CURRENT MEASUREMENTS AT A0 DISPOSAL GROUND

Field Data Report

Prepared for Port Otago Ltd

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

The Next Generation project at Port Otago involves the deepening of the approaches to Port Chalmers and the associated disposal of dredged material. A significant amount of modelling work has been undertaken to support this project, along with an oceanographic data collection program in 2008. The selection of a disposal ground (site A0) was based on the modelling outcomes, without specific measurements from the A0 location. A peer review of the Next Generation modelling work was undertaken in 2010. One of the recommendations of the review was that measurement of currents at site A0 would be beneficial; providing increased confidence in the modelling with respect to the dispersal of the sediments from the disposal ground.

This report provides details on a 47-day current measurement program that was conducted at the A0 disposal site from 19 October 2010 to 5 December 2010. The measurement program was undertaken by MetOcean Solutions Ltd, with assistance from staff at the Department of Marine Science at the University of Otago. The University research vessel *Polaris II* (Fig. 1.1) was used for deployment and recovery operations, and Skipper Bill Dickson and crew are gratefully acknowledged for their role in ensuring the safe and successful execution of the program.

Figure 1.1 The RV Polaris II used for deployment and recovery operations.

2. METHODOLOGY

2.1. Instrumentation and mooring

An InterOcean S4 current meter was used to measure point source current speeds and directions. The S4 meter samples at 2 Hz frequency and was programmed to record a 5-minute mean at 30 minute intervals.

The meter was deployed on a taut-wire mooring, positioning the sensors at 4.2 m above seabed using a 160 kg buoyancy set attached to the current meter (Fig. 2.1). A schematic of the mooring is presented Figure 2.2.

Figure 2.1 The S4 current meter (right) and the 160 kg buoyancy set.

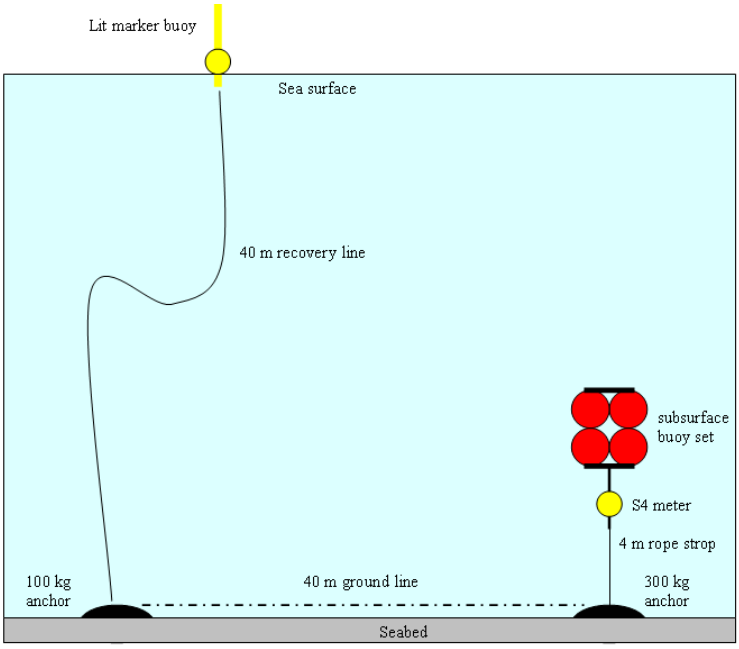

Figure 2.2 Schematic of the mooring.

3. RESULTS

The time series of the measured current speeds and directions are presented in Figures 3.1 and 3.2, respectively. Note the directions are provided in the 'going to' convention, and have been corrected for the local magnetic variance (24.97^o). These data are also provided as a joint probability distribution of speed and direction in Table 3.1, and as a current rose plot in Figure 3.3.

The highest recorded current speed was 50.1 cm.s^{-1} directed to the SE, while the mean current speed over the 47 days was 13.7 cm.s^{-1}. It is notable that relatively strong currents (i.e. > 35 cm.s^{-1}) were observed for all octants except E, W and SW. However, the strongest flows were all directed toward the NNE and SSE sectors. A progressive vector plot of the measured currents is provided in Figure 3.4.

