



RD Instruments
Acoustic Doppler Solutions

ADCP Transects Across Inshore Channel Clarify 2-Layer Flow -- Corpus Christi Bay, Texas

(Courtesy Drs. Jim Bonner and Frank Kelly at the Conrad Blucher Institute, Texas A&M University-Corpus Christi)

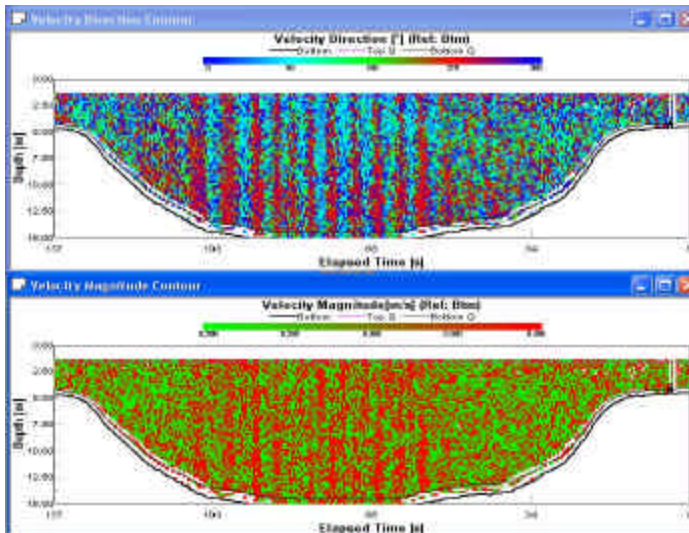


Figure 1. Channel Section: Single Ping data. Direction reversals (stripes) are hypothesized to be caused by waves with 5s period that are crossing the section traversed by the vehicle.

Inshore ADCP transects can show enhanced velocity variability when separate phenomena (e.g. tidal currents and waves) are superposed. At first blush, the data can seem very busy and difficult to interpret. In the data shown here, what we noticed at first was occasional stripes in the velocity contours that we dismissed as errors due to uncorrected ADCP motion (e.g. boat motion, movement of the ADCP mounting). By reducing the range of colors displayed in the contour plots, however, we exposed a very regular patterns of stripes in these velocity transects.

If the boat is moving steadily, then a periodic variation in the water currents can appear as regular variation in space. Regular stripes in a velocity contour plot can be caused by surface waves, with a dominant period, that are crossing the boat path.

By displaying the velocity data versus time (Fig. 1), we observed that the striped pattern had about a 5-s period. Waves with that period would have a wavelength of about 40 m and should have significant coherent signature through the depth of the channel being crossed in these data. This reinforces why the stripes can be seen from top-to-bottom.

In Figs. 2 and 4, you can see that averaging the ADCP data over an approximate 5-s period (10 ensembles) revealed a 2-layer flow in the center of the channel. Much lower velocities in Fig. 2 (cf. Fig. 1) reinforce that 2-layer regime is being masked in the raw velocity data by the strong wave signal. In Fig. 4, velocity vectors displayed at different depths show the reversal of flow with depth in mid channel. Also apparent in the vectors in the surface waters are counter flows at the channel edges.

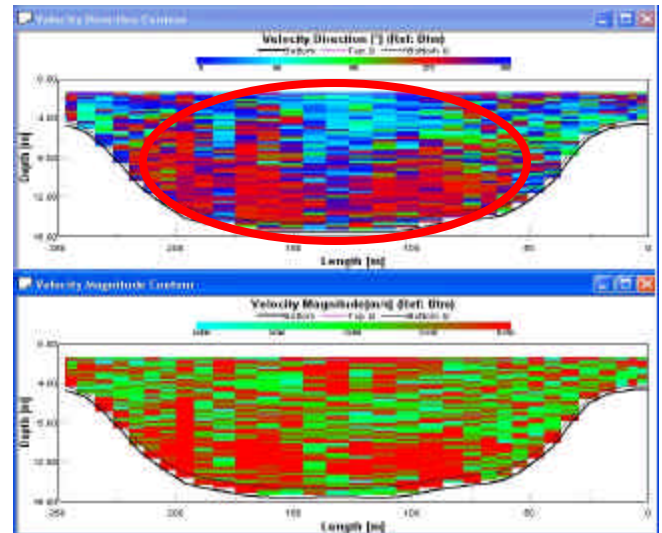


Figure 2. Same Channel Section: 5-s averaged data. 2-layer flow regime is more apparent after the wave signal is filtered out. Direction reverses from east in the surface layer to west at depth. In mid-channel, a layer of slower flow at mid depth is also apparent. Flow on the north side of the channel is directed more across-stream than along.

