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A COMPILATION OF MOORED CURRENT METER AND THERMISTOR STRING DATA DATA FROM THE GULF OF LION - DYNAMO

August 24 - August 31, 1997

Technical Report

97/7

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METROMED - MAST III
(DYNAMO DEPLOYMENT)

Current meter and thermistor string data
Processing Summary and Comments

1. Introduction

The current-meter and temperature data presented in this report were taken as part of the METRO-MED study on the particulate matter dynamics on Mediterranean continental shelves. The site of the study is the Gulf of Lion continental margin in the northwestern Mediterranean (Figure 1).

Two current meters and two thermistor strings were deployed from August 24 to August 30, 1997. The deployment was initially plan to last until mid-September, but the mooring was accidentally catch by a drifting net after one week. The mooring was released by cutting up the net and integrally recovered.

2. Experiment Design and Implementation

The mooring work was done from the R/V Tethys II of the INSU. The current meter and thermistor string work was done by Laboratoire de Sédimentologie et Géochimie Marines of the University of Perpignan.

2.1 Location of Moorings

Figure 1 shows the location of the study site. The coordinates of the mooring locations are from the ship's GPS position at the time of launch. The mooring is located on a ship wreck close to the Rhône river mouth.

The GPS position of the mooring as well as the depth of the currentmeters (RCM) and thermistors (TRS) are :

Mooring line	latitude	longitude	Water depth (m)	Instrument depth (m)
Dynamo	*43°15’335 N*	*04°42’166 E*	*65.5*	*4 (RCM)* *47 (RCM)* *11-31 (TRS)* *16-36 (TRS)*

2.2 Mooring Design

Figure 2 displays the mooring design.

2.3 Current Meter

The current meters were Aanderaa RCM 5S current meters.

They use a rotor to measure current speed, an internal compass to measure direction, a thermistor to measure temperature. The water pressure and conductivity were also measured for some current meters.

For this study, the sampling rate was set to 5 minutes. The RCM 5S current meters sense the compass and vane setting once every 5 minutes.

Stall speed of the rotor is not known for the current meters, but is typically about 1-2 cm/sec. The current speed accuracy is ± 1 cm/s or ±2% of the actual speed whichever is greater.

The compass has a 0.35° resolution and a ±5% accuracy for speed within 5 to 100 cm/s, otherwise accuracy is ±7,5%.

Time is measured by a quartz clock with an accuracy better than 2 sec/day.

The temperature sensor has a resolution of 0.1% of the selected range (from -0.34°C to 32.17°C) with an absolute accuracy of + 0.05°C.

The pressure sensor has a ±1% of range accuracy and a 0.1% of range resolution.

2.4 Thermistor String

The thermistor strings were Aanderaa 2862S with TR7 recording units.

The string were 20 m long, with one thermistor close the recording unit and four thermistors, spaced by 50 cm, at the other end. The string were moored with the recording unit down below.

Just as for the current meters, the sampling rate was set to 5 minutes.

The temperature sensor has a resolution of 0.1% of the selected range (from -2.46°C to 21.49°C) with an absolute accuracy of ± 0.05°C.

3. Data Quality

There were no mechanical or electronic problems with current meters or thermistor strings.

However, the shallow thermistor sensors for both strings were generally saturated as the water was warmer than the upper limit of the measurable range of temperature (-2.46°C to 21.49°C). Only, the deep thermistors of each strings - at 31 and 36 m deep respectively - worked correctly during the entire deployment.

Pressure of one current meter (RCM # 8574) showed spurious values. The pressure computed from the available conversion equations yield values one or two order of magnitude larger than the correct pressure. These measures were removed.

4. Current-Meter and Thermistor Data Processing

Speed and direction values were recorded every 5 minutes. Unfiltered raw data were plotted to check for bad data points and other problems. Few bad points were found.

The current meter directions were corrected by 0° for magnetic north variation so that 0° magnetic north corresponds to 0° true north.

According to calibrations for the rotor given by Aanderaa, the conversion of rotor revolutions/sec to cm/sec is linear with an intercept (stall out speed) of 1.1 cm/sec.

Temperatures were determined from the sensor counts using the calibration expressions given with the Aanderaa calibration sheets.

The nominal time series began August 24, 1997 at 07h55 UT and ended August 30,1997 at 19h00 UT.

4.1 Filtering

Smoothing - Smoothed values were produced by block averaging the raw data. This smoothing is obtain by applying one or several hanning passes to the data set. A hanning pass is defined as the application of the triangular filter

$$Y; = 0.25\ Y_{i-1} + 0.5\ Y_i + 0.25\ Y_{i+1}$$

to each data point except the end points, where an average between the two last points is computed. This filter was also used in smoothing the spectral amplitudes to produce the spectral estimates shown later in this report.