The directional distribution of currents from this 47-day program does not necessarily reflect the long term distribution, and it is notable that the strongest current event was directed toward the SSE and SE and coinciding with persistent northeasterly wind conditions. This event can be seen on the progressive vector plot (Fig. 3.4) starting at 30/10/2010. The co-temporal relationship between wind and current vector is illustrated in Figures 3.5 and 3.6, showing the timeseries of orthogonal wind and current vectors. Wind data from the Tairoa Head recording station were used in this plot. In particular, the north-south vector timeseries (Fig. 3.6) exhibit a clear correlation between wind velocity and current velocity. These observations imply the regional wind stress has a significant influence on the local current regime at A0.

To place the measurement period within a longer term context, the wind data from Tairoa Head for the measurement period has been compared with the previous 10 years of data. The results (Figure 3.7) show a broadly similar directional distribution, albeit with a bias toward more NE winds occurring during the 2010 current measurement program.

The measured current data exhibit periods with very clear tidal signals, and harmonic analysis of the data confirm the tidal currents reach up to 11 cm.s^{-1}. The tidal current rose for the measurement period is presented in Figure 3.8; the tidal ellipse is oriented approximately NW-SE. Tidal currents represent a relatively small fraction of the total current variance at site A0 (18.7% and 15.0 % of the east-west and north-south orthogonal velocities, respectively). The current regime at A0 appears to be predominantly influenced by regional-scale wind-driven flows. However, it is likely that the combined effects of bathymetric steering and the impingement of oceanic-scale flows will also be influential at this location.

Table 3.1 Joint probability distribution (parts-per-thousand) of current speed and direction (going to) over the measurement period in late 2010.

Current speed ($cm.s^{-1}$)	Current direction (degT) 'going to'								
	337.5 - 22.5	**22.5 - 67.5**	**67.5 - 112.5**	**112.5 - 157.5**	**157.5 - 202.5**	**202.5 - 247.5**	**247.5 - 292.5**	**292.5 - 337.5**	**Total**
> 0 <= 5	16.5	20.4	20.4	17.8	9.1	10.4	7.8	9.6	112
> 5 <= 10	31.3	38.7	50.4	49.6	33	18.7	16.1	19.1	256.9
> 10 <= 15	30	42.6	60.9	63.5	28.3	17.4	8.7	25.2	276.6
> 15 <= 20	19.1	11.7	42.6	45.7	14.8	5.7	8.7	20.4	168.7
> 20 <= 25	15.7	10.4	23.9	18.3	2.6	0.9	10	8.7	90.5
> 25 <= 30	9.1	10	9.1	13	1.3	0	2.2	3.9	48.6
> 30 <= 35	3.5	9.1	2.2	10	1.7	0	0.9	0.9	28.3
> 35 <= 40	2.2	1.3	0	8.3	2.6	0	0	0.4	14.8
> 40 <= 45	0.4	0	0	1.7	0.9	0	0	0	3
> 45 <= 50	0	0	0	0	0	0	0	0	0
Total	127.8	144.2	209.5	227.9	94.3	53.1	54.4	88.2	1000

