5.21 LADCP

(1) Personnel (*: Leg-1, **: Leg-2, ***: Leg-1+2)

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(2) Objective

To produce high vertical resolution horizontal velocity measurements.

(3) Overview of instrument and operation

To measure velocity structure at small vertical scales we used a high frequency ADCP in lowered mode (LADCP). The instrument, a Teledyne RDI Workhorse Sentinel 600kHz ADCP rated for 1000m depth, was attached to the CTD frame using a wide metal collar made of two halves joined by six retaining bolts (three on each side, as shown in Figure 1). A rubber sleeve was wrapped around the instrument to prevent direct contact between the instrument and the metal collar and to prevent vertical slippage. A rope was tied to the top of the instrument and attached to the CTD frame to further reduce vertical slippage and for added safety. The instrument was deployed on CTD stations 5SM001, 5SM002, 8SM001 through 8SM420 and performed well throughout its use.

Fig. 5.21-1: Teledyne RDI Workhorse Sentinel 600kHz ADCP attached to the CTD frame

The instrument is self-contained with an internal battery pack. The health of the battery is monitored by the recorded voltage count. The relationship between the actual battery voltage and the recorded voltage count is obscure and appears to vary with the instrument and environmental conditions. Taking a direct measurement of the state of the battery requires opening up the instrument. Two batteries (one for each leg) were used in the course of the mr11-07 cruise. Direct measurements of the battery voltage were taken before and after each leg and compared to the recorded voltage count. The results, summarized in Table 1, show an almost constant relationship of V~=0.29VC. RDI recommend the battery is changed when V gets below 30V.

Table 1. Battery characteristics before and after the deployment.

Leg 1

	Battery Voltage (V)	Voltage Count (VC)	ratio (V/VC)
Before	44.6	155	0.29
After	36.8	125	0.29

Leg 2

	Battery Voltage (V)	Voltage Count (VC)	ratio (V/VC)
Before	44.6	154	0.29
After	36.0	122	0.29

(4) Data processing

An initial sampling of the data was made using the following scripts to check that the instrument was performing correctly

scanbb - integrity check
plot_PTCV.py - plot pressure, temperature, voltage and current counts
plot_vel.py - plot velocity from all 4 beams

The principal onboard data processing was performed using the Lamont Doherty Earth Observatory (LDEO, Columbia University) LADCP software package version IX_4 (available at ftp://ftp.ldeo.columbia.edu/pub/ant/LADCP). The package, consisting of a number of matlab scripts, solves a set of inverse problems using LADCP raw data, incorporating CTD (for depth) and GPS data, to provide a vertical profile of the horizontal components of velocity, U and V (eastward and northward, respectively), that is a best fit to specified constraints. The down- and up-casts are solved separately, as well as the full cast inverse. The package also calculates U and V from the vertical shear of velocity.

The software is run using the matlab script **process_cast.m** with the configuration file **set_cast_params.m**. Frequent CTD data are required. Files of 1 second averaged CTD data were prepared for each cast. Accurate time keeping is essential, particularly between the CTD and GPS data. To ensure this the CTD data records also included the GPS position. The LDEO software allows the ship's ADCP data (SADCP) to be included in the inverse calculation. The SADCP data were not included on this cruise so as to provide an independent check on the functioning of the LADCP.

On-station SADCP velocity profiles were produced by averaging the five minute averaged profiles (mr1107L1004_000000.LTA for Leg 1 and mr1107L2001_000000.LTA for Leg 2 produced using *VmDAS*) over the period of the CTD/LADCP cast.

(5) Preliminary results

Figures 2 and 3 show the time series for the zonal (eastward) and meridional (northward) velocity components in the upper 300 meters for both legs of the cruise. The upward phase propagation is consistent with the dynamics of the near-inertial waves (NIWs) radiated from the mixed layer into the ocean interior.

Further evidence for the near-inertial nature of the wave pattern seen in these figures comes from the temporal frequency spectra (figures 4 and 5), which reveal a strong peak around the 4-day (i.e., the local inertial) period in the upper 50 meters.

Another near-surface feature seen in the frequency-depth diagrams is the distinct peak at approximately 6-day period. We conjecture that this may be a response to an atmospheric wave with a 6-day period described in Yasunaga *et al*. 2010, but a more complete analysis will be performed after the cruise.

