5 meters with a 5 second peak period.

100 seconds of raw velocity magnitude, vector direction, vertical velocity and acoustic echo intensity data are depicted in Figure 2. The location of the bottom as defined by the separate “bottom tracking” pulse is visible as the solid line at a depth of 3.5 meters.

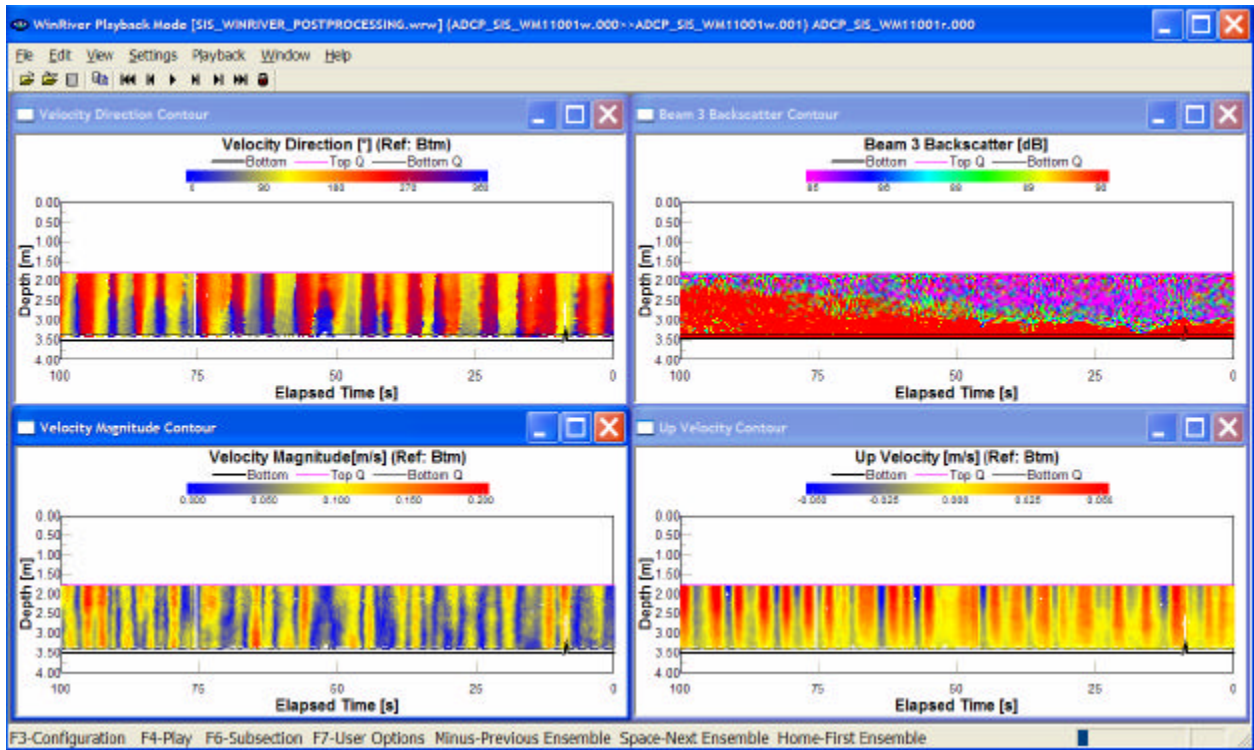


Figure 2: Raw MODE 11 ADCP Data

During this deployment, the peak vertical and horizontal velocities measured were 21 and 7 cm/sec respectively. Wave orbital oscillations are clearly visible in this time series. Also visible is an increase in near bottom echo intensity that propagates upwards towards the end of the time period (Left hand side of the plot). This increase in echo intensity is probably due to the injection of sediment particles into the water column. During this period there was also significant shear in the water column that was superimposed on the wave orbital signal.

The shear in the water column was most prevalent during the periods of lower horizontal velocity at wave phases corresponding to midway between the wave crest and trough. Figure 3 illustrates an individual velocity profile with 102 degrees of shear between the first bin at the surface and the last bin at the bottom. This profile was sampled at 96 seconds elapsed time from the data display in Figure 2.