The section of acoustic backscatter data provides another view of this 2-layer regime. The westbound flow in the lower layer is carrying much higher suspended load. You can see that in the surface and deep layers that backscatter level is reasonably uniform yet the deep layer is about 12dB higher than the surface. Mid-column depths show an intermediate level of backscatter possibly reflecting vertical exchange across the interface of the opposing flows.

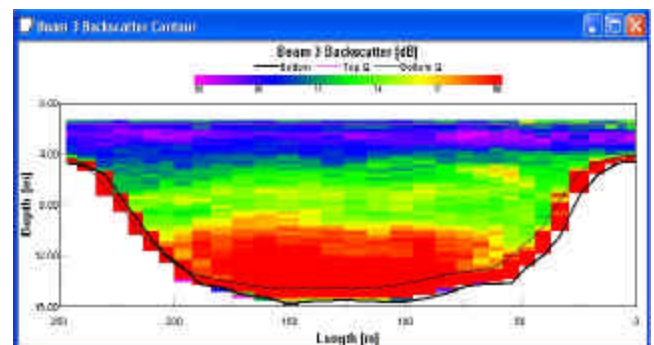
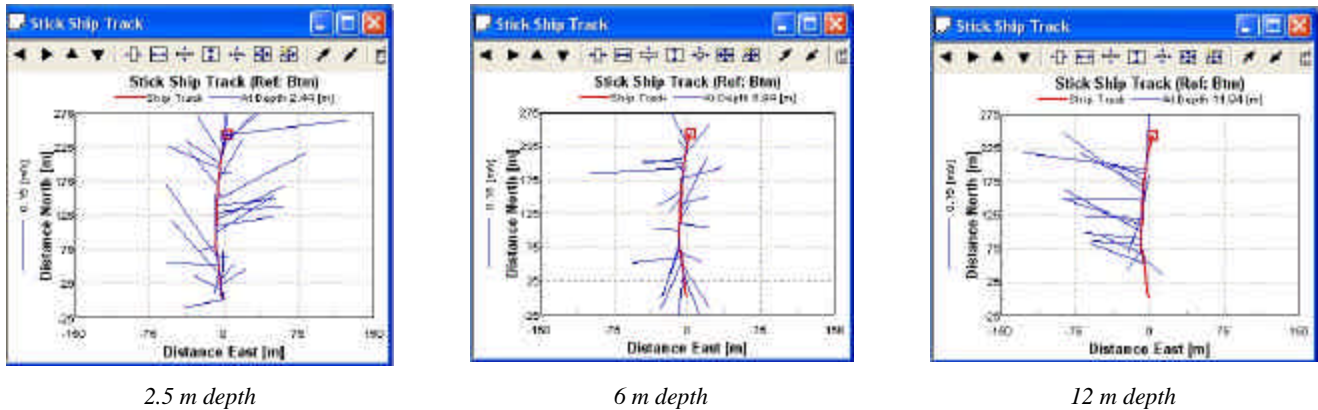


Figure 3. Channel section: Acoustic Backscatter (dB). Additional intriguing evidence of the 2-layer flow regime in this channel is found in the echo data. The backscatter values are determined by correcting raw echo intensity data for acoustic absorption and range spreading. After these corrections, a water column having uniform distribution of scatterers would display a uniform level for backscatter.

(Continued)



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2.5 m depth

6 m depth

12 m depth

Figure 4. Velocity vector plots displayed at 3 levels through water column. The surface layers show counter flows at the channel edges compared with its center. Also the center of the channel shows a 2-layer flow including flow reversal at depth. The depth-averaged shear is about 3 cm/s/m.

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