At greater depths the signal is dominated by somewhat higher frequencies and is consistent with propagation of NIWs generated at lower latitudes (8S to 12S) towards the equator.

Comparison of the LADCP velocity with the turbulent kinetic energy dissipation profiles obtained using microstructure measurements (TurboMAP) has proven to be very helpful in illuminating the physics of observed phenomena. Figure 6 shows shear S2 calculated from the LADCP velocity, and figure 7 shows the turbulent kinetic energy dissipation rate epsilon. The period of high epsilon between 170 and 300m near the end of Leg 1 seen in figure 6a is accompanied by the period of high S2 arising from an energetic NIW propagating through this range of depths during this time interval. A similar pattern can be seen between 100 and 150m depths at the end of Leg 2.

(6) Data archive

All raw datasets will be submitted to JAMSTEC Data Management Office (DMO).

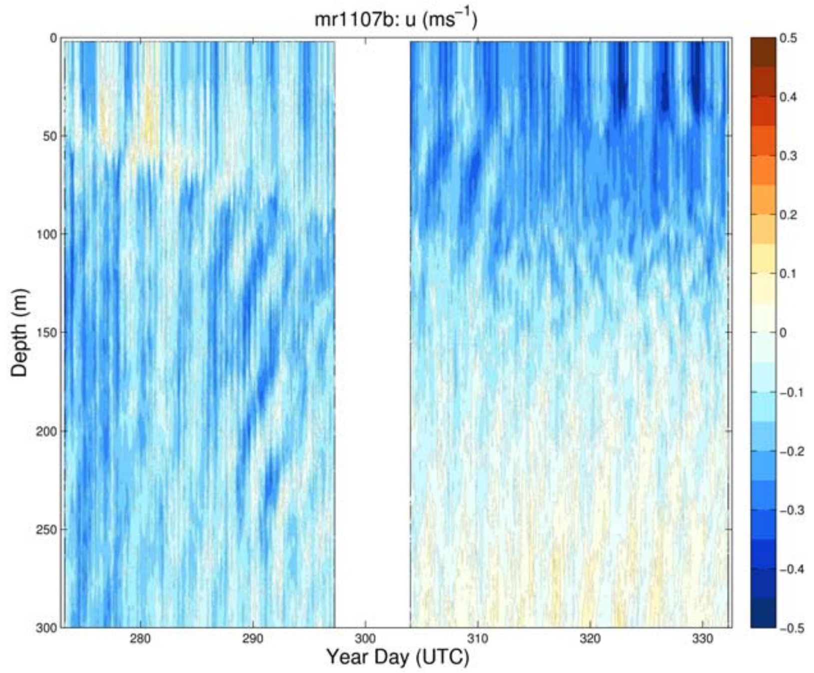

Fig. 5.21-2: Zonal (eastward) velocity time series.

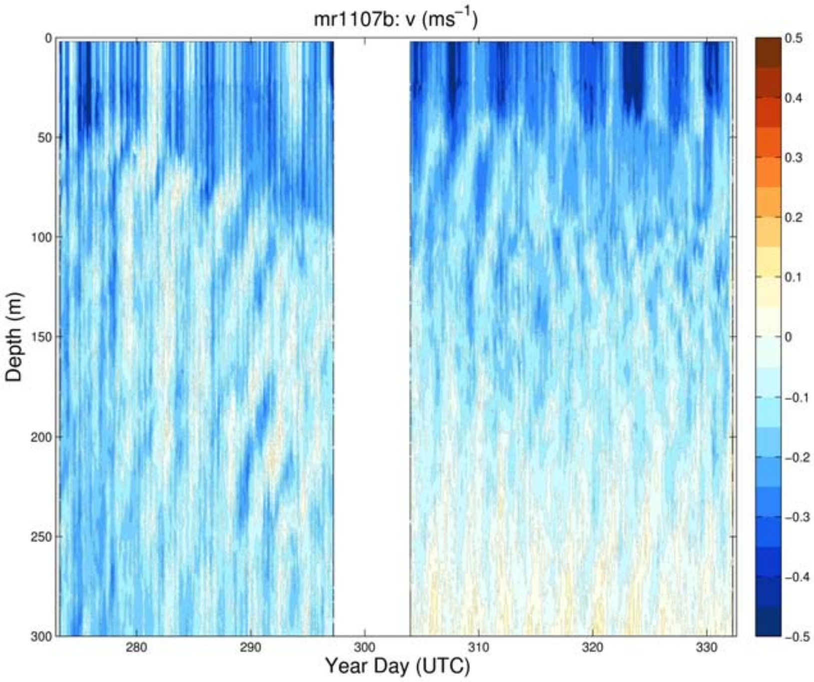

Fig. 5.21-3: Meridional (northward) velocity time series.

