Physics and Physical Oceanography Data Report 2011-2

Analysis of Physical Oceanographic Data from St. George's Bay, NS

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Introduction

This study is a joint project between scientists at Memorial University, in St. John's, and Dalhousie University, in Halifax. The work is part of a larger national research partnership program - the Canadian Healthy Oceans Network (CHONE). This program is collaborative between scientists at academic institutions across the country and researchers from Fisheries and Oceans Canada. The goal of this particular study is to improve our understanding of the relationship between oceanographic dynamics and larval dispersion and survival. The key larvae to be studied are those of lobster (*Homarus americanus)*, a species which is commercially important throughout Atlantic Canada. Larvae of lobster drift for many tens of days after release before settling on the bottom. For the most part, they drift passively during this period so understanding the water circulation is crucial for determining where they end up and how oceanographic features determine their survival.

A key component in this work is to make measurements of the circulation in St. George's Bay, NS. This relatively small coastal embayment has a large lobster population and a relatively weak coastal circulation and so makes an ideal location in which to study the relation between circulation and lobster larval dispersal. The first step in this work is to make direct measurements of the water characteristics and circulation when lobster larvae are in the water, during the summer. To address this, three moorings were deployed in the summer of 2010. Each mooring had thermistors, located from near the surface to the bottom, to measure temperature, as well as Acoustic Doppler Current Profilers (ADCPs) for current measurement. The ADCPs provide measurements of the horizontal and vertical currents from very near the bottom to just below the surface, at a resolution of about 1 m.

The moorings were deployed on July 21, 2010 (day 202) and retrieved on August 18, 2010 (day 230) for a total of roughly 28 days. All times in this report are represented in Julian day number, with January 1st being day 1. Both temperature and current velocity measurements were taken every 20 minutes for the entire sampling period. Mooring locations are shown in Figure 1. Further details about their locations and the ADCP specifications are found in Table 1 and Table 2.

Data Processing

Missing or bad data from both the thermistor and ACDP data were dealt with in the same manner: either they were replaced by linearly interpolated values from surrounding points if there was sufficient data, or if there was not, they were removed entirely and omitted from the plots. Specifically, the upper 1 m for M2, 3m for M3 and 2 m for M4 of the current data were removed due to backscatter effects. There were also a total of 4 other bad data measurements for M4 that were replaced with the interpolated values.

In Figures 2-4, averaged velocity vector data is shown as a time series. The mean magnitude of velocity components were taken over every 3-hour period and plotted with the magnitude of the velocity shown on the vertical axis, and the time represented on the horizontal axis. Wind data from Caribou Point, NS (45°46' N, 62°41' W) available on the Environment Canada website (http://www.climate.weatheroffice.gc.ca/climateData/canada_e.html) is also shown in these figures.

Progressive vector plots, shown in Figure 6 were created by calculating the distance travelled at each mooring using the unfiltered velocity data for each 20 minute interval. The position after each day is marked with an 'x', and the start and end positions are each marked with an unfilled and a filled circle, respectively.

In both the current velocity and the temperature isotherm time series plots (Figures 7-12), data were filtered using a 5^{th} order forward-and-reverse Butterworth low pass digital filter with a cut-off frequency of 30 hours in order to remove high frequency variability. The filtered data were then interpolated into 0.25 m bins in order to plot the isotherms.

Mooring	Latitude (°N)	Longitude (°W)	Water depth (m)	Distance of first ADCP bin from seafloor (m)
M2	45 46.993	61 51.773	24.7	2.1
M3	45 43.656	61 45.643	26.0	3.21
M4	45 43.127	61 37.442	24.4	2.09

Table 1: 2010 mooring location specifications.

Mooring	Start time:			End time:			ADCP frequency	ADCP serial number
	Day	Hour	Minute	Day	Hour	Minute		
M2	202	17	0	230	11	0	614.4 kHz	2069
M3	202	17	0	230	11	0	307.2 kHz	2460
M4	202	17	0	230	11	0	614.4 kHz	3785

Table 2: 2010 ADCP specifications.

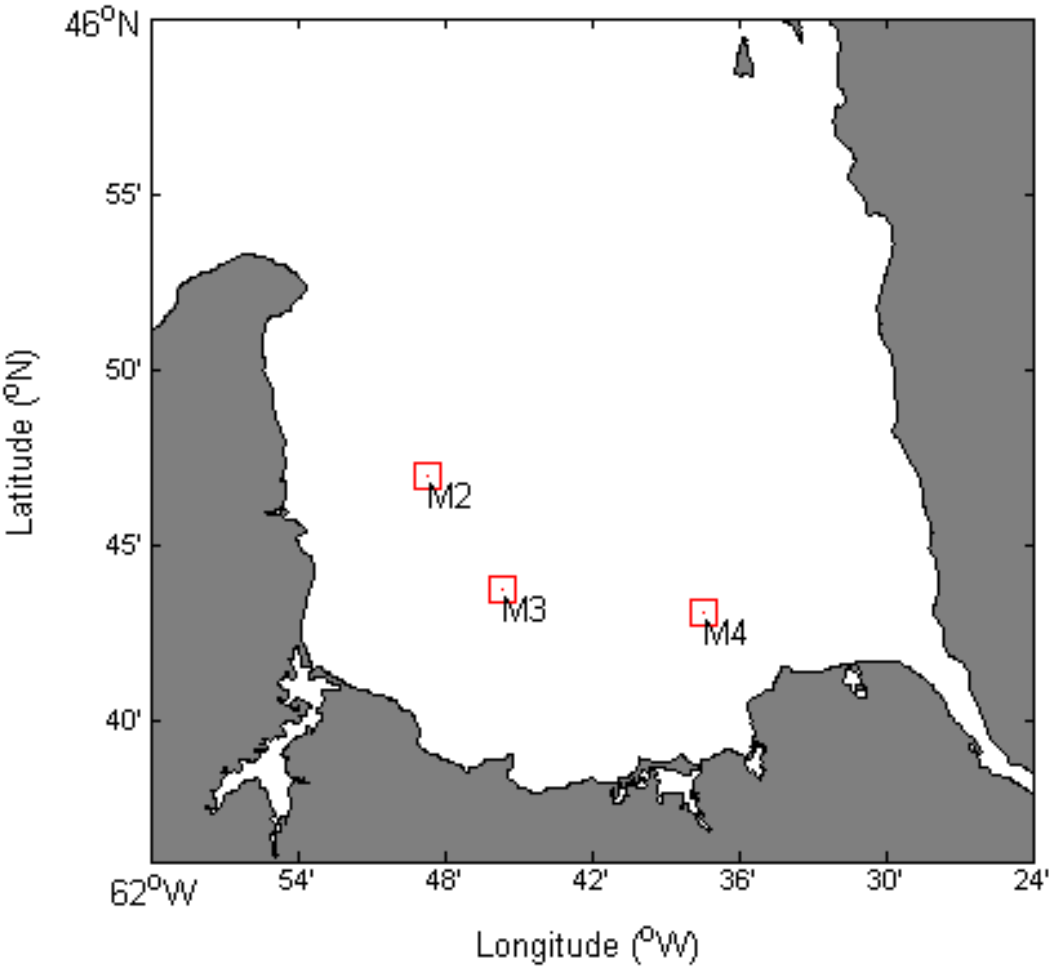
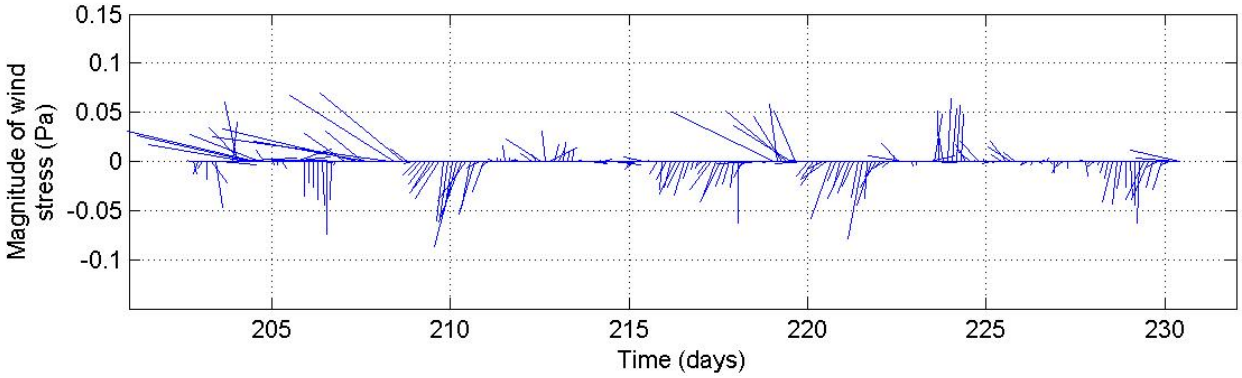