Phase space filtering - Low-pass, high-pass or band pass filtering is easily performed in the phase (fourier) domain. The data set (in time domain) is transformed by a Fast Fourier Transform (FFT) algorithm. The Fourier transform output (in phase domain) is multiply by a filter function H(f) and then an inverse Fourier transform is made to get back a filtered data set in time domain. The mean value of the time serie is remove before estimating the Fourier transforms and added the filtered serie after the inverse Fourier transform.

High-pass and low-pass filters eliminate the signal at low or high frequencies respectively. They are characterised by a cut-off (half-power) frequency fc.

A band-pass filter eliminates the signal that lies outside a certain frequency band, bounded by two cut-off frequencies fc_1 and fc_2 ($fc_1 < fc_2$).

A notch filter is used to remove only a frequency band bounded by two cut-off frequencies fc_1 and fc_2 ($fc_1 < fc_2$).

The filter function used here is a single (composite) sigmoide function centered around the cut-off frequency (frequencies). Cut-off frequencies can be expressed either in hours^{-1} or as equivalent period $T = 1/f$ in hours. The width of the transfer function (steepness of the filter) is defined by the coefficient α.

Low-pass :

High-pass :

Band-pass :

Notch :

4.2 Data Presentation

In this report, statistics, time-series plots, vector stick plots, progressive-vector diagrams, histograms, spectra, and scatter plots are presented.

4.3 Statistics

Computational procedures for statistical parameters are given below; over bars indicate mean components (averaged over the duration of the record). These parameters are computed from the raw current-meter data.

Variables	*x*, *y*
Number of mesurements	*n*
Velocity component vectors	*u* (east), *v* (north)
Temperature	*t*
salinity	*s*
Pressure	*p*

Average

Variance

Standard error =

Skewness =

Kurtosis =

Estimates of statistical errors on average and variance

Principal axis parameters:

The orientation angle is measured clockwise from due north. The slope of the major (γ_M) and minor (γ_m) axis are the roots of the following equation. The slope of the major axis,is the root with the same sign than the correlation coefficient ρ (= cov(uv) / $\sigma_u\sigma_v$) :

or

The slope of the major and minor axis are thus given respectively by

and the angle of the axis are then given by $\Theta = 90°- arctg\ (\gamma)$

The length of the major l_M and minor l_m axis are given by :

where F is

β_M and β_m axis are the larger and the smaller of the two solutions of the following equation :

thus

Ellipticity = 1 - (minor axis / major axis) = 1 - (β_m / β_M)

Covariance =

Reynolds Stress =

Correlation =

Average current =

Average current direction =

Mean kinetic energy =

Fluctuating kinetic energy =

AFV3 =

4.4 Vector Stick Plots

Vector stick plots of the raw and filtered time series are smoothed by two hanning passes.

4.5 Time Series Plots

Various quantities, depending on the data set, are plotted versus time.
Mean kinetic energy (MKE) and fluctuating (eddy) kinetic energy (EKE) are estimated over a 1 day intervals (moving window width) every 0.2 days.

4.6 Progressive Vector Diagram

The progressive vector diagram was created from the raw time series. The time interval for the long-term meters was 60 minutes. Stars indicate daily intervals.

4.7 Histograms

Histograms and cumulative histograms of the raw vector speed from the different currentmeters are presented.

4.8 Auto and Cross Spectra

All the spectra produced for this report use the Fast Fourier Transform (FFT) as implemented in the FORTRAN subroutine FOURT. Before the fourier transform was performed on the data, the mean and trend were removed from the data. Also all data sets were tapered 5% with a split cosine bell taper. The autospectra were presented as frequency times spectral estimates vs. the log of frequency (the "variance preserving" plot). The autospectra amplitudes were smoothed by 4 hanning passes to form spectral estimates.
To indicate strong correlations at a particular frequency for two different data time series, coherency squared for two series is plotted vs. frequency. The confidence limits on the plots are produced following the guidelines developed in Thompson (1979). The coherency squared amplitudes were smoothed by two hanning passes. The phase lag are plotted vs. frequency for coherency larger than a given confidence level (95%).

4.9 Rotary Spectra

The rotary spectrum is an alternate representation of the variance spectrum of a two dimensional time serie. It is easily derived from the complex FFT that is contained in the subroutine FOURT. The variance for each frequency is divided into two components, which are interpreted as the clockwise rotating variance (at negative frequency) and the counterclockwise rotating variance (at positive frequency). A more complete discussion can be found in O'Brien and Pillsbury (1974). A complex time serie is formed from the real current, w = u + iv, and used as input to FOURT.

5. Acknowledgements

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6. References

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