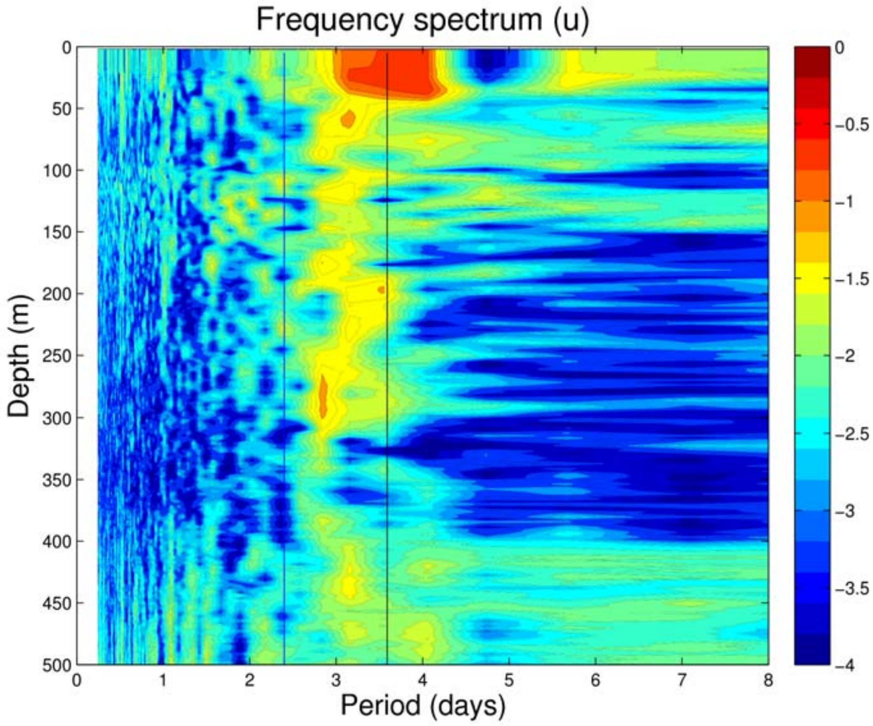

Fig. 5.21-4: Frequency-depth diagram for the zonal velocity U (Leg 2)

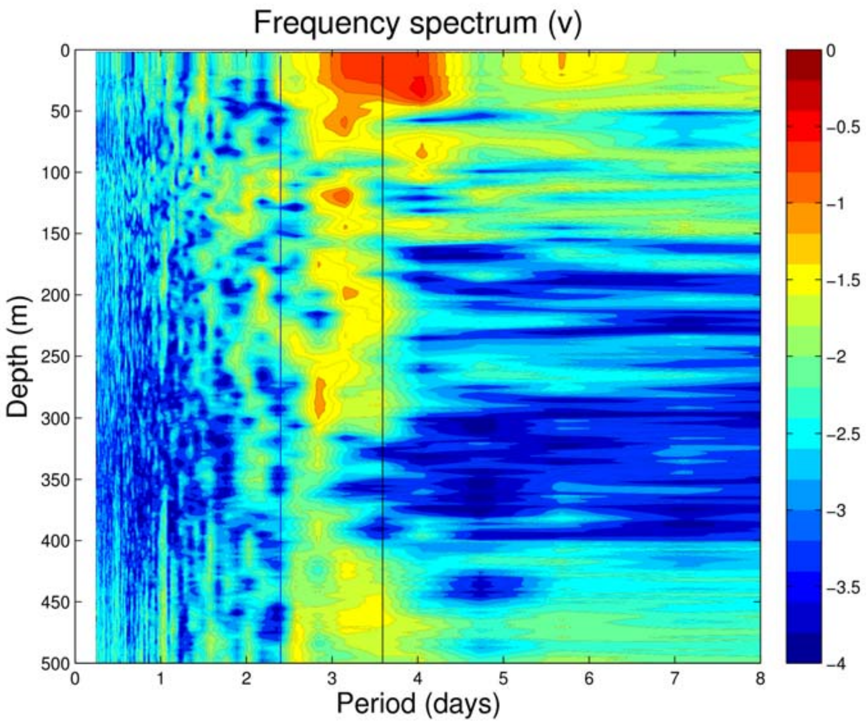

Fig. 5.21-5: Frequency-depth diagram for the meridional velocity V (Leg 2)