Figure 1: 2010 mooring locations for St. George's Bay, NS.

a)



b)

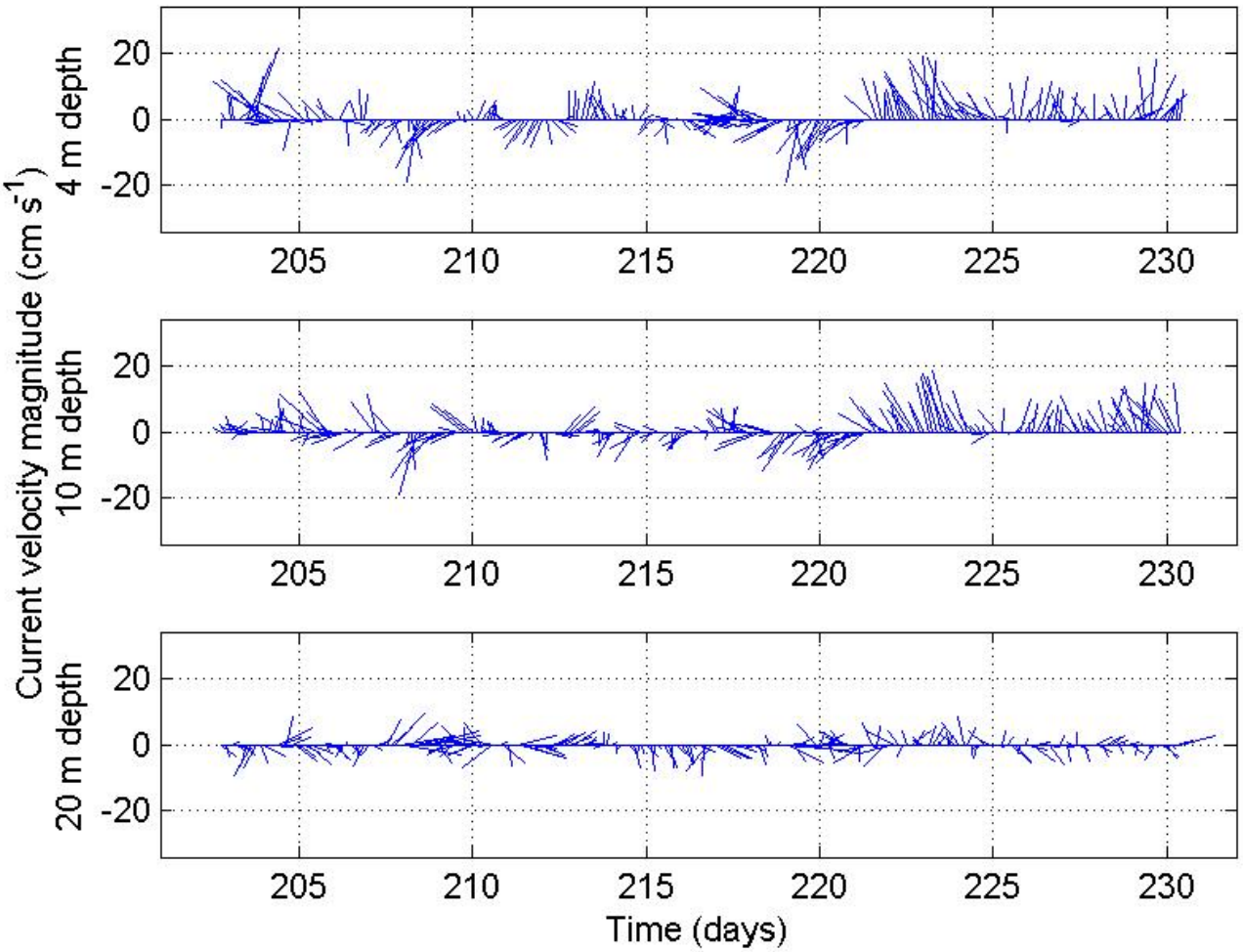
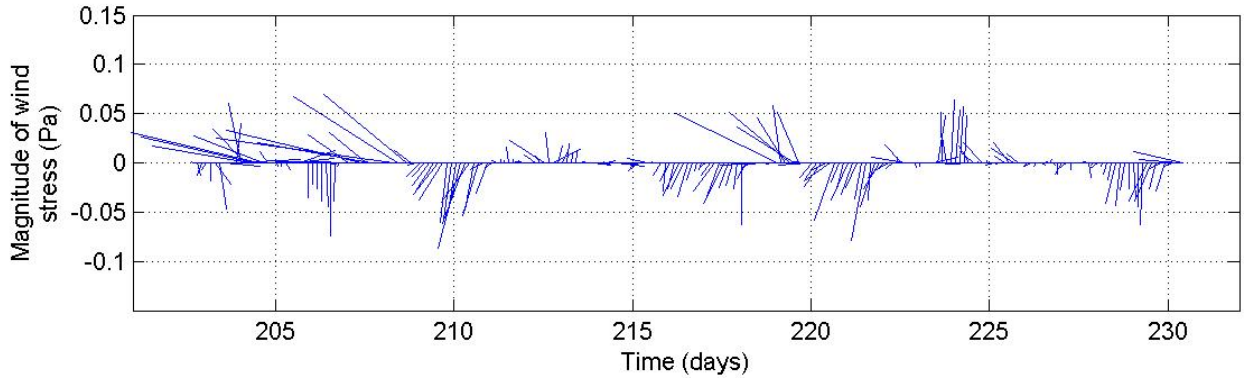


Figure 2: Magnitude and direction for a) wind stress and b) current velocity at surface (4 m), middle (10 m) and bottom (20 m) depths for mooring M2. Vectors shown represent averaged values of each 3 hour segment of the entire sampling period.

a)



b)