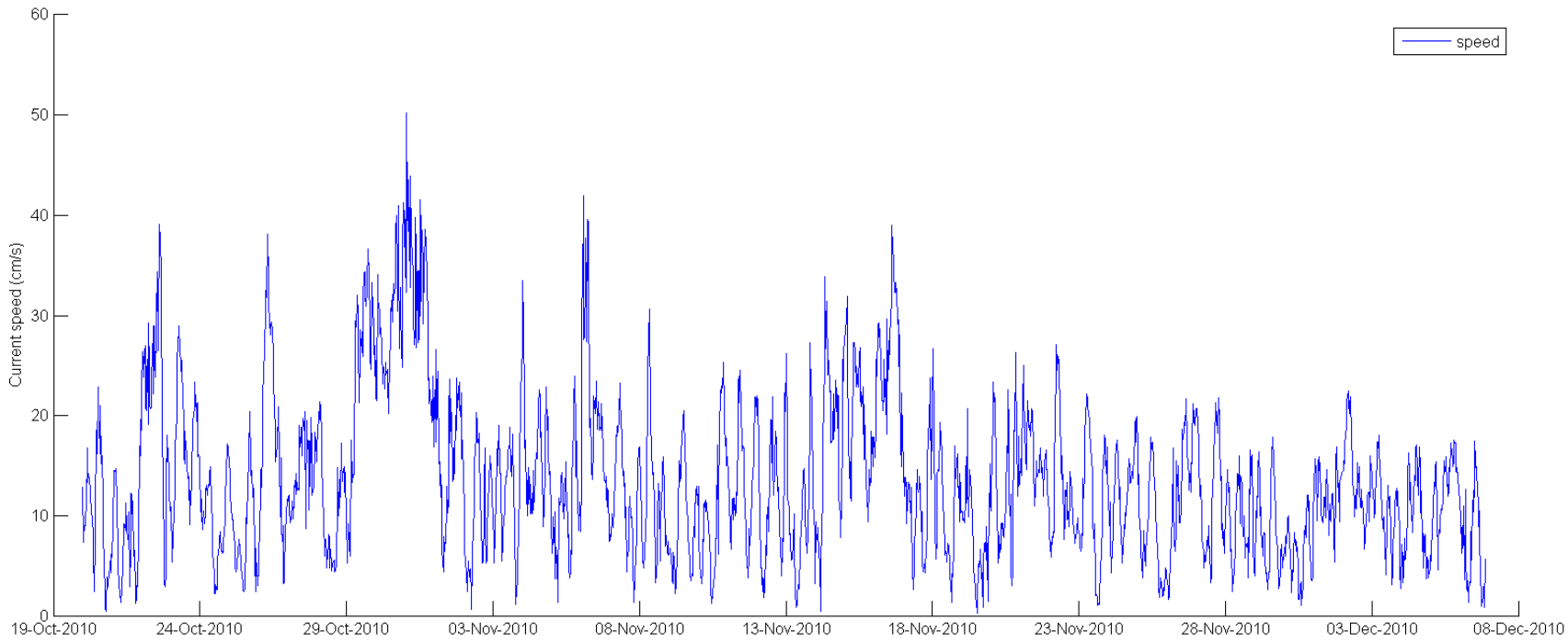

Figure 3.1 Measured current speeds at site A0.