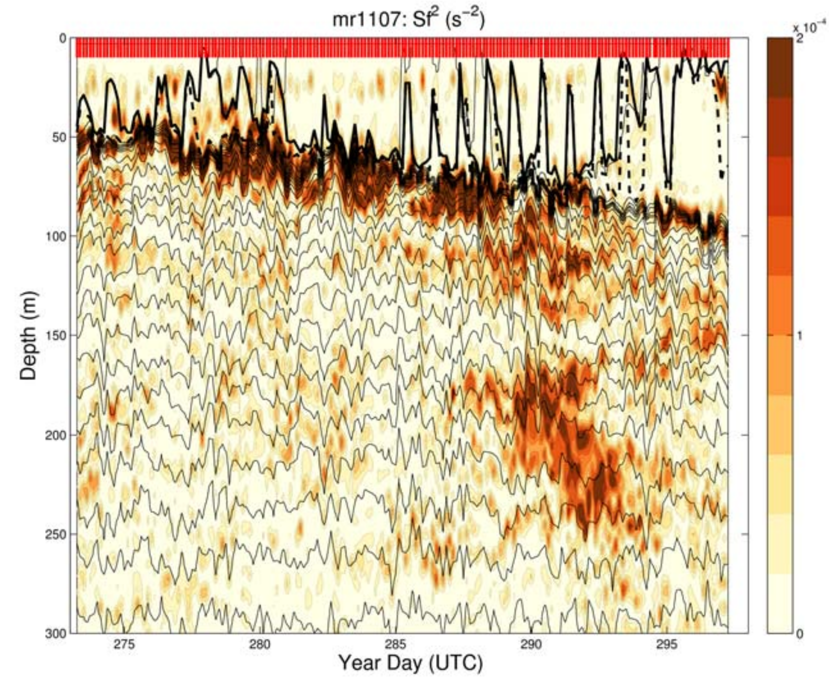

Fig. 5.21-6: LADCP velocity shear (S2) time series (Leg-1)

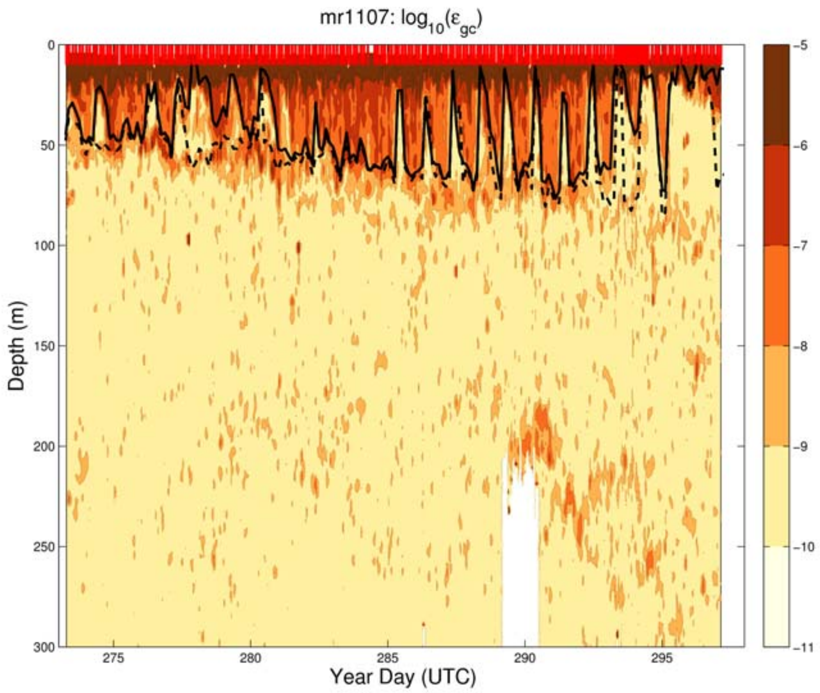

Fig. 5.21-7: Time series for the turbulent kinetic energy dissipation rate (epsilon) estimated from microstructure measurements (Leg-1)