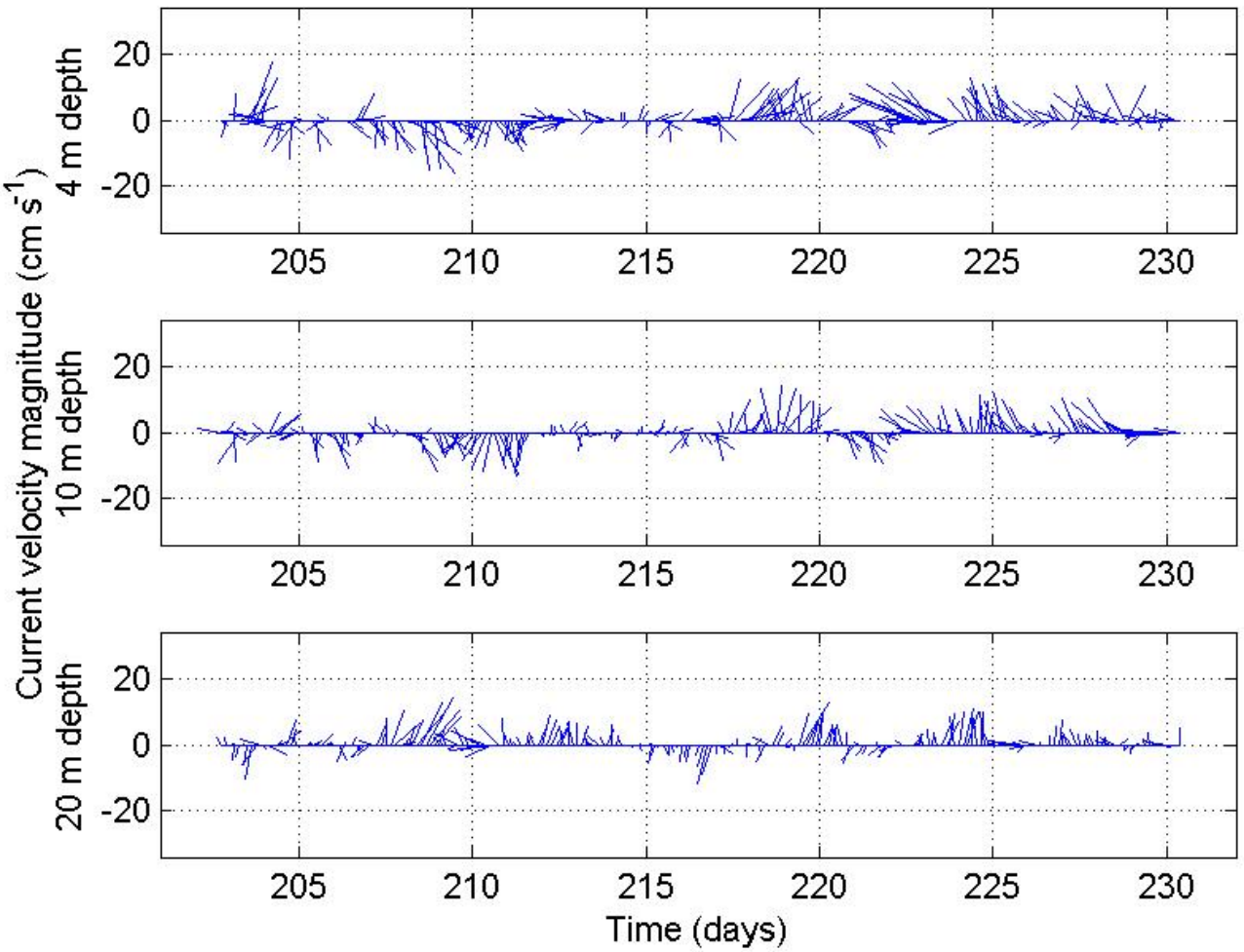
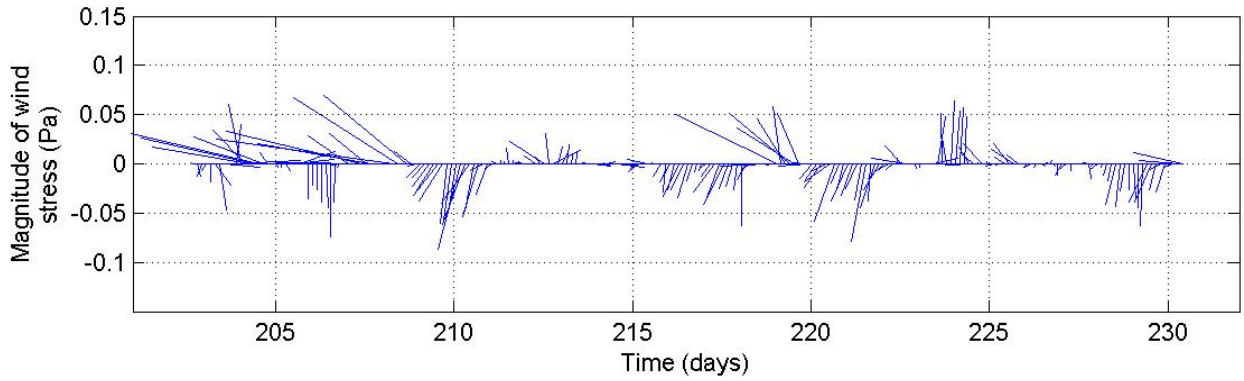


Figure 3: Magnitude and direction for a) wind stress and b) current velocity at surface (4 m), middle (10 m)

and bottom (20 m) depths for mooring M3. Vectors shown represent averaged values of each 3 hour segment of the entire sampling period.

a)



b)

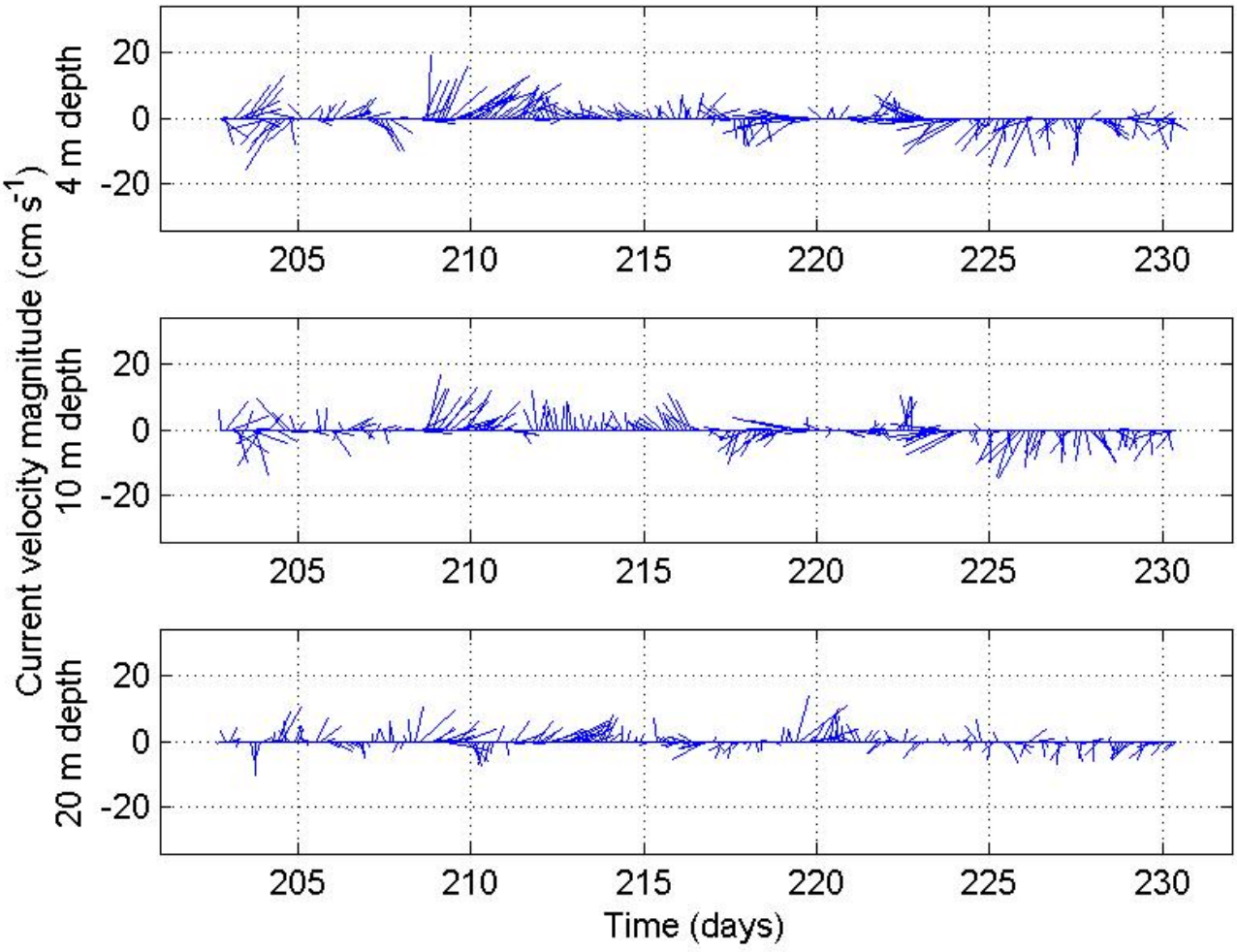
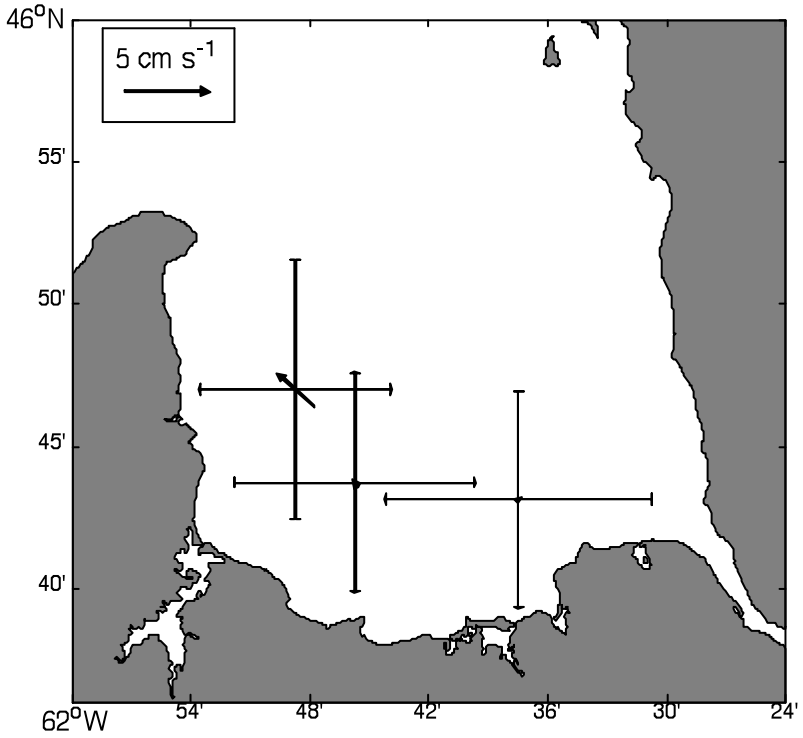
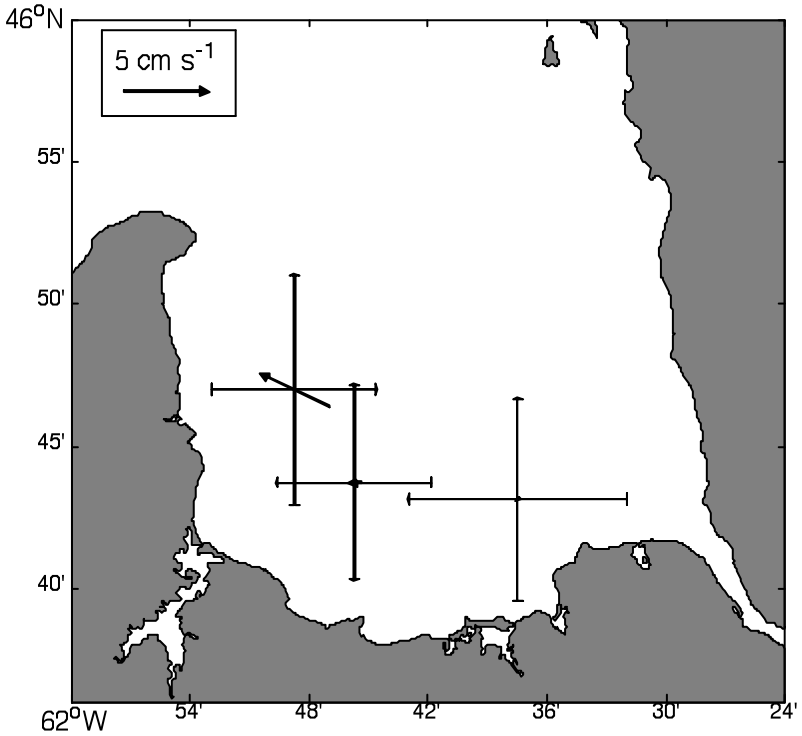