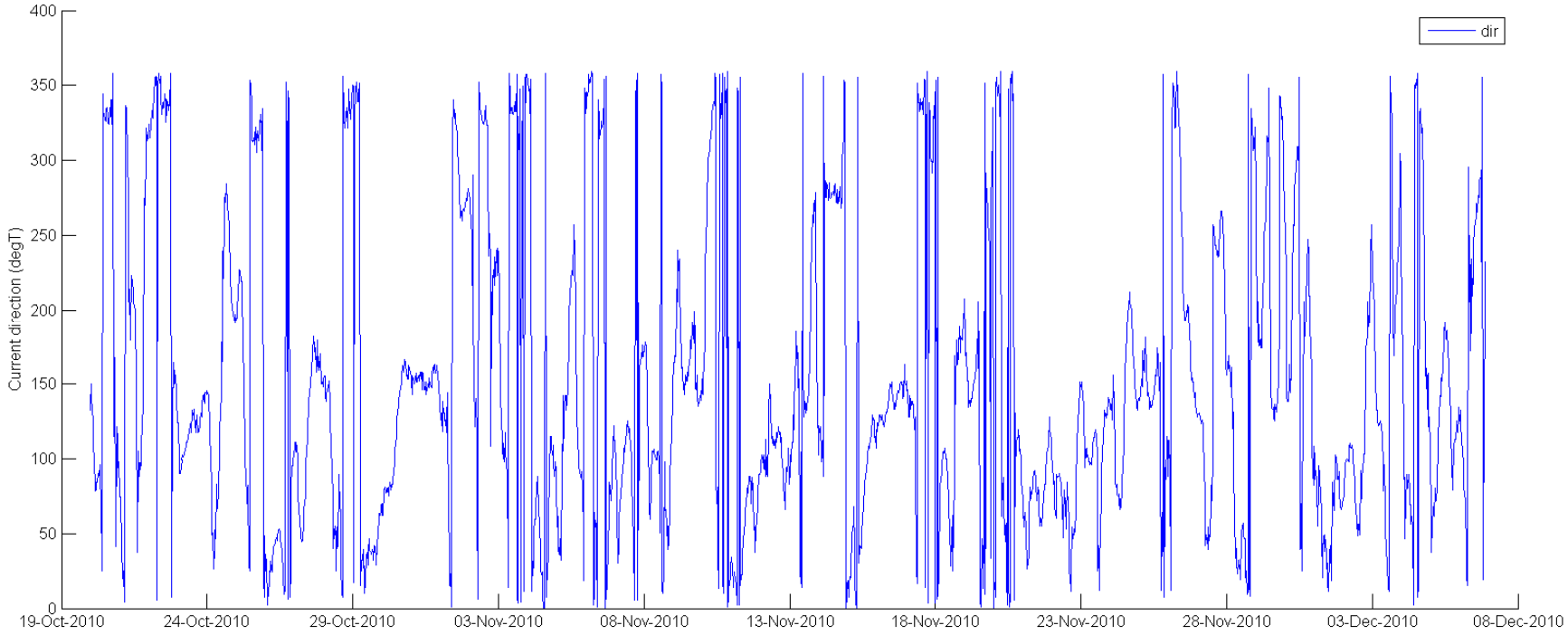

Figure 3.2 Measured current directions at site A0.