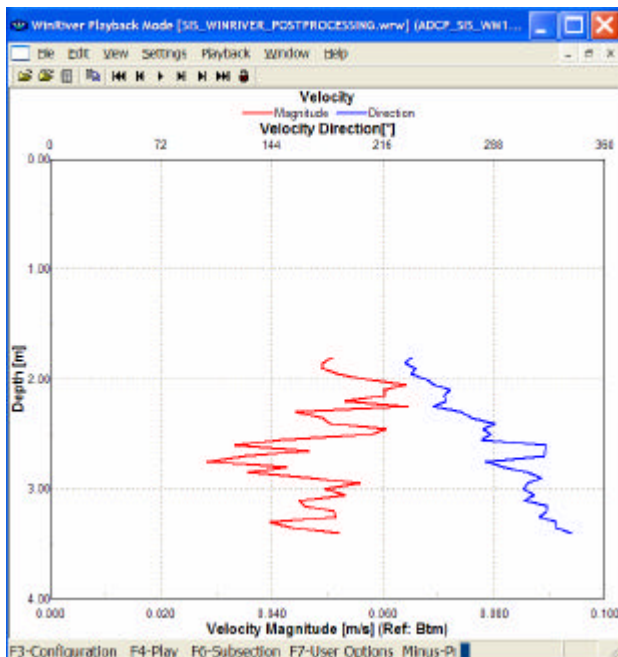


Figure 3: Individual Velocity Profile with Significant Shear.

By averaging data the wave induced oscillations are removed effectively leaving only the mean velocity where the shear in the data set is readily identifiable. Figure 4 contains a 43 pings (15 seconds) average of the raw data illustrated in Figure 1. The shear is readily identifiable with peak horizontal and vertical velocities are 6.5 cm/sec and 1.2 cm/sec respectively with the velocity shear occurring near the bottom (right hand side of the plot) at the beginning and steadily propagates upward to a depth of ~2.5 meters at the end of the time series (left hand side of the plot). There is also a distinct change in the echo intensity above and below the shear indicating a differential in the concentration of suspended sediments above and below this layer.

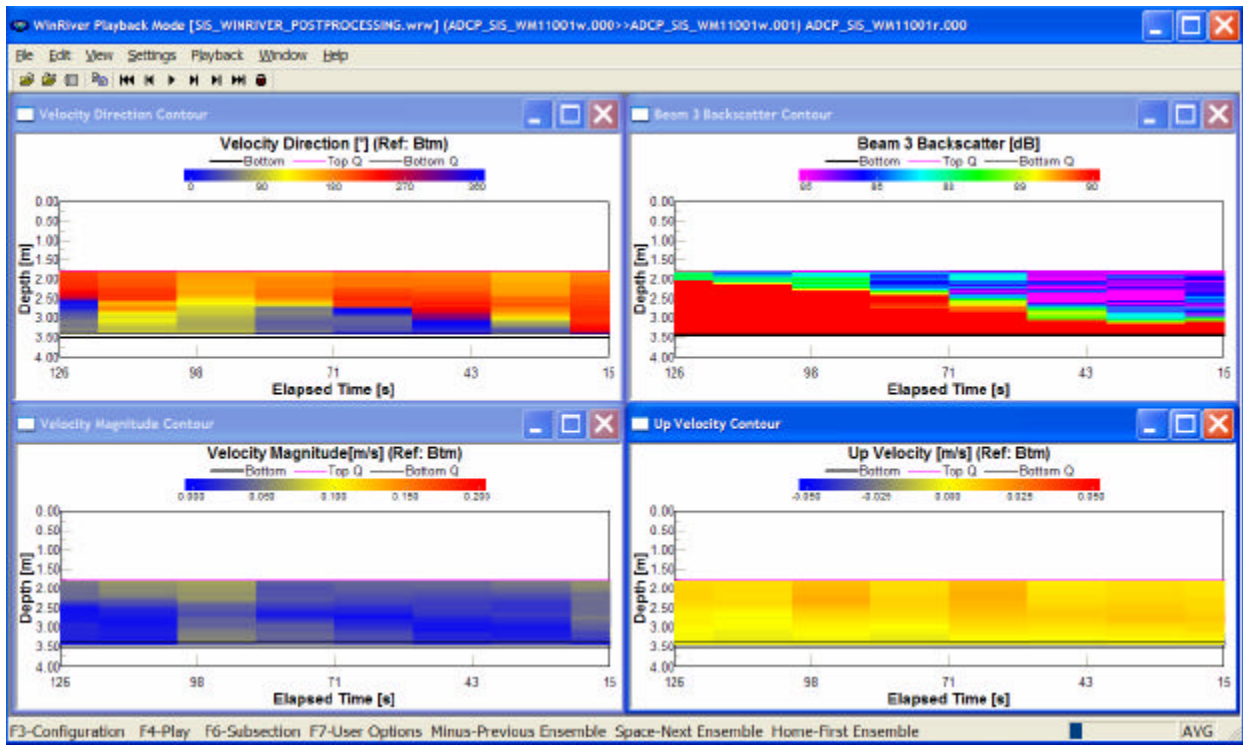


Figure 4: 43 Ping average (15 seconds duration) MODE 11 ADCP data.

In summary, Teledyne RD Instruments Pulse to Pulse Coherent Mode 11 can be used to:

- Collect high resolution and high precision velocity time series data (5 cm bin = <1 cm/sec std)
- Study turbulence
- Understand sediment transport phenomena on very small scales
- Use your ADCP in shallower depths than ever before