Figure 4: Magnitude and direction for a) wind stress and b) current velocity at surface (4 m), middle (10 m) and bottom (20 m) depths for mooring M4. Vectors shown represent averaged values of each 3 hour segment of the entire sampling period.

a)



b)


46°N
5 cm s-1
55'
50'
45'
40'
62°W
54'
48'
42'
36'
30'
24'

c)

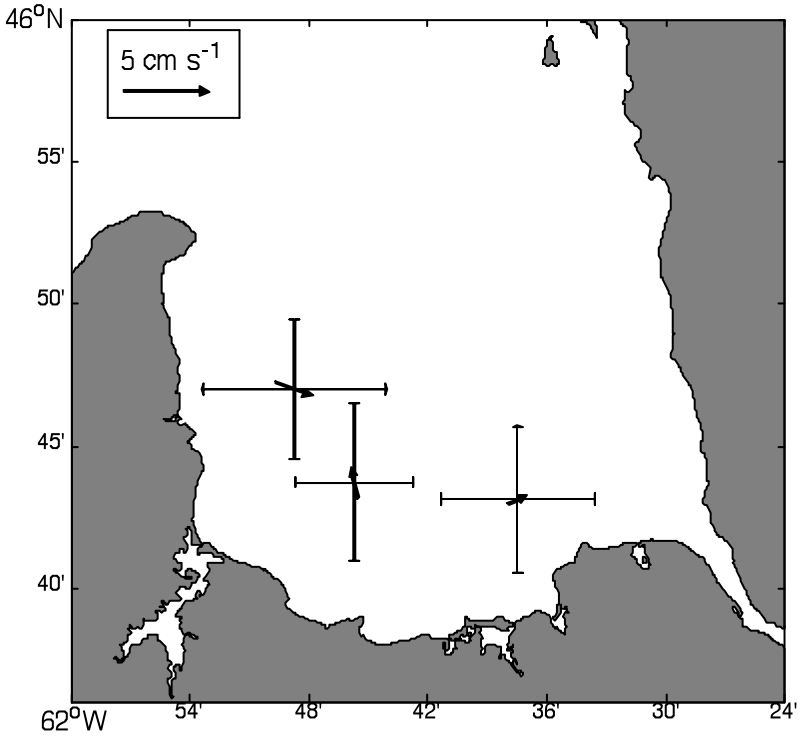
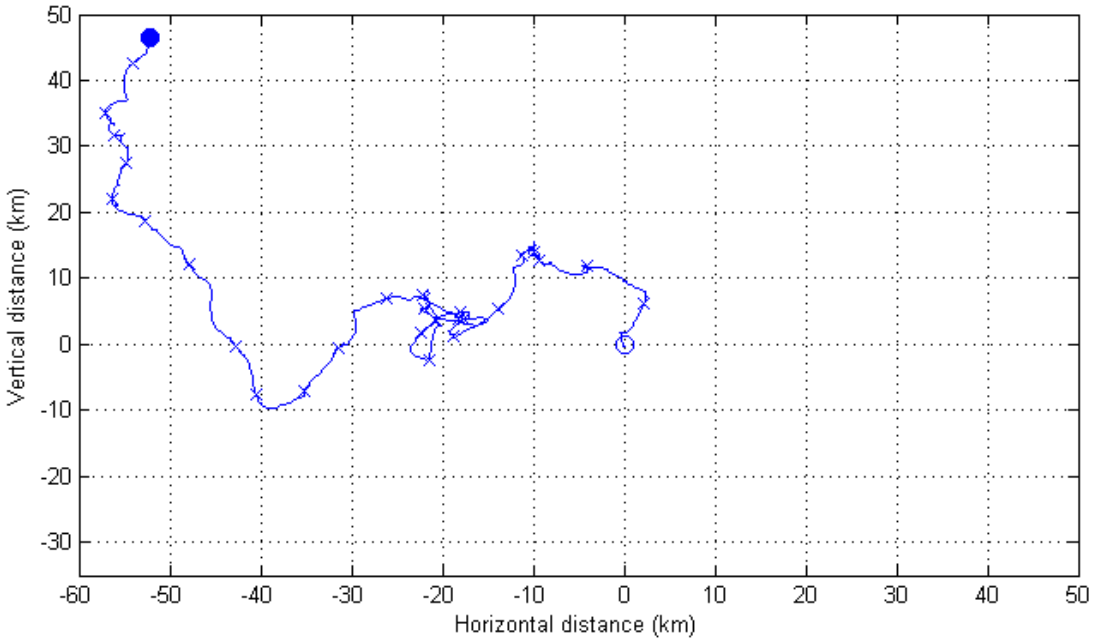
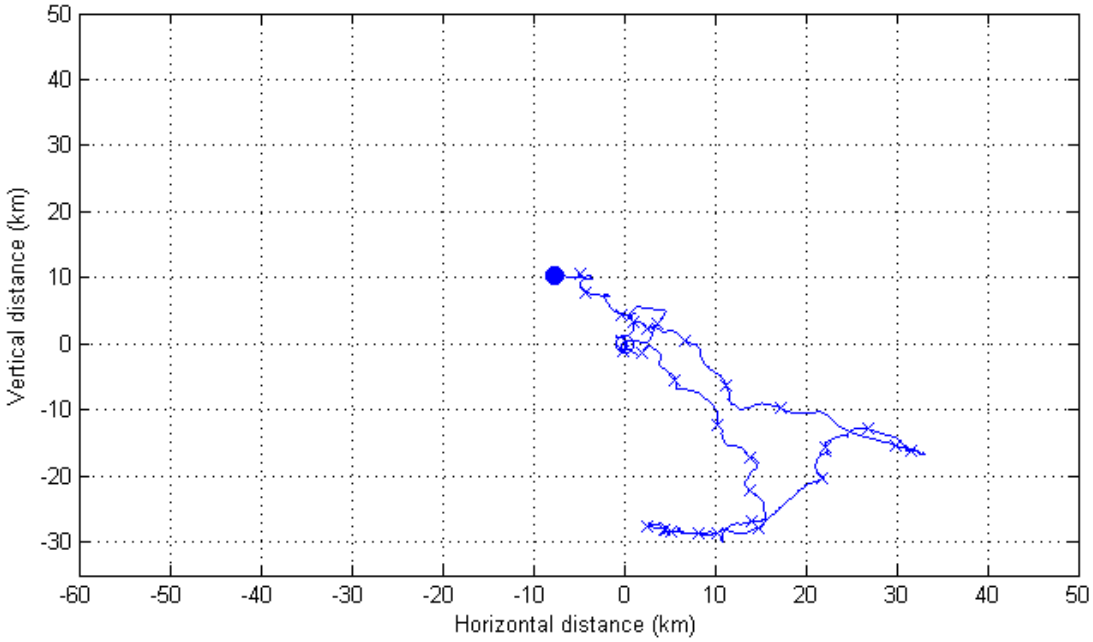