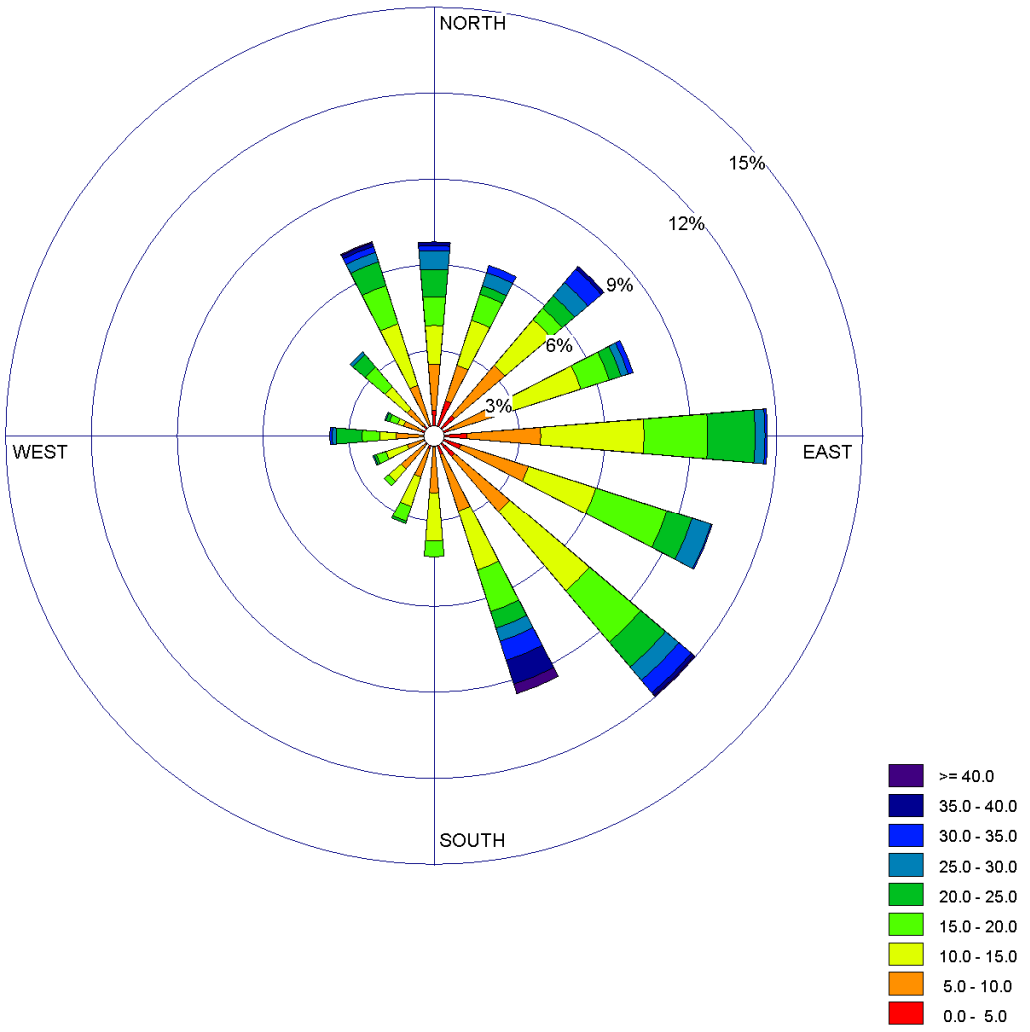

Figure 3.3 Current rose plot for the measurement period in late 2010.

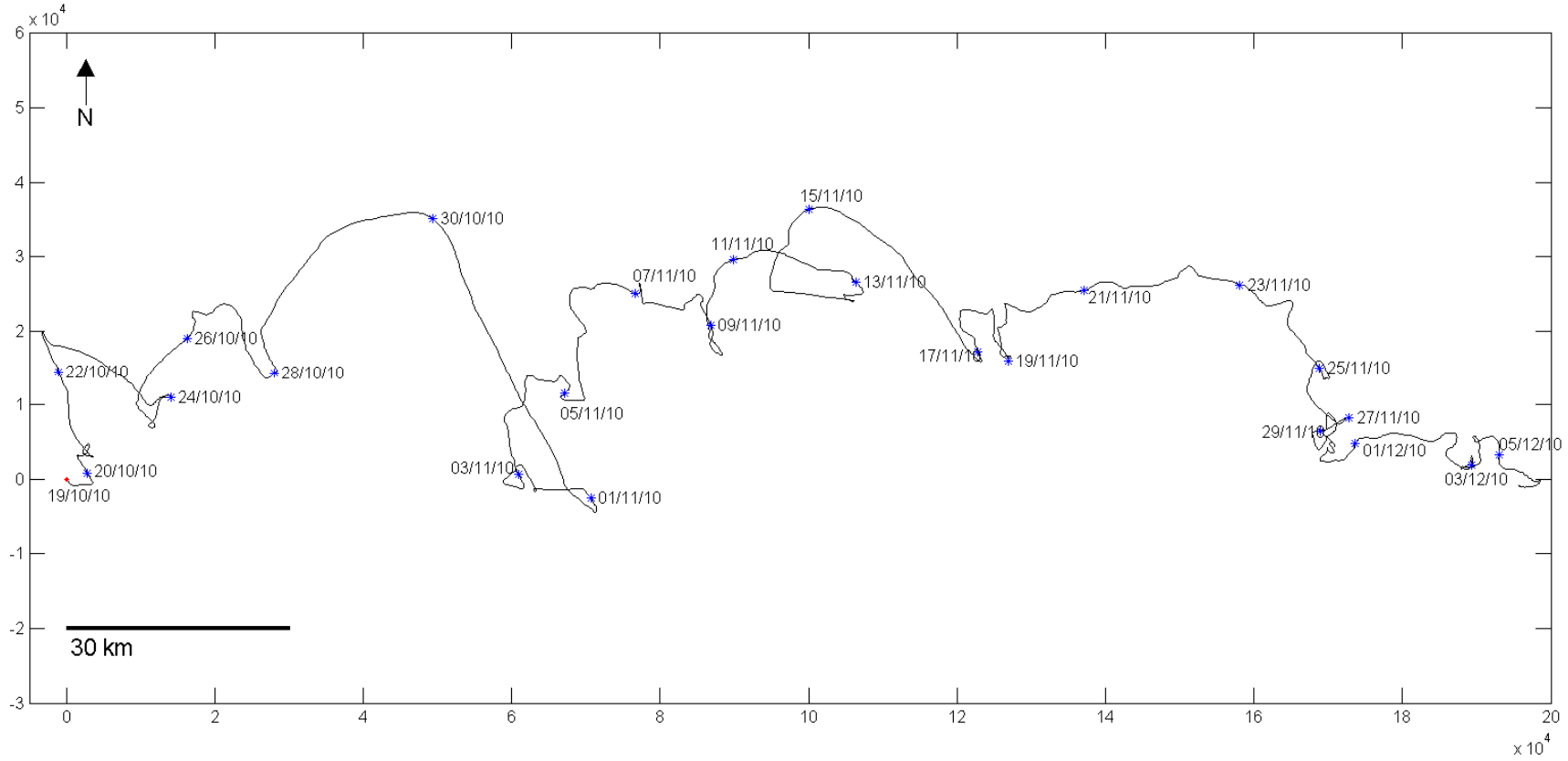

Figure 3.4 Progressive vector plot for the measurement period in late 2010.

Figure 3.5 Timeseries plot showing the east-west (u) orthogonal vectors for measured wind speed (green) and current speed (blue).

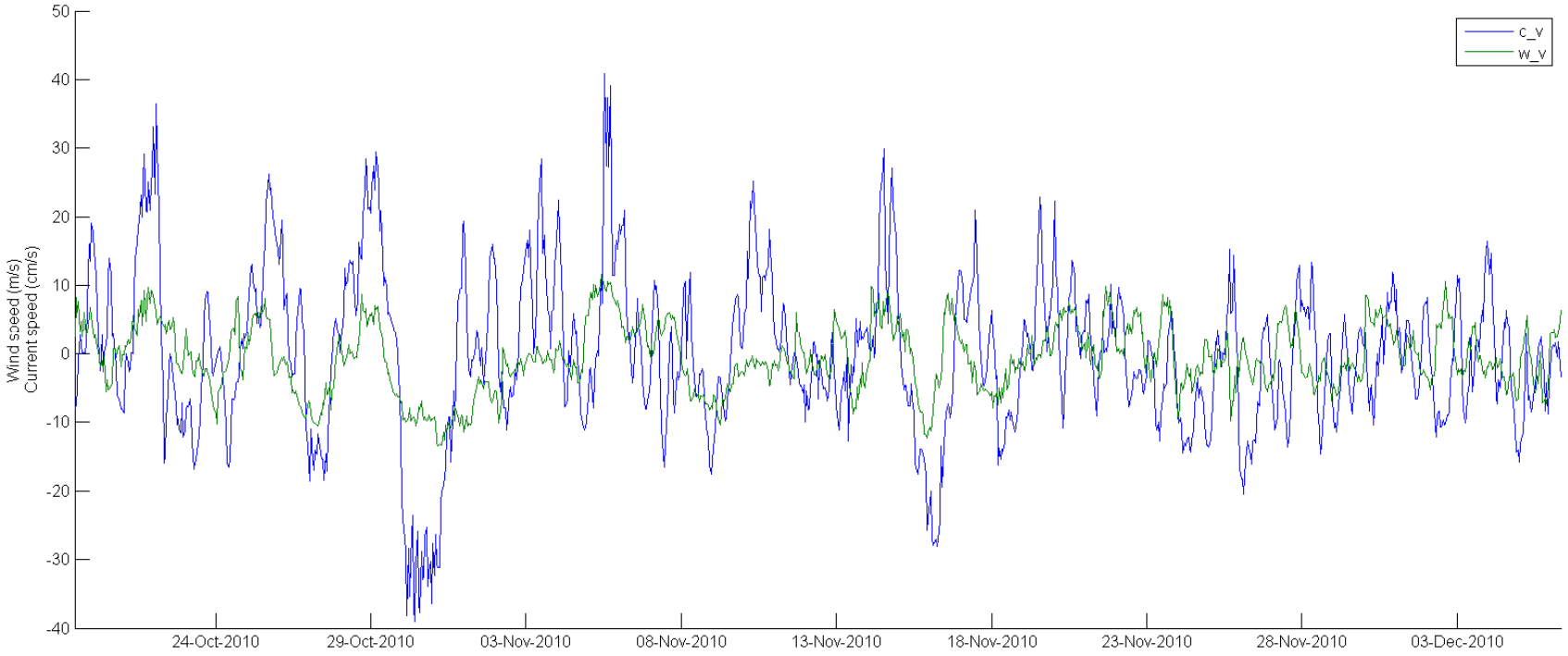

Figure 3.6 Timeseries plot showing the north-south (v) orthogonal vectors for measured wind speed (green) and current speed (blue).