46°N
5 cm s-1
55'
50'
45'
40'
62°W
54'
48'
42'
36'
30'
24'

Figure 5: Mean current velocities over the full sampling period for a) 4 m, b) 10 m, and c) 20 m depths. One standard deviation in both the N/S and E/W components of the current are shown.

a)


Vertical distance (km)
Horizontal distance (km)
50
40
30
20
10
0
-10
-20
-30
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50

b)


Vertical distance (km)
Horizontal distance (km)
50
40
30
20
10
0
-10
-20
-30
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50

c)

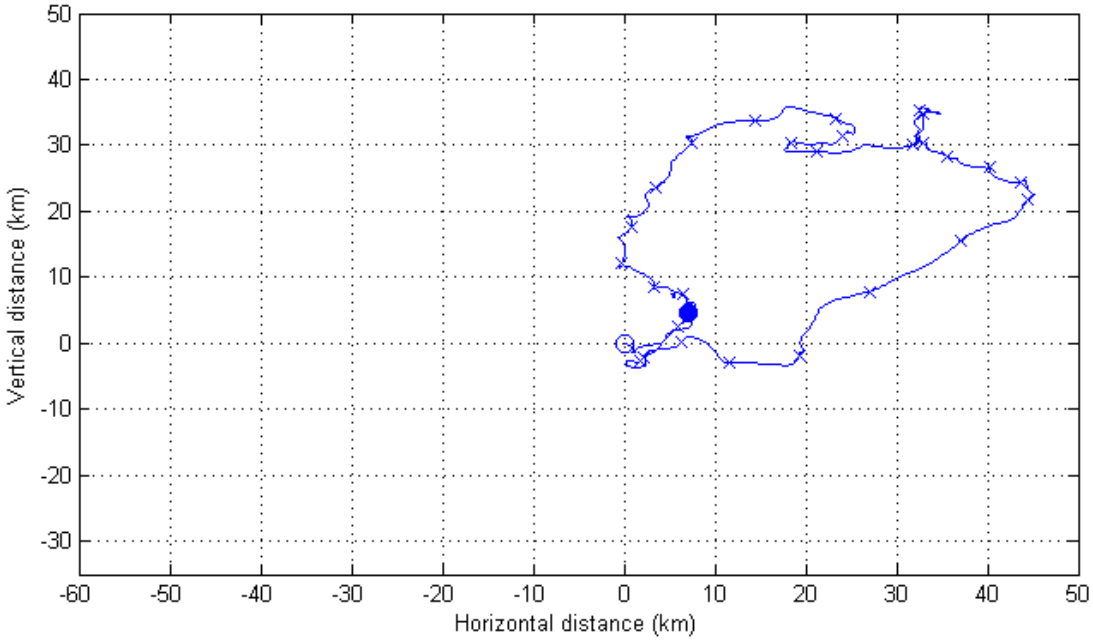
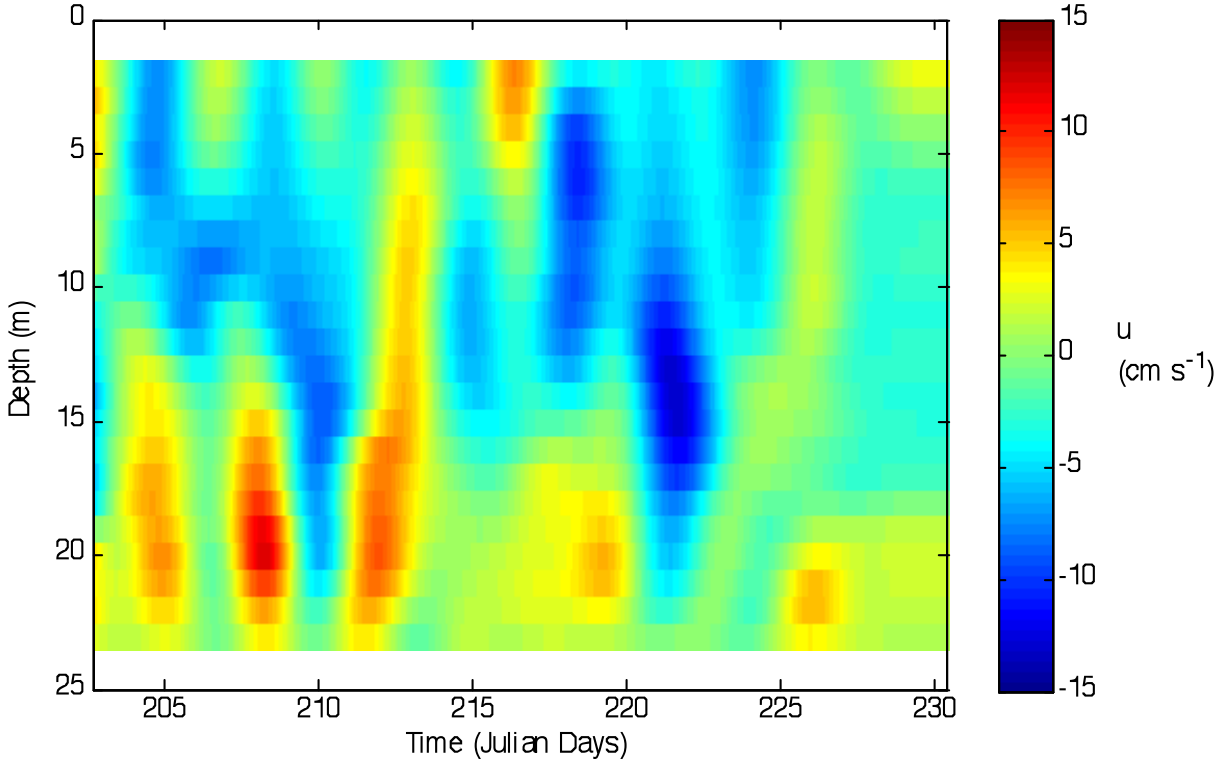