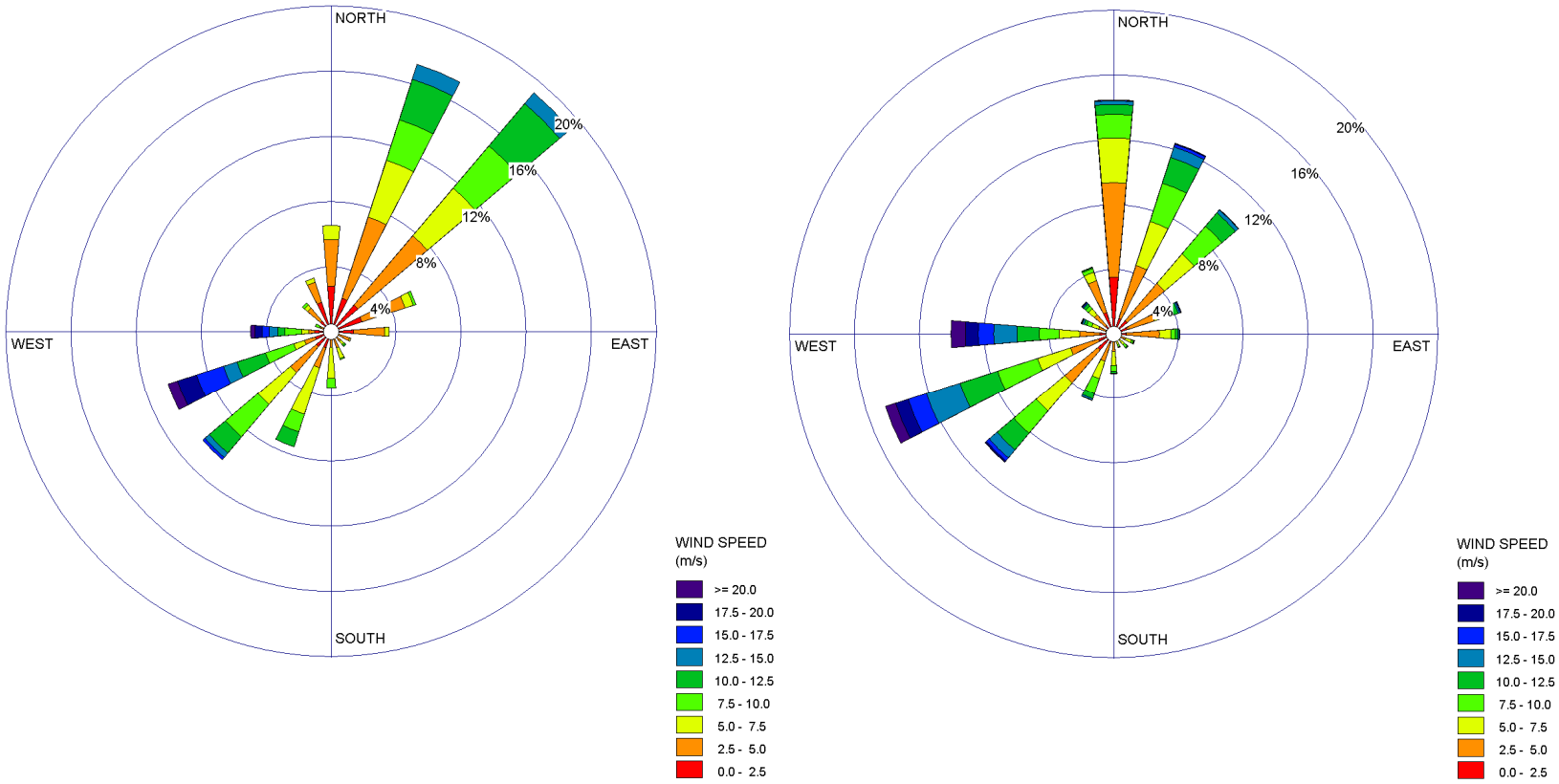

Figure 3.7 Wind rose plots for Tairoa Head over the current measurement period (left) and the previous 10 years (right).

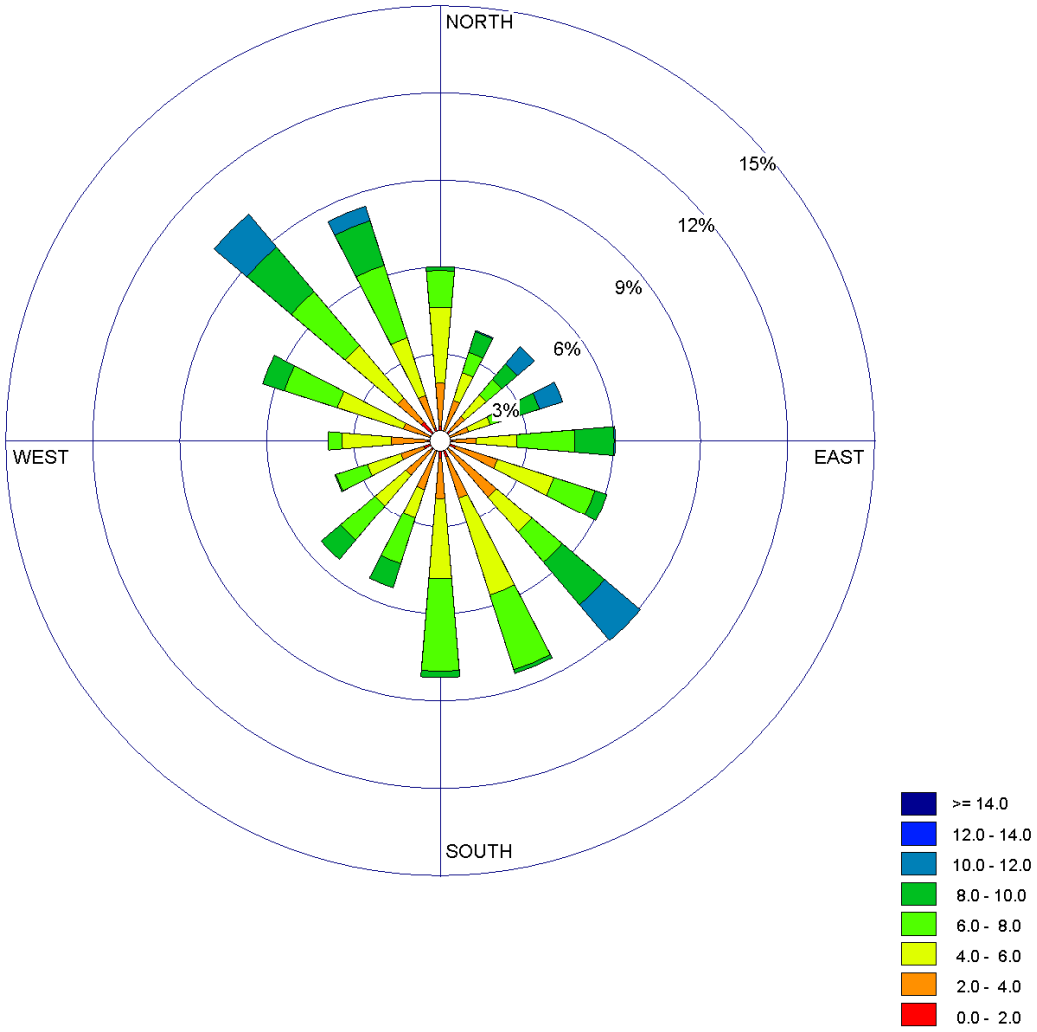

Figure 3.8 Tidal current rose plot for the measurement period in late 2010.