Figure 6: Position of object at 4 m depth for each mooring: a) M2, b) M3, and c) M4. Starting position is shown as an unfilled circle, end position as a filled circle, and position after each day as an 'x'.

a)


0
5
10
15
20
25
Depth (m)
205
210
215
220
225
230
Time (Julian Days)
15
10
5
0
-5
-10
-15
u
(cm s-1)

b)

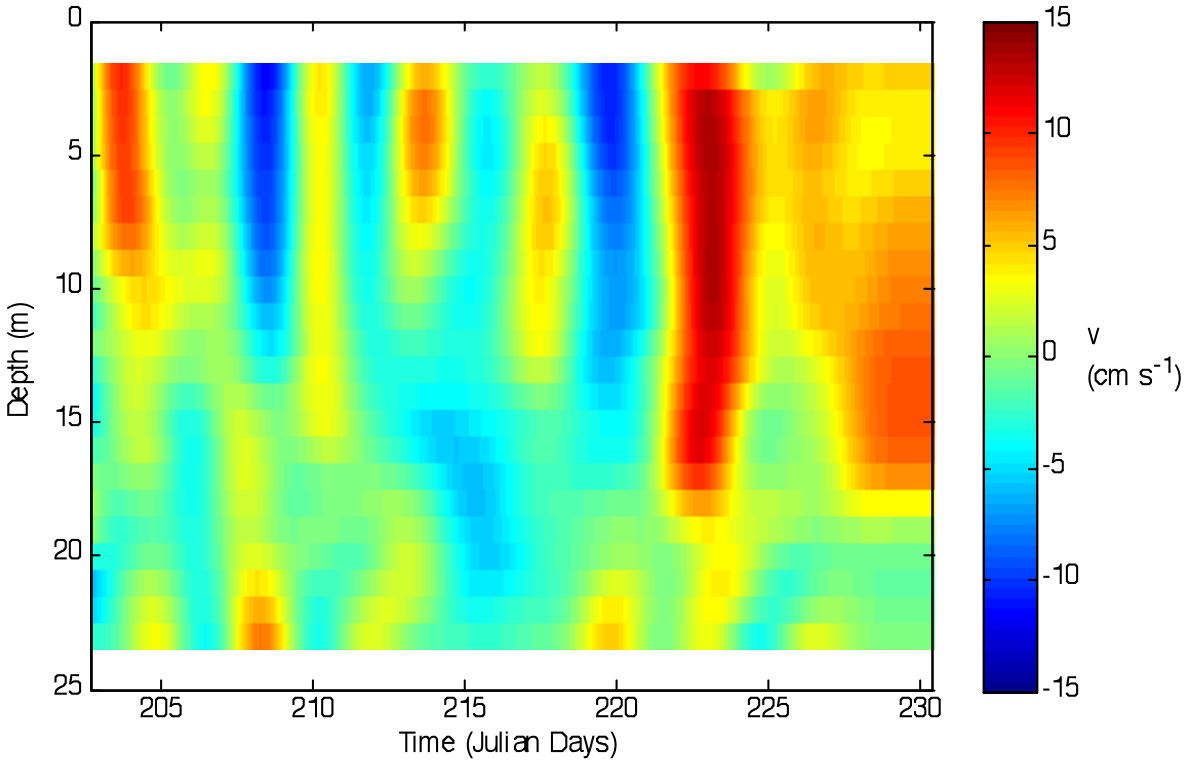
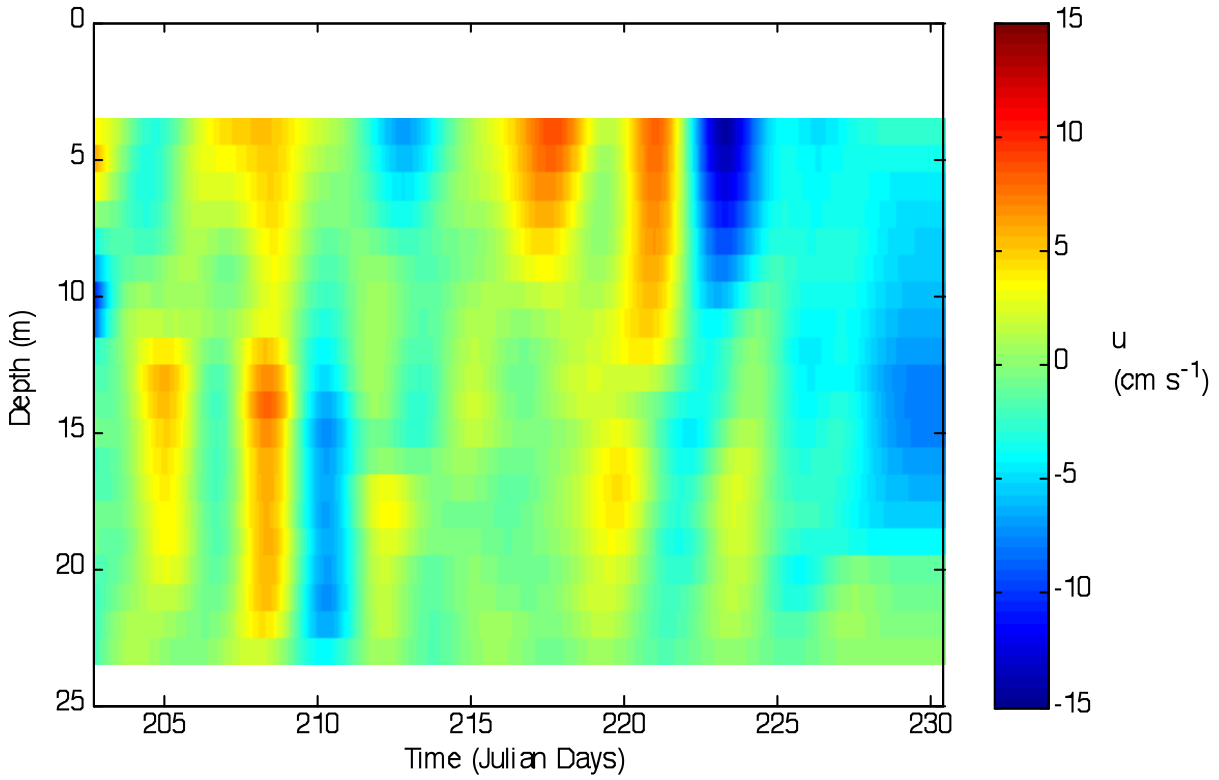

0
5
10
15
20
25
Depth (m)
205
210
215
220
225
230
Time (Julian Days)
15
10
5
0
-5
-10
-15
v
(cm s-1)

Figure 7: Magnitude of a) u velocity and b) v velocity for mooring M2.

a)



b)

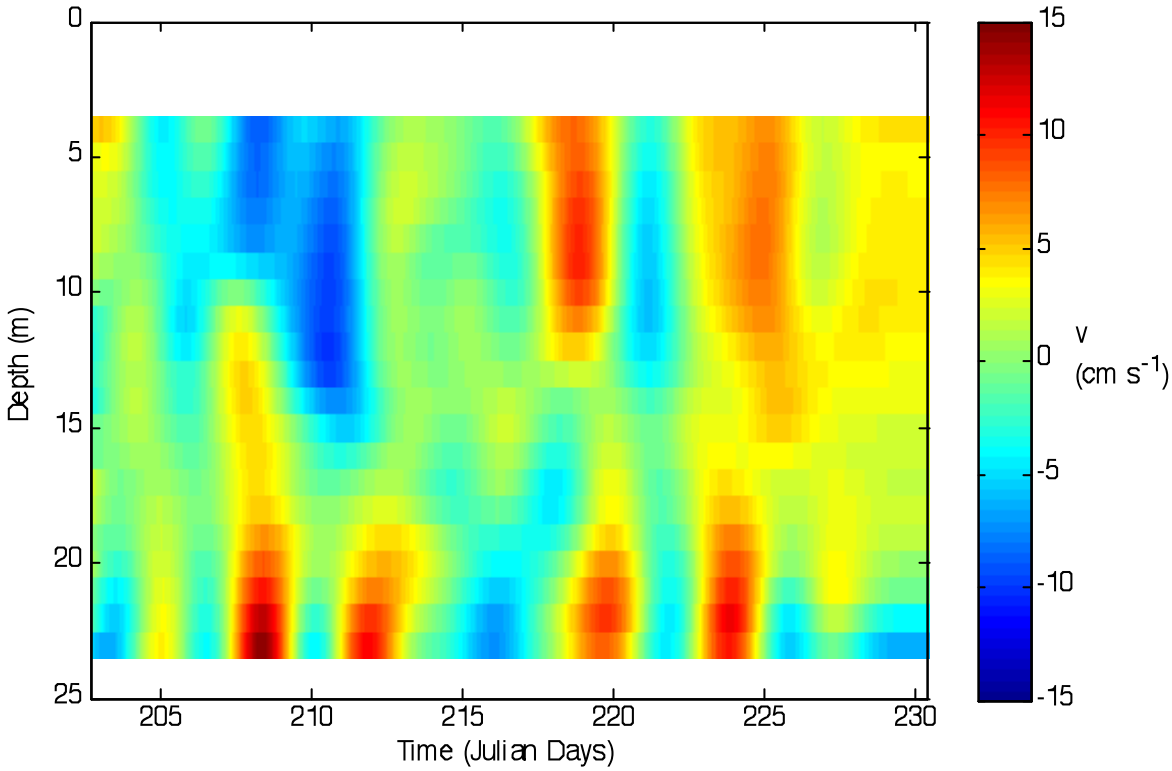
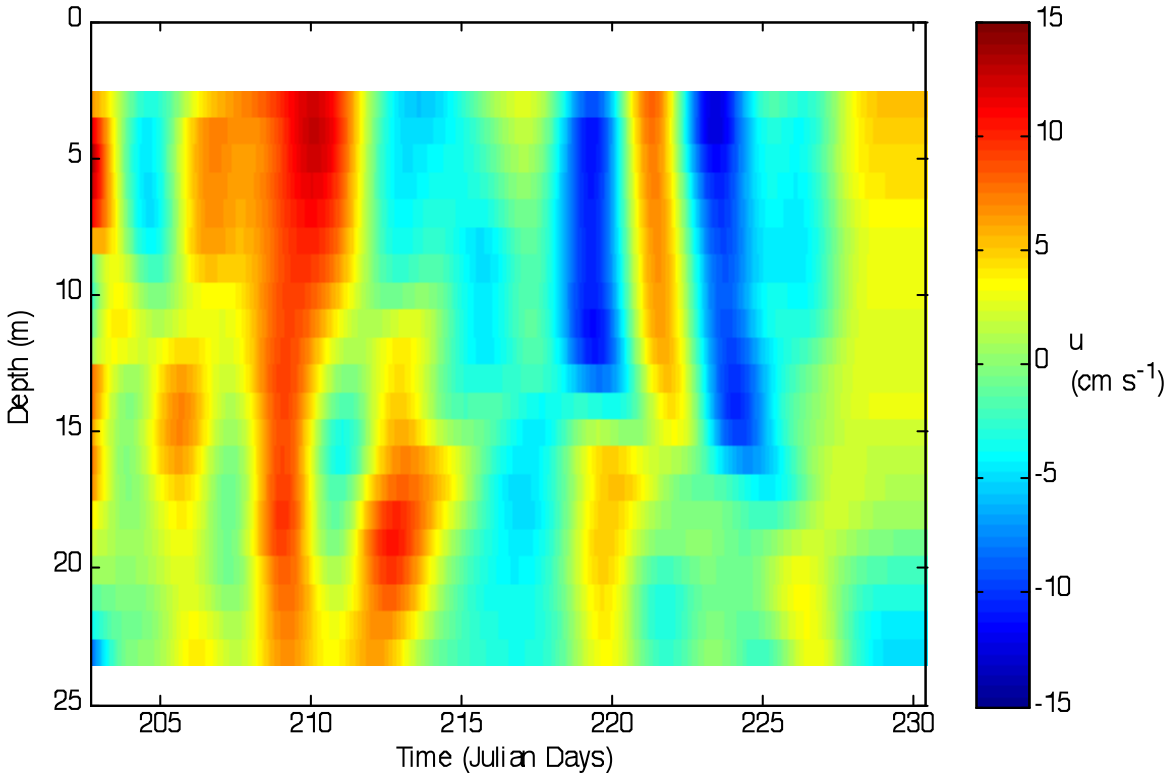


Figure 8: Magnitude of a) u velocity and b) v velocity for mooring M3.

a)



b)

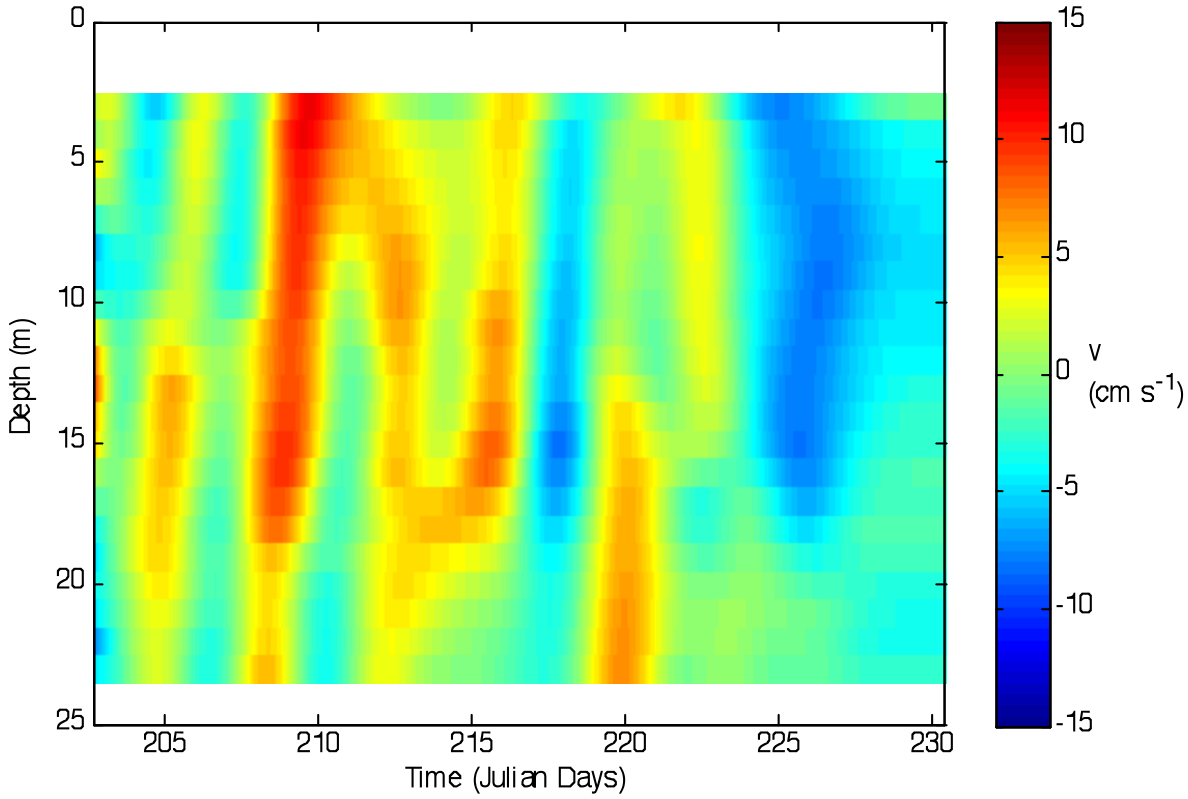


Figure 9: Magnitude of a) u velocity and b) v velocity for mooring M4.

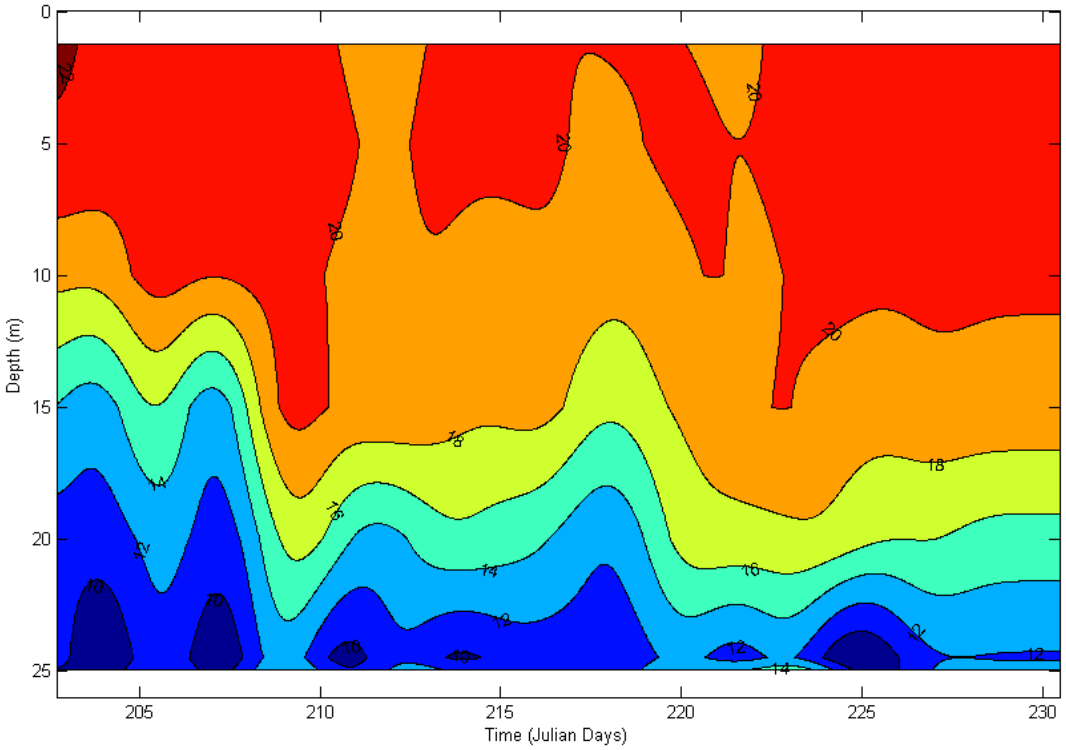


Figure 10: Isotherms for mooring M2.

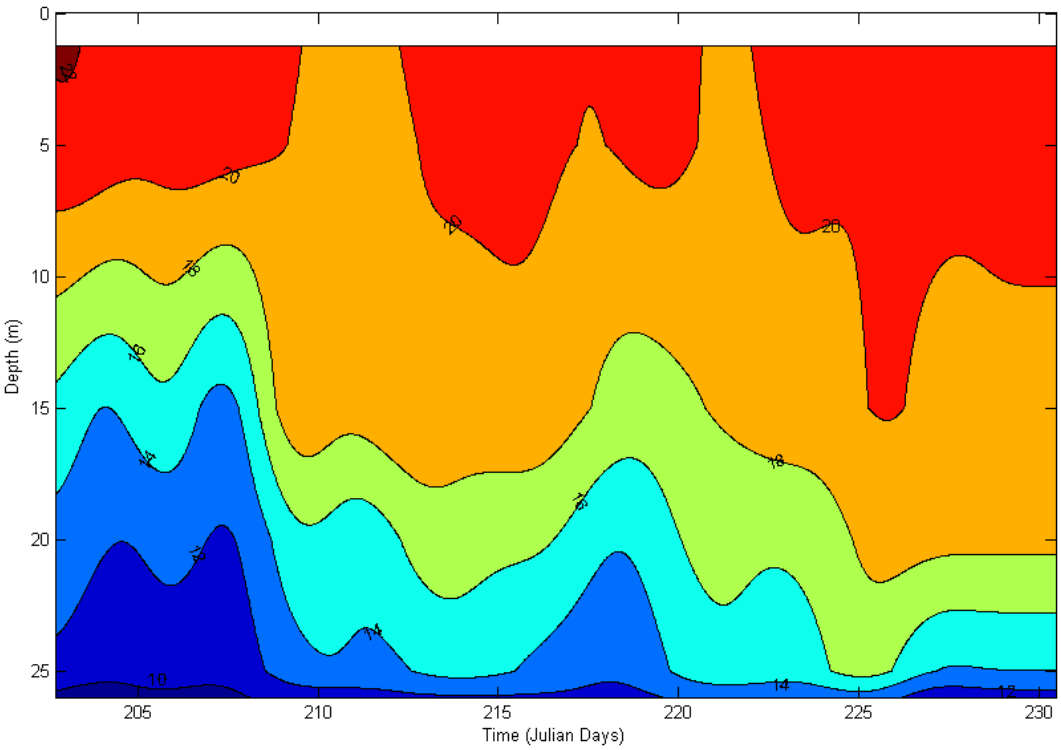


Figure 11: Isotherms for mooring M3.

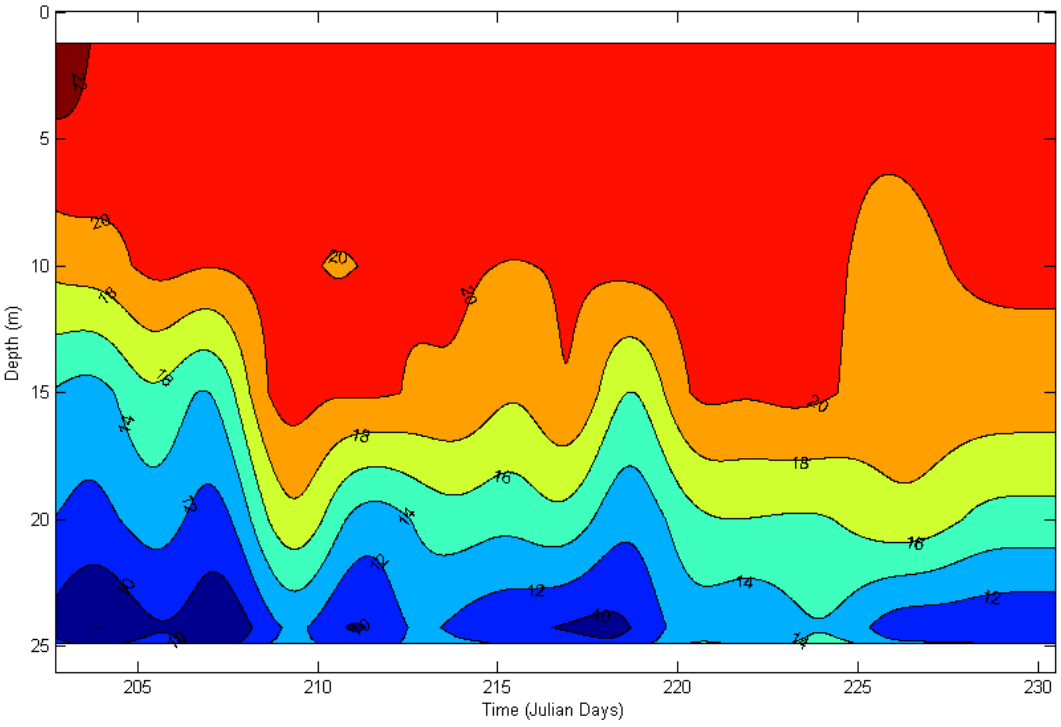


Figure 12: Isotherms for mooring M4.